Persistence of velvet worms (Onychophora: Peripatopsidae): effects of fire and climate in forests of south-west Western Australia

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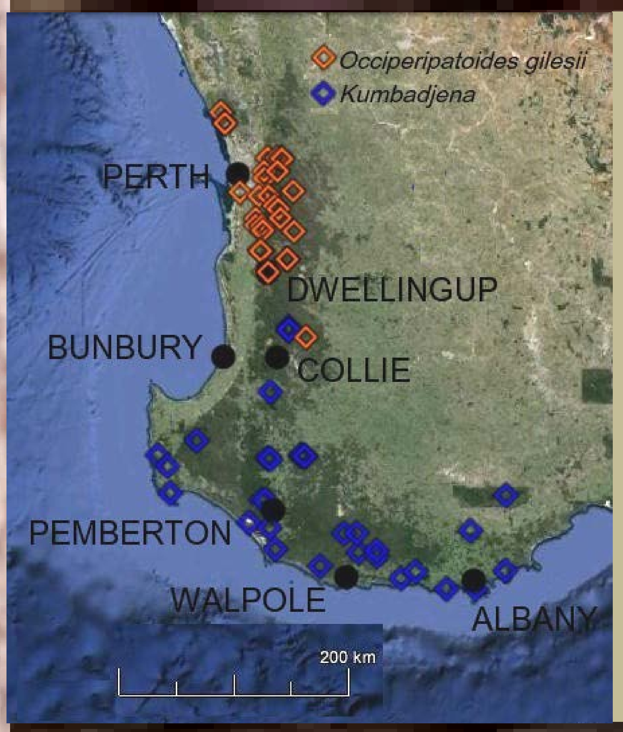
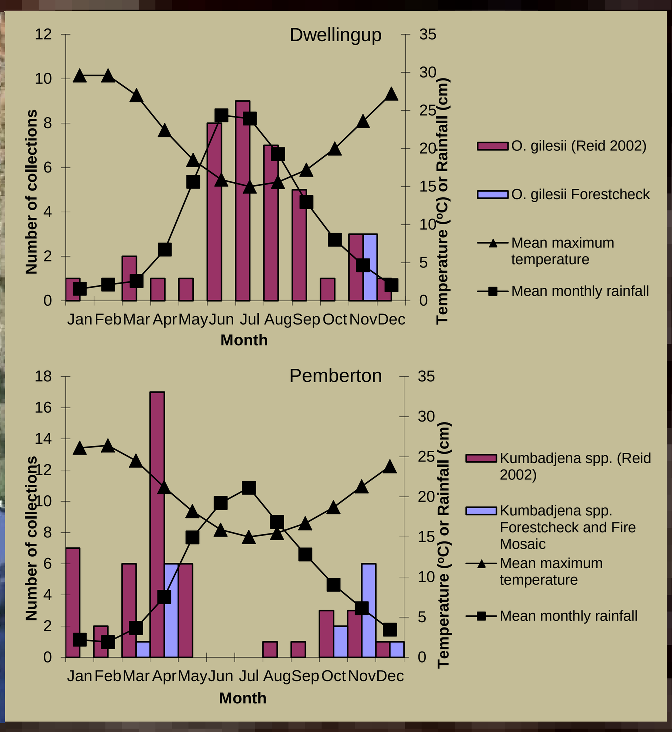




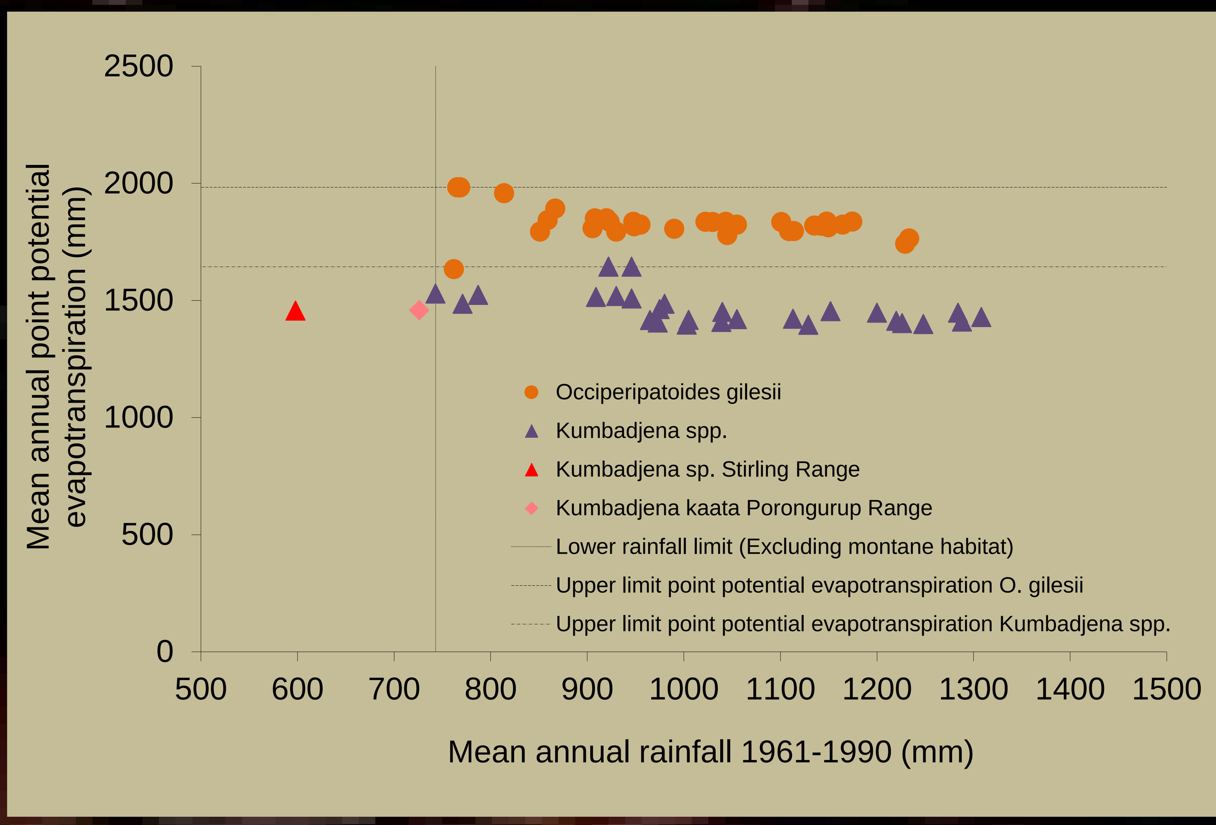
Introduction

In south-west Western Australia onychophorans are represented by the species *Occiperipatoides gilesii* and the genus *Kumbadjena* including three described species *K. kaata*, *K. occidentalis* and *K. shannonensis*, within a species complex of *Kumbadjena* spp. (Reid 2002). *O. gilesii* is known from isolated occurrences in a wetland and karst units of the Swan Coastal Plain (Van Der Lande 1978, Reid 2002) and from a more extensive distribution in jarrah (*Eucalyptus marginata*) forest of the eastern periphery of the Swan Coastal Plain (SCP) and the Darling Plateau from the Mount Helena area south to about Collie (Reid 2002, data this paper). *Kumbadjena* spp. have a southern distribution in an arc from the SCP near Bunbury, the jarrah forest north of Collie (data this paper) and from the Leeuwin-Naturalist Ridge to an eastern inland outlier in the Stirling Range north of Albany. Reid (2002) noted the importance of karri (*Eucalyptus diversicolor*) forest as a provider of habitat for *Kumbadjena* spp. though the genus is also known from jarrah forest and *Allocasuarina* dominated patches within jarrah forest. Observations and specimens of *O. gilesii* and *Kumbadjena* spp. collected during the FORESTCHECK jarrah forest biodiversity monitoring project (Farr et al. 2011, McCaw et al. 2011) and an investigation of effects of fine grain mosaic burning on biodiversity near Walpole Western Australia are reported here.

Climate effects

Long- term mean monthly maximum temperature and rainfall data were obtained for Dwellingup and Pemberton from the Bureau of Meteorology (BOM) web site in 2012. Collection frequencies for each month of *O. gilesii* and *Kumbadjena* spp.and were plotted along with mean monthly temperature and mean monthly rainfall for Dwellingup and Pemberton, locations central to the ranges of these taxa (Figures above right). Mean annual point potential evapotranspiration and mean annual rainfall for the period 1961-1990 were interpolated from gridded surfaces obtained from the BOM for localities listed in Reid (2002), and FORESTCHECK collection and fine grain fire mosaic collection localities (Figure right). All *O. gilesii* and *Kumbadjena* spp. collection sites except the montane sites of the Porongurup and Stirling Ranges experienced mean annual rainfall greater than or equal to 743 mm in the period 1961 and 1990. *Kumbadjena* spp. and *O. gilesii* collection sites were segregated by mean annual point potential evapotranspiration with a maximum value for *O. gilesii* of 1983 mm and a maximum value for *Kumbadjena* spp. of 1644 mm.

There are almost no mechanisms for physiological regulation of water loss in onychophorans. However, closely related species, and males and females of the same species, can differ in their rates of respiratory water loss under the same conditions (Weldon et al. 2013). Differences in seasonal activity, and the apparent difference in climatic tolerances of *Occiperipatoides* and *Kumbadjena* suggest that differences in respiratory water loss, and or life cycle traits may play a part in the distribution limits of Western Australian onychophorans.



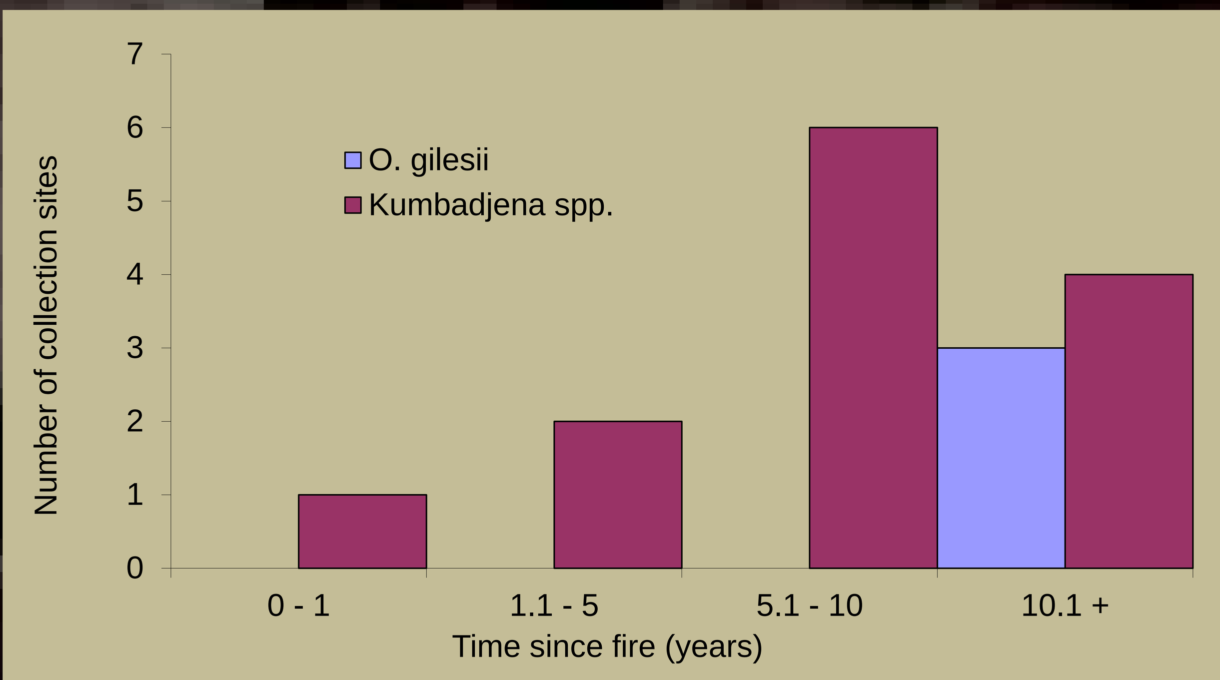
Time since fire and collection frequency

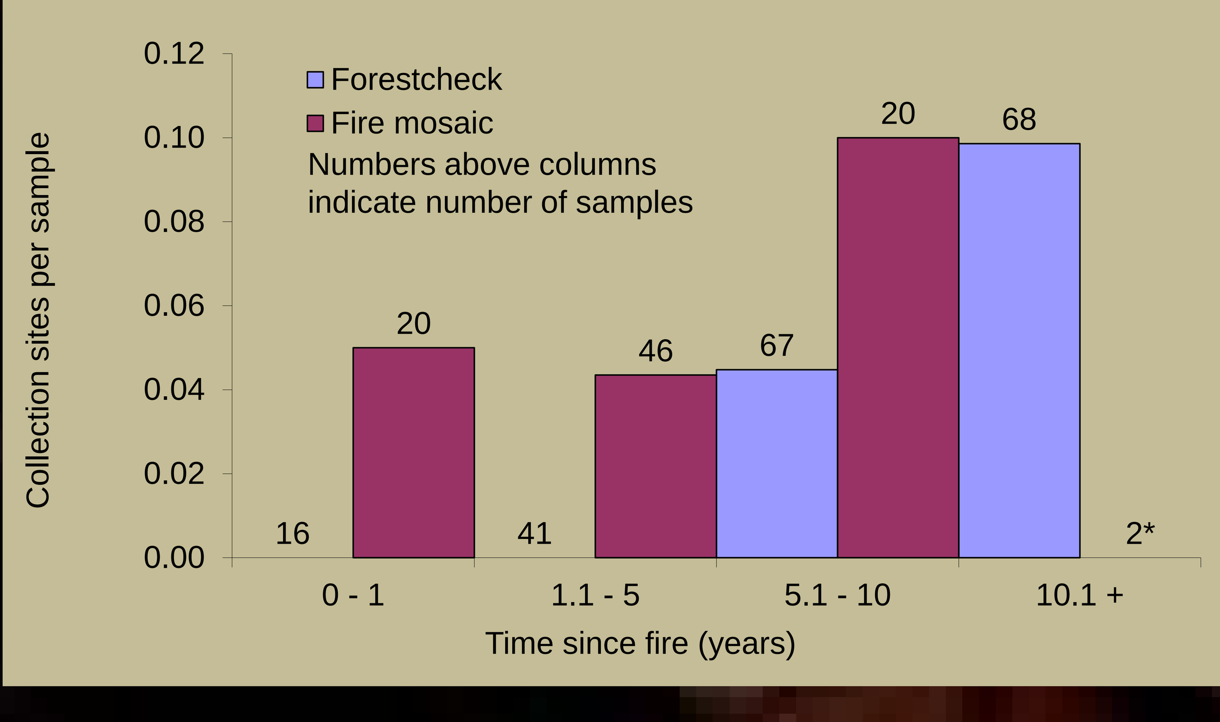
Litter is an important though insecure habitat for onychophorans in Western Australia. Three quarters of the specimens collected in the FORESTCHECK and fine grain fire mosaic projects were collected from litter or from pitfall traps in litter beds. The remaining specimens were collected from movable woody debris. Logs were not dissected. Much of the fine fuels that constitute the litter habitat used by onychophorans in jarrah forest is likely to be consumed in fires of the low intensities encountered in prescribed fuel reduction fires (61-98% fine fuel consumption in jarrah forest fires, with fire intensities < 700 kWm^{-1} (Hollis et al. 2010)). This highlights the ephemeral nature of litter habitat and the importance of fire durable fallen logs for onychophorans.

Collection sites were subjected to a variety of fire intensities ranging from wildfire (Photo left top) to cool controlled fire (Photo left bottom), under Western Australian conditions of fire management, and across a mix of unharvested, regeneration after partial harvest and regeneration after gap harvest silvicultural treatments (i.e. fire and silvicultural history effects were not controlled in the data presented here). Sampling took place in Autumn and Spring, times of low collection success rate for *O. gilesii* .

Kumbadjena sp. were collected from a single site 6 months after a cool, late spring prescribed fire, while no *O. gilesii* were collected less than 17 years after fire (Figure below, top).

Success rate of onychophoran collection increased with time since fire on both FORESTCHECK and fine grain fire mosaic sites. Highest rate of collection was from 10.1 or more years after fire in the FORESTCHECK collection and 5.1 or more years after fire in the fine grain fire mosaic collection (Figure below, bottom). Fisher's exact probabilities of observed or more extreme collection frequencies were significant for FORESTCHECK sampling (Probability of zero samples of post-fire age 5 or less years containing onychophora = 0.027), and not significant for fine grain mosaic samples (Probability of 3 or less samples of post-fire age 5 or less years containing onychophora = 0.367). From the present studies, collection rates from non-log habitat in samples categorized by time since fire tend to indicate that recovery of onychophoran populations after fires takes 5 to 10 years (southern) and at least 10 years (central and northern jarrah forest) to recover to pre-fire levels.





Acknowledgements

We thank DPaW districts staff and the many students and volunteers who have assisted in specimen collection and sorting for the FORESTCHECK and Walpole small grain fire mosaic projects. The above image of aftermath of wildfire was provided courtesy of Ted Middleton.

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