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Syngnathid feeding apparatus morphology: long vs short snouts

The family Syngnathidae (Gasterosteiformes) encompasses pipefishes and seahorses, which are characterized by an elongated snout with small terminal jaws. They are extremely fast suction feeders, with a feeding strike consisting of a rapid neurocranial elevation accompanied by an equally rapid retraction of the hyoid. Within the family, there is a large diversity in snout morphology, with variation in both snout length and diameter. A long and narrow snout is thought to increase the flow rate of the incoming water and allows prey to be captured from a greater distance. However, it also limits prey size, increases the moment of inertia during snout rotation and probably results in higher friction because of viscous forces becoming more important. So, is there an advantage of having a long snout? Are long snouted syngnathids really faster compared to short snouted ones? Kinematical analyses show that the snout of long snouted pipefishes travels a longer distance and so more elusive prey can be caught, but velocity and acceleration was lower in the long snouted syngnathids compared to the shorter snouted ones. The aim of this study is to investigate whether these observed kinematical differences can be explained by morphological variation in lever systems involved in suction feeding. A detailed morphological description of the cranium of a long and short snouted seahorse and of a long and short snouted pipefish is given, based on cleared and stained specimens, dissections, histological serial sections, CT scans and graphical 3D reconstructions. Special attention is paid to the anatomy of the ligament/tendon attachments and articulations between the moveable units (lower jaw, hyoid, suspensorium, neurocranium).

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The effects of limb kinematics on the motion of a legged robot on sand

Effective locomotion of organisms and physical models of organisms (robots) can require subtle changes of limb kinematics to achieve high performance on different substrates. To develop predictive models for legged devices and to provide hypotheses for biological locomotors, we systematically study the performance (forward speed) of a small legged robot, SandBot, on granular media as a function of stance and swing gait parameters. At fixed limb frequency and volume fraction, speed is sensitive to variations in the gait parameters that control angular onset, angular duration, and temporal duty factor of the stance phase of the limb cycle. High performance occurs only in a small region of gait parameter space. A modified version of an existing kinematic model [Li et. al, PNAS, 2009] predicts the speed, and reveals that performance is maximized when gait parameters minimize limb acceleration and interference to increase interaction with the solid phase of the media. For example, gait parameters that generate fast bouncing motion on hard ground generate much slower motion on sand. Instead, high performance on sand is achieved when the start of the stance phase is advanced to better utilize the asymmetric resistance force produced by rotational penetration of limbs into sand. A similar phase shift is observed in the zebra-tailed lizard, *Callisaurus draconoides*, when the substrate is changed from hard ground to sand, suggesting that the physics of granular media may constrain animals to employ similar strategies for achieving effective locomotion.

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Organization and function of lateral line afferent neurons in larval zebrafish

Afferent neurons of the zebrafish posterior lateral line relay hydrodynamic signals sensed along the body to the hindbrain. We labeled individual neurons to reveal their connections to single and multiple neuromasts along the body. Electroporation of Alexa 647 in HUC-Kaede fish, a transgenic line expressing a photo-convertible protein under control of a pan-neuronal promoter, indicates that single and multiple-neuromast afferent neurons correspond to later and early-born cells, respectively. We normalized ganglion area across individuals and plotted position of afferent neurons to show that early-born cells are located centrally in the ganglion, with newly developing cells added to the periphery. Whole-cell recordings of afferent neurons show an inverse relationship between soma area and input resistance, where input resistance is a proxy for excitability. Taken together, a picture is emerging that large, early-born cells are less excitable and may therefore fire only to strong hydrodynamic stimuli across the whole body, while small, later-born cells that are more excitable sense local flows. We hypothesize that large, coarse coding afferents innervating multiple hair cells are critical for initiating powerful escape responses while small, fine coding afferents are responsible for modulating routine motor behaviors such as swimming. Aspiration of ganglia led to the inability of animals to avoid a constant flow source in the absence of light compared to control animals, indicating that the posterior lateral line is required for rheotaxis.

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Physiological Correlations of Neophobic behavior: Is Regulation of the Hypothalamic-Pituitary-Adrenal Axis Correlated to Responses to Novelty?

One of the best predictors of success for an introduced species is response to novelty. Animals can be attracted to (neophilia), fearful of (neophobia), or indifferent to novelty, but those that minimize neophobia or enhance neophilia are most likely to exploit unfamiliar resources in new areas. Novelty has previously been associated with glucocorticoids (GCs), hormones released in response to stressors. In laboratory rodents, elevated GCs typically reduce interest in novelty. In the present study, we investigated relationships between GC regulation and response to novelty in house sparrows (*Passer domesticus*), a notoriously successful invader. We then experimentally manipulated GCs to assess their direct influence on response to novelty. We found that GC elevation in response to restraint was strongly positively correlated to dexamethasone-induced negative feedback, indicating that individuals releasing the most GCs also reduced it most rapidly. In terms of effects on novelty, individuals that released more GCs in response to restraint were also slowest to interact with a novel object when tested later in captivity and individuals with the most rapid negative feedback approached and consumed novel food most quickly. Direct manipulation of GCs indicated that these relationships were likely indirect, as treatment with metyrapone (to block GC surges in response to stressors) and corticosterone did not affect response to novel food or objects. In sum, GC regulation and response may be a physiological indicator of neophobia, and future study of regulation and neophobia in free-living birds will rectify captivity confounds and address possible correlations with invasion.