Phenotypic variation within contrasting environments: a study of the invasive macrophyte, *Hymenachne amplexicaulis* across Australia

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Summary *Hymenachne amplexicaulis* (Rudge) Nees is an aggressive invader of northern Australia's wetlands and waterways. The species is widespread, occurring extensively through the Northern Territory, Queensland and northern New South Wales. Currently there is limited information regarding the abiotic and biotic factors influencing the phenology of the plant. Such knowledge is essential to understand the invasion potential of the species, and to design effective management strategies. With this in mind the current study was undertaken to examine phenological variation (including growth, flowering and seeding events, and germination) within *H. amplexicaulis* populations across a range of environments. In addition the phenology and growth conditions of *H. acutigluma* (Steudel) Gilliland (native hymenachne) and *H. amplexicaulis* were compared where both plants were growing side by side. Initial results indicate variation in flowering and seeding events within and between environments. Where both species grow together, *H. amplexicaulis* flowers and seeds later in comparison to *H. acutigluma* and is restricted to shallower water depths. That a percentage of both populations flower simultaneously suggests that hybridisation of the two species is possible. Management implications are discussed.

Keywords Flowering, seeding, *Hymenachne acutigluma*, management.

INTRODUCTION

Invasive species, particularly aquatic plants, usually have broad ecological distributions and can dominate a wide range of habitats. Species that are able to colonise both vegetatively and via seeds have considerable advantages, often resulting in greater ecological damage. Many are phenotypically plastic, hence enabling these species to maintain reproductive capacity over a wide range of habitats. It follows that knowledge of the life history and growth patterns of an invasive species over its geographical range may provide insight into the factors that influence the mechanisms of invasion and rates of spread, thus leading to more effective management options.

Within northern Australia, the recent introduction of *Hymenachne amplexicaulis* for use in cattle grazing has resulted in its extensive spread and establishment in surrounding wetland and riparian habitats (Csurhes *et al.* 1999). The species is distributed from northern New South Wales, throughout wetland/floodplain/riparian systems in Queensland, and northern wetland/floodplain areas within the Northern Territory. Its current wide distribution is thought to be a result of human transfer of vegetative fragments and seeds between properties. Spread into surrounding riparian habitats has occurred primarily from areas where the species has been cultivated (Charleston 2006). Currently there is limited knowledge on the life history or growth patterns of this species, or the factors that drive these processes.

The current study is being undertaken within five areas across Australia (Rockhampton (central QLD), Ayr (northern QLD), Ingham (Northern QLD), Julatten (northern QLD), and Darwin (NT)). Phenological patterns and the associated broad (rainfall, temperature) and local scale factors (water depth, sediment nutrients) are being assessed within each site. Additional comparisons are being made between native hymenachne (*H. acutigluma*) and the invasive hymenachne (*H. amplexicualis*) in sites where both species occur simultaneously. As this is part of a longer term study, only the initial results are presented and discussed.

MATERIALS AND METHODS

In April – June 2007, plots (1 × 1 m) were established within *H. amplexicaulis* populations across five distinct geographic locations. Within one location (Julatten) plots were established within both *H. amplexicaulis* and *H. acutigluma* populations. Plots were established across a range of water depths and disturbances (grazing intensities). Site and plot numbers varied within each location due to site accessibility (Table 1).

The following measurements were undertaken within each plot every two weeks or at monthly intervals depending on site access and available monitors. Measurements include: (1) Water depth (cm) – one sample taken from the centre of each plot; (2) Plant height (taken from the top of the tallest plant); (3) Density rating (1 least dense – 10 dense) – established from photo standards and associated plant biomass; (4)

Photopoints; (5) Phenological stage of plants within each plot; (6) Evidence of damage; (7) Presence of germination/reshoots (yes/no). Phenological assessment of *H. amplexicaulis* plants within each plot was undertaken by counting individual stems and dividing them into one of five categories (1 – vegetative, no flower or seed development; 2 – closed flower, flower has formed but is encased within the leaf sheath; 3 – open flower, flower is fully exposed and the anthers of the floret are exposed); 4 – seed development, seeds developed but no seed drop; 5 – seed drop, seed dropping. Within the current paper, flowering events (closed and open flower) and seed events (closed seed and seed drop) have been combined. Hence results have been expressed as total % flowering, and total % seeding.

Hymenachne amplexicaulis flowering and seeding events were expressed as percentage of plants and compared across the five described locations. Due to monitoring difficulties in the initial stage of the study and current incomplete data sets, formal statistical analysis has yet not been applied.

Phenological variability and associated water depths were compared between *H. amplexicaulis* and *H. acutigluma*. Results were expressed as percentage of plants. No formal statistical analysis has currently been undertaken, as the data sets are incomplete.

RESULTS

Flowering and seeding variability between *H. amplexicaulis* populations Initial results suggest peak flowering of *H. amplexicaulis* populations occurs for 1–2 weeks during April and May across all populations. Populations continue to produce flowers until August in Ingham, although at a much reduced rate. In other populations, flowering was extended until July. Substantial damage resulting from buffalo limited flowering and seeding beyond July in Darwin populations (Figure 1a).

Seeding of *H. amplexicaulis* populations followed a similar trend to flowering events. Peak seeding of Ingham, Ayr and Darwin populations occurred during late May into early June. Populations continued to seed beyond June although at a much reduced rate (Figure 1b). Grazing had substantial impacts on some populations within Julatten, Ayr and Darwin, limiting both flowering and seeding of hymenachne populations.

Flowering and seeding variability between *H. amplexicaulis* and *H. acutigluma* populations *Hymenachne acutigluma* populations flowered and seeded substantially earlier than *H. amplexicaulis*. When monitoring of both species was undertaken in April, 25% of *H. acutigluma* populations were seeding.

Table 1. Location and numbers of phenological variation of *H. amplexicaulis* and *H. acutigluma* populations.

Location	Number of sites	Number of plots (1×1 m^2)
Ingham (wet tropics, northern QLD)	2	40
Rockhampton (central QLD)	2	28
Julatten (wet tropics, Northern, QLD)	1	20 (*H. amplexicaulis*) 20 (*H. acutigluma*)
Ayr (dry tropics, QLD)	2	40
Darwin (wet tropics, NT)	2	32

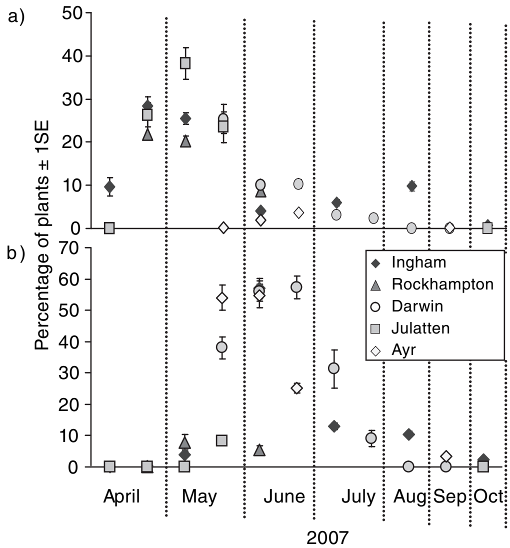

Figure 1. Phenological assessment of *H. amplexicaulis* populations across five locations in Australia. a) percentage of plants flowering; b) percentage of plants seeding.

In comparison no seeding of *H. amplexicaulis* populations had occurred. There was some overlap in April and May when a percentage of both species were flowering (Figure 2).

DISCUSSION

Phenological data from the current study suggests that *H. amplexicaulis* populations are flowering and seeding successfully across all locations. Peak flowering and seeding events occur during similar time periods, suggesting populations are responding to similar biotic and/or abiotic factors. In sites surveyed throughout the year, *H. amplexicaulis* continued to produce flowers and seeds well after peak reproductive events. Some

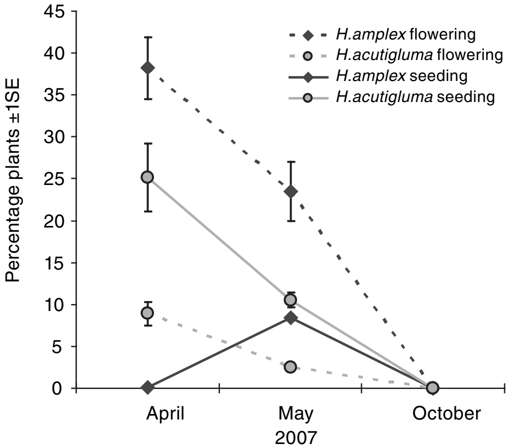

Figure 2. Phenological assessment of *H. amplexicaulis* and *H. acutigluma* populations at Julatten.

stems resprouted and produced up to three distinct flowering and seeding events during the seven months of monitoring. The ability to seed prolifically across a range of habitats and/or climates, as well as the capability of propagation through vegetative fragments, offer considerable advantages to plant species.

Grazing by buffalo and cattle substantially affected most *H. amplexicaulis* populations to some degree in the current study. Such disturbances have been suggested as potential mechanisms for control of *H. amplexicualis*. However, within all sites disturbed by grazing, plants were not trampled or grazed until the end of the dry season. By this stage they had already produced significant amounts of seed. Continued monitoring of these sites in comparison to ungrazed sites will provide greater insight into the longer term grazing effects on *H. amplexicaulis* phenology.

Comparison between *H. amplexicaulis* and *H. acutigluma* populations Peak flowering and seeding periods of *H. amplexicaulis* and *H. acutigluma* occurred approximately one month apart. However flowering of both species overlapped, suggesting hybridisation may be possible. Initial monitoring of *H. amplexicaulis* populations at Julatten indicate some evidence of hybridisation (J. Clarkson personal observations 2007). The implications this may have for management of *H. amplexicaulis* and *H. acutigluma* areas are unknown. Further investigation is currently being undertaken.

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REFERENCES

Charleston, K. (2006). *Hymenachne amplexicaulis* management: control methods and case studies. Department of Natural Resources, Mines and Water, Brisbane.

Csurhes, S.M., Mackay, A.P. and Fitzsimmons, L. (1999). Hymenachne (*Hymenachne amplexicaulis*) in Queensland. Department of Natural Resources, Brisbane.