Genomic footprints of selection during domestication in Old World camelids


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Introduction

'Camelid Group'
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Overview

DOMESTICATION

Background
- domestication syndrome hypothesis
- Old World camelid domestication
- Old World camel genome research
- International Camel Consortium for Genetic Improvement and Conservation

GENOME RESEQUENCING

Results
- Genetic Variation
- Admixture/Demographic History
- Identifying selected loci

“domestication syndrome” hypothesis

mild neural crest cell deficits during embryonic development

Wilkins et al. 2014

Special thanks to the organizers!

Plant and Animal Genome XXIV Conference, San Diego, Jan 9 2016
**Camelus ferus**

Great Gobi Strictly Protected Area "A"

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**Bactrian camel domestication**

- Domestication around 4000 ya
- Maybe further to the west than assumed previously
- Wild camels are related but not the ancestors
- Domestic Bactrian wild population

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**Old World Camel genome resources**

- Genome-wide divergent selection
  - Overall lower heterozygosity in the domestic genome
  - Artificial selection during domestication
- Adaptation to desert environment
  - Lineage specific accelerated evolutionary rates
  - GO categories enriched genes involved in
    - Fat and energy metabolism
    - Osmoregulation and water reservation
    - Organization of the MHC complex
    - Low polymorphisms in MHC class II genes

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**Old World Camels**

- Genomes reveal evolution and adaptation to desert environments
- Genome sequences of wild and domestic bactrian camels

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**Bactrian camel domestication**

- Late Bronze and Early Iron Age samples
  - South Uzbekistan, West Siberia

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**Dromedary domestication**

- Domestication around 3000 ya
- Minimum of 6 maternal lineages
- Wild dromedaries from the Southeast coast of the Arabian Peninsula contributed to the modern gene pool

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**Extinct wild camel population**

- 4,000–6,000 years ago
- Domestication 4,000–6,000 ya
- Maybe further to the west than assumed previously
- Wild camels are related but not the ancestors
- Domestication 4,000–6,000 ya
F&O meeting in Riyadh, April 2015: 23 participating countries
Established at the 6th ISOAGRD conference in Almaty, June 2015

Genome Resequencing

Dataset

25 Genomes ~15X coverage Mapped to C. ferus

Genetic Variation

Admixture/Demography

Detecting Selection

Genome-wide approach

Heterozygosity & S'Fst

- Pairwise species comparisons
- Reduced heterozygosity and high S'Fst

SMILEFINDER (Guiblet et al. 2015, Oleksyk et al. 2008)

Gene-centric approach

- Homogeneity Test
  - Polymorphism vs divergence
  - Species A vs [species B + C]
- HKA Test
  - Gene vs genome-wide average
  - Only if significant in a particular lineage
Detecting Selection

- Homogeneity/HKA Test
  - Dromedary vs [C. ferus/bactrianus]: 6,662 genes analyzed
    - STARTD9: microtubule motor
    - PRKDC: double strand break repair
    - CENPF: centromere-associated, transcription factor binding
    - DNAH1: ATPase activity, microtubule motor
    - FAM208B: protein binding
  - C. ferus vs C. bactrianus
    - ANKYRIN2: protein kinase binding and ion channel binding
    - OTOP1: behavior, neurological
    - ABCA13: ATPase activity

- Extreme Hc and S^2_FST: C. dromedarius

Summary

- Introgression from domestic to wild camel threatens the genomic integrity of Camelus ferus
- Population expansion of the wild camel during the last glacial maximum followed by a rapid decline
- Selection during domestication affects genes associated with neural physiology
  - "domestication syndrome"

Questions???

- Please see posters:
  - P0686
  - P0687
  - P0690

"domestication syndrome" hypothesis

Selection for Tameress

- Reduced neural crest input ("wild neurofibromatosis")
- Reduced in adrenal & sympathetic ganglia
- Reduced stress, reduced fear of humans, learning "turnaround"

Potential indirect side-effect of reduced neural crest input

Direct developmental results of reduced neural crest input

Selected Traits

- Reduced fornix size
- White patches (melanocytes)
- Floppy ears (chondrocytes)
- Reduced muzzles, & jaws (osteoclasts)
- Reduced teeth (odontoblasts)

Unselected By-products

- Reduced stress
- Reduced fear of humans, learning "turnaround"