



NEW INSIGHTS ON THE GENETIC DIVERSITY OF THE HONEYBEE PARASITE *NOSEMA CERANAE*



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Team Hosts-Parasites Interactions

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Nosema ceranae

- *Microsporidia* (fungi)
- Obligate intracellular parasites
- Invade the epithelial cells of honeybee midgut
- Highly resistant extracellular stage: the spore
- Specific infection tool: the Polar Tube



Impact of *Nosema ceranae*?



High mortality



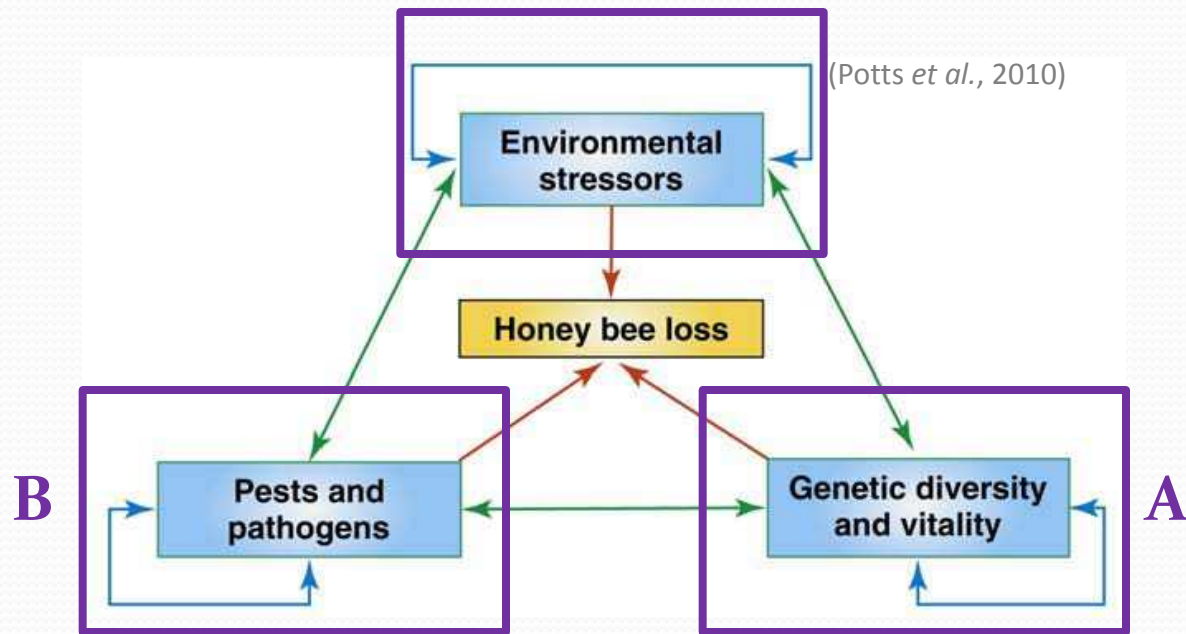
No higher mortality

No symptoms detected

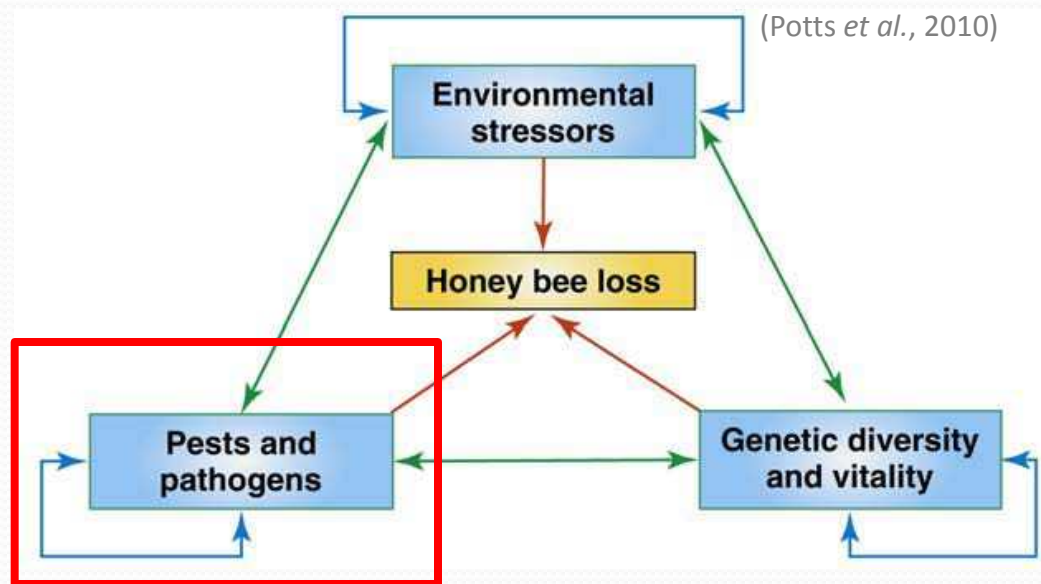
=> Variable virulence <=

Possible origin of the variable virulence

C



Possible origin of the variable virulence



Are there several variants of *N. ceranae* with different levels of virulence?

Study's objective

Is it possible to discriminate taxa of *Nosema ceranae* using molecular tools (genotyping)?

Strategy for genotyping

- Genetic marker
 - rDNA – protein encoding genes
 - *Multilocus*
- Isolate definition
 - One **isolate** = one bee
- Intra-isolate diversity



Experimental procedure

1 isolate
= 1 bee

= 4
N. ceranae
populations

Isolate A



Isolate B

4 distant
locations



10
genetic
markers

8 to 15 clones
sequenced

ATCGGTCGATTATGCTCGATGCA
AA**A**CGGTCGATTACGCTCGATGCA
ATCGGTCGATTATGCTCGATGCA
ATCGGTCGATTACGCTCGATGCA
AT**C**CGTCGATTACGCTCGATGCA

Intra-isolate A
diversity

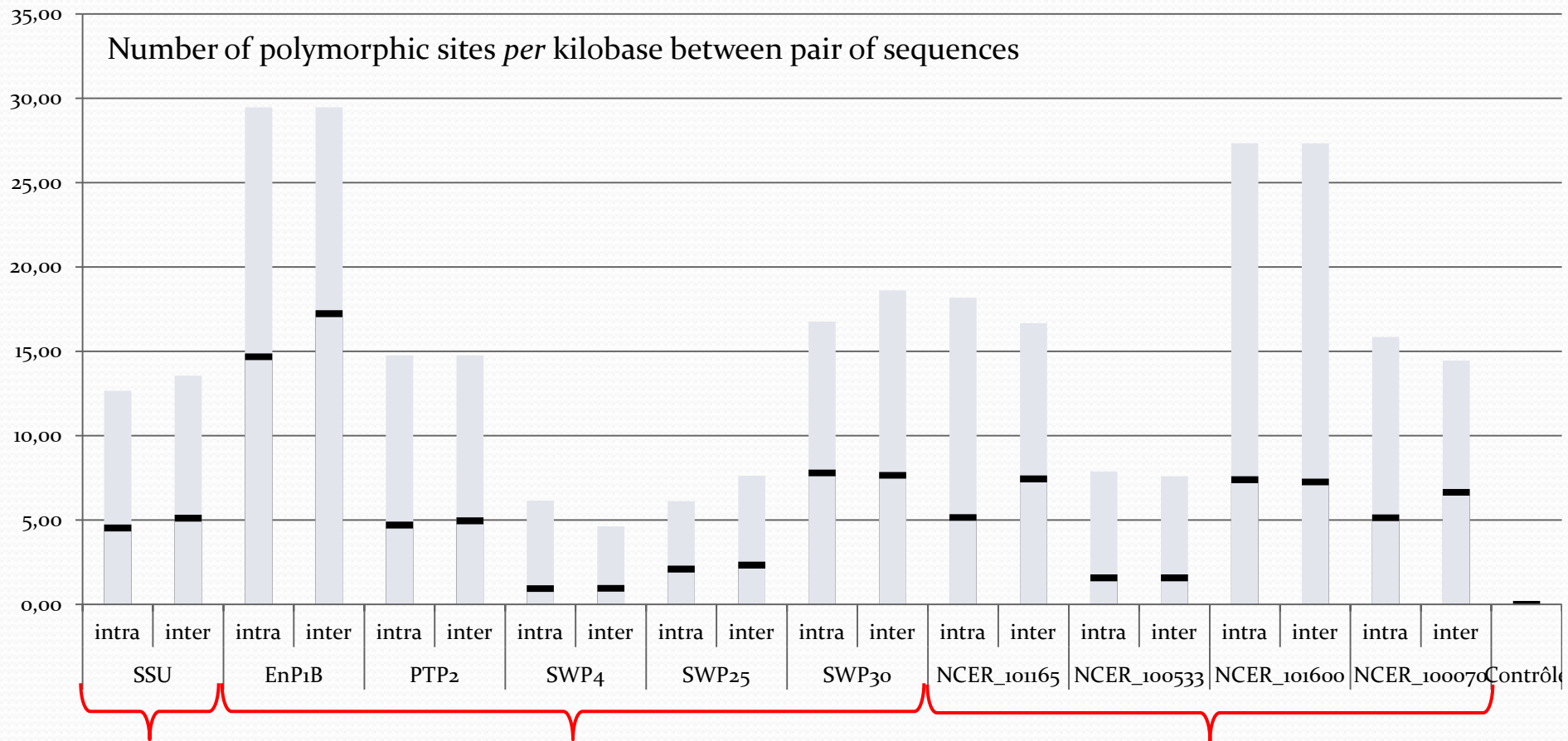


Inter-isolate
diversity

ATCGGTCGATTAG**G**GCTCGATGCA
ATCG**G**GCGATTAG**G**GCTCGA**A**GCA
ATCGGTCGATTAG**G**GCTCGATGCA
ATCGGTCGATTAG**G**GCTCGATGCA
ATCGGTCGATTAG**G**GCTCGATCCA

Intra-isolate B
diversity

Molecular markers used



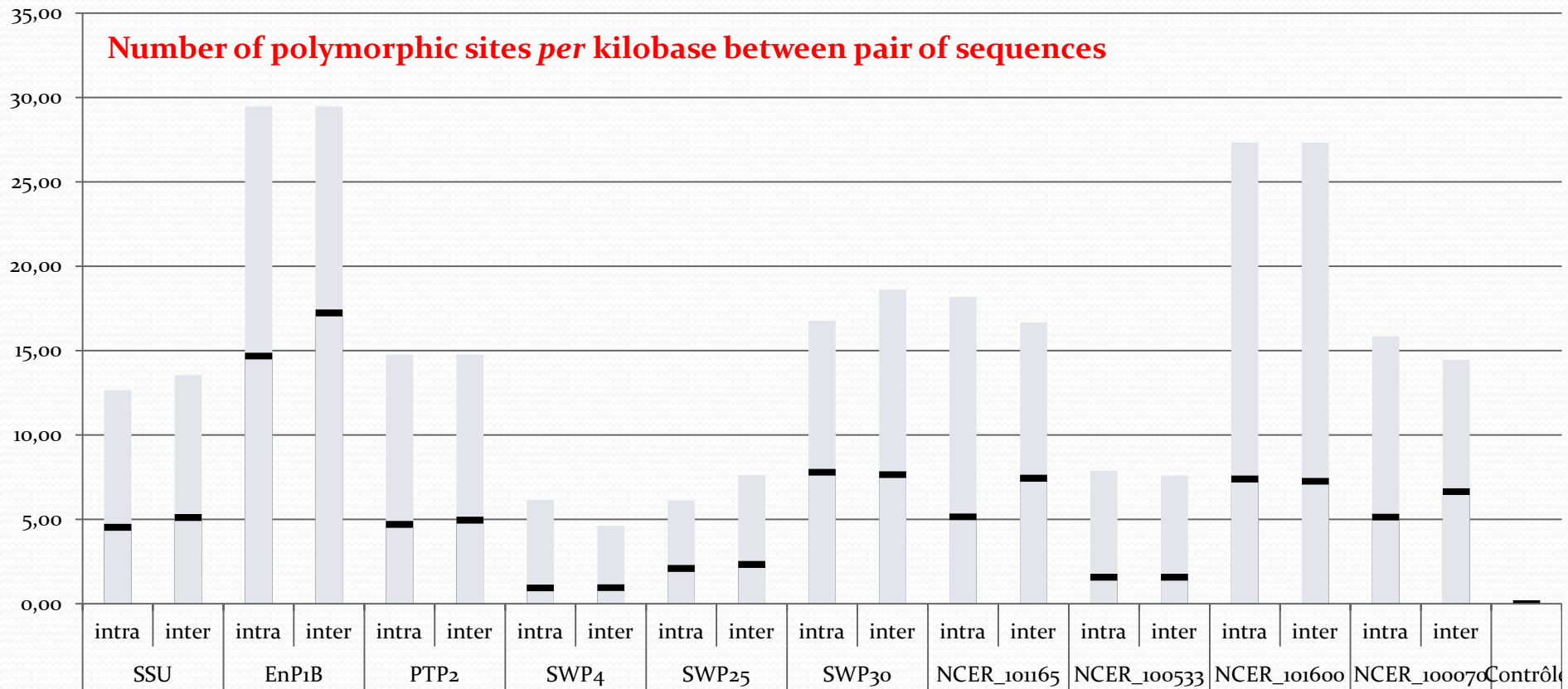
rDNA /

Protein encoding genes

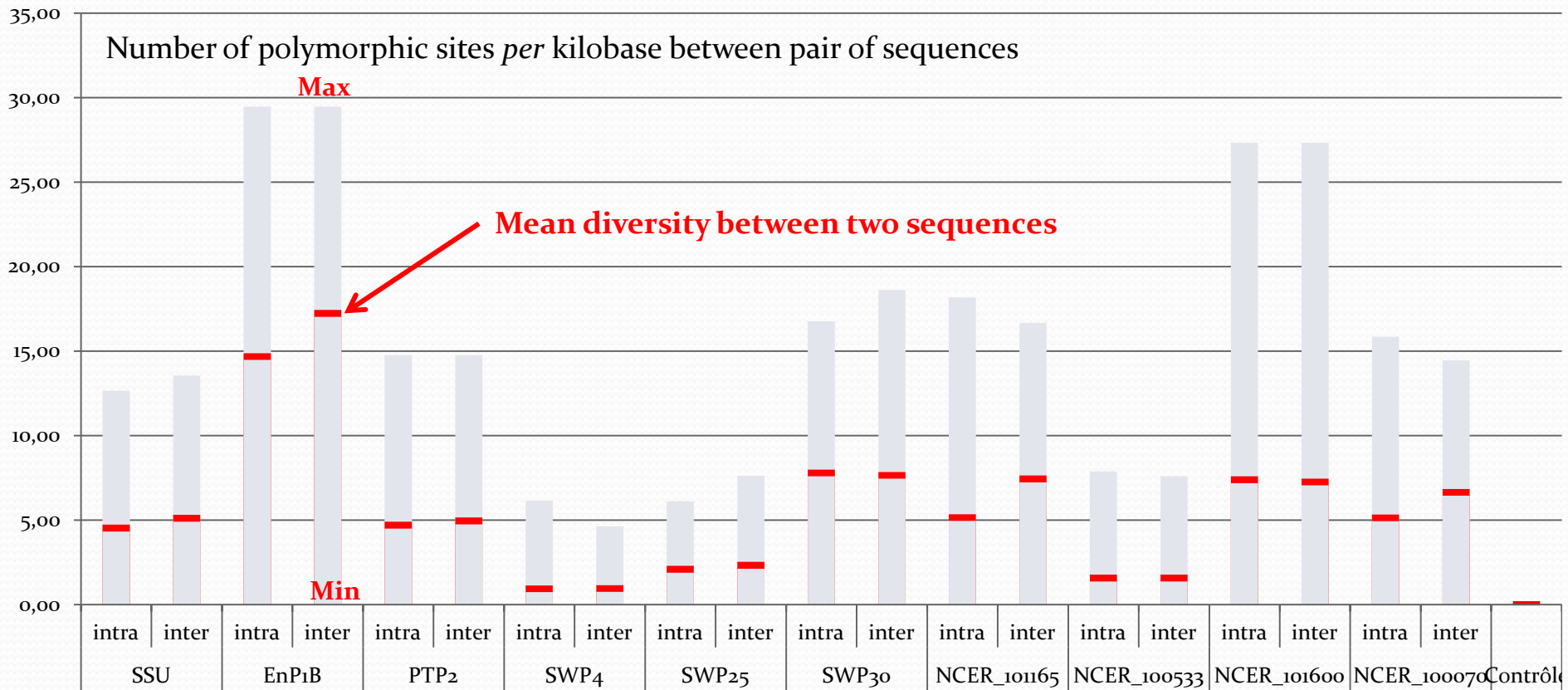
/ Unknown function genetic markers

Genetic diversity

Number of polymorphic sites per kilobase between pair of sequences

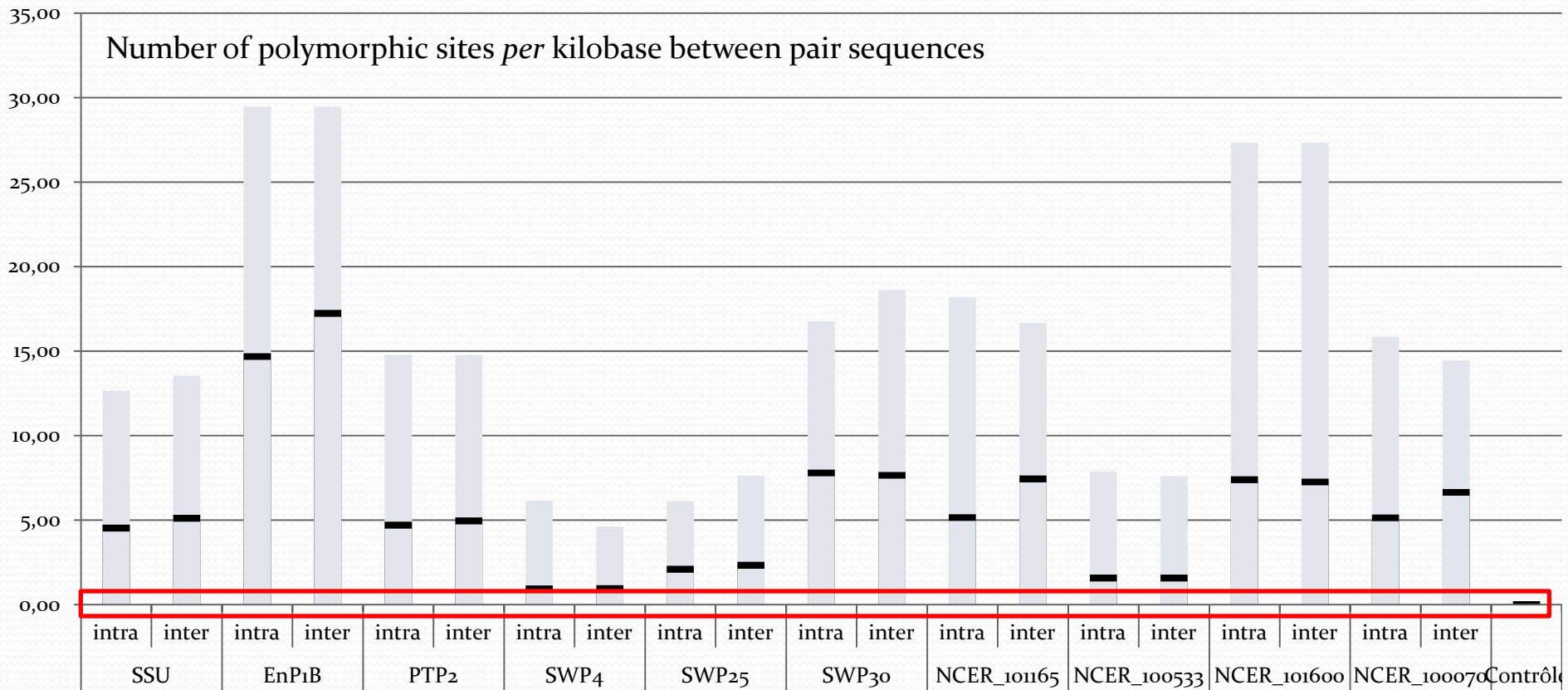


Genetic diversity



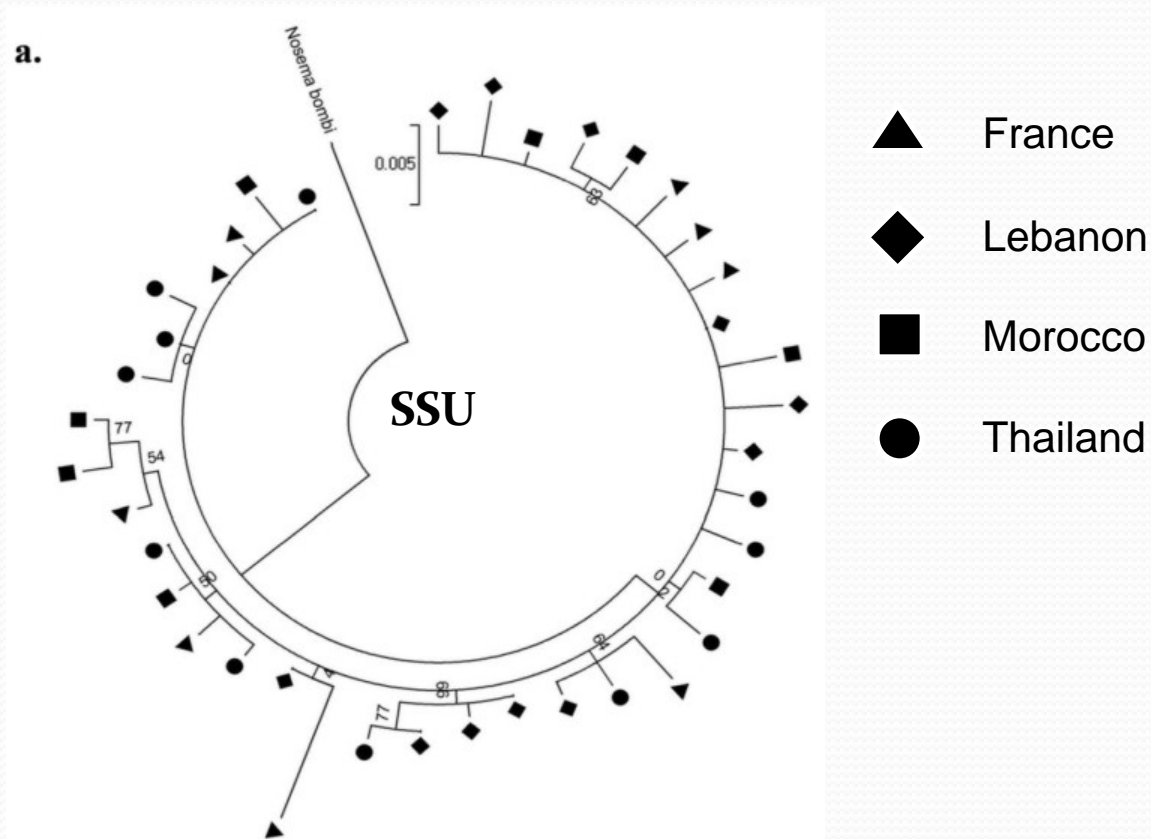
As much diversity within one bee as between two different bees

Genetic diversity



There are identical alleles in different bees

Phylogenetic analyses

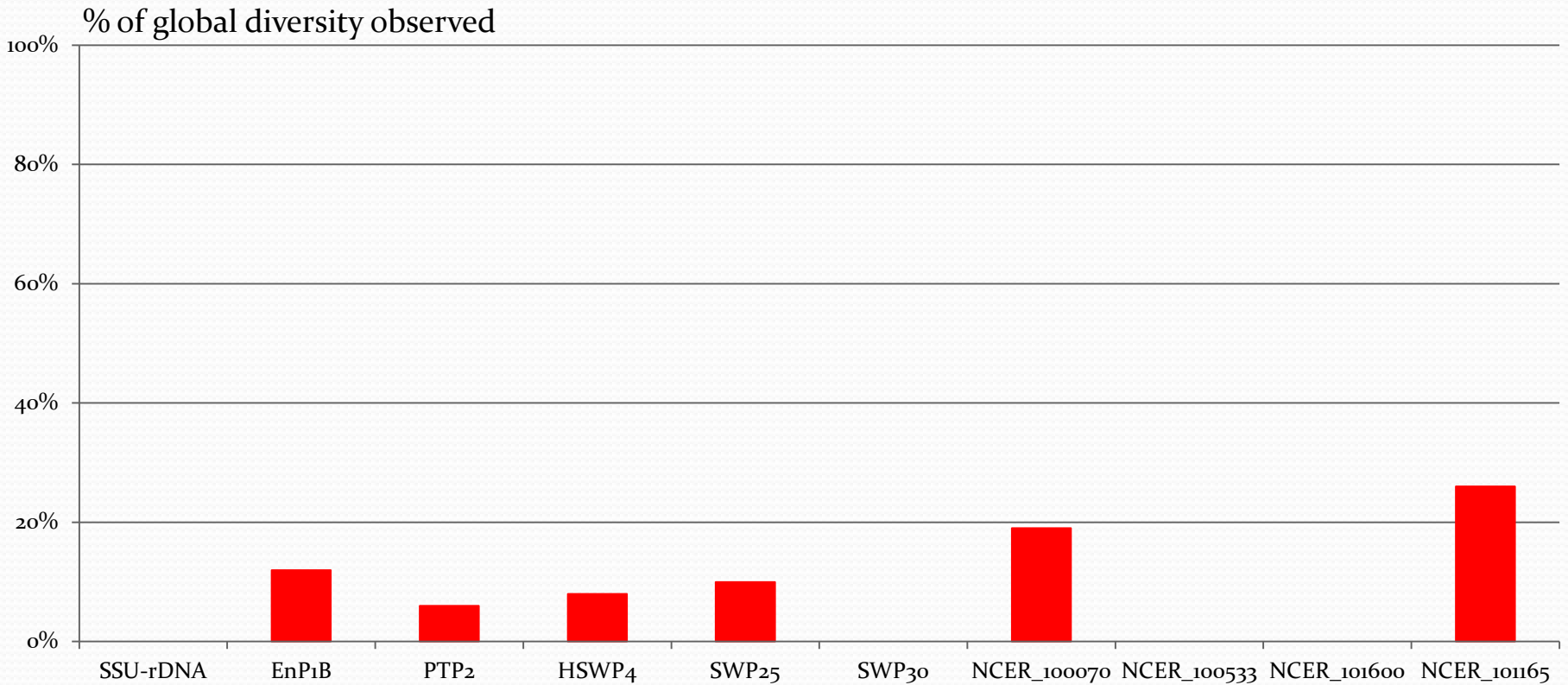


No isolate-specific taxon

Conclusions

- Genetic diversity precludes any variant differentiation

Genetic diversity statistics



Between-isolate diversity has a low weight in the global diversity

=> No divergence : similar population in isolates

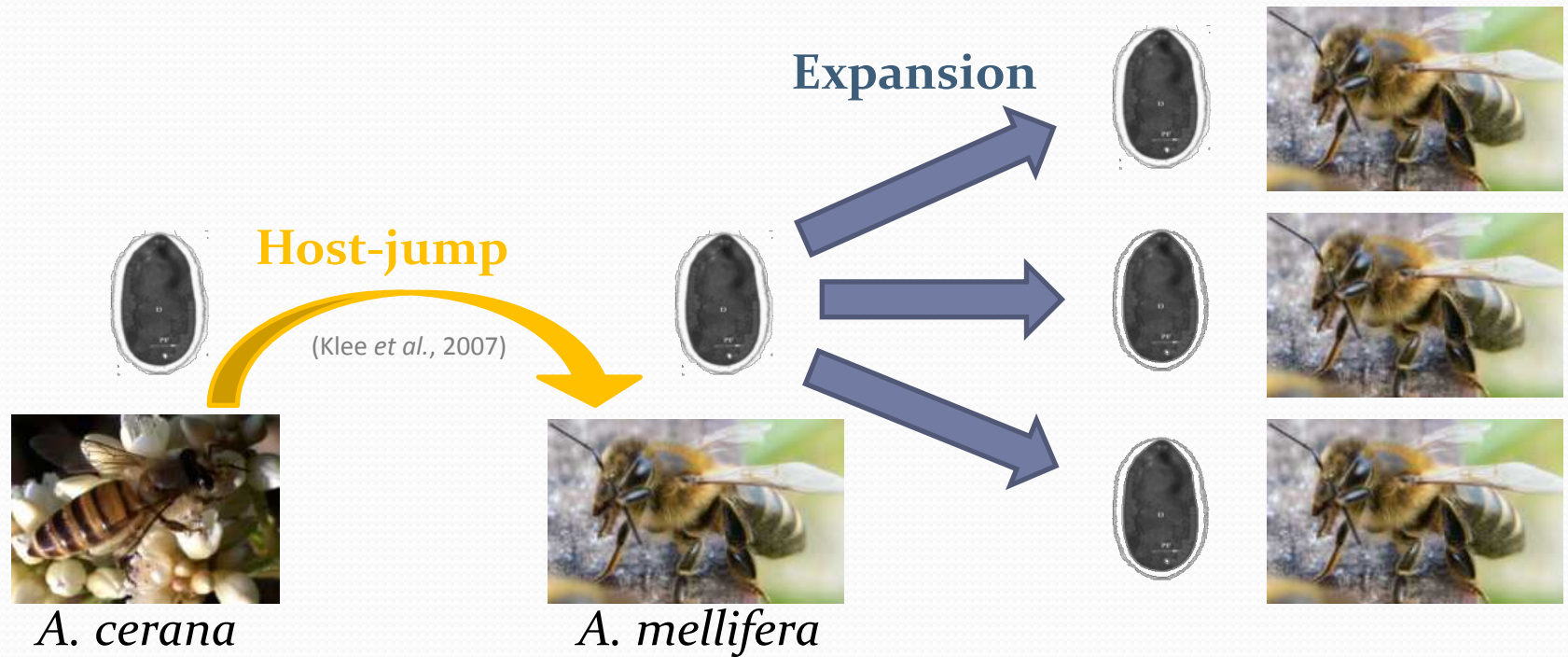
Conclusions

- Genetic diversity precludes any variant differentiation
- No divergence between populations from the 4 locations sampled

=> Same population of *N. ceranae* worldwide ?

Discussion

- Evolutionary tests



Related article

New insights on the genetic diversity of the honeybee parasite
Nosema ceranae based on *multilocus* sequence analysis

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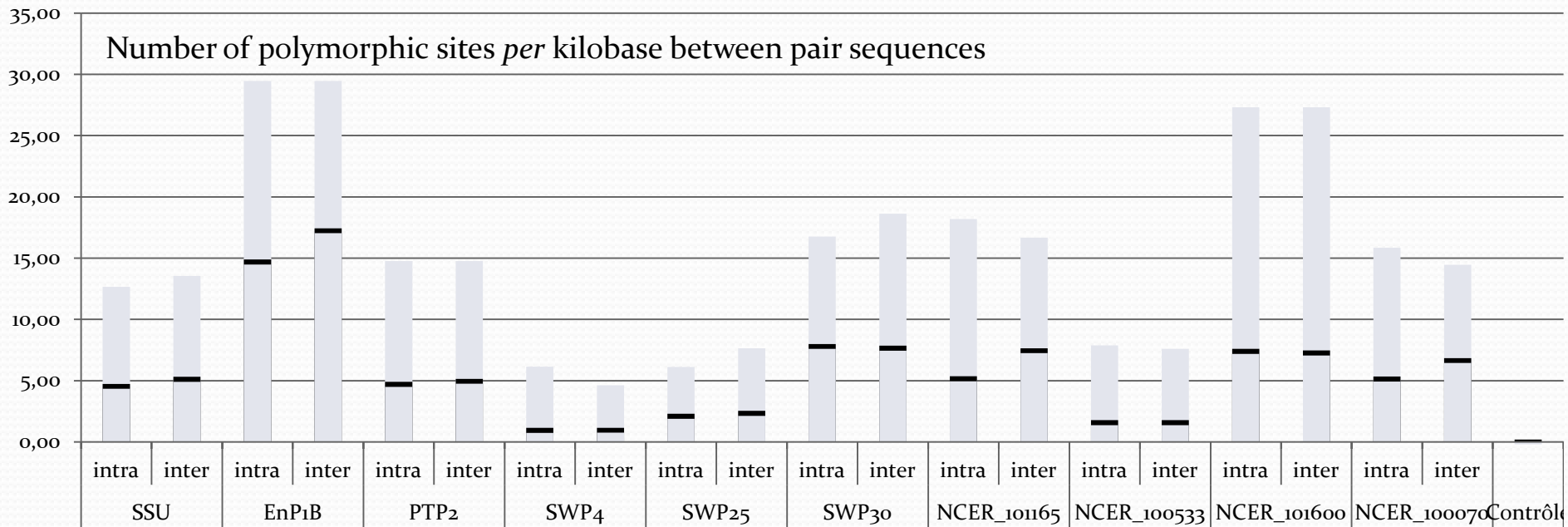
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(Received 25 February 2013; revised 23 May and 7 June 2013; accepted 8 June 2013; first published online 23 July 2013)

Parasitology: (2013), 140, 1346–1356.

Genetic diversity



Marker	SSU-rDNA	EnP1B	PTP2	HSWP4	SWP25	SWP30	NCER_100070	NCER_100533	NCER_101600	NCER_101165
Nb of sequences	39	41	44	42	39	42	40	37	59	44
Nb of alleles	37 (95%)	33 (80%)	22 (50%)	13 (31%)	20 (50%)	25 (59%)	22 (55%)	14 (38%)	27 (46%)	25 (57%)
Variable sites	66	56	26	14	23	35	23	18	48	31
Singleton variable sites	55 (83%)	24 (43%)	22 (85%)	14 (100%)	22 (96%)	28 (80%)	16 (70%)	17 (94%)	31 (65%)	24 (77%)

Thanks for your attention

Looking for a post-doctoral position!



Apiary in Aubière