**Supplementary Material**

**Diversity patterns of different life forms of plants along the elevational gradient in Crete, Greece**

Maria Lazarina[*1], Athanasios Charalampopoulos[1], Maria Psaralexi[1], Nikos Krigas[2], Danai-Eleni Michailidou[1], Athanasios S. Kallimanis[1], and Stefanos P. Sgardelis[1]

Addresses:

[1]Department of Ecology, School of Biology, Aristotle University, 54124 Thessaloniki, Greece. Maria Lazarina: mlazarin@bio.auth.gr, Maria Psaralexi: mpsarale@bio.auth.gr, Danai-Eleni Michailidou: dmichail@bio.auth.gr, Athanasios Charalampopoulos: athchara@bio.auth.gr, Athanasios S. Kallimanis: kalliman@bio.auth.gr, Stefanos P. Sgardelis: sgardeli@bio.auth.gr

[2]Institute of Plant Breeding & Genetic Resources, Hellenic Agricultural Organization Demeter, GR-57001 Thermi-Thessaloniki, Greece. Nikos Krigas: nikoskrigas@gmail.com

*Correspondence to: Maria Lazarina, Department of Ecology, School of Biology, Aristotle University, 54124, Thessaloniki, Greece. mlazarin@bio.auth.gr

Table S1 Mean elevation (elevational range) and sites of the 12 elevational zones in the study area of Crete, Greece. For the estimation of mean elevation we used a digital surface model produced in the framework of the Reference Data Access (RDA) Action of the EU GMES/Copernicus program (Copernicus Land Monitoring Services, 2018) and applied zonal statistics to calculate the mean elevation per site. Then, mean elevation of each zone was estimated as the mean elevation of the sites belonging to this zone.

| Elevational zone | Sites | Mean Elevation (range) |
|---|---|---|
| 0-100 | 17 | 64.18 (0.00-95.36) |
| 100-200 | 27 | 139.78 (100.85-198.81) |
| 200-300 | 25 | 256.72 (201.87-296.00) |
| 300-400 | 28 | 349.43 (301.41-398.57) |
| 400-500 | 21 | 442.50 (400.25-499.43) |
| 500-600 | 13 | 545.89(502.96-584.88) |
| 600-700 | 6 | 647.65 (612.82-688.19) |
| 700-800 | 4 | 755.76 (706.05-800.24) |
| 800-1000 | 4 | 895.65 (829.01-956.46) |
| 1000-1100 | 5 | 1042.96 (1005.12-1088.34) |
| 1100-1200 | 4 | 1197.05 (1143.91-1286.09) |
| >1200 | 6 | 1455.73 (1335.43-1614.01) |

Table S2 Elevational and environmental ranges of species of different life forms in the whole island of Crete. Different letters indicate significant differences between life forms, according to permutational one-way ANOVA, while non-significant differences are indicated in italics. Life forms abbreviations: C=chamaephytes, G= geophytes, H= hemicryptophytes, P=phanerophytes, T= therophytes.

| | C | G | H | P | T |
|---|---|---|---|---|---|
| **Elevation (m a.s.l.)** | | | | | |
| mean | 367±147$^{a}$ | 374±157$^{a}$ | 339±135$^{ab}$ | 372±176$^{ab}$ | 331±161$^{b}$ |
| *minimum* | *141±174* | *134±129* | *131±123* | *132±195* | *140±162* |
| maximum | 853±446$^{ac}$ | 890±476$^{a}$ | 763±444$^{bc}$ | 975±503$^{a}$ | 709±421$^{b}$ |
| range | 712±511$^{ac}$ | 756±516$^{a}$ | 631±487$^{bc}$ | 842±561$^{a}$ | 570±458$^{b}$ |
| **Temperature (ºC)** | | | | | |
| mean | 17.0±0.8$^{ab}$ | 17.0±0.8$^{a}$ | 17.2±0.7$^{b}$ | 16.9±1.0$^{ab}$ | 17.2±0.9$^{b}$ |
| minimum | 14.4±3.0$^{ac}$ | 14.1±2.6$^{a}$ | 14.9±2.5$^{bc}$ | 13.7±2.8$^{a}$ | 15.1±2.3$^{b}$ |
| *maximum* | *18.3±1.0* | *18.3±0.8* | *18.3±0.7* | *18.3±1.1* | *18.3±0.9* |
| range | 3.9±2.8$^{ac}$ | 4.2±2.9$^{a}$ | 3.4±2.7$^{bc}$ | 4.6±3.2$^{a}$ | 3.2±2.6$^{b}$ |
| **Temperature of the coldest quarter (ºC)** | | | | | |
| mean | 10.6±1.0$^{ab}$ | 10.5±1.0$^{a}$ | 10.8±0.8$^{ab}$ | 10.5±1.1$^{ab}$ | 10.8±1.0$^{b}$ |
| minimum | 7.6±2.8$^{ac}$ | 7.3±3.0$^{a}$ | 8.1±2.8$^{bc}$ | 6.8±3.2$^{a}$ | 8.4±2.7$^{b}$ |
| *maximum* | *12.1±1.2* | *12.2±1.0* | *12.1±0.8* | *12.2±1.3* | *12.1±1.1* |
| range | 4.6±3.3$^{ac}$ | 4.9±3.4$^{a}$ | 4.0±3.1$^{bc}$ | 5.4±3.7$^{a}$ | 3.8±3.0$^{b}$ |
| **Temperature seasonality** | | | | | |
| mean | 596.9±15.2$^{ab}$ | 559.8±15.0$^{a}$ | 557.9±13.1$^{ab}$ | 559.5±15.2$^{ab}$ | 556.7±15.0$^{b}$ |
| minimum | 531.7±23.2 | 530.4±19.2 | 533.0±17.6 | 530.0±21.2 | 531.9±20.3 |
| maximum | 593.7±27.6 | 595.1±29.7$^{ab}$ | 588.7±28.5$^{ac}$ | 598.0±29.4$^{b}$ | 586.5±27.6$^{c}$ |
| range | 62.0±38.3$^{ab}$ | 64.7±38.5$^{a}$ | 55.7±36.7$^{b}$ | 67.9±39.3$^{a}$ | 54.6±36.1$^{b}$ |
| **Precipitation** | | | | | |
| mean | 663±66$^{abc}$ | 674±67$^{a}$ | 659±57$^{bc}$ | 674±66$^{ab}$ | 654±64$^{c}$ |
| *minimum* | *560±78* | *562±65* | *558±62* | *556±83* | *563±71* |
| maximum | 830±145$^{ac}$ | 851±149$^{a}$ | 812±138$^{bc}$ | 865±135$^{a}$ | 793±129$^{b}$ |
| range | 270±172$^{ab}$ | 289±170$^{ab}$ | 253±162$^{b}$ | 308±170$^{c}$ | 230±151$^{ab}$ |
| **Precipitation of the wettest quarter (mm)** | | | | | |
| mean | 353±32 $^{ab}$ | 359±34$^{a}$ | 350±30$^{b}$ | 357±33$^{ab}$ | 349±32$^{b}$ |
| *minimum* | *298±41* | *298±36* | *295±34* | *292±44* | *300±38* |
| maximum | 436±71$^{ac}$ | 447±75 $^{a}$ | 427±69$^{bc}$ | 451±67 | 418±64$^{b}$ |
| range | 138±89$^{ab}$ | 149±89$^{ab}$ | 132±84$^{ac}$ | 160±88$^{b}$ | 118±77$^{c}$ |
| **Precipitation seasonality** | | | | | |
| mean | 85.5±1.5$^{bc}$ | 85.4±1.3$^{ab}$ | 85.3±1.2$^{ab}$ | 85.0±1.3$^{a}$ | 85.7±1.3$^{c}$ |
| minimum | 82.9±2.7$^{ab}$ | 82.6±2.6$^{a}$ | 82.9±2.3$^{ab}$ | 81.7±2.6$^{c}$ | 83.3±2.3$^{b}$ |
| maximum | 88.0±2.4 | 88.0±2.0 | 87.6±2.0 | 87.9±2.5 | 88.0±2.0 |
| range | 5.1±3.8$^{abc}$ | 5.4±3.6$^{ab}$ | 4.7±3.4$^{ac}$ | 6.2±4.2$^{b}$ | 4.7±3.3$^{c}$ |
| **Percentage of Human Land Uses** | | | | | |
| mean | 0.35±0.18$^{ab}$ | 0.36±0.16$^{ab}$ | 0.37±0.16$^{a}$ | 0.38±0.15$^{ab}$ | 0.35±0.15$^{b}$ |
| minimum | 0.09±0.19 | 0.09±0.19 | 0.11±0.19 | 0.09±0.17 | 0.10±0.17 |
| maximum | 0.72±0.32$^{ab}$ | 0.74±0.29$^{ab}$ | 0.75±0.29$^{ab}$ | 0.81±0.28$^{a}$ | 0.71±0.30$^{b}$ |
| range | 0.63±0.38$^{ab}$ | 0.65±0.36$^{ab}$ | 0.64±0.36$^{a}$ | 0.72±0.35$^{b}$ | 0.62±0.36$^{b}$ |

Table S3 Diversity indices of life forms along the elevational gradients. For the first six elevational zones using randomly sampled six sites for each zone (1000 permutations) to explore the effect of unequal number of samples among elevational zone to the observed diversity patterns, and all the available sites for the remaining elevational zones. Life forms abbreviations: C=chamaephytes, G= geophytes, H= hemicryptophytes, P=phanerophytes, T= therophytes.

| | C | G | H | P | T |
|---|---|---|---|---|---|
| | | **γ-diversity** | | | |
| 0-100 | 63.3±9.5 | 84.3±18.9 | 112.8±27.0 | 44.5±8.7 | 202.0±50.0 |
| 100-200 | 66.1±15.6 | 88.7±24.0 | 149.5±38.9 | 49.9±10.6 | 225.8±69.6 |
| 200-300 | 61.9±16.1 | 88.1±17.6 | 125.4±32.6 | 44.7±7.3 | 209.9±65.7 |
| 300-400 | 66.4±15.0 | 82.3±15.2 | 132.0±32.5 | 47.6±8.7 | 167.9±51.0 |
| 400-500 | 69.7±14.0 | 86.6±12.8 | 127.8±29.8 | 45.9±6.4 | 179.9±49.6 |
| 500-600 | 42.0±17.0 | 63.4±16.9 | 71.1±31.4 | 34.4±9.2 | 82.7±40.4 |
| 600-700 | 62 | 100 | 102 | 44 | 223 |
| 700-800 | 65 | 48 | 108 | 25 | 51 |
| 800-1000 | 24 | 54 | 59 | 32 | 70 |
| 1000-1100 | 36 | 77 | 65 | 37 | 83 |
| 1100-1200 | 41 | 57 | 64 | 25 | 65 |
| >1200 | 32 | 57 | 49 | 34 | 72 |
| | | **Mean α-diversity** | | | |
| 0-100 | 17.2±3.5 | 20.6±6.7 | 26.8±7.7 | 12.9±3.6 | 45.7±15.2 |
| 100-200 | 18.9±4.8 | 22.4±8.1 | 38.0±11.9 | 15.3±5.0 | 52.5±20.6 |
| 200-300 | 17.2±4.9 | 22.4±6.2 | 31.5±9.7 | 14.0±3.8 | 47.5±19.5 |
| 300-400 | 18.4±5.3 | 21.4±5.6 | 31.8±10.3 | 13.9±3.8 | 36.1±14.1 |
| 400-500 | 20.5±4.6 | 24.5±5.5 | 33.1±9.8 | 15.2±3.7 | 39.9±14.5 |
| 500-600 | 8.9±3.5 | 15.7±4.5 | 14.7±6.4 | 8.8±2.7 | 15.1±7.7 |
| 600-700 | 15.8±14.3 | 29.0±21.5 | 24.7±24.9 | 12.0±11.6 | 49.7±46.7 |
| 700-800 | 18.0±20.8 | 13.5±4.8 | 28.5±26.7 | 6.5±5.1 | 13.5±10.7 |
| 800-1000 | 6.8±8.3 | 17.3±17.3 | 17.5±19.5 | 9.0±9.4 | 18.0±24.5 |
| 1000-1100 | 10.4±8.9 | 25.4±16.7 | 17.2±14.6 | 11.8±8.9 | 18.0±25.5 |
| 1100-1200 | 12.3±9.0 | 15.0±4.5 | 19.5±14.4 | 7.0±7.7 | 17.5±20.4 |
| >1200 | 8.5±7.4 | 15.3±5.7 | 13.3±12.5 | 9.7±8.5 | 14.7±14.7 |
| | | **Mean Jaccard index** | | | |
| 0-100 | 0.88±0.04 | 0.93±0.03 | 0.93±0.03 | 0.87±0.05 | 0.95±0.02 |
| 100-200 | 0.87±0.05 | 0.92±0.04 | 0.91±0.04 | 0.87±0.06 | 0.95±0.03 |
| 200-300 | 0.87±0.04 | 0.91±0.03 | 0.90±0.03 | 0.85±0.06 | 0.95±0.02 |
| 300-400 | 0.87±0.04 | 0.90±0.04 | 0.93±0.03 | 0.88±0.05 | 0.96±0.02 |
| 400-500 | 0.85±0.05 | 0.88±0.04 | 0.91±0.04 | 0.83±0.06 | 0.95±0.02 |
| 500-600 | 0.94±0.03 | 0.91±0.03 | 0.94±0.03 | 0.91±0.04 | 0.97±0.02 |
| 600-700 | 0.92±0.11 | 0.86±0.11 | 0.92±0.09 | 0.91±0.12 | 0.95±0.04 |
| 700-800 | 0.98±0.03 | 0.95±0.03 | 0.98±0.04 | 0.99±0.03 | 0.99±0.02 |
| 800-1000 | 0.98±0.06 | 0.94±0.10 | 0.97±0.08 | 0.97±0.04 | 0.99±0.01 |
| 1000-1100 | 0.89±0.11 | 0.83±0.08 | 0.93±0.06 | 0.86±0.12 | 0.97±0.03 |
| 1100-1200 | 0.95±0.11 | 0.98±0.03 | 0.94±0.13 | 0.98±0.05 | 0.98±0.04 |
| >1200 | 0.92±0.14 | 0.86±0.11 | 0.92±0.15 | 0.90±0.15 | 0.96±0.07 |

Table S4 Summary statistics of Generalized Additive Models predicting γ-diversity, mean α-diversity, β-diversity and β-deviation as function of elevation (smooth term) by life form and life form along an elevational gradient in Crete, Greece.

| **γ-diversity = s(elevation, by= life form, k=5) + s(life form, bs="re")** | | | | |
|---|---|---|---|---|
| | Estimate | Std.Error | t-value | Pr(>\|t\|) |
| (Intercept) | 79.63 | 17.23 | 4.622 | <0.001 |
| *Smooth terms* | edf | Ref.df | F | p-value |
| s(elevation):γ-diversity,chamaephytes | 1.00 | 1.00 | 3.19 | 0.08 |
| s(elevation):γ-diversity,geophytes | 1.00 | 1.00 | 2.57 | 0.12 |
| s(elevation):γ-diversity,hemicryptophytes | 1.00 | 1.00 | 17.89 | <0.001 |
| s(elevation):γ-diversity,phanerophytes | 1.00 | 1.00 | 0.85 | 0.36 |
| s(elevation):γ-diversity,therophytes | 2.25 | 2.74 | 24.59 | <0.001 |
| s(life.form) | 3.88 | 4.00 | 33.29 | <0.001 |
| R-sq.(adj) =0.79 | Deviance | explained | = 82.60% | |

| **mean $\alpha$-diversity = s(elevation, by= life form, k=5) + s(life form, bs="re")** | | | | |
|---|---|---|---|---|
| | Estimate | Std.Error | t-value | Pr(>\|t\|) |
| (Intercept) | 20.31 | 3.49 | 5.82 | <0.001 |
| *Smooth terms* | edf | Ref.df | F | p-value |
| s(elevation):α-diversity,chamaephytes | 1.00 | 1.00 | 3.55 | 0.07 |
| s(elevation):α-diversity,geophytes | 1.00 | 1.00 | 1.22 | 0.28 |
| s(elevation):α-diversity,hemicryptophytes | 1.00 | 1.00 | 12.48 | <0.001 |
| s(elevation):α-diversity,phanerophytes | 1.00 | 1.00 | 1.37 | 0.25 |
| s(elevation):α-diversity,therophytes | 1.76 | 2.17 | 22.80 | <0.001 |
| s(life.form) | 3.81 | 4.00 | 20.00 | <0.001 |
| R-sq.(adj) =0.71 | Deviance | explained | = 75.6% | |

| **β-diversity = s(elevation, by= life form, k=5) + s(life form, bs="re")** | | | | |
|---|---|---|---|---|
| | Estimate | Std.Error | t-value | Pr(>\|t\|) |
| (Intercept) | 20.31 | 3.49 | 5.82 | <0.001 |
| *Smooth terms* | edf | Ref.df | F | p-value |
| s(elevation):β-diversity,chamaephytes | 3.08 | 3.56 | 3.31 | 0.03 |
| s(elevation):β-diversity,geophytes | 1.00 | 1.00 | 0.38 | 0.54 |
| s(elevation):β-diversity,hemicryptophytes | 1.28 | 1.50 | 0.31 | 0.57 |
| s(elevation):β-diversity,phanerophytes | 3.16 | 3.63 | 3.61 | 0.02 |
| s(elevation):β-diversity,therophytes | 1.00 | 1.00 | 0.75 | 0.39 |
| s(life.form) | 3.61 | 4.00 | 6.61 | <0.01 |
| R-sq.(adj) = 0.43 | Deviance | explained | = 55.8% | |

| **β-deviation = s(elevation, by= life form, k=5) + s(life form, bs="re")** | | | | |
|---|---|---|---|---|
| | Estimate | Std.Error | t-value | Pr(>\|t\|) |
| (Intercept) | 4.55 | 1.40 | 3.26 | <0.01 |
| *Smooth terms* | edf | Ref.df | F | p-value |
| s(elevation):β-diversity deviation,chamaephytes | 1.51 | 1.75 | 3.38 | 0.05 |

| | | | | |
|---|---|---|---|---|
| s(elevation):β-diversity deviation,geophytes | 1.91 | 1.99 | 14.17 | <0.01 |
| s(elevation):β-diversity deviation,hemicryptophytes | 1.89 | 1.99 | 14.33 | <0.01 |
| s(elevation):β-diversity deviation,phanerophytes | 1.76 | 1.94 | 5.37 | 0.02 |
| s(elevation):β-diversity deviation,therophytes | 1.92 | 1.99 | 34.14 | <0.01 |
| s(life.form) | 3.03 | 4.00 | 3.67 | 0.12 |

R-sq.(adj) =0.76 Deviance explained = 81.7%

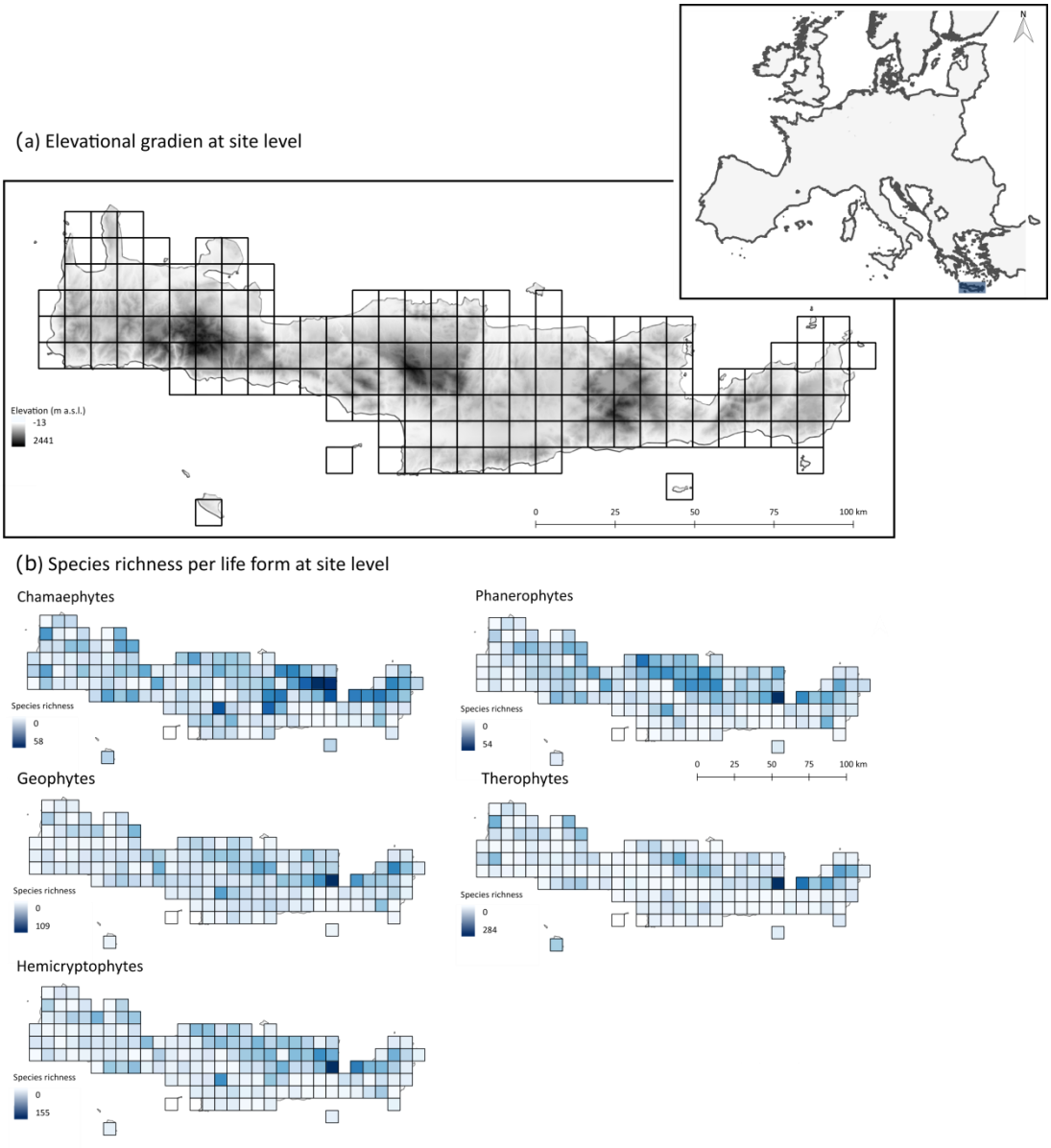



Figure S1 Map of the study area depicting the variation of elevation (a) and the species richness of different life forms (b) at site level in Crete, Greece.

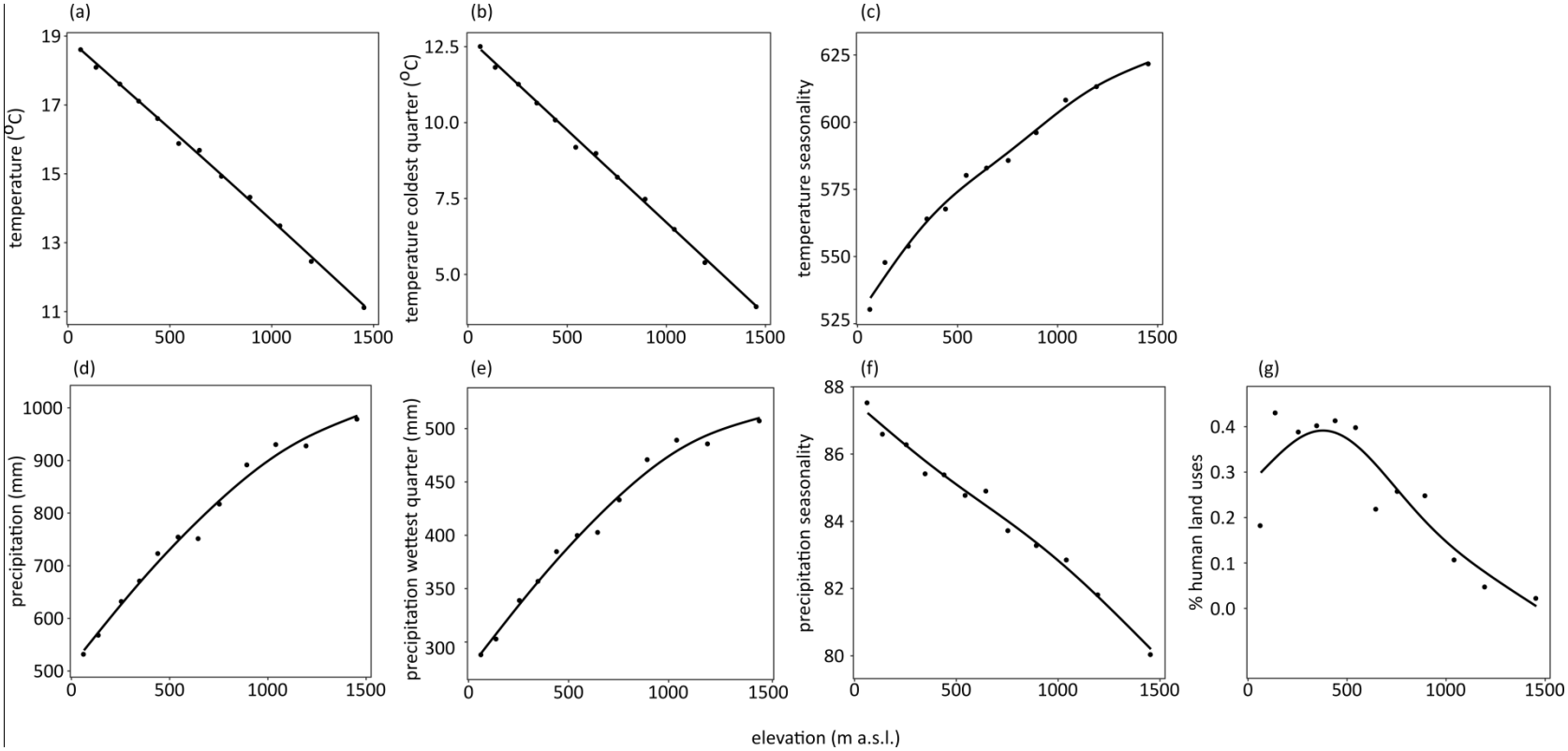



Figure S2 The elevational gradient of (a)-(c) temperature (mean annual temperature, temperature of the coldest quarter, and temperature seasonality) and (d)-(f) precipitation (mean annual precipitation, precipitation of the wettest quarter, and precipitation seasonality) related variables, and % human land uses across the 12 elevational zones in Crete, Greece. Points represent observed values and lines the predicted values by Generalized Additive Models predicting temperature, precipitation and % human land uses as function of elevation (smooth term).

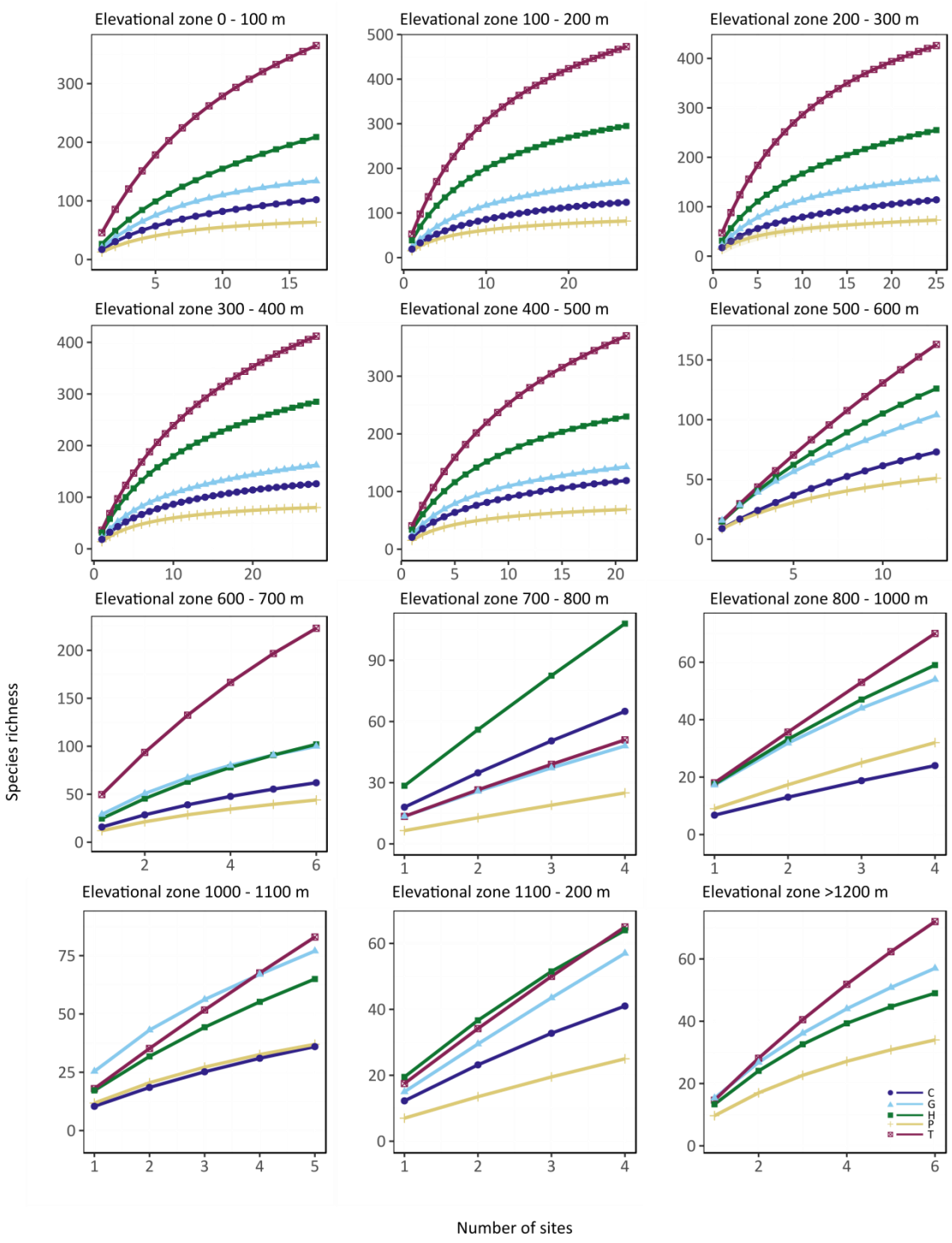
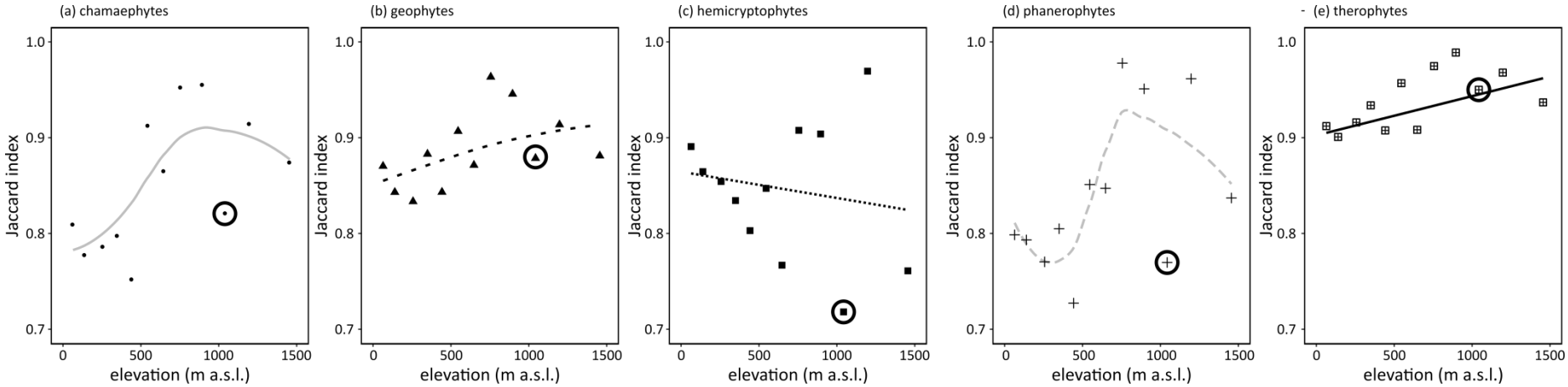



Figure S3. The species accumulation curves of different life forms in the 12 formulated elevational zones in Crete, Greece.


(a) chamaephytes
(b) geophytes
(c) hemicryptophytes
(d) phanerophytes
(e) therophytes
Jaccard index
elevation (m a.s.l.)
1.0
0.9
0.8
0.7
0
500
1000
1500