

Ecography

ECOG-03396

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Supplementary material

1 **Ecography - Supporting Information**

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3 Irene M.A. Bender, W. Daniel Kissling, Pedro G. Blendinger, Katrin Böhning-Gaese, Isabell
4 Hensen, Ingolf Kühn, Marcia C. Muñoz, Eike Lena Neuschulz, Larissa Nowak, Marta Quitián,
5 Francisco Saavedra, Vinicio Santillán, Till Töpfer, Thorsten Wiegand, D. Matthias Dehling and
6 Matthias Schleuning. Morphological trait matching shapes plant-frugivore networks across the
7 Andes. *Ecography* 000: 000-000.

8

9 **Appendix 1.** Sampling of the interaction networks.

10

11 **Table A1.** Comparison between the meta-analyses weighted by sampling effort and sampling
12 completeness.

13

14 **Fig. A1.** Accumulation curves and asymptotic bird richness for the eight interaction networks
15 across the Andes.

16

17 **Fig. A2.** Accumulation curves and asymptotic link richness (i.e., the number of interacting
18 species pairs) for the eight interaction networks across the Andes.

19

20 **Fig. A3.** Fourth-corner correlations between functional traits of frugivorous bird species and
21 fleshy-fruited plant species across the Andes.

22 **Appendix 1: Sampling of the interaction networks**

23

24 *Colombia*

25 We collected interaction networks of frugivorous birds and fleshy-fruited plants at two sites in
26 the Andes of Central Colombia (Munoz *et al.* 2017). Network Colombia 1 was collected at
27 Santuario de Flora y Fauna Otún Quimbaya in a high montane forest at 1800 m a.s.l. (hereafter
28 “m”). Network Colombia 2 was collected at Parque Regional Ucumari in upper montane forest at
29 2700 m.

30 At each location, we collected data during four time periods. Sampling was done approximately
31 every three months between February 2012 and November 2012, resulting in four temporal
32 replicates of each network. Two replicates cover the rainy season (May and November) and two
33 replicates the dry season (February and August). We recorded fruit removal by frugivorous birds
34 on all fleshy-fruited plant species located in 100 m × 20 m plots (five plots in Santuario, five
35 plots in Ucumari). During each time period, every plot was observed on five consecutive days
36 between dawn and noon for a total of 30 hours. The total observation time was 600 h in
37 Colombia 1 and 600 h in Colombia 2.

38

39 *Ecuador*

40 We sampled interaction networks of frugivorous birds and fleshy-fruited plants in and around
41 Podocarpus National Park in the south Ecuadorian Andes (Quitián *et al.* 2017). Network Ecuador
42 1 was sampled in an evergreen premontane forest at 1000 m. Network Ecuador 2 was sampled in
43 a lower montane forest at 2000 m.

44 We sampled plant-frugivore interactions four times in 2014 and 2015, twice in the most humid
45 season (May to July) and twice in the least humid season (October to December), resulting in
46 four temporal replicates of each network. We recorded seed removal by frugivorous birds on all
47 fleshy-fruited plant species located in 100 m × 30 m plots (three plots at every elevation). During
48 each time period, every plot was observed on five consecutive days between dawn and noon for
49 a total of 25 hours. The total observation time was 300 h for Ecuador 1 and 300 h for Ecuador 2.

50

51 *Peru*

52 We collected interaction networks of frugivorous birds and fleshy-fruited plants at two sites in
53 the Andes of south-east Peru (Dehling *et al.* 2014). Network Peru 1 was collected in lower
54 montane forest at 1500 m. Network Peru 2 was collected in upper montane forest at 3000 m. At
55 each location, we collected data during four time periods. Sampling was done approximately
56 every three months between December 2009 and September 2010, resulting in four temporal
57 replicates of each network. The first two replicates cover the beginning and peak of the rainy
58 season, the third and fourth replicate the beginning and peak of the dry season, respectively. We
59 recorded seed removal by frugivorous birds on all fleshy-fruited plant species located in 100 m ×
60 30 m plots (eight plots in San Pedro, six plots in Wayqecha). During each time period, every plot
61 was observed on five consecutive days between dawn and noon for a total of 30 hours. The total
62 observation time was 960 h in Peru 1 and 720 h in Peru 2 (Dehling *et al.* 2014).

63

64 *Bolivia*

65 We collected interaction networks of frugivorous birds and fleshy-fruited plants in the Andes of
66 South West Bolivia (Saavedra *et al.* 2014). Network Bolivia was collected in the vicinity of

67 Chulumani town in upper montane forest at 2500 m. We collected data during four observation
68 sessions, conducted during two dry seasons and two wet seasons between June 2010 and
69 February 2012. We recorded seed removal by frugivorous birds on all fleshy-fruited plant
70 species located in 100 m × 20 m plots (eight plots overall). During each observation session,
71 every plot was simultaneously observed by two observers on two consecutive days from 06:00
72 a.m. to 12:00 p.m. for a total of 24 hours. The total observation time was 768 h.

73

74 *Argentina*

75 We collected interaction networks of fruit-eating birds and fleshy-fruited plants at one site in the
76 Andes of north-west Argentina (Blendinger *et al.* 2012, 2015). Network Argentina was collected
77 at Parque Sierra de San Javier, Tucumán, in montane forest at 1000 m. We collected data bi-
78 monthly between September 2008 and August 2010, resulting in twelve temporal replicates of
79 the network (Blendinger *et al.* 2012, 2015). The bi-monthly sampling started in September 2008
80 and in October 2009, ensuring that the twelve temporal replicates represented all months of the
81 year. We recorded fruit removal by fruit-eating birds on all fleshy-fruited plant species located in
82 a 300 m × 200 m plot. At each time period, during three sampling days, five observers traversed
83 a block of 10 x 2 contiguous 20 x 20-m cells and recorded all fruit-consumption events for 20
84 min per cell. The total observation time was 600 h.

85

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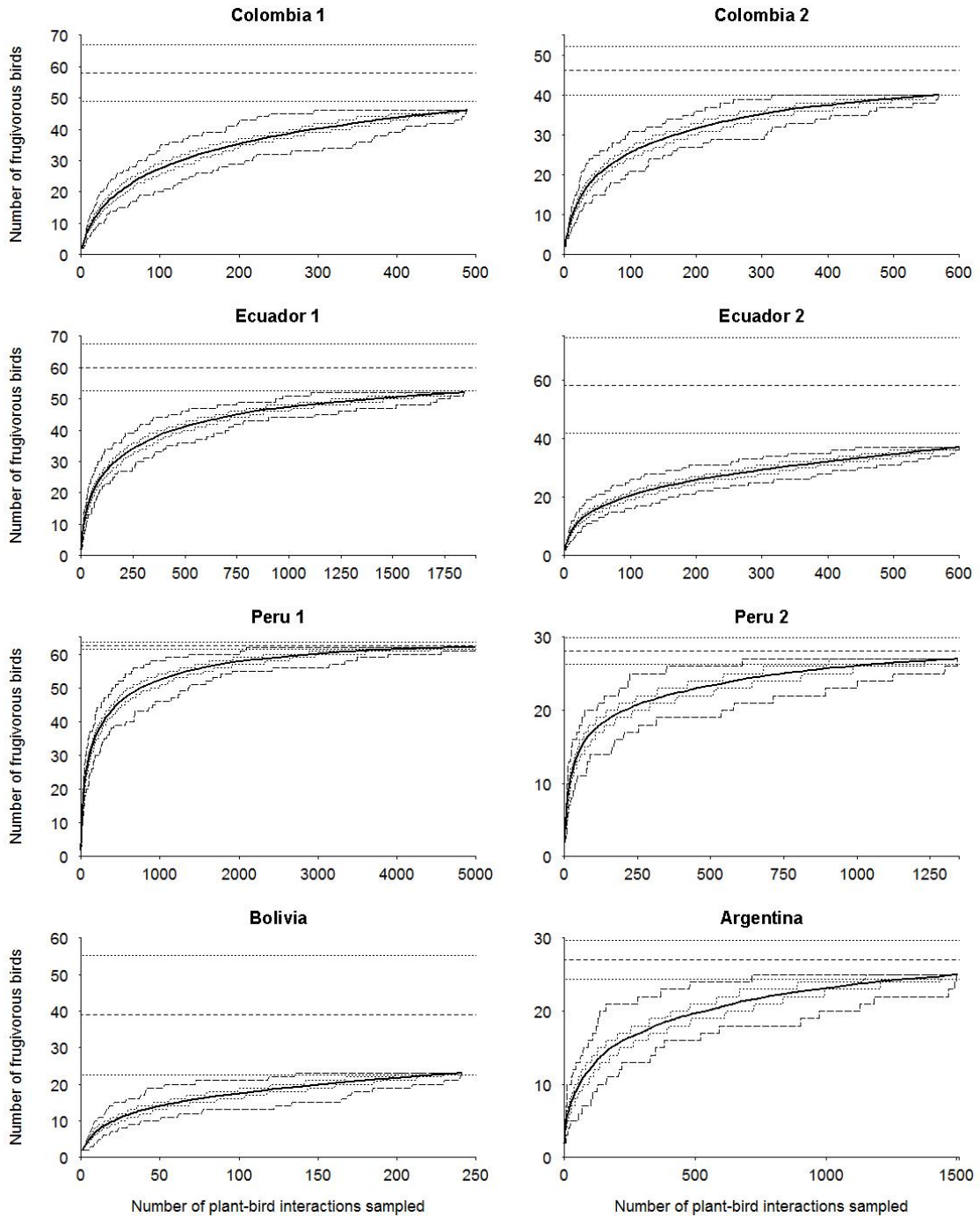
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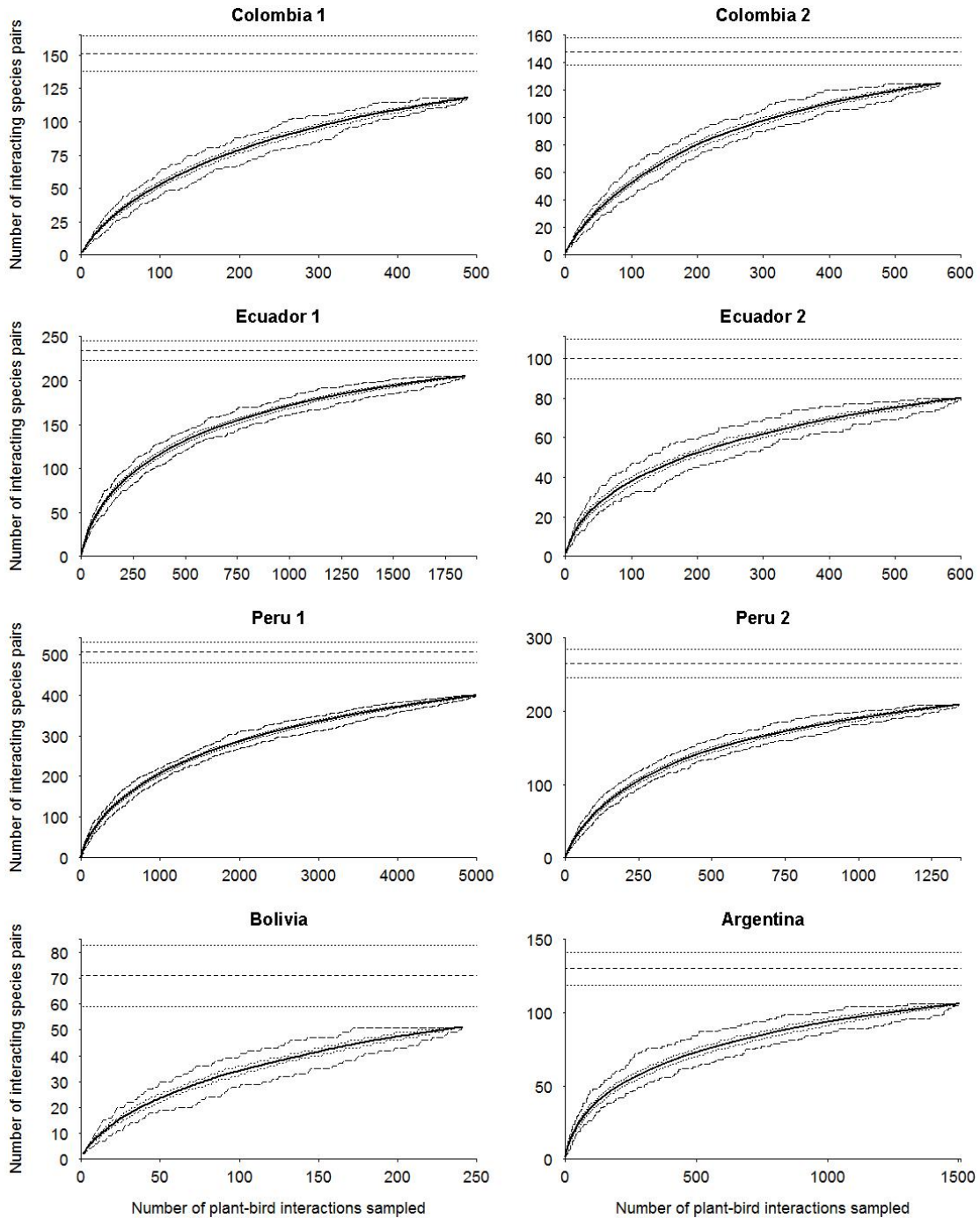
106 **Table A1.** Meta-analyses of fourth-corner correlations between traits of plants and frugivores
 107 across eight Andean networks. Meta-analysis (1) was weighted by sampling effort (i.e., the
 108 square-root of the total number of observed interactions per network), while meta-analysis (2)
 109 was weighted by sampling completeness (i.e., the observed link richness divided by the
 110 asymptotic richness based on the Chao estimator). Shown are model estimate (*Z mean*) and their
 111 respective standard errors (*SE*) and *P*-values.

<i>Traits</i>	Meta-analysis (1) weighted by sampling effort			Meta-analysis (2) weighted by sampling completeness		
	<i>Z mean</i>	<i>SE of Z</i>	<i>P</i>	<i>Z mean</i>	<i>SE of Z</i>	<i>P</i>
Fruit diameter ~ Bill width	0.32	0.07	< 0.001	0.29	0.07	< 0.001
Fruit length ~ Bill length	0.26	0.07	< 0.001	0.25	0.07	< 0.001
Plant height ~ Wing shape	0.33	0.06	< 0.001	0.29	0.04	< 0.001
Crop mass ~ Body mass	0.21	0.10	0.02	0.18	0.10	0.03

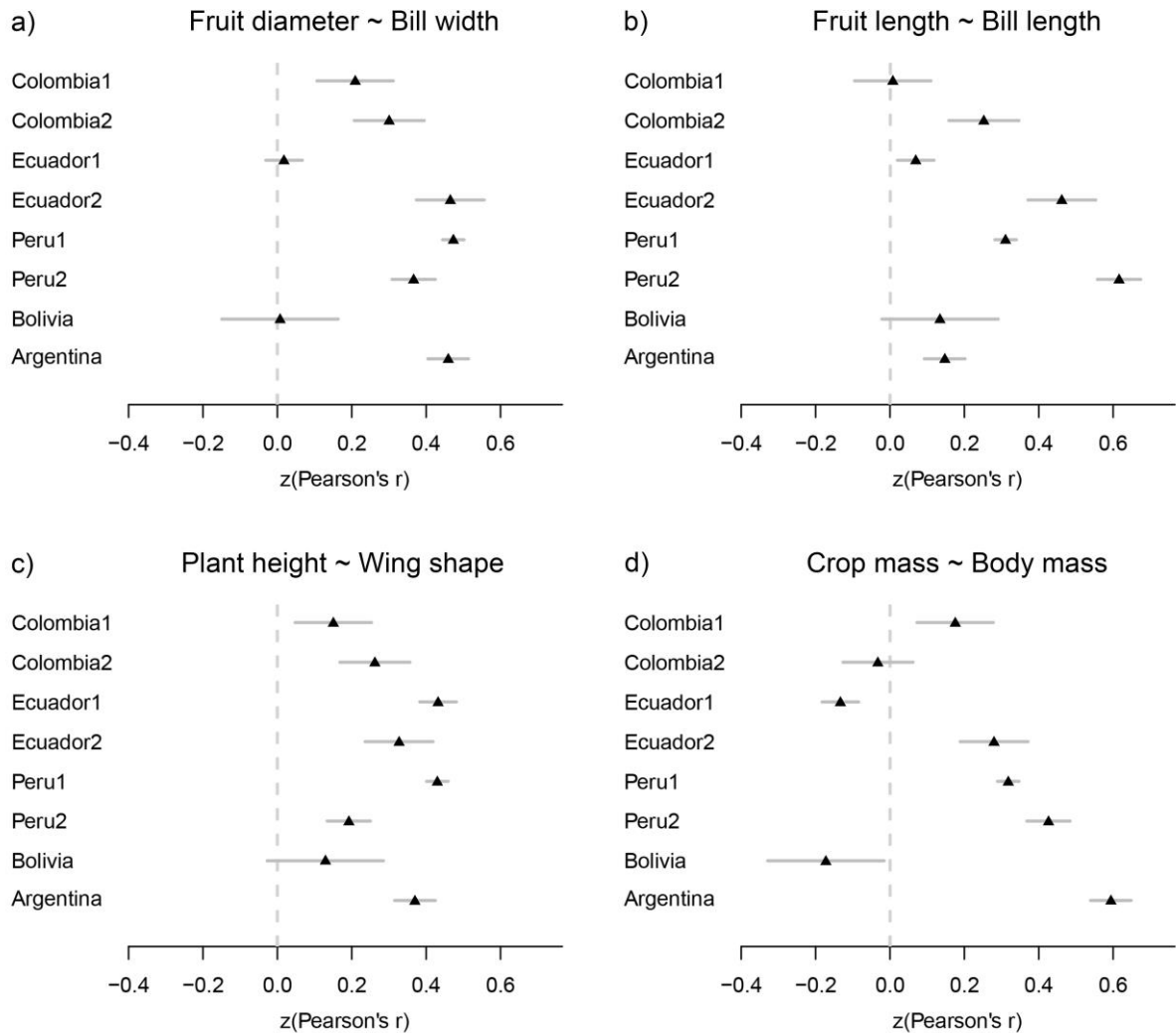
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113 **Fig. A1.** Accumulation curves of estimated bird richness for the eight interaction networks
 114 across the Andes. Dotted lines around the accumulation curves show the first and third quartiles
 115 and the standard errors, respectively; dashed lines show the asymptotic total richness with
 116 standard errors based on the Chao richness estimator (Oksanen *et al.* 2015).



117 **Fig. A2.** Accumulation curves of estimated link richness (i.e., the number of interacting species
 118 pairs) for the eight interaction networks across the Andes. Dotted lines around the accumulation
 119 curves show the first and third quartiles and the standard errors, respectively; dashed lines show
 120 the asymptotic link richness with standard errors based on the Chao richness estimator (Oksanen
 121 *et al.* 2015).



122 **Fig. A3.** Fourth-corner correlations between functional traits of frugivorous bird species and
 123 fleshy-fruited plant species across the Andes. Correlations of four trait pairs were tested in eight
 124 interaction networks across the Andes. The four analysed trait-pairs were; (a) fruit diameter and
 125 bill width, (b) fruit length and bill length, (c) plant height and wing shape, (d) crop mass and
 126 body mass. Triangles indicate the z-transformed Pearson's correlation coefficient r from the
 127 fourth-corner analysis; grey lines indicate the variance of the correlation coefficient derived from
 128 the square-root number of observed interaction events in each network.