**Supplementary Table 1.** List of butterfly species used for calculation of relationships between phenology and latitude (with altitude and year as co-variables) with their GBIF codes used for retrieving their distributional records and the number of used records (Mean/Onset/Termination).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Species | Family | GBIF\_species code | Number of records | |
|  |  |  |  |
| American dataset |  |  |  |
| *Carterocephalus palaemon* (Pallas, 1771) | Hesperiidae | 1947335 | 120/23/22 |
| *Hesperia comma* (Linnaeus, 1758) |  | 5142282 | 143/22/25 |
| *Thorybes pylades* (Scudder, 1870) |  | 1946500 | 229/30/28 |
| *Erynnis icelus* (Scudder & Burgess, 1870) | | 5977250 | 205/18/20 |
| *Erynnis persius* (Scudder, 1863) |  | 5977179 | 51/15/16 |
| *Pyrgus centaureae* (Rambur, 1840) |  | 1950006 | 47/11/12 |
| *Amblyscirtes vialis* (W.H. Edwards, 1862) | | 4301802 | 97/22/21 |
| *Parnassius smintheus* Doubleday, 1847 | Papilionidae | 1938975 | 140/24/23 |
| *Papilio machaon* Linnaeus, 1758 |  | 1937866 | 84/25/25 |
| *Papilio canadensis* Rothschild & Jordan, 1906 | | 1937739 | 128/22/23 |
| *Pieris marginalis* Scudder, 1861 | Pieridae | 5137894 | 226/35/33 |
| *Euchloe ausonides* (Lucas, 1852) |  | 1919327 | 129/23/22 |
| *Euchloe creusa* (Doubleday, 1847) |  | 1919328 | 40/11/10 |
| *Anthocharis sara* Lucas, 1852 |  | 1919700 | 229/22/22 |
| *Colias christina* W.H. Edwards, 1863 |  | 5137714 | 100/15/13 |
| *Colias canadensis* Ferris, 1982 |  | 5137693 | 22/6/6 |
| *Colias nastes* Boisduval, 1832 |  | 5137689 | 62/12/13 |
| *Colias gigantea* Strecker, 1900 |  | 5137700 | 73/13/12 |
| *Colias pelidne* Boisduval & Le Conte, 1830 | | 5137711 | 15/5/5 |
| *Colias interior* Scudder, 1862 |  | 5137664 | 86/17/17 |
| *Colias palaeno* (Linnaeus, 1760) |  | 5137582 | 43/12/11 |
| *Lycaena phlaeas* (Linnaeus, 1760) | Lycaenidae | 1929697 | 414/17/17 |
| *Lycaena dorcas* W. Kirby, 1837 |  | 5714559 | 50/13/13 |
| *Lycaena mariposa* (Reakirt, 1866) |  | 5139700 | 41/11/11 |
| *Callophrys augustinus* (Westwood, 1852) | | 4300303, 1921250 | 213/26/26 |
| *Callophrys polia* (Cook & Watson, 1907) |  | 1932417 | 99/14/16 |
| *Callophrys niphon* (Hübner, 1819) |  | 4300300 | 165/16/14 |
| *Callophrys eryphon* (Boisduval, 1852) |  | 4300286, 1921239 | 50/18/16 |
| *Celastrina ladon* (Cramer, 1780) |  | 1925922 | 415/24/21 |
| *Glaucopsyche lygdamus* (Doubleday, 1841) | | 1924106 | 263/33/33 |
| *Plebejus id*as (Linnaeus, 1760) |  | 5714690, 1926861 | 51/19/20 |
| *Icaricia saepiolus* (Boisduval, 1852) |  | 5138387 | 170/21/21 |
| *Agriades glandon* (Prunner, 1798) |  | 5714622, 1926054 | 113/27/27 |
| *Speyeria hesperis* (H.W. Edwards, 1864) | Nymphalidae | 1905296 | 148/21/21 |
| *Speyeria mormonia* (Boisduval, 1869 |  | 1905187 | 164/20/18 |
| *Boloria alaskensis* (Holland, 1900) |  | 1912470 | 31/5/5 |
| *Boloria eunomia* (Esper, 1799) |  | 4299535 | 99/19/18 |
| *Boloria bellona* (Fabricius, 1775) |  | 5714392 | 250/18/21 |
| *Boloria frigga* (Becklin, 1791) |  | 4299576 | 55/15/12 |
| *Boloria improba* (Butler, 1877) |  | 4299581 | 66/12/12 |
| *Boloria epithore* (W.H. Edwards, 1864) |  | 5133864 | 40/14/14 |
| *Boloria freija* (Becklin, 1791) |  | 4299599 | 97/17/17 |
| *Boloria astarte* (Doubleday, 1847) |  | 5714396 | 27/9/10 |
| *Boloria chariclea* (Schneider 1794) |  | 4299565 | 161/27/26 |
| *Phyciodes cocyta* (Cramer, 1777) |  | 1918971 | 136/15/13 |
| *Phyciodes pratensis* (Behr, 1863) |  | 1918980 | 42/12/11 |
| *Euphydryas chalcedona* (Doubleday, 1847) | | 4299304 | 117/15/15 |
| *Limenitis arthemis* (Drury, 1773) |  | 5132084 | 744/37/36 |
| *Limenitis archippus* (Cramer, 1775) |  | 5132398 | 533/28/27 |
| *Satyrodes eurydice* (Linnaeus, 1763) |  | 4299800 | 72/9/9 |
| *Coenonympha tullia* (Müller, 1764) |  | 1911112 | 607/34/35 |
| *Erebia mancinus* (Doubleday, 1849) |  | 5134598 | 26/9/10 |
| *Erebia discoidalis* (W. Kirby, 1837) |  | 5134517 | 61/13/13 |
| *Erebia epipsodea* Butler, 1868 |  | 5134759 | 122/21/21 |
| *Oeneis macounii* (W. H. Edwards, 1885) |  | 5128363 | 28/7/7 |
| *Oeneis chryxus* (Doubleday, 1849) |  | 5128250 | 105/20/20 |
| *Oeneis uhleri* (Reakirt, 1866) |  | 5128266 | 61/15/15 |
| *Oeneis bore* (Schneider, 1792) |  | 5128270 | 53/16/15 |
| *Oeneis jutta* (Hübner, 1806) |  | 5128357 | 82/15/16 |
| *Oeneis melissa* (Fabricius, 1775) |  | 5128326 | 102/20/18 |
| *Oeneis polixenes* (Fabricius, 1775) |  | 5128279 | 52/15/14 |  | |  |  |
| European dataset |  |  |  |
| *Carterocephalus palaemon* (Pallas, 1771) | Hesperiidae | 1947335 | 800/31/26 |
| *Hesperia comma* (Linnaeus, 1758) |  | 5142282 | 1122/29/27 |
| *Ochlodes sylvanus* (Esper, 1777) |  | 1946844 | 15195/30/32 |
| *Pyrgus alveus* (Hübner, 1803) |  | 1949794 | 594/19/20 |
| *Pyrgus andromedae* (Wallengren, 1853) | | 1949852 | 260/13/11 |
| *Pyrgus malvae* (Linnaeus, 1758) |  | 1949721 | 5449/28/26 |
| *Thymelicus lineolus* (Ochsenheimer, 1806) | | 1944020 | 11179/33/30 |
| *Aricia artaxerxes* (Fabricius, 1793) | Lycaenidae | 1933138 | 1067/28/26 |
| *Eumedonia eumedon* (Esper. 1780) |  | 1933793 | 125/10/10 |
| *Callophrys rubi* (Linnaeus, 1758) |  | 1932411 | 13204/33/34 |
| *Cyaniris semiargus* (Rottemburg, 1775) |  | 5139156 | 217/17/15 |
| *Glaucopsyche alexis* (Poda, 1761) |  | 1924097 | 814/25/23 |
| *Lycaena hippothoe* (Linnaeus, 1760) |  | 1929443 | 4459/28/29 |
| *Lycaena virgaureae* (Linnaeus, 1758) |  | 1929659 | 8831/29/32 |
| *Phengaris arion* (Linnaeus, 1758) |  | 4535168, 1922311 | 816/14/15 |
| *Vacciniina optilete* (Knoch, 1781) |  | 1922937, 5714713 | 86/15/15 |
| *Aphantopus hyperantus* (Linnaeus, 1758) | Nymphalidae | 1896841 | 30598/27/28 |
| *Argynnis adippe* (Schiffermüller, 1775) |  | 4535434 | 5924/28/30 |
| *Argynnis aglaja* (Linnaeus, 1758) |  | 4535447 | 9115/33/34 |
| *Argynnis niobe* (Linnaeus, 1758) |  | 4535439 | 1980/28/26 |
| *Argynnis paphia* (Linnaeus, 1758) |  | 1909398 | 7918/31/35 |
| *Boloria aquilonaris* (Stichel, 1908) |  | 1912372 | 2375/23/22 |
| *Boloria eunomia* (Esper, 1799) |  | 4299535 | 1199/16/16 |
| *Boloria euphrosyne* (Linnaeus, 1758) |  | 5772893 | 7113/35/32 |
| *Boloria napaea* (Hoffmannsegg, 1804) |  | 1912470 | 477/19/17 |
| *Boloria thore* (Hübner, 1806) |  | 5133921, 1894279 | 318/10/11 |
| *Brenthis ino* (Rottemburg, 1775) |  | 1902749 | 6777/27/31 |
| *Coenonympha glycerion* (Borkhausen, 1788) | | 1911125 | 2113/19/18 |
| *Coenonympha tullia* (Müller, 1764) |  | 1911112 | 3113/25/25 |
| *Erebia ligea* (Linnaeus, 1758) |  | 5134682 | 4602/30/29 |
| *Erebia pandrose* (Borkhausen, 1788) |  | 5134848 | 861/19/20 |
| *Euphydryas maturna* (Linnaeus, 1758) |  | 4535817 | 1203/11/10 |
| *Lasiommata maera* (Linnaeus, 1758) |  | 4535636 | 275/31/27 |
| *Lasiommata petropolitana* (Fabricius, 1787) | | 4535634 | 192/22/21 |
| *Limenitis populi* (Linnaeus, 1758) |  | 5132183 | 2028/20/21 |
| *Lopinga achine* (Scopoli, 1763) |  | 4535614 | 22/5/5 |
| *Maniola jurtina* (Linnaeus, 1758) |  | 5135513 | 51819/30/32 |
| *Melitaea athalia* (Rottemburg, 1775) |  | 1899433 | 4232/37/30 |
| *Melitaea diamina* (Lang, 1789) |  | 1899807 | 726/17/18 |
| *Parnassius apollo* (Linnaeus, 1758) | Papilionidae | 1938810 | 555/22/22 |
| *Parnassius mnemosyne* (Linnaeus, 1758) | | 1938520 | 392/16/18 |
| *Anthocharis cardamines* (Linnaeus, 1758) | Pieridae | 1919712 | 31849/39/35 |
| *Aporia crataegi* (Linnaeus, 1758) |  | 1920218 | 5172/34/35 |
| *Colias palaeno* (Linnaeus, 1760) |  | 5137582 | 2837/25/28 |