Harnessing viscous streaming in complex active systems

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Rachis
Barb
Humerus
Ulna
Radius
Carpometacarpus
Digits

Biceps Scapulotriceps
Pectoralis
Supracoracoideus

TAKEOFF MODE

Parimary remiges
Secondary remiges
Dorso-ventral
Antero-posterior

Elbow (yellow plane)
Antero-posterior (yellow plane)
Dorso-ventral (green plane)

HEAD
TAIL

EMG NOT REPORTED

CHARACTERIZATION & MODELING

(a) (b) (c)

Simulated force (mN) vs. Simulated pillars deformation (mm)

Time (s)

(d)

Simulated displacement mean value exp. 1 std. exp.

PREDICTIVE DESIGN

(b) (c) (d)


Streamfunction

$X = X_{cm} + \epsilon a \sin(\omega t)$

$U_o = \epsilon \omega a$

$R_o = \frac{U_o a}{\nu} = \frac{\epsilon \omega a^2}{\nu}$

$R_s = \frac{U_o^2}{\omega \nu} = \frac{\epsilon^2 \omega a^2}{\nu} = \epsilon R_o$

$R_o \sim \mathcal{O}(10), R_s \sim \mathcal{O}(1)$
Baseline: Gazzola et al., 2012.

\[ Re = \frac{U_1 D_m}{\nu} \]
Scaled Strouhal number

\[ \zeta = \frac{R_o}{Re} \]

Oscillatory versus translation timescales
Ro = 45
Different geometry

Genus 0

Genus 1
Saddle Focus