New *Phytophthoras* in Western Australia's natural ecosystems

Michael JC Stukely

Department of Environment and Conservation, Science Division, Locked Bag 104, Bentley Delivery Centre, WA 6983
Tel (08) 9334 0309
Fax (08) 9334 0327
Email Mike.Stukely@dec.wa.gov.au

***Phytophthora* spp. are recognised as important plant pathogens. Ten new and genetically diverse species, not previously reported from elsewhere, have recently been described from natural ecosystems in Western Australia (WA): *Phytophthora multivora*[1]; *P. elongata*[2]; *P. thermophila*, *P. gregata*, *P. gibbosa*, *P. litoralis*[3]; *P. arenaria*, *P. constricta*[4]; *P. fluvialis*[5]; and *P. amnicola*[6]. They were identified by DNA sequencing of recent and historical isolates from the WA Department of Environment and Conservation (DEC). Several additional new taxa await description. New records for WA of at least eight other *Phytophthora* taxa that are known overseas, some of them as yet undescribed, have also been confirmed: *P. inundata*[7]; *P.* taxon niederhauserii, *P.* taxon asparagi, *P.* taxon PgChlamydo, *P.* taxon personii[8]; *P.* taxon salixsoil[3]; *P. palmivora* and *P. rosacearum*. Furthermore, numerous *Phytophthora* hybrids have been identified in natural vegetation and waterways in WA[9]. The phylogenetic relationships of the new WA *Phytophthora* taxa, with their nearest relatives, are shown in Figure 1.**

The introduced plant pathogen, *Phytophthora cinnamomi*, is recognised as a major threat to a variety of native Australian plant communities and the Phytophthora Dieback disease caused by *P. cinnamomi* has been listed as a Key Threatening Process by the Australian Government (*Environment Protection and Biodiversity Conservation Act 1999*). Since 1978, an important element of the management of forest, woodland and heathland ecosystems in south-western WA has been to map the extent of *Phytophthora* dieback disease based on shadowless, colour aerial photography. The maps are validated by testing soil and root samples collected from beneath dying *Phytophthora*-sensitive plant 'indicator species' for the presence of the pathogen. Testing is carried out by the DEC Vegetation Health Service laboratory, which also maintains the *Phytophthora* culture collection and database.

All resulting *Phytophthora* isolates are identified to species and representatives are stored. DNA sequencing (based primarily on amplification of the internal transcribed spacer – ITS – region of the rDNA gene) as well as morphological examination of new and stored isolates has led to the discovery of the many new *Phytophthora* taxa listed above. This illustrates the value and importance of maintaining historical culture collections of live plant pathogens and adding new isolates to them. The previously recorded presence in WA's natural ecosystems of some *Phytophthora* species other than *P. cinnamomi* (*P. cryptogea, P. nicotianae, P. megasperma, P. boehmeriae*) has also been confirmed; however, *P. citricola* and *P. drechsleri* (previously believed to be present based on morphological identification alone) have not been confirmed among over 600 isolates dating back to 1980 that have so far been sequenced.

Some of the new species such as *P. multivora* are widely distributed, and are found in multiple land regions across south-west WA. Others appear to have a more restricted distribution; some are quite rare. Some species are active in different site conditions from those favouring *P. cinnamomi*; for example,

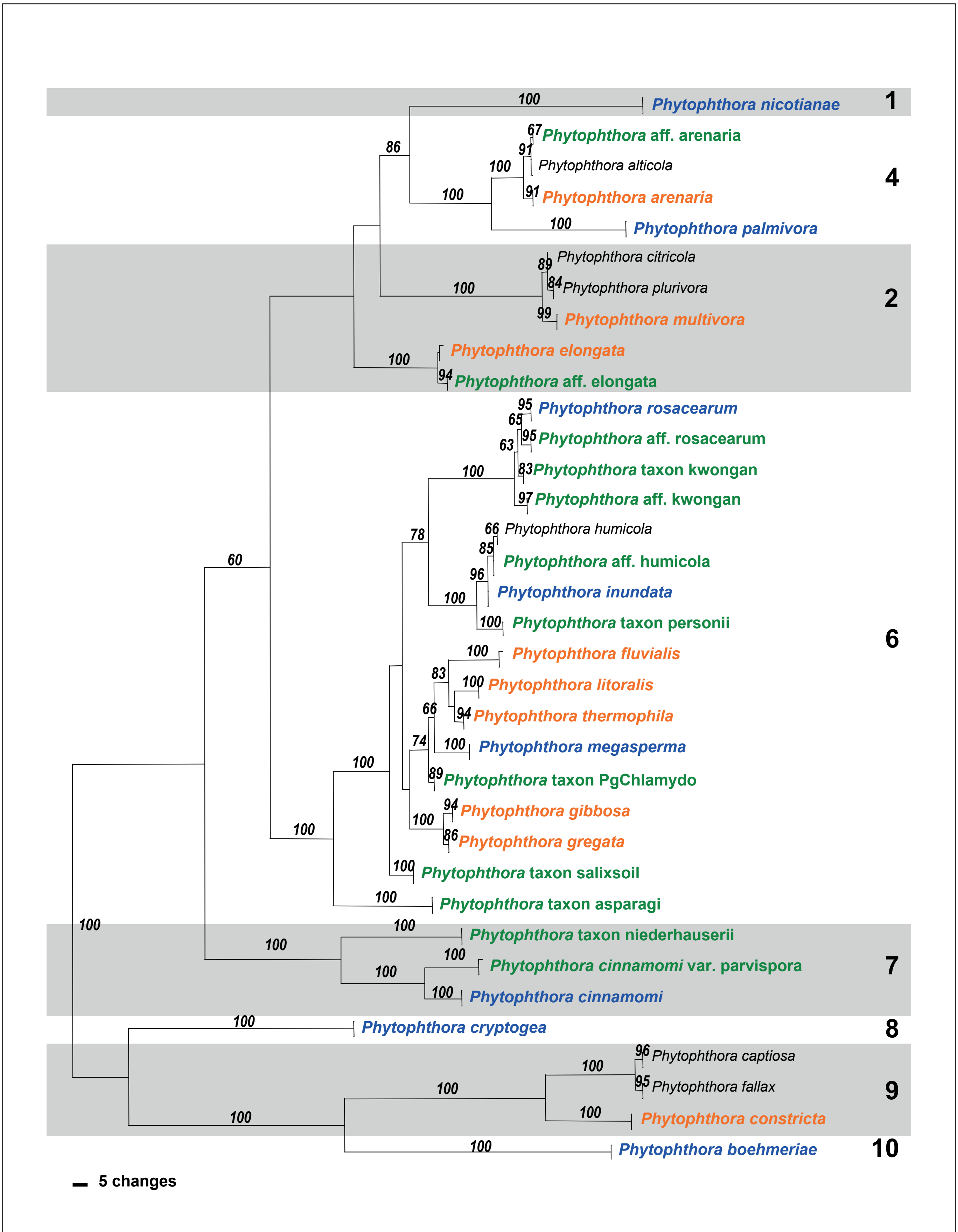

Figure 1. One of six most parsimonious trees of 1155 steps based on ITS sequences, showing the newly-described *Phytophthora* species and new records from Western Australian natural ecosystems. Numbers above branches represent bootstrap support values. The Clades delineated by the shaded blocks, with their numbers (1–10) shown at the right, are after Cooke *et al.* [10]. Previously-known species and recognised undescribed taxa found in WA are shown in blue and green print respectively; newly described species are shown in orange. *(Courtesy T.I. Burgess).*

P. multivora in the limestone soils of the tuart (*Eucalyptus gomphocephala*) forest[1]. *P. fluvialis* has been isolated only from waterways (to 2011). Some species (for example, *P. arenaria* and *P. constricta*) are believed to be endemic in WA[4]. The presence of the hybrids (recovered from routine samples being tested for *Phytophthora*)[9] shows that they are sufficiently stable and resilient to survive in the harsh Western Australian environment. Also, this raises the possibility of hybrids with significant pathogenic capability arising at any time from interactions between compatible *Phytophthora* species. Movement of infested soil and/or plant material between sites will clearly facilitate these interactions.

Most of the new *Phytophthora* species have been associated with plant deaths in natural Western Australian ecosystems, and some of them (for example, *P. multivora*) have already been linked to a very wide range of plant species. Some (for example, *P. constricta*) have caused high mortality following irregular, heavy summer rainfall events in coastal *Banksia* heathlands. Pathogenicity has so far been tested and demonstrated on limited numbers of plant species for *P. multivora*[1], *P. elongata*[2], *P. arenaria* and *P. constricta*[4]. Pathogenicity and host ranges, as well as other characteristics relating to survival, infection and spread, require further investigation to determine the level of threat posed to biodiversity by the new Phytophthoras.

Whilst species other than *P. cinnamomi* have often been associated with relatively low disease impact in natural ecosystems, changes leading to conditions more conducive to the pathogens and to disease expression (such as the increase in summer rainfall predicted with climate change) may increase their expression and impact. It is recommended that land managers apply the precautionary principle in managing these soil- and water-borne Phytophthoras in natural ecosystems, regardless of their present known impact and including the few that have not (yet) been associated with significant vegetation mortality. Collectively, they should be regarded as a threat to natural ecosystems that needs to be managed in the same way as *P. cinnamomi* in terms of minimising their further spread to priority areas[3]. Current management strategies for *P. cinnamomi* in WA focus on using prevention, containment and impact reduction programs, and these are appropriate for the newly described soil- and water-borne *Phytophthora* species including those that may be endemic. Proven local hygiene practices include restricting activities to dry soil conditions, utilising a risk management approach and ensuring that vehicles and footwear are thoroughly clean when moving from an infested to a non-infested area. These measures will be especially important for managing the *Phytophthora* taxa that are not yet widespread or common.

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Biography

Mike Stukely is a research scientist at the WA Department of Environment and Conservation and manages the Vegetation Health Service laboratory. His research interests include *Phytophthora* detection and taxonomy, plant disease management including selection for host resistance, and Mundulla Yellows disease of eucalypts.