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MITES ON WARM-SEASON TURFGRASSES IN AUSTRALIA: THE FAIRIES AT THE BOTTOM OF THE GARDEN?

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Introduction

Mites have been identified as a significant pest of warm-season turfgrasses around the world for over 70 years. However, because they are so tiny, mites are often dismissed as 'out of sight, out of mind' by Australian turf growers and facility managers who do not properly appreciate the full extent of damage caused by mites to their turf, to the point that they ignore these very problems.

For the turf farmer, slower extension of weak distorted lateral runners means that production fields take longer to grow in, lengthening the turn-around period from the harvest of one crop to the harvest of the next crop. Poor rooting ability is a common feature of mite-infested turf, which then leads to breakage of turf rolls and greater wastage during harvest. A common response by growers is to over-fertilise with N and to irrigate more to mask the damage being done by mites, but this also increases the environmental risk of losing excessive amounts of N through leaching and in run-off.

In other areas, notably recreational turf, mites can severely retard grass growth, which exacerbates wear damage by slowing recovery after heavy use. Poor rooting also reduces drought tolerance to the point where parks managers – unaware of the underlying cause of their problem - have been known to invest in expensive water crystal products of dubious or limited value. Mites transmit fungal and virus diseases and can also weaken the infested grass, pre-disposing it to secondary infections. For example, couchgrass summer decline has been diagnosed as being caused by a suite of ectotrophic root-infecting (ERI) fungi, but typically symptoms of mite damage are also present. In this context, anecdotal reports from experienced turf managers suggest that some turf diseases do seem to improve after spraying to control mites.

In Australia, the underlying assumption, based on overseas literature and some limited laboratory experience locally, has long been that mites of the family Eriophyidae are the main causal organisms of the distorted growth symptoms frequently seen and attributed to mite damage. The scientific literature related to turfgrass mites in Australia is almost non-existent, and commercial 'information' is based, usually erroneously, on USA experience with eriophyoid mites; and even then may include out-of-date and even mis-spelled and erroneous names for mites. The first step in rectifying this situation was to conduct a nationwide survey during 2010/11 funded by Horticulture Australia Ltd (Project#TU10002) using the Turf Levy and matched funds from the Australian Government to determine just what mites are present and on which warm-season turfgrasses in Australia.

What is a Mite?

Mites are not insects, although frequently studied along with insects by entomologists for the very practical reason that both groups include numerous pests of our cultivated plants and crops. Mites (subclass Acari) are arachnids (class Arachnida), a very large arthropod group that also includes spiders and ticks. Mites, however, are second only to the insects in terms of their diversity and number of species, with some 55,000 described species currently estimated to be only about 5% - a small fraction - of the 1 million or more mite species out there. But because mites are such tiny organisms (mostly <1 mm in length as adults, with many <0.25 mm), they

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are rarely seen without the aid of a microscope despite the very obvious damage (to the naked eye) that some species can cause.

Among the mites are a range of species that feed on plants, including turfgrasses. In Australia, warm-season turfgrasses are affected by plant-feeding (phytophagous) mites from four different families, which will be discussed below. These range from species that are highly specific in terms of their plant host through to others that can affect more than the one species of grass. All have very short life cycles, and can lay large numbers of eggs leading to rapid population increases particularly in hot dry weather which is conducive to their development.

In practice and for various practical reasons, identification of mite outbreaks is generally based on symptoms present rather than by direct examination of the mites under a microscope. Often, mites tend to be spread unevenly over an area, with 'hot spots' where infestations are greatest. Rather than being found in the older distorted growths, the mites may have moved on to fresher, younger growth perhaps showing little or no visible damage as yet. The numbers of plant-feeding mites can also wax and wane rapidly in response to predator populations and diseases than can affect mites.

TU10002 Survey Methodology

An Australia-wide survey was conducted under HAL project #10002 across 5 states and one territory during the 2010/11 growing season. A total of 119 samples were taken from turf production areas (40%), parks (30%), sporting venues (13%), research facilities (13%) and naturalised areas and submitted to Primary Industries NSW's laboratory in Orange for extraction and mite identification.

The grasses sampled included green couch (*Cynodon dactylon* and *Cynodon* hybrids - 44 samples), kikuyu grass (*Pennisetum clandestinum* - 26 samples), buffalo grass (*Stenotaphrum secundatum* - 16 samples), Zoysia grasses (*Zoysia japonica, Z. matrella, Z. pacifica*, *Z. japonica X pacifica* - 20 samples), blue couch (*Digitaria didactyla* - 3 samples), seashore paspalum (*Paspalum vaginatum* - 4 samples), marine couch (*Sporobolus* virginicus - 2 samples) and one sample from an associated weed grass species (*Digitaria sanguinalis*). The actual numbers of samples from each grass varied from state to state, depending on the mix of turfgrasses actually grown.

Because identification down to species level is a painstaking and time-consuming process, mites extracted from the samples collected were identified at this stage down to genus only for this base-line study. Differences in the associated symptoms were also recorded and photographed to develop a visual symptom-based guide to the type of mite present.

Australian Turfgrass Mites

There are 3 major groups of plant-feeding mites that affect warm-season turfgrasses in Australia. These come from the family Eriophyidae (super family Eriophyoidae - eriophyoid mites), the family Tetranychidae (spider mites), and the family Tenuipalpidae (false spider mites). Certain of these are quite specific and restricted to a particular host species or group, while others are found on a much wider range of grass species. The pest status of a fourth group, family Tarsonemidae (tarsonemid mites), is uncertain without further definitive work.

Grass Webbing Mites (Tetranychidae). Because of the distinctive protective webbing woven over the top of each colony (Plate 1), grass-webbing mites are the most immediately visible of the mites that affect turf grasses; however, they are also probably the least damaging. While not encountered or sampled during the survey, two native mite species (*Oligonychus araneum* and *Oligonychus digitatus*) have been recorded in Australia from a wide range of pasture and turf grasses, including green and blue couch, kikuyu and buffalo grass. Both mite species are often found together in the same infestation.

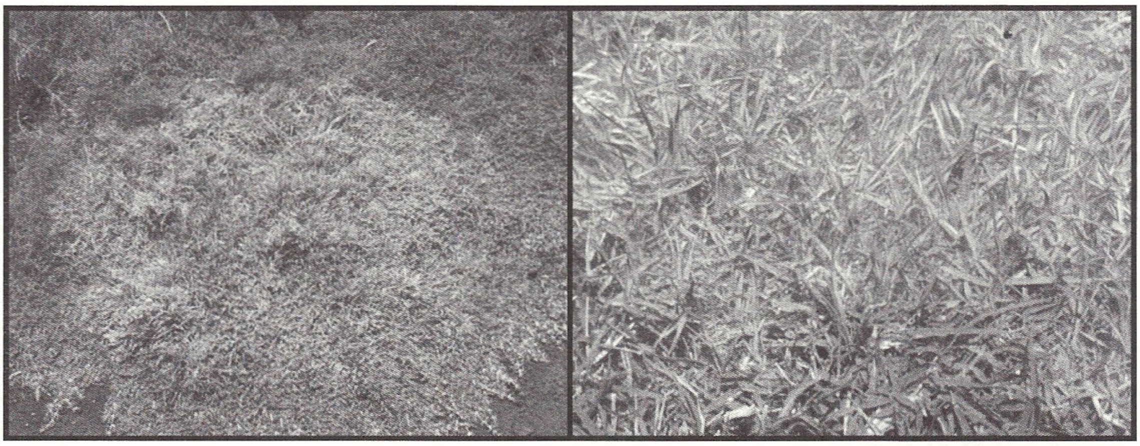

Plate 1. Infestation of grass-webbing mites on green couch, showing webbed colony roughly circular in outline (*left*) and close-up of webbing (*right*).

Eriophyoid Mites (Eriophyidae). These are tiny mites, mostly less than 200 µm (0.2 mm) in length as adults. All post-egg stages of eriophyoid mites have slim, worm-like, translucent bodies with only two pairs of legs (*cf.* 4 pairs of legs on adults from the other mite families) (Plate 2). Although slow-walking, eriophyoid mites can disperse for long distances on air currents or specific animal carriers; and after landing on a plant, they can distinguish between suitable and unsuitable hosts.

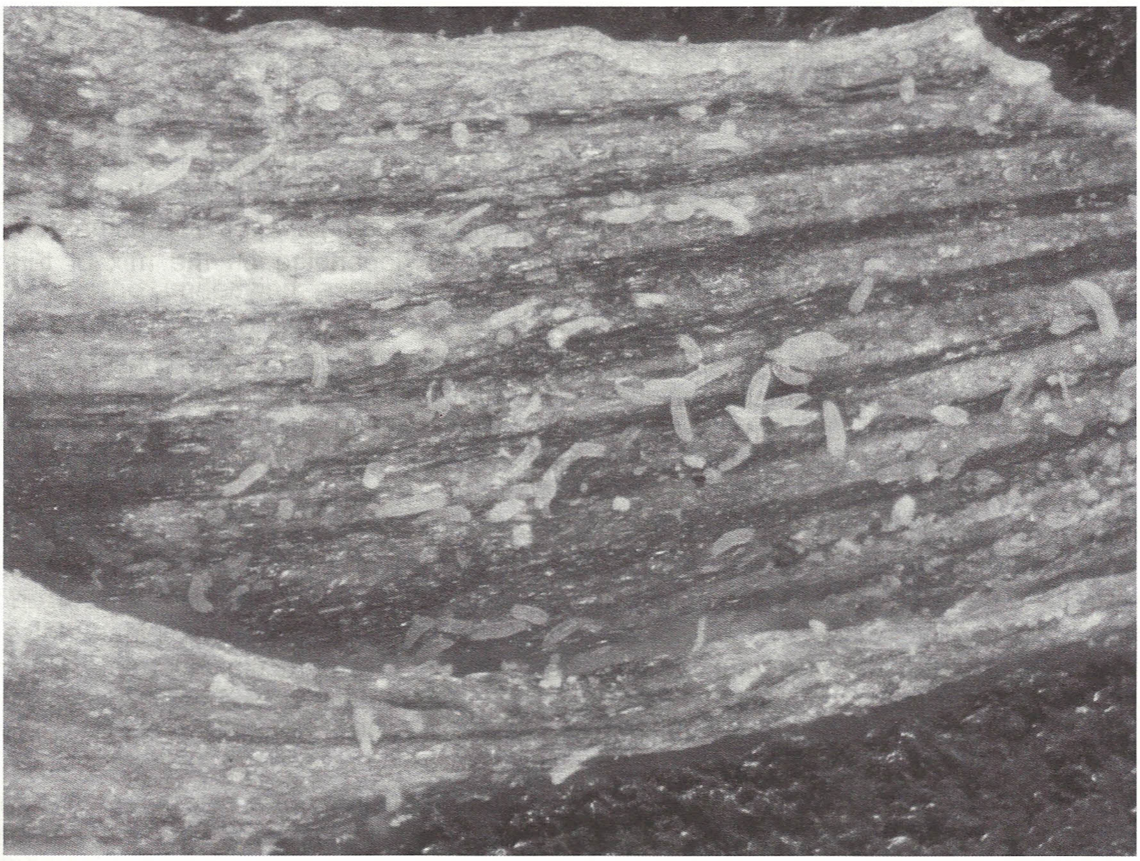

Plate 2. Eriophyoid mites (*Aceria* sp.) feeding under a leaf sheath of green couch.

All eriophyoids are parasites of plants and most are highly host-specific. The mouthparts of eriophyoids cause only minor mechanical wounding, but this together with the injections of specific salivary secretions into host-cells results in specific responses and sets of characteristic symptoms, which can enable a rapid field diagnosis to be made.

The eriophyoid species found on green couches is probably *Aceria cynodoniensis*, which is the species affecting the same host in the USA. It typically causes a proliferation of shoots giving a tufted rosette effect at each node (called a witch's broom) and poor root development on surface stolons (runners. At the same time, individual growths can show shortening and thickening to give a 'pinetree' effect (Plate 3). We have not seen symptoms on green couch in Australia typical of the second bermudagrass (couchgrass) mite, *Aceria cynodonis*, reported from the USA, nor has it been recorded previously in Australia.

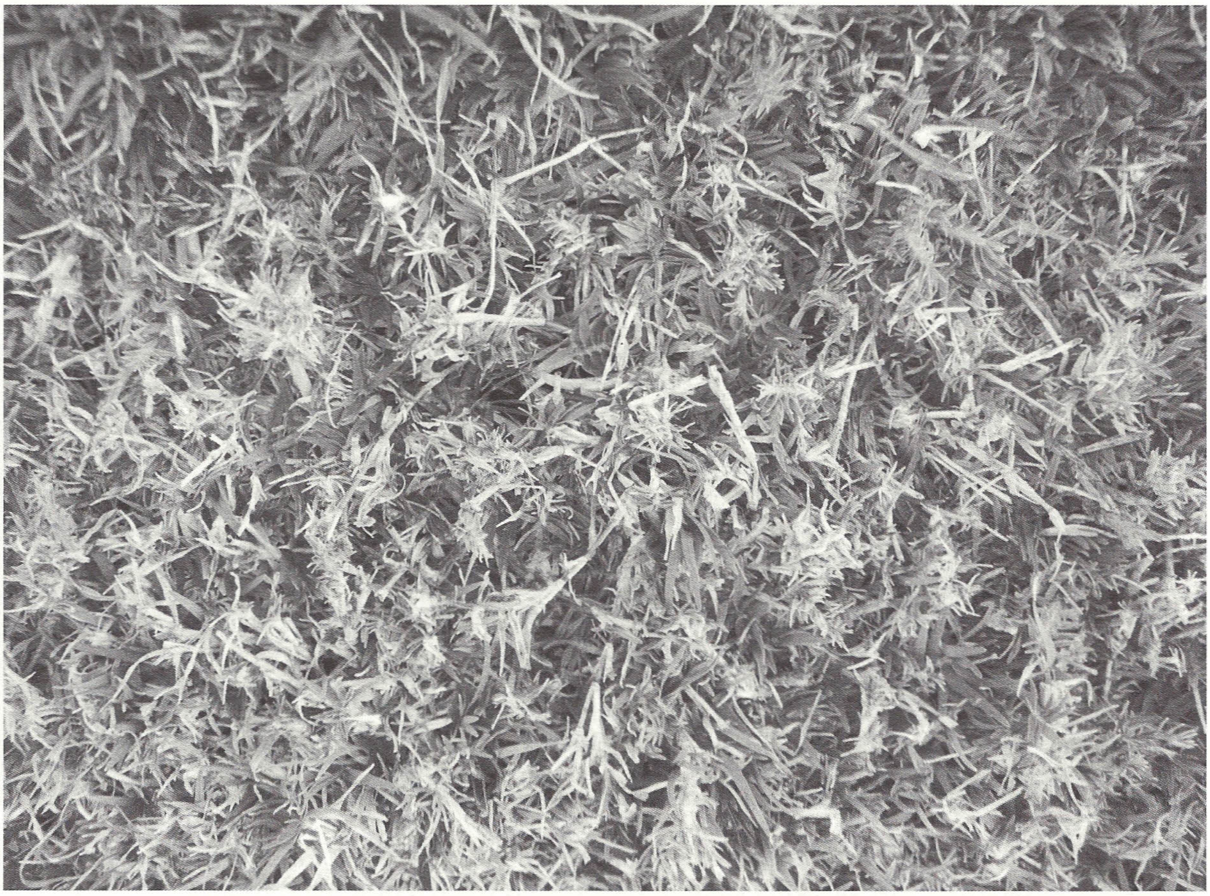

Plate 3. Witch's brooming and swollen constricted shoots on green couch infested with eriophyoid mites.

Zoysia grasses in Australia are affected by a different *Aceria* species, which does not cause the characteristic 'buggy-whipping' symptoms typical of the Asian zoysiagrass mite, *Aceria zoysiae*, found in the USA. Is it possible that a native *Aceria* species from a native Australian grass may be involved?

An *Abacarus* species was also found on one green couch sample collected from Western Australia. This is an interesting new development, since that genus includes two significant economic pests, *A. hystrix* (cereal rust mite) and *A. sacchari* (sugarcane rust mite). *A. hystrix* occurs in Australia and has a wider host range than most other eriophyoid mites, though it is thought to be a complex species consisting of specialised races for different hosts. It is also a vector for at least 2 plant virus diseases.

False Spider Mites (Tenuipalpidae). One or more *Dolichotetranychus* species was/were found on green couch, kikuyu grass, zoysia grasses and blue couch. These are larger and slower-moving animals than the *Aceria* species above, c. 0.4 mm long as adults, and are orange to red in colour (Plate 4).

For more than 50 years after *Dolichotetranychus australianus* was first recorded on a green couch bowls green at Gayndah in the early 1940s, it was thought to be restricted to Queensland. In our survey, however, widespread recordings of *Dolichotetranychus* species were made from Gordonvale (QLD) through to Perth (WA) and including intervening records from Brisbane, Sydney, Canberra, Melbourne and Adelaide plus other country sites. A sample of green couch for mite identification has since been received from Broome (WA) by the Queensland Museum, and *Dolichotetranychus* sp. extracted. The only other *Dolichotetranychus* species recorded in Australia, *D. floridanus,* is a pest of pineapples. However, with another 11 *Dolichotetranychus* species described overseas as coming from turf and similar warm-season grasses (including one from *Zoysia* spp. in Japan), we cannot be certain that we have only the one *Dolichotetranychus* species distributed Australia-wide on 4 different turfgrass groups.

In green couches, *Dolichotetranychus* sp. produces a characteristic thinning and weakening of the turf sward, usually concentrated in patches (but severe infestations may extend virtually across a paddock), without witch's brooming but with more thickened 'pinetree-like' growths (Plate 4). They can also persist in some quite old pinetree-like growths, though not as prevalent in numbers as in the fresher, younger growths.

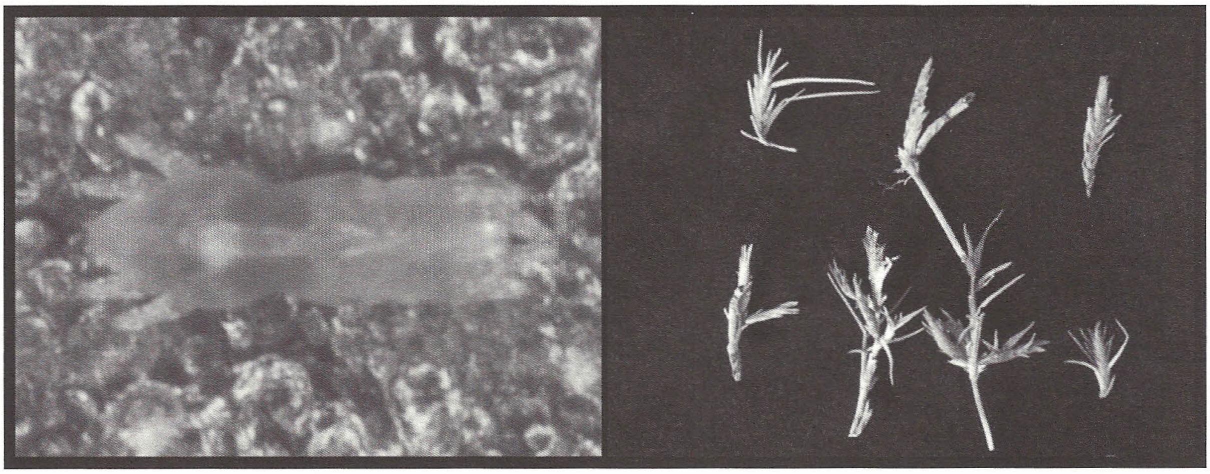

Plate 4. *Dolichotetranychus* sp. close-up (*left*) with typical symptoms in couch grass showing 'pinetree-like' growths without associated witch's brooming (*right*).

Symptoms associated with infestations of kikuyu grass by a *Dolichotetranychus* species include poor rooting down at the nodes, shortening of the internodes, and a proliferation of side shoots on isolated stolons (runners) and plants. In a dense stand without the need for further spread by surface stolons, erect shoots (tillers) show a proliferation of multiple growths, which individually are shortened and thickened to give a 'clubbed' appearance (Plate 5). In swards longer than about 100mm in height (e.g. racetracks), mite symptoms may display as bleached pale patches, especially as the weather cools down during autumn.

Plate 4. Symptoms of *Dolichotetranychus* sp. infestation on kikuyu.

Tarsonemid Mites (Tarsonemidae). Amongst all of this diversity, tarsonemid mites remain an enigma: are they part of the problem; or part of the solution?

The family Tarsonemidae covers a wide range of feeding behaviour. Some are parasites of insects and other animals, predators of mite eggs, and plant feeders (e.g. 14 *Steneotarsonemus* mite species are known to infest grasses). Most, however, feed on fungi and algae, and may even have a sporotheca (a special structure for carrying a specific fungus on which they feed). Tarsonemids are small, rapidly moving and migratory animals, which makes field diagnosis difficult.

In late 2011, infestations of *Dolichotetranychus* sp. in kikuyu at Murarrie (QLD) disappeared and were replaced by a *Stenotarsonemus* species; but the adjoining *Dolichotetranychus* infestations in green couch remained. There is also a previous report from NSW in the late 1960s of tarsonemids being recorded in kikuyu, causing white flecking of the leaves and bronzing of the leaf sheaths. In the course of our survey, small numbers of tarsonemid mites were recovered from a several samples (mainly kikuyu, but also green couch and zoysia), but were not thought to be plant-feeding species.

In the early 1960s, studies in Arizona on the biology of the bermudagrass/couchgrass mite *Aceria cynodoniensis* showed that the tarsonemid *Steneotarsonemus spirifex* was the organism most frequently associated with reduced eriophyoid mite populations, suggesting some sort of relationship between the two, and perhaps even a form of biological control. Other US work found that tarsonemid mites invaded eriophyoid galls on trees; the eriophyoids then abandoned their galls, leaving the tarsonemids to feed on the tissues of the vacated gall.

Other Grasses

Four species of mites, possibly all previously undescribed, were extracted from native *Sporobolus virginicus* sampled at Murarrie (QLD): *Acunda*, *Monoceronychus* and two *Aceria* species. This does illustrate just how little is really known about most of the mite species that may be present (given that some 95% of these are undescribed, and about which we know effectively nothing), as well as highlighting the complexity of infestation that can exist in some grass species. In this case, no species from either genus, *Acunda* or *Monoceronychus,* had previously been recorded in Australia.

Managing Mite-Infested Turf

The spread of mites is assisted by mowing and by dry weather. Under such conditions, the spread of mite infestations from small patches to larger areas can be quite rapid. Mites survive better in drier areas, in irrigation shadows, and around the edges of paddocks and sports fields which may then act as a reservoir for re-infestation. As a common sense precaution against spread, mowing equipment should also be sanitised when moving from affected areas to non-infested areas.

Chemical treatment should begin as soon as an infestation of mites is noticed. Treat with a registered miticide at label rates. But remember: mites are not insects, so dedicated insecticides will not work.

The Way Forward

Our survey has added a number of new mites and mite groups to the conventional picture espoused on commercial websites, which need to update their information and drastically improve its technical accuracy. The significance of the *Dolichotetranychus* species (singular or plural) is up there that of couchgrass mites: they occur Australia-wide, were found on numerous sites, and affect at least 4 turfgrass groups (not just the one). But although *D. australianus* was first described 70 years ago, false spider mites and the effects they have on turfgrasses have been largely ignored in this country in favour of some variation or other of the American bermudagrass (couchgrass) mite story.

At the scientific level, the next basic step is for the mites found during our survey to be identified down to species level (a painstaking and time-consuming process), not just down to genus as at present. While some of these will no doubt prove to be "old friends", there will also be new species to describe. But without accurate information as to the target mite species, there is little point in looking for new chemicals to control them, as chemical registration will be very difficult, if not impossible, without full species identifications.

In the short term, chemical control will remain the main way of reducing mite populations, at least until there is a more sophisticated understanding of predators and how to manage them better. However, to run field trials to find more effective miticides and combinations of miticides, there are practical difficulties that need to be overcome. Firstly, finding a uniformly affected trial site can prove very difficult, given the often patchy nature of mite infestations over quite short distances. Secondly, efficacy has traditionally been assessed by counting numbers of mite-affected growths per unit area - an indirect measure that does not change as quickly over time as the mite population present; there really needs to be at least some direct quantification of mite numbers *per se*.

As with treating any problem, the starting point is to make a correct diagnosis of the primary cause. Erroneous diagnoses, however, come in many forms. For example, an outbreak of aphids on a turf farm during our survey was diagnosed as mites by a commercial sales representative, leading to the use of the wrong pesticide. Another example was when large numbers of predatory mites found on turf farms led to spraying by farm managers to control what should have been a natural part of the solution, not their actual (undiagnosed) problem

Mites are ecology in action at a micro-scale. But with our present rudimentary state of knowledge, we can only guess at the complexities of the relationships and interactions in these hidden communities that cannot be seen at our macro level. Yet it is only through a better understanding of these relationships and interactions, together with the biology, ecology and population dynamics of the key species, that we can hope to develop better methods of controlling the plant-feeding mites that damage turfgrasses, or at least of reducing their populations to acceptable levels where it is not necessary to reach for a can of miticide quite as often.

Acknowledgment
We are grateful to Dr Owen Seeman (Queensland Museum) for sharing with us his identifications of *Dolichotetranychus* sp. in couch grass from Broome (WA) and *Stenotarsonemus* sp. in kikuyu from Murarrie (QLD).