**Supplementary File 1a**.Maximal activities (µmol/g tissue/min), body mass (g) and myoglobin (Mb; mg/g tissue) concentration in pectoralis muscle.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  **Cinnamon teal**  |  **Yellow-billed** **pintail** |  **Ruddy duck** |  **Crested duck** | **Puna teal (H)** **Silver teal (L)** |  **Speckled teal** | **Andean goose (H)****Magellan goose (L)** |
|  | **LA** | **HA** | **LA** | **HA** | **LA** | **HA** | **LA** | **HA** | **LA** | **HA** | **LA** | **HA** | **LA** | **HA** |
| Mass  | 515.5± 24.5 | 510.83± 9.57 | 793.0± 18.46 | 685.83± 15.1 | 631.5± 18.32 | 824.17± 38.91 | 954.5± 29.8 | 1038.63± 39.35 | 435.0± 9.43 | 468.57± 9.31 | 435.5± 12.17 | 413.75± 12.23 | 2701.7± 221.36 | 2503.85± 150.28 |
| Mb | 4.80± 0.45 | 5.40± 0.36 | 9.96± 0.23 | 9.41± 0.45 | 7.24± 0.35 | 6.88± 0.44 | 7.37± 0.46 | ***\*9.70******± 0.67*** | 6.01± 0.24 | 7.29± 0.49 | 6.58± 0.55 | 7.99± 0.47 | 8.77± 0.80 | 9.66± 0.82 |
| ***Carbohydrate metabolism*** |
| HK | 0.399± 0.050 | ***\*0.881******± 0.038*** | 0.398± 0.068 | ***\*0.897******± 0.093*** | 1.281± 0.156 | 1.184± 0.114 | 0.474± 0.078 | ***\*1.686******± 0.148*** | 0.410± 0.046 | 0.565± 0.110 | 0.359± 0.057 | 0.439± 0.057 | 0.264± 0.089 | 0.512± 0.063 |
| PK | 515.69± 43.09 | 464.12± 32.28 | 566.23± 42.57 | 504.04± 22.48 | 327.60± 13.43 | 398.60± 26.40 | 581.74± 55.29 | 449.22± 39.51 | 574.09± 36.16 | 502.06± 23.70 | 546.62 ± 46.95 | ***\*280.51******± 28.31*** | 372.27± 32.40 | 393.56± 20.52 |
| LDH | 348.51± 17.22 | 307.71± 12.20 | 359.57± 16.94 | 317.58± 14.28 | 407.24± 34.14 | ***\*227.49******± 12.44*** | 363.77± 25.26 | ***\*249.27******± 11.12*** | 425.06± 23.63 | ***\*332.94******± 13.56*** | 392.79 ± 28.31 | ***\*290.54******± 11.56*** | 379.27± 19.91 | ***\*279.66******± 7.98*** |
| ***Citric acid cycle*** |  |  |  |  |  |  |  |  |
| CS | 76.23± 7.42 | 94.91± 6.87 | 76.01± 7.04 | 83.17± 5.41 | 115.40± 7.82 | 102.97± 7.95 | 83.79± 6.70 | 95.80± 5.50 | 81.58± 10.88 | 65.09± 5.24 | 87.02± 10.88 | 95.82± 6.84 | 76.87± 4.87 | 74.33± 5.29 |
| IDH | 19.52± 1.50 | 23.06± 1.17 | 22.81± 0.53 | 21.56± 1.30 | 22.65± 2.22 | 19.53± 1.37 | 15.67± 1.53 | 19.07± 2.14 | 20.45± 1.18 | 17.12± 1.38 | 23.81± 0.88 | 20.75± 1.42 | 26.41± 3.30 | 24.10± 1.70 |
| MDH | 749.35± 42.13 | 873.41± 53.07 | 804.34± 84.57 | 696.72± 84.34 | 665.72± 37.88 | 699.00± 51.59 | 809.19± 66.10 | 801.91± 46.46 | 819.14± 62.41 | 634.06± 90.62 | 897.16± 81.00 | 699.31± 68.05 | 957.75± 84.89 | 782.28± 50.54 |
| ***Electron transport chain*** |  |  |  |  |  |  |  |  |
| CI | 5.77± 0.87 | 5.66± 1.14 | 1.74± 0.40 | 1.26± 0.22 | 1.30± 0.19 | 2.21± 0.43 | 1.86± 0.41 | 3.48± 0.56 | 3.71± 0.66 | 5.25± 0.82 | 1.56± 0.39 | 2.02± 0.27 | 2.67± 0.85 | 2.63± 0.29 |
| CII | 3.41± 0.27 | 4.5± 0.28 | 4.85± 0.39 | 4.78± 0.19 | 5.34± 0.18 | 4.23± 0.18 | 4.40± 0.27 | 5.10± 0.28 | 3.66± 0.29 | 3.84± 0.27 | 3.38± 0.29 | ***\*5.08******± 0.29*** | 3.61± 0.19 | 4.00± 0.23 |
| CIV | 39.88± 6.67 | ***\*25.69******± 2.44*** | 61.36± 3.61 | ***\*24.42******± 3.12*** | 10.77± 1.31 | ***\*26.75******± 4.04*** | 58.41± 2.14 | ***\*26.64******± 2.92*** | 55.92± 2.72 | ***\*24.79******± 3.66*** | 56.86± 1.97 | ***\*25.99******± 3.36*** | 72.63± 5.64 | ***\*21.62******± 2.86*** |
| ATPsyn | 7.74± 1.65 | 9.59± 2.36 | 7.63± 2.31 | 11.09± 3.37 | 10.03± 2.06 | 7.20± 1.78 | 6.93± 1.34 | 14.01± 4.55 | 7.86± 1.33 | ***\*15.73******± 1.90*** | 6.66± 1.49 | ***\*18.58******± 3.08*** | 6.10± 2.50 | ***\*18.84******± 2.54*** |
| ***Fatty acid metabolism*** |  |  |  |  |  |  |  |  |
| HOAD | 15.23± 1.03 | ***\*22.74******± 1.11*** | 11.53± 0.73 | ***\*25.37******± 1.11*** | 52.87± 0.94 | ***\*29.39******± 1.48*** | 8.50± 0.44 | ***\*16.31******± 1.15*** | 11.74± 0.52 | ***\*19.21******± 0.81*** | 11.74± 0.74 | ***\*16.46******± 1.17*** | 11.29± 0.53 | ***\*13.73******± 0.49*** |
| ***Adenylate metabolism*** |  |  |  |  |  |  |  |  |
| AK | 220.53± 8.10 | 183.06± 7.52 | 245.65± 17.16 | 268.57± 9.68 | 180.53± 11.90 | 175.45± 9.49 | 267.72± 11.58 | 241.08± 7.62 | 269.10± 12.70 | 265.93± 17.09 | 251.08± 21.29 | 234.40± 6.29 | 296.86± 47.21 | 231.79± 7.34 |
| CK | 65.68± 4.49 | ***\*36.05******± 2.17*** | 71.42± 5.78 | ***\*42.74******± 5.12*** | 52.38± 6.37 | ***\*31.32******± 5.48*** | 67.01± 4.13 | ***\*27.81******± 5.39*** | 63.86± 7.95 | ***\*32.45******± 4.87*** | 78.08± 7.50 | ***\*41.90******± 6.23*** | 26.79± 1.17 | ***\*13.84******± 2.16*** |

Values are given in as the mean ± SEM (*n* = 8-12). \* - Significant pairwise differences between the high-altitude and low-altitude populations within a high-low pair in Bonferroni post-tests (P < 0.05). List of abbreviations: HA = high altitude; LA = low altitude; Mb = myoglobin; HK = hexokinase; PK = pyruvate kinase; LDH = lactate dehydrogenase; CS = citrate synthase; IDH = isocitrate dehydrogenase; MDH = malate dehydrogenase; CI = complex 1 (syn. NADH:ubiquinone oxidoreductase); CII = complex 2 (syn. succinate dehydrogenase); CIV = complex IV (syn. cytochrome c oxidase); ATPsyn = FOF1 ATP synthase; HOAD = 3-hydroxyacyl-CoA dehydrogenase; AK = adenylate kinase; and CK = creatine kinase.

**Supplementary File 1b**.Two-factor ANOVA results of maximal activities (µmol/g tissue/min), mass (g) and myoglobin (Mb; mg/g tissue) concentration in pectoralis muscle.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Altitude** | **Species** | **Interaction** |
| Mass | F1,120 = 0.00135, P = 0.9707 | F6,120 = 50.35, **P < 0.0001** | F6,120 = 0.3430, P = 0.9127 |
| Mb | F1,120 = 7.358, **P = 0.0077** | F6,120 = 16.82, **P < 0.0001** | F6,120 = 1.686, P = 0.1301 |
| ***Carbohydrate metabolism*** |
| HK | F1,120 = 49.80, **P < 0.0001** | F6,120 = 23.31, **P < 0.0001** | F6,120 = 9.633, **P < 0.0001** |
| PK | F1,120 = 13.57, **P = 0.0003** | F6,120 = 8.669, **P < 0.0001** | F6,120 = 4.641, **P = 0.0003** |
| LDH | F1,120 = 82.29, **P < 0.0001** | F6,120 = 2.721, **P = 0.0163** | F6,120 = 2.854, **P = 0.0124** |
| ***Citric acid cycle*** |
| CS | F1,120 = 0.310, P = 0.5787 | F6,120 = 5.583, **P < 0.0001** | F6,120 = 1.602, P = 0.1525 |
| IDH | F1,120 = 0.916, P = 0.3406 | F6,120 = 4.436, **P = 0.0004** | F6,120 = 1.583, P = 0.1577 |
| MDH | F1,120 = 3.993, **P = 0.0480** | F6,120 = 1.630, P = 0.1445 | F6,120 = 1.650, P = 0.1393 |
| ***Electron transport chain*** |
| CI | F1,120 = 3.137, P = 0.0791 | F6,120 = 14.46, **P < 0.0001** | F6,120 = 0.9882, P = 0.4365 |
| CII | F1,120 = 7.836, **P = 0.0060** | F6,120 = 5.808, **P < 0.0001** | F6,120 = 5.190, **P < 0.0001** |
| CIV | F1,120 = 192.6, **P < 0.0001** | F6,120 = 15.06, **P < 0.0001** | F6,120 = 18.95, **P < 0.0001** |
| ATPsyn | F1,120 = 19.45, **P < 0.0001** | F6,120 = 0.780, P = 0.5874 | F6,120 = 2.362, **P = 0.0342** |
| ***Fatty acid metabolism*** |
| HOAD | F1,120 = 31.93, **P < 0.0001** | F6,120 = 221.1, **P < 0.0001** | F6,120 = 79.95, **P < 0.0001** |
| ***Adenylate metabolism*** |
| AK | F1,120 = 3.910, P = 0.0503 | F6,120 = 9.216, **P < 0.0001** | F6,120 = 1.207, P = 0.3072 |
| CK | F1,120 = 91.95, **P < 0.0001** | F6,120 = 11.08, **P < 0.0001** | F6,120 = 1.301, P = 0.2620 |

Two‐factor ANOVA was used to evaluate the main effects and interactions of altitude on enzyme activity (high- vs. low-altitude populations across all species) and species on enzyme activity (species-specific differences across all altitudes). List of abbreviations: HA = high altitude; LA = low altitude; Mb = myoglobin; HK = hexokinase; PK = pyruvate kinase; LDH = lactate dehydrogenase; CS = citrate synthase; IDH = isocitrate dehydrogenase; MDH = malate dehydrogenase; CI = complex 1 (syn. NADH:ubiquinone oxidoreductase); CII = complex 2 (syn. succinate dehydrogenase); CIV = complex IV (syn. cytochrome c oxidase); ATPsyn = FOF1 ATP synthase; HOAD = 3-hydroxyacyl-CoA dehydrogenase; AK = adenylate kinase; and CK = creatine kinase.

**Supplementary File 1c**.Two-factor ANOVA results of maximal activities (µmol/g tissue/min), mass (g) and myoglobin (Mb; mg/g tissue) concentration in pectoralis muscle excluding data for ruddy ducks from the subfamily *Oxyurinae*.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Altitude** | **Species** | **Interaction** |
| Mass | F1,106 = 0.1498, P = 0.6995 | F5,106 = 54.98, **P < 0.0001** | F5,106 = 0.2035, P = 0.9604 |
| Mb | F1,106 = 9.404, **P = 0.0027** | F5,106 = 19.00, **P < 0.0001** | F5,106 = 1.458, P = 0.2098 |
| ***Carbohydrate metabolism*** |
| HK | F1,106 = 76.19, **P < 0.0001** | F5,106 = 16.92, **P < 0.0001** | F5,106 = 10.84, **P < 0.0001** |
| PK | F1,106 = 19.56, **P < 0.0001** | F5,106 = 6.397, **P < 0.0001** | F5,106 = 3.531, **P = 0.0054** |
| LDH | F1,106 = 63.27, **P < 0.0001** | F5,106 = 3.590, **P = 0.0049** | F5,106 = 1.629, P = 0.1587 |
| ***Citric acid cycle*** |
| CS | F1,106 = 1.256, P = 0.2649 | F5,106 = 2.232, P = 0.0564 | F5,106 = 1.528, P = 0.1872 |
| IDH | F1,106 = 0.2803, P = 0.5976 | F5,106 = 5.779, **P < 0.0001** | F5,106 = 1.847, P = 0.1100 |
| MDH | F1,106 = 5.050, **P = 0.0267** | F5,106 = 1.018, P = 0.4111 | F5,106 = 1.626, P = 0.1594 |
| ***Electron transport chain*** |
| CI | F1,106 = 2.023, P = 0.1579 | F5,106 = 14.55, **P < 0.0001** | F5,106 = 1.076, P = 0.3781 |
| CII | F1,106 = 16.72, **P = 0.0002** | F5,106 = 5.355, **P < 0.0001** | F5,106 = 2.640, **P = 0.0273** |
| CIV | F1,106 = 257.2, **P < 0.0001** | F5,106 = 3.583, **P = 0.0049** | F5,106 = 5.649, **P = 0.0001** |
| ATPsyn | F1,106 = 25.13, **P < 0.0001** | F5,106 = 0.6869, P = 0.6344 | F5,106 = 1.439, P = 0.2164 |
| ***Fatty acid metabolism*** |
| HOAD | F1,106 = 185.6, **P < 0.0001** | F5,106 = 19.11, **P < 0.0001** | F5,106 = 8.531, **P < 0.0001** |
| ***Adenylate metabolism*** |
| AK | F1,106 = 4.058, **P = 0.0465** | F5,106 = 4.506, **P = 0.0009** | F5,106 = 1.341, P = 0.2527 |
| CK | F1,106 = 90.95, **P < 0.0001** | F5,106 = 13.75, **P < 0.0001** | F5,106 = 1.436, P = 0.2174 |

Two‐factor ANOVA was used to evaluate the main effects and interactions of altitude on enzyme activity (high- vs. low-altitude populations across all species) and species on enzyme activity (species-specific differences across all altitudes). List of abbreviations: HA = high altitude; LA = low altitude; Mb = myoglobin; HK = hexokinase; PK = pyruvate kinase; LDH = lactate dehydrogenase; CS = citrate synthase; IDH = isocitrate dehydrogenase; MDH = malate dehydrogenase; CI = complex 1 (syn. NADH:ubiquinone oxidoreductase); CII = complex 2 (syn. succinate dehydrogenase); CIV = complex IV (syn. cytochrome c oxidase); ATPsyn = FOF1 ATP synthase; HOAD = 3-hydroxyacyl-CoA dehydrogenase; AK = adenylate kinase; and CK = creatine kinase.

**Supplementary File 1d**.Test of covariance for enzyme activity (µmol/g tissue/min) or myoglobin content (Mb; mg/g tissue) and body mass (g).

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Statistical results** | **Regression analysis** |  |
| Mb | F1,12 = 4.371, P = 0.0585 | r2 = 0.2670 |  |
| ***Carbohydrate metabolism*** |
| HK | F1,12 = 0.2995, P = 0.5943 | r2 = 0.02435 |  |
| PK | F1,12 = 1.301, P = 0.2762 | r2 = 0.09784 |  |
| LDH | F1,12 = 0.1856, P = 0.6742 | r2 = 0.01523 |  |
| ***Citric acid cycle*** |
| CS | F1,12 = 0.9914, P = 0.3391 | r2 = 0.07631 |  |
| IDH | F1,12 = 4.045, P = 0.0673 | r2 = 0.2521 |  |
| MDH | F1,12 = 2.739, P = 0.1858 | r2 = 0.1858 |  |
| ***Electron transport chain*** |
| CI | F1,12 = 0.2976, P = 0.5954 | r2 = 0.02420 |  |
| CII | F1,12 = 0.4830, P = 0.5003 | r2 = 0.03870 |  |
| CIV | F1,12 = 0.6840, P = 0.4244 | r2 = 0.05393 |  |
| ATPsyn | F1,12 = 0.1366, P = 0.7181 | r2 = 0.01126 |  |
| ***Fatty acid metabolism*** |
| HOAD | F1,12 = 0.7024, P = 0.4184 | r2 = 0.05529 |  |
| ***Adenylate metabolism*** |
| AK | F1,12 = 1.217, P = 0.2916 | r2 = 0.09207 |  |
| CK | F1,12 = 4.131, P = 0.0649 | r2 = 0.2561 |  |

List of abbreviations: HA = high altitude; LA = low altitude; Mb = myoglobin; HK = hexokinase; PK = pyruvate kinase; LDH = lactate dehydrogenase; CS = citrate synthase; IDH = isocitrate dehydrogenase; MDH = malate dehydrogenase; CI = complex 1 (syn. NADH:ubiquinone oxidoreductase); CII = complex 2 (syn. succinate dehydrogenase); CIV = complex IV (syn. cytochrome c oxidase); ATPsyn = FOF1 ATP synthase; HOAD = 3-hydroxyacyl-CoA dehydrogenase; AK = adenylate kinase; and CK = creatine kinase.

**Supplementary File 1e**. Test of covariance for enzyme activity (µmol/g tissue/min) or myoglobin content (Mb; mg/g tissue) and body mass (g) excluding data for ruddy ducks from the subfamily *Oxyurinae*.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Statistical Results** | **Regression Analysis** |  |
| Mb | F1,10 = 3.558, P = 0.0886 | r2 = 0.2624 |  |
| ***Carbohydrate metabolism*** |
| HK | F1,10 = 0.1284, P = 0.7275 | r2 = 0.01268 |  |
| PK | F1,10 = 2.141, P = 0.1741 | r2 = 0.1763 |  |
| LDH | F1,10 = 0.1868, P = 0.6742 | r2 = 0.01834 |  |
| ***Citric acid cycle*** |
| CS | F1,10 = 3.851, P = 0.3730 | r2 = 0.08000 |  |
| IDH | F1,10 = 4.045, P = 0.0781 | r2 = 0.2780 |  |
| MDH | F1,10 = 2.210, P = 0.1680 | r2 = 0.1810 |  |
| ***Electron transport chain*** |
| CI | F1,10 = 0.4597, P = 0.5132 | r2 = 0.04395 |  |
| CII | F1,10 = 0.2776, P = 0.6098 | r2 = 0.02701 |  |
| CIV | F1,10 = 0.4159, P = 0.5335 | r2 = 0.03993 |  |
| ATPsyn | F1,10 = 0.09083, P = 0.7693 | r2 = 0.009002 |  |
| ***Fatty acid metabolism*** |
| HOAD | F1,10 = 1.036, P = 0.3327 | r2 = 0.09388 |  |
| ***Adenylate metabolism*** |
| AK | F1,10 = 1.113, P = 0.3162 | r2 = 0.1002 |  |
| CK | F1,10 = 3.851, P = 0.0781 | r2 = 0.2780 |  |

List of abbreviations: HA = high altitude; LA = low altitude; Mb = myoglobin; HK = hexokinase; PK = pyruvate kinase; LDH = lactate dehydrogenase; CS = citrate synthase; IDH = isocitrate dehydrogenase; MDH = malate dehydrogenase; CI = complex 1 (syn. NADH:ubiquinone oxidoreductase); CII = complex 2 (syn. succinate dehydrogenase); CIV = complex IV (syn. cytochrome c oxidase); ATPsyn = FOF1 ATP synthase; HOAD = 3-hydroxyacyl-CoA dehydrogenase; AK = adenylate kinase; and CK = creatine kinase.

**Supplementary File 1f**. Correlation analyses of phylogenetic independent contrasts of bird mass (g), myoglobin (Mb) content (mg/g tissue), or enzyme activity (µmol/g tissue/min) *versus* altitude (m).

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Pearson product-moment correlation coefficient** | **F2,10, P** | **R2** |
| Mass | -0.0683 | F2,12 = 0.0562, P = 0.8166 | r2 = 0. 0047 |
| Mb | 0.4943 | F2,12 = 3.8803, P = 0.0724 | r2 = 0.2443 |
| ***Carbohydrate metabolism*** |
| HK | 0. 7160 | F2,12 = 12.6211, **P = 0.0040** | r2 = 0. 5126 |
| PK | -0.7455 | F2,12 = 15.0169, **P = 0.0021** | r2 = 0. 5558 |
| LDH | -0.8655 | F2,12 = 35.8287, **P < 0.0001** | r2 = 0.7491 |
| ***Citric acid cycle*** |
| CS | 0.6128 | F2,12 = 7.2177, **P = 0.0198** | r2 = 0.3756 |
| IDH | -0.2884 | F2,12 = 1. 0886, P = 0.3173 | r2 = 0.0832 |
| MDH | -0.5350 | F2,12 = 4.8124, **P = 0.0487** | r2 = 0.2862 |
| ***Electron transport chain*** |
| CI | 0.3024 | F2,12 = 1.2082, P = 0.2933 | r2 = 0.0915 |
| CII | 0.6070 | F2,12 = 7.0016, **P = 0.0213** | r2 = 0.3685 |
| CIV | -0.8502 | F2,12 = 31.2905, **P = 0.0001** | r2 = 0.7228 |
| ATPsyn | 0.7842 | F2,12 = 19.1688, **P = 0.0009** | r2 = 0.6150 |
| ***Fatty acid metabolism*** |
| HOAD | 0.4356 | F2,12 = 2.8100, P = 0.1195 | r2 = 0.1897 |
| ***Adenylate metabolism*** |
| AK | -0.3552 | F2,12 = 1.7324, P =0.2127 | r2 = 0.1262 |
| CK | -0.9777 | F2,12 = 259.6513, **P < 0.0001** | r2 = 0.9558 |

List of abbreviations: HA = high altitude; LA = low altitude; Mb = myoglobin; HK = hexokinase; PK = pyruvate kinase; LDH = lactate dehydrogenase; CS = citrate synthase; IDH = isocitrate dehydrogenase; MDH = malate dehydrogenase; CI = complex 1 (syn. NADH:ubiquinone oxidoreductase); CII = complex 2 (syn. succinate dehydrogenase); CIV = complex IV (syn. cytochrome c oxidase); ATPsyn = FOF1 ATP synthase; HOAD = 3-hydroxyacyl-CoA dehydrogenase; AK = adenylate kinase; and CK = creatine kinase.

**Supplementary File 1g**. Correlation analyses of phylogenetic independent contrasts of bird mass (g), myoglobin (Mb) content (mg/g tissue), or enzyme activity (µmol/g tissue/min) *versus* altitude (m) excluding data for ruddy ducks from the subfamily *Oxyurinae*.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Pearson product-moment correlation coefficient** | **F2,10, P** | **R2** |
| Mass | -0.1735 | F2,12 = 0.3103, P = 0.5898 | r2 = 0.0301 |
| Mb | 0.5527 | F2,12 = 4.3990, P = 0.0624 | r2 = 0.3055 |
| ***Carbohydrate metabolism*** |
| HK | 0.7735 | F2,12 = 14.90, **P = 0.0032** | r2 = 0.5983 |
| PK | -0.8340 | F2,12 = 22.83904, **P = 0.0007** | r2 = 0.6955 |
| LDH | -0.9345 | F2,12 = 68.9180, **P < 0.0001** | r2 = 0.8733 |
| ***Citric acid cycle*** |
| CS | 0.4035 | F2,12 = 3.2194, P = 0.0916 | r2 = 0.1615 |
| IDH | -0.2070 | F2,12 = 0.4476, P = 0.5186 | r2 = 0.0428 |
| MDH | -0.5855 | F2,12 = 5.2158, **P = 0.0455** | r2 = 0.3428 |
| ***Electron transport chain*** |
| CI | 0.2198 | F2,12 = 0.5076, P = 0.4925 | r2 = 0.0483 |
| CII | 0.7767 | F2,12 = 15.2029, **P = 0.0030** | r2 = 0.6032 |
| CIV | -0.9595 | F2,12 = 116.0305, **P < 0.0001** | r2 = 0.9207 |
| ATPsyn | 0.8653 | F2,12 = 29.8020, **P = 0.0003** | r2 = 0.7488 |
| ***Fatty acid metabolism*** |
| HOAD | 0.8837 | F2,12 = 35.6387, **P = 0.0001** | r2 = 0.7809 |
| ***Adenylate metabolism*** |
| AK | -0.3606 | F2,12 = 1.4946, P =0.2495 | r2 = 0.1300 |
| CK | -0.9770 | F2,12 = 210.1855, **P < 0.0001** | r2 = 0.9546 |

List of abbreviations: HA = high altitude; LA = low altitude; Mb = myoglobin; HK = hexokinase; PK = pyruvate kinase; LDH = lactate dehydrogenase; CS = citrate synthase; IDH = isocitrate dehydrogenase; MDH = malate dehydrogenase; CI = complex 1 (syn. NADH:ubiquinone oxidoreductase); CII = complex 2 (syn. succinate dehydrogenase); CIV = complex IV (syn. cytochrome c oxidase); ATPsyn = FOF1 ATP synthase; HOAD = 3-hydroxyacyl-CoA dehydrogenase; AK = adenylate kinase; and CK = creatine kinase.

**Supplementary File 1h.** Assay conditions for enzymatic measurements.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **λ (nm)** | **ε (mmol-1 cm-1)** | **pH** | **Substrates** | **Other reagents** | **Specific inhibitor** | **Coupling enzymes** |
| ***Carbohydrate metabolism*** |  |  |
| **HK** | 340 | 6.22 | 7.2 | **\*Glucose (10 mM)**Mg·ATP (3 mM)MgCl2 (10 mM)NADP+ (1.5 mM) | --- | --- | 1 U G6PDH |
| **PK** | 340 | 6.22 | 7.2 | **\*PEP (10 mM)**Mg·ADP (2.5 mM) | --- | --- | 1 U LDH |
| **LDH** | 340 | 6.22 | 7.2 | **\*Pyruvate (5 mM)**NADH (0.15 mM) | --- | --- | --- |
| ***Citric acid cycle*** |  |  |
| **CS** | 412 | 14.15 | 8.0 | **\*Oxaloacetate (0.5 mM)**Acetyl CoA (0.15 mM)DTNB (0.15 mM) | --- | --- | --- |
| **IDH** | 340 | 6.22 | 8.0 | **\*Isocitrate (5 mM)**NADP+ (1.5 mM) | --- | --- | --- |
| **MDH** | 340 | 6.22 | 8.0 | **\*Oxaloacetate (0.5 mM)**NADP+ (1.5 mM) | --- | --- | --- |
| ***Electron transport chain*** |  |  |
| **CI** | 340 | 6.22 | 7.5 | CoQ10 (0.06 mM)NADH (0.15 mM) | BSA (3mg ml-1)KCN (0.3 mM) | **\*Rotenone (0.02 mM)** | --- |
| **CII** | 600 | 21.9 | 7.5 | **\*Succinate (20 mM)**DCPIP (XX mM)DUB (XX mM) | KCN (0.3 mM) | --- | --- |
| **CIV** | 550 | 28.5 | 7.0 | **†CytcH2 (2 mM)** | --- | --- | --- |
| **ATPsyn** | 340 | 6.22 | 7.5 | Mg·ADP (2.5 mM)MgCl2 (10 mM)PEP (10 mM)Glucose (10 mM)NADP+ (1.5 mM) | --- | **\*Oligomycin (0.01 mM)** | 1 U HK1 U G6PDH |
| ***Fatty acid metabolism*** |  |  |
| **HOAD** | 340 | 6.22 | 7.2 | **\*Acetoacetyl CoA (0.15 mM)**NADH (0.15 mM) | --- | --- | --- |
| ***Adenylate metabolism*** |  |  |
| **AK** | 340 | 6.22 | 7.2 | **\*Mg·ADP (2.5 mM)**MgCl2 (10 mM)PEP (10 mM)Glucose (10 mM)NADP+ (1.5 mM) | --- | --- | 1 U HK1 U G6PDH |
| **CK** | 340 | 6.22 | 7.2 | **\*Creatine (15 mM)**Mg·ATP (6 mM)MgCl2 (10 mM)PEP (15 mM)NADH (0.3 mM) | --- | --- | 2 U PK2 U LDH |

\* - Substrate omitted in measurement of background activity. † - Substrate auto-oxidation measured as background activity. List of abbreviations: Mb = myoglobin; HK = hexokinase; PK = pyruvate kinase; LDH = lactate dehydrogenase; CS = citrate synthase; IDH = isocitrate dehydrogenase; MDH = malate dehydrogenase; CI = complex 1 (syn. NADH:ubiquinone oxidoreductase); CII = complex 2 (syn. succinate dehydrogenase); CIV = complex IV (syn. cytochrome c oxidase); ATPsyn = FOF1 ATP synthase; HOAD = 3-hydroxyacyl-CoA dehydrogenase; AK = adenylate kinase; CK = creatine kinase; G6PDH = glucose-6-phosphate dehydrogenase; ATP = adenosine triphosphate; ADP = adenosine diphosphate; NADP = nicotinamide adenine dinucleotide phosphate; NADH = reduced nicotinamide adenine dinucleotide; CoA = coenzyme A; DTNB = Ellman's reagent (syn. 5,5'-dithiobis-2-nitrobenzoic acid); CoQ10 = ubiquinone; BSA = bovine serum albumin; DCPIP = 2,6-dichlorophenolindophenol; DUB = decylubiquinone (syn. 2,3-dimethoxy-5-methyl-6-decyl-1,4-benzoquinone); CytcH2 = reduced cytochrome c; and PEP = phosphoenolpyruvate

**Supplementary File 1i**. List of GenBank gene accession numbers for mtDNA control region used in the construction of the phylogenetic tree.

|  |  |
| --- | --- |
| **Species** | **Accession Numbers** |
|  |  |
| Yellow-billed Pintail | FJ618397-FJ618512 |
| Cinnamon Teal | JF914653-JF914754 |
| Ruddy Duck | AY747742-AY747751; AY747756-AY747778; AM084943-AM084997; JX910949-JX910971 |
| Crested Duck | HM063481-HM063503; JN833791-JN833847 |
| Puna Teal/Silver Teal | MN734269-MN734345 |
| Speckled Teal | JN223305-JN22337; MG520106-MG520175 |
| Andean Goose/Magellan Goose | KC109071-KC109080 |
|  |  |

**Supplementary File 1j**. Maximal activities (µmol/g tissue/min) in pectoralis muscle from surface, intermediate and deep tissue sampling locations.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  **Cinnamon teal**  |  **Yellow-billed** **pintail** |  **Ruddy duck** |  **Crested duck** | **Puna teal (H)** **Silver teal (L)** |  **Speckled teal** | **Andean goose (H)****Magellan goose (L)** |
|  | **LA** | **HA** | **LA** | **HA** | **LA** | **HA** | **LA** | **HA** | **LA** | **HA** | **LA** | **HA** | **LA** | **HA** |
| ***Carbohydrate metabolism*** |
| HK(S) | 0.318± 0.045 | 0.901± 0.073 | 0.421± 0.074 | 1.169± 0.057 | 1.661± 0.047 | 1.507± 0.070 | 0.452± 0.065 | 2.089± 0.080 | 0.451± 0.059 | 0.570± 0.101 | 0.353± 0.056 | 0.430± 0.043 |  | 0.698± 0.014 |
| HK(I) | 0.442± 0.114 | 0.903± 0.041 | 0.479± 0.079 | 0.874± 0.083 | 1.399± 0.117 | 1.291± 0.071 | 0.551± 0.127 | 1.655± 0.100 | 0.393± 0.038 | 0.571± 0.192 | 0.331± 0.050 | 0.401± 0.072 | 0.264± 0.089 | 0.407± 0.040 |
| HK(D) | 0.493± 0.082 | 0.830± 0.093 | 0.281± 0.024 | 0.558± 0.027 | 0.660± 0.096 | 0.785± 0.055 | 0.434± 0.059 | 1.279± 0.130 | 0.387± 0.039 | 0.555± 0.063 | 0.391± 0.069 | 0.486± 0.053 |  | 0.425± 0.067 |
| PK(S) | 558.95± 30.44 | 565.24± 14.92 | 689.47± 26.66 | 554.60± 14.84 | 361.09± 12.61 | 483.95± 17.08 | 682.16± 26.22 | 524.42± 15.29 | 677.11± 28.03 | 560.95± 12.84 | 671.93± 34.62 | 378.27± 13.89 |  | 469.77± 14.41 |
| PK(I) | 501.94± 29.78 | 476.95± 15.34 | 540.43± 21.81 | 510.48± 15.93 | 339.09± 10.18 | 392.00± 16.79 | 530.08± 16.39 | 430.99± 13.13 | 554.63± 25.41 | 510.48± 15.93 | 546.03± 42.05 | 249.26± 16.97 | 372.27± 32.40 | 363.81± 5.93 |
| PK(D) | 413.41± 49.61 | 330.25± 13.43 | 468.79± 42.84 | 401.44± 7.24 | 290.48± 8.55 | 317.97± 16.07 | 532.99± 17.83 | 398.53± 10.19 | 490.52± 28.02 | 436.27± 20.39 | 421.92± 25.74 | 207.94± 15.00 |  | 347.10± 8.32 |
| LDH(S) | 396.64± 20.93 | 368.38± 14.08 | 452.01± 21.69 | 379.74± 21.82 | 556.93± 13.48 | 267.23± 22.23 | 466.62± 38.90 | 312.53± 20.35 | 525.48± 31.50 | 407.43± 12.94 | 519.64± 32.13 | 352.66± 16.23 |  | 289.58± 14.26 |
| LDH(I) | 315.22± 27.17 | 308.51± 10.12 | 337.72± 17.13 | 307.04± 9.69 | 310.48± 15.93 | 194.31± 16.02 | 359.76± 35.71 | 253.49± 6.69 | 435.46± 32.46 | 332.08± 16.11 | 394.62± 32.91 | 281.21± 12.20 | 379.27± 19.91 | 257.09± 11.76 |
| LDH(D) | 270.71± 17.38 | 237.22± 10.70 | 288.98± 21.31 | 228.91± 11.05 | 164.63± 5.75 | 211.47± 14.37 | 264.92± 33.41 | 187.07± 6.18 | 314.23± 29.22 | 259.15± 10.86 | 264.11± 44.74 | 232.94± 13.73 |  | 292.31± 14.04 |
| ***Citric acid cycle*** |  |  |  |  |  |  |  |  |
| CS(S) | 62.86± 5.99 | 74.35± 8.34 | 75.77± 4.28 | 69.41± 5.42 | 127.31± 4.79 | 101.38± 9.02 | 70.82± 7.12 | 82.17± 4.06 | 52.69± 2.42 | 58.61± 3.88 | 75.29± 3.12 | 86.13± 4.68 |  | 62.24± 4.12 |
| CS(I) | 84.29± 5.44 | 101.65± 3.67 | 71.24± 3.41 | 90.90± 3.13 | 86.50± 3.71 | 86.92± 9.15 | 86.06± 5.59 | 103.22± 3.10 | 95.78± 5.03 | 73.43± 3.46 | 107.74± 4.71 | 106.59± 5.50 | 76.87± 4.87 | 71.40± 2.60 |
| CS(D) | 100.25± 10.49 | 108.80± 4.94 | 81.02± 11.15 | 90.91± 7.68 | 132.38± 4.44 | 116.03± 9.48 | 94.49± 5.55 | 102.01± 5.37 | 96.27± 10.46 | 64.75± 6.50 | 78.02± 16.67 | 94.49± 9.10 |  | 88.34± 4.50 |
| IDH(S) | 16.69± 1.15 | 19.87± 1.09 | 21.50± 0.52 | 18.33± 1.41 | 17.46± 1.13 | 17.68± 1.54 | 10.98± 0.63 | 17.83± 2.61 | 18.19± 0.83 | 14.26± 0.53 | 22.45± 0.70 | 18.00± 0.84 |  | 18.06± 0.84 |
| IDH(I) | 21.21± 1.44 | 24.39± 0.91 | 23.13± 0.48 | 23.16± 0.81 | 23.69± 3.05 | 18.49± 2.24 | 14.43± 0.41 | 18.72± 2.23 | 21.37± 0.63 | 17.29± 0.58 | 23.84± 0.49 | 23.22± 0.48 | 26.41± 3.30 | 23.52± 0.43 |
| IDH(D) | 24.62± 0.81 | 24.81± 1.25 | 23.81± 0.28 | 23.83± 1.52 | 26.80± 0.57 | 22.13± 1.23 | 21.61± 0.65 | 20.57± 0.91 | 21.80± 0.53 | 19.84± 0.73 | 25.16± 0.31 | 20.56± 0.86 |  | 29.73± 0.95 |
| MDH(S) | 701.76± 38.96 | 808.69± 37.43 | 547.07± 65.37 | 574.24± 91.46 | 616.35± 34.66 | 721.10± 50.97 | 709.97± 41.80 | 700.67± 43.76 | 624.44± 34.40 | 510.24± 38.39 | 851.73± 52.24 | 687.81± 69.42 |  | 670.42± 37.92 |
| MDH(I) | 746.65± 23.29 | 961.01± 68.77 | 855.41± 37.00 | 737.10± 74.08 | 650.81± 42.82 | 612.51± 75.20 | 778.40± 73.79 | 842.57± 37.59 | 867.99± 40.18 | 675.15± 78.05 | 917.49± 81.63 | 720.53± 76.88 | 957.75± 84.89 | 812.59± 46.07 |
| MDH(D) | 897.52± 72.13 | 822.21± 32.08 | 1010.54± 70.97 | 828.35± 114.36 | 728.51± 32.63 | 738.67± 69.86 | 939.22± 61.70 | 854.05± 36.05 | 945.53± 61.05 | 724.28± 120.20 | 922.25± 106.79 | 689.58± 51.69 |  | 863.83± 37.24 |
| ***Electron transport chain*** |  |  |  |  |  |  |  |  |
| CI(S) | 5.65± 1.00 | 4.29± 1.08 | 1.31± 0.28 | 1.00± 0.20 | 1.24± 0.18 | 1.98± 0.40 | 1.49± 0.34 | 2.85± 0.74 | 3.48± 0.77 | 4.49± 0.62 | 1.69± 0.61 | 1.42± 0.27 |  | 1.85± 0.24 |
| CI(I) | 5.86± 0.60 | 5.66± 1.51 | 2.22± 0.83 | 1.37± 0.24 | 1.29± 0.17 | 2.36± 1.11 | 2.12± 0.67 | 4.26± 0.51 | 3.23± 0.72 | 5.39± 0.71 | 1.51± 0.49 | 2.07± 0.22 | 2.67± 0.85 | 2.58± 0.16 |
| CI(D) | 6.22± 0.99 | 6.86± 0.79 | 1.84± 0.10 | 1.43± 0.36 | 1.34± 0.24 | 2.35± 0.47 | 2.11± 0.52 | 3.22± 0.22 | 4.61± 0.93 | 6.05± 1.18 | 1.52± 0.28 | 2.39± 0.26 |  | 3.46± 0.14 |
| CII(S) | 2.94± 0.23 | 3.64± 0.32 | 3.88± 0.31 | 4.36± 0.14 | 5.16± 0.18 | 4.00± 0.29 | 4.56± 0.20 | 4.08± 0.13 | 2.84± 0.08 | 3.30± 0.13 | 3.07± 0.22 | 4.56± 0.22 |  | 3.53± 0.16 |
| CII(I) | 3.57± 0.23 | 5.07± 0.18 | 5.36± 0.41 | 5.27± 0.13 | 5.70± 0.17 | 4.29± 0.10 | 4.51± 0.28 | 5.36± 0.14 | 3.82± 0.26 | 4.26± 0.20 | 3.71± 0.34 | 5.44± 0.32 | 3.61± 0.19 | 3.89± 0.14 |
| CII(D) | 4.49± 0.12 | 4.84± 0.13 | 5.32± 0.28 | 4.45± 0.12 | 5.17± 0.14 | 4.42± 0.21 | 4.14± 0.34 | 5.85± 0.10 | 4.31± 0.26 | 4.04± 0.34 | 3.35± 0.30 | 5.26± 0.22 |  | 4.57± 0.22 |
| CIV(S) | 34.02± 5.90 | 19.03± 1.85 | 58.55± 3.20 | 19.77± 2.83 | 8.80± 0.88 | 25.01± 5.56 | 54.43± 2.47 | 25.39± 3.83 | 48.19± 2.43 | 17.97± 2.15 | 53.27± 1.63 | 20.59± 1.72 |  | 20.70± 3.13 |
| CIV(I) | 42.96± 8.07 | 28.95± 2.38 | 69.23± 3.48 | 24.99± 2.93 | 11.59± 1.28 | 29.20± 3.14 | 59.33± 1.97 | 29.97± 2.13 | 58.89± 2.22 | 31.68± 4.02 | 59.71± 1.49 | 24.43± 2.70 | 72.63± 5.64 | 19.19± 2.27 |
| CIV(D) | 51.31± 9.03 | 28.64± 2.18 | 56.30± 3.03 | 31.54± 4.23 | 11.92± 1.56 | 26.75± 5.74 | 61.48± 1.38 | 24.47± 1.91 | 60.69± 1.70 | 25.98± 3.55 | 57.59± 2.28 | 33.57± 3.65 |  | 25.29± 2.27 |
| ATPsyn(S) | 7.31± 1.47 | 11.32± 3.21 | 9.90± 2.85 | 11.93± 4.33 | 11.75± 3.16 | 8.28± 2.19 | 7.82± 1.64 | 16.74± 4.78 | 11.46± 3.31 | 18.28± 2.98 | 5.90± 1.06 | 22.99± 2.76 |  | 23.53± 1.76 |
| ATPsyn(I) | 6.88± 1.57 | 10.05± 2.07 | 4.43± 1.06 | 10.67± 2.81 | 11.87± 2.08 | 8.32± 3.55 | 7.69± 1.34 | 13.94± 3.66 | 6.83± 1.64 | 19.21± 5.60 | 6.30± 1.36 | 18.07± 2.67 | 6.10± 2.50 | 20.02± 2.19 |
| ATPsyn(D) | 10.74± 3.61 | 6.96± 2.64 | 9.61± 2.53 | 10.42± 3.17 | 6.86± 1.42 | 5.34± 1.36 | 5.29± 0.91 | 11.34± 3.65 | 5.28± 1.06 | 11.28± 2.02 | 7.77± 1.99 | 14.28± 3.20 |  | 12.04± 2.15 |
| ***Fatty acid metabolism*** |  |  |  |  |  |  |  |  |
| HOAD(S) | 15.99± 1.14 | 18.76± 1.87 | 13.73± 1.13 | 21.41± 1.78 | 50.52± 1.75 | 28.36± 2.55 | 10.29± 0.81 | 15.33± 2.09 | 12.84± 0.85 | 17.25± 1.15 | 12.40± 0.78 | 15.53± 2.01 |  | 13.07± 1.15 |
| HOAD(I) | 16.61± 1.96 | 25.44± 1.73 | 9.39± 1.51 | 29.69± 0.95 | 50.41± 1.02 | 28.58± 3.96 | 7.10± 0.51 | 17.96± 2.67 | 11.20± 1.07 | 21.41± 1.04 | 9.58± 0.64 | 17.96± 2.67 | 11.29± 0.53 | 16.75± 1.30 |
| HOAD(D) | 10.20± 2.52 | 23.43± 1.27 | 11.47± 0.53 | 23.02± 1.23 | 57.69± 0.80 | 31.01± 1.80 | 8.12± 0.59 | 15.56± 0.86 | 11.18± 0.77 | 19.37± 1.64 | 13.25± 1.85 | 15.75± 0.97 |  | 11.37± 2.24 |
| ***Adenylate metabolism*** |  |  |  |  |  |  |  |  |
| AK(S) | 228.52± 5.89 | 200.90± 6.49 | 221.54± 10.98 | 265.82± 11.26 | 206.00± 6.37 | 196.98± 12.89 | 304.16± 7.86 | 237.02± 7.05 | 291.20± 7.19 | 304.65± 5.60 | 273.93± 21.32 | 235.30± 4.90 |  | 225.19± 5.66 |
| AK(I) | 211.383± 6.73 | 178.12± 7.45 | 228.93± 13.88 | 280.38± 8.08 | 192.81± 10.97 | 157.43± 9.52 | 258.16± 7.98 | 236.21± 8.43 | 270.90± 9.81 | 290.34± 8.42 | 257.36± 25.19 | 221.85± 5.58 | 296.86± 47.21 | 217.51± 4.72 |
| AK(D) | 214.85± 23.14 | 169.73± 7.22 | 286.48± 18.84 | 249.91± 12.93 | 142.77± 6.96 | 166.79± 6.93 | 240.85± 8.28 | 249.33± 5.53 | 245.21± 15.92 | 201.36± 11.85 | 221.94± 14.64 | 246.04± 5.52 |  | 254.59± 4.71 |
| CK(S) | 68.80± 2.49 | 33.46± 1.16 | 70.16± 7.37 | 42.15± 3.55 | 63.51± 4.71 | 35.01± 3.54 | 69.46± 5.99 | 36.16± 5.11 | 64.57± 11.68 | 38.94± 4.76 | 83.71± 9.61 | 49.47± 5.68 |  | 12.39± 1.30 |
| CK(I) | 59.74± 6.83 | 32.67± 1.70 | 71.87± 5.38 | 42.55± 6.37 | 61.75± 3.26 | 20.49± 1.93 | 67.31± 1.36 | 22.03± 4.63 | 61.06± 3.03 | 32.17± 2.54 | 84.58± 5.75 | 40.58± 7.17 | 26.79± 1.17 | 16.42± 1.63 |
| CK(D) | 68.23± 8.09 | 43.85± 2.21 | 72.32± 5.04 | 44.17± 8.55 | 31.87± 5.26 | 35.37± 9.76 | 64.27± 3.95 | 25.95± 4.75 | 65.97± 7.54 | 26.19± 5.45 | 62.93± 4.91 | 35.64± 4.48 |  | 12.50± 3.06 |

Values are given in as the mean ± SEM. List of abbreviations: HA = high altitude; LA = low altitude; S = tissue sampled from surface muscle; I = tissue sampled from intermediate muscle; D = tissue sampled from deep muscle; Mb = myoglobin; HK = hexokinase; PK = pyruvate kinase; LDH = lactate dehydrogenase; CS = citrate synthase; IDH = isocitrate dehydrogenase; MDH = malate dehydrogenase; CI = complex 1 (syn. NADH:ubiquinone oxidoreductase); CII = complex 2 (syn. succinate dehydrogenase); CIV = complex IV (syn. cytochrome c oxidase); ATPsyn = FOF1 ATP synthase; HOAD = 3-hydroxyacyl-CoA dehydrogenase; AK = adenylate kinase; and CK = creatine kinase.