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The ontogeny of the vocal apparatus in male and female goitred gazelle (*Gazella subgutturosa*)

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The vocal organs in adult goitred gazelles are sexually dimorphic yet isomorphic in male and female neonates. Three age classes were investigated: neonates, adolescents and adults, in total 19 individuals (11 males, 8 females). Vocal features develop with different speeds during ontogeny in males and females as a sexual dimorphism of larynx and vocal fold size is already noticeable in 6-9 months old adolescents, whereas other vocal features have not yet diverged at this age. In both sexes, the larynx descends during ontogeny. Probably, a descended larynx at birth would interfere with the removal of amniotic fluid from the oral and nasal vocal tract shortly after birth and with the suckling of milk during the first weeks of life. The larynx is already mobile in neonate and adolescents of both sexes and in adult female goitred gazelles, though to a much lesser degree than in adult males. Limited laryngeal mobility in young and adult female goitred gazelles is evident during production of their contact calls, in yawning (larynx retraction) and in swallowing (larynx protraction). In adults, the pronounced differences between the sexes ultimately result from a highly mobile larynx in adult males. Adult males differ from adult females in the following vocal features: larger larynx size, lower resting position of the larynx, more pronounced maximal retraction of the larynx, larger vocal folds, a longer thyrohyoid, a longer thyrohyoid ligament, a higher mobility of the larynx, a more pronounced vocal tract extension, a longer hyoepiglottic muscle, a shorter but wider sternothyroid muscle, a longer and more resilient pharynx, a longer soft palate, and more pronounced reserve loops of nerves. The consequences for males are a pronounced permanent descent of the larynx, momentary larynx retraction, a highly resilient hyoid-larynx connection and extremely contractible retractor muscles of the larynx. The evolutionary improvement of these functions probably helped to acoustically attract female mating partners and acoustically deter rival males and therefore was potentially rewarded by siring more offspring. The sexual dimorphism of the vocal features in adults therefore appears to be mainly a consequence of a high selection pressure on the males of polygynous goitred gazelle towards production of effective rutting calls.
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