

**A new far northern hybrid horsetail from Scotland:
Equisetum ×mchaffieae C. N. Page
 (*Equisetum fluviatile* L. × *E. pratense* Ehrh.)**

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ABSTRACT

A new hybrid horsetail *Equisetum ×mchaffieae* C. N. Page hybr. nov., with the parentage *E. fluviatile* L. × *E. pratense* Ehrh., is described from Caithness, Scotland, v.c.109. It is only the second known British *Equisetum* hybrid involving the northern *E. pratense* in its parentage, a species which itself is rare in the British Isles as a whole. A description is given, diagnosis with other hybrids made and the ecology of this unusual taxon outlined.

KEYWORDS: *Equisetum*, hybrid, morphology, ecology, Caithness, Scotland.

INTRODUCTION

A new hybrid horsetail, *Equisetum ×mchaffieae* C. N. Page, hybr. nov., with the parentage *E. fluviatile* L. × *E. pratense* Ehrh., is described. First found by Heather McHaffie in Caithness, v.c.109, northern Scotland, in August 2003 and submitted to the referee for *Equisetum*, this plant is clearly of hybrid origin and presents a distinctive individual vegetative morphology closely intermediate between that of its two, somewhat contrasting, parents. It is only the second known British *Equisetum* hybrid involving the northern *E. pratense* in its parentage, a species which itself is scarce in the British Isles as a whole. The formal description given here follows the initial format of most other hybrids in the *Equisetum* subgenus *Equisetum* (e.g. Page 1963, 1973, 1988a, 1995; Dines & Bonner 2002) to facilitate comparison. Further morphological details are given, diagnosis with other hybrids in *Equisetum* subgenus *Equisetum* involving either parent made, and the ecology so far known of this unusual taxon outlined.

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DESCRIPTION AND DIAGNOSIS

***Equisetum ×mchaffieae* hybr. nov.**

(*E. fluviatile* L. × *E. pratense* Ehrh.) Fig. 1

Caules 25–45 cm alti, 1.8–2.3 mm diameter, viridis, alte 7–12 sulcati, porci angulosus, pagina minutus asperatus; vaginae (dentibus exclusis) 3.5–4.1 mm, virides; dentes tot quot sulci, subulati, piliferous-acuminatus, nigrescentes, marginibus basium angustis scariosis, 1-costati; cavitas centralis 1/2 caulis diam. Ramuli patentes vel suberecti, regularites verticillati, simplices, tenuis, plerumque trigonis et tetragonis, carina aculis, internodium infimum vaginam caulis proximam aequans vel 1.5 superans; vaginae pallidae, dentibus acuminatis, patens, viridis.

Stems 25–45 cm, erect, 1.8–2.3 mm diameter, green, grooves 7–12, ridges angular, surface minutely rough; sheaths (excluding teeth) 3.5–4.1 mm, green; teeth as many as the grooves, subulate, piliferous-acuminate, blackish with narrow scarios basal margins, 1-ribbed; central hollow 1/2 diameter of stem. Branches spreading to suberect, in regular whorls, simple, slender, three or four angled, ridges acute, the lowest internode 1.0–1.5 times the length of the adjacent stem sheath; sheaths pale, teeth acuminate, non-spreading, pale green.

HOLOTYPE: Scotland, Caithness, St. John's Loch, Scotland, U.K., GR ND 220 718, 12 August 2003, Heather McHaffie (E).

Equisetum ×mchaffieae is clearly intermediate in shoot vegetative structure between *E. fluviatile* and *E. pratense*. Plants have slightly



FIGURE 1. Silhouette of type material of *Equisetum* *xmchaffieae* C. N. Page, hybr. nov. (*E. fluviatile* L. \times *E. pratense* Ehrh.).

decumbent to erect main stems 25–45 cm in height, but only 1.8–2.3 mm shoot diameter, with a broadly ovate outline closely reminiscent of that of *E. \times litorale* (*E. arvense* \times *fluviatile*), but with overall more slender, more delicate structure throughout and with more numerous notably more slender branches. Nodes throughout the middle 3/4 of the shoot are branch bearing, with typically 3–4 or more at the base of the shoot non-branch-bearing and 5–6 or more of the most distal forming a long slender 0.6–0.8 mm diameter or less gradually tapering terminal ‘tail’ to the upper extremity of each shoot. Main shoot internodes with numerous (7–12) shallow, highly angular ridges and grooves, with an overall minutely roughened surface texture of fine siliceous spicules detectable especially when a finger nail tip is drawn gently along. All main stem internodes also lack the easy elastic compressibility in fresh material of those of *E. \times litorale* resulting from the central canal of this hybrid being mostly little more than 1/2 the overall diameter of the stem combined with smaller diameter and tougher shoot structure. Characteristic main stem sheaths throughout the lower third of the shoot are scarcely inflated but strongly vertically grooved, c. 2.4 mm diameter and 3.5–4.0 mm long excluding teeth, green throughout or sometimes irregularly dark-patched at the base, their free teeth particularly numerous (7–12) for the sheath width, up to 1.9 mm long, dark brown to blackish throughout, initially broad at the base but tapering rapidly with narrow pale brown scarious margins in the basal portions only, and for their final half to two thirds (c. 0.8–1.0+ mm) tapering only slowly to form distinctive, individual, relatively long, straight, narrow, fine, entirely black, somewhat delicate piliferous acuminate teeth tips, which can become rather easily broken free in dried material. Branches slender and particularly numerous, up to 12 per whorl, neatly regimented, spreading-ascending to somewhat upward curving throughout the shoot, c. 9.5–10.5 cm long in the middle of the shoot, reducing to 4.5–5.5 cm in the upper part of the shoot, c. 0.6 mm or less diameter, their internodes (3)–4 angled, strongly furrowed, the furrow base with a shallow sulcus, the ridges acute, minutely pearly along their apices but not saw-toothed, the branch sheaths green, uniangulate, the teeth simple, mostly pale green sometimes tinged translucent brown towards the tips, slender, straight, not spreading.

The hybrid is named after Heather McHaffie, who collected the material, first recognised it to be distinctive in the field, and submitted it to the referee.

TAXONOMIC COMPARISONS

Equisetum \times mchaffieae is a distinctive hybrid, with shoots which are strikingly intermediate in size, morphology and anatomy between the somewhat contrasting morphologies of *E. fluviatile* L. and *E. pratense* Ehrh. As seems characteristic of a majority of colonies of hybrid horsetails, and often a feature of them, no shoots of this hybrid have yet been found to bear cones, but their strong intermediacy of vegetative structure is sufficiently consistent and distinctive to be a reliable guide to parentage, with clear characters which link directly with each of the above species. *Equisetum \times mchaffieae* possesses the overall markedly ovate *E. fluviatile*-dominated overall shoot outline characteristic of all of the known hybrids of this parent (*E. \times litorale* Kuhlew. ex Rupr., *E. \times dycei* C. N. Page, *E. \times willmotii* C. N. Page), and especially with a branchless portion at the base and a relatively long branchless terminating ‘tail’ portion to the tip of the shoot. However *E. \times mchaffieae* has an overall marked slenderness and delicacy of form with a thin but tough and angular main stem and overall slender branch structure readily apparent both in the field and in herbarium material, which distinguish it especially from the above hybrids. Further, the distinctive minute roughness of the main stem internodes to touch is unusual for any hybrid and is characteristic only of hybrids involving either *E. pratense* or *E. sylvaticum* in their parentage, but especially the former, which the notable angularity of the ridges in its main shoot cross-section also most closely approaches. Additionally in *E. \times mchaffieae*, the numerous long, straight, narrow, fine, delicate, black, entirely free teeth to the main stem sheaths through at least the lower third of the main shoot, with markedly piliferous acuminate tips, the highly angular slender branches, and lack of secondary branching of the branch systems, all confirm the unusual involvement of *E. pratense* in the parentage of this hybrid.

In more detailed comparisons with the other *Equisetum fluviatile* hybrids, *Equisetum \times mchaffieae* is thus superficially similar mainly

only to *E. ×litorale* in general outline, in comparison with which it looks smaller, much more slender and delicate, with clearly rougher surface texture, longer, narrower, numerous, dark, free, main stem teeth, and lack of the 'plastic-like' yield (Page 1997a) of the main shoot internodes when gently squeezed between finger and thumb, so characteristic in the field of *E. ×litorale*. In comparison with *E. ×dycei*, *E. ×mchaffieae* has also a typically rougher surface and more copious spreading-ascending more angular, more slender, branches and the distinctive *E. pratense*-like teeth to the main stem sheaths; and in comparison with *E. ×willmotii* is also of very much more overall slender and more delicate structure, with rougher main stem internode surfaces and more slender, simple, uniangulate, branch internodes with sheaths which are not bicarinate. In more detailed comparison with *E. ×mildeanum*, the only other *Equisetum pratense* hybrid so far known in Britain, *E. ×mchaffieae* differs clearly in possessing only simple (ie. unbranched) branch structure and in possession of the distinctive terminal 'tail' to the tip of the shoot, more often 4-angled branches (combining the tendency of respective parents to be dominated by 3 and 4-5 angled branches respectively), and clearly simpler more separated free teeth segments to the main shoot sheaths.

However, this particular hybrid would most easily be dismissed (as might also *E. ×dycei*) in the field as merely a slender and perhaps depauperate form of *E. ×litorale* (as might also *E. ×willmotii*, for example, as being a more robust form of *E. ×litorale*), and thus either mis-recorded or overlooked or not collected at all for being 'aberrant'. It may well be that the occurrence of this hybrid has been overlooked for these reasons. However, this hybrid is between two species of *Equisetum* which would also appear to not be especially closely-related (Page 1972), and the phylogenetic distance apart of their parents (but within the same subgenus) would seem likely to be a factor in its apparent rarity of occurrence. This distance apart, however, approximates also to that of the parents of each of *E. ×willmotii*, *E. ×bowmanii* and *E. ×robertsii*, all of which have so far proved to have a relatively small number of scattered stations in Britain and Ireland (in comparison with the relative frequency of *E. ×litorale* sites – now well over 100 in these islands), and all too, typically not necessarily always with both parents present (an aspect which may well echo past distributions, which the hybrids have outlived).

FIELD ECOLOGY

Equisetum ×mchaffieae occurs at the edge of St. John's Loch, Caithness, where it is associated with a slightly flushed fen near to the water's edge. The surrounding overall vegetation type includes mainly *Filipendula ulmaria*, *Potentilla palustris*, *Salix repens*, *Eriophorum angustifolium*, *Succisa pratensis*, *Achillea ptarmica*, *Senecio palustris*, *Parnassia palustris*, *Caltha palustris*, *Triglochin palustris*, *Lychnis flos-cuculi*, *Hydrocotyle vulgaris*, *Stachys palustris*, *Juncus effusus*, *J. conglomeratus*, *Carex panicea*, *Calamagrostis stricta*, *Molinia caerulea*, *Holcus lanatus*, *Anthoxanthum odoratum*, *Deschampsia cespitosa*, *Equisetum fluviatile* and *Equisetum palustre*. There are strips of fields running between a nearby road and the water's edge, with the upper part of each field above the 25 m contour usually cultivated, but their lower edges at least 10 m wide towards the loch are not cultivated, though might be sometimes grazed. The loch is freshwater, with a water level artificially maintained for native brown trout, for which there is a hatchery, and a track to the water's edge to access fishing boats.

Of the parent species, *Equisetum fluviatile* is present around the loch margins. *E. pratense* is not present immediately nearby, but is however, not insignificant in occurrence around the overall vice-county and adjacent region and has long been known from both 10 km grid squares immediately adjacent to the south of the loch (where it is most likely present along banks and sandy shoulders of upland streams and rivers feeding the lochs). It also grows as a substantial colony on Thurso riverside at ND1113673, and has also previously been found in rough vegetation at Dunnet links (ND215688, 1997, although its present survival at this location is questioned).

Within this overall setting, *Equisetum ×mchaffieae* is present in a small bay at the edge of the loch over a substratum of shelly clay originally of marine origin deposited within an area otherwise bounded by Old Red Sandstone. In terms of micro-topography, the hybrid occurs clinging to the wave-worn bare vertical clay created by wave action and through the vegetation behind. This sheer bank is some 1 m high topped by a thin layer of peat and bears the same flora as above. At the loch, hybrids of *Equisetum* would appear to be relatively vigorous, since, other collections from this location recognised as unusual in the field by Heather McHaffie and submitted to the referee for checking have proved to contain

also *E. ×litorale*, *E. ×dycei* and *E. ×rothmaleri* at this site. Shoots of what are possibly all of *E. ×mchaffieae* are scattered at a frequency of maybe 1 shoot per metre over a length of 1 km of shore explored, centred on the grid point ND22007211, and with a possible higher density in parts. Overall, members of the genus and especially *Equisetum* hybrids as a whole are clearly remarkably successful in this overall location, and their patterns of distribution are likely complex and may well be highly intermixed.

DISCUSSION

Equisetum ×mchaffieae is the sixth known hybrid in the genus *Equisetum* recognised within Scotland, and brings to a total of eleven the number of inter-specific hybrids within the genus as a whole known within Britain and Ireland. It also brings to nine, the number of hybrids known within *Equisetum* subgenus *Equisetum* (the deciduous-shooted horsetails) formed between the six native species of this subgenus in these islands. *Equisetum ×mchaffieae* is also the fourth known hybrid to involve *E. fluviatile* L. in its parentage: the others being [in order of frequency] *E. ×litorale* (*E. arvense* × *fluviatile*), *E. ×dycei* (*E. fluviatile* × *palustre*) and *E. ×willmotii* (*E. fluviatile* × *telmateia*), all of which hybrids are known in Britain now in multiple locations. *Equisetum ×mchaffieae* is, however, only the second known hybrid in Britain to involve *E. pratense* in its parentage, the other being *E. ×mildeanum* Rothm. (*E. pratense* × *sylvaticum*), which has now several known scattered stations in highland Scotland and in the mountains of northern and central Europe (Rothmaler 1944; Page 1988a, 1997a; Lubien-ski 2003). No known extra-British localities for this particular hybrid have, however, been either reported or as yet found in herbarium material from elsewhere, although, of its parents, both are species with extraordinarily wide temperate ranges (Hultén & Fries, 1986).

Equisetum fluviatile is circumboreal, occurring across Eurasia and far eastern Asia to Japan, northward from approximately latitude 36 degrees N and across North America at similar latitudes (Hultén & Fries 1986; Derrick *et al.* 1987). In Europe, *E. fluviatile* occurs widely from extreme southern Greenland, Iceland, and northern Scandinavia to approximately the Pyrenees and Caucasus, with outlying stations to southern Spain and Italy

(Jalas & Suominen 1972). It is most abundant at middle to northerly latitudes, where it is a species of “shores of lakes and slow rivers, often bordering reed swamp communities down to 1.5 m depth, forming large pure stands especially in oligotrophic lakes, mesotrophic and eutrophic mires, margins of bogs and oligotrophic fens, *Salix* and *Alnus carrs*” (Jonsell 2000). Within Britain and Ireland, *E. fluviatile* is similarly widespread, from the Orkneys and Shetlands to Cornwall (Jermy *et al.* 1978, Preston *et al.* 2002), especially at low to moderate elevations, and of a similar habitat range, but mainly a species of low to moderate altitude, part-shaded to exposed, lake and other of standing water margin, ditch and carr vegetation communities, sometimes forming dense and extensive cone-bearing stands in open water reedswamp communities. In Scotland it occurs quite widely at lower altitudes but ascends as mostly smaller-statured, often cone-inhibited, sparser stands to alpine lochans and even into wet heathland communities to an altitude of about 900 m.

Equisetum pratense is an arctic-alpine species which is most abundantly northern in its circumboreal range. It is present across Eurasia to the Altai, Manchuria, Kamtchatka and the Chukotsk Peninsula of far eastern Siberia, most abundantly north of approximately latitude 48 degrees N, and at similar latitudes across North America from Alaska to Labrador (Rothmaler 1944; Lellinger 1985; Hultén & Fries 1986; Derrick *et al.* 1987). In Russia, it is widespread and locally frequent across northern Russia and especially in Siberia from the South Siberian mountains northward (Komarov 1934; Krasnoborov 1988); and in northwestern Canada sometimes forms ‘dense stands on open wooded floodplains of rivers and streams’ (Cody & Britton 1989). In western Europe, it ranges from Iceland and northern Scandinavia to Central Europe and the Alps (Jalas & Suominen 1972; Hegi 1984), and especially in more northerly latitudes can be locally com-mon mainly on moist, base rich substrates in open woods, pastures, river banks, hay-meadows, alpine tall-herb communities, snow-beds and talus slopes (Jonsell 2000). Within Britain and Ireland, *E. pratense* is confined to the northern half of these islands, where it has scattered stations in the northern Pennines and in Northern Ireland, but more widely spread only in Scotland and especially in the central and eastern Highlands and north

to Caithness (Jermy *et al* 1978, 1994; Preston *et al.* 2002). In this range, *E. pratense* is a scarce British species largely of sandy-clayey river and streambanks, especially in moist, lightly shaded slopes, hence chiefly in the lower valleys of mountain districts, in sites typically where the ground contains a high mineral component, and this is especially of sand which is either calciferously derived or is base-flushed. In Scotland it ascends as more scattered populations near to tumbling mountain rills and on ledges over mica-schist rock to at least 915 m (and reported to ascend to 1,400 m in the mountains of mainland Europe (Prelli 2001). It is, however, only in its more northern stations in Britain (central Perthshire north) that I have found *E. pratense* currently to produce fertile cones (though a century ago, herbarium evidence shows that colonies were freely fertile as far south as Coquetdale, Weardale and Teesdale (Page 1988b, 1997b), where recent fieldwork shows the plant to still persist, but in entirely vegetative condition.

Equisetum. ×mchaffieae thus occurs within the northern part of the sympatric portion of the ranges of its two parents in Britain, and especially within the zone in which both are cone-bearing. The geological aspects of its Caithness site are also clearly especially suited to *Equisetum* growth as a whole, occurring within an area bounded by Old Red Sandstone and directly over a substrate of shelly clay of originally marine origin, overlain by peat and now exposed in a small freshwater lochside bay. For such exposed clay is a particularly edaphically-appropriate mineral habitat for the occurrence of species of *Equisetum*, since it provides the essential mineral combination of a substrate combining both available silica and calcium at the same time, here the calcium-source being especially in the form of the marine shell component within the sandy-clay

matrix (Page 1988b, 1997). The close association of this hybrid in this location with the face of a 1 m high eroding bank face of this shelly clay also appears significant. Clearly this face must afford rather better drainage than would occur within the fen vegetation itself, but nevertheless be influenced by both moving ground moisture and locally enhanced humidity. Further, the association of this hybrid with such a clear erosion-surface is notable as such erosion-surfaces which are in a more or less constant state of micro-disturbance are believed to be especially important in providing sites for the co-occurrence of prothalli of disparate species of *Equisetum* within cross-fertilisation distance, and hence especially effective in the induction of hybrid formation, in climates as recurrently moist and relatively mild as many of those of the British Isles, where, by European standards as a whole, hybrids within *Equisetum* subgenus *Equisetum* are especially rich (Page 1979, 2002; Page & Barker 1985; Page & McHaffie 1991; Dines & Bonner 2002). Here, at this Caithness site, the presence of such a concentration of co-extent different *Equisetum* hybrids (*E. ×litorale*, *E. ×dycei*, *E. ×rothmaleri* and *E. ×mchaffieae*), collectively involving different combinations of four local parent species, emphasises the significance of the combined role of appropriately moist climate, edaphic mineral balance, exposure of the mineralised surfaces and recurrent small disturbance processes operating on these, can generate in opening the opportunity for hybrids in this genus to form.

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REFERENCES

- CODY, W. J. & BRITTON, D. M. (1989). *Ferns and Fern Allies of Canada*. Agriculture Canada, Ottawa.
- DERRICK, L. N., JERMY, A. C. & PAUL, A. M. (1987). Checklist of European pteridophytes. *Sommerfeltia* **6**: 1–94.
- DINES, T. D. & BONNER, I. R. (2002). A new hybrid horetail, *Equisetum arvense* × *E. telmateia* (*E. ×robertsii*) in Britain. *Watsonia* **24**: 145–157.
- HEGI, G. (1984). *Illustrierte Flora von Mittel-Europa. Band I. Pteridophyta*. Paul Parey, Berlin & Hamburg.
- HULTÉN, E. & FRIES, M. (1986). *Atlas of North European Vascular Plants*. Königstein, Federal Republic of Germany.
- JALAS, J. & SUOMINEN, J. (1972). *Atlas Florae Europaeae*. 1. Pteridophyta. Committee for mapping the Flora of Europe, Helsinki.
- JERMY, A. C. (1994). *Equisetum pratense* Ehrh., in A. STEWART, D. A. PEARMAN, & C. D. PRESTON, eds. *Scarce Plants in Britain*, p.154. Joint Nature Conservation Committee, Peterborough.

- JERMY, A. C., ARNOLD, H. R., FARRELL, L. & PERRING, F. H. (1978). *Atlas of Ferns of the British Isles*. Botanical Society of the British Isles & British Pteridological Society, London.
- JONSELL, B. (2000). *Flora Nordica*. The Royal Swedish Academy of Sciences, Stockholm.
- KOMAROV, V. L. (ed.). (1934). *Flora of USSR*. Vol. 1. Academy of Sciences of USSR, Leningrad.
- KRASNOBOROV, I. M. (ed.). 1988. *Flora of Siberia*. Vol. 1. Nauka, Novosibirsk.
- LELLINGER, D. B. (1985). *A Field manual of the Ferns and Fern-allies of the United States and Canada*. Smithsonian Institution Press, Washington, D.C.
- LUBIENSKY, M. (2003). *Equisetum × mildeanum* Rothm. (*E. pratense* Ehrh. × *E. sylvaticum* L.), en snellehybrid ny for Norge. *Blyttia* **61**: 171–178.
- PAGE, C. N. (1963). A hybrid horsetail from the Hebrides. *British Fern Gazette* **9**: 117–119.
- PAGE, C. N. (1967). Sporelings of *Equisetum arvense* in the wild. *British Fern Gazette* **9**: 335–338.
- PAGE, C. N. (1972). An assessment of inter-specific relationships in *Equisetum* subgenus *Equisetum*. *New Phytologist* **71**: 355–369.
- PAGE, C. N. (1973). Two hybrids in *Equisetum* new to the British Flora. *Watsonia* **9**: 229–237.
- PAGE, C. N. (1979). *Equisetum × trachyodon* in western Scotland. *Fern Gazette* **12**: 178–179.
- PAGE, C. N. (1988a). Two hybrids of *Equisetum sylvaticum* new to the British Flora. *Watsonia* **17**: 2273–2277.
- PAGE, C. N. (1988b). *Ferns: Their Habitats in the Landscape of Britain and Ireland*. Collins New Naturalist no 74, London & Glasgow.
- PAGE, C. N. (1995). *Equisetum × willmotii* C. N. Page – a new hybrid horsetail from County Cavan, Ireland. *Glasra* **2**: 135–138.
- PAGE, C. N. (1997a). *The Ferns of Britain and Ireland*. 2nd edn. Cambridge University Press, Cambridge.
- PAGE, C. N. (1997b). Pteridophytes as field indicators of natural biodiversity restoration in the Scottish flora. *Botanical Journal of Scotland* **49**: 405–414.
- PAGE, C. N. (2001). Ferns and allied plants, in D. L. HAWKSWORTH ed. *The changing wildlife of Great Britain and Ireland*. Systematics Association Special Volume 62, pp 50–77. Taylor & Francis, London & New York.
- PAGE, C. N. (2002). The role of natural disturbance regimes in pteridophyte conservation management. *Fern Gazette* **16**: 284–290.
- PAGE, C. N. & BARKER, M. A. (1985). Ecology and geography of hybridisation in British and Irish horsetails. *Proceedings of the Royal Society of Edinburgh* **86B**: 265–272.
- PAGE, C. N. & MCHAFFIE, H. S. (1991). Pteridophytes a indicators of landscape changes in the British isles in the last hundred years, in J. M. CAMUS ed. *The History of British Pteridology*, pp. 25–40. British Pteridological Society, London.
- PRELLI, R. (2001). *Les Fougères et Plantes Alliees de France et d'Europe Occidentale*. Belin, Paris.
- PRESTON, C. D., PEARMAN, D. A., & DINES, T. D. (2002). *New Atlas of the British and Irish Flora*. Oxford University Press, Oxford.
- ROTHMALER, W. (1944). Pteridophyten Studien I. *Feddes Repertorium* **54**: 55–82.

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