Olfaction in *Artibeus jamaicensis* and *Myotis lucifugus* in the Context of Vision and Echolocation

It has long been recognized[1] that common insectivorous bats orient and hunt with the aid of a superbly developed system of echolocation, involving both phonation and hearing. However, echolocation can be less effective, or even lacking in other bats. This is particularly true of frugivorous ones with relatively larger eyes[2,3]. Taking the microchiropteran frugivorous *Artibeus jamaicensis* as a case in point, it is a nasal phonator and can echolocate[4], but the noseleaf which beams its ultrasounds is far simpler than some of the insectivorous rhinolophids[5,6]. In consequence, the echolocation used by *A. jamaicensis* might be adequate for avoiding relatively larger obstacles, but might not permit capture of small flying prey[4]. The large eyes of *A. jamaicensis* suggest more acute vision as one compensatory orientation mechanism. Could olfaction be another?

In an attempt to suggest a quantitative index for the interrelationship between vision and olfaction in *A. jamaicensis* and *Myotis lucifugus*, I have followed the procedures of TEICHMANN[7] and PFEIFFER[8]. They used (visual) retinal surface area as a baseline against which olfactory surface area in various fish was compared. I measured these areas in *A. jamaicensis* and *M. lucifugus* as follows: Two animals of each species were perfused via the left ventricle with Bouin's fluid after flushing with a sodium chloride-sodium nitrite solution. After decapitation, each head was kept in Bouin's fluid for at least 2 weeks. After further decalcification (in formic acid-sodium citrate)[9] and dehydration, the specimens were embedded in paraffin under vacuum. 10 µm frontal serial sections were prepared and stained with GOMORI's[10] one-step trichrome. The outlines of the nasal cavities and the visual retina in every 5th section were traced with the aid of a camera lucida at $\times 37.5$ magnification for *Artibeus* and $\times 87.5$ for *Myotis*. The total extent of olfactory epithelium and visual retina were measured in each series on the left side, tracing to the nearest 0.5 mm with a map measurer. Detailed procedures have been published elsewhere[11,12]. Total surface areas calculated from these data are given in the Table.

The striking similarity of olfactory surface areas as percentages of retinal areas, despite the 6-fold difference in retinal areas, suggests that further determinations of this sort in other species might prove most informative. The trend suggested here is that unlike *A. jamaicensis*, which has both larger eyes and a more sensitive olfaction[11-13], a more sophisticated echolocation in *M. lucifugus*[14] has been achieved, as it were, at the expense of vision and olfaction both of which appear diminished to remarkably similar degrees. Further work is warranted to support these preliminary suggestions that vision and olfaction both may diminish in relative importance as facility for orientation by echolocation increases.

Comparison of olfactory and retinal surface areas in *Artibeus jamaicensis* and *Myotis lucifugus*

Species and specimen No.	Olfactory receptor area in left nasal cavity (mm^2)	Left retinal area (mm^2)	Olfactory area as percent of retinal area: $\frac{100 \times \text{olfactory area}}{\text{retinal area}}$	Mean
Artibeus (A2)	122.99	8.10	1518	1329
Artibeus (A3)	109.47	9.59	1141	
Myotis (M5)	19.30	1.56	1241	1249
Myotis (M10)	17.02	1.35	1257	

Summary. Calculated retinal and olfactory surface areas of the Mexican fruit-bat *Artibeus jamaicensis* and the little brown bat *Myotis lucifugus*, when compared with known eye sizes and echolocation capabilities, suggest that vision and olfaction both may diminish in relative importance as facility for orientation by echolocation increases.

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