Protecting Offspring Against Fire: Lessons From *Banksia* Seed Pods

Abstract

Wildfires are a natural component in many terrestrial ecosystems and often play a crucial role in maintaining biodiversity, particularly in the fire-prone regions of Australia. A prime example of plants that are able to persist in these regions is the genus *Banksia*. Most *Banksia* species that occur in fire-prone regions produce woody seed pods (follicles), which open during or soon after fire to release seeds into the post-fire environment. For population persistence, many *Banksia* species depend on recruitment from these canopy-stored seeds. Therefore, it is critical that their seeds are protected from heat and rapid oxidation during fire. Here, we show how different species of *Banksia* protect their seeds inside follicles while simultaneously opening up when experiencing fire. The ability of the follicles to protect seeds from heat is demonstrated by intense 180 s experimental burns, in which the maximum temperatures near the seeds ranged from ~75°C for *B. serrata* to ~90°C for *B. prionotes* and ~95°C for *B. candolleana*, contrasting with the mean surface temperature of ~450°C. Many seeds of native Australian plants, including those of *Banksia*, are able to survive these temperatures. Structural analysis of individual follicles from these three *Banksia* species demonstrates that all of them rely on a multicomponent system, consisting of two valves, a porous separator and a thin layer of air surrounding the seeds. The particular geometric arrangement of these components determines the rate of heat transfer more than the tissue properties alone, revealing that a strong embedment into the central rachis can compensate for thin follicle valves. Furthermore, we highlight the role of the separator as an important thermal insulator. Our study suggests that the genus *Banksia* employs a variety of combinations in terms of follicle size, valve thickness, composition and geometric arrangement to effectively protect canopy-stored seeds during fire.

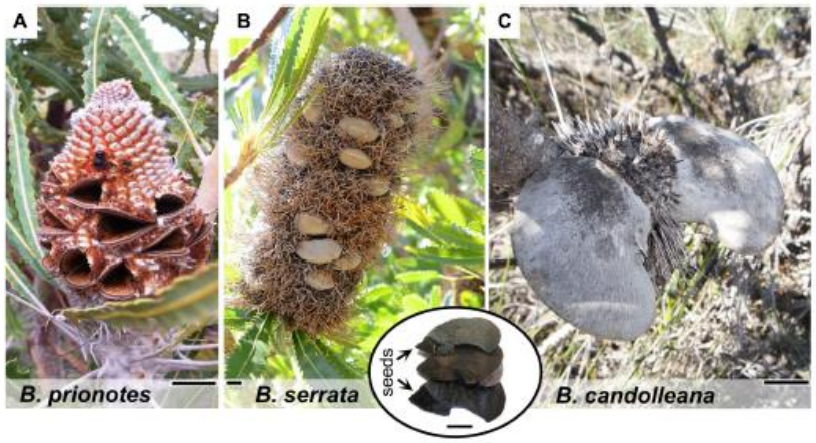

FIGURE 1 | Morphology of mature cones and follicles of different *Banksia* species. **(A)** Fruit of *B. prionotes* with open follicles and seeds already released. **(B)** Mature infructescence of *B. serrata* on the plant showing closed follicles surrounded by dried, flammable florets (photo by S. Ehrig, reproduced with permission). Inset: content of a single follicle with position of the seeds indicated. **(C)** Typical fruit of *B. candolleana* with large follicles. All scale bars: 1 cm.