# *IN UTERO* LOW FREQUENCY NOISE EXPOSURE IN RATS - I

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**Introduction** Occupational exposure to low frequency noise (LFN) (≤ 500 Hz, including infrasound) can lead to the development of vibroacoustic disease [1]. This creates a concern for pregnant women who carry their pregnancies to term while working exposed to LFN. The goal of this report is to describe the effects of LFN on the respiratory epithelia of rats exposed to LFN *in utero*.

**Methods** *Animals.* Ten Wistar rats were gestated and born while exposed to LFN on an occupationally-simulated schedule: 8 hrs/day, 5 days/week, weekends in silence. Control rats were gestated in equal living conditions, but in continuous silence. All animals were fed standard rat food, had unrestrained access to water, and were treated in accordance with applicable legislation (86/609/CE). *Noise Exposure.* The overall linear and A-weighted noise and spectral analysis collected inside the rat chamber using a digital real time analyzer (B&K 2144). An analog noise generator produced an amplified and frequency filtered acoustic signal so that acoustic energy was highly concentrated in the lower frequency bands, 50 Hz to 500 Hz, exceeding 90dB$_{Lin}$. The overall linear sound pressure level was above 109dB$_{Lin}$, and the A-weighted level was around 98dBA. *Microscopy.* After birth, animals were removed from the LFN environment, kept in continuous silence for one year, and then sacrificed by a lethal intravenous injection of sodium-pentobarbital. The trachea was divided in two, along the saggital line. Specimens prepared for scanning electron microscopy (SEM) (JEOL JSM-35C) were dehydrated, critical point-dried, coated with gold-palladium and examined at an accelerating voltage of 15 kV.

**Results.** After one year in silence, tracheal epithelial cells of rats gestated in LFN remain severely damaged. Ciliary fields are greatly depleted (Figs. 1 & 2), and appear shaggy.

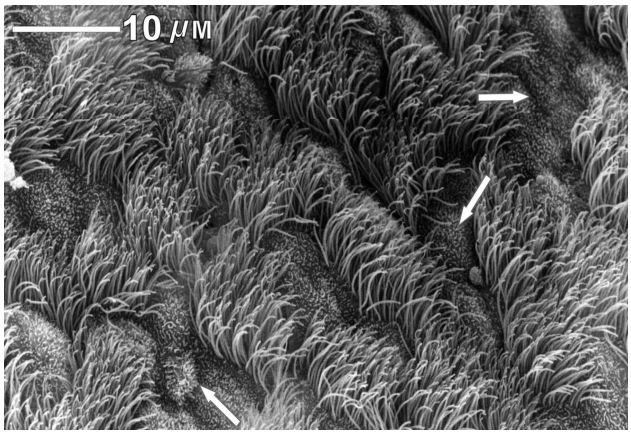


**Fig. 1**. SEM of control rat tracheal epithelium. Ciliary fields carpet the epithelium, interspersed with BCs (arrows). A ring of SC's surround each BC.

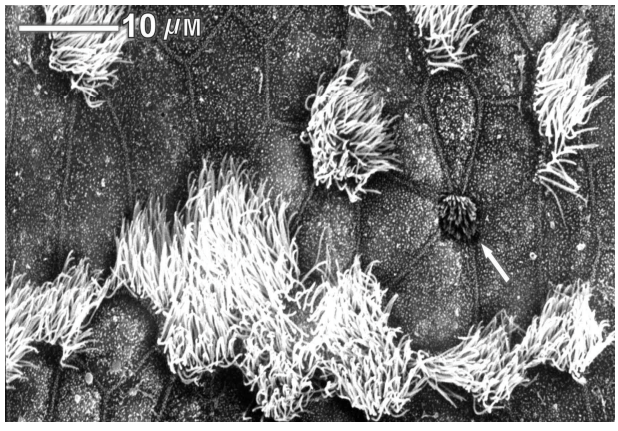


**Fig. 2**. SEM of rat gestated in LFN plus 1 year in silence. Ciliary fields are depleted. A rosetta-shaped structure centered on a BC (arrow) is evident.

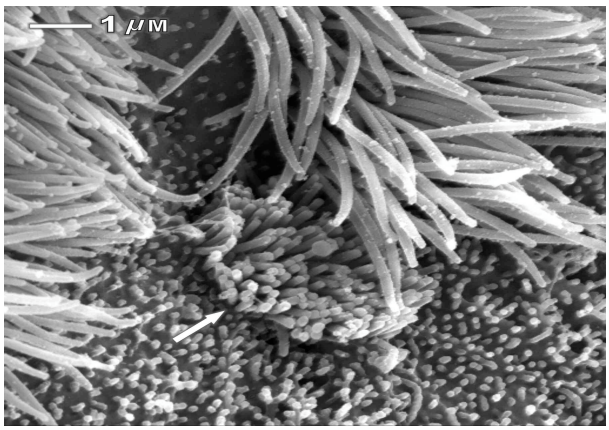


**Fig. 3**. SEM of control rat tracheal epithelium. Cilia concealing a BC (arrow). BC microvilli are evenly distributed and individually identifiable. Ciliary vesicles are also visible. SC microviili surrond the BC.

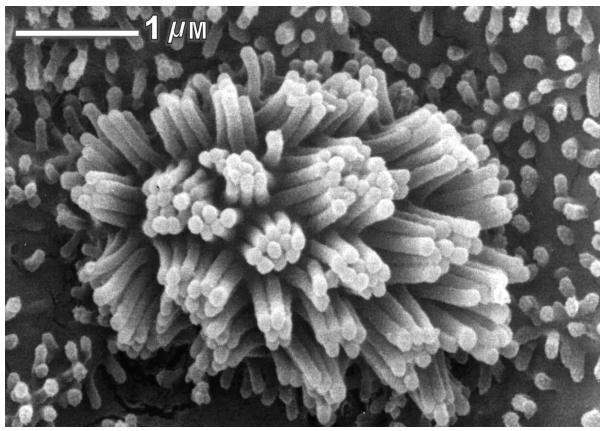


**Fig. 4**. SEM of rat gestated in LFN, plus 1 year in silence. Amplification of BC where microvilli are grouped together and seem fused in some locations. Surrounding SC microvilli are overall short and stubby.

Rosetta-shaped structures, formed by a ring of secretory cells (SC) centered on a brush cell (BC) (Fig. 2 & 4), are greatly evidenced by the lack of overhanging cilia (Fig. 3). SC microvilli are shorter than in controls and have not recoved their normal appearance.
In many micrographs of LFN-exposed specimens, SC shapes were variable, their surfaces flat or depressed, and intercellular junctions were prominent and thick, almost as in squamous metaplasia (Fig. 2). BC microvilli in controls were evenly distributed over the apical surface of the BC and could be individually identified (Fig. 3). This is in contrast with exposed specimens, where microvilli were clustered and grouped, appearing almost fused in some locations (Fig. 4).

**Discussion** In previously studies on LFN-exposed rat tracheal epithelia, not gestated and born in LFN, ciliary populations were also greatly affected, and aspects of cellular de-differentitation were also observed [2]. The genotoxicity of LFN has been previously demonstrated in both human [3] and animal [4] models. Therefore metaplastic cellular organizations are not entirely surprising. Morover, in vibroacoustic disease patients who suffered tumors in the respiratory tract, all were squamous cell carcinomas [5]. The foremost concern is for the irreversibility of lesions acquired *in utero*, despite the subsequent one year in silence. The implications of these results for human fetus' are unknown, but they do not seem to be trivial, particularly given the lack of LFN-related legislation in the workplace.

**Keywords:** vibroacoustic disease, cilia, brush cells, microvilli, noise exposure, occupational

**References**

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