Comments on the Physiology of Single-Ossicle Transmission Systems

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To the Editor,

In a recent article published in this journal, Vallejo et al[1] set out an odd hypothesis regarding the muscles of the middle ear in terrestrial vertebrates, in which they placed mechanics ahead of function, to the point where they subordinate the number of hearing bones to the number of muscles present. Nonetheless, this hypothesis does not explain why amphibians with tympanic ears and reptiles, which have a columellar system very similar to that of birds, mostly lack any muscle in the middle ear. Furthermore, the presence of these muscles in mammals is not constant either: for example, monotreme mammals do not have a stirrup muscle, despite having the 3 auditory bones; the scaly anteater (Manis) does not have a muscle to tense the eardrum; insect-eating mammals and rodents living underground have lost 1 of the 2 muscles in the middle ear and the remaining one is so small that it is doubtful whether it is capable of any function; and some terrestrial mammals in the group of heteromyids also lack any stirrup muscle.[2] The functional significance of such shortcomings is a subject of great discussion, in line with the lack of information on the exact function of the muscles in the middle ear. Since the stirrup muscle contracts milliseconds prior to vocalization, however, it is undeniable that it has to exercise a protective function when the noise of one's own vocalizations is excessive. At least from a phylogenetic standpoint, this seems to be its most plausible function. The louder a mammal's cries or vocalizations, the more developed its middle ear muscles (as in the case of bats or whales).[3] In birds, which are quite noisy animals, the middle ear muscles, comprising very fast contracting fibres, are activated in response to the vocalizations of the animal itself in order to protect its inner ear.[4] In reptiles, the presence of the middle-ear muscle or extracolumellar muscle is clearly linked to vocalization since, of the 3 middle-ear morphotypes that can be classified, iguanidae and scincidae lack any extracolumellar muscle and it is only present in geckonide ears, corresponding to the most vocal reptiles.[5] In the few reptiles without middle-ear muscle that also vocalize, since the tympanum is attached to the skin at its rear quadrant, these animals are felt to be capable of varying the tension in the eardrum and, therefore, the characteristics for conducting sound, via the variation in the tension of the ligaments close to the joint between the quadrate and lower jaw. And amphibians, although lacking an extracolumellar muscle, have developed an ingenious system to protect themselves from the sound of their croaking: they pressurize their middle ear (pumping up the eardrum) in order to disconnect, in part, the elements in the ossicle chain, through a Eustachian tube that always stays open.[6] This also explains the paradox worrying the authors as, from a phylogenetic standpoint the protection of the ear has originally been entrusted to an alteration in the tension of the tympanic membrane and the accompanying moving elements. The direct action of the muscle on the stirrup is a characteristic of mammals that institutes an innovative system, evolved independently from other vertebrates.

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