Supplementary material for: environmental determinants of haemosporidian parasite prevalence in a declining population of tree swallows

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|  |  |
| --- | --- |
| Common name | Binomial name |
| Horned Lark | *Eremophila alpestris* |
| Song sparrow | *Melospiza melodia* |
| Bobolink | *Dolichonyx oryzivorus* |
| Field sparow | *Spizella pusilla* |
| Chipping sparrow | *Spizella passerina* |
| Cliff swallow | *Hirundo pyrrhonota* |
| Tree swallow | *Tachycineta bicolor* |
| Clay-colored sparrow | *Spizella pallida* |
| Ipswich sparrow | *Passerculus sandwichensis* |
| Grasshopper sparrow | *Ammodramus savannarum* |
| Vesper sparrow | *Posoetes gramineus* |
| Le Conte's sparrow | *Ammodramus leconteii* |
| Ring-billed gull | *Larus delawarensis* |
| Red-winged blackbird | *Agelaius phoenicus* |
| American goldfish | *Carduelis tristis* |
| American crow | *Corvus brachyrhynchos* |
| Common starling | *Sturnus vulgaris* |
| Barn swallow | *Hirundo rustica* |
| Chimney swift | *Chaetura pelagica* |
| American robin | *Turdus migratorius* |
| Eastern bluebird | *Sialia sialis* |
| House sparrow | *Passer domesticus* |
| Grey Catbird | *Dumetella carolinensis* |
| Brown Thrasher | *Toxostoma rufum* |
| Alder flycatcher | *Empidonax alnorum* |
| Willow flycatcher | *Empidonax traillii* |
| Yellow warbler | *Dendroica petechia* |
| Common Yellowthroat | *Geothlypis trichas* |
| Indigo bunting | *Passerina cyanea* |
| Killdeer | *Charadrius vociferus* |
| Common Grackle | *Quiscalus quiscula* |
| Eastern Meadowlark | *Sturnella magna* |
| Eastern Kingbird | *Tyrannus tyrannus* |
| Brown-headed Cowbird | *Molothus ater* |

**Table A1** Pre-established list used during the point counts conducted on each farm during the breeding season of 2004 for the estimation of bird abundance and their species richness and diversity.

**Table A2** Description of environmental variables included in the initial adult models before standardization.

|  |  |  |  |
| --- | --- | --- | --- |
| Environmental Variables | Range | Mean | Standard deviation |
| Mean of daily temperature variation (°C) | 9.41 – 19.71 | 13.48 | 1.39 |
| Mean of precipitation (mm) | 0 – 9.58 | 3.48 | 1.27 |
| Mean of livestock | 0 – 30.39 | 3.29 | 6.08 |
| Proportion of nest-box occupied (Avian density) | 0.3 – 1.0 | 0.79 | 0.11 |
| Shannon's equitability | 0.56 – 0.72 | 0.65 | 0.04 |
| Abundance (Number of bird counted) | 110 – 302 | 188.70 | 52.21 |
| Percentage of anthropic areas within 5km | 1.75 – 13.72 | 5.20 | 3.21 |
| Percentage of water bodies within 5km | 0.001 – 11.21 | 1.74 | 2.01 |
| Percentage of extensive cultures within 5km | 10.37 – 43.32 | 24.43 | 7.07 |
| Percentage of anthropic areas within 500m | 0 – 40.82 | 8.57 | 5.59 |
| Percentage of water bodies within 500m | 0 – 7.99 | 0.73 | 1.35 |
| Percentage of extensive cultures within 500m | 0 – 82.64 | 29.12 | 22.56 |
| Percentage of forested areas within 500m | 0 – 68.29 | 16.94 | 17.65 |
| Julian Day | 123 – 205 | 158.70 | 11.47 |

**Table A3** Description of environmental variables included in the initial nestling models before standardization.

|  |  |  |  |
| --- | --- | --- | --- |
| Environmental Variables | Range | Mean | Standard deviation |
| Mean of daily temperature variation (°C) | 11.74 – 15.86 | 13.76 | 1.15 |
| Mean of precipitation (mm) | 2.28 – 5.82 | 3.56 | 1.01 |
| Shannon's equitability | 0.62 – 0.71 | 0.69 | 0.03 |
| Abundance (Number of bird counted) | 110 – 302 | 198.2 | 57.77 |
| Percentage of anthropic areas within 500m | 0.04 – 19.02 | 7.51 | 3.12 |
| Percentage of water bodies within 500m | 0 – 7.94 | 45.49 | 2.34 |
| Percentage of extensive cultures within 500m | 0.43 – 82.24 | 45.49 | 27.28 |
| Percentage of forested areas within 500m | 0 – 55.84 | 13.56 | 10.11 |

**Table A4** Pearson (upper panel) and Spearman (lower panel) correlations between environmental characteristics used in adult models before variable selection following collinearity tests. Coefficients > 0.8 are in bold.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1. Year | 1 | 0.013 | 0.009 | -0.113 | -0.435 | -0.427 | -0.390 | -0.424 | -0.099 | 0.273 | -0.037 | -0.041 |
| 2. Condition(Dead/Alive) | 0.014 | 1 | -0.266 | -0.036 | -0.189 | -0.186 | -0.169 | -0.172 | -0.155 | 0.038 | -0.028 | 0.081 |
| 3. Julian Day | 0.029 | -0.204 | 1 | -0.135 | 0.607 | 0.547 | 0.664 | 0.449 | 0.335 | -0.027 | 0.022 | 0.019 |
| 4. Daily temperature variation | -0.116 | -0.044 | -0.108 | 1 | 0.254 | 0.428 | -0.277 | 0.584 | 0.124 | 0.078 | 0.043 | -0.103 |
| 5. Daily temperature | -0.459 | -0.125 | 0.538 | 0.304 | 1 | **0.955** | **0.848** | **0.924** | 0.260 | 0.002 | -0.001 | -0.063 |
| 6. Diurnal temperature | -0.451 | -0.121 | 0.471 | 0.461 | **0.938** | 1 | 0.706 | **0.947** | 0.272 | -0.005 | 0.011 | -0.082 |
| 7. Minimum daily temperature | -0.414 | -0.131 | 0.619 | -0.157 | **0.855** | 0.701 | 1 | 0.617 | 0.221 | -0.038 | 0.011 | 0.039 |
| 8. Maximum daily temperature | -0.441 | -0.106 | 0.373 | 0.618 | **0.909** | **0.933** | 0.616 | 1 | 0.290 | 0.030 | 0.049 | -0.051 |
| 9. Mean precipitation | -0.074 | -0.137 | 0.380 | 0.103 | 0.274 | 0.269 | 0.235 | 0.268 | 1 | -0.078 | 0.130 | 0.015 |
| 10. Avian density | 0.300 | 0.040 | -0.044 | 0.123 | -0.008 | -0.021 | -0.053 | 0.017 | -0.110 | 1 | -0.046 | 0.028 |
| 11. Shannon's equitability | -0.028 | -0.026 | 0.036 | 0.073 | 0.000 | 0.030 | -0.013 | 0.064 | 0.085 | 0.005 | 1 | 0.088 |
| 12. Nb. of bird counted | -0.036 | 0.069 | 0.004 | -0.046 | -0.035 | -0.060 | 0.013 | -0.007 | -0.057 | 0.010 | 0.048 | 1 |
| 13. Nb. of bird species counted | -0.077 | 0.021 | -0.031 | 0.012 | -0.060 | -0.035 | -0.031 | 0.026 | -0.008 | -0.111 | 0.407 | 0.530 |
| 14. Water bodies 5km | 0.027 | -0.048 | 0.013 | 0.188 | -0.062 | -0.006 | -0.145 | 0.006 | -0.014 | -0.081 | 0.184 | -0.006 |
| 15. Extensive cultures 5km | -0.085 | 0.008 | 0.055 | -0.186 | -0.045 | -0.035 | 0.053 | -0.082 | 0.209 | -0.065 | 0.132 | -0.004 |
| 16. Anthropic areas 5km | 0.015 | -0.014 | 0.005 | -0.003 | 0.020 | -0.011 | 0.000 | -0.011 | 0.130 | -0.158 | 0.072 | -0.234 |
| 17. Intensive cultures 5km | 0.073 | 0.083 | -0.068 | 0.062 | 0.107 | 0.094 | 0.059 | 0.107 | -0.336 | 0.120 | -0.130 | 0.032 |
| 18. Forested areas 5km | -0.067 | -0.097 | 0.045 | 0.026 | -0.106 | -0.081 | -0.093 | -0.071 | 0.300 | 0.014 | 0.078 | 0.068 |
| 19. Extensive cultures 500m | -0.100 | 0.048 | 0.009 | 0.016 | -0.151 | -0.117 | -0.130 | -0.090 | 0.186 | -0.215 | 0.260 | 0.380 |
| 20. Anthropic areas 500m | 0.067 | 0.036 | 0.018 | -0.011 | 0.006 | -0.023 | 0.028 | -0.009 | 0.063 | -0.027 | 0.017 | 0.048 |
| 21. Intensive cultures 500m | 0.067 | -0.011 | -0.029 | -0.066 | 0.116 | 0.081 | 0.114 | 0.060 | -0.279 | 0.161 | -0.204 | -0.149 |
| 22. Forested areas 500m | -0.041 | -0.052 | 0.023 | 0.074 | -0.012 | 0.005 | -0.036 | 0.004 | 0.302 | 0.061 | 0.025 | -0.166 |
| 23. Water bodies 500m | 0.097 | -0.102 | 0.026 | 0.132 | 0.004 | 0.043 | -0.081 | 0.053 | -0.054 | 0.132 | 0.166 | -0.118 |
| 24. Mean nb. of livestock | 0.017 | 0.051 | 0.029 | 0.022 | 0.002 | 0.030 | -0.013 | 0.032 | 0.135 | 0.085 | 0.140 | 0.105 |

**Table A4** (*continued*)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 1. Year | -0.074 | 0.023 | -0.077 | 0.016 | 0.078 | -0.072 | -0.100 | 0.085 | 0.073 | -0.033 | 0.121 | -0.042 |
| 2. Condition(Dead/Alive) | 0.020 | -0.054 | 0.009 | -0.014 | 0.090 | -0.100 | 0.030 | 0.080 | -0.007 | -0.047 | -0.072 | 0.014 |
| 3. Julian Day | -0.009 | 0.044 | 0.070 | 0.007 | -0.070 | 0.050 | 0.014 | 0.005 | -0.037 | 0.045 | -0.017 | -0.013 |
| 4. Daily temperature variation | 0.007 | 0.172 | -0.198 | 0.044 | 0.059 | -0.005 | -0.028 | 0.000 | -0.042 | 0.095 | 0.161 | 0.065 |
| 5. Daily temperature | -0.051 | 0.029 | -0.031 | 0.021 | 0.078 | -0.085 | -0.156 | 0.016 | 0.099 | 0.031 | -0.075 | -0.023 |
| 6. Diurnal temperature | -0.040 | 0.077 | -0.035 | 0.003 | 0.067 | -0.070 | -0.135 | 0.000 | 0.066 | 0.063 | -0.030 | 0.000 |
| 7. Minimum daily temperature | -0.004 | -0.068 | 0.085 | -0.032 | 0.035 | -0.066 | -0.116 | 0.027 | 0.102 | -0.023 | -0.163 | -0.059 |
| 8. Maximum daily temperature | 0.008 | 0.083 | -0.085 | 0.008 | 0.076 | -0.059 | -0.119 | 0.022 | 0.051 | 0.059 | -0.007 | 0.004 |
| 9. Mean precipitation | 0.023 | -0.006 | 0.199 | 0.096 | -0.310 | 0.288 | 0.166 | 0.063 | -0.285 | 0.262 | -0.100 | 0.039 |
| 10. Avian density | -0.019 | -0.191 | -0.050 | -0.228 | 0.075 | -0.015 | -0.235 | -0.031 | 0.196 | -0.027 | 0.011 | -0.022 |
| 11. Shannon's equitability | 0.511 | 0.117 | 0.132 | 0.086 | -0.128 | 0.098 | 0.342 | 0.077 | -0.257 | -0.029 | 0.076 | 0.202 |
| 12. Nb. of bird counted | 0.584 | -0.112 | 0.081 | -0.237 | -0.008 | 0.048 | 0.408 | 0.137 | -0.179 | -0.249 | -0.149 | 0.128 |
| 13. Nb. of bird species counted | 1 | 0.017 | 0.189 | -0.272 | -0.027 | 0.026 | 0.373 | -0.166 | -0.167 | -0.139 | -0.008 | 0.030 |
| 14. Water bodies 5km | -0.023 | 1 | -0.060 | 0.282 | -0.095 | -0.010 | -0.005 | -0.084 | -0.010 | 0.048 | 0.011 | -0.181 |
| 15. Extensive cultures 5km | 0.152 | 0.011 | 1 | 0.134 | -0.602 | 0.326 | 0.408 | -0.030 | -0.411 | 0.209 | -0.253 | 0.302 |
| 16. Anthropic areas 5km | -0.331 | 0.275 | 0.279 | 1 | -0.300 | 0.118 | 0.305 | 0.081 | -0.337 | 0.165 | -0.078 | 0.407 |
| 17. Intensive cultures 5km | 0.023 | -0.259 | -0.592 | -0.410 | 1 | **-0.930** | -0.620 | 0.184 | 0.784 | -0.620 | 0.189 | -0.329 |
| 18. Forested areas 5km | 0.018 | 0.128 | 0.293 | 0.102 | **-0.879** | 1 | 0.573 | -0.215 | -0.763 | 0.648 | -0.117 | 0.251 |
| 19. Extensive cultures 500m | 0.350 | 0.167 | 0.431 | 0.267 | -0.624 | 0.530 | 1 | -0.080 | -0.799 | 0.120 | -0.110 | 0.495 |
| 20. Anthropic areas 500m | -0.235 | 0.022 | -0.074 | 0.088 | 0.114 | -0.152 | -0.029 | 1 | -0.104 | -0.040 | 0.036 | -0.095 |
| 21. Intensive cultures 500m | -0.154 | -0.182 | -0.425 | -0.325 | 0.771 | -0.700 | **-0.840** | -0.129 | 1 | -0.662 | 0.102 | -0.385 |
| 22. Forested areas 500m | -0.042 | 0.039 | 0.325 | 0.155 | -0.658 | 0.673 | 0.317 | 0.023 | -0.710 | 1 | -0.122 | 0.060 |
| 23. Water bodies 500m | -0.142 | -0.008 | -0.146 | 0.042 | 0.012 | 0.067 | -0.217 | -0.055 | 0.127 | -0.008 | 1 | -0.075 |
| 24. Mean nb. of livestock | 0.004 | -0.106 | 0.350 | 0.266 | -0.458 | 0.408 | 0.517 | -0.129 | -0.483 | 0.278 | 0.026 | 1 |

**Table A5** Pearson (upper panel) and Spearman (lower panel) correlations between environmental characteristics used in nestling models before variables selection following collinearity tests. Coefficients > 0.8 are in bold.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1. Daily temperature variation | 1 | -0.239 | 0.301 | **-0.826** | 0.524 | 0.120 | 0.090 | -0.104 | -0.424 | 0.015 | -0.060 | -0.374 |
| 2. Daily temperature | -0.191 | 1 | **0.815** | 0.734 | 0.686 | 0.124 | 0.597 | -0.154 | -0.609 | -0.685 | -0.467 | -0.462 |
| 3. Diurnal temperature | 0.314 | 0.738 | 1 | 0.241 | **0.897** | 0.065 | 0.503 | -0.248 | -0.735 | -0.559 | -0.252 | -0.756 |
| 4. Minimum daily temperature | **-0.833** | 0.660 | 0.126 | 1 | 0.048 | 0.071 | 0.312 | 0.004 | -0.047 | -0.372 | -0.281 | -0.002 |
| 5. Maximum daily temperature | 0.360 | 0.726 | **0.955** | 0.111 | 1 | 0.320 | 0.631 | -0.178 | **-0.821** | -0.535 | -0.530 | -0.666 |
| 6. Mean precipitation | 0.335 | 0.108 | 0.068 | -0.142 | 0.225 | 1 | 0.568 | -0.045 | -0.126 | 0.025 | -0.483 | -0.165 |
| 7. Avian density | 0.157 | 0.706 | 0.615 | 0.274 | 0.622 | 0.256 | 1 | 0.202 | -0.570 | -0.511 | -0.768 | -0.275 |
| 8. Shannon's equitability | -0.168 | -0.316 | -0.409 | -0.003 | -0.419 | -0.509 | -0.074 | 1 | 0.331 | 0.378 | -0.159 | 0.535 |
| 9. Nb. of bird counted | -0.295 | -0.442 | -0.549 | 0.058 | -0.507 | 0.192 | -0.496 | 0.232 | 1 | **0.859** | 0.512 | 0.607 |
| 10. Nb. of bird species counted | 0.039 | -0.648 | -0.418 | -0.324 | -0.370 | 0.080 | -0.648 | 0.244 | **0.824** | 1 | 0.491 | 0.368 |
| 11. Water bodies 5km | -0.085 | -0.669 | -0.344 | -0.334 | -0.449 | -0.439 | **-0.827** | 0.097 | 0.360 | 0.618 | 1 | -0.059 |
| 12. Extensive cultures 5km | -0.215 | -0.472 | -0.723 | -0.053 | -0.701 | -0.272 | -0.394 | 0.760 | 0.448 | 0.317 | 0.154 | 1 |
| 13. Anthropic areas 5km | -0.097 | -0.002 | -0.193 | 0.011 | -0.269 | -0.563 | -0.039 | 0.283 | -0.512 | -0.580 | -0.066 | 0.321 |
| 14. Intensive cultures 5km | 0.154 | 0.306 | 0.694 | 0.020 | 0.625 | -0.023 | 0.325 | -0.340 | -0.185 | 0.050 | 0.083 | -0.694 |
| 15. Forested areas 5km | -0.309 | -0.020 | -0.421 | 0.312 | -0.329 | 0.500 | 0.068 | 0.203 | 0.637 | 0.233 | -0.275 | 0.401 |
| 16. Extensive cultures 500m | -0.154 | -0.303 | -0.676 | -0.008 | -0.588 | 0.004 | -0.353 | 0.382 | 0.202 | 0.000 | -0.067 | 0.716 |
| 17. Anthropic areas 500m | 0.141 | -0.137 | 0.230 | -0.180 | 0.137 | -0.176 | -0.032 | 0.039 | 0.082 | 0.203 | 0.399 | -0.163 |
| 18. Intensive cultures 500m | 0.143 | 0.425 | 0.703 | 0.094 | 0.669 | 0.074 | 0.337 | -0.510 | -0.291 | -0.090 | -0.068 | -0.772 |
| 19. Forested areas 500m | -0.143 | -0.188 | -0.396 | 0.064 | -0.364 | 0.170 | 0.071 | 0.533 | 0.544 | 0.308 | -0.152 | 0.609 |
| 20. Water bodies 500m | 0.510 | 0.278 | 0.623 | -0.266 | 0.658 | 0.280 | 0.455 | -0.287 | -0.324 | -0.111 | -0.271 | -0.545 |
| 21. Mean nb. of livestock | -0.048 | 0.434 | 0.039 | 0.256 | 0.070 | -0.048 | 0.419 | 0.026 | -0.578 | **-0.827** | -0.650 | 0.123 |

**Table A5** *(continued)*

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 1. Daily temperature variation | 0.105 | 0.412 | -0.426 | -0.304 | 0.075 | 0.297 | -0.145 | 0.461 | 0.093 |
| 2. Daily temperature | 0.012 | 0.319 | -0.239 | -0.479 | 0.192 | 0.499 | -0.224 | 0.220 | 0.039 |
| 3. Diurnal temperature | -0.093 | 0.683 | -0.611 | -0.738 | 0.363 | 0.734 | -0.319 | 0.575 | -0.110 |
| 4. Minimum daily temperature | -0.095 | -0.126 | 0.197 | -0.070 | 0.016 | 0.095 | -0.037 | -0.207 | -0.055 |
| 5. Maximum daily temperature | 0.043 | 0.540 | -0.457 | -0.644 | 0.156 | 0.670 | -0.312 | 0.504 | 0.082 |
| 6. Mean precipitation | -0.385 | -0.185 | 0.416 | -0.291 | -0.269 | 0.217 | 0.274 | -0.053 | -0.243 |
| 7. Avian density | 0.070 | -0.023 | 0.163 | -0.452 | -0.019 | 0.335 | 0.294 | -0.022 | 0.139 |
| 8. Shannon's equitability | 0.275 | -0.484 | 0.411 | 0.294 | 0.009 | -0.353 | 0.288 | -0.383 | 0.186 |
| 9. Nb. of bird counted | -0.319 | -0.509 | 0.491 | 0.498 | -0.041 | -0.561 | 0.342 | -0.396 | -0.319 |
| 10. Nb. of bird species counted | -0.439 | -0.244 | 0.249 | 0.239 | -0.009 | -0.283 | 0.186 | -0.128 | -0.447 |
| 11. Water bodies 5km | -0.419 | 0.272 | -0.322 | -0.003 | 0.304 | -0.020 | -0.070 | 0.186 | -0.566 |
| 12. Extensive cultures 5km | 0.463 | **-0.903** | 0.762 | **0.901** | -0.278 | **-0.924** | 0.416 | -0.703 | 0.477 |
| 13. Anthropic areas 5km | 1 | -0.372 | 0.165 | 0.592 | -0.152 | -0.507 | -0.061 | -0.280 | **0.967** |
| 14. Intensive cultures 5km | -0.559 | 1 | **-0.960** | -0.793 | 0.345 | **0.862** | -0.570 | 0.754 | -0.436 |
| 15. Forested areas 5km | -0.287 | -0.478 | 1 | 0.624 | -0.353 | -0.724 | 0.632 | -0.713 | 0.261 |
| 16. Extensive cultures 500m | 0.523 | **-0.952** | 0.436 | 1 | -0.265 | **-0.941** | 0.161 | -0.579 | 0.607 |
| 17. Anthropic areas 500m | -0.246 | 0.395 | -0.114 | -0.368 | 1 | 0.163 | -0.153 | 0.460 | -0.238 |
| 18. Intensive cultures 500m | -0.505 | **0.903** | -0.487 | **-0.894** | 0.194 | 1 | -0.457 | 0.555 | -0.522 |
| 19. Forested areas 500m | -0.124 | -0.369 | 0.707 | 0.275 | -0.130 | -0.500 | 1 | -0.373 | -0.027 |
| 20. Water bodies 500m | -0.286 | 0.532 | -0.261 | -0.501 | 0.342 | 0.495 | -0.229 | 1 | -0.316 |
| 21. Mean nb. of livestock | 0.733 | -0.506 | 0.004 | 0.502 | -0.410 | -0.327 | -0.121 | -0.113 | 1 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PLASMODIUM | | | |  | LEUCOCYTOZOON | | | |  |
| Variables | Estimates | SE | z\_value | p\_value |  | Estimates | SE | z\_value | p\_value |  |
| Intercept | **-2.466** | **0.116** | **-21.189** | **< 0.001** |  | **-2.227** | **0.112** | **-19.922** | **< 0.001** |  |
| Year | -0.042 | 0.124 | -0.343 | 0.732 |  | 0.075 | 0.104 | 0.728 | 0.467 |  |
| Condition (Dead/Alive) | NA | NA | NA | NA |  | 0.653 | 0.494 | 1.321 | 0.187 |  |
| Julian Day of blood sample | 0.164 | 0.110 | 1.488 | 0.137 |  | 0.026 | 0.108 | 0.238 | 0.812 |  |
| Daily temperature variation | -0.045 | 0.129 | -0.349 | 0.727 |  | **-0.320** | **0.115** | **-2.789** | **0.005** |  |
| Mean precipitation | -0.194 | 0.135 | -1.442 | 0.149 |  | 0.179 | 0.105 | 1.697 | 0.090 |  |
| Avian density | 0.038 | 0.120 | 0.319 | 0.750 |  | -0.109 | 0.101 | -1.084 | 0.278 |  |
| Shannon's equitability | 0.080 | 0.123 | 0.655 | 0.512 |  | -0.020 | 0.105 | -0.190 | 0.849 |  |
| Nb. of bird counted | 0.014 | 0.163 | 0.090 | 0.929 |  | 0.048 | 0.140 | 0.345 | 0.730 |  |
| Water bodies 5km | -0.114 | 0.117 | -0.976 | 0.329 |  | -0.077 | 0.131 | -0.586 | 0.558 |  |
| Extensive cultures 5km | -0.062 | 0.130 | -0.476 | 0.634 |  | 0.142 | 0.122 | 1.169 | 0.242 |  |
| Anthropic areas 5km | 0.103 | 0.129 | 0.796 | 0.426 |  | 0.091 | 0.113 | 0.804 | 0.421 |  |
| Extensive cultures 500m | -0.215 | 0.118 | -1.820 | 0.069 |  | **0.546** | **0.092** | **5.930** | **< 0.001** |  |
| Anthropic areas 500m | **-0.302** | **0.135** | **-2.238** | **0.025** |  | -0.223 | 0.126 | -1.766 | 0.077 |  |
| Forested areas 500m | 0.154 | 0.114 | 1.353 | 0.176 |  | **0.230** | **0.100** | **2.295** | **0.023** |  |
| Water bodies 500m | 0.041 | 0.115 | 0.357 | 0.720 |  | 0.057 | 0.117 | 0.467 | 0.640 |  |
| Mean nb. of livestock | -0.051 | 0.159 | -0.321 | 0.748 |  | -0.147 | 0.113 | -1.300 | 0.194 |  |
| Temperature variation X Precipitation | -0.098 | 0.108 | -0.904 | 0.366 |  | 0.083 | 0.089 | 0.926 | 0.354 |  |

**Table A6** Full linear models of environmental factors effects on infection status of Tree swallow adults. All explanatory variables were standardized. Bold variables were included in the final models. No random variable was significant in these models.

**Table A7** Final models of environmental factors effects on haemosporidian parasites infection status of Tree swallow adults, without dead individuals, for all parasites of each genera and for the most common lineage of each genera.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PLASMODIUM | | | |  | SEIAUR01 | | | |  |
| Variables | Estimates | SE | z\_value | p\_value |  | Estimates | SE | z\_value | p\_value |  |
| Intercept | -2.428 | 0.116 | -20.903 | < 0.001 |  | -3.677 | 0.208 | -17.693 | < 0.001 |  |
| Anthropic areas 500m | -0.286 | 0.133 | -2.161 | 0.031 |  | -0.389 | 0.242 | -1.611 | 0.107 |  |
|  | LEUCOCYTOZOON | | | |  | CB1 | | | |  |
| Variables | Estimates | SE | z\_value | p\_value |  | Estimates | SE | z\_value | p\_value |  |
| Intercept | -2.242 | 0.114 | -19.638 | < 0.001 |  | -2.379 | 0.121 | -19.673 | < 0.001 |  |
| Daily temperature variation | -0.265 | 0.115 | -2.305 | 0.021 |  | -0.253 | 0.121 | -2.098 | 0.036 |  |
| Extensive cultures 500m | 0.545 | 0.095 | 5.757 | < 0.001 |  | 0.537 | 0.100 | 5.373 | < 0.001 |  |
| Forested areas 500m | 0.254 | 0.102 | 2.506 | 0.012 |  | 0.275 | 0.106 | 2.590 | 0.01 |  |

**Table A8** Full linear mixed models of environmental factors effects on infection status of Tree swallow nestlings. Nest-box identity was included as a random effect. All explanatory variables were standardized. Bold variables were included in the final models.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PLASMODIUM | | | |  | LEUCOCYTOZOON | | | |  | ALL GENERA | | | |
| Variables | Estimates | SE | z\_value | p\_value |  | Estimates | SE | z\_value | p\_value |  | Estimates | SE | z\_value | p\_value |
| Intercept | **-5.863** | **1.880** | **-3.118** | **0.002** |  | **-3.310** | **0.694** | **-4.769** | **< 0.001** |  | **-2.301** | **0.427** | **-5.390** | **< 0.001** |
| Year | NA | NA | NA | NA |  | NA | NA | NA | NA |  | NA | NA | NA | NA |
| Condition (Dead/Alive) | NA | NA | NA | NA |  | NA | NA | NA | NA |  | NA | NA | NA | NA |
| Julian Day of blood sample | NA | NA | NA | NA |  | NA | NA | NA | NA |  | NA | NA | NA | NA |
| Daily temperature variation | -0.626 | 0.962 | -0.651 | 0.515 |  | -0.308 | 0.409 | -0.754 | 0.451 |  | -0.524 | 0.413 | -1.270 | 0.204 |
| Mean precipitation | 0.210 | 0.551 | 0.381 | 0.703 |  | 0.494 | 0.346 | 1.429 | 0.153 |  | **0.744** | **0.306** | **2.428** | **0.015** |
| Avian density | NA | NA | NA | NA |  | NA | NA | NA | NA |  | NA | NA | NA | NA |
| Shannon's equitability | 1.847 | 1.027 | 1.799 | 0.072 |  | 0.356 | 0.431 | 0.827 | 0.408 |  | 0.391 | 0.327 | 1.196 | 0.232 |
| Nb. of bird counted | -0.051 | 0.891 | -0.058 | 0.954 |  | -0.379 | 0.423 | -0.894 | 0.371 |  | -0.369 | 0.361 | -1.021 | 0.307 |
| Water bodies 5km | NA | NA | NA | NA |  | NA | NA | NA | NA |  | NA | NA | NA | NA |
| Extensive cultures 5km | NA | NA | NA | NA |  | NA | NA | NA | NA |  | NA | NA | NA | NA |
| Anthropic areas 5km | NA | NA | NA | NA |  | NA | NA | NA | NA |  | NA | NA | NA | NA |
| Extensive cultures 500m | -0.628 | 0.690 | -0.910 | 0.363 |  | 0.468 | 0.433 | 1.082 | 0.279 |  | 0.494 | 0.506 | 0.098 | 0.922 |
| Anthropic areas 500m | -1.083 | 0.650 | -1.665 | 0.096 |  | -0.108 | 0.399 | -0.271 | 0.786 |  | -0.364 | 0.354 | -1.028 | 0.304 |
| Forested areas 500m | -0.747 | 1.410 | -0.530 | 0.596 |  | 0.338 | 0.326 | 1.034 | 0.301 |  | 0.511 | 0.383 | 1.336 | 0.181 |
| Water bodies 500m | 1.116 | 0.934 | 1.195 | 0.232 |  | 0.362 | 0.737 | 0.492 | 0.622 |  | 0.399 | 0.404 | 0.986 | 0.324 |
| Mean nb. of livestock | NA | NA | NA | NA |  | NA | NA | NA | NA |  | NA | NA | NA | NA |
| Temperature variation X Precipitation | 5.452 | 3.968 | 1.374 | 0.169 |  | -3.645 | 3.425 | -1.064 | 0.287 |  | 2.080 | 2.063 | 1.008 | 0.313 |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Source Paper** | **Host Population** | **Technique of capture** | **Type of detection** | **Nb. of year** | **Haemosporidian parasite genus/species identified** | **Sample Size** | **Nb. of Individuals infected** | **Prevalence** |
| Szymanski & Lovette 2005 | Freeville, USA | Directly in nest boxes | Nested PCR | 1 | *Haemoproteus* spp., *Plasmodium* spp. | 89 | 43 | 0.48 |
| Ellis *et al.* 2017 | Chicago, USA | Mist-nets | PCR | 16 | *Haemoproteus* spp., *Plasmodium* spp. | 5 | 0 | 0 |
| Ellis *et al.* 2017 | Connecticut, USA | Mist-nets | PCR | 16 | *Haemoproteus* spp., *Plasmodium* spp. | 1 | 0 | 0 |
| Ellis *et al.* 2017 | Tennessee, USA | Mist-nets | PCR | 16 | *Haemoproteus* spp., *Plasmodium* spp. | 8 | 0 | 0 |
| Matthews *et al.* 2015 | Tennessee, USA | Mist-nets | PCR | 1 | *Haemoproteus* spp., *Plasmodium* spp. | 8 | 0 | 0 |
| Medeiros *et al.* 2015 | Chicago, USA | Mist-nets | PCR | 2 | *Plasmodium* spp. | 3 | 0 | 0 |
| Herman 1938 | Cape Cod, USA | Captured in traps | Blood smears | NA | Undetermined | 74 | 2 | 0.03 |
| Barnard & Bair 1986 | Vermont, USA | Traps or mist-nets | Blood smears | 4 | *Leucocytozoon* spp. | 25 | 5 | 0.20 |
| Murdock 2005 | Gothic, USA | Potter traps and Mist-nets | Blood smears | 2 | *L. fringillinarum*,  *L. majoris* | 5 | 4 | 0.80 |
| Greiner *et al*. 1975 | North America | NA | Blood smears | NA | *Leucocytozoon* spp. | 91 | 1 | 0.01 |

**Table A9** Summary of surveys conducted in North America for which haemosporidian parasite prevalence data were available for Tree swallows. Technique of capture: method used to capture birds. Type of detection: method used to detect parasites. Nb. of year: number of year over which data were obtained.

**Table A10** Summary of anterior localizations and taxonomic order of hosts (Number of avian family) found in MalAvi database for *Plasmodium* and *Leucocytozoon* lineages detected in this study.

|  |  |  |
| --- | --- | --- |
| **Lineage Name** | **Continent** | **Order (Nb. of Family)** |
| BT7 | North America | Anseriformes (1) |
|  |  | Charadriiformes (2) |
|  |  | Falconiformes (1) |
|  |  | Passeriformes (5) |
|  | Europe | Passeriformes (3) |
|  |  | Falconiformes (1) |
|  | Asia | Passeriformes (5) |
| CATUST05 | North America | Passeriformes (1) |
|  | South America | Passeriformes (2) |
| GEOTRI09 | North America | Passeriformes (2) |
| PADOM11 | North America | Passeriformes (3) |
|  |  | Sphenisciformes (1) |
|  |  | Strigiformes (1) |
|  | South America | Passeriformes (7) |
| SEIAUR01\* | North America | Passeriformes (7) |
|  |  | Strigiformes (2) |
| SGS1\* | South America | Passeriformes (4) |
|  |  | Procellariiformes (1) |
|  |  | Trochiliformes (1) |
|  | Oceania | Passeriformes (3) |
|  | Europe | Passeriformes (13) |
|  |  | Strigiformes (1) |
|  |  | Columbiformes (1) |
|  |  | Ciconiiformes (2) |
|  |  | Charadriiformes (3) |
|  |  | Anseriformes (1) |
|  |  | Diptera (Culicidae) |
|  | Asia | Passeriformes (10) |
|  |  | Charadriiformes (1) |
|  |  | Diptera (Culicidae) |
|  | Africa | Passeriformes (9) |

|  |  |  |
| --- | --- | --- |
| STVAR04 | North America | Strigiformes (1) |
| WW3 | North America | Passeriformes (4) |
|  | Europe | Passeriformes (4) |
|  | Africa | Passeriformes (6) |
| CB1\* | North America | Passeriformes (6) |
|  |  | Diptera (Simullidae) |
|  | Europe | Passeriformes (2) |
| TABI09 | North America | Passeriformes (1) |
|  |  | Diptera (Simuliidae) |
| \* SEIAUR01 : *P. cathemerium*; SGS1: *P. relictum*; CB1 : *L. majoris* | | |

**Table A10** *(continued)*



**Figure A1** Relationship between the probability that birds were infected by *Plasmodium* (final model R2 = 0.01, A; dashed line) or *Leucocytozoon* parasites (final model R2= 0.09, B-D; solid line) separately, modelled using logistic regressions (black dots represent mean ± standard error), and standardized environmental variables: A) Percentage of anthropic areas within 500m, B) Mean of daily temperature variation, C) Percentage of extensive cultures within 500m, and D) Percentage of forested areas within 500m in adult Tree swallows, without data on dead individuals, southern Québec, Canada, 2012-2015. Gray areas depict the 95% confidence intervals of predictions.



**Figure A2** Relationship between the probability that birds were infected by the lineage CB1 (*Leucocytozoon majoris*; final model R2 = 0.08) modelled using a logistic regression (black dots represent mean ± standard error), and standardized environmental variables: A) Mean of daily temperature variation, B) Percentage of extensive cultures within 500m, and C) Percentage of forested areas within 500m in adult Tree swallows, without data on dead individuals, southern Québec, Canada, 2012-2015. Gray areas depict the 95% confidence intervals of predictions.