B73 Maize Gene Expression Atlas

Plant Ontology Use Case

MAIZEGDB
PLEXDB
PO
SEKHON ET AL. 2011

Presenter - Mary Schaeffer - USDA ARS - Curator MaizeGDB

PO:0009049 inflorescence
A reproductive shoot system that has as parts all of the shoot axes distal to the most distal foliage leaf of a shoot axis and all of the flowers borne by those axes. Must have two or more flowers as parts. [source: POC:Ramona_Walls]

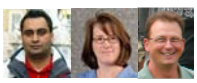
is_a **PO:0020126 tassel inflorescence**
is_a **PO:0020136 ear inflorescence**

Terms from Plant Ontology [PO] version #16 Oct 2011

THE DATA

Sekhon RS, Lin H, Childs KL, Hansey CN, Buell CR, de Leon N, Kaeppler SM (2011) *Plant J* 66:552-563.

"...Here we present a comprehensive atlas of global transcription profiles across developmental stages and plant organs. We used a NimbleGen microarray containing 80,301 probe sets to profile transcription patterns in 60 distinct tissues representing 11 major organ systems of inbred line B73. Of the 30,892 probe sets representing the filtered B73 gene models, 91.4% were expressed in at least one tissue. Interestingly, 44.5% of the probe sets were expressed in all tissues, indicating a substantial overlap of gene expression among plant organs. Clustering of maize tissues based on global gene expression profiles resulted in formation of groups of biologically related tissues..."



RajanSekhon Robin Buell Sean Kaeppler

Jack Gardiner (MaizeGDB curator)

Sekhon et al Mar 2010 Maize Meeting

THE DATA


>300,000 NimbleGen probes B73_V1 based gene models

60 maize tissues seed to seed

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B73_v2 gene models Mar 2010 released

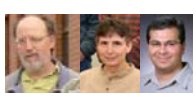
Jack Gardiner (MaizeGDB curator)

Sekhon et al Mar 2010 Maize Meeting

NEW DATATYPE for MAIZEGDB

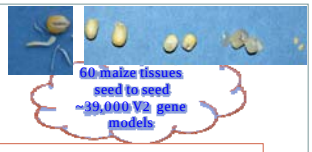
- Should we take in these 'raw' data?
- Lifetime of data -- What about the new version gene models?
- What will the community expect from us in future for similar 'BIG DATA' ?

On board expertise in whole genome gene expression/systems biology
Jack Gardiner, Ethalinda Cannon, TanerSen



April 2010 all staff meeting at Ames

Plant Ontology



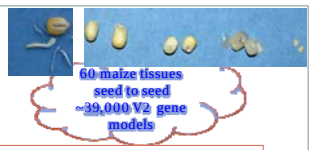
60 maize tissues
seed to seed
~39,000 V2 gene models

- Integrate tissues into MaizeGDB
  - -images, descriptions provided by R. Sekhon.
- Link to maize-specific component terms
- 'Inherit' PO accessions from the component terms

- MaizeGDB to provide PO associations files
  - after journal publication
  - for probe sets reanalyzed for the V2 gene models

Initial Plan Fall 2010

Plant Ontology



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Issues – Development/Growth

Multiple staging standards for maize
- Atlas [based on Ritchie].
- MaizeGDB [based on multiple sources, including Ritchie]
- PO [all plants]

Ritchie staging - Lack of precision in description of staging (leaf number, days after pollination), but has images to help.

MaizeGDB staging is independent of staging by leaf number, per se, but does describe the common situation for 'standard' corn belt lines, which includes B73 and refers to Ritchie staging

Similar term, different definition.

Controlled vocabulary standard 3 ways

Leaf number staging

PO:0007063
LP.07 7 leaves visible
PO:0020040 leaf base
PO:0001052 2 leaf expansion stage

2 tassel initiation/early whorl stage.[MaizeGDB]Apical dome of shoot meristem elongates, followed by appearance of tassel branch primordia. Under favorable conditions in adapted hybrids in the US Corn Belt, this may occur about 2-3 weeks after seedling emergence, when **4-6 leaf collars** are visible. Stem growing point is at or near soil surface. Tassel initiation is very sensitive to photoperiod and temperature; maximal sensitivity to these factors occurs during a brief period with a duration equivalent to the emergence of two leaves, just before tassel initiation (Poethig, 1994).

Leaf base of expanding leaf V5 [Atlas]

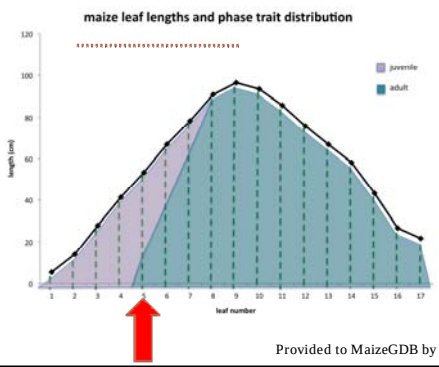
Leaf number staging

PO:0007116 LP.11 eleven leaves visible
PO:0001083 inflorescence development
PO:0020142 stem internode

3.2 late whorl stage [MaizeGDB term]
In adapted materials in the US Corn Belt, the collars of leaves 9-11 are visible (some of the lowest leaves may already have degenerated by this stage). By 10-leaf stage, new leaves appear every 2-3 days. Tassel development accelerates, and rapid stem elongation continues.

V9 fourth internode above ground [Atlas]

Phase trait distribution varies among maize lines and environment
A B73 approximation shown.



Provided to MaizeGDB by Erin Irish

Leaf number staging

PO:0007063 LP.07 7 leaves visible
PO:0020040 leaf base
PO:0001052 2 leaf expansion stage

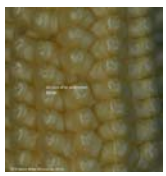
Assigned to adult leaf tissue from a transition leaf based on Irish et al 1998 Int J Plant Sci 159:695-701.

PO:0006340 adult vascular leaf
PO:0008018 transition vascular leaf

Leaf base of expanding leaf V5 [Atlas]

DAP days after pollination

PO:0007032 FF:00 fruit size up to 10%;
PO:0007633 endosperm development stages
PO:0001180 B proembryo stage



6.2 exponential [MaizeGDB term].
Salvador (1992) describes the exponential phase as a period of increased metabolic activity and rapid kernel development that links the dilatory phase with the linear grain-filling period. It occurs approximately 5-12 days after pollination (dap). In the endosperm, cell walls are laid down beginning about 5 dap, changing the free nuclear tissue into a cellular one (Kowles et al., 1992, Genetic Engineering, Vol. 14). The embryo continues in the proembryo stage through about 10 dap (Abbe and Stein, 1954). Maizedb includes a substage ("6.21 transition") for the late exponential phase when important events take place in the endosperm and embryo.

kernel 10 DAP [Atlas]

Definitions vary for similar names

0.3 coleoptile emergence from seed [MaizeGDB]

PO:0007045 Coleoptile emergence.
But defined as "emergence of coleoptile above ground". Hmmm.

Coleoptile 6 DAS [days after sowing; Atlas]

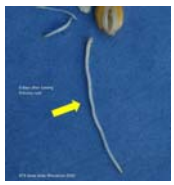
definitions

Coleoptile 6 DAS [Atlas]

0.3 coleoptile emergence [MaizeGDB]

PO:0007049 Coleoptile emergence, Emergence of coleoptile above ground

Primary root 6 DAS [Atlas]



0.2 radicle emergence from seed [MaizeGDB]

PO:0007015 radicle emergence
The stage at which the radicle or root emerges from seed

PO:0007057 seed germination stage

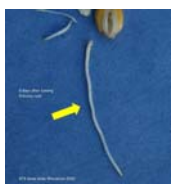
definitions

Coleoptile 6 DAS [Atlas]

0.3 coleoptile emergence [MaizeGDB]

PO:0007049 Coleoptile emergence, Emergence of coleoptile above ground

Primary root 6 DAS [Atlas]



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PO:0007015 radicle emergence
The stage at which the radicle or root emerges from seed

PO:0007057 seed germination stage

PO revision - no effect on PO accessions

Inflorescence PO:0009049
is_a ear inflorescence PO:0020136
is_a tassel inflorescence PO:0020126

Revised ontology structure only

PO revisions - term merging

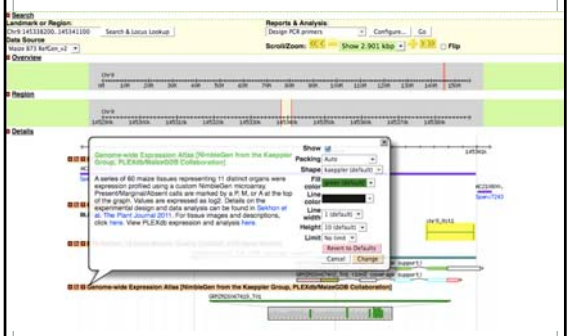
~~PO:0006469silk~~

PO:0009074style
An elongated part of a carpel or group of fused carpels between the ovary and the stigma, and through which the pollen tube grows.

~~PO:0006354ear floret~~

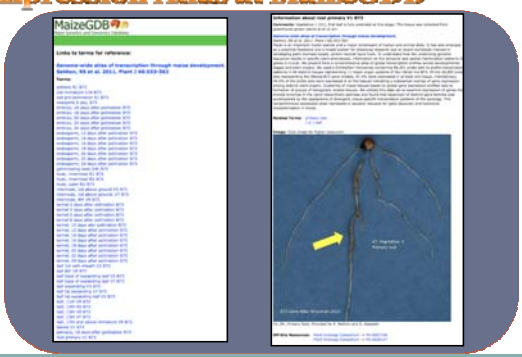
Use style instead of silk

Expression Atlas at MaizeGDB



Recomputed to v2 gene models

Expression Atlas at MaizeGDB

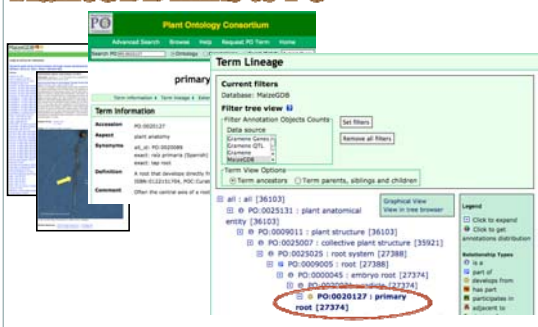


Information accessible from browser

Expression Atlas at MaizeGDB

Information accessible from tissue record

MaizeGDB links to PO



Information accessible from tissue record

Plant Ontology Team:

- Provided updated PO term lists and definitions with OBSOLETE terms included and indicated.
- Carefully considered my suggestions re. definitions and structure of the PO via the Source Forge ontology tracker
- Reviewed the list of some 180 annotations of the 60 tissues and provided information about plant anatomy parts that required double term entry, eg “style” needs also “ear floret
- Was happy to accept all the data where expression was over base level, per Sekhon et al. 2011.
- Mapped Classical Genes of Lyons and Schnable to the gene models for this project post delivery of the associations files
- Updated files to accommodate some changes in PO made after Oct.2011

Acknowledgements

ATLAS team
RajanSekon
Robin Buell
Sean Kaeppler

MaizeGDB team
Mary L Schaeffer [curated]
Ethalinda KL Cannon [v2 probe sets]
Jack M. Gardiner [coordinated]
Bremen M. Braun [browser views]
Darwin A Campbell
Carson M Andorf
Scott M Birkett
Lisa C Harper
Taner Z Sen
Carolyn Lawrence

PLEXdb team
[computed v2 expression values]
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Roger Wise
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Plant Ontology team
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PankajJaiswal

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