THE POTAMOGETONACEAE IN THE
SOUTHEASTERN UNITED STATES ¹

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POTAMOGETONACEAE Dumortier, Anal. Fam. 59, 61. 1829,

"Potamogetoneae," nom. cons.

(PONDWEED FAMILY)

Glabrous, herbaceous, perennial or rarely annual plants of fresh or brackish waters growing entirely submersed or with both submersed and floating leaves and/or emergent inflorescences. Stems slender, branched or unbranched, often dimorphic, the lower stems rhizomatous and root-bearing, the upper erect and foliaceous, the tips often modified into turions (winter buds). Leaves alternate or subopposite, 2-ranked, entire or toothed, sessile or petiolate, stipulate, 1 to many nerved, the stipules forming a tubular sheath around the stem, free from or adnate to the base of the blade, the nerves parallel, connected by perpendicular cross-veins; submersed leaves thin, linear to orbicular; floating leaves often leathery, lanceolate, elliptic, or ovate. Inflorescence an axillary or terminal spike or panicle of spikes of perfect flowers. Perianth absent or of 4 separate, rounded, short-clawed, greenish or brownish segments in one series. Stamens 2 or 4, the anthers 1- or 2-locular, linear, dehiscing vertically, the filaments adnate to the perianth claw or absent. Gynoecium of 2-16 distinct unilocular carpels, each with a single parietal campylotropous to orthotropous, bitegmic, crassinucellar ovule. Fruit drupaceous, with a membranaceous exocarp, fleshy mesocarp, and stony endocarp. Seed solitary, basal cell of the proembryo not dividing but becoming much enlarged, the embryo straight or coiled, with a strongly developed hypocotyl; endosperm helobial in development, absent in mature seed. (Including Ruppiaceae Hutchinson, Fam. Fl. Pl. 2: 48. 1934, nom. cons. Excluding Zannichelliaceae Dumortier, 1829; Zosteraceae Dumortier, 1829, nomina conservanda.) TYPE GENUS: *Potamogeton* L.

¹Prepared for the Generic Flora of the Southeastern United States, a project of the Arnold Arboretum of Harvard University made possible through the support of the National Science Foundation. This treatment, the eighty-fourth in the series, follows the format established in the first paper (Jour. Arnold Arb. 39: 296-346. 1958). The area covered includes North Carolina, South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, Arkansas, and Louisiana. The descriptions apply primarily to plants of this area, with supplementary information in brackets. References that I have not seen are marked by an asterisk.

I am indebted to Dr. Carroll E. Wood, Jr., principal investigator on the project, for his advice, suggestions, and help with the literature during the preparation of the manuscript.

The illustration of *Ruppia* was drawn by the late Dorothy H. Marsh under Dr. Wood's direction largely from material collected by Dr. R. B. Channell in Harrison County, Mississippi; that of *Potamogeton* was drawn by Karen S. Velmure under my direction from material that I collected in Alabama.

Contribution No. 2 from the Aquatic Biology Program, The University of Alabama.

A family of nearly cosmopolitan distribution with three genera and about 110 species. Two genera, *Potamogeton* and *Ruppia*, occur in the southeastern United States. *Groenlandia* J. Gay (*G. densa* (L.) Fourr., *Potamogeton densa* L.) is native to western Europe, North Africa, and southwestern Asia. Members of the Potamogetonaceae have been placed in the Najadaceae by Eyles & Robertson, Fassett, and Gleason (in Gleason & Cronquist) and have been combined with members of Zannichelliaceae and Zosteraceae by den Hartog, Fernald, and N. Taylor to comprise a taxon that has been called respectively Potamogetonaceae, Zosteraceae, and Zannichelliaceae. The Potamogetonaceae, as here interpreted, are separated from the Zannichelliaceae and Zosteraceae by their perfect flowers, lack of a spathe-like bract, and, in some species, the presence of turions. Thorne's order Zosterales includes Aponogetonaceae, Juncaginaceae, Potamogetonaceae (including *Ruppia*), Posidoniaceae, Zannichelliaceae, and Zosteraceae.

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KEY TO THE GENERA OF POTAMOGETONACEAE IN THE
SOUTHEASTERN UNITED STATES

- Stamens four; perianth present; stipule free from leaf blade or, if adnate, with the tip free; fruits sessile or very short stalked (see FIGURE 1). 1. *Potamogeton*.
- Stamens two; perianth absent; stipule adnate to leaf blade for entire length (without free tip); fruits long stalked (see FIGURE 2). 2. *Ruppia*.

1. *Potamogeton* Linnaeus, Sp. Pl. 1: 126. 1753; Gen. Pl. ed. 5. 61. 1754.

Annual or perennial, glabrous, herbaceous plants growing submersed in fresh (rarely brackish) waters, propagated by seeds, turions, or rhizomes. Stems varying in length with water depth, branched or unbranched, terete or compressed, rooting at lower nodes, the nodes occasionally with

oil glands. Leaves submersed or both submersed and floating, alternate to subopposite; submersed leaves pellucid, sessile or petiolate, linear to orbicular, subulate to obtuse at apex, acute to perfoliate at base, the margins entire or serrate, rarely crimped, the veins 1–35; floating leaves coriaceous, mostly petiolate [rarely subsessile], elliptic to ovate, acute to obtuse at apex, cuneate to rounded or cordate at base, the margins entire, the veins 1–51; stipules tubular, sheathing the stem and young inflorescences, connate or convolute, either free or adnate to the base of the submersed leaves, free from base of floating leaves. Turions (winter buds) present or absent, with extremely shortened internodes, divided into inner and outer leaves; the inner few to numerous, rolled into a fusiform structure or unmodified [shortened and oriented at 90° angles with respect to outer leaves]; the outer 1–5 per side, mostly similar to vegetative leaves [corrugated near base]. Inflorescence axillary or terminal, a capitate or cylindrical spike or panicle of spikes with 1–20 whorls of flowers, compact or moniliform, with 2–4 flowers in each whorl, submersed or held above surface of water. Perianth of 4, free, rounded, short-clawed segments. Androecium of 4 stamens, the filaments adnate to the perianth claw, the anthers 2-locular, extrorse, the tapetum amoeboid, the pollen spherical to fusiform, sculptured, 3-celled. Gynoecium of 4 carpels, the ovule orthotropous or campylotropous, the micropyle formed by the inner integument. Fruit dorsally rounded or keeled, beaked. Embryo coiled 1 or more times. Chromosome base number 13 or 14 (Stern). TYPE SPECIES: *P. natans* L.; see N. Taylor, N. Am. Fl. 17: 14. 1909. (Name from Greek, *potamos*, river, and *geiton*, neighbor.) — PONDWEED.

A genus of perhaps 100 species, in two subgenera, POTAMOGETON and COLEOGETON, both almost cosmopolitan in distribution, and both divided into two sections; represented in the United States by 31 species, some widely distributed, 15 occurring in our area.

Subgenus POTAMOGETON (peduncle mostly rigid and rarely with an endodermis, stigmatic papillae small, pollination mostly by wind), sect. ADNATI Hagström (stipules adnate for one-half their length to the leaf bases, inflorescence a panicle of spikes), apparently is represented in our area by a single collection of *P. Robbinsii* Oakes, $2n = 52$, from the Mobile delta in southwestern Alabama. Although this species occurred in northwestern Georgia at the height of the most recent glaciation (ca. 20,000 years B.P.) (see Watts), its present range is far to the north (from New Brunswick, south only to Delaware, and west to Washington and Oregon). Whether or not a mistake in labeling is involved in the Alabama record is uncertain. *Potamogeton Robbinsii* is easily recognized by its auriculate leaf bases and its inflorescence, a panicle of spikes. Section AXILLARES Hagström (stipules free or adnate for less than half their length, inflorescence a simple spike) consists of about 85 species, mostly of the Eastern Hemisphere. Thirteen species occur in our area: *P. crispus* L. (introduced), *P. amplifolius* Tuckerman, *P. pulcher* Tuckerman, *P. nodosus* Poiret (*P. americanus* Cham. & Schlecht., *P. lonchites* Tuckerman, *P. fluitans* sensu

FIGURE 1. *Potamogeton* section *Axillares*. a-m, *P. pusillus* (*P. Berchtoldii*). a, habit of plant, $\times \frac{1}{2}$; b, leaf with stipule, $\times 5$; c, detail of leaf blade to show venation, $\times 12$; d, young inflorescence with two flowers, tepals unshaded, $\times 10$; e, flower, seen obliquely from above, four tepals, three stamens, and four carpels visible, $\times 10$; f, flower in vertical section to show relationship of stamens to tepals (two stamens cut in half) and two of four carpels, $\times 20$; g, tepal with stamen, from above, $\times 20$; h, same, from the side, $\times 20$; i, carpel, side view, at anthesis, $\times 20$; j, carpel in vertical section (diagrammatic) to show single parietal campylotropous ovule, $\times 20$; k, infructescence, $\times 6$; l, single drupe, side view, $\times 10$; m, same, in vertical section, endocarp hatched, embryo unshaded, $\times 10$.

Small), *P. natans* L., *P. illinoensis* Morong (*P. angustifolius* and *P. lucens* sensu American authors), *P. perfoliatus* L., *P. diversifolius* Raf. (*P. capillaceus* Poiret), *P. epihydrus* Raf. (*P. Claytonii* Tuckerman, *P. Nuttallii* Cham. & Schlecht., *P. cayugensis* (Wieg.) Hagström), *P. tennesseensis*

Fern., *P. confervoides* Reichenb. (*P. Tuckermanii* Robbins), *P. foliosus* Raf. (*P. Curtissii* Morong, *P. niagarensis* Tuckerman, *P. pauciflorus* Pursh), and *P. pusillus* L. (*P. Berchtoldii* Fieber, *P. panormitanus* Biv., *P. lacunatus* Hagström). The exact nature of *P. floridanus* Small, based on two collections made by A. H. Curtiss in 1886 (NY) is uncertain (cf. Ogden, 1943, p. 192).

Subgenus COLEOGETON (Reichenb.) Raunk. (peduncles mostly flexible and with an evident endodermis, stigmatic papillae large, pollination mostly by water), section CONVOLUTI Hagstr. (sclerenchyma abundantly developed, stipule sheaths convolute) is represented in the southeastern United States by *Potamogeton pectinatus* L. (*P. columbianus* Suksdorf, *P. interruptus* Kit.), $2n = 78$, which occurs almost throughout the United States. It can be distinguished from other pondweeds by its stipules adnate nine-tenths of their length to the leaf blade and by its fruits with an evident beak. Section CONNATI Hagstr. (sclerenchyma poorly developed, stipule sheaths connate) is widespread in the northern United States and Canada but is not represented in our area.

The characters important in determining the various taxa of *Potamogeton* are found in the fruiting spikes, fruits, leaves, and turions. Among the most distinctive features of the fruits are the size and shape (whether widest at, above, or below the middle), the absence or presence and shape of keels on the dorsal surface, and the degree of coiling of the embryo. Important characters of the fruiting spike include its position (terminal or axillary), its shape (globose, cylindrical, or moniliform), the number of fruits per spike, and the anatomy of the peduncle. Distinctive features of the leaves include the presence or absence of floating leaves, the degree of adnation of the stipule with the blade of submersed leaves, the number of major veins, and the presence or absence of lacunae bordering the midrib of submersed leaves. Evident characteristics of the turions, if present, include the shape of the inner as compared with the outer leaves, and the time of year the turions germinate. Although several vegetative characteristics can be used for identifying the taxa of *Potamogeton*, characters of the fruits and peduncles are the most important ones, and care should be taken to collect only specimens with at least partially mature fruit.

The anatomy of *Potamogeton* has been studied by Ogden (see family references) and Singh (1964). According to Ogden, the stele is composed of fibrovascular bundles, mechanical tissue, and parenchyma cells. The arrangement of the bundles varies with the species. Four patterns can be recognized: 1) proto-type — bundles free, each with one patch of phloem, four median bundles, and a few smaller bundles along the sides; 2) trio-type — three of the median bundles fused to form a single xylem canal, with one patch of phloem on the outer face of the xylem canals and one or two on the inner face; 3) oblong-type — one or two median bundles lacking phloem on each side and with the stele oblong or elliptical in cross section; 4) one-bundled type — only a single bundle, this with four patches of phloem which often are not evident. The stem usually has an endodermis in which the cells are either O-cells having the wall of uniform

thickness, or U-cells in which the walls are thickened on the inner and lateral faces but thin on the outer face. The cortex, which is highly lacunate, may be without vascular bundles or fibers, or with vascular bundles and fibers, or only with fibers at some junctures of the chains of cells separating lacunae. According to Singh, cells of both the upper and lower epidermis have slightly thickened outer tangential walls. On floating leaves the upper epidermis has stomata and a distinct cuticle; submerged leaves lack stomata.

The flowering structures of *Potamogeton* have been interpreted variously. Miki, Uhl, and Eames have considered each perianth segment to be a sepaloid bract subtending and adnate to the corresponding stamen and have therefore regarded the flower as an inflorescence of four staminate flowers, each with a single stamen and its adnate bract, and four apetalous carpellate flowers, each of a single carpel with one ovule. In this interpretation, the spike represents a reduced compound inflorescence. Singh (1965), on the basis of the vascular anatomy and floral morphology of seven species of *Potamogeton*, chose to consider the flower a normal one with four perianth segments, but Sattler (1965) considered it impossible to classify the structure as either a true flower or an inflorescence, because it displayed characters of both. Sattler questioned the classical use of flower and inflorescence as two separate categories and emphasized the need for more developmental work in the Helobiales (Alismatidae). For the sake of convenience, Singh's concept is followed in this treatment.

Controversy has also existed as to the real nature of the perianth-like structures that are adnate to the stamens. Irmisch (1851), Ascherson (1889), Rendle (1930), and Markgraf (1936) considered the segments to be stamen connectives (outgrowths of the stamens), but both Sattler (1965) and Singh (1965) reached a different conclusion. Sattler, for example, demonstrated that in *Potamogeton Richardsonii* these structures are initiated on the floral apex before the stamens and thus cannot be outgrowths of them. He instead considered them to be perianth segments. After inception of the stamen primordia, growth occurs between the perianth primordium and that of the stamen, thereby uniting the base of the developing stamen and perianth segment.

Taxonomic difficulties in the genus are due in part to vegetative plasticity and to hybridization within the genus. Hunt (1962) and Haynes (1974) have reported that certain populations of narrow-leaved pondweeds show seasonal dimorphism. Other dimorphisms occur when populations occupy habitats different from the normal. Fernald separated *Potamogeton foliosus* into two varieties based on size, but Haynes (1974) suggests that these are only different growth forms, plants in flowing waters usually being much larger than those growing in standing waters. In addition, many floating-leaved species produce terrestrial forms that remain after the lake, pond, or pool in which they were growing dries. Reznicek & Bobbette indicate that the terrestrial forms of the *P. diversifolius* alliance are often nearly impossible to identify.

Taxonomic problems within the genus are compounded by numerous

populations of hybrids intermediate between their two putative parental species. These hybrids, although usually sterile, often form extensive populations by vegetative reproduction from rhizomes or turions. Hagström, Ogden (1943), Haynes & Williams, and Hellquist (pers. comm.) have reported probable hybrid populations.

The reproductive biology of the genus is largely unstudied. Most species are considered to be wind pollinated, but Thieret (pers. comm.) has noted that dragon flies have been observed to land on *Potamogeton nodosus* spikes. Although after the insects were collected, Thieret and his students observed pondweed pollen on them, there is no evidence that the insects actually accomplished pollen transfer to another inflorescence. It is not known whether some or all species are self compatible, but some that are considered to be wind pollinated have produced fruit during seasons in which the inflorescence never reached the surface of the water (Voss, 1972). Some appear to flower regularly under water and are presumably water pollinated.

According to Sculthorpe, certain species of *Potamogeton* reproduce by rhizome fragments, tubers, or turions. In some, the stem apex is modified by shortening of the internodes into turions that break off and eventually grow to produce new members of the clone. Turions can result in a phenomenal increase in the population, as shown by Yeo, who planted one turion of *Potamogeton crispus* on 1 April 1963 and found at the end of the growing season that 23,250 turions had been produced! In other species vegetative propagation is by fragmentation of the rhizome or by fragmentation of tubers from the rhizome.

All species reproduce to a certain extent by seeds. Muenscher (1936) demonstrated that the germination rate of *Potamogeton* seeds is greatly reduced by drying. Many species, according to Muenscher, require near-freezing temperatures for a period of one to three months. However, as shown by Sullivan for many of the broad-leaved species, the fruits can be induced to germinate without a previous cold treatment if the exocarp and mesocarp are split. The fruits of many pondweeds are among the most common foods of waterfowl (Martin & Uhler), which often digest only the exocarp and mesocarp, the endocarp with the intact seed being passed from the digestive system. Lohammar has shown that a high percentage of germination may follow.

The genus is economically important as a source of food for wildlife. For waterfowl Martin (1951) and Martin & Uhler rank it first in importance in the United States and Canada, and Gaevskaya lists 124 species of animals that have been known to feed on the genus. In addition, populations of *Potamogeton* have often been abundant enough in the southeastern United States to be regarded as weeds warranting the use of various methods of control.

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2. *Ruppia* Linnaeus, Sp. Pl. 1: 127. 1753; Gen. Pl. ed. 5. 61. 1754.

Glabrous, herbaceous, annual or perennial plants growing submersed in brackish or saline waters. Stems slender, terete, branched or unbranched, rooting at the lower nodes. Leaves all submersed, alternate to subopposite, sessile, divided into blade and stipular sheath; blade linear or setaceous, 1-nerved, the margins entire below, minutely serrulate above, the apex acute to truncate; stipular sheath formed by adnation of stipule to blade for entire length of stipule. Turions absent [present with one internode, the leaves undifferentiated]. Inflorescence a 2-[1- to few-]flowered

capitate spike, at first enclosed by sheathing leaf bases; peduncle elongating at anthesis, elevating the inflorescence to or near the water's surface, often becoming spirally twisted in fruit, then pulling the developing fruit below the surface. Perianth absent. Androecium of 2 sessile anthers, the two 1-loculate halves separated by a broad connective, the dehiscence extrorse, the tapetum amoeboid, the pollen elongate, 4 times as long as broad, arcuate, swollen at the ends and at the center on the convex side, 3-celled, the exine reticulate, exceedingly thin, discontinuous at the swellings, the intine rather thick, further thickened in the swollen regions. Gynoecium of 4 or 5 [2–16] distinct, stipitate [sessile] carpels, the gynophore (stipe, podogyne) elongating after anthesis, the placentation parietal, the ovule campylotropous, the micropyle formed by both integuments. Fruit asymmetrical, dorsally rounded [or with a prominent transversely ridged crest], beaked [or beak absent], long stipitate [or sessile], the exocarp and mesocarp often decaying leaving the operculate endocarp intact. Embryo straight. TYPE SPECIES: *R. maritima* L. (Name dedicated to Heinrich Bernhard Ruppius, 1689–1719, a German botanist.) — DITCH-GRASS.

An almost cosmopolitan genus of perhaps 10 species, represented in the United States by *Ruppia maritima* L., widgeon-grass, $2n = 20$, which occurs along the coast from Maine to Texas, then sporadically inland to Michigan, California, and Washington.

The characters important in determining the various taxa of *Ruppia* are based on the fruits (whether strongly asymmetrical or only slightly so); the carpels (4, 5, or 8–16); the gynophore (slender, stout, or absent); the shape of the leaf apex (acute, obtuse, or retuse); the cross sectional structure of the leaf (shape of the lacunae and number of cells separating the lacunae from the epidermis); and the presence or absence of turions.

The genus is poorly understood both taxonomically and ecologically, and a thorough revision utilizing data from ecology, chemistry, and cytology, as well as morphology, is needed. (See Reese.)

According to Ogden (see family references), the anatomy of the stem and peduncle is very similar to that of the narrow-leaved species of *Potamogeton*. There is a stele with a single vascular bundle, an endodermis of O-cells, and a cortex without interlacunar or subepidermal bundles. The leaf has a central vein with a lacuna on both sides running the entire length of the blade.

In their paper on the floral development of *Ruppia maritima*, Posluszny & Sattler investigated the development of "the small dorsiventral outgrowth on its stamen connective." (See FIGURE 2, e, h, i.) Contrary to previous conclusions that these outgrowths are homologous with the sterile appendages (tepals) of the *Potamogeton* flower, they found that "... developmental studies reveal a most remarkable difference between *Potamogeton* and *Ruppia*. In *Potamogeton* the appendages are initiated acropetally on the floral apex and develop like typical phyllomes (Posluszny and Sattler, 1973, 1974). In contrast . . . in *Ruppia maritima* the

FIGURE 2. *Ruppia*. a-l, *R. maritima*. a, portion of plant with flowers and young fruit, $\times \frac{1}{2}$; b, tip of shoot to show sheathing leaves (stipules completely adnate) inclosing inflorescence, above, and stipular sheath (sheath at right partially cut away), two young leaves, and peduncle of inflorescence, below, $\times 3$; c, inflorescence, side view, showing two flowers facing in opposite directions, each flower with four carpels and two stamens, $\times 5$; d, inflorescence, from above, at anthesis, pollen already shed from stamens of lower flower, $\times 5$; e, lower flower, side view, with two carpels and two half-anthers removed, $\times 10$; f, pollen grain, side view, $\times 330$; g, carpel shortly after anthesis, in vertical section (diagrammatic) to show ovule, carpel oriented as left carpel in "e," $\times 10$; h, inflorescence with developing carpels (flower to left), the gynophores elongating, and unfertilized carpels (flower to right), $\times 5$; i, partially mature fruits of two flowers, $\times 5$; j, two mature drupes, $\times 5$; k, endocarp, side view, lid to left, $\times 5$; l, endocarp, adaxial side, with lid removed, lid to right, $\times 5$.

connective outgrowth develops, unlike either a tepal or a bract, after stamen inception, in fact after the beginning of theca differentiation. It results from growth very slightly abaxial to the tip of the stamen connective. Although it becomes dorsiventral, it . . . lacks any vascularization at maturity. In general, it is similar to a vertical extension of the stamen connective in *Potamogeton* [*Groenlandia*] *densus* (Posluszny and Sattler, 1973), and may be considered homologous with the latter. . . . Carpel development is similar in *Ruppia* and *Potamogeton*. . . . Many who have made comparisons of vegetative appendages, mature flowers, and seeds

(Markgraf 1936; Uhl 1937; Singh 1965; Gamero 1968) claim that *Ruppia* is closely related to *Potamogeton*. [Floral development] does not contradict it, but it certainly does not bring the two genera closer together. . . . The floral development of *R. maritima*, though, does fit into a trend of simplification and reduction between *Potamogeton* and *Zannichellia*, as noted by Singh (1965). According to this trend, reduction occurs in the number of appendages per flower, flowers per inflorescence, and vegetative appendages on the renewal shoots before floral induction."

The observations of Gamero on the floral biology of *Ruppia cirrhosa* in Argentina are summarized below. Flowering begins by the opening of the leaf sheath which surrounds the developing inflorescence. This usually occurs in the afternoon and is followed by peduncle elongation, which is by cell enlargement alone, since no meristematic tissue is present. During the daylight hours of the first day, the peduncle usually elongates as much as 2 cm., and that night much greater elongation occurs (in most instances), pushing the inflorescence to the surface of the water. Usually very little emergence takes place, for the peduncle bends and lies horizontal just below the surface. In any case, there is a film of water surrounding the inflorescence. Occasionally elongation may occur on the second, instead of the first, night.

Pollen release occurs during the morning following elongation. Opening of the anther locule is indicated by the appearance of bubbles, mostly oxygen, at a line of abscission of each anther half from the connective. The bubbles continue to enlarge and become confluent until abscission is complete. At this time, the bubble, about twice the size of the anther half, carries it to the surface of the water. As the anther half contacts the atmosphere, it opens violently, spreading the pollen over the surface of the water, with clusters of grains adhering end to end, forming chains. The pollen grains are oriented with the concave cavity upward, and bubbles trapped in the cavity and reticulation of the exine keep the pollen chains afloat. Dehiscence of the anther half occurs by the curving of the walls downward and the edges inward. At the same time, the anther half remains afloat by the spreading over the surface of the water of an internal cutinized membrane.

Following pollen release, growth of the peduncle resumes, but the inflorescence, which has now been reduced to two apocarpous gynoecia, remains just below the aqueous film surrounding the pollen grains. The apex of the inflorescence curves slowly so that the carpels of the lower flower are inclined forward, the gynoecia of both flowers then being in line with the axis of the inflorescence. Gamero could not positively determine the time at which the stigmas are receptive to pollen, but it appears that the flowers are probably protandrous. The straightening of the inflorescence is complete within 24 hours of pollen release.

Within two or three days after pollen release, spiraling of the peduncle begins from its base upward. Spiraling is accomplished by the unequal enlargement of cells, the exterior ones enlarging more than the interior. As a result of the spiraling, the carpels are pulled deeper into the water

and are oriented toward the substrate. The spiraling process, which may occur with or without pollination, is completed within three or four days. Gynophore elongation, which occurs shortly after the spiraling process is complete, takes approximately seven to eight days to complete. This elongation, unlike spiraling, is dependent on fertilization. (Cf. FIGURE 2, h.) The fruits are mature within 15 days after gynophore elongation. The entire process is complete within 30 days after the inflorescence emerges from the leaf sheath.

Ortu, studying the influence of temperature and salinity on the germination of seeds of *Ruppia maritima*, has observed that sodium chloride in concentrations of 52 grams/liter generally inhibits germination; that the dormant period decreases with increase of temperature; and that at 30° C. seeds kept in solutions of 3.5 grams/liter have a higher germination rate, whereas at 20° C. a higher germination rate is observed among those kept in solutions of 6.5, 13, and 26 grams/liter.

Economically, the genus is important only as a source of food for waterfowl and other wildlife. Gaevskaya lists 14 species that have been known to feed on *Ruppia*.

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Haynes, R R. 1978. "The Potamogetonaceae in the Southeastern United States." *Journal of the Arnold Arboretum* 59(2), 170–191.

<https://doi.org/10.5962/p.324729>.

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