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# The identity of the African pine woolly aphid: a multidisciplinary approach[1]

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A pine woolly aphid of the genus *Pineus* was inadvertently introduced to Zimbabwe in 1962, and now damages plantations of exotic pines in eight countries of eastern and southern Africa. Identification of the species and its area of origin were needed to facilitate collection of potential control agents. Samples of *Pineus* were collected from Africa, Europe, USA, Australia and New Zealand. These were subjected to cytological, multivariate morphometric and DNA (RFLP) analyses. The African *Pineus* showed close correspondence with some of the Australian samples, confirming suspicions that Australia was the source of the introduction. However, there are no native pines in Australia. On morphological and cytological grounds, the African pine woolly aphid also shows affinity with samples from California and Hawaii, and seems likely to be conspecific with *P. boerneri*, originally described from *Pinus radiata* in California. Pine woolly aphid populations in Australia and New Zealand were found to include both *P. boerneri* and a species of European origin, *P. pini*.

## Introduction

Conifer woolly aphids (Homoptera, Adelgidae) are related to true aphids (Aphididae) but retain certain primitive features, such as parthenogenetic females that lay eggs rather than produce live young. The genus *Pineus* comprises species that typically host-alternate in the northern hemisphere between *Picea* spp. (primary hosts) and *Pinus* spp. (secondary hosts). As is frequent in aphids, the sexual phase of the life cycle on the secondary host may be lost, and many species are only known from their parthenogenetic generations on the secondary host. Adelgids have a complex polymorphism, and the apterous females on pines not only differ markedly from the *Picea*-feeding morphs, but they also have relatively few stable, species-specific morphological characters of their own. Taxonomic characterisation and identification of *Pineus* populations on pines is therefore very difficult.

Since about 1968, an introduced species of *Pineus* has become a serious pest of exotic pine plantations in eastern and southern Africa (Mills, 1990). Barnes *et al.* (1976) considered that it may have been introduced first into Zimbabwe, in 1962, on *Pinus taeda* scions from Australia, although there is no firm evidence of this. Very similar insects have infested conifers in Australia and New Zealand for many years, but in those countries also the pine woolly aphids are not indigenous — there being no native Australasian pines — and the number of species introduced and their origins are still in doubt (Eastop, 1966; Tanton & Alder, 1977).

Before attempting biological control of the African pine woolly aphid, it is advisable to know its correct identity and area of origin, so that the most suitable potential biocontrol agents can be located. With this objective in view, we used a multidisciplinary approach combining chromosome studies (performed by the first author), multivariate morphometrics (by the

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second author) and RFLP analysis (by the third author). Samples of eggs and adult insects for this work were collected from various *Pinus* species in Africa (Malawi, Kenya), Europe (UK), USA (California, Hawaii), Australia and New Zealand. What follows is a summary of results that will be published in greater detail elsewhere. Watson (1995) has published a preliminary report.

## Chromosomal analysis

Somatic metaphase spreads were prepared from embryonic cells obtained from eggs fixed in 3:1 methanol/acetic acid shortly (1–2 days) after oviposition. Chromosomes were measured using a Kontron Videoplan image analyser. A total of 40 samples provided chromosome preparations that could be karyotyped.

The eight African samples were collected from various *Pinus* spp. (*kesiya, maximinoi, patula, radiata*; five samples from Kenya and three from Malawi). They all had an apparently identical, structurally heterozygous (aneuploid) karyotype, comprising 17 chromosomes, the most

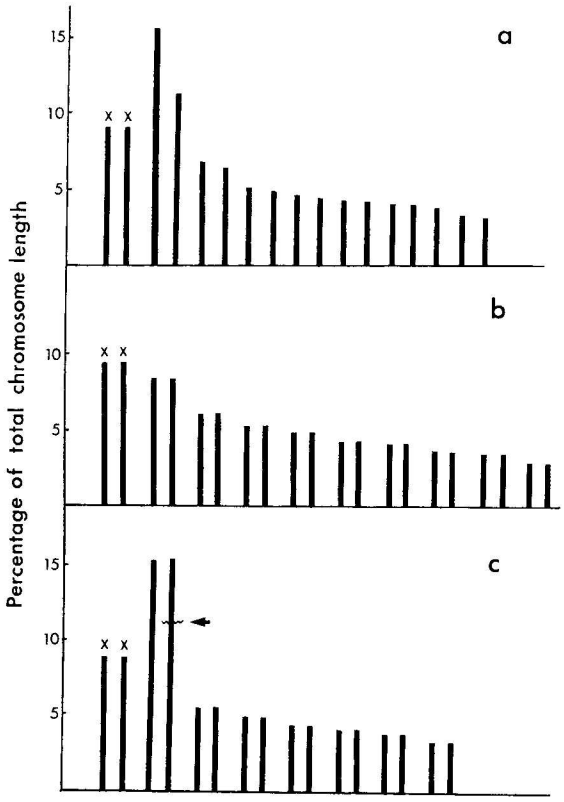


**Fig. 1.** Relative lengths of chromosomes in (a) 17-chromosome *Pineus* from Africa; (b) 2n = 20 from Europe; and (c) 2n = 16 from Hawaii. The arrow in (c) indicates the hypothetical breakpoint to give rise to the 17-chromosome karyotype.
Longueur relative des chromosomes chez les *Pineus* à: a) chromosomes d'Afrique; b) 20 chromosomes d'Europe; c) 16 chromosomes de Hawaii. La flèche dans c) indique le point supposé de rupture qui a conduit au karyotype de 17 chromosomes.