Column

There's no such thing as a mite

Nicky Wybouw

All evolutionary biologists require a good understanding of the phylogenetic position and evolutionary history of their focal species in order to correctly interpret research findings but also to formulate interesting research questions. So, it is a bit hard to admit for someone who has been studying mites for the last seven years, but I only recently fully became aware of two important characteristics of mite phylogeny. First, I realised that, in fact, there is no such thing as a mite. As I was looking at a deep phylogenetic tree, it struck me that, from a systematic point of view, 'mite' is simply a convenient descriptive umbrella term and does not have biological meaning. Animals we refer to as mites do not descend from a single common ancestor and are only called mites because of a certain set of traits. Mites are specified by a six-legged larval stage, a non-segmented body plan, and, well, a minute size. Despite these strict phenotypical criteria, mites are phylogenetically extremely diverse and are found in two superorders: Parasitiformes and Acariformes. Mites of the Parasitiformes lineage are spread over three orders (Opilioacarida, Holothyrida, and Mesostigmata) and have evolved an extremely wide variety of lifestyles and habitats. For instance, one genus of parasitiform mites, Dicrocheles, is only found in the ears of noctuid moths where it feeds on haemolymph. Gamasellus racovitzai, on the other hand, hunts springtails in maritime Antarctica. Mites of the Acariformes superorder can be found in two speciose orders, Trombidiformes (Prostigmata and Endeostigmata) and Sarcoptiformes, that date back to the Devonian period, 410 million years ago. Acariform mites likewise display a high diversity of lifestyles and habitats but have, in contrast to the Parasitiformes lineage, also successfully evolved phytophagy at various time points during their evolution. It is thus highly probable that any mite you find eating from your precious vegetables, fruit, or ornamental plants belongs to the Acariformes superorder.

Now that everyone is a bit more familiar with mite phylogeny and natural history, let us address the issue at hand. Mites are not a monophyletic taxon because, in addition to mite species, the Parasitiformes superorder also houses the tick group (or Ixodida) of approximately 1,000 species. All ticks are highly specialised blood feeders and have evolved a unique hypostome (feeding structure) with backward-pointing teeth. After cutting into their host's skin, ticks use this harpoon to anchor themselves to their hosts. The parasitiform mites are thus more closely related to the diverse group of blood thirsty ticks than to the mite species of the Acariformes lineage, making mites a paraphyletic collection of taxa. Moreover, molecular and morphological phylogenetics indicate that the superorders Acariformes and Parasitiformes might not even be related. This indicates that the set of traits that defines a mite has evolutionary independent origins. It would be similar as lumping bats and birds to a single descriptive category, simply because both bats and birds use wings to fly. For sake of clarity, allow me to continue to use the descriptive term mites to outline a second important feature of mite phylogeny.

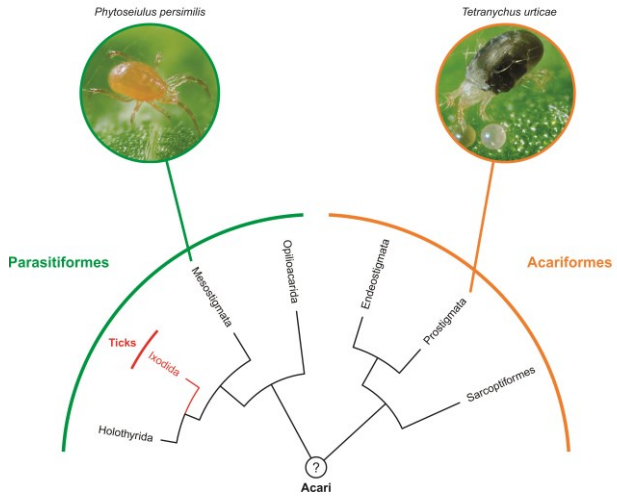

Fig 1. Mite phylogeny, depicting the major taxa in the Acariformes and Parasitiformes superorders. It is still debated whether the Acari have a diphyletic or monophyletic origin. Ticks are embedded within the parasitiform mite group. Photos depict a phytophagous adult female *Tetranychus urticae* with two eggs, and a predatory adult *Phytoseiulus persimilis,* © Jan van Arkel.

Fig. 1. Fylogenie van mijten, voorspelt de belangrijkste taxa binnen de Acariformes and Parasitiformes superordes. Er wordt nog steeds gedebatteerd of de Acari een difyletische of monofyletische oorsprong hebben. Teken worden ondergebracht in de parasitiforme mijtgroep. Foto's tonen een fytofaag volwassen vrouwelijke *Tetranychus urticae* met twee eieren, en een predatorische volwassen *Phytoseiulus persimilis,* © Jan van Arkel.

Fig 1. Phylogénie des acariens, illustrant les principaux taxons des superordres des Acariformes et des Parasitiformes. On discute encore si les Acari ont une origine diphylétique ou monophylétique. Les tiques sont intégrées au groupe des acariens parasitiform. Les photos représentent une femelle adulte phytophage *Tetranychus urticae* avec deux œufs et un adulte prédateur *Phytoseiulus persimilis,* © Jan van Arkel.

The Parasitiformes and Acariformes superorders are very species rich and hold well over 10,000 and 40,000 species, respectively. Even though the catalogued mite diversity is already astonishingly high, the great majority of mite species still crawls about in total obscurity. This dawned on me while browsing through the monograph of Fisher *et al*., 2017 Zookeys. Using a combination of morphological and molecular techniques, Fisher and co-authors discovered 66 (!) new water mite species of the Torrenticola genus across the North American continent. Mites: Ecology, Evolution & Behaviour, one of the acarologist bibles and written by D.E. Walter and H. C. Proctor, informed me that, today, we have only identified approximately 5 % of the true mite species richness, which is estimated to be near 1,000,000 species.

The set of mite traits has been a great evolutionary success and has allowed mites to adapt to almost any imaginable habitat in great diversity. I have had the pleasure of encountering some of this rich biodiversity firsthand during fieldwork.

My research focuses on mites that make their home on plants and most plants I sample in the field are the host of populations of multiple mite species. For example, from one small Vicia plant, barely 25 cm high, I identified populations of four plant-feeding mites (Bryobia, Petrobia, a tarsonemid and an eriophyid mite) and two predatory mite species, both with a vibrant red colouration. The Walter & Proctor bible assures me that the soil mite community is even richer, and a quick literature survey showed that over ten new soil mite species have been discovered and described in 2018 alone. With all this unexplored mite biodiversity and natural history, I urge fellow biologists to also take an interest in mites and include these speciose and fascinating groups in their studies.

References

Fisher J. R., Fisher D.M., Skvarla M.J., Nelson W.A. & Dowling A.P.G. 2017.Revision of torrent mites (Parasitengona, Torrenticolidae, Torrenticola) of the United States and Canada: 90 descriptions, molecular phylogenetics, and a key to species. – *ZooKeys* **701**: 1.

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