Australian Association of Bush Regenerators (WA) Inc

Volume 16 Issue 2 NEWSLETTER May 2008

Germinating Australian Seeds in the 21st Century – a new attitude on an old enigma

A talk by Dr David Merritt; Kings Park and Botanic Garden, West Perth, WA.

MARCH FORUM REPORT

David's talk to the AABR (WA) Annual General Meeting on March 12 was both fascinating and informative. After eleven years as a seed conservation scientist at the Kings Park laboratory he and colleagues are gradually unraveling germination secrets of many recalcitrant Western Australian native plant species. For some there is a complex interplay between temperature regimes, seed maturation periods, and seed dormancy where some species over long periods of time actually turn dormancy off and on depending on season and conditions. The challenge then, is to find the right combination of treatments to coax germination.

Seed research is essential for enhancing conservation efforts and the restoration of natural ecosystems. The priority research areas are seed storage, seed dormancy and germination, seed enhancement (to increase seedling emergence and survival under field conditions), and seed ecology. At Kings Park, seed dormancy currently is the main focus of this research.

The mining industry uses 70-80% of all native seed collected in Australia, which amounts to around 60 – 80 tonnes annually. Appropriate research can reduce the amount of seed used in restoration. Alcoa for example, now uses significantly less seed because of improved efficiency. Alcoa rehabilitate 550 hectares per year, and in the past 30 years has used 47 tonnes of seed.

Seed dormancy – a major impediment to restoration

Many genera of Australian plants are difficult to germinate, and this applies to around half of the species in typical Southwest bushland. Many of these difficult species are required for land restoration, being dominant understorey species. They are strongly represented by the following families: Restionaceae; Cyperaceae; Ericaceae; Dilleniaceae; Rutaceae; Myoporaceae; and Goodeniaceae.

There are good reasons for seed dormancy – after all, a seed bets its life on germination. It needs a mechanism to prevent germination during (transient) periods when conditions are conducive to germination, but seedling survival is unlikely. Dormancy does not mean there is something wrong with the seed or that there is an absence or failure of germination, nor is it associated with the external environment. **Thus dormancy is best defined as an internal condition of the seed that defines what environmental conditions must be met to make the seed germinate**.

Because seeds are shed with different degrees of dormancy, seed germination is distributed over time. Dormancy also reduces sibling competition, and allows a soil seed bank to build up.

70% of all angiosperm seeds across the world are dormant to some degree. Australian geosporous species (those

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Australian Association of Bush Regenerators (WA) Inc.
Perth Biodiversity Project
Local Government Natural Area Managers Network (NAMN)

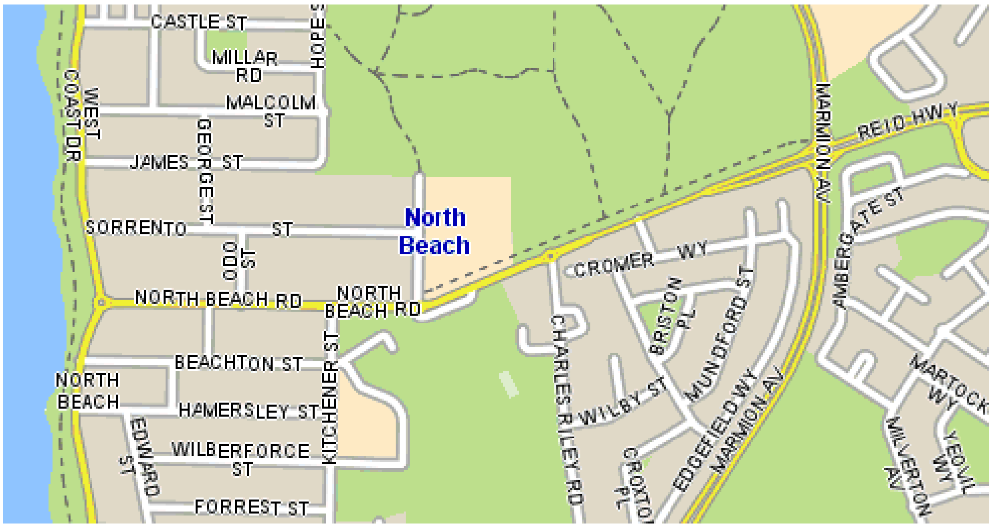
Forum

Wednesday 14th May 2008

Henderson Environmental Centre

RSVP: For catering purposes, RSVP to Cecilia Jordan (9213 2048 or cjordan@walga.asn.au) by **Friday 9th May**.

Where: The forum will be held in the **Henderson Environmental Centre** at the **City of Stirling** (Groat Street, North Beach).



Agenda

Time	Topic	Who
9:15am – 9:30am	Registration and tea/coffee	*All*
9:30am – 9:35am	Welcome and Housekeeping	Cecilia Jordan, PBP Dave Bright, AABR
9:35am – 10:35am	"The Little Things That Matter : invertebrates, fungi and slime moulds in our bushland" *Questions*	David Pike *All*
10.35am – 11.00am	Morning Tea	*All*
11.00am – 11:15am	"Veldt Grass Trial Results" *Questions*	Julia Cullity, Greening Australia *All*
11:15am – 12:00pm	Round Table Discussion	*All*

AABR (WA)'s *New* Management Committee

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Minutes Secretary
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Correspondence Secretary
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Committee members
Brett Kuhlmann

Non-committee members

Webmaster
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Newsletter Editor
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Vice Presidents' Report to 2008 Annual General Meeting

AABR (WA') Annual General Meeting was held in the Kings Park Administration Building on Wednesday March 12. Bob Dixon presented the following Vice Presidents' Report:

Committee

We were unable to fill the vacancies on our committee last year so have continued to operate at less than half-strength with both Vice Presidents filling in as President and other roles being shared. I would like to take this opportunity to thank the other committee members for their dedication to AABR.

Speakers

During the year we have had some excellent speakers at our forums/meetings and we continued the practice of jointly funding some day-time forums (one this year) with NAMN (Local Government 'Natural Area Management Network'). Speakers and topics included:

- **Mike Butcher; *More than One Way to Skin a Rabbit* (March).**
- **Jonny Profumo; *Frogs*** and **Mike Butcher; *Feral Pests* (May**).
- **John Moore, Crop Protection Adviser; *Herbiguide* (November).**

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that dehisce seed into the soil seed bank) make up 70 - 80% of the total species of plants, and are most likely to be dormant. Serotinous species (where seeds are retained in woody structures for long periods) are usually non-dormant.

Sought after families containing species that are difficult to germinate, with the most important in bold, are: Anthericaceae; Asteraceae; Campanulaceae; **Cyperaceae**; Dasypogonaceae; **Dilleniaceae**; **Ericaceae**; Euphorbiaceae; Goodinaceae; Gyrostemonaceae; Haloragaceae; Iridaceae; Lamiaceae; Myporaceae; Onagraceae; Phormiaceae; Pittosporaceae; Poaceae; Proteaceae; Ranunculaceae; **Restionaceae**; **Rutaceae**; and Violaceae.

Objectives in seed germination research

Research on seed germination ecology provides information on how and when seeds germinate in the field, dormancy loss/induction cycles, and the response to smoke or other germination stimulants.

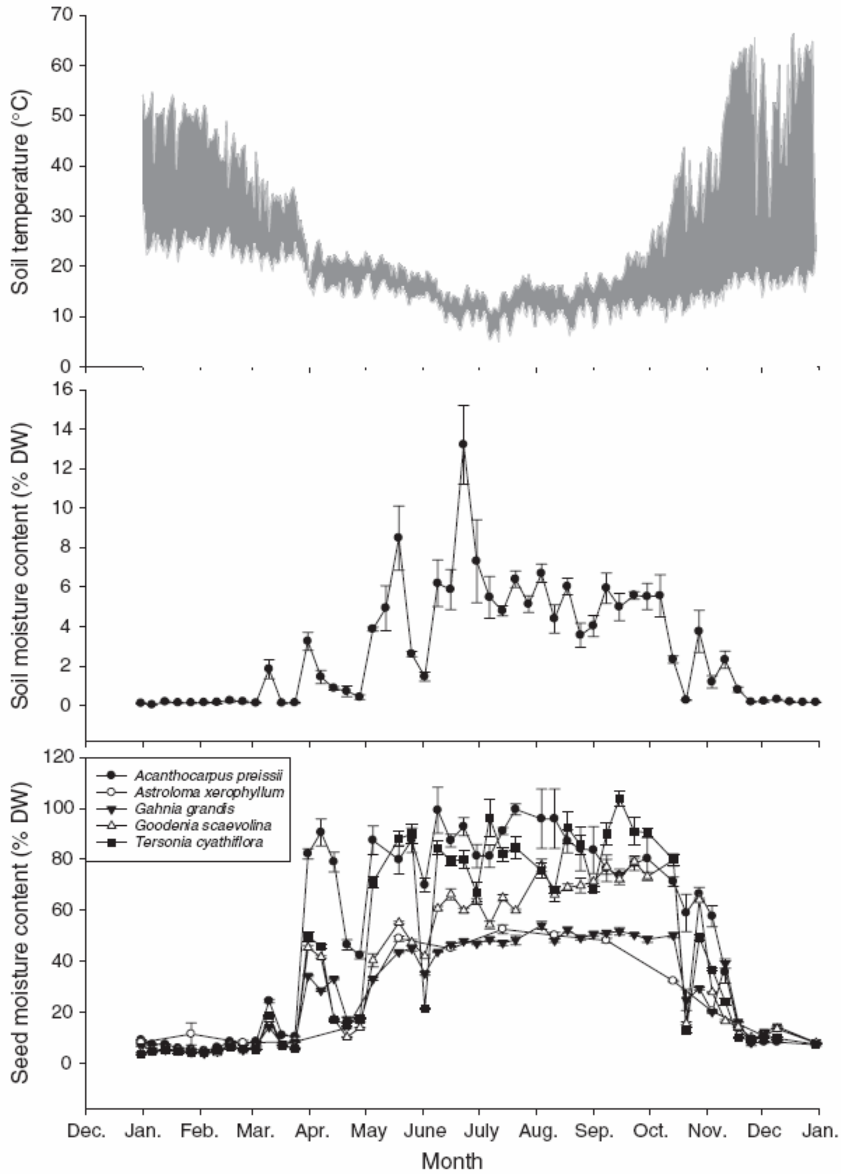
For conservation and restoration purposes it is important to be able to mimic germination ecology in the laboratory, and find treatments that are efficient, repeatable and applicable to large numbers of seeds. It is also important to understand the storage effects on the dormancy state and germination requirements.

Seed burial experiment

What can we learn from nature to better inform germination experiments? David and his colleagues found a way of measuring seed response to field conditions by burying seed. These were contained with sand in nylon-mesh sachets and buried 2cm below the soil surface at a bush site in Kings Park for the entire period of 2005. The sachets were retrieved and replaced weekly, and a sample of seeds measured for moisture content. The method defined natural temperature and moisture cycles, and identified periods of:

- Warm dry;
- Warm moist;
- Cool moist;
- Rapid wetting and drying.

The graphs below (Merritt *et al.* 2007) show the seed moisture content for five species as well as soil temperature and moisture over the year. In bushland seeds experience highly variable conditions prior to germination. Most seed is shed to soil in summer where surface temperatures are regularly 50˚C, and can rise to 60˚C and beyond. With the first autumnal rains seeds will absorb moisture, then lose it as the soil dries until the next wet period. Thus, seeds can be exposed to many cycles of variable temperature and moisture conditions before they germinate.



Soil temperature, soil moisture content and seed moisture content of five species buried in nylon-mesh sachets (75 µm), 2 cm below the surface in bushland sand (quartz-silica sand of the Spearwood dunes), within Kings Park and Botanic Garden, Perth, Western Australia, between 1 January and 31 December 2005. Seeds were buried on 1 January 2005 and retrieved weekly (monthly for *A. xerophyllum*) and seed moisture content (or seed plus surrounding endocarp for *A. xerophyllum*) determined gravimetrically (g H2O g–1 DW) following drying at 103˚C for 17 h (ISTA 1999). Three replicates of 15 seeds (or ~0.1 g seeds for smaller seeds) were used. Soil moisture content was determined weekly from three replicate soil samples (100 g each) that were dried for at least 24 h at 103˚C. Soil temperature was logged every 70 min by a Tiny TagTM data logger, with a temperature probe placed 2 cm below the soil surface. Temperature data presented represent the maximum and minimum temperatures recorded each day. Tick marks on the *x*-axis denote the beginning of the month.

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Variables in stratification and after-ripening treatments

- What temperature for stratification or after-ripening?
- What length of time for stratification or after-ripening?
- What incubation temperature?
- When and how to use smoke?

Seeds can be manipulated in the laboratory by mimicking natural temperature and moisture conditions, and introducing other known germination stimulation tools such as smoke treatment. In warm stratification seed is kept moist at 20˚C or more for a period, and in cold stratification at 5˚C or less. The latter is more important for Northern Hemisphere plants and has been employed by those in the nursery industry for years, whereas many Australian species respond well in winter when exposed to warm stratification. Previously warm stratification was overlooked, until Kings Park and Botanic Gardens began investigating it.

As well as warm or cold stratification it is useful to mimic day/night changes in temperature by exposing seed to alternating temperatures; for example, an 18˚C/33˚C regime (replicating summer) and 13˚C/26˚C regime (replicating autumn). After the stratification period, seed is incubated (either at a constant or alternating temperature) and percentage germination recorded. For instance *Acanthocarpus preissii* and *Lomandra preissii* both germinated well after warm stratification with either a 18˚C/33˚C or 13˚C/26˚C regime (5-15 weeks for the former, 4-8 weeks for the latter) followed by many weeks incubation at 7˚C /18˚C. *Xyris lanata* germinated best after a short three week stratification, followed by a cool constant incubation at 15˚C. It also did quite well with six weeks stratification, followed by incubation at 7˚C /18˚C, but failed with 12 weeks stratification. *Hopkinsia anoectocolea* prefers a longer stratification (12 weeks) and a warmer incubation (15˚C or 20˚C). For graphs showing some of these results along with additional information see the given references.

Some conclusions from stratification experiments

- Stratification for six weeks appears suitable to observe a response.
- Summer and autumn temperatures are equally effective.
- If a stratification response is identified, a matrix of stratification times and incubation temperatures is useful to refine a treatment.
- Positive response to warm stratification is found in many families including Dasypogonaceae, Dilleniaceae, Hopkinsiaceae, Laxmanniaceae, Pittosporaceae, and Xyridaceae.

Smoke

The role of smoke in enhancing germination was discovered in South Africa, and is a global phenomenon – even where fire is not part of the ecology. While it doesn't solve all germination problems, it has proven to be a very useful tool here in WA. Application of smoke has resulted in a 48 fold increase in the total number of germinants in the soil seed bank and a four fold increase in species diversity, with approximately 1,200 Western Australian species responding under field conditions. In the laboratory some 82 genera have been found to respond, with over 2,000 species showing an improvement in germination. Globally, more than 2,500 species respond.

After ten years research the active chemical was identified, and it is derived from the oxidation of cellulose (fire being an extreme oxidant). It is believed the breakdown of leaf litter (i.e. slow oxidation of plant matter) may also releases the same chemical, although this is yet to be proven. Interestingly, some seeds that need light to germinate will do so in the dark when exposed to the chemical. It is thought disturbance is part of the equation. For example, smoke sensitive species can also be observed germinating in disturbed areas (such as alongside a road) even where there has been no fire.

Kings Park experiments confirm that smoke is a germination stimulant, not a dormancy breaker. While some non-dormant seeds may need a germination stimulant such as smoke a dormant seed will not respond to smoke. Rather, dormancy is generally controlled by temperature and moisture factors. This is supported by laboratory tests on the following three species which responded well with a combination of stratification and smoke, followed by incubation with the presence of smoke: *Hopkinsia anoectocolea*, *Lomandra preissii*, and *Pyrorchis nigricans*. None germinated (regardless of smoke or not) until they'd undergone a period of stratification. Dry after ripening was found to be important for *Anigozanthos manglesii*. Its seed (which don't germinate well in the absence of smoke, but germinate strongly with it) needs to be many months old before smoke becomes effective. This raises question of how and when to apply smoke.

Rationalising germination strategies in a diverse flora

The following two graphs (Merritt *et al.* 2007) summarise the key aspects involved in seed dormancy and germination.

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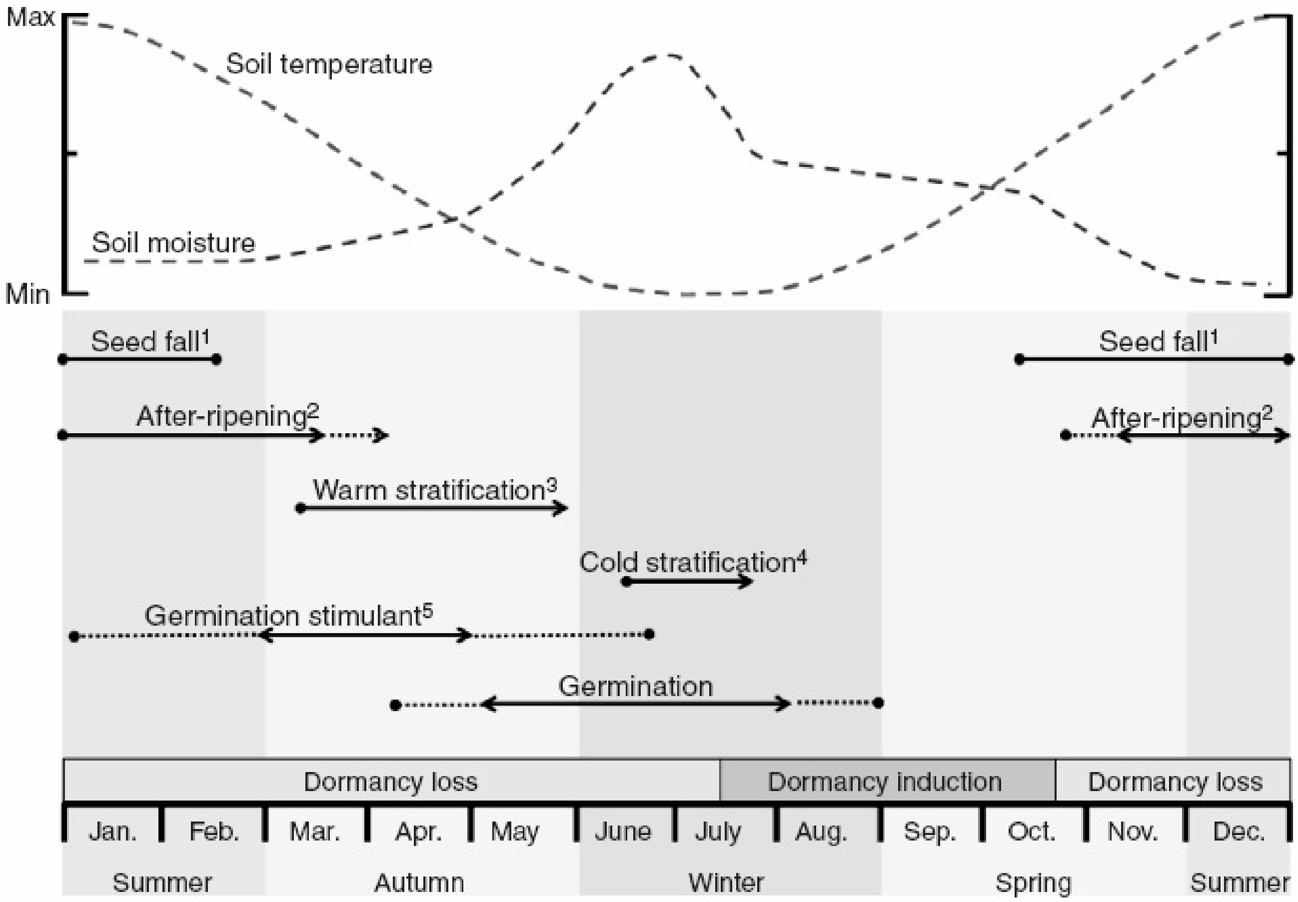
FUNGI

'TIS THE SEASON FOR FUNGI

We look forward to reporting on any unusual finds this year, so please contact the Editor with details and photographs. Ed.

FUNGI

Germinating Australian Seeds continued from page 5



A diagrammatic representation of the timing of seed dormancy loss/induction and germination events for seeds released into the soil seedbank in temperate areas of Australia. The dormancy loss/induction cycle may continue over several years until seeds experience appropriate conditions and germinate, or until seeds lose viability. Soil-temperature and soil-moisture profiles are indicative only, but are derived from data gathered over a 1-year period in a single location in south-western Australia. The solid lines represent the main time periods over which the specified events occur, and the dashed lines the less likely periods when the events may occur. 1Seed fall is defined as the entry of seeds into the soil seedbank, following shedding from the parent plant at maturity. 2After-ripening is defined as dormancy alleviation of seeds in a dry state. After-ripening usually occurs most efficiently at warmer temperatures (e.g. >15℃). 3Warm stratification is defined as dormancy alleviation of moist seeds at temperatures ≥15℃. 4Cold stratification is defined as dormancy alleviation of moist seeds at 0–10℃. 5The prominent naturally occurring germination stimulant in the Australian flora is smoke. Other less-commonly reported stimulants include light, nitrates and ethylene. The timing of the stimulant relates to when the seed receives the cue, for example on the percolation of smoke products into the soil profile during the first rainfall event following a fire.

Question Time

Most seed propagated for restoration projects are not done at the ideal time, generally starting in late spring, early summer ready so the plants are ready for mid year plantings. Ideally, community groups or nurseries should have access to cool room storage where seed can be kept at 15 °C for variable periods before use.

Other useful germination triggers include gibberellic acid. Of limited use is 1% concentrations of sulphuric acid. This works for Acacias, however hot water is adequate. It is best to avoid boiling water and long soaking times – 15-30 seconds at 90° C can be enough. Otherwise, keep in the water overnight.

While some species require a number of seasons cycling in and out of dormancy, there can be a reduction of seed viability with time. Assessing viability can be difficult. This can be done with stains, cutting, or extracting the embryo and growing it on a medium.

REFERENCES

Merritt DJ, Turner SR, Clarke S, Dixon K W. 2007. Seed dormancy and germination stimulation syndromes for Australian temperate species. *Australian Journal of Botany* **55**, 336–344

Turner SR, Merritt DJ, Ridley EC, Commander LE, Baskin JM, Baskin Conservation Category wetlands, Dixon KW. 2007. Ecophysiology of Seed Dormancy in the Australian Endemic Species *Acanthocarpus preissii* (Dasypogonaceae). doi:10.1093/aob/mcl203, available online at www.aob.oxfordjournals.org

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Footnote: Some of the figures presented in the talk were unpublished. AABR (WA) will keep an eye out for relevant papers when published, and advise readers in later editions of the newsletter.

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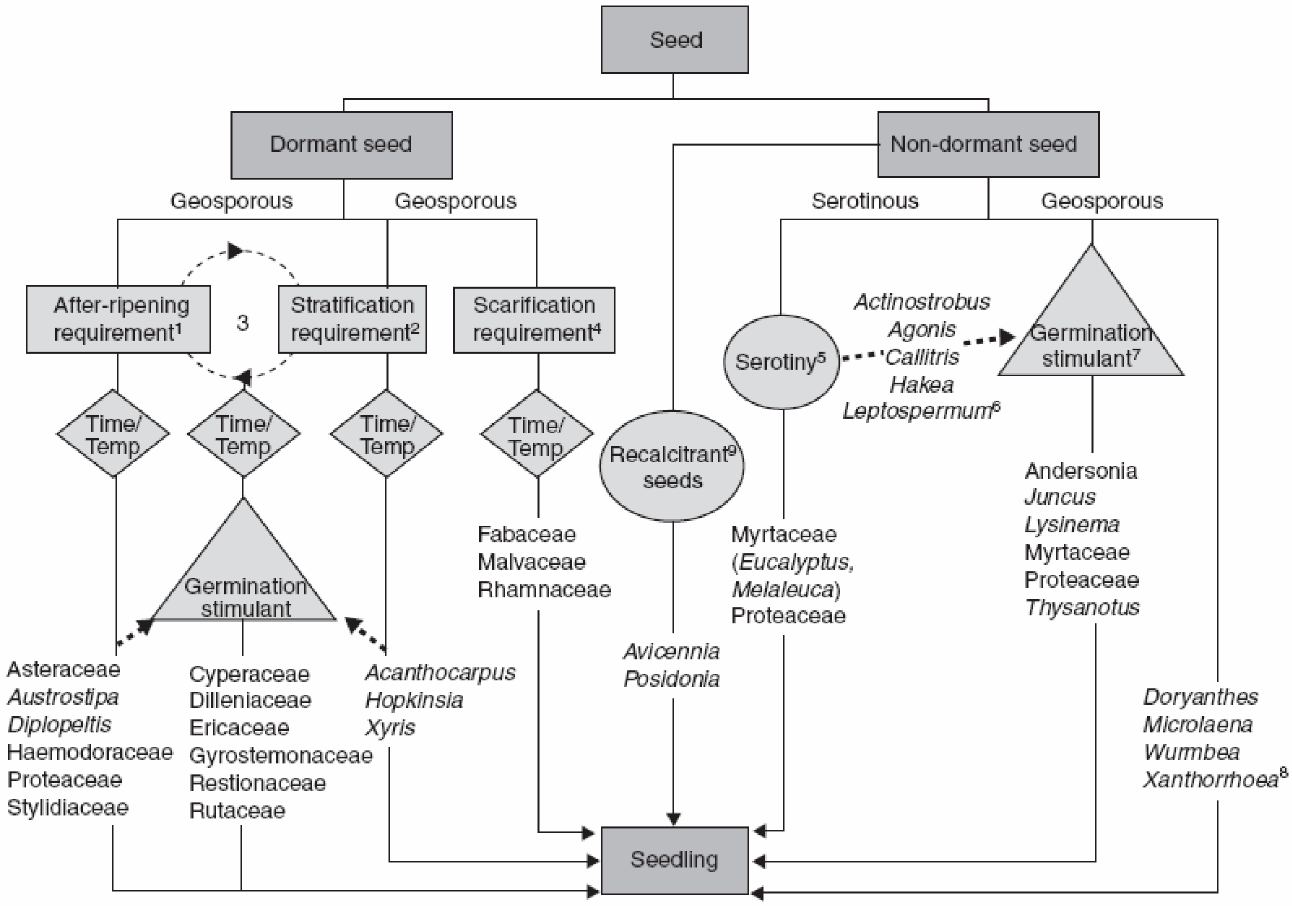

A diagrammatic representation of seed dormancy release/germination stimulation syndromes for Australian temperate species. The model is applicable to factors considered to control dormancy loss and germination in the field, as well as to strategies that may be used for propagation of seeds in the laboratory or nursery. Seed responses are based on the concept of using freshly collected, mature seed, *sensu* Baskin *et al.* (2006). Seeds have been classed as geosporous (seeds are released from the parent plant into the soil seedbank at maturity) or serotinous (mature seeds are stored on the parent plant, usually in highly protective structures for the medium (1–3 years) to long-term (>3 years). Families/genera that are typical examples of each syndrome are indicated, but these are not definitive. 1Refers to seeds that have an after-ripening requirement for germination (defined in Fig. 5). This after-ripening requirement is usually overcome by time (weeks or months) in dry soil (or dry storage). This syndrome refers mostly to seeds with physiological or morphophysiological dormany, but may also include seeds with combinational dormancy, where heat can alleviate physical dormancy but seeds also have a brief after-ripening requirement. Many species require a germination stimulant following a period of after-ripening, indicated by the dashed line. The agents considered as germination stimulants in this context include smoke/butenolide (most often), light and nitrates. The plant-growth regulator gibberellic acid may also be useful for promoting germination of these species. 2Refers to species with a requirement for warm or cold stratification (defined in Fig. 5). Some species may require a germination stimulant following stratification, indicated by the dashed line. 3Denotes species with poorly known germination requirements that remain buried in the soil for many seasons before germination occurs. These seeds probably possess deep and complex physiological or morphophysiological dormancy and may undergo dormancy cycling and/or require both dry after-ripening and stratification. For these species effective dormancy release is difficult and germination is often achieved only following a period (usually months or years) of soil burial under natural conditions. Seeds usually require a germination stimulant following retrieval from the buried environment at the appropriate time of year (usually autumn).4Refers to seeds with physical dormancy that require scarification of the seed coat before they can imbibe water. In these, dormancy is alleviated naturally by large diurnal fluctuations in temperature over periods of many weeks, months or even years. Artificial treatments include extreme dry heat (>100◦C), boiling water or acid scarification. 5Seeds originate from serotinous species and are non-dormant, requiring only incubation under appropriate germination conditions. 6A small group of serotinous species produce seeds that germinate to higher levels following a smoke cue. 7Refers to seeds that are non-dormant, but require a germination stimulant. That is, viable seeds will respond to the stimulant immediately on maturity and/or following any period of storage without additional treatment. 8Refers to non-dormant seeds that are released into the soil seedbank at maturity. 9Dessication-sensitive seeds where germination is usually precocious; uncommon in the Australian temperate flora. Indicative families/genera adapted from Mott (1974); Dixon *et al.* (1995); Roche *et al.* (1997); Bell (1999); Morris (2000); Tieu *et al.* (2001*a*, 2001*b*); Sch¨utz *et al.* (2002); Thomas *et al.* (2003); Baker *et al.* (2005*a*, 2005*b*); Turner *et al.* (2005, 2006*b*); D. J. Merritt and S. R. Turner, unpubl. data.

WANTED

Articles & Ideas for the AABR (WA) Newsletter

If anyone has interesting articles, helpful hints, or ideas for articles please send them to: the Editor, Kirsten Tullis (see contact details page 8)

WANTED

Vice Presidents' Report to AGM continued from page 3

Unfortunately, we were unable to organize forum speakers for July and September so these were cancelled.

Newsletter

Thanks to Kirsten for her continuing contribution as Newsletter Editor. The newsletter is produced on a regular basis and its content continues to be of interest to members particularly those unable to attend forums. It also contains many other interesting articles on many subjects close to the heart of bush regenerators, thank you to the many contributors throughout the year. We are also endeavoring to send it to members by email, where possible, to reduce costs and save paper.

Website

The AABR website is continuing to be updated despite the Webmaster Steve May residing in Albany a few phone calls and emails away. We have had a few problems with the system and some email addresses, our apologies for this. However, Steve is gradually working through these issues.

Finances

Our finances are in great shape, thanks to our Treasurer Rob Davies therefore we are able to continue to function and fund our usual activities.

Greenstock Publication

The planned 2007 publication of the document entitled "Guidelines for Growing Greenstock for Revegetating Local Natural Areas" didn't eventuate as a result of the resignation of three NAMN (Natural Area Management Network) subcommittee members due to their increased workload. Two AABR committee members filled the gap but progress has been slow and we are now looking toward a late 2008 publication date.

Display boards

The Vice Presidents continue to promote AABR in a formal/informal manner whenever the opportunity exists, especially when networking with other organizations and use the display boards whenever possible, these are housed with Bob Dixon at Kings Park and can be borrowed by members at any time.

SERI Conference

SERI (Society for Ecological Restoration International) Conference web site. Call for 'well managed' bushland sites with a minimum four years management to be included for delegates to visit by themselves. Sites will be assessed by an AABR Management Committee. Note, the conference starts as a welcome on Sunday 23 August 2009 and ends with a one day field trip on 27th.

See the next newsletter for more information on the Society for the Ecological Restoration International Conference.

The web address is:

www.seri2009.com.au/index.html

AABR was established in 1986 in NSW (with the WA branch forming in 1992) out of concern for the continuing survival and integrity of bushland and its dependent fauna in or near bushland areas. AABR seeks new members and friends for promoting good work practices in natural areas. The Association's aim is to foster and encourage sound ecological practices of bushland management by qualified people, and to promote the study and practice of Bush Regeneration.

To join AABR (WA) .....

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OR

go to our **website** for a membership form

www.aabr.com.au

For newsletter contributions:

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