

Are there enough Honey Bees for Sustainable Food Production?

Robin Crewe

Social Insects Research Group

Department of Zoology and Entomology



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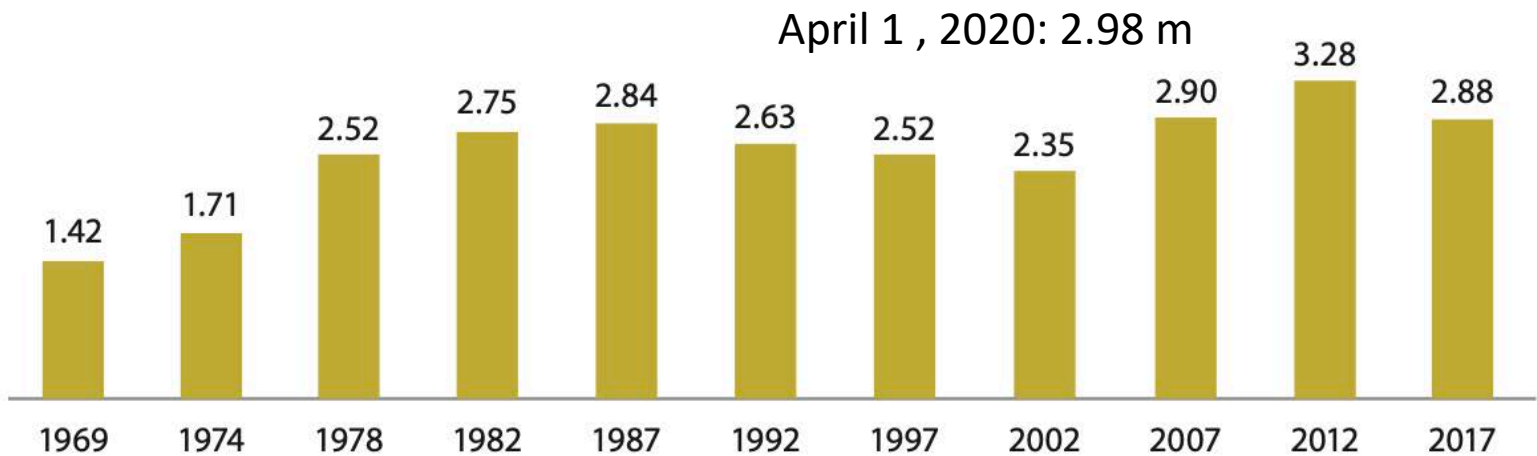


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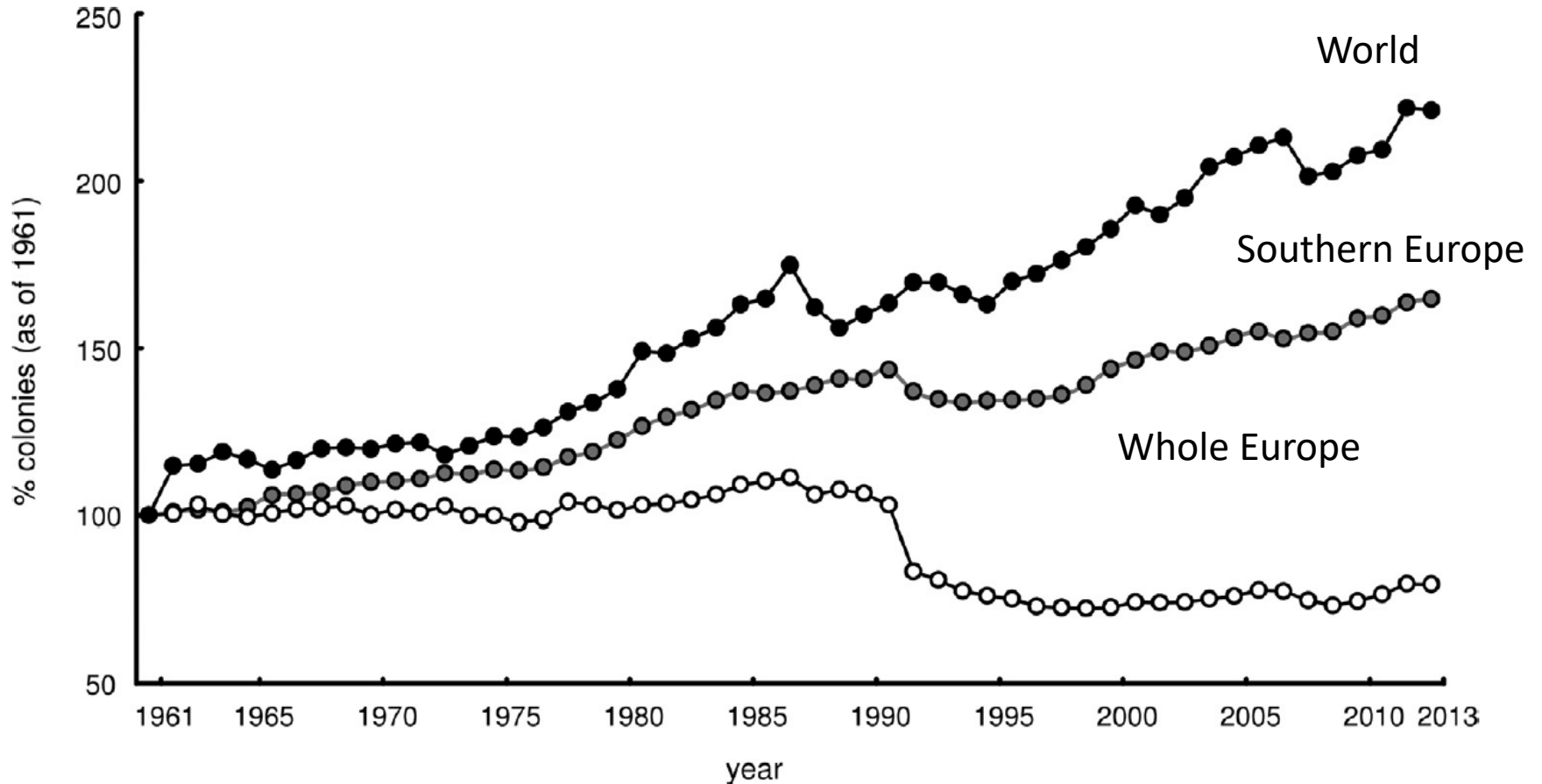
Fig. 1. U.S. Honey Bee Colonies, various years, 1969 – 2017 (million)



Source: USDA NASS, Census of Agriculture (various years, 1969-2017).

Almond pollination in California requires 2.5 million colonies annually

Decline in managed bee colonies?-FAO data



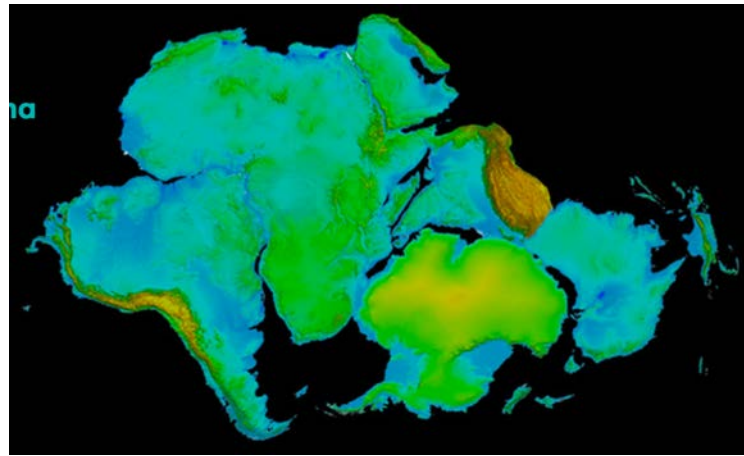
What did the world looked like before bees



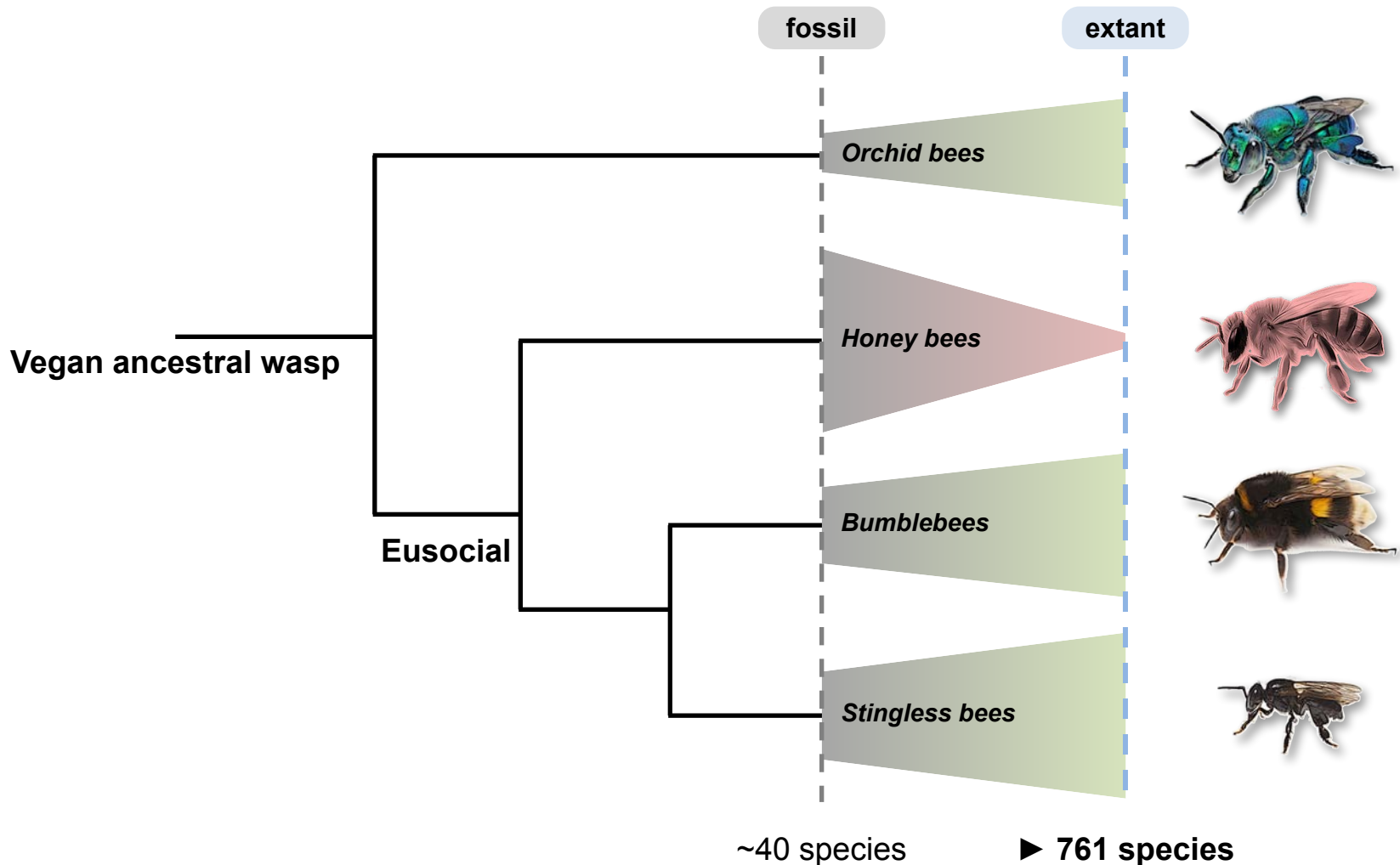
Origins of Bees

The early Cretaceous era (145-113 mya) when flowering plants and their associated bees emerged for the first time.

Collaboration between evolving flowering plants and early bee species started in the relatively dry regions of Western Gondwana some 120 million years ago



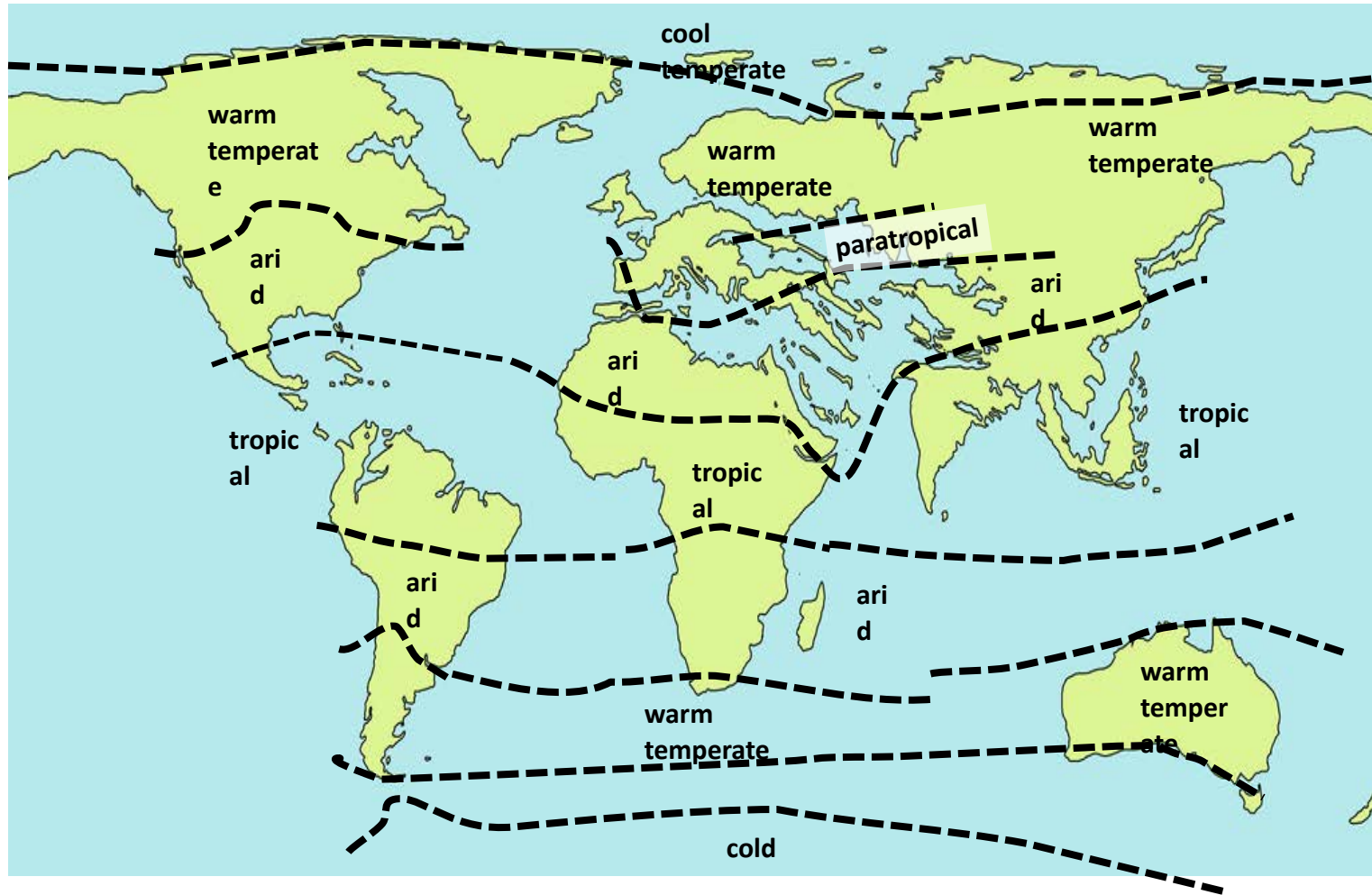
Relationship between Fossil Apid bees and contemporary species



Oldest fossil *social* bee worker –stingless bee -60 Mya (Engel, 2000)



Oligocene climates- 34 -23 mya



Boucot, A. J., Chen Xu, & Scotese, C. R. (2013). Phanerozoic Paleoclimate: An Atlas of Lithologic Indicators of Climate, SEPM Concepts in Sedimentology and Paleontology, (Print-on-Demand Version), No. 11, 478 p, ISBN 978-1-56576-289-3, October 2013, Society for Sedimentary Geology, Tulsa, OK.

Nesting types of honey bees

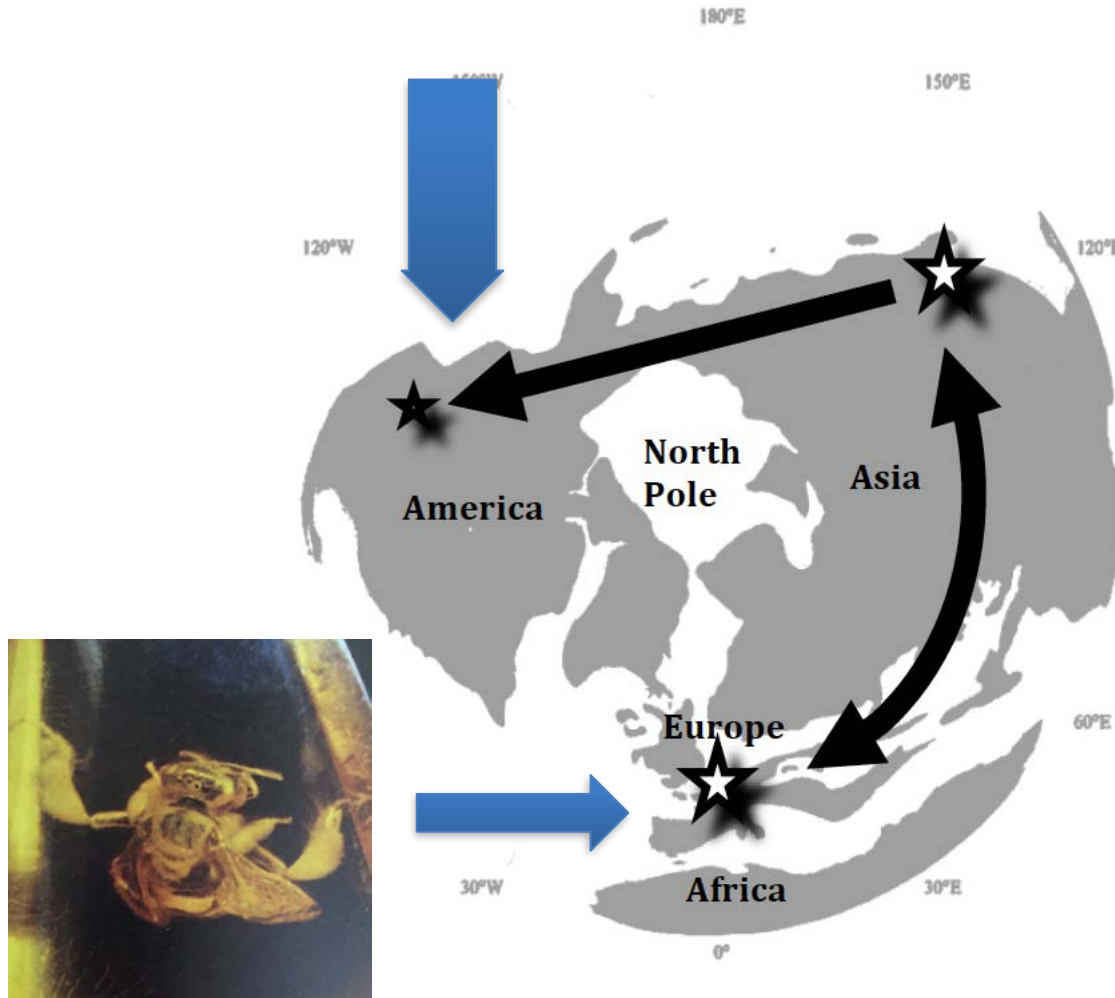


Single comb
Open nest species
Dwarf & giant species

Multiple combs
Cavity nesting species
Intermediate size



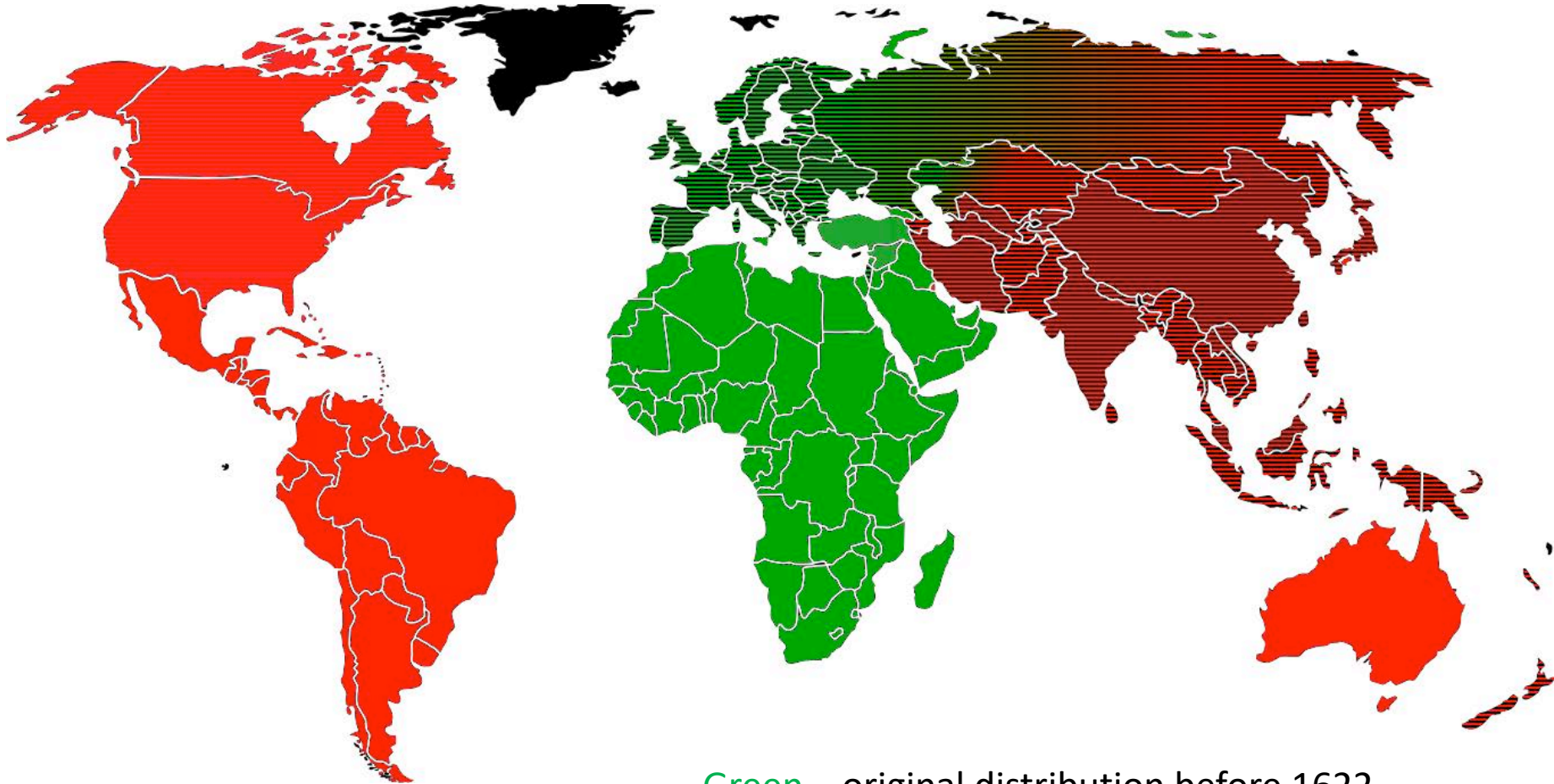
Honey bee extinction



White Stars indicate fossil worker bees in amber

SPECIES	LOCATION	NEST TYPE	WORKER SIZE
<i>Apis florea</i>	Arabian peninsula to South East Asia and China	Exposed comb	Dwarf bees
<i>A. adreniformis</i>	South East Asia and China	Exposed comb	Dwarf bees
<i>A. dorsata</i>	India to South-east Asia	Exposed comb	Giant bees
<i>A. laboriosa</i>	India to Laos – high altitude	Exposed comb	Giant bees
<i>A. breviligula</i>	Philippines	Exposed comb	Giant bees
<i>A. binghami</i>	Sulawesi	Exposed comb	Giant bees
<i>A. cerana</i> Asian honey bee	Widespread in Asia	Cavity nesting	Intermediate size
<i>A. koschevnikovi</i>	Malay Peninsula, Borneo, Brunei, Java, Sabah, Sarawak, and Sumatra	Cavity nesting	Intermediate size
<i>A. nigrocincta</i>	Sulawesi	Cavity nesting	Intermediate size
<i>A. nuluensis</i>	Sabah	Cavity nesting	Intermediate size
<i>A. mellifera</i> Western honey bee	Europe, Africa and the middle East	Cavity nesting	Intermediate size

Current Global Western Honey bee Distribution

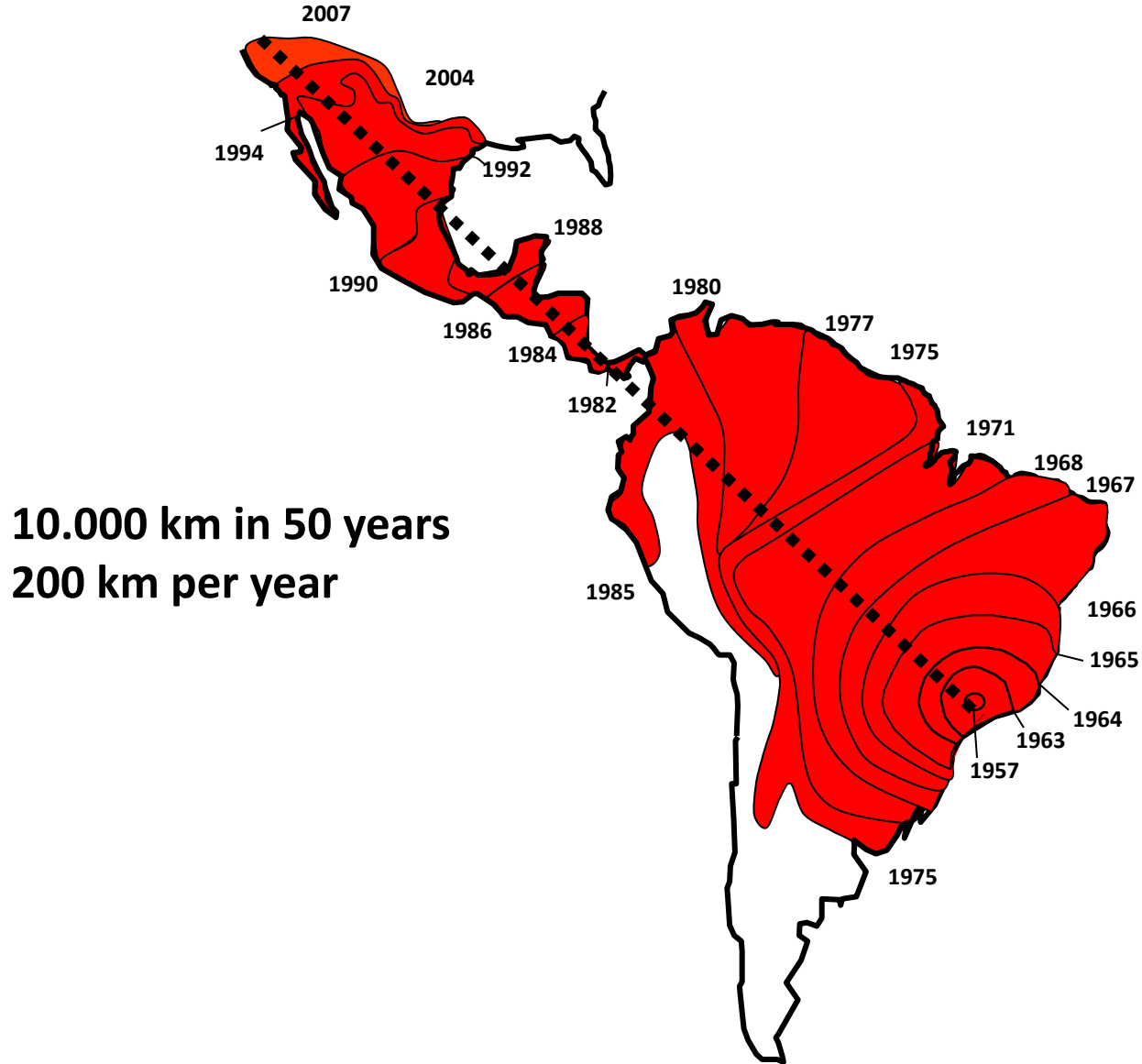


Green – original distribution before 1622

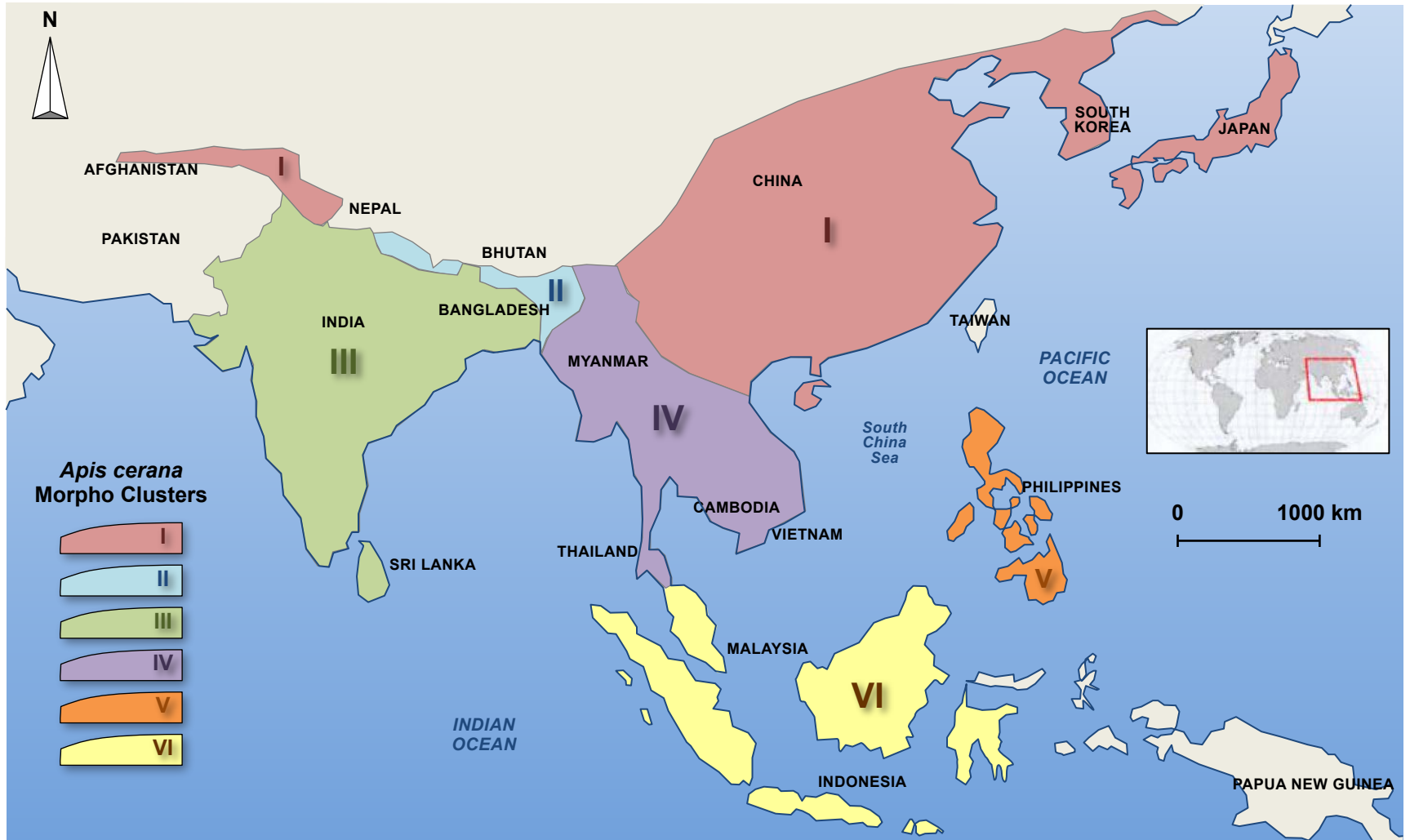
Red – Introduction by humans

Bars – predominantly managed

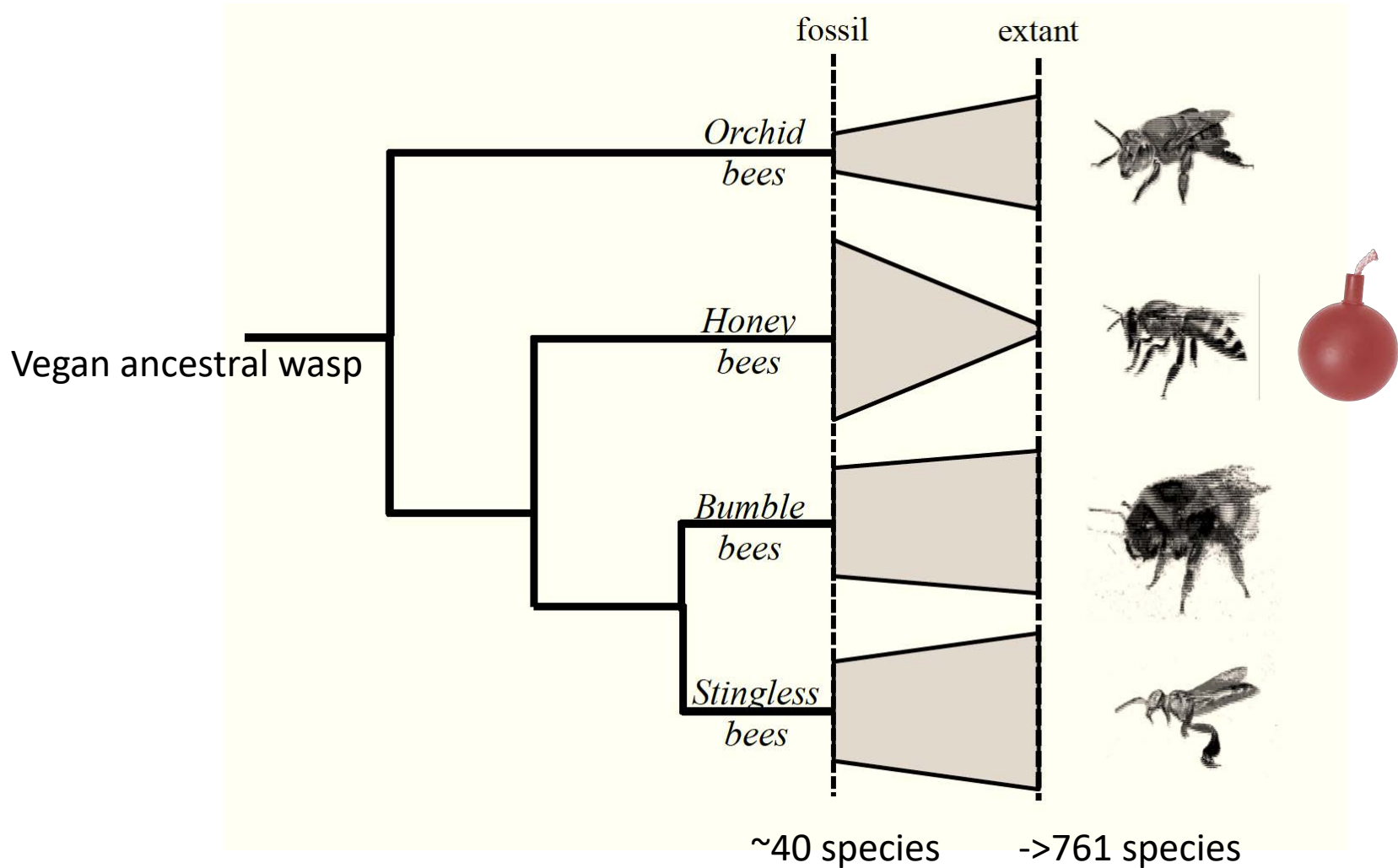




Distribution of *Apis cerana*



Relationship between Fossil bees and contemporary species



Provision of Pollination Services: dependent on a single bee species

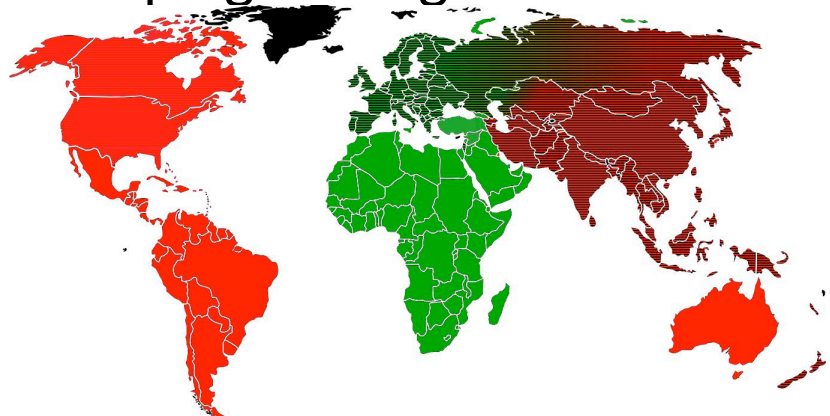
The Western honey bee

- Essential for productive industrialised agriculture
- Dependent on reliable supply of managed colonies of the western honey bee
- Dependent on a **sustainable source** of honey bee colonies



Source of honey bee colonies

- Either from wild (Africa, Europe or middle east) or feral populations (Americas, Australia)
- Influence of beekeepers – may be **colony multipliers** (Europe, North America, China, Australia/New Zealand) and/or **colony harvesters** (Africa, Central and South America)
- Sustainability is dependent on the management of these two kinds of beekeeping strategies



Responsible **colony harvesting** for industrial farming & rural development

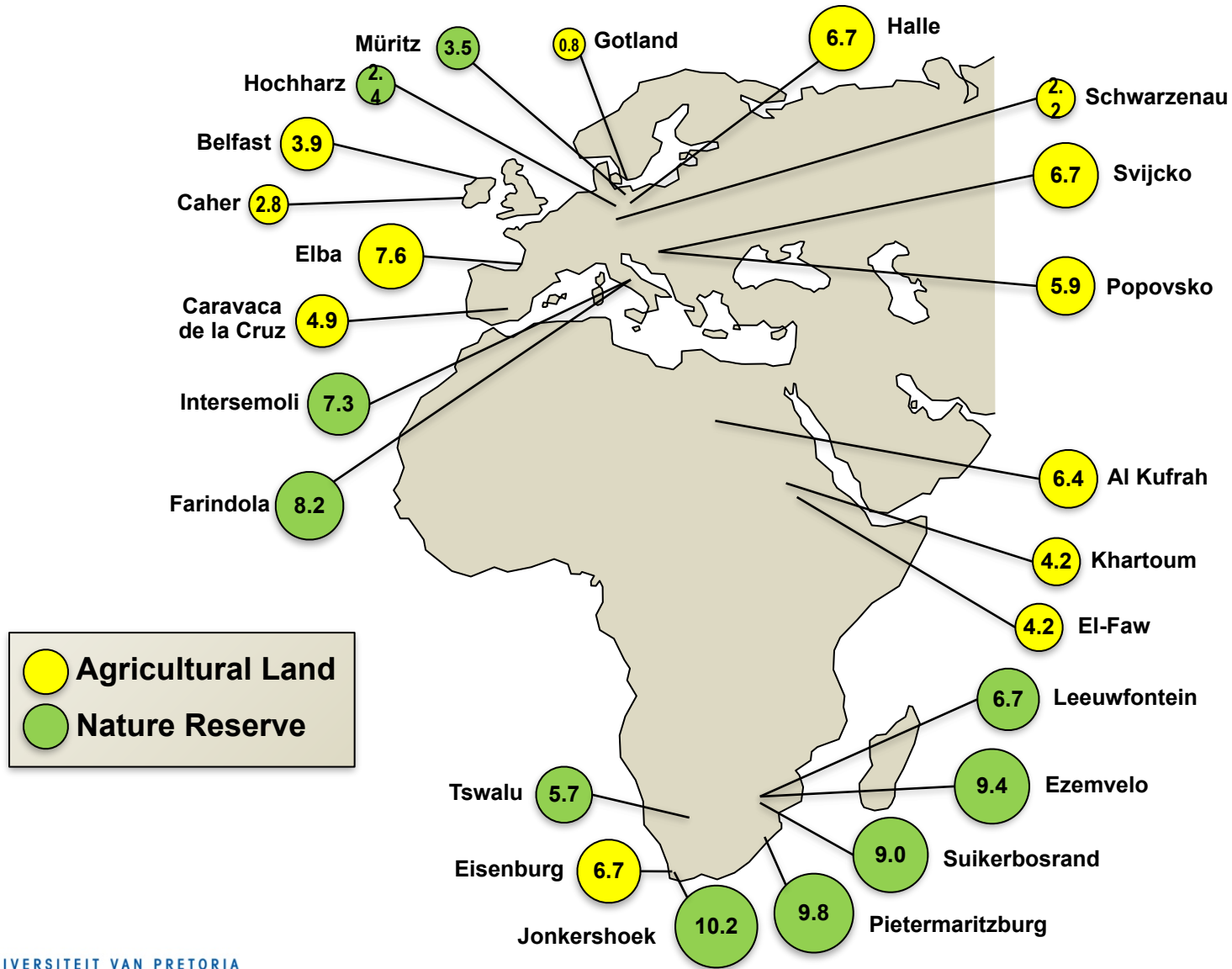
- ❖ Determine the size of the wild population.
- ❖ Variation in population size in relation to climate
- ❖ Determine safe levels of harvesting in various biomes
- ❖ Continuous monitoring of the state of the wild population to adjust harvesting levels.



Estimation of honey bee population densities

- Effective population size of social insects is determined by **number of colonies** which reflects number of reproductively active queens
- Finding and counting colonies is very difficult because they are cryptic –so alternative estimation methods required.
- Drone ‘trapping’ through virgin queens and analysis of their offspring.
- Direct drone trapping with Williams drone traps or UAVs

Colonies densities (per km²)



Ensuring an adequate supply of honey bees

- We know too little about colony density over large geographic areas.
- We know nothing about the fluctuation in colony numbers seasonally.
- Are there enough colonies to provide for scaling up agricultural production? Determined by # colonies + # beekeepers
- Effectively manage honey bee populations to ensure sustainable agricultural production

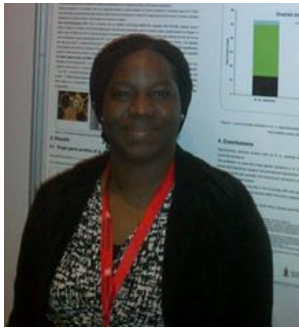
What is the FAO data NOT telling us?

- Pollination services do not get measured by national governments-measuring products and not services
- The number of colonies used in providing pollination services is not recorded.
- There is no current method for determining what the **pollination service deficit** will be in the future.
- Pollination services are a unique national requirement that must be provided locally.
Cannot be solved by importation



Members of the Social Insects Research Group

Ola Okosun



A. A. Yusuf



Hannelie Human



Fiona Mumoki



Christian Pirk



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