Fire-free environments across southern Africa's biomes: distribution and refugial value

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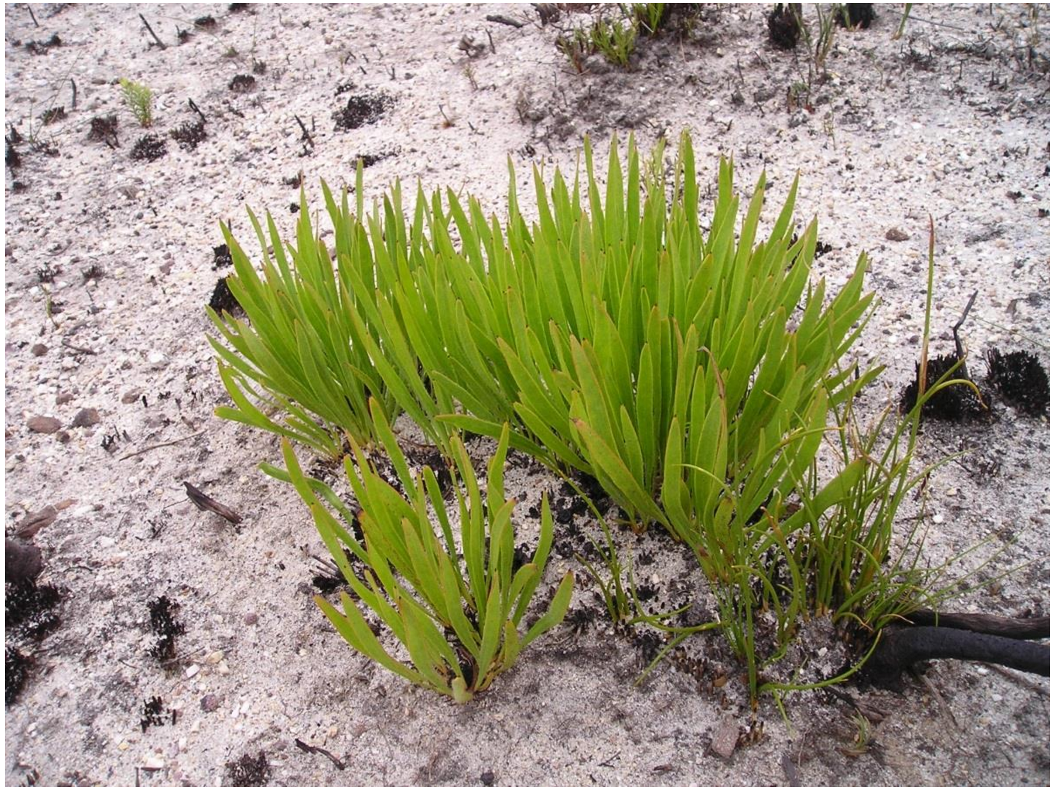
Fire: wonderful adaptations



So what about those who are not adapted?

Fire influences populations:

- Directly (mortality, germination in plants, dispersal in animals)
- Indirectly: ability to survive, compete in new post-fire landscape

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Grasshopper response to a 40-year experimental burning and mowing regime, with recommendations for invertebrate conservation management

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Fire resilience of ant assemblages in long-unburnt savanna of northern Australia

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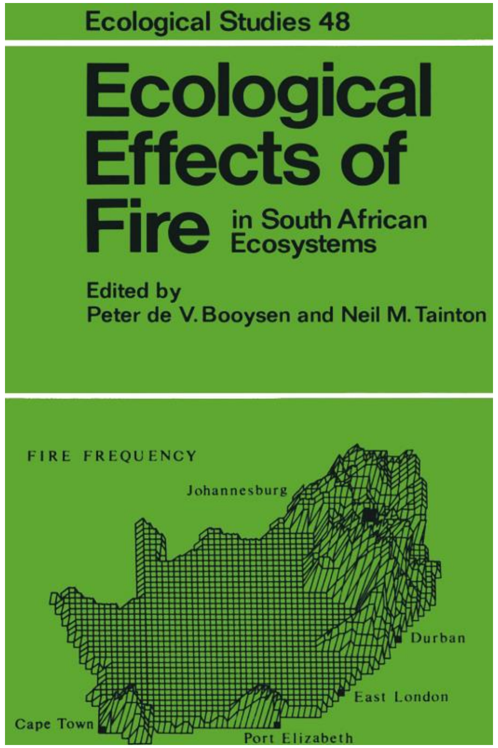
- We have a good understanding of the latter. The former, mostly in plants
- How do animals survive fire?

How do animals deal with fire?

- A) adults survive fire by hiding or fleeing
- B) die, only survive as concealed eggs/pupae/other dormant stages



Chapter 13 The Responses and Survival of Organisms in Fire-Prone Environments

P. G. H. Frost

comprised 23% of the area) was 280% higher than the prefire density in the same area. Correspondingly, the number of grasshoppers per unit area of burnt ground declined by 94% (Figure 11). Similar observations have been made in west Africa (Gillon and Pernes 1968).

Less mobile invertebrates which cannot flee the fire must take shelter in situ. For ground dwelling invertebrates, sheltered sites might include cracks in the ground, rodent burrows, termite mounds, rocks or any other site where some relief from high temperatures can be obtained. These fire-sensitive species should have well developed sensory capabilities to detect and respond to an approaching fire. For example, ticks drop to the ground and seek shelter at the slightest sensation of smoke, apparently reacting to volatile substances which are released only at high temperatures (T Bosman, personal communication, 1979). Such responses enable many slow moving invertebrates such as arachnids, blattids, tetrigids, lygeids and myriapods, as well as substantial numbers of mantids, grillids and carabids to survive fires (Gillon and Pernes 1968). Subsequently though, most of the survivors disappear, presumably because of the unsuitability of the immediate post-fire environment.

Arboreal insects do not appear to survive fires well. Gandar (1982) reports almost complete destruction of the arboreal insect fauna on *Ochna pulchra* and *Dombeya rotundifolia* (wild pear) during a savanna fire. Eggs and pupae may survive in sheltered sites (such as beneath bark or in hollows) and some adults may be able to fly to unburnt sites, but the exposed environment in trees, and the heat and smoke from the fire below, makes survival difficult.

Insect populations recover after fire through immigration or through the development of larvae which, as eggs deposited in the soil, survive the fire in situ. For example, after a savanna fire, grasshopper numbers gradually increased on the burnt areas while the numbers on adjacent unburnt areas decreased (Figure 11), suggesting immigration to burnt areas as the vegetation recovered (Gandar 1982). At the same time, there was no significant difference between the numbers of Scarabaeidae and Curculionidae emerging within two months of the fire on burnt and unburnt plots, indicating that the eggs, larvae and pupae living in the soil were unaffected by fire (Gandar 1982). In the fynbos, scarab beetle larvae are often found in *Amitermes hastatus* termite mounds (F Kruger, personal communication, 1980). Similarly, the larvae of a number of lycaenid butterflies (eg *Lepidochrysops trimeni, L. methymna, L. variabilis)* shelter inside the nests of the ants *Anoplolepis custodiens* and *Camponotus maculatus* with which they have symbiotic relationships (Clark and Dickson 1971). In these cases, escape from fire may merely be a consequence of associations which have evolved in response to other selection pressures, though it is noteworthy that the food plants of these species (principally *Selago* spp, including *S. serrata*, and possibly *Aspalathus sarcantha)* are more common after fire (Clark and Dickson 1971; Jackson 1976).

In brief:

- Many don’t or seldom do.
- Matter of spatial grain, population growth rates etc

- Some of these could be ancient lineages of relevance to conservation.

- Ultimately, where are they more likely to survive in a fire-dominated region?

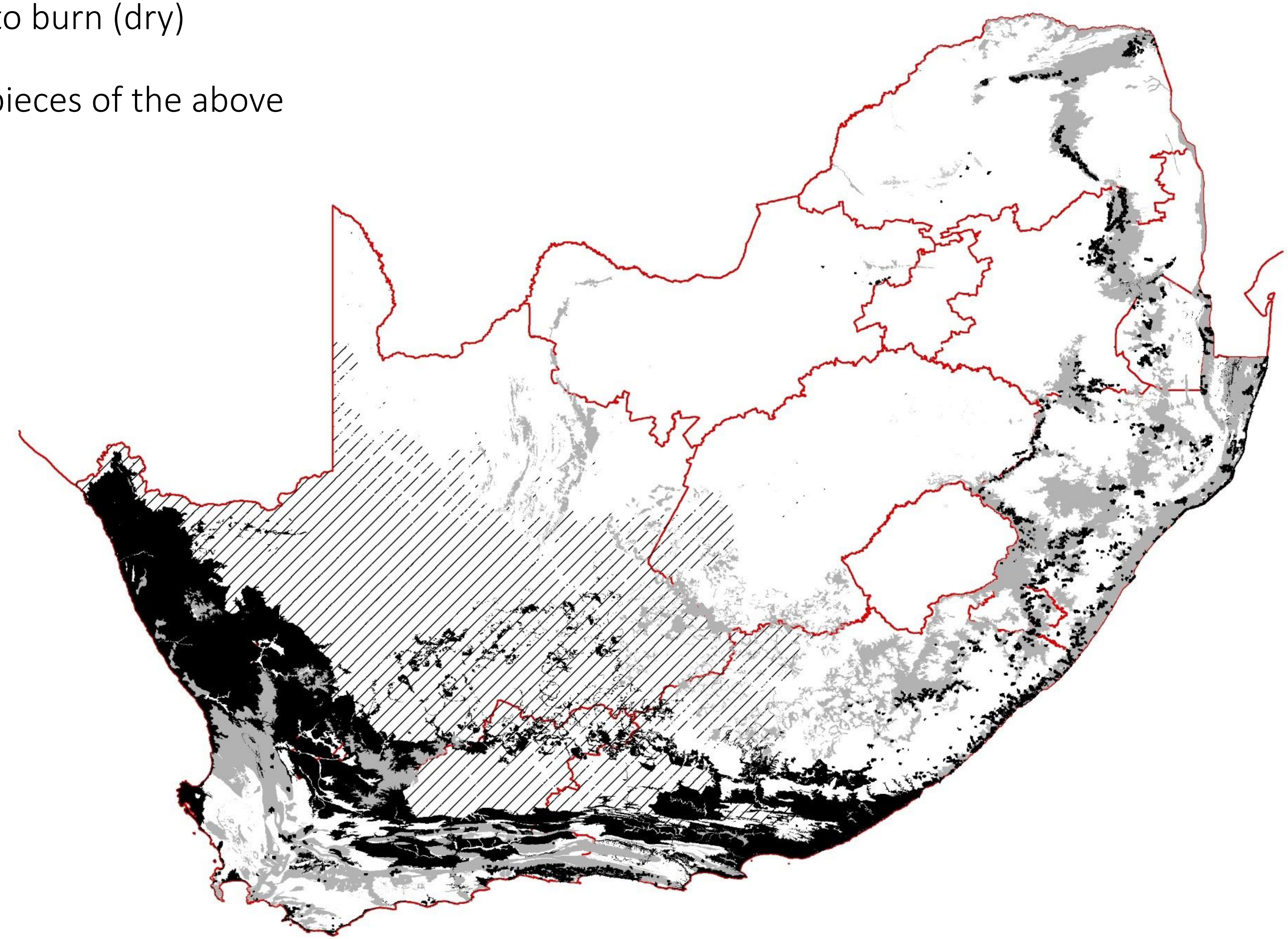
So what is fire-free?

A) too wet (either waterlogged, or succulent)

B) too little to burn (dry)

C) too rocky

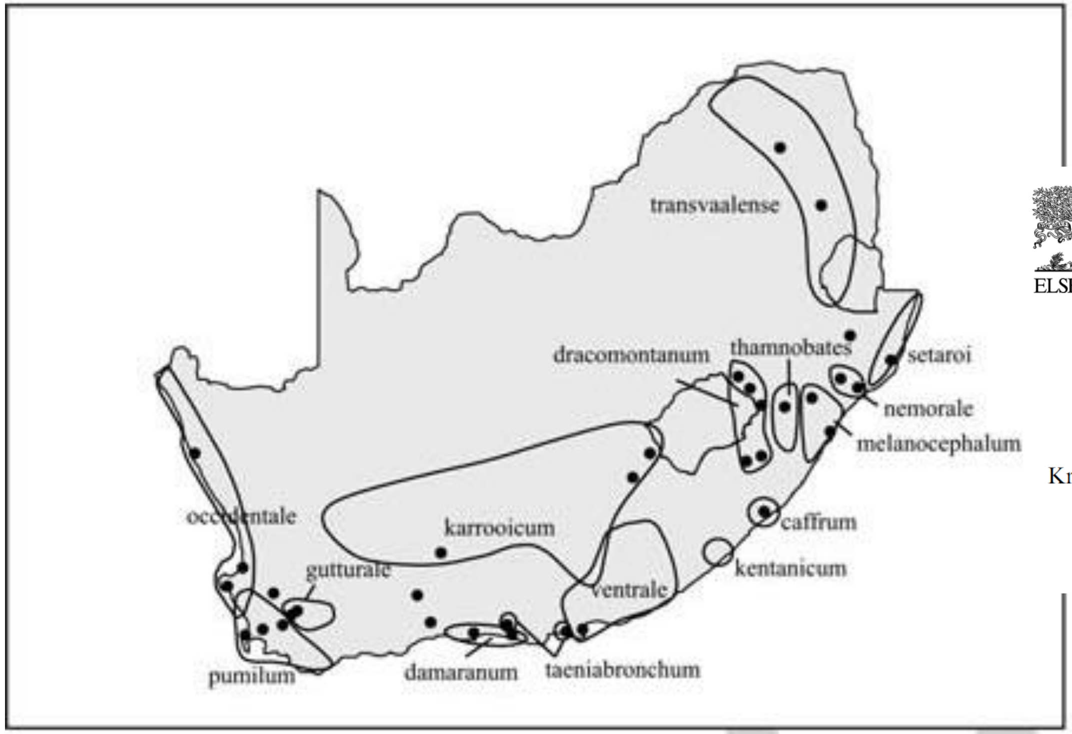
D) bits and pieces of the above



So this is where we expect to find ancient plant and animal lineages that are not fire-adapted

Examples:

Dwarf chameleons (*Bradypodion*)



Movement of the Cape dwarf chameleon (*Bradypodion pumilum*): are they vulnerable to habitat fragmentation?

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Phylogenetics of the southern African dwarf chameleons, *Bradypodion* (Squamata: Chamaeleonidae)

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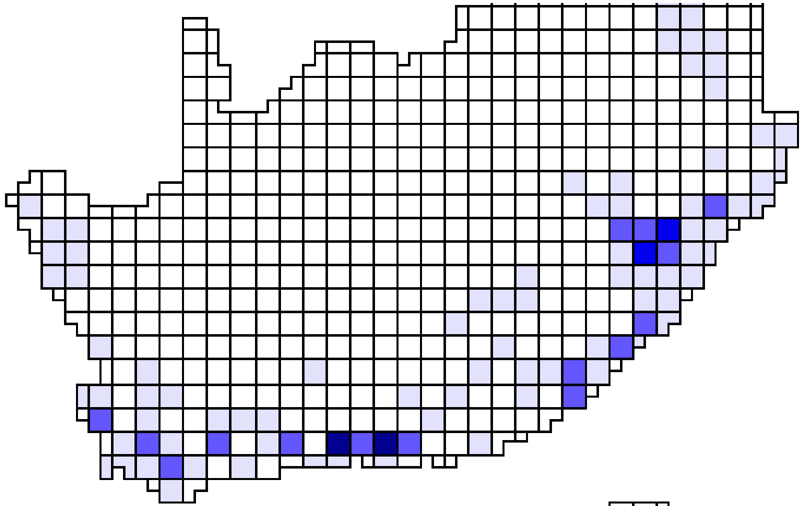

Grass lizards (*Chamaesaura*)

Pneumoridae (bladder grasshoppers)

Pyrgomorphidae (gaudy grasshoppers)

How does the distributions of such lineages add up?

- No such studies to my knowledge

- But probably most ancient lineages survive in this type of environments
- Map of ancient lineage diversity

Mapping the distributions of ancient plant and animal lineages in southern Africa

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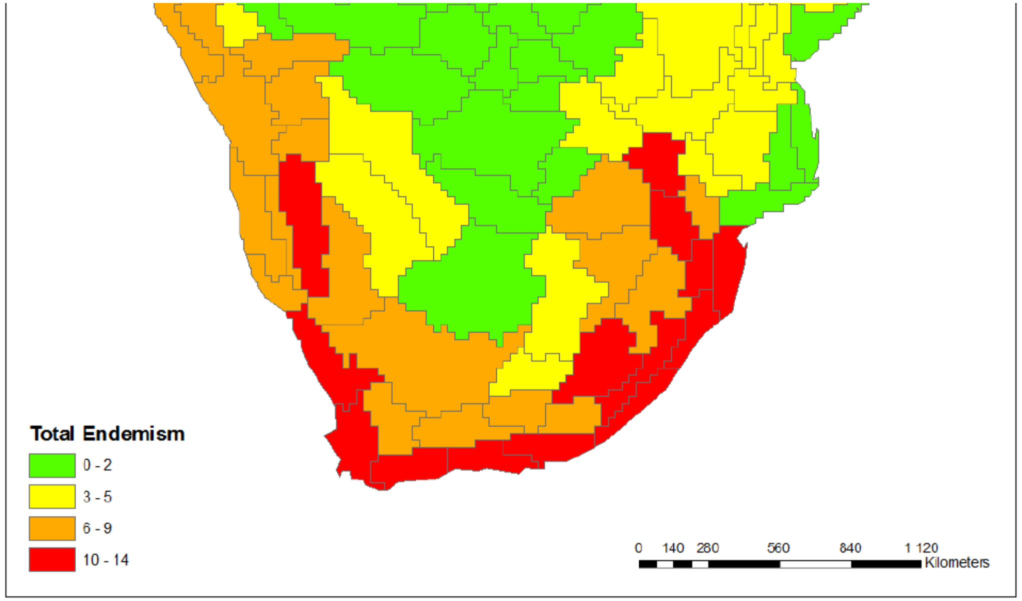

Figure 4.1: Total endemism map for the ancient plant and tetrapod lineages of southern Africa. A graduated colour symbol was used to display total endemism scores using four classes of Jenks Natural Breaks in ArcGIS ArcMap (ESRI, 2006). Operational Geographic Units

	Lineage:
1.	*Grielum*
2.	*Rhoptropella*
3.	*Petromus typicus*
4.	*Malacothrix typica*
5.	*Platysaurus*
6.	*Narudasia*
7.	*Tulbaghia*
8.	Bruniaceae
9.	*Bradypodion*
10.	*Afroedura*
11.	Promeropidae
12.	Heleophrynidae
13.	*Rhoptropus*
14.	Geissolomataceae
15.	Lanariaceae
16.	Greyiaceae
17.	Grubbiaceae + Curtisiaceae
18.	Roridulaceae
19.	*Stangeria*
20.	Welwitschiaceae
21.	*Agapanthus*
22.	*Moringa ovalifolia*
23.	*Anthochortus + Willdenowia*
24.	*Nectaropetalum*
25.	Nivenioideae
26.	*Hypocalyptus*
27.	Achariaeae

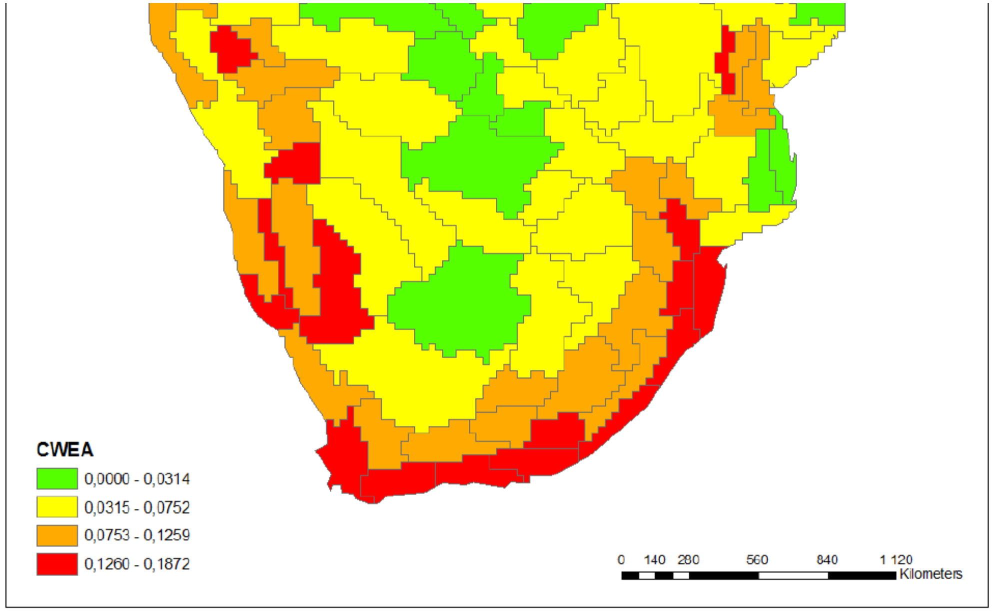

Figure 4.2: Corrected Weighted Endemism for southern Africa. A graduated colour symbol was used to display CWEA scores using four classes of Jenks Natural Breaks in ArcGIS ArcMap (ESRI, 2006). OGUs shown in red indicated the highest CWEA scores, whereas green units have the lowest CWEA scores.

What can we do?

- Fire exclosure experiments – both towards research and as conservation units as such
- Mapping of fire-sensitive lineages as such – regionally
- Mapping them fine-scale, in the field
- Observations on behaviour in the face of fire

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