



**Ephemeral wetlands
a race against time for aquatic plants**

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Thanks to national growth, in 2016 the Pzes online store was created (pzes.es), shipping premium quality fish and plants. In addition, during the last year, we decided to take a new leap and expand the store in downtown Madrid. The new venue has a more modern and minimalist design and facilities that offer a different shop without losing the essence of Pzes: an elegant exhibition hall, a meeting place and a space to hold workshops that promote respect for nature and design underwater. This space was inaugurated by Masashi Ono and Takayuki Fukada in February 2018.

This year Pzes participated in the creation and implementation of what is now the largest Natural Aquarium in Spain, located on the premises of Loroparque on the island of Tenerife. An aquarium 10 meters long and 18,000 liters of

water will be a world leader when it opens in May of this year.

The future of Pzes? Who knows where we will be in a few years, but little by little we will implement the idea that we always had in mind: to foment and respect nature, to learn from it and to grow affection for the hobby in Spain and the rest of the world. 🌿



EPHEMERAL WETLANDS— A RACE AGAINST TIME FOR AQUATIC PLANTS

by Ole Pedersen, University of Copenhagen, Denmark

Photos by the Author

Some of our most popular aquarium plants grow in natural habitats where water is in short supply. In extreme cases, seeds germinate and develop into flowering plants within weeks in order to complete their lifecycle before the water disappears. In the present article, I provide some striking examples from ephemeral wetlands in Western Australia hosting species of *Glossostigma*, *Marsilea* and *Isoetes*, which are all well-known genera in our planted aquaria.

Ephemeral wetlands, i.e. wetlands existing for just a short time, are common features in areas with Mediterranean climate such as California, Argentina, South Africa, Western Australia and obviously also the Mediterranean

countries. This kind of climate is characterized by mild winters and hot, dry summers and the majority of the annual precipitation falls during winter. In areas with hard, compressed soils, excess rain accumulates in shallow depressions of the landscape to form wetlands that exist for weeks to months depending on how fast the water evaporates. In the early summer, the evaporation can exceed 10 mm per day in Western Australia when temperature soars to 40°C (104°F) and the wind picks up. Plants inhabiting such ephemeral wetlands must be ready to grow from spores or seeds whenever the opportunity arises, and then it is a race against time to complete the lifecycle so that a new cohort of spores or

seeds can be produced to enable persistence in the environment. Needless to say, ephemeral wetlands also host a unique fauna that has to overcome the same challenges; good examples are species of killifish where many eggs require partial desiccation (drying out), a kind of diapause, to restore further development of the embryo.

We are using a range of aquatic plants from ephemeral wetland in planted aquaria. One of the most widely used is the genera of *Glossostigma* and several of these are from Western Australia. *Glossostigma* is used as a foreground plant or to form dense carpets in tanks inspired by the Nature Aquarium concept of Takashi Amano. *Glossostigma* is a flowering plant so it germinates from seeds when the environmental conditions are suitable. The minute purple or blue flowers self-pollinate in populations that thrive in deep

- ▼ *Emergent population of flowering Glossostigma drummondii but in between leaves of Marsilea sp. are also seen (the spatula-shaped leaves).*



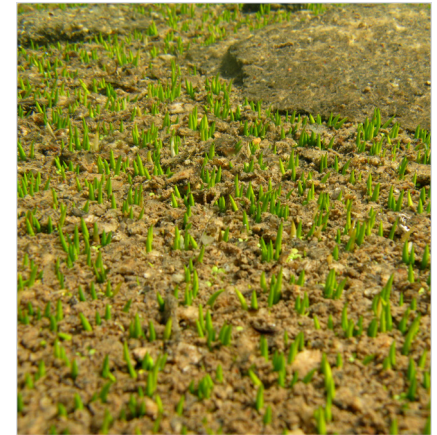
water, i.e. more than 25 cm (10"), but often the plants do not flower until the water recedes. Once the plants become air-exposed, they start flowering and most are pollinated by insects. The fruit (capsule) develops quickly and the seeds are released as both sediment and plants dry up completely (see the series of photos). One species of *Glossostigma*, *G. trichodes*, produces a peduncle that is up to 10 cm long to support its flower floating upon the water surface to enable insect pollination even though the plant is growing relatively deep (10 cm is in fact rather deep when the plant itself is no more than 5-10 mm tall). See Pedersen et al. (2009) for a nice example of *G. trichodes* growing side-by-side with *Isoetes australis* in a vernal rock pool in Western Australia.

Glossostigma can also form dense mats in natural wetlands both because the seed density can be extremely high—and they all germinate at the same time when the moisture comes back to the system—but also because they form runners and thereby spread very efficiently by vegetative reproduction. *Glossostigma cleistanthum* has been recorded in North America although it is native to Australia and New Zealand. *G. cleistanthum* has invaded natural wetlands of low pH, low alkalinity, low phosphorus and thus waters with high transparency. It is highly competitive and it threatens



- ▲ *A shallow ephemeral wetland in Western Australia. The evaporation can be as high as 10 mm per day so within a few weeks the water is entirely gone. It is essential that the plants complete their life cycle in order to secure the next generation in this spectacular habitat.*

- ▼ *It is a race against time! The soil is cracking but still moist and the flowers are struggling to complete the seed production in order to secure the next generation of Glossostigma drummondii in this habitat (a vernal rockpool in Western Australia).*



- ▲ *A dense submerged (yes, the water is so clear that it seems that these plants are growing in air) population of Isoetes australis. The tiny leaves are no longer than 20-30 mm and the dispersal unit (spores) are formed in sporangia on the basal part of each leaf.*

- ▼ *Time is up! The moisture is gone, and the sediment is totally dry. The only living organism left are the seeds of Glossostigma drummondii. The seeds are small and light, they are very tolerant to desiccation and thus they form an ideal dispersal unit.*



species of *Elatine* forming the natural vegetation of these lakes (Les et al. 2006). When I first heard about these observations 10 years ago, I was surprised that such a pretty little and fragile plant could cause any harm to the



▲ The water has almost disappeared from this population of *Isoetes australis*. The sediment may remain moist for another couple of days but then it is all over unless the water comes back within a few weeks. If so, this species has a trick—it can produce new roots and leaves from its storage organ, the corm.

▼ A population of *Isoetes australis* that is doomed! Unless the water comes back in a few weeks, this population has to start all over from the beginning with a new generation of sporophytes formed from the haploid generation.



natural vegetation, but the various species of *Elatine* are no bigger than *G. cleistanthum*, so if the latter grows a little bit faster, is a little more competitive and maybe also less susceptible to diseases and grazing, it may only take a few plant generations until the newcomer has outcompeted the native vegetation. Lesson to be learnt: make sure that you never contribute to the unintended spreading of aquatic plants. This website lists a number of ways to prevent exactly that: <http://www.sleloinvasives.org/10-ways-help-stop-spread-invasive-species>.

In addition to flowering plants, ephemeral wetlands also host interesting species of pteridophytes that are widely used in planted aquaria. Examples are species of *Isoetes* and *Marsilea* both belonging to spore plants, i.e. plants reproducing by spores rather than seeds. Pteridophytes are exciting in that they “still” have two independent generations in their respective lifecycles—one with one set of chromosomes (haploid) and one with two sets of chromosomes (diploid). It is the diploid generation that we use in planted aquaria and the diploid plants reproduce by spores; hence, the diploid generation is also called sporophytes (plants that produce spores). The spores are formed in fertile clusters on the leaves—maybe you know the phenomenon from ferns that often are littered with small, brown dots on the lower sides of the fronds; these

are the sporangia. In the sporangia, the meiosis occurs where spores are formed with only one set of chromosomes. The spores are tiny, most tolerate extreme desiccation and therefore these are excellent dispersal units, just like seeds in angiosperms (flowering plants).

The unique thing happens now! When the spore “germinate,” they give rise to a whole new generation of plants with only one set of chromosomes. Often, this generation is inconspicuous and consists of a flat green, photosynthetic thallus not much larger than a few square millimetres. Nevertheless, this structure produces male and female organs where the reproductive gametes are produced. The male gametes look like sperm since they are motile unicellular cells and they need water in order to swim over to a female egg cell where the fertilization takes place. Once the fertilization is successful, the new diploid sporophyte (two sets of chromosomes) starts growing directly out of the female reproductive organs and the haploid gametophyte (a plant producing gametes) dies. The cycle is complete! The point is that we rarely observe the thalloid gametophyte whereas the sporophyte is the “real” plant that we know from our hobby.

In the case of *Isoetes*, the sporophyte consists of roots, leaves and a corm. The corm is a swollen stem that can act as a

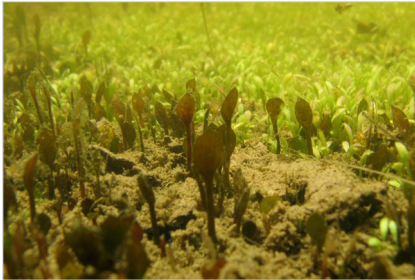
storage organ for starch and it is used by *Isoetes* to enable survival during times where the ponds it is inhabiting dries up for a shorter time. During desiccation, the leaves and roots are wilting and the corm also shrinks but once the water comes back into the system, new leaves and roots are formed and the plant can fully recover within days. Nevertheless, once the water dries up for a long time, the spores are the only units that enable survival between years.

Species of *Marsilea* are similar except that they do not possess a corm. But in contrast to *Isoetes*, they spread extremely fast by vegetative runners. In the aquatic form, the leaves normally only consist of spatula-shaped leaves but intermediates between aquatic and terrestrial leaves can also be formed under water and these often look like a clover leaf. When the

▼ Species of *Marsilea* with the typical aquatic leaves under water and new leaves looking like clover emerging into the air. These leaves have stomata and do not desiccate when exposed to air due to the protective layer of wax, the cuticle.



pond dries up, the whole plant dies and it has to start over from spores once the water comes back into the system. However, both species have in common that they have an inconspicuous haploid generation that most people have never seen. (In fact, I have never seen the haploid gametophyte of either



- ▲ Submerged species of Marsilea with the spatula-shaped leaves. Marsilea is growing side-by-side with a dense population of Glossostigma (the bright green leaves in the background).
- ▼ Marsilea is under severe time pressure! The water is receding so fast that it cannot keep pace and produce the new aerial leaves (clover-shaped). Most leaves are aquatic leaves (spatula-shaped) and these will desiccate within the next few days.



Isoetes or *Marsilea*.) In summary, the reason why these pteridophytes are so common in ephemeral wetland is because the spores are very tolerant to desiccation.

Plants from ephemeral wetlands are popular in planted aquaria for two major reasons. 1) the aquarium plant nurseries love plants that can be grown as emergent individuals because algae are much easier to control in emergent cultures compared to submerged and 2) these plants are often opportunistic, fast-growing plants and this is something we all like. Fast-growing plants are less prone to getting covered by algae (think about *Anubias* where the older leaves always tend to look sad as they accumulate more and more algae).

Interzoo, the world's largest pet fair, took place in May in Germany and a large proportion of the plants in the stunning display tanks was indeed originally from ephemeral wetlands. 🌿

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TWO COMPOSITIONS WITH RED STEM PLANTS

by Aqua Design Amano

Translated by Tomoko Schum Photos by Aqua Design Amano

The shape of a composition is an important element in Nature Aquarium for the refinement of a layout. A composition is produced by placing driftwood and stones, and planting aquatic plants. Red stem plants are helpful for making a well-defined composition with the strong impact of their color. In this article, we are going to discuss the effective use of red stem plants using two different aquascapes: one

with mound shape composition and another with triangular composition. The above photo is a layout with a mounded composition produced using gracefully-shaped branches of Branch Wood and the bright, red color of the stem plants. While the open spaces in the left and the right sides of an aquarium are a vital part of a mounded composition, a small open space was also created in the center to give a sense of