

PHENOLOGICAL STUDIES IN A DIOECIOUS HEPATIC, *PELLIA ENDIVAEFOLIA* (DICKS.) DUMORT

Kanu Anand, Anu Sharma* and Anima Langer

Dept. of Botany, University of Jammu, Jammu, J&K - 180 006

Received-10.12.2017, Revised-26.12.2017

Abstract: Events of the sexual reproductive cycle of 40 populations of *Pellia endivaeifolia* were noticed for 3 years.. The phenological events were different among different populations at different sites. There was a seasonal effect on the maturation of gametangia and sporophytes. Some populations exhibited sporophyte formations twice a year whereas others had sporophyte formation only once. Such variations could be on account of various environmental factors.

Keywords: Bryophyte, Egg, Phenological studies, Sexual reproduction

INTRODUCTION

Sexual reproduction of bryophytes is a tightly harmonised and coordinated process involving a number of phenological stages, from the production of gametangia and gametes, via the fertilisation of eggs to the development and maturation of the sporophytes which occur sequentially. The whole process of production of various stages is a seasonal phenomena (Arnell 1875, Grimme 1902, Van der Wijk 1960). The length of the reproductive cycle as a whole and the duration of the individual stages differs considerably between species as well as within species. Comparisons between populations and species have been made easier by a standardized subdivision of the life cycle. Detailed studies of the phenology of particular species show, that there is also quite some variation among individuals within populations in this respect (Hancock and Brassard 1974).

Pellia is a widespread genus represented by six different species namely *P. endivaeifolia*, *P. megaspora*, *P. columbiana*, *P. borealis*, *P. epiphylla* and *P. neesiana*. All the species of this genera are worldwide in distribution. However, the common species are *P. endivaeifolia*, *P. epiphylla* and *P. neesiana*.

Among bryophytes, the seasonality of gametangial and sporophyte development recorded in the phenological cycle has been reported for many mosses (Egunyomi, 1979; Odu, 1981; Miles *et al.*, 1989) but such data available for hepatics are quite meagre. Stark *et al.* (1997) and Solli *et al.*, (1998) reported the winter and late autumn as the suitable

season for antheridial formation in *Syntrichia inermis* and *Dicranum majus* respectively. Such results prompted the bryophyte reproductive biologists to undertake phenological studies in larger number of taxa growing in various regions. While Ayukawa *et al.*, (2002) recorded antheridial formation in subalpine moss *Polytrichum ohiense* in May-August, Madhu's (2014) work in this direction is quite interesting as she compared the phenology of male phase in several members of families Aytoniaceae and Marchantiaceae (order Marchantiales) growing in Jammu region (North West Himalaya) and observed a striking difference in the period of antheridial initiation/ maturation between these families. Thus, while antheridia were formed during May and August-September in Aytoniaceae, these events took place in the family Marchantiaceae during entirely different months (February-March). Comparable results were obtained by Sharma (2014) on male phenological events in four taxa belonging to Aytoniaceae (*Plagiochasma appendiculatum*, *Reboulia hemispherica*, *Asterella wallichiana* and *A. multiflora*) growing under almost uniform conditions in Sunderbani area of Jammu. Antheridia were produced during the same period (July-August) in three taxa (*P. appendiculatum*, *R. hemispherica* and *A. wallichiana*) but during a different season in *A. multiflora* (November).

The reproductive system operating within a plant population has a profound influence on both, the pattern of variation and evolutionary flexibility exhibited by the population (Longton and Miles, 1982). Utility of phenological studies in understanding the factors which permit the

*Corresponding Author

development of a given stage (vegetative, gametangial initiation, maturation and dehiscence, fertilisation, formation and dispersal of spores, elaters etc.) was suggested by Forman (1965). It also helps in interpreting physiological responses controlling these life cycle events. In view of the tremendous significance of phenological studies, studies were undertaken to carry out phenological studies in various populations of *Pellia endivaefolia*.

MATERIAL AND METHOD

Periodical explorations were undertaken between February 2011 and March 2014 from various sites of Jammu region (Table 1). During collection trips in the field, photography was done for the populations growing in diverse habitats and a field book was maintained with all the information regarding various ecological parameters like place and date of collection, temperature, habitat, altitude, pH, thallus colour, texture and patch size.

Phenology

Young thalli of *P. endivaefolia* appeared in the field during April as innovations from the dried thalli and formed dense patches which later bore reproductive structures under favourable conditions. Various populations exhibited variation in their phenological pattern. Antheridial initiation occurred during April-May in 50% of populations while in three populations, they were recorded during June. Still more glaring deviation was recorded in all the five populations from Kishtwar as they produced antheridia twice a year, once in summer (May), then in winters (November, Pe 03, Pe 08 and Pe 09; September, Pe 10, and October, Pe 12). Mature antheridia were first observed during May-June and remained at this stage till July (Table 2). They matured earlier also i.e. April in two populations. In general, antheridia began to dehisce from August

onwards till September. V.S. of male thalli revealed that antheridium was globular with a small stalk, embedded in the thallus in an antheridial chamber.

Female phase of *P. endivaefolia* also showed phenological variation as young involucre appeared during July and August in six and four populations respectively. However, they were formed twice i.e. during July-August and November in Pe 19 and Pe 27. Archegonia matured during August-September and remained at this stage till November. In the fertile populations from Himachal Pradesh, mature archegonia were collected in October only, probably due to lack of more field visits. Archegonia typically a flask shaped structure with broad venter and long neck; present in groups of 3-10 per involucre. Two populations (Pe 08 and Pe 10) showed unique variation as in these thalli, 1-2 archegonia per involucre were collected which also degenerated at very early stages of development.

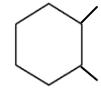
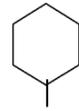
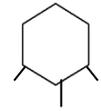
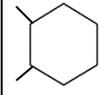
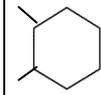
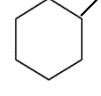
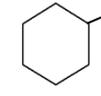
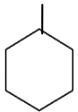
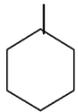
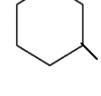
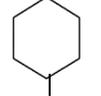
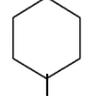
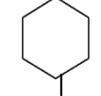
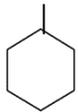
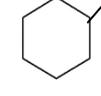
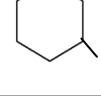
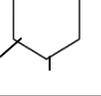
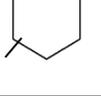
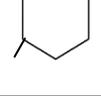
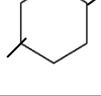
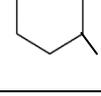
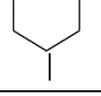
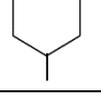
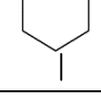
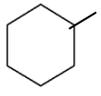
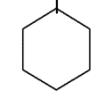
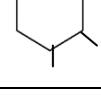
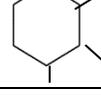
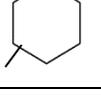
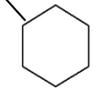
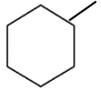
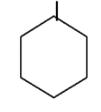
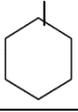
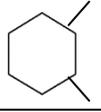
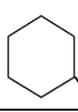
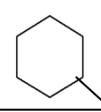
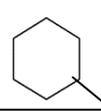
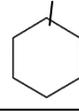
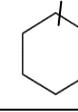
Only one sporophyte within each involucre developed to maturity, the other archegonia degenerated; sporophyte formation occurred during different months in different populations. Production of sporophytes started during August in two populations (Pe 17 and Pe 27), while September was most suitable for three populations (Pe 12, Pe 16, Pe 30). Two more populations (Pe 22 and Pe 25) showed deviation as sporophyte formation occurred during November. Populations from Himachal Pradesh (Pe 37 and Pe 40) and Patnitop (Pe 01) also exhibited variation as in these three populations sporophytes were observed during October (Table 2). It is worthwhile to mention here that there were 4 populations from where sporophytes were collected twice a year. Besides, August, in two populations, Pe 17 and Pe 27, sporophytes were collected in the month of February also where as in Pe 16 and Pe 19, they were recorded during peak winter months i.e. December- January.

Table 1: Sites of collection of various accessions of *Pellia endivaefolia*.

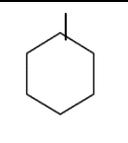
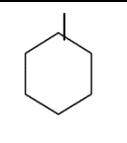
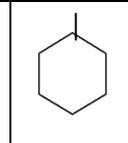
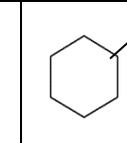
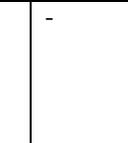
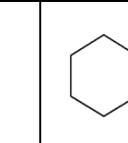
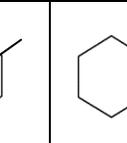
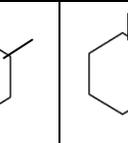
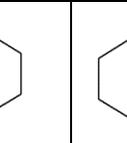
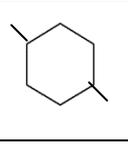
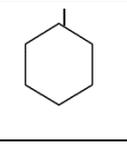
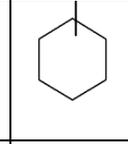
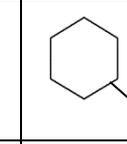
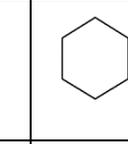
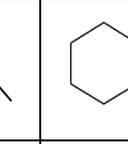
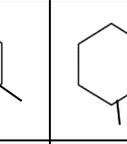
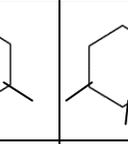
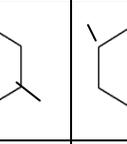
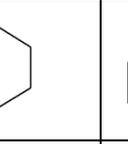
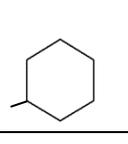
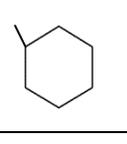
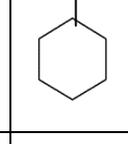
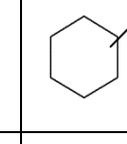
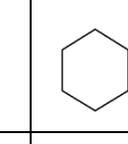
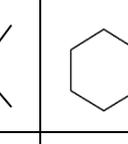
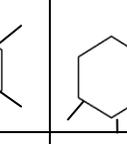
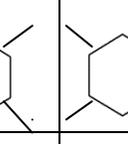
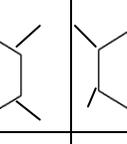
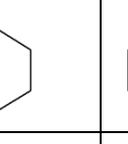
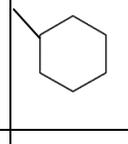
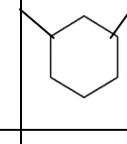
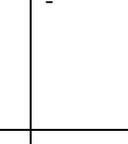
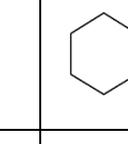
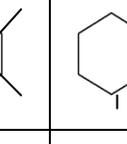
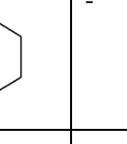
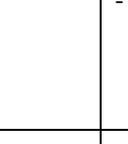
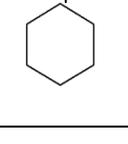
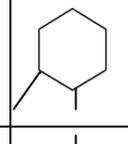
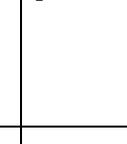
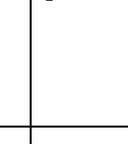
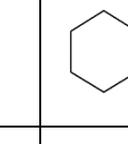
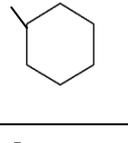
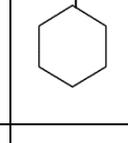
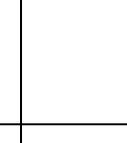
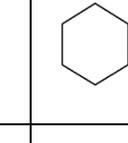
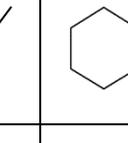
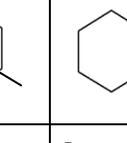
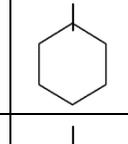
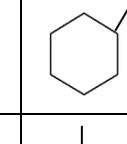
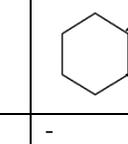
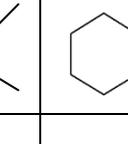
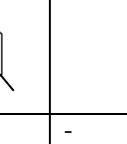
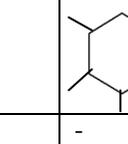
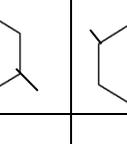
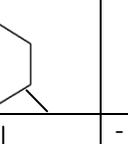
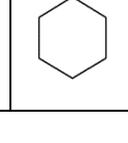
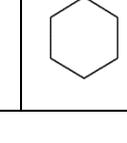
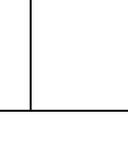
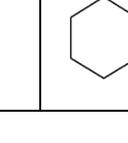
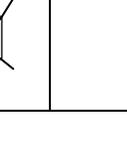
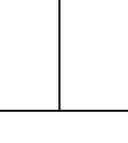
S.No.	District	Site	Accession No.	Altitude (m)
1.	Udhampur	Ghordi	Pe 32	650
			Pe 33	-
		Jib	Pe 34	545
			Pe 35	540

		Pancheri	Pe 20	756
		Patnitop	Pe 01 Pe 02	2060 2030
		Ram nagar	Pe 18	628
		T.Morh	Pe 36	550
2.	Doda	Bhaderwah		
		Chhabra	Pe 22	1520
		Jaii	Pe 23	1938
		Nalthi	Pe 24	1813
		Gandoh	Pe 19	1250
		Prem Nagar	Pe 25	1350
		Thopal	Pe 28 Pe 29	1200 1210
3.	Jammu	Nagbani	Pe 14 Pe 15 Pe 16 Pe 17	350 - - -
4.	Kishtwar	Kudaya	Pe 03	1016
		Dool	Pe 04	1524
		Ekhala	Pe 05	1706
		Galhar	Pe 06	1707
		Keru Nallah	Pe 07	1706
		Kwarh	Pe 08	1676
		Mughal Maidan	Pe 09	1005
		Nageni	Pe 10	1219
			Pe 11	-
			Pe 12	-
		Waserkund	Pe 13	1280
5.	Poonch	Noori Chhamb	Pe 27	1850
6.	Rajouri	Shahadra Sharief	Pe 31	1668
		Thanna Mandi	Pe 30	1478
7.	Reasi	Pouni	Pe 26	510
8.	Ramban	Ramsoo	Pe 21	1210
9.	Himachal Pradesh	Bagsu waterfall	Pe 39	2223
		Dal Lake	Pe 38	-
		Naddi	Pe 40	1875
			Pe 41	2188

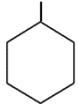
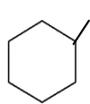
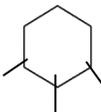
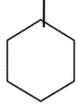
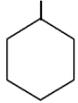
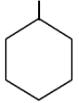
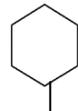
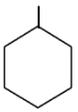
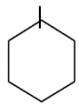
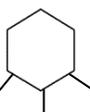
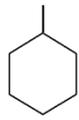
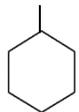
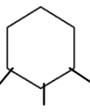
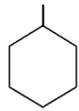
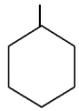
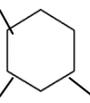
Table 2. Phenological details of gametangial/sporophyte formation in *P. endivaeifolia*.

Acc.No	January	February	March	April	May	June	July	August	September	October	November	December
Pe 01	-	-		-								-
Pe 03		-	-	-			-	-	-			-
Pe 08		-		-								-
Pe 09		-		-								-
Pe 10		-		-								-
Pe 12		-		-								-
Pe 14												-

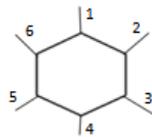
Contd....

Pe 15					-						-	-
Pe 16											-	-
Pe 17											-	-
Pe 19	-	-			-				-	-		
Pe 22		-		-	-		-			-		-
Pe 25		-		-				-		-		-
Pe 27	-	-					-			-		
Pe 29	-	-			-		-	-		-		

Contd....

Pe 30	-	-			-		-				-	-
Pe 31	-	-			-		-				-	-
Pe 37	-		-		-	-	-	-	-		-	
Pe 38	-		-		-	-	-	-	-		-	
Pe 40	-		-		-	-	-	-	-		-	

1-Vegetative, 2/3- young and mature antheridia,
4/5-Young and mature archegonia, 6- Sporophyte



CONCLUSION

On the basis of the observations, it can be concluded that there is lot of variation in phenology in different populations. Variations could be on the account of various environmental factors like habitat, temperature, availability of water, nutrients available etc. which need further investigations.

REFERENCES

- Arnell, H.W.** (1875). De skandinaviska löfmossornas kalendarium. – Uppsala Univ. Årsskrift Math. Nat. 4: 1–129.
- Ayukawa, E.S., Imura, S., Kudoh, S. and Kanda, H.** (2002). Reproductive phenology of sub alpine moss *Polytrichum ohioense*. Ren Et Card. Polar Bioscience. 11:89-96.
- Egunyomi, A.** (1979). Autoecology of *Octoblepharum albidum* Hedw. J. Hattori. Bot. Lab. 41: 205-223.
- Forman, R.T.T.** (1965). A system for studying moss phenology. The Bryologist. 68: 289-300.
- Grimme** (1902). Über die Blüthezeit deutscher Laubmoose und die Entwicklungsdauer ihrer Sporogone. – Hedwigia 42: 1–75.
- Hancock, J.A. and Brassard, G.R.** (1974). Phenology, sporophyte production, and life history of *Buxbaumia aphylla* in Newfoundland, Canada. The Bryologist 77: 501–513.
- Longton, R.E. and Miles, C.J.** (1982). Studies on the reproductive biology of mosses. Journal of Hattori Botanical Laboratory. 52: 219-240.
- Madhu (2014)**. Studies on the reproductive biology of some hepatics of Jammu province, Ph.D thesis, University of Jammu, Jammu.
- Miles, C.J., Odu, E.A. and Longton, R.E.** (1989). Phenological studies on British Mosses. Journal of Bryology. 15:607-621.
- Odu, E.A.** (1981). Reproductive phenology of some tropical African Mosses. *Fissidens* sp. and *Recopilum* sp. Annals of Botany. 14:147-152.
- Sharma P** (2014). Phonological studies in some members of the family Aytoniaceae. M.Phil Dissertation. Department of Botany, University of Jammu, Jammu.
- Solli S., Söderström, L., Bakken, S., Flatberg, K.I. and Pedersen, B.** (1998). Reproductive phenology of *Dicranum majus* in central Norway. Journal of Bryology 20:311–321.
- Stark, L.R., Mishler, B.R. and McLetchie, D.N.** (1997). Sex expression and growth rates in natural populations of the desert soil crustal moss *Syntrichia caninervis*. Journal of Arid Environments. 40:401-416.
- Van der Wijk, R.** (1960). De periodiciteit in de ontwikkeling der bladmossen. – Buxbaumia 1: 25–39.

