Dataset

3D models related to the publication: Inner ear morphology in wild vs laboratory house mice

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Abstract

This contribution contains 3D models of left and right house mouse (*Mus musculus domesticus*) inner ears analyzed in Renaud et al. (2024). The studied mice belong to four groups: wild-trapped mice, wild-derived lab offspring, a typical laboratory strain (Swiss) and hybrids between wild-derived and Swiss mice. They have been analyzed to assess the impact of mobility reduction on inner ear morphology, including patterns of divergence, levels of inter-individual variance (disparity) and intra-individual variance (fluctuating asymmetry).

Keywords: fuctuating asymmetry, geometric morphometrics, intraspecific variation, *Mus musculus domesticus*, semicircular canals

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INTRODUCTION

The semicircular canals (SSC) of the inner ear are involved in balance and velocity control (Malinzak et al., 2012; Perier et al., 2016). Release of selection in slow-moving animals has been argued to lead to morphological divergence and increased inter-individual variation (Billet et al., 2012). Such effects could be tested using the house mouse (*Mus musculus*) as a model. In its natural habitat, the house mouse moves in a tridimensional space where efficient balance is required. In contrast, laboratory strains evolved since about one century in cages severely restricting their ability to move, possibly releasing selection on the inner ear morphology. The role of plastic response to mobility reduction as a factor of between-population divergence is questioned by the early development of the inner ear, that achieves its adult morphology before birth (Costeur et al., 2017). However, maternal movements during pregnancy can modulate the development of the inner ear (Ronca et al., 2008). This contribution presents 3D models of left and right inner ears for 74 specimens of Western European house mice (*Mus musculus domesticus*) belonging to four groups, chosen to assess the effects of mobility reduction at different scales: (1) Three populations of wild mice trapped in commensal habitats in France (surroundings of Lyon, South-Western France, and Brittany); (2) their second-generation laboratory offspring, to assess plastic effects related to breeding conditions; (3) a standard laboratory outbred strain (Swiss) that evolved for many generations in a regime of mobility reduction; and (4) hybrids between wild offspring and Swiss mice. For each specimen, the left and right inner ears were segmented and the morphology of the semicircular canals was quantified using a set of 3D landmarks and semi-landmarks analyzed using geometric morphometric protocols. Levels of inter-population, inter-individual (disparity) and intra-individual (asymmetry) variation were compared (Renaud et al. 2024). All wild mice shared a similar inner ear morphology, in contrast to the important divergence of the Swiss strain (Fig.1). The release of selection in the laboratory strain obviously allowed for an important and rapid drift, leading to a morphology characterized by an expansion of the posterior SSC relative to the anterior SSC. The resulting unbalanced inner ear morphology is reminiscent of the one observed in domestic pigs (Evin et al., 2022), suggesting a common response to mobility reduction in captivity. The lab-bred offspring of wild mice also differed from their wild relatives, suggesting that plastic response related to maternal locomotory behavior can modulate the development of the inner ear, potentially inducing fine variations at an ecological time scale. The signature observed in lab-bred wild mice and the lab strain was however not congruent, suggesting that plasticity did not participate to the divergence of the laboratory strain. Contrary to the expectation, levels of inter-individual variation (disparity) were slightly higher in wild than in laboratory mice, possibly due to the higher levels of genetic variance. Differences in intra-individual variance (fluctuating asymmetry) were detected, with the laboratory strain occasionally displaying higher asymmetry scores than its wild relatives, possibly due to a release of selection in the laboratory strain.

Inv nr.	Sex	Weight	Collection
Bal02	indet	7.6	LBBE
Bal04	F	21.7	LBBE
Bal06	M	17.9	LBBE
Bal08	F	17.25	LBBE
Bal11	M	10.85	LBBE
Bal12	F	11.7	LBBE
Bal15	M	11.16	LBBE
Bal16	M	15.87	LBBE
Bal17	M	7.9	LBBE
Bal18	F	9.41	LBBE
Bal19	M	16.32	LBBE
Bal20	M	12.65	LBBE
Bal21	M	17.6	LBBE
Bal22	F	13.89	LBBE
Bal23	F	15.37	LBBE
Bal24	M	14.36	LBBE
Bal25	M	9.75	LBBE
Balan_LAB_035	F	14.65	LBBE
Balan_LAB_046	F	16	LBBE
Balan_LAB_054	F	17.41	LBBE
Balan_LAB_056	F	16.28	LBBE
Balan_LAB_082	M	25.8	LBBE
Balan_LAB_086	M	24.03	LBBE
Balan_LAB_092	M	20.99	LBBE
Balan_LAB_319	F	18.53	LBBE
Balan_LAB_325	M	22.46	LBBE
Balan_LAB_329	M	20.98	LBBE
Balan_LAB_330	M	23.55	LBBE
Balan_LAB_F2b	F	16.05	LBBE
Balan_LAB_BB3weeks	indet	9.03	LBBE
BAL_F1_30x17_27j	M	10.08	LBBE
BAL_F1_167_48j	M	21.86	LBBE
BAL_F1_188_32j	M	11.63	LBBE
BAL_F1_192_28j	M	13.36	LBBE
BAL_F1_194_46j	M	13.89	LBBE
BAL_F1_196_44j	F	14.03	LBBE
BAL_F2_40x56_24j	M	9.23	LBBE
BAL_F2_47x61_22j	F	10.75	LBBE
Gardouch_3419	M	13.3	CBGP
Gardouch_3432	F	13.4	CBGP
Gardouch_3437	M	15.3	CBGP
Gardouch_3439	M	12.4	CBGP
Gardouch_3450	M	17.4	CBGP
Gardouch_3453	F	14.2	CBGP
Gardouch_3459	M	12.9	CBGP
Gardouch_3462	M	12.3	CBGP
Tourch_7819	F	12	CBGP
Tourch_7821	F	11	CBGP
Tourch_7839	M	9	CBGP
Tourch_7873	M	13	CBGP
Tourch_7877	F	11	CBGP
Tourch_7922	M	15	CBGP
Tourch_7923	F	16	CBGP
Tourch_7925	M	13	CBGP
Tourch_7927	F	9	CBGP
Tourch_7932	M	9	CBGP
SW0ter	M	34.43	LBBE
SW343	M	37.46	LBBE
SW1	M	44.34	LBBE
SW2	M	39.9	LBBE
SW5	M	41.55	LBBE
SWF3	F	41.5	LBBE
SW342	indet	40.31	LBBE
SW341	indet	39.56	LBBE
SW339	indet	39.43	LBBE
SWF4	F	38.47	LBBE
SW0bis_350	indet	27.73	LBBE
SW0_348	indet	28.1	LBBE
SW347	indet	29.49	LBBE
SW345	indet	32.8	LBBE
hyb_125xSW_01	F		LBBE
hyb_125xSW_02	F		LBBE
hyb_SWx126_01	F		LBBE
hyb_SWx126_02	F		LBBE

Table 1. List of models of pairs of bony labyrinth of *Mus musculus domesticus*.

METHODS

Skulls of wild mice from Balan, Tourch, Gardouch, most laboratory offspring and five Swiss were scanned at a cubic voxel resolution of 12 µm on the General Electric (GE) Nanotom microtomograph (µCT) of the AniRA-ImmOs platform of the SFR Biosciences, Ecole Normale Supérieure (Lyon, France). The dataset was complemented by one Balan Wild scanned at 12 µm, eight Balan Lab scanned at 17 µm, and nine Swiss scanned at 19 µm at the Mateis laboratory (INSA, Lyon, France), using a similar equipment. The bony labyrinths were subsequently segmented using a two-step approach (Evin et al., 2022). A pre-segmentation of one slice every 5-10 slices was performed using Avizo 2021.1 (Thermo Fisher Scientific). The Biomedisa smart interpolation tool (Lösel et al., 2020) was used to complement this pre-segmentation. The extracted left and right bony labyrinths (see Table 1) were then exported as surface PLY files. Mice from Balan, their lab-bred offspring, the Swiss mice and the hybrids are stored at the LBBE as laboratory collection. Mice from Gardouch and Tourch are stored at the Centre de Biologie pour la Gestion des Population, Univ Montpellier, CIRAD, INRAE, Institut Agro, IRD, Montpellier, France "CBGP - Small Mammal Collection", https://doi.org/10.15454/WWNUPO.

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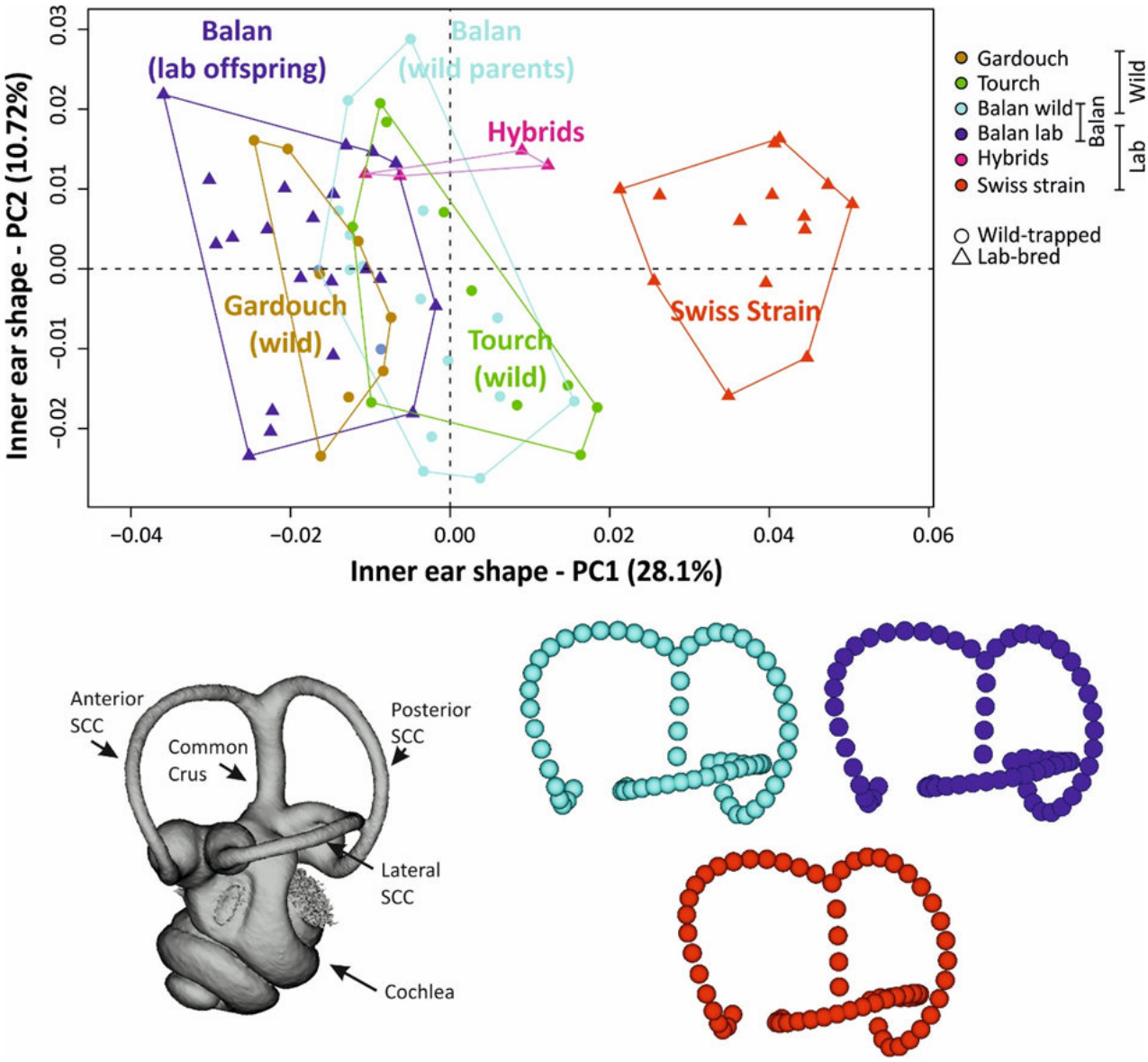

Figure 1. Inner ear morphospace and mean shapes of main groups. Above, morphospace corresponding to a Principal Component Analysis (PCA) on the aligned coordinates. Convex hulls enclose each group, coded by colosr. Below left: Example of the extracted surface of a left inner ear (Balan Wild #15). Below right: mean inner ear shape of Balan wild (cyan), Balan lab offspring (deep blue) and Swiss strain (red).

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