Datasets user guide

Multi-modal locomotor costs favor smaller males in a sexually dimorphic leaf-mimicking insect

Boisseau et al., 2022

This user guide provides further details on the datasets used in the main article. For information on methods and data collection, please refer to the methods section of the main article. R scripts that use these datasets for analyses and plotting are also available.

Let us know if you have questions regarding this data and their analysis:
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Dataset #1: Phyllium_measurements.xlsx

Name in dataset	Variable	Unit	Description
ID	Individual ID		Identification number of each individual
sex	Sex		M: Male F: Female
body_mass_mg	Body mass	mg	Wet body mass
flight_muscle_dry_mass	Flight muscles mass	mg	Dry mass of dissected metathoracic male flight muscles
body_length	Body length	mm	Full body length
antenna_length	Antenna length	mm	Average length of the two antennae
front_femur	Front femur length	mm	Average length of the two prothoracic femurs
body_area	Body dorsal area	mm^2	Dorsal area of the body (excluding legs, wings and antennae)
body_circularity	Body circularity		Body circularity = $\frac{4\pi \times Area}{Perimeter^2}$ (excluding legs, wings and antennae)
body_AR_ImageJ	Body aspect ratio		Body aspect ratio as calculated by default in Image J. AR = $\frac{major\ axis}{minor\ axis}$ of the fitted ellipse.
body_AR	Body aspect ratio		Average body aspect ratio calculated as: AR = $\frac{Body\ length}{Average\ body\ width} = \frac{Body\ length^2}{Body\ dorsal\ area}$
Total_wing_area	Wing area	mm^2	Area of both extended wings combined. Hindwings for males Forewings for females
wing_loading	Wing loading	$N.m^{-2}$	Wing loading = $\frac{Body\ weight}{Wing\ area}$
wing_length	Wing length	mm	Average length of the two wings. Hindwings for males Forewings for females

Dataset #2: flight_experiments.xlsx

Name in dataset	Variable	Unit	Description
ID	Male ID		Identification number of each male
Trial	Trial number		Trial ID number for which flight trajectory was straight
body_mass	Body mass	mg	Wet body mass
body_weight	Body weight	N	Calculated with g = 9.81 $m.s^{-2}$
body_length	Body length	mm	Full body length
wing_length	Wing length	mm	Average length of the two hindwings.
wing_area	Wing area	mm^2	Area of both extended hindwings combined
body_area	Body area	mm^2	Dorsal area of the body (excluding legs, wings and antennae)
body_AR	Body aspect ratio		Average body aspect ratio calculated as: $AR = \frac{Body\ length}{Average\ body\ width} = \frac{Body\ length^2}{Body\ dorsal\ area}$
wing_disc_area	Wing disc area	m^2	Area swept out by the wing during a wing beat cycle. $A_{WD} = 2\pi\ wing\ length^2\ \frac{Amplitude}{360}$
wing_disc_loading	Wing disc loading	$N.m^{-2}$	$DL = \frac{Body\ weight}{A_{WD}}$
wing_loading	Wing loading	$N.m^{-2}$	Wing loading = $\frac{Body\ weight}{Wing\ area}$
t1	Time t_1	s	Time at which the insect open its wings and starts correcting its body pitch
t2	Time t_2	s	Time at which the insect stabilizes its body pitch
bangle_change_slope	Rotational velocity	$°.s^{-1}$	Average rotational velocity when the insect corrects its body pitch. $\omega = \frac{Body\ pitch\ (t_2) - Body\ pitch\ (t_1)}{t_2 - t_1}$
stable_bangle	Stable body pitch	°	Average body pitch after t_2
t_max_velocity	Time maximum speed	s	Time at which the insect reaches its maximum speed during the first phase (free fall)
local_max_velocity	Maximum velocity during free fall	$m.s^{-1}$	Maximum velocity reached during the first phase (free fall)
max_velocity	Maximum flight velocity	$m.s^{-1}$	Maximum flight velocity reached after t_2
mean_velocity_stable_bangle	Average flight velocity	$m.s^{-1}$	Average flight velocity reached after t_2
mean_acceleration_stable_bangle	Average flight acceleration	$m.s^{-2}$	Average flight acceleration reached after t_2
mean_vertical_velocity_stable_bangle	Average vertical flight velocity	$m.s^{-1}$	Average vertical flight velocity reached after t_2
mean_vertical_acceleration_stable_bangle	Average vertical flight acceleration	$m.s^{-2}$	Average vertical flight acceleration reached after t_2
mean_horizontal_velocity_stable_bangle	Average horizontal flight velocity	$m.s^{-1}$	Average horizontal flight velocity reached after t_2
mean_horizontal_acceleration_stable_bangle	Average horizontal flight acceleration	$m.s^{-2}$	Average horizontal flight acceleration reached after t_2
t_max_vertical_velocity	Time maximum vertical velocity	s	Time when insect reaches maximum vertical velocity
t_min_vertical_velocity	Time minimum vertical velocity	s	Time when insect reaches minimum vertical velocity

max_vertical_velocity	Maximum vertical velocity	$m.s^{-1}$	Maximum vertical velocity reached by the insect (> 0 : downwards)
min_vertical_velocity	Minimum vertical velocity	$m.s^{-1}$	Minimum vertical velocity reached by the insect (> 0 : downwards)
mean_vertical_acceleration_free_fall	Average vertical fall acceleration	$m.s^{-2}$	Average acceleration during free fall (< t_1)
mean_vertical_acceleration_stable	Average stable vertical acceleration	$m.s^{-2}$	Average vertical acceleration after body pitch stabilization (> t_2; > 0 : downwards)
mean_vertical_velocity_stable	Average stable vertical velocity	$m.s^{-1}$	Average vertical velocity after body pitch stabilization (> t_2; > 0 : downwards)
t_start_horizontal_movement	Start horizontal movement	s	Time at which the insect starts moving forward
t_local_max_horizontal_velocity	Time local maximum horizontal velocity	s	Time at which the insect reaches the first local maximum in horizontal velocity (before entering a steady state)
local_max_horizontal_velocity	Local maximum horizontal velocity	$m.s^{-1}$	Local maximum horizontal velocity (before entering a steady state)
max_horizontal_velocity	Maximum horizontal velocity	$m.s^{-1}$	Maximum horizontal velocity over the whole trajectory
mean_horizontal_velocity_stable	Average stable horizontal velocity	$m.s^{-1}$	Average horizontal velocity after body pitch stabilization (> t_2)
mean_horizontal_acceleration_stable	Average stable horizontal velocity	$m.s^{-2}$	Average horizontal acceleration after body pitch stabilization (> t_2)
wing_frequency_stable	Wingbeat frequency	Hz	Number of wingbeat cycle per second after body pitch stabilization (> t_2)
number_of_stable_half_strokes	Number of half strokes		Number of downstrokes + number of upstrokes after body pitch stabilization (> t_2)
angular_velocity_downstroke_stable	Angular downstroke velocity	$rad.s^{-1}$	Average angular velocity of the tip of the wing during downstroke after body pitch stabilization (> t_2)
angular_velocity_upstroke_stable	Angular upstroke velocity	$rad.s^{-1}$	Average angular velocity of the tip of the wing during upstroke after body pitch stabilization (> t_2)
amplitude_stable_m	Average projected wing stroke amplitude	m	Average projected wing stroke amplitude after body pitch stabilization (> t_2)
amplitude_stable_degrees	Average wing stroke angular amplitude	°	Average wing stroke angular amplitude after body pitch stabilization (> t_2)
mean_velocity_downstroke_stable_m/sec	Downstroke velocity	$m.s^{-1}$	Average wing tip velocity during downstroke after body pitch stabilization (> t_2)
mean_velocity_upstroke_stable_m/sec	Upstroke velocity	$m.s^{-1}$	Average wing tip velocity during upstroke after body pitch stabilization (> t_2)
average_wing_angular_velocity	Average wing tip angular velocity	$rad.s^{-1}$	Average wing tip velocity during upstrokes and downstrokes after body pitch stabilization (> t_2)
landing_velocity	Landing velocity	$m.s^{-1}$	Body velocity right before making contact with the landing target.

Dataset #3: Phyllium_attachment.xlsx

Name in dataset	Variable	Unit	Description
Sex	Sex		M: Male F: Female
adhesion	Adhesion force	mN	Maximum adhesion force (perpendicular to substrate). Average of three trials.
friction	Friction force	mN	Maximum friction force (parallel to substrate). Average of three trials.
body_mass	Body mass	mg	Body mass at time of experiment
body_length	Body length	mm	Full body length
SF_adh	Static adhesion safety factor		$SF_{static,\ adhesion} = \frac{Adhesion\ force}{Body\ weight}$ Body weight calculated with g = 9.81 $m.s^{-2}$
SF_frct	Static friction safety factor		$SF_{static,\ friction} = \frac{Friction\ force}{Body\ weight}$ Body weight calculated with g = 9.81 $m.s^{-2}$
projected_pad_area	Total projected pad area	mm^2	Total projected attachment pad area -- the surface area of the tarsus specialized for adhesion and friction -- of the right metathoracic tarsi
arolium	Arolium area	mm^2	Arolium pad area of the right metathoracic tarsi
euplantula	Euplantula area	mm^2	Euplantula pad area of the right metathoracic tarsi

Dataset #4: Phyllium_CFD.xlsx

Name in dataset	Variable	Unit	Description
Model	Model ID		ID of male leaf insect 3D model
description	Model description		Description of 3D model
shape_number	Abdominal shape treatment		1: male original shape 2: Very wide 3: Very thin 4: wide 5: thin
length_number	Size treatment		1: original body length 2: original body length x 1.15 3: original body length x 0.85 4: original body length x 1.05 5: original body length x 0.95
Number_nodes	Number of nodes in final mesh		Number of nodes in final mesh of the fluid volume
Number_elements	Number of elements in final mesh		Number of elements in final mesh of the fluid volume
iterations	Number of iterations		Total number of iterations in the final simulation (i.e., with the final mesh) until convergence
Fx	Force x-axis	μN	Force applied by the air on the insect model along the x-axis
body_lift	Lift force	μN	Force applied by the air on the insect model along the y-axis: lift
body_drag	Drag force	μN	Force applied by the air on the insect model along the x-axis: drag
body_length	Model length	mm	Full body length of the insect model
total_body_dorsal_area	Model dorsal area	mm^2	Dorsal area of the body (excluding legs, wings and antennae)
body_AR	Model aspect ratio		Average body aspect ratio calculated as: AR = $\frac{Body\ length}{Average\ body\ width} = \frac{Body\ length^2}{Body\ dorsal\ area}$
body_projected_area	Model projected frontal area	mm^2	Projected frontal area of the insect model
Cd	Drag coefficient		$$C_D = \frac{2\,F_{drag}}{\rho v^2}$$ using the model frontal area (A), the mass density of air (ρ = 1.20473 kg.m^{-3}), the velocity of the insect (v =1.57 m.s^{-1}) and drag force (Fz_N)
Cl	Lift coefficient		$$C_L = \frac{2\,F_{lift}}{\rho v^2}$$ using the model frontal area (A), the mass density of air (ρ = 1.20473 kg.m^{-3}), the velocity of the insect (v =1.57 m.s^{-1}) and lift force (Fy_N)
Reynold_number	Reynolds number		$$Re = \frac{\rho v L}{\mu}$$ using the mass density of air (ρ = 1.20473 kg.m^{-3}), the velocity of the insect (v =1.57

			m.s^{-1}), its body length (L) and the dynamic viscosity of air (μ = 18.1 μPa.s)
L/D	Lift to drag ratio		L/D $= \frac{C_L}{C_D}$
body_mass_mg	Model mass	mg	Body mass of insect model taking into account extensions or reductions of abdominal lobes.
weight	Model weight	μN	Body weight calculated with g = 9.81 m.s^{-2}