CENTRAL CONTROL OF AIR-BREATHING IN FISH

Richard J.A. Wilson
Department of Medical Physiology and Biophysics,
University of Calgary, 3330 Hospital Drive, N.W.
Calgary, Canada; T2N 4N1
Tel. (403) 220-4528 Fax. (403) 270-8928
wilsonr@ucalgary.ca

Michael B. Harris,
Department of. Physiology,
Dartmouth Medical College, USA

John E. Remmers,
Department of Medical Physiology and Biophysics,
University of Calgary, Canada

Steven F. Perry,
Institut für Zoologie,
Rheinische Friedrich Wilhelms-Universität,
Bonn, Germany

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One of the most important steps in the evolution of tetrapods was the transition from water to land. In vertebrates, air-breathing dates back over 400 million years to the Devonian. Air breathing is found in both the ancestors of tetrapods, the lobe-finned (sarcopterygii) fish, and primitive ray-finned fish (actinopterygii), raising the possibility that early air-breathing evolved from a common ancestor. Anatomical similarities suggest that the air-breathing organ of tetrapods may have arisen in such an ancestor. However, three lines of evidence have been used to suggest air breathing in these lineages arose independently:

1. Neuronal mechanism. Air-breathing in ray-finned fish was thought to be reflexive, whereas in lung fish and tetrapods the motor pattern for air

breathing is produced by a central rhythm generating circuit within the brainstem.

2. Central chemosensitivity. Central H^+/CO_2 chemosensitivity was thought to be absent in ray-finned fish but provides substantial respiratory drive in the descendants of lobe-finned fish.

3. Mechanical differences. Primitive ray-finned fish use a "four-stroke" buccal pump mechanism, whereas most, but not all-bimodal breathers of the other lineage use a "two-stroke" mechanism.

Using a superfused *in vitro* preparation, we have found that the brainstem of a primitive actinopterygian, the long nose gar (*Lepisosteus osseus)*, is capable of autonomous production of a rhythmic motor pattern which resembles that produced during air -breathing. This autonomous motor pattern is sensitive to H^+/CO_2. Therefore, we propose that the brainstem of the gar has a central rhythm generator for air-breathing that is chemosensitive. Furthermore, this system appears to be similar to that found in tadpoles and other tetrapods. Given the apparent similarity in the neuronal control of air-breathing in gar and tadpoles, we speculate that air-breathing in tetrapods and gar may have originated in a common ancestor pre-dating the divergence of the ray-finned and lobe-finned lineages. Comparative studies of the neuronal circuit involved in air-breathing in the tadpole and gar are urgently needed in order to test this hypothesis.