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The rare green alga *Pediastrum privum* (Chlorophyta, Sphaeropleales) in a Scottish kettle loch: new to British freshwaters

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Pediastrum is a widely-distributed genus of green alga characteristically consisting of disc-shaped colonies or 'coenobia', assembled from at least four inter-connecting cells (Komárek & Jankovská, 2001).

Many species belonging to the genus are common constituents of lake phytoplankton communities, though *Pediastrum privum* (Printz) Hegewald [=*Stauridium privum* (Printz) Hegewald in Buchheim *et al*., 2005] is notably rare (Komárek & Jankovská, 2001; Tsarenko & John, 2011). There appear to be no published records from Britain. Sporadic lake phytoplankton and sub-fossil sediment finds from Europe, reflect a sparse scattering of *Pediastrum privum*, confined mostly to temperate and sub-arctic latitudes of the northern hemisphere (Hegewald & Schnepf, 1979; Komárek & Jankovská, 2001; Geriš, 2004; Kowalska & Wołowksi, 2010). By comparison, the close phylogenetic relative *Pediastrum tetras* (Ehrenberg) Ralfs [=*Stauridium tetras* (Ehrenberg) Hegewald in Buchheim *et al*., 2005] displays a cosmopolitan distribution (Komárek & Jankovská, 2001).

Freshwater phytoplankton communities are important indicators of the biointegrity of standing waters and are therefore used by the Scottish Environment Protection Agency (SEPA) to assess the ecological status of around 80 freshwater lochs in Scotland. Phytoplankton samples are collected at varying frequencies, but at a minimum are taken three times a year between July and September. Sub-samples of phytoplankton (preserved in Lugol's iodine) are examined using an inverted microscope and analysed according to standard procedures with counts of approximately 400 individuals (Brierley *et al*., 2007; CEN, 2004 & 2008).

Low abundances (typically 1-5 coenobia, comprising both four- and eight-cells, per 100 ml sub-sample) of *Pediastrum privum* were found in phytoplankton samples collected from Loch Kinord during 2009–2011. Loch Kinord is a small kettle lake located in Aberdeenshire, Scotland (NGR: NO 44150 99388). The loch, formed by glacial retreat approximately 10,000 years ago, has an area of c. 0.8 km^2, is shallow (mean depth <2 m) and is characterized by relatively low alkalinity (annual mean 10.7 mg L^{-1} as $CaCO_3$ over 2009-11) and mesotrophic water chemistry (annual mean total phosphorus (TP) concentration 19.9 µg L^{-1} over 2009-11). A palaeolimnological study using fossil diatoms implied that eutrophication has driven water quality in Loch Kinord slightly away from its reference state (Bennion *et al*., 2004).

Pediastrum privum has appeared consistently in the phytoplankton community of Loch Kinord since 2009. This is the first known documented record of *Pediastrum privum* in British freshwaters. Previously, this uncommon species may have gone unnoticed or been misidentified due to its inconspicuous size and general unfamiliarity to UK taxonomists. The coenobia of *Pediastrum privum* (Figs 1a-d) morphologically resemble *Pediastrum tetras* (Figs 2a-d), in terms of their relatively small diameter (usually 15–25 µm). However, it is possible to separate the two species by comparison of the outer cell wall structure, which is weakly concave (central depression) in *P. privum* and distinctly notched (central incision) in *P. tetras* (Komárek & Jankovská, 2001; Kowalska & Wołowksi, 2010; Tsarenko & John, 2011).

Pediastrum privum has been recorded mostly from European waterbodies including Norway (Printz, 1914), Finland (Hegewald & Schnepf, 1979), Poland (Pełechaty *et al*., 2007; Kowalska & Wołowksi, 2010), Russia (Jankovská & Komárek, 2000), Slovakia (Hindák & Hindáková, 2008), and the Czech Republic (Geriš, 2004), though the WISER phytoplankton database (www.wiser.eu) may also contain previously undocumented localities. Other reports exist from the USA (Smith, 1920; Prescott, 1962), as well as more recently from Korea (An *et al*., 1999), Spain (Negro *et al*., 2000) and Canada (Hindák & Hindáková, 2008). Collectively, observations suggest that *Pediastrum privum* occurs discretely in oligotrophic and/or dystrophic freshwaters (Jankovská & Komárek, 2000; Komárek & Jankovská, 2001). However, some accounts suggest it is also capable of occupying nutrient-enriched habitats (An *et al*., 1999), typically associated with *P. tetras* (Komárek & Jankovská, 2001), which makes its restricted distribution difficult to explain (Kowalska & Wołowksi, 2010). Morphological plasticity (variation between the 4- and 8-celled life cycle stages) has been related to environmental nutrient concentrations or zooplankton predation in *Pediastrum tetras* (Rojo *et al*., 2008), and though fully described (Hegewald & Jeon, 2000) is as yet inadequately understood for *P. privum*. More research is required to establish the ecological requirements of *Pediastrum privum* and the reasons for its apparent rarity.

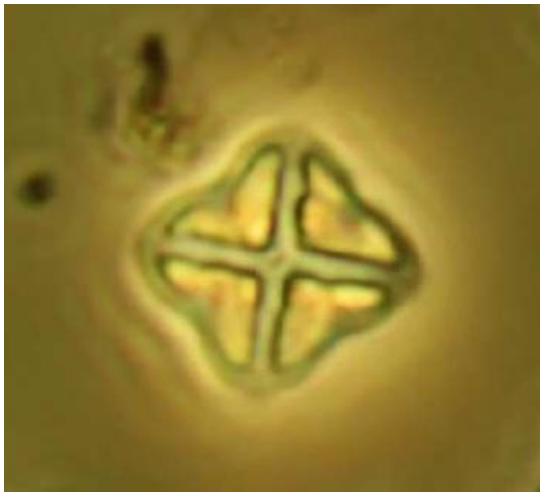

Fig. 1a. Photo-micrograph of *Pediastrum privum* 4-celled coenobium (x630 magnification) preserved in Lugol's Iodine.

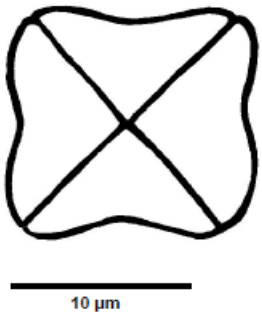

Fig. 1b. Illustration of *Pediastrum privum* 4-celled coenobium.

Fig. 1c. Photo-micrograph of *Pediastrum privum* 8-celled coenobium (x630 magnification) preserved in Lugol's Iodine.

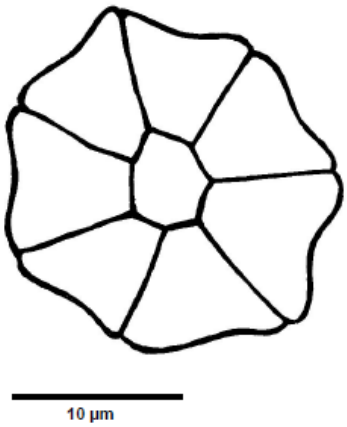

Fig. 1d. Illustration of *Pediastrum privum* 8-celled coenobium.

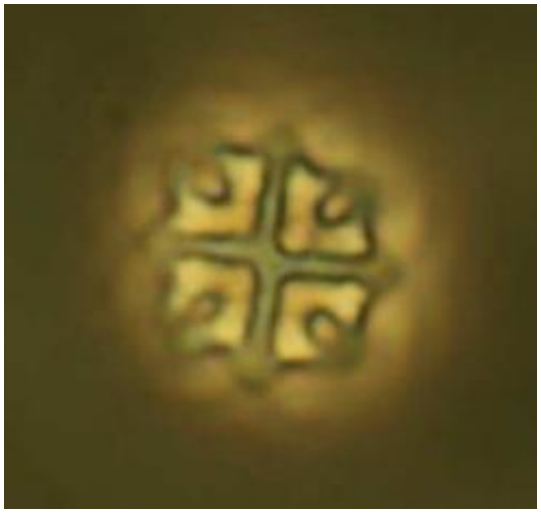

Fig. 2a. Photo-micrograph of *Pediastrum tetras* 4-celled coenobium (x630 magnification) preserved in Lugol's Iodine.

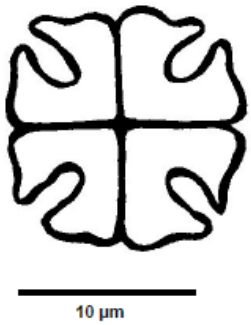

Fig. 2b. Illustration of *Pediastrum tetras* 4-celled coenobium.

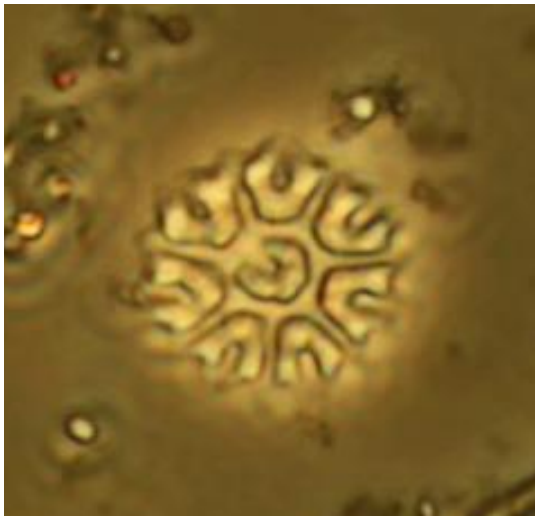

Fig. 2c. Photo-micrograph of *Pediastrum tetras* 8-celled coenobium (x630 magnification). preserved in Lugol's Iodine

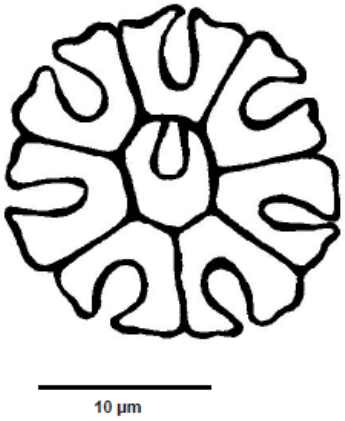

Fig. 2d. Illustration of *Pediastrum tetras* 8-celled coenobium.

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