

# The invasion of alien populations of *Solanum elaeagnifolium* in two Mediterranean habitats modifies the soil communities in different ways

Maria Karmezi <sup>1,\*</sup>, Nikos Krigas <sup>2</sup>, Efimia M. Papatheodorou <sup>3</sup> and Maria D. Argyropoulou <sup>1,\*</sup>

<sup>1</sup> Department of Zoology, School of Biology, Faculty of Sciences, Aristotle University, 54124 Thessaloniki, Greece

<sup>2</sup> Institute of Plant Breeding and Genetic Resources, Hellenic Agricultural Organization Demeter, 57001 Thessaloniki, Greece; nikoskrigas@gmail.com

<sup>3</sup> Department of Ecology, School of Biology, Faculty of Sciences, Aristotle University, 54124 Thessaloniki, Greece; papatheo@bio.auth.gr

\* Correspondence: mkarmezi@bio.auth.gr (M.K); margyrop@bio.auth.gr (M.D.A.)

**Table S1.** Mean concentration ( $\pm$  SE) of PLFA biomarkers (nmol/g) recovered in two different habitat types (Q: *Quercus coccifera* shrublands, P: *Pinus brutia* forests) and three different disturbance regimes (c: core, pr: periphery not invaded, inv: periphery invaded by *Solanum elaeagnifolium*).

PLFA biomarkers	Functional groups	Qc	Qpr	Qinv	Pc	Ppr	Pinv
2-OH10:0	G-				0.16 (0.10)	0.18 (0.11)	
2-OH12:0	G-		0.44 (0.25)	0.29 (0.18)	0.41 (0.05)	0.55 (0.08)	0.49 (0.06)
3-OH12:0	G-				0.71 (0.35)	0.28 (0.19)	0.16 (0.16)
14:0	Microbia	3.93 (0.73)	4.95 (0.37)	5.40 (1.46)	22.66 (1.54)	23.78 (0.90)	14.88 (1.51)
i15:0	G+	18.35 (2.82)	20.36 (1.70)	24.75 (4.93)	32.19 (1.42)	32.86 (0.85)	29.25 (1.79)
a15:0	G+	11.09 (1.82)	14.05 (1.44)	16.20 (3.18)	24.39 (2.21)	25.68 (0.30)	20.48 (2.02)
15:0	Bacteria	2.35 (0.56)	2.34 (0.29)	2.48 (0.98)	7.54 (0.94)	7.71 (0.61)	4.81 (0.49)
2-OH14:0	G-			0.03 (0.03)		0.80 (0.80)	
3-OH14:0	G-		0.32 (0.19)	0.60 (0.36)	0.97 (0.21)	2.30 (1.58)	1.12 (0.60)
i16:0	G+	10.65 (1.27)	12.17 (1.14)	13.39 (2.79)	22.43 (1.43)	17.20 (5.75)	18.92 (1.89)
16:1 $\omega$ 7c	G-	11.45 (1.76)	12.43 (1.51)	14.71 (3.01)	22.02 (1.07)	21.75 (0.20)	15.80 (5.37)
16:0	Bacteria/fungi	28.55 (1.82)	28.97 (3.33)	33.17 (4.65)	38.77 (4.04)	40.01 (0.36)	35.43 (1.38)
10Me16:0	Actinobacteria	7.29 (1.10)	7.72 (0.97)	9.90 (2.17)	13.30 (0.66)	12.30 (0.82)	11.20 (1.01)
i17:0	G+	5.42 (0.54)	6.09 (0.66)	7.09 (1.57)	11.95 (1.09)	12.18 (0.61)	8.82 (0.75)
17:1 $\omega$ 7c	G-	2.52 (0.34)	2.85 (0.21)	3.95 (1.28)	7.81 (1.17)	8.84 (0.67)	5.49 (0.55)
cy17:0	G-	6.99 (0.78)	7.74 (0.87)	4.93 (1.82)	16.82 (1.22)	15.28 (0.91)	12.68 (1.20)
17:0	Bacteria	4.62 (0.48)	5.41 (0.44)	6.01 (1.22)	8.52 (0.91)	8.68 (0.47)	8.21 (1.09)
2-OH16:0	G-				0.05 (0.05)		0.47 (0.47)
10Me17:0	Actinobacteria	1.48 (0.21)	1.88 (0.23)	1.92 (0.39)	4.25 (0.48)	4.66 (0.50)	2.76 (1.02)
18:3 $\omega$ 6c	Fungi	0.40 (0.16)	0.70 (0.11)	1.03 (0.42)	1.96 (0.24)	2.25 (0.13)	1.70 (0.47)
18:2 $\omega$ 6c	Fungi	6.96 (0.55)	7.35 (0.97)	7.52 (1.46)	18.33 (1.08)	15.64 (0.72)	12.52 (0.59)
18:1 $\omega$ 9c	G-/fungi	16.86 (1.36)	17.91 (1.52)	20.07 (3.41)	24.60 (1.41)	25.54 (0.49)	22.64 (1.25)
18:1 $\omega$ 9t	G-/fungi	14.80 (1.82)	15.07 (1.76)	17.61 (3.32)	25.87 (2.48)	24.03 (2.15)	20.96 (1.67)
18:0	Microbia	8.76 (0.95)	9.97 (1.19)	11.68 (2.45)	19.62 (2.71)	20.66 (0.34)	18.05 (1.98)
10Me18:0	Actinobacteria	5.17 (0.80)	6.29 (0.94)	6.79 (1.33)	10.93 (0.88)	12.01 (1.08)	10.08 (1.39)
cy19:0	G-	0.87 (0.17)	1.22 (0.31)	1.46 (0.52)	2.51 (0.28)	3.12 (0.22)	1.58 (0.15)
20:4 $\omega$ 6c	Protozoa	0.19 (0.05)	0.30 (0.04)	0.40 (0.12)	0.06 (0.06)		0.66 (0.41)
20:5 $\omega$ 3c	Micro-eukaryotes	0.23 (0.10)	0.25 (0.07)	0.34 (0.10)	0.46 (0.09)	0.57 (0.09)	0.53 (0.09)
20:3 $\omega$ 6c	Protozoa	0.79 (0.22)	0.93 (0.19)	1.30 (0.56)	1.92 (0.32)	2.66 (0.35)	2.16 (0.56)
20:2 $\omega$ 6c	Protozoa	0.69 (0.07)	0.64 (0.04)	0.69 (0.09)	0.62 (0.06)	0.67 (0.06)	0.73 (0.02)
20:0	Microbia	1.91 (0.38)	1.93 (0.21)	2.40 (0.78)	7.88 (0.64)	10.43 (0.55)	5.68 (0.57)
22:6 $\omega$ 3c	Micro-eukaryotes	2.17 (0.64)	1.87 (0.43)	2.10 (0.53)	3.32 (0.43)	2.84 (0.40)	4.29 (0.45)

PLFA biomarkes	Functional groups	Qc	Qpr	Qinv	Pc	Ppr	Pinv
22:0	Micro-eukaryotes	1.45 (0.19)	1.70 (0.07)	2.14 (0.71)	8.78 (0.84)	12.80 (0.74)	5.32 (0.68)
23:0	Micro-eukaryotes	0.17 (0.03)	0.15 (0.01)	0.25 (0.08)	0.53 (0.20)	1.07 (0.08)	0.45 (0.04)
24:0	Micro-eukaryotes	0.55 (0.12)	0.58 (0.03)	0.71 (0.22)	5.00 (0.62)	6.82 (0.56)	2.02 (0.18)

**Table S2.** Biomass of microbial groups (nmol/g) in each composite sample taken from the four replicate sites of two different habitat types (Q: *Quercus coccifera* shrublands, P: *Pinus brutia* forests) and three different disturbance regimes (c: core, pr: periphery not invaded, inv: periphery invaded by *Solanum elaeagnifolium*).

Samples	Microbia	Bacteria	G+	G-	Actinobacteria	Fungi	Protozoa	Microeukaryotes
Qc1	153.57	77.92	40.12	18.12	14.85	5.66	1.30	7.21
Qc2	232.63	121.53	63.23	30.70	19.13	9.12	2.32	6.88
Qc3	165.34	84.03	45.52	20.22	11.82	7.25	1.59	5.39
Qc4	152.37	66.10	33.19	18.28	9.96	7.40	1.49	5.46
Qpr1	182.17	97.93	49.85	24.02	18.43	7.18	1.50	6.92
Qpr2	218.83	114.44	61.37	28.97	17.38	7.90	1.85	5.74
Qpr3	226.73	114.82	59.33	29.72	17.72	11.01	2.00	5.67
Qpr4	148.10	73.17	40.12	17.28	10.06	6.13	2.13	7.37
Qinv1	135.31	65.81	35.32	16.25	11.52	5.49	1.28	6.61
Qinv2	162.00	83.43	45.62	19.14	12.64	5.25	1.44	5.36
Qinv3	302.25	157.67	84.96	38.67	23.99	12.31	3.33	10.26
Qinv4	282.84	145.19	79.80	29.76	26.29	11.15	3.50	9.47
Pc1	400.60	204.00	100.47	59.33	28.33	21.91	2.40	19.57
Pc2	361.39	174.01	85.00	48.43	29.70	22.08	2.00	22.36
Pc3	295.08	154.03	77.10	42.58	23.56	17.06	2.60	15.98
Pc4	409.77	205.75	101.25	55.52	32.33	20.12	3.40	24.83
Ppr1	379.83	188.60	92.00	52.71	30.30	18.14	3.00	25.34
Ppr2	360.52	177.84	94.14	47.62	24.18	16.05	3.73	26.74
Ppr3	396.54	196.59	92.37	53.56	34.82	19.37	2.69	29.53
Ppr4	365.03	170.00	73.18	58.50	26.56	18.01	3.89	28.13
Pinv1	300.78	150.86	73.74	43.49	21.91	14.41	4.26	15.83
Pinv2	343.48	189.04	95.09	48.83	30.24	15.18	2.87	17.05
Pinv3	258.60	132.52	65.16	38.02	19.98	12.42	3.61	14.41
Pinv4	295.48	130.54	75.86	20.83	24.02	14.86	3.43	17.28

**Table S3.** Abundance of nematode trophic groups in each composite sample taken from the four replicate sites of two different habitat types (Q: *Quercus coccirefa* shrublands, P: *Pinus brutia* forests) and three different disturbance regimes (c: core, pr: periphery not invaded, inv: periphery invaded by *Solanum elaeagnifolium*).

Samples	Total abundance	Root/ fungal feeders	Plant parasitic	Bacterivores	Fungivores	Predators	Omnivores
Qc1	871.17	260.26	234.24	229.19	147.48	0.00	0.00
Qc2	1367.63	205.14	13.68	847.93	273.53	27.35	0.00
Qc3	2243.66	571.92	384.02	474.53	813.19	0.00	0.00
Qc4	1743.08	371.13	122.93	581.44	602.97	64.60	0.00
Qpr1	1050.43	312.85	208.57	274.11	243.33	11.59	0.00
Qpr2	727.19	189.07	138.17	210.89	145.44	43.63	0.00
Qpr3	1158.67	182.93	117.60	434.23	397.79	26.13	0.00
Qpr4	934.55	302.17	87.73	378.95	165.71	0.00	0.00
Qinv1	2203.49	318.88	1099.27	564.18	196.63	0.00	24.53
Qinv2	1606.81	265.86	336.48	788.47	182.78	16.62	16.62
Qinv3	668.03	222.85	112.17	149.85	183.16	0.00	0.00
Qinv4	1374.81	109.99	838.64	247.47	178.73	0.00	0.00
Pc1	12913.80	155.46	470.27	8138.73	4149.35	0.00	0.00
Pc2	688.85	34.44	6.89	247.99	399.53	0.00	0.00
Pc3	1304.42	13.48	64.11	754.97	458.38	13.48	0.00
Pc4	1727.17	103.63	69.09	846.31	690.87	17.27	0.00
Ppr1	1214.17	163.05	69.88	398.92	570.67	11.65	0.00
Ppr2	2058.64	331.24	110.41	888.26	728.73	0.00	0.00
Ppr3	1798.55	346.65	40.78	595.48	754.47	61.17	0.00
Ppr4	2256.07	0.00	34.72	1457.41	763.93	0.00	0.00
Pinv1	554.12	20.34	40.68	340.54	142.39	0.00	10.17
Pinv2	804.90	112.69	201.23	321.96	160.98	8.05	0.00
Pinv3	636.87	63.69	6.37	343.91	210.17	12.74	0.00
Pinv4	1069.84	32.10	160.48	609.81	235.37	32.10	0.00

**Table S4.** List of Greek native plant species and subspecies found in *Quercus coccifera* shrublands (Q) and *Pinus brutia* forests (P) at three different disturbance regimes (c: core, pr: periphery not invaded, inv: periphery invaded by *Solanum elaeagnifolium*). The presence of plants is indicated by colored cells.

	Qc	Qpr	Qinv	Pc	Ppr	Pinv
<i>Acinos alpinus</i> (L.) Moench subsp. <i>nomismophyllus</i> (Rech. fil.) Leblebici						
<i>Acinos suaveolens</i> (Sm.) Loudon						
<i>Alkanna tinctoria</i> Tausch subsp. <i>tinctoria</i>						
<i>Allium rhodopeum</i> Velen.						
<i>Allium sphaerocephalon</i> L. subsp. <i>sphaerocephalon</i>						
<i>Alyssum simplex</i> Rudolphi						
<i>Anacamptis pyramidalis</i> (L.) Rich.						
<i>Anthyllis hermanniae</i> L. subsp. <i>hermanniae</i>						
<i>Asparagus aphyllus</i> L. subsp. <i>aphyllus</i>						
<i>Avena barbata</i> Link						
<i>Ballota nigra</i> L.						
<i>Brachypodium sylvaticum</i> (Huds.) P. Beauv. subsp. <i>sylvaticum</i>						
<i>Bromus madritensis</i> L.						
<i>Celtis australis</i> L.						
<i>Centaurea grisebachii</i> (Nyman) Heldr. subsp. <i>grisebachii</i>						
<i>Chrysopogon gryllus</i> (L.) Trin.						
<i>Cistus creticus</i> L. subsp. <i>creticus</i>						
<i>Convolvulus althaeoides</i> L.						
<i>Crupina crupinastrum</i> (Moris) Vis.						
<i>Cupressus sempervirens</i> L.						
<i>Cynosurus echinatus</i> L.						
<i>Dactylis glomerata</i> subsp. <i>hispanica</i> (Roth) Nyman						
<i>Dasypyrum villosum</i> (L.) P. Candargy						
<i>Dianthus corymbosus</i> Sm.						
<i>Dianthus illyricus</i> (Ard.) Fassou, N.Korotkova, Dimop. & Borsch						
<i>Dianthus illyricus</i> (Ard.) Fassou, N.Korotkova, Dimop. & Borsch subsp. <i>illyricus</i>						
<i>Dianthus illyricus</i> subsp. <i>haynaldianus</i> (Nyman) Fassou, N.Korotkova, Dimop. & Borsch						
<i>Dianthus pinifolius</i> Sm. subsp. <i>pinifolius</i>						
<i>Echium plantagineum</i> L.						
<i>Eryngium campestre</i> L.						
<i>Erysimum crassistylum</i> C. Presl						
<i>Festuca valesiaca</i> Gaudin						
<i>Fumana thymifolia</i> (L.) Webb						
<i>Helianthemum salicifolium</i> (L.) Mill.						
<i>Hirschfeldia incana</i> (L.) Lagr.-Foss.						
<i>Hypericum olympicum</i> L.						
<i>Hypericum perforatum</i> L.						
<i>Juniperus oxycedrus</i> subsp. <i>deltoides</i> (R.P. Adams) N.G. Passal.						
<i>Malabaila aurea</i> (Sm.) Boiss.						
<i>Melica ciliata</i> L. subsp. <i>ciliata</i>						
<i>Melilotus albus</i> Medik.						
<i>Micromeria juliana</i> (L.) Rchb.						
<i>Minuartia attica</i> (Boiss. & Spruner) Vierh. subsp. <i>attica</i>						
<i>Nigella arvensis</i> L.						
<i>Onopordum illyricum</i> subsp. <i>cardunculus</i> (Boiss.) Arènes						

	Qc	Qpr	Qinv	Pc	Ppr	Pinv
<i>Phillyrea latifolia</i> L.						
<i>Piptatherum miliaceum</i> (L.) Coss.						
<i>Piptatherum miliaceum</i> (L.) Coss. subsp. <i>miliaceum</i>						
<i>Prunus spinosa</i> subsp. <i>dasyphylla</i> (Schur) Domin						
<i>Rostraria cristata</i> (L.) Tzvelev						
<i>Salvia verbenaca</i> L.						
<i>Sarcopoterium spinosum</i> (L.) Spach						
<i>Scabiosa triniifolia</i> Friv.						
<i>Silene gigantea</i> subsp. <i>rhodopea</i> (Janka) Greuter						
<i>Stipa capensis</i> Thunb.						
<i>Teucrium capitatum</i> L.						
<i>Thymus sibthorpii</i> Benth.						
<i>Trifolium angustifolium</i> L.						
<i>Trifolium stellatum</i> L.						
<i>Verbascum leucophyllum</i> Griseb.						
<i>Verbascum undulatum</i> Lam.						
<b>Number of species</b>	23	34	29	11	26	13