Oikos

OIK-03567

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Appendix 1

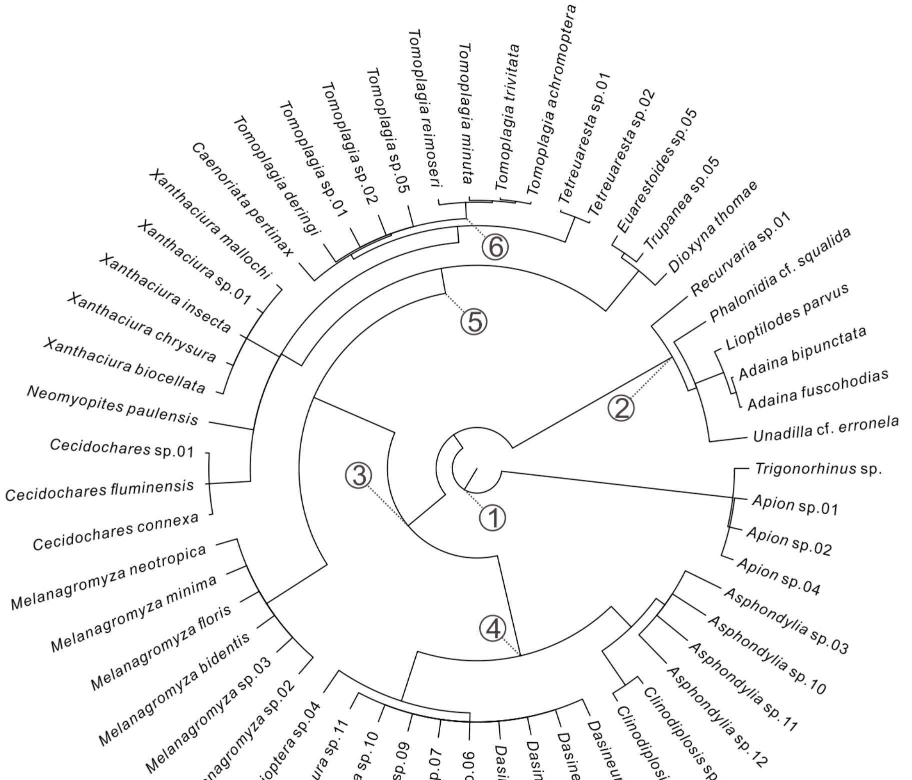

Figure A1. Phylogenetic tree of the 55 species of flower head insects studied in this work. 1) relationships between orders follow Ishiwata et al. (2011); 2) relationships between Lepidoptera families follow Regier et al. (2013); 3) relationships between Diptera families follow Wiegmann et al. (2011); 4) relationships between Cecidomyiidae genera follow Joy (2013); 5) relationships between Tephritidae subfamilies and tribes follow Komeyeve (1999), Han and Ro (2009); 6) relationships between *Tomoplagia* species follow Yotoko et al. (2005).

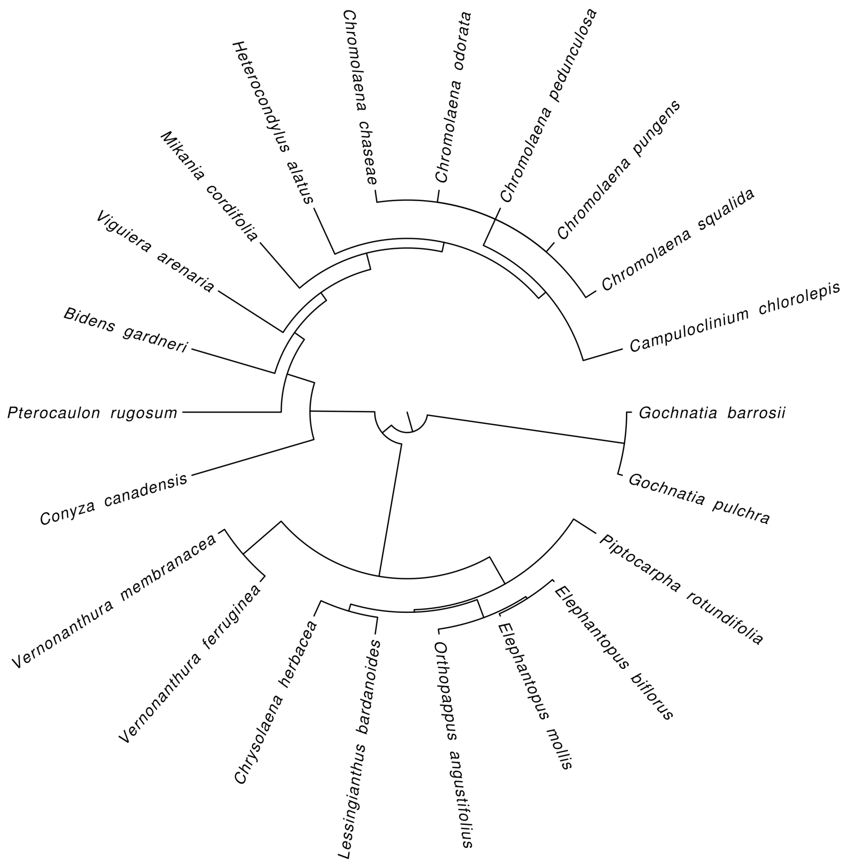

Figure A2. Phylogenetic tree of the 22 Asteraceae species studied in this work.

Table A1. DSI-S values for each species with more than one antagonist. Values computed with branch lengths set to 1 and values computed with branch lengths computed by Grafen's transformation gave similar results (correlation between values = 0.76). Ast= Asteraceae, endo = Endophages. 95% confidence intervals due to phylogenetic uncertainty associated with polytomies are shown in parenthesis for the DSI-S values.

Subnetwork	Trophic level	Taxon name	No. of counterparts	DSI-S (Branch length 1)	DSI-S
Cecidomyiidae	ast	*Asphondylia* sp.12	2	2.01	1.60 (1.46 – 2.13)
Cecidomyiidae	ast	*Clinodiplosis* sp.03	2	0.90	1.13 (1.01 – 1.23)
Cecidomyiidae	endo	*Chromolaena odorata*	2	0.99	1.36 (1.17 – 1.46)
Cecidomyiidae	endo	*Chromolaena pedunculosa*	2	1.13	1.39 (1.18 – 1.46)
Cecidomyiidae	endo	*Chromolaena pungens*	2	1.01	1.46 (1.16 – 1.45)
Cecidomyiidae	endo	*Gochnatia pulchra*	2	2.18	1.75 (1.60 – 2.26)
Cecidomyiidae	endo	*Mikania cordifolia*	2	1.62	1.55 (1.54 – 1.84)
Cecidomyiidae	endo	*Vernonanthura membranacea*	3	2.99	3.10 (2.81 – 3.37)
Lepidoptera	ast	*Adaina bipunctata*	7	4.57	5.75 (5.40 – 6.42)
Lepidoptera	ast	*Lioptilodes parvus*	2	-0.03	-0.69 (-0.79 - -0.64)
Lepidoptera	ast	*Phalonidia cf. squalida*	12	-0.01	2.31 (2.36 – 2.78)
Lepidoptera	ast	*Recurvaria* sp.01	11	-0.73	1.65 (1.59 – 1.93)
Lepidoptera	ast	*Unadilla cf. erronela*	14	-0.24	0.75 (0.76 – 1.03)
Lepidoptera	endo	*Bidens gardneri*	3	1.74	3.17 (2.83 – 3.37)
Lepidoptera	endo	*Campuloclinium chlorolepis*	2	1.09	1.95 (1.80 – 2.16)
Lepidoptera	endo	*Chromolaena chaseae*	4	1.97	4.13 (3.65 – 4.36)
Lepidoptera	endo	*Chromolaena odorata*	4	1.97	4.13 (3.65 – 4.36)
Lepidoptera	endo	*Chromolaena pedunculosa*	4	1.97	4.13 (3.65 – 4.36)
Lepidoptera	endo	*Chromolaena pungens*	4	1.97	4.13 (3.65 – 4.36)
Lepidoptera	endo	*Chromolaena squalida*	4	1.97	4.13 (3.65 – 4.36)
Lepidoptera	endo	*Conyza canadensis*	2	1.34	2.21 (1.83 – 2.18)
Lepidoptera	endo	*Mikania cordifolia*	3	1.98	3.35 (2.87 – 3.39)
Lepidoptera	endo	*Piptocarpha rotundifolia*	3	1.74	3.17 (2.83 – 3.37)
Lepidoptera	endo	*Vernonanthura ferruginea*	3	1.74	3.17 (2.83 – 3.37)
Lepidoptera	endo	*Vernonanthura membranacea*	5	2.56	5.30 (4.48 – 5.24)
Lepidoptera	endo	*Viguiera arenaria*	2	0.82	1.92 (1.76 – 2.08)
Tephritidae	ast	*Cecidochares connexa*	4	4.28	3.77 (3.51 – 4.35)
Tephritidae	ast	*Cecidochares fluminensis*	4	4.28	3.77 (3.51 – 4.35)
Tephritidae	ast	*Cecidochares* sp.01	5	5.24	4.77 (4.44 – 5.36)
Tephritidae	ast	*Euarestoides* sp.05	2	1.99	2.21 (1.91 – 2.18)
Tephritidae	ast	*Neomyopites paulensis*	6	4.86	5.01 (4.74 – 5.65)
Tephritidae	ast	*Tetreuaresta* sp.01	2	1.86	2.02 (1.74 – 1.99)
Tephritidae	ast	*Tetreuaresta* sp.02	2	1.78	1.86 (1.75 – 2.02)

Tephritidae	ast	*Tomoplagia minuta*	2	1.98	2.19 (1.88 – 2.20)
Tephritidae	ast	*Tomoplagia* sp.01	2	0.91	1.12 (0.99 – 1.22)
Tephritidae	ast	*Tomoplagia trivitata*	2	1.99	2.21 (1.91 – 2.18)
Tephritidae	ast	*Trupanea* sp.05	5	4.25	4.54 (3.98 – 4.84)
Tephritidae	ast	*Xanthaciura biocellata*	8	4.98	6.68 (5.99 – 6.89)
Tephritidae	ast	*Xanthaciura chrysura*	8	4.98	6.68 (5.99 – 6.89)
Tephritidae	ast	*Xanthaciura* sp.01	6	5.09	5.65 (5.05 – 5.96)
Tephritidae	endo	*Bidens gardneri*	2	0.52	0.87 (0.76 – 0.99)
Tephritidae	endo	*Campuloclinium chlorolepis*	3	3.52	3.12 (2.93 – 3.45)
Tephritidae	endo	*Chromolaena chaseae*	6	4.32	3.39 (3.21 – 4.60)
Tephritidae	endo	*Chromolaena odorata*	8	5.75	4.37 (4.19 – 5.96)
Tephritidae	endo	*Chromolaena pedunculosa*	8	5.75	4.37 (4.19 – 5.96)
Tephritidae	endo	*Chromolaena pungens*	8	5.75	4.37 (4.19 – 5.96)
Tephritidae	endo	*Chromolaena squalida*	7	6.45	4.26 (4.18 – 6.23)
Tephritidae	endo	*Gochnatia barrosii*	2	-1.02	-0.85 (-1.00 - -0.76)
Tephritidae	endo	*Gochnatia pulchra*	2	-1.02	-0.85 (-1.00 - -0.76)
Tephritidae	endo	*Heterocondylus alatus*	4	2.80	2.80 (2.71 – 3.22)
Tephritidae	endo	*Mikania cordifolia*	3	3.12	1.99 (1.97 – 3.22)
Tephritidae	endo	*Orthopappus angustifolius*	2	2.33	2.34 (2.01 – 2.32)
Tephritidae	endo	*Piptocarpha rotundifolia*	4	4.41	3.77 (3.39 – 4.08)
Tephritidae	endo	*Vernonanthura ferruginea*	2	1.50	1.98 (1.65 – 2.06)
Tephritidae	endo	*Vernonanthura membranacea*	2	2.03	2.01 (1.85 – 2.21)
Entire network	ast	*Adaina bipunctata*	7	4.80	6.13 (5.43 – 6.37)
Entire network	ast	*Apion* sp.02	4	4.23	4.02 (3.51 – 4.28)
Entire network	ast	*Asphondylia* sp.12	2	2.02	1.52 (1.45 – 2.11)
Entire network	ast	*Cecidochares connexa*	4	4.32	3.84 (3.52 – 4.34)
Entire network	ast	*Cecidochares fluminensis*	4	4.32	3.84 (3.52 – 4.34)
Entire network	ast	*Cecidochares* sp.01	5	5.14	5.00 (4.48 – 5.30)
Entire network	ast	*Clinodiplosis* sp.03	2	0.89	1.07 (1.00 – 1.24)
Entire network	ast	*Euarestoides* sp.05	2	2.00	2.12 (1.87 – 2.17)
Entire network	ast	*Lioptilodes parvus*	2	-0.06	-0.69 (-0.64 - -0.77)
Entire network	ast	*Melanagromyza bidentis*	8	0.42	2.28 (2.20 – 2.65)
Entire network	ast	*Melanagromyza minima*	2	0.55	0.78 (0.71 – 0.92)
Entire network	ast	*Melanagromyza neotropica*	3	0.47	1.62 (1.49 – 1.87)
Entire network	ast	*Melanagromyza* sp.02	2	-0.16	-1.02 (-1.02 - -0.95)
Entire network	ast	*Melanagromyza* sp.03	2	2.08	1.98 (1.86 – 2.19)
Entire network	ast	*Neomyopites paulensis*	6	4.74	5.40 (4.78 – 5.61)
Entire network	ast	*Phalonidia cf. squalida*	12	0.02	2.57 (2.38 – 2.77)
Entire network	ast	*Recurvaria* sp.01	11	-0.71	1.75 (1.60 – 1.93)
Entire network	ast	*Tetreuaresta* sp.01	2	1.89	1.87 (1.77 – 2.02)
Entire network	ast	*Tetreuaresta* sp.02	2	1.91	1.83 (1.74 – 2.03)
Entire network	ast	*Tomoplagia minuta*	2	2.08	1.98 (1.86 – 2.19)

Entire network	ast	*Tomoplagia* sp.01	2	0.89	1.07 (1.00 – 1.24)
Entire network	ast	*Tomoplagia trivitata*	2	2.00	2.12 (1.87 – 2.17)
Entire network	ast	*Trupanea* sp.05	5	4.15	4.22 (3.96 – 4.79)
Entire network	ast	*Unadilla cf. erronela*	14	-0.26	0.86 (0.75 – 1.02)
Entire network	ast	*Xanthaciura biocellata*	8	5.02	6.52 (5.99 – 6.94)
Entire network	ast	*Xanthaciura chrysura*	8	5.02	6.52 (5.99 – 6.94)
Entire network	ast	*Xanthaciura* sp.01	6	5.03	5.80 (5.14 – 6.02)
Entire network	endo	*Bidens gardneri*	9	2.11	0.89 (0.71 – 0.97)
Entire network	endo	*Campuloclinium chlorolepis*	6	1.57	0.62 (0.43 – 0.67)
Entire network	endo	*Chromolaena chaseae*	13	1.17	-0.59 (-0.71 - -029)
Entire network	endo	*Chromolaena odorata*	15	1.70	0.48 (0.31 – 0.97)
Entire network	endo	*Chromolaena pedunculosa*	17	1.82	-0.28 (-0.45 – 0.10)
Entire network	endo	*Chromolaena pungens*	16	1.56	-0.35 (-0.52 – 0.07)
Entire network	endo	*Chromolaena squalida*	14	2.31	-0.14 (-0.28 – 0.43)
Entire network	endo	*Conyza canadensis*	2	1.42	1.87 (1.83 – 2.17)
Entire network	endo	*Gochnatia barrosii*	4	-2.38	-0.83 (-0.95 - -0.78)
Entire network	endo	*Gochnatia pulchra*	6	-1.59	-0.59 (-0.71 - -0.51)
Entire network	endo	*Heterocondylus alatus*	5	1.93	1.42 (1.16 – 1.47)
Entire network	endo	*Mikania cordifolia*	11	0.74	-1.83 (-1.96 - -1.65)
Entire network	endo	*Orthopappus angustifolius*	3	0.16	0.22 (0.16 – 0.35)
Entire network	endo	*Piptocarpha rotundifolia*	8	0.22	0.36 (0.20 – 0.44)
Entire network	endo	*Vernonanthura ferruginea*	8	-0.80	-0.33 (-0.42 - -0.24)
Entire network	endo	*Vernonanthura membranacea*	12	-1.48	-0.19 (-0.32 - -0.13)
Entire network	endo	*Viguiera arenaria*	3	0.51	0.11 (0.04 – 0.22)

Table A2. DSI-S values for each module with more than one antagonist. Values computed with branch lengths set to 1 and values computed with branch lengths computed by Grafen's transformation gave similar results (correlation between values = 0.75). Ast= Asteraceae, endo = Endophages.

Sub network	Trophic level	Module	No. of species	DSI-S (Branch length 1)	DSI-S
Cecidomyiidae	ast	9	2	0.93	1.14 (1.00 – 1.24)
Cecidomyiidae	endo	2	2	1.10	1.29 (1.17 – 1.43)
Cecidomyiidae	endo	4	2	0.98	1.41 (1.17 – 1.44)
Cecidomyiidae	endo	7	2	2.26	1.79 (1.62 – 2.23)
Cecidomyiidae	endo	8	2	1.64	1.81 (1.51 – 1.82)
Cecidomyiidae	endo	10	3	2.98	3.29 (2.82 – 3.30)
Lepidoptera	ast	2	5	0.37	-0.18 (-0.24 - -0.07)
Lepidoptera	ast	3	4	3.37	3.54 (3.21 – 3.99)
Lepidoptera	ast	5	3	-1.09	-0.38 (-0.43 - -0.26)
Lepidoptera	ast	12	4	0.07	0.68 (0.47 – 0.69)
Lepidoptera	endo	5	2	1.06	2.18 (1.83 – 2.17)
Tephritidae	ast	1	2	1.85	2.01 (1.91 – 2.17)
Tephritidae	ast	4	6	4.69	5.14 (4.74 – 5.69)
Tephritidae	ast	7	2	2.02	1.92 (1.75 – 2.01)
Tephritidae	ast	8	2	1.97	2.09 (1.86 – 2.21)
Tephritidae	endo	1	2	0.42	0.88 (0.76 – 0.98)
Tephritidae	endo	4	7	5.18	4.16 (3.73 – 5.25)
Tephritidae	endo	8	2	-1.04	0.95 (0.77 – 1.00)
Tephritidae	endo	10	4	4.34	3.72 (3.35 – 4.09)
Tephritidae	endo	11	2	2.03	2.13 (1.88 – 2.23)
Entire network	ast	3	3	-0.73	-0.51 (-0.58 - -0.43)
Entire network	ast	4	2	1.80	1.89 (1.74 – 2.04)
Entire network	ast	5	5	4.12	4.39 (4.16 – 5.00)
Entire network	ast	6	6	-0.29	-1.22 (-1.35 - -1.15)
Entire network	endo	3	6	-1.56	-0.42 (-0.48 - -0.32)
Entire network	endo	5	14	1.69	0.03 (-0.09 – 0.47
Entire network	endo	6	27	-0.97	0.01 (-0.09 – 0.09)
Entire network	endo	7	2	-0.73	-0.47 (-0.54 - -0.40)

Table A3– Correlations between phylogenetic distance and the two metrics of compositional overlap (Jaccard and Unifrac) for each subnetwork and trophic level, using branch lengths set to 1. Ast= Asteraceae, endo = Endophages.

Sub network	Trophic level	Dissimilarity measure	*r*	Z-value	p
Tephritidae	endo	Jaccard	0.308	3.864	0.001
Tephritidae	ast	Jaccard	0.602	8.164	0.001
Tephritidae	endo	unifrac	0.405	5.555	0.001
Tephritidae	ast	unifrac	0.682	9.130	0.001
Lepidoptera	endo	Jaccard	0.208	0.670	0.261
Lepidoptera	ast	Jaccard	0.235	2.415	0.008
Lepidoptera	endo	unifrac	-0.269	-0.835	0.273
Lepidoptera	ast	unifrac	0.321	3.459	0.002
Cecidomyiidae	endo	Jaccard	0.030	0.308	0.392
Cecidomyiidae	ast	Jaccard	0.116	0.900	0.235
Cecidomyiidae	endo	unifrac	0.162	1.567	0.042
Cecidomyiidae	ast	unifrac	0.562	4.272	0.001
Entire network	endo	Jaccard	0.114	3.131	0.002
Entire network	ast	Jaccard	0.420	6.713	0.001
Entire network	endo	unifrac	0.145	3.602	0.001
Entire network	ast	unifrac	0.327	5.171	0.001

Table A4. Results from the binomial GLMs modelling the relationship between phylogenetic distance of species pairs and the probability that both belong to the same module, for each subnetork and trophic level, using branch lengths set to 1. Ast= Asteraceae, endo = Endophages.

Sub network	Trophic level	Beta	Z-value	p
Lepidoptera	ast	-0.084	-2.289	0.015
Lepidoptera	endo	0.000	-0.090	0.401
Cecidomyiidae	ast	-0.100	-0.187	0.375
Cecidomyiidae	endo	-0.089	-0.464	0.383
Tephritidae	ast	-0.501	-13.156	0.001
Tephritidae	endo	-0.407	-3.923	0.001
Entire network	ast	-0.126	-3.652	0.004
Entire network	endo	-0.003	-0.183	0.448

Table A5. Modularity values for the entire network and the subnetworks. Z-values were computed as the difference between the observed value and the mean of 999 simulations, divided by the standard deviation of the 999 simulations.

Subnetwork	Observed modularity value (Q)	Z-value
Entire Network	0.651	297.16
Tephritidae	0.458	148.01
Lepidoptera	0.460	25.17
Cecidomyiidae	0.687	127.88

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