DNA Barcoding of ants from the Galápagos: searching native and introduced species

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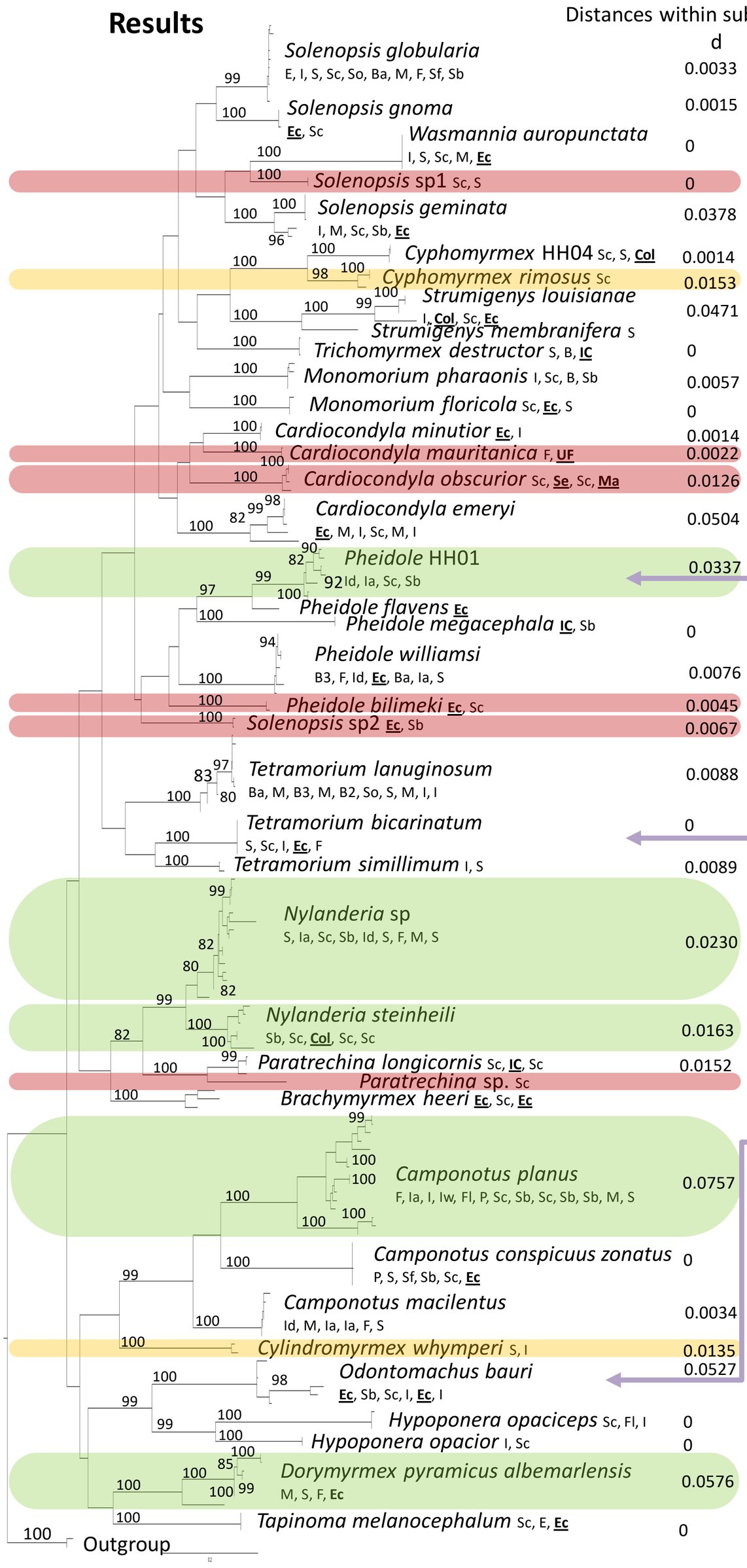
Abstract

Until now **50 ant species** have been recorded from the Galápagos Archipelago. Yet, for 26 of them it is still unclear if they are native to the Galápagos. This uncertainty is due to the fact that the ant fauna of mainland South America is too poorly known to unequivocally infer the status of species in the Galápagos. Here we explore the possibility to use amounts of COI sequence variation (a DNA barcoding fragment) as an indicator to distinguish between introduced and native species.

For the presumed endemic species *C. planus, Dorymyrmex pyramicus albemarlensis* and *N. steinheili*, large intraspecific nucleotide diversity was observed that was structured according to island geography. We observed a similar pattern of variation for two species with an unknown status i.e. *Pheiodole* HH1 and *Nylanderia* sp., which suggests that these are **probably native species**. *Camponotus conspicuous zonatus, Pheidole megacephala, Hypoponera opacior, Hypoponera opacipes, Monomorium floricola, Cardiocondyla emery* and *Strumigenys louisianae*, showed no COI variation, which might indicate that they are **recently introduced species**.

Significance: Our results stress that future studies should include a sufficient number of distinct populations from the archipelago and from areas where the species are native to increase confidence in the status of a species. If these conditions are met, our initial results showed that COI may serve as an indicative tool to distinguish native from introduced species, even if mainland relatives are unknown. Nevertheless lack of variation within COI might also be caused by other factors than recent introduction and this will be discussed and illustrated.

Results



Discussion

Based on variation of COI:

Native :

- *Pheidole* HH01, *Nylanderia* sp, *Nylanderia steinheili*, *Dorymyrmex pyramicus albemarlensis* & *Camponotus planus*

Possible Native (not enough samples):

- *Cyphomyrmex rimosus* & *Cylindromyrmex whymperi*

New Records for Galapagos:

- *Solenopsis* sp1, *Solenopsis* sp2, *Cardiocondyla mauritanica, Cardiocondyla obscurior, Pheidole bilimeki* & *Paratrechina* sp.

Sufficient **variation in COI** can be an indication the species is **native.** If sequences of COI display a large distances within subpopulations (d>0.01) and if this variation **is island related**.

Example: *Pheidole* HH01 certain sites (volcano Alcedo vs volcano Darwin) or islands (Isabela, Santa Cruz and San Cristobal) cluster separately.

This is caused by **natural distribution** of species throughout the Galapagos archipelago and **random genetic drift** of COI-gene. This in contrast to **exotic species** which were relatively recent introductions who display **little to no variation of COI** (d ~ 0) between specimens collected on different islands.

Example: *Tetramorium bicarinatum* sequences (Santiago, Santa Cruz, Isabela, Fernandina and mainland Ecuador) are identical.

This species is a cosmopolitan species and a recent introduction to the Galapagos.

However! **Multiple introductions of specimens** from different source areas can cause confusion as different haplotypes can be introduced. A large divergence in COI (d>0.01) can be mimicked by introduction from multiple source areas.

Example: *Odontomachus bauri* sequences do not cluster by island (Isabela sequences have two separate clusters).

Though variation occurs random, sequences do not cluster by island as is the case for variation of species from endemic populations. This makes the distinction between exotic and native species and in return suggestions for conservation difficult.

Based on this analysis **6 new species** were recorded for Galapagos. Bringing the estimated total amount of recorded species to **56** !

Conclusion :

Exotic species are arriving at Galapagos at an alarming speed, in 2009 alone 9 new records were made. Hence there are **15 new species introductions in less than 10 years**! Status of species cannot always be correctly identified by use of COI-variation. These results stress the need for **continued monitoring** and correct species identification in Galapagos. This way potentially harmful species can be discovered and possibly eradicated.

ML Tree of ants collected from Galápagos and Ecuador, and some other countries

Galápagos Islands: Ba = Bartholomew, B2 = Beagle 2, B3 = Beagle 3, S = Santiago, E = Espanola, F = Fernandina, Fl = Floreana, I = Isabela (a:Alcedo-, d:Darwin-, w:Wolf- volcano), M = Marchena, P = Pinzon, Sb = San Cristobal, Sc = Santa Cruz, Sf = Santa Fe. **BLACK/BOLD and underlined=** Extracted from specimen collected in mainland Ecuador (**Ec** = Ecuador) or collected elsewhere or downloaded from BOLD (**Col** = Columbia, **IC** = Ivory Coast, **Se** = Seychelles, **UF** = USA Florida and **Ma** = Madagascar,)

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