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'Left-handed' fish and asymmetrical brains

Konstanz biologists discover relationship between 'handedness', brain structure and genes in extremely specialised cichlid fish

UNIVERSITY OF KONSTANZ

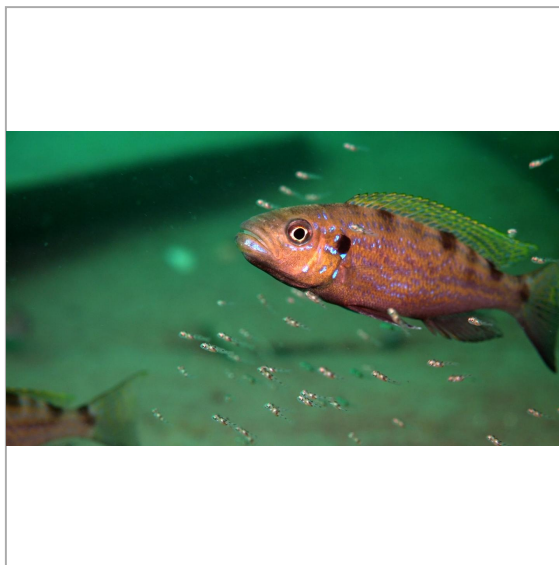


IMAGE: THESE ARE CICHLIDS OF THE *PERISSODUS MICROLEPIS* SPECIES ENDEMIC TO LAKE TANGANYIKA IN AFRICA. [view more >](#)

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To humans, being right-handed or left-handed plays an important role. The majority favours the right side of their bodies, while only about three per cent of people innately use both hands equally well. Preferring one side of the body over another is not unique to humans: the phenomenon occurs in the animal kingdom as well, for instance in great apes or birds, although their "handedness" is typically not as obvious as it is in humans. "Handedness" is particularly pronounced in cichlid fish of the species *Perissodus microlepis*, which is endemic to Lake Tanganyika in Africa. This cichlid is highly specialised, living exclusively of the scales of other fish that they obtain from one side of the bodies of their prey only. When hunting, not only do individual fish display a pronounced predilection for attacking their prey from one direction; this preference is also mirrored by the shape of their heads: many individuals of this cichlid have asymmetrical jaws that bend to the left or right. Biologists from the University of Konstanz examined the relationship between the cichlids' preference for one side, the structure of their brains and their gene expression. A team led by Professor Axel Meyer, Professor of Zoology and Evolutionary Biology at the University of Konstanz, was able to demonstrate that a preference for one side in the animal's feeding behaviour correlates with a corresponding asymmetry of the cerebral hemispheres as well as unequal gene expression in the different hemispheres. The research results have been published in the current issue of the science journal *Genome Biology and Evolution*.

"Our research helps us to understand handedness and hemispheric asymmetries better. We hope that our results also will contribute to further our understanding of handedness in humans", explains the Konstanz biologist Dr Ralf Schneider, who, along with Dr Hyuk Je Lee, is one of the lead authors of the study.

In their study, the biologists documented the preference for one side of approximately 40 individual cichlids, followed by an examination of their brains. "We found a clear asymmetry across the animals' brains, especially in the Tectum Opticum region of the brain. However, this asymmetry was present only in individuals who displayed a distinct preference for one side when hunting", says Ralf Schneider. The Tectum Opticum is the region in the brain responsible for processing vision. In the respective cichlids, the hemisphere of the Tectum Opticum that controls the eye on the preferred side of the body was more strongly developed than the other. Individuals that did not display a marked preference for one side showed greater symmetry within the Tectum Opticum. The same proved true for other regions of the animals' brains. "This is interesting because it suggests a functional relationship between the shape of the brain and behavioural laterality", says Schneider.

Analyses of the genes (gene expression profiling) across several parts of the brain showed which genes tend to be expressed more strongly in the respective regions of the brain. The analyses revealed similar patterns to what the researchers had found in the fishes' brains structures: in the Tectum Opticum region alone, as much as 140 genes showed differing activity in the two hemispheres - corresponding with the animals' preference for one side, gene activity in the respective hemispheres of the brain was increased or decreased. The most pronounced correspondence was determined for the gene synuclein gamma alpha (snca) - a particularly interesting result because previous studies on zebrafish have shown that this gene is expressed predominantly in the so-called habenula, a part of the brain that is asymmetric in all vertebrates, including humans. Besides synuclein gamma alpha, a range of other genes, some of which are associated with handedness and schizophrenia in humans, showed expression patterns in the brain hemispheres of the cichlids that suggest a link to handedness. There is reason to believe that some asymmetries in the brains of vertebrates could have originated in the habenula's asymmetry. The cichlids' preference for feeding on scales from just one side of their prey's body, as well as the asymmetrical shapes of their heads and brains, probably evolved due to the extremely fast "side-specific" development of gene regulation in their brains, the biologists suggest.

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Original publication:

Hyuk Je Lee, Ralf F. Schneider, Tereza Manousaki, Ji Hyoun Kang, Etienne Lein, Paolo Franchini, Axel Meyer. Lateralized Feeding Behavior Comes with Asymmetrical Neuroanatomy and Lateralized Gene Expressions in the Brain in Scale-Eating Cichlid Fish. *Genome Biology and Evolution*, published online on 24 October 2017

Facts:

- Recent publication in *Genome Biology and Evolution*, published online on 24 October 2017
- Study of "handedness" (behavioural laterality) in the *Perissodus microlepius* species of African cichlids
- Behavioural observations, examinations of their brains as well as gene analyses (gene sequencing)
- Participating organisations: University of Konstanz, Sangji University (South Korea), Korea University (South Korea), Hellenic Center for Marine Research (HCMR, Greece)

- Funding provided by: German Research Foundation (DFG), Ministry of Oceans and Fisheries (South Korea), Young Scholar Fund of the University of Konstanz

Note to editors:

A selection of pictures is available for download here:

https://cms.uni-konstanz.de/fileadmin/pi/filesserver/2017/Bilder/Axel_Meyer_Perissodus%20microlepis_1.jpg

Caption: Cichlids of the Perissodus microlepis species endemic to Lake Tanganyika in Africa

https://cms.uni-konstanz.de/fileadmin/pi/filesserver/2017/Bilder/Axel_Meyer_Perissodus%20microlepis_2.jpg

Caption: Cichlid fry with bent jaw

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