Eleocharis mitracarpa not confirmed in UK

Introduction

The work detailed in this discussion document was prompted by the publication in *Sedges of the British Isles* (BSBI Handbook No. 1, Edition 3) of the "possible presence" of *E. mitracarpa* Steud.:

> "Recent studies into *E. palustris* and related species by G.A. Swan have revealed the possible presence of a further species, *E. mitracarpa* Steud., in the British flora. This species is distinguished from *E. palustris* by having the style-base wider than long and mitriform and by the glumes having a very wide hyaline margin (Walters 1980)". [p. 125]

The name also features as a species entry in Arthur Chater's recent (2010) *Flora of Cardiganshire*.

These literature references derive from identifications made by the late Professor G.A. Swan, in 2002 and 2005 respectively, of specimens from Midlothian (Bush Estate, Penicuik; Glencorse Reservoir outflow) and from Cardiganshire (Ynys-las; Gwbert) (Swan (2005), in what is referred to hereafter as the 'unpublished note' – see **Note 1**, at the end of this document).

It should be emphasised that Professor Swan evidently never finalised his views on *E. mitracarpa*, and that the accounts of his identification of it were quoted in the two publications above in the hope that they would stimulate further investigation. As the BSBI referee for *Eleocharis* this is what I am attempting in the present note.

What follows draws on data derived from various specimens, including the originals where I have been able to have sight of them; other specimens from the same localities; and specimens from my own collection.

The desk study

The taxonomic status of *Eleocharis mitracarpa* Steudel

Note that the following discussion makes an important distinction between the two UK subspecies of *Eleocharis palustris.* The familiar UK plant is the tetraploid subspecies ***vulgaris,*** which has a fairly limited world range across western and northern Europe. The diploid subspecies ***palustris*** is apparently rare and southern in UK, but extends across Eurasia, where (depending upon taxonomic interpretation) it may be variously represented or replaced by the species named below (see Bureš, *et al.,* 2004, for maps of the European ranges based on chromosome counts).

To the best of my knowledge, Strandhede's monumental work (1966) remains the authority on European taxa. (He cultivated 3500 plants from 1100 localities, and examined 4000 herbarium specimens!) I am not aware of any more recent research which materially alters Strandhede's conclusions with regard to *palustris* and its near relatives (and I would obviously be grateful to be informed of any such).

In his discussion of *palustris* subspecies *palustris* Strandhede mentions various Near Eastern and Asian species. He includes *E. mitracarpa* Streud. within "the *mitracarpa* form series" (others being *E. kasakstanica* Zinserl.; *E. argyrolepidoides* Zinserl.; *E. crassa* (Finsch. & Mey.) Zinserl.; *E. argyrolepis* Kjerulff ex Bunge., "... and probably a few other combinations" [p. 113]).

Although much variation within the "form series" is put down to environmental influences,

> "Several morphological characters are common to the whole group, for example the achenes with markedly convex and large stylopodia, the often large spikes and, of course, the micromorphological characters which are common for the whole subspecies *palustris*" [p. 113].

However,

> "Large convex stylopodia are rather common [in *palustris* subsp. *palustris*] in S.E. Europe and further eastwards, and they seem to change into the stylopodia of *E. mitracarpa* in Asia without discontinuity" [p. 78/9].

He reports, of *mitracarpa:*

"The chromosome number is 2n = 16. ... The morphological analyses performed on the herbarium specimens available show that *E. mitracarpa* and the species mentioned [as bracketed above] are synonymous with or at least very closely related to the European ssp. *palustris*. Characters which are possible to correlate to each other and to the chromosome number, viz. stomatal length and pollen size, etc., coincide with those of [subsp.] *palustris*. Other characters which are more variable in [subsp.] *palustris*, viz. fruit characters and the occurrence [or absence] of bristles, are also variable in the taxa under consideration. ... Possibly, these taxa ought to be treated only as variants of ssp. *palustris*" [pp. 113/7].

(But he refrains from "making any definite evaluation of the taxonomical status" of these taxa [p. 117].)

Conclusion 1: On the basis of the limited work he was able to carry out on these eastern forms Strandhede seems not to regard *mitracarpa* as a particularly distinct entity, rather as a **name applied to eastern variants** of the widespread **diploid** subspecies *palustris*.

This perhaps casts doubt on the wisdom of raising the name *mitracarpa* for a plant in a quite different part of the range of the wider subspecies *palustris* – or indeed even beyond it. (The obvious exception might of course be in the event that it was an introduction, a possibility I return to briefly later.)

The 'macromorphological' characters

Strandhede's work shows that the *mitracarpa* form series shares many features with *palustris* subsp. *palustris*. Some characters – such as width of stems, number of vascular bundles, colour of stems, length of spikes – seem to be variable and often under environmental modification, and Strandhede does not accord them much significance.

In Floras (such as those mentioned below), the macromorphological characters given to distinguish the *mitracarpa* group from *palustris* subspecies *palustris* are the **shape of the stylopodium** (broader than in typical subsp. *palustris*, and **often wider than long**) and the **width of the hyaline margin** to the fertile glumes (wider than in subsp. *palustris*).

I think it is important to stress that in Floras covering regions from the far east of Europe eastwards, the characters given for *mitracarpa* are evidently to distinguish it from *palustris* subspecies *palustris* – since that is the *palustris* form in the east from which it needs to be distinguished. Such Floras do not intend, however, to distinguish *mitracarpa* from *palustris* subspecies *vulgaris,* since that form is not in contention, being restricted to a relatively small area of central, northern and western Europe (Bure š, *et al.,* 2004).

As I shall seek to show below, unfortunately for the diagnosis of putative *mitracarpa* in UK, the features said to distinguish *mitracarpa* from *palustris* subsp. *palustris* are routinely displayed in forms of subsp. *vulgaris*.

The mitriform stylopodium

I am uncertain at what point the term 'mitriform' came to be applied to the shape of the stylopodium. Strandhede has no mention of the term, referring to the shape in terms of length (height) versus width, and the outline being "convex".

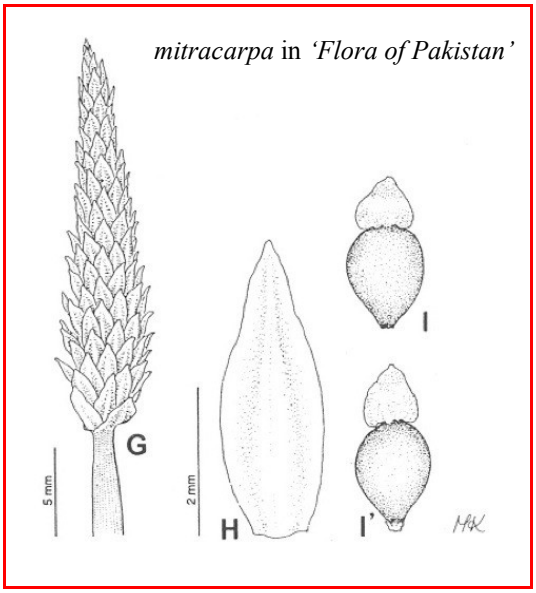
He lists for the type specimen of *mitracarpa:* stylopodium length 0.5-0.6 mm and width 0.7 mm (thus, a length:width ratio of 0.71-0.85); shape convex; neck present.

It is entertaining, although far from illuminating, to investigate what is meant by the term 'mitriform'. The OED gives a definition, *Resembling or shaped like a mitre, conical, hollow, and open at the base ... applied to the calyptra of mosses and to certain fruits,* the first listings referring to bryophytes (1830), and later to conchology (1843).

Some on-line definitions, e.g. “having the form of a mitre, or a peaked cap”, lead to investigation on the shape of mitres down the ages, or conversely what type of cap is intended.

In the present context, this gets us little further, since there appears to be disagreement as to which taxon has what type of stylopodium.

Whilst eFloras’ *Flora of China (www.eFloras.com)* suggests both mitriform and mammiform stylopodia in the key couplet for *mitracarpa* (but only mitriform, and not mammiform, in the description), the equivalent *Flora of Pakistan* gives *palustris* subsp. *palustris* as having a mitriform stylopodium, and *mitracarpa* mammiform. This rather conflicts with the diagram from the same source (right) where the stylopodium drawings (I′ in particular) look (to my understanding) convincingly mitriform, but neither are mammiform!

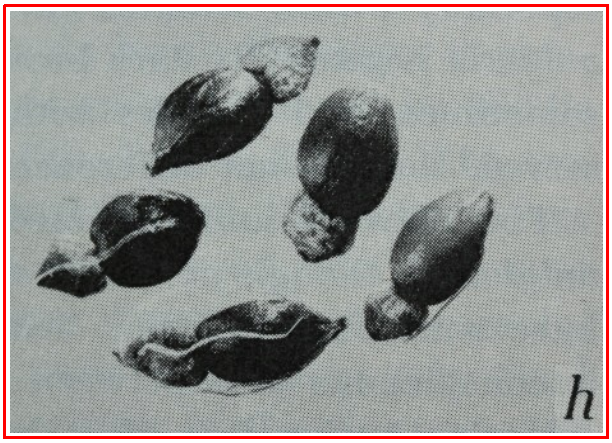


mitracarpa in *‘Flora of Pakistan’*

Flora S.S.S.R. (Komarov, 1976) gives in the key for *E. argyrolepidoides* (apparently a synonym of *mitracarpa*) “tubercle [i.e. stylopodium] cylindric-subglobular, mammillate-conical, or subglobular-short-conical (often knobbed at the summit)” – which covers most bases.

Strandhede (1966) makes some remarks pertinent for the present study – and indeed any study of *Eleocharis:*

> “The cells of the stylopodia are big and rounded and their walls become firm rather late during development. If the achenes are taken somewhat unripe, the stylopodia shrink considerably, which makes for too low values of their sizes. Their shape is also affected, and the stylopodia are concave or mamillate also in samples where no such shapes are normally found (cf. figs. 11a-d). This factor is especially important to remember when studying herbarium specimens, which are most often collected in stages with unripe fruits.” [etc.; p. 84]

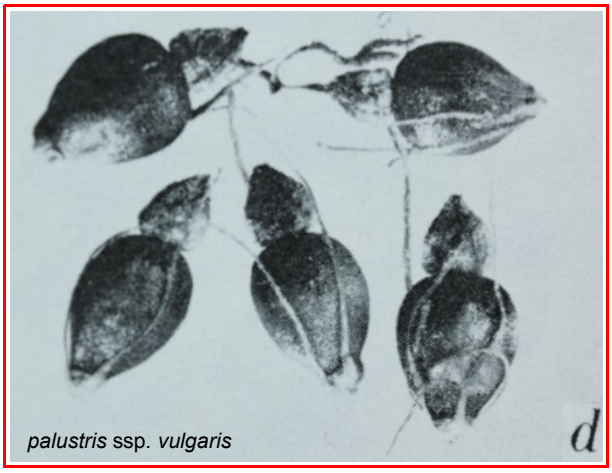


Strandhede includes some useful photographs, which help to illustrate the range of (ripe) stylopodium shapes.

Those of *palustris* **subspecies *palustris*** look often more bulky and tall than our familiar subspecies *vulgaris*, but – as Strandhede is at pains to point out – there are **broader** forms of subsp. *palustris*, such as the picture [right; Fig. 7h, p. 58, from Hungary]. These stylopodia look mitriform to my understanding.

Of the stylopodium of **subspecies *vulgaris*** Strandhede makes the highly significant remark,

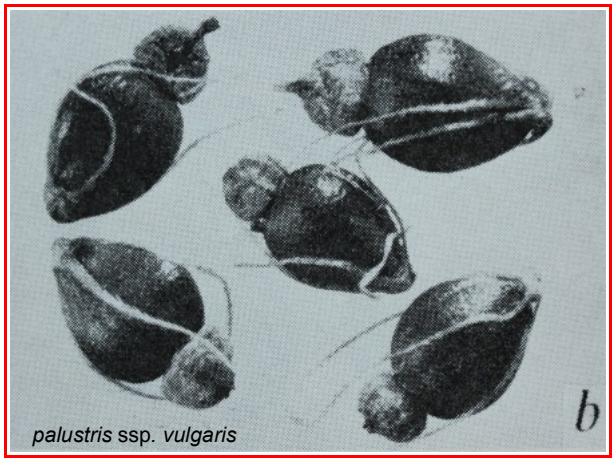
> “The length is often smaller than the width, in contrast to the most common conditions found in ssp. *palustris*” [p. 79].

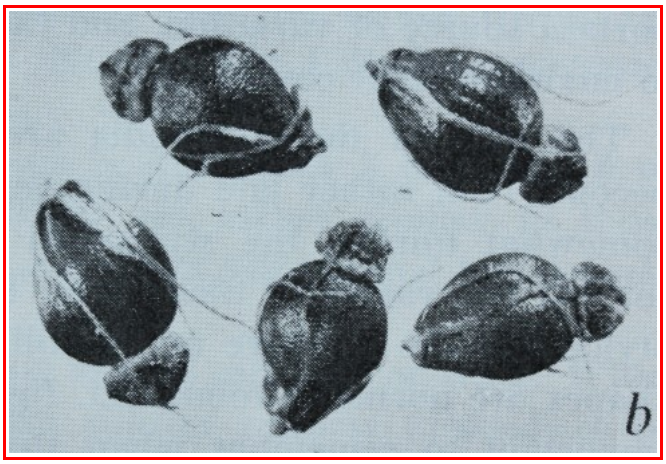


He illustrates several ***vulgaris*** which are recognisably like local UK forms, with stylopodia generally conic or convex-conic, but with alarming variation in size (partly owing to the degree of maturity when gathered – see the quote above).

Some, such as the example right [Fig. 9d, p. 60, from Sweden], have large and elongated, convex, and similarly mitriform, stylopodia. These appear to match several series within subsp. *palustris*.

Other ***vulgaris*** illustrated by Strandhede are broader and lower, some arguably still mitriform, others globose, but with a considerably lower length:width ratio, less than unity – see examples below [left: fig. 9b, p. 60; right: fig. 11b, p. 83].

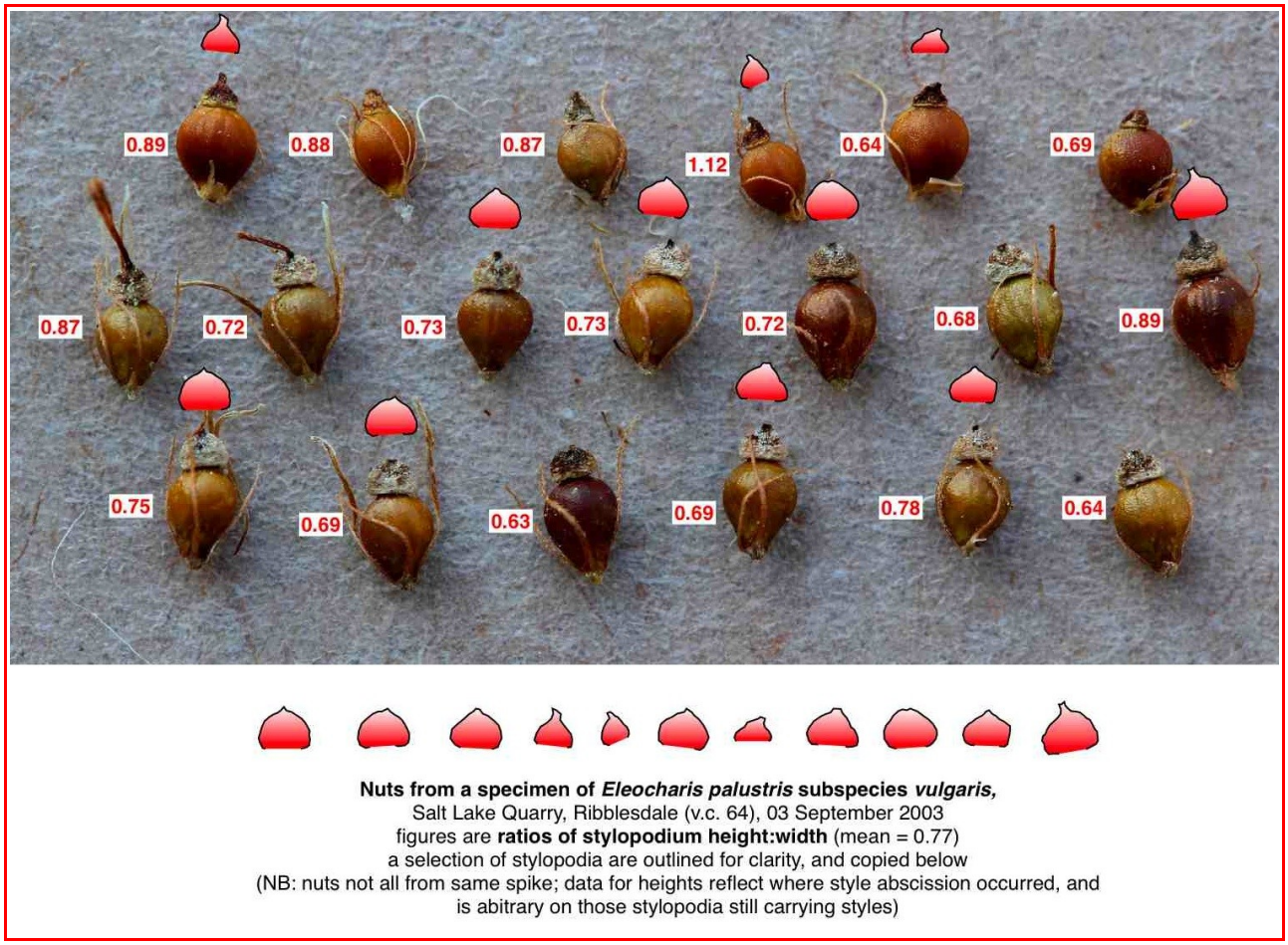




From my own collections, it is easy to find samples of subspecies *vulgaris* in which some stylopodia are similarly low and convex.

The chart of a ***vulgaris*** specimen (below), from Ribblesdale, shows a selection of ripe achenes, each with its stylopodium length:width ratio. Some of the stylopodia have been digitally outlined for clarity, the outlines then displaced upwards, and the same copied in a row below. Although these are in the main less bulky than Strandhede's examples above, some are arguably mitriform, and others even mammiform.

The stylopodium length:width ratio varies from close to unity to well below, in this sample down to 0.63 – *i.e.* much wider than long. The variation in development is striking.



Nuts from a specimen of *Eleocharis palustris* subspecies *vulgaris*,
Salt Lake Quarry, Ribblesdale (v.c. 64), 03 September 2003
figures are **ratios of stylopodium height:width** (mean = 0.77)
a selection of stylopodia are outlined for clarity, and copied below
(NB: nuts not all from same spike; data for heights reflect where style abscission occurred, and is abitrary on those stylopodia still carrying styles)

Conclusion 2: The value of a mitriform stylopodium for distinguishing *mitracarpa* from either UK subspecies of *palustris* is doubtful, if not useless, given that:

- there is some doubt in the Floras about what precise shape is intended;
- there is disagreement about what taxa can reliably display this shape;
- both *palustris* subspecies, ssp. *palustris* and ssp. *vulgaris,* can display a wide variety of stylopodia, some a good match for this shape;
- the shape depends upon the state of development, and varies markedly even within the same spike.

The hyaline margins of fertile glumes

Referring to the fertile glumes, Strandhede says:

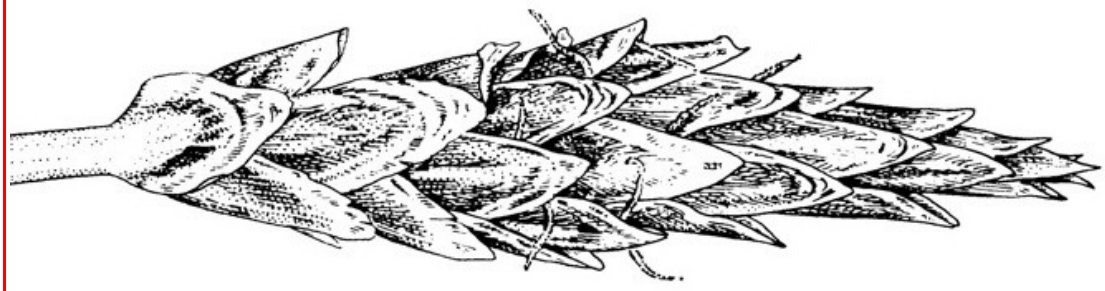
> "The hyaline margins of [subspecies] *palustris* are usually narrow or lacking in the young spikes, but during the summer they grow broader, when the glumes become increasingly hyaline" [p. 113], and in *mitracarpa* itself, the "glume colours vary widely from nearly white to dark brown".

This does suggest that some forms of *mitracarpa,* especially 'xeromorphic' types having "broad midribs and hyaline margins" [p. 117] may be distinguishable from subspecies *palustris* by having wider hyaline margins, at least early in the season.

However, **what wide hyaline margins will not do** is distinguish *mitracarpa* from subspecies *vulgaris*, since

> "The glumes of *vulgaris* have distinct, often conspicuously broad, silvery, hyaline margins, also in the young spikes". [p. 46]

Strandhede & Dahlgren have a delightful figure of *palustris* subspecies *vulgaris* (below) which provides a nice comparison with a *vulgaris* spike from Ribblesdale (page 6). Notice particularly the wide hyaline margins to the glumes in both, widest in the lowest glumes, where they become rugose in the apical areas.



palustris ssp. *vulgaris*

Strandhede discusses in detail the point that

> "The colour of the glumes ... varies between, as well as within, taxa. It also modifies during the season as the glumes become more hyaline when fruits ripen. The last mentioned variation is conspicuous, and it is therefore difficult to give any definite characters separating the taxa under consideration" [p. 47].

Hence subsp. *vulgaris* shares with *mitracarpa* wide hyaline glume margins, particularly marked in the later season. In addition the character may in any case be too variable to be of diagnostic value.

Without a clearer idea of what is meant by 'wide' – never defined by Strandhede – the character cannot be applied with any confidence. The only reference I have discovered so far which provides a definition is that in Komarov's key (1976):

> "Margin of scales is here referred to as broad hyaline (transparent-membranaceous) in those instances where it equals or exceeds one third of half the width of the scale, and as narrow where it amounts to less". [p. 50]

As illustrated below and right, it is easy to find forms of subspecies *vulgaris* with wide hyaline margins, indeed amply wider than the definition just given (specimen from Ribblesdale).

The table below has data from this same Ribblesdale sample (clearly *vulgaris* on stomatal length: see below), including the actual width and the % width of the hyaline glume margins, measured 2 mm below the tip.

Specimen: Ribblesdale, Salt Lake Quarry, 3 Sept 2003	
Stomata length (mean; µm)	66.13 n=3x10 s.d.=3.69
Glume length (mean; mm)	3.83 n=10 s.d.=0.22
% width hyaline glume margin (mean)	54% n=20 s.d.=6
Width hyaline margin (mean; mm)	0.44 n=20 s.d.=0.06
Stylopodium shape (L/W ratio; mean)	0.77 n=19 s.d.=0.12
Nut length (mean; mm)	1.41 n=8 s.d.=0.06
Receptacle density (no. flowers/cm rachis)	39.9

Clearly the hyaline margin is substantially wider than Komarov's definition of what constitutes 'wide'.

Conclusion 3: If *mitracarpa* occurs in UK, it needs to be distinguished from *palustris* subspecies *vulgaris* by **other** characters than wide hyaline glume margins and wide, convex stylopodia, since these characters occur freely in *vulgaris*.

Flora Europaea

I believe the key to the '*E. palustris* group' (Volume **V**, page 283) has a number of 'issues' (which I detail in a separate note ("*Eleocharis:* some problems with the *Flora Europaea* account")).

The *E. palustris* group **key** (**V**, p. 283, couplet 3) is content merely to utilise **ratios** to distinguish *mitracarpa* from *palustris* (*i.e.* the **species,** thus implying both subspecies): thus, stylopodia longer than wide in *palustris;* wider than long in *mitracarpa* (however the **description** for the latter (p. 283) does mention 'mitriform').

(Bristles are also mentioned, but only to indicate that species *palustris* has none in some forms (four in the majority), whilst *mitracarpa* has '4(-5)'. In fact, Strandhede mentions that the type specimen of *mitracarpa* also lacks bristles, so '(0)4(-5)' might accord better with the literature.)

"Stylopodia longer than wide" as given above for the **species** *palustris* might fit subspecies *palustris*, but it seems to ignore the many forms of subspecies *vulgaris* in which – as previously demonstrated – the "length is often smaller than the width". Hence an entirely normal sample of subspecies *vulgaris*, especially one with conspicuous hyaline glume margins, would key out as *mitracarpa*.

Conclusion 4: use of the *Flora Europaea* key would suggest *"mitracarpa"* for many samples of *palustris* subsp. *vulgaris*.

(See the separate note as mentioned above, for a separate issue with the *Flora Europaea* key and *E. mamillata*.)

Incidentally, the quote at the start of this document from the *Sedges...* handbook mentions for *mitracarpa* "glumes having a very wide hyaline margin (Walters 1980)". In fact SMW says simply "Like **8** [i.e. the whole species *palustris*] but glumes usually with a wide hyaline margin": the inserted "very" probably derives from Professor Swan's description in the unpublished note, or private correspondence.

However, neither in the key nor in the species and subspecies accounts for *palustris* in *Flora Europaea* [p. 283] is there mention of the presence of any hyaline margin. This could be taken to suggest (if this was one's only source) that here was a good diagnostic character.

***Palustris* subspecies *palustris* in Scotland or Wales?**

From previous quotes, *mitracarpa* and its relatives are **diploid**, sharing the same ploidy level as *palustris* subsp. *palustris.* (Strandhede's chromosome counts in *palustris s.s.* have been widely confirmed by more recent workers – see, e.g., Bureš, *et al.* (2004) – although I have not located in the literature a recent confirmation for *mitracarpa*.)

If it is accepted that *mitracarpa* is a synonym, or a local variant, of the wider *palustris* subsp. *palustris*, then any candidate for *mitracarpa* would first have to pass muster as subsp. *palustris!*

Given that *E. palustris* subsp. *palustris* itself would be new to – or at least is very rare in? – both Wales and Scotland (where the plants in question originated), the uncovering of a diploid plant would be of great interest, and indeed of greater significance than the questionably distinct '*mitracarpa'*.

The 'micromorphological' characters

If it accepted that *mitracarpa* is diploid and *vulgaris* tetraploid, any characters which correlate with ploidy level would separate them definitively. What characters do we have available?

The characters which correlate most strongly with ploidy level, according to Strandhede, are the 'micromorphological' characters of **stomatal length** and **pollen grain size:**

> "The stomatal length of [subsp.] *palustris* ... has great diagnostic interest in relation to [subsp.] *vulgaris.* The mean values of the Scandinavian and Finnish samples of *palustris* cultivated reach between 38 and 50 µm, and those of *vulgaris* between 54 and 70 µm." [p. 29]

These ranges are broadened somewhat in Strandhede & Dahlgren (1968), where the same overall ranges are given – but I believe with greater clarity and applicability – as:

subspecies ***palustris*** (35-) 39-49 (-56) µm

subspecies ***vulgaris*** (50-) 54-70 (-77) µm

The equivalent figures in both *Sedges of the British Isles* and *Flora Europaea* are 35-56 µm and 50-77 µm respectively. Both clearly derive from Strandhede & Dahlgren, as above. Note that the figures refer to mean values.

Stomatal length and pollen size characters should also hold good also for *mitracarpa*, as these fall into "the micromorphological characters which are common for the whole subspecies *palustris*" [Strandhede (1966), p. 113].

Strandhede examined type specimens of *mitracarpa* and others of the form series, and gives a table on pages 118/9, summarised here, with mean stomatal length; mean length of fertile glumes; width of hyaline margins of fertile glumes; and length of bristles (compared to achenes). The stomatal and glume lengths agree closely with the ranges for subspecies *palustris.*

	Stomatal length	Length fertile glumes	Width of hyaline margins of fertile glumes	Length of bristles (vs. achenes)
mitracarpa	49 µm	3.5 mm	0-broad	(none[1])
argyrolepidoides	44 µm	3.3 mm	broad	equal
kasakstanica	40 µm	c. 3 mm	broad	longer
argyrolepis	50 µm	—	broad	?
crassa	43-50 µm	3-4 mm	± broad	longer
subsp. *palustris*	44 µm (s.d.=5)	3.0-3.5 mm	variable	variable

Data based on type specimens, except for subsp. *palustris*: "means in Scandinavian main populations", and *crassa*: "extreme mean values of four specimens determined by Zinserling".

[1] The type specimen of *mitracarpa* lacks bristles, like some forms of subsp. *palustris.*

Pollen sizes are variable, but means given by Strandhede & Dahlgren (1966) are: *palustris* 38.1 µm (s.d. = 4.1); *vulgaris* 47.1 µm (s.d. = 6.0). (Strandhede was not able to measure pollen length for several of the form series type specimens, including *mitracarpa.*)

Unfortunately, although some tiny residual pollen clumps were found in some spikes of the specimens examined in this investigation (see next section), these appeared inadequate to use with any degree of confidence in this study.

Glume length appears to have some diagnostic value between diploid and tetraploid, with the diploids (subspecies *palustris* and the forms in the table above) being in most instances smaller than in the tetraploid *vulgaris.* Strandhede has:

> "The length of the imbricate fertile glumes of [*mamillata, austriaca,* and *palustris* subspecies] *palustris* is commonly about 3 mm in the middle part of the spikes, and it reaches more rarely 3.5 mm or more (cf. however, the *palustris* plant no. 184301, where glumes reach 4.2 mm). *Vulgaris* has broader and longer fertile glumes that *palustris*. The length is commonly about 3.5-4 mm but may sometimes be shorter." [p. 45] (Measurements of glume widths are however not given.)

Conclusion 5: We should be able to separate both putative *mitracarpa* and subspecies *palustris* from subspecies *vulgaris* by stomatal length and pollen size. Fertile glume length would provide confirmation in most cases.

The plants

I have not had sight of the precise specimens from Scotland and Wales which Professor Swan named as possible *mitracarpa*. **(Update, February 2013:** see page 14 below: "A named specimen".)

However, through the kindness of Douglas McKean, I have now been able to examine the specimens (**E)** which initially 'caught the eye' of Professor Swan in 2002. According to Professor Swan's unpublished note, these were:

- Bush Estate, Penicuik, margin of pond, W. Marshall, 6 July 1958 (acquisition no. E00477411, also annotated 'var. vulgaris' in an unknown hand; NT247637 approx. – DMcK's grid reference)
- Glencorse Reservoir, Pentland Hills, 3 July 1956, A. Currie (acquisition no. E0044412, also annotated by DMcK, 5 February 1998, as 'ssp. vulgaris'; NT209635 approx. – DMcK's GR)

At Professor Swan's request, DMcK had visited these localities in September 2002 and collected a quantity of material at each site, samples of which were sent to Professor Swan (Swan, unpublished note).

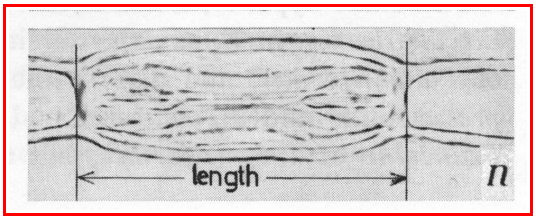
I am very grateful to DMcK who sent me a number of his own specimens (fifteen in all) retained from both Midlothian localities. Note that since Professor Swan evidently identified some samples as subspecies *vulgaris,* whilst others were the putative *mitracarpa*, it is uncertain which of these fifteen, if any, are precise clones of those identified by Professor Swan as *mitracarpa.*

At a later stage, DMcK suggested that I might see the original specimens above, held in **E.** Through his good offices, these specimens were sent to Tullie House Museum, Carlisle, and I examined them there on 13 February 2012. Having obtained clearance from RGBE to remove a portion of stem, I was able to measure stomatal lengths from epidermal peels on 16 February.

The DMcK specimens

Whilst awaiting the arrival of the **E** specimens (see below), I gathered data on the fifteen DMcK specimens. I measured glume length for all fifteen, and for more features for a selection of ten specimens, summarised in the table below.

(Glume lengths for the five specimens not included in the table below were commensurate with the means for subsp. *vulgaris;* these specimens were therefore not examined further.)



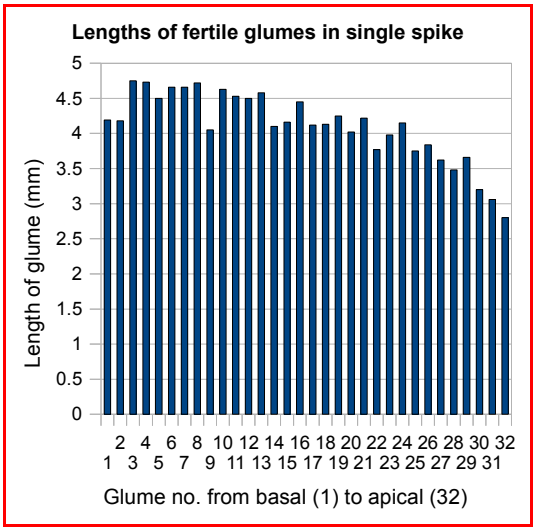
Data were collected as follows:

Stomata

Given the variation in lengths of stomata, for most samples ten stomata were measured in three separate ranks from across the sample, giving 30 in total. Lengths were measured precisely as Strandhede's (1966, p. 28) diagram (right).

Glume length

About ten glumes were carefully excised from the middle third of the spike, and measured with digital calipers. (These represent the longest, the lengths decreasing both upward and downward. Glumes selected from the 'middle' of a spikelet originate from receptacles rather below the middle. The graph (right) shows the length of all 32 glumes from a typical spikelet of subspecies *vulgaris.* Most are more than 3.5 mm)



Hyaline margin to glume

For two samples – chosen for their well-developed hyaline glume margins – the width of the hyaline margin was measured under a microscope (×40) at a level 2 mm below the tip of the glume, and compared with the width from the

margin to the midrib at this level. Data are presented both as absolute width and as a percentage of the width.

Stylopodium shape

The length and width of the stylopodium were measured for a number of nuts under the microscope (×40) and the mean ratio of length:width given. Thus a ratio greater than unity implies a stylopodium longer (higher, taller) than wide, and less than unity implies wider than high.

Nut length

Earlier samples in the sequence had nuts measured under the microscope (×40). This information appears not to be of particular value in diagnosis and so was not collected for all samples.

Mean figures are summarised below. (NB: full spreadsheets of all these data are available on request.)

n = number in sample; s.d. = standard deviation; — = data not collected

Summary of data from ten specimens from Bush Estate Pond and Glencorse Reservoir outflow

Specimens (my ref. numbers)	1 (Glen-corse)	2 (Bush)	3 (Glen-corse)	4 (Bush)	5 (Bush)	6 (Glen-corse)	7 (Glen-corse)	8 (Glen-corse)	9 (Glen-corse)	10 (Bush)
Stomata length (mean; µm)	**62.0** n=20 s.d.=3.5	**68.4** n=20 s.d.=3.4	**71.5** (69.8; 70.6; 74.2) n=3x10 s.d.=2.89	**58.7** (56.1; 58.6; 61.5) n=3x10 s.d.= 3.99	**63.9** (63.7; 64.8; 63.1) n=3x10 s.d.=1.91	**69.1** (66.6; 69.1; 71.5) n=3x10 s.d.=3.3	**65.4** (61.3; 65.7; 69.1) n=3x10 s.d.=3.7	**62.8** (60.8; 62.9; 64.6) n=3x10 s.d.=2.61	**63.8** (60.3; 64.5; 66.65) n=3x10 s.d.=3.58	**65.6** (63.5; 64.8; 68.6) n=3x10 s.d.=3.61
Glume length (mean; mm)	**3.83** n=10 s.d.=0.22	**4.32** n=12 s.d.=0.12	—	**4.08** n=15 s.d.=0.25	**4.15** n=15 s.d.=0.28	**4.40** n=14 s.d.=0.25	**4.26** n=8 s.d.=0.20	**4.46** n=10 s.d.=0.12	**4.84** n=10 s.d.=0.12	**4.15** n=14 s.d.=0.17
% width hyaline glume margin (mean)	—	—	—	—	—	—	—	—	56% n=7 s.d.=13	37% n=14 s.d.=5
Width hyaline margin (mean; mm)	—	—	—	—	—	—	—	—	0.37 n=7 s.d.=0.13	0.30 n=14 s.d.=0.04
Stylopodium shape (ratio L/W; mean)	—	—	—	**1.13** n=21 s.d.=0.17	**1.00** n=20 s.d.=0.11	**0.67** n=19 s.d.=0.08	—	—	**0.70** n=20 s.d.=0.08	**0.98** n=16 s.d.=0.19
Nut length (mean; mm)	1.41 n=8 s.d.=0.06	1.60 n=20 s.d.=0.07	—	1.61 n=21 s.d.=0.15	1.50 n=20 s.d.=0.07	—	—	—	—	—
Nut width (mean; mm)	—	1.26 n=20 s.d.=0.06	—	1.28 n=21 s.d.=0.10	1.14 n=20 s.d.=0.08	—	—	—	—	—
Receptacle density (no. flowers/cm rachis)	38.8	31.5	—	27.56	41.4	37.7	—	—	—	—
Bristle length (vs. achene+stylopod-ium)	**>**	**=**	**>**	**>**	**>**	**>**	**≥**	**>**	**>**	**≥**

Results

The mean **stomatal lengths** vary in the range 58.7 to 71.5 µm. This range fits very comfortably within the accepted range for subspecies *vulgaris,* but all exceed the range of subspecies *palustris.* Indeed, many of the means are towards the upper end of the range of *vulgaris*. A putative *mitracarpa* would be expected to fall well below the range seen here.

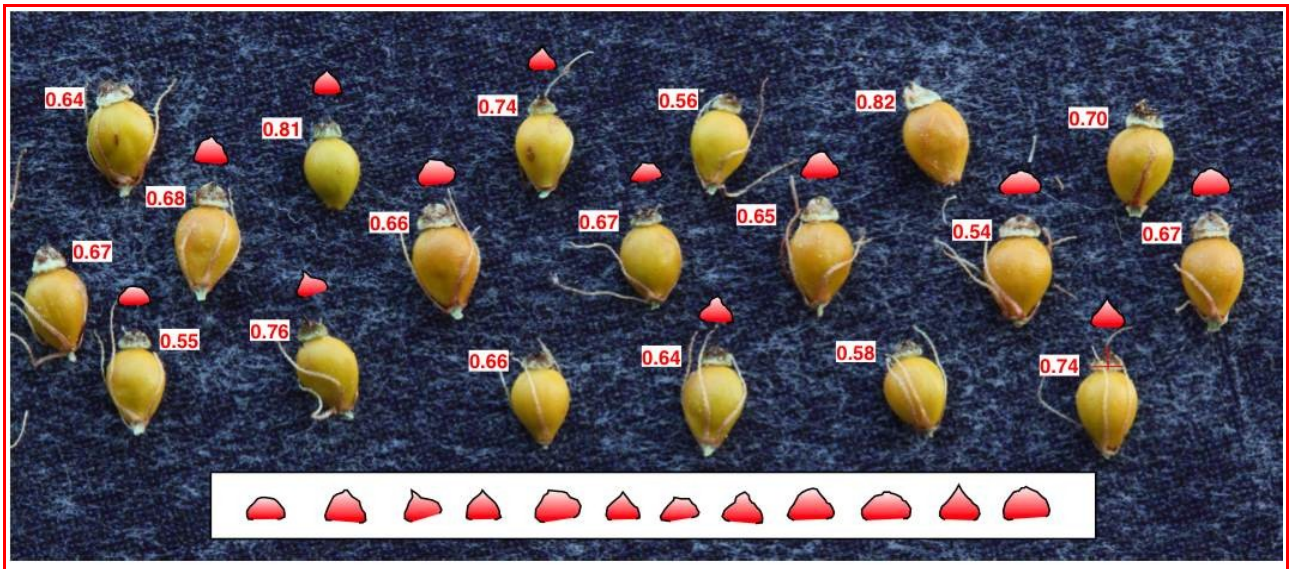
The mean **glume lengths** for the nine specimens checked vary in the range 3.83 to 4.84 mm. This range is again commensurate with subspecies *vulgaris;* all are above Strandhede's range for subspecies *palustris.* Indeed, many of the means are towards the upper end of the range of *vulgaris*. A putative *mitracarpa* would be expected to fall well below the range seen here.

Where measured, the **stylopodium shape** ratio is variable, and either close to unity or somewhat below (i.e., stylopodium is wider than tall). This would be expected for subspecies *vulgaris*. See also later.

Nut-length and **-width** are not diagnostic – due to overlap in measurements – but sit more comfortably with the range given by Strandhede for subsp. *vulgaris*.

Receptacle density is variable, but four of the five measured fall below the "40 florets per cm of rachis" of Strandhede as typical of subsp. *vulgaris*, and one just above 40, in the range of subsp. *palustris*.

A sample from Glencorse Reservoir (my ref. no. 9) was chosen for this comparison (below) with the Ribblesdale *vulgaris* on page 4, as one of the samples having convex and low stylopodia. (Others were taller, and often conic rather than convex.)



Nuts from a specimen of *Eleocharis palustris* subspecies *vulgaris*,
Glencorse Reservoir, Midlothian (v.c. 83), 5 August 2003 (coll. D. McKean)
figures are **ratios of stylopodium height/width ratios** (mean = 0.70)
a selection of stylopodia are outlined for clarity, and copied below
(NB: nuts all from one spike; data for heights reflect where style abscission occurred)

In the Glencorse specimen the length:width ratios are often lower than in the Ribblesdale example, but the overall shape is similar. (The collection date is a month earlier than the Ribblesdale example: the achenes are yellow rather than brown, and the stylopodia are unripe. Unripe stylopodia often blacken at the tip in the press, as here, and do not show well against this dark background.)

> **Conclusion 6**: on morphological criteria, none of these fifteen specimens are other than *palustris* subspecies *vulgaris*.

Original specimens

Examination of the 'original' Bush Estate and Glencorse Reservoir specimens exposed a number of puzzles.

Neither specimen had any annotation from Professor Swan. The specimens were somewhat sparse, consisting merely of four fertile stems (Bush Estate), and two small tufts with six spikes, one loose in a packet (Glencorse Reservoir).

In both specimens all spikes were intact and apparently undisturbed, and it was unclear if they had been examined at all closely. Whilst the glume margin features were obviously visible, it was difficult to see whether and how Professor Swan might have judged the stylopodium shape from any of the spikes.

Specimen from Glencorse Reservoir outflow

From the loose spike in the Glencorse packet I took a photograph (below, left) and removed a few glumes to measure. The fruits were very poorly developed; many were aborted and those actually developing were immature. Only two examples were extracted (below, right).

The mean length of the eleven glumes measured from two spikes was 4.10 mm (s.d. = 0.22), table right.

Glume length (mm)	
spike 1	spike 2
4.38	4.32
4.47	3.83
3.89	4.16
4.09	3.85
	4.13
	3.96
	3.99
mean = 4.10 mm	

The widths of the hyaline glume margins were not measured, but can be judged from the photo, right. The glumes can be closely matched by those from *vulgaris* specimens in my own collection, such as one from Ribblesdale (page 6).

The stomata were measured from four different ranks, as in the table right ('units' are those of the graticule, where 1 unit = 2.58 µm).

The overall mean was 62.73 µm (s.d. = 3.25).

Stomatal length			
rank 1	rank 2	rank 3	rank 4
(units)	(units)	(units)	(units)
24	24.5	24.5	23
23.5	24.5	24.5	23.5
23	25	25	22
25	26.5	25.5	22
24	25.5	24	22
22	24.5	25.5	22
23	25	25.5	25
24	24	25.5	25
23.5	25	26	27
24	25.5	25	24
conversion: 1 unit = 2.58 µm			
means (µm)			
60.89	**64.5**	**64.76**	**60.76**

Conclusion 7: the original Glencorse specimen has mean stomatal and mean glume lengths commensurate with *palustris* subspecies *vulgaris,* the identification already annotated by DMcK.

Specimen from Bush Estate Pond

The Bush spikes were small, immature and poorly developed (the example below, left being one of the larger!). I did not dissect the spikes, except to remove one glume (below, right) from the single loose head in the packet , which was from near the base of the spike and had a length of 3.89 mm.

The stomata were measured from four different ranks, as in the table right ('units' are those of the graticule, where 1 unit = 2.58 µm.)

The overall mean was 70.34 µm (s.d. = 2.41).

Stomatal length			
rank 1	**rank 2**	**rank 3**	**rank 4**
(units)	(units)	(units)	(units)
28	27	28	28
26.5	28	28	28.5
27	26	27.5	28
28	26.5	29	27.5
27	26.5	28	28
24.5	27	28.5	26.5
25.5	27	28	27.5
26.5	28.5	27	28
26.5	27	26	27
27	27.5	26	28
conversion: 1 unit = 2.58 µm			
means (µm)			
68.76	**69.92**	**71.21**	**71.47**

Conclusion 8: the original Bush Estate specimen has a very long mean stomatal length at the upper end of Strandhede's range for *palustris* subspecies *vulgaris*, and can only be referred to this. The single glume length measured (3.89 mm) also fits here.

The Welsh specimens

In 2004 AOC sent some Cardiganshire *Eleocharis* specimens, possibly representing hybrids, to Professor Swan for comment. In Professor Swan's opinion (unpublished note; see Note 1 below) some of these appeared to be identical with the specimens from Bush Estate.

AOC kindly supplied to me two specimens (AOC 06/243 & 06/252) which in his view appeared to match others sent to Professor Swan. They have fairly obvious hyaline glume margins, but the stylopodia are rather small, conic, and of *vulgaris* type.

The mean stomatal lengths and mean glume lengths (right) place both specimens firmly in the range of *vulgaris*.

AOC specimens	**mean stomatal length (µm)**		**mean glume length (mm)**
	culm 1	culm 2	
AOC 06/243	64.56 n=20; s.d.=3.25	61.15 n=20; s.d.=2.53	4.00 n=20; s.d.=0.26
	mean = 62.86 µm		
AOC 06/252	63.98 n=20; s.d.=3.20	63.34 n=20; s.d.=2.90	4.49 n=20; s.d=0.31
	mean = 63.66 µm		

Without sight of the actual specimens named by Professor Swan, we would have to accept his view that amongst AOC's Cardiganshire specimens a number appeared to be identical with the putative *mitracarpa* from the Bush Estate. If they are indeed identical, and if – as I suggest – the Bush Estate plants are *palustris* subsp. *vulgaris,* then the assumption would be that the Welsh plants too would be referable to subsp. *vulgaris.*

A named specimen

In autumn 2012, many months after carrying out the work just described, a small polythene packet came to light amongst other material in my herbarium. I recognised it as being a collection sent to me by Professor Swan in (about) 2004 during the many exchanges we had had in connection with ongoing studies into *Eleocharis austriaca,* but mislaid over the years since. This bag contained not only some spike-rush fruits but also – most usefully, and not in accord with my vague memory of it – a spikelet and lengths of stem! A label written in Professor Swan's hand says "cf. *Eleocharis mitracarpa* Bush Estate NT247.607*, 04.09.02 Collected by D.R. McKean". (* The "0" in the grid-reference as written may be a transcription error for NT247.637 as given earlier.)

Here was an actual specimen named by Professor Swan, overlooked in my collection! The specimen proved to be a close match with the other Bush Estate specimens already examined, with hyaline glume-margins of similar width, mean stomatal length of 71.6 μm (s.d. = 3.9; n = 40), and glumes 4.09 mm, 4.11 mm, and 4.20 mm (n = 3). There seemed no reason to place this elsewhere than in *palustris* subspecies *vulgaris.*

Discussion

After examination of the original specimens which first 'caught the eye' of Professor Swan, I remain puzzled as to why these should be referred to anything out of the ordinary. Neither collection has ripened fruits, and so it appears to be only the wide hyaline glume-margins that were thought to be unusual. It would presumably be for this reason that DMcK was asked to collect material from both sites.

It seems that the putative identification as *mitracarpa* was made on the basis of just the two characters, stylopodium shape and width of hyaline glume margins. Yet these two characters are closely matched between *mitracarpa* and *palustris* subspecies *vulgaris.*

It is striking that there is no mention of stomatal characters in the unpublished note. It is clear that Professor Swan was fully familiar with Strandhede's publications; in my view it is inconceivable that he would not be aware of the "great diagnostic interest" of stomatal length as a strong confirmatory character for putative *mitracarpa*, versus subspecies *vulgaris.* (Indeed, in 2003 and 2004 he had drawn my attention to the significance of stomatal lengths in relation to ploidy, in *E. palustris* and in *E. mamillata/austriaca*.)

Perhaps related is a puzzling section in which an obscure point is picked up relating to Strandhede's Table 38, p. 115, where two specimens (the holotype and another) referred to *E. argyrolepidoides* (an eastern species in the *mitracarpa* form series) are said by Strandhede to be "different in key characters, a fact which makes it questionable that they have the same chromosome number" (p. 118). Professor Swan has rather firmed up this statement, saying the two forms are "... regarded [by Strandhede] as being diploid and tetraploid respectively."

He continues "It is conceivable that Turkish and British '*mitracarpa'* might be tetraploid...". This last statement seems a large leap of conjecture, and an apparent diversion from the main argument. Note however that it provides a justification, not otherwise developed, for why 'British *mitracarpa*' might be found to have the longer stomata and glumes associated with tetraploid forms, rather than the anticipated shorter stomata and glumes of diploid forms.

It is of course possible that a plant such as *E. mitracarpa* might occur as an introduction in UK, and could be detectable within populations of subspecies *vulgaris* by its similarity to subspecies *palustris* in the critical characters, especially stomatal length. But the evidence gives no hint of this.

Acknowledgements

I am very much indebted to Arthur Chater and Douglas McKean variously for discussion, advice, copies of notes and correspondence, loan of specimens, etc. Mike Porter kindly commented upon an earlier draft. Nigel Blackstock first drew my attention to Strandhede's monograph (1966), although I little knew at the time how closely and attentively I would later need to digest it!

References

Bureš, P., Rotreklová, O., Holt, S.D.S., & Pikner, R. (2004) Cytogeographical Survey of *Eleocharis* subser. *Eleocharis* in Europe 1: *Eleocharis palustris*. *Folia Geobotanica* **39**: 235–257

Gregor, Thomas (2003) *Eleocharis mamillata* - Distribution and Infraspecific Differentiation. *Folia Geobotanica* **38**: 49–64)

Komarov, V.L. (ed.) (1976) *Flora of the USSR (Flora SSSR)*

Strandhede, Sven-Olov (1966) Morphologic variation and taxonomy in European *Eleocharis*, Subser. Palustres. *Opera Botanica* **10**:2, 1-188).

Strandhede, S-O & Dahlgren, R. (1968) Drawings of Scandinavian Plants 9-10. *Botaniska Notiser* **121**-1, pp. 1-10.

Walters, S.M. (1963) *Eleocharis austriaca* Hayek, a species new to the British Isles. *Watsonia* **5** (6), 1963, 329-335.

Note 1

I am grateful to AOC for copying to me a short unpublished note ("Possible occurrence of *Eleocharis mitracarpa* Steudel in Britain") in which Professor Swan describes his identification of specimens as putative *E. mitracarpa,* and includes (some) details on the identification of this taxon. It has been necessary to select and mention a few particular points from this note where these have directed my investigations. The unpublished note does help to confirm Professor Swan's concentration solely on the two characters mentioned above for his conclusions.

To the best of my knowledge Professor Swan made no further progress with this study, so that the unpublished note provides the only guide we have as to his thoughts on the issue at that time. Although the note was never published, published references to *"mitracarpa"* have appeared, and it is to address these that this paper has been written.

Jeremy Roberts

2 March 2012

updated: 13 February 2013

www.edencroft2.demon.co.uk