PHENOLOGY OF THREE MOSSES FROM UPPER OGUN, A SAVANNA AREA OF SOUTHWESTERN NIGERIA

Oyesiku, O. O.
Department of Plant Science and Applied Zoology Olabisi Onabanjo University, Ago-Iwoye. Nigeria.
E-mail: busik1000@gmail.com
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ABSTRACT

The reproductive phenology of one acrocarpous and two pleurocarpous mosses, *Calymperes erosum* C. Muell., *Erythrodontium barteri* (Mitt.) Broth and *Thuidium gratum* (Palis) Jaeg. were investigated over a 27-month period in the savanna zone of Southwestern Nigeria. The actual time of fertilization was not ascertained, but the stages of dehiscence of mature sex organs coincided with the swollen venter (SV) stage of sporophyte development. Initiation of sexual organs and dehiscence of capsules occurred over a brief period of 3-6 months. Sporophytes developed from December to March (dry season) and spores were mostly discharged from capsules from April to October (wet season). Rainfall, temperature, light intensity and relative humidity contributed to the pattern of phenological cycles.

Key words: Phenology, *Calymperes, Thuidium, Erythrodontium,* Savanna, Nigeria.

INTRODUCTION

Although the gametangial and sporophytic developments of bryophytes often display defined seasonal patterns of variation and indicate evolutionary flexibility, about half of the populations of bryophyte species exhibit dioecism, which will imply some degree of out-crossing in bryophytes (Longton and Miles, 1982; Miles *et al*., 1989). There are thus clear ecological implications of the phenological cycles in bryophytes. Quite a few studies on the phenology of tropical African mosses are known from rainforest and derived Savanna (Egunyomi, 1979; Makinde and Odu, 1994, Fatoba, 1998) whereas phenological knowledge of mosses from true Savanna is very limited (Porto and De Oliveira, 2002).

Phenological data is of great importance in ecological studies not only for comparative interspecific and intra-specific ecological studies of mosses from different regions and evaluating the overall phenological pattern of such moss species, but also for monitoring their life-cycle strategies and the impact(s) of environmental factors on extant species. Egunyomi (1979), working on the phenology of *Octoblepharum albidum* Hedw., reported that the development and maturation of sporophytes occurred between August and September and that the spores were dispersed between December and March. He concluded that light, moisture and nutrients have great impact on the production of sporophytes.

Other workers have reported that gametangial initiation and development are influenced by photoperiods, moisture, nutrients and temperature (Monroe, 1965; Newton, 1972; Egunyomi, 1979, Fatoba, 1997). Newton (1972) observed the influence of photoperiod control (long-day) on the initiation and development of gametangia in *Mnium undulatum* Hedw. and *M. hornum* Hedw., and concluded that interaction between climatic factors and endogenous rhythms may be responsible for the observed initiation and development of gametangia in bryophytes. Besides, Fatoba (1997) working in the rain forest of Nigeria, further confirmed that photoperiod controls the initiation and development of gametangia and subsequent production of sporophytes in two acrocarpous mosses - *Bryum coronatum* and *Hyophila involute*.

However, in the derived savanna in Southwestern Nigeria, Makinde and Odu (1994) focused on the influence of seasons, and reported the duration of development and maturation of gametangia to be very brief within the rainy season, while mature sporophytes disperse their spores in September and October (dry season). These phenological patterns enable ecobryologists to understand the survival strategy of mosses of a particular region, particularly in the savanna zone that is prone to regular bush burning. Thus, phenological stages

from gametangial initiation to dehisced capsules are very brief in both derived savanna and rainforest mosses compared with the longer period observed in the temperate moss *Pleurozium schreberi* (Longton and Greene, 1969).

As a contribution to the phenological studies of Nigerian mosses, this paper reports studies on the seasonal patterns of development in the sexual-reproduction organs in one acrocarpous moss, *Calymperes erosum*, and two pleurocarpous mosses, *Erythrodontium barteri* and *Thuidium gratum* common woodland savanna species of South-western Nigeria.

MATERIALS AND METHODS

Study area and Species Collection

Phenological studies were conducted on three mosses commonly found in Upper Ogun - a Savanna area of Oyo North, Southwestern Nigeria located within the Lat. 8° 10"N and Lat. 8° 41"N; Long. 3° 21" E and, Long. 3° 36" E in the Guinea Savanna vegetation zone (Fig 1). Fresh shoots of three common long-lived, perennial, sexually reproducing mosses, *Calymperes erosum*, *Erylhrodontium barteri* and *Thuidium gratum* were collected monthly for two consecutive years (1997 to 1999) from populations. The locality and microhabitat descriptions of the mosses are in Table 1.

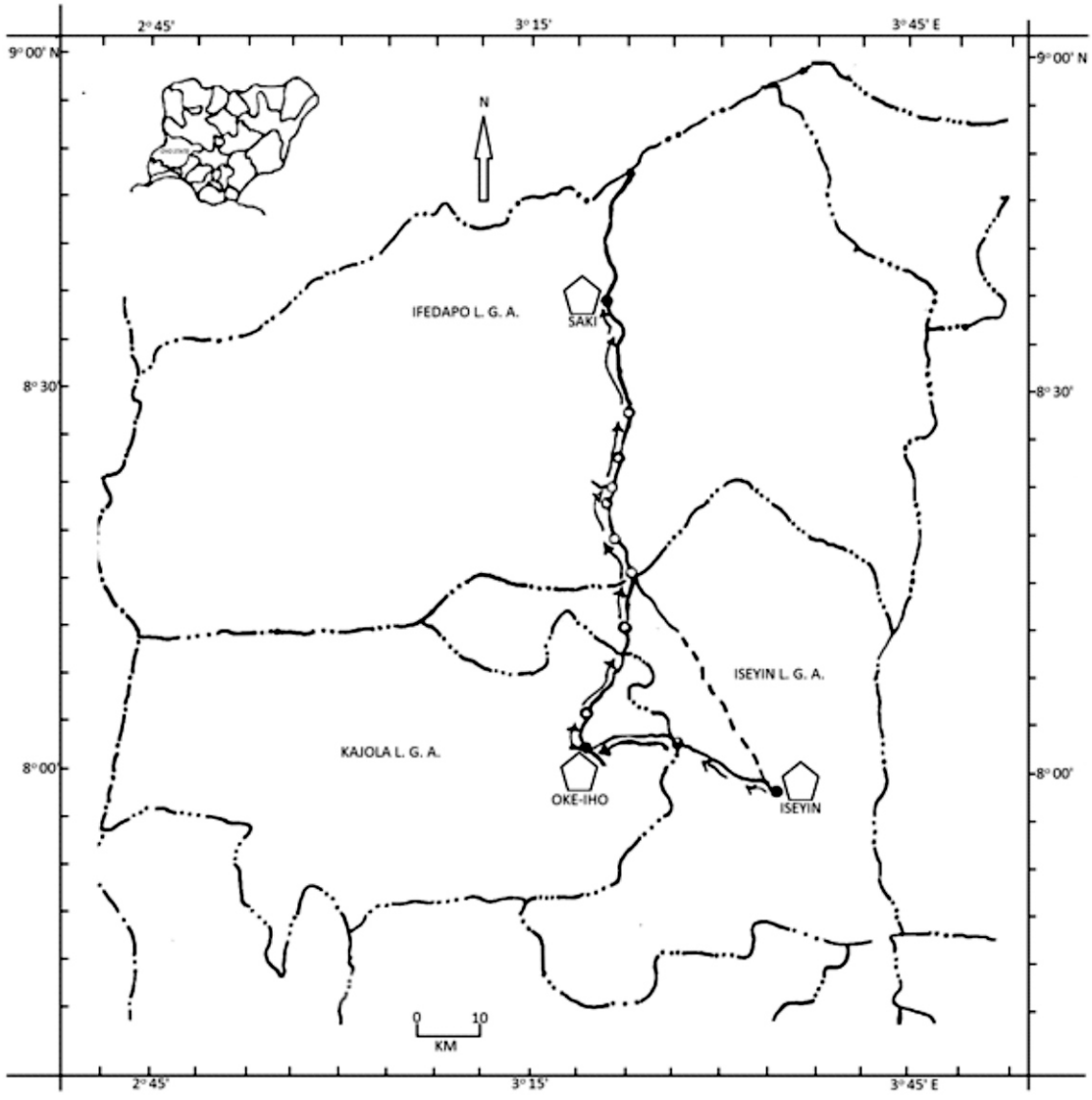

Figure 1. Study Area Showing Itinerary Followed During Collection of the Mosses.

Table 1. Details of populations of three common mosses sampled in woodland Savanna zone of Upper Ogun Southwestern Nigeria

Species	Locality	Microhabitat
Calymperes erosum	Iseyin, Oke-Iho and Otu	Along stream bank on tree bark, and palm tree trunk pockets in light streaks condition
Erythrodontium barteri	Otu, Ago-Are and Saki	On trees characterized by horizontal branches near the roads and in the valley forming coat around the trunk and branches
Thuidium gratum	Iseyin, Oke-Iho and Agunrege	On rock surface on the river bank in shaded condition. On rotten log in shaded situation and on tree bases on the river bank.

Methods

The developmental stages of gametangia and sporophytes were observed microscopically and index ratings scored using phenological standard procedures (Greene, 1960; Longton and Greene, 1967, Miles *et al.*, 1989; Pôrto and Oliveira, 2002), (Table 2). From 10 shoots of current-season growth, five perichaetia and five perigonia and 40 sporophytes were randomly obtained for each population of the species. Developmental stages of gametangia and sporophytes were scored monthly with the aid of a light dissecting microscope. Average maturity index for stages of development of gametangia and sporophytes was calculated each month using the formula of Longton and Greene (1967).

$$Mean\ Index = \frac{Index\ rating\ x\ no.of\ gametangia/sporophytes}{Total\ no.of\ gametangia/sporophytes}$$

The local climatic factors such as temperature, relative humidity and light intensity were measured and the rainfall data were collected from Meteorological sub-station, Oke-Iho in the vicinity of the study area.

Table 2. Developmental stages of gametangia, sporophytes and their index rating in selected three woodland Savanna mosses

Maturation stage	Symbol	Index rating	Identification clue
Gametangia			
Juvenile	J	1	Visible pale green gametangia
Immature	I	2	Half the length of full gametangia
Mature	M	3	Ruptured apices of gametangia
Dehisced	D	4	Brownish ruptured apices
Aborted	A	-	Brownish or hyaline intact apices
Sporophyte			
Swollen Venter	SV	1	Venter begin to swell
Early Calyptra in Perichaetium	ECP	2	Calyptra emerging from Perichaetium bracts
Late Calyptra in Perichaetium	LCP	3	Calyptra extends half way above Perichaetium
Early Calyptra Intact	ECI	4	bracts
Late Calyptra Intact	LCI	5	Calyptra extended fully above Perichaetium bracts
Early Operculum Intact	EOI	6	Swelling of capsules begin
Late Operculum Intact	LOI	7	Operculum becomes brownish
Operculum Fallen	OF	8	Whole capsule becomes brownish
Empty and Fresh	EF	9	Operculum falls
Aborted	-	-	Almost 80% of spores are dispersed Sporophyte apices withers before spore formation

RESULTS

The patterns of climatic variation in the study area are as shown in Fig 2A-D. Early dry season (October-December) coincided with the dehiscence of sex organs (gametangia) in both *Calymperes erosum* and *Erythrodontium barteri* whereas late dry season (January-March) favoured the *Thuidium gratum* gametangia development.

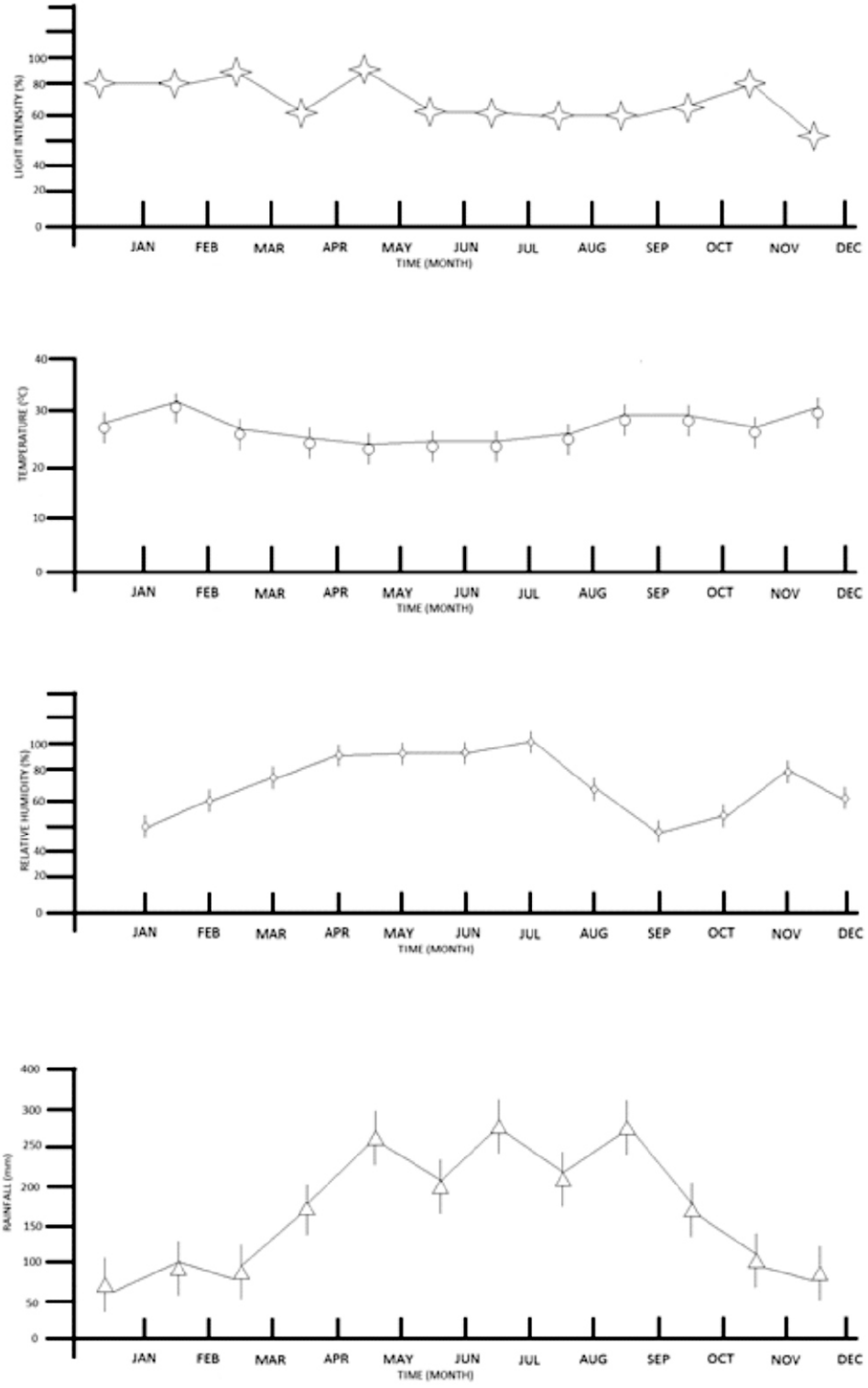

Figure 2. Mean variation of selected environmental factors at the study area from 1997 to 1999. Light intensity (A); Temperature (B); Relative Humidity (C); Rainfall (D). Bar, Standard Deviation (±SD).

Calymperes erosum

There was a seasonal effect on the maturation of male and female gametangia and sporophytes. The juvenile male gametangia, antheridia, developed twice in June and September 1997, during the wet season and dehisced in August and December the same year, as shown in Fig 3. By this time, the female gametangia, archegonia were mostly matured and dehisced. Fertilization mostly occurred in January through May as evidently shown by the sporophytes swollen venter initiation. Development of sporophytes mostly occurred within a short period between January and March when the spores were mostly matured and ready for dispersal between April and November.

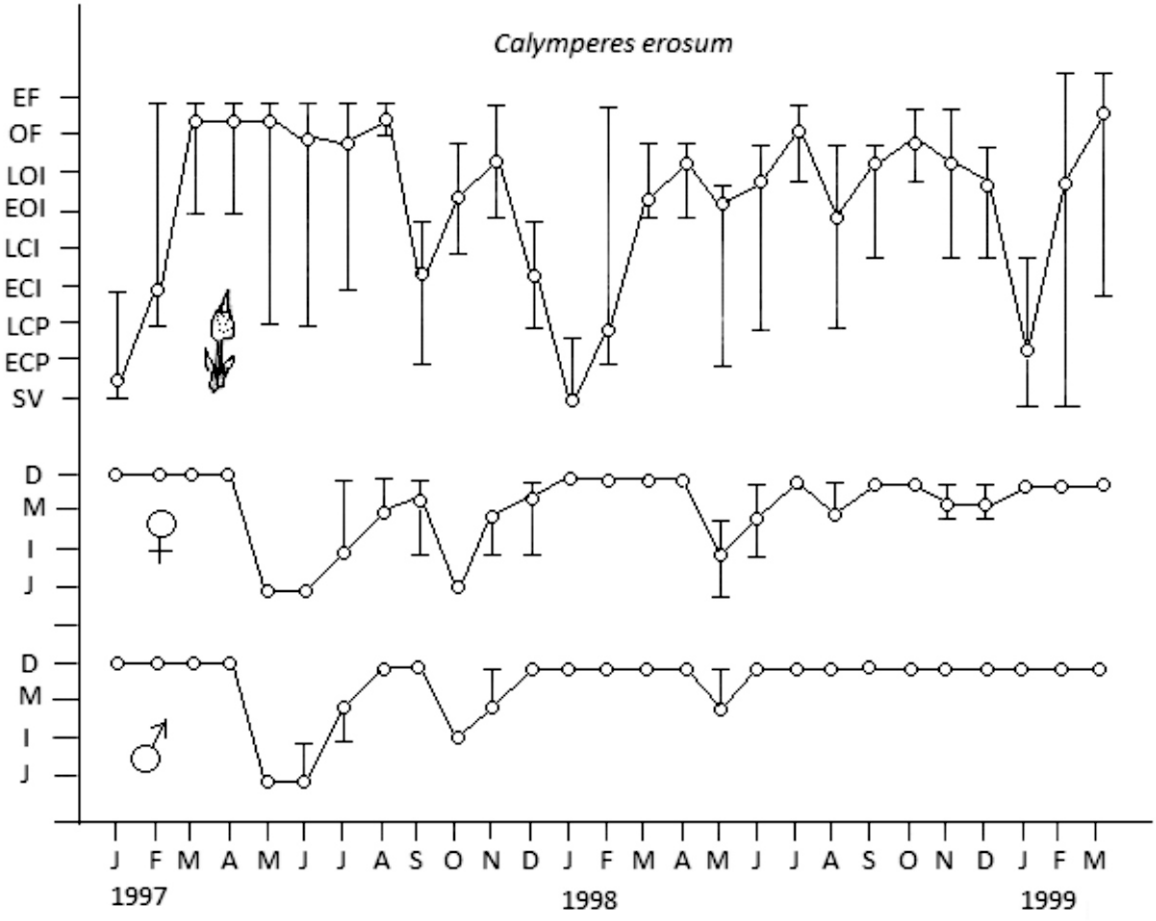

Figure 3. Phenological patterns of *Calymperes erosum* in a Savanna zone of Upper Ogun Oyo State. Vertical bar = stages present. Sporophyte, male gametangium ♂, female gametangium ♀.

Erythrodontium barteri

Similarly there was a seasonal effect on the maturation of gametangia and sporophytes. The juvenile stage of male gametangia (antheridia) occurred mostly in April and dehisced in July while the female gametangia (archegonia) matured in September as shown in Fig. 4. The development of the sporophytes was most rapid during the dry season (from December to March) which coincided with the period of annual bush fire. Spore dispersal commenced in the rainy season (April to October).

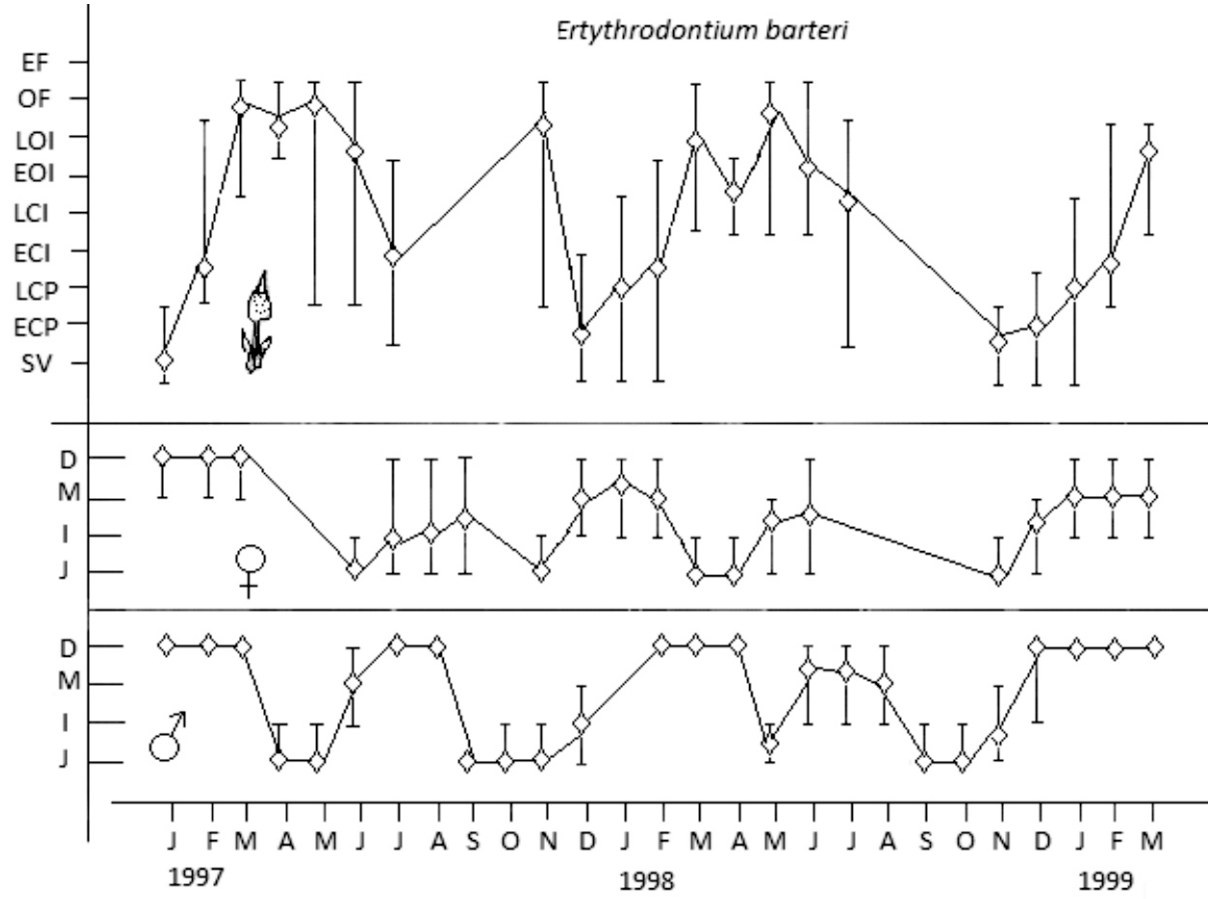

Figure 4. Phenological patterns of *Erythrodontium barteri* in a Savanna zone of Upper Ogun Oyo State. Vertical bar = stages presen Sporophyte ♂ male gametangium ♀, female gametangium

Thuidium gratum

Similarly there was a seasonal effect on the maturation of gametangia and sporophytes. The mature gametangia occurred during the rainy season (Fig. 2D), April to July; they dehisce mostly in July thus coinciding with the occurrence of dehisced female gametangia (Fig 5). The life span of the female gametangia, archegonia were very brief. The juvenile archegonia stage occurred in January and completely dehisced in May and another cycle started in August to November. The most commonly observed stage of sporophyte on the field was the Early Calyptra Intact (ECI). Matured spores were dispersed in February and September/October.

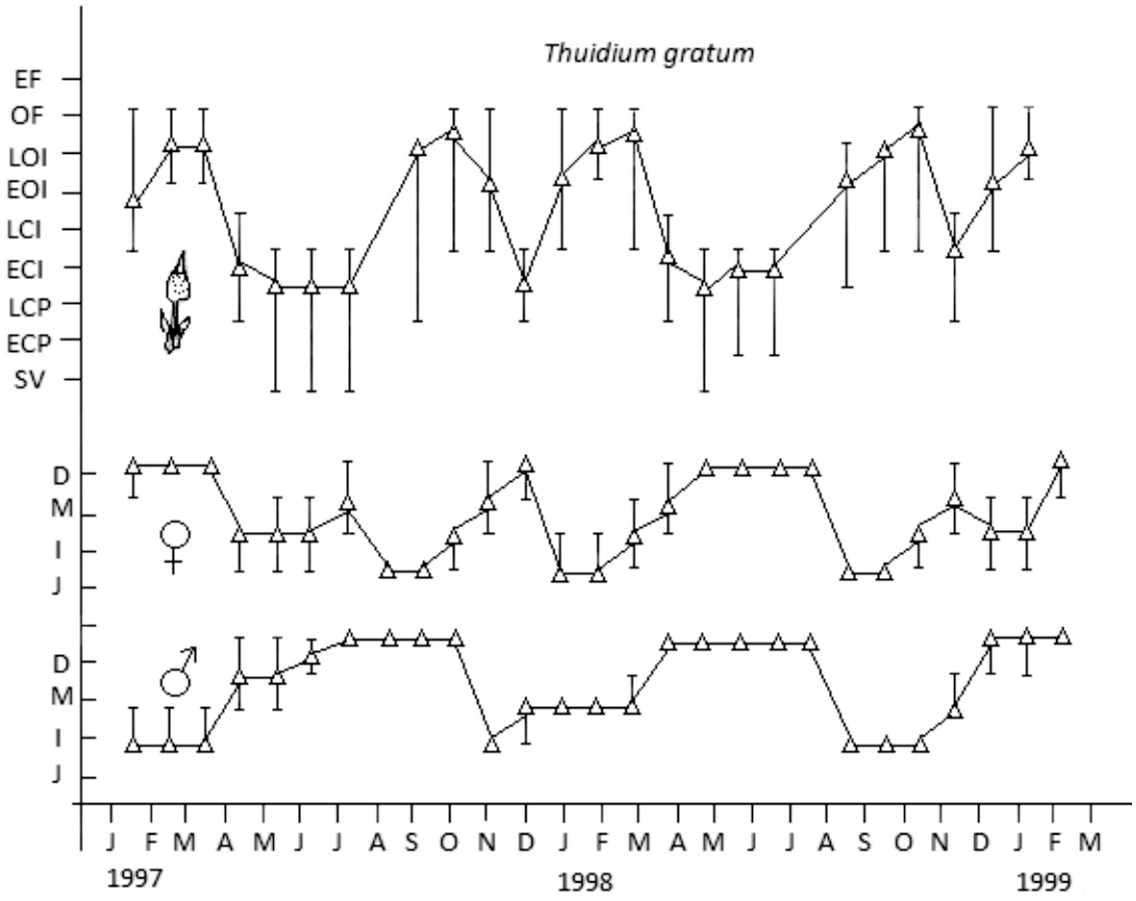

Figure 5. Phenological patterns of *Thuidium gratum* in a Savanna zone of Upper Ogun Oyo State. Vertical bar represent range of stages present. Sporophyte, male gametangium ♂, female gametangium ♀

DISCUSSION

Annual bush burning in the Savanna seems to stimulate the growth and development of the common bryophyte species, *Calymperes erosum, Thuidium gratum* and *Erythrodontium barteri.* The brief developmental duration (3 to 6) months between sex organs and capsule dehiscence observed in the present study species is essentially similar to that previously reported for *Archidium ohioense, Bryum coronatum, Fissidens minutifolius* and *Trachycarpidium tisserantii;* all found on the rocks in the derived Savanna (Makinde and Odu, 1994).

The short reproductive cycle is an adaptation to escape the annual bush burning. The phenological timing pattern in *T. gratum* was found to be very similar to that of *Brachythecium rutabulum* (Greene, 1960) and *Octobleplarum albidum* (Egunyomi, 1979). Phenological patterns are valuable information for interpreting physiological responses such as the control of gametangial initiation (Chopra and Blatta, 1983; Fatoba 1998). The similarity of the timing of gametangial initiation in both *C. erosum* and *E: barteri* corresponds closely to the similarity of their habitats. The increasing moisture availability, temperature and light intensity thus enhance the initiation of gametangia and the consequent production of sporophytes. This finding supports the opinion that photoperiod controls the initiation and development of gametangia (Newton, 1972; Fatoba, 1997). Some tropical mosses have shown special adaptation to high temperatures (Odu, 1979). As an example, immature stage of antheridia in *Thuidium gratum* was able to withstand the irregular and relatively high temperatures between January and March.

CONCLUSION

This phenological study of selected mosses from the savanna zone of Nigeria have shown that bryophytes are endowed with morphological, physiological and reproductive adaptive strategies.

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