A8
Nuphar lutea community

Synonymy
Floating-leaf association Pallis 1911 *p.p.*; *Nuphar lutea-Lemna* vegetation Tansley 1911; *Myriophyllo-Nupharetum* Koch 1926 *p.p.*; *Nymphaeetum albo-luteae* Novinski 1927 *p.p.*; *Sagittaria-Nuphar* vegetation Butcher 1933 *p.p.*; *Potameto-Nupharetum* Müller & Gors 1960; *Nuphar lutea* society Spence 1964.

Constant species
Nuphar lutea.

Rare species
Nuphar pumila, *N.* × *spennerana*, *Nymphoides peltata.*

Physiognomy
Like *Nymphaea alba*, *Nuphar lutea* has been widely planted as an ornamental aquatic throughout lowland Britain, and it figures as a sparse occasional in a variety of vegetation types of open waters, but the *Nuphar* community includes all those stands in which its submerged and floating foliage, put up annually in the spring, makes up a substantial proportion of the cover. Much of the vegetation is species-poor, consisting of little else apart from *N. lutea*, and even where its associates are more numerous and consistent it is hard to know whether the assemblages are wholly natural because of the frequent introduction of the plant. Some stands, mostly in southern Britain, also have *N. alba*: indeed, almost all vegetation with both the species is closer to the *Nuphar* community than the *Nymphaeetum*. Most records for our other native yellow water-lily, the rare Continental Northern *Nuphar pumila*, a plant largely confined to Scotland with us, seem to be with the *Nuphar* community too. And a very few sites have the hybrid *N.* × *spennerana*, which persists in some places in the apparent absence of *N. pumila* (Heslop-Harrison 1955*c*). Another rarity, *Nymphoides peltata*, is to be found, again probably sometimes planted, in stands in southern England (Perring & Walters 1962, Perring 1968): with its yellow flowers, it can be taken for *N. lutea* at a distance, though these are bunched in fascicles in *Nymphoides* and the petals are fringed.

Few other species occur with any consistency throughout the community, but *Elodea canadensis* (rarely, it seems, *E. nuttallii*) can be very common and abundant beneath the canopy of floating leaves and, in the different kinds of *Nuphar* stand, a range of other aquatics enriches the various elements of the vegetation. Quite often, for example, there are fragments of a duckweed mat occurring among the lily pads, with *Lemna minor* being particularly frequent, and other floating-leaved plants, notably *Polygonum amphibium* and, rather less commonly, *Potamogeton natans*, sometimes contribute to the surface cover. Then, among the submerged species, *Callitriche stagnalis* and, less often, *C. hermaphroditica*, *C. platycarpa* and *C. obtusangula*, can be found, with a variety of pondweeds occurring in the different sub-communities, sometimes in abundance: *Potamogeton crispus*, *P. berchtoldii*, *P. pectinatus*, *P. obtusifolius*, *P. perfoliatus* and *P. pusillus*. *Zannichellia palustris* can also be very common, with *Ceratophyllum demersum* and *Myriophyllum spicatum* infrequent, but locally prominent. The water-crowfoots *Ranunculus hederaceus*, *R. circinatus* and *R. trichophyllus* may also be found in quite dense clumps and *Sparganium emersum*, *S. minimum*, *Littorella uniflora* and the rare *Eleocharis* have been recorded. Some stands have locally dense swards of *Nitella* spp. or *Chara* spp.

Smaller plants of water margins, such as various *Glyceria* spp., *Sagittaria sagittifolia*, *Veronica beccabunga*, *Apium nodiflorum* and *Mentha aquatica*, may also be found trailing among or growing through the cover of *Nuphar* leaves.

Sub-communities

Species-poor sub-community. *N. lutea* is sometimes the only plant here, with just very occasional *Lemna minor* on the surface, *Elodea canadensis*, *Callitriche stagnalis*, *Zannichellia* or *Ceratophyllum demersum* beneath, and a

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few shoots or clumps of *Sagittaria*, *Apium*, *V. beccabunga* or *Mentha aquatica*.

***Callitriche stagnalis-Zannichellia palustris* sub-community.** The surface cover of the floating leaves of *N. lutea* is often discontinuous in this sub-community and there is frequently some *Polygonum amphibium* and patches of *Lemna minor*, with very occasional *N. alba*. More striking, though, is the richness and abundance of the submerged element. *E. canadensis* tends to be more common and luxuriant here than elsewhere in the community, but more strongly preferential are *Zannichellia palustris* and *Callitriche stagnalis*. *C. hermaphroditica* is occasional, too, and there can also be some *C. obtusangula* and *C. platycarpa* and, with the scarcity of fruiting material and the vegetative plasticity of these plants, some care needs to be taken with their diagnosis (Wiggington & Graham 1981). Then, there can be occasional water-crowfoots, though these do not usually cause any problems of identification: *R. hederaceus*, which has just laminate leaves, is the commonest and the less frequent *R. circinatus* and *R. trichophyllus* can be separated on the arrangement of their fine leaf divisions (Holmes 1979). *Potamogeton* spp. also tend to be more numerous and varied in this sub-community, with occasional *P. crispus*, *P. berchtoldii*, *P. pectinatus*, *P. perfoliatus* and *P. pusillus*, although *P. obtusifolius*, as well as the floating-leaved *P. natans*, is scarce. *Sparganium emersum* and *Eleocharis acicularis* have been recorded here and there are sometimes entangled thalli of *Lemna trisulca*. *Glyceria fluitans* is also quite common, trailing in from the margins of stands, with *G. plicata* and *G. declinata* more occasional, and separation of these, relying on the size and shape of the lemmae, can be awkward (Wigginton & Graham 1981).

***Nymphaea alba* sub-community.** The floating leaves of *N. lutea* and *N. alba* dominate in this sub-community, the two water-lilies occurring in all possible proportions, frequently with some *Lemna minor* and occasionally with *Polygonum amphibium* and *Potamogeton natans*. Beneath, there is occasional *E. canadensis*, *C. stagnalis* and *L. trisulca*, with some stands approaching the richness of the *Callitriche-Zannichellia* sub-community in the sporadic occurrence of other submerged aquatics. *Hippuris vulgaris* has been recorded in some sites and local abundance of the moss *Fontinalis antipyretica* can be a striking feature.

***Potamogeton obtusifolius-Juncus bulbosus* sub-community:** *Nuphar lutea* society Spence 1964. *N. lutea* is generally the dominant of the floating-leaved element here, although *N. pumila* and/or *N.* × *spennerana* are found in abundance in some stands, and there is occasional *Potamogeton natans*. *E. canadensis* is occasional but not usually abundant and *Callitriche* spp. and many of the submerged *Potamogeton* spp. are absent. Quite frequent, though, and preferential to this kind of *Nuphar* vegetation, is *P. obtusifolius*, with *Juncus bulbosus* also occurring occasionally. Some stands have a sparse sward of *Littorella uniflora* beneath and *Sparganium emersum* has been recorded.

Habitat

The *Nuphar* community is characteristic of deeper, standing and slow-moving waters, mesotrophic and eutrophic and, in some cases, lime-rich, mostly in the southern lowlands of Britain. It occurs widely in lakes and pools, dykes and disused canals, sluggish streams and rivers and has frequently been encouraged in ornamental water bodies by planting.

N. lutea seems to be a more nutrient-demanding plant than *Nymphaea alba* (Heslop-Harrison 1955*a*) and, though widely introduced, its general distribution in Britain still reflects the natural concentration of richer waters in the lowland south of the country. It can grow on a wide range of substrates, though it favours fine mineral materials like clays and silts, such as are typical of water bodies on softer rocks and superficials, or where there is deposition in sluggish waters. It readily tolerates some turbidity because the food reserves of its extensive rhizomes can support the growth of the floating leaves up through 3 m or more of water, more than is generally favourable for *N. alba* (West 1910, Ellenberg 1978). Unlike *N. alba*, too, it has submerged foliage and the thin, translucent laminae have negligible cuticle, so dissolved nutrients or those in suspended particles caught on the leaves are readily taken up (Haslam 1978).

The *Nuphar* community is thus often seen at the outer limit of floating-leaved vegetation and large volumes of water of considerable depth are required for the full development of the bulky water-lily plants (Haslam 1978). Heslop-Harrison (1955*a*) suggested that light attenuation restricts colonisation from seed below a certain depth and that occurrence deeper results from vegetative spread, but germination could perhaps take place in drier years, when water-levels were lower: this might not have to happen very often, since she suggests that individual plants can live for a century and more. Once established, *N. lutea* gains a firm hold, with roots that grow down deeply from the rhizomes, a feature which gives the plant some defence against turbulence, although the very large leaves can get torn in storm flows and erosion sometimes exposes and breaks off fragments of the rhizomes (Haslam 1978). Typically, though, this is not a community of fast-flowing waters: *N. lutea* is occasionally found in streams and rivers with a moderate flow, but it grows densely only in standing waters or where movement is negligible to slow.

Variation among the sub-communities probably

relates in part to the character of the waters. The *Callitriche-Zanichellia* sub-community is found most often in richer, unpolluted waters in England and Wales, often marly, with conductivities of 200–750 μmho, alkalinities up to 250 mg l^{-1} calcium carbonate and pH values over 7.4 (Palmer 1992, Palmer *et al.* 1992). More nutrient-demanding plants figure prominently among the associates and rich and abundant growth of the submerged element is probably enhanced by the clarity of the more marly waters, with particular luxuriance occurring where the cover of the water-lilies is more open: with both submerged and floating leaves, *N. lutea* can cast dense shade.

The *Nymphaea* sub-community sometimes approaches the *Callitriche-Zannichellia* type in diversity where the floating leaves are not too closely crowded. It, too, is characteristic of richer waters, though not always so eutrophic or lime-rich as above: conductivities here range from 100 to 750 μmho with alkalinities up to 100 mg l^{-1} calcium carbonate (Palmer 1992, Palmer *et al.* 1992). One or both water-lilies, especially perhaps *N. alba*, may have been introduced into this vegetation and, with their somewhat greater tolerance of turbidity and contamination with fertiliser run-off or sewage effluent, they can extend the range of the community into waters unfavourable for some other aquatics. Many stands of the Species-poor sub-community probably reflect the combined effect of dense shading and cultural eutrophication on the associated flora.

The *Potamogeton obtusifolius* sub-community can also be found in clean waters of high pH and conductivity (Spence 1964), but it is characteristic of more nutrient-poor conditions than usual, and is the typical kind of *Nuphar* vegetation found towards the limit of the range of this water-lily in Scotland. More eutrophic associates and those favouring warmer climates are very poorly represented, while less nutrient-demanding plants, such as *P. obtusifolius*, *P. natans*, *Littorella* and *Juncus bulbosus* are preferentially common, with an occasional locus for the Continental Northern *Nuphar pumila* and hybrid *N.* × *spennerana*.

Zonation and succession

Even more so than the *Nymphaeetum*, the *Nuphar* community occurs towards the outer limit of floating-leaved vegetation in British waters, sometimes with remnants of free-floating communities, or alone or with stands of other floating-leaved aquatics. Beneath, there can be assemblages of submerged plants, free-floating or rooted, and the community sometimes persists towards the outer fringe of more open or patchy stands of emergents colonising the water margins.

In the more eutrophic waters of which the *Nuphar* community is especially characteristic, it naturally develops as a successor to free-floating vegetation like the *Lemnetum minoris* or, more locally, the *Spirodela-Hydrocharis* community, and patches of these can persist, temporarily or locally, among the water-lily leaves as they come to assert dominance, or remain on the sheltered water surface in a zone landwards of the *Nuphar* community. Other floating-leaved communities can figure in such zonations, too, notably the *Polygonum amphibium* vegetation: this plant sometimes trails out into sufficiently deep water to form an element of richer *Nuphar* stands, but it may develop virtually pure covers behind the *Nuphar* vegetation or thicken up locally in mosaics of the two. Where *Nymphaea alba* assumes extensive dominance in waters where the two species occur together, such patterns are again best considered as mosaics of the *Nuphar* community and the *Nymphaeetum*, with just more fine-textured mixtures being included in the *Nymphaea* sub-community of the former vegetation type.

This type of *Nuphar* vegetation and the Species-poor sub-community often have little in the way of associated submerged aquatic assemblages, but with the *Callitriche-Zannichellia* sub-community in particular there can be strong continuity with locally dense stands of such vegetation. *Elodea canadensis*, for example, can thicken up beneath the *Nuphar* community and there can be patches of *Callitriche* vegetation.

In larger standing water bodies, the various aquatic communities can form distinct zones in relation to depth, but patterns are often much more compressed and fragmentary in narrower dykes or the more slow-moving stretches of streams and rivers. The contribution from emergent vegetation varies in these different circumstances, too. Where the *Nuphar* community is growing towards its depth limit, it is generally impossible for any swamp dominants to gain a hold, although the *Scirpetum lacustris* can survive in waters well over 1 m deep and is frequently seen among the inner fringe of the *Nuphar* zone or forming a belt nearing the shore. In shallower waters, the *Nuphar* community can be replaced by stands of a variety of emergents, in belts of the *Phragmitetum*, the *Typhetum latifoliae*, the *Typhetum angustifoliae*, the *Caricetum paniculatae*, the *Glycerietum maximae* or the *Phalaridetum*, and where terrestrialisation is active, these can be seen as ultimately replacing the aquatic vegetation. Across narrow dykes and small streams, zonations are less well marked, clumps of various of these swamp communities occurring in the shallows along the length of the water-body, sometimes alternating with stretches of open water where there is advanced overgrowth. In such circumstances, too, the *Nuphar* community can be closely associated with various kinds of Glycerio-Sparganion water-margin vegetation, in which such plants as *Apium*, *Veronica beccabunga* and smaller *Glyceria* spp. can trail out into the water.

Where the *Nuphar* community extends into northern and western Britain, it can sometimes be found, in more eutrophic waters, in patterns which preserve this general character, occurring with the *Polygonum* community, over stands of *Elodea* vegetation, in lakes and pools, and giving way landwards to the *Scirpetum* swamp, or to the *Phragmitetum* or *Typhetum latifoliae*. Usually, in such situations, the *Nuphar* vegetation is represented by the *Potamogeton-Juncus* sub-community, and where *P. natans* occurs in the floating-leaved element, this can thicken up locally to form virtually pure stands that can extend out into even deeper water. Another unusual feature in some Scottish lakes is the occurrence of this kind of *Nuphar* vegetation over the *Potamogeton perfoliatus-Myriophyllum alterniflorum* community and swards of *Littorella-Lobelia* vegetation, a pattern more associated with the *Nymphaeetum* (Spence 1964). Where the *Nuphar* community occurs in these less eutrophic waters, the surrounding swamps, which are often of the *Caricetum rostratae* type, seem to encroach only very slowly, if at all.

Distribution

The *Nuphar* community is largely confined to the southern lowlands of Britain where Species-poor, *Callitriche-Zannichellia* and *Nymphaea* types can all be found. The *Potamogeton-Juncus* sub-community extends the range of the community into scattered localities in Scotland.

Affinities

Nuphar vegetation has figured little in the literature, sometimes being defined as a community (Pallis 1911, Spence 1964, Birse 1984), often receiving just passing mention as part of more all-embracing aquatic floras (Tansley 1911, Butcher 1933). As characterised here, the assemblage accommodates all these, together with our mixed *Nuphar-Nymphaea* stands. In its richest expression, in the *Callitriche-Zannichellia* sub-community, British *Nuphar* vegetation approaches Continental associations like the *Myriophyllo-Nupharetum* Koch 1926, now subsumed by some authors into the *Potameto-Nupharetum* Müll. & Gors 1960 (Westhoff & den Held 1969, Oberdorfer 1977). This is the most common kind of floating-leaved vegetation through Central Europe, and often the richest, with frequent records in its various sub-associations for *Potamogeton crispus*, *P. natans*, *Myriophyllum verticillatum*, *M. spicatum*, *Elodea canadensis* and *Ceratophyllum demersum* (Oberdorfer 1977, Ellenberg 1978). Some authors have also described a *Potamogeton obtusifolius-Nuphar* association of more nutrient-poor waters (Ellenberg 1978) and this comes close to the *Potamogeton* sub-community here. *Nuphar* vegetation of these kinds is placed in the Nymphaeion alliance.

Floristic table A8

	a	b	c	d	8
Nuphar lutea	V (3–10)	V (1–8)	V (4–10)	V (4–10)	V (1–10)
Mentha aquatica	I (1–3)				I (1–3)
Veronica beccabunga	I (4)				I (4)
Apium nodiflorum	I (2)				I (2)
Callitriche stagnalis	I (1–4)	IV (1–4)	II (4–8)		III (1–8)
Lemna minor	I (1–4)	III (4–6)	III (1–10)	I (1)	III (1–10)
Polygonum amphibium	I (3)	III (4–8)	II (2–10)		II (2–10)
Zannichellia palustris	I (1–4)	III (1–8)	I (4–5)		II (1–8)
Potamogeton crispus		II (1–4)	I (1–4)	I (1–3)	I (1–4)
Potamogeton berchtoldii		II (1–6)	I (4–8)	I (1–3)	I (1–8)
Glyceria fluitans	I (1–4)	II (4–8)	I (1–4)		I (1–8)
Potamogeton pectinatus	I (3–8)	II (1–8)	I (1–4)		I (1–8)
Callitriche hermaphroditica		II (4–8)		I (1–3)	I (1–8)
Ranunculus hederaceus		II (1–6)			I (1–6)
Potamogeton perfoliatus		I (1–4)			I (1–4)
Glyceria plicata		I (4)			I (4)
Spirodela polyrhiza		I (1–6)			I (1–6)

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Floristic table A8 (*cont.*)

	a	b	c	d	8
Sparganium emersum		I (2–6)			I (2–6)
Glyceria declinata		I (4)			I (4)
Riccia fluitans		I (4)			I (4)
Eleocharis acicularis		I (4–8)			I (4–8)
Nymphaea alba		I (1–8)	V (4–8)	I (2–10)	II (1–10)
Fontinalis antipyretica	I (6–8)	I (4–6)	II (4–10)		I (4–10)
Hippuris vulgaris	I (3)	I (1–3)	II (4–10)		I (1–10)
Potamogeton obtusifolius	I (1–4)	I (6)	I (4–8)	III (1–3)	I (1–8)
Littorella uniflora		I (1–8)	I (4–8)	II (1–3)	I (1–8)
Juncus bulbosus				II (1–4)	I (1–4)
Sparganium minimum				I (1–3)	I (1–3)
Equisetum fluviatile				I (1–3)	I (1–3)
Elodea canadensis	II (1–6)	III (1–8)	II (1–10)	II (1–3)	II (1–10)
Lemna trisulca	I (1–3)	II (1–4)	II (1–10)	I (1)	II (1–10)
Potamogeton natans		I (4)	II (1–10)	II (1–3)	I (1–10)
Ceratophyllum demersum	I (1–6)		I (6)	I (6–10)	I (1–10)
Chara spp.	I (1)		I (1–6)	I (4–8)	I (1–8)
Potamogeton pusillus		I (2–6)	I (1–8)	I (1)	I (1–8)
Ranunculus trichophyllus		I (8)	I (4–5)	I (1–3)	I (1–8)
Sagittaria sagittifolia	I (1–6)	I (1–7)			I (1–7)
Myriophyllum spicatum		I (4)	I (1–4)		I (1–4)
Ranunculus circinatus		I (1–6)	I (1–8)		I (1–8)
Callitriche obtusangula		I (1–4)	I (4–10)		I (1–10)
Callitriche platycarpa		I (1–6)	I (4)		I (1–6)
Nitella spp.		I (1–6)	I (4)		I (1–6)
Number of samples	26	55	28	13	122
Number of species/sample	4 (1–9)	8 (3–18)	7 (2–13)	5 (3–10)	6 (1–18)

a Species-poor sub-community
b *Callitriche stagnalis-Zannichellia palustris* sub-community
c *Nymphaea alba* sub-community
d *Potamogeton obtusifolius-Juncus bulbosus* sub-community
8 *Nuphar lutea* community (total)

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