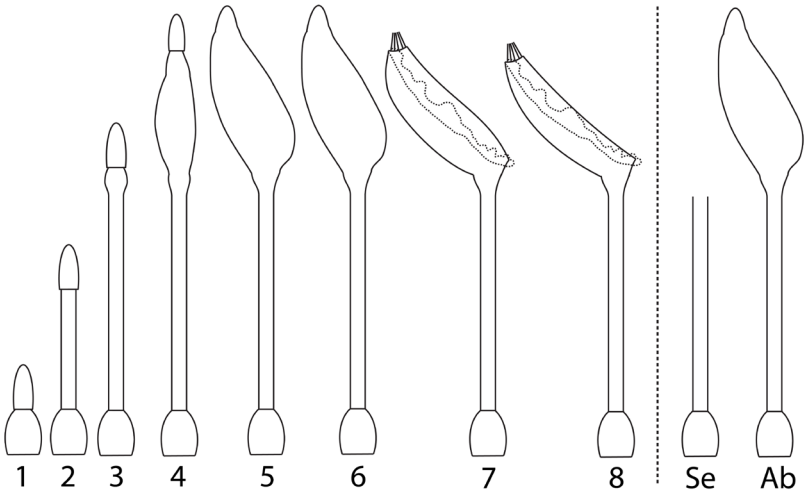


Stage	Description
1	Calyptra emerging from female gametophyte but no seta visible
2	Seta undergoing elongation
3	Seta fully grown and small swelling just below calyptra
4	Capsule undergoing development, calyptra may or may not remain attached
5	Capsule fully developed, inclined and pure green (filled with immature spores)
6	Spores reaching maturity and becoming brownish, but operculum intact
7	Operculum fallen and dorsal cuticle of capsule peeling away
8	Most spores liberated and capsule largely empty
Se	Only seta visible, following predation of capsule
Ab	Capsule fully developed but appears hollow (small spore mass may be visible)

△Fig. 1. Classification of sporophyte stages in *Buxbaumia viridis.*

Classification of sporophyte stages in *Buxbaumia viridis*

Des Callaghan & Stewart Taylor propose new standard terms for use in the recording of *Buxbaumia viridis* sporophytes

Introduction

Generally rare in Europe and enjoying special legal protection, in recent years much attention has been spent on *Buxbaumia viridis* to better understand its distribution, status and ecology (e.g. Holá *et al.*, 2014; Taylor, 2010; Wiklund, 2003). Despite there being an excellent study of the plants growth (Wolf, 2015), to date there has been no classification of sporophyte stages for use in field recording, though such is available for *B. aphylla* (Hancock & Brassard, 1974). The purpose of this note is to provide a classification for recording stages of sporophyte production in *B. viridis,* in order to encourage field recording and associated phenology studies.

Classification

Ten main stages of the sporophyte are recognised, illustrated and described in Figure 1. The first eight are sequential growth stages in the development of the sporophyte, the other two being miscellaneous conditions. Photographs that illustrate the classification are provided in Figure 2.

Application

Preliminary data on the temporal distribution of sporophyte stages from various sites in Scotland are provided in Table 1. The data suggest that, at least in Scotland, development from Stage 1 through to Stage 7 takes about 10 months, generally starting in September and ending with the start of spore liberation in about June. This is remarkably like the phenology reported for *Buxbaumia aphylla* in Newfoundland, where it was found that capsules over-wintered in an immature state (Hancock & Brassard, 1974).

However, detailed studies have not been undertaken on *B. viridis* in Scotland and it is hoped that this note will encourage such studies. Long-term monitoring would be particularly valuable, with such basic data having many potential applications, such as plant-climate interactions. Capsule predation is also a matter worth research. ST has seen capsules predated from Stage 2 right through to Stage 6, and the predation rate can be very high in some instances, for example in February 2008 a population of 73 sporophytes had 66 (90%) capsules predated. The identity of the predators, which take only the capsules and not the setae, is unknown and their possible role as dispersal vectors is of significant interest.

References

Hancock, J. A., & Brassard, G. R. (1974). Phenology, sporophyte production, and life history of *Buxbaumia aphylla* in Newfoundland, Canada. *The Bryologist*, 77: 501-513.

Holá, E., Vrba, J., Linhartová, R., Novozámská, E., Zmrhalová, M., Plášek, V., & Kučera, J. (2014). Thirteen years on the hunt for *Buxbaumia viridis* in the Czech Republic: still on the tip of the iceberg? *Acta Societatis Botanicorum Poloniae,* 83: 137-145.

Taylor, S. (2010). *Buxbaumia viridis* in Abernethy Forest and other sites in northern Scotland. *Field Bryology,* 100: 9-14.

Wiklund, K. (2003). Phosphorus concentration and pH in decaying wood affect establishment of the red-listed moss *Buxbaumia viridis*. *Canadian Journal of Botany*, 81: 541-549.

Wolf, T. (2015). Studies on the developmental stages of *Buxbaumia viridis* (Lam. & DC.) Moug. & Nestl. (Green Goblin Moss). *Carolinea*, 73: 5-15.

Acknowledgements

Part of the information presented in this article was collected during surveys funded by Scottish Natural Heritage, coordinated by Dave Genney.

Des Callaghan - Consultant Bryologist, Bryophyte Surveys Ltd, 65 Belle Vue Road, Stroud, Gloucestershire, GL5 1PY. **e** des.callaghan@bryophytesurveys.co.uk www.bryophytesurveys.co.uk

Stewart Taylor - Firwood, Nethybridge, Inverness-shire, PH25 3DE

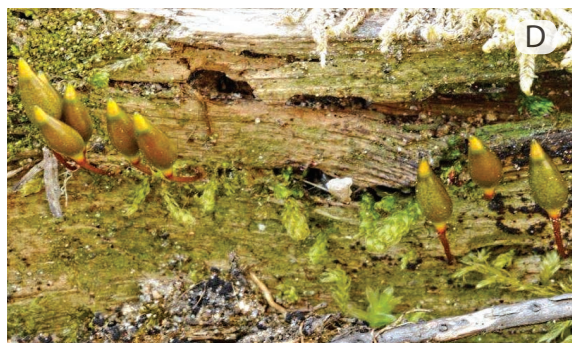
Stage	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1	3											
2	5	2	1									
3		1	1									
4			21		1	1						
5					10	4						
6									13			
7										1	3	
8		1	1									1

◁Table 1. Preliminary data on the temporal distribution of the stages of sporophytes (n=69) from various sites in Scotland. Data from field observations by D.A. Callaghan and dated photographs taken by S. Taylor.

A: Stage 1 (arrowed) **& 2**. Note that the female gametophyte, not usually detectable in the field, is just visible as a brownish swelling at the base of the setae. September 2008. S. Taylor.

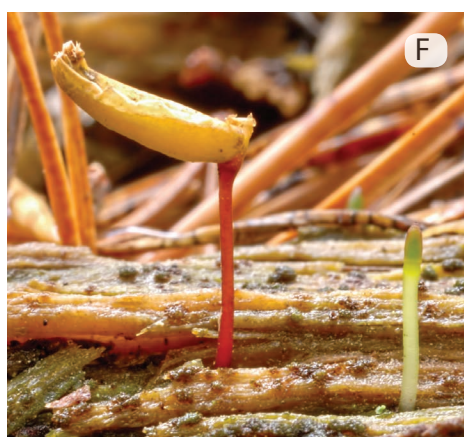
B: Stages 3 & 4. November 2016. D.A. Callaghan

C: Stage 5. January 2008. S. Taylor.



D: Stage 6. May 2007. S. Taylor.

E: Stage 7. June 2008. S. Taylor.



F: Stages 8 & 2. October 2008. S. Taylor.

G: Stage Se. November 2016. D.A. Callaghan

H Stage Ab: November 2016. D.A. Callaghan

△Fig. 2. Photographs illustrating the stages of sporophyte development, as noted in Figure 1.