Pieris virginiensis progress report 05

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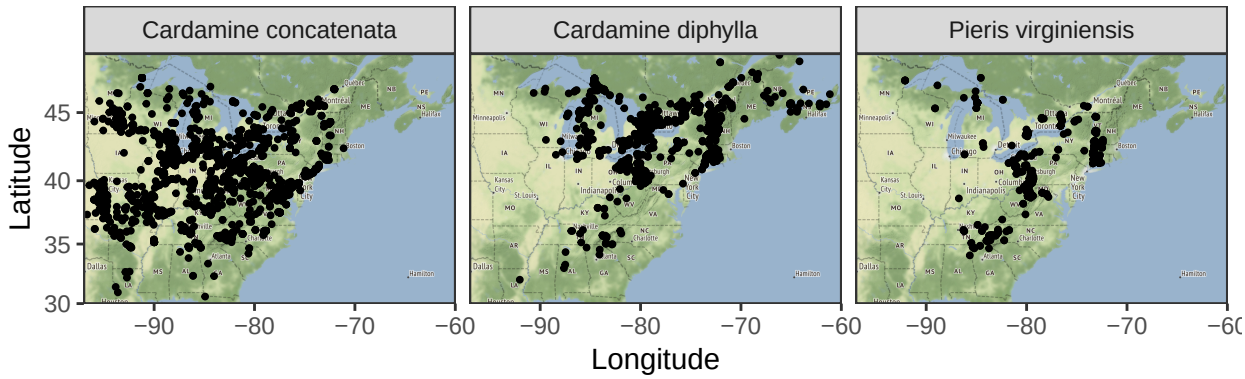
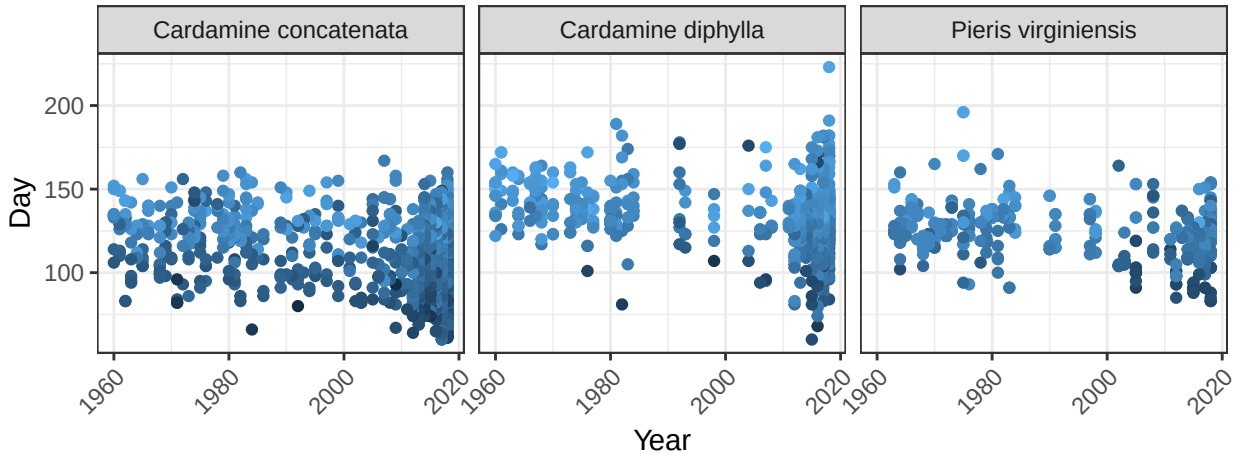
Retrieval from iNaturalist and GBIF returned 3369 total observations.

Following date and sample size filtering, observation counts for species:

- *Pieris virginiensis*: 544 observations
- *Cardamine concatenata*: 1963 observations
- *Cardamine diphylla*: 862 observations

Observations for 1960 - 2018 (total of 3369 observations following date and sample size filtering):





Note in lower plot, **darker** points are from lower latitudes, while **lighter** points are from higher latitudes.

Relationship with interaction between year and latitude

Just considering the insect data, compare the simple model,

$$Julian\ day = \beta_0 + \beta_1 Year + \beta_2 Latitude$$

with

$$Julian\ day = \beta_0 + \beta_1 Year + \beta_2 Latitude + \beta_3 Year \times Latitude$$

```
##
## Call:
## lm(formula = yday ~ year + latitude, data = insect_obs)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -37.499  -6.734  -1.239   4.909  52.240
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 90.15158   55.42154   1.627   0.1044
## year        -0.05777    0.02597  -2.224   0.0265 *
## latitude     3.55155    0.19474  18.238   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 11.41 on 541 degrees of freedom
## Multiple R-squared:  0.4442, Adjusted R-squared:  0.4422
## F-statistic: 216.2 on 2 and 541 DF,  p-value: < 2.2e-16
```

Now the complex model, with a year x latitude interaction

```
##
## Call:
## lm(formula = yday ~ year + latitude + year * latitude, data = insect_obs)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -37.253  -6.937  -1.238   4.998  53.748
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)   1163.86919  896.32152   1.298    0.195
## year            -0.59419    0.44770  -1.327    0.185
## latitude       -22.01147   21.29967  -1.033    0.302
## year:latitude    0.01277    0.01064   1.200    0.231
##
## Residual standard error: 11.4 on 540 degrees of freedom
## Multiple R-squared:  0.4457, Adjusted R-squared:  0.4426
## F-statistic: 144.7 on 3 and 540 DF,  p-value: < 2.2e-16
```

Compare the two models

```
## Analysis of Variance Table
##
## Model 1: yday ~ year + latitude
## Model 2: yday ~ year + latitude + year * latitude
##   Res.Df   RSS Df Sum of Sq      F Pr(>F)
## 1    541 70379
## 2    540 70192  1    187.24 1.4405 0.2306
```

The complex model is *not* significantly better than the simple model ($F = 1.441$, $p = 0.23$).