A4
Hydrocharis morsus-ranae-Stratiotes aloides community

Synonymy

Stratiotes aloides vegetation Pallis 1911, Ellis 1939, Lambert & Jennings 1951, Lambert 1965, all *p.p.*; *Hydrocharitetum morsus-ranae* van Langendonck 1935 *p.p.*; *Hydrocharito-Stratiotetum* (van Langendonck 1935) Westhoff 1946 *p.p.*; *Ceratophyllum-Stratiotes* nodum Wheeler & Giller 1982.

Constant species

Callitriche platycarpa, *Ceratophyllum demersum*, *Hydrocharis morsus-ranae*, *Lemna minor*, *L. trisulca*, *Polygonum amphibium*, *Stratiotes aloides*, *Utricularia vulgaris*.

Rare species

Myriophyllum verticillatum, *Stratiotes aloides*.

Physiognomy

The *Hydrocharis morsus-ranae-Stratiotes aloides* community has a usually abundant submerged element comprising luxuriant masses of *Ceratophyllum demersum* with *Utricularia vulgaris* and quite often some of the rare *Myriophyllum verticillatum*. *Callitriche platycarpa* occurs very frequently in small amounts and there is commonly a little *Elodea canadensis* and occasionally some *Potamogeton obtusifolius* or the rare *Ceratophyllum submersum*. Another rarity, *Stratiotes aloides*, is now particularly associated with this kind of vegetation within its much contracted range, and its striking large rosettes of rigid leaves can be quite abundant here. They remain submerged for much of the time, rising to the surface at flowering, but reproduction is by offsets in this country, male plants being very scarce and fruit never set (Clapham *et al.* 1962).

Floating above this layer is a surface mat of *Hydrocharis morsus-ranae*, *Lemna minor*, *L. trisulca*, *Polygonum amphibium* and *Nuphar lutea*, often mixed in with an abundant algal scum, mainly *Rhizoclonium*. Occasionally there are some emergent shoots of *Potentilla palustris*, *Hottonia palustris*, *Berula erecta*, *Oenanthe aquatica*, *Sparganium erectum*, *Nasturtium officinale*, *Sium latifolium*, *Alisma plantago-aquatica* or *Sagittaria sagittifolia*.

Habitat

The *Hydrocharis-Stratiotes* community is a very local vegetation type of mesotrophic, calcareous standing waters. It seems now to be restricted to a few localities, mostly in Broadland, though similar vegetation appears to have been more common there are one time, and perhaps occurred scattered through eastern England in the past.

In their study of the Catfield and Irstead fens in the Ant valley in Norfolk, Wheeler & Giller (1982*b*) showed that this community was most characteristic of those parts of the closed internal dyke system nearer to the fen margins, where there was direct or indirect influx of land-drainage waters and a shift from the deep peat of the fen basin to a mineral substrate. Chemical analysis of both waters and sediments there revealed higher levels of inorganic nitrogen (mainly nitrate) than in the more central areas of the fens, and slightly, but significantly, greater concentrations of calcium and magnesium throughout the year. They thought it possible that the mineral substrates around the fen edge, where the sediments showed higher redox characteristics, could have some influence on the gradient of trophic state and alkalinity, but suggested that it might be fertiliser run-off from the surrounding agricultural land, much chemically-manured and limed for the production of arable crops, that helped maintain the greater fertility in a comparatively nutrient-poor system.

The precise ecological needs of *Stratiotes*, the most distinctive plant in this community, are unclear. However, the *Hydrocharito-Stratioteum* described from the Continent has been designated characteristic of eutrophic waters (van Donselaar 1961) and, although Wiegleb (1978) considered *Stratiotes* typical of situations poor in both nitrogen and phosphorus, van Wirdum (1979) noted that the plant seemed to grow best in relatively nutrient-rich places, such as those irrigated by run-off from fertilised fields. Indeed, Westhoff & den Held (1969) attributed the extension of the range of *Stratiotes* in The Netherlands to increased use of fertilisers.

There is the interesting possibility, then, that the decline of the plant is related to nutrient depletion. Wheeler & Giller (1982*b*) gathered anecdotal evidence to support a previously abundant distribution of *Stratiotes* through much of the internal dyke system on the Catfield–Irstead fens, as recently as 15 years earlier: so much so, that the plants had to be dredged out of the waterways to allow passage of boats carrying away the sedge harvest. The decline there was much later than the more general loss of macrophyte vegetation from the open Broads (Phillips *et al.* 1978) and, although many stands of *Stratiotes* (as described by Pallis (1911), for example) disappeared from such sites, a more precise cause than simple 'nutrient enrichment' may have been responsible. Certainly, there has been increased input from agricultural run-off, but various workers have suggested that it is a rise in phosphorus content that is particularly important for the development of dense phytoplankton blooms and the loss of macrophytes (Phillips 1977, Moss 1978, Moss *et al.* 1979), with sewage effluent being an important contributory cause (Moss *et al.* 1979). Interestingly, Wheeler & Giller (1982*b*) noted that a small turf pond, isolated within the internal drainage system of the fens, close to the land margin but receiving no drainage from it, had virtually no macrophytes. Unlike the neighbouring dykes and pools with the *Hydrocharis-Stratiotes* community, this pond received input from a nearby septic tank.

The decline of *Stratiotes* has been much more widespread than just within Broadland and, although its distinctive appearance has commended it for introduction as an ornamental aquatic, its native localities are now few and far between across its former recorded range in East Anglia, the Fens and the north-east and north-west Midlands (Perring & Walters 1962). Through Europe it has a Continental distribution (Matthews 1955) extending from mid-Sweden down to northern Italy (Godwin 1975), and has probably never occurred in this country outside the warmer lowlands: all records, past and present, occur within the 28 °C mean annual maximum isotherm (Conolly & Dahl 1970) and, even in those rare situations where both sexes of the plant occur in the warmest part of the range, seed is never set. Some other members of this assemblage, although largely confined to the south and east of Britain, do retain a wider distribution than *Stratiotes* and, where they occur together in suitably unpolluted waters, could be considered as fragments of this kind of vegetation. From the rather vague descriptions provided of the dense growths of *Stratiotes* and *C. demersum* that once characterised now largely barren open waters in places like the Broads, it is very difficult to tell whether they occurred in this exact community. Clearly, there is a general similarity, although some species, like *Hydrocharis* for example, were apparently not important in the open Broads.

Zonation and succession

The *Hydrocharis-Stratiotes* community persists as a local aquatic element in the fragmentary and abbreviated open-water transitions of dykes and pools, passing landwards to swamp and fen, and being replaced by other aquatic vegetation with shifts in the trophic state and base richness of the waters.

In the kind of extended open-water transitions described by Pallis (1911) and Lambert & Jennings (1951), *Stratiotes* is shown growing beyond or persisting among emergent *Scirpetum lacustris*, *Typhetum angustifoliae* and *Typhetum latifoliae* swamps, and in the pools and dykes where it survives today, very narrow strips or clumps of such communities can be interposed between it and the banks, together with patches of other swamps like the *Phragmitetum*. Or, the open waters may give way sharply to fen vegetation, usually in Broadland of the *Peucedano-Phragmitetum*, the more species-poor *Phragmites-Eupatorium* fen or the eutrophic *Phragmites-Urtica* fen.

Where the waters became more enriched in nitrate-nitrogen, calcium and magnesium, Wheeler & Giller (1982*b*) showed that the dykes of the Catfield–Irstead fens supported a fairly rich kind of *Elodea canadensis* vegetation, from which *Stratiotes*, *Utricularia vulgaris* and *Myriophyllum verticillatum* were absent, but where floristic continuity was maintained through the floating element of the flora. Towards the other extreme, where the waters were impoverished, this element also persisted, though in a rather attenuated form, together with *M. verticillatum*, *Potamogeton obtusifolius* and *Nuphar lutea*, with *Utricularia vulgaris* usually the most abundant plant. In this scheme, such assemblages are best retained here as fragmentary stands.

In spatial terms, this environmental and floristic gradient was disposed through the dyke system, running from the fen margin to its centre.

Distribution

The *Hydrocharis-Stratiotes* community is now very local and mostly confined to Broadland.

Affinities

This community has been characterised almost entirely from the small data set of Wheeler & Giller (1982*b*) and more comprehensive sampling of vegetation with *Stratiotes* is needed before a satisfactory definition of this kind of assemblage in Britain can be given. Its relationship with the *Spirodela-Hydrocharis* community also needs clarifying because some Continental schemes would group both communities together in a *Hydrocharitetum* (as in Oberdorfer 1977), while others would prefer a narrow view of a *Hydrocharito-Stratiotetum* (as in Westhoff & den Held 1969). There is also some disagreement as to whether this kind of vegetation should be placed in a Lemnion minoris (Oberdorder 1977) or a Hydrocharition (Westhoff & den Held 1969, de Lange 1972).

Floristic table A4

Hydrocharis morsus-ranae	V (1–4)
Stratiotes aloides	V (1–7)
Lemna minor	V (1–3)
Lemna trisulca	V (1–5)
Callitriche platycarpa	V (1–3)
Polygonum amphibium	IV (1–3)
Utricularia vulgaris	IV (1–7)
Ceratophyllum demersum	IV (1–7)
Myriophyllum verticillatum	III (1–3)
Nuphar lutea	III (1–2)
Potamogeton obtusifolius	III (1–6)
Elodea canadensis	III (1–4)
Potentilla palustris	II (1–2)
Hottonia palustris	II (1–2)
Berula erecta	II (1)
Ceratophyllum submersum	II (1–6)
Oenanthe aquatica	II (1–3)
Sparganium erectum	II (1–3)
Nasturtium officinale	II (1–3)
Sium latifolium	II (1–3)
Alisma plantago-aquatica	I (1–3)
Nymphaea alba	I (1–3)
Ranunculus lingua	I (1–3)
Sagittaria sagittifolia	I (1–3)
Potamogeton crispus	I (1)
Sparganium emersum	I (3–4)
Number of samples	12
Number of species/sample	14 (11–19)

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Azolla filiculoides in aquatic vegetation

Azolla filiculoides is a small, free-floating aquatic fern that is native to tropical America, but which has become widely naturalised through the southern lowlands of Britain since it was first noticed a century or so ago. The number and wide scatter of early records suggests multiple introduction, but rapid spread over the past few decades (Perring & Walters 1962, Jermy *et al.* 1978) is probably due in some measure to the wide dispersal of fragments on the feet and feathers of water fowl (Rostron 1983, Page 1982*a*). Although the plant is known from as far north as Edinburgh, it is probably limited in its distribution by climate: Britain lies at the northern edge of its range and more northerly populations here survive only in milder winters. It is possible that *Azolla* does produce viable spores in this country in favourable seasons but, with us, reproduction is probably largely vegetative, a process which occurs very readily by fragmentation of the diminutive branched shoots.

In congenial situations, the increase of the plant can be formidable. It favours sheltered but unshaded waters of moderate to high fertility, and its prodigious growth is much enhanced by a symbiotic association with a nitrogen-fixing blue-green alga, *Anabaena azollae*. Even within a week or two, a few fragments can extend over the entire surface of a smaller pond or quieter lake bay, forming a continuous mat so luxuriant and apparently substantial as to trick the eye into forgetting the water beneath. The plants are green as growth begins in spring and summer, but in well-illuminated sites the carpet tends to turn red as temperatures drop in autumn. With the onset of winter, the plants sink or die, growth beginning again from any surviving fragments in the following season (Page 1988).

We have very few samples of *Azolla* and have not characterised a distinct community in which it is dominant. It seems commonest in smaller ponds, ornamental pools and stagnant dykes among such other aquatics as *Elodea canadensis*, *Ceratophyllum demersum*, *Callitriche* spp. and the various duckweeds, but its prolific and very buoyant growth is well able to crowd out both other floating and also submerged aquatics, such that it is often found in virtually pure mats. It may also benefit from the eutrophication of standing waters that has been so prevalent in the intensively agricultural lowlands, provided these have not become choked with floating, filamentous algae which seem to present a check on the growth of *Azolla* (Rostron 1983). Within the general limits of climatic control, the plant seems likely to spread further throughout Britain and with more sampling it may be sensible to delimit an assemblage. Some Continental schemes have characterised such units, like the *Lemno-Azolletum filiculoidis* (Br.-Bl. 1952) Segal 1965 (Westhoff & den Held 1969) and the *A. filiculoides* Gesellschaft of Oberdorfer (1977), and located these in the Lemnetea. *A. caroliniana* has also become naturalised on the European mainland (Segal 1965, Westhoff & den Held 1969) but in Britain seems to be still confined to pools in botanic gardens (Rostron 1983).