APPENDIX

APPENDIX S4. SUPPLEMENTAL FIGURES

Figure A1. Frequency of the number of populations included in reviewed studies. The histogram excludes Roy et al. (2015) for clarity; this paper had a range of 58-1361 populations per species.

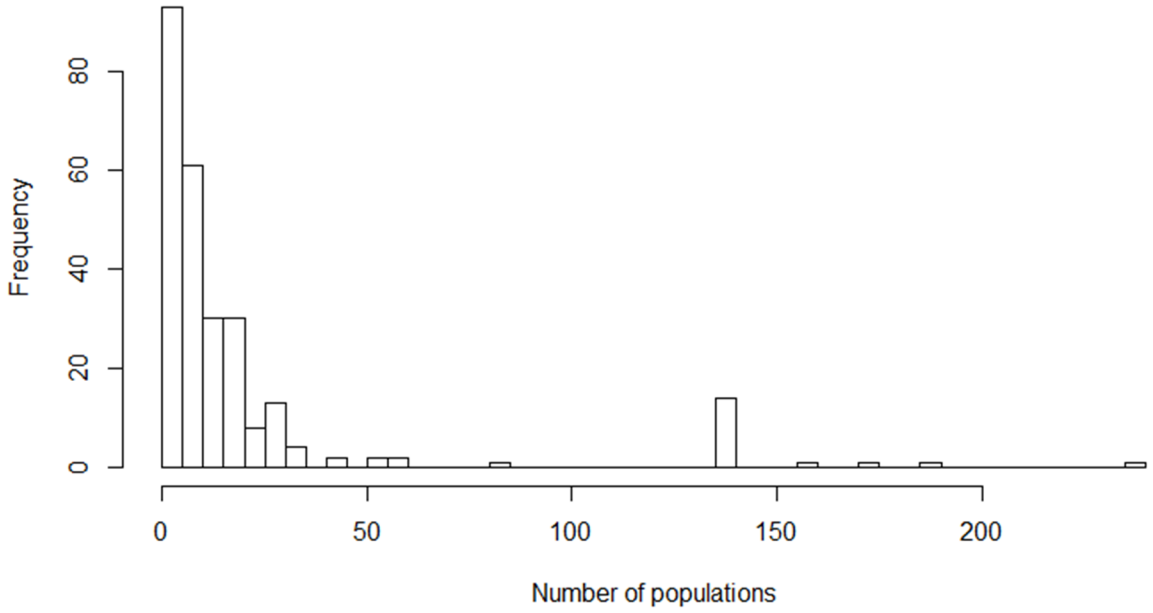
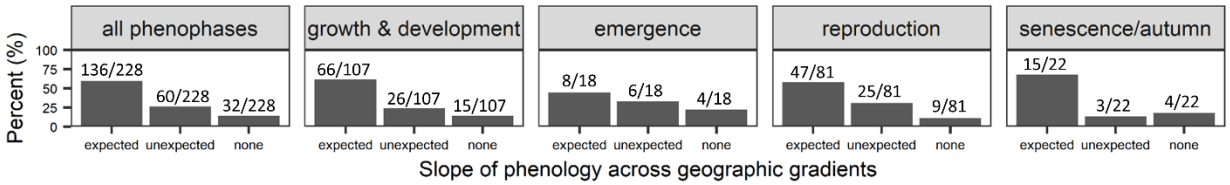
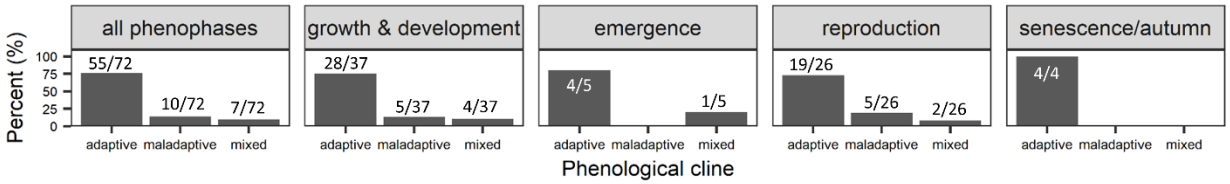


Figure A2. Percent of cases supporting each of the hypotheses outlined among plant taxa only for (left to right) all phenophases combined, growth and development, emergence, reproduction, and senescence/autumn phenology. Values represent the number of cases for or against each hypothesis out of the total number of cases that addressed that hypothesis. (H1a) We examine whether the leading edge (i.e. higher latitude or elevation) populations demonstrate delayed spring phenology (growth and development, emergence, and reproduction) and earlier autumn phenology relative to trailing edge (i.e., lower latitude or elevation) populations. "Expected" slopes indicate that phenology follows this pattern; "unexpected" indicates the reverse; "none" indicates no pattern across a geographic gradient. (H1b) We examine whether phenology demonstrates adaptive phenotypic plasticity (i.e., phenological plasticity is in the same direction as the geographic cline and so shifts phenotypes in the direction that would be adaptive in the novel environment), maladaptive plasticity (i.e., phenological plasticity is not consistent with the geographic cline), or mixed evidence. (H1c) We examine whether phenology demonstrates co-gradient genetic clines (i.e., many populations grown in a common environment demonstrate phenological plasticity consistent with the geographic and phenotypic cline), a counter-gradient genetic cline ("counter"), or mixed evidence. For (H2), we examine whether (H2a) edge versus central and (H2b) leading vs. trailing edge populations (or neither) demonstrate greater phenological plasticity, respectively. (H3) is not shown on this figure due to low sample size. For (H4), we examine whether (H4a) edge vs. central and (H4b) leading vs. trailing edge populations (or neither) demonstrate lower genetic variation in phenological traits, respectively.

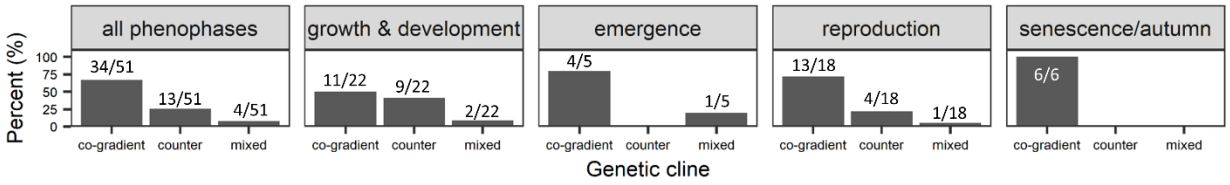
H1a: Does phenology vary in an expected or unexpected direction across geographic gradients?



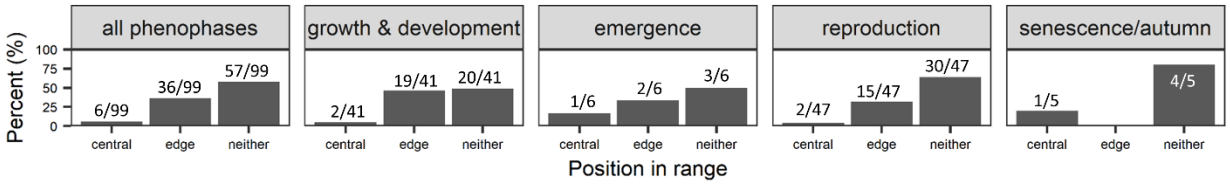
H1b: Does phenology demonstrate adaptive or maladaptive phenotypic plasticity?



H1c: Does phenology demonstrate a co- or counter-gradient genetic cline?

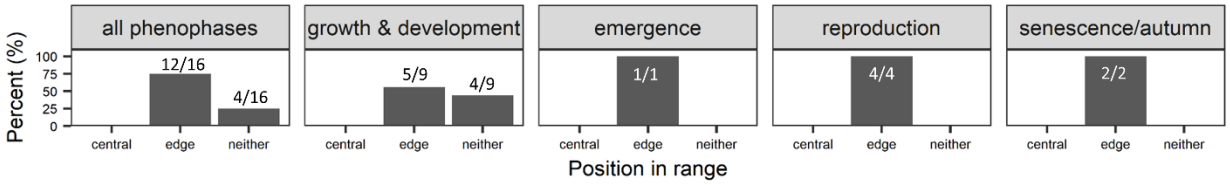


H2a: Are edge or central populations more phenologically plastic?



H2b: Are leading or trailing edges more phenologically plastic?

H4a: Is genetic variation lower in edge or central populations?



H4b: Do leading or trailing edges harbor less genetic variation?

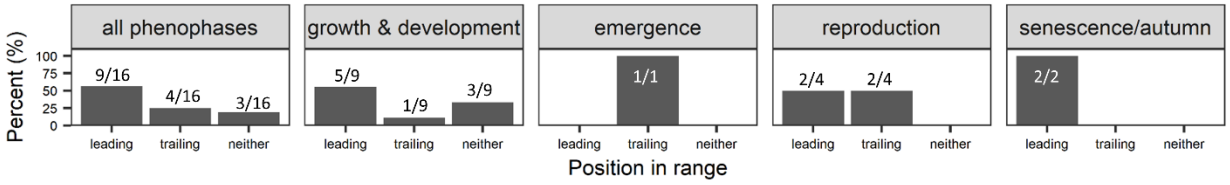
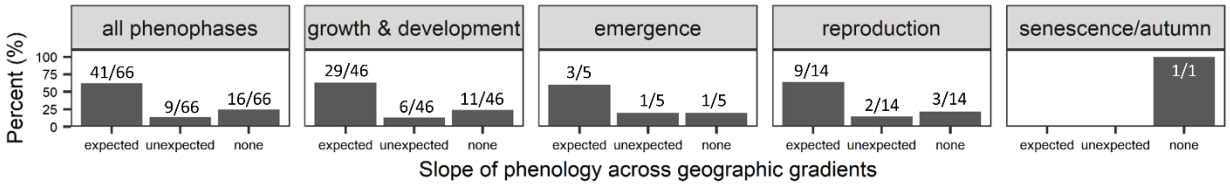
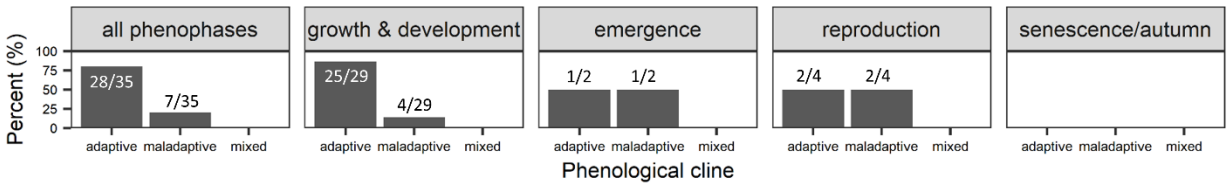


Figure A3. Percent of cases supporting each of the hypotheses outlined among animal taxa only for (left to right) all phenophases combined, growth and development, emergence, reproduction, and senescence/autumn phenology. Values represent the number of cases for or against each hypothesis out of the total number of cases that addressed that hypothesis. (H1a) We examine whether the leading edge (i.e. higher latitude or elevation) populations demonstrate delayed spring phenology (growth and development, emergence, and reproduction) and earlier autumn phenology relative to trailing edge (i.e., lower latitude or elevation) populations. "Expected" slopes indicate that phenology follows this pattern; "unexpected" indicates the reverse; "none" indicates no pattern across a geographic gradient. (H1b) We examine whether phenology demonstrates adaptive phenotypic plasticity (i.e., phenological plasticity is in the same direction as the geographic cline and so shifts phenotypes in the direction that would be adaptive in the novel environment), maladaptive plasticity (i.e., phenological plasticity is not consistent with the geographic cline), or mixed evidence. (H1c) We examine whether phenology demonstrates co-gradient genetic clines (i.e., many populations grown in a common environment demonstrate phenological plasticity consistent with the geographic and phenotypic cline), a counter-gradient genetic cline ("counter"), or mixed evidence. For (H2), we examine whether (H2a) edge versus central and (H2b) leading vs. trailing edge populations (or neither) demonstrate greater phenological plasticity, respectively. (H3) is not shown on this figure due to low sample size. For (H4), we examine whether (H4a) edge vs. central and (H4b) leading vs. trailing edge populations (or neither) demonstrate lower genetic variation in phenological traits, respectively.

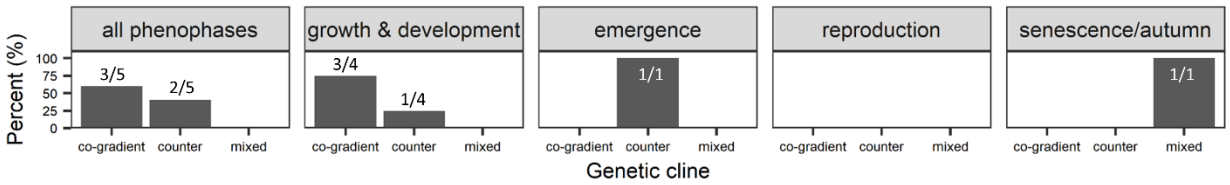
H1a: Does phenology vary in an expected or unexpected direction across geographic gradients?



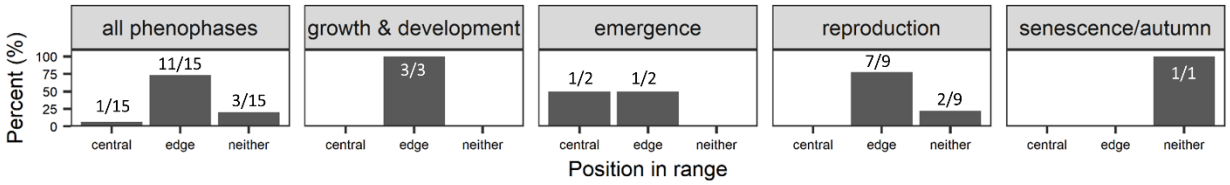
H1b: Does phenology demonstrate adaptive or maladaptive phenotypic plasticity?



H1c: Does phenology demonstrate a co- or counter-gradient genetic cline?

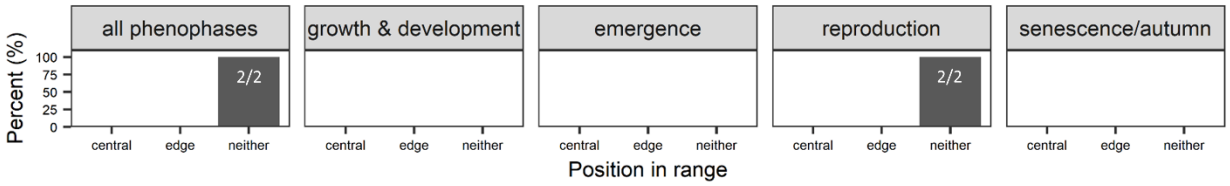


H2a: Are edge or central populations more phenologically plastic?



H2b: Are leading or trailing edges more phenologically plastic?

H4a: Is genetic variation lower in edge or central populations?



H4b: Do leading or trailing edges harbor less genetic variation?

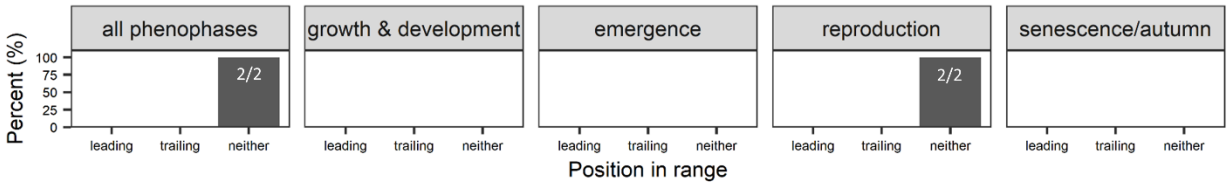
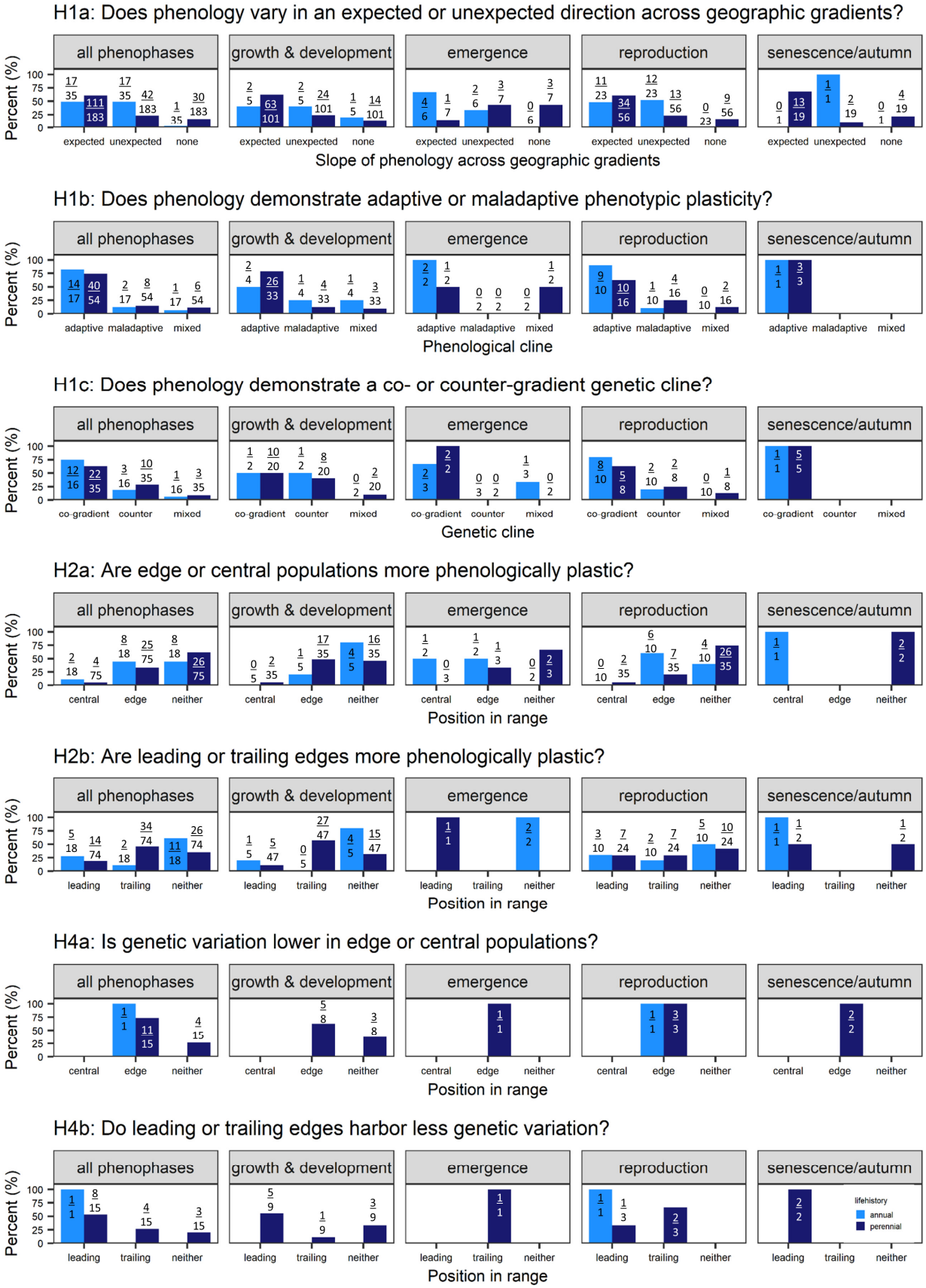


Figure A4. Percent of cases supporting each of the hypotheses outlined in annual (light blue) vs. perennial (dark blue) plants for (left to right) all phenophases combined, growth and development, emergence, reproduction, and senescence/autumn phenology. Values represent the number of cases for or against each hypothesis out of the total number of cases that addressed that hypothesis. (H1a) We examine whether the leading edge (i.e. higher latitude or elevation) populations demonstrate delayed spring phenology (growth and development, emergence, and reproduction) and earlier autumn phenology relative to trailing edge (i.e., lower latitude or elevation) populations. "Expected" slopes indicate that phenology follows this pattern; "unexpected" indicates the reverse; "none" indicates no pattern across a geographic gradient. (H1b) We examine whether phenology demonstrates adaptive phenotypic plasticity (i.e., phenological plasticity is in the same direction as the geographic cline and so shifts phenotypes in the direction that would be adaptive in the novel environment), maladaptive plasticity (i.e., phenological plasticity is not consistent with the geographic cline), or mixed evidence. (H1c) We examine whether phenology demonstrates co-gradient genetic clines (i.e., many populations grown in a common environment demonstrate phenological plasticity consistent with the geographic and phenotypic cline), a counter-gradient genetic cline ("counter"), or mixed evidence. For (H2), we examine whether (H2a) edge versus central and (H2b) leading vs. trailing edge populations (or neither) demonstrate greater phenological plasticity, respectively. (H3) is not shown on this figure due to low sample size. For (H4), we examine whether (H4a) edge vs. central and (H4b) leading vs. trailing edge populations (or neither) demonstrate lower genetic variation in phenological traits, respectively.


H1a: Does phenology vary in an expected or unexpected direction across geographic gradients?
all phenophases
growth & development
emergence
reproduction
senescence/autumn
Percent (%)
expected unexpected none
Slope of phenology across geographic gradients
H1b: Does phenology demonstrate adaptive or maladaptive phenotypic plasticity?
adaptive maladaptive mixed
Phenological cline
H1c: Does phenology demonstrate a co- or counter-gradient genetic cline?
co-gradient counter mixed
Genetic cline
H2a: Are edge or central populations more phenologically plastic?
central edge neither
Position in range
H2b: Are leading or trailing edges more phenologically plastic?
leading trailing neither
Position in range
H4a: Is genetic variation lower in edge or central populations?
Position in range
H4b: Do leading or trailing edges harbor less genetic variation?
Position in range
lifehistory
annual
perennial