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ORIGINAL PAPER

The root rot pathogen *Phytophthora cinnamomi*: a long-overlooked threat to the Cape Floristic Region of South Africa

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Abstract The globally important plant pathogen *Phytophthora cinnamomi* was first reported in South Africa in 1931, where it caused substantial damage to avocado orchards. Surprisingly, 40 years passed before the pathogen was recognised as a significant threat to South Africa's natural ecosystems. This first became evident when *P. cinnamomi* caused a "quick decline" of the iconic silver trees (*Leucadendron argenteum*) in the Cape Floristic Region (CFR) of the Western Cape Province. Subsequent research has underscored the role of *P. cinnamomi* as a major root rot pathogen affecting numerous native species. Despite these findings, there has been limited research on the extent of the threat *P. cinnamomi* poses to Cape flora, leaving the risk of extinction for many species largely unknown. A recent observation of *P. cinnamomi* causing rapid mortality in *Sorocephalus imbricatus,* a Critically Endangered Proteaceae, underscores the urgent need for a comprehensive evaluation of this pathogen's impact on Cape flora and the associated extinction risks. Given the high number of rare and threatened species in the CFR, many of which belong to families known to be vulnerable to *P. cinnamomi*, there is a pressing need to initiate an intensive local research programme to fill this critical gap. To address this, we propose a structured research programme that will guide targeted mitigation efforts against *P. cinnamomi*. Enhancing our understanding of *P. cinnamomi*'s threat to the CFR, a global biodiversity hotspot, will be essential to inform conservation strategies and to set restoration priorities in the region.

Keywords Biodiversity hotspot · Extinction risk · Fynbos · Invasive pathogen · Red list · Threatened species

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Introduction

Phytophthora cinnamomi Rands is a globally important plant pathogen, causing root and crown rot, cankers, dieback and mortality of approximately 5000 woody plant species worldwide (Hardham and Blackman 2018). It is included in the Global Invasive Species Database list of 100 of the world's worst invasive alien species, and is one of only four plant pathogens on this list (GISD 2024). First described in Sumatra in 1922 as the causal agent of stripe canker of *Cinnamomum burmanni* (Nees & T.Nees) Blume (cinnamon) (Rands 1922), the exact origin of *P. cinnamomi* remains uncertain. High genetic diversity has been reported from Papua New Guinea (Zentmyer 1988), supporting this as a putative natural range. However, parts of East and South-East Asia, including Indonesia, Malaysia, Taiwan and Vietnam, have also been proposed as endemic ranges and alternate centres of origin (Ko et al. 1978; Arentz 2017; Shakya et al. 2021). *Phytophthora cinnamomi* is now widely established in many parts of the world, with its global spread almost certainly having occurred through horticulture and the transport of live plants (Zentmyer 1985; Arentz 2017).

While *P. cinnamomi* is recognised as an important pathogen of agricultural crops in tropical and subtropical regions (Drenth and Guest 2004), its most significant impacts have been observed in ecosystems characterised by a Mediterranean-type climate (Burgess et al. 2017). It has been reported as the primary biotic agent involved in oak declines in Mediterranean Europe (Scanu et al. 2013; Brasier et al. 1993), and its impact on native species in California wildlands is also well documented (Serrano and Garbelotto 2020). The Southwest Australian Floristic Region (SWAFR) has experienced profound impacts, with estimates suggesting susceptibility of over 2000 plant species (Shearer et al. 2007, 2004; Barrett and Rathbone 2018). *Phytophthora cinnamomi* has been documented as the cause of root rot and mortality in fynbos species of the Cape Floristic Region (CFR) of South Africa (von Broembsen and Kruger 1985; Van Wyk 1973), however, significant gaps remain in understanding the full extent of the threat this invasive pathogen poses to the unique flora of the region (Paap et al. 2023).

Phytophthora cinnamomi in South Africa

The first report of *P. cinnamomi* in South Africa was by Doidge and Bottomley (1931), from *Persea americana* Mill. (avocado). This report was from Mpumalanga, a province in the northeast of the country. The first record of *P. cinnamomi* causing disease in the Western Cape was in 1972, from grapevines (van der Merwe et al. 1972). Population studies have, however, demonstrated higher levels of genetic diversity in the Western Cape than other provinces, indicating this may have been the initial point of introduction for *P. cinnamomi* into the country (Engelbrecht et al. 2022).

Since its detection in South Africa, *P. cinnamomi* has become established as a major pathogen affecting plants important to the fruit, forestry and horticultural industries as well as natural vegetation across the country (von Broembsen 1984b). The first report of mortality caused by *P. cinnamomi* in natural ecosystems of South Africa was by Van Wyk (1973), who provided an account of the pathogen causing "quick decline" of *Leucadendron argenteum* (L.) R.Br. in the CFR. Subsequent studies highlighted the importance of *P. cinnamomi* as a root rot pathogen of numerous native species, both in natural ecosystems and in cultivation (von Broembsen 1984b; von Broembsen and Kruger 1985). Despite this initial evidence for *P. cinnamomi* being a notable threat to the flora of the CFR, very few studies have investigated the relative susceptibilities of the Cape flora to this pathogen by artificial inoculation (Van Wyk 1973; von Broembsen and Brits 1985).

The regulation of alien species is a key component in South Africa's approach to combating biological invasions (Wilson and Kumschick 2024). *Phytophthora cinnamomi* is listed as a Category 1b species (invasive species requiring control) under the South African National Environmental Management: Biodiversity Act (NEM:BA, Act 10 of 2004) Alien and Invasive Species Regulations (NEM:BA A&IS Regulations; (Department of Environment Forestry and Fisheries 2020a, b)). It is one of only seven microbes listed among the 560 taxa currently included and has been on the list since its initial promulgation in 2014. At the time of its listing, decisions were based on expert opinion. To improve transparency and strengthen the connection to scientific evidence, a new process has been developed to support the listing and categorisation of invasive species in the country. This process utilises the Risk Analysis for Alien Taxa (RAAT) framework (Wilson and Kumschick 2024). This framework provides a structured approach to evaluate the potential invasion risks and impacts of alien species, facilitating efficient listing under legal requirements and ensuring transparent recommendations for species management (Kumschick et al. 2020).

A Risk Analysis for *P. cinnamomi* has recently been completed, reaffirming its listing as a Category 1b species (https://doi.org/10.5281/zenodo.14858

265). Notably, while Category 1b species require control, there has been no active management of *P. cinnamomi* in South Africa's natural ecosystems despite it being listed for the past ten years. The recent observation of the pathogen causing rapid mortality of *Sorocephalus imbricatus* (Thunb.) R.Br., a Critically Endangered Proteaceae endemic to the CFR, highlights the urgent need to better understand the threat that *P. cinnamomi* poses to conservation of the Cape flora (Paap et al. 2023).

The CFR, a global biodiversity hotspot under threat

Located predominantly in the Western Cape Province of South Africa, the CFR is a biodiversity hotspot of global significance (Myers et al. 2000) (Fig. 1). Renowned for its exceptional plant diversity, the CFR is home to over 9,000 plant species, approximately 70% of which are endemic (Manning and Goldblatt 2012). However, with approximately 20% of its plant species classified as threatened with extinction (including the Vulnerable, Endangered and Critically Endangered categories of the IUCN Red List (IUCN 2012)), the CFR faces significant challenges.

The dominant vegetation type of the CFR is fynbos, characterised by sclerophyllous, fire-prone shrubland. Fynbos constitutes the major component of the Fynbos Biome, with renosterveld and strandveld thicket comprising the remaining vegetation types. The Fynbos Biome covers approximately 80% of the CFR, while the remaining areas include components of the Succulent Karoo, Albany Thicket and Afrotemperate Forest Biomes (Manning and Goldblatt 2012).

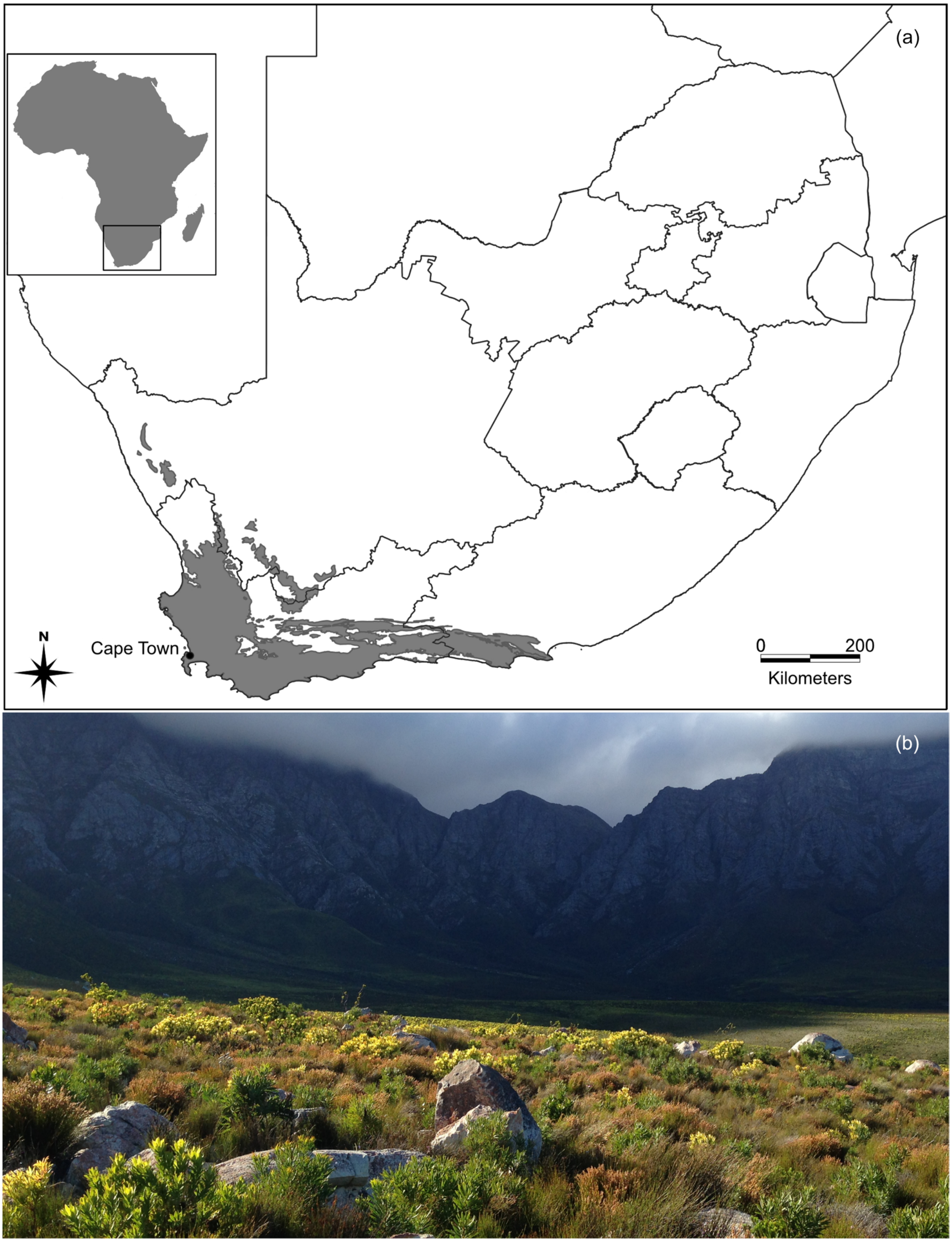
One of the greatest threats to CFR biodiversity is habitat loss, primarily due to agriculture and urban expansion. Lowland areas have been disproportionately affected, but even in mountain areas, where agriculture has typically been more limited due to poor soils, cultivation of ornamental flowers, rooibos and honeybush tea, has resulted in habitat losses (Skowno et al. 2021; Manning and Goldblatt 2012). Invasive alien plants further threaten CFR biodiversity and ecosystem services (Rouget et al. 2003). In addition to direct impacts resulting from shading or competition, these invasions have led to changes in soil chemistry, altered microbial systems, increased fuel loads resulting in more severe fires, and a loss of water resources (Holmes et al. 2020; van Wilgen et al. 2016). Further compounding these issues are habitat degradation from over-grazing and trampling, altered fire regimes, over-exploitation, pollution, and climate change (Van der Colff et al. 2023; Skowno et al. 2019). These anthropogenic pressures, coupled with the fact that many CFR species are highly localised endemics with very small populations, significantly increase the extinction vulnerability of Cape flora (Manning and Goldblatt 2012; Van der Colff et al. 2023). Despite substantial investment in research and management of invasive alien plants (van Wilgen 2020), there is a critical lack of similar efforts to manage invasive alien pathogens like *P. cinnamomi*.

The Fynbos Biome contains nearly 70% of South Africa's threatened plant taxa (Skowno et al. 2019), highlighting the disproportionately high number of threatened plant species found in the CFR. This is also evident when considering larger southern African plant families with notably high proportions of threatened taxa, such as Aizoaceae, Asphodelaceae, Ericaceae, Fabaceae, Iridaceae, Proteaceae and Rutaceae. Most of these are characteristic of the Cape flora and contribute significantly to the high proportion of threatened species in the region (Manning and Goldblatt 2012).

Parallels between the SWAFR and the CFR

Like South Africa's CFR, the Southwest Australian Floristic Region (SWAFR) is a global biodiversity hotspot, characterised by a Mediterranean climate and old, weathered, nutrient-deficient landscapes (Hopper and Gioia 2004). The SWAFR is an area of exceptionally high species richness and endemism. Similar to the CFR, the region has experienced significant land transformation, with biodiversity threatened by habitat loss, habitat degradation, the impacts of invasive alien plant species and climate change (Monks et al. 2019). Additionally, *P. cinnamomi* is regarded as one of the most significant threats to the conservation of floristic diversity of the SWAFR (Shearer et al. 2004, 2007; Barrett and Rathbone 2018).

In the SWAFR, *P. cinnamomi* has caused profound changes to species assemblages, richness and structure of impacted plant communities (Shearer et al. 2007; Barrett and Yates 2015; Barrett and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◂**Fig. 1** **a** Map detailing the extent of the Cape Floristic Region (CFR) in South Africa (illustrated in grey). **b** Fynbos vegetation, a key component of the CFR

Rathbone 2018). Substantial effort has been made towards quantifying susceptibility to *P. cinnamomi* infection (Shearer et al. 2004, 2007, 2013), with this work fundamental to informing conservation strategies for threatened SWAFR flora (Barrett et al. 2024). Notably, several of the plant families most severely impacted by *P. cinnamomi* in the SWAFR (e.g., Ericaceae, Fabaceae, Proteaceae), are families that are important components of the CFR (Manning and Goldblatt 2012; Barrett and Yates 2015).

Current state of knowledge

Despite early indications of the impact of *P. cinnamomi* on the flora of the CFR, research on this issue has been limited, with most studies conducted in the 1970s and 1980s. The earliest studies include reports by Van Wyk (1973) and van der Merwe and van Wyk (1973), which detailed the responses of 13 CFR species to *P. cinnamomi*. These reports noted mortality in seven of these species, all of which were Proteaceae. Shortly thereafter, Knox-Davies (1975) identified *P. cinnamomi* as a significant cause of mortality and decline in several fynbos species. Knox-Davies also suggested that *P. cinnamomi* was likely a major pathogen for many fynbos components and called for controlled inoculations to assess species susceptibilities. It is unfortunate that this work was followed by a near 10-year gap, before additional evidence of *P. cinnamomi*'s negative impacts on Cape flora emerged.

A series of publications led by von Broembsen (von Broembsen and Brits 1985; von Broembsen 1984b; von Broembsen and Kruger 1985) provided the most substantial contributions to our current state of knowledge with regards to the susceptibility of Cape flora to *P. cinnamomi.* Four additional reports followed in subsequent years (Lübbe and Geldenhuys 1990; Lübbe and Mostert 1991; Bezuidenhout et al. 2010; Benic 1986), each adding information for one or two additional CFR species. In 2023, however, the observation that *P. cinnamomi* was causing rapid mortality of the Critically Endangered and range restricted *Sorocephalus imbricatus* renewed concerns that this invasive pathogen poses a substantial and seriously overlooked threat to the flora of the CFR (Paap et al. 2023).

To date, there are details of *P. cinnamomi* susceptibility for 97 CFR species, with 83% of these reports involving members of the Proteaceae (Fig. 2). Other CFR families reported to be affected by *P. cinnamomi* include Bruniaceae (one species), Cupressaceae (three species), Curtisiaceae (one species), Ericaceae (five species), Fabaceae (one species), Lauraceae (one species), Meliaceae (one species), Rosaceae (one species) and Rutaceae (two species). The full list of data and sources is provided in Supplementary material S1. We have chosen to exclude reports from commercially farmed Proteaceae cultivars from our dataset, as they detract from a focus on indigenous species in their natural environments. However, these agronomic reports are available in the complete host list for *P. cinnamomi* in South Africa, as an appendix to the Risk Analysis (https://doi.org/10.5281/zenodo.14858265).

Knox-Davies (1975) cautioned that compiling host range lists for *P. cinnamomi* without conducting pathogenicity studies through artificial inoculations could lead to presumptive conclusions. Our review identified pathogenicity results for 31 species, with all but one belonging to the Proteaceae (von Broembsen and Brits 1985; Van Wyk 1973; Bezuidenhout et al. 2010). This limited dataset highlights several issues: a lack of inoculation studies for many species, inconsistencies in scoring host responses and determining susceptibility, and inadequate replication numbers. For example, the majority of these results are from the study of von Broembsen & Brits (1985) with only five replicates per species, which is arguably an insufficient number to ensure robust and reliable conclusions.

An alternative method to assess the extent to which *P. cinnamomi* is recognised as a threat to Cape flora is by reviewing Red List assessments. South Africa has achieved the notable feat of assessing all plant taxa, a first for a country with a megadiverse flora (Raimondo et al. 2009). We screened the Red List of South African Plants for assessments containing the broader term "*Phytophthora*" (search conducted on 20–05–2024). Only nine CFR species ($<0.1\%$) mentioned *Phytophthora*, with all but one belonging to the Proteaceae family. Interestingly, only five of these nine species have any data published on their susceptibility to *P. cinnamomi,* and only one has data from


(a)
(b)
(c)
(d)
(e)

◂**Fig. 2** *Phytophthora cinnamomi* causing root collar lesions and mortality of **a**, **b** *Sorocephalus imbricatus* and **c**–**e** *Leucadendron argenteum,* two Proteaceae species endemic to the Cape Floristic Region

glasshouse pathogenicity trials to support a susceptibility rating (Supplementary material S1).

Distribution of *P. cinnamomi* in the CFR

Phytophthora cinnamomi is likely established across many areas of the CFR. However, understanding the full extent of its distribution is fundamentally important for effective management and the implementation of hygiene measures to prevent further spread. Although significant ad hoc sampling has been conducted, the absence of a centralised database of *P. cinnamomi* occurrences remains a notable gap.

Historically, Von Broembsen (1984a) observed that *P. cinnamomi* appeared to be widespread across natural areas of the Western Cape, leading her to propose that it might be indigenous to the region. This hypothesis was based on her frequent recovery of the pathogen from river water samples. However, this assertion is contentious. Studies conducted elsewhere typically report that *P. cinnamomi* is rarely recovered from streams or rivers using similar sampling methods (e.g., filtering or *in-situ* stream baiting) (Hüberli et al. 2013; Schoebel et al. 2024; Seddaiu et al. 2020). To resolve this question and to confirm the pathogen's persistence in aquatic environments, systematic sampling of streams and rivers using both traditional culture-based methods and environmental DNA techniques is recommended.

While both mating types of *P. cinnamomi* have been found around the world, the global epidemic is primarily driven by the A2 mating type (Shakya et al. 2021). In the Western Cape, both A1 and A2 mating types have been identified; however, A2 isolates are predominantly found in commercial crops, whereas A1 isolates are more commonly associated with natural (fynbos) vegetation (Linde et al. 1997). Shakya et al. (2021) proposed that both South Africa and Australia acted as bridgehead regions for the global spread of *P. cinnamomi*, noting that the similar genetic profiles and intermediate diversity levels in these regions might result from either shared introduction sources or migration between the two regions.

Population genetic studies have shown higher levels of genetic diversity in the Western Cape than other provinces, supporting this as the point of introduction for *P. cinnamomi* into the country (Engelbrecht et al. 2022; Linde et al. 1997). This is likely analogous to the introduction of *Armillaria mellea* into the Company Gardens by early European settlers in the seventeenth century, which was facilitated by the introduction of potted plants into Cape Town (Coetzee et al. 2001). Similarly, *P. cinnamomi* probably arrived with imported plants or soil associated with early horticultural activities. Subsequent spread of the pathogen has likely been facilitated by human activities, primarily the movement of infested plants and soil.

An urgent need for *P. cinnamomi* research in the CFR

In 1975, Knox-Davies highlighted the potential vulnerability of Cape flora to *P. cinnamomi* and emphasised the need for a comprehensive local research initiative. Nearly 50 years later, there has been little advancement in this area. Given the high number of rare and threatened species in the CFR, many of which belong to families known to be at risk from *P. cinnamomi*, it seems imperative that a research programme similar to that proposed by Knox-Davies (1975) be established. We advocate for a comprehensive approach to address this critical knowledge gap, which would directly inform conservation strategies and empower stakeholders to take proactive measures in preserving CFR biodiversity. Figure 3 provides a visual representation of the proposed research workflow. This approach should include:

In-field assessments

Systematic field surveys and sampling should be initiated to map the distribution of *P. cinnamomi* and assess impact. This will provide essential field-based data on the pathogen's effects at both the species and community levels. The generated data can also be used to develop a detailed database and map of *P. cinnamomi* occurrences, guiding subsequent research and management strategies.

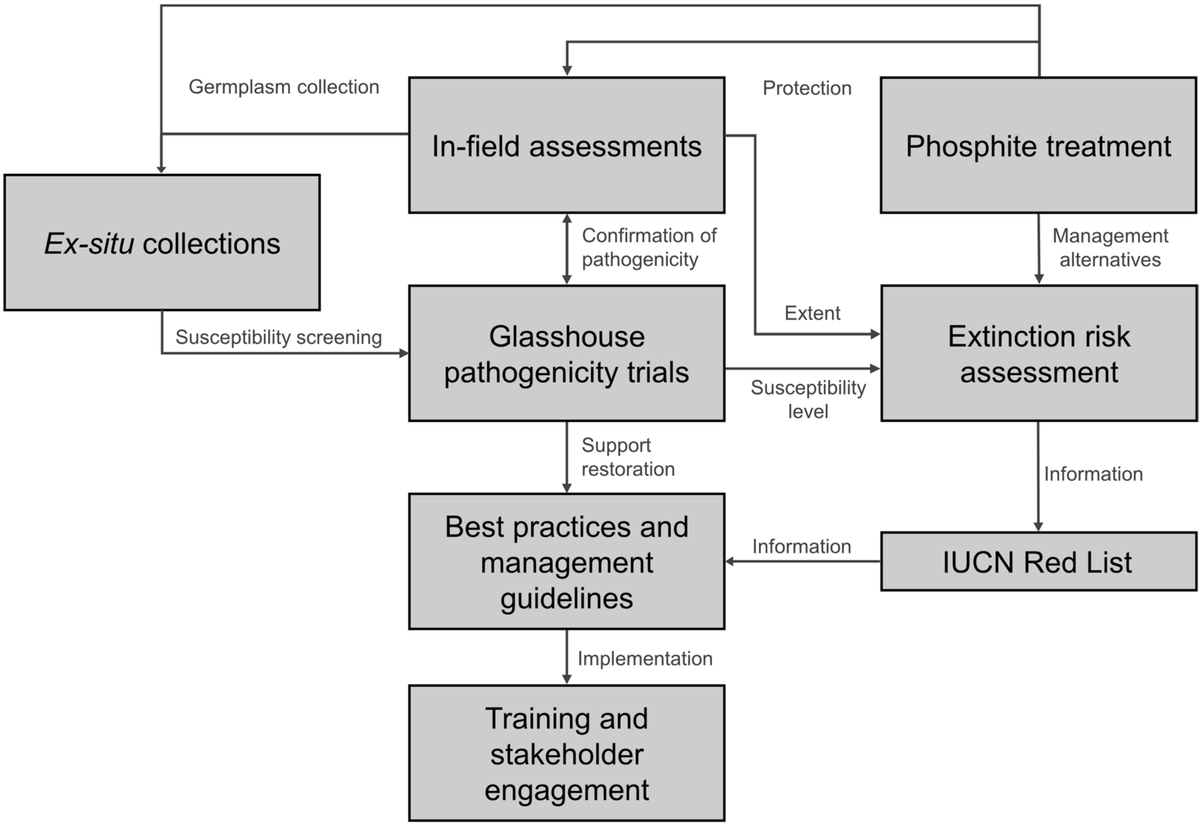

Fig. 3 A diagrammatic overview of the proposed research programme to investigate the impact of *Phytophthora cinnamomi* in the Cape Floristic Region (CFR). The workflow integrates key components, with each stage directly informing the conservation strategies required to mitigate the impacts of *P. cinnamomi* on vulnerable CFR species

Glasshouse pathogenicity trials

By monitoring disease development under controlled conditions, researchers will be able to assess species susceptibility and host response. Combined with in-field assessment data, this information will support Red List threat assessments and assist in selecting species to be prioritised for conservation and management efforts. Given the limitation that glasshouse trials can only be conducted on species in *ex-situ* cultivation, additional collections (including germplasm and living plant collections) are necessary.

Supporting and enhancing *ex-situ* collections

Target 8 of the Global Strategy for Plant Conservation (GSPC; a programme adopted under the Convention on Biological Diversity) aims for 'at least 75 per cent of threatened plant species in *ex-situ* collections, preferably in the country of origin, and at least 20 per cent available for recovery and restoration programmes'. South Africa's Strategy for Plant Conservation (NSPC) adapts these targets to suit its megadiverse flora, aiming for 'at least 60% of threatened plants in *ex-situ* collections, preferably in the country of origin, and available for recovery (restoration) programmes, with 1% in active reintroduction programmes' (Raimondo 2015).

The Plant Search tool of Botanic Gardens Conservation International (BGCI) can be used to identify gaps in *ex-situ* collections and select species for germplasm collection. Prioritisation should be guided by IUCN Red List status and data from in-field assessments, with special attention given to rare and threatened taxa. This approach not only supports conservation targets but also enables further host response testing in glasshouse trials, while ensuring that *ex-situ* collections are a valuable resource for future restoration and reintroduction programmes.

Phosphite treatment

Evidence from the SWAFR supports the use of the systemic biodegradable fungicide phosphorous acid (phosphite) to protect threatened flora populations and threatened ecological communities (Barrett and Rathbone 2018; Barrett et al. 2024; Boulle et al. 2023). While phosphite cannot eliminate *Phytophthora* from the soil, it has been shown to enhance resistance in susceptible species (Hardy et al. 2001; Shearer et al. 2012). Recent trials with *Leucadendron argenteum* demonstrate phosphite's efficacy in protecting CFR species (Msweli et al. unpublished), however, additional trials should be conducted in both glasshouse and field settings to refine application protocols. Treatment of highly susceptible species with few extant localities should be prioritised, as employing such a strategy can mitigate the impacts of *P. cinnamomi,* bolster *in-situ* conservation efforts and facilitate the collection of germplasm for *ex-situ* preservation as well as future translocation programmes.

Best practice and management guidelines

The main objectives of on-ground management should be to prevent the further spread of *P. cinnamomi* and to mitigate its impact at infested sites. To achieve this, comprehensive biosecurity best practice and management guidelines should be developed, informed by data gathered from in-field assessments and glasshouse trials. Additionally, a policy statement incorporating evidence-based data should be drafted to address the impact of *P. cinnamomi* on indigenous flora and ensure active management in natural ecosystems. This addresses a critical gap with regard to the NEM:BA A&IS listing of *P. cinnamomi* as a category 1b species, which currently lacks management plans.

Training and stakeholder engagement

Targeted training programmes should be developed to raise awareness and improve management practices for *P. cinnamomi*. These programmes will enhance stakeholder capacity by equipping them with the skills needed to reduce the spread of *P. cinnamomi* and mitigate its impact. Efforts should also be made to integrate these initiatives with socio-economic development, such as improving wildflower harvesting practices to support both biodiversity and local livelihoods. A basic training package on dieback awareness and biosecurity measures, including hygiene best practices, should be created and incorporated into existing training for land management and conservation professionals. This initiative can draw on the successful model of Western Australia's Dieback Working Group Green Card Training™ programme, which has proven effective in empowering stakeholders to protect vulnerable ecosystems in the SWAFR.

Extinction risk assessment

Assessing the extinction risk to CFR flora from *P. cinnamomi* is crucial to inform species management and setting conservation priorities. McDougall et al. (2024) proposed a risk matrix for assigning extinction risk to Australian flora. Their approach replaces the extensive array of susceptibility categories previously used by various research groups, offering simplified categories that reflect response to *P. cinnamomi*: no response, mild response and severe response. This is then combined with conservation status and habitat suitability to assign an extinction risk category: Low, Moderate, High, Very High. A similar approach should be applied to CFR flora to ensure consistency in future assessments.

Prioritisation

Given the extraordinary diversity of the CFR, assessing the threat of *P. cinnamomi* to all plant species is impractical. However, prioritisation can be achieved by leveraging existing data. Several families that are important components of the CFR have disproportionately high numbers of threatened taxa (Manning and Goldblatt 2012). This includes families known to contain species at higher extinction risk due to *P. cinnamomi*, including Ericaceae, Fabaceae, Proteaceae and Rutaceae (McDougall et al. 2024). Initial assessments should therefore focus on these families. Additionally, range restricted and threatened species should be prioritised due to their heightened vulnerability.

There is a strong case to begin with the Proteaceae. The 8th largest family of the CFR, with 333 extant species, this family exhibits extraordinarily high endemism (96%) and nearly half of its species are threatened with extinction (IUCN 2024). Moreover, the majority of known reports of *P. cinnamomi* on CFR flora are from this family, suggesting a relatively higher threat level. However, many of these reports are based solely on field observations and lack host response data from glasshouse inoculation trials. It would be highly beneficial to build on existing knowledge by incorporating host response data from controlled trials. Similarly, the Ericaceae, the 4th largest family in the CFR, shows extremely high endemism (97%) and contains a disproportionately high proportion of threatened taxa. Although there are only five reports of disease caused by *P. cinnamomi* from this family, it remains the second most represented family (after Proteaceae) in the list of known hosts from the CFR.

Conclusions

While substantial efforts have been made to identify and address many of the threats to the CFR, there is an urgent need to better understand the role of *P. cinnamomi* as a key process threatening the flora of this region. Recognising *P. cinnamomi* as a disease-causing agent is an important component regarding the management of threatened species. Studies from the SWAFR, a region described as analogous in many ways to the CFR (Manning and Goldblatt 2012), have demonstrated dramatic ecosystem changes as a consequence of the invasion of *P. cinnamomi*. This includes extensive alterations in ecosystem composition through local extinctions or severe reductions in populations of plant species, particularly within the Proteaceae, Ericaceae and Fabaceae families (Barrett and Yates 2015).

Researchers working with threatened flora of the SWAFR have developed methods to position taxa on a *P. cinnamomi* resistance-susceptibility continuum (Shearer et al. 2013), and McDougall et al. (2024) have proposed a method to integrate these data with spatial data on plant species distribution and habitat suitability to assign extinction-risk categories. It is imperative that an intensive research initiative be established for the CFR of South Africa. The knowledge gained through the programme that we propose here will directly inform conservation strategies and empower stakeholders to take proactive measures to protect CFR biodiversity. In the absence of such an initiative, the risk of species extinction may become imminent, potentially leading to irreversible impacts. The ultimate goal must be to preserve the region's biodiversity and thus prevent the catastrophic loss of species due to *P. cinnamomi*.

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Data availability Data sources for the susceptibility of Cape flora to *Phytophthora cinnamomi* are provided in Supplementary material S1.

Declarations

Conflict of interest The authors declare that they have no conflicts of interest.

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