Large scale DIE-OFF of an iconic South African tree - *Euphorbia ingens*

Unexplained die-off of *Euphorbia ingens* (Candelabra, Naboom or Mokgoto) in the Limpopo Province (Fig. 1) has captured the attention of researchers associated with the CTHB. Results from research on this phenomenon suggest that it is the product of a complex interaction between various biotic and abiotic factors. Discoveries made by Johan van der Linde for his M.Sc. dissertation laid a solid foundation towards a better understanding of the large-scale deaths of these iconic trees. His research also led to the description of two previously unknown fungal species and an increase in our knowledge of the fungal biodiversity of South Africa.

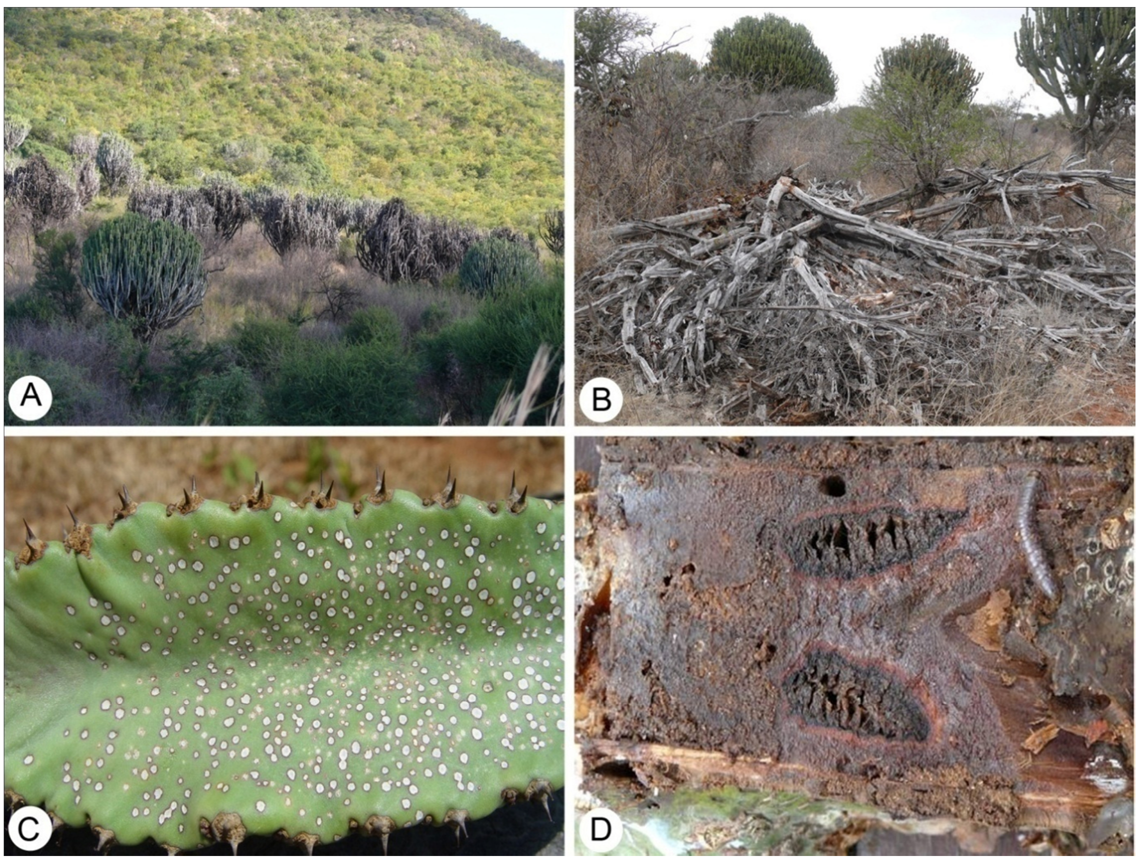


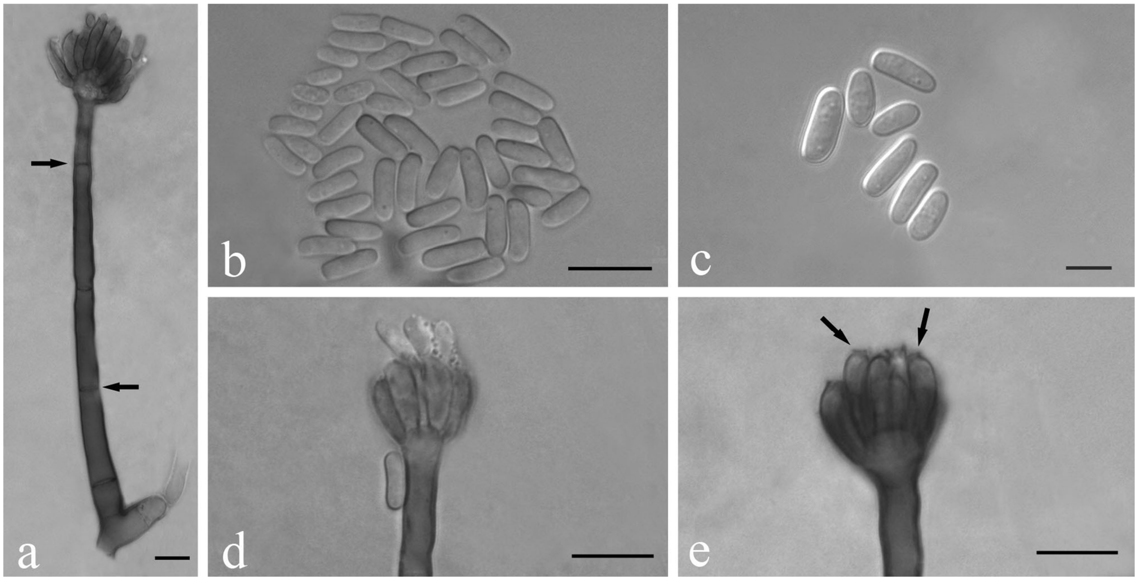
Figure 1: Mortality of *E. ingens* in the Limpopo Province and symptoms found on diseased and dying trees. (A) Large-scale mortality of *E. ingens* trees at Mokopane, (B) Dead *E. ingens* trees near Louis Trichard, (C) Spotting on the external area of the succulent branches, (D) Internal rotting and feeding damage caused by *Megasis* sp.

During the last 10 years it has been observed that *E. ingens* trees in the Limpopo Province are becoming diseased and dying without direct evidence of a causal agent. A survey conducted in 2006 by Mrs. Rentia Malan at the National Zoological Gardens Biodiversity Conservation Centre (NZG) in Mokopane (Potgietersrus) revealed that all *E. ingens* trees in this centre were diseased, and many had died over a short period of time. A pilot study conducted in 2007, aimed at characterizing disease on *E. ingens* at the Game Breeding Centre in Mokopane, identified several fungi and insects associated with dying trees (Roux *et al*. 2008, 2009). A gray discoloration of tree stems and branches, as reported previously by Malan (2006), was also found. Additionally, rotting and browning of the succulent branches, white and yellow spots on succulent branches, blue stain of the wood in the main stems and numerous insects infesting the stems and branches were found (Fig. 1) (Roux *et al*. 2008, 2009). Various genera of fungi were isolated from diseased material.

Studies conducted during 2009 and 2010 at multiple sites in the Limpopo Province considered both abiotic and biotic factors in the death of *E. ingens* trees. Three main areas showing trees suffering from die-off were studied: The National Game Breeding Centre in Mokopane, a domestic farm in the vicinity of the Capricorn Toll plaza and a private game farm close to Louis Trichardt. These areas were compared with two healthier sites located in the North West Province. As a first step the disease symptoms on the trees were characterized. Various spots and scars on the external areas of the succulent branches, internal rotting of the succulent branches and gray discoloration of the healthy succulent branches were observed (Fig. 1).

A high diversity of fungi was isolated from diseased *E. ingens* and a number of insects belonging to different genera were collected. The most commonly isolated fungi resided in the Botryosphaeriaceae, Cordycipitaceae, Microascales, Nectriaceae, Ophiostomataceae and the Teratosphaeriaceae. In the Botryosphaeriaceae, *Lasiodiplodia mahajangana* and *Lasiodiplodia theobromae* were identified (Van der Linde *et al.* 2011). The Microascales included a previously unknown species, which was decribed as *Gondwanamyces serotectus* (Fig. 2). Insects included *Cyrtogenius africus* (Coleoptera: Curculionidae, Scolytinae), *Cossonus* sp., *Stenoscelis* sp. (Coleoptera: Curculionidae, Cossoninae) and a *Megasis* sp. (Lepidoptera: Pyralidae).

Temperature and rainfall studies showed an increase in temperature with reduced rainfall in areas where *E. ingens* displayed severe die-off. Temperature and precipitation data were analysed over a 40-year period at four sites in the Limpopo Province and two sites (areas of less severe die-off) in the North West Province. Compared to the Limpopo Province, the sites in the North West province were cooler with higher rainfall levels over the 40-year period. Furthermore, evapotranspiration and water balance levels were investigated and results showed that trees were under more stress in the Limpopo Province. This finding might explain the more severe die-offs in the Limpopo Province since the trees will be more vulnerable to pathogen and insect attack due to their state of increased stress.



Morphology of *Gondwanamyces serotectus* (A) Conidiophore showing foot cell and sinuate stipe, (B) Obovate conidia, (C) Conidia of variable size, (D) Conidiophore with phialidic conidiogenous cells and newly produced conidia, (E) Conidiophore with conidiogenous cells showing phialides with distinct collarettes. Bars: A, B, D, E = 10 µm; C = 5 µm.

The death of *E. ingens* appears to be caused by a combination of biotic and abiotic factors acting in concert. Further studies are needed to consider the unexpected die-off of different species of *Euphorbia* residing in different provinces. These studies must also include more in depth evaluation of land management and fire regimes as well as climate data for each province in order to better understand the possible involvement of fungi, insects and the various abiotic factors in the decline of native trees in South Africa.

For more information see:

Malan R, 2006. Aspects of population biology and ecology of *Euphorbia ingens* on the Mokopane game breeding centre in the Limpopo province of South Africa. Assignment 3, Plant studies 4A, B. Tech Nature Conservation, Department of Nature Conservation, Tshwane University of Technology, Pretoria, South Africa.

Roux J, Malan R, Howitt M, Six D, Wingfield MJ, 2008. Discovery of new fungi associated with the decline and death of *Euphorbia ingens* in the Limpopo province of South Africa. *South African Journal of Botany* 74: 377-378.

Roux J, Malan R, Howitt M, Six D, Wingfield MJ, 2009. Fungi associated with diseased *Euphorbia ingens* in South Africa. 46th Biannual Conference of the Southern African Society for Plant Pathology, 25th January – 28th January 2009, Gordons Bay, South Africa.

Van der Linde JA, Six DL, Wingfield MJ, Roux J, 2011. *Lasiodiplodia* species associated with dying *Euphorbia ingens* in South Africa. Accepted by *Southern Forests*.

Van der Linde JA, Six DL, Wingfield MJ, Roux J, 2011. New species of *Gondwanamyces* from dying *Euphorbia* trees in South Africa. Accepted by *Mycologia*.

Acknowledgements

We thank the Department of Science and Technology/National Research Foundation (DST/NRF) Centre of Excellence in Tree Health Biotechnology (CTHB) and the University of Pretoria, South Africa, for financial support; Mr Mark Howitt, Mrs Rentia Malan, Mr Keith Johnson, Mr Manie Elof, Mr Chris Richards, Ms Hermien Roux and Mr Alf Sephton are thanked for permission to undertake field studies. We also thank the South African Weather Service for the temperature and precipitation data and Dr. Norbert Hahn, Soutpansberg Herbarium, for assistance with field work.