# Kingdom 1. PLANTAE

An aquatic multicellular green alga was probably the ancestor of all land plants, but these became less dependent on external water for reproduction as their conducting tissue, cuticle, stomata and seeds evolved. Their photosynthetic pigments (chlorophyll and carotenoids), their chief storage product of starch and their cellulose-rich cell walls all provide evidence for this origin. Plants have a life cycle with an alternation of generations in which haploid gametophytes alternate with diploid sporophytes. Spores resulting asexually from meiosis in sporophytes grow into gametophytes, which produce male and female cells for sexual reproduction.

The oldest fossils of land plants date from the Silurian period, somewhat over 400 million years ago.

Cronquist, A., Takhtajan, A. & Zimmermann, W. (1966). On the higher taxa of Embryobionta. *Taxon* **15**: 129–134.

1. Herbs reproducing by spores; flowers absent 2.
1. Plants often woody, reproducing by seeds; flowers with stamens or carpels or both 4.
2. Stems jointed; leaves not green, forming a sheath at the nodes **2. EQUISETOPHYTA**
2. Stems not jointed; leaves green, not connate into a sheath 3.
3. Leaves not differentiated into a lamina and petiole **1. LYCOPODIOPHYTA**
3. Leaves (fronds) with distinct lamina and petiole (stipe) **3. POLYPODIOPHYTA**
4. Trees or shrubs with small green needle-like or scale-like leaves; perianth absent; ovules naked, either on the upper surface of scales arranged in cones or solitary and terminal on a short, scaly axillary shoot; pollen sacs 2 or more on the lower surface of a flat sporophyll or several that are pendulous from the apex of a peltate sporophyll; male sporophylls always in cones **4. PINOPHYTA**
4. Perianth usually consisting of an outer set of members, the sepals, forming a calyx, and an inner set, the petals, forming a corolla; ovules completely enclosed in a carpel; pollen sacs 4 (or occasionally fewer) surrounding and adnate to a connective at the apex of a usually slender filament **5. MAGNOLIOPHYTA**

# Division 1. LYCOPODIOPHYTA Cronquist, Takht. & W. Zimm.

*Herbs*. *Stems* simple or sparingly branched, bearing roots. *Leaves* simple, with 1 vein. *Sporangia* homosporous or heterosporous, borne singly in leaf axils or on the upper side of a leaf near the base; sporangium-bearing leaves often aggregated into a cone. *Gametophytes* of homosporous species free-living, subterranean, mycorrhizal and saprophytic, those of heterosporous species much reduced and retained in the spore, which lies on the ground.

Contains 3 isolated families worldwide, each in a separate order.

Derrick, L. N., Jermy, A. C. & Paul, A. M. (1987). Checklist of European Pteridophytes. *Sommerfeltia* **6**: i–xx, 1–94.
Hyde, H. A., Wade, A. E. & Harrison, S. G. (1978). *Welsh ferns, clubmosses, quillworts and horsetails*. Ed. 6. Cardiff.
Jermy, C. & Camus, J. (1991). *The illustrated field guide to ferns and allied plants of the British Isles*. London.
Page, C. N. (1997). *The ferns of Britain and Ireland*. Ed. 2. Cambridge.

1. Stems short, tuberous, with cells producing secondary tissue; leaves subulate or filiform, 10–250(–400) mm long; sporangia more or less embedded in leaf-bases; spermatozoids multiciliate **3. ISOETACEAE**
1. Stems long, without secondary thickening; leaves scale-like, 2–8 mm long; sporangia in leaf axils; spermatozoids biciliate 2.
2. Sporangia of two kinds, the megasporangia borne at the base and the microsporangia at the apex of ill- to well-defined terminal cones **2. SELAGINELLACEAE**
2. Sporangia all alike, borne in well-defined terminal cones or on sporophylls like the foliage leaves **1. LYCOPODIACEAE**

## Order **1. LYCOPODIALES** Trevis.

As family.

### **1. LYCOPODIACEAE** P. Beauv. ex Mirb.

*Perennial herbs*. *Stems* elongated, not, little or considerably branched, bearing roots. *Leaves* small, simple, bearing 1 vein, without ligule. *Homosporous*. *Sporangia* in leaf axils, all alike, borne near the base of the upper surface of the leaves, which vary from being like stem leaves and arranged among them to being strongly differentiated from the stem leaves and arranged in terminal cones, unilocular, compressed, dehiscing by splitting, with numerous spores. *Gametophyte* subterranean, saprophytic and with mycorrhizae; antheridia in the centre of the apical part of the gametophyte, containing biciliate spermatozoids; archegonia in a ring around the antheridia.

Contains six to eight genera in temperate and tropical regions.

1. Stems ascending, divided dichotomously into branches of equal length; sporangia axillary **1. Huperzia**
1. Stems creeping and rooted, with short lateral branches; sporangia in terminal cones 2.
2. Leaves 4-ranked, opposite and decussate; branches more or less flattened **4. Diphasiastrum**
2. Leaves in whorls, alternate or spiral; branches not flattened 3.
3. Stem leaves and sporangium-bearing leaves similar, without either hair points or scarious margins **2. Lycopodiella**
3. Either stem leaves with hair points or sporangium-bearing leaves with scarious toothed margins **3. Lycopodium**

#### **1. Huperzia** Bernh.

*Selago* Hill; *Urostachys* Herter

*Perennial evergreen herbs*. *Stems* all ascending to erect, divided into equal, unflattened branches. *Leaves* spirally arranged, imbricate, often with bud-like gemmae in their axils which detach and take root. *Sporangia* axillary, not forming a terminal spike, usually in a fertile zone alternating with sterile ones; fertile leaves not differentiated from the sterile ones. *Gametophyte* without chlorophyll, subterranean, large and cylindrical.

Contains about 100 species, cosmopolitan.

Headley, A. D. & Callaghan, T. V. (1990). Modular growth of *Huperzia selago* (Lycopodiaceae: Pteridophyta). *Fern Gazette* **13**: 361–372.
Hultén, E. & Fries, M. (1986). *Atlas of north European vascular plants north of the Tropic of Cancer.* 3 vols. Königstein.
Jermy, C. & Camus, J. (1991). *The illustrated field guide to ferns and allied plants of the British Isles.* London.
Page, C. N. (1997). *The ferns of Britain and Ireland.* Ed. 2. Cambridge.

1. Stems up to 30 cm, 6–12 mm thick; leaves more or less spreading, green when healthy, linear-lanceolate **1(a). selago** subsp. **selago**
1. Stems up to 10 cm, 5–6 mm thick; leaves adpressed to stem, yellowish-green, ovate-lanceolate to narrowly ovate **1(b). selago** subsp. **arctica**

**1. H. selago** (L.) Bernh. ex Schrank & Mart.
Fir Clubmoss

*Lycopodium selago* L.; *Plananthus selago* (L.) P. Beauv.; *Mirmau selago* (L.) H. P. Fuchs; *Lycopodium abietiforme* Gray nom. illegit.

*Perennial evergreen herb* with numerous tough, wiry roots. *Stems* numerous, 5–30 cm, decumbent at base, then stiffly erect, each more or less the same height and dividing dichotomously into branches of equal lengths, densely leafy, the whole looking like a small, stiff bush. *Leaves* spirally arranged, dense and imbricate, suberect to spreading, 2–8 mm, slightly glossy, bright green, linear to ovate-lanceolate, acute at apex, entire or very minutely serrulate, often bearing in their axils bud-like gemmae which readily detach, disperse and take root as new plants. *Sporangia* borne in the axils of many of the leaves, not forming a terminal spike but usually in fertile zones alternating with sterile ones on the stem. *Spores ripe* 6–8, but probably not functional in Great Britain and Ireland; reproduction probably only by gemmae. $2n = >260$.

**(a)** Subsp. **selago**
*Stems* up to 30 cm, 6–12 mm thick. *Leaves* more or less spreading, green when healthy, linear-lanceolate.

**(b)** Subsp. **arctica** (Grossh. ex Holm) Á. & D. Löve
*Lycopodium selago* subsp. *arctica* Grossh. ex Holm; *Lycopodium selago* var. *appressum* Bach. Pyl. ex Desv.; *H. appalachiana* Beitel & Mickel; *H. appressa* (Bach. Pyl. ex Desv.) Á. & D. Löve; *H. selago* subsp. *appressa* (Bach. Pyl. ex Desv.) D. Löve; *H. selago* var. *appressa* (Bach. Pyl. ex Desv.) Kukkonen
*Stems* up to 10 cm, 5–6 mm thick. *Leaves* adpressed to stem, yellowish-green, ovate-lanceolate to narrowly ovate.

Native. Heaths, moors, mountain grassland, rock ledges and mountain tops up to 1310 m. Common in upland Great Britain south to Wales, with scattered records in upland Ireland; rare in the lowlands, especially in England. Most of Europe, but in the south only on high mountains; Himalayas; North America; southern South America and adjacent islands. The common plant is subsp. *selago*. Subsp. *arctica* is rare in Scotland and also occurs in northern Europe. Circumpolar Boreo-arctic Montane element.

#### **2. Lycopodiella** Holub

*Lepidotis* P. Beauv.

*Perennial herbs* dying down in the first winter and persisting into the second year in a semi-decayed state with a green growing tip. *Stems* prostrate and rooting, with short lateral branches. *Leaves* spirally arranged. *Sporangia* at first green, but maturing to an olive-yellow colour;

sporangium-bearing leaves tapering and closely adpressed, forming a cone 1–3 cm. *Gametophyte* with conical subterranean base and green leaf-like appendages at apex.

Contains about 50 species worldwide.

Hultén, E. & Fries, M. (1986). *Atlas of north European vascular plants north of the Tropic of Cancer.* 3 vols. Königstein.
Jermy, C. & Camus, J. (1991). *The illustrated field guide to ferns and allied plants of the British Isles.* London.
Page, C. N. (1997). *The ferns of Britain and Ireland.* Ed. 2. Cambridge.
Stewart, A., Pearman, D. A. & Preston, C. D. (Edits.) (1994). *Scarce plants in Britain*. Peterborough.

**1. L. inundata** (L.) Holub Marsh Clubmoss
*Lycopodium inundatum* L.; *Lepidotis inundata* (L.) Opiz

*Perennial herb* which largely dies away in its first winter and persists into the second year only in a brownish semi-decayed state, with a green growing tip, from which the new season's growth resumes. *Stems* 5–20 cm, closely prostrate and rooting, sparingly branched, densely leafy. *Leaves* spirally inserted but secund towards the upper side of the stem, erecto-patent, 4–6 mm, bright green, linear-subulate, acute at apex, entire. *Fertile branches* 3–10. *Sporangia* at first green but maturing to an olive-yellow colour, their leaves tapering and closely adpressed, forming a cone 1–3 cm. *Spores ripe* 6–9. $2n = 156$.

Native. Wet heaths, often on bare peaty soil, often partly immersed in pools, mainly in lowlands but up to 305 m. Formerly in scattered localities almost throughout Great Britain and Ireland, but now very local and virtually extinct in central and eastern England. Most of Europe except the Mediterranean region and eastern Russia; western Caucasus; North America and Alaska to Pennsylvania, Idaho and Oregon. European Boreo-temperate element.

## 3. Lycopodium L.

*Perennial evergreen herbs*. *Stems* creeping and rooting, with short lateral branches. *Leaves* spirally arranged or in whorls, flat, linear to lanceolate, adpressed or spreading. *Sporangia* at first greenish, becoming yellowish, forming a terminal cone; sporangium-bearing leaves with scarious, toothed margins. *Gametophyte* without chlorophyll, disc-shaped or tuberous, without appendages.

Contains about 100 species worldwide.

Callaghan, T. V. et al. (1986). The modular growth of *Lycopodium annotinum*. *Fern Gazette* **13**: 63–76.
Hultén, E. & Fries, M. (1986). *Atlas of north European vascular plants north of the Tropic of Cancer.* 3 vols. Königstein.
Jermy, C. & Camus, J. (1991). *The illustrated field guide to ferns and allied plants of the British Isles.* London.
Page, C. N. (1997). *The ferns of Britain and Ireland.* Ed. 2. Cambridge.
Rumsey. F. J. (2007). An overlooked boreal clubmoss *Lycopodium lagopus* (Laest. ex Hartm.) Zinserl. ex Kusen. (Lycopodiaceae) in Britain. *Watsonia* **26**: 477–480.
Stewart, A., Pearman, D. A. & Preston, C. D. (Edits.) (1994). *Scarce plants in Britain*. Peterborough. [*L. annotinum.*]

1. Leaves acute to acuminate at apex, but without long whitish point; cones sessile at apex of leafy stems **3. annotinum**
1. Leaves acuminate at apex, with whitish apical point 1.5–4.0 mm; cones usually on sparsely leaved peduncles less than 7(–20) cm, at apex of leafy stems, rarely sessile 2.
2. Peduncles 2.5–7(–20) cm; cones (1–)2–3(–5) on each peduncle **1. clavatum**
2. Peduncles 0–1.2(–3) cm; cones 1–2 on each peduncle **2. lagopus**

**1. L. clavatum** L. Stag's-horn Clubmoss
*Lepidotis clavata* (L.) P. Beauv.

*Perennial evergreen herb* with rather shallow roots. *Stems* 30–100 cm, prostrate and rooting at intervals, much branched, all the branches except the fertile ones procumbent, densely leafy. *Leaves* of main stem 5–7 mm, yellowish-green, lanceolate, acuminate at apex, those of branches 3–5 mm, bright glossy green, narrowly lanceolate, overlapping, incurved and adpressed, with a distinct midrib and ending in a conspicuous long slender, colourless or silvery, hair-like tip, which incurves towards the stem, giving a characteristic hoary appearance even at a distance. *Fertile branches* 10–25 cm, erect, with a long, slender, pale yellow peduncle 2.5–7(–20) cm, bearing only minute remote leaves and typically forking one or more times, with each branch ending in a cone. *Cones* (1–)2–3(–5) on each peduncle, 2–4 cm long, erect, shuttle-shaped, catkin-like, at first pale green, becoming bright creamy yellow by midsummer; sporangium-bearing leaves ovate, with a long white apical hair and a scarious denticulate margin. *Spores* bright yellow, *ripe* 6–9. $2n = 68$.

Native. Heaths, moors and mountain grassland ascending to 840 m, common in mountain districts, rare or absent in the lowlands. Formerly throughout Great Britain and Ireland but now absent from much of the lowlands. North and central Europe, extending locally southwards to central Spain and Portugal, central Italy and Bulgaria. Circumpolar Boreo-temperate element.

**2. L. lagopus** (Laest. ex Hartm.) Zinserl. ex Kuzen.
Hare's-foot Clubmoss
*L. clavatum* var. *lagopus* Laest. ex Hartm.; *L. clavatum* var. *monostachyon* Grev. & Hook.

*Main shoots* always on the ground; erect branches 3–10 cm × 5–7 mm. *Leaves* 2.5–3.5 mm, more or less yellowish-green, adpressed, sometimes only loosely, acuminate at apex with a whitish apical point 1.5–3.0 mm, with margin entire or somewhat serrate. *Peduncles* 0–1.2 (–3) cm. *Cones* 1–2 on each peduncle. *Spores ripe* in late summer to late autumn.

Native. Mountain slopes above 800 m. Garbh Bheinn, Fersit Forest, and Geal Carn, Glen Feshie, both in Inverness-shire. Circumpolar Arctic-montane element.

**3. L. annotinum** L. Interrupted Clubmoss
*Lepidotis annotina* (L.) P. Beauv.

*Perennial herb,* all the leaves of which persist for several years, with the end of each growing season marked by a ring of leaves which are smaller and more adpressed to the stem, thus marking the yearly vegetative growth by constrictions or interruptions. *Stems* 30–60 cm, tough, flexuous and creeping, giving rise to ascending side branches at intervals of a few centimetres, up to about 10 cm high, but as they gradually lengthen they recline and become prostrate, often themselves rooting and giving rise to fresh side branches. *Leaves* of creeping stems 3–5 mm, lanceolate, acuminate at apex, spirally arranged and somewhat distant, those of the branches 5–7 mm, lanceolate, acute at apex, more crowded, spreading to ascending and somewhat prickly to the touch. *Fertile branches* 10–25 cm, arising from the ends of some of the longer branches and bearing cones 1–3 cm long, at first greenish, becoming yellowish-brown when mature by midsummer; sporangium-bearing leaves ovate, acuminate at apex, with a wide scarious denticulate margin. *Spores ripe* 6–8. $2n = 68$.

Native. Moors and mountains from 45 to 1000 m, on thin soil over rocks, often among *Calluna*. Local in central and northern Scotland with one locality in Westmorland; extinct in southern Scotland, the rest of northern England and North Wales. Almost circumboreal, it extends into the arctic and is found as far south as the Appalachian and Rocky Mountains. Circumpolar Boreo-arctic Montane element.

**4. Diphasiastrum** Holub

*Perennial evergreen herbs. Stems* procumbent, often rhizomatous, with erect branches, forked several times and forming fan-like caespitose tufts; the erect stems more or less flattened. *Leaves* in 4 rows, opposite and decussate, those of the lateral rows keeled. *Sporangia* at first olive-green, later becoming a more conspicuous pale yellowish-brown, forming a sessile cone, with its leaves lanceolate to ovate. *Gametophyte* without chlorophyll, with conical subterranean base bearing a subglobose apical appendage.

Contains about 30 species in Europe, central and east Asia and North America.

Callaghan, T. V. et al. (1986). The modular growth of *Lycopodium annotinum*. *Fern Gazette* **13**: 63–76.
Druce, G. C. (1916). Plant notes, etc., for 1915. *Lycopodium complanatum* L. (with illustrations). *Lycopodium Chamaecyparissus* A. Braun. *Rep. Bot. Soc. Exch. Club Brit. Isles* **4(3)**: 218–223.
Hultén, E. & Fries, M. (1986). *Atlas of north European vascular plants north of the Tropic of Cancer.* 3 vols. Königstein.
Jermy, A. C. (1989). The history of *Diphasiastrum issleri* (Lycopodiaceae) in Britain and a review of its taxonomic status. *Fern Gazette* **13**: 257–265.
Jermy, C. & Camus, J. (1991). *The illustrated field guide to ferns and allied plants of the British Isles.* London.
Kukkonen, I. (1967). Studies on the variability of *Diphasium* (*Lycopodium*) *complanatum*. *Ann. Bot. Fenn. Vanamo* **4:** 441–470.
Page, C. N. (1997). *The ferns of Britain and Ireland.* Ed. 2. Cambridge.
Stewart, A., Pearman, D. A. & Preston, C. D. (Edits.) (1994). *Scarce plants in Britain*. Peterborough.
Wigginton, M. J. (Edit.) (1999). *British red data books.* 1. *Vascular plants*. Peterborough.

1. Erect branches slightly flattened; ventral leaves on branches about 0.5 mm wide with more than 1.0 mm free from stem; lateral leaves fused to stem for about one-twelfth of their length **1(a). complanatum** subsp. **alpinum**
1. Erect branches strongly flattened; ventral leaves on branches about 1.0 mm wide, with less than 1.0 mm free from stem; lateral leaves fused to stem for about two-thirds of their length **1(b). complanatum** subsp. **issleri**

**1. D. complanatum** (L.) Holub Alpine Clubmoss
*Lycopodium complanatum* L.; *Diphasium complanatum* (L.) Rothm.

*Perennial evergreen herb* with slender, tough, whitish rhizomes or prostrate stems, bearing roots and usually half buried. *Stems* 15–50(–100) cm, frequently branched, with the branches, erect, forked several times and forming caespitose tufts of parallel shoots which create a distinct bluish-green, level-topped appearance and are in various degrees dorsiventrally flattened. *Leaves* of rhizomes small, scale-like and distant, on the erect branches, adpressed and strongly 4-ranked, glaucous, oblong-lanceolate or elliptical-lanceolate, acute or acuminate at apex, entire, concave. *Fertile branches* 4–7 cm, terminating in a small sessile cone 1.5–2.0 cm long, at first olive-green, later becoming a more conspicuous pale yellowish-brown; sporangium-bearing leaves lanceolate, ovate-lanceolate or ovate, acute or acuminate at apex and with a scarious, entire or denticulate margin. *Spores ripe* 6–8. $2n = c.\ 48$.

**(a)** Subsp. **alpinum** (L.) Jermy
*D. alpinum* (L.) Holub; *Diphasium alpinum* (L.) Rothm.; *Lycopodium alpinum* L.; *Lycopodium complanatum* subsp. *alpinum* (L.) Hook. fil.
*Erect branches* slightly flattened, glaucous. *Ventral leaves* on branches about 0.5 mm wide, with more than 1.0 mm free from stem; lateral leaves fused to stem for about one-twelfth of their length; leaves of cone lanceolate or ovate-lanceolate.

**(b)** Subsp. **issleri** (Rouy) Jermy
*Lycopodium alpinum* race *issleri* Rouy; *Lycopodium issleri* (Rouy) Domin; *D. issleri* (Rouy) Holub; *Lycopodium alpinum* var. *decipiens* Syme ex Druce
*Erect branches* strongly flattened, scarcely glaucous. *Ventral leaves* on branches about 1.0 mm wide with less

than 1.0 mm free from stem; lateral leaves fused to stem for about two-thirds of their length; leaves of cone ovate.

Native. Subsp. *alpinum* occurs on moors, in mountain grassland and among *Calluna* on exposed mountain tops up to 1220 m. It is locally common in north and west Great Britain south to Derbyshire and South Wales and was formerly in Devon; still in north, east and west Ireland. Circumpolar Arctic-montane element. Subsp. **complanatum**, which is widespread in Continental Europe, is not found in Great Britain and Ireland. Subsp. *issleri* is variable and somewhat intermediate between subsp. *complanatum* and subsp. *alpinum* and it has been suggested that it is a hybrid between the two. It was formerly in scattered localities in central and north Scotland and western England, but it is now extinct except in a few places in Northumberland, Aberdeenshire and Sutherland. It also occurs in central Europe, central France and the Ardennes. Circumpolar Boreal-montane element.

## Order **2. SELAGINELLALES** Wettst.

As family.

### **2. SELAGINELLACEAE** Willk.

*Perennial herbs* with long, usually creeping stems producing leafless branches (rhizophores) which bear the roots or arise with them on a corm-like swelling at the base of the stem. *Leaves* small, spirally arranged or 4-ranked and of two kinds, bearing a minute ligule at the base. *Heterosporous*. *Sporangia* in leaf axils, the sporangium-bearing leaves in ill- to well-defined cones, with megasporangia at base and microsporangia at apex. *Megaspores* (1–)4(–42). *Microspores* numerous. *Male gametophyte* contained in the microspore until maturity, with a vegetative cell and an antheridium containing numerous biciliate spermatozoids. *Female gametophyte* many-celled, filling the megaspore and protruding from its split top; archegonia several, at the top of the prothallus. *Fertilisation* occasionally takes place before the shedding of the megaspore.

Contains one genus.

#### **1. Selaginella** P. Beauv.

*Bernhardia* P. Beauv. ex Gray

See family description; the only genus.

Contains about 700 species, cosmopolitan, but mainly tropical.

Clement, E. J. et al. (2005). *Illustrations of alien plants of the British Isles*. London.
Hultén, E. & Fries, M. (1986). *Atlas of north European vascular plants north of the Tropic of Cancer.* 3 vols. Königstein.
Jermy, C. & Camus, J. (1991). *The illustrated field guide to ferns and allied plants of the British Isles.* London.
Page, C. N. (1997). *The ferns of Britain and Ireland.* Ed. 2. Cambridge.
Reynolds, S. C. P. (2002). *A catalogue of alien plants in Ireland.* Glasnevin.

1. Leaves all similar, spirally arranged **1. selaginoides**
1. Leaves of two sizes in four rows **2. kraussiana**

**1. S. selaginoides** (L.) P. Beauv. Lesser Clubmoss
*Lycopodium selaginoides* L.; *S. spinosa* P. Beauv.; *S. spinulosa* A. Braun; *Lycopodium ciliatum* Lam.; *S. ciliata* (Lam.) Opiz; *Bernhardia spinosa* Gray nom. illegit.

*Perennial herb. Stems* 3–15 cm, decumbent to procumbent, with short vegetative and long ascending, more robust fertile branches, with the roots borne on small corm-like swellings (rhizophores) at the base of the stem. *Leaves* all of one kind, 1–4 mm, spirally arranged, spreading or somewhat adpressed, lanceolate, acute at apex, spinulose-ciliate. *Fertile branches* 2–6 cm, suberect, terminating in a solitary, sessile, ill-defined cone 1.0–1.5 cm long, bright green at first, becoming a pale yellowish-green; sporangium-bearing leaves similar to those on the sterile part of the stem but becoming more spreading at maturity revealing the shining, whitish sporangia; megasporangia occupying the greater part of the cone; microsporangia few in its upper part and often absent. *Spores ripe* 6–8. $2n = 18$.

Native. Damp places among mosses and grasses, mainly in mountains. Locally common in Great Britain and Ireland south to Co. Limerick, Cardiganshire and Yorkshire; formerly to Co. Cork, Derbyshire and Lincolnshire. North and central Europe, Pyrenees, Arctic, north temperate Asia and America, south to the Caucasus, Colorado and New Hampshire. Circumpolar Boreal-montane element.

**2. S. kraussiana** (Kunze) A. Braun Krauss's Clubmoss
*Lycopodium kraussianum* Kunze; *Didiclis kraussiana* (Kunze) Rothm.; *S. denticulata* auct.

*Perennial herb. Stems* up to 1 m, creeping, jointed at the nodes, dorsiventrally flattened, with the roots borne at the end of specialised leafless branches (rhizophores). *Leaves* of 2 kinds, in 4 rows, those of the upper side of the stem 1–2 mm, unequal at base, with a rounded auricle on outer margin, adpressed, the lateral ones 2–4 mm, ovate-lanceolate, acute at apex, rounded at base, spreading. *Fertile branches* erect, with a solitary sessile cone near the tip, about 2 cm long, 4-sided; sporangium-bearing leaves ovate, cuspidate at apex, keeled, minutely toothed. *Spores ripe* 6–8. $2n = 20$.

Introduced. Grown as ground cover in mild damp regions and more or less naturalised in shrubberies and damp shady places. Scattered records in Great Britain, east, west and south Ireland and the Channel Islands north to south Scotland, Argyll, Isle of Man, Co. Mayo and Co. Down. Native of tropical Africa, South Africa and the Azores.

## Order **3. ISOETALES** Engl.

As family.

### **3. ISOETACEAE** Dumort.

Aquatic or terrestrial, *perennial*, heterosporous *herbs*. *Stems* 1, rarely 2 rings of meristematic cells producing secondary tissue, short and stout, dichotomously branched, the roots arising from the 2- or 3-lobed stem base. *Leaves* crowded in a dense rosette, subulate or filiform, usually more or less terete, often tubular and septate, sheathing at base; with a minute ligule on the upper side near the base. The first-produced leaves in any season bearing megasporangia, the next microsporangia, and the last sterile. *Sporangia* sessile, more or less embedded in the leaf-base below the ligule and usually covered by an indusium formed from the leaf-base. *Spores* on germination giving rise to prothalli. *Male gametophytes* (from microspore) of one vegetative cell and an antheridium, with a 4-celled wall surrounding 2 cells which give rise to 4 spermatozoids. The multiciliate spermatozoids are liberated by the dehiscence of the spore and breaking down of the antheridium wall. *Female gametophyte* (from megaspore) is many-celled, fills the megaspore and bears archegonia, the necks of which protrude from the split top of the megaspore. The young plant develops with a resting stage from the fertilised archegonium.

Contains 2 genera, *Isoetes* and the monotypic *Stylites* from the Andes of Peru, sometimes only recognised as a subgenus.

#### **1. Isoetes** L.

As family.

Contains about 130 species distributed throughout the world.

Babington, C. C. (1863). On British species of *Isoetes*. *Jour. Bot. (London)* **1**: 1–5.
Camus, J. M., Jermy, A. C., Paul, A. M., Preston, C. D. & Taylor, W. C. (1988). Hybridization and speciation in North Temperate *Isoetes*. *B.S.B.I. News* **49**: 41–42.
Jermy, C. & Camus, J. (1991). *The illustrated field guide to ferns and allied plants of the British Isles*. London.
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1. Leaves present from October to June, with dark bases **3. histrix**
1. Leaves present from January to December; leaf-bases not dark 2.
2. Megaspores with blunt anastomosing tubercles **1. lacustris**
2. Megaspores covered with long sharp fragile spines **2. echinospora**

**1. I. lacustris** L. Quillwort
*Calamaria lacustris* (L.) Kuntze; *I. morei* Moore

Aquatic *perennial* heterosporous *herb*. *Stems* without persistent leaf bases, 2-lobed. *Leaves* with a rosette-like habit, 80–250(–400) × 2–5 mm, parallel-sided for most of their length, then tapered to an acute apex, dark green, stiff, internally with 4 longitudinal, septate air canals. *Megaspores* 530–700 µm in diameter, with blunt, anastomosing tubercles. *Spores ripe* 5–7. $2n = 110$.

Native. In lakes and tarns where water is poor in dissolved salts, on substrata of stones with little silt, boulder clay, sand, or rarely thin peat. South Devonshire, mountain districts of Wales, Shropshire, Yorkshire, Lake District and Scotland and Ireland. North and central Europe. Eurosiberian Boreal-montane element. Also in North America.

**2. I. echinospora** Durieu Spring Quillwort
*I. setacea* auct.; *Calamaria echinospora* (Durieu) Kuntze; *I. lacustris* subsp. *echinospora* (Durieu) Moore & More

Aquatic *perennial* heterosporous *herb*. *Stems* without persistent leaf-bases and 2-lobed. *Leaves* with a rosette-like habit, 30–150 × 2–3 mm, pale green, flaccid, gradually tapering throughout their length to end in slender, very acute apices, internally with 4 longitudinal septate air canals. *Megaspores* 440–550 µm in diameter, white or yellowish, covered with long sharp fragile spines. *Spores ripe* 4–7. $2n = 22$.

Native. In clear upland lakes, mostly on peaty substrata. Cornwall, Devonshire, Dorsetshire, Glamorganshire, Cardiganshire, Merionethshire, Caernarvonshire, Cumberland, Scotland and Ireland. North and central Europe, southwards to north Italy and Spain. Circumpolar Boreal-montane element.

× **lacustris** = **I.** × **hickeyi** W. C. Taylor & Luebke
Intermediate between the parents and sterile. $2n = 66$.

Native. Occurs with both parents in Cardiganshire, Scotland and perhaps elsewhere.

**3. I. histrix** Bory Land Quillwort
*Cephaloceraton histrix* (Bory) Gennari; *Calamaria histrix* (Bory) Kuntze

Terrestrial *perennial* heterosporous *herb*. *Stems* covered with persistent short blackish leaf bases each with 2 long points. *Leaves* with a rosette-like habit, 10–40(–100)

× about 1 mm, dark green, shiny, half-terete, gradually tapering from the base to a pointed tip, soft and flexible, pellucid towards the base, lacking the transverse septa of other species; towards the corm the leaves broaden into whitish, clasping bases, some of which contain sporangia inside with a single longitudinal air canal. *Megaspores* 400–500 µm in diameter, grey, with short blunt tubercles coalescing into ridges. *Spores ripe* 4–5. *Vegetative growth* 10–4. $2n = 20$.

Native. Sandy or peaty hollows on cliff-tops near the sea, where water lies in winter. Extremely local in Guernsey and Alderney and on the Lizard Peninsula in Cornwall. Atlantic coast of Europe and Mediterranean region. Mediterranean-Atlantic element.

# Division **2. EQUISETOPHYTA** Cronquist, Takht. & W. Zimm.

*Rhizomatous perennial herbs* with aerial stems elongated, jointed, simple or bearing whorls of branches at the nodes. *Leaves* borne in whorls and fused into a sheath around the stem, simple, with 1 vein. *Sporangia* homosporous, borne in clusters under peltate, specialised branches which are arranged in terminal cones. *Gametophytes* free-living, green and photosynthetic.

A single surviving family.

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Hyde, H. A., Wade, A. E. & Harrison, S. G. (1978). *Welsh ferns, clubmosses, quillworts and horsetails.* Ed. 6. Cardiff.
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## Order **1. EQUISETALES** Trevis.

As Equisetophyta.

### **4. EQUISETACEAE** Rich. ex DC.

*Perennial herbs* with creeping rhizomes, bearing aerial stems at intervals. *Stems* all green or the fertile stems without chlorophyll, all grooved, simple or branched from near the base, with the branches resembling the stems or with whorls of slender green branches from the nodes, with a *central cavity* surrounded by two circles of smaller cavities, the larger, outer ones called *vallecular canals*. *Leaves* in whorls, united into sheaths above the nodes, the sheaths ending in free teeth usually of the same number as the grooves on the stem, usually not green; sheaths of branches much smaller with fewer teeth. *Sporangiophores* in whorls, closely aggregated to form a spike or cone, usually terminal on the main stem and occasionally also on the branches. *Spores* all alike, numerous in sporangia borne in groups around the under surface of the sporangiophore. *Archegonia* and *antheridia* borne on separate gametophytes, the female being larger. *Gametophytes* with a cushion-like base bearing green flat lobed structures arising from the under surface, with the sex organs borne on the upper surface of the cushion. *Spermatozoids* multiciliate.

Contains a single living genus.

#### **1. Equisetum** L.

As family.

Contains about 23 species, almost cosmopolitan but absent from Australasia.

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Hauke, R. L. (1963). A taxonomic monograph of the genus *Equisetum* subgenus *Hippochoete*. *Beih. Nova Hedwigia* **8**: 1–163.
Jermy, C. & Camus, J. (1991). *The illustrated field guide to ferns and allied plants of the British Isles.* London.
Page, C. N. (1963). A hybrid horsetail from the Hebrides. *Brit. Fern Gaz.* **9**: 117–119.
Page, C. N. (1972). An assessment of inter-specific relationships in *Equisetum* subgenus *Equisetum*. *New Phytol.* **71**: 355–369.
Page, C. N. (1973). Two hybrids in *Equisetum* new to the British flora. *Watsonia* **9**: 229–237.
Page, C. N. (1997). *The ferns of Britain and Ireland.* Ed. 2. Cambridge.
Page, C. N., McHaffie, H. & Butler, J. K. (2007). A new far northern hybrid horsetail from Scotland: *Equisetum* × *mchaffieae* C. N. Page (*Equisetum fluviatile* L. × *E. pratense* Ehrh.). *Watsonia* **26**: 339–345.
Preston, C. D. & Croft, J. M. (1997). *Aquatic plants in Britain and Ireland*. Colchester. [*E. fluviatile* and × *littorale*.]
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1. Stems brown or whitish, rarely tinged green, simple, with a cone at apex 2.
1. Stems green, simple or branched, with or without a cone at apex 5.
2. Leaf-sheaths with (15–)20–30(–40) teeth; cones (20–)40–80 mm **12. telmateia**
2. Leaf-sheaths with 3–20 teeth; cones 10–40 mm 3.
3. Leaf-sheaths with teeth united into 3–6 obtuse lobes at least at some nodes **10. sylvaticum**
3. Leaf-sheaths with (3–)6–20 separate (or sometimes slightly united) acute teeth 4.
4. Green colour absent from stems and leaf-sheath; branches normally not produced **8. arvense**
4. Base of stems and leaf-sheaths usually tinged green; green branches soon produced **9. pratense**
5. Leaf-sheaths normally with subterminal and sub-basal black bands; teeth falling off before or as soon as stems are fully expanded 6.
5. Leaf-sheaths with 0–1 black bands or more or less black all over; teeth present on fully expanded shoots 7.
6. Plant evergreen; leaf-sheaths about as long as wide, without teeth from very early on **1. hyemale**
6. Plant wholly or largely dying down in winter; leaf-sheaths distinctly longer than wide, with teeth until sheath is fully expanded **2. × moorei**
7. Stems evergreen, with the previous year's cones persisting; cones obtuse to apiculate at apex 8.
7. Stems dying down in winter, with the previous year's cones not persisting; cones rounded at apex 12.
8. Stem ridges 8–20; teeth of leaf-sheaths at least near the tip with narrow scarious margins no wider than the black centre, tapering to a fine point 9.
8. Stem ridges 4–10; teeth of leaf-sheaths with broad scarious margins, each much wider than the black centre, obtuse at maturity 10.
9. Stems not or sparsely branched, with central cavity less than half of the width of the stem; spores sterile **3. trachyodon**
9. Stems usually more or less well branched, with central cavity generally more than half of the width of the stem; spores fertile **4. ramosissimum**
10. Stems up to 100 cm; internodes smooth **5(iii). variegatum** var. **wilsonii**
10. Stems usually not more than 40 cm; internodes rough 11.
11. Stems up to 2 mm in diameter, prostrate, decumbent or erect **5(i). variegatum** var. **variegatum**
11. Stems up to 4 mm in diameter, strongly erect **5(ii). variegatum** var. **majus**
12. Stem internodes ivory-white, often more than 10 mm wide, with 18–40 ridges; stems with whorls of branches more or less to the top **12. telmateia**
12. Stem internodes green, mostly less than 10 mm wide, with 4–30 ridges, if more than 18 then at least the upper part of the stem without whorls of branches 13.
13. Branches regularly branched again; teeth of leaf-sheaths united into 3–6 lobes, fewer than stem ridges **10. sylvaticum**
13. Branches absent or present but not or sparsely and irregularly branched again; teeth of leaf-sheaths not fused, as many as stem ridges 14.
14. Stem internodes with central cavity more than three-quarters of the width of the stem, with 10–30 ridges, usually more than 20 in stems more than 8 mm wide **6. fluviatile**
14. Stem internodes with central cavity less than three-quarters of the width of the stem, usually about half or less, with 4–20 ridges; stems rarely more than 8 mm wide 15.
15. Stems with vallecular canals with a diameter scarcely smaller than that of the central cavity; stem internodes with 5–9(–12) ridges **11. palustre**
15. Stems with vallecular canals with a diameter less than half that of the central cavity; stem internodes with 6–20 ridges 16.
16. Internodes of branches mostly 3-angled, the lowest shorter than the adjacent leaf-sheath on main stem **9. pratense**
16. Internodes of branches mostly 4-angled or more, the lowest as long as to longer than the adjacent leaf-sheath on main stem 17.
17. Stem internodes with central cavity half to two-thirds of the width of the stem; cones, when present, always on green stems **7. × litorale**
17. Stem internodes with central cavity clearly less than half of the width of the stem; cones only exceptionally produced on green stems **8. arvense**

Subgenus **1. Hippochaete** (Milde) Baker
*Hippochaete* Milde

*Stems* all alike, hard, usually persisting through the winter. *Stomata* sunk below level of other epidermal cells. *Spikes* apiculate.

**1. E. hyemale** L. Rough Horsetail
*Hippochaete hyemalis* (L.) Bruhin

*Perennial evergreen herb* with rhizomes. *Stems* 70–100 cm, bright green, turning dark bluish-green, rough, tough, erect, simple; internodes somewhat swollen, with 12–24 conspicuous 2-angled longitudinal ridges and furrows, the ridges rough, with 2 regular rows of conspicuous angular tubercles; central cavity about two-thirds of the width of the stem or more; leaf-sheaths 3–9 mm, about as long as wide, soon whitish, with a black band at top and bottom, adpressed; teeth as many as the grooves, very quickly detached as a ring and carried up at tip of elongating shoot, leaving a crenulate upper margin to the sheath, sometimes persisting on some stems of depauperate plants. *Cones* on scattered shoots otherwise similar to vegetative ones, terminal, 8–15 mm, green near the base and black above or black throughout, barrel-shaped, capped by a hard dark-coloured bluntly pointed tip. *Spores ripe* 7–8. $2n = 216$.

Native. Ditches, river and stream banks, often in dense vegetation, up to 535 m altitude. Scattered records throughout most of Great Britain and Ireland, but decreasing. Most of Europe, but rare in the Mediterranean region; Caucasus; north and central Asia; western North America south to California and New Mexico. Circumpolar Boreo-temperate element.

**2. E. × moorei** Newman Moore's Horsetail
**E. hyemale × ramosissimum**
*E. occidentale* (Hy) Coste; *E.* × *samuelssonii* W. Koch ex Rothm.; *Hippochaete moorei* (Newman) H. P. Fuchs; *E. hyemale* var. *occidentale* Hy; *E. hyemale* subsp. *moorei* (Newman) Moore & More

*Perennial,* partially evergreen *herb* with rhizomes forming scattered clumps, which die down either partially or completely, depending on exposure, in winter. *Stems* 40–60 cm, yellowish-green, erect, normally completely unbranched; central cavity about three-fifths of the width of the stem; internodes not swollen, with 10–15 2-angled longitudinal ridges; leaf-sheaths about twice as long as broad, loosely fitting and funnel-shaped, at first uniformly green, but developing a black band around the base of the teeth, followed by one around the base of the sheath; in the upper nodes the central portion usually turns white, but in the lower nodes the whole sheath usually becomes black; teeth narrow, dark brown or black, each drawn into a fine, tapering, straight or flexuous tip, usually persisting until the shoots are fully expanded but then frequently breaking away at their base, leaving a truncate, slightly crenate upper margin to the sheath. *Cones* produced only occasionally, small, black, oblong-ovoid and containing only abortive spores. $2n = 216$ with irregular meiotic pairing.

Native. Dunes and banks by the sea. Known only between Wexford Harbour, Co. Wexford, and Ardmore Point, Co. Wicklow, in the absence of *E. ramosissimum* and usually of *E. hyemale*. It is widespread in Europe and is recorded by the Caspian Sea and in Japan. Through most of its range both parents are sympatric, but its presence in Ireland and Gotland, where *E. ramosissimum* is absent, and by the Caspian Sea, where *E. hyemale* is absent, is highly problematic.

**3. E. × trachyodon** A. Braun Mackay's Horsetail
**E. hyemale × variegatum**
*E. hyemale* var. *mackaii* Newman, *E. mackaii* (Newman) Brichan; *Hippochaete trachyodon* (A. Braun) Börner; *E. hyemale* subsp. *trachyodon* (A. Braun) Moore & More; *E. elongatum* sensu Hook.; *E. ramosum* sensu Benth.

*Perennial evergreen herb* with rhizomes, growing singly or in clumps. *Stems* 30–60(–90) cm, dark green, sometimes with an orange tinge, decumbent or erect, often sinuous below, infrequently branched; internodes not swollen, with 6–14 longitudinal ridges, each of which is longitudinally grooved, forming 2 angles along each of which is a row of small tubercles; central cavity less than half the width of the stem; leaf-sheaths longer than broad, fairly close-fitting and slightly funnel-shaped, at first pale green with a narrow black band near the top, but during the course of their first season becoming mostly black, particularly on the side of the shoot most exposed to light; the teeth, which persist on the shoot after its initial expansion and mostly remain throughout the season, are long, black and narrowly tapering; near their junction with the sheath they usually spread outwards slightly before turning upwards for most of their length, although their extreme tips may become spreading; their margins are variously scarious and after overwintering they are irregularly broken off. *Cones* borne singly on the stems, small and apiculate, black or sometimes orange-tinged, usually remaining half in the upper sheath; spores highly misshapen and entirely abortive. $2n = 216$ with irregular pairing at meiosis.

Native. Sandy lake shores, river banks and damp places in dunes. Very scattered localities in Ireland and Scotland and in Yorkshire, often far from one or both parents. Also in scattered localities in Continental Europe, Greenland and temperate North America.

**4. E. ramosissimum** Desf. Branched Horsetail
*E. campanulatum* Poir.; *E. ramosum* DC.; *E. elongatum* Willd.

Stems 50–100 cm, greyish-green, sprawling, usually with axillary whorls of branches in lower half; sometimes whorls only partial or absent; internodes rough with scattered tubercles, with 7–20 rounded ridges; central cavity half to two-thirds of the width of the stem; leaf-sheaths about 8 mm, green, becoming brown with a black band at the bottom; teeth black with narrow white margins and a more or less persistent hair-like apex; branches hollow; lowest internode about one-third the length of the adjacent stem-sheath. *Cones* on normal vegetative shoots, 6–12 mm, obtuse to apiculate. *Spores ripe* 5–8. $2n = 216$.

Probably introduced. Long grass by the River Witham in Lincolnshire since 1947 and in rough grass near the sea at one site in Somersetshire since 1963. Native of central and south Europe, extending locally northwards to Holland, Latvia and central Russia; Asia; Africa; America. Eurasian Southern-temperate element.

× **variegatum** = **E. × meridionale** (Milde) Chiov. This hybrid has been identified from plants found in Anglesey in 2000. It has since been recognised in Cheshire (where it had been confused with *E.* × *trachyodon*) and in Lancashire.

**5. E. variegatum** Schleich. ex F. Weber & D. Mohr Variegated Horsetail
*E. hyemale* subsp. *variegatum* (Schleich. ex F. Weber & D. Mohr) Moore & More; *Hippochaete variegata* (Schleich. ex F. Weber & D. Mohr) Bruhin

*Perennial evergreen herb* with rhizomes. *Stems* to 40(–100) cm, dark blue-green, prostrate, decumbent or erect, often sinuous below, unbranched or rarely branched at base; internodes with 4–10, 2-angled, longitudinal ridges, with 2 rows of minute tubercles; 4-ribbed central cavity about one-third of the width of the stem; leaf-sheaths 2–4 mm, with a conspicuous black band, rather loose, topped by short triangular teeth with a narrow dark centre, very broad papery white margins, giving the shoot a

banded appearance, and a dark, finely pointed tip, which is soon shed; sometimes when the plant grows near the sea both nodes and internodes become orange-tinged. *Cones* on normal vegetative shoots, 3–4 mm, slightly longer than broad, with a bluntly pointed tip. *Spores ripe* 7–8. $2n = 16$.

The three following varieties retain their characters in cultivation.

**(i)** Var. **variegatum**
*Stems* 15–25 cm and up to 2 mm in diameter, prostrate, decumbent or erect; internodes rough.

**(ii)** Var. **majus** Syme
*Stems* up to 40(–80) cm and up to 4 mm in diameter, strongly erect; internodes rough.

**(iii)** Var. **wilsonii** Newman
*E. variegatum* subsp. *wilsonii* (Newman) Moore & More
*Stems* up to 100 cm; internodes smooth.

Native. Dune slacks, river banks, lake shores and wet, stony mountain slopes. Scattered records in Ireland and west and north Great Britain; very rare in central and southern England. North and central Europe, extending southwards to the Pyrenees, northern Apennines and south Urals; northern Asia; North America. Circumpolar Boreo-arctic Montane element. Var. *variegatum* is the usual plant over much of Scotland and England and probably occurs in some Irish stations. It grows in dune slacks on the coast, in mountain river shingle and cut-offs and in a few lowland sites in southern England. Var. *majus* is the more usual plant in Ireland with a few localities elsewhere. It is mainly a plant of lowland lake margins, river and stream banks and Irish canal banks, surviving in more closed vegetation than var. *variegatum*. Var. *wilsonii* is known only from Co. Kerry in south-west Ireland.

Subgenus **2. Equisetum**

Fertile and vegetative *stems* dying down in autumn. *Stomata* not sunk below level of other epidermal cells. *Spikes* obtuse.

**6. E. fluviatile** L. Water Horsetail
*E. limosum* L.; *E. heleocharis* Ehrh. nom. illegit.; *E. maximum* Lam. nom. illegit.; *E. polystachyum* Brückn.; *E. uliginosum* Muhl. ex Willd.

*Perennial herb* with glabrous rhizomes dying down in autumn. *Stems* 50–150 cm × 2–12 mm, glossy yellowish-green, more or less erect, simple or progressively better furnished with fairly short, straight, slender, usually 5-angled branches in spreading or slightly ascending whorls in the middle of the stem; internodes with 10–30 very shallow longitudinal ridges and grooves and very smooth to the touch; central cavity three-quarters to nine-tenths of the width of the stem and easily squashed; leaf-sheaths 5–10 mm, green, often tinged orange, tight; teeth as many as the grooves, about 1.0 mm, black, with an inconspicuous pale margin and subulate; vallecular canals present only in some plants and then usually in the lower part of the stem; lowest internode about as long as the stem-sheath. *Cones* on slightly shorter shoots than sterile ones, 10–20 mm, greenish or blackish, ellipsoid, borne out of the uppermost leaf-sheath on short, thick, colourless stalks. *Spores ripe* 6–7. $2n = 216$.

Extremely variable in size and degree of branching. Unbranched forms were long known as a separate species, *E. limosum*. Transplant experiments, however, show that all forms when cultivated together are virtually identical. In exposed situations plants often have no branches, but branching increases with shelter and shade.

Native. Throughout Great Britain and Ireland. Most of Europe; temperate Asia; North America. Circumpolar Boreo-temperate element.

× **palustre** = **E.** × **dycei** C. N. Page
Intermediate between the parents.

Native. Occurs in scattered sites in Great Britain and in west and south-west Ireland.

× **pratense** = **E.** × **mchaffieae** C. N. Page
Intermediate between the parents.

Native. Discovered in Caithness in 2003 by H. McHaffie. Endemic.

× **telmateia** = **E.** × **willmotii** C. N. Page
Intermediate between the parents.

Native. Found in Co. Cavan in 1984 by A. J. Willmot and subsequently in several sites in Great Britain. Endemic.

**7. E.** × **litorale** Kühlew. ex Rupr. Shore Horsetail
**E. arvense** × **fluviatile**
*E. inundatum* Lasch; *E. uliginosum* Hügel ex Milde

*Perennial herb* with a rhizome, dying down in autumn. *Stems* 80–100 cm, tall and slender, forming thickets, glossy yellowish-green and often with an orange tinge around the nodes as in *E. fluviatile*, slimmer and tougher than in that species, with dense branches through much of the central area and the upper portion always remaining long and unbranched; internodes with 6–20 shallow longitudinal ridges and grooves and smooth to the touch; central cavity half to two-thirds of the width of the stem, yielding slightly to pressure, with a diameter more than twice that of the vallecular canals; leaf-sheaths loose; teeth adpressed, with a minute black apex. *Cones*, when present, borne on stems similar to sterile ones, small, blackish, ellipsoid and rounded at apex, never completely opening and containing only abortive spores. $2n = 216$.

Plants in drier situations are often shorter and more bushy, while in wetter situations they are taller and more slender, but all become similar if transplanted to a similar habitat.