



Short communication

Abnormal morphology of the embryo and seedling of *Welwitschia mirabilis*, and some observations on seed-associated fungi

C. Whitaker*, P. Berjak, N.W. Pammenter

School of Biological and Conservation Sciences, University of KwaZulu-Natal, Durban 4041, South Africa

Received 5 November 2007; received in revised form 27 November 2007; accepted 2 December 2007

Abstract

Welwitschia mirabilis normally possesses only two true leaves, which emerge from deeply-set meristem in the crown of the plant. The leaves display continuous growth from the base, while the tips die off due to water loss caused by climatic factors and age. Extensive splitting of the leaves may occur, giving the appearance of many smaller leaves. Here we report on observations of abnormal seedling morphology, including twinning, lack of pigment, and supernumerary cotyledons. A note on fungal species associated with the seeds is also appended. © 2007 SAAB. Published by Elsevier B.V. All rights reserved.

Keywords: Abnormal morphology; Fungi; Seedling; Seeds; *Welwitschia mirabilis*

1. Introduction

Welwitschia mirabilis Hook. fil. is a unique and rare plant endemic to the Namib Desert. It is categorised among the Gymnospermae (order Gnetales), but displays many characteristics intermediate between gymnosperms and angiosperms. Recent genetic analyses tentatively indicate that the Gnetales arose from within the conifers, and that morphological similarities between angiosperms and Gnetales are separately derived (Chaw et al., 2000). Supporting fossil evidence (*Palaeognetaleana auspicia* cones) from the Upper Permian has been reported in North China—the earliest known evidence of the Gnetales (Wang, 2004). *W. mirabilis* retain their first-and-only-formed leaves, the tissue of each being continually regenerated from a deep-set meristem, throughout their lifespan, with growth rates varying seasonally, and in response to rainfall events (Henschel and Seely, 2000). The tips of the leaves die off as a result of extensive water loss induced by climatic factors and age (Eller et al., 1983). There are only two of these leaves, although they become so longitudinally dissected by uneven growth of the truncated stem that the basal meristem becomes

segmented (Bornman et al., 1972), giving the plant the appearance of having many long, ribbon-like leaves, with micro- or mega-strobili (depending on the sex of the individual) appearing between the bases.

The dry seed (c. $7 \times 5 \times 2$ –3 mm; average mass 120 mg) contains a centrally located embryo, often separated by a narrow space from the surrounding gametophyte tissue, as described by Bornman et al. (1979). Upon germination, the shoot apex, with its paired cotyledons, appears to be withdrawn from the seed as the hypocotyl elongates (Bierhorst, 1971). The attenuated cotyledons, which become photosynthetic, persist for a matter of 2–3 years (Chamberlain, 1966), even when the two later-developing true leaves have become considerably longer than they are (Bornman et al., 1972).

During the course of investigations previously described (Whitaker et al., 2004, 2008), and associated studies over 5 years, more than 3000 seeds were germinated, and several unusual variations on the expected morphology of *W. mirabilis* seedlings were observed. Seeds were collected in the field by staff of the National Plant Genetic Resources Centre (NPGRC) of Namibia, and transported to Durban by overnight courier. Table 1 outlines the provenance of accessions collected.

Seeds were germinated on 1% water agar in Petri dishes sealed with Parafilm® in a growth room at 24 °C with a 16 h photoperiod (PAR 50–90 $\mu\text{mol m}^{-2} \text{s}^{-1}$).

* Corresponding author.

E-mail address: clairew@mailbox.co.za (C. Whitaker).