

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-Ochya

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

Update on the distribution, ecology and conservation of *Fissidens fontanus* in Portugal



Fissidens fontanus (*Octodiceras fontanum*) is a scarce but widespread species across Europe.

Cecilia Sérgio and colleagues discuss its distribution and ecology in Portugal, demonstrating parallels with its status in Britain.

◀ *F. fontanus*. Fred Rumsey

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 (Pursell, 1987, 2001; Godfrey, 2005) and Africa, where it has been reported from Zambia (Phiri & Ochyra, 1988).

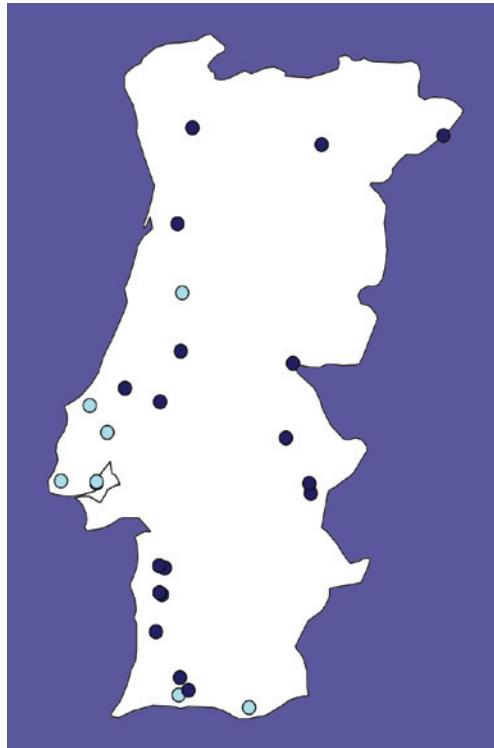
In the first Portuguese Red List (Sérgio *et al.*, 1994), *F. fontanus* was considered 'Rare' because although there were at the time about 10 localities recognized in Portugal, only three of these records were post-1960. However, since publication of these data on *F. fontanus* (Casas *et al.*, 1989),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



△ Fig. 1. Distribution map of *F. fontanus* in Portugal. Light blue circles represent records from before 1960; black circles represent records from 1960 to 2008.

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

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).

Province	10X10 km square	Locality	Collector	Year
Mi	NF58	Guimarães, Silvares, Pontilhóes, Ponte Nova	C. Vieira	2005
TM	QF28	Rio Douro, Barragem de Picote	C. Sérgio <i>et al.</i>	2001
TM	PF47	Bragança, Pereiros, Codeçais, Rio Tua	C. Sérgio <i>et al.</i>	2008
BL	NF40	Albergaria-a-Velha, Ribeira de Fráguas	A. Albuquerque <i>et al.</i>	2005
R	ND36	Santarém, Casével, Casal das Azinheiras	C. Garcia	1999
E	NC32	Setúbal, Grândola, Ribeira de Grândola	F. Aguiar & L. Lopes	2004
BB	PE50	Tejo Internacional, Monforte da Beira	C. Sérgio <i>et al.</i>	2007
AAI	PD23	Cabeço de Nisa	C. Sérgio	1994
AAI	PC39	Vila Viçosa	C. Sérgio	2000
AAI	PC38	Alandroal	C. Sérgio	2002
BAI	NB36	Odemira, São Luís, Ribeira do Torgal	A. Albuquerque <i>et al.</i>	2004
BAI	NB39	Santiago do Cacém, Rib. de São Domingos	F. Aguiar & L. Lopes	2004
BAI	NC30	São Domingos to Santiago do Cacém	C. Sérgio	1994
Ag	NB43	Monchique, Alferce, Ribeira de Odelouca	S. Mendes & J. Abreu	2005
Ag	NB41	Silves	L. Catarino & A. Franco	1999

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 for **limnophilous** conditions.

Limnophilous – having an affinity for freshwater lakes.

The most recent locality where *F. fontanus* has been found (Tejo International Natural Park) is in an old tank of a drinking trough (Fig. 2a), in eutrophic conditions as revealed by the presence of colonies of cyanobacteria (Fig. 2b), demonstrating another novel habitat for the species. It should be noted that in this location floating *Philonotis caespitosa*

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*, *Cinclidotus fontinaloides*, *C. riparius*, *Dendrocryphaea lamyana*, *Dialytichia mucronata*, *Fontinalis hypnoides*, *Leptodictyum riparium* and *Platyhypnidium riparioides*.

Threats

Increasing pollution in aquatic environments may be a reason for 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 Kučera & 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 throughout 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.

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



△ Fig. 2. (a) Habitat of *F. fontanus* in an old drinking trough (Monforte 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

understand the actual conservation status of this interesting *Fissidens* species.

C. Sérgio¹, C. Vieira², & I. Silva³, M. Brugués⁴, R. Cros⁴ & S. Stow¹

¹Jardim Botânico, Museu Nacional de História Natural, Universidade de Lisboa / Centro de Biologia Ambiental. Rua da Escola Politécnica, 58, 1250-102, Lisboa, Portugal (e csergio@fc.ul.pt); ²CIBIO/Departamento de Botânica, FCUP, Universidade do Porto, Rua do Campo Alegre, 1191, 4150-181, Porto, Portugal; ³Instituto de Investigação Científica Tropical, Jardim Botânico Tropical, Trav. Conde da Ribeira, 9, 1300-142 Lisboa, Portugal; ⁴Botànica, Facultat de Biociències, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain.

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References

- Anonymous (1995). Arrêté du 27 avril 1995 relatif à la liste des espèces végétales protégées en région Basse-Normandie complétant la liste nationale. www.mnhn.fr/mnhn/cbnp/flore/textes/detail/basse.htm (accessed November 2009).
- Bednarek-Ochyra, H., Ochyra, R., Kłosowski, S. & Szańkowski, M. (1996). A new locality for *Octodiceras fontanum* (Musci, Fissidentaceae) in West Pomerania and a review of its distribution in Poland. *Fragmenta Floristica et Geobotanica* 41(2), 821–826.
- Casas, C., Brugués, M. & Cros, R.M. & Sérgio, C. (1989). Cartografia de Briófitas. Península Ibérica i les Illes Balears, Canarias, Açores i Madeira. *Institut d'Estudis Catalans* 2, 51–100.
- Dierßen, K. (2001). *Distribution, Ecological Amplitude and Phytosociological Characterization of European Bryophytes*. Berlin: J. Cramer.
- Düll, R. (1984). Distribution of the European and Macronesian mosses (Bryophytina). *Bryologische Beiträge* 4, 1–113.
- Garcia, C. & Sérgio, C. (2001). Novas referências para Portugal de *Octodiceras fontanum* (B. Pyl.) Lindb. in *Notulae Bryoflorae Lusitanicae VII*. 11. *Anuário da Sociedade Broteriana '1999'* 65, 114–115.
- Godfrey, M.F. (2005). *Octodiceras fontanum*. *Field Bryology* 87, 9–10.
- Hodgetts, N. (2009). *Threatened Bryophyte Database (TBDB)*. British Bryological Society. <http://rbg-web2.rbge.org.uk/bbs/Bryodiversity/tbdp.htm>. (accessed November 2009).
- Kučera, J. & Váňa, J. (2003). Check- and Red List of Bryophytes of the Czech Republic. *Preslia* 75, 193–222.
- Lilleleht, V. (2001–2002). *Red Data Book of Estonia*. Commission for Nature Conservation of the Estonian Academy of Sciences. www.zbi.ee/punane/liigid/samblad_e.html (accessed November 2009).
- van Melick, H. (1986). De verspreiding van *Fissidens fontanus* (La Pyl.) Lindb. in Nederland. *Lindbergia* 11, 169–171.
- Phiri, P.S.M. & Ochyra, R. (1988). A preliminary account of the mosses of Zambia. *Journal of Bryology* 15, 177–197.
- Preston, C.D. & Smith, A.J.E. (1992). In *Atlas of the Bryophytes of Britain and Ireland, Vol. 2. Mosses*, Edited by M. O. Hill, C.D. Preston & A.J.E. Smith. Colchester: Harley Books.
- Privitera, M. & Puglisi, M. (1994). *Fissidens fontanus* (Musci): a new record from Sicily. *Flora Mediterranea* 4, 171–174.
- Pursell, R.A. (1987). A taxonomic revision of *Fissidens* subgenus *Octodiceras* (Fissidentaceae). *Memoirs of the New York Botanical Garden* 45, 639–660.
- Pursell, R.A. (2001). *Bryophyte Flora of North America*. www.mobot.org/plantscience/BFNA/bfnamenu.htm (accessed November 2009).
- Schnyder, N., Bergamini, A., Hofmann, H., Müller, N., Schibiger-Bossard, C. & Urmi, E. (2004). *Liste Rouge des Espèces Menacées en Suisse: Bryophytes*. Berne: Office Fédéral de l'Environnement, des Forêts et du Paysage (OFEPF).
- Sérgio, C., Casas, C., Brugués, M. & Cros, R.M. (1994). *Red List of Bryophytes of the Iberian Peninsula*. Lisbon: Instituto de Conservação da Natureza e Museu, Laboratório e Jardim Botânico da Universidade de Lisboa.
- Sérgio, C., Brugués, M., Cros, R.M., Casas, C. & Garcia, C. (2007). The 2006 Red List and an updated Check List of Bryophytes of the Iberian Peninsula (Portugal, Spain and Andorra). *Lindbergia* 31(3), 109–125.