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MORPHOPHYSIOLOGICAL BASIS OF VOCAL COMMUNICATION IN MAMMALS

Vocalisation in mammals requires the integrated action of parts of the respiratory and digestive system. Apparently, it was the ancestral coupling of these systems in a ‘branchio-pharynx’ that necessitated the retaining of this connection in all tetrapods. This connection became reduced though to a narrow intra-pharyngeal ostium. Major parts involved in vocalisation are the larynx, the pharynx, the hyoid apparatus, and the oral or nasal vocal tract. The hyoid apparatus derives from the 2nd and 3rd branchial arch. It is connected to the skull, the tongue, the pharynx and the larynx and involved in support of the tongue, suspension of the larynx and deglutition. Primordially, the segments of the hyoid apparatus were ossified. In some species, certain parts were evolutionarily transformed into a hyoid ligament. The larynx derives from the 4th and 5th branchial arch. It is connected to the hyoid apparatus and pharynx rostrally, the oesophagus dorsally, the trachea and lungs and the sternum caudally. In most mammals, oral vocalization involves a slight retraction of the larynx, by which the laryngeal entrance is shifted ventrally, off the intra-pharyngeal ostium, so that an expiratory air stream will pass exclusively through the oral vocal tract towards the mouth opening. Appropriate positioning of the larynx for vocalizing is effected by the extrinsic laryngeal muscles. Central to vocalization are two steps: first, the intrinsic laryngeal muscles rotate the vocal processes of the arytenoid cartilages into a phonatory position and keep them in this adducted position under appropriate pull so that closure of the glottis and tensioning of the vocal folds is achieved; second, an expiratory airstream can then induce self-sustained vocal fold oscillations, entailing a pulsating airflow as the basis for vocalisation. On its way through the oral vocal tract, this primary signal, the fundamental frequency, becomes acoustically transformed and a secondary signal is released to the environment. Some species evolved a permanently descended larynx that can be further descended momentarily by muscle action. This extension of the vocal tract decreases formant dispersion, thereby acoustically exaggerating own body size and, ultimately, providing a selective advantage and an increase in reproductive success. An overview on the extrinsic (head-and-neck) and intrinsic (laryngeal) morphological features of vocalisation are diagrammatically exemplified in overlay reconstructions.