

TYPES OF SPORE GERMINATION, PROTHALLIAL DEVELOPMENT AND MATURE PROTHALLUS IN RELATION TO TAXONOMY OF HOMOSPOROUS FERNS*

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ABSTRACT

Importance of ten types of spore germination, ten of prothallial development and five of mature prothallus (recognized earlier) in relation to taxonomy of homosporous ferns has been discussed.

INTRODUCTION

The studies on the prothallus during the present century by STOKEY AND ATKINSON individually and jointly and the school at the National Botanical Research Institute have clearly indicated the importance of the prothallus in the taxonomy of the homosporous ferns (STOKEY, 1951 ; ATKINSON & STOKEY, 1964 ; NAYAR & KAUR, 1971).

Detailed studies on various groups and genera have shown occurrence of five types of mature prothallus, viz. Cordate-thalloid, ribbon-like, filamentous, strap-like and tuberous (for details see NAYAR, 1971 ; NAYAR & KAUR, 1971). These types of adult prothallus are formed as a result of definite patterns of growth, differing in sequence of cell divisions and stage and region at which meristem gets established. Depending upon these criteria ten different types of prothallial development have been recognized. These are *Actinostachys* type, *Lophidium* type, *Schizaea* type, *Marattia* type, *Osmunda* type, *Adiantum* type, *Drynaria* type, *Ceratopteris* type, *Kaulinia* type and *Aspidium* type (for details see NAYAR & KAUR, 1969 ; 1971).

The types of prothallial development and the adult prothallus referred to above are formed as a result of definite patterns of germination of spore. Thus, based on the plane of cell divisions in relation to polarity of spore and direction of growth of the 1st rhizoid and the prothallus, three main types of spore germination have been recognized—Amorphous, Polar and Equatorial. Of these, the polar type is subdivided into 3 different types, viz. *Osmunda* type, *Anemia* type and the *Vittaria* type. Similarly the equatorial type of spore germination is subdivided into 6 types, viz. *Gleichenia* type, *Christiopteris* type, *Cyathea* type, *Hymenophyllum* type, *Trichomanes* type and *Mecodium* type. Of these the *Hymenophyllum* type, *Trichomanes* type and *Mecodium* types are tripolar, all the others being bipolar except Amorphous type where no polarity with regard to cell division or direction of growth is exhibited (for details see NAYAR & KAUR, 1968, 1971).

Existence of various types of mature prothallus, prothallial development and spore germination in different families of homosporous ferns (*sensu* NAYAR, 1970, 1974) are detailed here (Fig. 1, Table 1). The subclass Ophioglossidae constitutes a single family Ophioglossaceae where the spore germination is of the Amorphous-type forming a globose mass

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and protallial development of the *Actinostachys* type developing to the mature thallus of the Tuberosus-type. In the 2nd subclass Marattiidae, four families Angiopteridaceae, Danaeaceae, Kaulfussiaceae and Marattiaceae are recognized all possessing a Cordate-thalloid mature prothallus with many cells thick wings and massive midrib, Amorphous type of spore germination and *Marattia* type of prothallial development.

The largest subclass Filicidae constitutes four orders Osmundales (2 families), Schizaeales (8 families), Cyatheaales (14 families) and Gleicheniales (6 families). Both the families of Osmundales—Osmundaceae and Plagiogyriaceae, possess Cordate-thalloid type of mature prothallus, the former possessing *Osmunda* type spore germination and *Osmunda* type prothallial development and the latter *Vittaria* type spore germination and *Adiantum* type prothallial development. As is pointed out earlier *Adiantum* type of prothallial development could have evolved from the *Osmunda* type by the process of reduction. *Vittaria* type spore germination could have also evolved from *Osmunda* type as explained earlier. Thus, relationship between Plagiogyriaceae and Osmundaceae seems to be justified.

In the order Schizaeales, three families, Schizaeaceae, Anemiaceae and Lygodiaceae, have been shown as three distinct families indicating independent lines of evolution. Schizaeaceae among these is supposed to be most primitive and is characterized by Amorphous-type of spore germination and three different types of prothallial development—*Actinostachys* type, *Lophidium* type and *Schizaea* type resulting in the Tuberosus-type or Filamentous-type of mature prothallus. In the family Anemiaceae, spore germination is of *Anemia* type, prothallial development of the *Ceratopteris* type and the mature prothallus of the cordate-thalloid type and in the family Parkeriaceae which is supposed to be related to the Anemiaceae, similar type of prothallial development and mature prothallus occurs but the spore germination is of the *Vittaria* type which has been shown to have evolved from the *Anemia* type, the one occurring in the Anemiaceae. The third family Lygodiaceae to which all the other families of the order are supposed to be related, possesses *Anemia* type of spore germination, *Adiantum* type of prothallial development and cordate-thalloid mature prothallus. Among the families related to Lygodiaceae all possess *Vittaria* type of spore germination, Cheilantheaceae possessing *Adiantum* type of prothallial development, Pteridaceae *Ceratopteris* type and Adiantaceae both *Adiantum* type and *Ceratopteris* type with stages intermediate between the two. Family Vittariaceae in this group possesses *Kaulinia* type of prothallial development which is supposed to have originated from *Adiantum* type of prothallial development resulting in Ribbon-like mature prothallus. It may be noted here that both *Ceratopteris* type and *Kaulinia* type of prothallial development have been shown to have evolved from *Adiantum* type (NAYAR & KAUR 1969, 1971).

In the order Cyatheaales, primitive families like Cyatheaceae and Loxsomaceae possess *Cyathea* type of spore germination and *Adiantum* type prothallial development in the former and *Drynaria* type in the latter, resulting in a Cordate-thalloid mature prothallus in both. Most of the other families of this order are said to be related to various subfamilies of the family Cyatheaceae and all except the Grammitidaceae possess *Vittaria* type spore germination and a Cordate-thalloid mature prothallus. Grammitidaceae possesses Strap-like mature prothallus which is intermediate between the Cordate-thalloid and Ribbon-like thallus. The types of prothallial development, however, are different in the various families of the order (Fig. 1) but it may be pointed out here that all these types are said to have originated from *Adiantum* type. Among the three families of Dicksonioid affinity, Dennstaedtiaceae and Hypolepidaceae

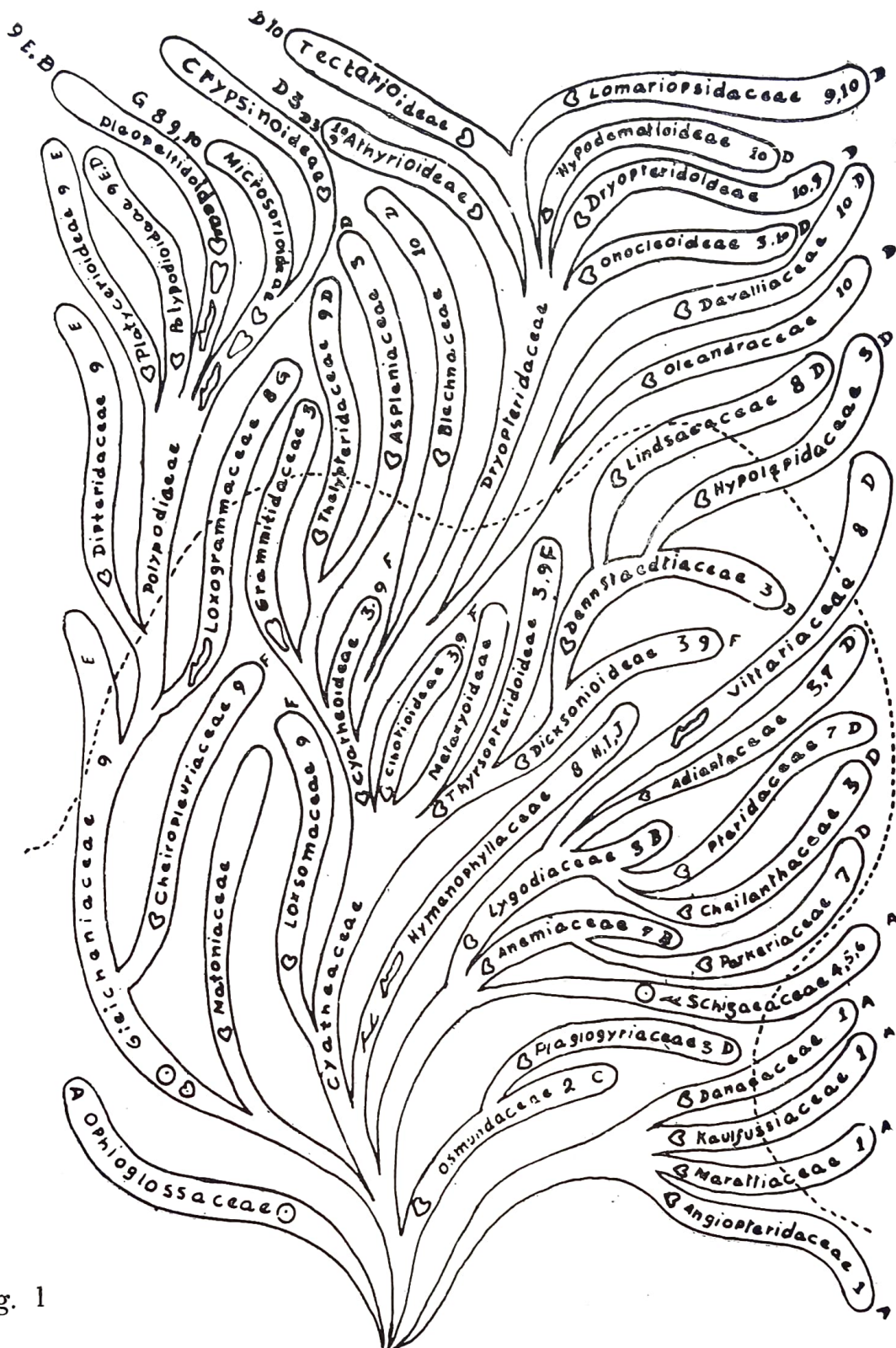


Fig. 1

Mature prothallus

- Tuberous
- ♡ Cordate-thalloid
- ∩ Strap-like
- ∩ Ribbon like
- ∩ Filamentous

Prothallial Development

1. Marattia type
2. Osmunda type
3. Adiantum type
4. Schizaea type
5. Actinostachys type
6. Lophidium type
7. Ceratopteris type
8. Kaulinia type
9. Drynaria type
10. Lophidium type

Spore Germination

- A. Amorphous
- B. Anemia
- C. Osmunda
- D. Vittaria
- E. Gleichenia
- F. Cyathea
- G. Christiopteris
- H. Hymenophyllum
- I. Mecodium
- J. Trichomanes

Table 1—Types of Mature Prothallus, Prothallial Development and Spore Germination in various families (*sensu* Nayar, 1970, 1974)

Type of Mature Prothallus	Type of Prothallial Development	Type of spore Germination	Examples	
Tuberous	Actinostachys	Amorphous	Ophioglossidae Schizaeaceae (<i>Actinostachys</i> , <i>Lophidium</i>)	
	Lophidium		Gleicheniaceae (<i>Stromatopteris</i>)	
Filamentous	Schizaea	Amorphous	Schizaeaceae (<i>Schizaea</i>)	
	Kaulinia	Trichomanes	Hymenophyllaceae (<i>Trichomanes</i> group)	
	Marattia	Amorphous	Marattidae	
Cordate-thalloid	Osinunda	Osmunda	Osmundaceae	
	Ceratopteris	Anemia	Anemiaceae, Parkeriaceae	
		Vittaria	Adiantaceae (<i>Acrostichum</i>) Cheilanthaceae Pteridaceae, Plagiogyriaceae	
		Adiantum	Anemia Cyathea	Lygodiaceae Cyatheaceae Loxsomaceae Cheiropleuriaceae
	Drynaria	Christiopteris	Polypodiaceae (<i>Christiopteris</i>)	
	Kaulinia	Gleichenia	Polypodiaceae	
	Aspidium	Vittaria	Aspleniaceae Blechnaceae Davalliaceae Dryopteridaceae Oleandraceae etc.	
	Ribbon-like	Kaulinia	Hymenophyllum	Hymenophyllaceae (<i>Hymenophyllum</i> group)
			Mecodium	Hymenophyllaceae (<i>Mecodium</i>)
		Aspidium	Vittaria	Polypodiaceae
Drynaria		Gleichenia	Loxogrammaceae	
Strap-like	Drynaria	Gleichenia	Polypodiaceae Grammitidaceae	
	Kaulinia			
	Adiantum			
	Aspidium	Vittaria	Lomariopsidaceae (<i>Elaphoglossum</i> , <i>Rhipidopteris</i>)	

show the presence of *Adiantum* type and the Lindsaeaceae *Kaulinia* type of prothallial development. All other families in this order are supposed to have cyatheoid affinity.

Families Asplenaceae and Grammitidaceae show *Adiantum* type of prothallial development, Thelypteridaceae *Drynaria* type, subfamily Athyrioideae either *Adiantum* type or *Drynaria* type, subfamily Dryopteridoideae and family Lomariopsidaceae either *Drynaria*-type or *Aspidium*-type and all other families and subfamilies *Aspidium*-type. As pointed out earlier family Hymenophyllaceae possesses three different types of spore germination in three different groups of genera—*Hymenophyllum*-type, *Trichomanes*-type and *Mecodium*-type. The prothallial development in all the three groups, however, is of the *Kaulinia*-type resulting in a Ribbon-like prothallus except in the *Trichomanes* group where a Filamentous-type of prothallus is the result.

In the order Gleicheniales the most primitive genus *Stromatopteris* (Gleicheniaceae) possesses Tuberous-type mature prothallus, most of the other families possessing a Cordate-thalloid prothallus resulting from *Drynaria*-type of prothallial development. In subfamilies Pleopeltidoideae and Microsorioideae in addition to the Cordate-thalloid prothallus, Strap-like and Ribbon-like prothalli also occur. In the latter prothallial development is also of 3 types—*Kaulinia*-type, *Aspidium*-type and *Drynaria*-type. Only Ribbon-like prothallus occurs in the Loxogrammaceae as a result of *Kaulinia*-type of prothallial development.

Families Gleicheniaceae, Dipteridaceae, Subfamily Platycerioideae possess *Gleichenia* type spore germination whereas subfamily Crypsinoideae possesses *Vittaria*-type spore germination and subfamilies Polypodioideae and Pleopeltoideae both *Gleichenia*-type and the *Vittaria*-type. Subfamily Microsorioideae possesses *Christiopteris*-type spore germination which is a variation of the *Gleichenia*-type. Among the families in the *Gleichenia*-type, Cheiroleptiaceae which is supposed to be more near to the cyatheoid stock is seen to possess *Cyathea*-type of spore germination.

BIERHORST (1968) has suggested, on the basis of gametophytic characters in addition to some of the sporophytic ones, inclusion of the family Psilotaceae in the Filicales showing relationships with *Stromatopteris*, a genus of the family Gleicheniaceae which is also raised to family level by him.

REFERENCES

- ATKINSON, L. R. & STOKEY, A. G. (1964). Comparative morphology of the gametophyte of the homosporous ferns. *Phytomorphology* **14** : 51-70.
- BIERHORST (1968). On the Stromatopteridaceae (Fam. nov.) and on the Psilotaceae. *Phytomorphology* **18** : 232-268.
- NAYAR, B. K. (1970). A phylogenetic classification of the homosporous ferns. *Taxon* **19** : 229-236.
- NAYAR, B. K. (1971). Morphology of the adult prothallus of homosporous ferns and its taxonomic significance. *J. Indian bot. Soc.* **50A** : 140:153.
- NAYAR, B. K. (1974). Classification of the homosporous ferns. In *Companion to Beddome's Handbook to the ferns of British India, Ceylon and Malay Peninsula*, Chronica Botanica, New Delhi. B. K. Nayar & S. Kaur (eds.): 111-201.
- NAYAR, B. K. (1976). The classification of ferns. In *Recent Advances in Botany*, Bishen Singh Mahendra Pal Singh, Dehradun, P. Kachroo (ed.): 145-204.
- NAYAR, B. K. & KAUR, S. (1968). Spore germination in homosporous ferns. *J. Palynol.* **4** : 1-14.
- NAYAR, B. K. & KAUR, S. (1969). Types of prothallial development in homosporous ferns. *Phytomorphology* **19** : 179-188.
- NAYAR, B. K. & KAUR, S. (1971). Gametophytes of homosporous ferns. *Bot. Rev.* **37** : 295-396.
- STOKEY, A. G. (1951). The contribution by the gametophyte to the classification of the homosporous ferns. *Phytomorphology* **1** : 39-58.