In mainland Europe, *Fissidens fontanus* (Bach. Pyl.) Steud. [*Octodiceras fontanum* (Bach.Pyl.) B. Pyl.] Lindb., has been reported to range from Spain, France, Britain, Switzerland, Austria, Italy and Germany to the Czech Republic and Slovakia, and it is considered to be a sub-Mediterranean species (Düll, 1984). Additionally, it has been recorded in Belgium (van Melick, 1986) and more recently new localities in northern Poland (Bednarek-Ochyra et al., 1996) have been identified. In the British Isles it is considered to be a ‘Nationally Scarce’ species, but not ‘Endangered’. According to Godfrey (2005) it has a scattered distribution, mainly in the centre and south of Britain, but it has not been recorded in Scotland. Its distribution across Europe indicates that it is probably a widespread but infrequent species. It is also considered a rare or threatened moss in several European regions, not only in Central Europe, but also in Mediterranean areas.

Outside Europe, *F. fontanus* is known from North America, Mexico, Chile, Australia, New Zealand (Pursel, 1987, 2001; Godfrey, 2005) and Africa, where it has been reported from Zambia (Phiri & Ochyra, 1988).

In the first Portuguese Red List (Sérgio et al., 1994), *F. fontanus* was considered ‘Rare’ because although there were at the time about 10 localities recognized in Portugal, only three of these records were post-1960. However, since publication of these data on *F. fontanus* (Casas et al., 1989), Garcia & Sérgio (2001) have reported three new records.

**New data for Portugal**

New data on the distribution of this species have been obtained from field studies carried out in Portuguese river catchments as part of the implementation of the EU Water Framework Directive for integrated river basin management in Portugal (DQA-2000/60/EC). Additionally, field expeditions, mainly in north-western Portuguese mountain streams, have revealed new sites for *F. fontanus* that demonstrate an Atlantic distribution of the species in comparison to the previously known, more Mediterranean distribution. These new data from field studies have greatly improved our knowledge of the distribution of this species, and it is now known to occur not only in the littoral central and southern parts of the country, but also from the north and central eastern continental regions (Table 1 and Fig. 1).

**Ecology**

The new data on the ecology and distribution of *F. fontanus* in Portugal indicate that this species might be relatively abundant in this country in both natural and man-made aquatic habitats, and is perhaps more widespread than we were expecting until very recently. According to reports from other European countries (Privitera & Puglisi, 1994; Bednarek-Ochyra et al., 1996; Dierßen, 2001; Godfrey, 2005) this species seems to be able to tolerate a reasonable range of pollution levels, from pure water to moderately polluted water, and may even develop in estuaries. Although it was recorded in relatively polluted stretches of river in Portugal, in such sites its populations are weaker and probably correspond to populations in regression that endure the increasing levels of eutrophication and pollution.

In Portugal, *F. fontanus* has been found growing in a variety of situations, as it does in...
other areas of its range (Godfrey, 2005); submerged or seasonally exposed, but in the splash zone of the current, on roots and stones, in the still water of water fountain tanks, public water reservoirs, and also in the bed of rivers or irrigation canals, forming small to large colonies, mostly in still to slow-moving waters, showing a tendency to colonize becomes restricted. Nevertheless, in watercourses subjected to management for irrigation purposes it is highly probable that populations are negatively influenced by the unpredictable water discharges and sudden changes in the mean level of water tables throughout the year, especially in drier seasons.

An additional threat to *F. fontanus* populations arises from the fact that many inhabit artificial water reservoirs such as fountains and drinking troughs for animals. Due to water-saving measures, these localities have intermittent, or in some cases no water availability for long periods of the year, placing further stress on these populations.

We recommend that potential habitats and localities of this species are explored to further

### Table 1. New records of *F. fontanus* in Portugal since publication of Casas et al. (1989)

The table is ordered north to south and east to west. Province abbreviations follow Casas et al. (1989).

<table>
<thead>
<tr>
<th>Province</th>
<th>10x10 km square</th>
<th>Locality</th>
<th>Collector</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mi</td>
<td>NF58</td>
<td>Guimarães, Silvares, Pontilhões, Ponte Nova</td>
<td>C. Vieira</td>
<td>2005</td>
</tr>
<tr>
<td>TM</td>
<td>QF28</td>
<td>Rio Douro, Barragem de Picote</td>
<td>C. Sérgio et al.</td>
<td>2001</td>
</tr>
<tr>
<td>TM</td>
<td>PF47</td>
<td>Bragança, Pereiros, Cidade, Rio Tua</td>
<td>C. Sérgio et al.</td>
<td>2008</td>
</tr>
<tr>
<td>BL</td>
<td>NF40</td>
<td>Albergaria-a-Velha, Ribeira de Frãgaas</td>
<td>A. Albuquerque et al.</td>
<td>2005</td>
</tr>
<tr>
<td>R</td>
<td>ND36</td>
<td>Santarém, Caçavel, Casal das Azinheiras</td>
<td>C. Garcia</td>
<td>1999</td>
</tr>
<tr>
<td>E</td>
<td>NC32</td>
<td>Seribal, Grândola, Ribeira de Grândola</td>
<td>F. Aguiar &amp; L. Lopes</td>
<td>2004</td>
</tr>
<tr>
<td>BB</td>
<td>PE50</td>
<td>Tejo Internacional, Montforte da Beira</td>
<td>C. Sérgio et al.</td>
<td>2007</td>
</tr>
<tr>
<td>AAl</td>
<td>PD23</td>
<td>Cabeço da Sinta</td>
<td>C. Sérgio</td>
<td>1994</td>
</tr>
<tr>
<td>AAl</td>
<td>PC39</td>
<td>Vila Viçosa</td>
<td>C. Sérgio</td>
<td>2000</td>
</tr>
<tr>
<td>AAl</td>
<td>PC38</td>
<td>Alandral</td>
<td>C. Sérgio</td>
<td>2002</td>
</tr>
<tr>
<td>BAl</td>
<td>NB36</td>
<td>Odeceixe, São Luís, Ribeira do Torgal</td>
<td>A. Albuquerque et al.</td>
<td>2004</td>
</tr>
<tr>
<td>BAl</td>
<td>NB39</td>
<td>Santiago do Cacém, Rib. de São Domingos</td>
<td>F. Aguiar &amp; L. Lopes</td>
<td>2004</td>
</tr>
<tr>
<td>BAl</td>
<td>NC30</td>
<td>São Domingos to Santiago do Cacém</td>
<td>C. Sérgio</td>
<td>1994</td>
</tr>
<tr>
<td>Ag</td>
<td>NB43</td>
<td>Monchique, Alferce, Ribeira de Odelouca</td>
<td>S. Mendes &amp; J. Abreu</td>
<td>2005</td>
</tr>
<tr>
<td>Ag</td>
<td>NB41</td>
<td>Silveres</td>
<td>L. Catarino &amp; A. Franco</td>
<td>1999</td>
</tr>
</tbody>
</table>

#### Limnophilous – having an affinity for freshwater lakes.

was also present, a habit that has been little reported in the literature for this species.

In contrast, natural stretches of water courses such as river margins and oxbow lakes, the bryophyte community in which *F. fontanus* was found is much richer and includes species such as *Brachythecium rivulare*, *Cnidosспорes fordii*, *C. riparioides*, *Dendrocryphaea lamyana*, *Dialytrichia mucronata*, *Fontinalis hypnoides*, *Lepidodictyum riparium* and *Platyhypnidium riparioides*.

### Threats

Increasing pollution in aquatic environments may be a reason why *F. fontanus* is becoming extinct or scarce in many British localities (Preston & Smith, 1992), and has been integrated into the Red Lists of many European countries. In France, it is a protected species in the Basse-Normandie region (Anonymous, 1995). In the same way, this species is monitored and considered vulnerable according to the criteria of the Red Data Book of Estonia (Lilleleht, 2001–2002), considered vulnerable in Switzerland (Schnyder et al., 2004) and in the British Isles is now included in the Threatened Plant Database Project (Hodgetts, 2009). In the Czech Republic Red List it is considered as LR-nt (lower risk – near-threatened) by Kůčera & Váňa (2003).

Although *F. fontanus* was considered ‘Rare’ in the first Portuguese Red List (Sérgio et al., 1994), it is not included in the more recent Iberian Red List in light of the number of new records, and it may therefore have been somewhat overlooked in the past (Sérgio et al., 2007).

However, given that there seems to be some evidence that *F. fontanus* may be reasonably tolerant of eutrophic dirty water in Britain and Portugal at least, one has to consider other potential threats. Alterations in the natural water regime, caused by a variety of both climatic changes and anthropogenic reasons, are prominent risk factors. Under natural conditions, the water level in Mediterranean watercourses varies with the year with reduced flow during summer, leading to a possible reduction in species populations or vitality because the permanent submerged zone which they usually colonize becomes restricted. Nevertheless, in watercourses subjected to management for irrigation purposes it is highly probable that populations are negatively influenced by the unpredictable water discharges and sudden changes in the mean level of water tables throughout the year, especially in drier seasons.

![Fig. 2. (a) Habitat of F. fontanus in an old drinking trough (Montforte da Beira, Tejo International Natural Park). (b) In this tank a colony of Philonotis caespitosa floating above the water can be seen above an abundant, immersed colony of F. fontanus. C. Sérgio](image)
understand the actual conservation status of this interesting *Fissidens* species.

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References  


