Wednesday 8th July 2026 16:20

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Drain flies (Psychodidae, *Clogmia albipunctata*) thrive in wet environments such as household showers. Consequently, their bodies and wings are covered with hydrophobic, hair-like wax structures, giving them their characteristic fuzzy appearance. These hairs increase wing area by 45% on average, while contributing to 30–60% of total wing mass. As a result, drain fly wings represent approximately 2.5% of their body mass, making them the heaviest to date within Diptera. This raises the question: Could there be an additional aerodynamic benefit for the hydrophobic wax? On the one hand, the drain flies' increased wing mass is associated with increased inertial costs and relatively low wingbeat frequencies, which decrease from 150 to 115 Hz with increasing wing mass. Nonetheless, the waxy hairs appear to play a significant aerodynamic role. When their contribution to effective wing area is considered, wing aspect ratio, i.e., length to width ratio decreeses from 6 to 4, with wing loading decreasing from 3.5 to 2.2 N mm^{-2}. Furthermore, aerodynamic analysis of flapping kinematics indicates that the additional area, assuming a non-permeable structure, increases the average vertical aerodynamic force by 32%, jumping from 1.61 to 2.13 milligram-force. Given an average body mass of 1.72 mg, this increase suggests that, while accounting for their porous nature, the hairs are necessary to support body weight during flight, revealing the hair's dual functionality in repelling water while contributing to aerodynamic force production.

A16.38 FINITE ELEMENT MODELS SUGGEST THAT THE SWIM BLADDER HELPS RESOLVE THE 180-DEGREE AMBIGUITY IN DIRECTIONAL HEARING IN A VOCAL FISH

Wednesday 8th July 2026 16:25

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Fish hear sound primarily by detecting particle motion, which inherently produces a 180-degree ambiguity in determining sound direction. Species with a swim bladder coupled to the inner ears can also sense acoustic pressure. The phase model proposes that these fishes resolve the 180-degree ambiguity by comparing the phase relationship between acoustic pressure and particle motion. However, it remains unclear whether the swim bladder generates direction-dependent differences in otolith motion, required to resolve the 180-degree ambiguity. We used finite element modelling to compute steady-state motion of the otoliths with and without a gas-filled swim bladder for single-frequency plane wave sounds in the plainfin midshipman (*Porichthys notatus*). At 50 and 100 Hz, otolith motion was identical for opposite sound directions in the absence of a swim bladder. When the swim bladder was present, the otoliths followed elliptical trajectories with opposite handedness for opposite sound directions, potentially leading to distinct patterns of hair cell activation. At 200 and 1000 Hz, otolith motion was similar across all tested directions, even with the swim bladder present, suggesting a limited contribution to directional hearing at higher frequencies. At 100 Hz, reversing the phase relationship between acoustic pressure and particle motion reversed the handedness of orbital otolith motion, replicating the trajectory produced by a sound arriving from the opposite direction. These results suggest that swim bladder-induced reversal in the handedness of otolith motion may provide a biomechanical cue enabling computation of phase differences between acoustic pressure and particle motion, thereby resolving the 180-degree ambiguity in directional hearing.

A16.92 WHY DO CHARAXES BUTTERFLIES HAVE TAILS : ASSESSING THE EFFECT OF WING SHAPE ON FLIGHT PERFORMANCE IN A FAST FLYING BUTTERFLY GENUS

Thursday 9th July 2026 11:00

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Butterflies present a stunning diversity of wing size and shape, yet the evolutionary drivers of this diversity are poorly known. In particular, many species harbour tails on their hindwings, differing in number, length and shape. Surprisingly, little is known about the selective forces affecting their evolution. Here we explore the hypothesis that tails might contribute to flight performance, which might influence fitness, since flight is involved in escape, patrolling and foraging in butterflies.

Here we focus on a genus of fast flying paleotropical butterflies,*Charaxes*, displaying a high diversity of wing shapes, including species with no tail, one pair of tails, or two pairs of tails. We compared the flight of 20 morphologically diverse and sympatricCharaxesspecies in central Côte d'Ivoire, using stereographic videography in semi natural conditions (an outdoor flight insectary).

We filmed several individuals from each species (leading to a total of 230 individual flights) with high speed cameras (120 frames per second), and reconstructed their 3D flight trajectories using a custom tracking tool. We then extracted flight variables to quantify the variation in flight behaviour across species.

We are now using phylogenetic comparative analyses to assess how flight parameters correlate with morphology, including mass, wing loading and wing shape quantified through geometric morphometrics. By contrasting tailed and tailless species, we aim at identifying the effect of wing tails on flight, allowing to better understand the drivers of their morphological evolution, and contribute unraveling the link between wing morphology and flight performance.

A16.91 STRETCHING THE LIMITS: DEFORMATION OF BASKING SHARK SKIN IS PROMOTED BY THE ATYPICAL ARRANGEMENTS OF THEIR DISTINCT DENTICLES

Thursday 9th July 2026 11:15

Mike Schindler (City University of Hong Kong, Hong Kong), Tairan Li (University College London, United Kingdom), Frederik H. Mollen (Elasmobranch Research Belgium (ERB), Belgium), Shahrouz Amini (Max Planck Institute of Colloids and Interfaces, Germany), Ruien Hu (Hong Kong Polytechnic University, Hong Kong), Mason Dean (City University of Hong Kong, Hong Kong)

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Antithetically to the common streamlined alignment on other sharks, skin denticles of the filter feeding basking shark (*Cetorhinus maximus*) differ significantly in terms of arrangement and shape. The denticles are not standing in lines but instead are densely clumped together to form 'paver blocks' elevated on the skin, separated by unscaled folds, resembling the wrinkled skin of elephants. The denticles in the blocks are circularly arranged with tips covering all azimuthal directions, reaching above the folds and towards adjacent denticles in other blocks. The combination of soft stretchable folds between non-deformable regions (paver blocks) creates a tiled and dynamic armor, crucial for this species' huge inflation of the mouth and oral cavity during ram filter feeding. Using high-resolution µCT scans, histology and mechanical tests we display that denticles are significantly larger than those of other sharks, with paver block arrangement guiding anisotropic skin folding. In combination with large-area laser scanning, surface topology measurements, motion capturing and allometry of the head, we illustrate distinct geometries of folds associated with particular body regions, especially the dorsal head, caudo-lateral to the jaws, and the ventral throat. We further discuss how anisotropic skin stretching relates to the skeletal architecture of the head to enable the enormous oral volume enlargement during mouth opening. These anatomical findings provide much-needed insights into the functional morphology of large marine filter feeders, while offering inspiration for derive novel bio-inspired filter systems that benefit from dynamic, non-clogging processes and scalability.

A16.93 EFFECTS OF WING SURFACE TEMPERATURE ON AERODYNAMIC PERFORMANCE INSPIRED BY SEABIRD WING COLORATION

Thursday 9th July 2026 11:30

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This study investigates the aerodynamic effects of localized surface heating inspired by black wingtip coloration in long-distance flying seabirds. Long-distance flying seabirds frequently exhibit distinctive black-and-white wing patterns, with dark pigmentation concentrated near the wingtips. Because darker surfaces absorb greater solar radiation, localized heating may occur during prolonged flight. Such temperature differences could influence boundary-layer behavior and potentially contribute to aerodynamic efficiency. In our previous wind-tunnel experiments using 3D-printed NACA0012 and NACA2412 airfoils with embedded film heaters, surface heating improved the lift-to-drag ratio at specific angles of attack, and oil flow visualization suggested delayed flow separation under heated conditions. These findings raise the possibility that wing pigmentation may function as a passive flow-control mechanism. To examine the generality of this effect, we extended the experiments to additional cambered NACA airfoils (NACA3412 and NACA4412) under identical thermal conditions. Force measurements and oil flow visualization were compared systematically across airfoil geometries. Preliminary results indicate that the aerodynamic response to heating depends on airfoil camber, with larger camber leading to greater performance improvements under certain flow conditions. The study is further expanded to include additional camber configurations and a morphologically inspired wing model of the streaked shearwater. By progressively transitioning from simplified airfoil models to biologically representative geometries, this work aims to clarify whether black wingtip coloration may provide functional aerodynamic benefits during sustained flight in seabirds.

A16.94 NEED FOR SPEED: DO JAW MUSCLE CONTRACTION KINETICS DIFFER AMONG SONGBIRDS WITH VARYING BITE FORCES?

Thursday 9th July 2026 11:45

Jana De Ridder (Ghent University, Belgium), Maja Mielke (University of Antwerp, Belgium), Sam Van Wassenbergh (University of Antwerp, Belgium), Dominique Adriaens (Ghent University, Belgium)

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Beak morphology in songbirds is often shaped by feeding ecology. Granivorous species for example, have evolved larger, stronger beaks to crack hard seeds. Song production, however, favours rapid beak movements associated with high trill rates. This creates a functional trade-off between bite force and movement speed. The biomechanical mechanisms underlying this force–velocity trade-off remain unclear but may primarily involve differences in muscle contraction kinetics. We therefore hypothesise that species with higher bite forces exhibit longer contraction and relaxation times in their jaw muscles. To test this, tetanic contraction and relaxation times were measured in vitro for an opener and a closer muscle in five granivorous songbird species. We found that the stronger biting species indeed had slower muscle force kinetics, and especially a longer force rise time, compared to the weaker biters. These differences were more pronounced in the closer muscles. Because muscle contraction kinetics are influenced by fibre type composition, the slower contraction kinetics observed in strong biting species may reflect a greater proportion of slow fibres. Future work will test this by examining fibre type composition in jaw muscles.

A16.95 FLYING IN A TURBULENT WORLD: HOW DO PIGEONS RESPOND TO GUSTS?

Thursday 9th July 2026 12:00

Charles A Proe (Swansea University, United Kingdom), Lydia A France (Oxford University, United Kingdom), Emily LC Shepard (Swansea University, United Kingdom), Alper Celik (Swansea University, United Kingdom)