Modulation of yaw by the caudal fin in the yellow boxfish (Ostracion cubicus)

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ABSTRACT BOOK

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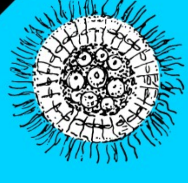

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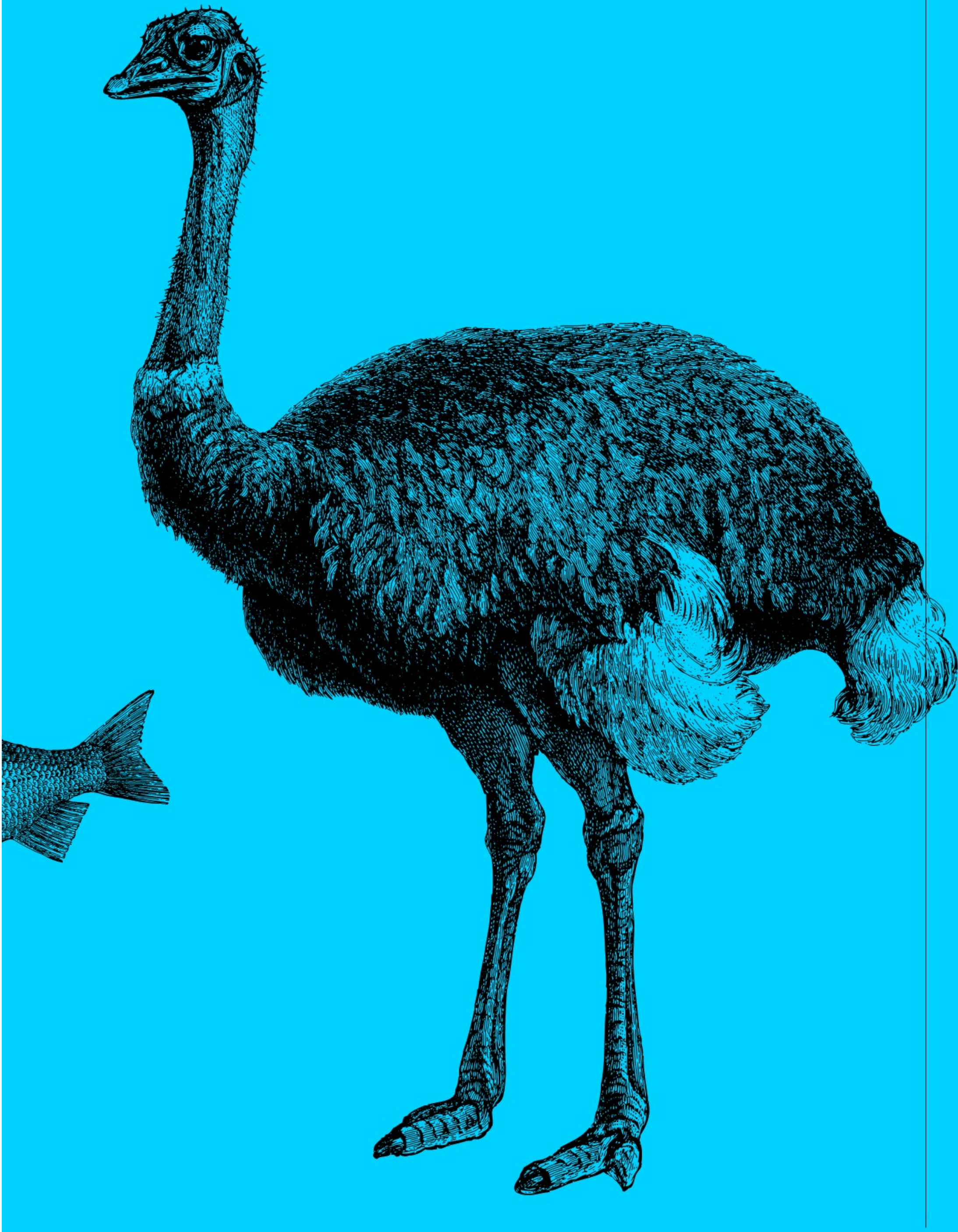

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Guidance and control of aerial attack behaviour is expected to be intimately related to its ecological setting. Here we analyse a very large dataset of state-of-the-art motion capture data, confirming that Harris' Hawk guidance is best modelled by a mixed guidance law, proportional navigation pursuit (PNP), in contrast to the proportional navigation (PN) guidance best modelling Peregrine Falcons. Furthermore, with PN fitted to both species, it is parameterised very differently between them, likely reflecting disparate ecologies: hawks operating in cluttered environments, hunting agile prey against a close background; falcons operating in open environments against distant backgrounds and potentially less agile prey. We extend our understanding by showing that PNP pursuit in hawks is just as effective when sensory input is modelled in a local background reference frame (LRF) as when in an inertial frame (IRF). This is a priori surprising as effective PN guidance is impossible using an LRF, and engineered missile systems absolutely rely on IRF measurements. The possibility only arises in hawks because of their use of mixed PNP guidance. This is interesting, because the motion vision system naturally makes measurements in the LRF. This result implies input from a single sensory modality – vision – could successfully implement PNP, with no necessary requirement for fusion with inertial measurements from the vestibular system. This may explain why hawks use PNP, while falcons use PN given target motion measured against a distant background approximates being measured in an IRF.

A8.35 HIERARCHY OF GRAVITY-RECEPTIVE ORGANS IN CRICKETS

Tuesday 6 July 2021 **12:40**

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For almost all organisms a reliable detection of the gravitational vector is an important fitness criterion. This detection is based on relatively simple physical principles, however physiologically "implemented" a variety of different sensor types. Arthropods and in particular insects show a great variety of different exoskeletal sensors sensitive to the gravitational vector. Previous studies show that in many cases the gravity reception of insects most likely relies on some sort of sensor fusion, resulting in an astonishing overall accuracy and precision. Within these complex sensor systems, it however seems likely that some gravity receptive organs might play a more important role in determining the overall gravitational vector than other sensors. To answer this question, we performed behavioural experiments on house crickets (*Acheta domesticus*) with selectively deactivated gravity perceiving structures. Animals with different treatments were buried inside a transparent box filled with granular material. The box was then randomly rotated to disorient the insect. We then recorded the directions in which the crickets tried to escape the box and the respective time. Our results show that ablation of the cerci resulted in a decrease in sensing performance of approximately 39.59%. Additional ablation of the antennae further decreased the overall sensing performance. A possible participation of the leg proprioceptors in gravity perception could not be shown experimentally. In general, the failure of individual sensory structures could be fully compensated, whereas the failure of the club-shaped sensilla on the cerci could only be compensated with an overall loss in sensing performance.

A8.36 MODULATION OF YAW BY THE CAUDAL FIN IN THE YELLOW BOXFISH (OSTRACION CUBICUS)

Tuesday 6 July 2021 **14:00**

Pim G. Boute (Experimental Zoology Group - Wageningen University and Research, Netherlands), Sam Van Wassenbergh (Department of Biology - University of Antwerp, Belgium), Eize J. Stamhuis (Department of Ocean Ecosystems - University of Groningen, Netherlands)

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Boxfishes (Ostraciidae; Tetraodontiformes) have a rigid carapace which restricts body undulation. Swimming movements can only be generated by the fins which protrude from the carapace. Nevertheless, these fishes are highly manoeuvrable and manage to swim with remarkably dynamic stability. However, the rigid carapace of boxfishes shows an inherently unstable response in yaw caused by course-disturbing flows. Hence, any net stabilising effect should come from the fishes' fins. Here, we aim to determine the effect of the surface area and orientation of the caudal fin on the yaw torque exerted on the square cross-sectional shaped yellow boxfish (*Ostracion cubicus*). Yaw torques were quantified in a flow tank using a 3D printed physical yellow boxfish model with an attachable closed or open caudal fin. The model was positioned at different body and tail angles and exposed to different water flow speeds. We show that the caudal fin is crucial for yaw control. These flow tank results were confirmed by computational fluid dynamics simulations. The caudal fin acts as both a course-stabiliser and rudder for the naturally unstable rigid carapace with regard to yaw. By using physical models and computer simulations, we quantitatively show that actively changing the shape and orientation of the caudal fin plays an important role in controlling yaw torque in yellow boxfish. Further study is needed to unravel how all components of the boxfishes' locomotor apparatus function together, from a dynamic perspective, during lateral gust flows and turning.

A8.37 SNAKES AND SNAKE ROBOTS TRAVERSING LARGE, SMOOTH OBSTACLES

Tuesday 6 July 2021 **14:35**

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