環境生物学II
Environmental Biology II

早川卓志 (Takashi Hayakawa)
Group of Ecological Genetics, Faculty of Environmental Earth Science



Comparative genomics in wild mammals

-- 早川卓志（はやかわ たかし）
-- 地球環境科学研究院
-- 生態遺伝学分野

Web: https://noah.ees.hokudai.ac.jp/hayakawa/

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講義スライド：https://noah.ees.hokudai.ac.jp/hayakawa/students.html
🔍 早川　北大　生態遺伝

Comparative genomics in wild mammals

① In African primates

- Sensory biology in the wild

② In Asian primates

- What does genome tell us?

③ In Australian marsupials

- Mammalian-wide evolution

④ In Australian monotremes

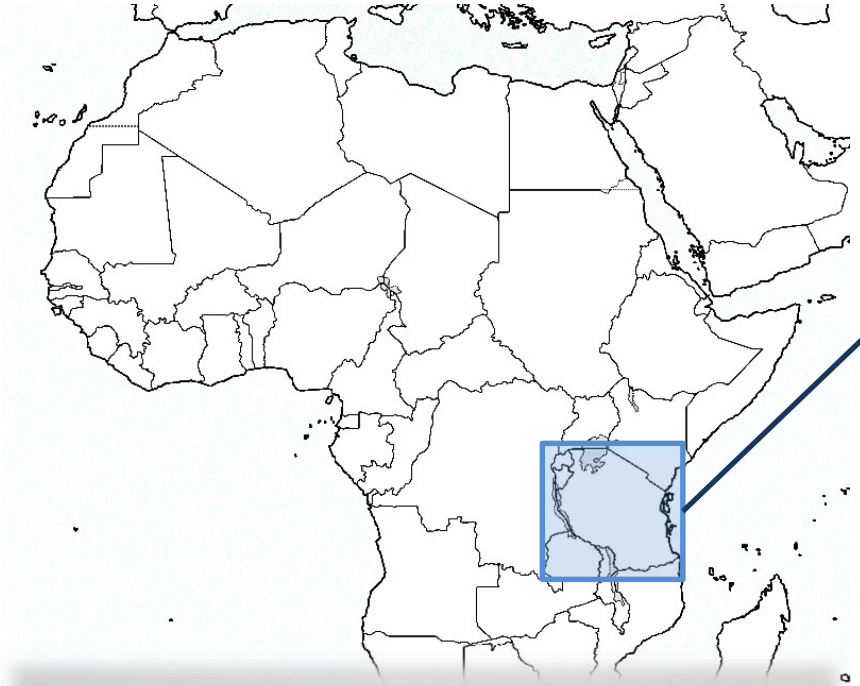
- What is the origin of mammals

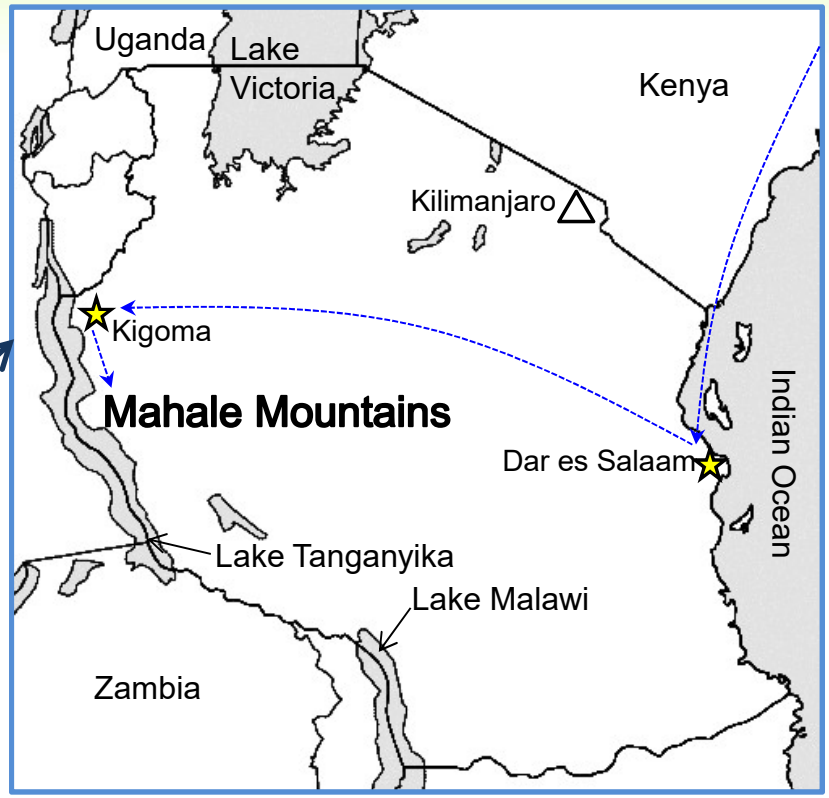

Go to Africa
A graduate student in tropical forest

Research in Uganda with Ankole people

Sept 29, 2014

Go to Mahale Mountains, Tanzania

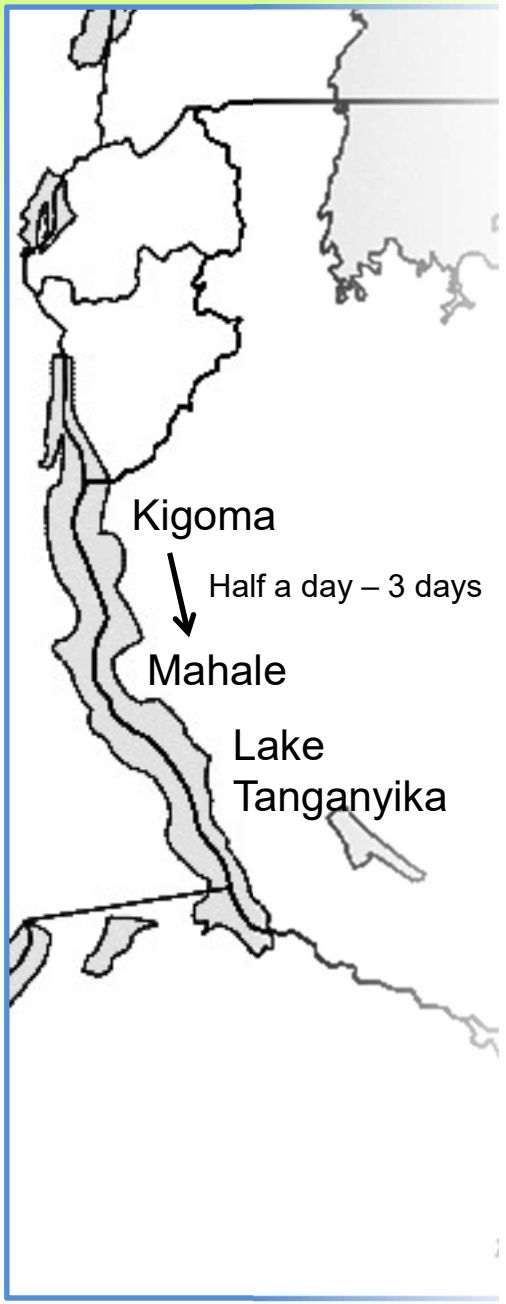




United Republic of Tanzania

Great mountains and lakes in the Great Rift Valley

African Great: Lake Tanganyika



Direct observation of wild chimpanzees in Mahale

Individual discrimination and focal sampling
(個体識別と個体追跡調査)

Behavior observation

Teddy
9-year boy

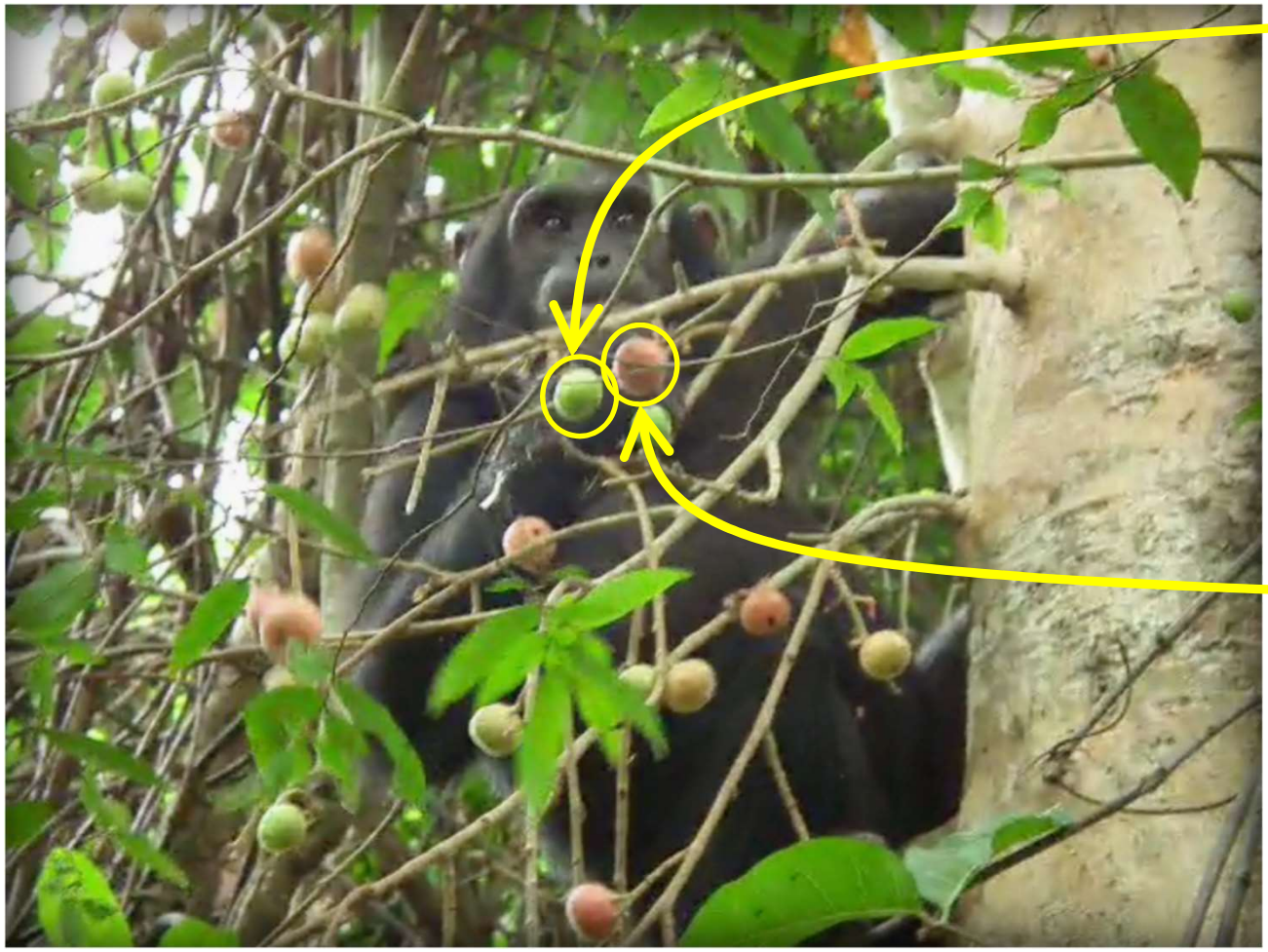
Playing “Guruguru” and “Denguri”
Chimpanzee behavior tell us human evolution

Multi-male multi-female social system in chimpanzees

Playing among juveniles and adult males with laughing:
Understanding the complex chimpanzee social system

Senses in feeding

Her sense knows that red figs are nutritionally good



A female juvenile in Mahale

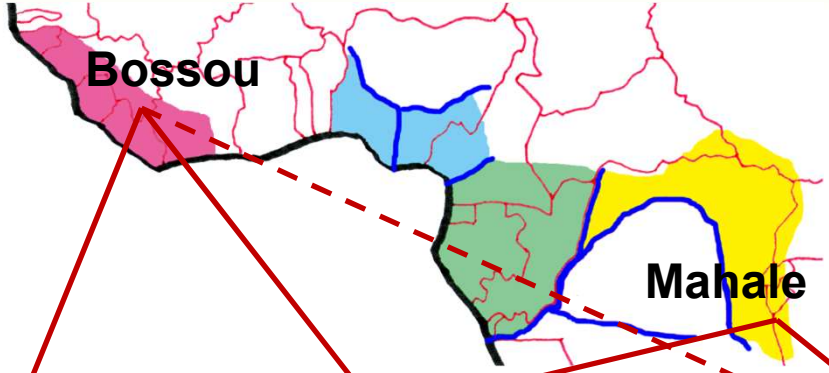
Unripe fig fruit
- ✓ Green
- ✓ Astringent
- ✓ Small

Ripe fig fruit
- ✓ Red
- ✓ Sweet
- ✓ Large


“Bitter” plant in the chimpanzee forest
Mahale chimps eat *Vernonia* leaves and pith
© Miho Nakamura (Kyoto University)

Geographic difference of “bitter” diet

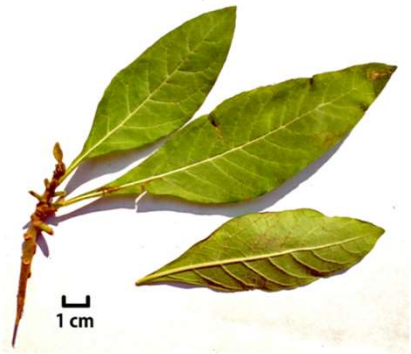
Western chimpanzees



Eastern chimpanzees

Gongronema latifolium
Only in West Africa

Pycnanthus angolensis
Eaten in both Africa

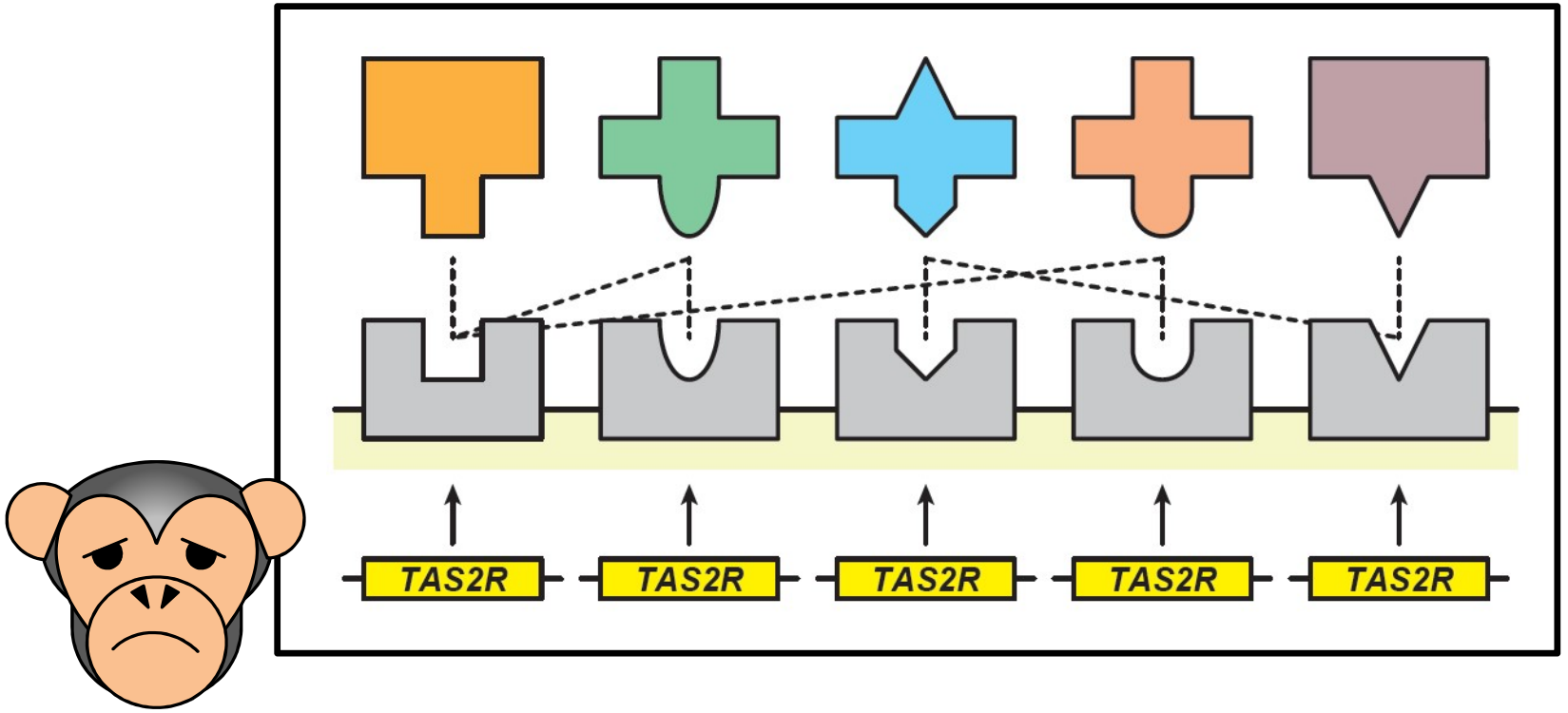


Vernonia amygdalina
Present in both Africa
but only eaten in East Africa

Nishida and Uehara 1983. *Afr. Stud. Monogr.*
Nishida et al. 1983 *J. Hum. Evol.*
Sugiyama and Koman 1992. *Afr. Stud. Monogr.*

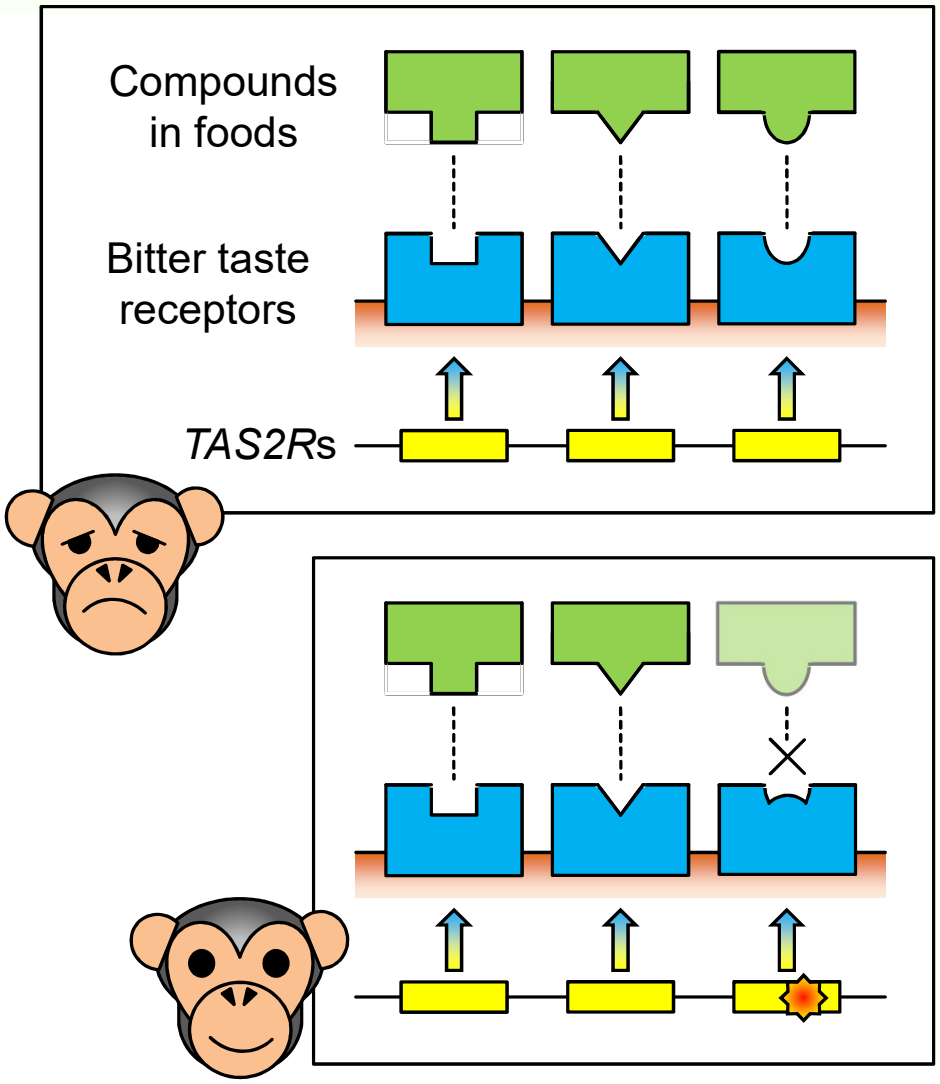
Taste receptor genes

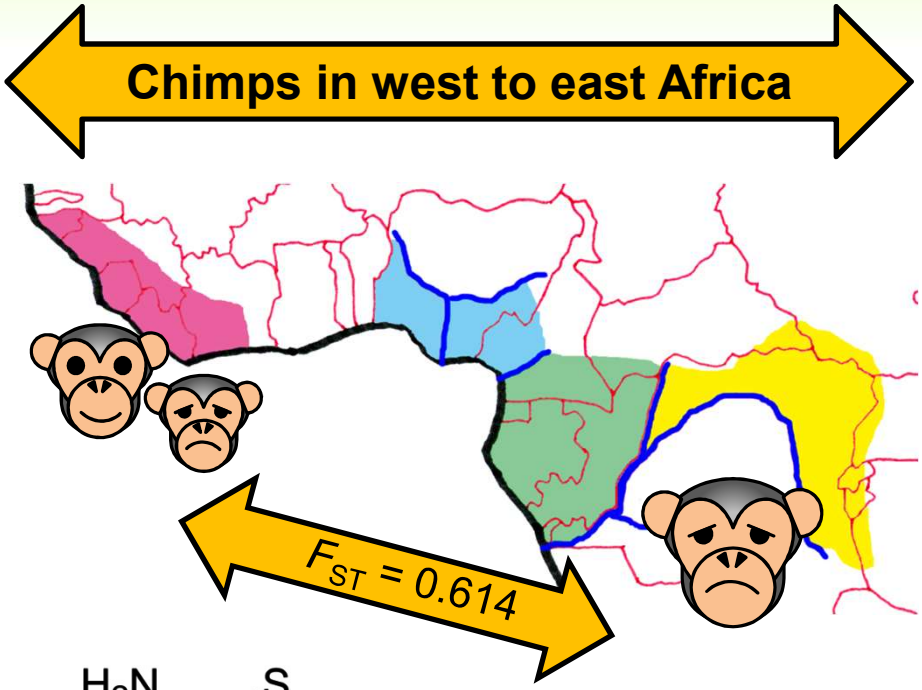
- Recognize dietary compounds in the oral cavity
- Several-dozens of bitter taste receptors (TAS2Rs)

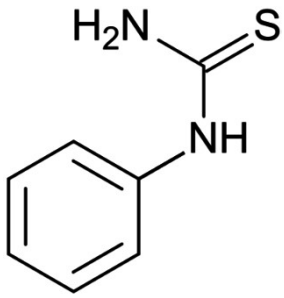


Chandrashekar et al. 2006 *Nature*

Chimps have population-specific *TAS2R* variants:
Adaptation to specific food environments







A nonfunctional *TAS2R38* variant is only distributed in West Africa, which causes less sensivitity to PTC.

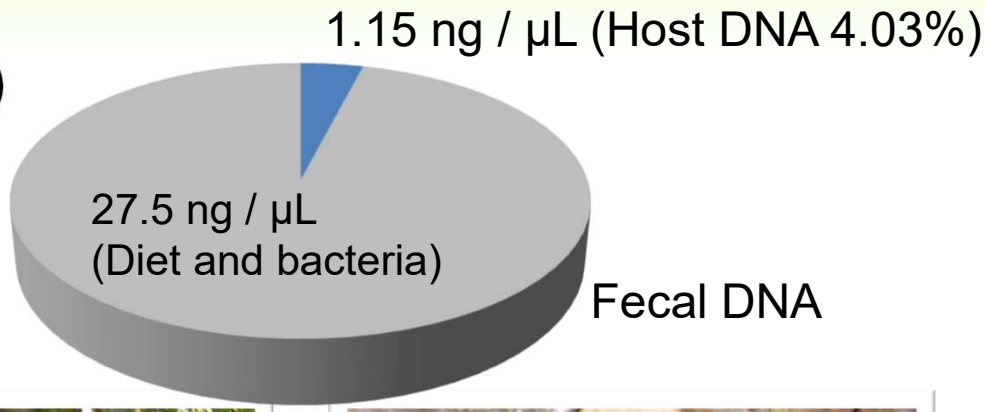
Hayakawa et al. (2012) *PLOS ONE*

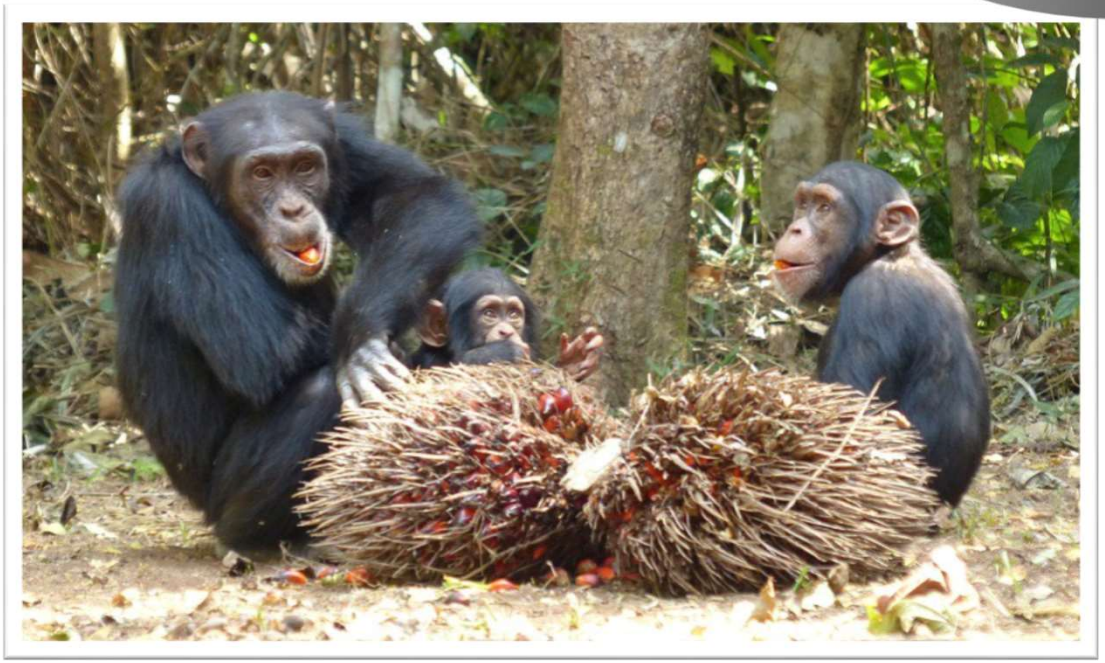
Collect dropped ones

An adult female eastern chimpanzee (Kalinzu, Uganda)

Fecal DNA analysis

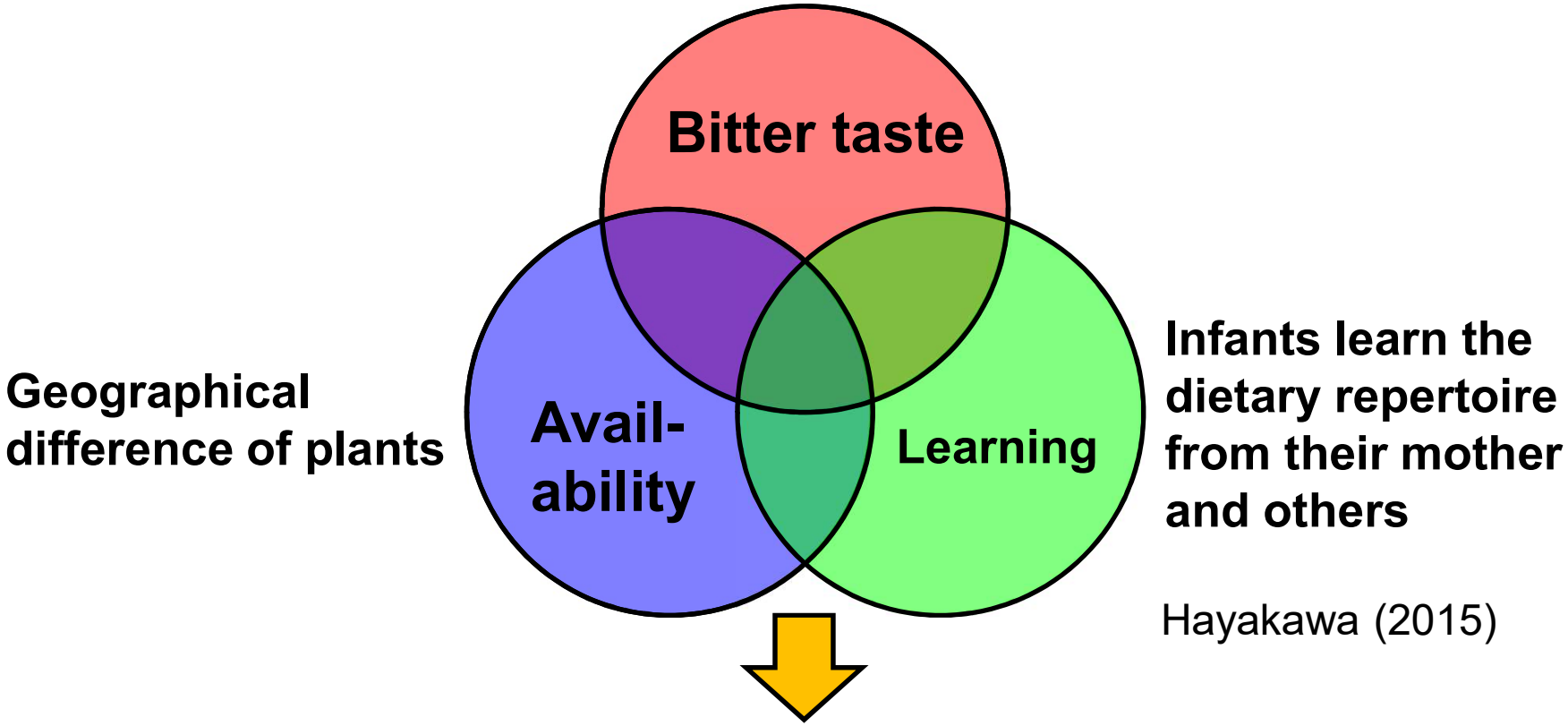
- Feces content (糞内容物)
  - Epithelial cell (腸壁細胞)
  - Digested diet (食べかす)
  - Gut bacteria (腸内細菌)





Taste ecology and evolution

Population-specific *TAS2R* functional variants



Hayakawa (2015)

Bitter taste receptor diversity may regulate population-specific food choice in wild chimpanzees

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① **In African primates**

- Sensory biology in the wild

② **In Asian primates**

- What does genome tell us?

③ **In Australian marsupials**

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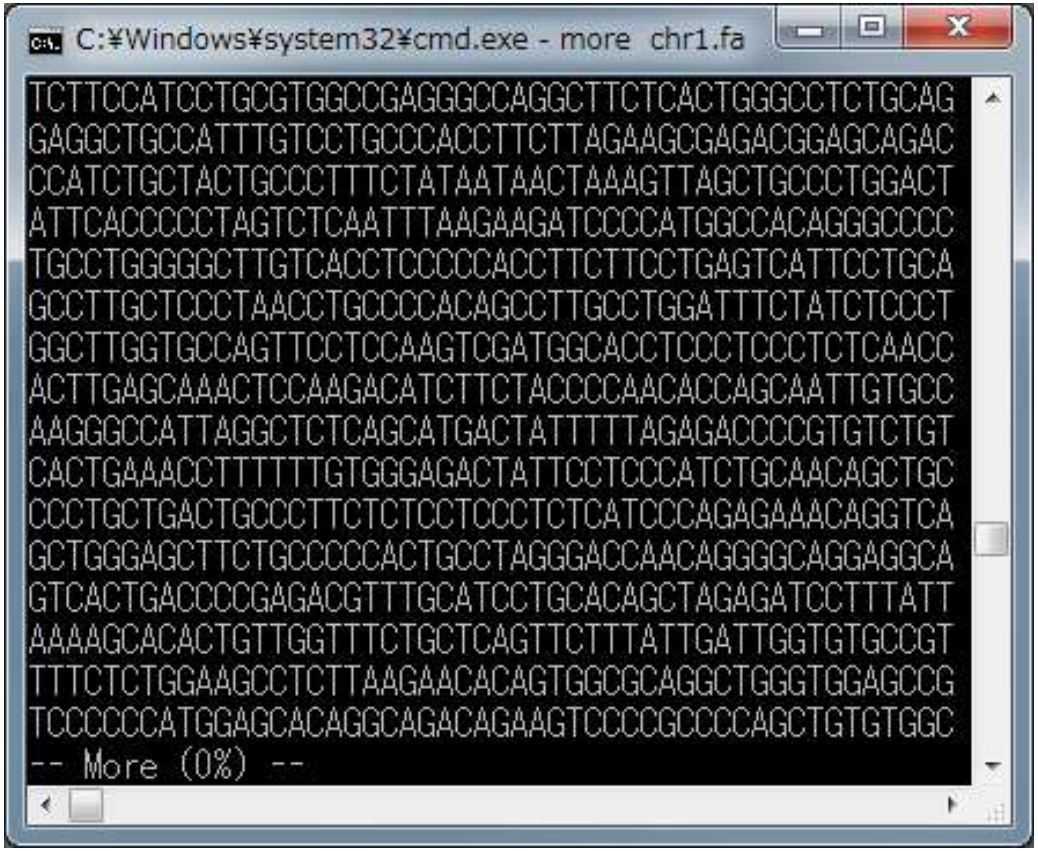
④ **In Australian monotremes**

- What is the origin of mammals

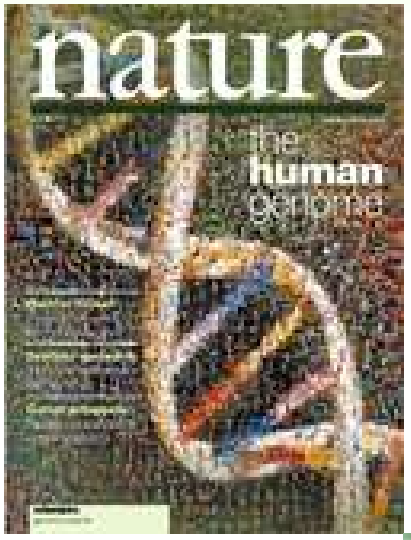
Read whole genome
～全ゲノムを読む～

- ~30,000 protein-coding genes in ~3 billion nucleotides (A/T/G/C) in mammalian genome



3GB information!

Comparative genomics in primates



Human genome (2001)

Chimp genome (2005)

Macaque genome (2007)

Tarsier (2011)
Galago (2011)
Lemur (2011)
Aye-aye (2012)
Gorilla (2012)
Bonobo (2012)

Orang genome (2011)

Search TAS2R genes in whole genome

Similarity-based search (BLAST algorithm)

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TAS2R31  ATGACAACTTTTATACCCATCATTTTTTCCAGTGTGGTAGTGGTTCTATTTGTTATTGGAAATTTTGCTAATGGCTTCATAGCATTGGTAAATTCCATTGAGCGGGTCAAGAGACAAAAG
TAS2R43  ATGATAACTTTTCTACCCATCATTTTTTCCAGTCTGGTAGTGGTTACATTTGTTATTGGAAATTTTGCTAATGGCTTCATAGCACTGGTAAATTCCATTGAGTGGTTCAAGAGACAAAAG
         **** ******* ******************** ***********  ************************************ ***************** ** **************

TAS2R31  ATCTCTTTTGCTGACCAGATTCTCACTGCTCTGGCGGTCTCCAGAGTTGGTTTGCTCTGGGTATTATTATTAAATTGGTATTCAACTGTGTTTAATCCAGCTTTTTATAGTGTAGAAGTA
TAS2R43  ATCTCCTTTGCTGACCAAATTCTCACTGCTCTGGCGGTCTCCAGAGTTGGTTTGCTCTGGGTATTATTATTAAACTGGTATTCAACTGTGTTGAATCCAGCTTTTAATAGTGTAGAAGTA
         ***** *********** ************************************************************ ***************** ************ **************

TAS2R31  AGAACTACTGCTTATAATGTCTGGGCAGTAACCGGCCATTTCAGCAACTGGCTTGCTACTAGCCTCAGCATATTTTATTTGCTCAAGATTGCCAATTTCTCCAACCTTATTTTTCTTCAC
TAS2R43  AGAACTACTGCTTATAATATCTGGGCAGTGATCAACCATTTCAGCAACTGGCTTGCTACTACCCTCAGCATATTTTATTTGCTCAAGATTGCCAATTTCTCCAACTTTATTTTTCTTCAC
         ****************** ********** * *  ************************** ****************************************** **************

TAS2R31  TTAAAGAGGAGAGTTAAGAGTGTCATTCTGGTGATGCTGTTGGGGCCTTTACTATTTTTGGCTTGTCAACTTTTTGTGATAAACATGAAAGAGATTGTACGGACAAAAGAATATGAAGGA
TAS2R43  TTAAAGAGGAGAGTTAAGAGTGTCATTCTGGTGATGTTGTTGGGGCCTTTGCTATTTTTGGCTTGTCATCTTTTTGTGATAAACATGAATGAGATTGTGCGGACAAAAGAATTTGAAGGA
         ********************************** ************* ***************** ******************* ******** ************* *******

TAS2R31  AACTTGACTTGGAAGATCAAATTGAGGAGTGCAGTGTACCTTTCAGATGCGACTGTAACCACGCTAGGAAACTTAGTGCCCTTCACTCTGACCCTGCTATGTTTTTTGCTGTTAATCTGT
TAS2R43  AACATGACTTGGAAGATCAAATTGAAGAGTGCAATGTACTTTTCAAATATGACTGTAACCATGGTAGCAAACTTAGTACCCTTCACTCTGACCCTACTATCTTTTATGCTGTTAATCTGT
         *** ********************** ******* ***** ***** **  *********** * *** ********* ***************** **** **** **************

TAS2R31  TCTCTGTGTAAACATCTCAAGAAGATGCAGCTCCATGGTAAAGGATCTCAAGATCCCAGCACCAAGGTCCACATAAAAGCTTTGCAAACTGTGATCTTTTTCCTCTTGTTATGTGCCGTT
TAS2R43  TCTTTGTGTAAACATCTCAAGAAGATGCAGCTCCATGGTAAAGGATCTCAAGATCCCAGCACCAAGGTCCACATAAAAGCTTTGCAAACTGTGATCTCCTTCCTCTTGTTATGTGCCATT
         *** ********************************************************************************  ****************** **

TAS2R31  TACTTTCTGTCCATAATGATATCAGTTTGGAGTTTTGGGAGTCTGGAAAACAAACCTGTCTTCATGTTCTGCAAAGCTATTAGATTCAGCTATCCTTCAATCCACCCATTCATCCTGATT
TAS2R43  TACTTTCTGTCCATAATGATATCAGTTTGGAGTTTTGGAAGTCTGGAAAACAAACCTGTCTTCATGTTCTGCAAAGCTATTAGATTCAGCTATCCTTCAATCCACCCATTCATCCTGATT
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TAS2R31  TGGGGAAACAAGAAGCTAAAGCAGACTTTTCTTTCAGTTTTGCGGCAAGTGAGGTACTGGGTGAAAGGAGAGAAGCCTTCATCTCCATAG
TAS2R43  TGGGGAAACAAGAAGCTAAAGCAGACTTTTCTTTCAGTTTTTTGGCAAATGAGGTACTGGGTGAAAGGAGAGAAGACTTCATCTCCATAG
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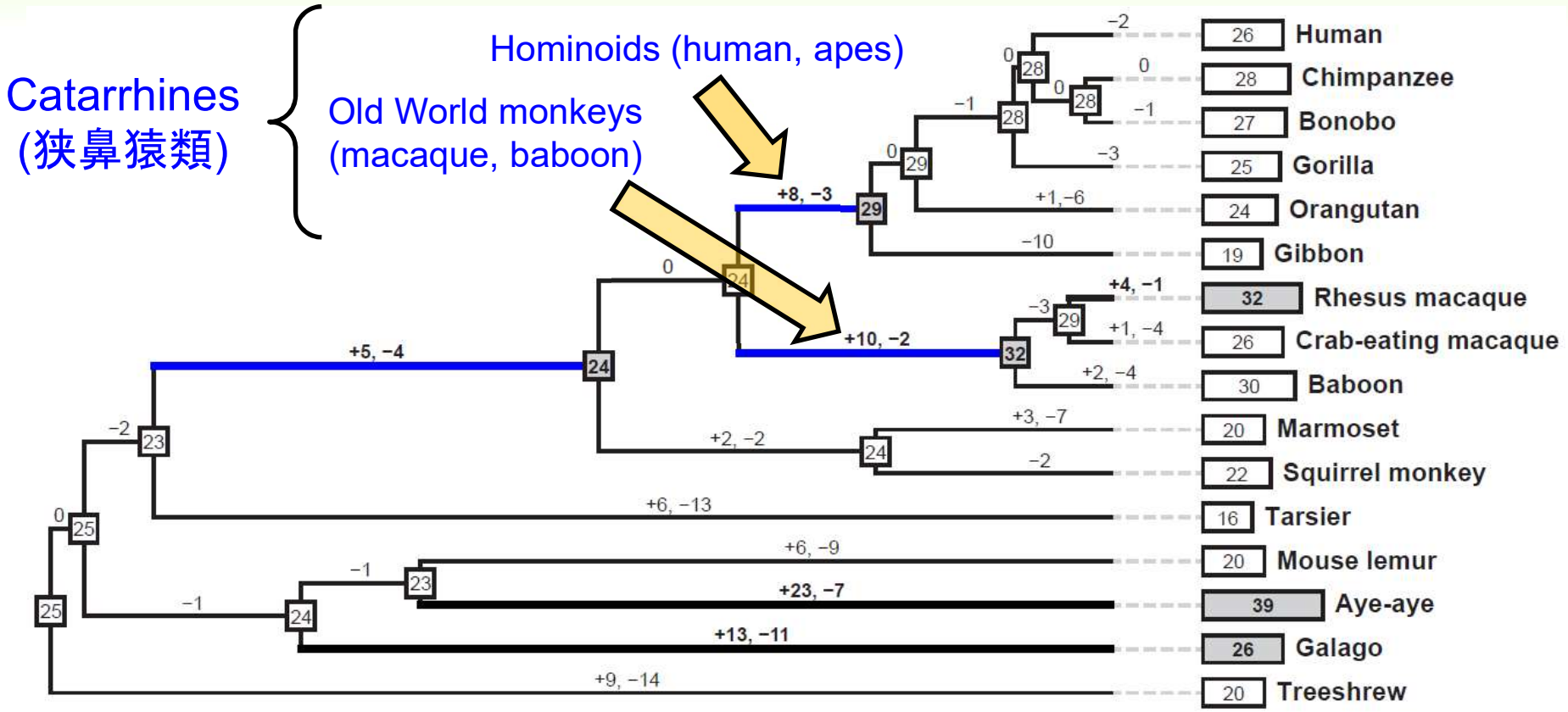
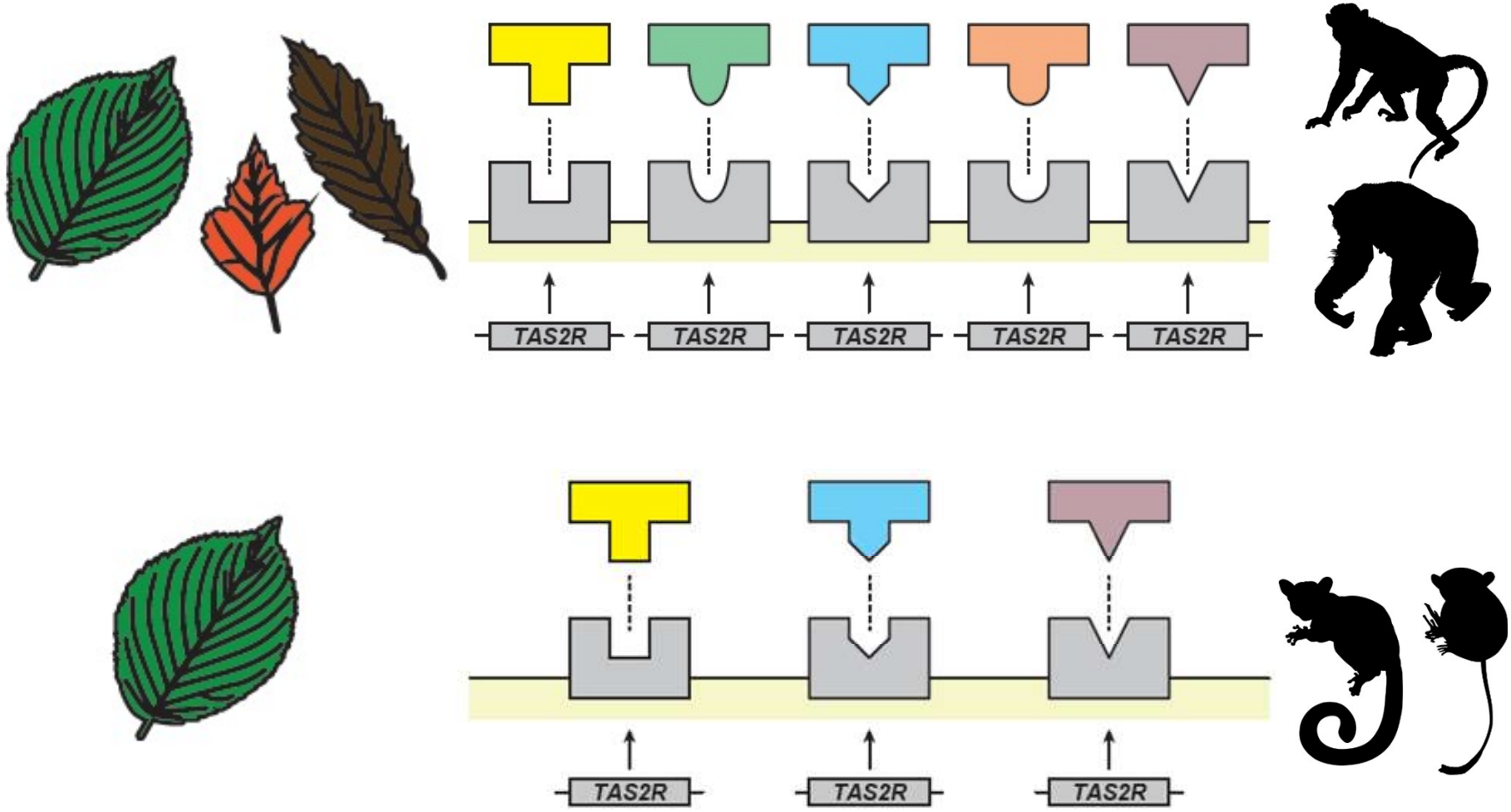
Alignment of two *TAS2R* gene sequences

Plant eaters have large *TAS2R* repertoires: adaptation to toxins of plant diet



- ✓ **Vertebrate-wide**: Li and Zhang 2014 *MBE*
- ✓ **Primates**: Hayakawa et al. 2014 *MBE*
- ✓ **Birds**: Wang and Zhao 2015 *GBE*
- ✓ **Laurasiatherian mammals**: Liu et al. 2016 *Frontiers in Zoology*
- ✓ **Reptiles**: Zhong et al. 2017 *PeerJ*

The number of *TAS2R* genes account for recognizable repertoire of poisons



To be continued:
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