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Systematic Studies on the Conducting Tissue of the Gametophyte in Musci

(8) On the Essential Coordination Among the Anatomical Characteristics of the Stems in Some Species of Amblystegiaceae

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Abstract The cross sections of the stem of nine species of Amblystegiaceae are observed, and the observations of the stem in fifty-four species of Amblystegiaceae by KANDA (1976) are surveyed. From these observations, the anatomical characteristics of the stem in Amblystegiaceae are classified into four types.: **III-Q(P)-M(N)-S, III-Q (P)-N(M)-R, III-P-M(N)-S** and **III-P-N(M)-S.** Next, a longitudinal section is observed, which is obtained from the stem of each type, and the stems of the three species (*Cratoneuron filicinum, Leptodictyum riparium and Calliergonella cuspidata*) are comparatively studied on the basis of the anatomical characteristics on the cross and the longitudinal sections.

From Table 4, the anatomical characteristics of the stem for *Calliergonella* can be shown as **III-3a-M-P-S,** for *Leptodictyum* as **III-4a-N-P-S,** and for *Cratoneuron* as **III-4a-N-Q-R.** These characteristics are all those of the hadrom, seen both from a cross and a longitudinal section. Thus, the anatomical characteristics of the hadrom are likely to be more essential.

We wish to make further research into the matter pertaining to what sort of feature is the essential characteristic after this.

Introduction

From the stand-point of morphogenesis, a stem is composed of three fan-shaped portions in its cross section. In the species of Musci, the modes of division of the three portions generally closely resemble each other.

For making an analysis of the organization of the stem, we must gain a better understanding of the process of development in the gametophyte. That is, we must to investigate what mode of division goes on in three series of segments, Segment **I**, Segment **II** and Segment **III**, which have been cut off from apex of the stem. We wish to research what sort of tissue compose the stem of this type.

Materials and Methods

The materials used for this research are composed of specimens of mosses collected in Japan. All the samples studied are deposited in the Moss Herbarium of Kanazawa University.

Leptodictyum riparium (HEDW.) WARNST. : Ehime (35057), Kumamoto (37518), Wakayama (39255), Ehime (37517), Kumamoto (35061), Aichi (38562), Kumamoto (38539). *Cratoneuron filicinum* (HEDW.) SPR.: Toyama (32711), Nara (34948), Tokushima (32622), Nagano (34995). *Cratoneuron filicinum* (HEDW.) SPR. var. *fallax* (BRID.) ROTH: Toyama (36253). *Pleurozium schreberi* (BRID.) MITT.: Yamanashi (37402), Gifu (39164), Wakayama (39411). *Calliergonella cuspidata* (HEDW.) LOESK. : Niigata (35209), Hokkaidoo(37345), Niigata (37403). *Campyliadelphus chrysophyllus* (BRID.) KANDA: Ishikawa(36197), Miyagi (34905), Kumamoto (35022) Nagano (32710). *Campyliadelphus stellatus* (HEDW.) KANDA: Tokushima (39384). *Sasaokaea aomoriensis* (PAR.) KANDA: Niigata (35235), Hyoogo (39408), Aichi (39232). *Sanionia uncinata* (HEDW.) LOESK.: Ishikawa (36222).

The hard mosses are boiled in water for about an hour in order to prevent the soft tissue from breaking. The inner structure of the stem is studied from transverse and longitudinal sections having a thickness of five microns. Gentian violet and acid fuchsin combinations are used for staining anatomical preparations.

Observation and Discussion

In the nine species of Amblystegiaceae, the cross sections and the longitudinal sections of the stem are observed.

(1) Anatomical characteristics on the cross section of the stem

The affinity regarding the anatomical characteristics of the stem in Amblystegiaceae is considered(Plate I–XII and Tab. 1). From what KANDA (1976) stated, the species of Amblystegiaceae are classified into five subfamilies (Tab. 2). Namely, the species of this family are divided into **A**-grop and **B**-group through the exterior forms of the gametophyte. The **A**-group is divided into **AI**-group and **AII**-group through the shapes of the leaf-cell and of the pseudoparaphyllia. The **AI**-group is divided into **AI-a** and **AI-b** through the shapes of the leaf-cell and of the capsule. The **B**-group is divided into **BI**-group and **BII**-group through the forms of the stem-leaves(**AI-a**: Amblystegioideae, **AI-b**: Campylioideae, **AII**: Hygrohypnoideae, **BI**: Drepanocladoideae, **BII**: Calliergonoideae).

The relationship between the affinity regarding the anatomical characteristics and this classification is discussed(Tab. 3). From the table, the stem of the species belonging to the identical subfamily shows similar anatomical characteristics, except the subfamily Amblystegioideae. Of the anatomical characteristics, the four characteristics (**III**–, **P.Q**–, **M.N**– and **R.S**–types) may be of great importance to the classification system.

Tab. 1 Anatomical characteristics of the stems in nine spacies of Amblystegiaceae

		Cratoneuron filicinum (Hedw.) Spr.	*Cratoneuron filicinum* (Hedw.) Spr.	*Cratoneuron filicinum* (Hedw.) Spr.	*Cratoneuron filicinum* (Hedw.) Spr.	*Cratoneuron filicinum* (Hedw.) Spr.	*Cratoneuron filicinum* (Hedw.) Spr.
Number of the figures in the Plate		II-1	II-2	II-3	II-4	II-5	II-6
The stem differentiates into an epidermis, cortex, leptom and a hadrom (**III**-type)		III	III	III	III	III	III
Cell walls of the hadrom are thicker (**O**-type), as thick (**P**-type) or thinner (**Q**-type) than those of the leptom		Q(P)	Q(P)	Q(P)	Q(P)	Q(P)	Q(P)
Cells of the hadrom are larger (**L**-type), as large (**M**-type) or smaller (**N**-type) than those of the leptom		N(M)	N(M)	N(M)	N(M)	N(M)	N(M)
Cells of the hadrom are parenchymatous (**R**-type) or not (**S**-type)		R	R	R	R	R	R
Cells of the epidermal layer are parenchymatous (**T**-type) or not (**U**-type)		U	U	U	U	U	U
Epidermal cell walls are thicker (**G**-type), as thick (**H**-type) or thinner(**I**-type) than those of the cortex		G	G	G	G	G	G
Cells of the epidermal layer are larger (**V**-type), as large (**W**-type) or smaller (**X**-type) than those of the cortex		X	X	X	X	X	X
Number of the cell layers of the cortex is 1-4 cell layers(**C**-type) or 4-7 cell layers (**D**-type)	Type	3(3-4)C	3(2-3)C	3(3-3)C	3(2-3)C	4(4-4)C	3(3-4)C
	Layers						
Number of the cell layers ef the leptom is 1-4 cell layers (**A**-type) or 4-13 cell layers (**B**-type)	Type	4(3-4)A	3(2-4)A	4(4-5)B	4(3-4)A	4(3-4)A	4(3-5)B
	Layers						

Cratoneuron filicinum v. *fallax* (BRID.) ROTH	4(3-4)A	3(3-4)C	X	G	U	R	N(M)	Q(P)	III	III-1
Cratoneuron filicinum v. *fallax* (BRID.) ROTH	2(2-3)A	3(3-4)C	X	G	U	R	N	Q(P)	III	III-2
Cratoneuron filicinum v. *fallax* (BRID.) ROTH	3(3-4)A	4(3-4)C	X	G	U	R	N(M)	Q(P)	III	III-3
Cratoneuron filicinum v. *fallax* (BRID.) ROTH	3(2-3)A	3(2-3)C	X	G	U	R	N(M)	Q(P)	III	III-4
Cratoneuron filicinum v. *fallax* (BRID.) ROTH	4(4-4)A	3(3-4)C	X	G	U	R	N(M)	Q(P)	III	III-5
Cratoneuron filicinum v. *fallax* (BRID.) ROTH	4(4-4)A	3(2-3)C	X	G	U	R	N(M)	Q(P)	III	III-6
Cratoneuron filicinum v. *fallax* (BRID.) ROTH	4(3-4)A	3(3-4)C	X	G	U	R	N(M)	Q(P)	III	IV-1
Leptodictyum riparium (Hedw.) WARNST.	5(5-5)B	3(3-3)C	X	G	U	S(R)	N(M)	P(Q)	III	I-1
Leptodictyum riparium (Hedw.) WARNST.	5(4-5)B	3(2-3)C	X	G	U	S(R)	N	P(Q)	III	I-2
Leptodictyum riparium (Hedw.) WARNST.	4(3-4)B	3(3-3)C	X	G	U	S(R)	N	P(Q)	III	I-3
Leptodictyum riparium (Hedw.) WARNST.	5(5-5)B	3(2-3)C	X	G	U	S(R)	N	P(Q)	III	I-4
Leptodictyum riparium (Hedw.) WARNST.	7(6-8)B	3(2-3)C	X	G	U	S(R)	N	P(Q)	III	I-5
Leptodictyum riparium (Hedw.) WARNST.	6(5-7)B	3(2-3)C	X	G	U	S(R)	N	P(Q)	III	I-6
Campyliadelphus chrysophyllus (BRID.) KANDA	5(4-6)B	4(4-4)C	V(W)	I	U	S	N(M)	P	III	VII-3
Campyliadelphus chrysophyllus (BRID.) KANDA	6(5-10)B	4(3-4)C	V(W)	I	U	S	N(M)	P	III	VII-4
Campyliadelphus chrysophyllus (BRID.) KANDA	5(4-6)B	4(4-4)C	V(W)	I	U	S	N(M)	P	III	VIII-1
Campyliadelphus chrysophyllus (BRID.) KANDA	4(3-6)B	4(3-4)C	V(W)	I	U	S	NM	P	III	VIII-2
Campyliadelphus chrysophyllus (BRID.) KANDA	5(4-5)B	4(4-5)D	V(W)	I	U	S	NM	P	III	VIII-3
Campyliadelphus chrysophyllus (BRID.) KANDA	4(3-6)B	4(4-4)C	V(W)	I	U	S	N(M)	P	III	VIII-4
Campyliadelphus stellatus (HEDW.) KANDA	4(4-5)B	3(2-4)C	X	I	U	S	N(M)	P(Q)	III	VIII-5
Campyliadelphus stellatus (HEDW.) KANDA	3(3-4)A	2(2-3)C	X	I	U	S	N(M)	P(Q)	III	VIII-6
Campyliadelphus stellatus (HEDW.) KANDA	3(3-4)A	2(2-3)C	X	I	U	S	N(M)	P(Q)	III	IX-1
Campyliadelphus stellatus (HEDW.) KANDA	4(3-4)A	2(2-3)C	X	I	U	S	N(M)	P(Q)	III	IX-2
Campyliadelphus stellatus (HEDW.) KANDA	4(4-6)B	2(2-3)C	X	I	U	S	N(M)	P(Q)	III	IX-3
Campyliadelphus stellatus (HEDW.) KANDA	4(3-4)A	3(2-3)C	X	I	U	S	N(M)	P(Q)	III	IX-4
Sasaokaea aomoriensis (PAR.) KANDA	5(4-7)B	3(2-3)C	X	G	U	S	M(N)	P	III	IX-5
Sasaokaea aomoriensis (PAR.) KANDA	6(5-8)B	3(2-4)C	X	G	U	S	M(N)	P	III	X-1
Sasaokaea aomoriensis (PAR.) KANDA	5(4-6)B	3(3-4)C	X	G	U	S	M(N)	P	III	X-2
Sasaokaea aomoriensis (PAR.) KANDA	6(5-8)B	2(2-3)C	X	G	U	S	M(N)	P	III	X-3
Sasaokaea aomoriensis (PAR.) KANDA	6(5-8)B	3(3-4)C	X	G	U	S	M(N)	P	III	XI-1
Sasaokaea aomoriensis (PAR.) KANDA	5(5-8)B	3(2-3)C	X	G	U	S	M(N)	P	III	XI-2
Sanionia uncinata (HEDW.) LOESK.	5(4-5)B	4(4-5)D	V	I	T	S	MN	P	III	XI-3
Sanionia uncinata (HEDW.) LOESK.	5(5-6)B	5(4-5)D	V	I	T	S	M(N)	P	III	XI-4
Sanionia uncinata (HEDW.) LOESK.	5(4-6)B	4(3-5)D	V	I	T	S	M(N)	P	III	XII-1
Sanionia uncinata (HEDW.) LOESK.	5(4-6)B	5(4-5)D	V	I	T	S	M(N)	P	III	XII-2
Sanionia uncinata (HEDW.) LOESK.	5(5-6)B	4(4-5)D	V	I	T	S	M(N)	P	III	XII-3
Sanionia uncinata (HEDW.) LOESK.	3(3-5)A	4(3-5)D	V	I	T	S	M(N)	P	III	XII-4
Sanionia uncinata (HEDW.) LOESK.	4(3-5)B	4(3-4)C	V	I	T	S	M(N)	P	III	XII-5
Sanionia uncinata (HEDW.) LOESK.	5(5-6)B	4(4-5)D	V	I	T	S	M(N)	P	III	XII-6

Calliergonella cuspidata (HEDW.) LOESK.	4(3-4)A	3(2-4)C	V	I	T	S(R)	M(N)	P	III	VI-1
Calliergonella cuspidata (HEDW.) LOESK.	4(3-5)A	3(3-4)C	V	I	T	S(R)	M(N)	P	III	VI-2
Calliergonella cuspidata (HEDW.) LOESK.	4(3-6)B	3(2-4)C	V	I	T	S(R)	M(N)	P	III	VI-3
Calliergonella cuspidata (HEDW.) LOESK.	4(3-4)A	3(2-4)C	V	I	T	S(R)	M(N)	P	III	VI-4
Calliergonella cuspidata (HEDW.) LOESK.	4(4-5)B	3(3-4)C	V	I	T	S(R)	MN	P	III	VI-5
Calliergonella cuspidata (HEDW.) LOESK.	4(4-5)B	4(3-4)C	V	I	T	S(R)	M(N)	P	III	VII-1
Calliergonella cuspidata (HEDW.) LOESK.	4(3-5)B	3(3-4)C	V	I	T	S(R)	M(N)	P	III	VII-2
Pleurozium schreberi (BRID.) MITT.	8(8-10)B	4(4-4)C	X(W)	G	U	S	MN	P	III	IV-2
Pleurozium schreberi (BRID.) MITT.	8(7-10)B	3(3-4)C	X(W)	G	U	S	MN	P	III	IV-3
Pleurozium schreberi (BRID.) MITT.	9(8-10)B	3(2-3)C	X(W)	G	U	S	N	P	III	IV-4
Pleurozium schreberi (BRID.) MITT.	9(8-11)B	3(3-4)C	X(W)	G	U	S	MN	P	III	V-1
Pleurozium schreberi (BRID.) MITT.	9(9-11)B	3(3-4)C	X(W)	G	U	S	MN	P	III	V-2
Pleurozium schreberi (BRID.) MITT.	9(8-10)B	4(3-4)C	X(W)	G	U	S	MN	P	III	V-3

Tab. 2 Affinity regarding the anatomical characteristics of the stem in Amblystegiaceae

			Species	Leptom	Cortex	Epidermis			Hadrom			Types
A	AI	AI-a	*Hygroamblystegium varium* (HEDW.) MOENK.	A	C	X	I	U	S	M(N)	Q(P)	III
			Hygroamblystegium calcareum KANDA	A	C	W	I	U	S	M(N)	Q(P)	III
			Cratoneuron commutatum (HEDW.) ROTH	A	C	XW	H	U	R	N(M)	Q(P)	III
			Cratoneuron filicinum (HEDW.) SPR.	A	C	X	G	U	R	N(M)	Q(P)	III
			Cratoneuron filicinum v. *fallax* (BRID.) ROTH	A	C	X	G	U	R	N(M)	Q(P)	III
			Cratoneuron formosanum BROTH.	A	C	X	G	U	R(S)	N(M)	Q(P)	III
			Cratoneuron tenerrimum (WARNST.) KANDA	A	C	X	G	U	R(S)	N(M)	Q(P)	III
			Platydictya fauriei (CARD.) IWATS. et NOG.	A	C	W	H	U	S	M	P	III
			Platydictya hattorii KANDA	A	C	W	H	U	S	M	P	III
			Platydictya subtilis (HEDW.) CRUM	A	C	W	H	U	S	M	P	III
			Platydictya shiroumensis KANDA	A	C	X	G	U	S	M	P	III
			Leptodictyum riparium (HEDW.) WARNST.	B	C	X	G	U	S(R)	N(M)	P(Q)	III
			Leptodictyum bandaiense (TAK.) KANDA	A	C	X	G	U	S	N(M)	P	III
			Leptodictyum mizushimae (SAK.) KANDA	B	C	WX	H	U	S	N(M)	P	III
			Leptodictyum kochii (B.S.G.) WARNST.	A	C	WX	H	U	S	N(M)	P	III
			Leptodictyum radicale (P. BEAUV.) KANDA	A	C	X	H	U	S	N(M)	P	III
			Amblystegium serpens (HEDW.) B.S.G.	A	C	W	H	U	S	N(M)	P	III
			Amblystegium juratzkanum SCHIMP.	A	C	W	H	U	S	N(M)	P	III
			Amblystegium rishiriense KANDA	A	C	X	G	U	S	N(M)	P(O)	III

		A I-b	*Campylium hispidulum* (BRID.) MITT.	A	C	X	I	T(U)	S	N(M)	P	III
			Campylium pulchrum KANDA	A	C	W	I	T	S	N(M)	P	III
			Campylium sommerfeltii (MYR.) J. LANG.	A	C	X	I	U	S	N(M)	P	III
			Campylium squarrosulum (BESCH. et CARD.) KANDA	A	C	X	I	U	S	N(M)	P	III
			Campylinm rishiriense KANDA	A	C	W	I	U	S	N(M)	P	III
			Campylophyllum halleri (HEDW.) FL.	B	C	WX	I	U	S	N(M)	P	III
			Campyliadelphus chrysophyllus (BRID.) KANDA	B	C	V(W)	I	U	S	N(M)	P	III
			Campyliadelphus polygamus (B.S.G.) KANDA	A	C	X	I	U	S	N(M)	P(Q)	III
			Campyliadelphus stellatus (HEDW.) KANDA	A	C	X	I	U	S	N(M)	P(Q)	III
			Campyliadelphus stellatus v. *brotheri* (IHS.) KANDA	B	C	X	G	U	S	N(M)	P	III
			Campyliadelphus elodes (LINDB.) KANDA	B	C	X	G	U	S	N(M)	P	III
	A II		*Hygrohypnum ochraceum* (WILS.) LOESK.	A	C	V	I	T	S	M(N)	P	III
			Hygrohypnum luridum (HEDW.) JENN.	A	C	X(W)	G(H)	U	S	M(N)	P	III
			Hygrohypnum luridum v. *subspraericarpon* (BRID.) C. JENN.	A	C	W	G(H)	U	S	M(N)	P	III
			Hygrohypnum tsurugizanicum CARD.	A	C	W	G(H)	U	S	M(N)	P	III
			Pseudohygrohypnum eugyrium (B.S.G.) KANDA	A	C	W	I	U	S	M	P	III
			Pseudohygrohypnum purpurascens (BROTH.) KANDA	A	C	W	I	U	S	M(N)	P	III
B	B I		*Sanionia uncinata* (HEDW.) LOESK.	B	D	V	I	T	S	M(N)	P	III
			Drepanocladus revolvens (SW.) WARNST.	A	C	V	I	T	S	M(N)	P	III
			Drepanocladus aduncus (HEDW.) WARNST.	A	C	X	H(I)	U	S	M(N)	P	III
			Drepanocladus aduncus v. *pseudofluitans* (SAN.) GLOW.	B	C	X	H	U	S	M(N)	P	III
			Drepanocladus fluitans (HEDW.) WARNST.	B	C	X	H	U	S	M(N)	P	III
			Drepanocladus fluitans v. *kutcharokensis* KANDA	A	C	X	G	U	S	M(N)	P	III
			Drepanocladus schulzei (LIMPR.) ROTH	A	C	X(W)	G	U	S	M(N)	P	III
			Drepanocladus exannulatus (B.S.G.) WARNST.	A	C	X	G	U	S	M(N)	P	III
			Drepanocladus exannulatus v. *purpurascens* (SCHIMP.) HERZ.	B	C	X	G(H)	U	S	M(N)	P	III
			Drepanocladus trichophyllus (WARNST.) PODP.	A	C	X(W)	G(H)	U	S	M(N)	P	III
			Drepanocladus vernicosus (MOL.) WARNST.	A	C	X	G	U	S	M	P	III
			Sasaokaea aomoriensis (PAR.) KANDA	B	C	X	G	U	S	M(N)	P	III
	B II		*Calliergonella cuspidata* (HEDW.) LOESK.	A(B)	C	V	I	T	S(R)	M(N)	P	III
			Calliergon cordifolium (HEDW.) KINDB.	A	C	W(X)	H	U	S	M(N)	P	III
			Calliergon stramineum (BRID.) KINDB.	A	C	X	G(H)	U	S	M(N)	P	III
			Calliergon sarmentosum (WAHLENB.) KINDB.	B	C	X	G	U	S	M(N)	P	III
			Loeskypum wickesii (GROUT) TUOM.	A	C	X	G	U	S	M(N)	P	III
			Pleurozium schreberi (BRID.) MITT.	B	C	X(W)	G	U	S	MN	P	III

Tab. 3 Relationship between the affinity regarding the anatomical characteristics and this classification

Classification				Anatomical characteristics
A	A I	A I-a	Amblystegioideae	III-Q(P)-M(N)-S
				III-Q(P)-N(M)-R
				III-P-M-S
				III-P-N(M)-S
		A I-b	Campylioideae	III-P-N(M)-S
	A II		Hygrohypnoideae	III-P-M(N)-S
B	B I		Drepanocladioideae	III-P-M(N)-S
	B II		Calliergonoideae	III-P-M(N)-S

(2) Anatomical characteristics on the longitudinal section of the stem

In consequence of the observation of the cross section, the anatomical characteristics of the stem in Amblystegiaceae are classified into four types, **III-Q(P)-M(N)-S, III-Q(P)-N(M)-R, III-P-M(N)-S** and **III-P-N(M)-S.** A longitudinal section is observed on each one of the species with the stem belonging to each type. That is, the stems of the three species, *Cratoneuron filicinum* (HEDW.) SPR. as the species with the stem of **III-Q(P)-N(M)-R** type, *Leptodictyum riparium* (HEDW.) WARNST. as that of **III-P-N(M)-S** type and *Calliergonella cuspidata* (HEDW.) LOESK. as that of **III-P-M (N)-S** type, are observed by longitudinal section. As a result of observation of the various characteristics, the seven characteristics as in Table 4 are considered. The stems of the three species are comparatively studied on the basis of the anatomical characteristics on the cross and longitudinal sections.

The stems of all three species, which develop into an epidermis, cortex, leptom and a hadrom (**III**-type), have a spindle shaped hadrom, and the septum of the hadrom is as thick as the cell walls of hadrom. In *Calliergonella* the cell-length of the hadrom is three times as long as that of the epidermis (**3a**), but in *Leptodictyum* and *Cratoneuron* it is four times as long as that of the epidermis (**4a**). In *Calliergonella* the cells of the hadrom are as large as that of the leptom (**M**-type), but in *Leptodictyum* and *Cratoneuron* smaller than that of the leptom (**N**-type). In *Calliergonella* and *Leptodictyum* the cell walls of the hadrom are as thick as that of the leptom (**P**-type), but in *Cratoneuron* thinner than that of the leptom (**Q**-type). In *Cratoneuron* the cells of the hadrom are parenchymatous (**R**-type), but in *Calliergonella* and *Leptodictyum* are not parenchymatous (**S**-type). From the table, the anatomical characteristics of the stem of *Calliergonella* can be shown as **III-3a-M-P-S,** those of *Leptodictyum* as **III-4a-N-P-S,** and of *Cratoneuron* as **III-4a-N-Q-R.**

Tab. 4 Affinity regarding the anatomical characteristics on the cross and longitudinal sections in three species of Amblystegiaceae

Type of the stem	III		
Septum of the hadrom (central tissue) is as thick(**Y**-type) or thinner (**Z**-type) than cell walls of the hadrom	Y		
Shape of cell in the hadrom (central tissue)	Spindle		
Length of cell in the hadrom(central tissue) **a**: Length of cell in the epidermis	3a	4a	
Cells of the hadrom (central tissue) are as large (**M**-type) or smaller (**N**-type) than those of the leptom (internal cortex)	M	N	
Cell walls of the hadrom (central tissue) are as thick (**P**-type) or thinner (**Q**-type) than those of the leptom (internal cortex)	P	P	Q
Cells of the hadrom (central tissue) are parenchymatous (**R**-type) or not (**S**-type)	S	S	R
Length of cell in the cortex(external cortex) **a**: Length of cell in the epidermis	a	a	2a
Length of cell in the leptom (internal cortex) **a**: Length of cell in the epidermis	3a	2a	3a
Shape of cell in the cortex (external cortex)	Rhombic	Rectangular (Rhombic)	Rectangular (Rhombic)
Shape of cell in the leptom (internal cortex)	Rectangular (Rhombic)	Rectangular	Rectangular (Rhombic)
Shape of cell in the epidermis	Rhombic	Rectangular	Rectangular (Rhombic)
Genera	*Calliergonella*	*Leptodictyum*	*Cratoneuron*

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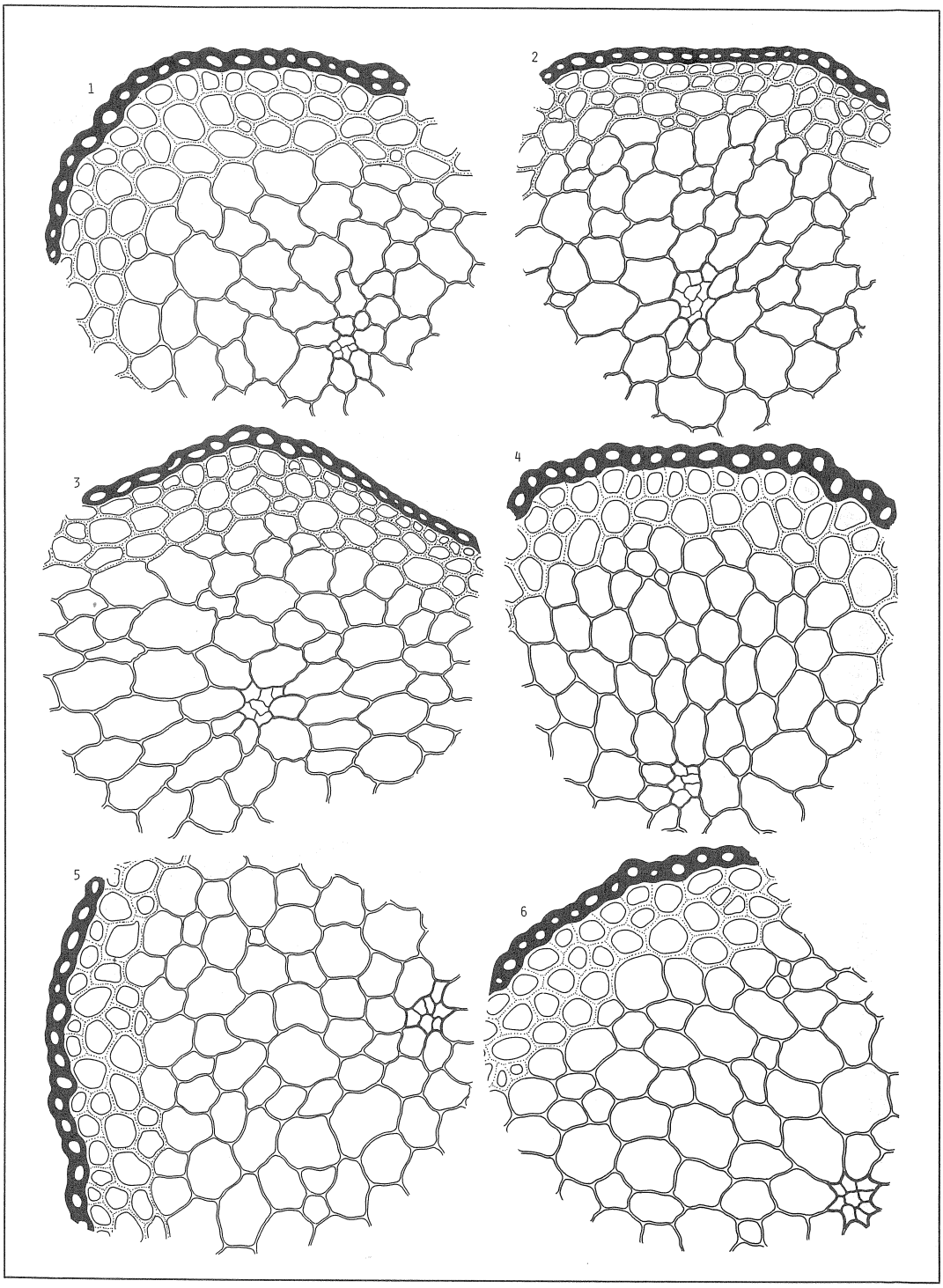


Plate I Cross sections of the stem
Fig. 1–6 : *Leptodictyum riparium* (HEDW.) WARNST. ×240

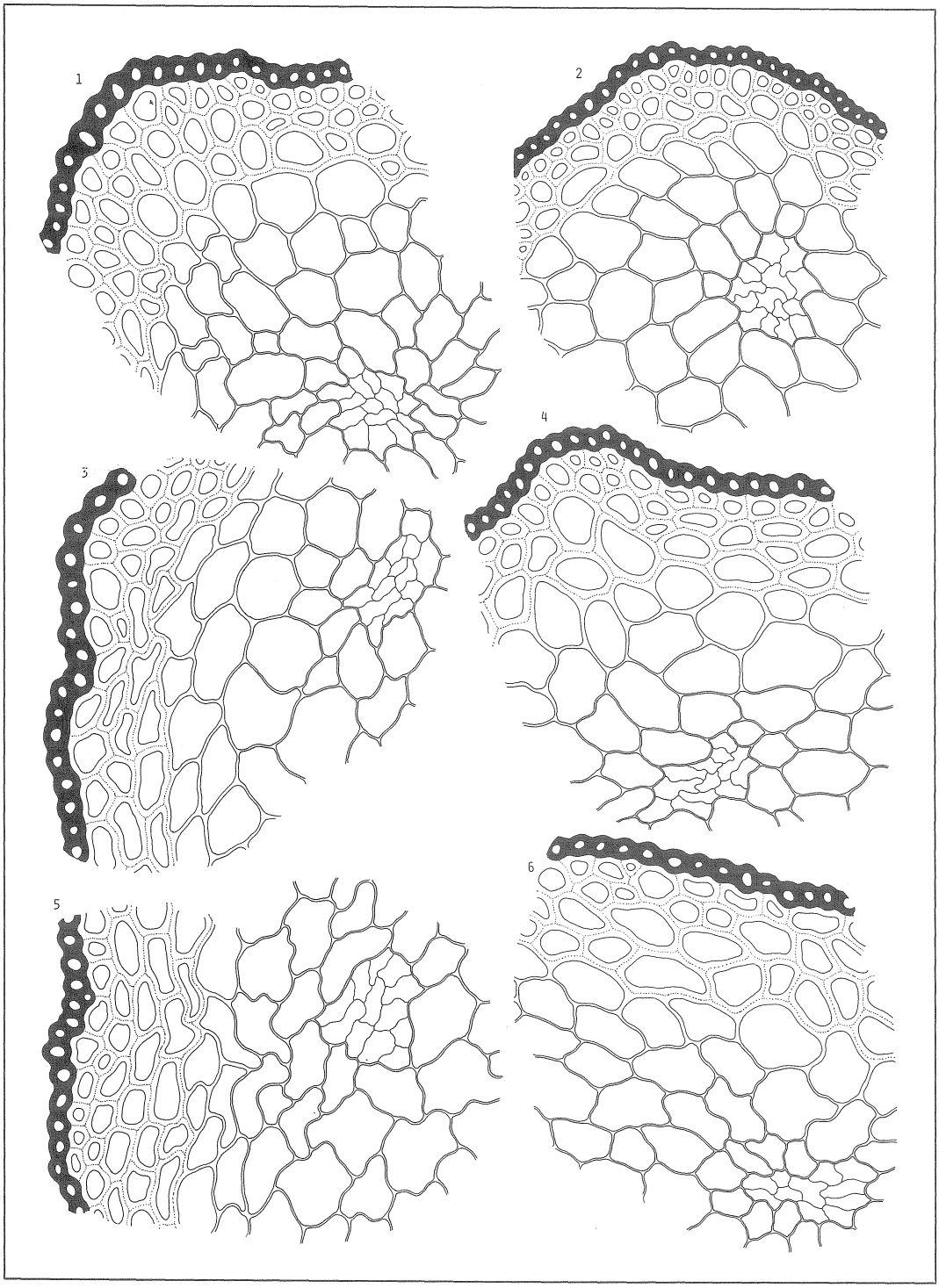


Plate II Cross sections of the stem
Fig. 1–6 : *Cratoneuron filicinum* (HEDW.) SPR. ×240

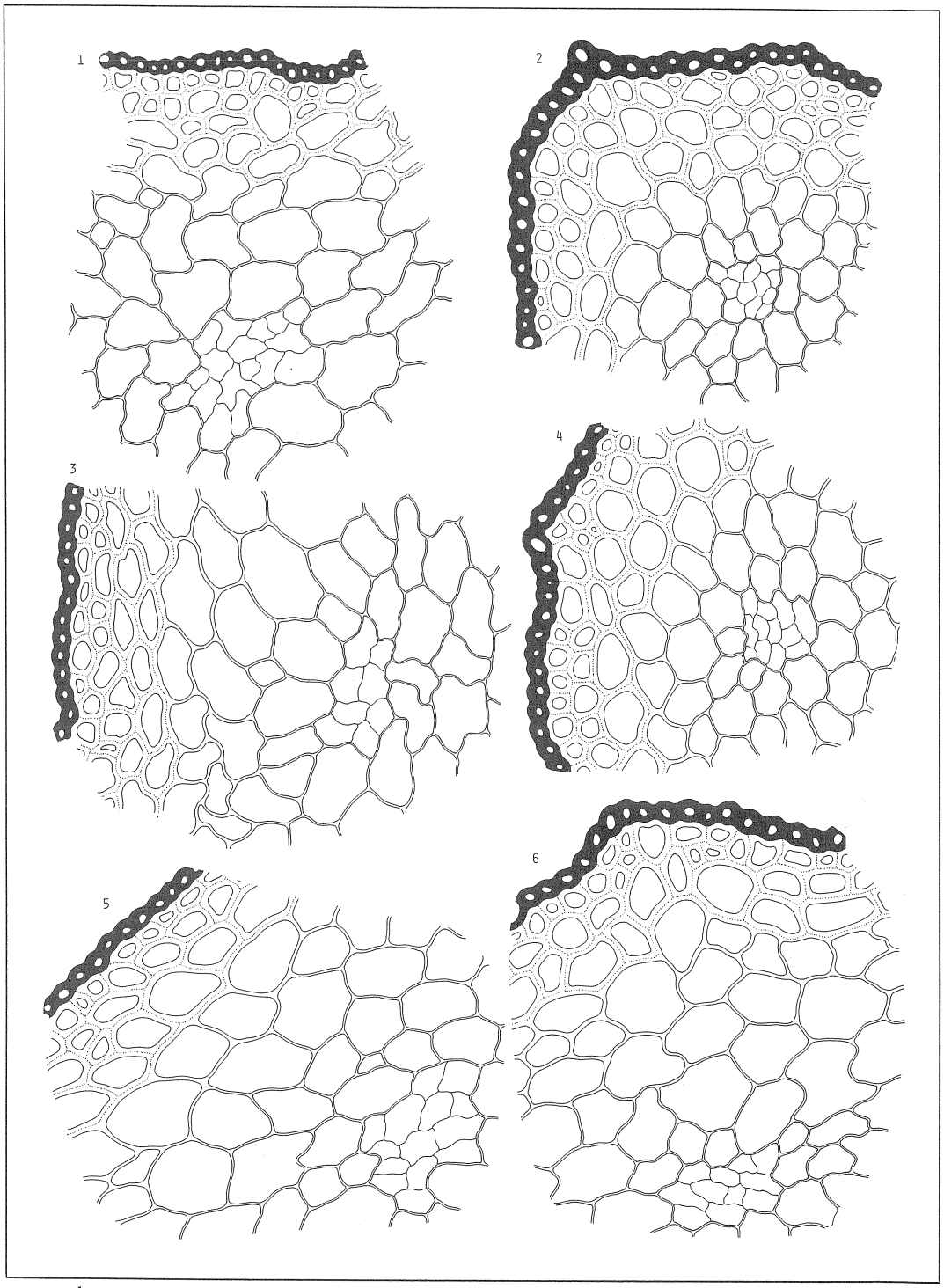


Plate III Cross sections of the stem
Fig. 1–6 : *Cratoneuron filicinum* (HEDW.) SPR. var. *fallax* (BRID.) ROTH ×240

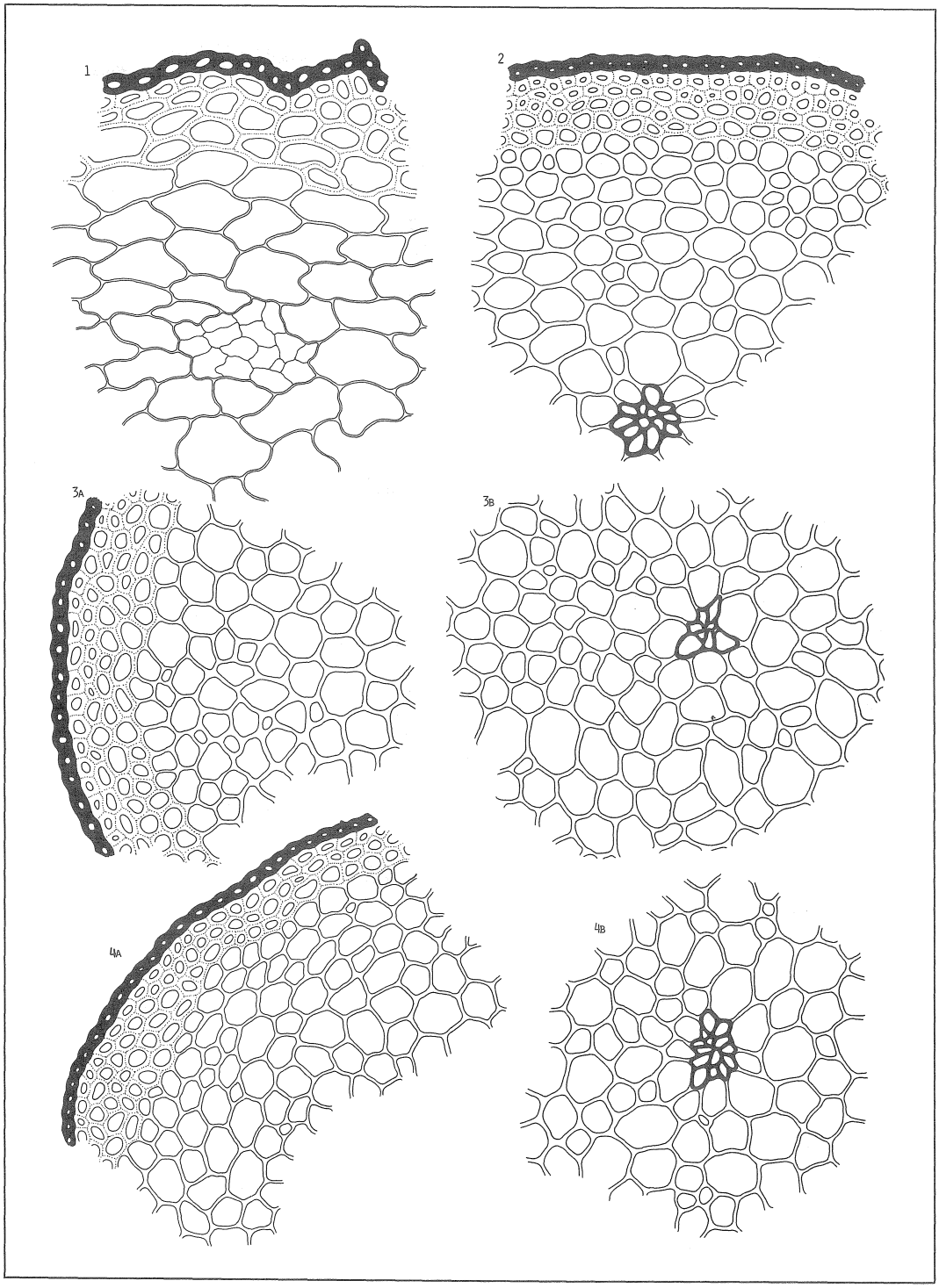


Plate IV Cross sections of the stem
Fig. 1 : *Cratoneuron filicinum* (HEDW.) SPR. var. *fallax* (BRID.) ROTH ×240
Fig. 2–4 : *Pleurozium schreberi* (BRID.) MITT. ×200
A : Outer part of the stem
B : Central part of the stem

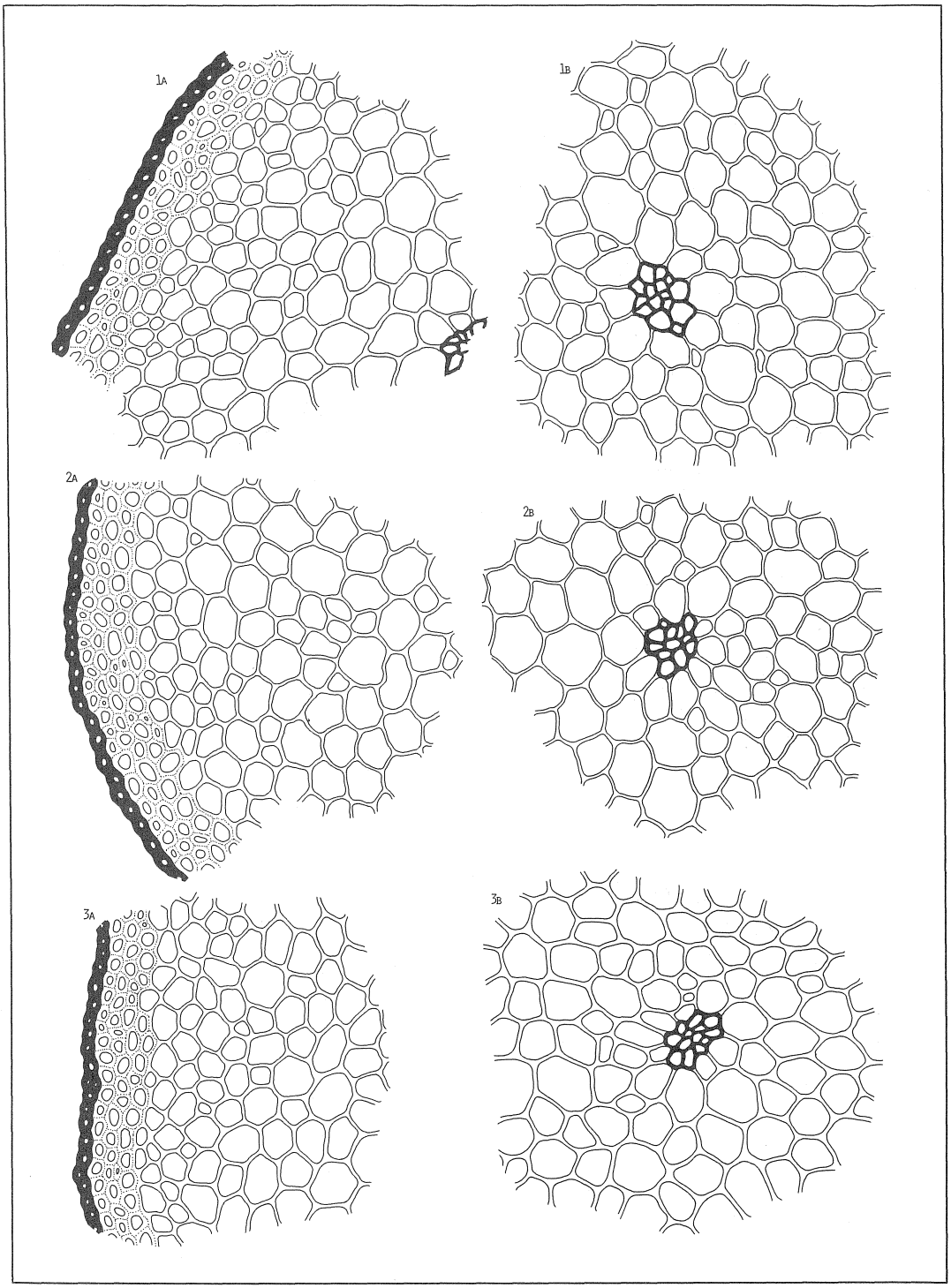


Plate V Cross sections of the stem
Fig. 1-3 : *Pleurozium schreberi* (BRID.) MITT. ×200
A : Outer part of the stem
B : Central part of the stem

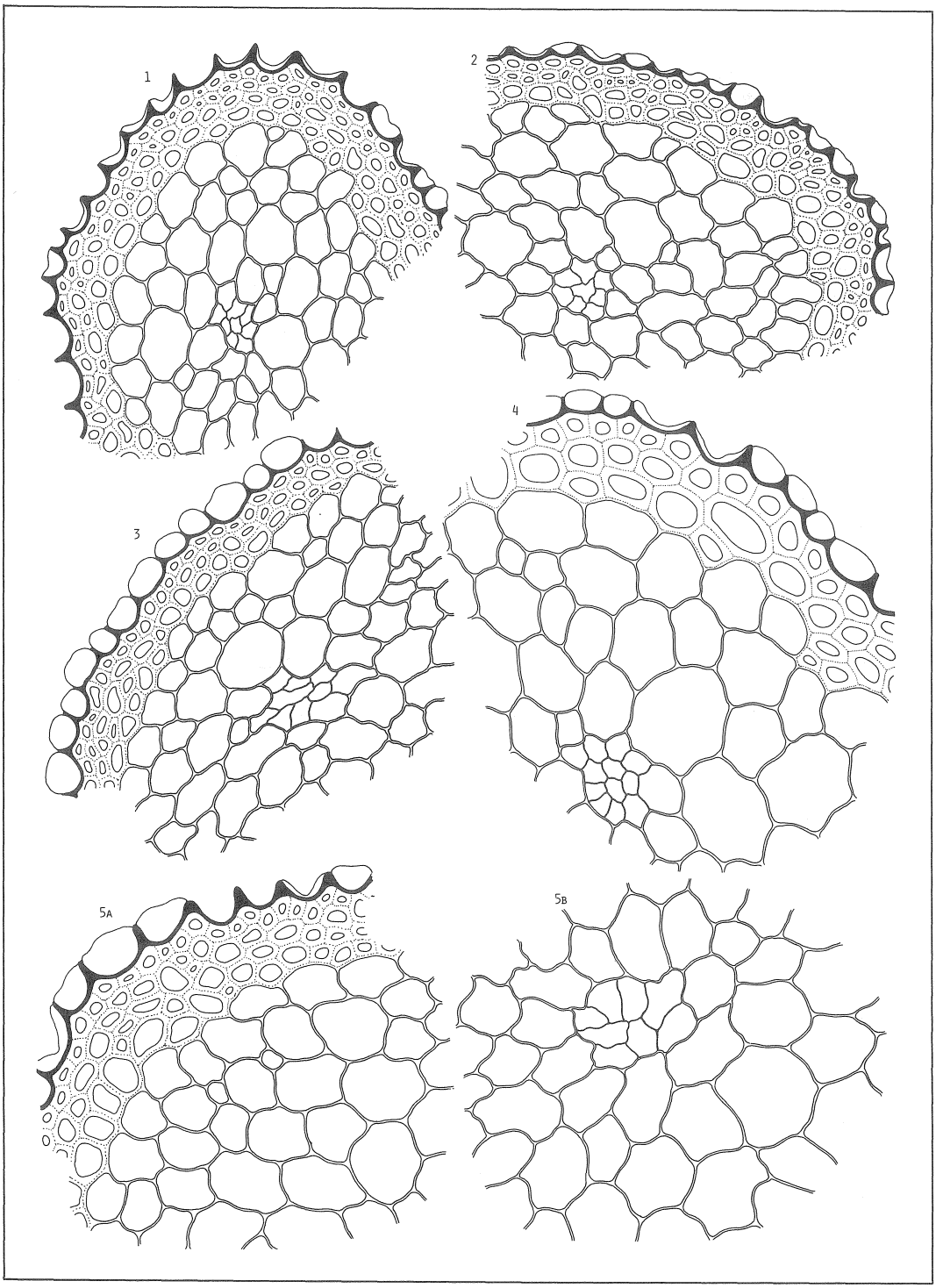


Plate VI Cross sections of the stem
Fig. 1-3, 5 : *Calliergonella cuspidata* (HEDW.) LOESK. ×300
Fig. 4 : *Calliergonella cuspidata* (HEDW.) LOESK. ×400
A : Outer part of the stem
B : Central part of the stem

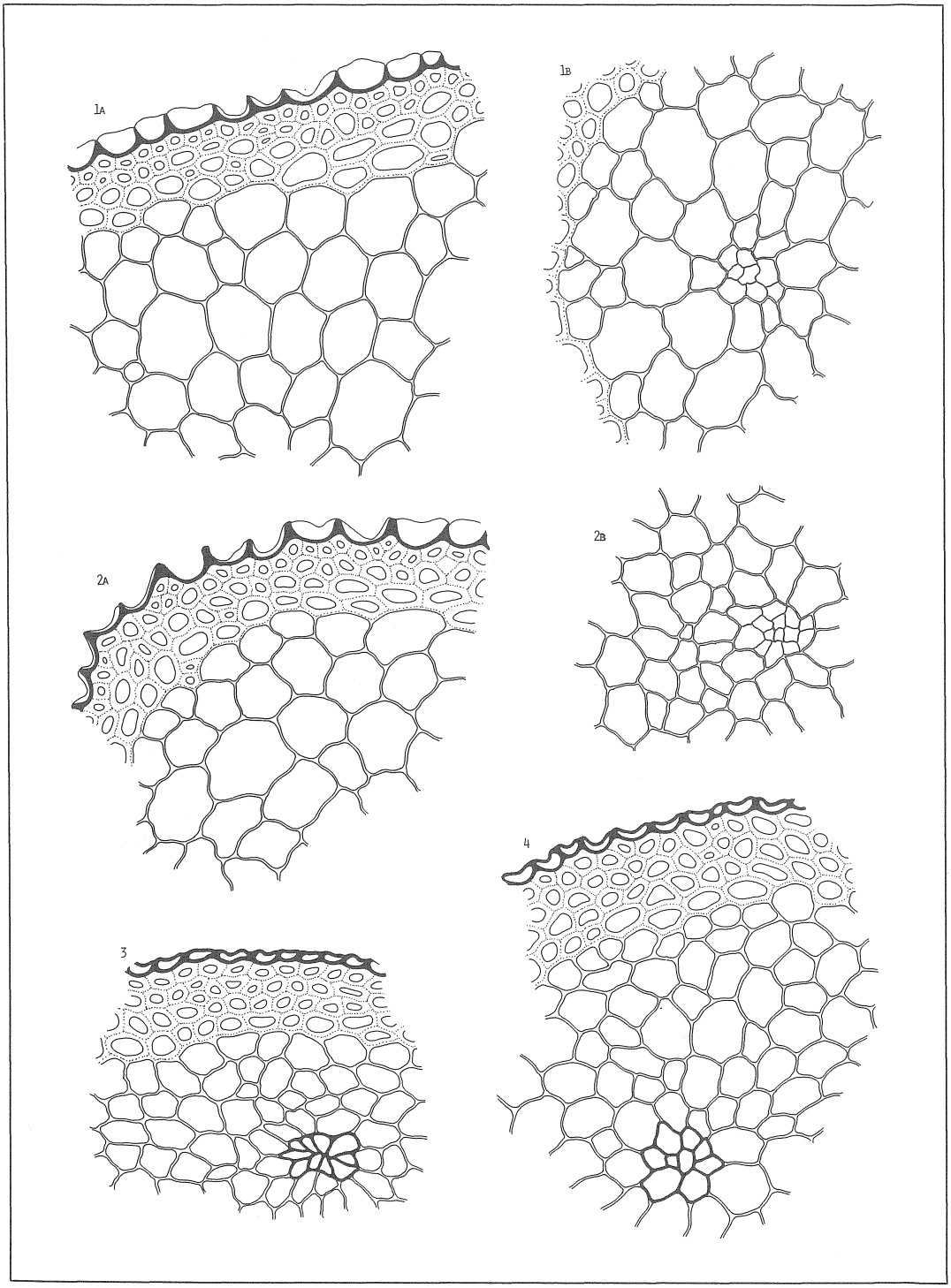


Plate VII Cross sections of the stem
Fig. 1–2 : *Calliergonella cuspidata* (HEDW.) LOESK. ×300
A : Outer part of the stem
B : Central part of the stem
Fig. 3–4 : *Campyliadelphus chrysophyllus* (BRID.) KANDA ×240

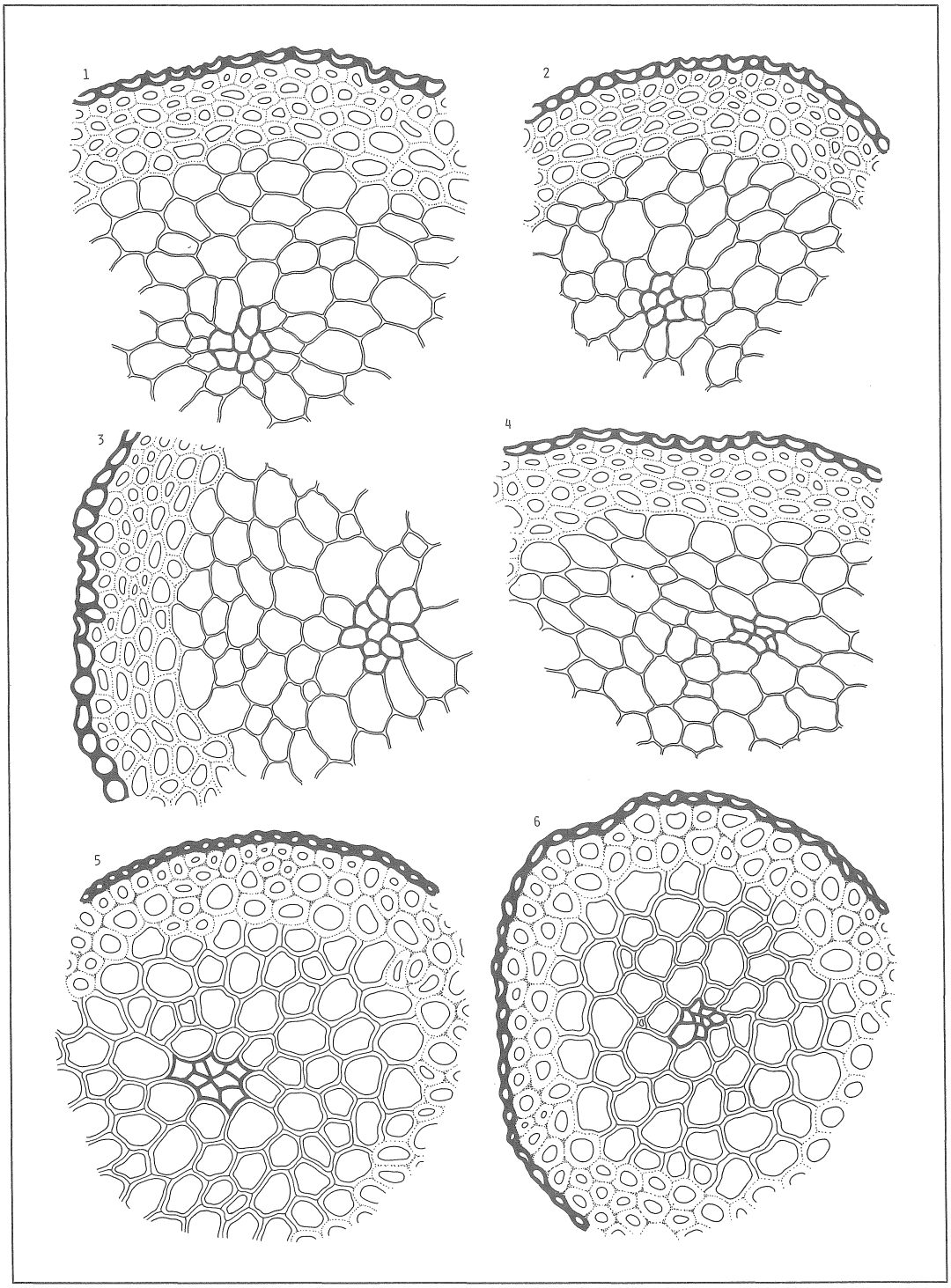


Plate VIII Cross sections of the stem
Fig. 1–4 : *Campyliadelphus chrysophyllus* (BRID.) KANDA ×240
Fig. 5–6 : *Campyliadelphus stellatus* (HEDW.) KANDA. ×240

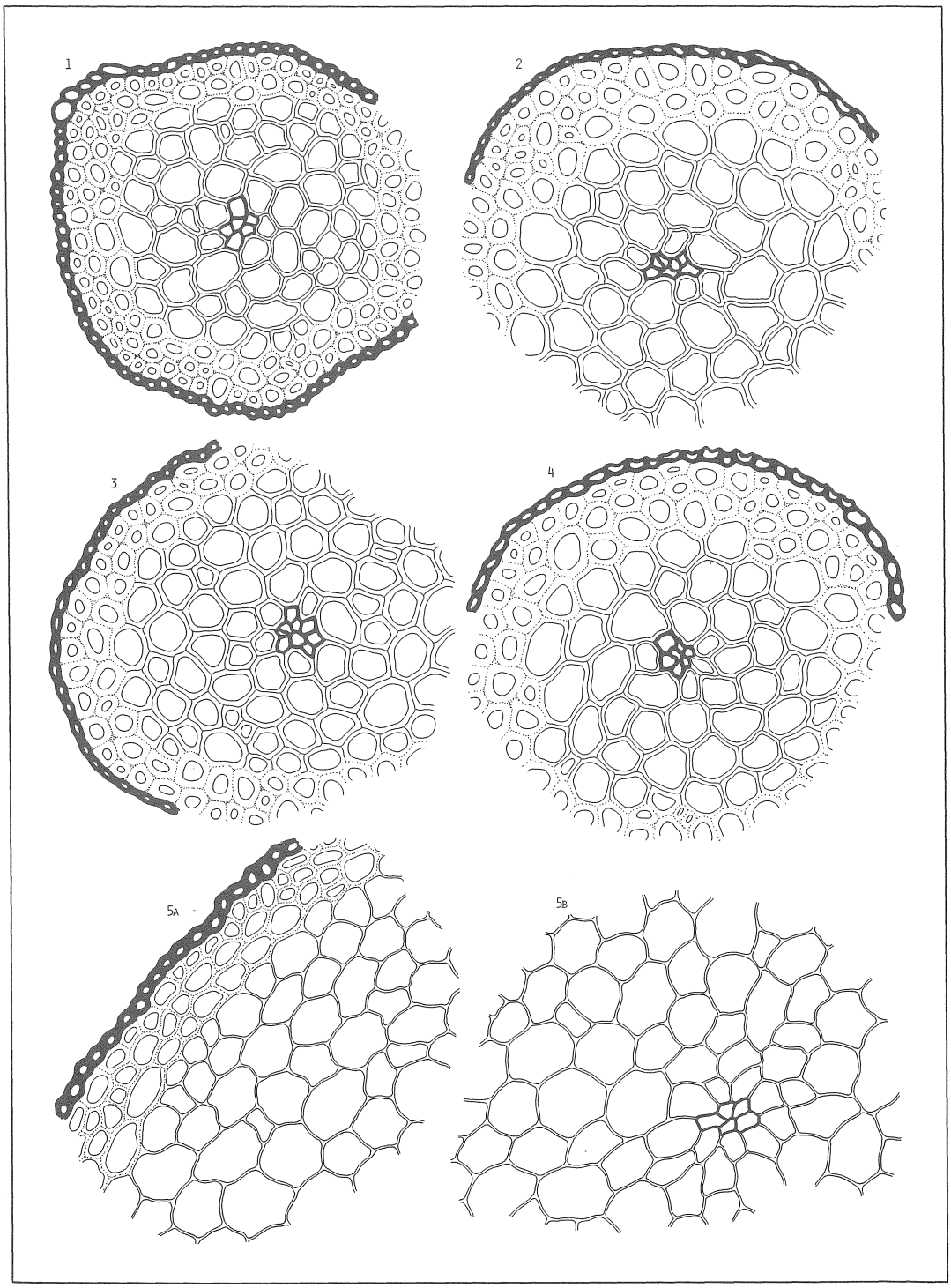


Plate IX Cross sections of the stem
Fig. 1–4 : *Campyliadelphus stellatus* (HEDW.) KANDA ×240
Fig. 5 : *Sasaokaea aomoriensis* (PAR.) KANDA ×240
A : Outer part of the stem
B : Central part of the stem

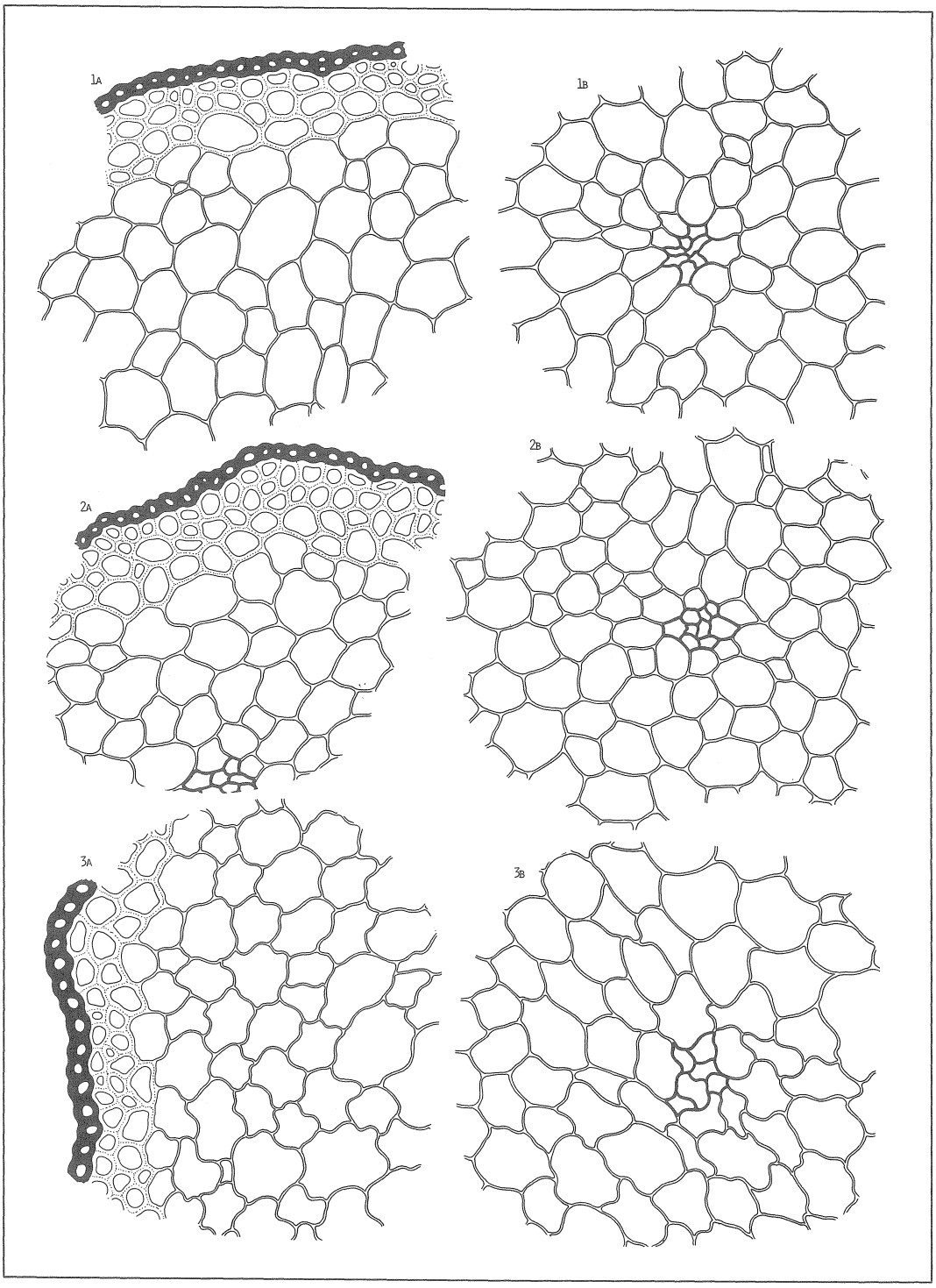


Plate X Cross sections of the stem
Fig. 1–3 : *Sasaokaea aomoriensis* (PAR.) KANDA ×240
A : Outer part of the stem
B : Central part of the stem

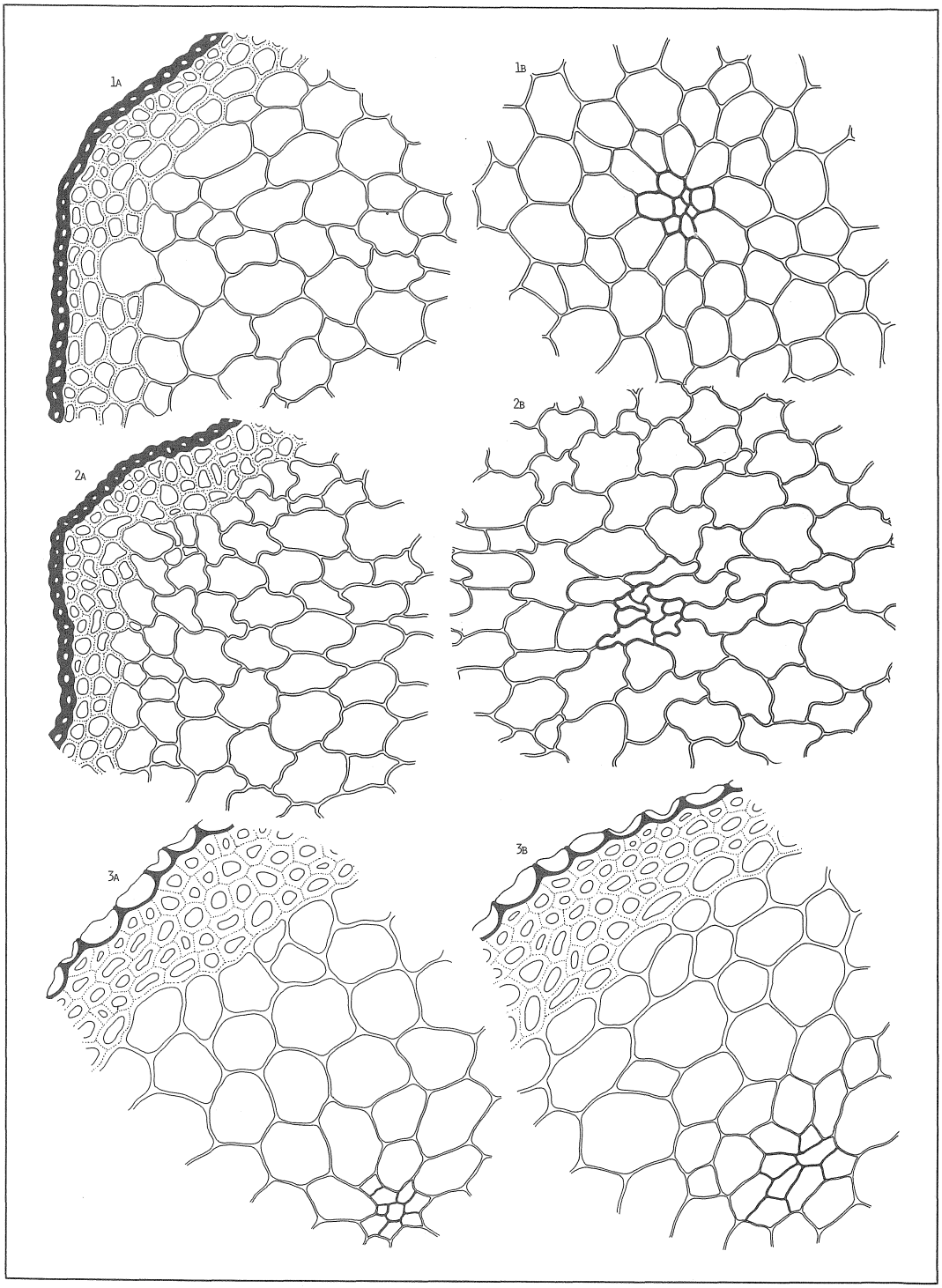


Plate XI Cross sections of the stem
Fig. 1–2 : *Sasaokaea aomoriensis* (PAR.) KANDA ×240
A : Outer part of the stem
B : Central part of the stem
Fig. 3–4 : *Sanionia uncinata* (HEDW.) LOESK. ×240

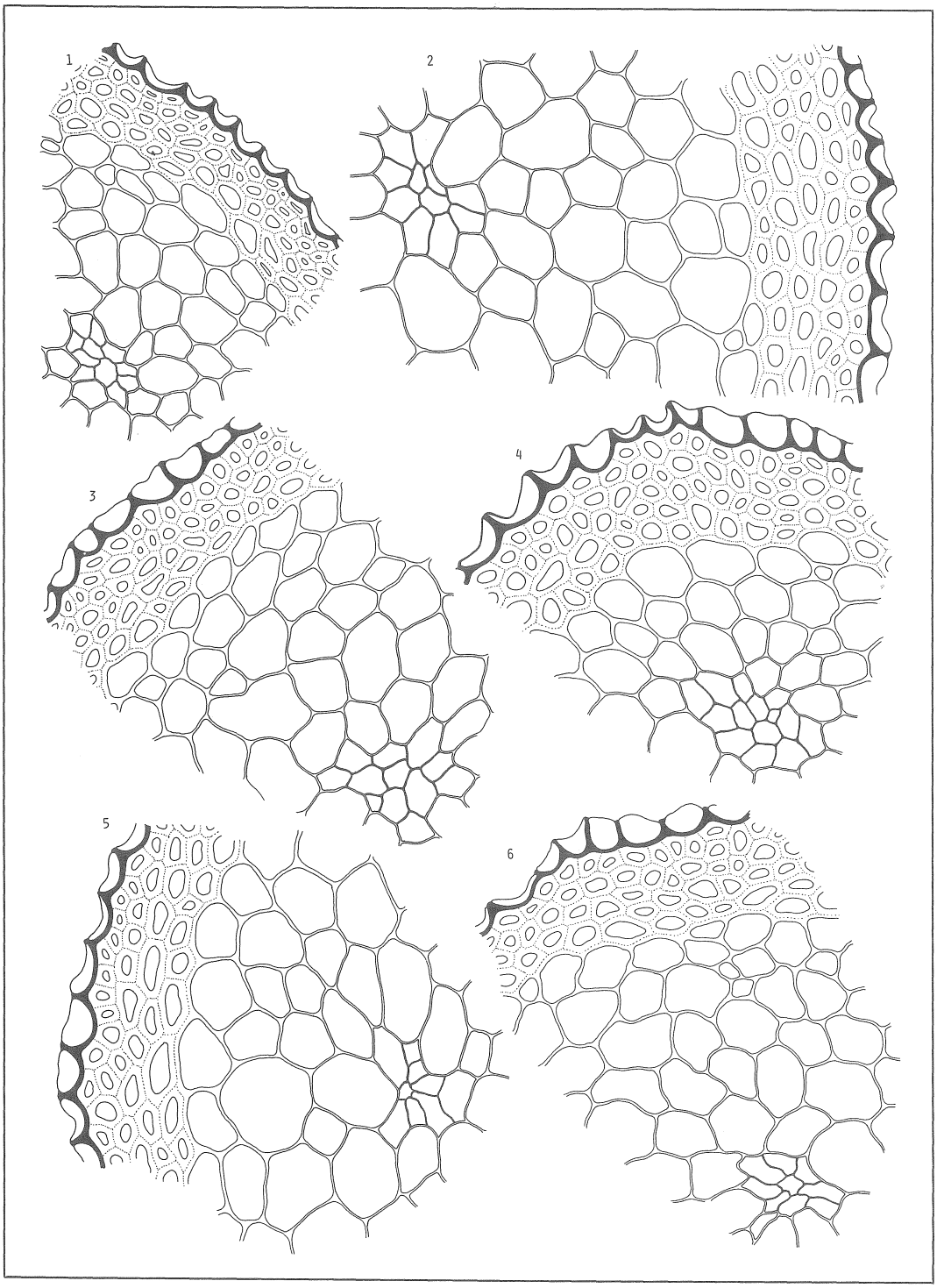
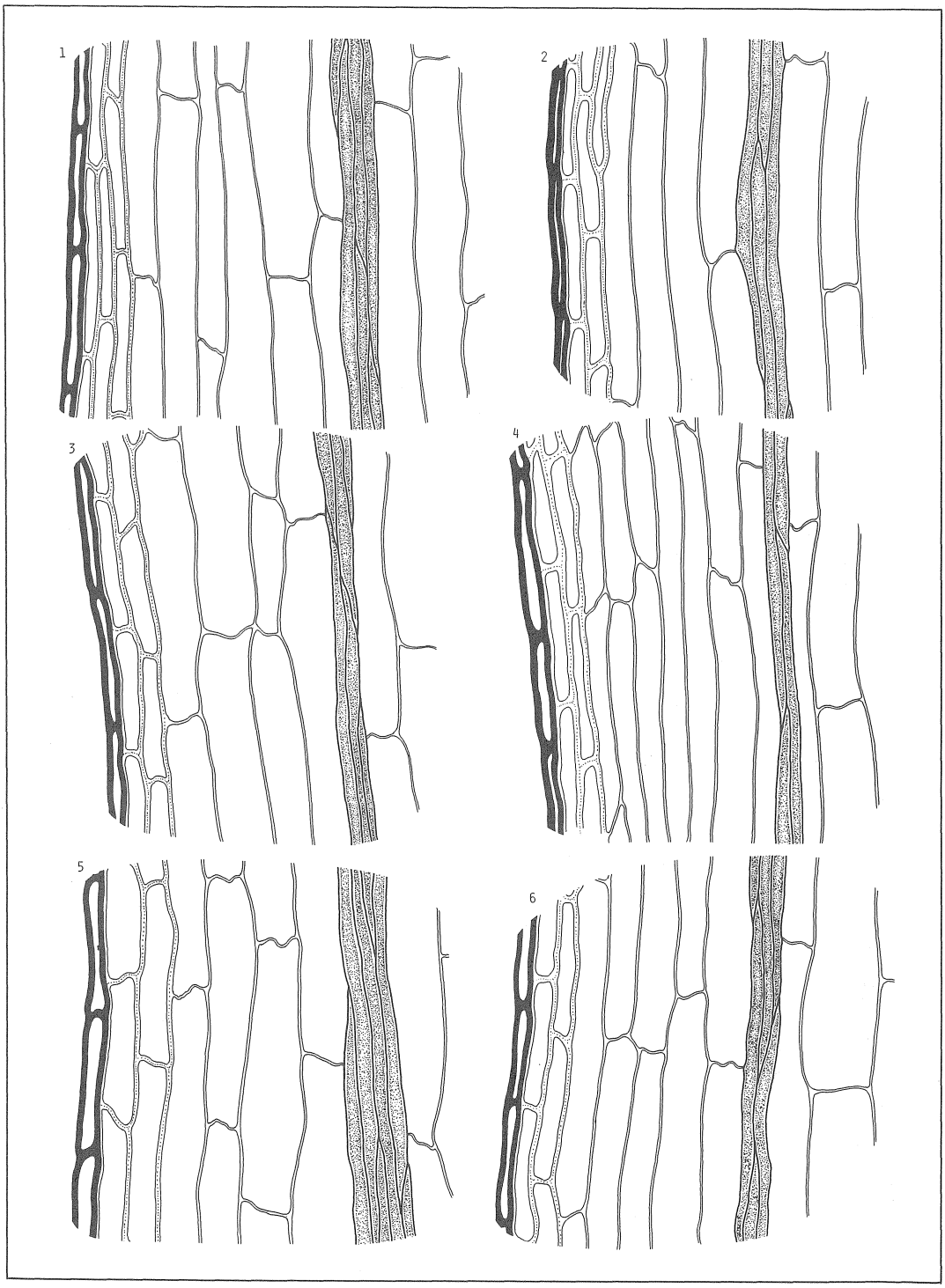


Plate XII Cross sections of the stem
Fig. 1–6 : *Sanionia uncinata* (HEDW.) LOESK. ×240



PIate XIII Longitudinal sections of the stem
Fig. 1-6 : *Leptodictyum riparium* (HEDW.) WARNST. ×240

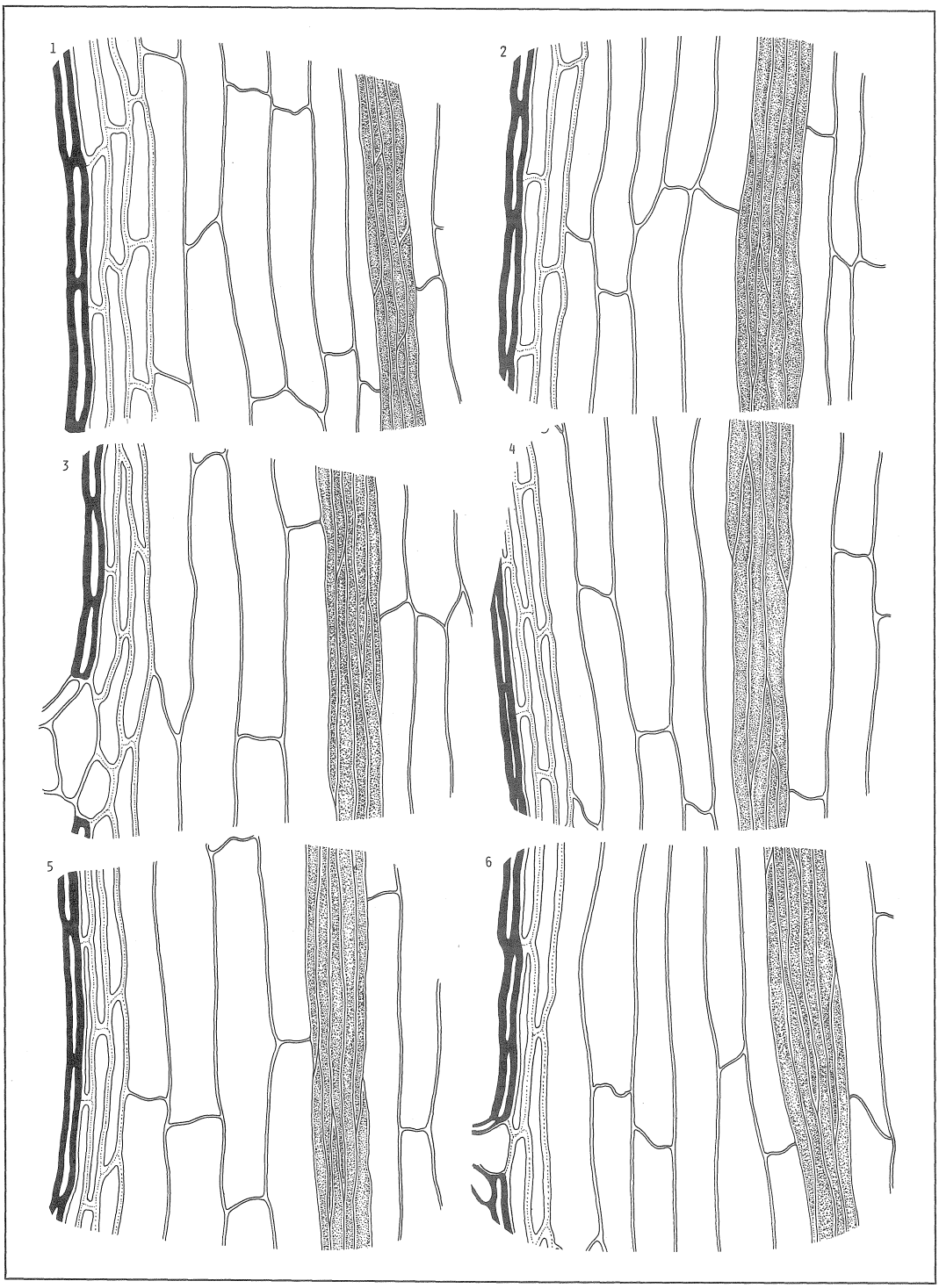


Plate XIV Longitudinal sections of the stem
Fig. 1–6 : *Cratoneuron filicinum* (HEDW.) SPR. ×240

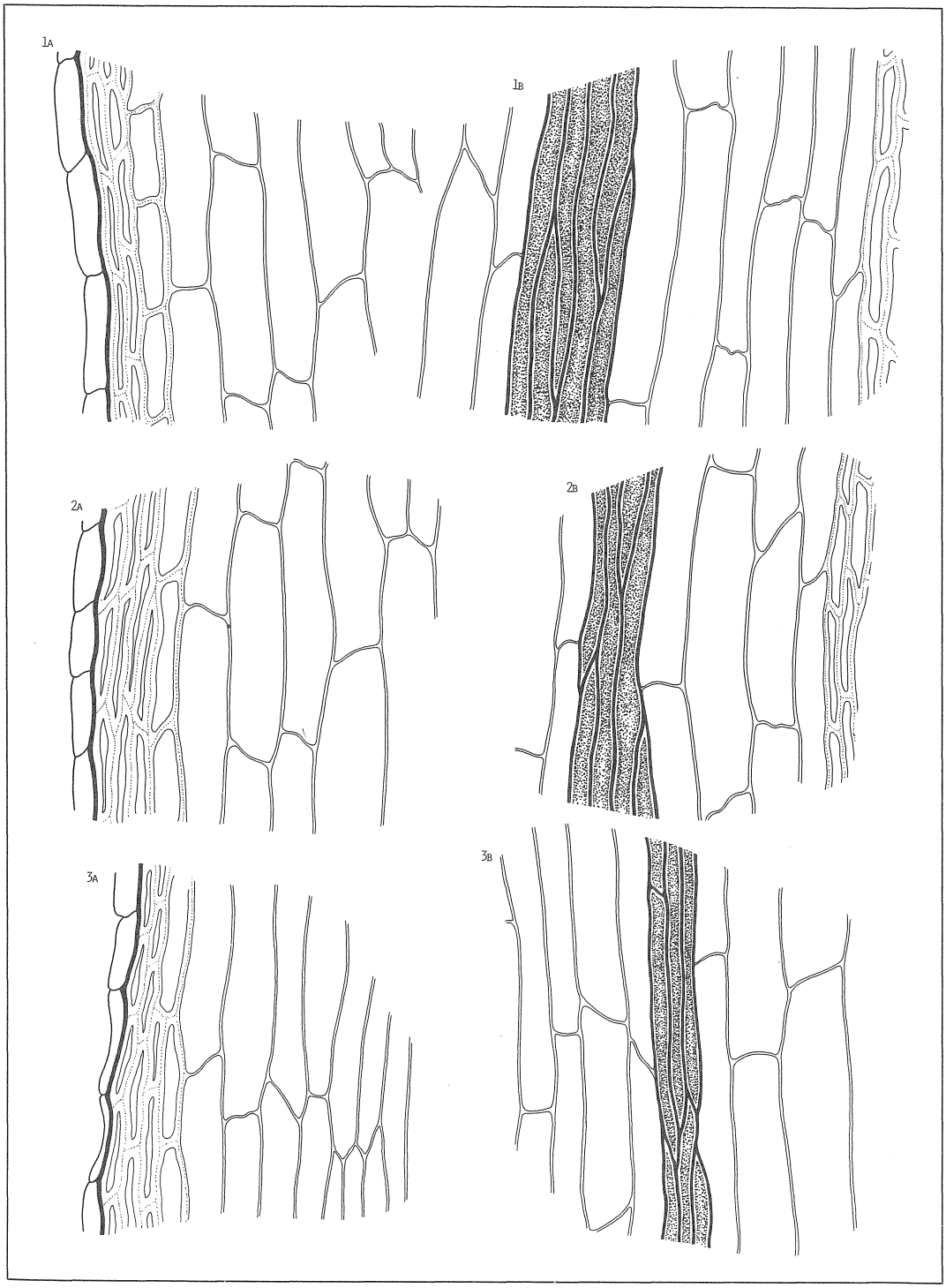


Plate XV Longitudinal sections of the stem
Fig. 1–3 : *Calliergonella cuspidata* (HEDW.) LOESK. ×240
A : Outer part of the stem
B : Central part of the stem