

**Table S1.** Data for environmental variables used in the present study

| Layer (abbreviation)                         | Description                                                                  | Source <sup>a</sup>                                                                                               |
|----------------------------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| BIO1(°C)                                     | Annual mean temperature: $2.5 \times 2.5$ min                                | WorldClim.org (Fick & Hijmans, 2017)                                                                              |
| BIO2 (°C)                                    | Mean diurnal range: $2.5 \times 2.5$ min                                     |                                                                                                                   |
| BIO3                                         | Isothermality: $2.5 \times 2.5$ min                                          |                                                                                                                   |
| BIO4                                         | Temperature seasonality: $2.5 \times 2.5$ min                                |                                                                                                                   |
| BIO5 (°C)                                    | Maximum temperature of warmest month: $2.5 \times 2.5$ min                   |                                                                                                                   |
| BIO6 (°C)                                    | Minimum temperature of coldest month: $2.5 \times 2.5$ min                   |                                                                                                                   |
| BIO7 (°C)                                    | Temperature annual range: $2.5 \times 2.5$ min                               |                                                                                                                   |
| BIO8 (°C)                                    | Mean temperature of wettest quarter: $2.5 \times 2.5$ min                    |                                                                                                                   |
| BIO9 (°C)                                    | Mean temperature of driest quarter: $2.5 \times 2.5$ min                     |                                                                                                                   |
| BIO10 (°C)                                   | Mean temperature of warmest quarter: $2.5 \times 2.5$ min                    |                                                                                                                   |
| BIO11 (°C)                                   | Mean temperature of coldest quarter: $2.5 \times 2.5$ min                    |                                                                                                                   |
| BIO12 (mm)                                   | Annual precipitation: $2.5 \times 2.5$ min                                   |                                                                                                                   |
| BIO13 (mm)                                   | Precipitation of wettest month: $2.5 \times 2.5$ min                         |                                                                                                                   |
| BIO14 (mm)                                   | Precipitation of driest month: $2.5 \times 2.5$ min                          |                                                                                                                   |
| BIO15 (%)                                    | Precipitation seasonality: $2.5 \times 2.5$ min                              |                                                                                                                   |
| BIO16 (mm)                                   | Precipitation of wettest quarter: $2.5 \times 2.5$ min                       |                                                                                                                   |
| BIO17 (mm)                                   | Precipitation of driest quarter: $2.5 \times 2.5$ min                        |                                                                                                                   |
| BIO18 (mm)                                   | Precipitation of warmest quarter: $2.5 \times 2.5$ min                       |                                                                                                                   |
| BIO19 (mm)                                   | Precipitation of coldest quarter: $2.5 \times 2.5$ min                       |                                                                                                                   |
| SRad ( $\text{kJ m}^{-2} \text{ day}^{-1}$ ) | Solar radiation: $2.5 \times 2.5$ min                                        |                                                                                                                   |
| Elev (m)                                     | Elevation (m): $30 \times 30$ s                                              |                                                                                                                   |
| TR                                           | Global topography – terrain roughness index: $10 \times 10$ km               | Earthenv.org (Amatulli <i>et al.</i> , 2018)                                                                      |
| Slope                                        | Global topography – slope: $10 \times 10$ km                                 |                                                                                                                   |
| Eto ( $\text{mm day}^{-1}$ )                 | Reference evapotranspiration (ETo): $0.5 \times 0.5^\circ$                   | Version 3 of the Global Aridity Index and Potential Evapotranspiration Database (Zomer <i>et al.</i> , 2022)      |
| AI                                           | Aridity index (AI): $0.5 \times 0.5^\circ$                                   |                                                                                                                   |
| FCH (m)                                      | Global Forest Canopy Height, 2019: $30 \times 30$ m                          | The Global Land Analysis and Discovery (GLAD) laboratory (Potapov <i>et al.</i> , 2021)                           |
| Focc                                         | Forests of the World, 2010: $250 \times 250$ m                               | FAO Global Forest Resources Assessments (FAO, 2020)                                                               |
| T-SpH                                        | Top soil pH: $30 \times 30$ s                                                | Harmonized World Soil Database (HWSD) version 2.0 (FAO & IIASA, 2023)                                             |
| S-SOC ( $\text{g kg}^{-1}$ )                 | Soil organic carbon content at depth 0 cm (soil surface): $250 \times 250$ m | International Soil Reference and Information Centre (ISRIC) – World Soil Information (Hengl <i>et al.</i> , 2017) |

<sup>a</sup> References

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**Table S2.** Numerical ranges of 30 continuous variables at different levels of Hymenophyllaceae species richness (e.g. ‘20+’ means 20 or more species within a 100 × 100 km grid cell)

| Environmental variable <sup>a</sup> | Species richness level |             |               |               |
|-------------------------------------|------------------------|-------------|---------------|---------------|
|                                     | 0+                     | 20+         | 40+           | 60+           |
| Grid quantity                       | 2226                   | 203         | 29            | 5             |
| BIO1                                | –3–29                  | 7–27        | 15–23         | 17–22         |
| BIO2                                | 4–17                   | 4–14        | 6–12          | 9–10          |
| BIO3                                | 18–93                  | 28–92       | 38–91         | 78–84         |
| BIO4                                | 13–1534                | 13–450      | 26–337        | 36–70         |
| BIO5                                | 10–38                  | 15–35       | 20–29         | 23–28         |
| BIO6                                | –28–23                 | –2–22       | 5–19          | 11–16         |
| BIO7                                | 6–55                   | 7–22        | 9–20          | 11–13         |
| BIO8                                | 1–29                   | 6–27        | 15–24         | 17–21         |
| BIO9                                | –19–29                 | 4–28        | 12–23         | 17–22         |
| BIO10                               | 5–31                   | 11–28       | 15–24         | 18–23         |
| BIO11                               | –19–28                 | 2–27        | 11–22         | 16–21         |
| BIO12                               | 138–6556               | 997–4902    | 1224–3498     | 1274–3402     |
| BIO13                               | 26–1269                | 142–791     | 160–524       | 160–524       |
| BIO14                               | 0–420                  | 3–259       | 23–207        | 46–96         |
| BIO15                               | 7–150                  | 7–107       | 16–74         | 26–60         |
| BIO16                               | 75–3058                | 375–2033    | 432–1256      | 432–1256      |
| BIO17                               | 0–1367                 | 31–824      | 92–654        | 188–368       |
| BIO18                               | 0–2860                 | 183–2006    | 290–1282      | 290–679       |
| BIO19                               | 0–2456                 | 35–1638     | 102–1291      | 300–883       |
| Elev                                | 0–4645                 | 67–3142     | 795–2158      | 850–1834      |
| Latitude (absolute)                 | 0–67                   | 0–46        | 0–23          | 0–10          |
| SRad                                | 1706–27,855            | 4110–23,416 | 11,648–23,333 | 11,702–19,255 |
| TR                                  | 0–227                  | 1–88        | 22–78         | 27–62         |
| Slope                               | 0–33                   | 0–22        | 7–21          | 7–16          |
| Et0                                 | 370–2919               | 867–1972    | 1035–6667     | 1210–1552     |
| AI                                  | 783–57,350             | 6453–35,668 | 9040–31,158   | 10,755–23,523 |
| FCH                                 | 0–43                   | 1–41        | 10–30         | 16–23         |
| Focc                                | 4–99                   | 1–99        | 6–89          | 34–50         |
| T-SpH                               | 38–82                  | 28–62       | 43–58         | 52–53         |
| S-SOC                               | 0–476                  | 17–261      | 52–142        | 82–118        |

<sup>a</sup> See Table S1 for explanation of codes.

**Table S3.** Numerical ranges of 30 continuous variables at different levels of hymenophylloid and trichomanoid species richness (e.g. ‘20+’ means 20 or more species within a 100 × 100 km grid cell)

| Environmental variable <sup>a</sup> | Species richness level |             |              |              |
|-------------------------------------|------------------------|-------------|--------------|--------------|
|                                     | Hymenophylloid         |             | Trichomanoid |              |
|                                     | 0+                     | 20+         | 0+           | 20+          |
| Grid quantity                       | 1513                   | 39          | 2054         | 55           |
| BIO1                                | –3–28                  | 8–27        | 3–29         | 16–27        |
| BIO2                                | 3–17                   | 5–15        | 4–17         | 6–11         |
| BIO3                                | 18–93                  | 38–91       | 20–93        | 38–92        |
| BIO4                                | 11–1534                | 22–397      | 10–1306      | 23–340       |
| BIO5                                | 6–37                   | 15–35       | 12–38        | 23–34        |
| BIO6                                | –28–24                 | –2–21       | –19–24       | 8–22         |
| BIO7                                | 7–55                   | 9–21        | 6–49         | 8–16         |
| BIO8                                | –2–29                  | 6–27        | 1–29         | 18–26        |
| BIO9                                | –19–29                 | 4–28        | –12–28       | 13–27        |
| BIO10                               | 4–29                   | 10–28       | 7–31         | 19–27        |
| BIO11                               | –19–28                 | 3–27        | –12–28       | 12–26        |
| BIO12                               | 138–6690               | 1185–3585   | 283–6276     | 1315–5032    |
| BIO13                               | 28–1269                | 140–818     | 34–1171      | 157–630      |
| BIO14                               | 0–448                  | 15–196      | 0–381        | 19–246       |
| BIO15                               | 7–143                  | 17–94       | 7–150        | 15–76        |
| BIO16                               | 75–3058                | 370–2099    | 91–3058      | 431–1672     |
| BIO17                               | 0–1517                 | 57–614      | 0–1260       | 92–846       |
| BIO18                               | 0–2860                 | 183–2072    | 15–2414      | 215–1277     |
| BIO19                               | 1–1791                 | 98–1246     | 0–2456       | 116–1551     |
| Elev                                | 0–4645                 | 101–3221    | 0–4123       | 65–1605      |
| Latitude (absolute)                 | 0–67                   | 0–45        | 0–57         | 0–23         |
| SRad                                | 1621–27,855            | 4750–19,818 | 4133–27,549  | 11511–23,329 |
| TR                                  | 0–187                  | 1–86        | 0–306        | 6–75         |
| Slope                               | 0–33                   | 0–22        | 0–39         | 1–20         |
| Et0                                 | 355–2919               | 949–1780    | 618–2577     | 1070–1744    |
| AI                                  | 872–58,079             | 8922–31,482 | 1319–49,854  | 9427–36,558  |
| FCH                                 | 0–41                   | 7–30        | 0–43         | 9–30         |
| Focc                                | 0–99                   | 1–90        | 0–99         | 3–99         |
| T-SpH                               | 9–82                   | 41–56       | 6–80         | 31–58        |
| S-SOC                               | 0–367                  | 20–173      | 0–476        | 20–141       |

<sup>a</sup> See Table S1 for explanation of codes.

**Table S4.** Collinearity and stepwise variance inflation factor selection results

| Variable ( $ r  < 0.7$ ) <sup>a</sup> | Original regression |          |                    | After stepwise regression |          |                    |
|---------------------------------------|---------------------|----------|--------------------|---------------------------|----------|--------------------|
|                                       | Estimate            | Pr(> t ) | Significance level | Estimate                  | Pr(> t ) | Significance level |
| (Intercept)                           |                     | 1.000    |                    |                           | 0.000    | ***                |
| BIO2                                  | 0.039               | 0.119    |                    | 0.053                     | 0.019    | *                  |
| BIO5                                  | −0.303              | 0.000    | ***                | −0.292                    | 0.000    | ***                |
| BIO6                                  | 0.166               | 0.000    | ***                | 0.190                     | 0.000    | ***                |
| BIO14                                 | 0.056               | 0.113    |                    | 0.052                     | 0.031    | *                  |
| BIO16                                 | 0.094               | 0.019    | *                  | 0.091                     | 0.002    | **                 |
| BIO18                                 | 0.083               | 0.025    | *                  | 0.082                     | 0.002    | **                 |
| BIO19                                 | 0.007               | 0.858    |                    |                           |          |                    |
| SRad                                  | 0.051               | 0.039    | *                  | 0.050                     | 0.031    | *                  |
| TR                                    | 0.204               | 0.000    | ***                | 0.201                     | 0.000    | ***                |
| Et0                                   | 0.020               | 0.524    |                    |                           |          |                    |
| FCH                                   | 0.055               | 0.024    | *                  | 0.055                     | 0.017    | *                  |
| Focc                                  | 0.004               | 0.853    |                    |                           |          |                    |
| T-SpH                                 | −0.052              | 0.016    | *                  | −0.046                    | 0.025    | *                  |
| S-SOC                                 | −0.027              | 0.344    |                    |                           |          |                    |
| Adjusted <i>R</i> -squared            | 0.1741              |          |                    | 0.175                     |          |                    |
| AIC                                   | 5908.288            |          |                    | 5901.808                  |          |                    |

AIC, Akaike information criterion.

<sup>a</sup> See Table S1 for explanation of codes.\*,  $p < 0.05$ ; \*\*,  $p < 0.01$ ; \*\*\*,  $p < 0.001$ .

**Table S5.** Results of multipredictor regression models used to investigate Hymenophyllaceae species richness within  $100 \times 100$  km grid cells

| Variable <sup>a</sup>                   | Generalised linear models |          |                    | Simultaneous autoregressive model |          |                    |
|-----------------------------------------|---------------------------|----------|--------------------|-----------------------------------|----------|--------------------|
|                                         | Estimate                  | Pr(> t ) | Significance level | Estimate                          | Pr(> z ) | Significance level |
| (Intercept)                             | 13.87                     | 0.000    | ***                | 19.062                            | 0.000    | ***                |
| BIO2                                    | 0.209                     | 0.000    | ***                | 0.376                             | 0.016    | *                  |
| BIO5                                    | −0.636                    | 0.052    |                    | −0.875                            | 0.000    | ***                |
| BIO6                                    | 0.220                     | 0.000    | ***                | 0.261                             | 0.000    | **                 |
| BIO14                                   | 0.008                     | 0.000    | ***                | 0.006                             | 0.272    |                    |
| BIO16                                   | 0.003                     | 0.059    |                    | 0.001                             | 0.223    |                    |
| BIO18                                   | 0.003                     | 0.005    | **                 | 0.005                             | 0.002    | **                 |
| SRad                                    | 0.000                     | 0.002    | **                 | 0.000                             | 0.025    | *                  |
| TR                                      | 0.086                     | 0.025    | *                  | 0.063                             | 0.000    | ***                |
| FCH                                     | 0.062                     | 0.030    | *                  | 0.056                             | 0.018    | *                  |
| T-SpH                                   | −0.038                    | 0.000    | ***                | −0.036                            | 0.022    | *                  |
| Adjusted <i>R</i> -squared              | 0.1811                    |          |                    |                                   |          |                    |
| AIC                                     | 14,579.23                 |          |                    | 14,226.66                         |          |                    |
| Moran's <i>I</i> statistic <sup>b</sup> | 0.397                     |          |                    | −0.0109                           |          |                    |

AIC, Akaike information criterion.

<sup>a</sup> See Table S1 for explanation of codes.

<sup>b</sup> Moran's  $I > 0$ , with spatial autocorrelation; Moran's  $I \approx 0$  or Moran's  $I < 0$ , no spatial autocorrelation.

\*,  $p < 0.05$ ; \*\*,  $p < 0.01$ ; \*\*\*,  $p < 0.001$ .

**Table S6.** Results of multipredictor regression models used to investigate hymenophylloid species richness within  $100 \times 100$  km grid cells

| Variable <sup>a</sup>                   | Generalised linear models |          |                    | Simultaneous autoregressive model |          |                    |
|-----------------------------------------|---------------------------|----------|--------------------|-----------------------------------|----------|--------------------|
|                                         | Estimate                  | Pr(> t ) | Significance level | Estimate                          | Pr(> z ) | Significance level |
| (Intercept)                             | 9.088                     | 0.000    | ***                | 13.491                            | 0.000    | ***                |
| BIO2                                    | 0.410                     | 0.000    | ***                | 0.450                             | 0.000    | ***                |
| BIO5                                    | -0.419                    | 0.000    | ***                | -0.559                            | 0.000    | ***                |
| BIO6                                    | 0.077                     | 0.008    | **                 | 0.103                             | 0.026    | *                  |
| BIO14                                   | 0.005                     | 0.111    |                    | 0.003                             | 0.589    |                    |
| BIO16                                   | 0.002                     | 0.005    | **                 | 0.002                             | 0.030    | *                  |
| BIO18                                   | 0.001                     | 0.244    |                    | 0.001                             | 0.295    |                    |
| SRad                                    | 0.000                     | 0.349    |                    | 0.000                             | 0.783    |                    |
| TR                                      | 0.036                     | 0.000    | ***                | 0.023                             | 0.002    | **                 |
| FCH                                     | 0.025                     | 0.222    |                    | 0.035                             | 0.078    |                    |
| T-SpH                                   | -0.017                    | 0.178    |                    | -0.022                            | 0.038    | *                  |
| Adjusted <i>R</i> -squared              | 0.1691                    |          |                    |                                   |          |                    |
| AIC                                     | 7673.2                    |          |                    | 7449.4                            |          |                    |
| Moran's <i>I</i> statistic <sup>b</sup> | 0.413                     |          |                    | -0.012                            |          |                    |

AIC, Akaike information criterion.

<sup>a</sup> See Table S1 for explanation of codes.

<sup>b</sup> Moran's  $I > 0$ , with spatial autocorrelation; Moran's  $I \approx 0$  or Moran's  $I < 0$ , no spatial autocorrelation.

\*,  $p < 0.05$ ; \*\*,  $p < 0.01$ ; \*\*\*,  $p < 0.001$ .

**Table S7.** Results of multipredictor regression models used to investigate trichomanoid species richness within  $100 \times 100$  km grid cells

| Variable <sup>a</sup>                   | Generalised linear models |          |                    | Simultaneous autoregressive model |          |                    |
|-----------------------------------------|---------------------------|----------|--------------------|-----------------------------------|----------|--------------------|
|                                         | Estimate                  | Pr(> t ) | Significance level | Estimate                          | Pr(> z ) | Significance level |
| (Intercept)                             | 3.802                     | 0.012    | *                  | 5.945                             | 0.002    | **                 |
| BIO2                                    | 0.008                     | 0.913    |                    | 0.090                             | 0.359    |                    |
| BIO5                                    | −0.249                    | 0.000    | ***                | −0.339                            | 0.000    | ***                |
| BIO6                                    | 0.137                     | 0.000    | ***                | 0.164                             | 0.000    | ***                |
| BIO14                                   | 0.001                     | 0.635    |                    | 0.003                             | 0.379    |                    |
| BIO16                                   | 0.002                     | 0.003    | **                 | 0.001                             | 0.183    |                    |
| BIO18                                   | 0.003                     | 0.000    | ***                | 0.003                             | 0.000    | ***                |
| SRad                                    | 0.000                     | 0.000    | ***                | 0.000                             | 0.002    | **                 |
| TR                                      | 0.030                     | 0.000    | ***                | 0.023                             | 0.000    | ***                |
| FCH                                     | 0.053                     | 0.000    | ***                | 0.043                             | 0.003    | **                 |
| T-SpH                                   | −0.005                    | 0.669    |                    | −0.008                            | 0.421    |                    |
| Adjusted R-squared                      | 0.1425                    |          |                    |                                   |          |                    |
| AIC                                     | 11,018.61                 |          |                    | 10,780.53                         |          |                    |
| Moran's <i>I</i> statistic <sup>b</sup> | 0.358                     |          |                    | −0.012                            |          |                    |

AIC, Akaike information criterion.

<sup>a</sup> See Table S1 for explanation of codes.

<sup>b</sup> Moran's *I* > 0, with spatial autocorrelation; Moran's *I*  $\approx$  0 or Moran's *I* < 0, no spatial autocorrelation.

\*,  $p < 0.05$ ; \*\*,  $p < 0.01$ ; \*\*\*,  $p < 0.001$ .