BRAIN RESEARCH 1375 (2011) 7–18

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BRAIN RESEARCH

Research Report

Olfactory marker protein expression in the vomeronasal neuroepithelium of tamarins (*Saguinus* spp)

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ARTICLE INFO

Article history:
Accepted 21 December 2010
Available online 30 December 2010

Keywords:
OMP
Primates
Saguinus
Tamarins
Vomeronasal organ

ABSTRACT

Knowledge of the vomeronasal neuroepithelium (VNNE) microanatomy is disproportionately based on rodents. To broaden our knowledge, we examined olfactory marker protein (OMP) expression in a sample of twenty-three non-human primates. The density of OMP (+) vomeronasal sensory neurons (VSNs) in the VNNE was measured. Here we compared OMP (+) VSN density in five species of *Saguinus* (a genus of New World monkey) of different ages to a comparative primate sample that included representatives of every superfamily in which a VNO is postnatally present. In *Saguinus* spp., the VNNE at birth is thin, usually comprising one or two nuclear rows. At all ages studied, few VNNE cells are OMP reactive as view in coronal sections. In the comparative sample, the OMP (+) VSNs appear to be far more numerous in the spider monkey (another New World monkey) and the bushbaby (a distant relative). Other species (e.g., owl monkey) had a similar low density of OMP (+) VSNs as in *Saguinus*. These results expand our earlier finding that few VSNs are OMP (+) in *Saguinus geoffroyi* to other species of the genus. Our sample indicates that the number of OMP (+) VSNs in primates varies from ubiquitous to few with New World monkeys varying the most. The scarcity of OMP (+) cells in some primate VNOs reflects a lower number of terminally differentiated VSNs compared to a diverse range of mammals. If primates with relatively few OMP (+) VSNs have a functional vomeronasal system, OMP is not critical for stimulus detection.

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doi:10.1016/j.brainres.2010.12.069

1. Introduction

The vomeronasal organ (VNO) neuroepithelium is similar in morphology to main olfactory neuroepithelium (see reviews by Døving and Trotier, 1998; Halpern and Martínez-Marcos, 2003), but our understanding of mammalian VNO microanatomy is disproportionately based on rodents (e.g., Barber and Raisman, 1978; Breipohl et al., 1979; Ciges et al., 1977). Although our knowledge of variation in the mammalian VNO is increasing (e.g., Dennis et al., 2003; Salazar et al., 2007; Vedin et al., 2010) some taxonomic groups remain relatively less-studied, including primates, in which the VNO appears relatively similar rodents in some taxa (Schilling, 1970) but is completely absent in others (Bhatnagar and Meisami, 1998; Bhatnagar and Smith, 2006; Smith et al., 2001). Recent work suggests that within primate suborders, and even subfamilies, species vary in expression of neuron-specific markers in the vomeronasal neuroepithelium (VNNE).

In this study, we examine the expression of olfactory marker protein (OMP), a neuronal marker of terminally differentiated olfactory or vomeronasal receptor neurons (Farbman, 1980; Farbman and Margolis, 1980; Weiler and Benali, 2005), in the VNNE of non-human primates. Whereas the precise function(s) of OMP remains unknown, it is thought to have an important role in olfactory and vomeronasal chemoreception (Bock et al., 2006; Buiakova et al., 1996; Farbman et al., 1988; Kawagishi et al., 2009; Weiler and Benali, 2005). Our previous reports suggested that the primate VNO is diverse in its OMP expression pattern. The VNO of the greater bushbaby (genus *Otolemur*), a primate in which nasal anatomy is morphologically primitive (Smith et al., 2007a), has numerous OMP (+) vomeronasal sensory neurons (VSNs)(Dennis et al., 2004; Smith et al., 2005). OMP expression begins at birth (Smith et al., 2005, 2007b) as reported for rodents (e.g., Kulkarni-Narla et al., 1997; Tarozzo et al., 1998). Strepsirrhine primates (bushbabies, lemurs, and their allies) are taxa with VNOs that may resemble the ancestral primate condition (Smith et al., 2007a). In contrast, the VNO is far more variable in haplorhine primates (monkeys, apes, humans, and tarsiers), being absent or vestigial in some taxonomic families (Hunter et al., 1984; Smith et al., 2001, 2003). Broadly, haplorhine primates exhibit a morphological trend for reduction in olfactory structures (Smith et al., 2007a), a trend that genetic evidence supports (Young et al., 2007). Thus, these primates are potential models for understanding microanatomical signs of reduction in the VNS. Dennis et al. (2004) studied several species of New World monkeys and reported little or no OMP expression in the VNNE of newborns and infants, though only qualitative observations were reported. In juveniles and adults, OMP (+) VSNs are numerous in some species (e.g., common marmosets) and rare in others (Geoffroy's tamarins) (Dennis et al., 2004).

Samples of most non-human primate species are relatively scarce, and our previous report on New World monkeys (Dennis et al., 2004) relied on a small sample size. A particular observation that demands further scrutiny is the paucity of OMP expression in the vomeronasal neuroepithelium (VNNE) of the Geoffroy's tamarin (*Saguinus geoffroyi*). At present, it is unclear how much *S. geoffroyi* differs from the other primates because of the limited sample and qualitative nature of our observations (Dennis et al., 2004). Moreover, it is unclear whether these findings may be generalized to other species of *Saguinus*, a genus of arboreal New World monkeys. Herein we compared OMP expression in five species of *Saguinus* of different ages to a comparative primate sample that included representatives of every superfamily in which a VNO is postnatally present.

2. Results

2.1. *General findings on tamarins (Saguinus spp.)*

The VNNE at birth is relatively thin compared to juveniles and adults (Fig. 1). In two species represented by an age range

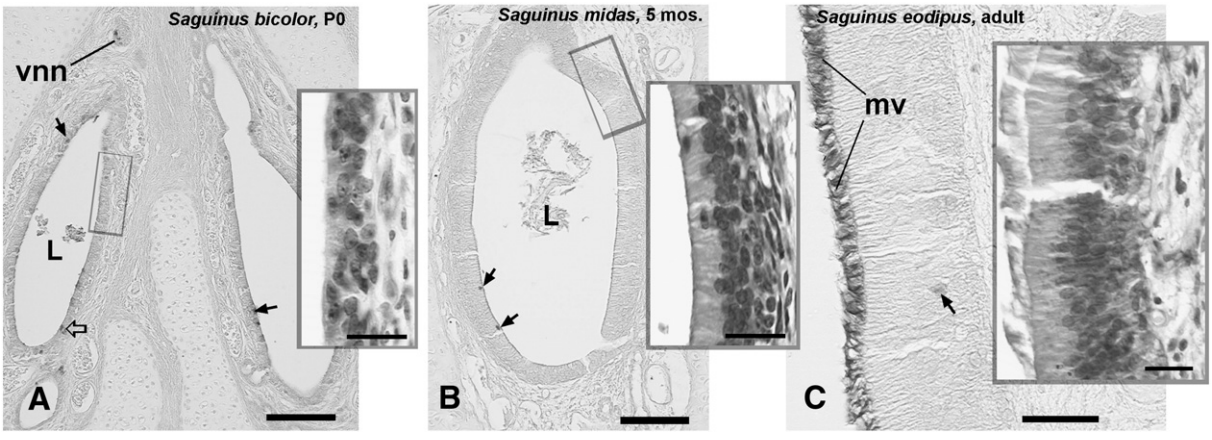

Fig. 1 – OMP reactivity in the vomeronasal organs of perinatal *Saguinus bicolor* (1A), 5-month-old *S. midas* (1B), and adult *S. oedipus* (1C). OMP (+) cells (arrows) were sparsely distributed in all species. Most reactive cells had OMP (+) nuclei. Some cells with reactive cytoplasm were also seen (open arrow). The epithelium of the VNO is thin in perinatal specimens (inset, 1A) mostly comprising one to two rows of nuclei. In juvenile (inset, 1B) and adult (inset, 1C) specimens, the epithelium is thicker with more numerous rows of nuclei. In juvenile and adults there is a larger nuclear-free zone, indicating development of a supporting cell layer. mv, microvilli; vnn, vomeronasal nerves. Scale bars: A, B, 100 μm; C, 40 μm.

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