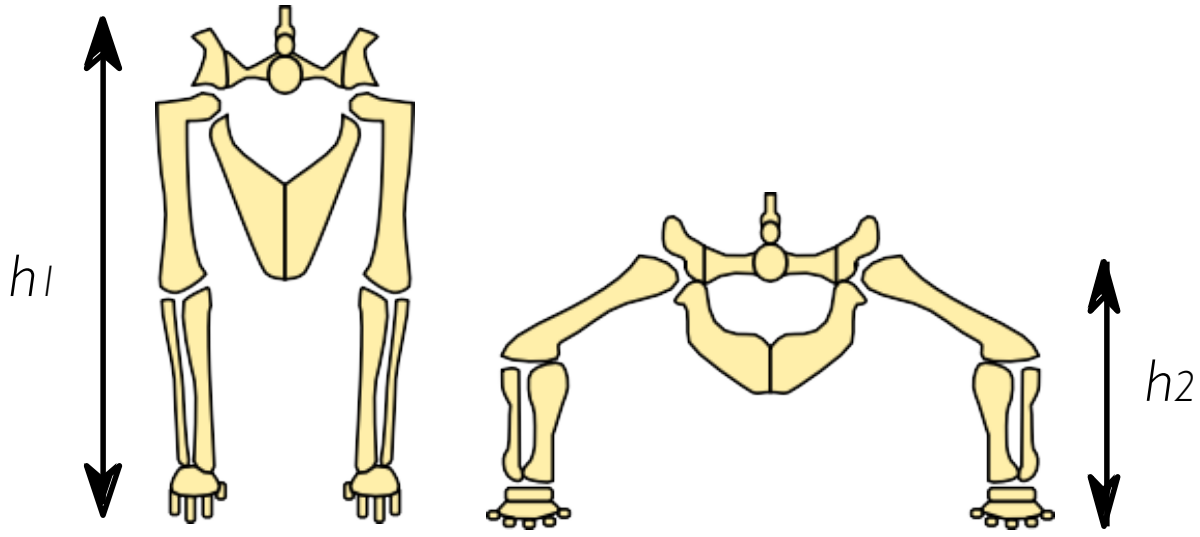
Why do sprawled animals have more legs?

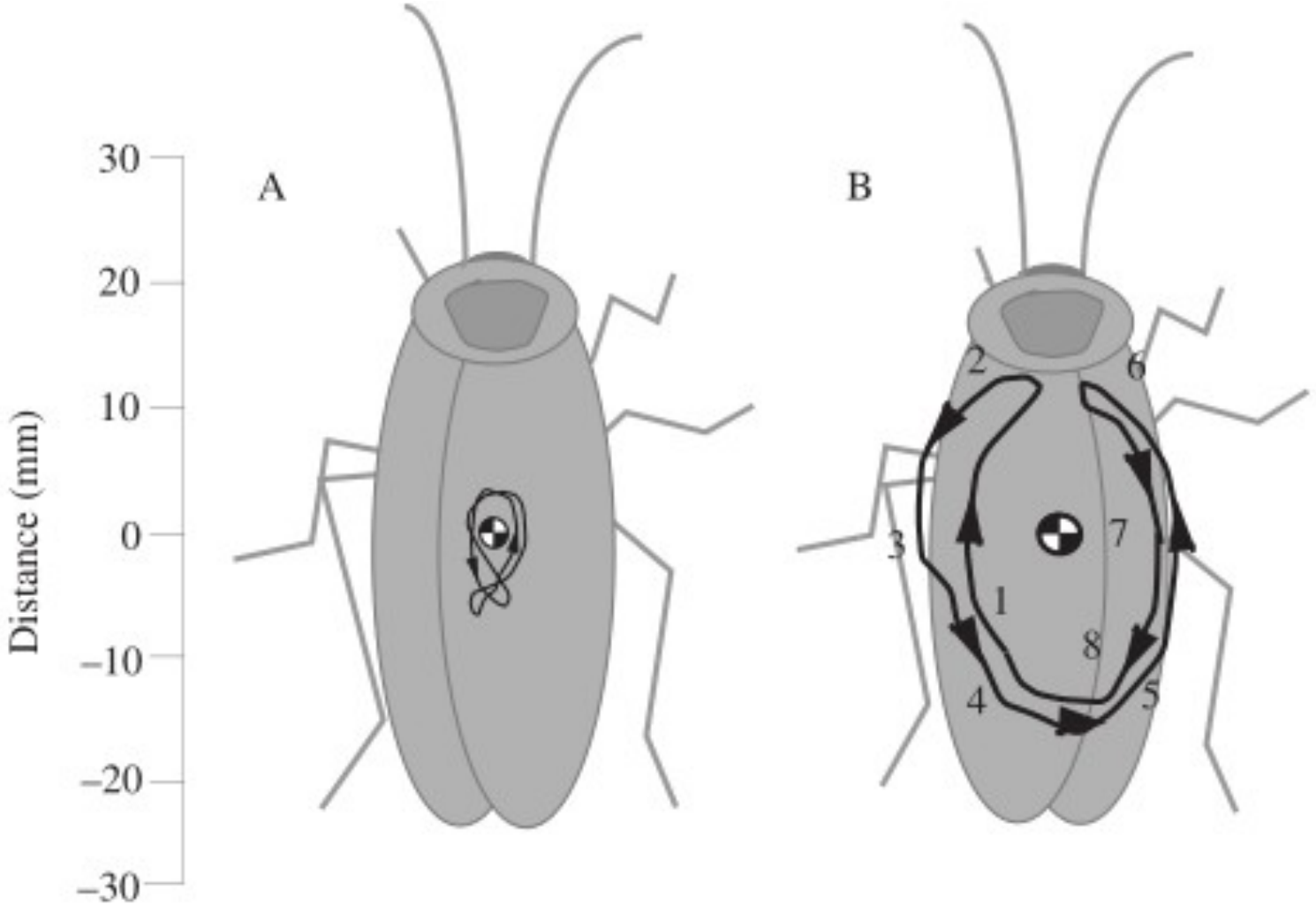


Derived from "Sprawling and erect hip joints - horizontal" by Fred the Oyster. Licensed under CC BY-SA 4.0 via Commons

- From Alexander [1982]
  - Assume: CoM height h, stride period
  - Time to fall $(2h/g)^{1/2}$
  - Reaction time $\sigma := f\,(2h/g)^{1/2}$ stride periods
- Example (dog vs. cockroach)

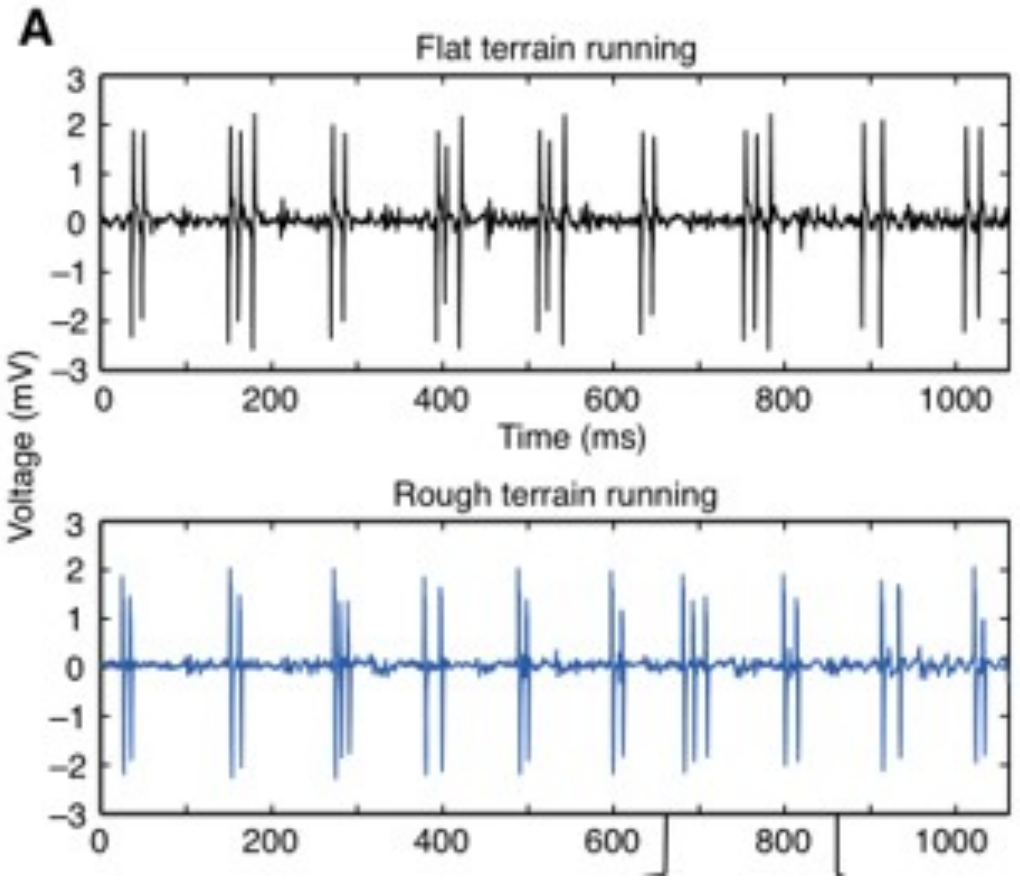
So do cockroaches move quasi-statically?

- *P. americana*: 1.5 m/s (50 body lengths/s) Full and Tu [1991]
- Cheetah: 16 body lengths/s
- Ting et al. [1994]

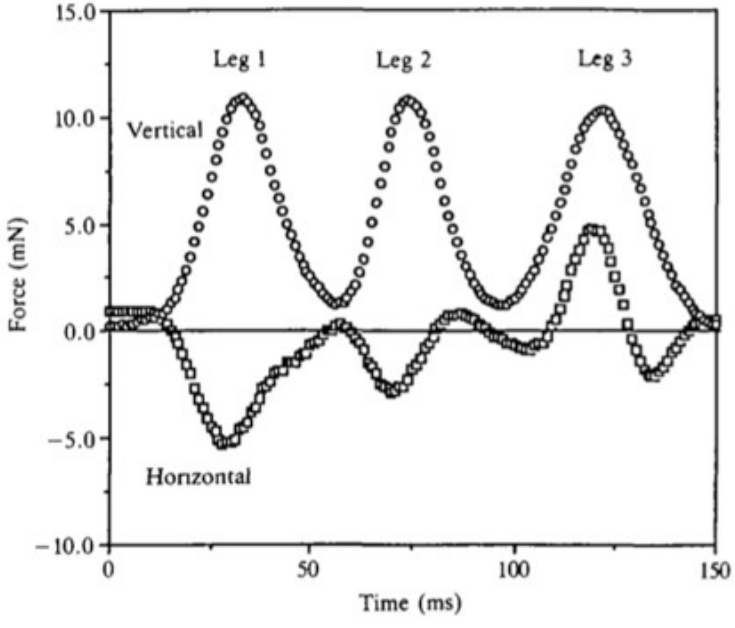


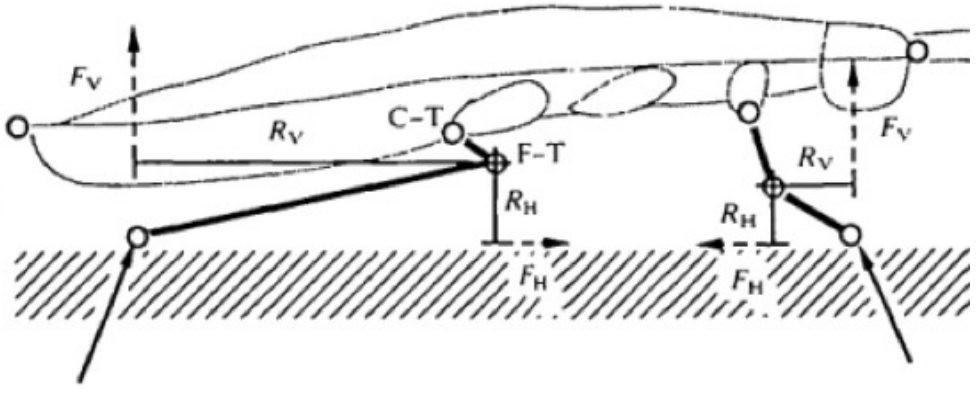
Do cockroaches actively stabilize dynamic gaits?

From Sponberg and Full [2008], in *B. discoidalis*



Why are cockroach legs splayed?

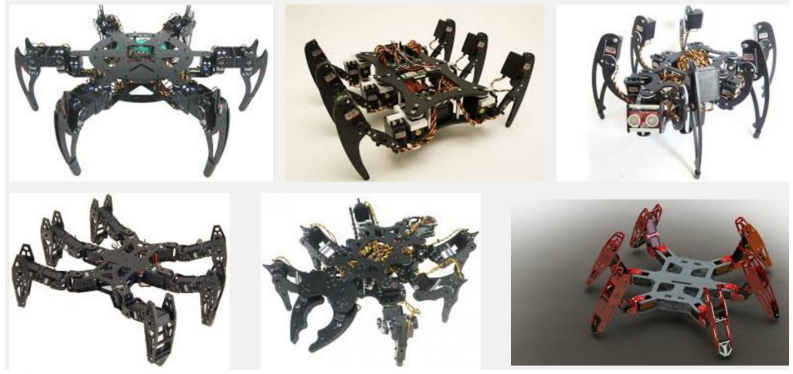




- Legs seem to push against each other
- GRF patterns have large horizontal forces
- Horizontal forces direct GRF towards joints

Sprawled posture robots

- 18 active DOF

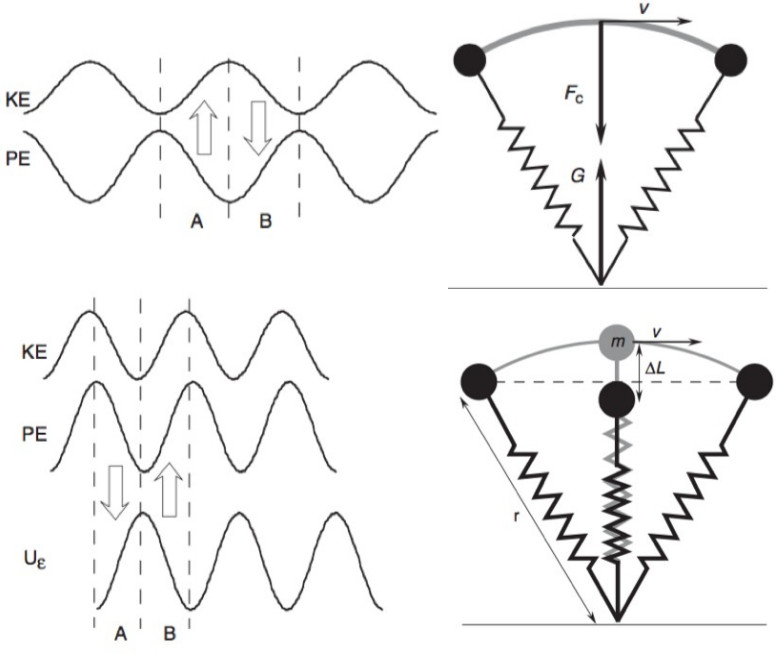


- 6DOF

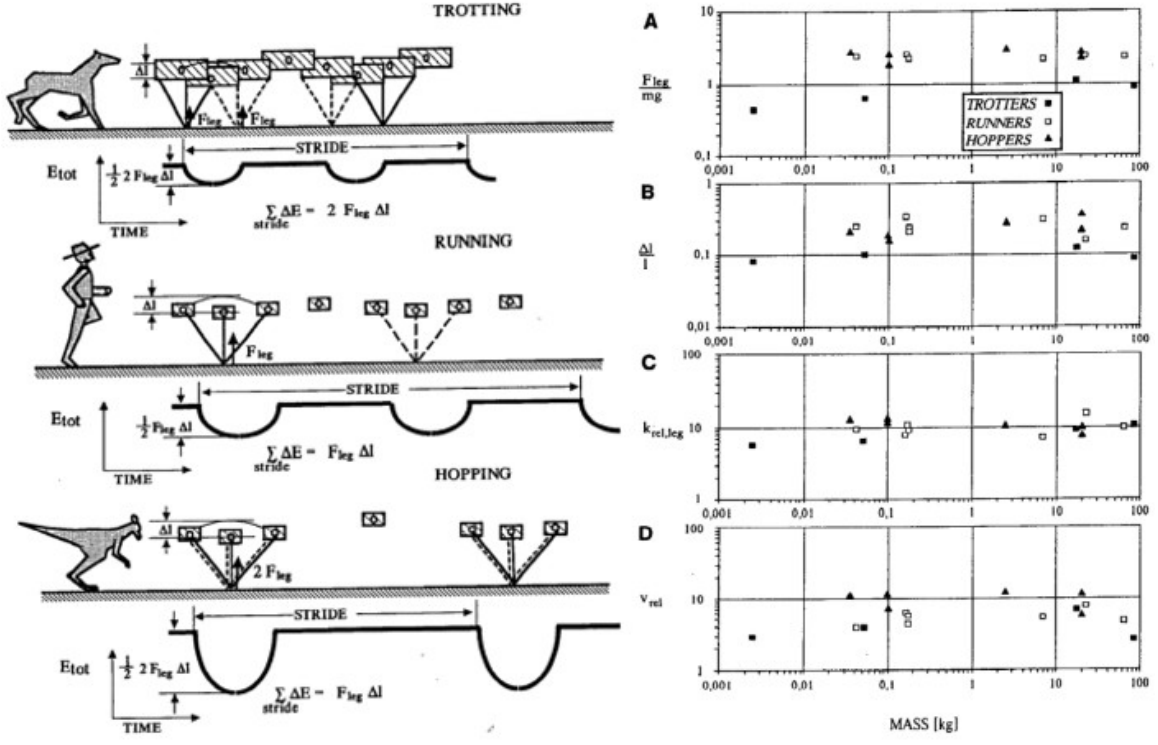
- Which one is more like the cockroach/spider/crab?

Design implications for running

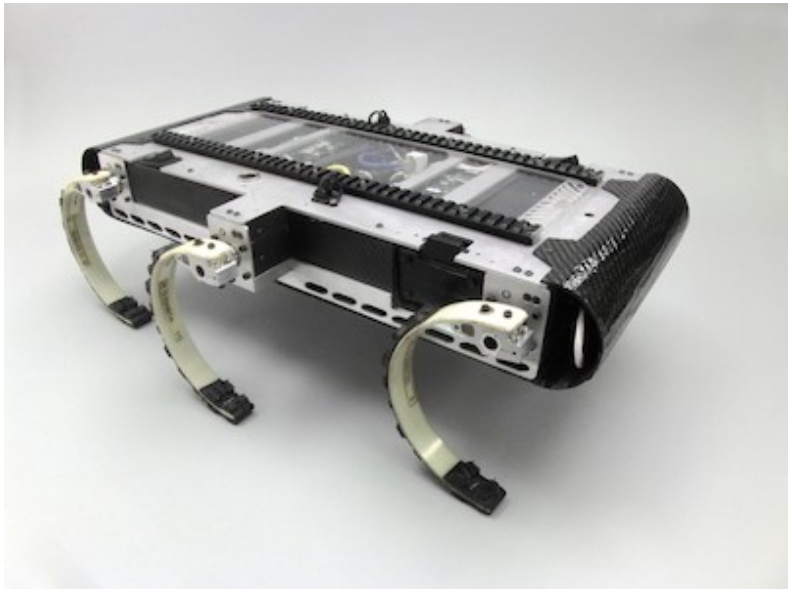
From Cavagna et al. [1977]; figure from Biewener [2003]

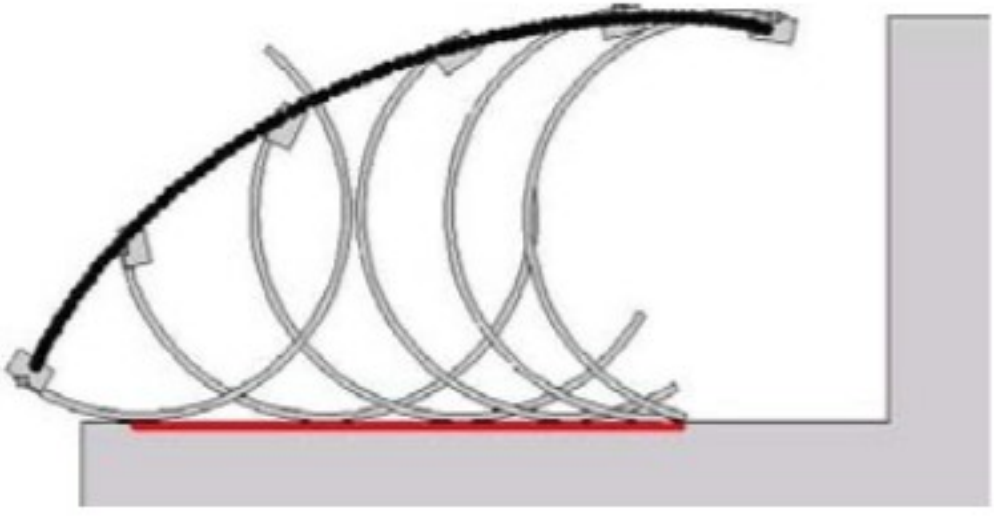


Universality of "bouncing:" Blickhan and Full [1993]



RHex design



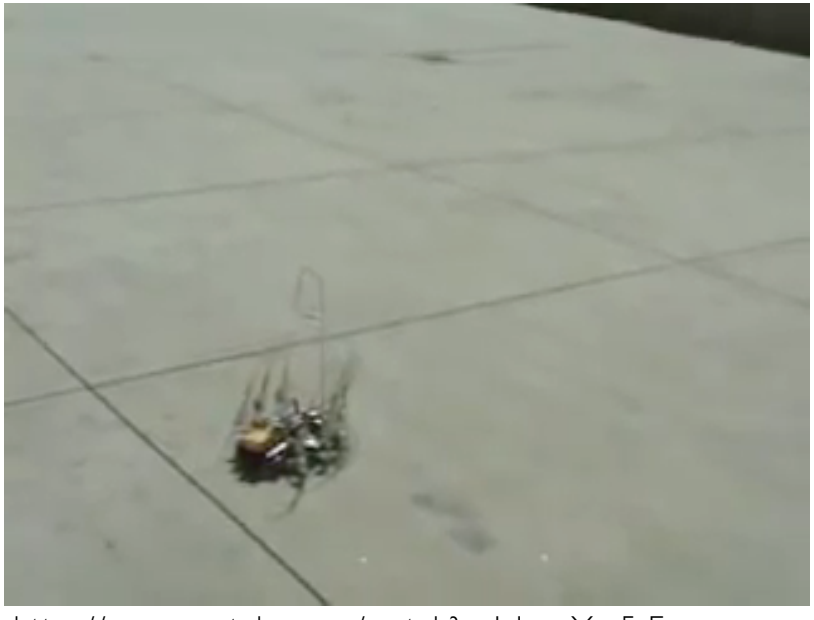


- 6 legs
- 1 actuator/leg
- Compliance
- "C" shape Moore [2002]

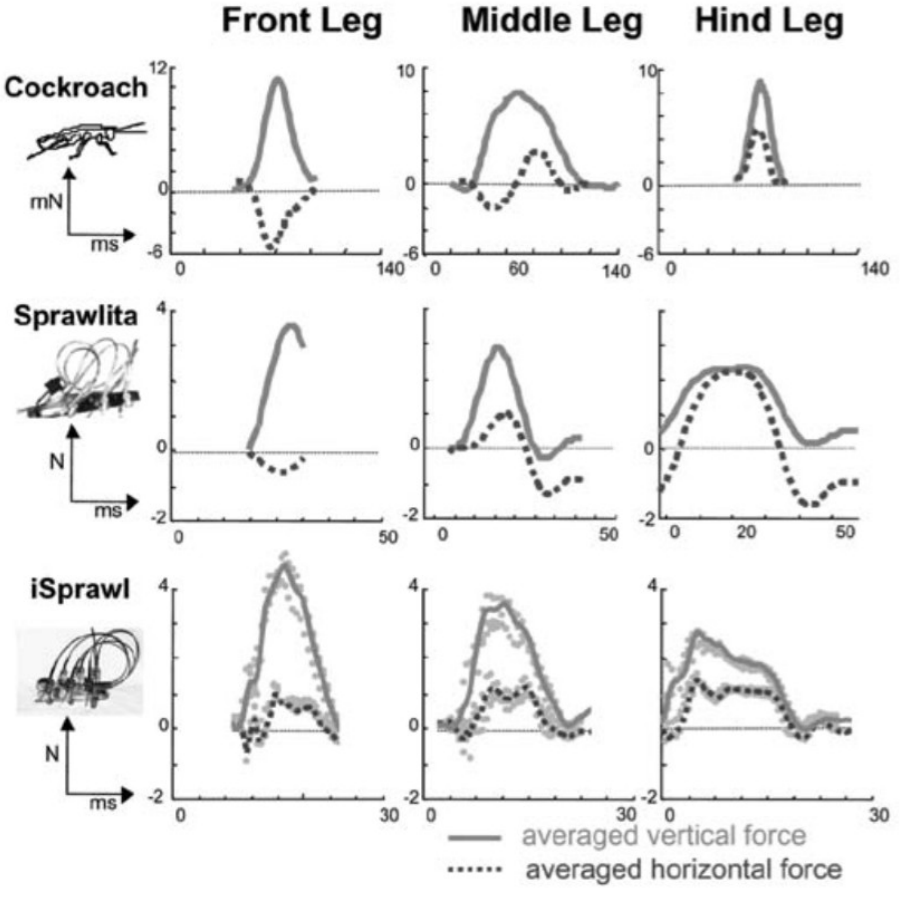
Much more on the conceptual development of RHex in 4.1!

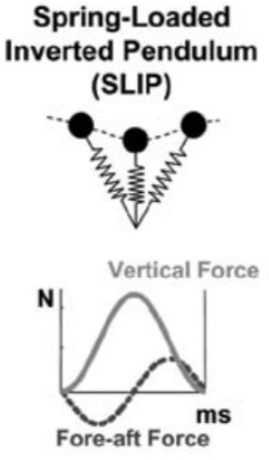
Leg differentiation

iSprawl (0.3 Kg, 15 bl/s), from Kim et al. [2006]



https://www.youtube.com/watch?v=JoI_onXm5rE





Lessons from sprawled animals and robots

Biomechanists tell us

- Sprawled animals need more legs—Alexander [1982]
- But they run dynamically—Ting et al. [1994]
- They don't use their brains—Sponberg and Full [2008], Jindrich and Full [2002]

Roboticists learn

- Dynamic locomotion offers advantages—Raibert and Hodgins [1993]
- Important to think of energy exchange to "run"—Saranlı et al. [2001]
- Bodies are designed accordingly—Saranlı et al. [2001], Kim et al. [2006]

Revisit: do robots need 6 legs?