Defensive insect symbiont leads to cascading extinctions and community collapse

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Table and figure legends (Supporting information)

Table S1. Mixed effects model analyses, and survival analyses on aphid and parasitoids in communities where the aphid clone (collected on *Medicago* and protected, or collected on *Ononis* and non-protected) and the symbiont *Hamiltonella defensa* (present or absent) were manipulated in *Acyrthosiphon pisum* aphids. Analyses test symbiont effects in both *A. pisum* clones independently, and clone effects in replicates without symbionts. * d.f. are 1, 197 in *M. viciae* models, ** d.f. are 1, 198 in *L. fabarum* models.

Table S2. Mixed effects model analyses on aphid relative abundances in communities where the aphid clone (collected on *Medicago* and protected, or collected on *Ononis* and non-protected) and the symbiont *Hamiltonella defensa* (present or absent) were manipulated in *Acyrthosiphon pisum* aphids.

Table S3. Mixed effects model analyses on aphid and parasitoids in communities where the aphid clone (collected on *Medicago* and protected, or collected on *Ononis* and non-protected) and the symbiont *Hamiltonella defensa* (present or absent) were manipulated in *Acyrthosiphon pisum* aphids. Analyses test all four treatments simultaneously (i.e. symbiont and clone effects, and their interaction). * d.f. are 1, 28 in *M. viciae* model in clone or symbiont parameters, ** d.f. are 1,397 for *A. ervi* in week parameters.

Figure S4. Relative aphid abundance (solid line) and 95% confidence intervals (dotted line) for model predictions in replicates without symbionts where the aphid clone (collected on *Medicago* and fast-growing, or collected on *Ononis* and slow-growing) was manipulated in *Acyrthosiphon pisum* aphids. Communities with the slow-growing clone are represented with light grey lines, and those with the fast-growing clone are represented with dark grey lines.

Figure S5. Parasitoid attacks on host and non-host aphids. Mean number (±SE) of *Aphidius ervi* attacks on *Acyrthosiphon pisum* host aphids (dark grey bars), and on *Megoura viciae* and *Aphis fabae* non-host aphids (light grey bars). Treatments represent *A. pisum* aphids alone, or with one or both of the non-host aphids.

Table S1

Protective clone

Parameters		*Acyrthosiphon pisum*		*Megoura viciae*		*Aphis fabae*	
Aphids	d.f. *	F-value	p	F-value	p	F-value	p
Intercept	1, 198	**318.08**	**<.0001**	**103.59**	**<.0001**	**97.45**	**<.0001**
Symbiont	1, 9	**6.93**	**0.027**	4.79	0.057	2.90	0.123
Week	1, 198	**19.00**	**<.0001**	**108.45**	**<.0001**	0.66	0.418
Week 2	1, 198	**17.09**	**<.0001**	**13.34**	**<.0001**	2.73	0.100
Symbiont x Week	1, 197			**11.11**	**<.0001**		
Parasitoids	d.f. **	*Aphidius ervi*		*Aphidius megourae*		*Lysiphlebus fabarum*	
Intercept	1, 197	**125.72**	**<.0001**	**125.91**	**<.0001**	**23.29**	**<.0001**
Symbiont	1, 9	**98.35**	**<.0001**	**5.22**	**0.048**	2.66	0.137
Week	1, 197	**6.97**	**0.009**	**138.67**	**<.0001**	0.17	0.681
Week 2	1, 197	**8.83**	**0.003**	2.14	0.145	0.12	0.732
Symbiont x Week	1, 197	**5.89**	**0.016**	**8.07**	**0.005**		

Non-protective clone

Parameters		*Acyrthosiphon pisum*		*Megoura viciae*		*Aphis fabae*	
Aphids	d.f.	F-value	p	F-value	p	F-value	p
Intercept	1, 198	**197.66**	**<.0001**	**96.10**	**<.0001**	**96.65**	**<.0001**
Symbiont	1, 9	3.51	0.094	1.68	0.227	**6.62**	**0.030**
Week	1, 198	**84.90**	**<.0001**	**141.69**	**<.0001**	**4.53**	**0.035**
Week 2	1, 198	1.45	0.229	**4.25**	**0.041**	0.48	0.488
Parasitoids	d.f.	*Aphidius ervi*		*Aphidius megourae*		*Lysiphlebus fabarum*	
Intercept	1, 198	**154.19**	**<.0001**	**117.02**	**<.0001**	**70.88**	**<.0001**
Symbiont	1, 9	0.20	0.669	2.93	0.121	**5.44**	**0.045**
Week	1, 198	**142.01**	**<.0001**	**213.83**	**<.0001**	0.47	0.493
Week 2	1, 198	2.79	0.097	1.51	0.221	1.11	0.293

Clonal lineage (cured lines)

Parameters		*Acyrtosiphon pisum*		*Megoura viciae*		*Aphis fabae*	
Aphids	d.f. *	F-value	p	F-value	p	F-value	p
Intercept	1, 198	**217.26**	**<.0001**	**100.22**	**<.0001**	**106.05**	**<.0001**
Clone	1, 9	**8.09**	**0.019**	2.30	0.164	1.03	0.336
Week	1, 198	**34.22**	**<.0001**	**109.83**	**<.0001**	3.34	0.069
Week 2	1, 198	3.91	0.050	**6.44**	**0.012**	0.43	0.515
Symbiont x Week	1, 197			**30.20**	**<.0001**		
Parasitoids	d.f. **	*Aphidius ervi*		*Aphidius megourae*		*Lysiphlebus fabarum*	
Intercept	1, 197	**217.11**	**<.0001**	**134.46**	**<.0001**	**58.99**	**<.0001**
Clone	1, 9	**6.23**	**0.034**	2.60	0.141	0.14	0.722
Week	1, 197	**39.78**	**<.0001**	**140.21**	**<.0001**	0.79	0.377
Week 2	1, 197	**7.43**	**0.007**	**3.98**	**0.047**	1.81	0.181
Symbiont x Week	1, 197	**5.03**	**0.026**	**18.07**	**<.0001**		

Survival

Survival		*Acyrthosiphon pisum*		*Megoura viciae*		*Aphis fabae*	
Parameters	d.f.	X^2	p	X^2	p	X^2	p
Symbiont (protective clone)	1	0.00	0.970	**7.09**	**0.008**	3.45	0.063
Symbiont (non-protective)	1	2.37	0.123	0.16	0.688	3.76	0.053
Clonal lineage (cured lines)	1	**6.33**	**0.012**	3.55	0.061	3.11	0.078
		Aphidius ervi		*Aphidius megourae*		*Lysiphlebus fabarum*	
	d.f.	X^2	p	X^2	p	X^2	p
Symbiont (protective clone)	1	**22.00**	**<.0001**	**21.40**	**<.0001**	**20.30**	**<.0001**
Symbiont (non-protective)	1	0.49	0.486	3.10	0.078	**6.34**	**0.019**
Clonal lineage (cured lines)	1	**13.22**	**<.0001**	**13.11**	**<.0001**	**6.33**	**0.012**

Table S2

Protective clone

Parameters	*Acyrthosiphon pisum*				*Megoura viciae*				*Aphis fabae*			
	Estimate	Std	z-value	p	Estimate	Std	z-value	p	Estimate	Std	z-value	p
Intercept	0.91	0.61	1.51	0.132	**-2.64**	**0.69**	**-3.84**	**0.000**	**-2.14**	**0.61**	**-3.48**	**<0.0001**
Symbiont (present)	0.96	0.51	1.89	0.058	**2.43**	**0.71**	**3.44**	**0.001**	**-1.35**	**0.60**	**-2.24**	**0.025**
Week	**-0.40**	**0.20**	**-1.99**	**0.047**	0.12	0.23	0.53	0.597	**0.44**	**0.20**	**2.23**	**0.026**
Week 2	**0.04**	**0.02**	**2.41**	**0.016**	-0.02	0.02	-0.83	0.406	**-0.03**	**0.01**	**-2.18**	**0.029**
Symbiont x Week					**-0.81**	**0.12**	**-6.99**	**<0.0001**				

Non-protective clone

Parameters	*Acyrthosiphon pisum*				*Megoura viciae*				*Aphis fabae*			
	Estimate	Std	z-value	p	Estimate	Std	z-value	p	Estimate	Std	z-value	p
Intercept	-1.34	0.77	-1.74	0.082	-0.89	0.68	-1.32	0.187	**-1.48**	**0.67**	**-2.21**	**0.027**
Symbiont (present)	1.06	0.88	1.21	0.227	**-1.13**	**0.58**	**-1.97**	**0.049**	**1.27**	**0.53**	**2.38**	**0.017**
Week	0.55	0.28	1.92	0.055	0.34	0.24	1.41	0.158	-0.20	0.27	-0.77	0.442
Week 2	**-0.07**	**0.02**	**-3.37**	**0.001**	**-0.09**	**0.02**	**-4.28**	**<0.0001**	**0.07**	**0.02**	**3.29**	**0.001**
Symbiont x Week	**-0.61**	**0.23**	**-2.64**	**0.008**								

Clonal lineage

Parameters	*Acyrthosiphon pisum*				*Megoura viciae*				*Aphis fabae*			
	Estimate	Std	z-value	p	Estimate	Std	z-value	p	Estimate	Std	z-value	p
Intercept	0.48	0.43	1.128	0.259	**-2.24**	**0.67**	**-3.34**	**0.001**	**-1.73**	**0.45**	**-3.83**	**<0.0001**
Clone (slow-growing)	**-0.74**	**0.31**	**-2.378**	**0.017**	**2.55**	**0.71**	**3.57**	**<0.0001**	-0.32	0.38	-0.85	0.393
Week	-0.07	0.16	-0.441	0.659	-0.03	0.20	-0.16	0.870	0.20	0.17	1.17	0.242
Week 2	-0.01	0.01	-0.564	0.573	0.00	0.01	-0.13	0.894	0.00	0.01	0.19	0.853
Symbiont x Week					**-0.36**	**0.14**	**-2.48**	**0.013**				

Table S3

Paramenters		*Acyrtosiphon pisum*		*Megoura viciae*		*Aphis fabae*	
Aphids	d.f. *	F-value	p	F-value	p	F-value	p
Intercept	1, 398	**568.93**	**<.0001**	**336.83**	**<.0001**	**709.43**	**<.0001**
Symbiont	1, 27	1.61	0.216	**9.70**	**0.004**	0.18	0.677
Clone	1, 27	**58.06**	**<.0001**	0.11	0.919	1.61	0.215
Week	1, 398	**72.06**	**<.0001**	**224.57**	**<.0001**	**17.24**	**<.0001**
Week 2	1, 398	**13.57**	**0.000**	0.77	0.381	1.53	0.217
Symbiont x Clone	1, 27	**10.89**	**0.002**			**15.54**	**0.001**

		Aphidius ervi		*Aphidius megourae*		*Lysiphlebus fabarum*	
Parasitoids	d.f. **	F-value	p	F-value	p	F-value	p
Intercept	1, 398	**578.61**	**<.0001**	**288.41**	**<.0001**	**172.60**	**<.0001**
Symbiont	1, 27	**84.85**	**<.0001**	**9.89**	**0.004**	0.30	0.587
Clone	1, 27	**14.72**	**<.0001**	0.54	0.470	**9.08**	**0.006**
Week	1, 398	**89.77**	**<.0001**	**317.46**	**<.0001**	0.27	0.605
Week 2	1, 398	**3.08**	**<.0001**	**0.03**	**0.868**	1.96	0.163
Symbiont x Clone	1, 27	**79.07**	**<.0001**			**14.76**	**0.001**

Figure S4

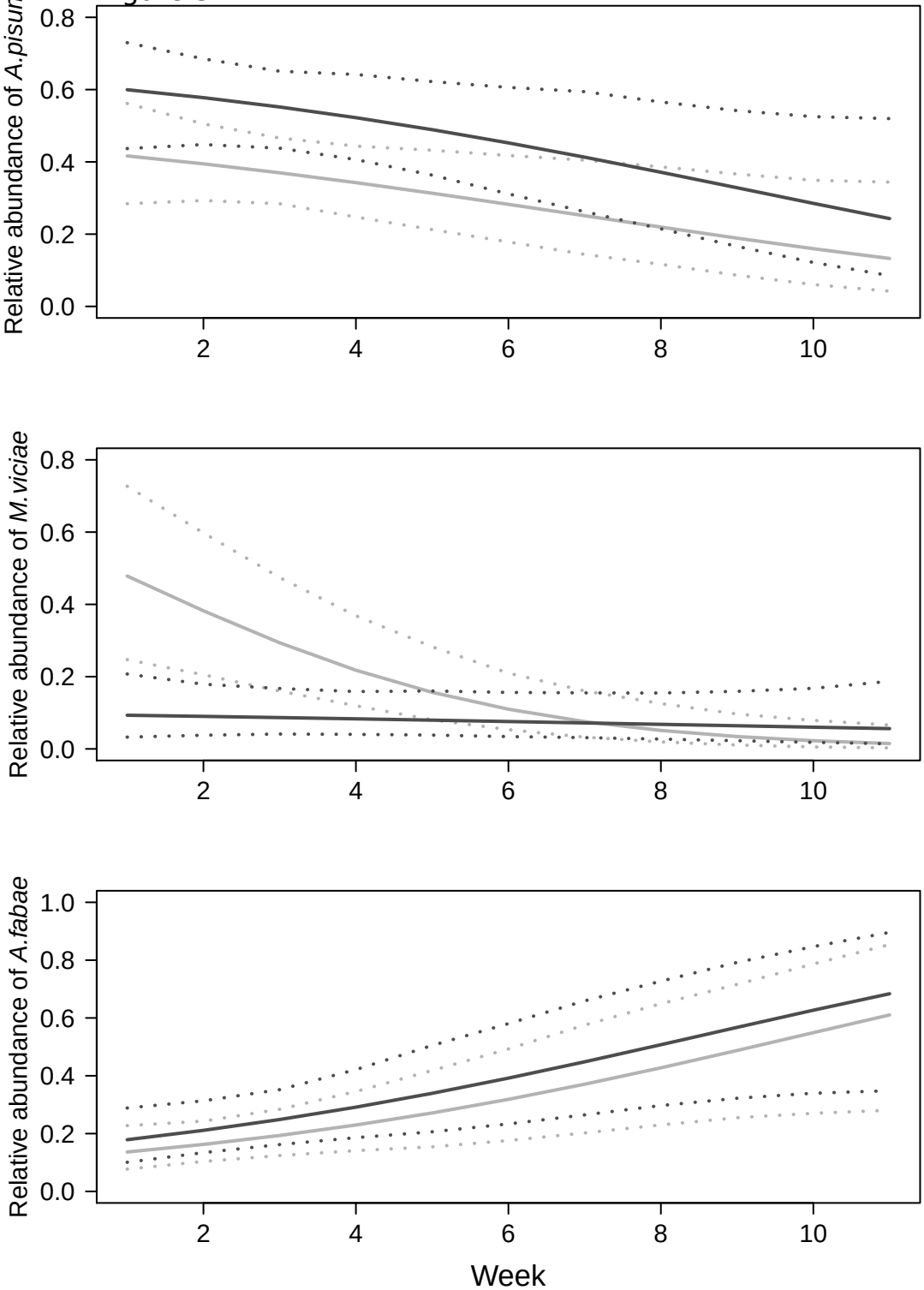
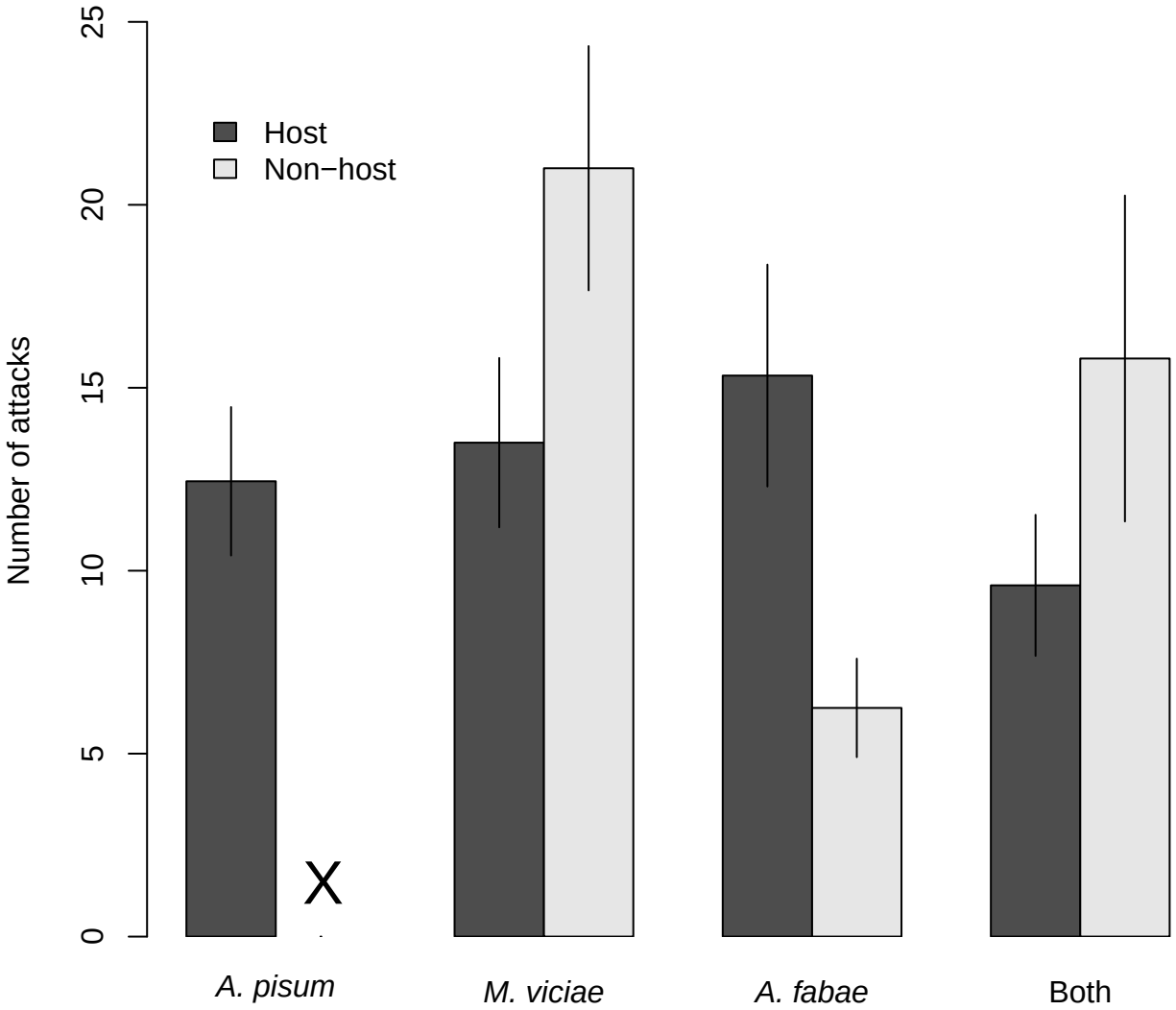

Relative abundance of A.pisum
0.0
0.2
0.4
0.6
0.8
2
4
6
8
10
Relative abundance of M.viciae
0.0
0.2
0.4
0.6
0.8
2
4
6
8
10
Relative abundance of A.fabae
0.0
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
Week

Figure S5


Host
Non−host
Number of attacks
0
5
10
15
20
25
X
A. pisum
M. viciae
A. fabae
Both