Effect of phenotypic trait skewness on selection gradients

Supplementary Material. Measuring natural selection on multivariate phenotypic traits. A protocol for verifiable and reproducible analyses of natural selection. Facundo Palacio, Mariano Ordano, and Santiago Benitez-Vieyra.

Load packages

```
library(ggplot2)
library(gridExtra)
```

Step 1. Simulation design

```
set.seed(77)
n.simulations <- 1000
beta <- runif(5, min = -1, max  = 1)
grad.LA.lin <- matrix(NA, nrow = n.simulations, ncol = 2)
grad.LA.quad <- matrix(NA, nrow = n.simulations, ncol = 2)
z1.skew <- c()
z2.skew <- c()
S1 <- c()
S2 <- c()
C1 <- c()
C2 <- c()

for(i in 1:n.simulations){
N <- 100

lambda <- 1:n.simulations
x1 <- rpois(N, lambda = lambda[i])
x2 <- rpois(N, lambda = lambda[i])
z1 <- (x1 - mean(x1))/sd(x1)
z2 <- (x2 - mean(x2))/sd(x2)
z1.skew[i] <- 1/sqrt(lambda[i])
z2.skew[i] <- 1/sqrt(lambda[i])

W <- 1 + beta[1]*z1 + beta[2]*z2 + beta[3]*z1^2 + beta[4]*z2^2 + beta[5]*z1*z2 +
     rnorm(N, mean = 0, sd = 0.2)
wrel <- W/mean(W)
S1[i] <- cov(wrel, z1)
S2[i] <- cov(wrel, z2)
C1[i] <- cov(wrel, z1^2)
C2[i] <- cov(wrel, z2^2)
# Models to estimate linear gradients
LA.lin <- lm(wrel ~ z1 + z2)
LA.quad <- lm(wrel ~ z1 + z2 + I((1/2)*z1^2) + I((1/2)*z2^2) + z1:z2)
grad.LA.lin[i,] <- LA.lin$coeff[2:3]
grad.LA.quad[i,] <- LA.quad$coeff[2:3]
}
```

Step 2. Gradient estimations

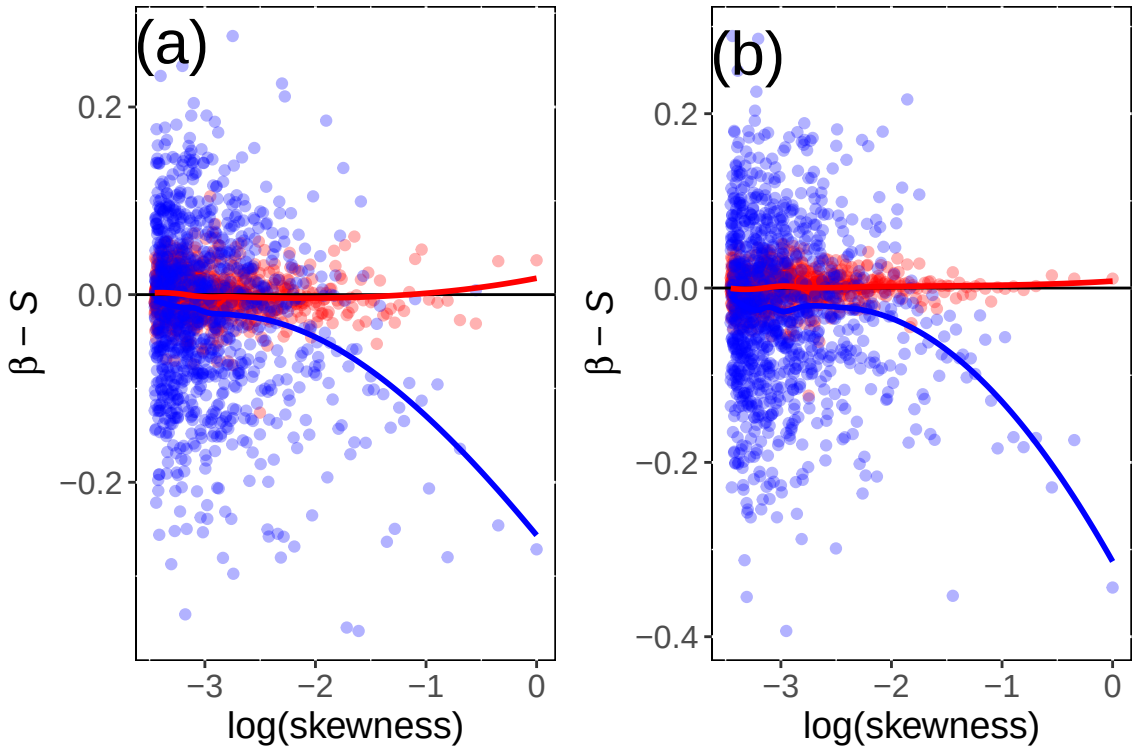
```
grad.LA.lin <- as.data.frame(grad.LA.lin)
names(grad.LA.lin) <- c("z1" , "z2")
grad.LA.quad <- as.data.frame(grad.LA.quad)
names(grad.LA.quad) <- c("z1" , "z2")
grad.LA.lin$z1.skew <- z1.skew
grad.LA.quad$z2.skew <- z2.skew
grad.LA.lin$diff.z1.S1 <- grad.LA.lin$z1 - S1
grad.LA.lin$diff.z2.S2 <- grad.LA.lin$z2 - S2
grad.LA.quad$diff.z1.S1 <- grad.LA.quad$z1 - S1
grad.LA.quad$diff.z2.S2 <- grad.LA.quad$z2 - S2
```

Step 3. Plot

```
p1 <- ggplot() + geom_point(data = grad.LA.lin, aes(log(z1.skew), diff.z1.S1),
                            col = "red", alpha = 0.3) +
  geom_point(data = grad.LA.quad, aes(log(z1.skew), diff.z1.S1),
                            col = "blue", alpha = 0.3) +
  geom_hline(yintercept = 0) +
  xlab("log(skewness)") +
  ylab(bquote(italic(beta) ~ "-" ~ italic(S))) +
  geom_smooth(data = grad.LA.lin, aes(log(z1.skew), diff.z1.S1),
              method = "loess", se = FALSE, col = "red") +
  geom_smooth(data = grad.LA.quad, aes(log(z1.skew), diff.z1.S1),
              method = "loess", se = FALSE, col = "blue") +
  theme(panel.background = element_rect(fill = "white",
                                        colour = "black"),
        axis.title = element_text(size = 14), axis.text = element_text(size = 12)) +
  annotate("text", label = "(a)", x = -3.3, y = 0.27, size = 8)

p2 <- ggplot() + geom_point(data = grad.LA.lin, aes(log(z2.skew), diff.z2.S2),
                            col = "red", alpha = 0.3) +
  geom_point(data = grad.LA.quad, aes(log(z2.skew), diff.z2.S2),
                            col = "blue", alpha = 0.3) +
  geom_hline(yintercept = 0) +
  xlab("log(skewness)") +
  ylab(bquote(italic(beta) ~ "-" ~ italic(S))) +
  geom_smooth(data = grad.LA.lin, aes(log(z2.skew), diff.z2.S2),
              method = "loess", se = FALSE, col = "red") +
  geom_smooth(data = grad.LA.quad, aes(log(z2.skew), diff.z2.S2),
              method = "loess", se = FALSE, col = "blue") +
  theme(panel.background = element_rect(fill = "white", colour = "black"),
        axis.title = element_text(size = 14), axis.text = element_text(size = 12)) +
  annotate("text", label = "(b)", x = -3.3, y = 0.27, size = 8)

grid.arrange(p1, p2, nrow = 1)
```


(a)
(b)
β − s
log(skewness)
0.2
0.0
−0.2
−0.4
−3
−2
−1
0