Exploring the germination ecology of *Iris pseudacorus* populations invading California wetlands

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Context

- Seed germination:
  - Important life stage which plays critical role in seedling establishment, environmental adaptation[1]
  - largely influenced by environmental factors
- Sexual propagules contribute to plant distribution, invasiveness and spread of a species

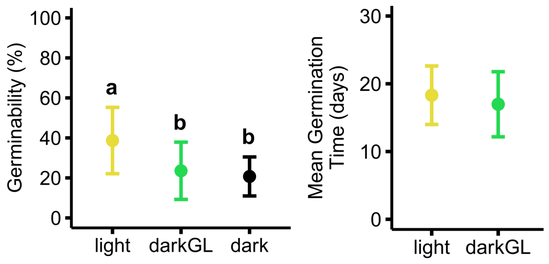
→ **Knowing germination ecology is important to improve management strategies**

- *Iris pseudacorus* (yellow flag iris), native to Europe:
  - Invades and spreads in California wetlands
  - Reproduces mostly from seed[2] (unusual for aquatic plants)
  - Little is known about its germination requirements

Aim — Unravelling some of the germination requirements of invasive populations of *I. pseudacorus*, by testing seed response to stratification, light, seed coat presence and temperature in controlled conditions.

Light requirement

- 3 populations tested (CS, AN, BC)
- 6 replicates per pop. per treatment
- Seeds exposed to one of the following conditions, at 20/12°C:
  - Light: 80 µmol·m^{-2}·s^{-1}, photoperiod 12/12
  - DarkGL: continuous darkness, germination monitored under green light (520-560 nm)
  - Dark: continuous darkness, germination checked only at the end of the experiment

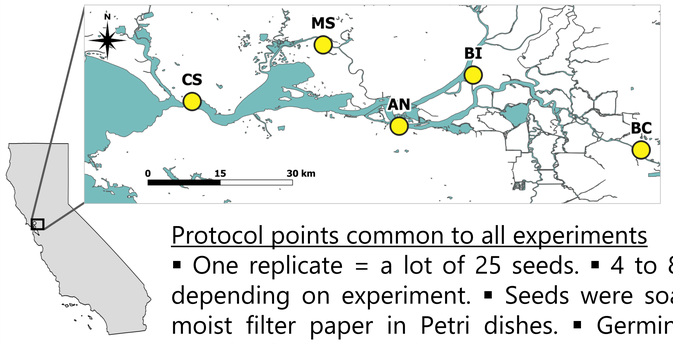


► *I. pseudacorus* is able to germinate in the dark, but germinates better under light

► However, the presence or absence of light does not impact the germination velocity

References
[1]Donohue K. *et al*. (2010) Germination, postgermination adaptation, and species ecological ranges. *Annual Review of Ecology, Evolution & Systematics*. 41: 293–319; [2]Gaskin, J.F. *et al*. (2016) An unusual case of seed dispersal in an invasive aquatic; yellow flag iris (*Iris pseudacorus*). *Biological Invasions*, 18: 2067–2075.

Materials & Methods

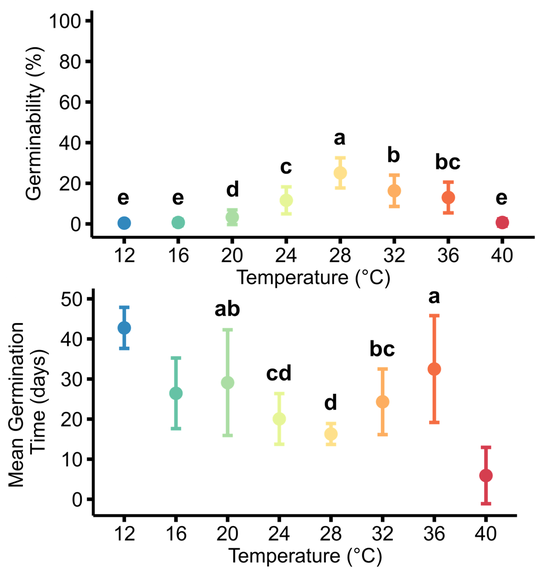


Studied populations
- Up to 5 populations used in the experiments
- Located from the Sacramento – San Joaquin Delta to the San Francisco Estuary
- Invasiveness of the species + vulnerability of the ecosystem = growing concerns

Protocol points common to all experiments
- One replicate = a lot of 25 seeds.
- 4 to 8 replicates per population and per treatment, depending on experiment.
- Seeds were soaked in DI water for 7 days, and then put on moist filter paper in Petri dishes.
- Germination was monitored daily until the peak of germination was reached; then every other day and every three days as germination was slowing down. Experiments were stopped when no germination was recorded for 10 days.

Temperature requirement

Constant temperatures
- 5 populations tested (CS, MS, AN, BI, BC)
- 8 replicates per pop. per treatment
- Seeds exposed to eight constant temperatures: 12°C, 16°C, 20°C, 24°C, 28°C, 32°C, 36°C, 40°C.

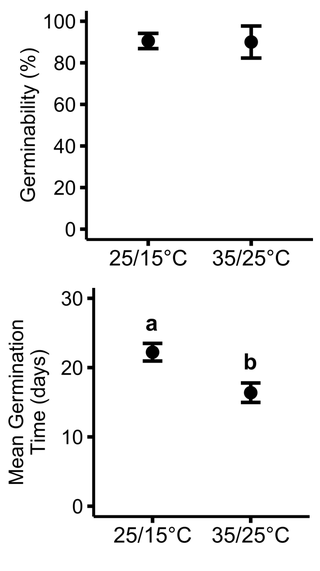


► At constant temperature, only a small fraction of *I. pseudacorus* seeds germinated

► More seeds germinated and did so faster at 28°C

► A decent proportion of seeds are still able to germinate at 36°C

Alternating temperatures
- 1 populations tested (AN)
- 8 replicates per pop. per treatment
- Seeds exposed to 25/15°C and to 35/25°C



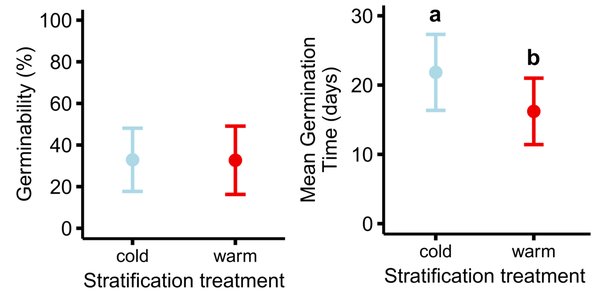
► 90% of the seeds were able to germinate at 25/15°C and at 35/25°C, independently on the temperature regime

► Seed germinated faster when they were exposed to 35/25°C

Exposure to alternating daily temperature is a requirement for the species to achieve high germination fraction

Stratification requirement

- 3 populations tested (CS, AN, BC)
- 6 replicates per pop. per treatment
- Two stratification treatments: seeds soaked at 4°C or at 25/15°C for 7 days, then placed at 20/12°C

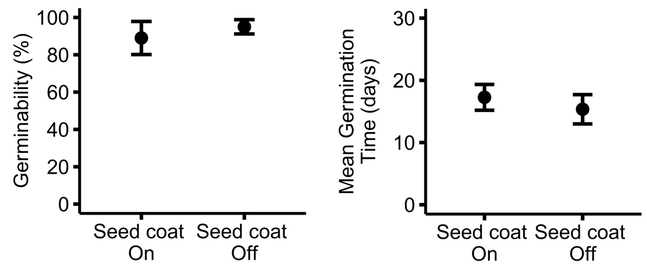


► Neither cold or warm stratification treatment improved the seed fraction that germinated

► Seeds germinated faster after warm stratification

Seed coat presence/absence

- 1 population tested (MS)
- 4 replicates per treatment
- Seeds with or without coat were exposed to greenhouse conditions



► Removing the seed coat does not increase the germination fraction

► The absence of seed coat had no impact on the germination velocity

Conclusions

The seed germination of *I. pseudacorus*:
- **Does not require a cold or warm stratification treatment**
- **Is not impacted by the presence or the absence of the seed coat**
- **Can happen in the dark, but is enhanced by light**
- **Is greatly enhanced by alternating temperatures**
- **Can happen at high temperature**

These results are important for risk assessments of *I. pseudacorus*, and raise concerns about the ability of this species to germinate under climate warming. Germination under a wide range of conditions indicates the need for long-term management approaches.