# A review of the ecology of *Lophopus crystallinus* (Plumatellida, Lophopodidae), a rare species within the U.K.

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**Abstract:** Little is known about the ecology of the rare freshwater bryozoan, *Lophopus crystallinus* (Pallas 1768). Only a few papers contain mention of *L. crystallinus* and, to date, no autecological studies have been completed. *Lophopus crystallinus* is thought to have undergone a worldwide decline in numbers over the past century (Rieradevall & Busquets 1990) but only within the U.K. is it given any legislative protection, being listed as a priority species in the U.K. Biodiversity Action Plan (Anonymus 1999). This paper reviews what is known about the ecology of *L. crystallinus*. A greater knowledge of the ecology of *L. crystallinus* is important in the production of its Species Action Plan within the U.K. and to promote wider interest in the study of this animal.

**Key words:** Freshwater bryozoans, Phylactolaemata, Species Action Plan, geographical distribution.

## 1 Introduction

*Lophopus crystallinus* (Pallas 1768) (Fig. 1) is a phylactolaemate in the family Lophopodidae. The first description of *L. crystallinus* is generally attributed to Pallas (1768), but it is thought that the depiction of the 'Polype à Panache' by Trembley (1744) actually refers to *L. crystallinus* (Mundy 1980). If so, this would make *L. crystallinus* the first bryozoan to be described. Despite the early scientific interest in *L. crystallinus* relatively little is known about its life history. Only a handful of papers contain mention of *L. crystallinus* (for instance Marcus 1934; Bushnell 1974; Wöss 1996; Grabow et al. 2001), and to date no autecological studies of *L. crystallinus* have been reported.

According to Bushnell (1974) *L. crystallinus*' distribution ranges from the eastern Nearctic to the western Palearctic. There are records of *L. crystallinus* in Italy (Ceccagnoli et al. 1997; Elia et al. 2001), Great Britain (Cooke 1906; Hurrell 1910, 1944), France (d'Hondt & Clauss 1999), Germany (Marcus 1934; Grabow et al. 2001), Spain (Rieradevall & Busquets 1990), Israel (Massard et al. 1992), and Austria (Wöss 1996). It has also been found in Switzerland (Okamura unpubl. data).

*Lophopus crystallinus* is thought to have undergone a worldwide decline in numbers over the past century (Bushnell 1974; Rieradevall & Busquets 1990); however the evidence is anecdotal and little is known as to its true distribution.

Within the U.K., *L. crystallinus* was once abundant in such places as the Norfolk Broads where colonies were described as growing in such abundance that "a single haul would have filled an ordinary-sized pail" (Hurrell 1910). However, today it is believed to only occur in a few sites in southern England (Bratton 1991). Due to its decline within the U.K., a management plan (known as a Species Action Plan) for the conservation of *L. crystallinus* was produced as part of the U.K. Biodiversity Action Plan (Anonymus 1999). The study of the ecology and life history of *L. crystallinus* is crucial to the success of this management plan and may be useful in the production of similar plans across Europe. This paper reviews what is currently known about the ecology of *L. crystallinus* and gathers together information from a diversity of sources.

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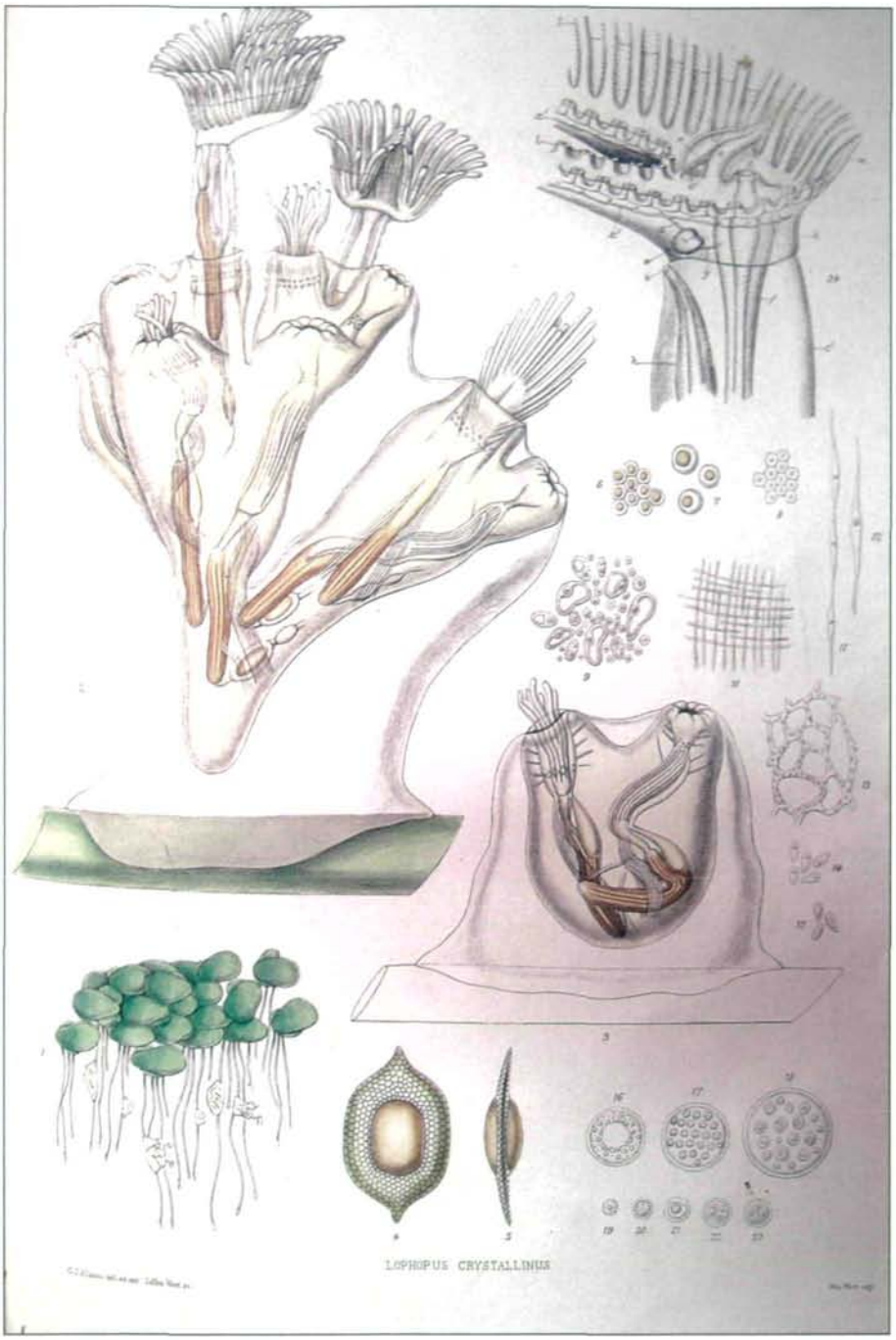


**Fig. 1**: This beautiful illustration of *Lophopus crystallinus* is taken from a paper by *Allman* in 1856.

## 2 Description

The common name for *L. crystallinus* is the "Bellflower Animal" which refers to its beautiful fan-shaped colonial structure (Fig. 1, 2; ALLMAN 1856). The gelatinous colonies may grow up to 1cm in diameter and are relatively transparent (Fig. 2, 3). Due to their gelantinous nature, colonies of *L. crystallinus* may often be mistaken for aquatic vertebrate eggs; however, once placed underwater their digestive tracts and lophophores are clearly visible with a hand lens. The lophophores are horseshoe-shaped and may carry up to 60 tentacles (Fig. 4).

## 3 Life history

As with all phylactolaemates, *L. crystallinus* reproduces both asexually, through budding and statoblast production, and sexually, through the production of larvae (OKAMURA pers. obs.). Growth occurs when the rate of production of zooids, through asexual budding on the outer edge of the colony, exceeds the death rate of the older zooids in the centre of the colony. Colonies split and move apart presumably when they exceed their optimal size (BUSHNELL 1966).

Throughout its range, *L. crystallinus* has been recorded to show seasonal variation in abundance (this will be discussed in further detail in a later section). Colonies are found throughout the year within the U.K. and seasonal fluctuations in abundance are common (HILL unpubl. data; O'DEA 2002).

Statoblasts are lemon-shaped and approximately 1mm in length (Fig. 5). They are unadorned by hooks or spines, so may not achieve dispersal by attachment to vertebrate hosts, but may well be transported if ingested (FIGUEROLA et al. 2004). Furthermore, *L. crystallinus* statoblasts, once dried, are able to float (MUKAI & ODA 1980), and so may be dispersed by water currents. Seasonal patterns of statoblast production are variable. HURRELL (1910) observed statoblasts throughout the year in the U.K., and HILL (unpubl. data) found statoblast production to be maximal in the spring through to the autumn. O'DEA (2002) observed colonies containing statoblasts only in the spring in the U.K. MASSARD et al. (1992) found colonies containing statoblasts in Israel in March, but not in June. They did not find *L. crystallinus* colonies at other times of the year. In Germany, GRABOW et al. (2001) found statoblasts only in the spring and summer.

WÖSS (1996) regarded larval production as rare in *L. crystallinus* colonies in Austria. Despite close monitoring of populations for a two year period, larval production was not observed in colonies collected within the U.K. (Hill unpubl. data). Larval production has been observed in colonies found in the

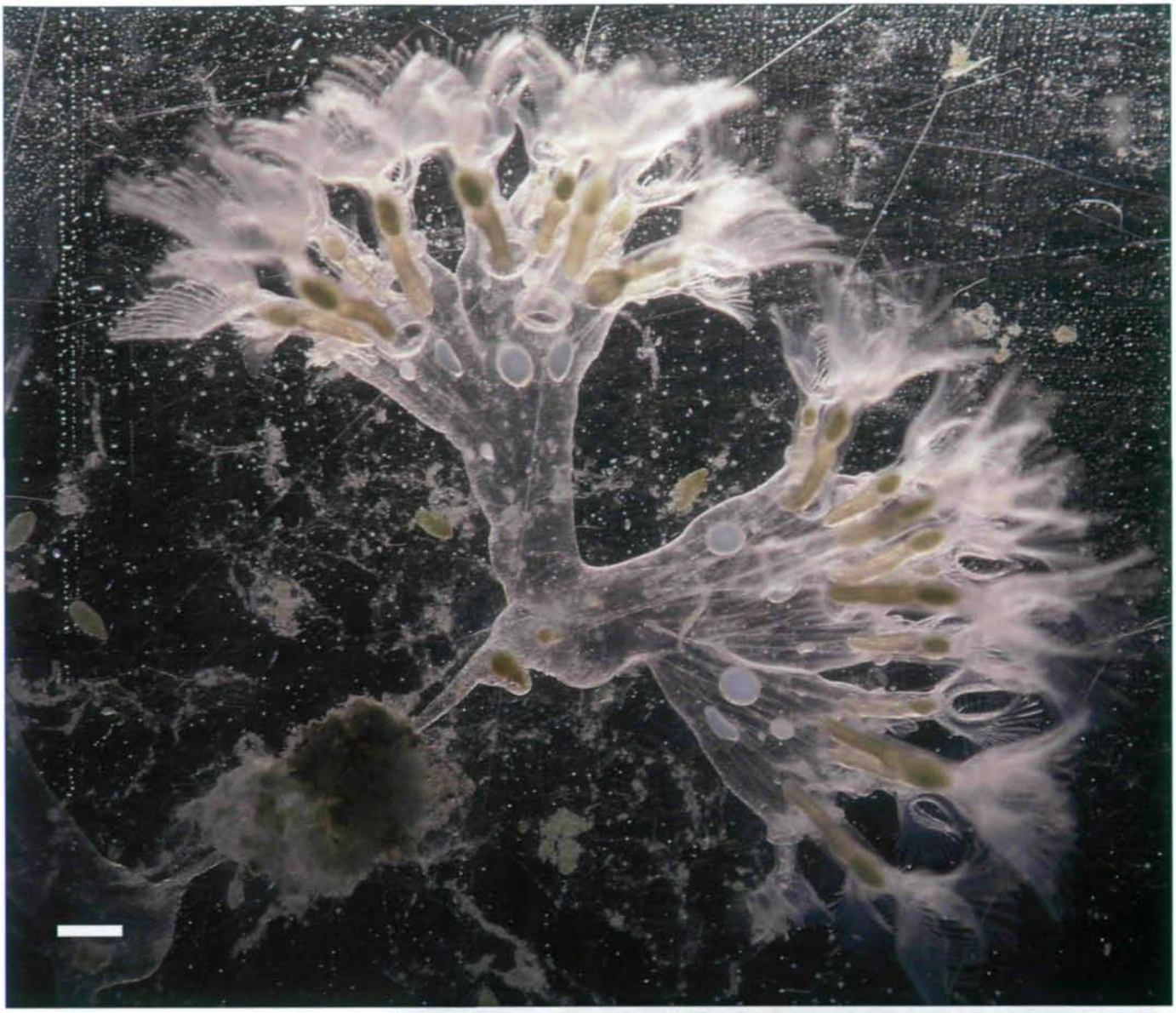

**Fig. 2**: *Lophopus crystallinus*. Colony was collected from Barton Blow Wells, Lincolnshire, and kept in a culture system at Reading University. Scale bar = 1 mm.

River Furtbach, Switzerland, in June (OKAMURA pers. obs.).

## 4 Habitat

*Lophopus crystallinus* does not seem to have pronounced preferences for particular substrata. It has been found on the underside of various floating debris, including fallen leaves and sticks (Fig. 3), polystyrene, glass, and plastic (O'DEA 2002). It is also found on

**Fig. 3**: *Lophopus crystallinus* growing on a branch in the Barton Blow Wells, Lincolnshire. Scale bar = 5 mm.

**Fig. 4**: Horseshoe-shaped lophophore of *Lophopus crystallinus*. Scale bar = 100 µm.

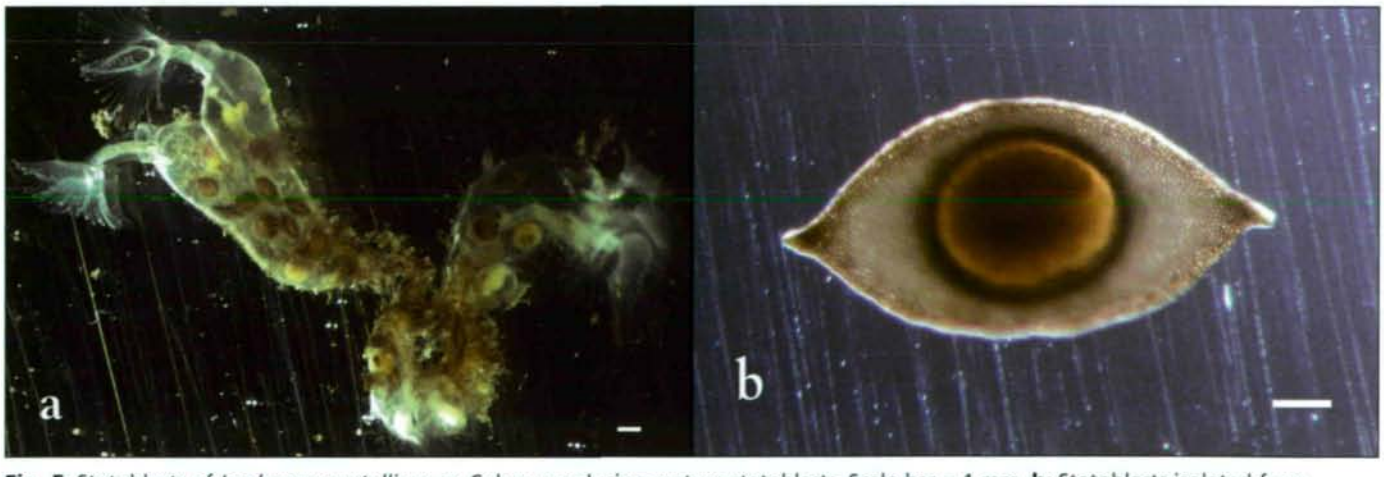


**Fig. 5**: Statoblasts of *Lophopus crystallinus*. **a**: Colony producing mature statoblasts. Scale bar = 1 mm. **b**: Statoblasts isolated from colonies in culture. Scale bar = 100 µm.

the stems and leaves of aquatic vegetation, as well as on submerged tree roots and branches, rocks, and even on snail shells (ALLMAN 1856; COOKE 1906; HURRELL 1927; MARCUS 1934; RIERADEVALL & BUSQUETS 1990; ELIA et al. 2001; GRABOW et al. 2001).

*Lophopus crystallinus* is thought to prefer shaded and slightly alkaline waters (HURRELL 1927; O'DEA 2002). Some authors report colonies to be associated with lotic habitats (WOOD 2001) while others report occurrence in lentic habitats (ELIA et al.

2001). It is thought to be intolerant of polluted waters (RIERADEVALL & BUSQUETS 1990). Despite its ability to colonise substrata in running waters, WÖSS (1996) reported that *L. crystallinus* has only an intermediate colonising ability (as compared to other phylactolaemates), and that colonies are poor at surviving physical disturbance.

*Lophopus crystallinus* appears to have a wide tolerance for temperature variation (MARCUS 1934). Colonies have been observed growing in waters as cold as 3 °C (HILL unpubl. data), and Israeli colonies have been found inhabiting lakes that reach temperatures of 30 °C, although at this time colonies were not found (MASSARD et al. 1992). This tolerance may be reflective of genetically distinct races or strains; however it may be a sign of acclimation as a single population has been observed to survive annual temperature ranges from 8 to 26 °C in Lago di Piediluco in Italy (ELIA et al. 2001), and colonies have been shown to be viable after freezing within a laboratory environment (BUSHNELL & RAO 1974; MARCUS 1934). Most authors agree that *L. crystallinus* can thrive in cold waters, perhaps due to reduced metabolic rates (HURRELL 1910; MARCUS 1934). It has also been proposed that *L. crystallinus* may survive cold winters by receding to an inactive tissue mass, or a hibernaculum, made up of brown bodies contained within the cystid, which will regenerate itself in the spring (COOKE 1906; GRABOW et al. 2001). This process is known to occur in some gymnolaemates (BUSHNELL & RAO 1974), but it has been argued not to occur in *L. crystallinus* (HURRELL 1927; ROGICK 1935). ELIA et al. (2001) suggest an upper tolerance limit of 20 °C for active colonies, with colony size regressing at greater temperatures. This would imply that colonies observed at 26 °C in Italy (see above) may have been regressing.

## 5 Information from different countries

### 5.1 United Kingdom and Ireland

ALLMAN (1856) reports that *L. crystallinus* has been observed in a millpond near Little Baddow, Essex, a pond in the Zoological Gardens, Dublin, and "in the water by the side of the Willow-walk, Chelsea, and in various waters in the neighbourhood of London." He maintains that *L. crystallinus* is only found in ponds and ditches, where it may be found attached to submerged plants, and that it avoids exposure to bright sunlight.

**Fig. 6**: Rockland Broad, Norfolk, U.K. – a site where *Lophopus crystallinus* was once abundant.

HURRELL (1944) observed *L. crystallinus* in dykes within the Norfolk Broads only during the summer months. In particular, he found *L. crystallinus* in the Yare River, a dyke leading into Rockland Broad (Fig. 6), Wheatfen Broad, a ditch flanking the North Denes at Yarmouth, a small lake at Burgh Castle, and in Surlingham Broad (HURRELL 1910, 1944). Colonies were found "on most of the larger water-plants and one season found the long trailing growths of a *Potomageton* literally crowded with it and giving an impression of ropes of living pearls." He also found colonies on stones, shells, submerged sticks and straws, sunken posts and even the keel of a ferry boat. He reported that colonies were constantly dislodged by river crafts.

MUNDY (1980) describes *L. crystallinus* as rare in the U.K. and probably confined to the east of England. He reports that colonies have been found in the River Ravensbourne, Kent, the Wheatfen Broad, Norfolk, and the River Yare, Norfolk.

As a consequence of *L. crystallinus* being listed as a priority species in the U.K. Biodiversity Action Plan, O'DEA (2002) undertook surveys in 2001 and 2002 at four loca-

**Fig. 7**: Barton Blow Wells, Lincolnshire, U.K. – one of two sites in the U.K. where *Lophopus crystallinus* is currently found.

tions within the U.K. These represented the only U.K. sites with records for *L. crystallinus* within the last 30 years, and included the Wheatfen Broad where both MUNDY (1980) and HURRELL (1910) had previously reported the presence of *L. crystallinus*. He visited the sites every three months, from August 2001-May 2002. O'DEA used two methods for detecting the occurrence of colonies: 1) searching for live colonies on the undersides of possible substrata; 2) collecting bottom sediment samples and floating debris samples which were investigated for the presence of statoblasts.

O'DEA (2002) was able to locate colonies in only two waterbodies, the Barton Blow Wells, Lincolnshire (Fig. 7), and the Chil Brook, Oxfordshire (Fig. 8) thus reducing the number of known localities by 50%. The Barton Blow Wells are formed from a series of artesian springs. The water flow is moderate, and, as it is flowing from underground directly into the pools, it remains at a relatively constant temperature throughout the year. O'DEA recorded temperatures between 9.4 °C and 12.6 °C during his visits. Primary productivity in the Barton Blow Wells is low (O'DEA 2002). Colonies were located throughout the year within the Barton Blow Wells with numbers peaking in November 2001. O'DEA suggested that colony abundance may be related to water levels within the Barton Blow Wells.

The Chil Brook is a small stream with relatively fast flowing water. Water levels and temperature varied during O'DEA's sampling visits: levels varied from 20-100 cm and temperatures from 5.7-17.1 °C. Colonies were only located by O'DEA in November 2001 and February 2002; however subsequent work has found colonies within the Chil Brook year-round (HILL unpubl. data).

O'DEA (2002) only found one *L. crystallinus* statoblast in his collections of sediment and floating debris. The sample containing the statoblast was collected in the Barton Blow Wells in August 2001.

O'DEA (2002) also surveyed the following locations in 2001/2002 for colonies and statoblasts of *L. crystallinus*: Lapworth, Warwickshire; Weston Moor, North Somerset; Clapton Moor, North Somerset; Avonmouth Pools, Gloucestershire; Bathampton Oxbow Lake, North Somerset; Chew Valley Lake, East Somerset; Burgh Castle, Norfolk; Winford, Somerset; and Maesybont, Camarthenshire. No colonies or statoblasts of *L. crystallinus* were found in any of these locations, although *Plumatella fungosa* was located in Lapworth and Bathampton.

### 5.2 Israel

*Lophopus crystallinus* colonies were found in a lake in the Hula Nature Reserve in March of 1966 and 1964. In March 1966, two fragments of colonies without statoblasts were discovered. In March 1964 three complete colonies were found with one colony producing statoblasts at one site on the lake, and at another site one colony fragment was found associated with 15 loose statoblasts. In May 1989 statoblasts were discovered, but no colonies were found. The site was also surveyed in August 1989, but at this time no evidence of the presence of *L. crystallinus* was discovered. Yearly water temperatures in the lake range from 12-30 °C (MASSARD et al. 1992).

### 5.3 Italy

O'DEA (2002) found *L. crystallinus* within the Lago di Piediluco, Italy, in December 2001. CEGGAGNOLI et al. (1997) had previously reported the presence of colonies in this lake from August through to May. The Lago di Piediluco is a large and deep lake

with areas of lentic water flow (O'DEA 2002). Colonies were found here in great abundance attached to aquatic vegetation growing in shallow waters (CEGGAGNOLI et al. 1997; O'DEA 2002). Okamura (pers. obs.) found *L. crystallinus* in Lago di Piediluco in August 2002 and noted that some colonies were producing statoblasts.

### 5.4 Austria

In Austria colonies have been recorded from June to late August in a backwater of the March near the village of Hohenau (WÖSS 1996). The March is a river that runs into the Danube.

### 5.5 Switzerland

Okamura (pers. obs.) located colonies growing on the undersurfaces of rocks in the River Furtbach (Fig. 9), Switzerland, on the 6th June, 2001. The River Furtbach is a narrow, shallow river that experiences varying water levels that are directly related to rainfall levels (Okamura pers. obs.; Hill pers. obs.). Colonies were producing both statoblasts and larvae at this time. *Fredericella sultana* and *Plumatella* spp. were present on rock surfaces alongside *Lophopus crystallinus*.

### 5.6 Spain

RIERADEVALL & BUSQUETS (1990) found statoblasts of *L. crystallinus* within Banyoles Lake, Spain. Banyoles Lake is large (over 2 km long) with depths reaching 130 m. Temperatures range between 4-25 °C.

### 5.7 Germany

*Lophopus crystallinus* was found in fast-flowing rivers, the Woltersdorfer Lock and the Muhenfliess, and in a slow-flowing ditch, the Golmer Ditch, by MARCUS (1934). Colonies were growing upon various aquatic plants and on poplar twigs and leaves, and were able to survive winter temperatures occurring deep under ice (MARCUS 1934). Colonies that were frozen within ice in the winter months were observed to release statoblasts upon thawing in the spring, and MARCUS (1934) was able to germinate approximately 50 % of the statoblasts that were collected from frozen colonies.

GRABOW et al. (2001) found *L. crystallinus* in 14 localities in eastern Lower Saxony.

**Fig. 8**: The Chil Brook, Oxfordshire, U.K. – one of two sites in the U.K. where *Lophopus crystallinus* is currently found.

**Fig. 9**: The river Furtbach, Switzerland.

Colonies were found in a variety of habitats that included "streams and small rivers, a pond, an ox bow, a man made lake, a ditch and two canals." Colonies were found only in the fast-flowing areas of canals, and were often found downstream of sewage outflows. GRABOW et al. (2001) observed that many sites either had a strong anthropogenic influence, or else were man-made. *Lophopus crystallinus* colonies were found year-round, but statoblasts were only found in the spring and summer. Statoblast production/colony was noted to be low with many colonies only containing a single statoblast. Various substrata were colonized by *L. crystallinus*, including floating branches, stones, broken glass, and even snail shells (GRABOW et al. 2001). Colonies were noted to be growing in dense patches. For instance, over 40 colonies were found on the underside of a 30 cm long stone (GRABOW et al. 2001).

### 5.8 Denmark

OKAMURA (pers. obs.) found a single statoblast of *L. crystallinus* in a moat surrounding Spøttrup Castle connected to Spøttrup Sø in Jutland.

LACOURT (1968) collected material from an enclosure near Fredriksborg. LACOURT (1968) found *L. crystallinus* growing on aquatic plants to a depth of 2 m. He reports that colonies may withstand temperatures as low as 0 °C.

### 5.9 United States

KOFOID (1908) found *L. crystallinus* colonies in a channel containing discharge from Quiver Lake, Illinois. Colonies were found floating in surface waters.

Statoblasts of *L. crystallinus* were discovered in Mississippi in Mosquito Lake, Bear Creek, Matthew's Lake, and Roebuck Lake (COOPER & BURRIS 1984).

### 5.10 France

The presence of *L. crystallinus* in the Strasbourg area of France was reported by D'HONDT & CLAUSS (1999). This was the first time that anyone had recorded the presence of *L. crystallinus* in France since 1926. D'HONDT & CLAUSS (1999) believe that *L. crystallinus* is rare in France but note that very few surveys for the species have been carried out in France, thus knowledge of its distribution is incomplete. Colonies were found in May 1997, but not found in subsequent surveys. D'HONDT & CLAUSS (1999) suggested this was due to *L. crystallinus* being intolerant of varying conditions. *Lophopus crystallinus* was found upon branches and aquatic plants, but only rarely upon hard substrata (d'HONDT & CLAUSS 1999).

## 6 Conclusion

*Lophopus crystallinus* colonies have been located throughout Europe in a variety of habitats. Despite its apparently broad tolerance, *L. crystallinus* appears to be undergoing a worldwide decline in numbers. It was clearly once more common and abundant, occurring in many sites from which it seems to have disappeared. A greater knowledge of the ecology of *L. crystallinus* is important in the production of its Species Action Plan within the U.K. and may influence the production of similar plans across Europe.

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