The **DryBrain** Project: cell populations in the brain of the anhydrobiotic midge and protection from complete desiccation in different cell types

SMTB

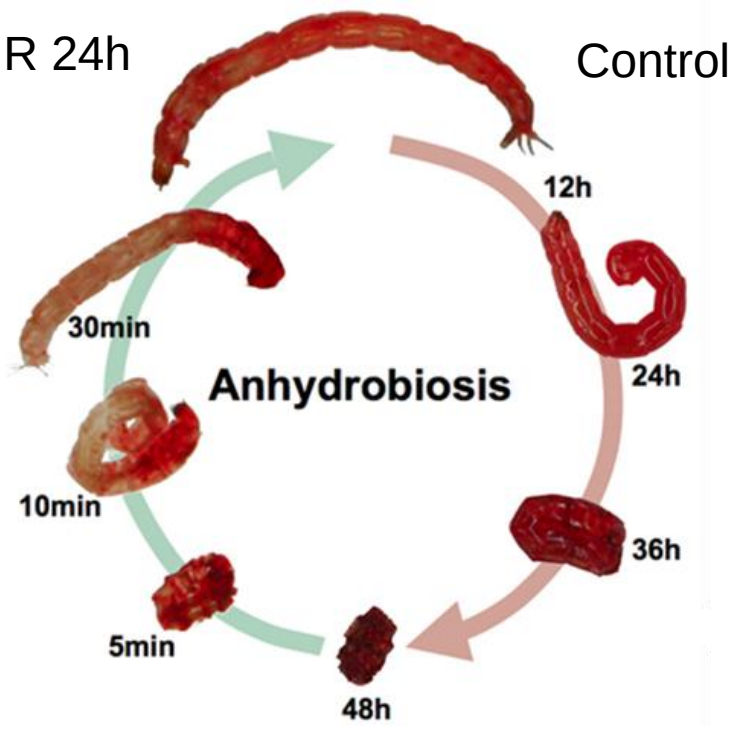
Petrovax

BIOINFORMATICS INSTITUTE

ZIMIN FOUNDATION

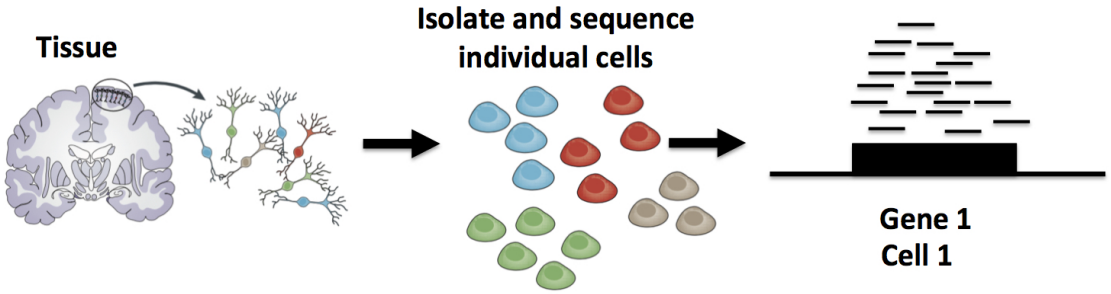
How brain of the x-midge survives complete desiccation?

X-midge
Polypedilum vanderplanki



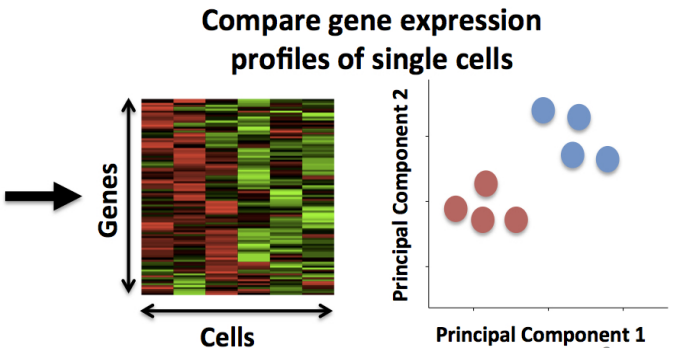
D 48h

Single-cell transcriptomics of x-midge brain

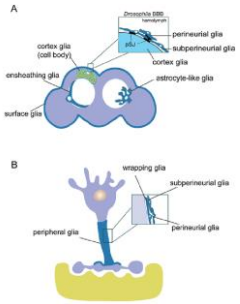


Read Counts

	Cell 1	Cell 2	...
Gene 1	18	0	
Gene 2	1010	506	
Gene 3	0	49	
Gene 4	22	0	
...			

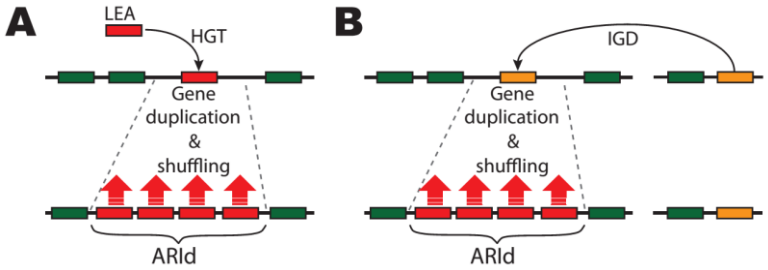


Q1: What cell types are there in x-mide brain?



Similar to Drosophia?

Q2: How anhydrobiosis-related genes work in different cell types?



Extreme bioinformatics team

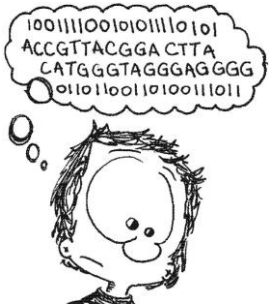
Mastering bioinformatics approaches, analyzing data, thinking about results :

Irina Malysheva

Sofia Rekhlova

Fedor Kagakin

Sofia Kanaeva



Alexei Kolodyazhnii

Training and supervising

Sasha Dekan

Ruslan Deviatiiarov

Tried not to interfere

Oleg Gusev

Undifferentiated neurons and neuronal progenitor cells

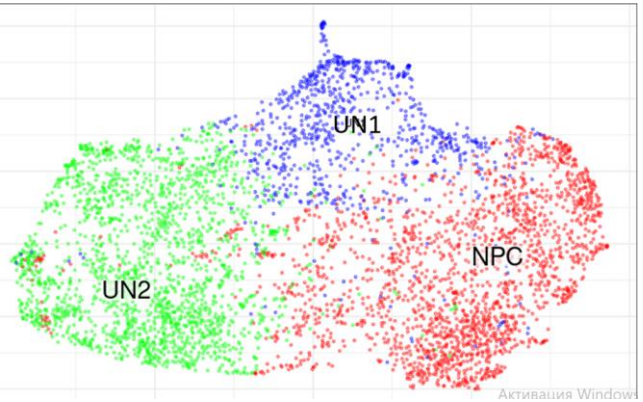


Fig. 1. General map of UMAP cells. We found two subtypes of undifferentiated neurons (UN1 and UN2) NPC - Neuronal Progenitor Cells

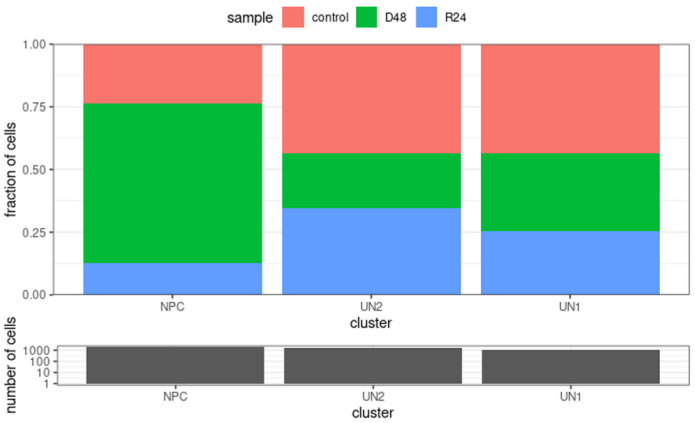


Fig. 2 Distribution of different cell types across anhydrobiosis cycle.

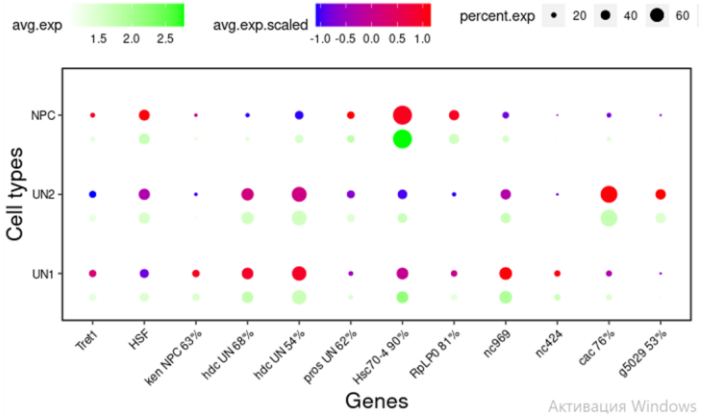


Fig. 3 Expession level of UN 1 and UN 2 share several key features with NPC. Clearly different from Drosophila

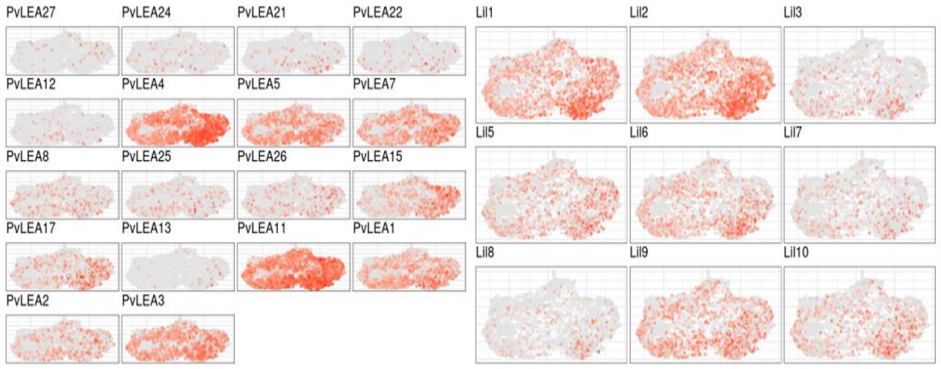
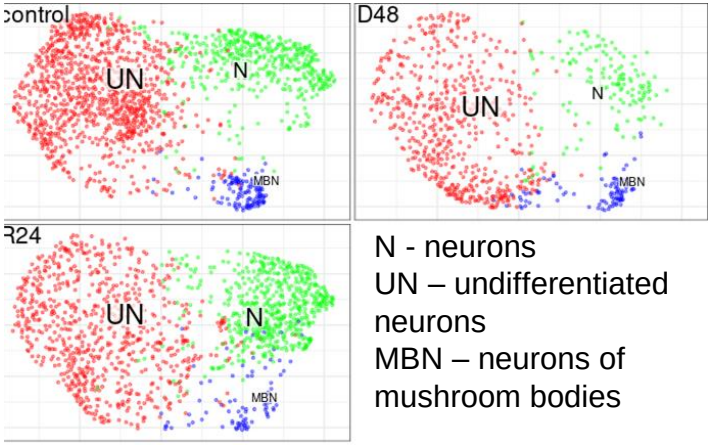


Рис. 4. LEA and Lil genes expression profile

Conclusions:

1. We found that UN subtypes do not correlate with similar subtypes in Drosophila;
2. During dehydration, the proportion of neuronal precursors increases.
3. We found genes specific for certain types: for UN1 - ken NPC 63%, hdc UN 68%, hdc UN 54%, nc 969, nc424; for UN2 - hdc UN 68%, hdc UN 54%, cac 76%, g5029 53%; for NPC - pros UN 62%, Hsc70-4 90%, Tret1, HSF, RpLP0 81%
4. Protective genes LEA- and Lil- are differentially expressed in different types of cells.
5. Neuronal precursors express protective genes and the anhydrobiosis regulator HSF more strongly than undifferentiated neurons.

Comparison of mushroom body cells, neurons and neuronal precursors



N - neurons
UN – undifferentiated neurons
MBN – neurons of mushroom bodies

Fig. 1 General map of the cells

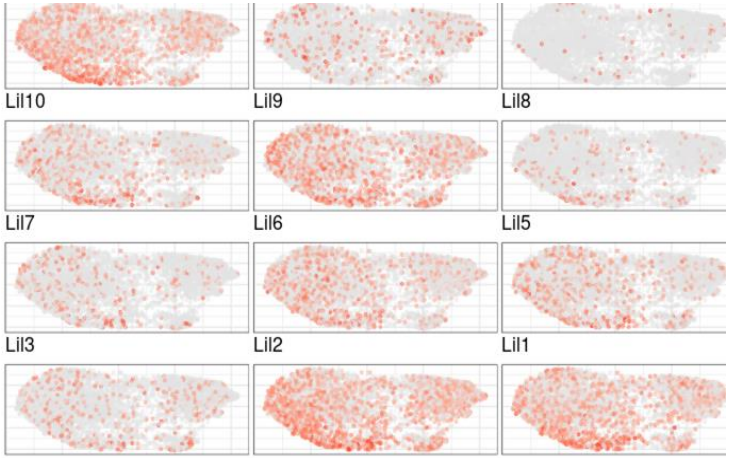


Рис. 2 Lil genes expression map

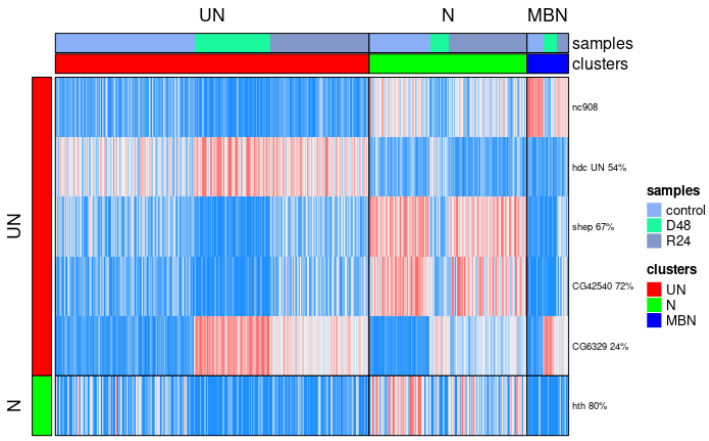


Рис. 3 Тепловая карта дифференциально-экспрессированных генов

Cocnlusions:

1. We identified neurons, undifferentiated neurons, neurons of the mushroom body.

2. During dehydration, the proportion of neurons decreases, and during rehydration increases again. At the same time, the proportions of the cells of the mushroom body and undifferentiated neurons stay stable.

3. Protective genes are most strongly expressed in undifferentiated neurons.

4. Protective genes are expressed heterogeneously in different cell types.

5. We found interesting cell types expressed genes. In the mushroom body: nc908, CG6329; in neurons: shep, CG4250, hth; in undifferentiated neurons: hdc UN, CG6329.

Glia, its subtypes and specific gene expression

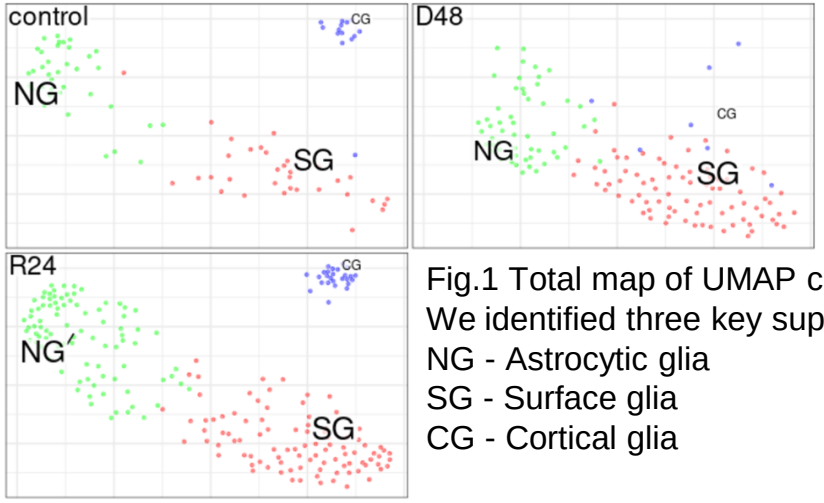


Fig.1 Total map of UMAP cells.
We identified three key sup-types
NG - Astrocytic glia
SG - Surface glia
CG - Cortical glia

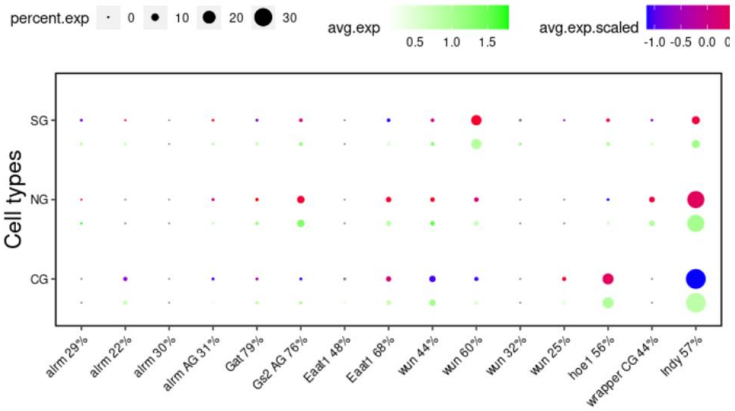


Fig. 2. Dotplot of Expression of marker genes for Drosophila glia in the cells of x-midge

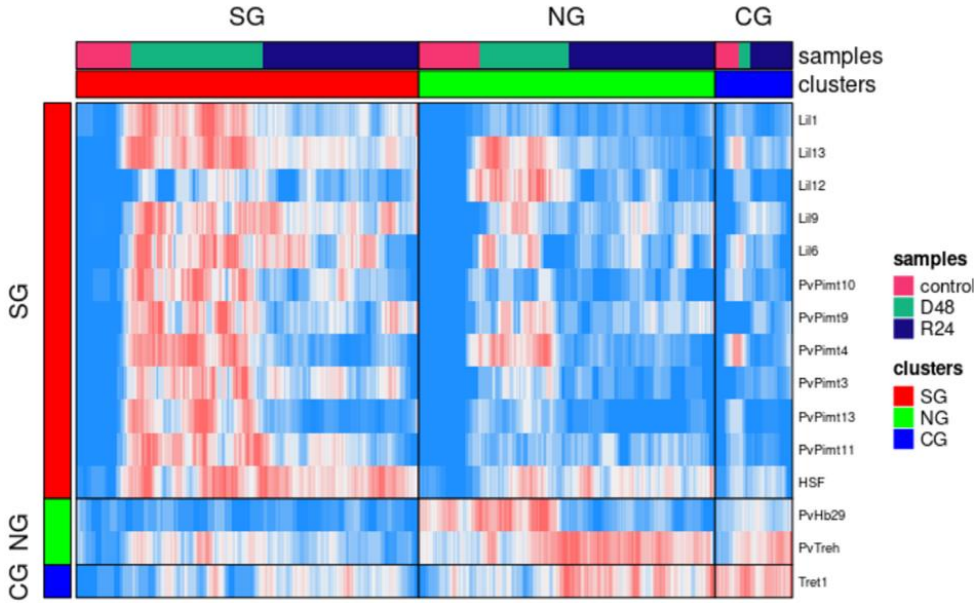


Fig. 3. Heatmap of expression of anhydrobiosis-related genes

Conclusions

1. Cortical glia virtually disappears by the time of dehydration, while other subtypes of glia remain.

2. It is not always possible to use D. melanogaster markers when defining glia subtypes.

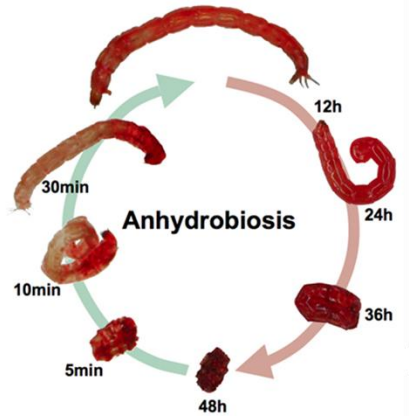
3. During dehydration, protective genes are most strongly expressed in the superficial glia.

4. Globin-29 is expressed only in astrocytic glia, there are no other hemoglobins.

5. PvTreh - trehalase is expressed mostly in astrocytic and cortical glia - hence responsible for trehalose metabolism.

6. The main factor of anhydrobiosis HSF is absent in the cortical glia, due to which they can disappear

DryBrain: take-home message



Some of the cell types do not survive dehydration,
and then restored from other cells upon rehydration

At least one of the explanations for the multi-copy nature of the protective genes in the x-midge - is cell types-specific activity

introduction

P.vanderplanki

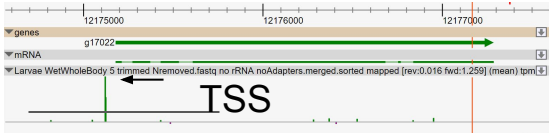
object and methods

~2.2M trimmed reads

~80% mapped

CAGE

Zenbu example



results

analysis of motives

HSF

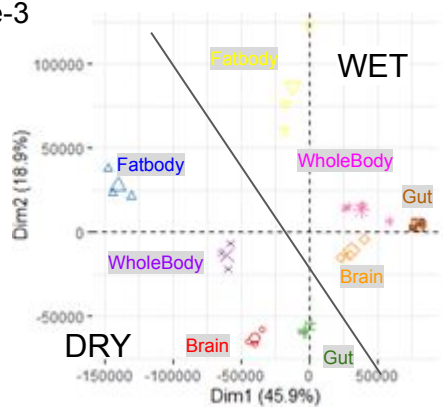
E-value: 4.7e-3

broad

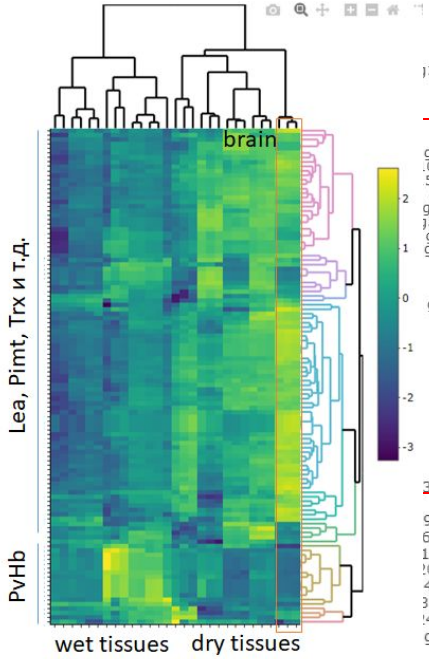
new

expression analysis

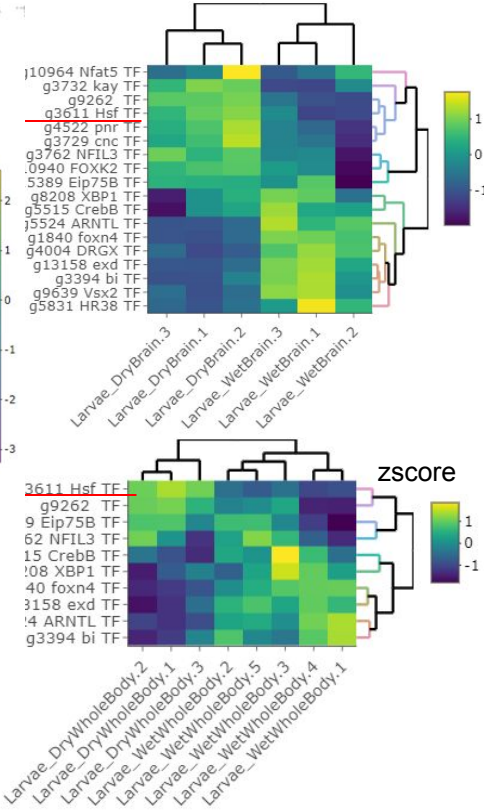
PCA



heatmap - cryptogenes

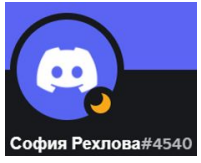


heatmap - TFs

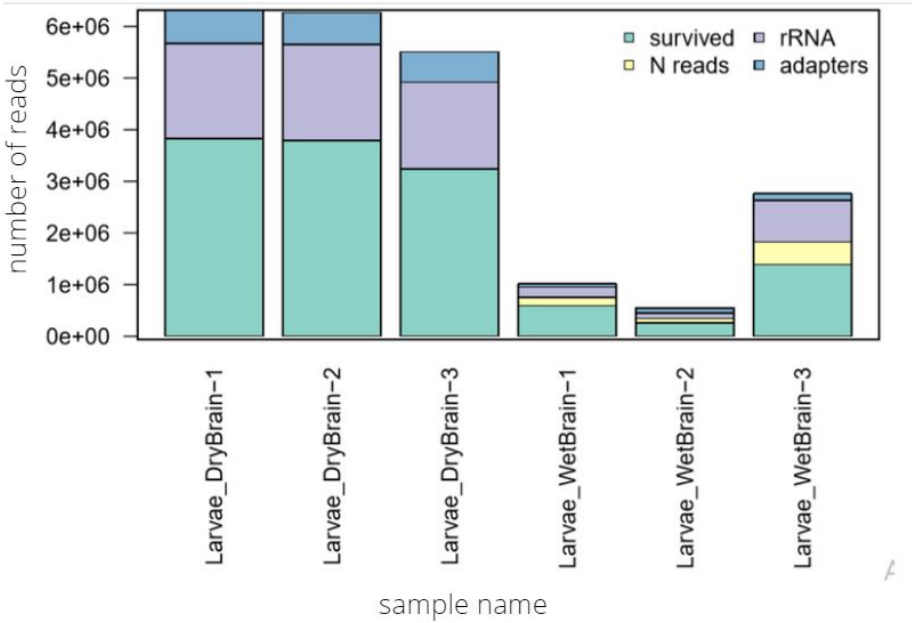


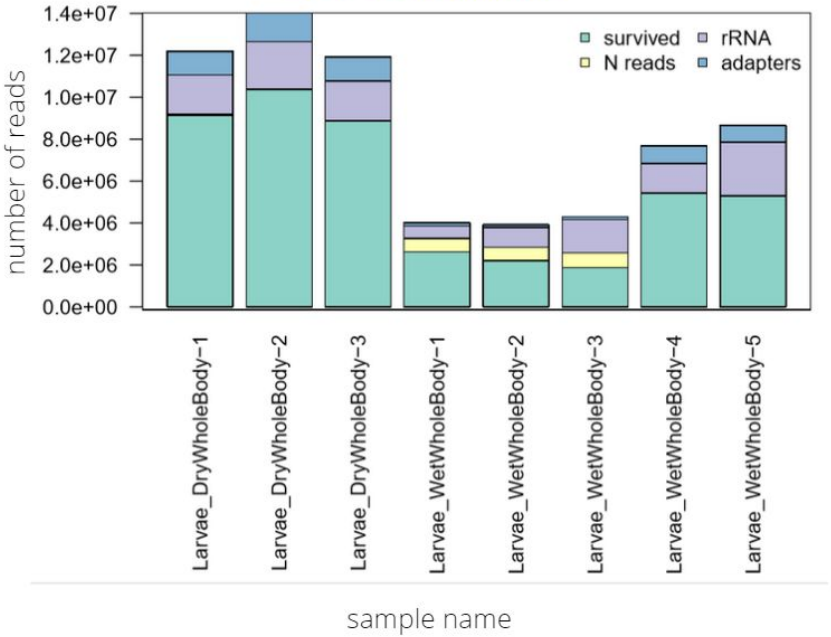
conclusions

1. anhydrobiosis genes (cryptogens) are active in the brain
2. HSF - universal transcription factor of anhydrobiosis

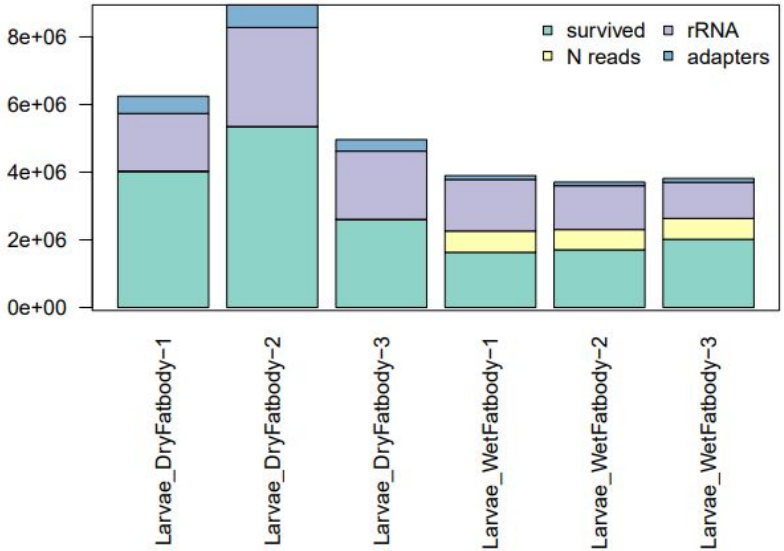


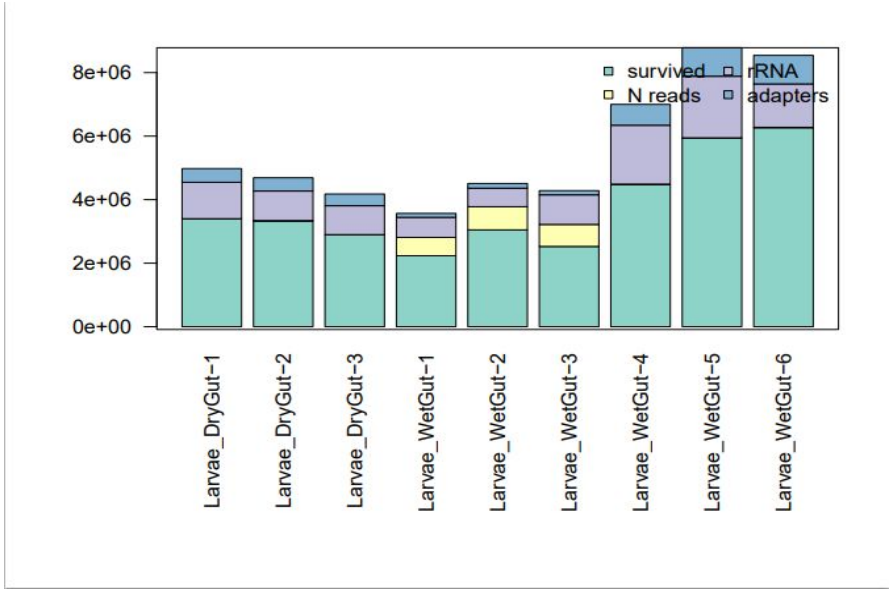
General statistics: brain and larva



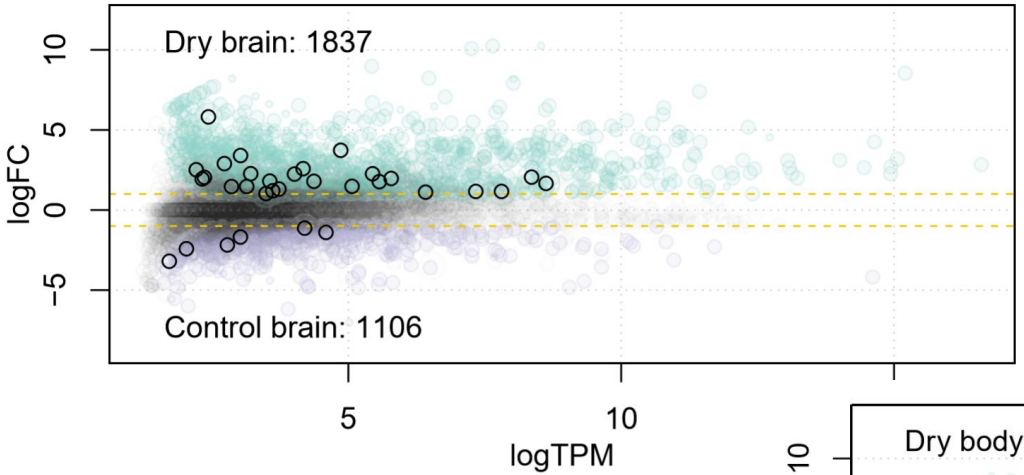


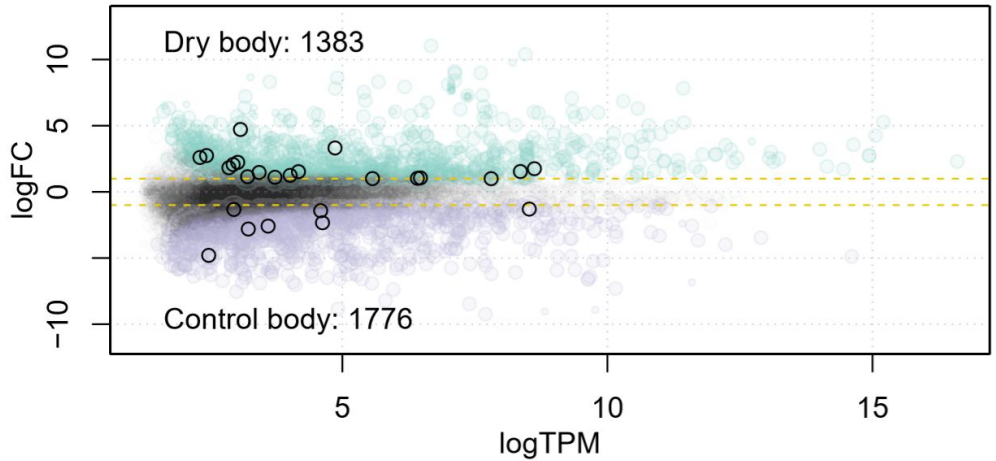
General statistics: gut and fat body



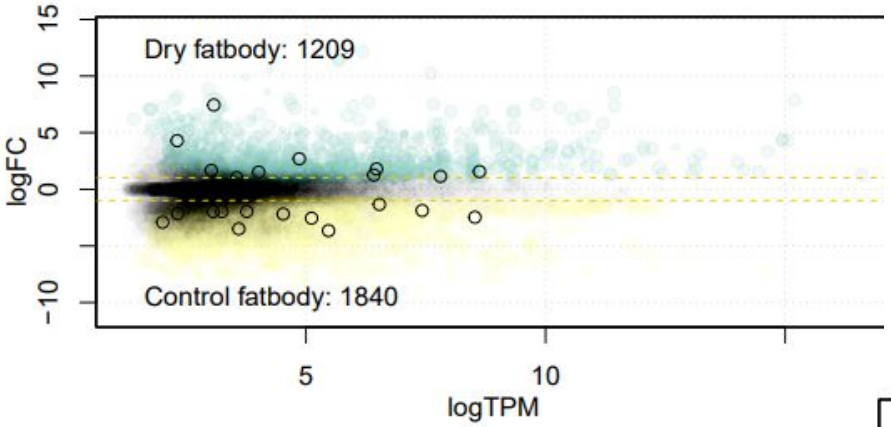


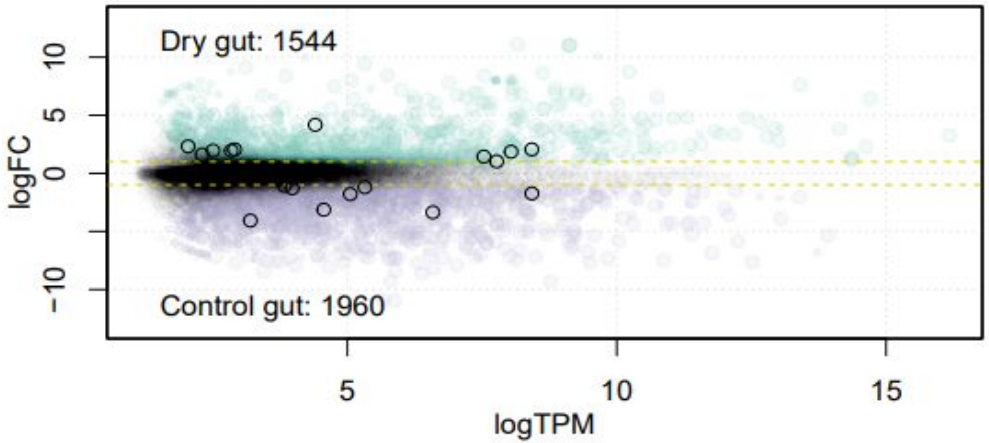
Differential Expression



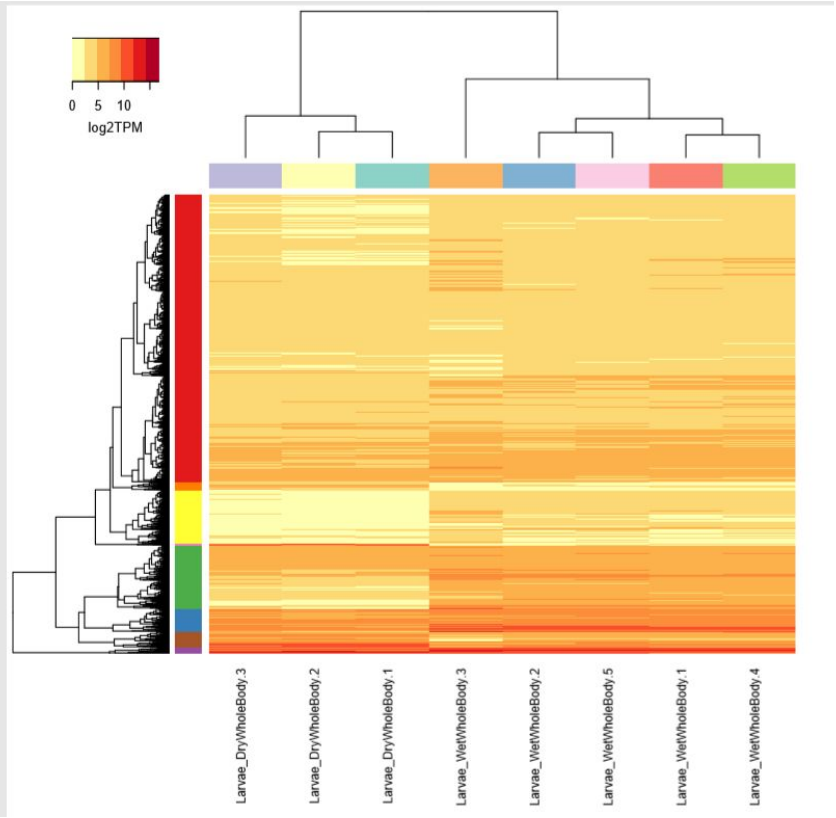


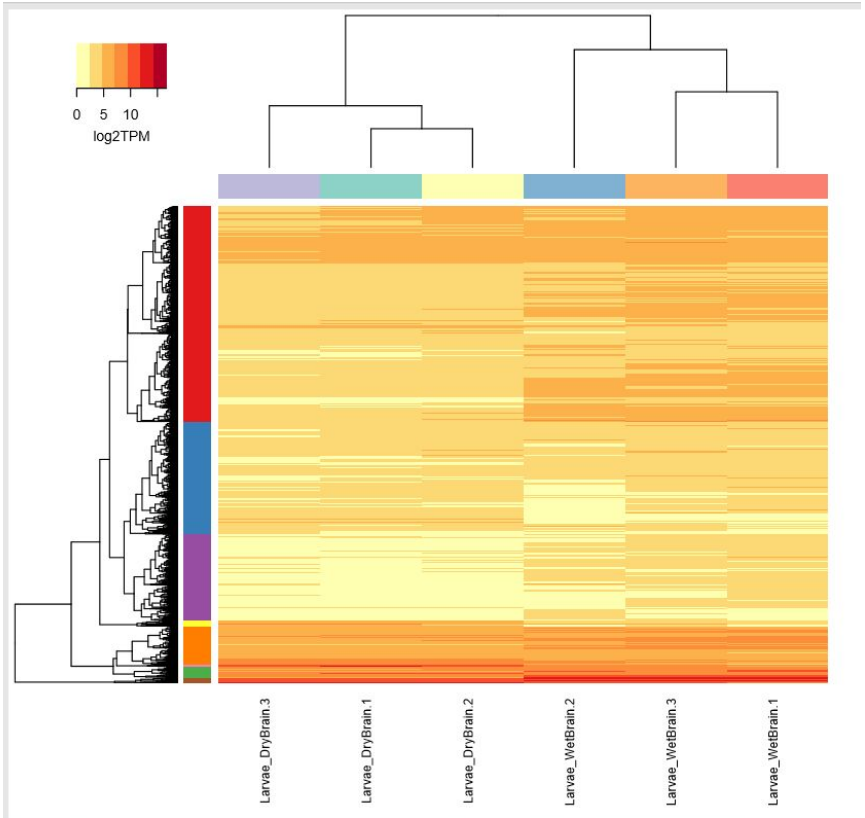
Differential Expression





Genes' Expression Heatmaps





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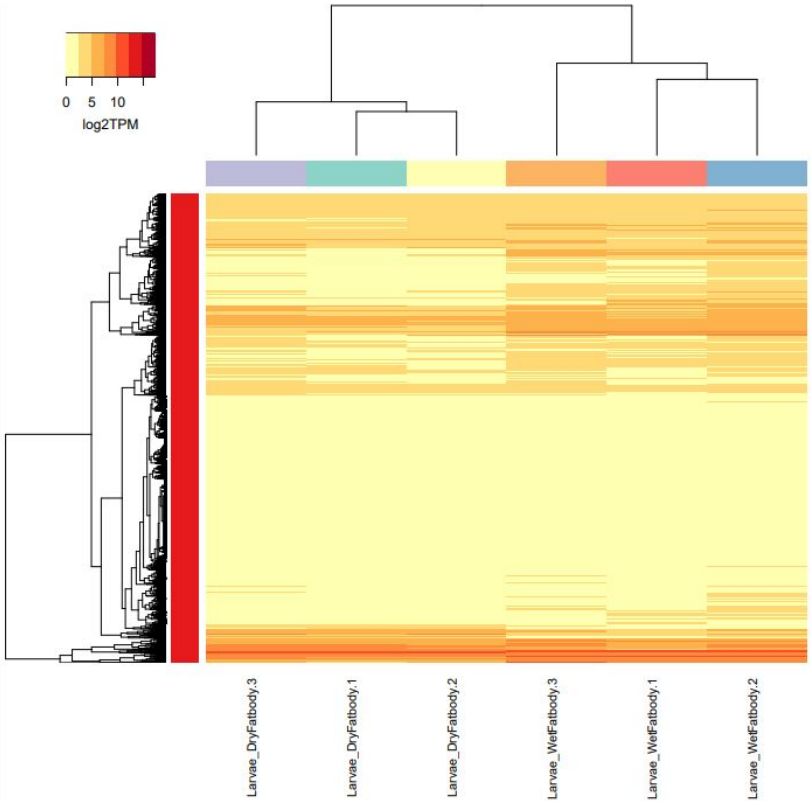

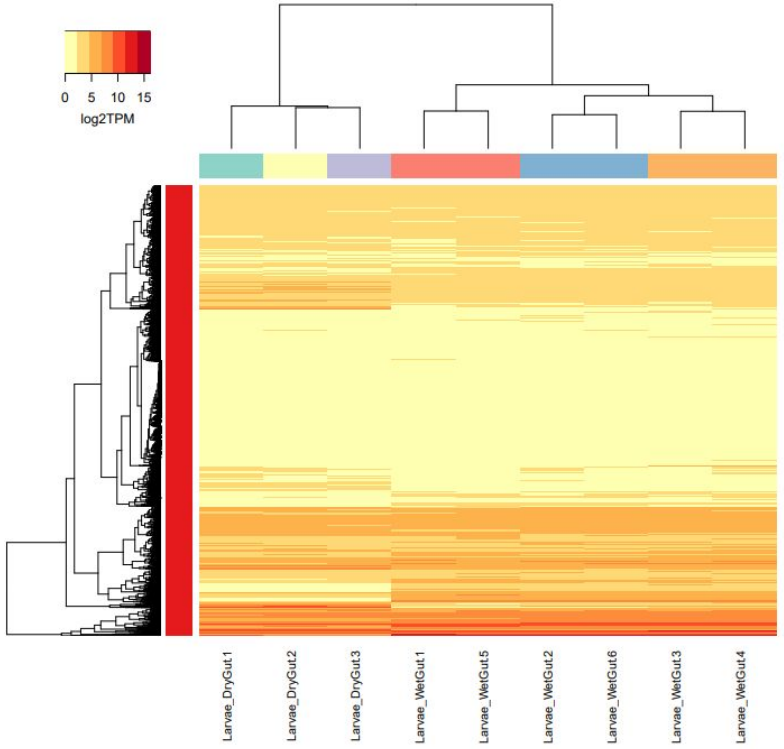

Transcription factors' expression heatmaps