拟南芥叶子生长对缺水适应的系统分析

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材料方法

植物的叶片对植物获取能量和碳转移方面有着非常重要的作用，因此，叶的生长必须与周围的环境条件相适应。本实验是以拟南芥长出来的第六片叶子为基准，在两种情况下进行：1.最佳含水量。2.恒定缺水。阶段1，最大的相对面积和厚度增加;阶段2，最大面积和厚度绝对速率增加;阶段3，降低的叶片面积和厚度增加比例;阶段4，结束叶面积和厚度增加。

结果

1.土壤缺水严重影响叶的生长
2.叶片DNA的倍性增加，但在缺水时仍旧很低
3.转录组和蛋白组都随不同的时期变，转录组是不断的变化
4.除少数例外，叶片的蛋白质组并不呈现明显的波动

5.每天的转录物波动依赖于叶子的生长状况，并受缺水的强烈影响

6.从长远来看，叶的生长，只保留了早期的发育过程

7. 水分亏缺降低了支持快速增长基因的表达

8.对水分亏缺的适应涉及到一些冷激蛋白的表达

土壤缺水严重影响叶的生长

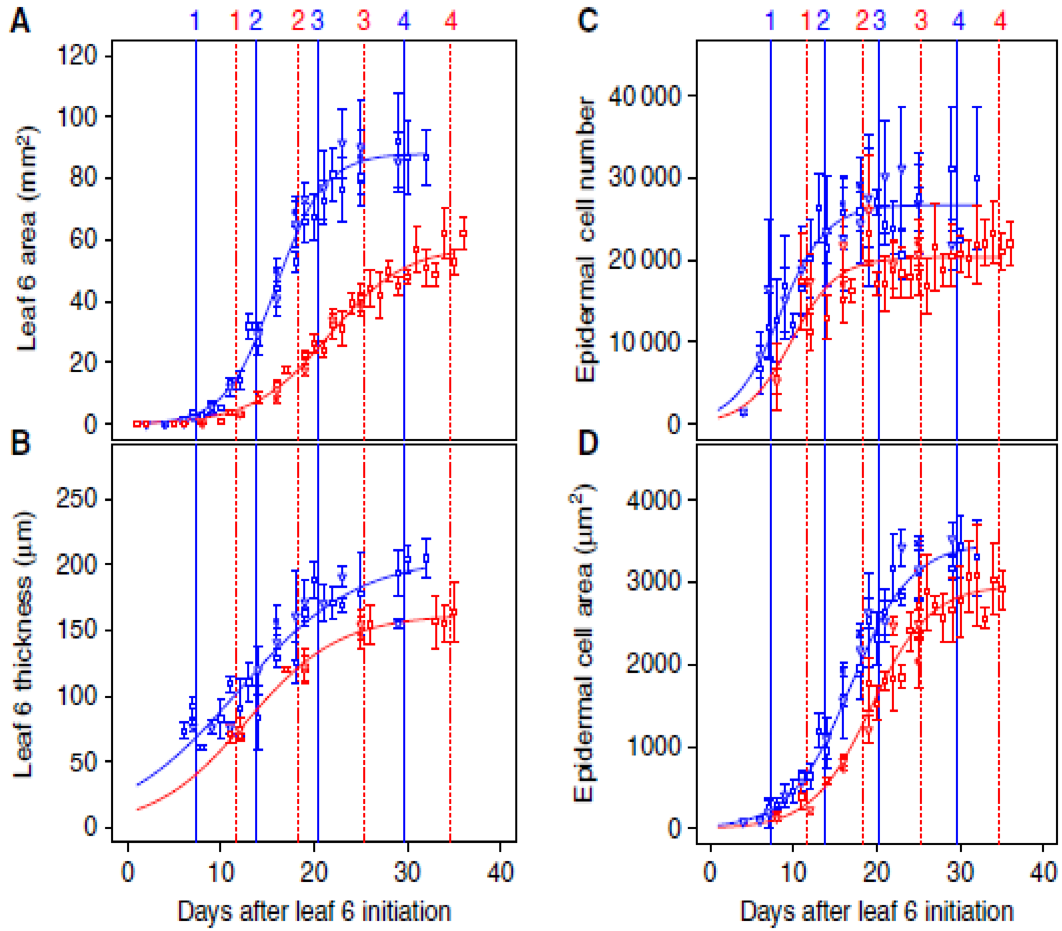


Figure 1 Growth phenotypes of leaves harvested for profiling. Kinematic expansion phenotypes of leaves in the SOW (blue) and SWD (red) experiments. Each symbol represents an independent experiment. Leaf 6 changed over time in area (**A**), thickness (**B**), epidermal cell number (**C**) and epidermal cell area (**D**). Data are presented as mean and s.d. values, $n = 5$. The numbers at the top of the graphs indicate the four growth stages. Source data is available for this figure in the Supplementary Information.

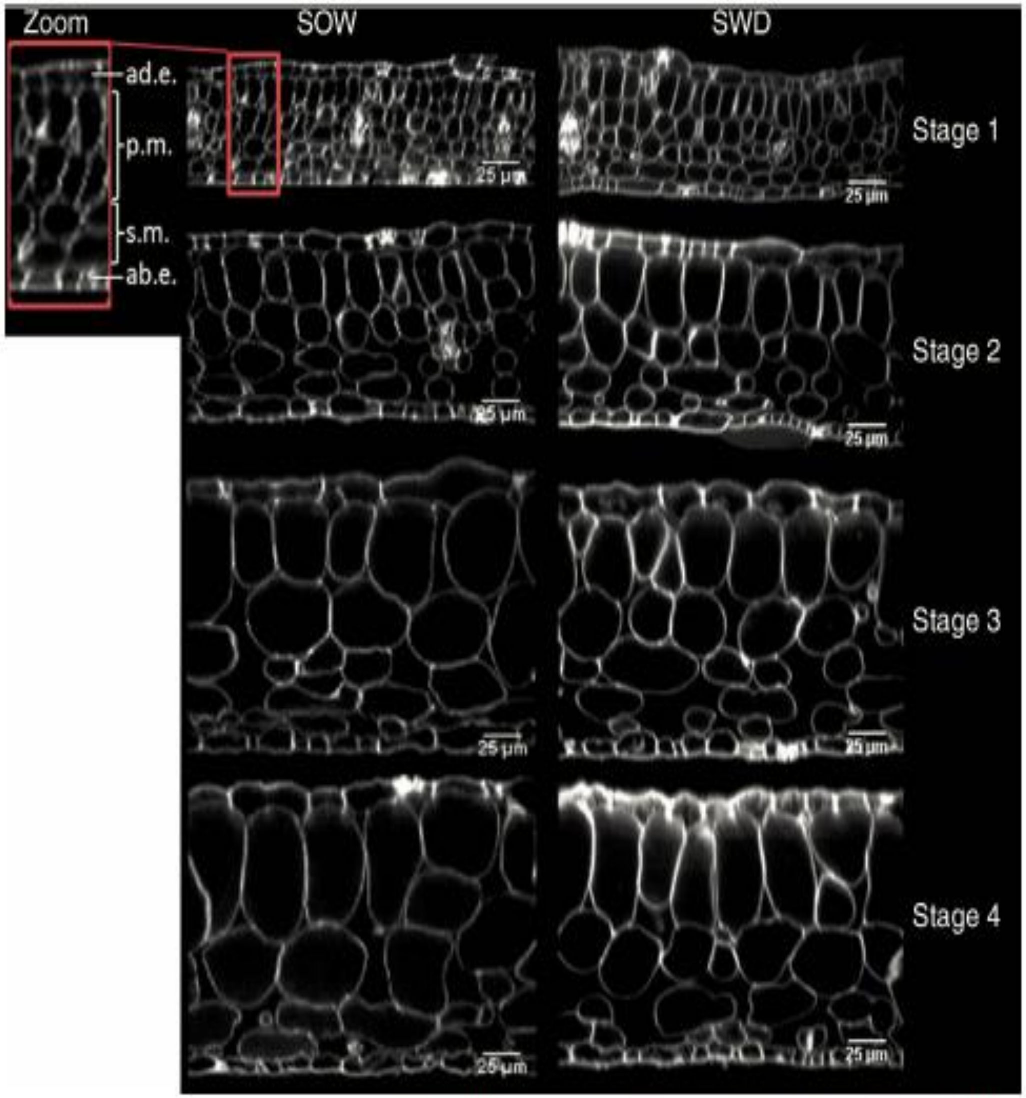


Figure 2 Transversal sections of leaves across development in SOW and SWD. Sections of leaf 6 in SOW (left panels) and SWD (right panels) were imaged with biphotonic microscopy at the four stages. Tissue layers are marked in the left side zoom section: ad.e. = adaxial epidermis, p.m. = palisade mesophyll, s.m. = spongy mesophyll, ab.e. = abaxial epidermis. Scale bars indicate 25 µm.

叶片DNA的倍性增加，但在缺水时仍旧很低

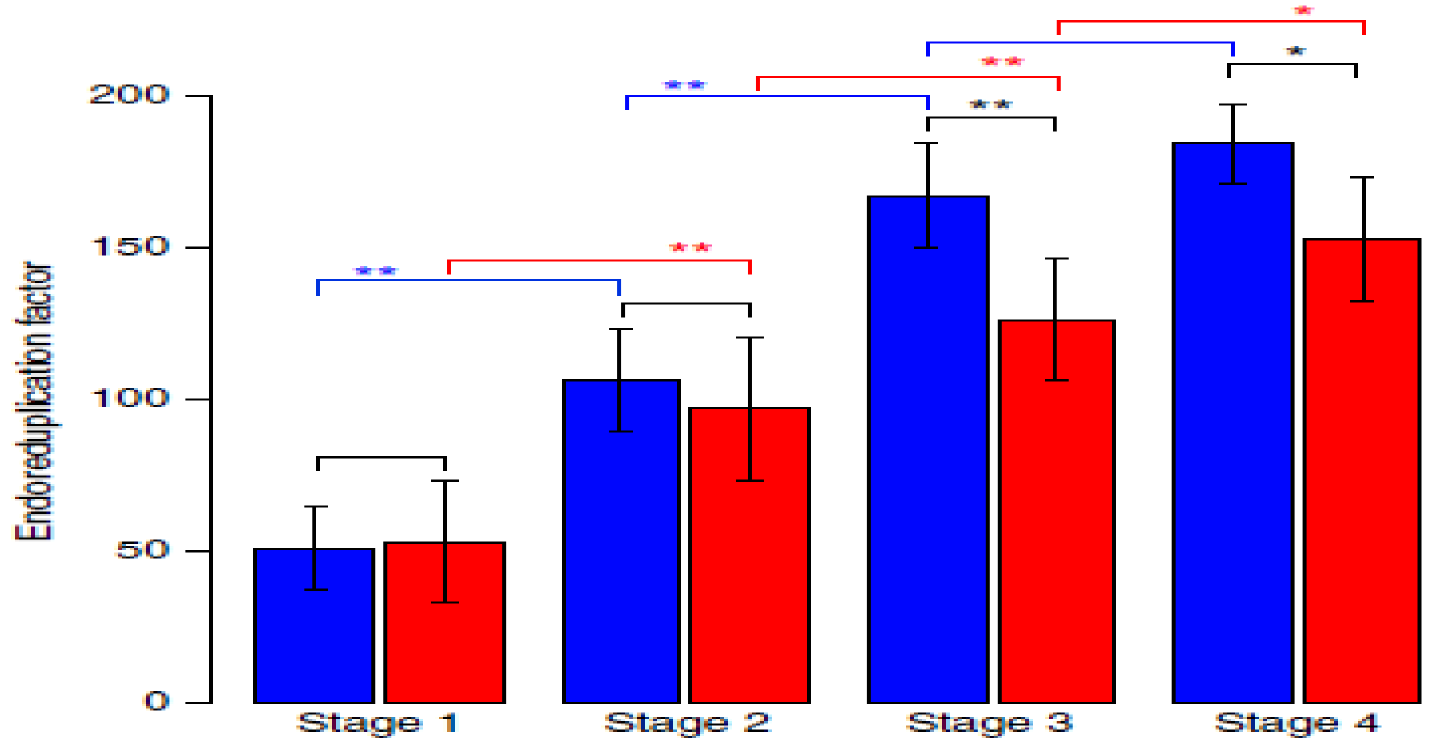
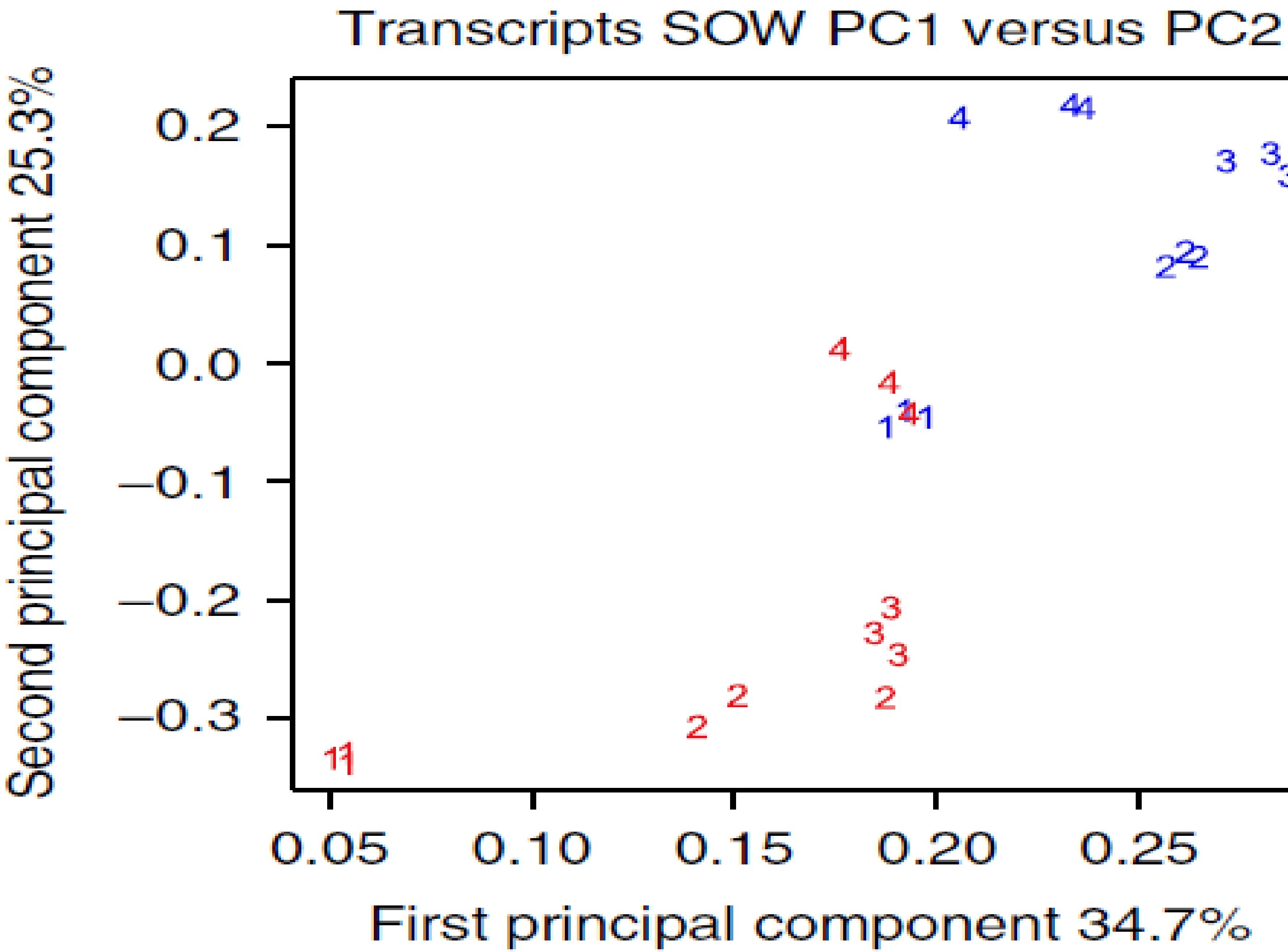
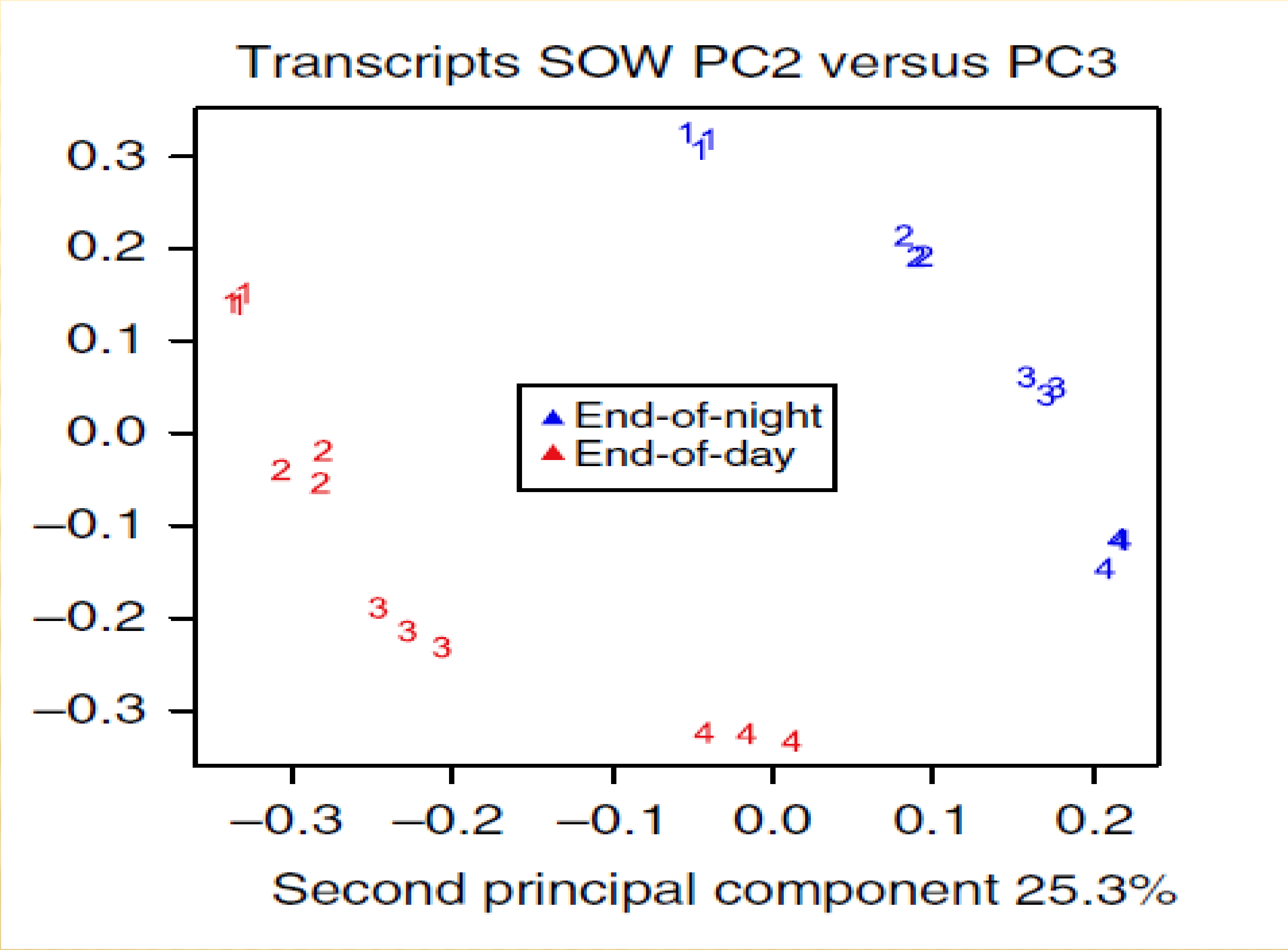


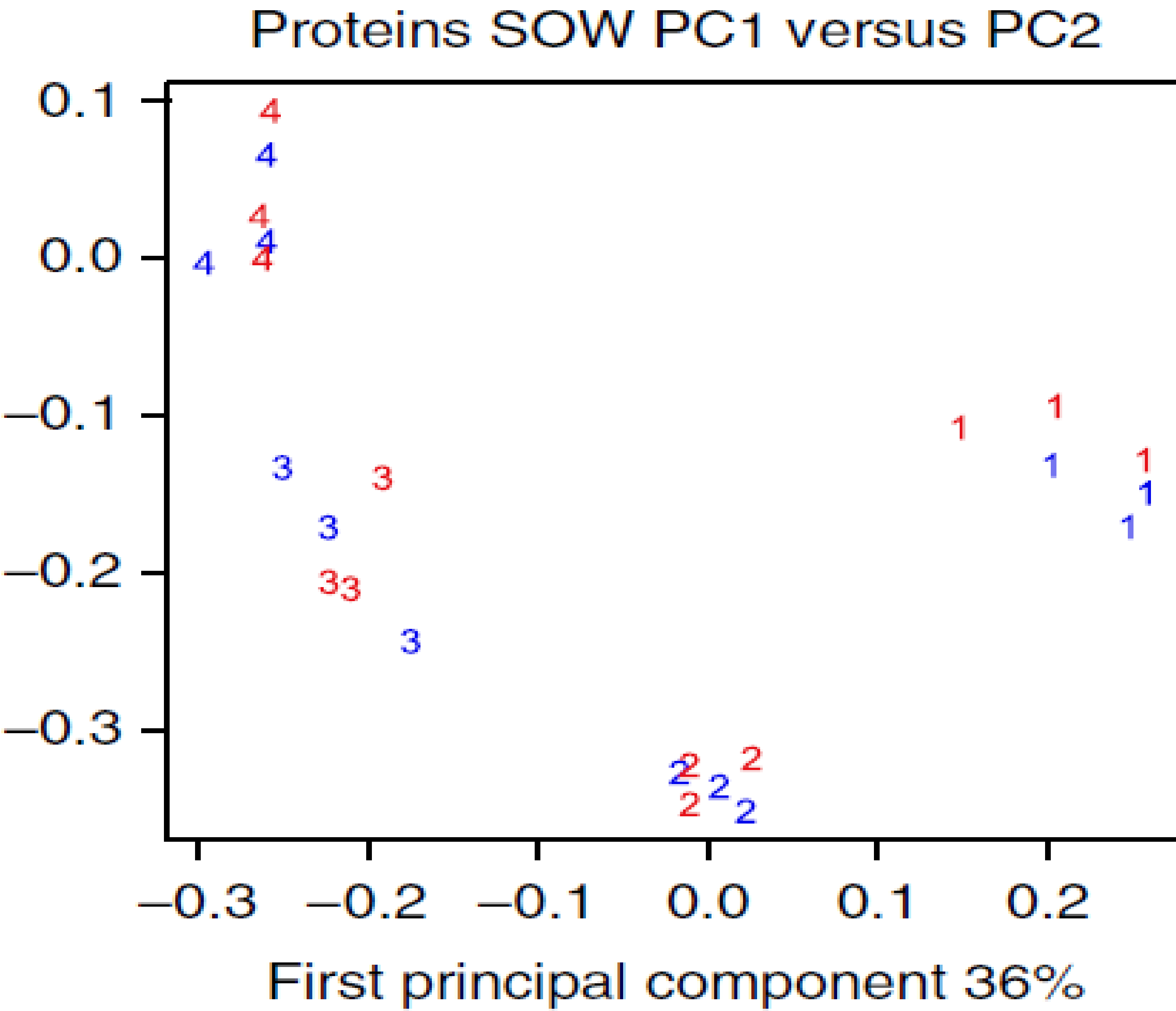
Figure 3 Endoreduplication during leaf development. Endoreduplication factors were calculated and compared for the four development stages in SOW (blue) and SWD (red). Graphs show mean and s.d. values, $n \geq 5$; ** indicates statistical significance at level $P < 0.01$, and * at level $P < 0.05$ (two-sided Welch test). Source data is available for this figure in the Supplementary Information.

转录组和蛋白组都随不同的时期变，转录组是不断的变化

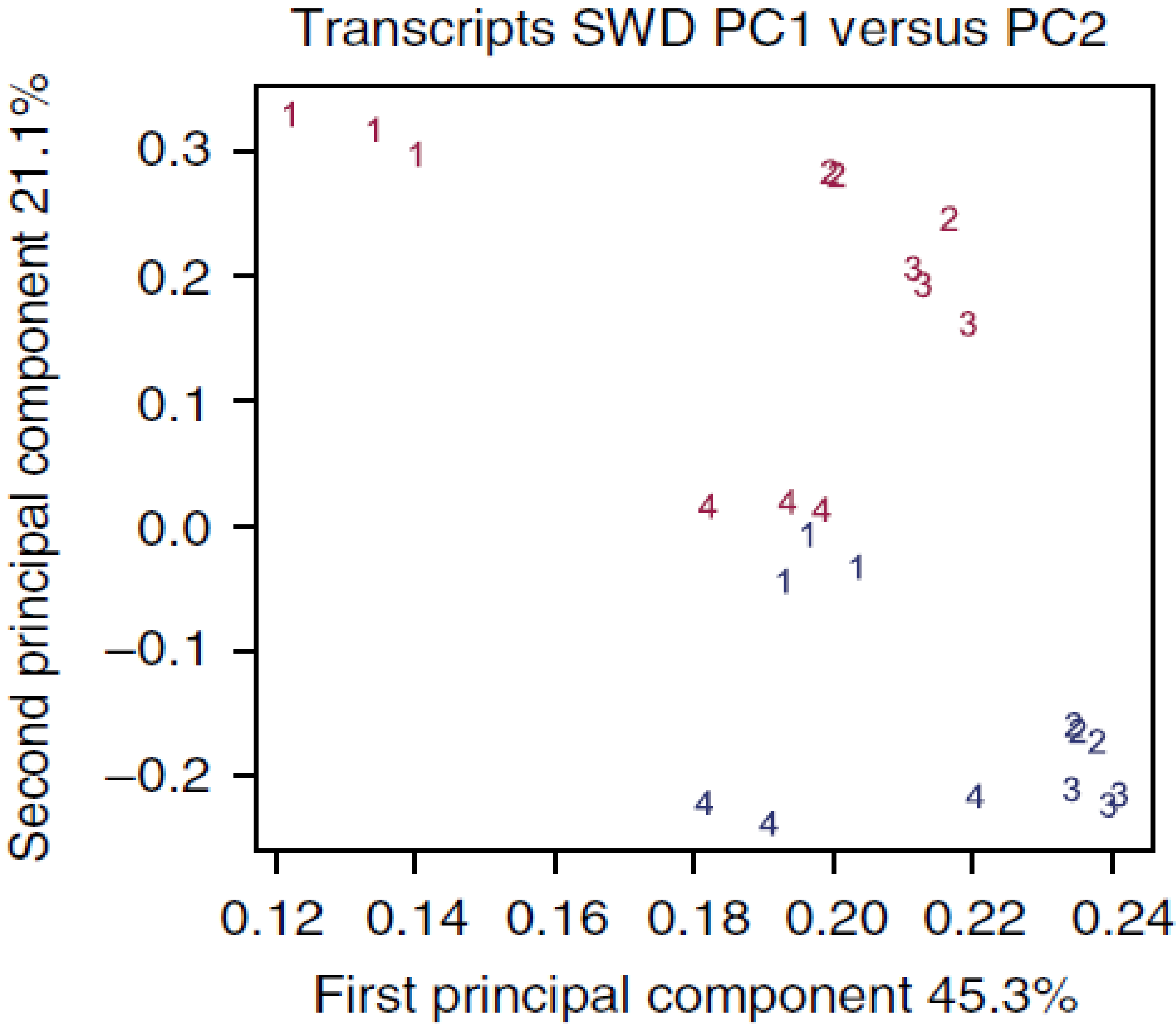


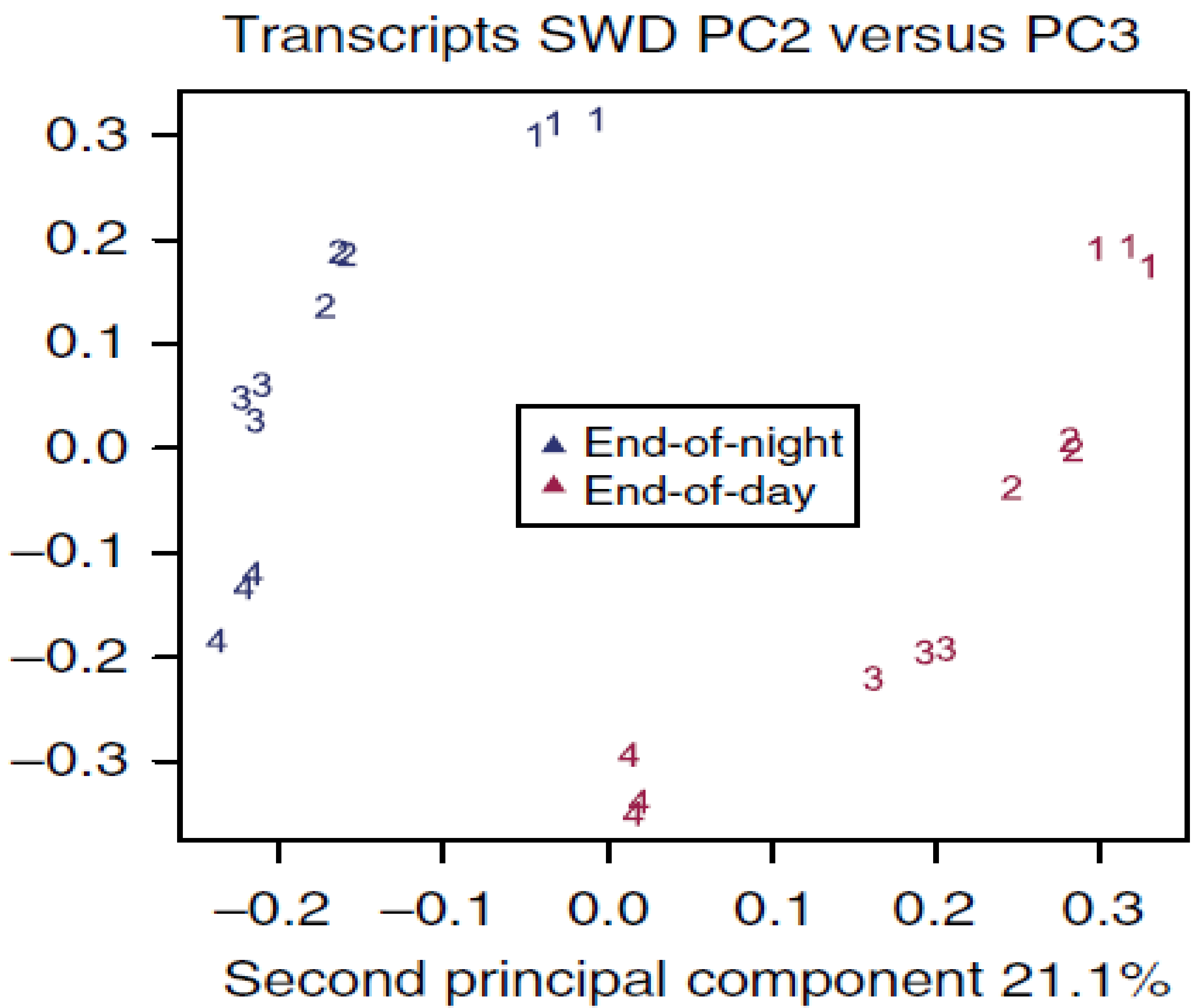


Transcripts SOW PC2 versus PC3
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
End-of-night
End-of-day
−0.3
−0.2
−0.1
0.0
0.1
0.2
Second principal component 25.3%

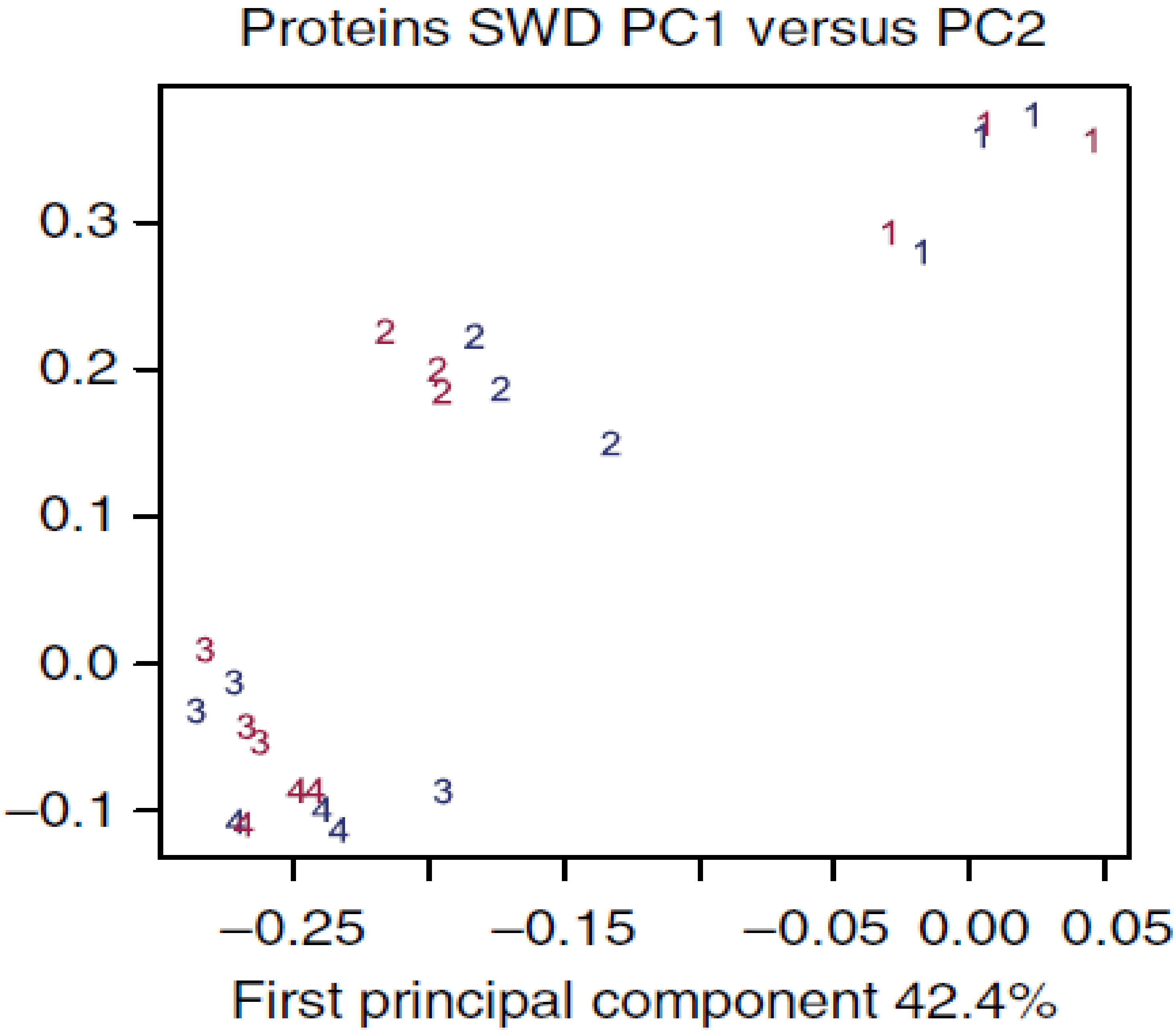


Proteins SOW PC1 versus PC2
0.1
0.0
−0.1
−0.2
−0.3
−0.3
−0.2
−0.1
0.0
0.1
0.2
First principal component 36%

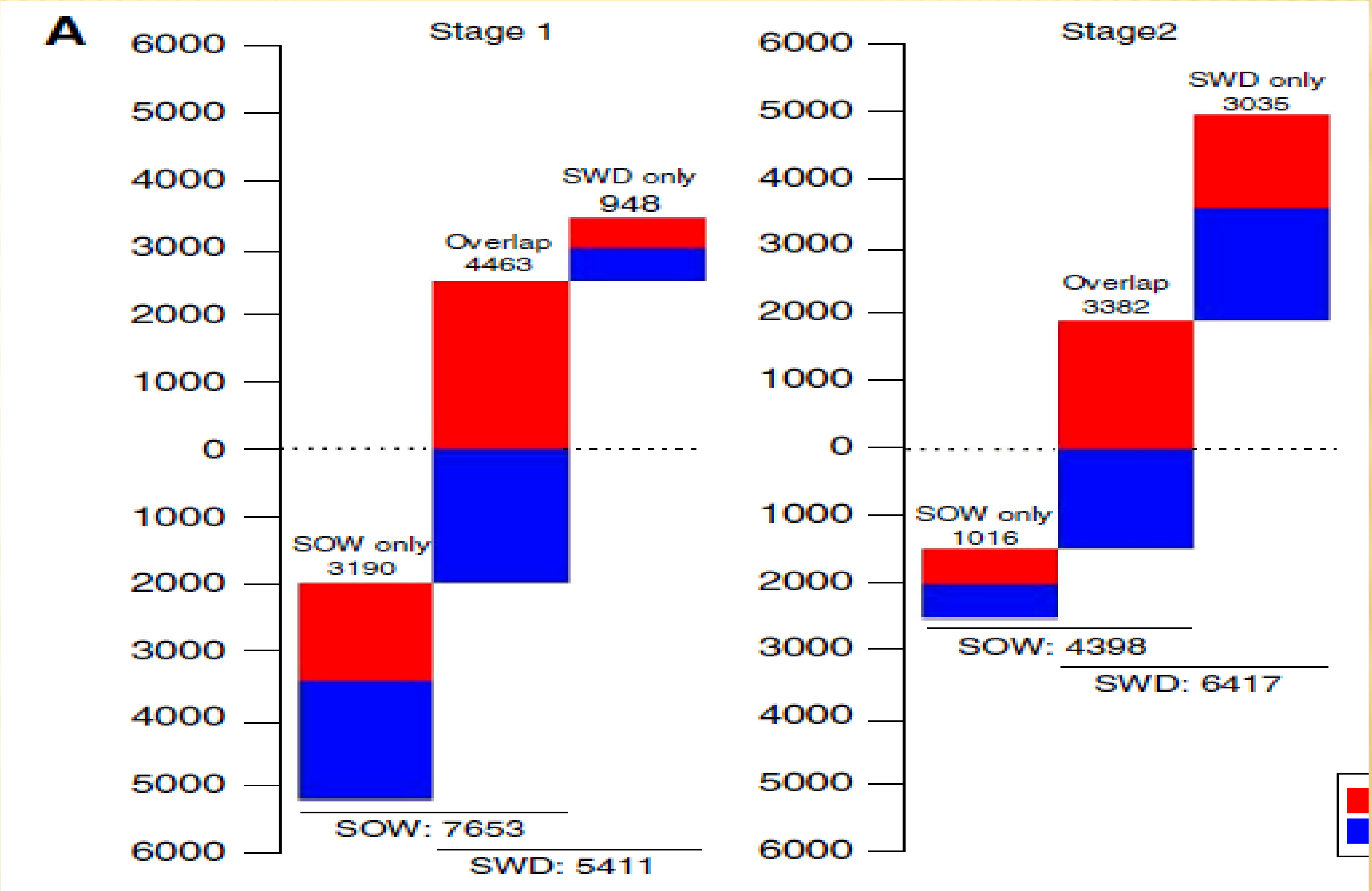

Transcripts SWD PC1 versus PC2
Second principal component 21.1%
First principal component 45.3%
0.3
0.2
0.1
0.0
−0.1
−0.2
0.12
0.14
0.16
0.18
0.20
0.22
0.24

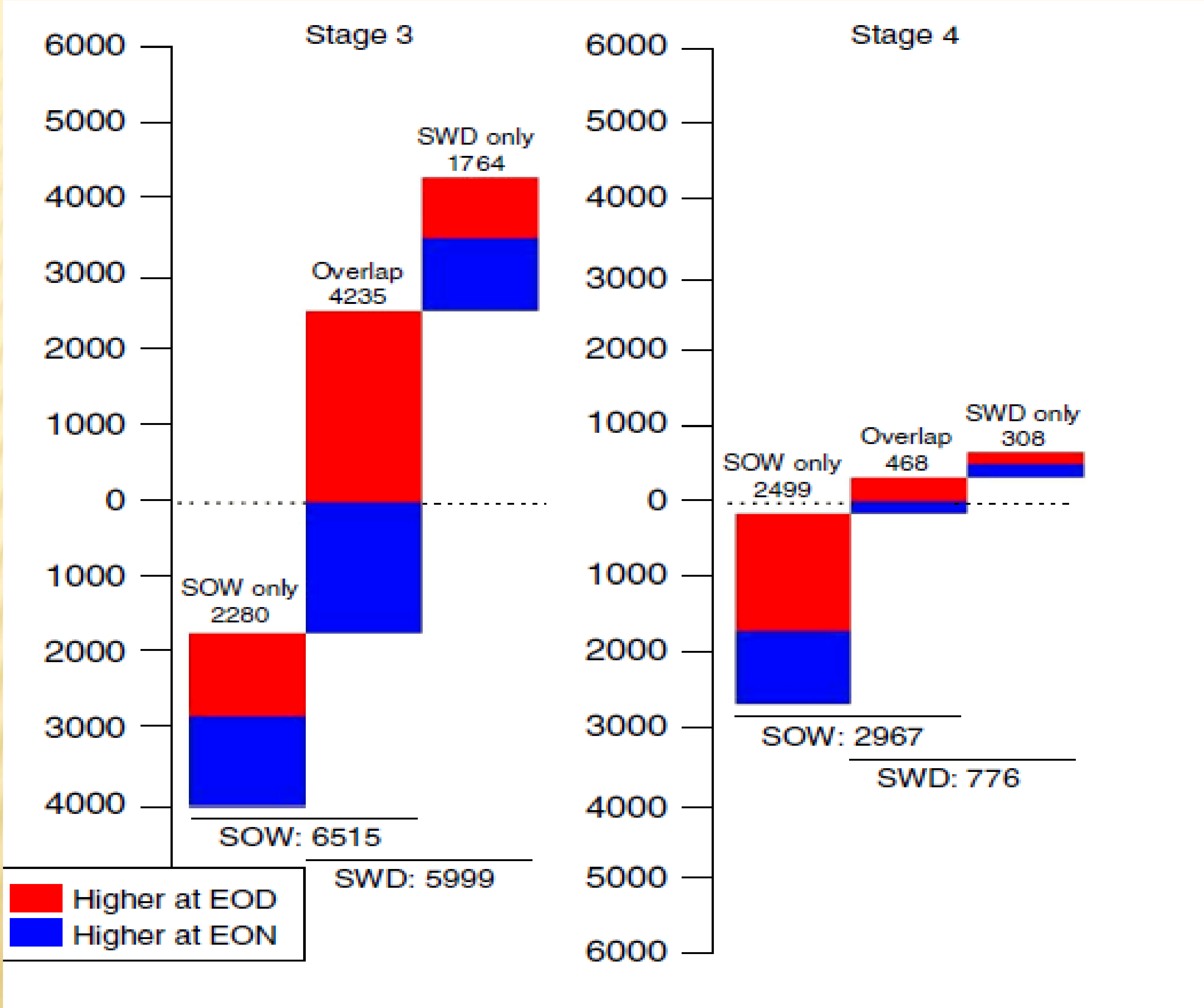


Transcripts SWD PC2 versus PC3
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
End-of-night
End-of-day
−0.2
−0.1
0.0
0.1
0.2
0.3
Second principal component 21.1%

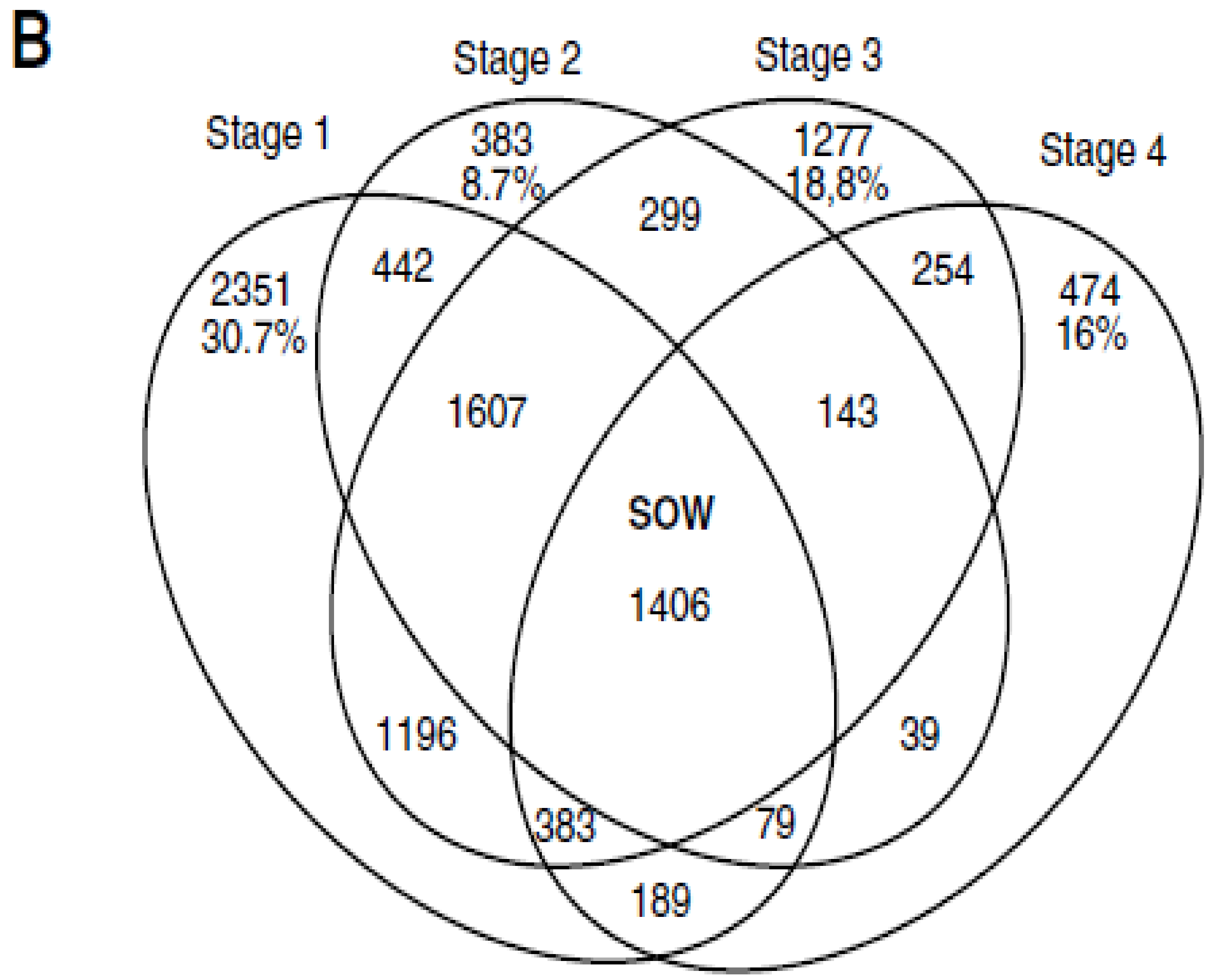

Proteins SWD PC1 versus PC2
0.3
0.2
0.1
0.0
−0.1
−0.25
−0.15
−0.05
0.00
0.05
First principal component 42.4%

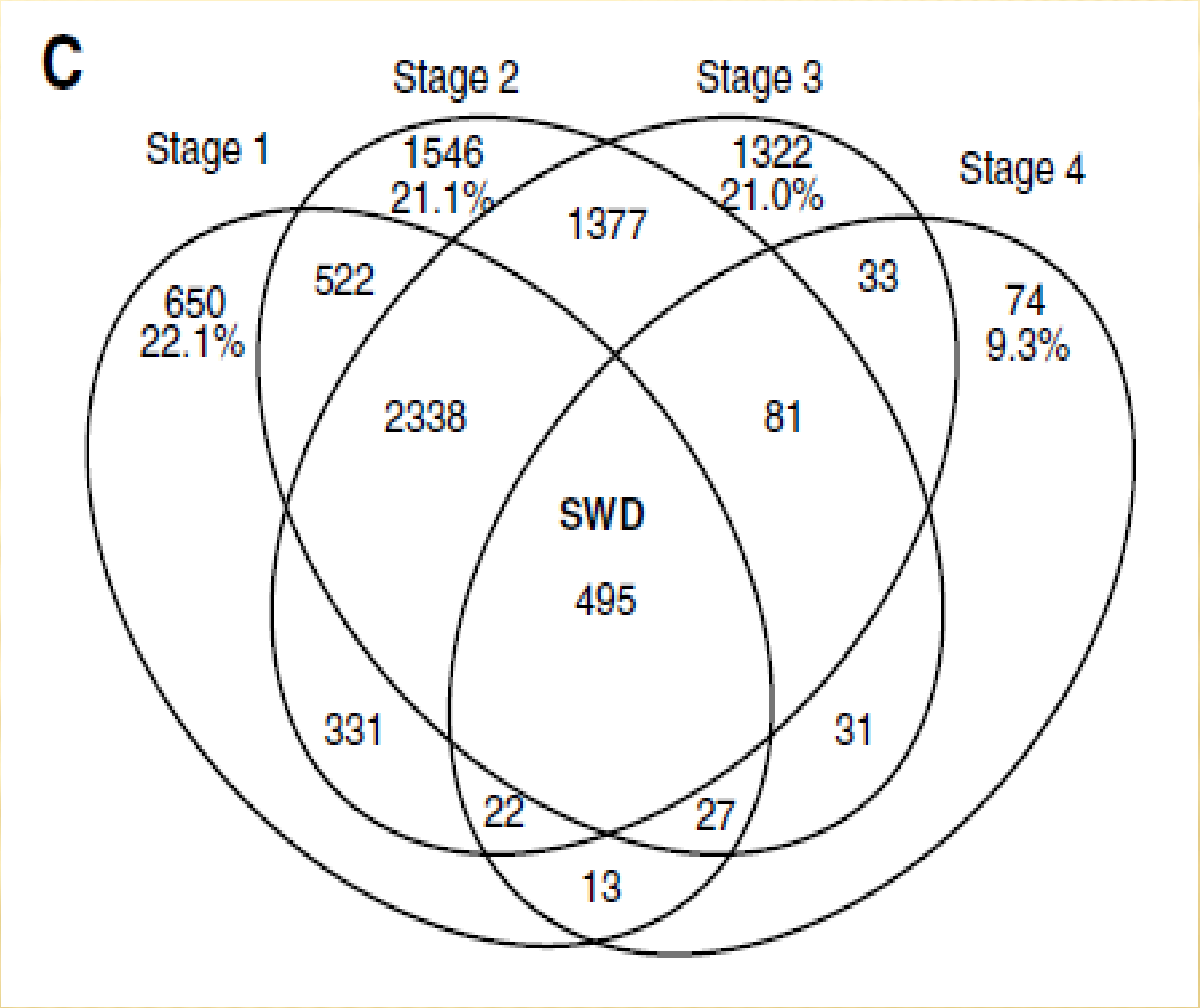
每天的转录物波动依赖于叶子的生长状况，并受缺水的强烈影响





Stage 3
6000
5000
4000
3000
2000
1000
0
1000
2000
3000
4000
SWD only
1764
Overlap
4235
SOW only
2280
SOW: 6515
SWD: 5999
Higher at EOD
Higher at EON
Stage 4
6000
5000
4000
3000
2000
1000
0
1000
2000
3000
4000
5000
6000
SWD only
308
Overlap
468
SOW only
2499
SOW: 2967
SWD: 776


B
Stage 1
Stage 2
Stage 3
Stage 4
383
8.7%
1277
18,8%
2351
30.7%
474
16%
299
442
254
1607
143
SOW
1406
1196
39
383
79
189


C
Stage 1
Stage 2
Stage 3
Stage 4
1546
21.1%
1322
21.0%
1377
522
33
650
22.1%
74
9.3%
2338
81
SWD
495
331
31
22
27
13

最重要的两大结论！！！

1.恒定的减少水分，使拟南芥生长缓慢，但这只是延长生长时间，在分子水平上是一种适应，并不表现出干旱胁迫。

2.叶片大量的转录物表现出强烈的昼夜波动且不与蛋白质的波动水平相匹配。

收获

1. 转录物的波动是为了更快的响应环境条件的改变。这就很难实现mRNAs浓度的恒定。也可以说，在缺水情况下，植物可以通过调节整体mRNAs的代谢水平使自己在一个次优的条件下生长。

2. 在土壤中生长的植物，连续降低水分显示出潜在的系统适应过程，这完全不同于对干旱胁迫的反应。

3. 通过对转录组和蛋白组的系统分析，进一步从分子水平深入理解了植物对缺水的适应性与干旱胁迫的区别。

谢谢