

# 日本列島におけるオニヤブソテツ複合種(オシダ科)の繁殖様式と種分化に関する種生態学的研究

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## 緒 論

岩槻 (1997) はその著書「文明が育てた植物たち」において人類による攪乱環境下で繁殖する無融合生殖 (シダ類の無配生殖を含む) 種等、自殖種の拡大を訴えている。本研究は自然環境下でいかにして無配生殖を含む自殖性が進化したかオニヤブソテツを材料にして解析した。

オニヤブソテツ *Cyrtomium falcatum* (L. f.) C. Presl はオシダ科ヤブソテツ属の一種で、日本を中心に東アジアに広く分布している。日本では北海道南部以南の海岸から内陸にかけて多様な環境に普通に見られ、変異又は可塑性 (Plasticity) の大きな種とされてきた (田川 1959, 倉田 1963, Sato 1984, 倉田・中池 1987)。常緑耐寒性の丈夫なシダで古くから観葉植物として栽培され、欧米 (Jermy *et al.* 1978, Lellinger 1985) やオセアニア地域 (Jones and Clemesha 1981, Wagner, Jr. 1981) では逸出して帰化植物となっている。ところで、本種は無配生殖の研究材料としてオオバノイノモトソウ *Pteris cretica* (イノモトソウ科) と共に古くからかかわってきた。すなわち、受精せずに配偶体の体細胞から孢子体が直接形成される。この現象を De Bary (1878) によって、Apogamy (無配生殖) と名づけられ、また Manton (1950) はミヤマワラビ *Phegopteris connectilis* (ヒメシダ科) も含め、真性無配生殖種 (Obligate Apogamous Species) の代表として非減数性孢子形成 (Diplospory) の仕組みを細胞学的に研究した。筆者はこれら広分布種の生態的意義や分類を困難にしている原因などを探るため、有性生殖型も見つかっている日本を中心とした東アジアで野外調査を進めてきた。モンスーン気候の東端の日本列島は湿潤な気候だけでなく、季節風、移動性低気圧、台風または人の活動などによる植生破壊が随所に見られ、ミヤマワラビは亜高山、オオバノイノモトソウは人里、オニヤブソテツは海岸の不安定な環境に無配生殖型が生育し、有性生殖型 (種) との交雑も見つかり、分類を困難にしている実態が判明してきた (松本 1976, 1982, Matsumoto 1982, 松本・矢野 1989, 志村ら 1978)。葉縁に細鋸歯が無いという特徴で区別されるオニヤブソテツには細胞学的に 3 倍体無配生殖型: B (Mehra and Loyal in Mehra 1961, Abraham *et al.* 1962, Mitui 1968, Bhavanandan 1981, 中池・松本 1990)、だけでなく 2 倍体有性生殖型: A1 (Mitui 1980, 松本・志村 1985, 安田 1987), A2 (Mitui 1973) 及び 4 倍体有性生殖型: C (Mitui 1965, Weng and Qiu 1988, Tsai and Shieh 1975, Shimura *et al.* 1978) の計 4 型が報告された [4 倍体無配生殖型の報告 (Tsai and Shieh 1985) があるが未確認]。分頁学的には Thunberg が長崎で採集した 2 種類の標本 (var.  $\alpha$ ,  $\beta$ ) のうち var.  $\alpha$  がオニヤブソテツ種で、これを本属のタイプとし、また、Koidzumi (1932) が別種としてやや内陸部にも分布するナガバヤブソテツ *C. devexiscapulae* (Koidz.) Ching を記載した時、上記の var.  $\beta$  を従基準標本 (Paratype) としている。中国の Ching (1936) や Shing (1965) はこの種を認めたが、日本ではオニヤブソテツの変種、品種、さらに区別されないものとなってきていた。このようにオニヤブソテツは複合種の可能性があり、細胞学的データと合わせた分類学的研究が望まれていた。

そこで本研究は Manton が明らかにした Diplospory で、1 孢子嚢中 64 個の代わりに 3 個の孢子ができる性質をメルクマールにして、日本列島の海岸の裸地から林床にかけて集団調査を行い、生育環境、外部形態および染色体数との関連を調べ、またハーバリウムの標本により分布を調べた結果、上記の基本的 4 型の生態的構造を把握できた。さらに混生地における雑種の低次倍数体無配生殖型 (種) や分離による低次倍数体無配生殖型の形成を配偶体培養による生活史を通して認識した。またこれらの種分化を探るため、自然雑種や人工雑種の減数分裂の観察によるゲノム分析、無配生殖と自配自家受精の遺伝的背景及び有性生殖型の交配様式を探り、同一環境下での栽培による外部形態の比較など種遺伝学的解析を行った。これらの結果を総合し、オニヤブソテツ複合種の繁殖様式と種分化に関する種生態学的考察を行った。

## 第1章 日本産オニヤブソテツの基本的4型

### 第1節 基本的4型の集団調査と生態的すみわけ

#### 材料および方法

日本各地の海岸から内陸にかけて主に胞子の成熟する5～6月又は10～12月に胞子葉を集団サンプリングし、顕微鏡で胞子囊中の胞子数の算定やシクネスダイヤルゲージで葉の厚さを測り、また他の形質調査を行なうため標本を作製した。また同時に、または胞子数による判定結果から再度現地にて、染色体観察用さらに形態実験用に生株のサンプリングを行った。これらの証拠標本は国立科学博物館(TNS)におさめた。また住み分け環境の把握のため国土地理院の地図にプロットして解析を行い、その一部で植生調査も行った。染色体は減数分裂又は根端の体細胞分裂で観察した。減数分裂は若い胞子囊のついた葉を1～2時間、5℃の水で前処理し、カルノア液(99%エタノール:クロロフォルム:氷酢酸=6:3:1)で固定、冷凍庫で保存し、酢酸カーミン押しつぶし法でプレパラートを作成した。体細胞染色体は勢いよく伸びている根を18～20℃の8オキシキノリンで4～4.5時間前処理し、酢酸アルコール液(1:3)で固定、冷凍庫に保存し、又は約5℃の45%酢酸で10～30分処理し、60℃の1N塩酸と45%酢酸混合液(1:1)に1分間つけて細胞を解離し、酢酸オルセイン押しつぶし法によった(高宮 1988)。観察した核板はミニコピーフィルムで撮影し、保存資料とした。

#### 結果および考察

調査の結果、オニヤブソテツに基本的4型を認め、それぞれA1, A2, B, およびC型とし、Fig. 1-1にその概要を示した。これらの詳細な調査結果は以下の通りである。

伊豆半島の下田市、伊東市、南伊豆町および長崎市小瀬戸等で海岸から低山地にかけて詳細な集団調査を行なった結果、基本的4型のうち2倍体有性生殖のA1は岬の突端、海蝕崖の裸地に生育し、葉が厚く、通常葉長30 cm以下で矮小形、3倍体無配生殖のBは主に海岸入江の草地や林縁のやや乾いた環境に生育し、葉質や葉長(30～90 cm)に変異が大きく、4倍体有性生殖のCは低山地の谷や湿った林床に主として生育し、葉質薄く、60～100 cmと最も大型となり、また他の3者と区別が容易で、同所的すみわけ分布が見られた(Figs. 1-2, 1-3, 1-4, および 1-5, Table 1-1)。また長崎市小瀬戸はThunbergがオニヤブソテツの基準標本を採集した場所と推定され(Thunberg 1784, 外山 1977)、BおよびC型のみが見られ、同様に住み分けていた(Fig. 1-5)。A2型は小笠原諸島、沖縄本島や九州南部および西部(福江島)で調査したが、主として岬のやや乾いた林床に生育し、葉が薄く、葉長40～70 cmで、A1型とは異所的分布がみられた(Figs. 1-6, 1-7, 1-8 および 1-9, Table 1-2)。またA2とB型も沖縄本島や鹿児島では異所的だが九州西部(福江島)では同所的すみわけが見られた。無配生殖のB型を除くと有性生殖の3者は形態的に区別可能であった。

2倍体有性生殖型A1とA2の生育地の植生景観をFig. 1-10に示す。このうちC図は伊東市城ヶ崎海岸でFig. 1-3およびTable 1-1の、D図は福江市でFig. 1-9の調査地域の写真である。このような生育環境の違いが特に葉のサイズと厚さの形態に反映していると考えられる。

植生遷移の3適応戦略の見地(Grime 1974)からA1は攪乱依存戦略(r-selection strategy)、Bは競争戦略(competition s.)、A2及びCは光に対するストレス耐性戦略(K-selection s.)をとっていると考えられる。

## 第2節 基本的4型の日本における分布

南北に連なる日本列島はそこに各サイトタイプなどの分布が載せられれば、それらの進化の実験場としてとらえる事ができる。上記の野外集団調査に加え、日本シダの会企画の標本に基づく全国分布図を載せた日本のシダ植物図鑑が発刊され(倉田・中池 1987), この大規模な標本を中心に利用し、短期間に基本的4型の分布を得ることができた。

### 材料および方法

孢子囊中の孢子数は野外集団では10個以上の孢子囊で判定したが、標本からは5個前後で行った。標本から孢子囊を針で紙に取り、斜めにして紙のふちをたたき、はじけていない孢子囊を選別し、オイキットで封じてプレパラートを作成した。C型は上記の集団調査の結果から外部形態で区別できたので孢子の算定は大部分につき行なわなかった。分布図の作成の方法は上記、倉田・中池(1987)に従った。すなわち、マッピングインデックスとして、日本全国の五万分の一地図名と、それを4等分した位置(右上, 右下, 左上, 左下の順にそれぞれ1, 2, 3, 4とする)を示し、図示した。

### 結果および考察

野外集団(255産地1928個体)、染色体観察数(186産地341個体)及びハーバリウム標本(TNS: 国立科学博物館, 一部RYU: 琉球大学, TI: 東京大学理学部, TOFO: 東京大学農学部, Y: 山口県立博物館などの892標本)の解析によりA1型が北海道南部から足摺岬, 八丈島までの冷温帯から暖温帯に(Figs. 1-11, 1-12, 1-19, Appendix 1, 5), A2型は九州西部(福江島)および南部(佐多岬, 野間岬), 小笠原諸島(伊藤 1944参照), 屋久島, 沖縄本島, 与那国島, (台湾の蘭嶼)などの暖温帯から亜熱帯に偏り(Figs. 1-13, 1-14, 1-20, Appendix 2, 6), いずれも岬などに局地的分布をするのに対し, B型は青森~西表島, 八丈島まで(Figs. 1-15, 1-16, 1-17, 1-20, Appendix 3, 7, 小笠原諸島では精査したが発見できず, 台湾, 韓国および中国南部にも分布確認), C型は新潟県~鹿児島県(Figs. 1-18, 1-21, Appendix 4, 8, 済州島, 台湾, 中国南部にも分布確認)などの暖温帯常緑広葉樹林帯を中心に, 上記のように住み分けて普通に見られた。

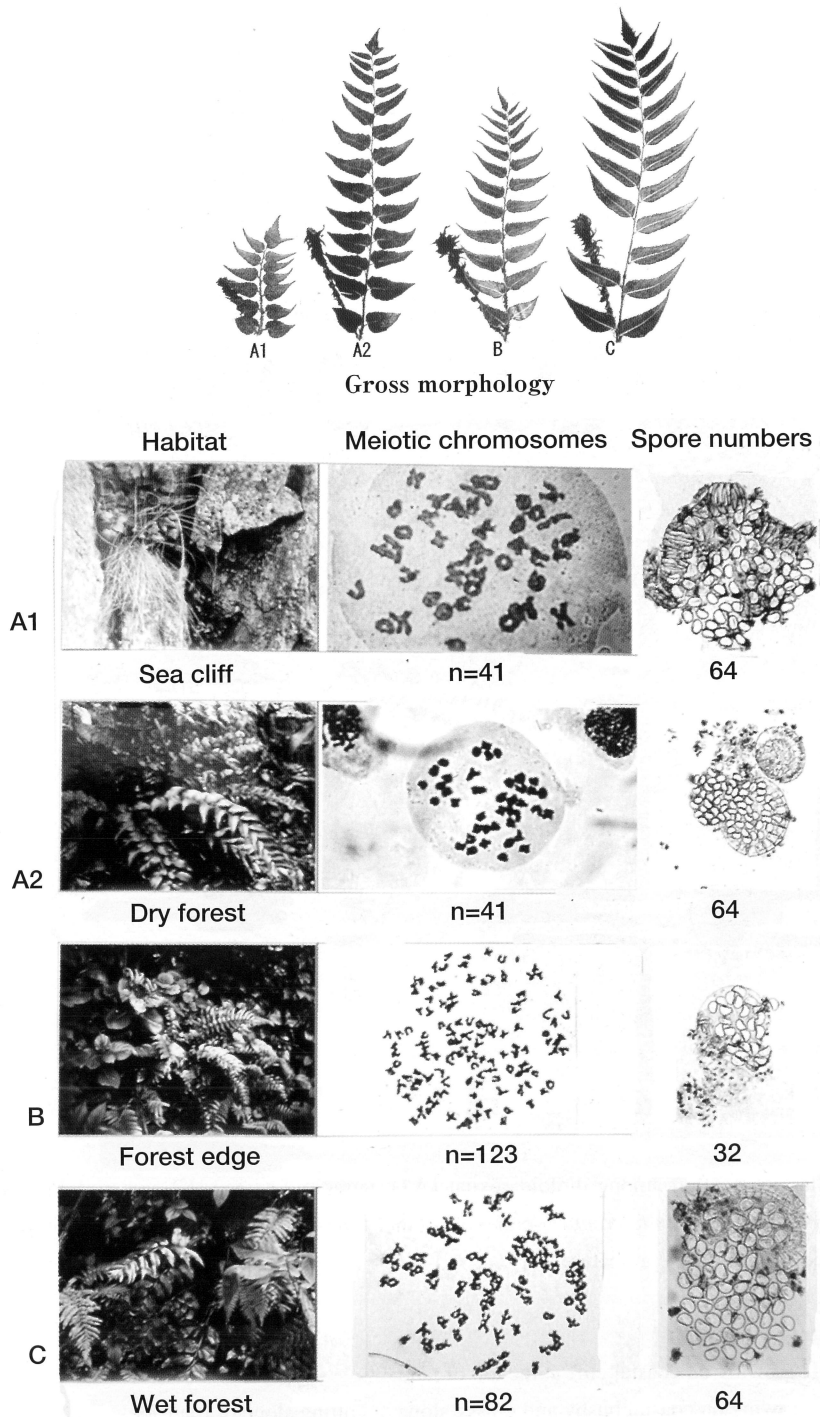


Fig. 1-1. Gross morphology, habitat, meiotic chromosomes and spore numbers on basic 4 types (A1, A2, B, C) of *Cyrtomium falcatum* complex, A1: diploid sexual type growing on sea cliff, A2: diploid sexual type growing on dried forest floor near sea, B: triploid apogamous type growing on forest edge near seashore, C: tetraploid sexual type growing on wet forest floor in lower mountain or hill.

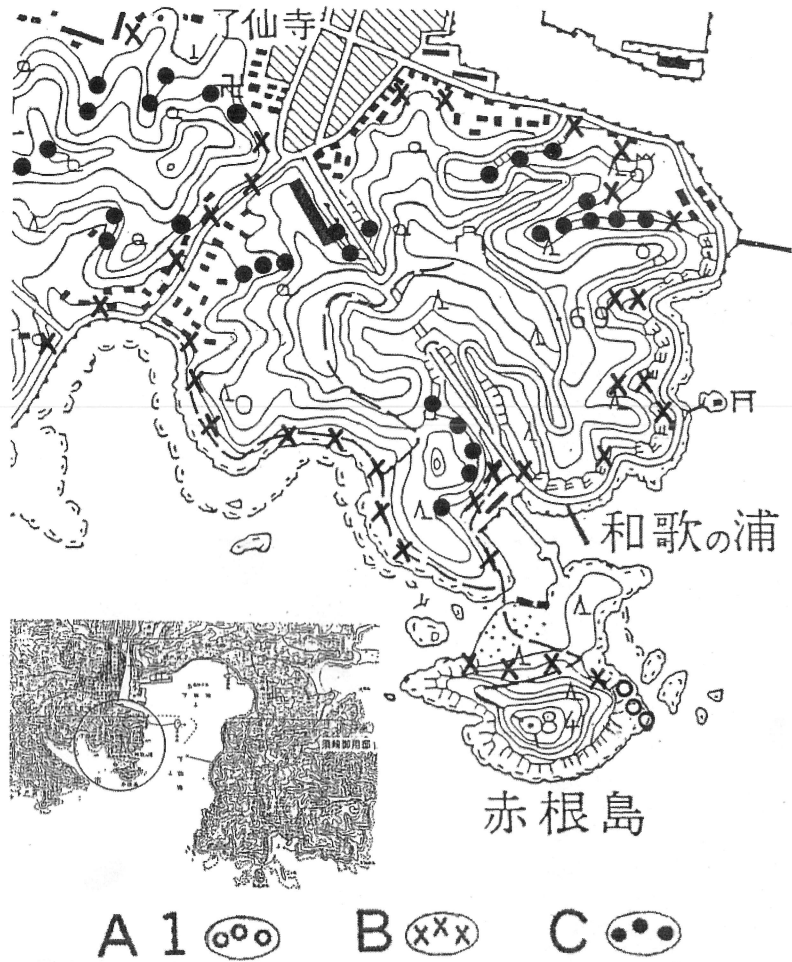


Fig. 1-2. Habitat segregation among diploid sexual (A1), tetraploid sexual (C) and triploid apogamous types (B) of *Cyrtomium falcatum* complex from maritime to inland vegetation in Shiro-yama Park, Shimoda-shi, Shizuoka prefecture.

#### Habitat

##### Maritime vegetation

A1: growing on coastal cliff at the top of land.

B: growing on coastal bushy and grassy slope or cutting slope of roadside.

##### Inland vegetation

C: growing on bank of small valley in forest.

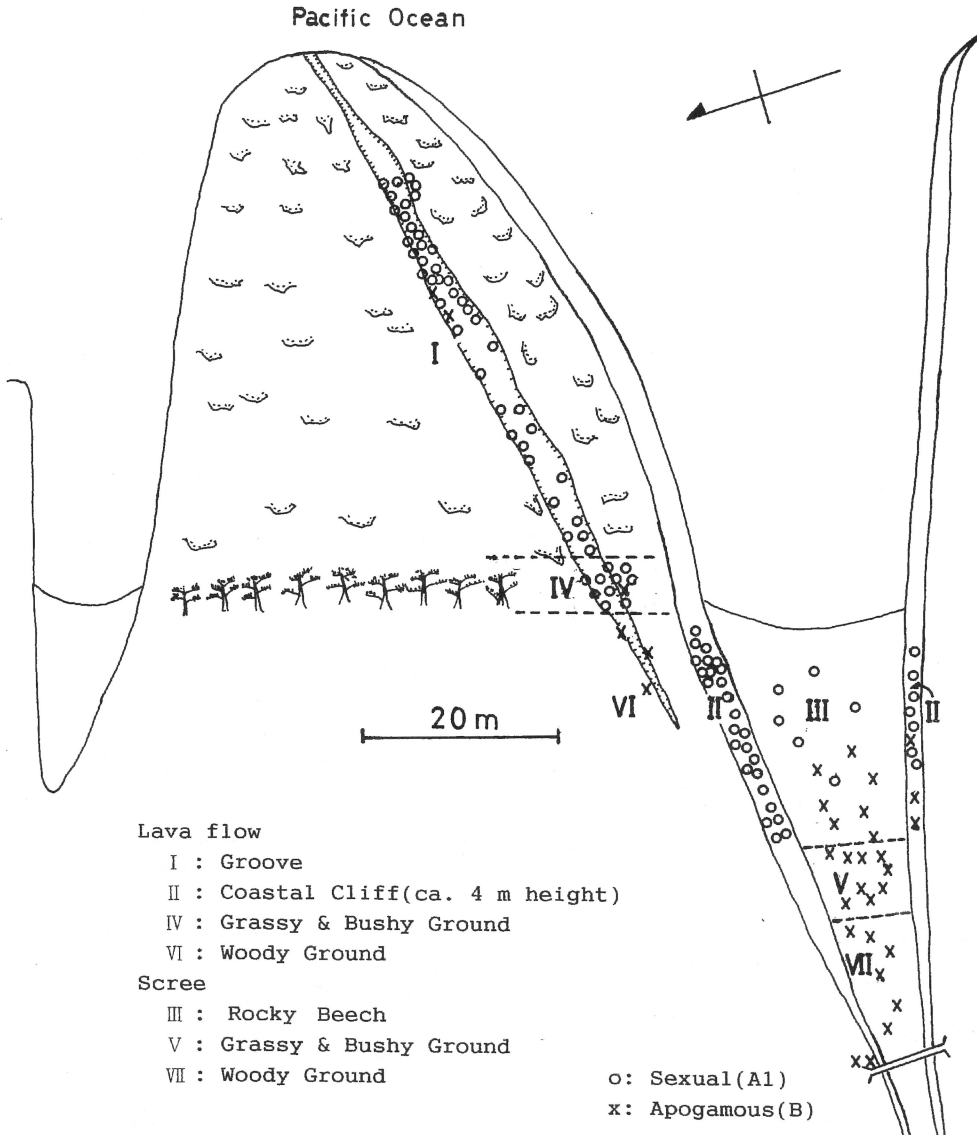


Fig. 1-3. Habitat segregation between sexual (A1) and apogamous (B) types of *Cyrtomium falcatum* to maritime vegetation developed on the top of lava flow from Mt. Omuro volcano in Jogasaki-kaigan, Ito-shi, Shizuoka prefecture.

Table 1-1. Vegetation of habitat on sexual (A1) and apogamous (B) types of *Cyrtomium falcatum* at research sites ( I, II, III, IV, V, VI, VII) of Fig. 1-3 in Jogasaki-kaigan, Ito-shi, Shizuoka prefecture

	Inner forest ( VI, VII)		Forest edge ( IV, V)		Open land ( I, II, III)	
Tree layer	<i>Pinus thunbergii</i> <i>Machilus thunbergii</i>	27 m H. 25 m H.	<i>Pinus thunbergii</i>	15 m H.		
Subtree layer	<i>Machilus thunbergii</i> <i>Cinnamomum japonicum</i> <i>Neolitsea sericea</i>		<i>Pittosporum tobira</i> <i>Ligstrum ovalifolium</i> <i>Sabina chinensis</i> <i>Daphniphyllum teijismanni</i> <i>Neolitsea sericea</i> <i>Eurya japonica</i> <i>Morus kagayamae</i> <i>Mallotus japonicus</i> <i>Ficus erecta</i> <i>Neolitsea sericea</i> <i>Ficus erecta</i> <i>Pittosporum tobira</i>			
Shrub layer	<i>Ficus erecta</i>		<i>Cyrtomium falcatum</i> (A1, B) <i>Miscanthus sinensis</i> <i>Euonimus fortunei</i> var. <i>radicans</i> <i>Farfugium japonicum</i> <i>Scutellaria parvifolia</i> <i>Asparagus lucidus</i> <i>Machilus thunbergii</i> <i>Podocarpus macrophyllus</i>	++ ++ ++ + + - - -	<i>Cyrtomium falcatum</i> (A1 > B) <i>Chrysanthemum pacificum</i> <i>Peucedanum japonicum</i> <i>Fimbristylis ferruginea</i> var. <i>sieboldii</i> <i>Titmalus jolkini</i> <i>Hedyotis coreana</i> <i>Sedum orizifolium</i> <i>Miscanthus sinensis</i> <i>Setaria viridis</i> var. <i>pachystachys</i> <i>Crepidiastrum keiskeanum</i> <i>Lilium maculatum</i>	++ ++ ++ ++ + + + + + + - -
Herbaceous layer	<i>Arachniodes aristata</i> +++ <i>Cyrtomium falcatum</i> (B) -					
Relative light intensity	1.5 ~ 3.0 % 0 % (11)		20.0 % 50 % (20)		100.0 % 87 % (92)	
% of A1 type on <i>C. falcatum</i>	Epilithic ( VI ) : 0 % (3) Terrestrial ( VII ) : 0 % (8)		Epilithic ( IV ) : 91% (11) Terrestrial ( V ) : 0 % (9)		Epilithic ( I, II ) : 94% (79) Rocky terrestrial ( III ) : 46 % (13)	



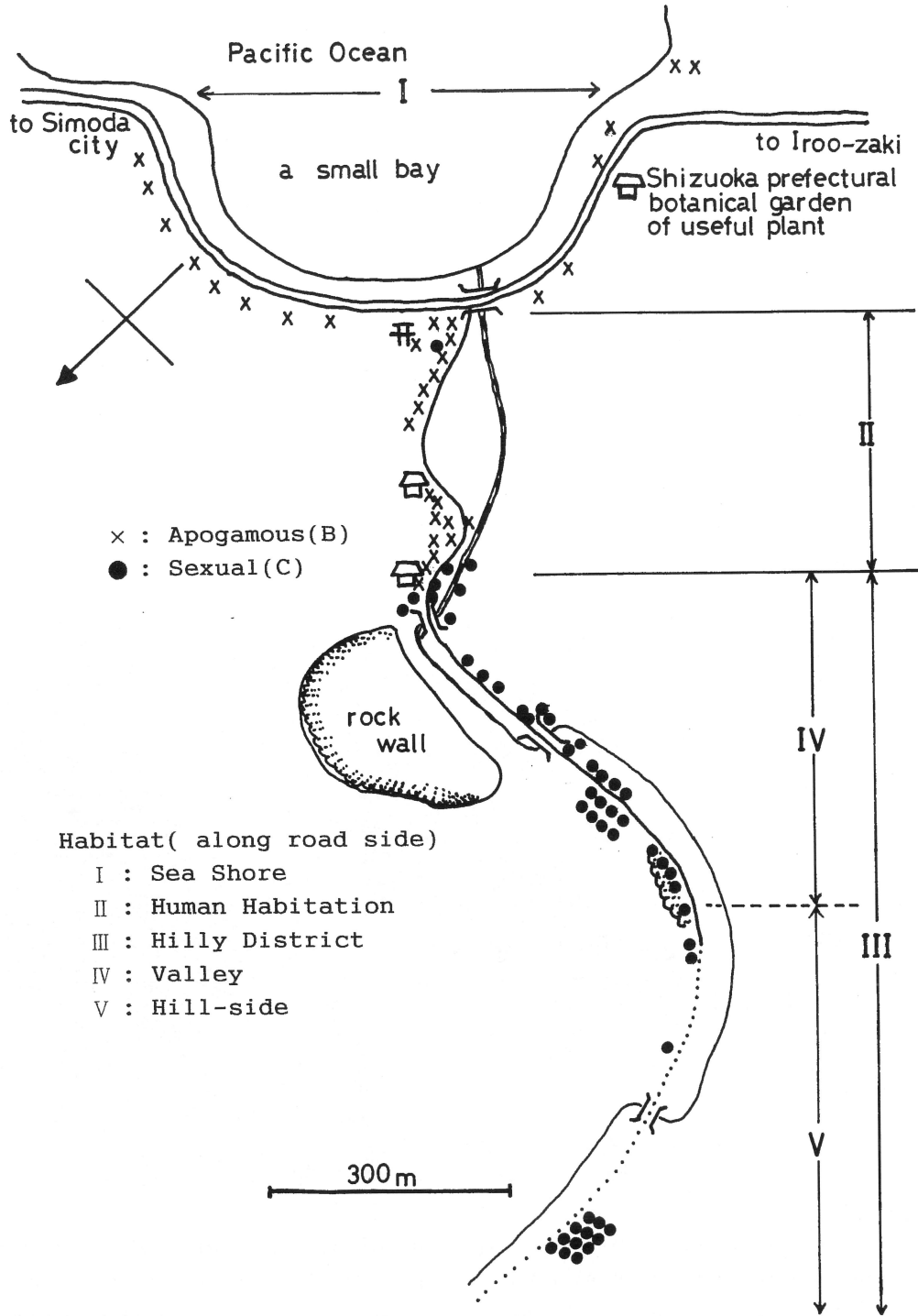


Fig. 1-4. Habitat segregation between sexual (C) and apogamous (B) types of *Cyrtomium falcatum* complex from maritime vegetation to inland vegetation in Ose, Minami-izu-cho, Shizuoka prefecture.

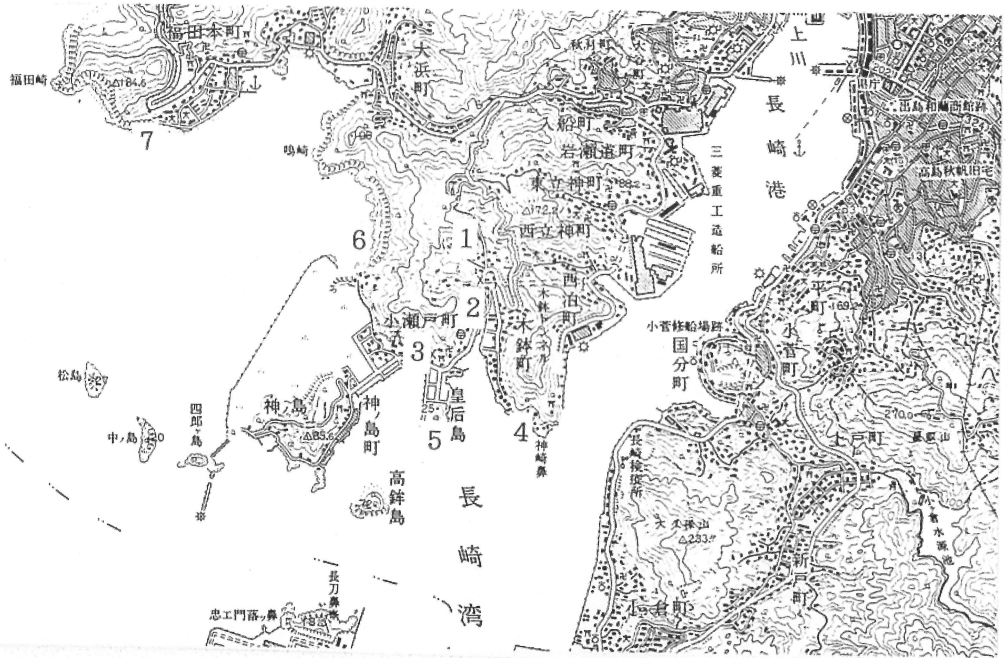
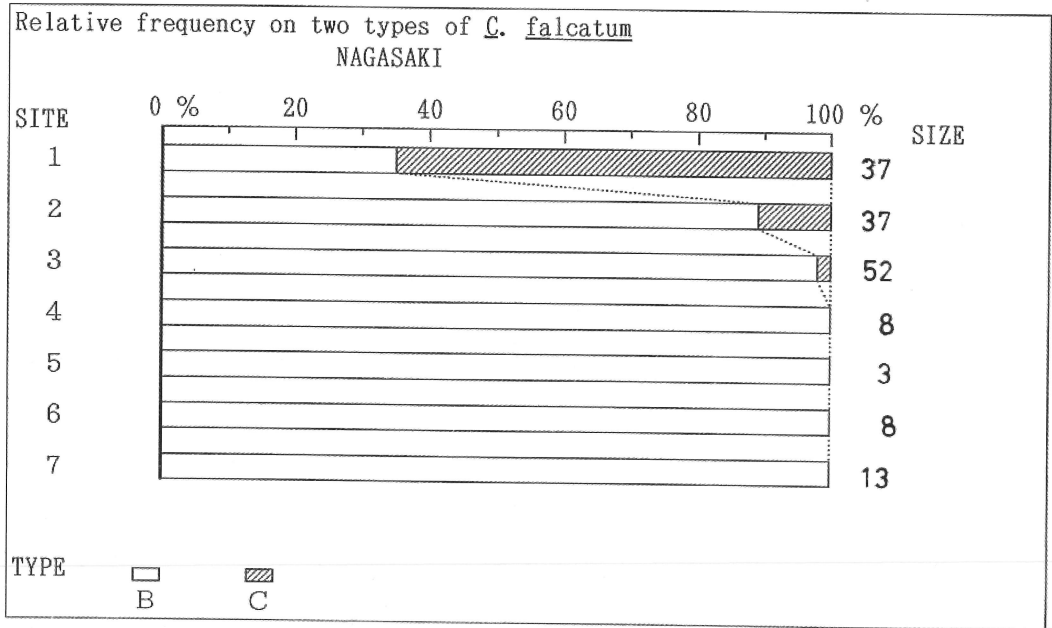


Fig. 1-5. Habitat segregation on sexual (C) and apogamous (B) types of *Cyrtomium falcatum* complex from maritime vegetation (site no. 3, 4: cutting slope of roadside, 5: bush of seaside, 6, 7: sea cliff) to inland vegetation (site no. 1, 2: bank of small valley) in Kosedo-cho, Nagasaki-shi, Nagasaki prefecture.

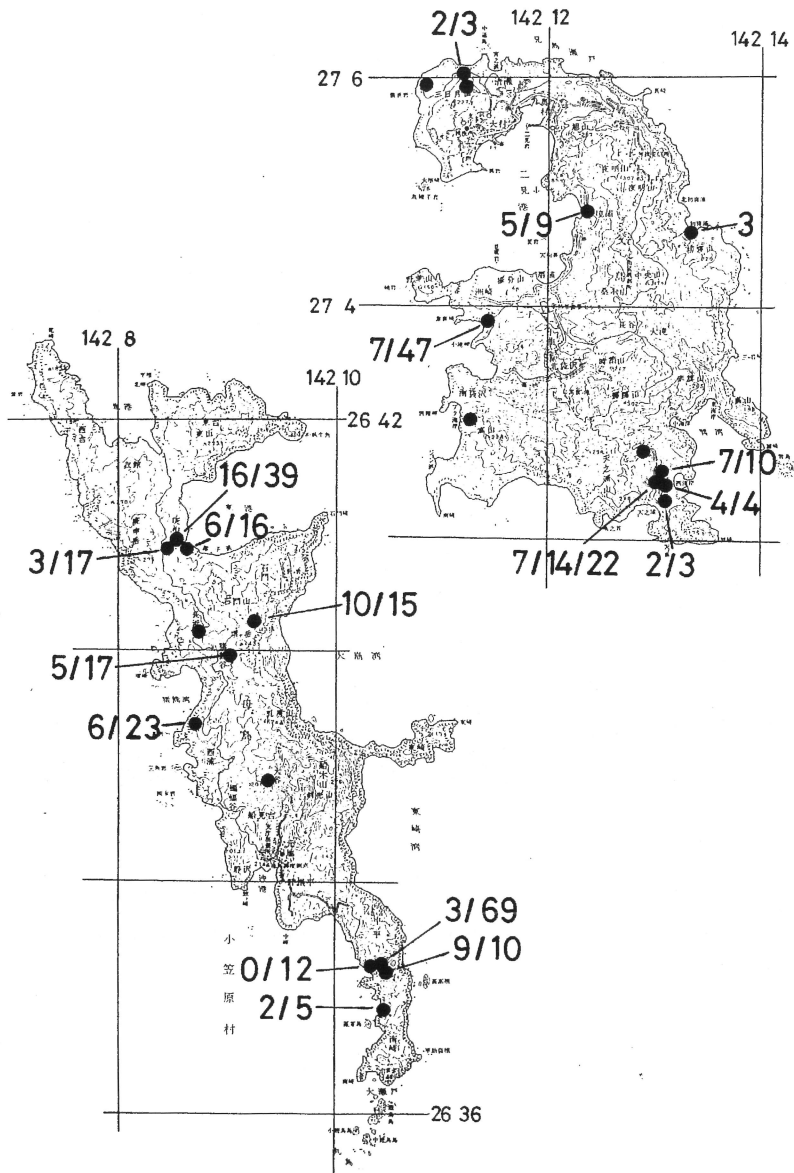


Fig. 1-6. Populations including only diploid sexual type (A2) of *Cyrtomium falcatum* on Bonin Isls. (Chichi-jima and Haha-jima Isls.), Tokyo prefecture. The number of the numerator is a number of collected specimens, the denominator is a number of individuals in the population.

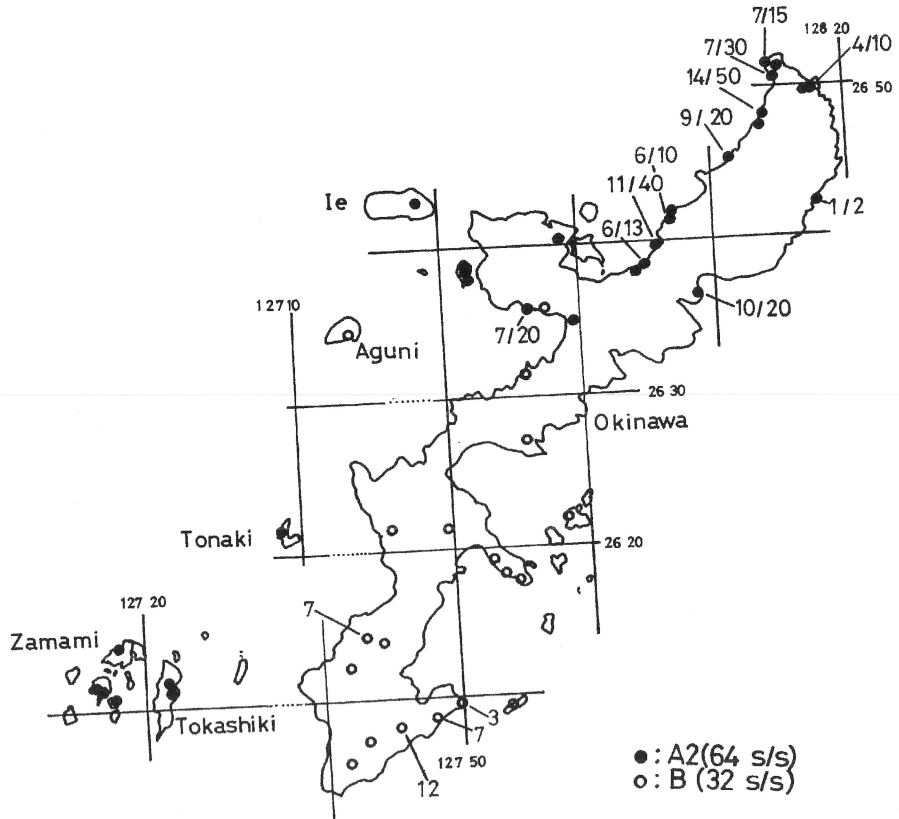


Fig. 1-7. Allopatric distribution between sexual (A2) and apogamous (B) types of *Cyrtomium falcatum* in Okinawa Isls. The number of the numerator is a number of collected specimens, the denominators is a number of individuals in the population.

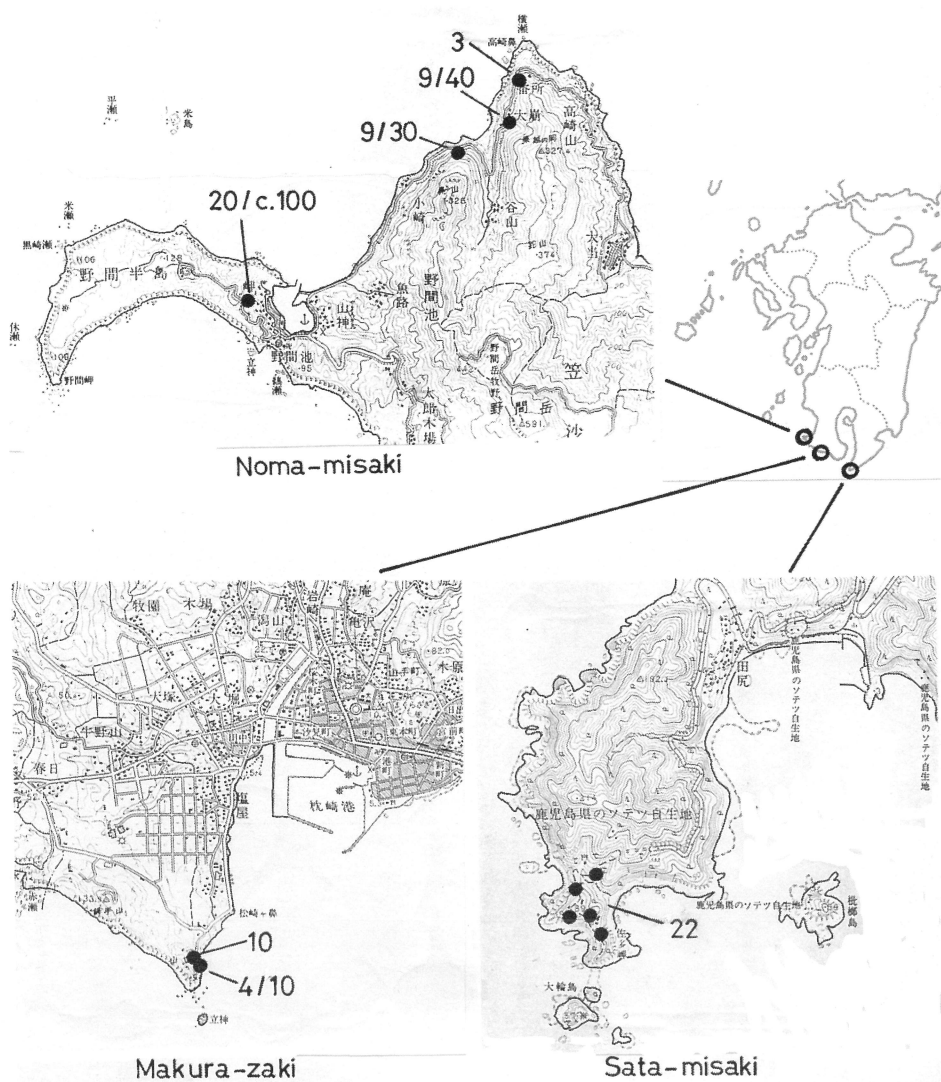


Fig. 1-8. Populations including only diploid sexual type (A2) of *Cyrtomium falcatum* at three tops (Noma-misaki, Makura-zaki and Sata-misaki) of southern Kyushu. The number of the numerator is a number of collected specimens, the denominators is a number of individuals in the population.

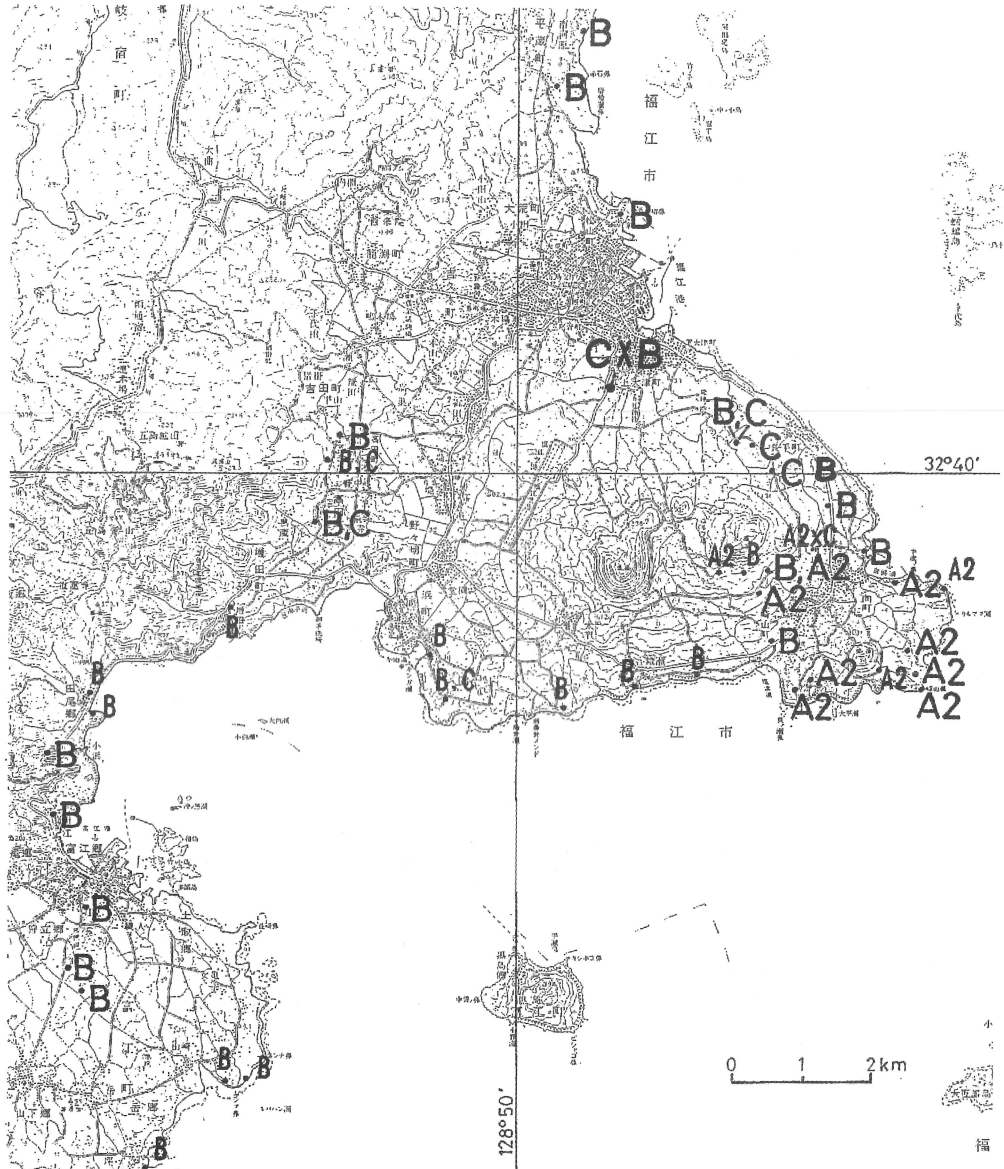


Fig. 1-9. Distribution of three types (A2, B, C) and their hybrids (A2 × C, C × B) of *Cyrtomium falcatum* complex in Fukue Isl., Nagasaki prefecture.

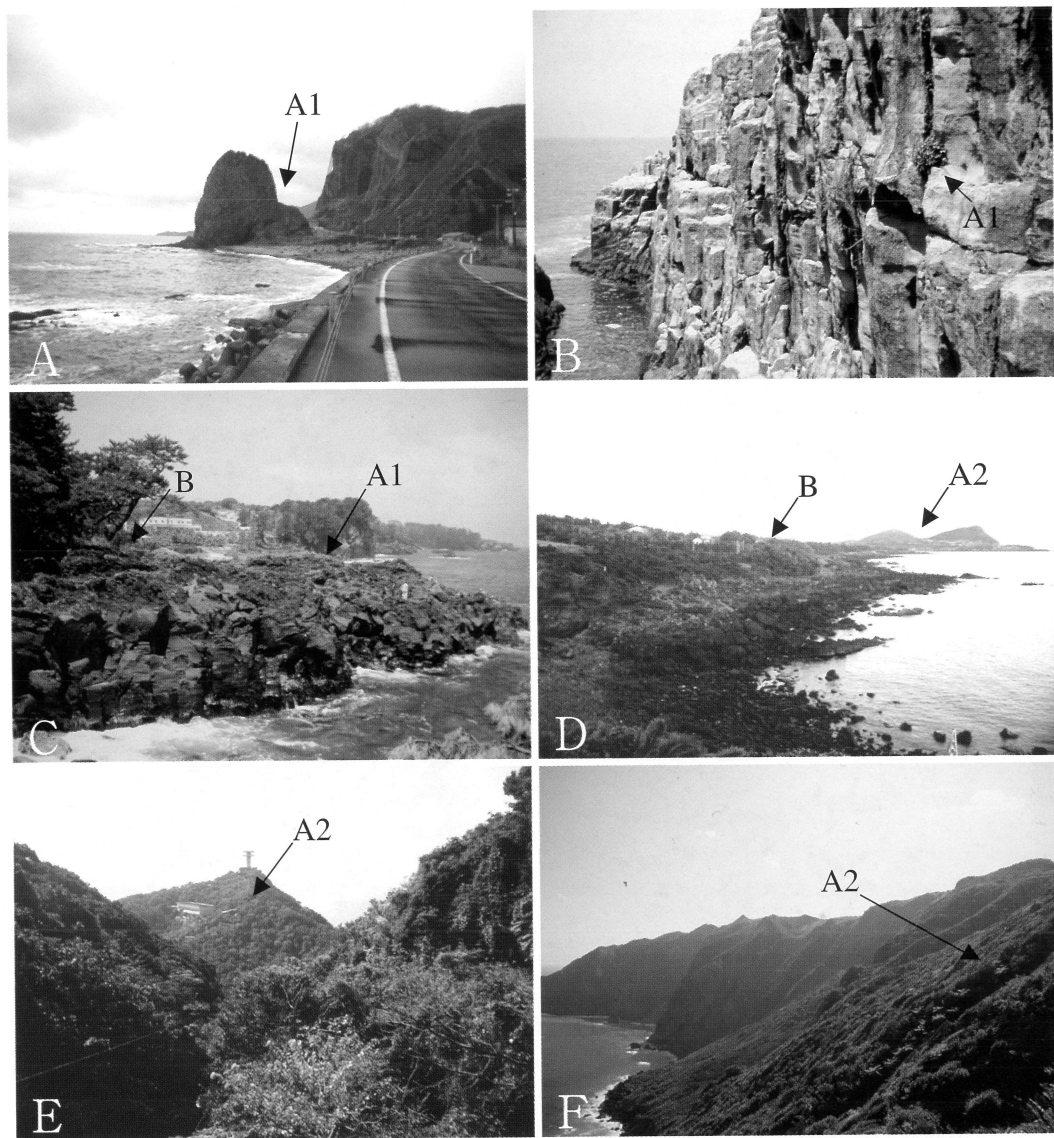


Fig. 1-10. Habitat of diploid sexual types on *Cyrtomium falcatum* complex. A: Hoya-ishi, Okushiri Isl., Hokkaido (A1 type), B: Tojin-bo, Fukui pref. (A1 type), C: Jogasaki, Ito-shi, Shizuoka pref. (A1 and B types), D: Abunze, Fukue Isl., Nagasaki pref. (A2 and B types), E: Sata-misaki, Kagoshima pref. (A2 type), F: Haha-jima, Bonin Isls. (A2 type).

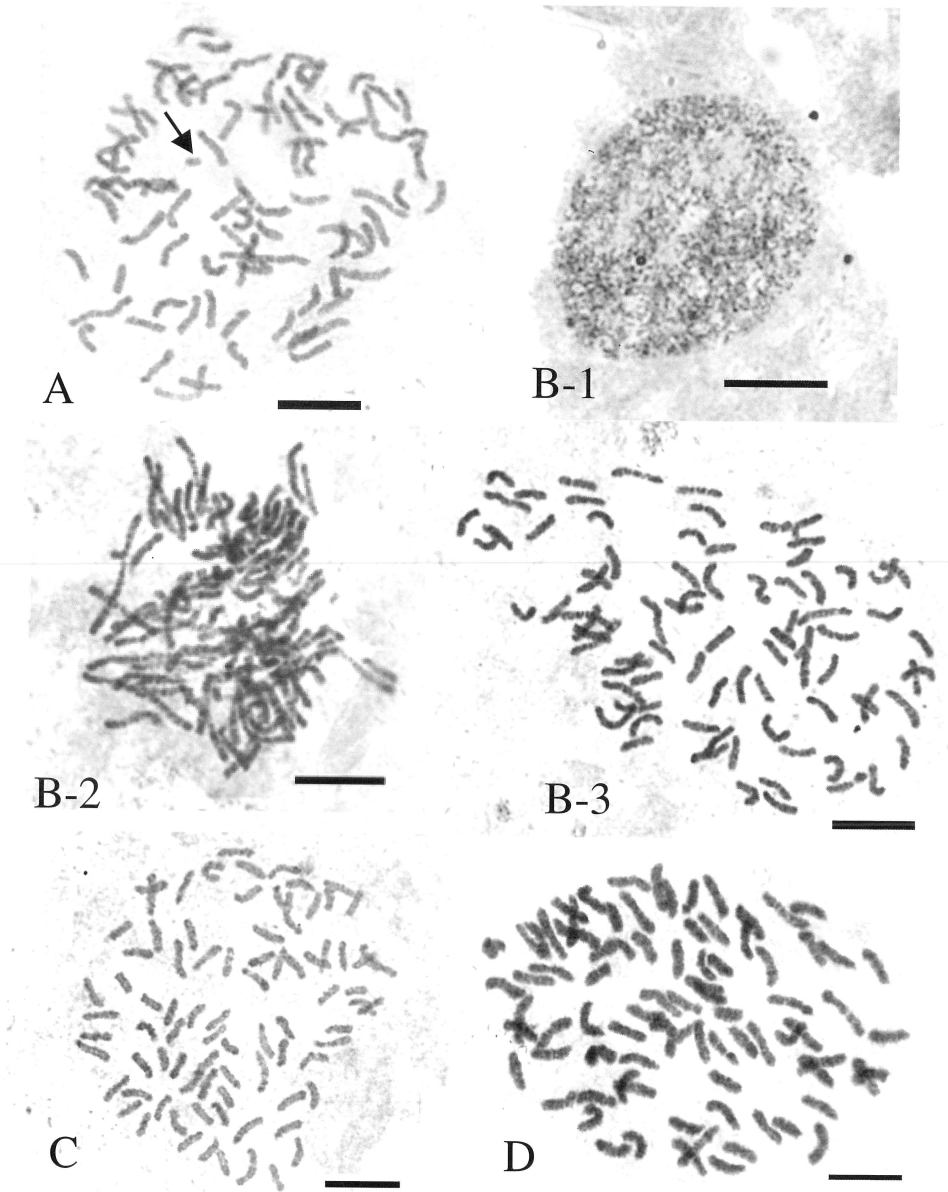


Fig. 1-11. Cytological observations of AI type on *Cyrtomium falcatum* complex. A: Choshi-misaki Point, Todohokke, Hokkaido (A1-121),  $2n = 82+1$  fragment (arrow).

**B-1 ~ B-3:** Esan-misaki Point, Todohokke, Hokkaido (A1-134), **B-1:** metabolic phase, **B-2:** prophase, **B-3:** metaphase,  $2n = 82$ , **C:** Tachimachi-misaki Point, Hakodate, Hokkaido (A1-136),  $2n = 82$ , **D:** Hoya-ishi, Okushiri Isl., Hokkaido (A1-143),  $2n = 82$ . Bar:  $10 \mu m$ .



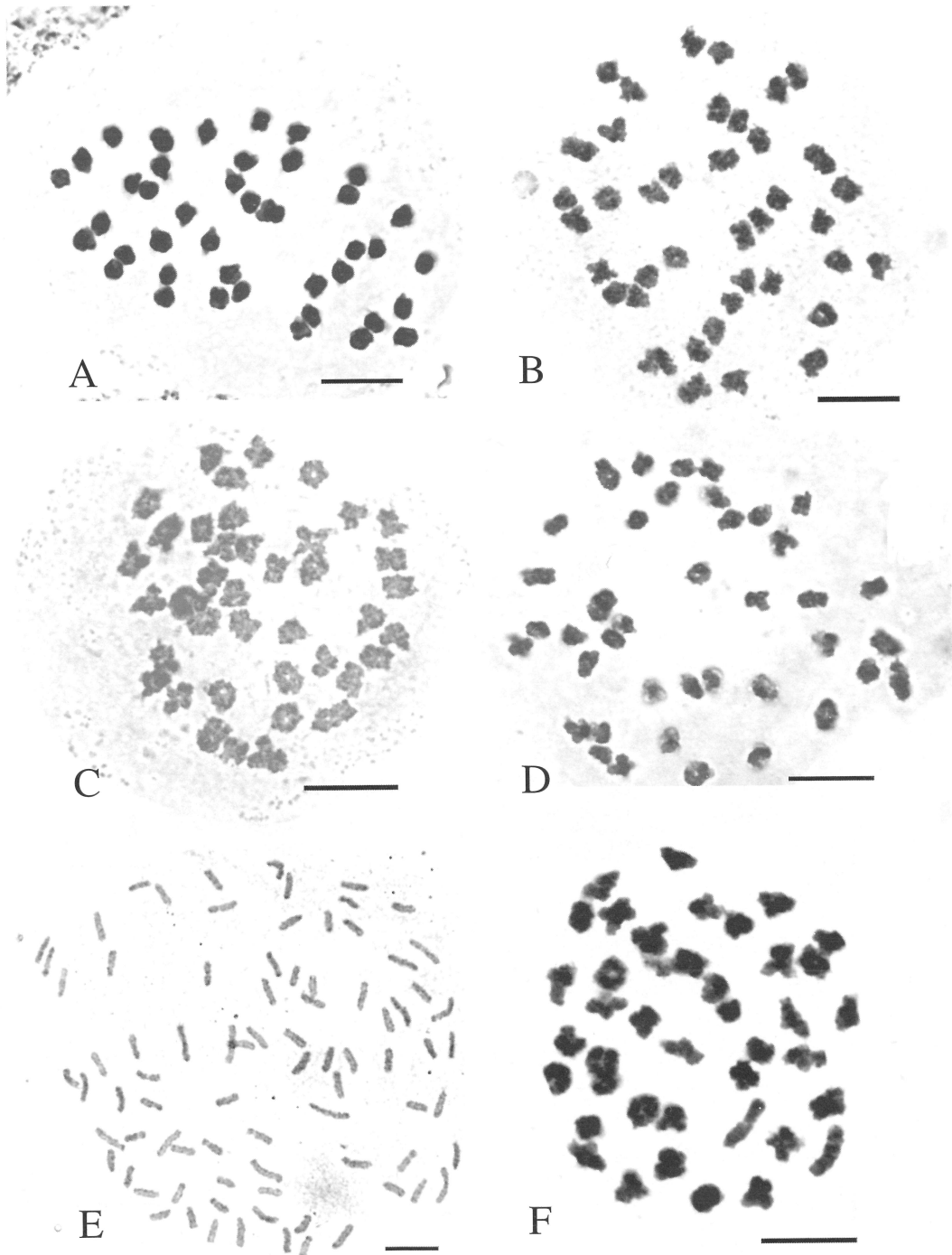


Fig. 1-12. Chromosomes of A1 and A1' types on *Cyrtomium falcatum* complex. A: Tanesashi-kaigan, Hachinohe-shi, Aomori pref. (A1-82),  $n = 41$ , B: Izura-kaigan, Kitaibaraki-shi, Ibaraki pref. (A1-69),  $n = 41$ , C: Borawazawa-kaigan, Hachijo Isl., Tokyo pref. (A1'-58),  $n = 41$ , D: Jogasaki-kaigan, Ito-shi, Shizuoka pref. (A1-43),  $n = 41$ , E: Shiono-misaki Point, Kushimoto-cho, Wakayama pref. (A1-106),  $2n = 82$ , F: Ashizuri-misaki Point, Tosashimizu-shi, Kochi pref. (A1-89),  $n = 41$ . Bar:  $10 \mu m$ .

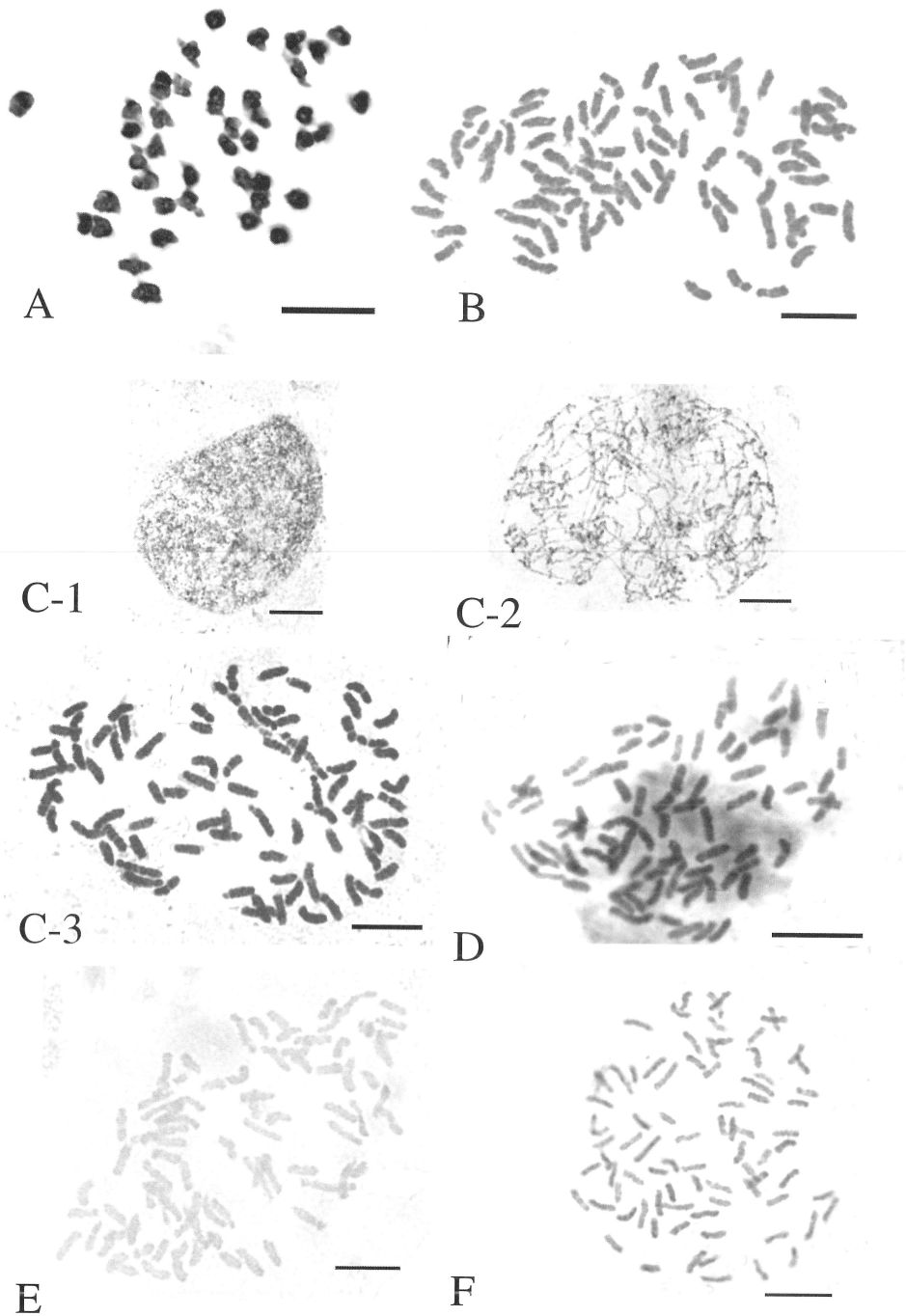


Fig. 1-13. Cytological observations of **A2** type on *Cyrtomium falcatum* complex. **A**: Chichi-jima Isl., Bonin Isls. (A2-5),  $n = 41$ , **B**: Haha-jima Isl., Bonin Isls., Tokyo pref. (A2-67),  $2n = 82$ , **C-1 ~ C-3**: Fukue Isl., Nagasaki pref. (A2-107), 1: metabolic phase, 2: prophase, 3: metaphase,  $2n = 82$ , **D**: Kasasa-cho, Kagoshima pref. (A2-22),  $2n = 82$ , **E**: Okino-erabu Isl., Kagoshima pref. (A2-85),  $2n = 82$ , **F**: Hedo-misaki Point, Okinawa, Okinawa pref. (A2-58),  $2n = 82$ . Bar:  $10 \mu m$ .

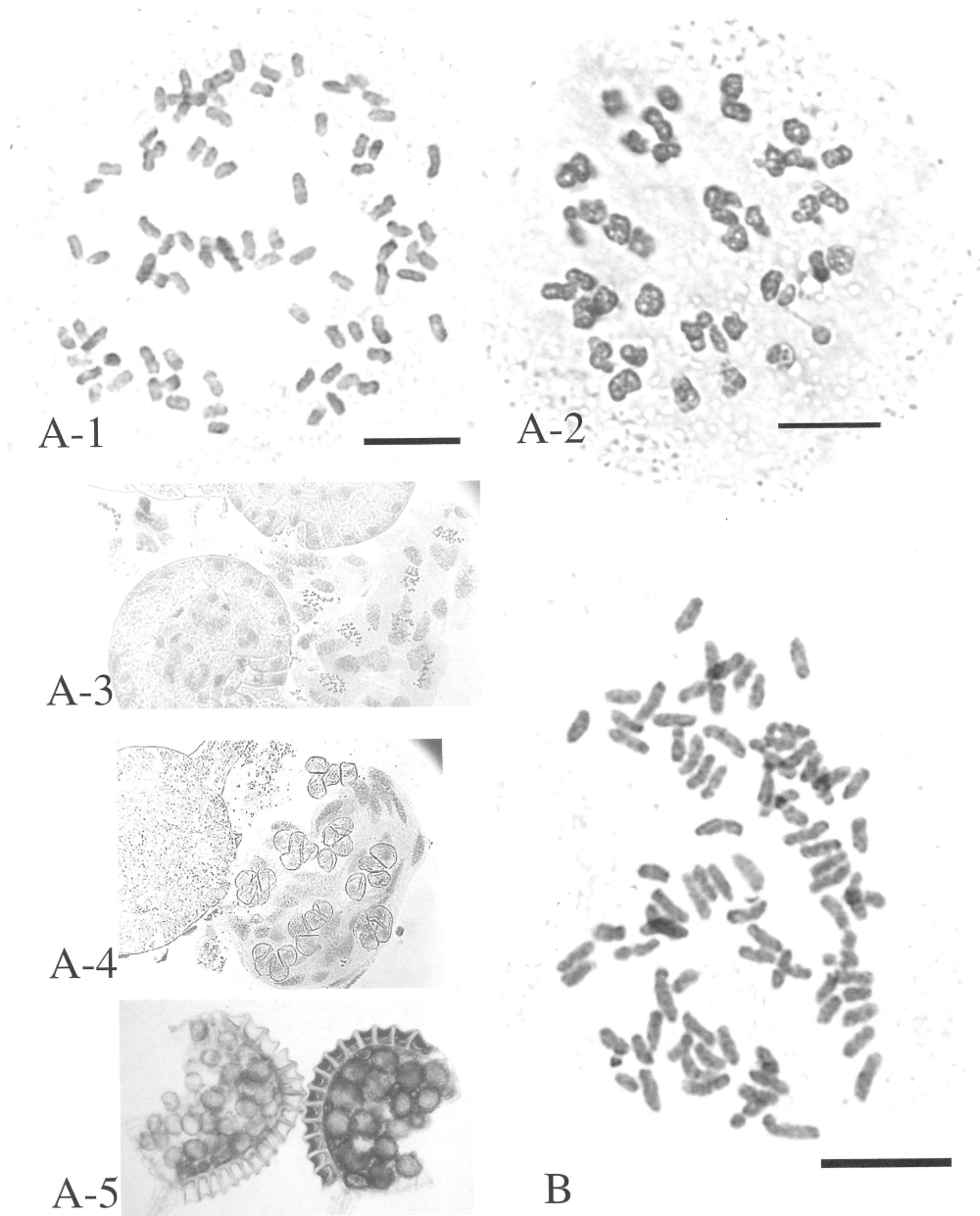


Fig. 1-14. Cytological observations of A2 and A2' types on *Cyrtomium falcatum* complex. A-1 ~ A-5: Nago, Okinawa, Okinawa pref. (A2'-115), A-1: metaphase on mitosis,  $2n = 82$ , A-2: metaphase on meiosis,  $n = 41$ , A-3: 8-celled sporangium with metaphase,  $n = 41$ , A-4: 32-spored sporangium, A-5: making both 32 and 64 spored sporangia, B: Yonakuni Isl. (A2-90),  $2n = 82$ . Bar:  $10 \mu m$ .

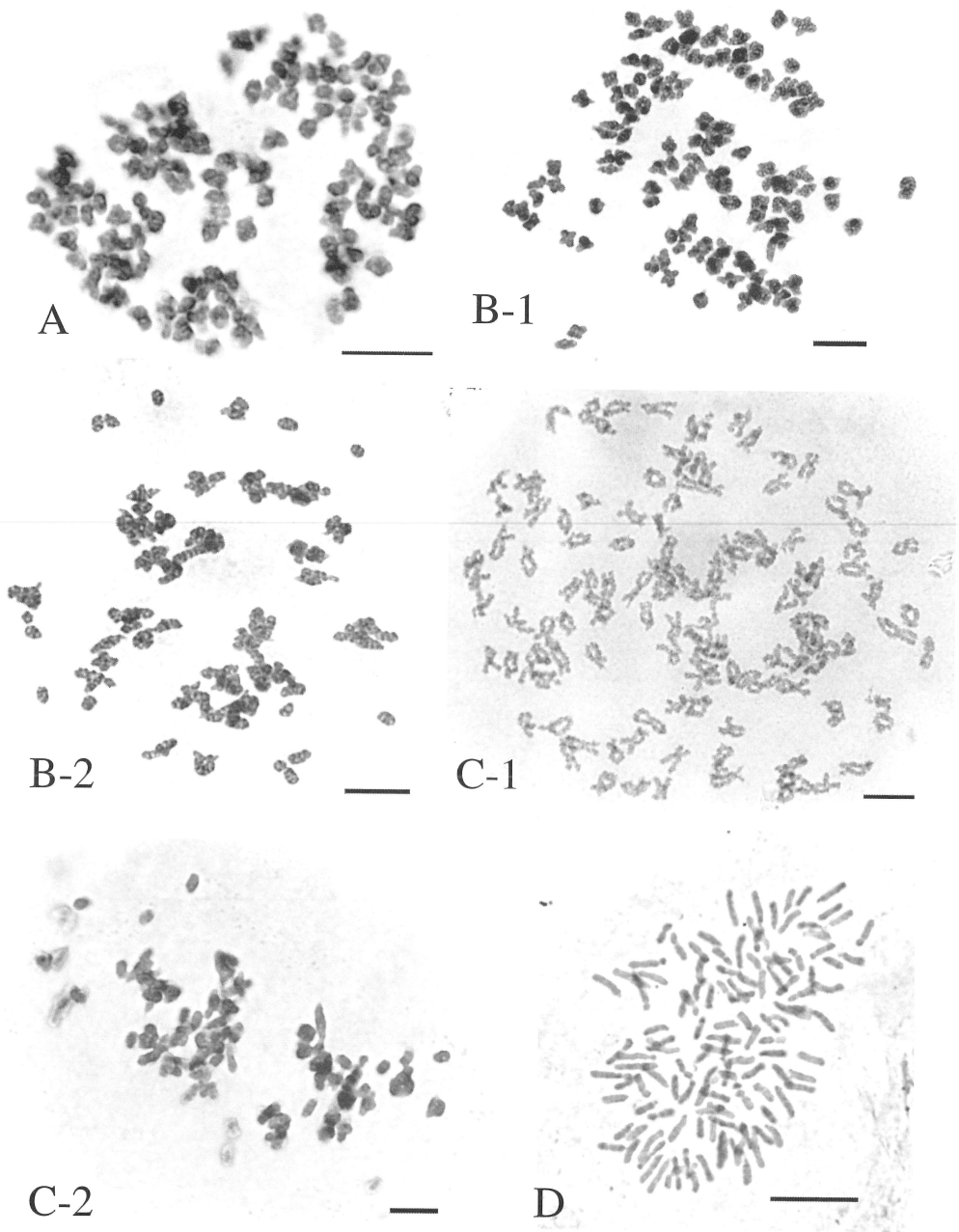


Fig. 1-15. Chromosomes of B type on *Cyrtomium falcatum* complex. A: Kinkazan Isl., Miyagi pref. (B-82),  $n = 123$ , B-1 and B-2: Tajiri-hama, Hitachi-shi, Ibaraki pref. (B-72), B-1: unreduced meiosis,  $n = 123$ , B-2: reduced meiosis,  $22\text{III}+19\text{II}+19\text{I}$ , C-1 and C-2: Kozu Isl., Tokyo pref. (B-36), C-1: unreduced meiosis,  $n = 123$ , C-2: reduced meiosis,  $22\text{III}+19\text{II}+19\text{I}$ . D: Hachijo Isl., Tokyo pref. (B-103),  $2n = 123$ . Bar:  $10 \mu\text{m}$ .

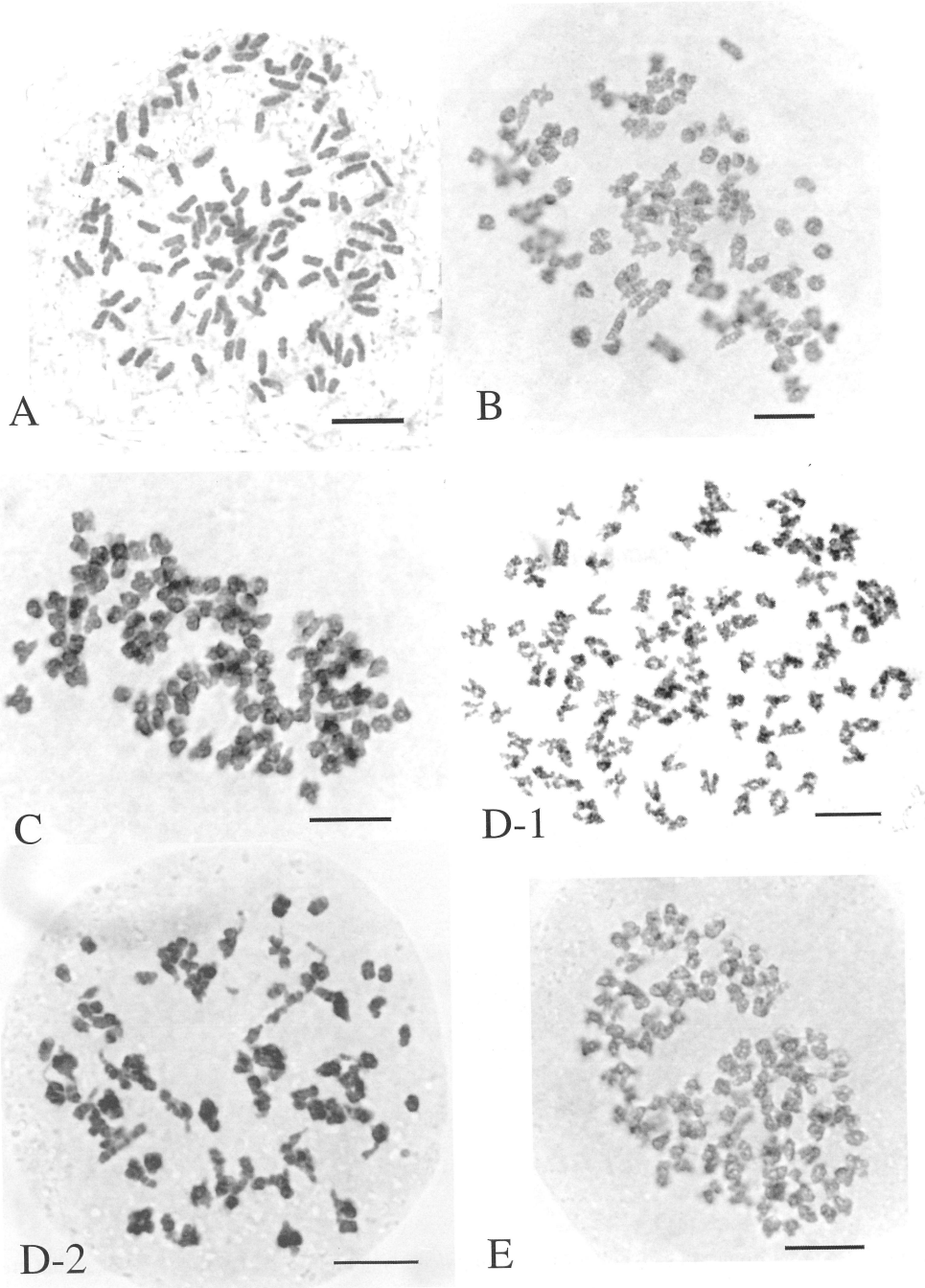


Fig. 1-16. Chromosomes of B type on *Cyrtomium falcatum* complex. A: Aoga-shima Isl., Tokyo pref. (B-191),  $2n = 123$ , B: Sado Isl., Niigata pref. (B-110),  $n = 123$ , C: Mikata-cho, Fukui pref. (B-78),  $n = 123$ , D-1 and D-2: Ito-shi, Shizuoka pref. (B-159), D-1: unreduced meiosis,  $n = 123$ , D-2: reduced meiosis,  $24 \text{ III} + 17 \text{ II} + 17 \text{ I}$ , E: Daio-zaki Point, Mie pref. (B-88),  $n = 123$ . Bar:  $10 \mu\text{m}$ .

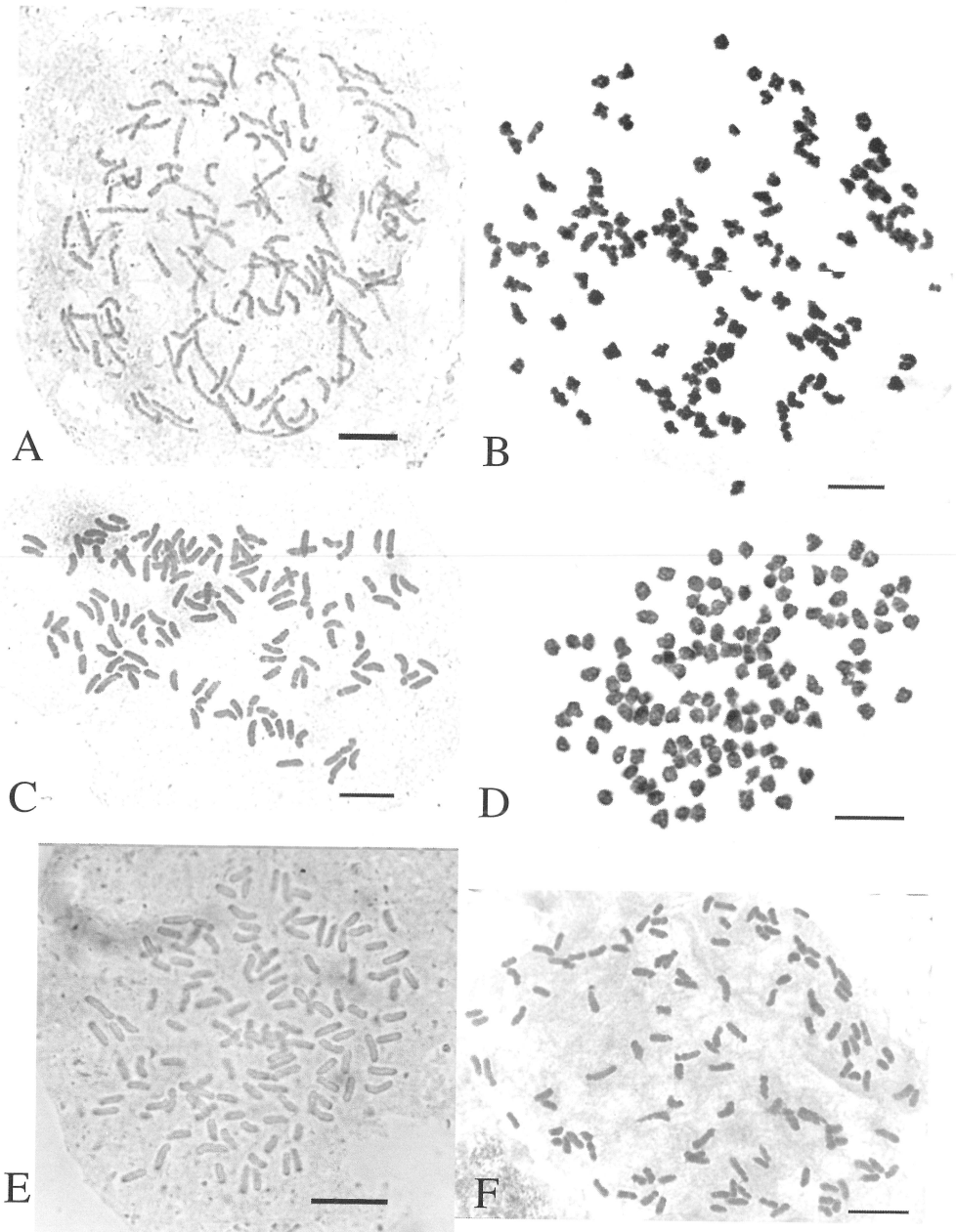


Fig. 1-17. Chromosomes of B type on *Cyrtomium falcatum* complex. A: Koza-cho, Wakayama pref. (B-197),  $n = 123$ , B: Aki-shi, Kochi pref. (B-28),  $n = 123$ , C: Fukue Isl., Nagasaki pref. (B-247),  $2n = 123$ , D: Kawachi-cho, Kumamoto pref. (B-25),  $n = 123$ , E: Yamakawa-cho, Kagoshima pref. (B-163),  $2n = 123$ , F: Kikai Isl., Kagoshima pref. (B-217-2),  $2n = 123$ . Bar:  $10 \mu\text{m}$ .

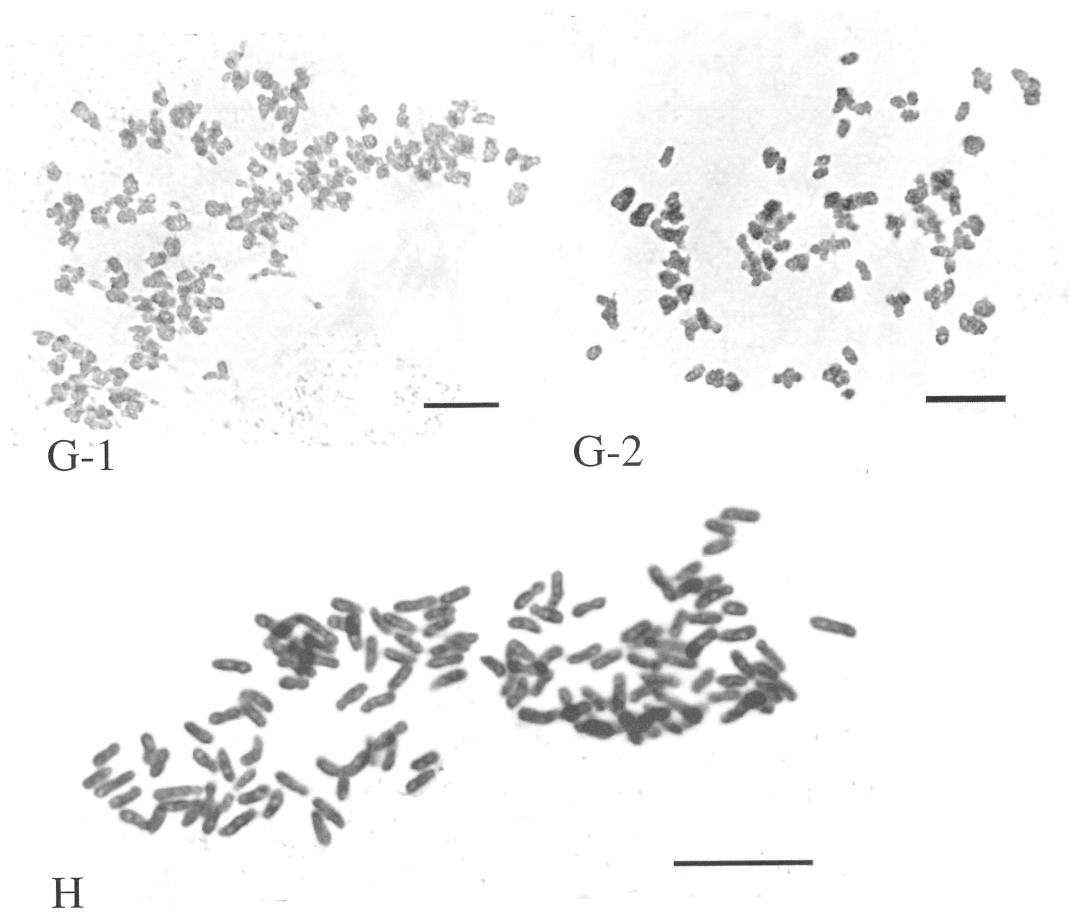


Fig. 1-17.

-(continued)-

**G-1** and **G-2**: Okinawa (B-11), **G-1**: unreduced meiosis ( $n = 123$ ), **G-2**: reduced meiosis,  $19\text{ III} + 24\text{ II} + 18\text{ I}$ , **H**: Kita-daito Isl., Okinawa pref. (B-275),  $2n = 123$ . Bar:  $10\ \mu\text{ m}$ .

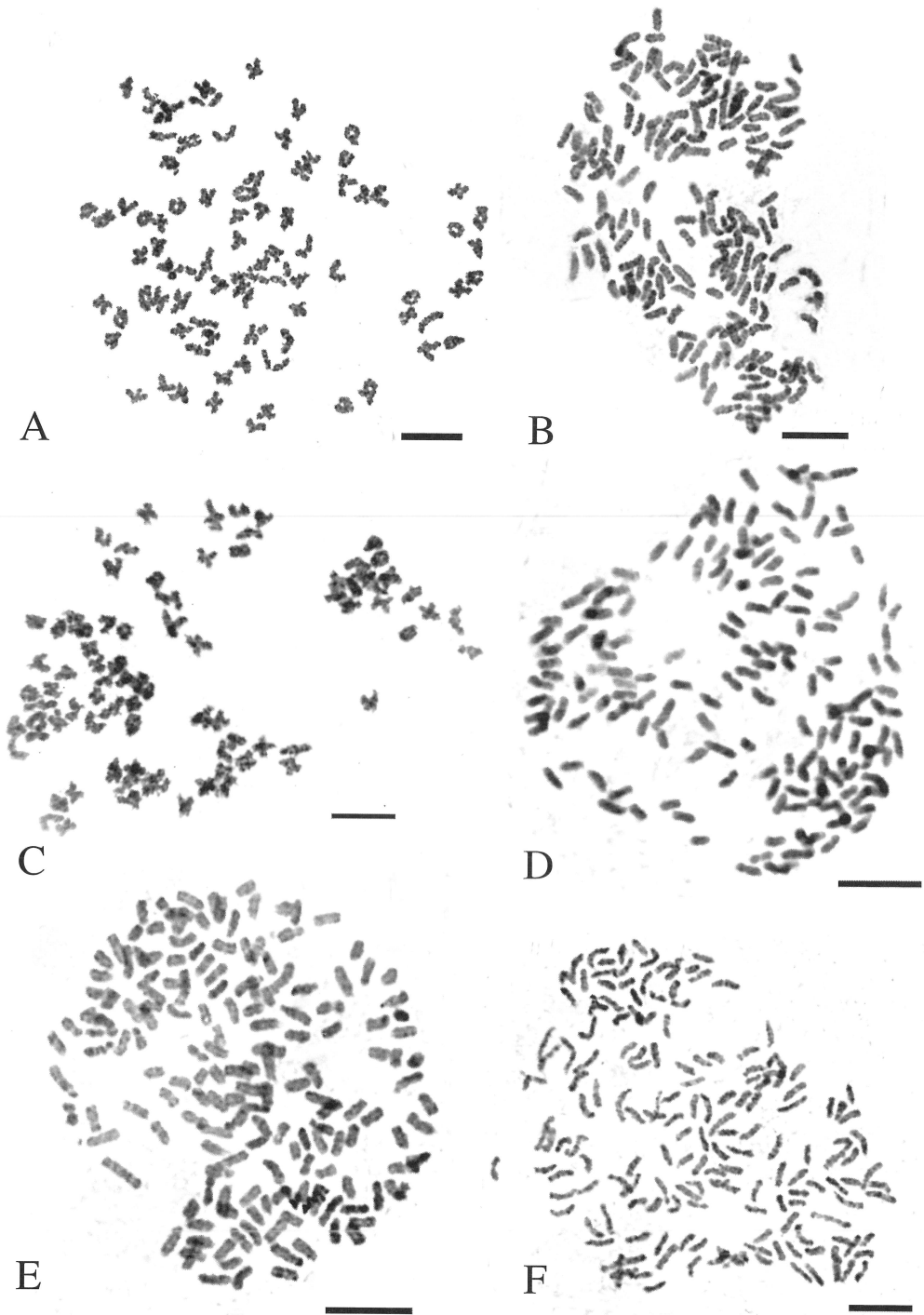


Fig. 1-18. Chromosomes of C type on *Cyrtomium falcatum* complex. A: Shimoda-shi, Shizuoka pref. (C-3),  $n = 82$ , B: Nishi-izu-cho, Shizuoka pref. (C-1),  $2n = 164$ , C: Shizuoka, Shizuoka pref. (SM730429-11),  $n = 82$ , D: Ujina Isl., Hiroshima pref. (C-32),  $2n = 164$ , E: Kosedo, Nagasaki, Nagasaki pref. (C-29),  $2n = 164$ , F: Kaba Isl., Nagasaki pref. (C-28),  $2n = 164$ . Bar:  $10 \mu\text{m}$ .



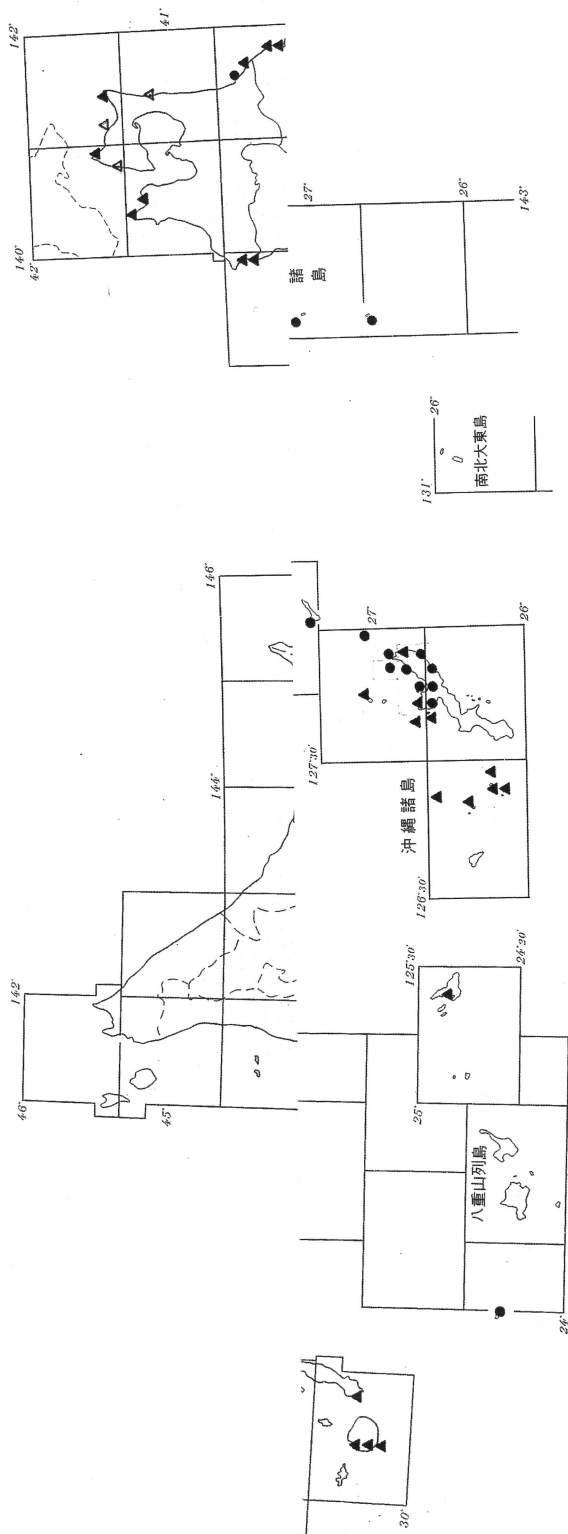


Fig. 1-19. Distribution map of diploid sexual (A1 and A2) types on *Cyrtomium falcatum* complex in Japan.  
 ● : indicate individuals (or populations) observed both reproductive type and chromosome count.  
 ▲ : indicate individuals (or populations) observed reproductive type. ○, △ : cited from the reference.



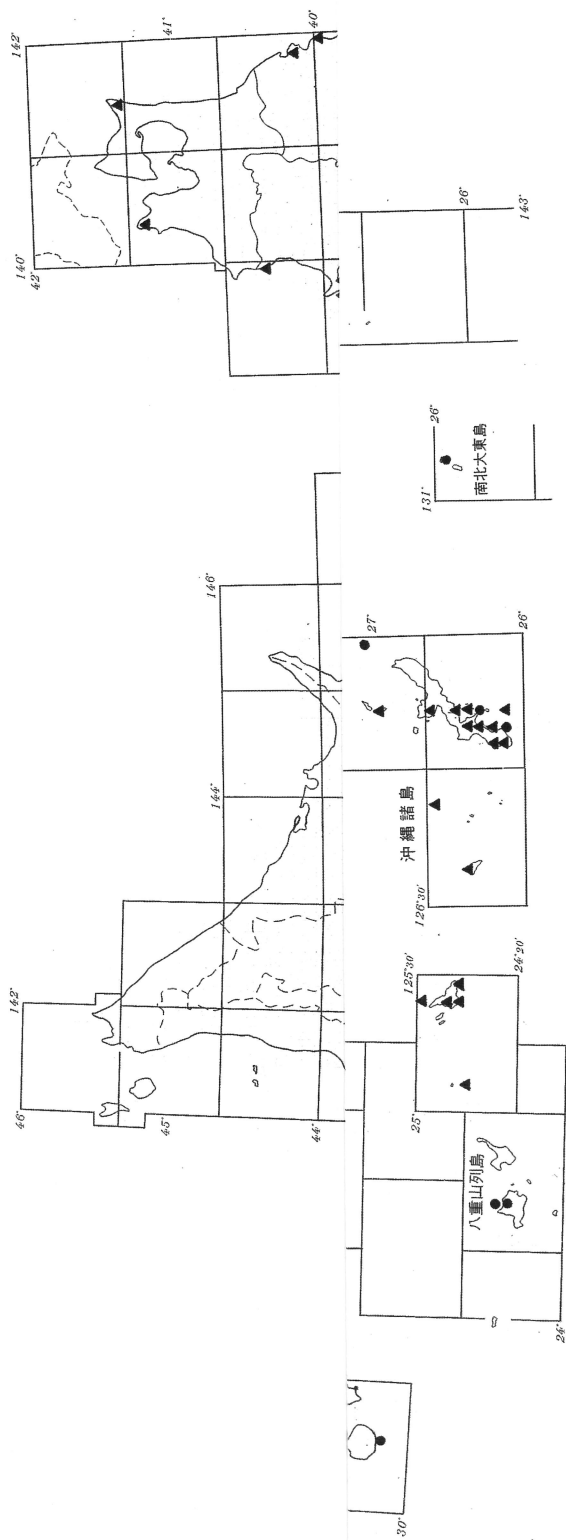


Fig. 1-20. Distribution map of triploid apogamous (B) type on *Cyrtomium falcatum* complex in Japan.  
 ● : indicate individuals (or populations) observed both reproductive type and chromosome count.  
 ▲ : indicate individuals (or populations) observed reproductive type. ○, △ : cited from the reference.



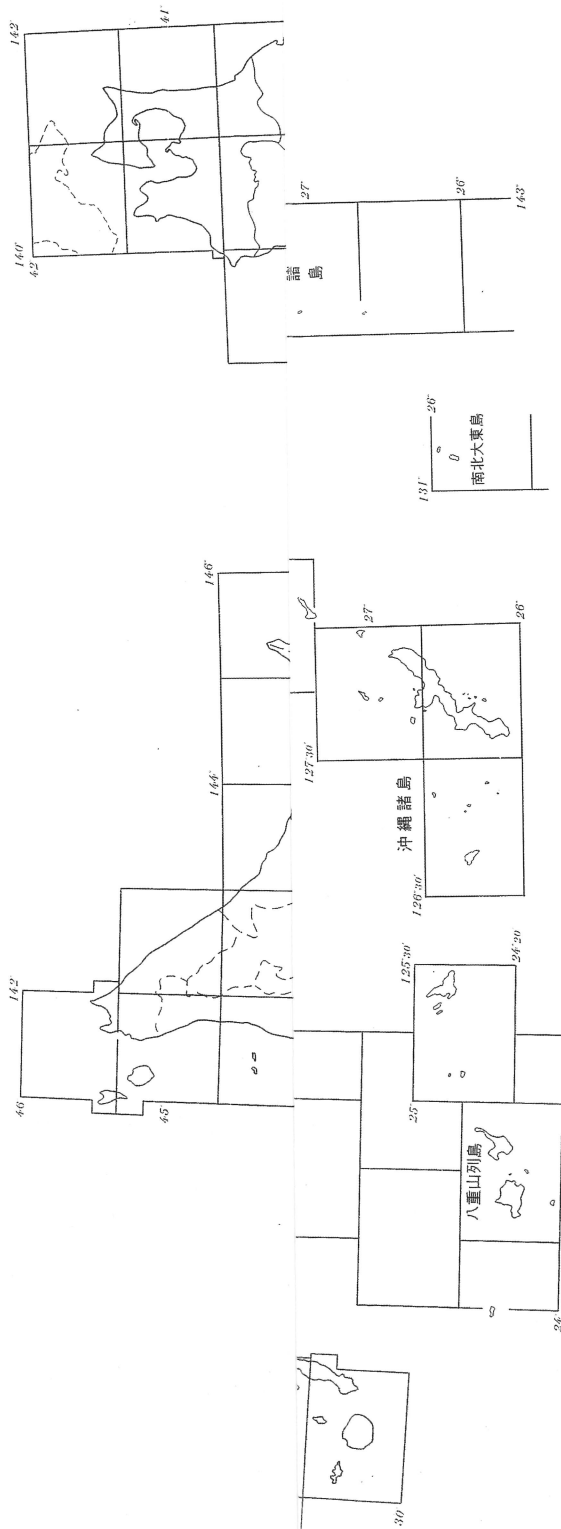


Fig. 1-21. Distribution map of tetraploid sexual (C) type on *Cyrtomium falcatum* complex. ● : indicate individuals (or populations) observed both reproductive type and chromosome count. ▲ : indicate individuals (or populations) observed reproductive type. ○ : cited from the reference. - : indicate individuals (or populations) morphologically unidentified.



## 第2章 自然交雑による倍数体の形成

### 第1節 有性生殖型と無配生殖型(種)の自然交雑による高次倍数体無配生殖型の形成

松本・志村(1985)は日本産ヤブソテツ属の無配生殖を含むすべての種に造精器をつけることを示し、オニヤブソテツ有性生殖型との混生地における雑種形成の可能性を提示した。志村ら(1978)はその5倍体雑種の1例[ $C \times F$  (*C. caryotideum* (Wall. ex Hook. et Grev.) *C. Presl*: メヤブソテツ)]を示し、外部形態が中間形で孢子のサイズの変異が大きいことや不稔孢子を含む孢子嚢が多く作られること、無配生殖で繁殖することを示した。また中池(1992)は倉田(1963)の*C. fortunei* J. Sm. var. *fortunei* (ヤブソテツ)の概念を変え、檜山が*C. fortunei*の品種として記載したテリハヤブソテツを認識しやすいことから*C. laetevirens* (Hiyama) Nakaikeとして種にランクを上げた。これとオニヤブソテツC型との雑種をクマモトヤブソテツ *C. \times kawai* Nakaike in shed.として記録した(倉田・中池1994)。さらに1999年、岡 武利により横浜市金沢区でC型とミヤコヤブソテツ *C. fortunei* J. Sm. var. *intermedium* Tagawaの雑種と推定されるものが見つかり記録されている(山本2001)。

### 方法

野外集団の調査において混生地における中間形を探索し、孢子嚢中の孢子数に加え孢子サイズの変異や不稔性孢子が存在などに注目し、染色体数を算定し雑種の判定を行った。また雑種におけるDiplosporyを行なう孢子嚢の割合、袋かけをして自然落下した孢子の発芽率、無配芽や造卵器、造精器形成の有無について調べた。この培養はシャーレに入れたハイポネックス0.1%寒天培地(pH: 6.5)に播種し、20℃、約2000ルクス、1日16時間の明所下で行った。発芽率の観察は播種後、2週間で行い、落下した孢子に対する発芽した孢子数で示した(不稔の程度が高いと孢子嚢がはじけないこともある)。配偶体は1サンプルにつき50個体前後を酢酸カーミンで染色し、放水クロラル・フォルマリン液に保存し、またプレパラートのマウント液としても利用し、顕微鏡で観察した。

### 結果および考察

伊豆半島南部の下田市においてオニヤブソテツの有性生殖型とヤブソテツ属の無配生殖種(3倍体)が混在する31カ所を調べた結果、15カ所で雑種が見つかった。それらはA1×B(4倍体)、C×B(5倍体)、C×D(5倍体、Dはテリハヤブソテツ)、C×E(5倍体、Eはヤマヤブソテツ)、C×F(5倍体、Fはメヤブソテツ)であった。これらの雑種形成率は有性生殖種間の不稔雑種形成率とあまり変わらず、野外では無配生殖で増えているようには思えなかった(Table 2-1, Fig. 2-1)。同半島の伊東市、大仁町、松崎町および河津町、静岡市南部、三浦半島、鳥取県および熊本県などでもそれぞれの混生地の現地調査で雑種が見つかった(Tables 2-2~2-7, 2-10, Figs. 2-2~2-9)。有性生殖型間の3倍体雑種(A2×C)は不稔性の程度が高く減数分裂は16個の母細胞の段階でストップし、孢子嚢も未熟のままであった(Fig. 2-3A, B)。4倍体のA1×Bは非減数性孢子形成(32-spored sporangium: Diplospory)だけでなく減数性孢子形成(64-spored sporangium: Haplospory)も1個の多価染色体が形成されることがあるが孢子形成はほぼ正常であった(Fig. 2-2)。Table 2-10のC×B、C×D、C×Eはオニヤブソテツとして同定された分布図引用標本(倉田・中池 1987)から見出されたものである。またこれらの雑種の片親であるD、E、F種についても細胞学的観

察をした結果、いずれも3倍体無配生殖型を確認した (Fig. 2-8, Table 2-9)。特に、筒井 (1988) によりヤマヤブソテツ (E) と同定される種が形態的に4つに分けることが提唱され、そのうち雑種の推定親の3型 (E1: 光沢葉型: ヒラオヤブソテツ, E2 つやなし型: ツヤナシヤマヤブソテツ, E3: 多羽片型: ホソバヤマヤブソテツとした) の染色体数を調べたことになる。これらの雑種は Diplospory (8 ~ 58%) をおこない、発芽率がかなり高く (24 ~ 90%), 無配生殖で増殖し、造精器も形成していた (Table 2-11)。このほかに C × G (G はミヤコヤブソテツ) も三浦半島で最近1株発見された (Table 2-8)。この染色体数のデータはないが孔辺細胞のサイズおよび胞子のサイズとその変異幅が大きいことから5倍体無配生殖型と推定され (Appendix 10), さらに無配生殖で多くの幼植物を得、造精器形成も確認した (Fig. 2-10)。

## 第2節 倍数性半数体無配生殖型の形成

自然雑種 A1 × B (2系統4株) は非減数性胞子だけでなく定型の減数性胞子も形成され、その割合も45 ~ 70% と高い。この減数性胞子を播いて (発芽率43.4 ~ 67.3% : Table 3-4), 有性生殖と無配生殖の配偶体が分離したが、無配生殖によって形成された胞子体は2倍体で、かつ無配生殖が固定し、4倍体から生まれた2倍体 (Dihaploid: 複半数体) である (Table 3-6)。この現象は顕花植物では知られているが (Nogler 1984), シダ植物では知られておらず、オニヤブソテツでも野外ではまだ発見されていない\*\*。シダ類には2倍体無配生殖種が知られ、その起源について示唆を与えるものである。またこの Dihaploid の配偶体の観察でも造精器が形成された (Table 2-12)。このことは混生地で A1 または A2 と戻し交配が行われると3倍体無配生殖の新しい B 型が生まれ、このようなサイクルによって変異が形成されることも示唆された。

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\*\* 沖縄県名産の2倍体 ( $2n = 82$ ) は Fig. 1-14A-A, B, C, D, E に示した A2'-115 株のように32と64個の胞子をつけるので Dihaploid の野外における例と思われたが、8母細胞でも通常の減数した41の2価染色体が観察され、32個の胞子を形成するものと考えられた。この原因は胞子嚢が小さいため8個の段階で胞子母細胞が形成されたものと思われる。この証拠は Fig. 1-14A-E の胞子嚢を取り巻く環帯細胞数が胞子数64個の方は17に対し32個の方が14個と少ないことが上げられる。ホングウシダ科の胞子数が32個であるにもかかわらず通常の減数分裂を行うのは (Lin *et al.* 1990), 同じ原因が科のレベルで固定したものと推定される。



Table 2-1. Intra- or inter-specific hybridization of the genus *Cyrtomium* at the 31 sites (see Fig. 2-1) in Shimoda-shi, southern part of Izu peninsula (the number indicates a number of individuals of the population)

Site \ Taxa*	A1	B	C	D	E	F	A1 × B	C × B	C × D	C × E	C × F
1	43	150	-	-	-	-	3(0.03)**	-	-	-	-
2	-	30	10	-	-	-	-	-	-	-	-
3	9	67	-	-	-	-	-	-	-	-	-
4	-	30	-	-	-	-	-	-	-	-	-
5	-	3	21	-	-	-	-	-	-	-	-
6	-	4	18	-	-	-	-	1(0.05)	-	-	-
7	-	11	25	-	-	-	-	1(0.03)	-	-	-
8	-	15	4	-	-	-	-	-	-	-	-
9	-	6	15	-	-	-	-	1(0.05)	-	-	-
10	6	3	-	-	-	-	-	-	-	-	-
11	-	10	15	-	-	-	-	2(0.08)	-	-	-
12	25	3	-	-	-	-	-	-	-	-	-
13	-	11	-	-	-	-	-	-	-	-	-
14	-	5	40	1	-	-	-	-	-	-	-
15	-	5	-	-	-	-	-	-	-	-	-
16	-	4	40	-	-	-	-	-	-	-	-
17	-	20	7	-	-	-	-	1(0.04)	-	-	-
18	-	-	ca.50	-	-	-	-	-	-	-	-
19	-	15	15	5	-	-	-	-	-	-	-
20	-	-	30	-	-	-	-	-	-	-	-
21	-	21	35	40	-	-	-	-	6(0.08)	-	-
22	-	3	ca.50	ca.50	-	-	-	-	-	-	-
23	-	2	25	40	-	-	-	-	3(0.05)	-	-
24	-	-	ca.50	ca.50	-	-	-	-	1(0.01)	-	-
25	-	3	ca.50	ca.50	4	-	-	-	3(0.03)	-	-
26	-	-	41	13	61	15	-	-	2(0.04)	4(0.04)	1(0.02)
27	-	-	11	33	-	-	-	-	5(0.11)	-	-
28	-	-	10	ca.50	5	-	-	-	1(0.02)	-	-
29	-	-	1	25	5	-	-	-	-	-	-
30	-	-	15	12	18	-	-	-	-	1(0.02)	-
31	-	-	30	10	30	-	-	-	-	2(0.03)	-
Total	83	421	408	179	123	15	3	6	21	21	1

\* A1: diploid sexual type of *C. falcatum*, B: triploid apogamous type of *C. falcatum*, C: tetraploid sexual type of *C. falcatum*, D: *C. fortunei* var. *fortunei*, E: *C. fortunei* var. *clivicola*, F: *C. caryotideum*.

\*\* : Ratio of hybridization (the number of hybrids / the number of parents).

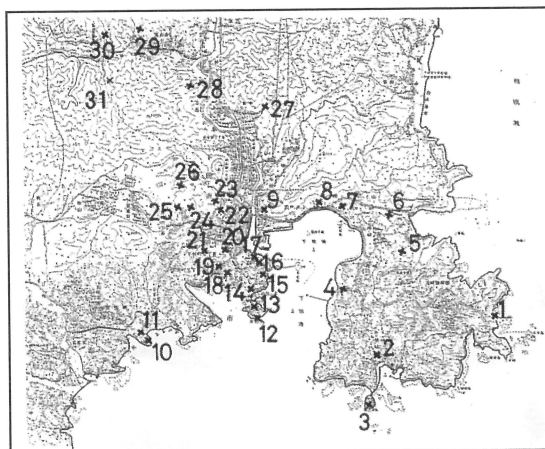


Fig. 2-1. Investigated sites.

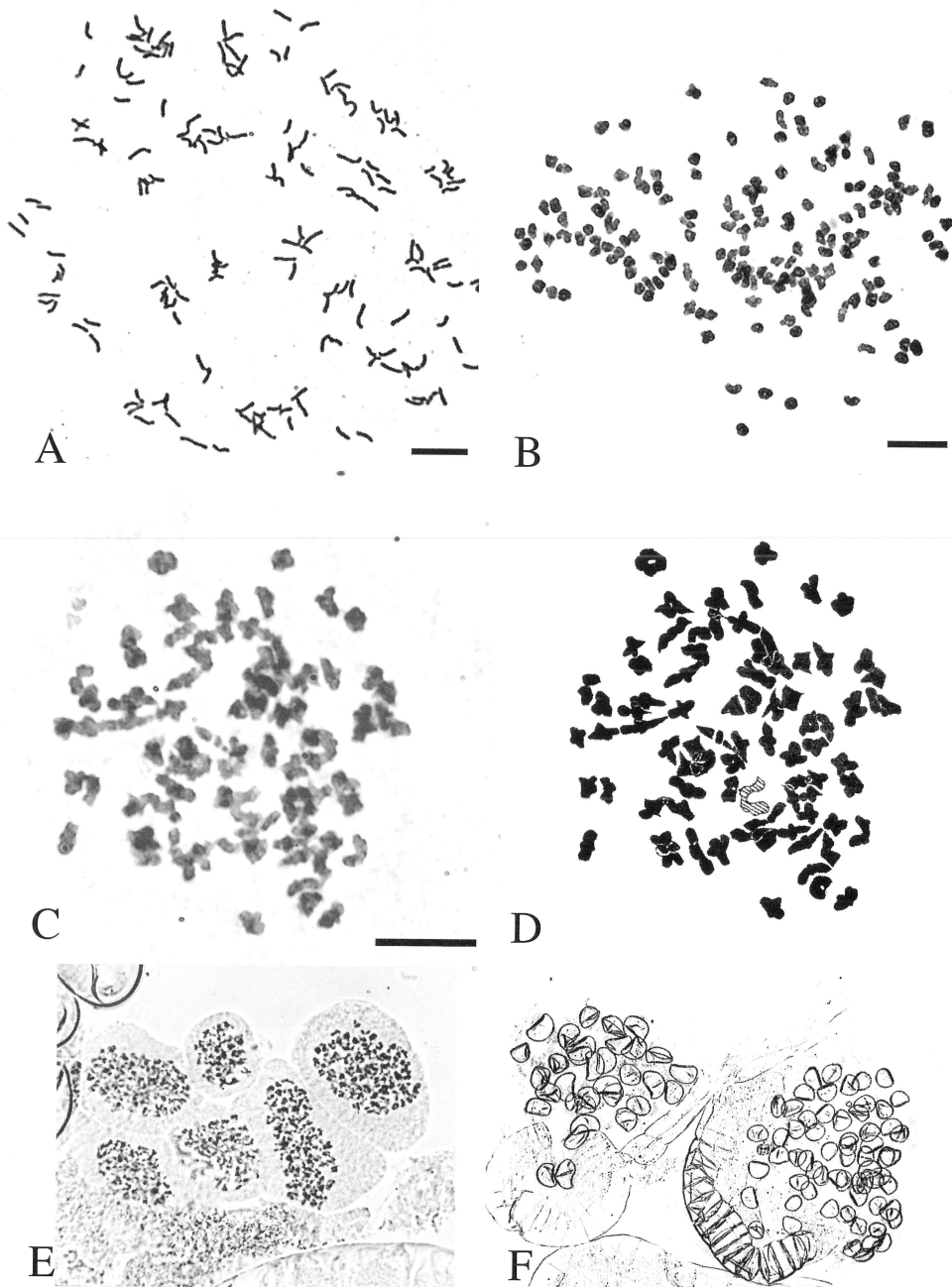


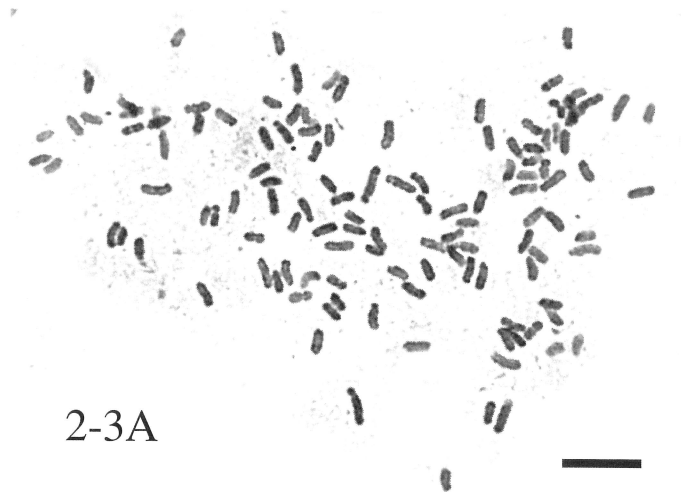
Fig. 2-2. Cytological data of A1 × B-1 on *Cyrtomium falcatum* complex. A:  $2n = 164$ , B:  $n = 164$  (8-celled sporangium), C: sexual meiosis in 16-celled sporangium, D: explanatory diagram of Fig. C, 11V + 80II, E: six various size of spore mother cells on cleave celled sporangium, F: sixty four spored sporangium (haplo-spores) and 32-spored sporangium (diplo-spores). Bar:  $10 \mu\text{m}$ .

Table 2-2. List of locality and the cytological data on **A1** × **B** type of *Cyrtomium falcatum* complex

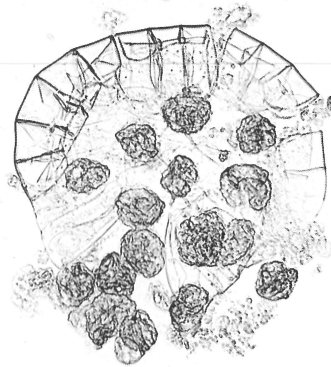
Locality ([ ]: mapping index, <b>A1</b> × <b>B</b> -: stock-culture number)	Cytological Data*(n)		
	S/S	2n, n and chromosome association	Fig.
<b>Shizuoka pref.</b>			
[Ito-2] Ito-shi, Jogasaki, Oshimagane, on rock-wall of seashore with <b>A1</b> and <b>B</b> types (S. Matsumoto, May 19, 1980, <b>A1</b> × <b>B</b> -2)	32, 64 s/s, variable good spores	n = 164 (8 c/s)	
[Ito-2] Ito-shi, Jogasaki, Oshimagane, on rock-wall of seashore with <b>A1</b> and <b>B</b> types (S. Matsumoto, June 15, 1980, <b>A1</b> × <b>B</b> -3)	32, 64 s/s, variable good spores		
[Ito-2] Ito-shi, Jogasaki, Oshimagane, on rock-wall of seashore with <b>A1</b> and <b>B</b> types (S. Matsumoto, June 15, 1980, <b>A1</b> × <b>B</b> -4)	32, 64 s/s, variable good spores	n = 164 (8 c/s)	
[Ito-2] Ito-shi, Jogasaki, Tsunakiri, on rock-wall of seashore with <b>A1</b> and <b>B</b> types (S. Matsumoto, Mar. 16, 1982, <b>A1</b> × <b>B</b> -5)	32, 64 s/s, variable good spores	n = 164 (8 c/s)	
[Ito-2] Ito-shi, Jogasaki, Oshimagane, on rock-wall of seashore with <b>A1</b> and <b>B</b> types (S. Matsumoto, June 15, 1980, <b>A1</b> × <b>B</b> -8)	32, 64 s/s, variable good spores	2n = ca. 170	
[Ito-2] Ito-shi, Jogasaki, Oshimagane, on rock-wall of seashore with <b>A1</b> and <b>B</b> types, (S. Matsumoto, June 15, 1980, <b>A1</b> × <b>B</b> -9)	32, 64 s/s, variable good spores	2n = 168	
[Mikomoto-jima-1] Shimoda-shi, Suzaki, Tsumekisaki, on rock-wall of seashore with <b>A1</b> and <b>B</b> types (S. Matsumoto, May 27, 1973, <b>A1</b> × <b>B</b> -1)	32, 64 s/s, variable good spores	2n = n = 164 (8c/s), 1IV + 80II (16c/s)	2-2
[Mikomoto-jima-1] Shimoda-shi, Suzaki, Tsumekisaki, on rock-wall of seashore with <b>A1</b> and <b>B</b> types (S. Matsumoto, May 27, 1973, <b>A1</b> × <b>B</b> -6)	32, 64 s/s, variable good spores	2n = 164	
Total	3 localities (8 individuals)	3 localities (6 individuals)	

Showing apogamous and sexual tetraploid hybrid between sexual diploid (**A1**) and apogamous triploid (**B**).

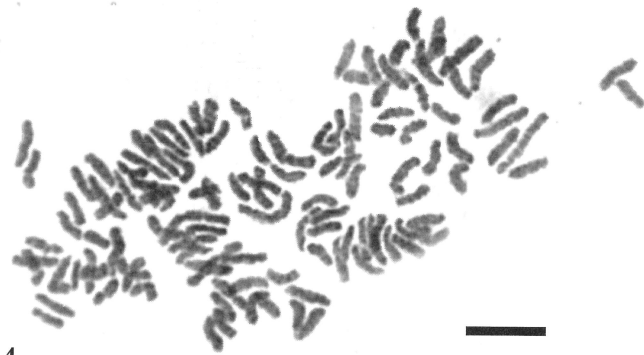
\*(n): a number of individuals, s/s: spore number per sporangium (64: 64 haplo-spores, 32: 32 diplospores), 2n: chromosome number in mitosis, n: a number of bivalent in meiosis.



2-3A



2-3B



2-4

Figs. 2-3 and 2-4. Chromosomes of triploid natural hybrid between diploid (A2 type) and tetraploid (C type) on *Cyrtomium falcatum* complex at Fukue Isl., Nagasaki pref. Fig. 2-3A. A2 × C-1 (Kokuzou),  $2n = 123$ . Fig. 2-3B. Abortive 16-spores from 16-celled sporangium. Fig. 2-4. A2 × C-2 (Nagate),  $2n = 123$ . Bar:  $10 \mu\text{m}$ .

Table 2-3. List of locality and the cytological data on  $A2 \times C$  type of *Cyrtomium falcatum* complex

Locality ([ ]: mapping index, $A2 \times C$ -: stock-culture number)	Cytological Data*(n)			Fig.
	C/S	2n or n		
<b>Nagasaki pref.</b>				
[Tomie-3] Fukue-shi, Kokuzou, bank along stream (O. Terai, Mar. 23, 1994, $A2 \times C-1$ )	16(1)	2n = 123, sterile	hybrid	2-3
[Tomie-4] Fukue-shi, Nagate (O. Terai, Mar. 23, 1994, $A2 \times C-2$ )	16(1)	2n = 123, sterile	hybrid	2-4

Showing triploid sterile hybrid between sexual diploid ( $A2$ ) and sexual tetraploid ( $C$ ). \*(n): a number of individuals, C/S: spore mother cell's number per sporangium (16: 16 haplo-spores), 2n: chromosome number in mitosis.

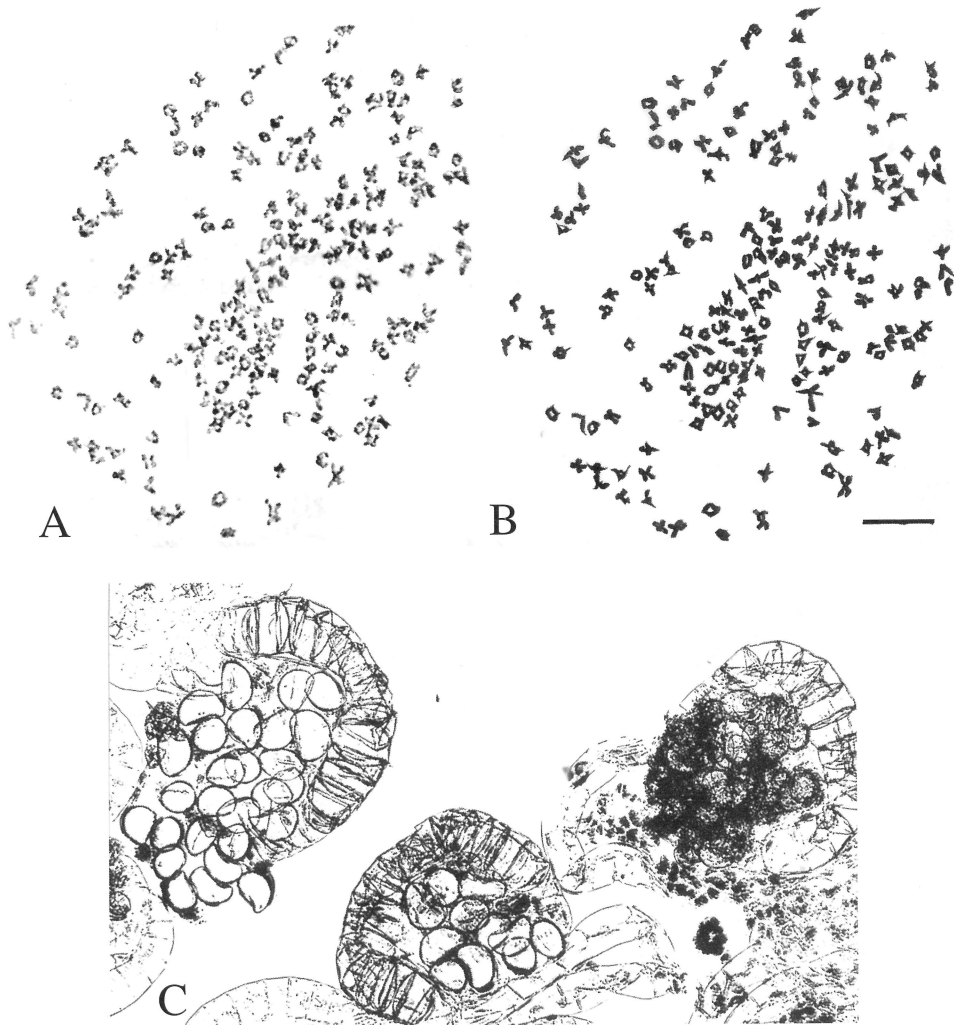
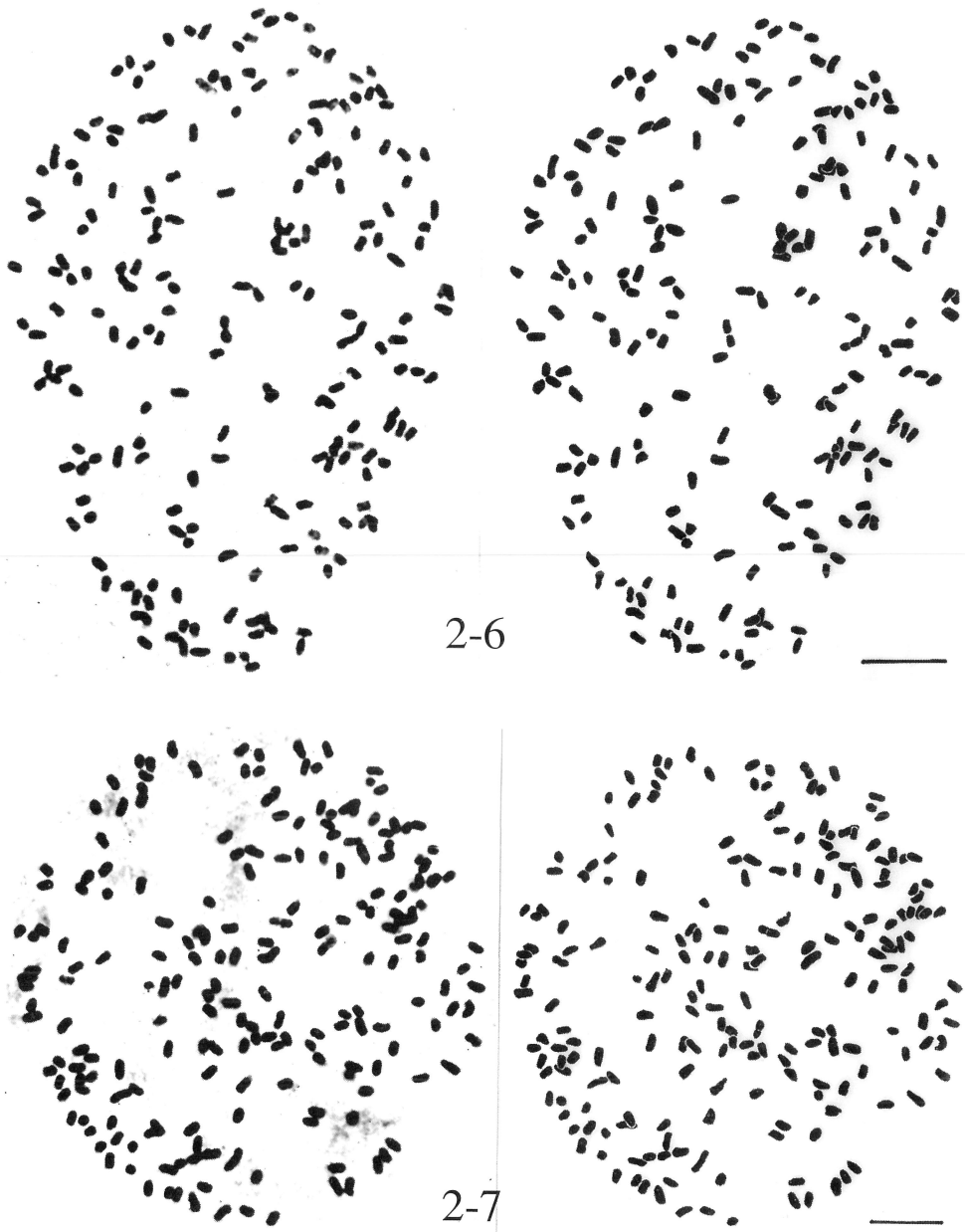


Fig. 2-5. Meiotic auto-bivalent chromosomes and various spore formations of  $C \times B-2$  type on *Cyrtomium falcatum* complex, collected from Hiramatsu, Shizuoka-shi,  $n = 205$  (8-celled sporangium), pentaploid, A: photograph, B: explanatory diagram, C: forming abortive spores from the 16-celled sporangium (right), 32-spores from the 8-celled sporangium (left) and about 16 spores from 4-celled sporangium (center). Bar:  $10 \mu m$ .



Figs. 2-6 and 2-7. Mitotic chromosomes of pentaploid hybrids on *Cyrtomium falcatum* complex. Fig. 2-6. C × B-3 (Sekibe, Shizuoka-shi),  $2n = 205$ . Fig. 2-7. C × D-1 (Jo-yama, Ohito-cho, Shizuoka pref., D: *C. laetevirens*),  $2n = 206$ , hyper pentaploid, left: photograph, right: drawing. Bar:  $10 \mu\text{m}$ .

Table 2-4. List of locality and the cytological data on **C** × **B** type of *Cyrtomium falcatum* complex

Locality ([ ]: mapping index, <b>C</b> × <b>B</b> -: stock-culture number, SM: Matsumoto collection number)	Cytological Data*(n)		
	S/S	2n or n and chromosome association	Fig.
<b>Kanagawa pref.</b>			
[Misaki-1] Miura-shi, Matsuwa, on hill-slope of road-side (S. Matsumoto, Jul. 2, 1972, <b>C</b> × <b>B</b> -1)	32(1), variable spores	2n = 205 + 1f	
<b>Shizuoka pref.</b>			
[Shizuoka-1] Shizuoka-shi, Hiramatsu near Suruga Bay, on stone-wall of road-side with <b>C</b> type and <b>B</b> type (S. Matsumoto, June 26, 1973, <b>C</b> × <b>B</b> -2)	32(1), variable spores	2n = ca.205, n = 205, 2IV+78II+41I (16c/s)	2-5
[Shizuoka-4] Shizuoka-shi, Sekibe, near Suruga Bay, on stone-wall of bank of stream (S. Matsumoto, Sept. 2, 1973, <b>C</b> × <b>B</b> -3)	32(1), variable spores	2n = 205, n = 205	2-6
[Mikomoto-jima-1] Shimoda-shi, Kisami, Irita-hama, on terrestrial bank of small valley (S. Matsumoto, Mar. 15, 1982, <b>C</b> × <b>B</b> -4)	16 ~ 32(1), variable spores	2n = ca.205	
[Mikomoto-jima-1] Shimoda-shi, Kisami, Irita-hama, on terrestrial bank of small valley (S. Matsumoto, Mar. 15, 1982, <b>C</b> × <b>B</b> -5)	32(1), variable spores	2n = ca.205	
[Mikomoto-jima-1] Shimoda-shi, Kisami, Irita-hama, on terrestrial bank of small valley (S. Matsumoto, Mar. 15, 1982, <b>C</b> × <b>B</b> -6)	32(1), variable spores	2n = 201	
[Shimoda-2] Shimoda-shi, Uenoyama to Soto-ura, on northern mountain-slope of road-side (S. Matsumoto, Oct. 9, 1981, <b>C</b> × <b>B</b> -7)	32(1), variable spores	2n = 205	
[Shimoda-2] Shimoda-shi, Uenoyama to Soto-ura, on northern mountain-slope of road-side (S. Matsumoto, Oct. 9, 1981, <b>C</b> × <b>B</b> -8)	32(1), variable spores	2n = ca.205	
[Shimoda-2] Shimoda-shi, Uenoyama to Kakisaki, on northern mountain-slope of road-side (S. Matsumoto, May 1, 1988, <b>C</b> × <b>B</b> -10)	32(1), variable spores	2n = ca.205	

Showing apogamous pentaploid hybrid between sexual tetraploid (**C**) and apogamous triploid (**B**). \*(n): a number of individuals, s/s: spore number per sporangium (32: 32 diplo-spores), 2n: chromosome number in mitosis, n: a number of bivalent in meiosis.

Table 2-5. List of locality and the cytological data on  $C \times D$  type of *Cyrtomium falcatum* complex

Locality ([ ]: mapping index, $C \times D$ - : stock-culture number)	Cytological Data*(n)		
	S/S	2n, n and chromosome association (16c/s)	Fig.
<b>Kanagawa pref.</b>			
[Misaki-1]Miura-shi, Matsuwa, on mountain slope of roadside (S. Matsumoto, Jul. 2, 1972, $C \times D$ -8)	32/64, variable spores		
[Yokosuka-3] Miura-shi, Kanazawa-hakkei (S. Matsumoto, June 16, 2001, $C \times D$ -10)	32/64, variable spores		
<b>Shizuoka pref.</b>			
[Numazu-2] Ohito-cho, Mt. Joyama, on bank of valley with $C$ type and species ( $D$ ) (S. Matsumoto, Feb. 8, 1971, $C \times D$ -1)	32/64S/S, variable spores	2n = 206, n = 206, 2IV + 4 III + 75 II + 36 I (16c/s)	2-7
[Shimoda-2] Shimoda-shi, Shikine, Mamushiga-kubo, on bank of small valley (S. Matsumoto, Feb. 11, 1980, $C \times D$ -2)	32<64, variable spores	2n = ca.205	
[Shimoda-2] Shimoda-shi, Shikine, Mamushiga-kubo, on bank of small valley (S. Matsumoto, Feb. 11, 1980, $C \times D$ -3)	32<64, variable spores	2n = 205	
[Shimoda-2] Shimoda-shi, 5 cho-me, Kasuga-yama, on mountain slope (S. Matsumoto, Oct. 5, 1981, $C \times D$ -4)	32<64, variable spores	2n = 205	
[Shimoda-2] Shimoda-shi, 5 cho-me, Kasuga-yama, on mountain slope (S. Matsumoto, Oct. 5, 1981, $C \times D$ -5)	32<64, variable spores	2n = 205, 1 III + 76 II + 40 I	
[Shimoda-2] Shimoda-shi, Icho-me, beside tunnel, on mountain slope (S. Matsumoto, Oct. 6, 1981, $C \times D$ -6)	32<64, variable spores		
[Mikomoto-jima-1] Shimoda-shi, Kisami, Tatado-hama, on mountain slope near seashore (S. Matsumoto, Mar. 15, 1982, $C \times D$ -7)	32<64, variable spores	2n = ca.205	
<b>Tottori pref.</b>			
[Hamasaka-3] Iwami-cho, Uratomi-kaigan, on mountain slope (S. Matsumoto, Apr. 1, 1972, $C \times D$ -9)	32/64, variable spores	2n = 205	

Showing apogamous pentaploid hybrid between sexual tetraploid ( $C$ ) and apogamous triploid species ( $D$ : *C. laetevirens*). \*(n): a number of individuals, S/S: spore number per sporangium (32: 32 diplo-spores, 64: 64 irregular haplo-spores), 2n: chromosome number in mitosis, n: chromosome number in meiosis of eight mother celled sporangium (apo-meiosis). 16c/s: chromosome association in meiosis of 16 mother celled sporangium (sexual meiosis).



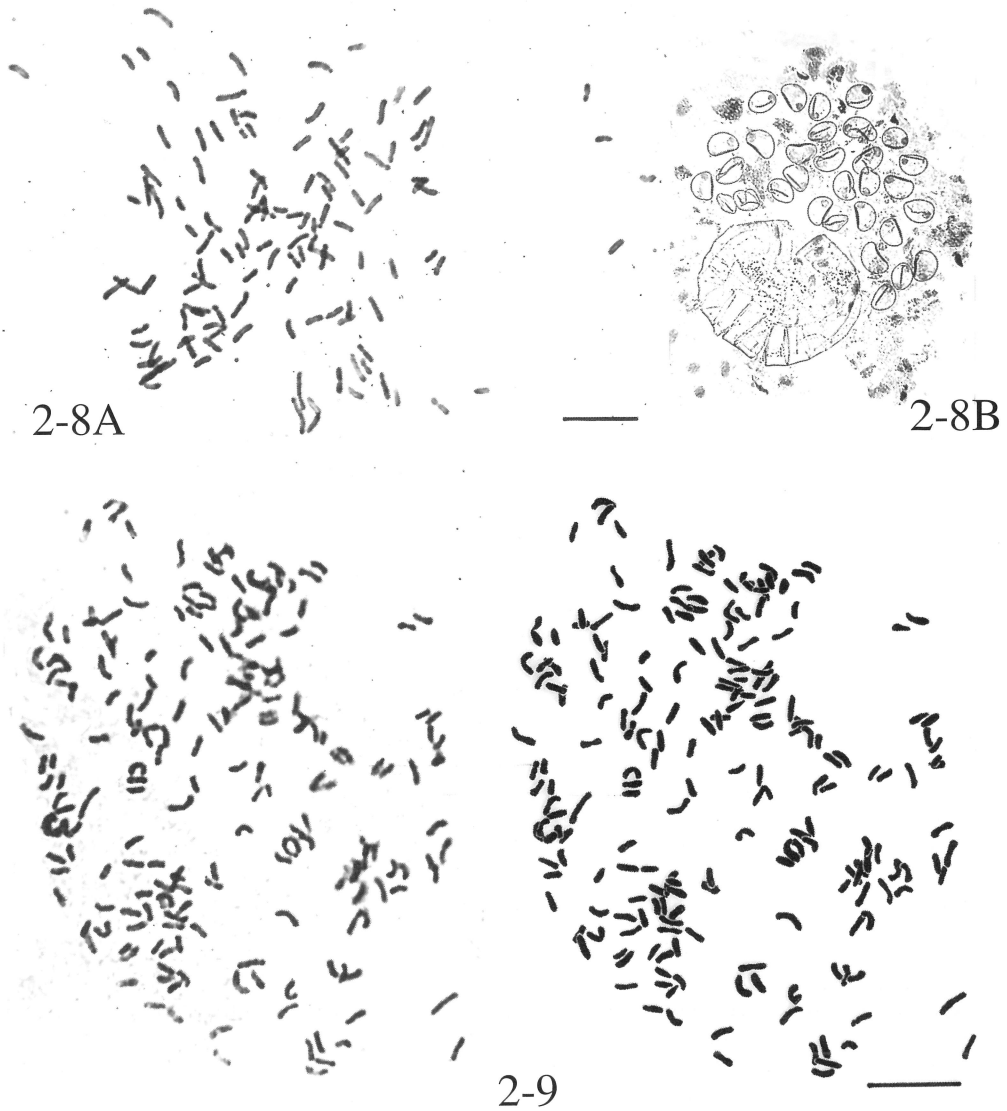


Fig. 2-8. Cytological data of E3-6 (E3: a form of *Cyrtomium fortunei* var. *clivicola*; Hosoba-yamayabusotetsu type), Otaki, Kawazu-cho, Shizuoka pref., A:  $2n = 123$ , B: 32-spored sporangium, triploid apogamous species.

Fig. 2-9. Mitotic chromosomes of pentaploid hybrids between C type and E3 on *Cyrtomium falcatum* complex. C  $\times$  E3-8 (Iwado limestone cave, Kuma-mura, Kumamoto pref.),  $2n = 205$ , left: photograph, right: drawing. Bar:  $10 \mu\text{m}$ .

Table 2-6. List of locality and the cytological data on C × E type of *Cyrtomium falcatum* complex

Locality ([ ]: mapping index, C × E -: stock-culture number)	Cytological Data*(n)		
	S/S	2n, n and chromosome association (16c/s)	Fig.
<b>Kanagawa pref.</b>			
[Yokosuka-3] Miura-shi, Kanazawa-hakkei, on cutting rock-wall (S. Matsumoto, June 16, 2001, C × E2 -13)	64 > 32, variable spores		
[Yokosuka-3] Miura-shi, Kanazawa-hakkei, on cutting rock-wall (S. Matsumoto, June 16, 2001, C × E2 -14)	64 > 32, variable spores		
<b>Shizuoka pref.</b>			
[Shimoda-1] Kawazu-cho, Otaki water fall, rocky bank of valley (S. Matsumoto, May 5, 1973, C × E2 -4)	64 > 32, variable spores	2n = 205	
[Shimoda-1] Kawazu-cho, Onabe, on mountain slope (S. Matsumoto, Oct. 4, 1974, C × E1 -5)	64 > 32, variable spores	2n = 205	
[Shimoda-1] Kawazu-cho, Onabe, on mountain slope (S. Matsumoto, Oct. 4, 1974, C × E1 -6)	64 > 32, variable spores	2n = ca.205	
[Shimoda-1] Shimoda-shi, Shikine, Mamushiga-kubo, on cutting rock-wall (S. Matsumoto, Feb. 11, 1980, C × E1 -1)	64 > 32, variable spores	n = ca.205	
[Shimoda-1] Shimoda-shi, left valley of Kami-osawa, rocky slope of roadside (S. Matsumoto, June 4, 1995, C × E3 -10)	64 > 32, variable spores		
[Shimoda-1] Matsuzaki-cho, Ikeshiro to Mt. Chokuro, on mountain slope of roadside (S. Matsumoto, May 4, 1987, C × E2 -9)	64 > 32, variable spores	2n = 205	
[Shizuoka-3] Shizuoka-shi, Ubume to Makigaya, on bank of valley (S. Matsumoto, June 3, 1973, C × E1 -2)	64 > 32, variable spores	2n = 205, 3IV +3 III +73 II +38 I (16c/s)	
[Shizuoka-3] Shizuoka-shi, Ubume to Makigaya, on bank of valley (S. Matsumoto, June 3, 1973, C × E2 -3)	64 > 32, variable spores	n = 205	
<b>Kumamoto pref.</b>			
[Touchi-4] Itsuki-mura, Takeno-kawa, on stone-rich slope of roadside (S. Matsumoto, May 4, 1975, C × E2 -7)	64 > 32, variable spores	2n = 205	
[Sajiki-3] Kuma-mura, Shiroishi, Iwato limestone cave, on stone-rich slope of stream (S. Matsumoto, May 4, 1975, C × E3 -8)	64 > 32, variable spores	2n = 205, n = 205, 79II +47 I (16c/s)	2-7
<b>Korea</b>			
Cheju do (Quelpart Isl.) (T. Nakaïke, C × E2 -11)	64 > 32, variable spores		
Cheju do (Quelpart Isl.) (T. Nakaïke, C × E2 -12)	64 > 32, variable spores		

Showing apogamous pentaploid hybrid between sexual tetraploid (C) and apogamous triploid species (E: *C. fortunei* var. *clivicola*, E1: polish-frond type, E2: nonpolish-frond type, E3: multi-pinnate type). \*(n): a number of individuals, S/S: spore number per sporangium (32: 32 diplo-spores, 64: 64 irregular haplo-spores), 2n: chromosome number in mitosis, n: chromosome number in meiosis of eight mother celled sporangium (apo-meiosis), 16c/s: chromosome association in meiosis of 16 mother celled sporangium (sexual meiosis).

Table 2-7. List of locality and the cytological data on C × F type of *Cyrtomium falcatum* complex

Locality ([ ]: mapping index, C × F -: stock-culture number, SM: Matsumoto collection number)	Cytological Data*(n)	
	S/S	2n, n and chromosome association (16c/s)
<b>Shizuoka pref.</b>		
[Shimoda-2] Shimoda-shi, Shikine, Mamushiga-kubo, on cutting rock-wall (SM990419-1)	64, 32, variable spores	
[Shizuoka-2] Shizuoka-shi, Sokusawa, on rocky bank of valley (S. Matsumoto, Jul. 12, 1973, C × F-1)	32, 64, variable spores	2n = 205
[Shizuoka-2] Shizuoka-shi, Sokusawa, on rocky bank of valley (S. Matsumoto, Jul. 12, 1973, C × F-3)	32, 64, variable spores	2n = 205, 1IV +2III +68 II +59 I (16c/s)
[Yoshiwara-4] Yui-cho, Utsugino, 138° 32' E, 35° 07' N (T. Hosokura, Sept. 31, 1999, C × F-4)	32, 64, variable spores	

-(continued)-

Table 2-7.

-(continued)-

Kumamoto pref.		
[Touchi-4] Itsuki-mura, Takeno-kawa, on stone-rich slope of road-side (S. Matsumoto, May 4, 1975, C × F -2)	32, 64, variable spores	2n = 205, n = 205
[Takamori-3] Choyo-mura, Kawayo, alt. 300 m (S. Matsumoto, Feb. 2, 2001, SM01-003, C × F -5)	32, 64, variable spores	

Showing apogamous pentaploid hybrid between sexual tetraploid (C) and apogamous triploid species (F: *C. caryotideum*). \*(n): a number of individuals, S/S: spore number per sporangium (32: 32 diplo-spores, 64: 64 irregular haplo-spores), 2n: chromosome number in mitosis, n: chromosome number in meiosis of 8 mother celled sporangium (apo-meiosis), 16c/s: chromosome association in meiosis of 16 mother celled sporangium (sexual meiosis).

Table 2-8. List of locality and the cytological data on C × G type of *Cyrtomium falcatum* complex

Locality ([ ]: mapping index, C × G -: stock-culture number)	Cytological Data*(n)	
	S/S	Stomata cell size and Exospore size ( μ m)
Kanagawa pref.		
[Yokosuka-3] Yokohama-shi, Kanazawa-ku, Seto, on forest floor (S. Matsumoto, June 16, 2001, C × G -1)	64, 32, variable spores	Cell: (51.3) 60.0 ± 4.9 (69.7) Spore: (26.7) 42.6 ± 8.9 (61.5) (Apogamous pentaploid)

Showing apogamous pentaploid hybrid between sexual tetraploid (C) and apogamous triploid species (G: *C. fortunei* var. *intermedium*). \*(n): a number of individuals, S/S: spore number per sporangium (32: 32 diplo-spores, 64: 64 irregular haplo-spores).

Table 2-9. List of locality and the cytological data on apogamous *Cyrtomium* species related to *C. falcatum* complex

Locality ([ ]: mapping index, D, E, F, G-: stock-culture number)	Cytological Data*(n)		
	S/S	2n, n and chromosome association (16c/s)	Fig.
<i>Cyrtomium laetevirens</i> (Hiyama) Nakaïke (D)			
[Shimoda-2] Shizuoka pref., Shimoda-shi, Shikine, (D-7)	32	2n = 123	
Locality unknown (D-4)	32	n = ca.123	
<i>C. fortunei</i> J. Sm. var. <i>clivicola</i> (Makino) Tagawa (E1: polish-frond type, E2: nonpolish-frond type, E3: multi-pinna type)			
[Shimoda-1] Shizuoka pref., Kawazu-cho, mouth of Onabe left side bank of valley (S. Matsumoto, Nov. 4, 1974, E1-1).	32	41 II +41 I (16 c/s)	
[Shimoda-1] Shizuoka pref., Kawazu-cho, mouth of Onabe left side bank of valley (S. Matsumoto, Mar. 17, 1982, E2-4)	32	n = ca.123	
[Shimoda-1] Shizuoka pref., Kawazu-cho, Otaki (S. Matsumoto, Mar. 17, 1982, E1-5)	32	n = 123	
[Shimoda-1] Shizuoka pref., Kawazu-cho, Otaki (S. Matsumoto, Mar. 17, 1982, E3-6)	32	2n = 123	2-8
[Shimoda-3] Shizuoka pref., Matsuzaki-cho, Ikeshiro to Mt. Chokuro (S. Matsumoto, May 4, 1987, E2-8)	32	n = 123	
<i>C. caryotideum</i> (Wallich ex Hook. Grev.) C. Presl (F)			
[Touchi-4] Kumamoto pref., Itsuki-mura, Takenokawa (growing with hyb. C × F-2) (S. Matsumoto, May 4, 1975, F-1)	32	2n = 123	
Nepal, Syabru-Lama Hotel, alt. 2400-2600 m (T. Iwashina, Nov. 11, 1986, F-5)	32	2n = 123	
Nepal, Syabru-Lama Hotel, alt. 2400-2600 m (T. Iwashina, Nov. 11, 1986, F-6)	32	2n = 123	
Nepal, Jiri-Dhunge, alt. 1900-2500 m (S. Matsumoto, Oct. 3, 1986, F-9)	32	n = 123	
<i>C. fortunei</i> J. Sm. var. <i>intermedium</i> Tagawa (G)			
[Shimoda-1] Shizuoka pref., Kawazu-cho, Numano-kawa, (S. Matsumoto, Oct. 10, 1981, G-1)	32	n = 123	

\*(n): a number of individuals, S/S: spore number per sporangium (32: 32 diplo-spores, 2n: chromosome number in mitosis, n: chromosome number in meiosis of 8 mother celled sporangium (apo-meiosis), 16c/s: chromosome association in meiosis of 16 mother celled sporangium (sexual meiosis).

Table 2-10. Locality on herbarium specimens of hybrids in *Cyrtomium falcatum* complex

[Mapping index]	Locality*	S/S**	Type of hybrid***
<b>Fukushima pref.</b>			
[Kawabe-2]	Iwaki-shi, Seto-cho (Z. Kaneda, 1979, TNS)		C × E
<b>Aichi pref.</b>			
[Morozaki-3]	Mihama-cho, Noma (K. Inukai, 1986, TNS)		C × E
<b>Toyama pref.</b>			
[Isurugi-3]	Oshimizu-cho, Mugi (S. Komaki, 1978, TNS)	ste	C × B
[Isurugi-3]	Shiyu-cho, Shoshibara, Karamusubara (H. Kubo, 1991, TNS)	32, ste	C × E
<b>Hyogo pref.</b>			
[Muraoka-1]	Yashika-cho, Ishihara (T. Shiraiwa, 1969, TNS)	32, ste	C × E
<b>Yamaguchi pref.</b>			
[Yanai-1]	Kuka-cho, Heishin-jima (A. Minami · S. Umemoto, 1989, Y)		C × B
[Hagi-1]	Hagi-shi, Kasayama (S. Miyake, 1968, Y)	32-16, ste	C × E
<b>Ehime pref.</b>			
[Unomachi-1]	Hijikawa-cho, Minokoshi (M. Hyodo, 1981, TNS)	ste	C × E
<b>Kagoshima pref.</b>			
[Kokubu-2]	Takarabe-cho, Mt. Hakushika (K. Takesako, 1976, TNS)		C × E

\* TNS: National Science Museum, Tokyo, Y: Yamaguchi Prefectural Museum, S/S\*\*: spore numbers per sporangium. ste: sterile, \*\*\* B and C: two cytotypes of *C. falcatum*, E: *C. fortunei* var. *clivicola*.

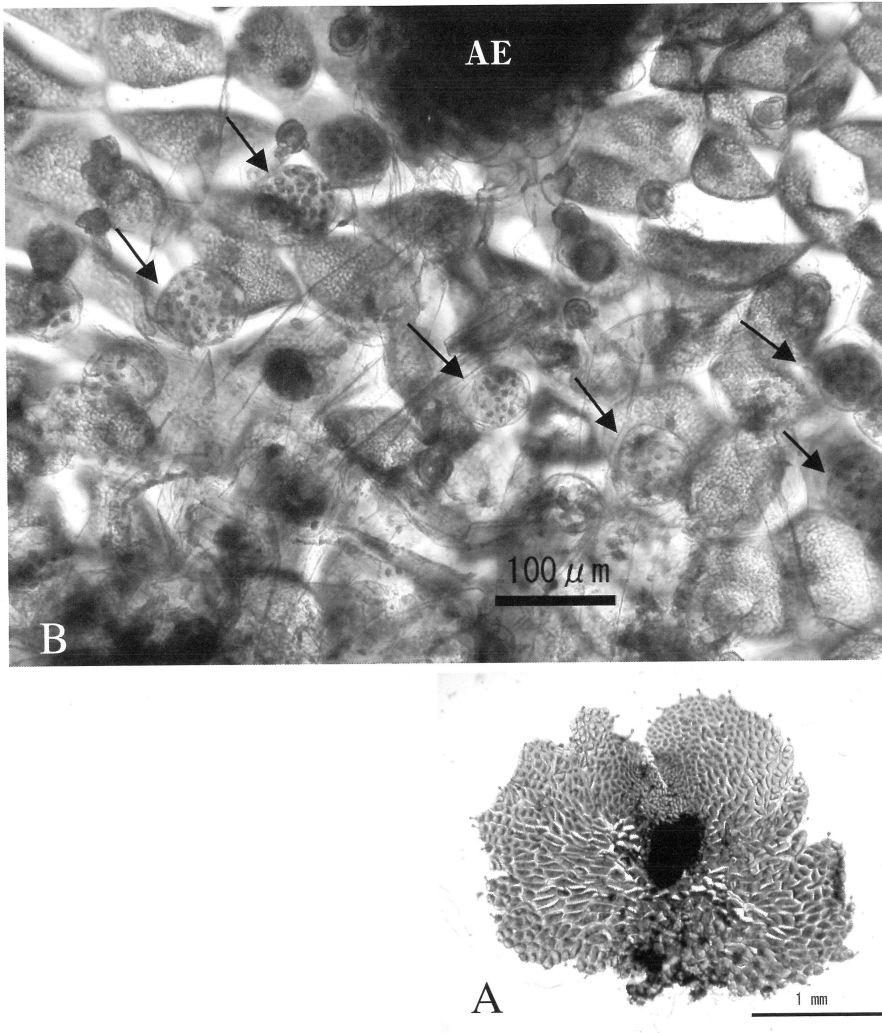


Fig. 2-10. Gametophyte of *Cyrtomium fortunei* var. *intermedium*. A: all shape, B: archegonia and apogamous embryo stained by acetocarmine on the gametophyte. AE: apogamous embryo. Arrow: antheridium including sperm cells.

Table 2-11. Frequency of diplospory (32 spores per sporangium) and ratio of germination and reproductive characters of gametophyte on *Cyrtomium falcatum* complex and related taxa

Taxa*	Locality	Frequency of diplospory (no. of sporangia)	Germination (no. of spores: 500)	Gametophyte**		
				Sex or AE	Ar	An
A1-26	2x Jogasaki-kaigan	0% (100)	96%	Sex	+	+
A1-55	2x Tsumeki-saki	0% (200)	96%	Sex	+	+
A2-2	2x Chichi-jima	0% (200)	78%	Sex	+	+
A1 × A2-1	2x Artificial hybrid	0% (200)	77-87%	Sex	+	+
C-31	4x Sekibe	0% (200)	92%	Sex	+	+
B-51	3x Jogasaki-kaigan	99% (100)	96%	AE	-	+
B-60	3x Kisami	100% (1000)		AE	-	+
B-71	3x Sekibe	96% (1070)	88%	AE	-	+
B-159	3x Jogasaki-kaigan	47% (76)	3%			
D	3x Makigaya	100% (200)		AE	±	+
E	3x Ubume	100% (200)	95%	AE	±	+
F	3x Sokusawa	100% (200)	90%	AE	-	+
A1 × B-1	4x Tsumeki-saki	51% (100)	66-74%	Sex	AE	+
A1 × B-4	4x Jogasaki-kaigan	30% (100)	69-81%	Sex	AE	+
A1 × B-5	4x Jogasaki-kaigan	55% (60)	89-90%	Sex	AE	+
A1 × B-6	4x Tsumeki-saki	55% (650)	55-79%	Sex	AE	+
C × B-2 (n = 205)	5x Hiramatsu	58% (150)	76-85%	AE	-	+
C × B-3 (2n = 205)	5x Sekibe	28% (60)	70-83%	AE	-	+
C × B-4 (2n = ca.205)	5x Kisami		74%	AE	-	+
C × B-6 (2n = ca.201)	5x Kisami		83%	AE	-	+
C × D-1 (2n = 206)	5x Jo-yama	10% (300)	37-44%	AE	±	+
C × D	- Naka, Shimoda-shi	8% (300)				
C × D-6	- Shimoda		32-68%	AE	±	+
C × E-2	5x Ubume	48% (200)	31-49%	AE	±	+
C × E-3	5x Ubume		38%	AE	±	-
C × E-4	5x Otaki	40% (250)	26-30%			
C × E-5	5x Onabe		30%	AE	±	+
C × E-8	5x Shiroishi	32% (250)	24-27%	AE		
C × F-1	5x Sokusawa	48% (545)	49-53%	AE	-	+
C × F-2	5x Takenokawa		59-68%	AE	±	+
C × F-3	5x Sokusawa		69%	AE	-	+
C × G-1	5x? Yokohama			AE		+
(A1 × B) × C-58	4x Artificial hybrid	57% (200)	60%	AE	-	+
(A1 × B) × C-64	4x Artificial hybrid		55%	AE	-	+
(A1 × B) × C-75	4x Artificial hybrid	66% (100)	45%	AE	-	+

\*A1, A2, B, C: *Cyrtomium falcatum*, D: *C. laetevirens*, E: *C. fortunei* var. *clivicola*, F: *C. caryotideum*, G: *C. fortunei* var. *intermedium*, C × F-1: cited from Matsumoto and Shimura (1985), \*\*Sex: sexual, AE: apogamous embryo, Ar: archegonium, An: antheridium.

Table 2-12. Gametophytes yielding apogamous embryo and /or antheridia on the dihaplod, F2 generation from apogamous gametophytes, sowed haplo-spores (64-spored sporangium) of the tetraploid hybrid (**A1** × **B-5**) between sexual and apogamous types of *Cyrtomium falcatum* complex

Size(mm) of Gametophyte	Embryo & Gametangium formation*							Total
	AE	AE & Ar	AE & An	An	Ar	He	Ve	
0.5-0.9	1	0	0	5	0	0	3	6
1.0-1.9	0	0	0	1	0	0	2	1
2.0-2.9	3	0	5	1	0	0	0	4
3.0-3.9	11	0	4	0	0	0	0	11
4.0-4.9	15	0	2	0	0	0	0	15
5.0-5.9	19	0	0	0	0	0	0	19
6.0-6.9	6	0	0	0	0	0	0	6
Total (%)	55(71)	0(0)	11(14)	7(9)	0(0)	0(0)	5(6)	78

Strain No. **A1** × **B-5**, Haplo-apo-31, days after sowing: 87, \* AE: apo-embryo, Ar: archegonium, An: antheridium, He: hermaphrodite, Ve: vegetable stage.

Table 2-13. Gametophytes yielding apo-embryo and /or gametangium formation of the hybrid between sexual and apogamous types on dihaploid yielded from haplospores of **A1** × **B-5**

Strain	Days after sowing	Samples	Embryo & Gametangium formation*(%)					
			AE	AE & Ar	AE & An	An	Ar	Ve
Apo-1	87	79	85	0	0	6	0	9
Apo-2	59	58	83	0	0	7	0	10
Apo-3	59	45	69	0	0	0	0	31
Apo-8	87	74	86	0	11	0	1	0
Apo-29	59	50	94	0	2	2	0	2
Apo-31	87	78	71	0	14	9	0	6

\* AE: apo-embryo, Ar: archegonium, An: antheridium, He: hermaphrodite, Ve: vegetable stage.

### 第3章 種遺伝学的解析

オニヤブソテツの基本的4型のゲノム構造を明らかにすることで系統関係を推定できる。特に、3倍体のB型と4倍体のC型のゲノム構造を知る必要がある。また種分化の要因となった無配生殖、自配自家受精 (Intragametophytic selfing) の遺伝的背景を探り、外部形態の特徴をほぼ同一条件下で育て、遺伝的性質として葉長、葉質をとらえた。またC型のゲノム構造を参考にA1, A2, Bにない形質を探り当てた。また各倍数体を含むサイトタイプの同定のため胞子と孔辺細胞径を測定した。

#### 第1節 人工雑種およびゲノム分析

ゲノム分析のため、以下の組み合わせでハイボネックス0.1%寒天培地において人工雑種を作成した。

2倍体雑種A1×A2はA1-55(下田市爪木崎、灰褐色の胞膜)の雌性配偶体の造卵器形成部位にA2-2(小笠原父島、マーカーとして胞膜が黒褐色の株を使用)の雄性配偶体を置いて灌水を行なった結果、25個体中92%の成功率でF1ができた(Appendix 12)。F1の減数分裂は正常で発芽率が56.2~98.4%と高かった。

3倍体雑種C×A1はC-31(静岡市石部)の配偶体(20個体)の造卵器形成部位にA1-13(下田市爪木崎)の雄性配偶体を置いて作出、20株の幼植物中栽培管理の失敗で1株のみが得られ不稔性の3倍体であった(Appendix 12)。

4倍体雑種(A1×B)×CはA1×Bの減数性胞子とCの胞子を混播した結果、6系統64個体の子孫を得て、その15%にあたる2系統H1, H2は雑種であった(Table 3-1)。H1(10個体)は不稔性の4倍体、H2(7個体)は無配生殖をする4倍体で、CとA1×Bの有性配偶体との受精でH1, 無配生殖配偶体の精子との受精でH2ができたものと推定される。

自然雑種および上記の人工雑種でゲノム分析に利用した材料をTable 3-2に示した。無配生殖をする雑種でもSexual Meiosisを観察することができる。

解析結果をTable 3-3に示した。各雑種のSexual Meiosisの代表的データを示すとA1×A2は41Ⅱ, A1×Bは1Ⅳ+80Ⅱ(Dihaploidは1Ⅳ+40Ⅱ, 40Ⅱ+3Ⅰ+1f), B-159(Sexual Meiosisの高頻度系統)は24Ⅲ+17Ⅱ+17Ⅰ, A1×B×Cは24Ⅲ+17Ⅱ+57Ⅰ, A1×Cは41Ⅱ+41Ⅰ, B×Cは2Ⅳ+78Ⅱ+41Ⅰ, C×Dは2Ⅳ+4Ⅲ+75Ⅱ+36Ⅰ, C×Eは3Ⅴ+1Ⅳ+13Ⅲ+59Ⅱ+29Ⅱ, C×Fは1Ⅳ+2Ⅲ+68Ⅱ+59Ⅰで、これより各型のゲノムはA1, A2がAA, BがAAAと同質3倍体, CがAABBの異質4倍体と推定された(Figs. 3-1~3-5)。この3倍体は2倍体のA1, またはA2と4倍体のCとの交雑由来ではなかった。C型はオニヤブソテツのAゲノムと未知のBゲノム種[テリハヤブソテツ(D), ヤマヤブソテツ(E)およびメヤブソテツ(F)はBゲノムを含む3倍体と推定された]との交配によって成立したものと考えられる。

#### 第2節 無配生殖の遺伝的背景

##### 材料および方法

自然雑種A1×Bの胞膜色の異なる2系統4株を材料にし(Table 3-4)、減数性胞子を分離し、0.1%ハイボネックス寒天培地に播種して、無配生殖と有性生殖の配偶体の分離比を求めた(Fig. 3-6)。



### 結果および考察

その結果、実験値は統計的に理論値 1 : 1 に合値し、優性の単性メンデル遺伝することが判明した (Table 3-5, Fig. 3-7)。無配生殖を行った F<sub>2</sub> の孢子形成は 25 株中 24 株が Diplospory を行い無配生殖と連鎖がみられ (Table 3-6)、Agamospory (Obligate Apogamy) は超遺伝子 (Super Gene) の可能性があり、その 2 遺伝子の距離は生育不良、不稔性や枯死個体もあり、不明である。無配生殖が優性の 1 遺伝子で支配されていることはシダ植物では初めての発見である。

ワラビの誘導無配生殖を行った研究ではスクロース存在下でのみ 8 日間の誘導期間でエチレンに反応して孢子体が誘導されることがわかっている (Elmore and Whittier 1973, 1975)。今回発見した遺伝子は無配生殖のスイッチを入れる働きが想定されるが、エチレン生合成に関与するメチオニンサイクルなどのスイッチ遺伝子の可能性がある。また Diplospory に関して、Mehra and Bir (1960) は 3 倍体無配生殖種のウスバクジャク *Asplenium cheirosorum* Kunze ex Mett. を研究し、Dopp-Manton 様式の Agamospory の理解をさらに深めた。それは減数分裂で相同染色体のペアリングは起こらず、1 回細胞分裂が省略され、倍数核ができたとき染色体が複製されて 4 重になり (Auto-bivalents)、これがあたかも 2 価染色体のように 2 回続けて起こる分裂で 4 個の娘細胞に分配される *Allium odorum* Kar. et Kir. の研究例 (Hokansson and Levan 1957) を引用し、ウスバクジャクもこれと同じ現象とした。オニヤブソテツの Dihaploid はこの問題を追及する良い材料になるであろう。

### 第 3 節 有性生殖型の交配様式とその遺伝的背景

シダ類には造卵器と混在して造精器をつける配偶体 (混在型) とそうでない配偶体 (分離型) があり、前者は自配自家受精を、後者は他配他家、又は他配自家受精を主として行い、前者は倍数体に多いとした (Masuyama 1975, 1982, 1987)。

### 材料および方法

栽培されている各地の有性生殖 A<sub>1</sub>, A<sub>2</sub>, C 型および人工雑種 A<sub>1</sub> × A<sub>2</sub> の孢子を材料にした (Tables 3-8, 3-9)。

方法は Fig. 3-7 に示した。シャーレに入れたハイポネックス 0.1% 寒天培地に孢子を播く (条件は前出)。2 ヶ月後、幅 2-3mm となった配偶体を実体顕微鏡でのぞきながらピンセットで 1 個体ずつ取り出し、予めエタノールと蒸留水で洗浄したフリージングコンテナに 0.1% ハイポネックス液のパーミキュライト培地で 9 ~ 10 ヶ月間単離培養した。この培地は熱消毒冷却後これに詰め、器を振動させると表面が水平になるので、これに 40 穴の仕切り板を押し込んで、この穴に配偶体を植え付けた。週 1 回スポイトで灌水して孢子体を形成させ自殖率を求めた。一方、生殖器官の観察のため培養 3 ヶ月後、配偶体を管ビンに取り酢酸カーミン染色後、水洗し、放水クローラル・フォルマリン液で保存、またこの液でプレパラートのマウントをした。

### 結果および考察

孢子を寒天培地に播いて 3 ~ 4 ヶ月後の配偶体の観察結果から、2 倍体の A<sub>2</sub> と 4 倍体の C は分離型、2 倍体の A<sub>1</sub> は分離型から混在型まで頻度に段階が見られた (Tables 3-8, 3-9)。次に混在型 (A<sub>1</sub>) と分離型 (A<sub>2</sub>) の人工雑種 (中間型) の F<sub>2</sub> 分離比はそれぞれ 106 : 98 ≐ 1 : 1 であったが

(Table 3-7, Fig. 3-8), 上記 **A1** の中間型は 71.9 ~ 76.7, 38.0 ~ 39.1, 16.9 ~ 27.8% といろいろな分離比を示しながらも 3 グループに分けられそうである。すなわち理論値 75, 50, 25 に比較的近い値と推定できるので, 独立遺伝する 4 つの量的遺伝子を想定可能である。S 型は AAAA (0%), I 型は AAAa (25%), AAaa (50%), Aaaa (75%), M 型は aaaa (100%) となる。ただ再現性がないこともあり, ゆっくり成長させる培養条件の検討が必要である。

日本列島において南方型の **A2** の他殖型から伊豆七島から伊東にかけて **A1** の他殖型を一部含みながら自殖性への展開が北の北海道, 南の紀伊半島南部, 四国に見られた (Fig. 3-11)。

このような例は 4 倍体であるがミズワラビの南方型 (他殖, 多年生, 正常サイズ, 安定した池) と北方型 (自殖, 1 年草, 矮性, 水田のかく乱環境) の分化 (Masuyama 1992, 1996, Masuyama and Watano 1990), ハワイの林から溶岩の流れた裸地にかけて生育する非パイオニアとパイオニアのシダでは他殖型から自殖型への割合が高くなること (Lloyd 1974), さらに世界に広く分布するワラビにおいて大陸では他殖が, ガラパゴス諸島では高い自殖率が知られている。移住 (Migration) に際し, 自殖で侵入し, 時間がたつて集団が大きくなると他殖性になるのではなからうか。八丈島や伊東市城ヶ崎海岸の **A1** 型の集団は大きく, 葉のサイズも大きいものがあり, これは移住後, 時間がたつて他殖性の遺伝子が進入, 増加したためではないであろうか。

自配受精テストは主として 40 サンプルの単離した配偶体を週一回受精のための灌水を行なって 9 ヶ月間培養し, 胞子体を得た。混在型は 100% 近い自配受精を行なうが, 分離型や中間型は胞子体形成が 2 ~ 3 ヶ月遅れて, 0 ~ 95% まで見られ変化に富んでいた。分離型の **A2** の自殖率は大部分が 50% 以下で遺伝的荷重 (Genetic load) が大きいと推定され, よって他殖性を示し, **C** 型の多くは 50% を越え, 他殖もするが, 時間がたてば自殖も行い, 遺伝的荷重は **A2** よりも小さい (Figs. 7-3, 7-4)。ただし伊東市城ヶ崎海岸の **A1** の分離型 2 系統について 1 個の配偶体をいくつかに切り, そのまま培養すると 100% の自殖率が得られたので遺伝的荷重はなく, 一度雌になると雌雄同体になりにくいだけで, この母集団は劣性致死遺伝子の蓄積がない若い集団かもしれない。

#### 第 4 節 外部形態に関する種遺伝学的解析

ほぼ同一条件のビニールハウス内で 2 年以上栽培し, 外部形態を調べた結果を羽片の幅に対する長さの比と葉長の分散図に落とすと, 有性生殖型の **A1**, **A2**, **C** はほとんど相互に重ならないが, 無配生殖型の **B** がこの間を埋め, 区別をつきにくくしていた。**A1** は **A2** より葉長が短く, 葉質もより厚いなど大きな差がみられ, **C** は **A2** より羽片の長さや幅比が大きく区別される (Fig. 3-18)。オニヤブソテツは環境変異の大きな種とされていたが, 移植実験でも基本的 4 型の野外で観察された草丈や葉質など, それぞれの特徴は遺伝的なものであった (Figs. 3-12, 3-13, 3-16, 3-17)。胞膜は **A2** と **C** が黒褐色, まれに灰白色だが **A1** は灰白色, **A1**, 特に **C** は **A2** よりその径が大きい (Appendix 5, 6, 7, 8, 9)。八丈島や伊東市の **A1'** は海蝕崖だけでなく, 林縁や人家の石垣等にもみられ, 移植実験でも大型となって **A2** と似てくる (Figs. 3-14, 3-15, 8-3)。**A2**, **B**, **C** 型は播種後, 成熟するまで少なくとも 3 年近くかかるのに対し, **A1** 型は一年で成熟し, 第 6 葉目の幼形の単葉で胞子をつけた (Fig. 3-19)。野外でも海食崖の洞窟の入口など出よく見られるが, これは幼形成熟の一つ, Progenesis (Guerrant 1982) と考えられる。さらに羽状葉にもなるが, 矮性で羽片数が少なく, 裸葉羽片数がほとんどないことも Progenesis と考えられる (Figs. 3-12B, 3-13A)。中国雲南省には石灰岩に生育する森林性で単葉の *Cyrtomium hemionitis* Christ が知られていて, それと近縁, 又は同一種とされる *C. fengianum* Ching & Shing は羽状葉である。Mitsuta (1977) はヤブソテツ属幼植物の網状脈離の発生を調べ, 上記中国の単葉植物の進化について論じた。オ

ニヤブソテツの **A1** 型の単葉形成と似ており、平行進化と考えられる。このような例はチャセンシダ科ではホウビシダ *Asplenium hondoense* Murak. et Hatan. とヒメタニワタリ *Asplenium cardiophyllum* (Hance) Baker およびヒノキシダ *Asplenium prolongatum* Hook. とオオタニワタリ、トキワシダ *Asplenium yoshinagae* Makino とホコガタシダ *Asplenium ensiforme* Wall. ex Hook. et Grev. (Murakami et al. 1999), ヌリトラノオと *Asplenium speluncae* Christ (松本・岩科 未発表), メシダ科ではナチシケシダ *Deparia petersenii* (Kunze) M. Kato とヘラシダ *Deparia lancea* (Thunb. ex Murray) Fras.-Jenk. (Matsumoto and Nakaïke 1990, Sano et al. 2000) が上げられる。筆者は亜熱帯～暖温帯にかけ、主に樹上、又は岩上などの着生植物に共通して単葉への進化がみられるのは強い日射と季節的乾燥などと、幼形進化のひとつ Progenesis とのかかわりで形成されたものとする。

**C** 型の羽片の先端付近にはまれに鋸歯がみられ、さらに幼葉では顕著であること、**C** 型および **C** 型を片親とする雑種の若い葉の上面には早落性の小鱗片(多細胞毛状)が点在し、**A** ゲノムのみを有する **A1**, **A2**, **B** 型には見られないこと、日本産ヤブソテツ属の他種にはすべてこれらが見られることから、**C** 型はオニヤブソテツ種とは異なる種とすることが可能である (Fig. 3-20, Table 3-11)。

オニヤブソテツ複合種のサイトタイプを同定するため、孔辺細胞と胞子のサイズを測定した。孔辺細胞サイズは生材料を乾かないようにビニール袋で維持し、下から第二番目の羽片基部側 3 分の 1 の場所にセメダインを平らに塗って乾燥後、セロハンテープで裏打ちしてスライドグラスに貼り付ける簡易スンプ法で行った。胞子は直接オイキットで封入し、周皮を含めない Exospore の直径を測定した。結果は Appendix 10 に示した。体細胞と胞子細胞の倍数性と測定結果はよく一致していた。乾燥標本と比較すると、ややその湯戻しの方のサイズが大きくなるが、これを物差しにしてハーバリウムの乾燥標本の、特に無融合複合種(体)の解析に利用可能である。

Table 3-1. Artificial F1 hybrids by mixing both the spores of **C** type and the 64 spores of **A1** × **B** type

♀ \ ♂	<b>C</b> type 2X sex, ●	<b>A1</b> × <b>B</b> type 2X sex, ○	<b>A1</b> × <b>B</b> type 2X apo, ○
<b>C</b> type 2X sex, ●	<b>C</b> type (33) sex, ●	<b>H1</b> (10) 4X ste, ●	<b>H2</b> (7) 4X apo/ste, ●
<b>A1</b> × <b>B</b> type 2X sex, ○		<b>B1</b> (3) sex, ○	<b>B2</b> (3) apo/sex, ○
			<b>B3</b> (8) apo, ○

Forming six race including two kind of hybrid (**H1** and **H2**). The **H1** (10 individuals) is sterile tetraploid, but the **H2** (7 individuals) is apogamous tetraploid. ●: black indusium, ○: white indusium, sex: 64 spores in a sporangium, apo: 32 spores in a sporangium, ste: sterile spores.

Table 3-2. Materials for genome analysis on *Cyrtomium falcatum* complex

Strain	Source	Cytological data(*)
B-159	Ito-shi, Jogasaki	3x apo/sex (S)
Natural hybrid		
A1 × B -1, 6	Shimoda-shi, Tsumeki-saki	4x apo /sex (F)
A1 × B -4, 5	Ito-shi, Jogasaki	4x apo /sex (F)
C × B -2	Shizuoka-shi, Hiramatsu	5x apo /sex (S)
C × D -1	Shizuoka, Ohito-cho, Jo-yama	5x apo /sex (S)
C × E -8	Kumamoto, Kuma-mura, Iwato	5x apo /sex (S)
C × F -3	Shizuoka-shi, Sokusawa	5x apo /sex (S)
Dihaploid		
A1 × B -6, 64 s/s, ap-12	F2 from reduced spore	2x apo /sex (F)
A1 × B -5, 64 s/s, ap-8	F2 from reduced spore	2x apo /sex (F)
Artificial hybrid		
A1 × A2 -1, 6 (Nearest neighbor's transplant technique; A1: ♀, A2: ♂)		2x sex (F)
A1-55: Shimoda-shi, Tsumeki-saki (Dwarf form, ○ : indusium's color)		
A2-2: Ogasawara, Chichi-jima Isl. (Normal form, ● : indusium's color)		
C × A1 -1 (Nearest neighbor's transplant technique; C: ♀, A1: ♂)		3x sex (S)
C-31: Shizuoka-shi, Sekibe		
A1-13: Shimoda-shi, Tsumeki-saki		
(A1 × B) × C -56 (Sowing mixed spores technique)		4x sex (S)
A1 × B -1(64 s/s): Shimoda-shi, Tsumeki-saki		
C-31: Shizuoka-shi, Sekibe		
(A1 × B) × C -43	same above	4x apo /sex (S)

(\*) (F): fertile spores, and (S): sterile spores on sexual meiosis.

Table 3-3. Chromosome associations (pairings) and fertility on sexual meiosis of *Cyrtomium falcatum* complex

Strain	Chromosome association (Cells)	Fertility
A1 × A2 -1	41 II (4)	Germin. ; 87.3%
A1 × A2 -6	41 II (1)	Germin. ; 87.8%
A1 × B -1	1 IV + 80 II (1)	Germin. ; 43.4% (inc. apo 74.8%)
A1 × B -6	82 II (1)	Germin. ; 67.3% (inc. apo 79.0%)
A1 × B -4	82 II (1)	Germin. ; 58.5% (inc. apo 68.8%)
A1 × B -5	82 II (1)	Germin. ; — (inc. apo 88.6%)
A1 × B -6, 64s/s ap-12	1 IV + 40 II (1)	
A1 × B -5, 64s/s ap-8	40 II + 3 I + 1f (1) (two types of spore size; ca.30 μ m 41 II + 1 I (3) : sexual, ca.42 μ m; apogamous)	
B -159	[7 III + 34 II + 34 I (1) 13 III + 28 II + 28 I (1) 14 III + 27 II + 27 I (1) 19 III + 23 II + 23 I (1) 21 III + 20 II + 20 I (1) 23 III + 18 II + 18 I (3) 24 III + 17 II + 17 I (5) 25 III + 16 II + 16 I (1) 27 III + 14 II + 14 I (3) 28 III + 13 II + 13 I (1) 29 III + 12 II + 12 I (3) 33 III + 8 II + 8 I (1)] : (22)	
C × A1 -1	[ 41 II + 41 I (25) 40 II + 43 I (2) 1 III + 40 II + 40 I (1) 2 III + 39 II + 39 I (1)] : (29)	Sterile
(A1 × B) × C -56 (H-1; 4x sex)	24 III + 17 II + 57 I [ I : 47(1), 48(2), 49(1), 51(2), 52(3), 56(1), 57(2) 61(2), 62(2)] : (16)	Sterile
(A1 × B) × C -43 (H-2; 4x apo / sex)	30 III + 11 II + 52 I [ I : 33(2), 35(2), 39(2) 40(6), 41(1), 42(1), 44(2), 45(1), 46(1), 47(1), 49(1), 50(2), 52(1), 54(1), 88(1)] : (25)	Sterile
C × B -2 5x apo / sex	2 IV + 78 II + 41 I [ I : 41(1), 42(1), 43(1), 44(1), 45(1), 47(1), 48(2), 49(2), 52(1), 56(2), 57(1), 58(1), 61(1), 64(1), 66(1), 69(1)] : (20)	Sterile
C × D -1	2 IV + 4 III + 75 II + 36 I (1)	
C × E -8	3 V + 1 IV + 13 III + 59 II + 29 I (1)	
C × F -3	1 IV + 2 III + 68 II + 59 I (1)	

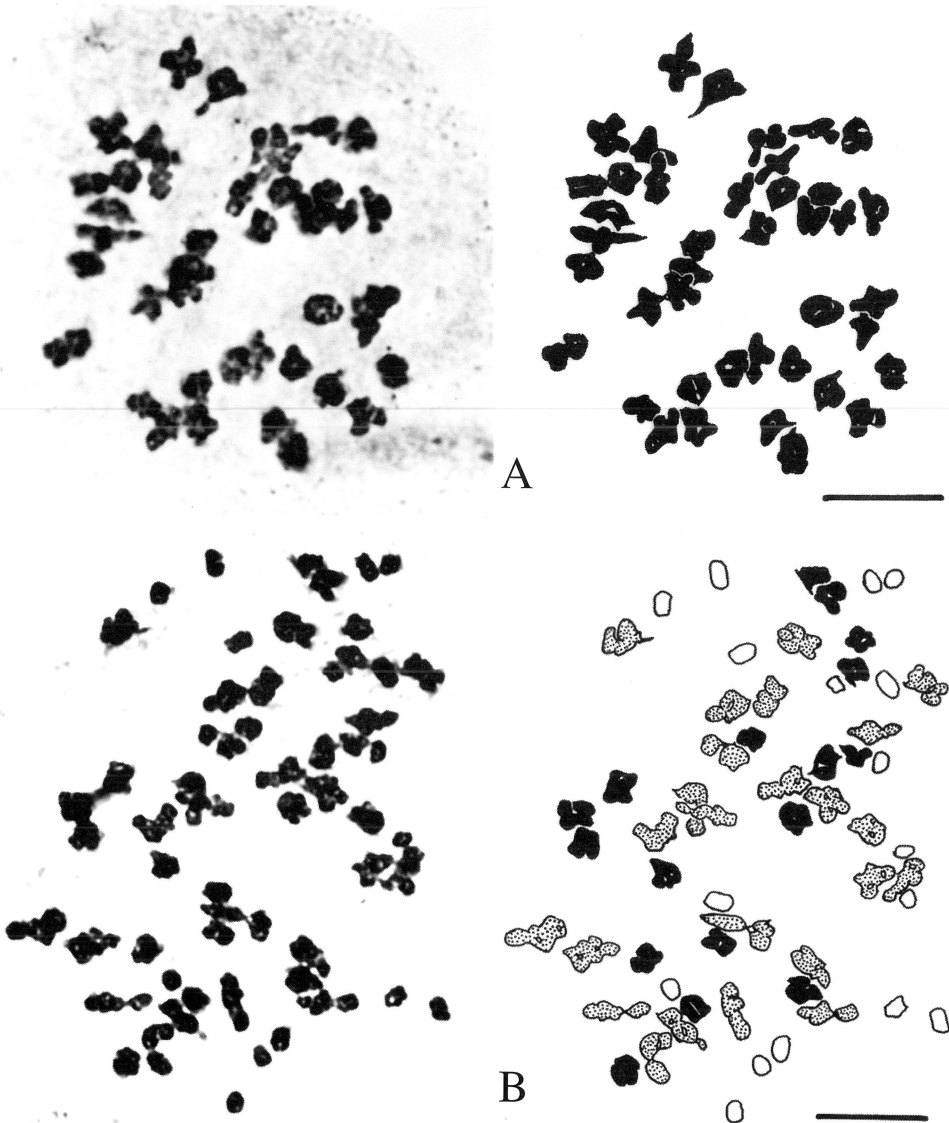


Fig. 3-1. Chromosome pairings of sexual meiosis. A:  $A1 \times A2-1$ ; 41II ( $2n = 82$ : AA), B: B-159; 24III+17II+17I ( $2n = 123$ : AAA). Left: photograph, Right: explanatory diagram. Bar:  $10 \mu m$ .

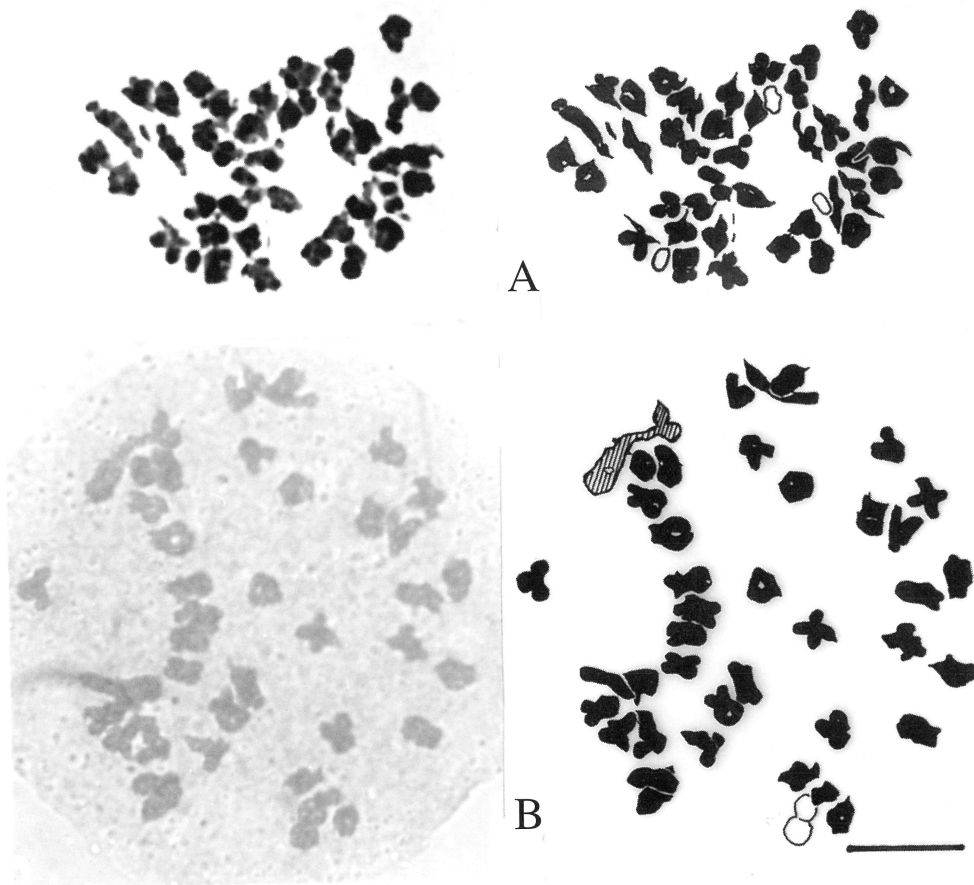


Fig. 3-2. Chromosome pairings of sexual meiosis on dihaploid, **A**:  $A1 \times B-5$ , Apo-8;  $40II+3I+1f?$  ( $2n = 83$ ; AA), **B**:  $A1 \times B-6$ , Apo-4;  $1IV+40II$  ( $2n = 84$ ; AA). Left: photograph, Right: explanatory diagram. Bar:  $10 \mu m$ .

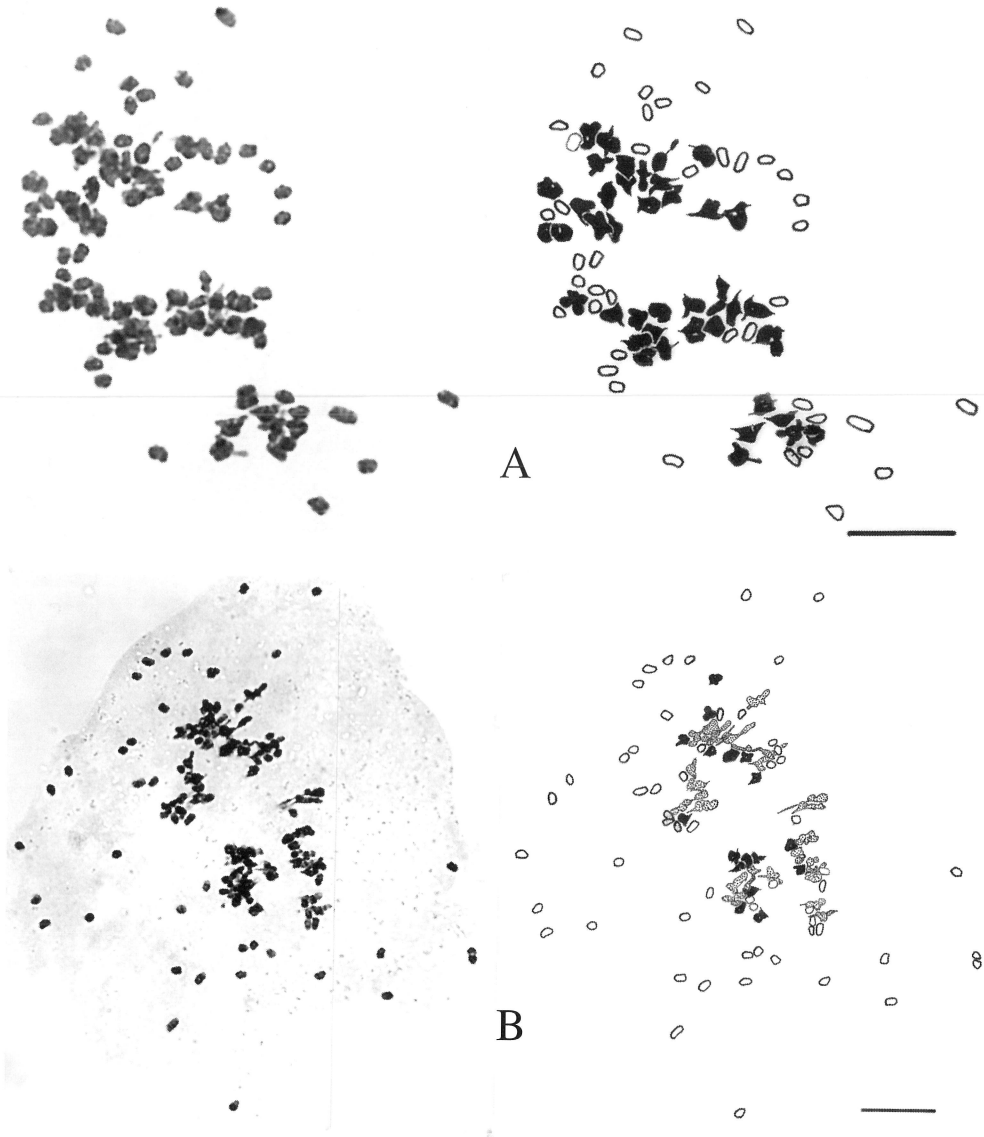


Fig. 3-3. Chromosome parings of sexual meiosis. **A**:  $C \times A1-1$ ;  $41II+41I$  ( $2n = 123$ : AAB), **B**:  $(A1 \times B) \times C-56$ ;  $24III+17II+57I$  ( $2n = 163$ : AAAB). Left: photograph, Right: explanatory diagram. Bar:  $10 \mu m$ .



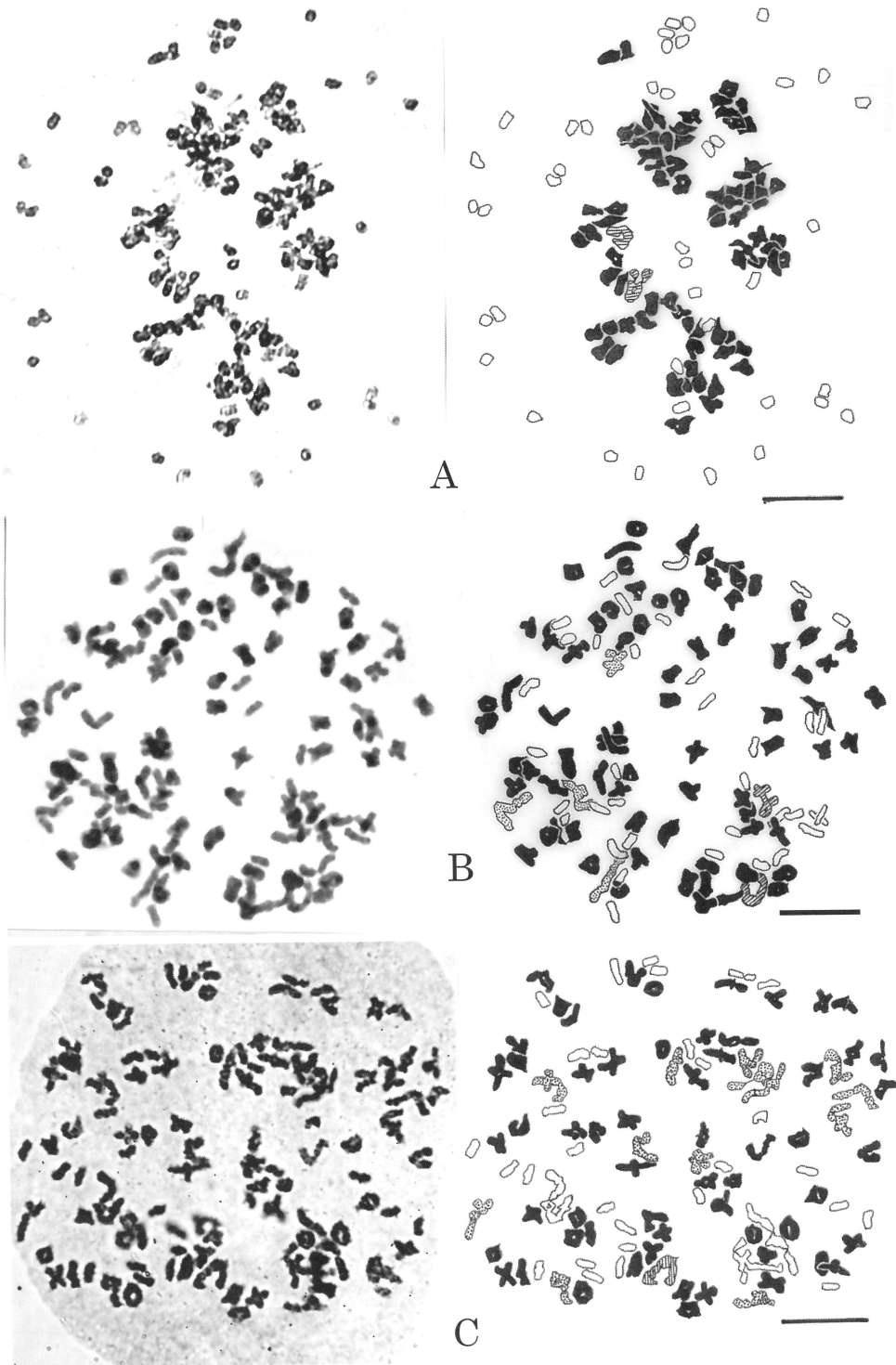


Fig. 3-4. Chromosome pairings of sexual meiosis. A: C × B-2; 2IV+78II+41I (2n = 205: AAAAB), B: C × D -1; 2IV+4III+75II+36I (2n = 206: AABBB?), C: C × E-8, 3V+11V+13III+59II+29I (2n = 205: AABBB?). Left: photograph, Right: explanatory diagram. Bar: 10 μ m.

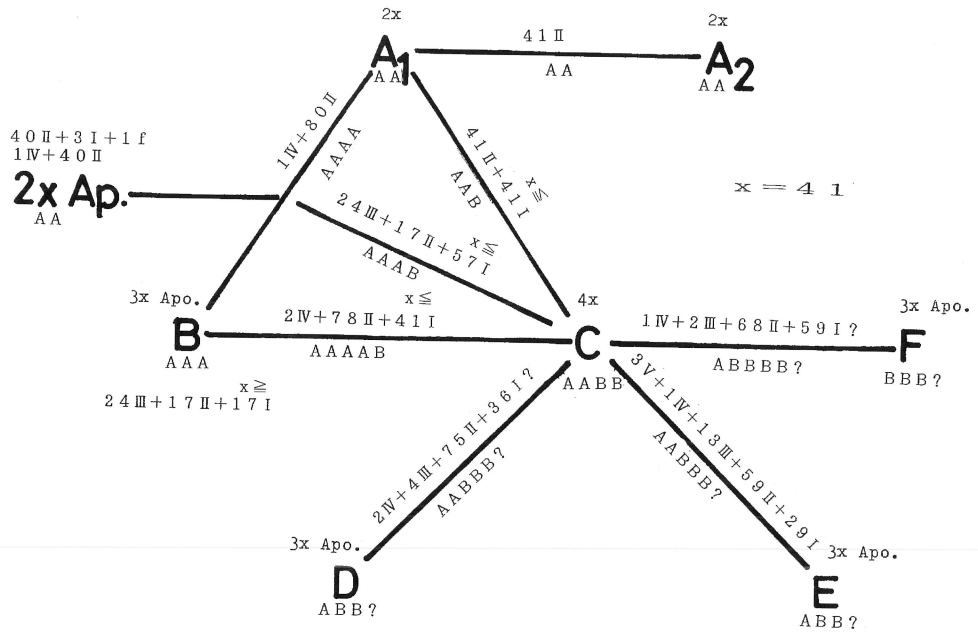


Fig. 3-5. Genome analysis of *Cyrtomium falcatum* complex. A1, A2, B and C: basic 4 types of *Cyrtomium falcatum* complex, D: *C. atrovirens* (apogamous triploid), E: *C. fortunei* var. *clivicola* (apogamous triploid), F: *C. caryotideum* (apogamous triploid). Showing B type is autotriploid (AAA genome), but C type is allotetraploid (AABB genome), and suggesting D and E species include A genome.

Table 3-4. Materials to analyze genetic background of apogamy

Strain	Locality	Apomeiosis(%)	Germination(%)	
			Direct sowing	Reduced spores sowing
A1×B -1	Tsumeki-zaki, Shimoda-shi	51 (n = 164, 82)	74.8	43.4
A1×B -6	Same above	55 (n = 164, 82)	79.0	67.3
A1×B -4	Jogasaki-kaigan, Ito-shi	55 (n = 164, 82)	68.6	58.8
A1×B -5	Same above	55 (n = 164, 82)	88.6	-

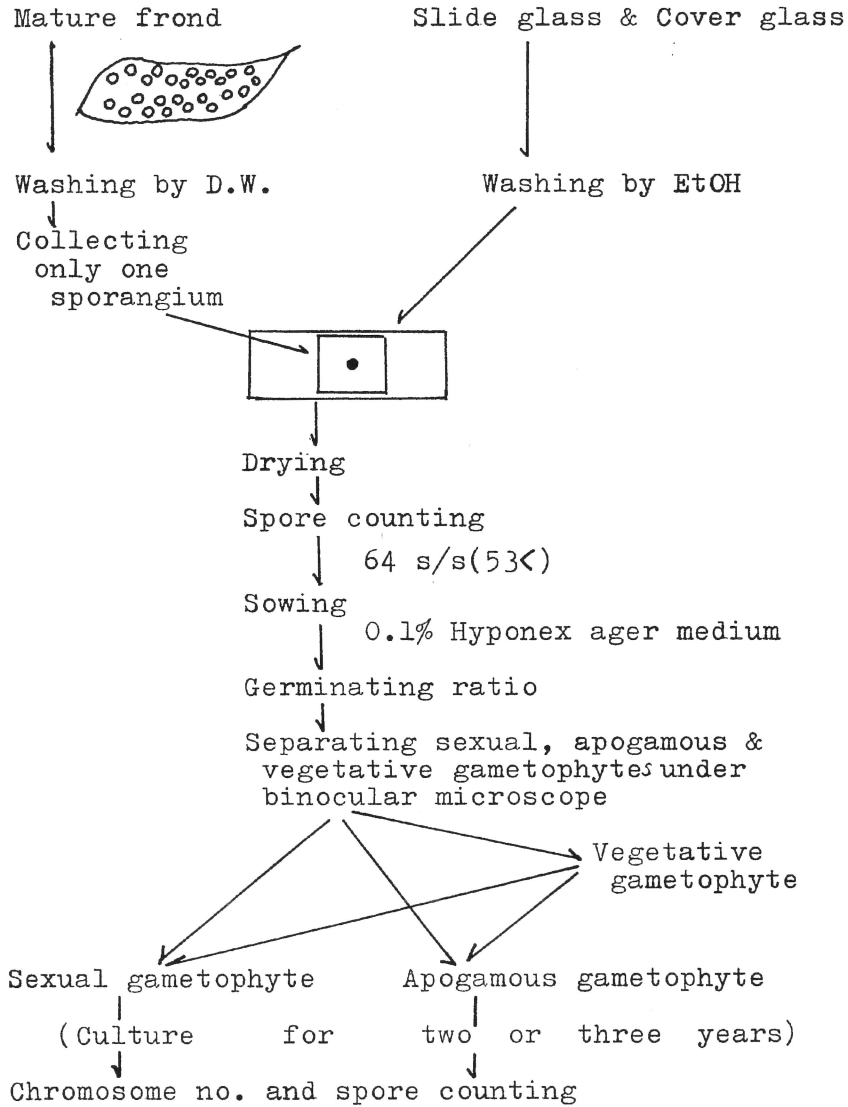


Fig. 3-6. Method to analyze genetic background of apogamy used  $A1 \times B$  type of *Cyrtomium falcatum* complex.



Table 3-6. Cytological observation of F2 generation from reduced spores (64 spored sporangium: 64s/s) of natural tetraploid hybrid (A1 × B-5: 2n = 164) between sexual diploid and apogamous triploid type on *Cyrtomium falcatum* complex

64 spored sporangium — apogamous embryo			64 spored sporangium — sexual embryo			
Strain No.	Chromosome number		Spores per sporangium (s/s)	Strain No.	Chromosome number (2n)	Spores per sporangium (s/s)
	2n	n				
1	82	82	32, 16, 8, (64)	1	163	64
2	82	82	32, 16, 8, (64)	2	168	Ab
3	82	82	32, 16, 8, (64)	3	164	Ab
4	Lost			4-5	Lost	
5	82	82	Ab*	6	ca.161	64
6	82	82, 164	32, 16	7	ca.164	64, (32)
7	ca.82		32	8	160	64
8	83	41II+1I+1 f(8c/s)	32 (spore size variable)	9	ca.166	Ab
9	82		32	10	ca.161	64, (32)
10	82		32	11		
11	82		32	12	164	64, (32)
12				13	ca.162	64, (32)
13	82		32, (16, Ab, 64)	14		
14	82		32, (64)	15	162	64, (32)
15	82			16	ca.170	-
16-17	Lost			17	ca.165	64
18	82			18	-	Ab
19-21	Lost			19	163	Ab
22	81			20	164	64, (32)
23-25	Lost			21	163	Ab
26	82		Ab, (32)	22		
27	82		32, (Ab)	23	166	
28	83		32	24	166	Ab
29	82		32, 16, 8	25	166	
30	82		32	26	161	
31	83		32	27	163	64, (32, Ab)
32	83		32			
33	83		32			
34	84		32			
35	83		32			
36	83		32			
37	82		32			
38	83		32			

Ab\*: Abnormal spores

Table 3-7. Segregation ratio on the mating system of artificial hybrid between A1-55 (growing on sea cliff) and A2-2 (growing on forest floor) types of *Cyrtomium falcatum*

Strain	A (separate) type	B (mix) type	Total
A1-55	5 (3.1%)	155 (96.9%)	160
A2-2	133 (98.5%)	2 (1.5%)	133
A1-55×A2-2	106 (52.0%)	98 (48.0%)	204

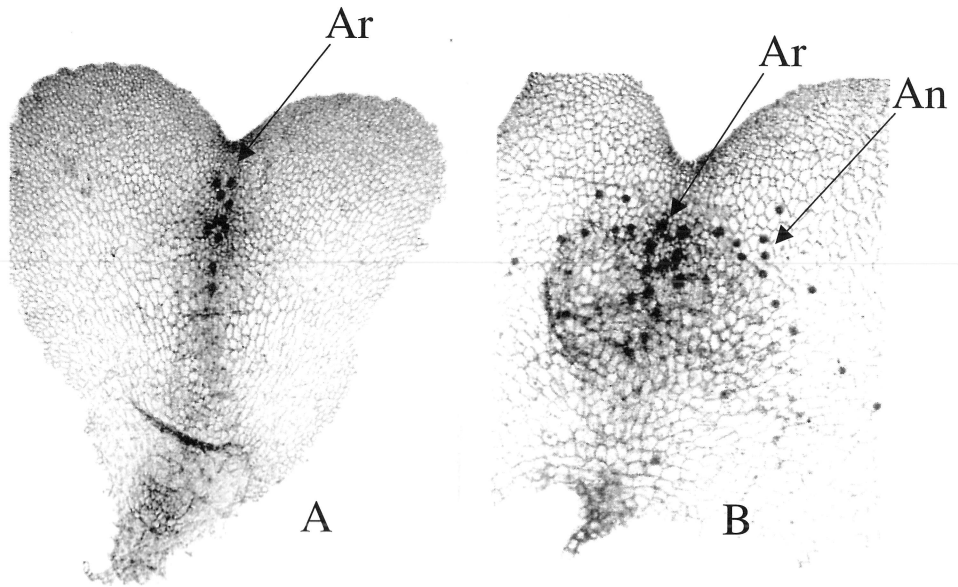


Fig. 3-8. Showing two type gametophytes, separate (A) and mix (B) type on gametangium formation.  
Ar: archegonia, An: antheridia.

Table 3-8. Mode of gametangium formation and intragametophytic selfing tests on sexual types (AI: diploid)

Locality & Strain		Mode of gametangium formation*			Intragameto-phytic selfing tests**		Crossing types*** for mapping index
		No. of gametophytes tested	% of mixed type	Judgement of each type (M,S,I)	No. of gametophytes tested	% of self-fertiles	
Hokkaido; Okushiri Isl.	AI-140	50	100.0	M	40	100.0	●
Choshi-saki	AI-119	50	100.0	M	40	100.0	●
same above	AI-121	70	100.0	M	-	-	●
Esan-misaki	AI-129	50	100.0	M	40	100.0	●
same above	AI-134	50	100.0	M			●
Aomori; Tanesashi-kaigan	AI-71	-	-	-	40	97.5	●
same above	AI-74	43	100.0	M	40	100.0	●
Ibaraki; Izura-kaigan	AI-67	46	91.3	M	40	100.0	●
Tajiri-hama	AI-46	-	-	-	40	100.0	●
Shizuoka; Tsumeki-saki	AI-13	57	96.5	M	40	82.5	●
same above	AI-55	160	96.9	M	40	100.0	●
Tokyo; Mikura Isl.	AI-5	43	93.0	M	40	100.0	●
same above	AI-1	-	-	-	40	100.0	
same above	AI-3	-	-	-	40	100.0	
Wakayama; Kantori-saki	AI-117	50	100.0	M	40	100.0	●
Shiono-misaki	AI-104	50	100.0	M	40	100.0	●
Sandan-peki	AI-102	50	100.0	M	40	100.0	●
Kochi; Muroto-misaki	AI-85	53	98.1	M	39	84.6	●
Aomori; Tanesashi-kaigan	AI-77	54	27.8	I	40	95.0	●
same above	AI-84	43	76.7	I	40	97.5	●
Ishikawa; Nanaura-kaigan	AI-16	51	39.1	I	40	100.0	●
Tokyo; Kozu Isl.	AI-7	71	16.9	I	39	66.6	○
Miyake Isl.	AI-8	57	71.9	I	39	82.0	●
same above	AI-10	-	-	-	40	67.5	
Mie; Daio-zaki	AI-51	50	38.0	I	40	95.0	●
Kochi; Ashizuri-misaki	AI-88	53	75.4	I	37	73.0	○
Niigata; Sado Isl., Senkaku-wan	AI-64	50	0.0	S	40	35.0	○
Shizuoka; Jogasaki	AI-15	19	0.0	S	40	27.5	○
(cut the gametophytes)		-	-	-	40	100.0	○
same above	AI-27	61	0.0	S	40	25.0	○
(cut the gametophytes)		-	-	-	40	100.0	
same above	AI-26	50	0.0	S	40	5.0	○
Tokyo; Hachijo Isl.	"AI"-56	50	0.0	S	40	12.5	○
same above	"AI"-58	50	0.0	S	40	2.5	○
same above	"AI"-61	50	0.0	S	40	5.0	○

\*Gametophytes of larger size (>2.0 m) were fixed at 3 months after sowing.

M: Mixed type (gametophytes bearing both archegonia initials and antheridia initials mixed) ; (>90% of mixed type).

S: Separate type (gametophyte bearing their two kind of primordia initials separated or yeirding each another gametophyte) ; (<10% of mixed type).

I: Intermediate type; (11~89% of mixed type).

\*\*Gametophytes were cultured for about one year after sowing.

\*\*\* ● : Inbreeding type (M + >80% of self fertile), ● : Intemediate type (I + >70% of self fertile), ◎ : Intermediate type (I + 50 ~ 60% of self fertile), ○ : Outcrossing type but sometimes inbreeding (S + >55% of self fertile), ○ : Outcrossing type (S + <54% of self fertile).

Table 3-9. Mode of gametangium formation and intragametophytic selfing tests on sexual types (A2: diploid, C: tetraploid)

Locality & Strain		Mode of gametangium formation*			Intragameto-phytic selfing tests**		Crossing types*** for mapping index
		No. of gametophytes tested	% of mixed type	Judgement of each type (M,S,I)	No. of gametophytes tested	% of self-fertiles	
Kagoshima; Sata-misaki	A2-13	51	0.0	S	40	20.0	○
Okuzure	A2-20	50	0.0	S	40	0.0	○
Noma	A2-26	50	0.0	S	40	15.0	○
Yamatatsugami	A2-32	50	0.0	S	40	2.5	○
Ogasawara; Chichi-jima Isl.,							
Mikazuki-yama	A2-1	24	0.0	S	39	51.3	○
near Gihei-iwa	A2-2	135	1.5	S	40	20.0	○
Taka-yama	A2-3	156	0.0	S	40	5.0	○
Nishi-kaigan	A2-5	68	1.5	S	40	40.0	○
Hatsune-kaigan	A2-8	39	2.6	S	40	82.5	⊗
Kopepe-kaigan	A2-9	62	0.0	S	31	0.0	○
Haha-jima Isl.,							
Yashi-hama	A2-67	50	0.0	S	40	2.5	○
Okinawa; Kunigami-son,							
Iji	A2-11	47	0.0	S	40	22.5	○
same above	A2-12	55	1.8	S	40	7.5	○
Uka	A2-55	50	0.0	S	40	5.0	○
Yonakuni Isl., Kinda-hana	A2-89	50	0.0	S	40	12.5	○
Shizuoka; Shimoda-shi,							
Shikine	C-3	45	0.0	S	40	67.5	⊗
Sotoura	C-6	41	0.0	S	40	55.0	⊗
Shiroyama-koen	C-8	38	0.0	S	40	92.5	⊗
same above	C-10	44	0.0	S	40	37.5	○
same above	C-14	48	0.0	S	40	57.5	⊗
Kawazu-cho, Onabe	C-2	48	2.1	S	40	95.0	⊗

\*Gametophytes of larger size (>2.0 m) were fixed at 3 months after sowing.

M: Mixed type (gametophytes bearing both archegonia initials and antheridia initials mixed); (>90% of mixed type).

S: Separate type (gametophyte bearing their two kind of primordia initials separated or yielding each another gametophyte); (<10% of mixed type).

I: Intermediate type; (11~89% of mixed type).

\*\*Gametophytes were cultured for about one year after sowing.

\*\*\* ⊗ : Outcrossing type but sometimes inbreeding (>55% of self fertile), ○ : Outcrossing type (<54% of self fertile).



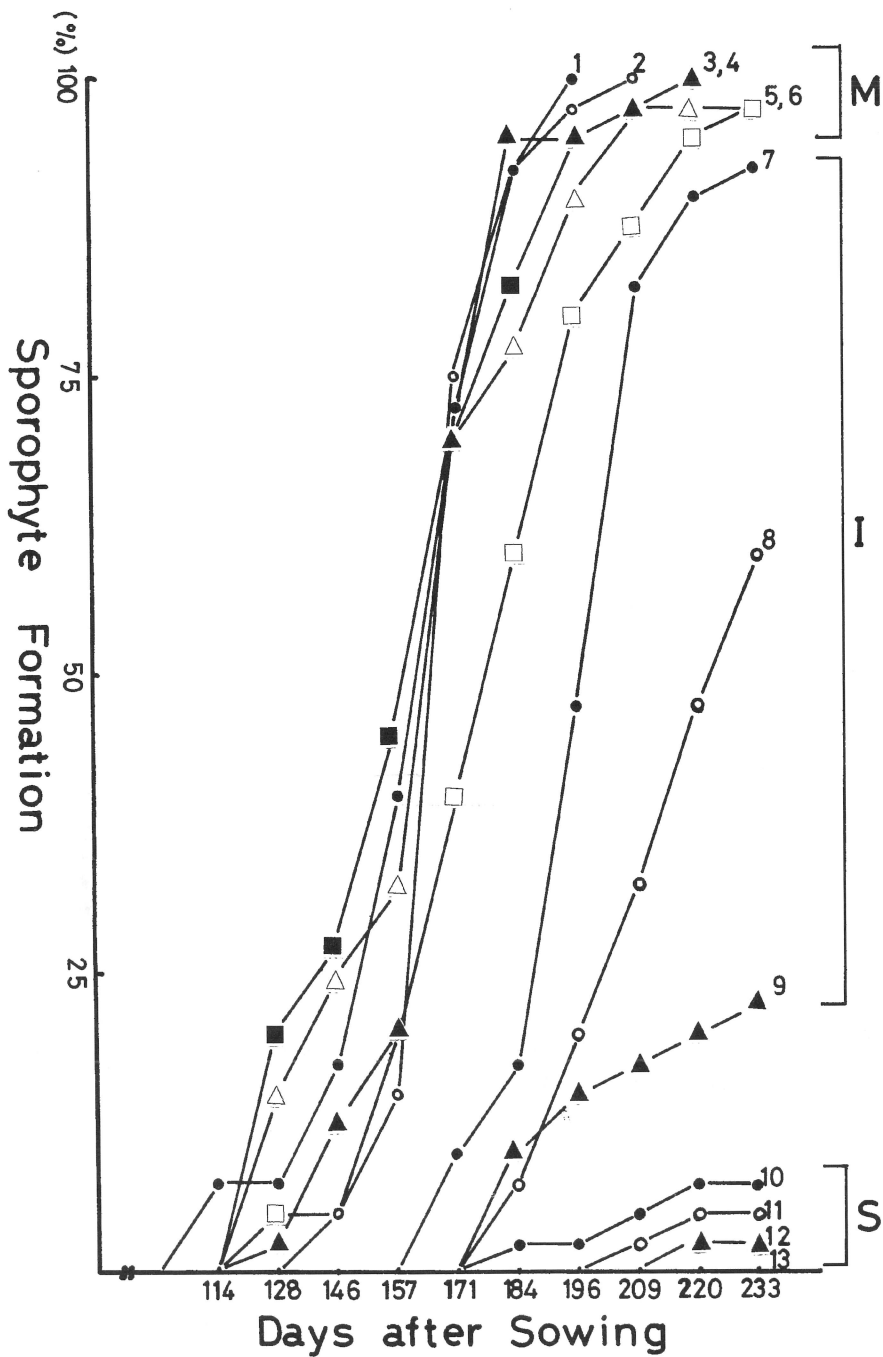


Fig. 3-9. Intragametophytic selfing tested, and showing to correlate with gametangium formation types (M, I, S) on the A1 type of sexual diploid.

M (mix) type: 1(●; A1-67), 2(○; A1-1), 3(▲; A1-16), 4(■; A1-74), 5(□; A1-84), 6(△; A1-71).

I (intermediate) type: 7(●; A1-77), 8(○; A1-10), 9(▲; A1-64).

S (separate) type: 10(●; A1'-56), 11(○; A1'-61), 12(▲; A1'-58), 13(A1-26).

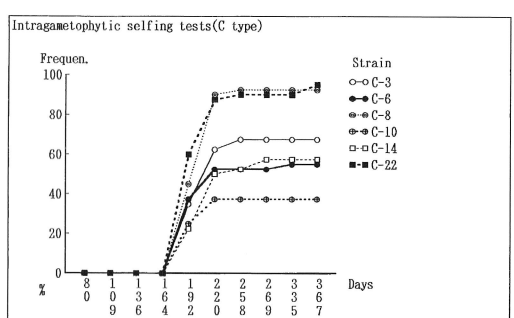
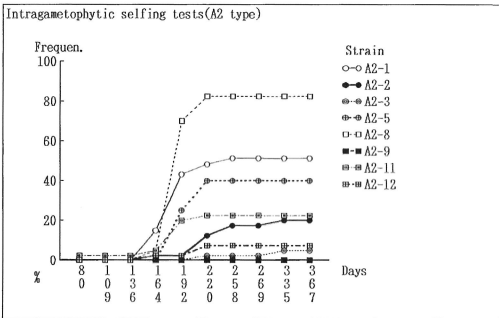
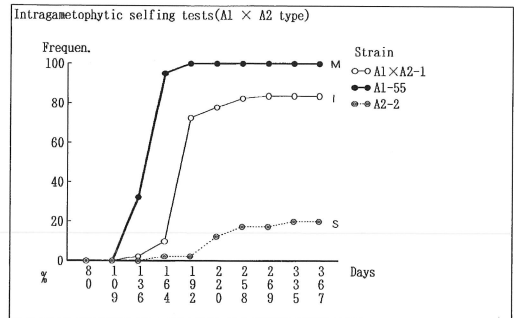
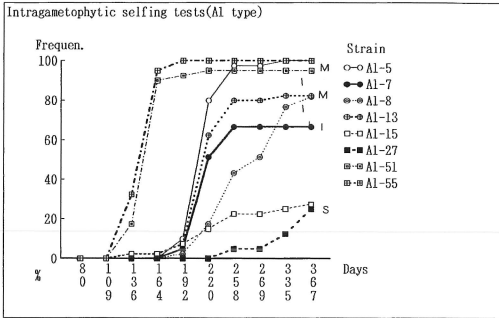


Fig. 3-10. Intragametophytic selfing tested, and showing to correlate with gametangium formation types (M, I, S) on the A1 (2x), A2 (2x), A1 x A2 (2x) and C types (4x).

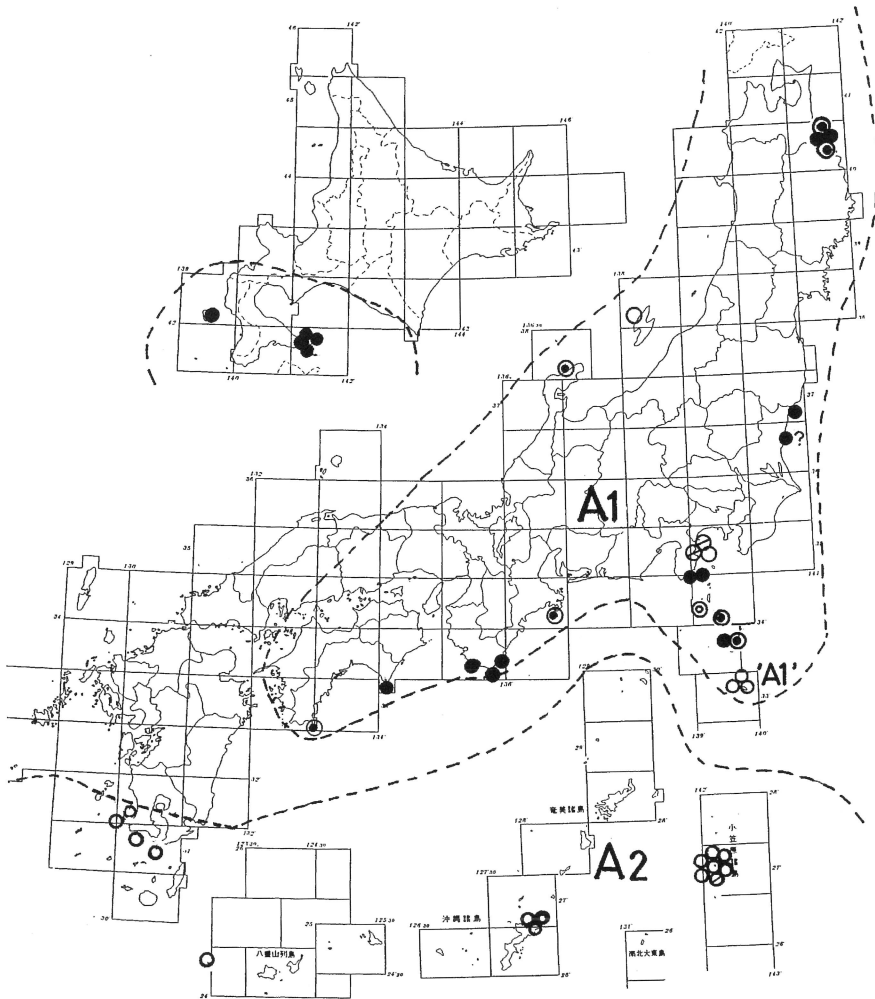


Fig. 3-11. Distribution on the selfing and crossing types on A1 and A2 types of *Cytomium falcatum* (see, Tables 3-8 and 3-9). ● : Inbreeding type ( $M + >80\%$  of self fertile), ● : Intermediate type ( $I + >70\%$  of self fertile), ⊙ : Intermediate type ( $I + 50 \sim 60\%$  of self fertile), ⊖ : Outcrossing type but sometimes inbreeding ( $S + >55\%$  of self fertile), ○ : Outcrossing type ( $S + <54\%$  of self fertile).

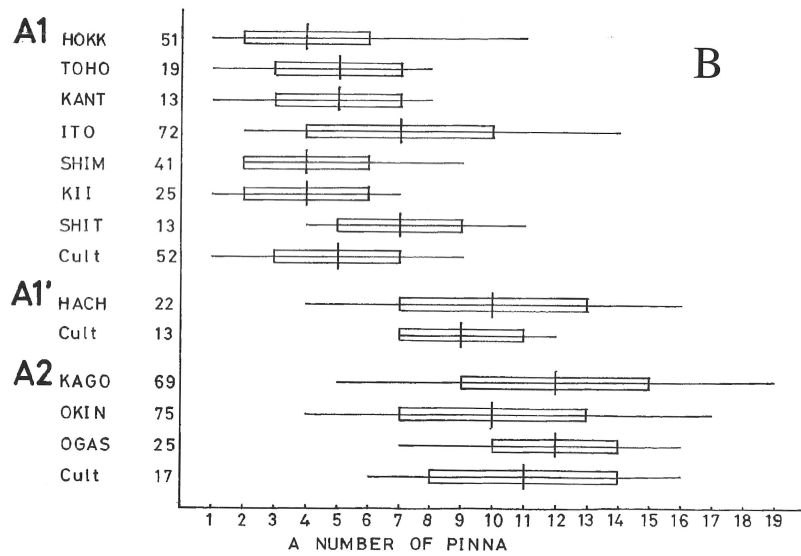
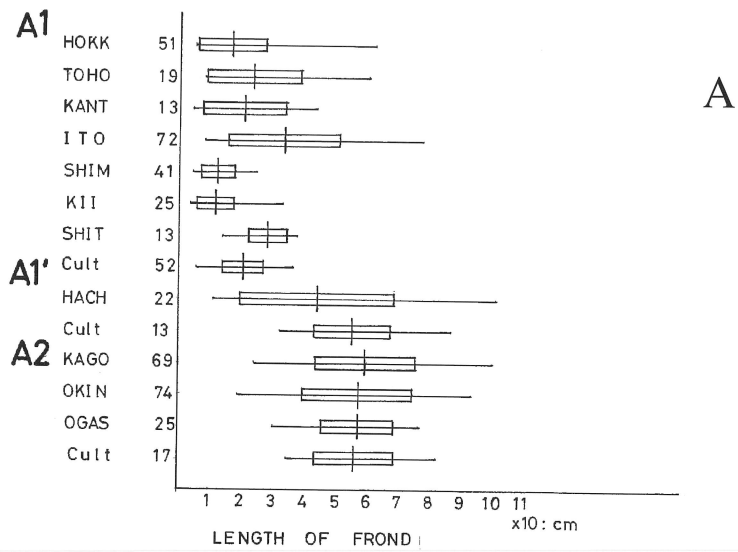


Fig. 3-12. Local variation of length of frond (A) and a number of pinna (B) on A1, A1' and A2 types of *Cyrtomium falcatum* complex. HOKK: Hokkaido, TOHO: Tohoku district, KANT: Kanto district, ITO: Jogasaki, Ito-shi, Shizuoka pref., SHIM: Shimoda-shi, Shizuoka pref., CULT: Cultivated plant in a green house, HACH: Hachijo Isl., KAGO: Kagoshima pref., OKIN: Okinawa pref., OGAS: Ogasawara (Bonin) Isls. (see, Appendix 18).

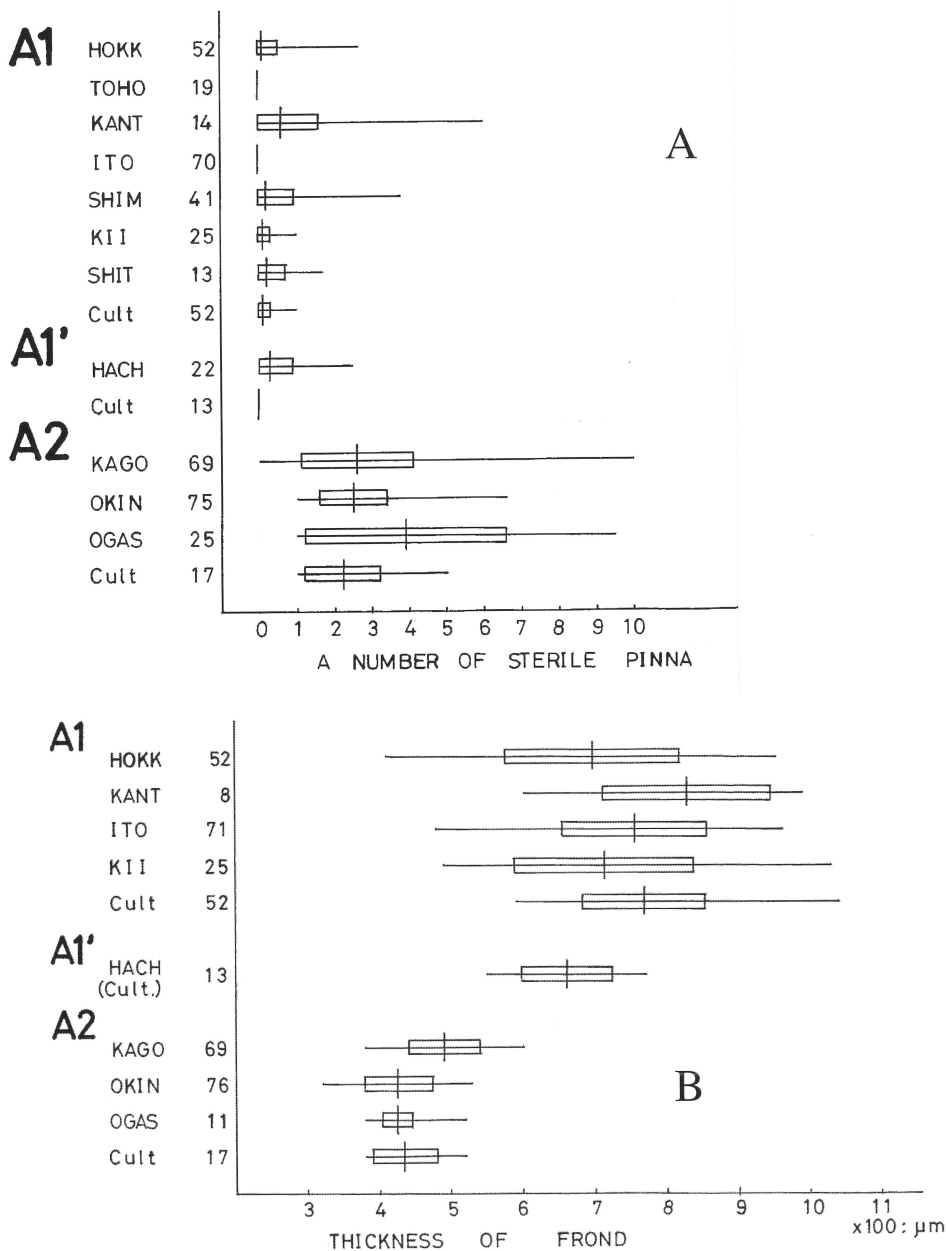


Fig. 3-13. Local variation of a number of sterile frond (A) and thickness of frond (B) on A1, A1' and A2 types of *Cyrtomium falcatum* complex. HOKK: Hokkaido, TOHO: Tohoku district, KANT: Kanto district, ITO: Jogasaki, Ito-shi, Shizuoka pref., SHIM: Shimoda-shi, Shizuoka pref., CULT: Cultivated plant in a green house, HACH: Hachijo Isl., KAGO: Kagoshima pref., OKIN: Okinawa pref., OGAS: Ogasawara (Bonin) Isls. (see, Appendix 18).

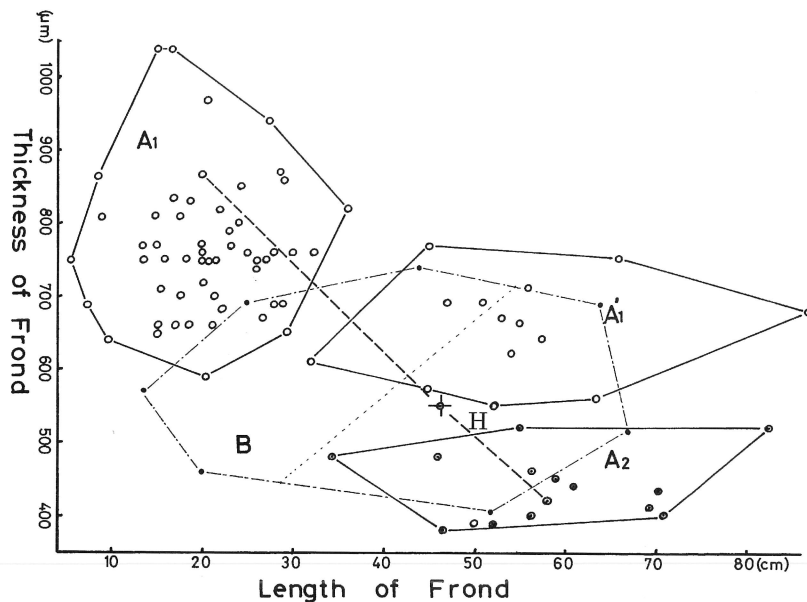


Fig. 3-14. Scatter diagrams of **A1**, **A2** and three intermediate types, **A1'** type from Hachijo Isl. and **B** type showing only the border line (see, Fig. 3-15) and **H** type showing hybrid between **A1** and **A2** types, on the length of frond, the thickness of frond and the color of indusium, whitish (○) and blackish (●). All plants cultivated in green house of 50 % shaded condition.

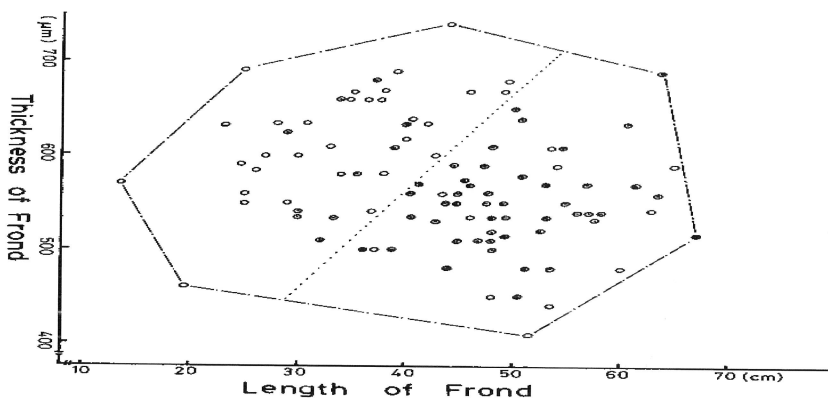


Fig. 3-15. Scatter diagram on the length of frond, the thickness of frond and the indusium's color (open circle: whitish, black circle: blackish) on the triploid apogamous type (**B** type) cultivated in 50% shaded condition. The left side samples of the broken line are similar to **A1** type and the right side ones are similar to **A2** type.

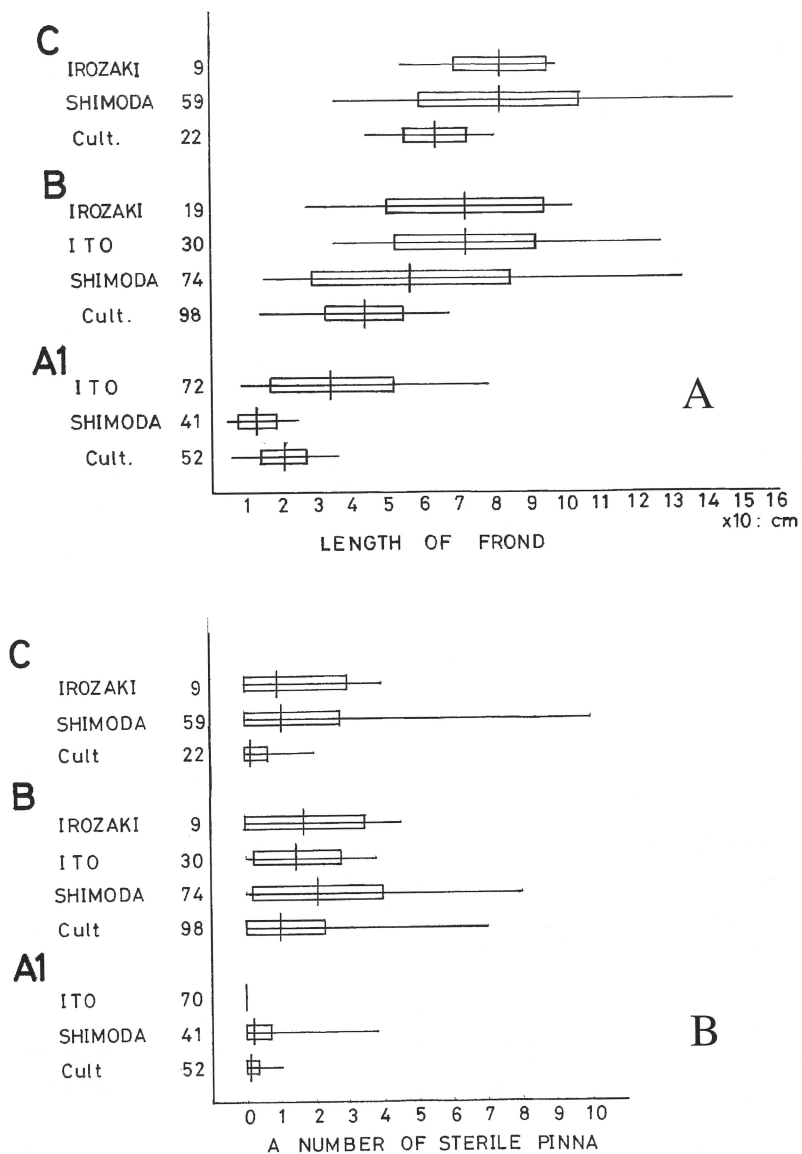


Fig. 3-16. Local variation of length of frond (A) and a number of sterile frond (B) on A1, B and C types of *Cyrtomium falcatum* complex. The number of Y axis is a number of sample. IROZAKI: Irozaki, Minami-izu-cho, Shizuoka pref., SHIMODA: Shimoda-shi, Shizuoka pref., ITO: Jogasaki, Ito-shi, Shizuoka pref., Cult: Cultivated plant in a green house (see, Appendix 18).

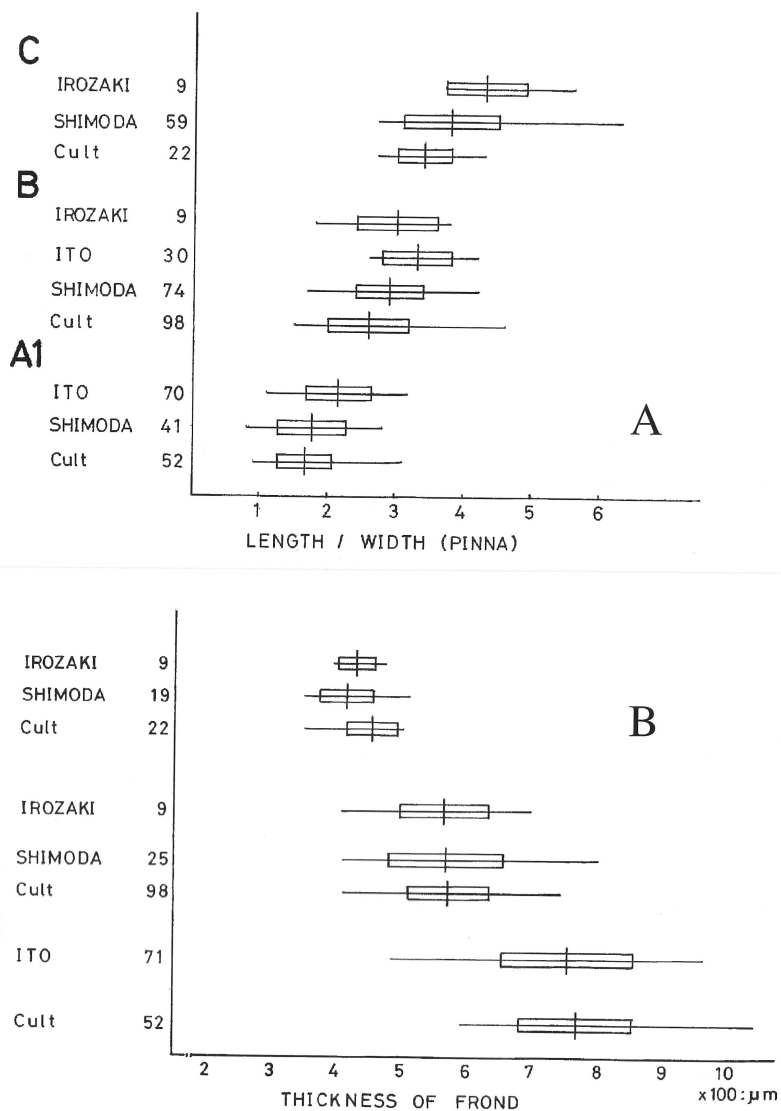


Fig. 3-17. Local variation of length / width of pinna (A) and thickness of frond (B) on A1, B and C types of *Cyrtomium falcatum* complex. The number of Y axis is a number of sample. IROZAKI: Irozaki, Minami-izu-cho, Shizuoka pref., SHIMODA: Shimoda-shi, Shizuoka pref., ITO: Joga-saki, Ito-shi, Shizuoka pref., Cult: Cultivated plant in a green house (see, Appendix 18).



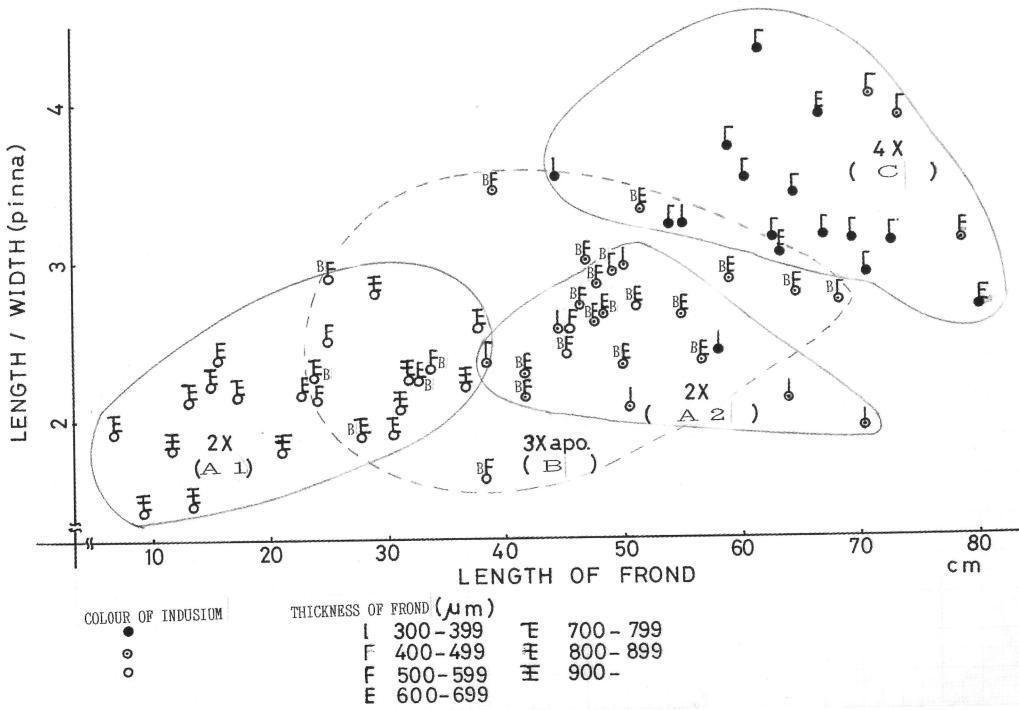


Fig. 3-18. Scatter diagram of 4 characters on basic 4 types of *Cyrtomium falcatum* complex cultivated in green house of 50 % shaded condition.

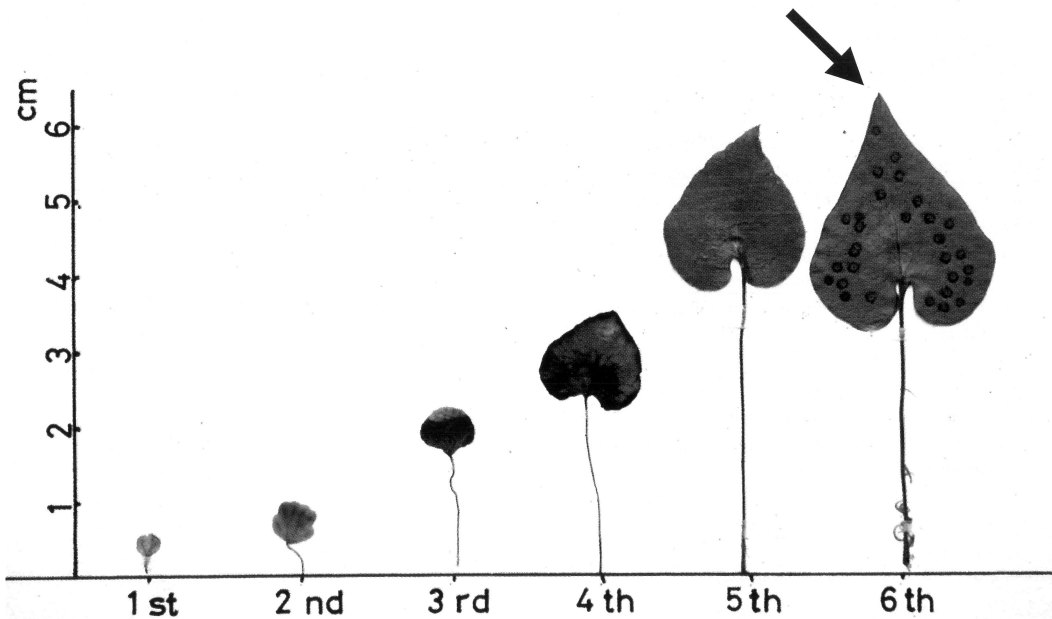


Fig. 3-19. Showing spore formation of single frond (at 6th frond), juvenile form of *Cyrtomium* species, at one year after sowing on A1 type (A1-15: Jogasaki, Ito-shi, Shizuoka pref.) of *C. falcatum*. This phenomena correspond to progenesis.

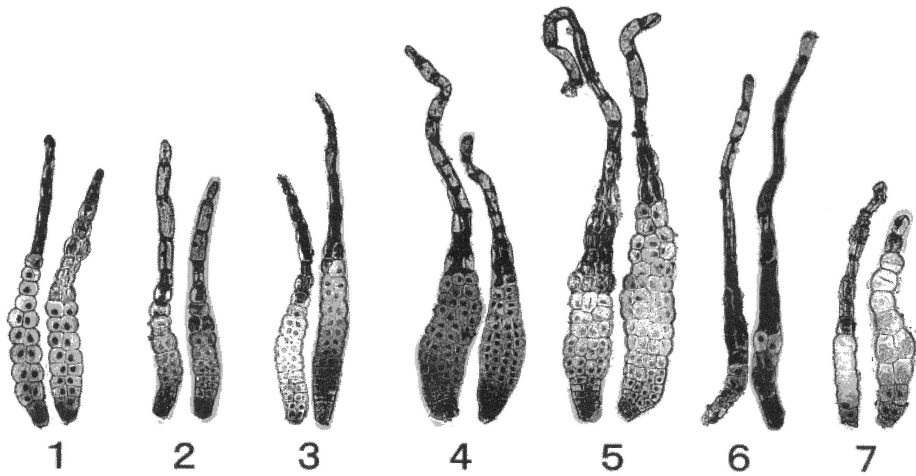


Fig. 3-20. Micro-scales on the upper surface of opening young frond in some Japanese *Cyrtomium*. 1: C type (C-25) of *Cyrtomium falcatum* complex, 2: *C. laetevirens* (D-4), 3: *C. fortunei* var. *intermedium* (G-1), 4: *C. fortunei* var. *clivicola* (lustrous type, E-2), 5: *C. fortunei* var. *clivicola* (non-lustrous type, E-13), 6: *C. microindusium* (K-1), 7: *C. caryotideum* (left: F-5, right: F-2).

Table 3-10. Observations of micro-scales on the upper surface of opening young frond in Japanese *Cyrtomium*

Taxa (Strain)	Source of Materials	A number of Sample	Micro-scales*
<i>C. falcatum</i>			
(A1)	Aomori to Kochi pref. and Hachijo Isl.	84	—
(A2)	Kagoshima pref., Bonin Isls. and Okinawa Isl.	18	L: -, ±
(B)	Central Japan to Iriomote Isl.	111	L: -, ±
(C)	Shizuoka and Nagasaki pref.	31	L: +++
(A1 × B × C)	Artificial hybrid	15	L: ++, +
(A1 × C)	Artificial hybrid	1	L: ++
(B × C)	Natural hybrid	9	L: ++
<i>C. atrovirens</i>	Shizuoka pref. and unknown locality	4	L: +++
<i>C. caryotideum</i>	Shizuoka and Kumamoto pref. (and Nepal)	5	L: +++
<i>C. fortunei</i>			
var. <i>clivicola</i>	Nagano and Shizuoka pref.	14	L: ++
var. <i>intermedium</i>	Shizuoka pref.	1	L: +++
<i>C. laetevirens</i>	Tokyo, Shizuoka and Nagasaki pref.	7	L: +++
<i>C. macrophyllum</i>			
var. <i>macrophyllum</i>	Shizuoka pref.	1	L: +++
var. <i>tukusicola</i>	Shizuoka pref.	1	L: +++
<i>C. microindusium</i>	Kumamoto pref.	1	L: +++
<i>C. balansae</i>	Kagoshima pref.	1	S: +++
<i>C. hookerianum</i>	Kagoshima pref.	1	S: +++

\* Type of scales, L; linear-lanceolate scales (caduceus), S; irregular-stellate scales (persistent), +: present, -: absent, ±: rarely present on the base of pinna.

## 第4章 オニヤブソテツ複合種の繁殖様式と種分化に関する種生態学的考察

### 第1節 生態構造と種分化

種生態学的研究によって明らかにしたオニヤブソテツ複合種の基本的4型の生態構造を図示し、種遺伝学的解析によって明らかにした種分化の過程を述べ、適応戦略と繁殖戦略との関係を考察し、生物学的実態を明らかにした。

横軸に海蝕崖の裸地から林床までの植生遷移を、縦軸に緯度と温量指数から植生帯をとり、4型をこれに乗せた。植生遷移から林床が光に対するストレス耐性戦略(K-Selection Strategy)、林縁から草地が競争戦略(Competition S.)、海蝕崖はかく乱依存戦略(r-Selection S.)に対応する(Grime 1974, Fig. 4-1)。

ヤブソテツ属の主な種はヒマラヤから日本にかけて照葉樹林帯の林床に生育している。その中から海岸に進出したオニヤブソテツの起原型を同じAAゲノムを持ちA1に比べて特殊化の程度の低いA2と推定した。すなわちA2(光に対するストレス耐性戦略者)は亜熱帯を中心に分布し、大型で葉質が薄く、海岸林床性で、胞膜は集団中に黒褐色のものが大部分だが灰白色のものもあり、他殖性の傾向を示すのに対し、A1(攪乱依存戦略者)は温帯に進出し、葉は多肉質で矮小化が進み、幼形の単葉でありながら孢子囊群をつけるものもあり、生活環が短縮し(幼形成熟 Progenesis)、ニッチェの空いていた海蝕崖に、遺伝的浮動(Genetic drift)により胞膜が灰白色の系統のみが特殊化したものと考えられる。また自配自家受精(Intragametophytic selfing)は1個の孢子で子孫を残せるため海蝕崖という不安定な環境下では有利で、矮小化によって洞などの岩壁の微環境にも生育できる体制と伴って急速に北海道まで分布を広げたものであろう(一次的種分化)。A2とA1の分布接点付近の八丈島やその北方、伊東市の集団の一部は苞膜が灰白色だが林縁に生育し、大型で他殖の傾向があり、集団が大きいので自殖から他殖にもどったものと推定される。

次に2倍体のA1、A2型が岬などに極限的分布するのに対し、倍数体のBとC型は暖温帯常緑広葉樹林帯を中心に、海岸とそれに続く低山地の谷などに住み分けて普通に見られた。BとCは自殖可能で、野外でもBはスピーディに、Cは他殖できないときは自殖によって繁殖を行っていると思われる。また剛健な生育をするのは以下のように遺伝的にヘテロ性が強いためであろう。低山地林床性のC型(光に対するストレス耐性戦略者)はゲノム分析の結果や葉上面の小鱗片の存在から、二次的種分化としてA2型とヤブソテツ群の種との雑種起源の種と推定される。無配生殖のB型(競争戦略者)も二次的に形成された同質3倍体と推定され、しかも外部形態が2倍体のA1からA2型に似たものまで変異が見られ、一元的ではないように思われる。これに関して、A1やA2とB型の混生地で無配生殖型の精子による雑種、その分離によるDihaploid、そしてバッククロスが行われると $3X \rightarrow 4X \rightarrow 2X \rightarrow 3X$ とサイクルを形成する可能性があり、上記の変異に示唆を与えるものである。また無配生殖の遺伝子(優性)が一遺伝子の分離をすることから、容易にこれらの遺伝子を獲得できるものかもしれない。一度獲得したものが雑種を作ると、それが固定し、高次倍数体の無配生殖種または型を作り、一方、減数性孢子による分離から、低次倍数体の無配生殖型が形成され、さまざまな二次的種分化を起こして複雑化していくものと推定された。

適応戦略と繁殖戦略の立場から見ると、A1は植生が破壊され変動する環境に生活するため、性を放棄して自殖し、幼形で生殖成長に変わり生活環を短縮している。B型は光と土壤養分など資源が豊富なため、競争の世界で生きている。同質だが3倍体という遺伝的ヘテロによって剛健な性質と大きな変異を持ち、性を止めたスピーディな無配生殖によって競走に打ち勝ち、また乾燥に耐える性質も備えていることは海岸林縁に生活するのに有利である。

一方、CとA2は陰地性で乾性と湿性の差はあるが、ゆっくりと栄養成長するため病気のアタックを受けやすく、特にウイルス病など病気抵抗性を維持するために、有性生殖を行う必要があると考えられている。A2が林床で他殖を行うためには時々地表面が裸地化する必要があり、台風などによる林のギャップが必要となるため、この影響の出やすい岬の突端に分布が局限されるのではないだろうか。しかし劣性突然変異を蓄積しやすく、遺伝的荷重が大きいと、集団が小さくなると絶滅し易くなる。C型は種間雑種起源のためヘテロ性が強く、他の胞子が近くに発芽するまで待って他殖し、来ないときは遺伝的荷重が少ないため自殖可能で内陸部に広がっている。

オニヤブソテツのゲノムA(葉が厚く、全縁で光沢がある)はC型を通してヤブソテツ属の他種との交雑により内陸部に浸透し、外部形態的に区別しにくい高次倍数体無配生殖型を形成していた。

## 第2節 種生態学的検討によって得られたオニヤブソテツ複合種の分類

Thunbergの採集した *Cyrtomium falcatum* (L. f.) C. Preslはその基準標本産地と推定される長崎市小瀬戸の調査、およびタイプ標本の形態を検討した結果B型に(Fig. 4-2)、本種のシノニムとされていた *C. devexiscapulae* (Koidz.) Chingのタイプ標本(済州島産)は胞子も葉上面の小鱗片も落ちて確認できないが、他の外部形態ではC型に相当し、異質4倍体であるので別種としてこの学名を生かし、また新たに *C. falcatum* の亜種としてA1(subsp. *littorale* S. Matsumoto), A2(subsp. *australe* S. Matsumoto)を認めた。さらに無配生殖型を片親とする5つの種間雑種は繁殖力があるので種の扱いにすべきもので、上記新2亜種を含め、新7分類群記載の準備中である。

### Taxonomy of *Cyrtomium falcatum* complex

#### Original species

*Cyrtomium falcatum* (L. f.) C. Presl

subsp. *falcatum* (B type, 3x apo.) "Oni-yabusotetsu"

subsp. *littorale* S. Matsumoto (A1 type, 2x sex.) "Hime-oni-yabusotetsu"

subsp. *australe* S. Matsumoto (A2 type, 2x sex.) "Munin-oni-yabusotetsu"

*C. devexiscapulae* (Koidz.) Ching (C type, 4x sex.) "Nagaba-yabusotetsu"

#### Natural hybrid origin

*C. falcatum* subsp. *littorale* × subsp. *falcatum* (A1 × B, 4x apo. and sex.)

"Atsuba-oni-yabusotetsu"

*C. devexiscapulae* × *C. falcatum* subsp. *falcatum* (C × B, 5x apo.)

"Ai-oni-yabusotetsu"

*C. devexiscapulae* × *C. atrovirens* (D) (C × D, 5x apo.)

"Nagaba-yabusotetsu-modoki" (Kumamoto-yabusotetsu)

*C. devexiscapulae* × *C. fortunei* var. *clivicola* (E) (C × E, 5x apo.)

"Mamushi-oni-yabusotetsu"

*C. devexiscapulae* × *C. caryotideum* (F) (C × F, 5x apo.)

"Nagaba-me-yabusotetsu"

(C. × *pseudocaryotideum* Shimura, Matsumoto & Yamamoto *nom. nud.*, 1978.

J. Geobot. Kanazawa 25: 247-259)

*C. devexiscapulae* × *C. intermedium* (G) [C × G, (5x?) apo.]

"Nagaba-miyako-yabusotetsu"

**Artificial hybrid**

*C. falcatum* subsp. *littorale* × subsp. *australe* (A1 × A2, 2x sex.)

*C. devexiscapulae* × (*C. falcatum* subsp. *littorale* × subsp. *falcatum*)

[C × (A1 × B), 4x apo. and 4x sterile]

*C. devexiscapulae* × *C. falcatum* subsp. *littorale* (C × A1, 3x sterile)

**Dihaploid yielded from tetraploid hybrid**

*C. falcatum* subsp. *littorale* × subsp. *falcatum*

(A1 × B /2, 2x apo.)

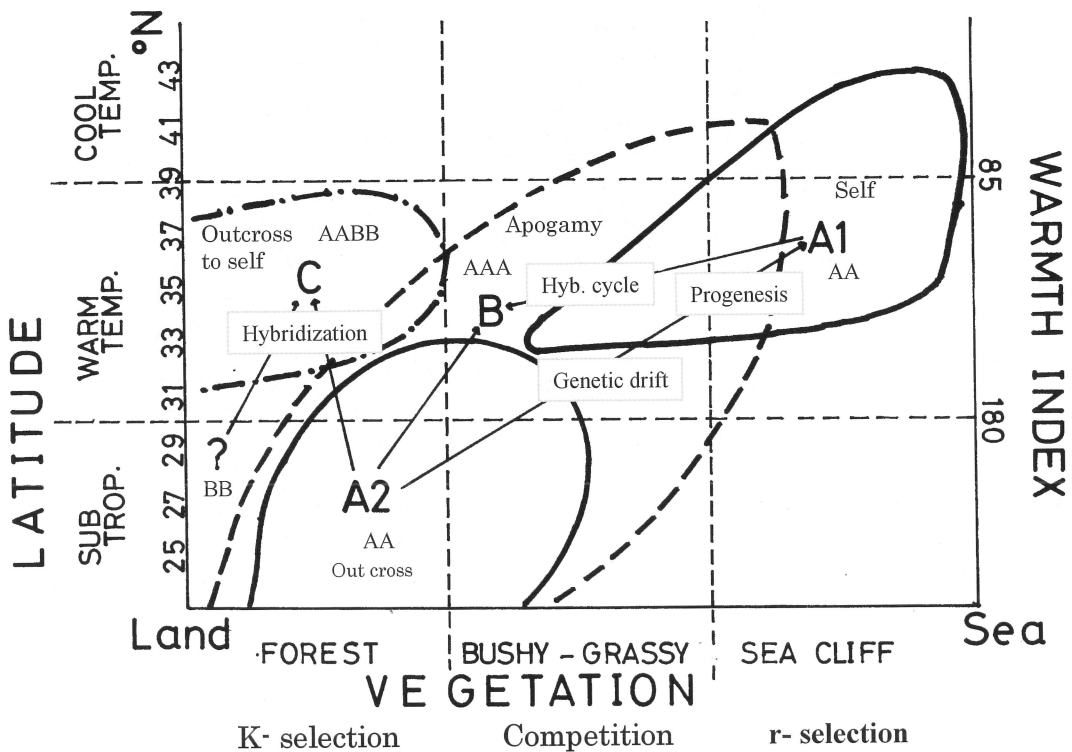


Fig. 4-1. Ecological structure and speciation on basic 4 cyto-types of *Cyrtomium falcatum* complex in Japanese Archipelago.

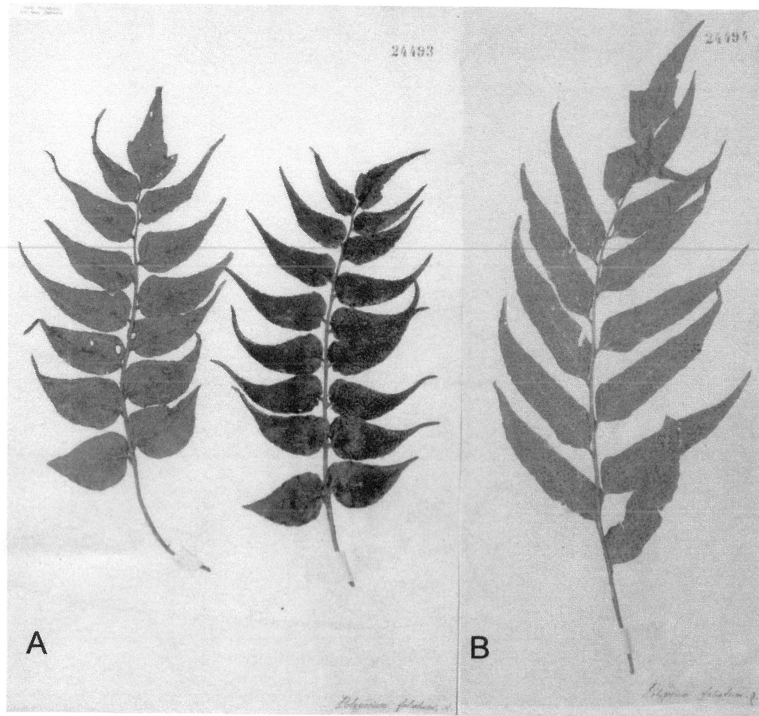


Fig. 4-2. Two kinds of specimens on *Cyrtomium falcatum* deposited in Uppsala University of Sweden collected by Thunberg from Nagasaki at 1776. **A:** Holotype of *Cyrtomium falcatum* (L. f.) C. Presl (*Polypodium falcatum*  $\alpha$  ). **B:** Paratype of *Cyrtomium devexiscapulae* (Koidz.) Ching (*Polypodium falcatum*  $\beta$  ).

### Summary

The ornamental fern, *Cyrtomium falcatum* (L. f.) C. Presl native in Eastern Asia naturalized coastal region of the warm-temperate zone in the world. The chromosome number for cytotypes on 186 localities (341 individuals) and the spore-number per sporangium for reproductive mode on 794 localities (2,467 individuals including herbarium specimens and population samples) in Japan were surveyed. Four cytotypes, two sexual diploid (**A1**: dwarf, **A2**: normal), one sexual tetraploid (**C**) and one apogamous triploid (**B**) were mainly recognized.

In central Japan, **A1**, **B** and **C** types show that the habitat segregation among sea-cliff, coastal grassy ground and forest floor are sympatric. While, **A1** and **A2** types show that the geographic segregation between northern part and southern part in Japan are allopatric.

And also, several polyploid hybrids were recognized at contact zones of each cytotype and another apogamous triploid species. There are one sterile triploid (**A1** × **C**), one apogamous and sexual tetraploid (**A1** × **B**) and four apogamous pentaploid [**C** × **B** (♂), **C** × **D** (**D**: *C. laetevirens* (Hiyama) Nakaike: ♂), **C** × **E** (**E**: *C. fortunei* (J. Sm.) var. *clivicola* (Makino) Tagawa: ♂), **C** × **F** (**F**: *C. caryotideum* (Wall. ex Hook. et Grev.) C. Presl: ♂)]. The polyhaploid (apogamous dihaploid) was gotten from reduced spores (64 spores in a sporangium) of the tetraploid (**A1** × **B**). This apogamous dihaploid considered to make variation of **B** type as donor of sperm by backcross (hybrid cycle: 3x to 4x to 2x to 3x).

Artificial hybrid for genome analysis were synthesized as follow, fertile diploid (**A1** × **A2**), sterile triploid (**A1** × **C**) and sterile and apogamous tetraploid [**C** × (**A1** × **B**)]. Sexual meiosis of all hybrids including natural apogamous hybrids and dihaploid were analyzed for the basic 4 types, **A1**, **A2**, and **B** types were same genome as AA, AA and AAA respectively, but **C** type was allotetraploid having AABB (see Fig. 3-5).

On the genetic background of agamospory, the apogamy was considered to be one dominant gene from the segregation ratio of gametophytes to originate in reduced-spores of tetraploid hybrid, **A1** × **B**. And also linkage of apogamy and diplospory genes considered as to be present, for reason to show diplospory on the almost dihaploid.

On the variation of mating systems, ratio of the gametangium formation (mix or separate antheridia with archegonia) and sporophyte formation by intragametophytic selfing test were investigated on the **A1**, **A2** and **C** types, and one hybrid **A1** × **A2**. **A2** and **C** were separate types, but **A1** was variable from separate to mix type and the hybrid was intermediate type with the half ratio. Sporophyte formation of the mix types including parent (**A1**) of the hybrid were high frequencies by self-fertility, but that of separate types were low in **A1** and **A2** types of diploid or relatively low in **C** type of tetraploid. And also sporophyte formation of separate types later one month than that of mix type.

On the comparative study under the cultivation, dwarf form of **A1** type specialized genetically from **A2** type was considered as 'Progenesis'. The shape of **B** type intermediates between **A1** and **A2** types. While, **C** type was distinguished from another types with shape of pinna and presence of micro-scale on upper surface of frond.

Correlation of the ecological structure and speciation on basic 4 cytotypes of *Cyrtomium falcatum* complex in Japanese Archipelago were considered from viewpoint of species ecological study (see Fig. 4-1). Most basic **A2** type growing subtropical maritime forest with cross mating evolved under K-selection. The **A1** type growing warm and cool temperate sea-cliff evolved under r-selection from **A2** type, as follows, the first by genetic drift, migrating only grayish indusium strain with self mating, the second by progenesis, shorten the life cycle from three years or more to one or two years. Most widely spread **B** type growing the coastal forest edge with apogamous reproduction evolved by hybridization at several

times or by hybrid cycle from **A2** and **A1** types under competition environment. The C type growing warm temperate wetly forest floor evolved under K-selection, by hybridization between **A2** type and unknown another species of *Cyrtomium*.

Taxonomy of basic 4 types on *Cyrtomium falcatum* complex was as follows by examination of two holotype specimens.

*Cyrtomium devexiscapulae* (Koidz.) Ching (C type)

*C. falcatum* (L. f.) C. Presl subsp. *falcatum* (B type)

subsp. *littorale* S. Matsumoto (A1 type)

subsp. *australe* S. Matsumoto (A2 type)

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## 付 表 (Appendix)

- Appendix 1. List of locality and the cytological data on **A1** type of *Cyrtomium falcatum* complex
- Appendix 2. List of locality and the cytological data on **A2** type of *Cyrtomium falcatum* complex
- Appendix 3. List of locality and the cytological data on **B** type of *Cyrtomium falcatum* complex
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- Appendix 5. Locality on herbarium specimens of **A1** type having the 64 spored sporangium and the single color type of indusium in *Cyrtomium falcatum* complex
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Appendix 1. List of locality and the cytological data on AI type of *Cyrtomium falcatum* complex

Locality ([ ]: mapping index, AI-: stock-culture number, SM: Matsumoto collection number)	Cytological Data* (N)	
	S/S	2n or n
<b>Hokkaido</b>		
[Esan-1] Todohokke-mura, Choshi-misaki, among rock on the cliff faced sea (A1-119, 120, SM921022-4)	64(3)	
Same loc. (A1-118)	64(1)	2n = 82 (1)
Same loc. (A1-121)	64(1)	2n = 82 + 1f (1)
[Esan-1] Todohokke-mura, Moto-mura, among rock on the cliff faced sea (A1-123, 124, 126, 127, SM921022-12, 13)	64(6)	
Same loc. (A1-122, 125)	64(2)	2n = 82 (2)
[Esan-1] Todohokke-mura, Esan-misaki, among rock on the cliff faced sea (A1-129, 130, 132, SM921022-18, 20)	64(5)	
Same loc. (A1-131)	64(1)	n = ca.38 (1)
Same loc. (A1-128, 133, 134)	64(3)	2n = 82 (3)
[Hakodate-2] Hakodate-shi, Tachimachi-misaki, on crevice of cliff (A1-135, 137, 138, 139, 145, SM921023-6 ~ 23)	64(23)	
Same loc. (A1-136)	64(1)	2n = 82 (1)
[Okushiri-to-hokubu-2] Okushiri Isl., Gakeno-misaki, on crevice of cliff (SM921024-4)	64(1)	
Same loc. (A1-140 ~ 142)	64(3)	2n = 82 (3)
[Okushiri-to-nanbu-3] Okushiri Isl., Hoya-ishi, on crevice of cliff (SM921025-3, 4)	64(2)	
Same loc. (A1-143, 144)	64(2)	2n = 82 (2)
<b>Aomori pref.</b>		
[Hachinohe-tobu-4] Hachinohe-shi, Tanesashi-kaigan, on rock-wall of seaside (A1-71, 73, 74, 79, 80, 83)	64(6)	
Same loc. (A1-70, 72, 75 ~ 78, 81, 82, 84)	64(9)	n = 41 (9)
[Fukaura-1] Fukaura-cho, Higashi-tugaru-gun, N40° 38' 53", E139° 55' 57", on sea cliff (T. Iwashina, Oct. 8, 1999, A1-148 ~ 155)	64(8)	
<b>Miyagi pref.</b>		
[Kinkazan-3] Kinkazan Isl. Oshika-cho, on rock-wall of seaside (SM730924-18, 21 ~ 23)	64(4)	
Same loc. (SM730923-7, SM730924-17, 19, 20)	64(4)	n = 41 (4)
<b>Ibaraki pref.</b>		
[Otu-3] Kita-ibaraki-shi, Izura-kaigan, on rock-wall of seaside (A1- 68, 69)	64(2)	n = 41 (2)
Same loc. (A1-67)	63(1)	2n = 82, n = 41 (1)
[Hitachi-1] Hitachi-shi, Tajiri-hama, on rock-wall of seaside (SM800716-1, SM831120-1 ~ 7)	64(8)	
Same loc. (A1-46)	64(1)	n = 41
<b>Chiba pref.</b>		
[Choshi-2] Choshi-shi, on rock-wall of seaside (T. Nakaïke, May 21, 1995)	64(1)	
[Choshi-2] Choshi-shi, Sendaga-iwa, on rock-wall of seaside (A1-146, 147)	64(2)	
<b>Tokyo pref.</b>		
[Kozu-jima] Maehama, on rock-wall of seaside (S. Matsumoto, July 23, 1972)	64(1)	2n = ca.82
[Kozu-jima] Kaerihama, on rock-wall of seaside (A1-7, SM810711-13, 14)	64(3)	
[Miyake-jima] Usuki, on rock-wall of seaside (A1-9)	64(1)	
Same loc. (A1-8, 10, 11)	64(3)	n = 41 (3)
[Miyake-jima] Sabigahama, on rock-wall of seaside (SM810706-38, 39)	64(2)	
Same loc. (A1-6)	64(1)	n = 41
[Mikura-jima] Sato, on artificial rock-wall of human colony, alt. ca.200 m (A1-1, 4, 5, SM810709-9, 14)	64(5)	
Same loc. (A1-2, 3)	64(2)	n = 41 (2)
[Hachijo-jima] Borawazawa-kaigan, on rock-wall of seaside (A1'-91)	64(1)	

-(continued)-

App. 1.		-(continued)-	
Same loc. (A1'-56 ~ 59, 90, 94)	64 (6)	2n = 82 (6), n = 41 (3)	
Same loc. (A1'-92)	64 (1)	n = 41	
[Hachijo-jima] Nakanogo, on cutting slope of roadside in half shade, 550 m distance from sea, alt. 130 m (A1'-60, 62, 96)	64 (3)	2n = 82 (3), n = 41 (1)	
[Hachijo-jima] Kashitate, on cutting slope of roadside, 830 m distance from sea, alt. 150 m (A1'-61, 95)	64 (2)	2n = 82 (2), n = 41 (1)	
[Hachijo-jima] Sueyoshi, on cutting slope of roadside, 500 m distance from sea, alt. 80 m (A1'-93)	64 (1)	n = 41	
[Hachijo-shozoku-shoto] Aoga-shima Isl. ( N. Sahashi, 1977 and cultivated by M. Yamashita)	64 (1)	2n = 82 (1)	
<b>Kanagawa pref.</b>			
[Misaki-1] Miura-shi, Ken-zaki, on rock-wall of seaside (S. Matsumoto & K. Tsuboi July 2, 1972)	64 (4)		
Same loc. (SM720702-14)	64 (1)	2n = 82	
Same loc. (SM720702-7,8)	64 (2)	n = 41 (2)	
<b>Shizuoka pref.</b>			
[Ito-2] Ito-shi, Jogasaki-kaigan, on rock or rock-wall of seaside (A1-19, 36, S. Matsumoto Dec. 31, 1975, May 15, 1976, May 8, 1977, May 29, 1977, May 15, 1980, June 15, 1980, Oct. 3, 1981, Mar. 16, 1982, Mar. 11, 1988)	64 (178), 64 or 128* (2)		
Same loc. (A1-15, 29, 31)	64 (3)	2n = 82 (3), n = 41 (2)	
Same loc. (A1-20, 21, 24 ~ 28, 30, 32 ~ 35, 37 ~ 40, 42 ~ 45, SM880511-8, 11, 12, 19)	64 (24)	n = 41 (24)	
[Shimoda-4] Matsuzaki-cho, Kumomi-kaigan, on rock-wall of seaside (S. Matsumoto Aug. 28, 1974)	64 (1)		
[Mikomoto-jima-1] Shimoda-shi, Tsumeki-saki, on rock-wall of seaside (A1-12, S. Matsumoto, May 27, 1973, July 8, 1973, Oct. 3, 1973, July 17, 1975, Oct. 11, 1981, Apr. 30, 1988)	64 (46)		
Same loc. (A1- 13, 55, SM880430-1)	64 (3)	n = 41 (3)	
Same loc. (A1-14)	64 or 128 (1)	n = 41 (1)	
[Mikomoto-jima-1] Shimoda-shi, Suzaki, Ebisu-jima, on rock-wall of seaside (S. Matsumoto, Oct. 11, 1981)	64 (9)		
[Mikomoto-jima-1] Shimoda-shi, Akane Isl., on rock-wall of seaside (S. Matsumoto, Aug. 18, 1972, May 10, 1988)	64 (18)		
Same loc. (SM720818-4, 8, 9, 14, 15, 19)	64 (6)	n = 41 (6)	
[Mikomoto-jima-1] Shimoda-shi, Tatado-kaigan to Irita-hama, on rock-wall of seaside (S. Matsumoto, Aug. 18, 1972, May 27, 1973, Mar. 15, 1982)	64 (11)		
Same loc. (SM730527-32)	64 (1)	n = 41	
[Mikomoto-jima-1] Shimoda-shi, Toji, on rock-wall of seaside (A1-98)	64 (1)		
[Mikomoto-jima-3] Minami-izu-machi, Iro-zaki, on rock-wall of seaside (SM020105-1)	64 (1)		
<b>Aichi pref.</b>			
[Iraiko-zaki-4] Atsumi-cho, Hii-no-sekimon, on rock-wall of seaside (SM980314-1, 2)	64 (2)		
<b>Niigata pref.</b>			
[Aikawa-1] Sado Isl., Senkaku-wan, on rock-wall of seaside (A1-63, 97)	64 (2)		
Same loc. (A1-64 ~ 66)	64 (3)	n = 41 (3)	
[Yahiko-3] Maki-machi, Kakuda-hama (cited from Mitui 1980)	64 (1)	n = 41	
<b>Ishikawa pref.</b>			
[Wajima-4] Noto-hanto, Monzen-machi, Nanaura-kaigan, on rock-wall of seaside (A1-16)	64 (1)	n = 41	
[Mikuni-2] Tojin-bo, on rock-wall of seaside (SM770503-3, 5, 8)	63 (3)		
Same loc. (SM770503-1, 2, 7, 9 ~ 12)	64 (7)	n = 41 (7)	
<b>Mie pref.</b>			
[Namikiri-1] Daio-cho, Daio-zaki, on rock-wall of seaside (A1-51)	64 (1)	n = 41	

## App. 1.

-(continued)-

<b>Wakayama pref.</b>		
[Nachi-katu-ura-1] Taichi-cho, Kantori-saki, on rock-wall of seaside (A1-113 ~ 117, SM920920-26)	64(5)	
Same loc. (A1-112, 114)	64(2)	2n = 82 (2)
[Kushimoto-3] Kushimoto-cho, Shiono-misaki, on rock-wall of seaside (A1-105 ~ 110, SM731103-7 ~ 12, 14, 17, 20-21, 24, 27, 30, 33, 36, SM920920-11)	64(21)	
Same loc. (A1-104, 106)	64(2)	2n = 82 (2)
[Kushimoto-3] Oshima Isl. Umikongo, on rock-wall of seaside (SM731104-5, 6)	64(2)	
[Kushimoto-3] Oshima Isl. Kashino-zaki, on rock-wall of seaside (SM7301104-10, 11, 19, 20)	64(4)	
[Tanabe-4] Shirahama-cho, Sandan-peki, on rock-wall of seaside (A1-100, SM920919-6 ~ 11)	64(8)	
Same loc. (A1-102, 103)	64(2)	2n = 82 (2)
<b>Kochi pref.</b>		
[Muroto-misaki-1] Muroto-shi, Muroto-misaki, on rock wall of seaside (A1-87)	64(1)	
Same loc. (A1-85, 86)	64(2)	2n = 82 (2)
[Tosa-shimizu-2] Tosa-shimizu-shi, Ashizuri-misaki, on rock-wall of seaside (A1-88)	64(1)	2n = 82
Same loc. (A1-89)	64(1)	n = 41
Total	44 localities (515 individuals)	34 localities (115 individuals)

\*(N): a number of individuals, s/s: spore number per sporangium (64: 64 haplo-spores), 2n: chromosome number in mitosis, n: a number of bivalent in meiosis.

Appendix 2. List of locality and the cytological data on A2 type of *Cyrtomium falcatum* complex

Locality ([ ]: mapping index, A2-: stock-culture number, SM: Matsumoto collection number)	Cytological Data* (N)	
	S/S	2n or n
<b>Tokyo pref.</b>		
[Chichijima-retto] Northern slope of Mt. Mikazuki, alt.180 m, on floor of forest (A2-1)	64(1)	2n = 82
[Chichijima-retto] Northern slope of Mt. Mikazuki, alt. 80 m, on forest floor of roadside (A2-2, 19)	64(2)	n = 41 (1), 2n = ca.82(1)
[Chichijima-retto] Middle elevation of Mt. Takayama, alt. 100 m, on floor of forest (A2-3)	64(1)	n = 41
[Chichijima-retto] Tatsumidani, alt.140 m, on mountain slope in forest (A2-4)	64(1)	
[Chichijima-retto] Eastern slope of Tenno-ura, alt. 130 m, on mountain forest (SM940117-1, 2)	64(2)	
Same loc. (A2-76)	64(1)	2n = ca.81
[Chichijima-retto] Nishi-kaigan, alt. 40 m, on forest floor fased sea (A2-5)	64(1)	n = 41
[Chichijima-retto] Nishi-kaigan, alt. 70 m, on forest floor (SM940117-70 ~ 73)	64(4)	
Same loc. (A2-77)	64(1)	2n = 82
[Chichijima-retto] Nishi-kaigan, alt. 65 m, on forest floor (A2-78, SM940117-74 ~ 79)	64(7)	
[Chichijima-retto] Nishi-kaigan, alt. 80 m, on foot of rock-wall (A2-79)	64(1)	2n = 82
[Chichijima-retto] Hatsune, on floor of seashore forest (A2-8, 16, 17)	64(3)	n = 41 (2), 2n = 82 (1)
[Chichijima-retto] Kopepe-kaigan, on floor of seashore forest (SM940113-6 ~ 10)	64(5)	
Same loc. (A2-9, 64, 65)	64(3)	2n = 82 (3)
[Chichijima-retto] Sakaiura, on floor of seashore forest (SM 940113-1 ~ 5, A2-15)	64(6)	
Same loc. (A2-18)	64(1)	2n = ca.82
[Hahajima-retto] Koshin-zuka to Yashi-hama, alt. 100 m, on forest floor (SM94014-1 ~ 5)	64(5)	
Same loc. (A2-66)	64(1)	2n = 82
[Hahajima-retto] Yashi-hama (K. Mitui 1972, TNS, cited from Mitui 1973)	64(1)	n = 41
[Hahajima-retto] Yashi-hama, alt. 10-50 m, on banks of small valley (SM94014-6 ~ 20)	64(15)	
Same loc. (A2-67)	64(1)	2n = 82
[Hahajima-retto] Yashi-hama, alt. 5 m, on banks of waterfall, bussy habitat (SM94014-21, 22)	64(2)	
Same loc. (A2-68)	64(1)	2n = 82
[Hahajima-retto] South of Nagahama, alt. 140 m, on mountain roadside (A2-6)	64(1)	n = 41
[Hahajima-retto] North-western slope of Kuwanoki-yama, alt. 200 m, forest floor (SM940114-23 ~ 28)	64(6)	
Same loc. (A2-69)	64(1)	2n = ca.82
[Hahajima-retto] Inokuma-dani, alt. 200 m, on forest floor (SM940115-1 ~ 4)	64(4)	
Same loc. (A2-70)	64(1)	2n = 82
[Hahajima-retto] Southern slope of Mt. Sekimon, alt. 350 m, on forest floor (SM940115-5 ~ 12)	64(11)	
Same loc. (A2-71)	64(1)	2n = 82
[Hahajima-retto] Mimami-zaki, Omoto-hama, alt. 25 m, on floor of seashore forest (A2-72)	64(1)	2n = ca.82
Same loc. (A2-7)	64(1)	2n = 82
[Hahajima-retto] Mimami-zaki, Omoto-hama, alt. 30 m, on floor of seashore forest (SM940116-1 ~ 3)	64(3)	
Same loc. (A2-73)	64(1)	2n = ca.82
[Hahajima-retto] Mimami-zaki, Omoto-hama, alt. 50 m, on floor of seashore forest (SM940116-4 ~ 11)	64(8)	
Same loc. (A2-74)	64(1)	2n = 82
[Hahajima-retto] Mimami-zaki, Omoto-hama to Horai-kaigan, alt. 40 m, on floor of seashore forest (SM940116-12)	64(1)	
Same loc. (A2-75)	64(1)	2n = 82
<b>Nagasaki pref.</b>		
[Tomie-1] Fukue Isl., Fukue-shi, Shirahama-ura (A2-112, 116, 117)	64(3)	
[Tomie-1] Fukue Isl., Fukue-shi, Sakiyama bay (A2-118)	64(1)	2n = 82

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## App. 2.

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[Tomie-1] Fukue Isl., Fukue-shi, Sakiyama-bana (A2-87, 98, 99, 100, 101)	64 (5)	
Same loc. (A2-102)	64 (1)	2n = 82
[Tomie-1] Fukue Isl., Fukue-shi, around Mt. Mitake (A2-104)	64 (1)	
Same loc. (A2-103)	64 (1)	2n = 82
[Tomie-1] Fukue Isl., Fukue-shi, Sakiyama-Shiozu (A2-88, 105)	64 (2)	2n = 82 (1), n = ca.41 (1)
[Tomie-3] Fukue Isl., Fukue-shi, Kamisakiyama (A2-94)	64 (1)	
Same loc. (A2-95, 96)	64 (2)	2n = 82 (2)
[Tomie-3] Fukue Isl., Fukue-shi, Abunze (A2-106)	64 (1)	2n = 82
[Tamanou-ura-1] Fukue Isl., Tomie-cho, Nagamine (A2-107)	64 (1)	2n = 82
[Tamanou-ura-1] Fukue Isl., Tamanoura-cho, Arakawa (A2-111)	64 (1)	
[Tamanou-ura-3] Fukue Isl., Tamanoura-cho, Osezaki (A2-108)	64 (1)	
Same loc. (A2-109, 110)	64 (2)	2n = 82 (2)
<b>Kagoshima pref.</b>		
[Sata-misaki-2] Sata-cho, Sata-misaki, on mountain slope under bush and trees faced sea, alt. ca. 100 m (A2-36, 38, SM901210-12 ~ 29)	64 (19)	
Same loc. (A2-13)	64 (1)	n = 41
Same loc. (A2-35, 37)	64 (2)	2n = 82 (2)
[Makura-zaki-4] Makurazaki-shi, Yamatatsugami, on rock wall of seaside and on floor of bush, alt. 2-5 m (A2- 28 ~ 32, 34, SM901209- 9 ~ 14)	64 (12)	
Same loc. (A2-27, 33)	64 (2)	2n = 82 (2)
[Noma-dake-1] Kasasa-cho, Bansho to Taniyama, on mountain slope of roadside under bush and trees faced sea, alt. ca. 100 m (A2-21, 24, SM901208- 1 ~ 5, 10 ~ 18)	64 (15)	
Same loc. (A2- 20 ~ 23)	64 (3)	2n = 82 (3)
[Noma-dake-1]Kasasa-cho, Noma-hanto, on mountain slope of roadside under bush and trees faced sea, alt. ca. 100 m (SM901208- 21 ~ 38, & pinna samples)	64 (42)	
Same loc. (A2-25, 26)	64 (2)	2n = 82 (2)
[Okino-erabu-4] Okino-erabu Isl., China-cho, Kamishiro (A2-85)	64 (1)	2n = 82
[Okino-erabu-4] Okino-erabu Isl., China-cho, Tamina-saki (A2-86)	64 (1)	2n = 82
[Yoron-to-2] Yoron Isl., Yoron-cho, Gusuku (A2-81)	64 (1)	
Same loc. (A2-80)	64 (1)	2n = 82
[Yoron-to-2] Yoron Isl., Yoron-cho, Izen (A2-82 ~ 84)	64 (3)	2n = 82 (3)
<b>Okinawa pref.</b>		
[Oku-2] Kunigami-son, Oku, alt. 15 m, on mountain slope by grave-yard (A2-59, SM911127- 67, 68)	64 (3)	
Same loc. (A2- 60)	64 (1)	2n = 82
[Oku-2] Kunigami-son, Ginama, on floor of seashore forest (A2-57, SM911127- 55 ~ 57)	64 (5)	
Same loc. (A2-56)	64 (1)	2n = 82
[Oku-4] Kunigami-son, around light-house of hedo-misaki, alt. 50 m, on floor of bush of <i>Cycas</i> (SM911127- 59 ~ 64)	64 (6)	
Same loc. (A2-58)	64 (1)	2n = 82
[Hetona-2] Kunigami-son, Awa, on mountain slope of seaside (A2-61)	64 (1)	2n = 82
[Hetona-3] Kunigami-son, Uka, on mountain slope by grave-yard faced sea (SM911127- 40 ~ 52)	64 (13)	
Same loc. (A2-55)	64 (1)	2n = ca.82
[Hetona-3] Kunigami-son, Iji, on cutting slope of roadside faced sea (A2- 53, 54, SM911127- 31 ~ 37)	64 (9)	
Same loc. (A2- 10 ~ 12)	64 (3)	n = 41 (3)
[Nakasone-2] Ogimi-son, Nerome, alt. 10 m, on mountain slope by roadside (A2-52, SM911127- 21 ~ 24)	64 (5)	
Same loc. (A2-51)	64 (1)	2n = 82
[Kunigami-heira-1] Higashi-son, Izena, on rock-wall of seaside (A2-62, SM911127- 72 ~ 80)	64 (10)	
Same loc. (A2-63)	64 (1)	2n = 82

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## App. 2.

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[Kunigami-heira-3] Ogimi-son, Miyagi-shima, on rock-wall or mountain slope of seaside forest (A2-49, SM730719-5,7,10, 13,15,17, SM911127-12 ~ 20)	64(17)	
Same loc. (A2-50)	64(1)	2n = 82
[Kunigami-heira-3] Nago-shi, Kushibaru, on rock-wall or mountain slope of seaside forest (A2-47, 48, SM911127- 4 ~ 7)	64(6)	
Same loc. (A2-46)	64(1)	2n = 82
[Nago-1] Nago-shi, Awa, northern side of small isl. on forest floor (A2-40 ~ 42, SM911126-8, 9)	64(5)	
Same loc. (A2-39)	64(1)	2n = 82
[Nago-1] Nago-shi, Awa, left side valley of Ryukyu Cement Co. LTD., alt. 50 m, on crevice of rocky roadside (A2'-113, 114)	32 > 64(2)	2n = 82 (2)
Same loc. (A2'-115)	32 > 64(1)	2n = 82 (1), n = 41 (1)
[Yonaguni] Yonaguni Isl., Kindahana (A2-89, H. Hatta, Mar. 22, 1994)	64(1)	
Same loc. (A2- 90)	64(1)	2n = 82
[Yonaguni] Yonaguni Isl., Kukurabari (A2-91, 92, H. Hatta, Mar. 22, 1994)	64(2)	
<b>Taiwan</b>		
Taitung Prov.: Lanyu Isl. (A2-93, S. Masuda, Dec. 1988)	64(1)	2n = 82
Taitung Prov.: Lanyu Isl., Zhongai bridge (忠愛橋) [Jinn-Fen Chen (陳進分), SM00-121, 122 ]	64(2)	
Total	57 localities (337 individuals)	52 localities (72 individuals)

\*(N): a number of individuals, s/s: spore number per sporangium (64: 64 haplo-spores), 2n: chromosome number in mitosis, n: a number of bivalent in meiosis.

Appendix 3. List of locality and the cytological data on **B** type of *Cyrtomium falcatum* complex

Locality ([ ]: mapping index, B-: stock-culture number, SM: Matsumoto collection number)	Cytological Data* (N)	
	S/S	2n or n
<b>Miyagi pref.</b>		
[Kinkazan-3] Oshika-cho, Kinkazan Isl. (SM730923- 5, 6, 14)	32(3)	
Same loc. (B-82)	32(1)	2n = 123 (1)
Same loc. (B-81, 83, 84)	32(3)	n = 123 (3)
<b>Ibaraki pref.</b>		
[Otu-3] Kitaibaraki-shi, Izura-kaigan, on artificial rock-wall and grassy grounds of seaside (B-107, 108)	32(2)	
Same loc. (B-106)	31(1)	n = ca.123(1)
[Hitachi-1] Hitachi-shi, Tajiri-hama, on soil wall of seaside (SM831120-11 ~ 17)	32(7)	
Same loc. (B-72)	32(1)	n = 123(1), 16 c/s: 22III + 19II + 19I
[Naka-minato-4] Nakaminato-shi, Ajigaura, on rocky seashore (B-74 ~ 77)	32(4)	
Same loc. (B-73)	32(1)	n = 123 (1)
<b>Chiba pref.</b>		
[Mobara-2] Ichinomiya-cho (S. Matsumoto, July 13, 1971)	32(1)	
<b>Tokyo pref.</b>		
[Tokyo-nanseibu-1] Minato-ku, Shirogane 3-chome, on roadside (SM730120- 2)	32(1)	
[Kozu-jima] Kozu Isl., Kaeri-hama, on rock-wall of seaside (B-35, 37, S. Matsumoto, July 11, 1981)	32(6)	
Same loc. (B-36)	32(1)	2n = n = 123 (1), 16 c/s : 22III + 19II + 19I
[Kozu-jima] Kozu Isl., Mae-hama, on grassy ground near sea (S. Matsumoto, July 10, 1981)	32(3)	
[Miyake-jima] Miyake Isl., Usuki, on cutting slope of roadside near sea (B-39, 41)	32(2)	
Same loc. (B-38, 40)	32(2)	n = 123 (2)
[Miyake-jima] Miyake Isl., Sabiga-hama, on rocky ground of seaside (S. Matsumoto, July 6, 1981)	32(1)	
[Mikura-jima] Mikura Isl., on cutting slope of roadside (B-32, S. Matsumoto, July 10, 1981)	32(5)	
Same loc (B-33, 34)	32(2)	n = 123 (2)
[Hachijo-jima] Hachijo Isl., Borawazawa-kaigan, on artificial rock-wall faced sea (B- 101, S. Matsumoto, Jan. 27, 1989)	32(3)	
Same loc. (B-102)	32(1)	2n = 123 (1)
[Hachijo-jima] Hachijo Isl., Nakanogo to Kashitate, on cutting slopes of roadside (B- 105)	32(1)	
Same loc. (B-103, 104)	32(2)	2n = 123 (2)
[Hachijo-shozoku-shoto] Aoga-shima Isl., Yasumiya (B-191, T. Shimakawa)	32(1)	2n = 123(1)
<b>Kanagawa pref.</b>		
[Yokosuka-1] Yokosuka-shi, Kannon-zaki, on rock-wall and grounds near sea (S. Matsumoto, July 1, 1971)	32(10)	
[Misaki-1] Miura-shi, Ken-zaki, on rock-wall and grassy grounds of seashore (S. Matsumoto, July 15, 1972)	32,16(5)	
<b>Niigata pref.</b>		
[Aikawa-1] Sado Isl., Aikawa-cho, Senkaku-wan on rock-wall of seaside (B-157, 158)	32(2)	
Same loc. (B-156)	32(1)	n = 123(1)
[Aikawa-2] Sado Isl., Aikawa-cho, Tassya, on mountain slope faced sea (B-109)	32(1)	
Same loc. (B-110, 111)	32(2)	n = 123(2)

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## App. 3.

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<b>Ishikawa pref.</b>		
[Wajima-4] Monzen-cho, Minazuki, Nanaura-kaigan, on rock-wall and rocky, grassy, woody grounds of seashore (SM770502-1, 3, 17 ~ 20, 23, 30, 31)	32(9)	
Same loc. (B-80, SM770502-4)	32(2)	n = 123(2)
<b>Fukui pref.</b>		
[Mikuni-2] Mikuni-cho, Tojinbo, on rock-wall of seaside (S. Matsumoto, May 3, 1977)	32(1)	
[Mikuni-2] Mikuni-cho, Oshima, on rocky-ground of seaside (S. Matsumoto, May 3, 1977)	32(4)	
Same loc. (SM770503- 30, 32, 34)	32(3)	n = ca.123 (3)
[Fukui-3] Fukui-shi, Sugao (B-79, M. Nakata)	32(1)	
[Nishitsu-3] Mikata-cho, Umiyama, on cutting slope of roadside (B-78)	32(1)	n = 123 (1)
<b>Shizuoka pref.</b>		
[Ito-2] Ito-shi, Jogasaki, on rock-wall and rocky, grassy, woody grounds of seashore (B-53, S. Matsumoto, Dec. 31, 1975, May 15, 1976, May 8, 1977, May 29, 1977, May 19, 1980, June 15, 1980, May 11, 1988)	32(94)	
Same loc. (SM880511- 34)	32(1)	2n = 123 (1)
Same loc. (B-51, 52)	32(2)	n = ca.123 (2)
[Ito-2] Ito-shi, Jogasaki, on rock-wall and rocky, grassy, woody grounds of seashore, Tsunakiri (B-159)	32 : 64s/s = 36 : 40	2n = n = 123, 16c/s: 24III+17II+17I
[Inatori-3] Higashi-izu-machi, Inatori, on rock-wall and woody ground of seaside (S. Matsumoto, Aug. 19, 1972)	32(4)	
Same loc. (SM720819- 6)	32(1)	2n = ca.123 (1)
[Shimoda-2] Shimoda-shi, Kakisaki to Suzaki, on rock-wall and rocky, grassy grounds of seashore (S. Matsumoto, May 21, 1978, Oct. 7, 1987, Oct. 11, 1987)	32(13)	
Same loc. (B-93)	32(1)	n = 123 (1)
[Shimoda-2] Shimoda-shi, Soto-ura, on cutting slope of roadside faced sea (B-48, 50, 95)	32(3)	
Same loc. (B-49, 56)	32(2)	n = 123 (2)
[Shimoda-2] Shimoda-shi, Madoga-hama, back side of Hotel Buzansou (B-173)	32(1)	2n = 123 (1)
[Shimoda-4] Matsuzaki-cho, Kumomi, on rock-wall and woody ground (S. Matsumoto, Aug. 28, 1974)	32(5)	
[Mikomoto-jima-1] Shimoda-shi, Oura-kaigan, on cutting slope of roadside faced sea and roadside of human habitation (B-54, S. Matsumoto, Aug. 18, 1972, Oct. 4, 1981, Oct. 6, 1981)	32(47)	
Same loc. (B-55)	32(1)	n = 123 (1)
[Mikomoto-jima-1] Shimoda-shi, Suzaki, Ebisu Isl., on rock-wall of seashore (B-57)	32(1)	n = 123 (1)
[Mikomoto-jima-1] Shimoda-shi, Suzaki, Fuku-ura, on rock-wall of seashore (B-58)	32(1)	n = 123 (1)
[Mikomoto-jima-1] Shimoda-shi, Tsumeki-saki, on rock-wall and rocky, grassy grounds of seashore (B-112, 114, S. Matsumoto, Jan. 3, 1973, May 27, 1973, July 17, 1975)	32(40)	
Same loc. (B-113)	32(1)	n = 123 (1)
[Mikomoto-jima-1] Shimoda-shi, Kisami to Tatado-kaigan, on rock-wall and rocky, grassy, woody grounds of seashore (B-63, 65 ~ 68, 70, 94, S. Matsumoto, May 27, 1973)	32(19)	
Same loc. (B-59)	32(1)	2n = 123 (1)
Same loc. (B-60 ~ 62, 64, 69)	32(5)	n = 123 (5)
[Mikomoto-jima-3] Minami-izu-cho, Ose, on cutting slope of roadside faced sea and roadside of human habitation (B-42, S. Matsumoto, Dec. 26, 1972, May 16, 1976)	32(48)	
[Shizuoka-1] Shizuoka-shi, Hiramatsu, on artificial rock-wall near sea (S. Matsumoto, Apr. 21, 1973, May 20, 1973)	32(14)	
Same loc. (SM730520-2, 11)	32(2)	n = 123 (2)
[Shizuoka-1] Shizuoka-shi, Shikiji, on bank of roadside (S. Matsumoto, Aug. 30, 1973)	32,16(4)	
[Shizuoka-2] Shizuoka-shi, Sekibe, on artificial rock-wall along stream near sea (B-71)	32(1)	2n = n = 123 (1)
<b>Mie pref.</b>		
[Namikiri-1] Daio-cho, Daio-zaki, on rock-wall of seaside (B-87, 89 ~ 92, 96 ~ 99)	32(9)	

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## App. 3.

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Same loc. (B-88, 100)	32(2)	n = 123 (2)
[Kimoto-4] Kumano-shi, Oniga-jo, on rock-wall of seaside (B-31)	32(1)	
Same loc. (B-30)	32(1)	n = 123 (1)
<b>Wakayama pref.</b>		
[Nachi-katsuura-1] Taiji-cho, Kantori-saki, on the ground of rocky seaside (B-198)	32(1)	2n = ca.123 (1)
[Nachi-katsuura-4] Koza-cho, on rock-wall in seaside forest (SM920920-13)	32(1)	
Same loc. (B-197)	32(1)	2n = 123 (1)
[Kushimoto-3] Kushimoto-cho, Shiono-misaki, on rock-wall of seaside (S. Matsumoto, Nov. 3, 1973)	32(11)	
Same loc. (B-196)	32(1)	2n = 123 (1)
[Kushimoto-3] Kushimoto-cho, Oshima Isl., on rock-wall and rocky ground of seaside (S. Matsumoto, Nov. 3, 1973, SM920920-1 ~ 3)	32(17)	
[Gobo-4] Mihama-cho, Hino-misaki, on rock-wall and rocky ground of seaside (B-192, 194, 195)	32(3)	
Same loc. (B-193)	32(1)	2n = 123 (1)
<b>Tottori pref.</b>		
[Hamasaka-3] Iwami-cho, Uratomi-kaigan, on rocky, grassy woody grounds of seashore (S. Matsumoto, Apr. 1, 1972)	32(4)	2n = 123 (1)
<b>Hiroshima pref.</b>		
[Hiroshima-2] Hiroshima-shi, Ujina-jima, on woody ground (B-172)	32(1)	2n = 123 (1)
<b>Tokushima pref.</b>		
[Hiwasa-4] Hiwasa-cho, the end of highway "Minamiawa sun-line", on cutting slope of roadside faced sea (B-27, M. Nakata)	32(1)	n = ca.123 (1)
<b>Kochi pref.</b>		
[Muroto-misaki-3] Muroto-shi, Moto (B-115)	32(1)	n = ca.123 (1)
[Aki-1] Aki-shi, Nishino-hama, Oyama-zaki, on rock-wall of seaside (B-125, 126)	32(2)	
Same loc. (B-28, M. Nakata, B-124)	32(2)	n = 123 (2)
[Tosa-shimizu-1] Tosa-shimizu-shi, Ari-saki, on rocky ground of seaside (B-29, M. Nakata)	32(1)	n=123 (1)
[Tosa-shimizu-2] Tosa-shimizu-shi, Ashizuri-misaki, on rock-wall of seaside (B-123)	32(1)	n = 123 (1)
[Tosa-shimizu-3] Tosa-shimizu-shi, Tatsugushi, on rock-wall of seaside (B-121)	32(1)	
Same loc. (B-122)	32(1)	n = ca.123 (1)
[Tosa-shimizu-3] Otsuki-cho, Kosaitsuno-kaigan, on cutting slope of roadside faced sea (B-120)	32(1)	
Same loc. (B-119)	32(1)	n = ca.123 (1)
<b>Nagasaki pref.</b>		
[Nagasaki-3] Shikimi-machi, on rocky ground of seaside (B-26, H. Nakanishi)	32(1)	n = 123 (1)
[Nagasaki-4] Nagasaki-shi, around of Kosedo-cho, on rock-wall and rocky, grassy, woody grounds (B-128, 130 ~ 134, 140 ~ 143, S. Matsumoto, Nov. 24, 1989, Nov. 26, 1989)	32(127)	
Same loc. (B-127, 129)	32(2)	n = 123 (2)
[Nomo-zaki-3] Nomo-zaki, on cutting slope of roadside near sea (B-137, S. Matsumoto, Nov. 25, 1989)	32(29)	
[Nomo-zaki-3] Nomo-zaki, on rock-wall and rocky, grassy, woody grounds of seaside (B-136, S. Matsumoto, Nov. 25, 1989)	32(22)	
Same loc. (B-135)	32(1)	2n = 123 (1)
[Nomo-zaki-3] Kaba Isl., on rock-wall of seaside and cutting slope of roadside (B-138, 139, S. Matsumoto, Nov. 25, 1989)	32(29)	
[Fukue-4] Fukue-shi, Takada (B-227, O. Terai, Mar. 23, 1994)	32(1)	
[Fukue-4] Fukue-shi, Kamiotsu (B-237 ~ 239, O. Terai, Mar. 23, 1994)	32(3)	2n = 123 (3)
[Fukue-4] Fukue-shi, Nagate (B- 241, O. Terai, Mar. 23, 1994)	32(1)	

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## App. 3.

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Same loc. (B-240)	32(1)	2n = 123 (1)
[Fukue-4] Fukue-shi, Toraku (B-248, O. Terai, Mar. 23, 1994)	32(1)	
Same loc. (B-249)	32(1)	2n = 123(1)
[Fukue-4] Fukue-shi, Minami-kawara (B-250 ~ 252, O. Terai, Mar. 23, 1994)	32(3)	
[Fukue-4] Fukue-shi, Kashinoura (B-253, 254, O. Terai, Mar. 23, 1994)	32(2)	2n = 123 (2)
[Tomie-1] Fukue-shi, Shimosakiyama (B-244, O. Terai, Mar. 23, 1994)	32(1)	2n = 123 (1)
[Tomie-1] Fukue-shi, Sakiyama-kou (B-245, O. Terai, Mar. 23, 1994)	32(1)	2n = 123 (1)
[Tomie-3] Fukue-shi, Kokuzo (B-228, O. Terai, Mar. 23, 1994)	32(1)	
[Tomie-3] Tomie-cho, Tao (B-230, 231, O. Terai, Mar. 23, 1994)	32(2)	
Same loc. (B-229, O. Terai, Mar. 23, 1994)	32(1)	2n = 123 (1)
[Tomie-3] Tomie-cho, Tanoe ( B-232, 233, O. Terai, Mar. 23, 1994)	32(2)	
[Tomie-3] Tomie-cho, Tomie (B-234, O. Terai, Mar. 23, 1994)	32(1)	
[Tomie-3] Tomie-cho, Dake (B-235, O. Terai, Mar. 23, 1994)	32(1)	
[Tomie-3] Tomie-cho, Yamashita (B-236, O. Terai, Mar. 23, 1994)	32(1)	
[Tomie-3] Fukue-shi, Kamisakiyama-1 (B-242, O. Terai, Mar. 23, 1994)	32(1)	
[Tomie-3] Fukue-shi, North of Abunze (B-243, O. Terai, Mar. 23, 1994)	32(1)	2n = 123 (1)
[Tomie-3] Fukue-shi, Kamisakiyama (B-246, O. Terai, Mar. 23, 1994)	32(1)	
Same loc. (B-247, O. Terai, Mar. 23, 1994)	32(1)	2n = 123 (1)
<b>Oita pref.</b>		
[Sagaseki-3] Sagaseki-cho, Ohira, on stone wall of seaside (B-255)	32(1)	
[Sagaseki-1] Sagaseki-cho, Sekizaki, on rock wall of seaside (B-256 ~ 260)	32(5)	
[Tsuru-misaki-3] Tsurumi-cho, Tsuru-misaki, on rock-wall of seaside (B-261 ~ 263)	32(3)	
[Usa-1] Kakaji-cho, Nagasaki-bana, on rock-wall of seaside (B-267 ~ 269)	32(3)	
Same loc. (B-264 ~ 266)	32(3)	2n = 123 (3)
[Hime-jima-2] Kunimi-cho, Konpira-bana, on rock-wall of seaside (B-271, 272)	32(2)	
Same loc. (B-270)	32(1)	2n = 123 (1)
[Hime-jima-2] Kunimi-cho, Narahara, on rock-wall of seaside (B-273)	32(1)	
<b>Miyazaki pref.</b>		
[Hyuga-aoshima-2] Miyazaki-shi, Kochiumi, northern part of Kinchaku Isl. (SM911112-16, 17, T. Iwashina)	32(2)	
Same loc. (B-182, 183)	32(2)	2n = 123 (2)
[Obi-1] Nichinan-shi, Udo-zaki, on rock-wall of seaside (B-169 ~ 171)	32(3)	
Same loc. (B-168)	32(1)	2n = 123 (1)
[Obi-2] Nichinan-shi, Odotu, Inohana-zaki (SM911112-7 ~ 9, T. Iwashina)	32(3)	
Same loc. (B-176 ~ 181)	32(6)	2n = 123 (6)
[Shibushi-2] Kushima-shi, Takamatsu (B-175, SM911112-1 ~ 3, T. Iwashina)	32(4)	
Same loc. (B-174)	32(1)	2n = ca.123(1)
<b>Kumamoto pref.</b>		
[Misumi-2] Ariake-cho, Biro Isl., on rock-wall of seaside (B-155, M. Takamiya)	32(1)	2n = 123 (1)
[Minamata-2] Kawachi-cho (B-22 ~ 25, R. Hirayama)	32(4)	n = 123 (4)
[Ushibuka-4] Ushibuka-shi, Shimosu-jima, below Turuba-yama park, on seaside (B-201 ~ 208, T. Iwashina)	32(8)	
Same loc. (B-199, 200)	32(2)	2n = 123 (2)
<b>Kagoshima pref.</b>		
[Onejime-4] Nejime-cho, Nejime bay, on cutting slope of roadside (B-164)	32(1)	2n = 123 (1)
[Kaimon-dake-2] Yamakawa-cho, Yamakawa bay, on volcanic rock-wall in forest faced sea (B-163)	32(1)	2n = 123 (1)
[Sata-misaki-1] Sata-cho, Izashiki, on rock-wall of seaside (B-165)	32(1)	2n = ca.123 (1)
[Sata-misaki-2] Sata-cho, Shima-domari, on woody ground of seaside (B-167)	32(1)	
Same loc. (B-166)	32(1)	2n = ca.123 (1)
[Sata-misaki-3] Yamakawa-cho, Nagasaki-bana, on rock-wall of seaside (B-161, 162)	32(2)	
Same loc. (B-160)	32(1)	2n = 123 (1)

-(continued)-

## App. 3.

-(continued)-

[Yakushima-tonanbu-4] Yaku Isl., Ono-aida, on rock-wall of seaside (B-18, 19, 20, 85, 86)	32(5)	
Same loc. (B-17)	32(1)	n = 123 (1)
[Kikai-jima-1] Kikai Isl., Kikai-cho, Oasato (B-217, T. Konishi & R. Hirayama, Feb. 27, 1994)	32(1)	2n = 123 (1)
[Kikai-jima-1] Kikai Isl., Kikai-cho, Onotsu (B-218, 219, T. Konishi & R. Hirayama, Feb. 27, 1994)	32(2)	
Same loc. (B-220)	32(1)	2n = 123 (1)
[Kikai-jima-1] Kikai Isl., Kikai-cho, Urahara (B-221, 222, T. Konishi & R. Hirayama, Feb. 27, 1994)	32(2)	2n = 123 (2)
[Kikai-jima-1] Kikai Isl., Kikai-cho, Shito-oke (B-223, T. Konishi & R. Hirayama, Feb. 28, 1994)	32(1)	
[Akagi-na-4] Amami-oshima Isl., Nase-shi, Yagijima (B-214 ~ 216, T. Konishi & R. Hirayama, Feb. 25, 1994)	32(3)	
[Yama-2] Tokuno-shima Isl., Kanami-zaki (B-212, T. Konishi & R. Hirayama, Feb. 25, 1994)	32(1)	
Same loc. (B-213)	32(1)	2n = 123 (1)
[Okino-erabu-3] Okino-erabu Isl., China (B-224, 225, T. Konishi & R. Hirayama, Feb. 28, 1994)	32(2)	2n = 123 (2)
[Okino-erabu-4] Okino-erabu Isl., Saouzu (B-226, T. Konishi & R. Hirayama, Feb. 28, 1994)	32(1)	
[Yoron-to-2] Yoron Isl., Ritcho (B-209, T. Konishi & R. Hirayama, Feb. 23, 1994)	32(1)	2n = 123 (1)
[Yoron-to-2] Yoron Isl., Tujimiya, Yunnurakuen (B-210, T. Konishi & R. Hirayama, Feb. 23, 1994)	32(1)	2n = ca.121 (1)
[Yoron-to-2] Yoron Isl., Yoron-kou (B-211, T. Konishi & R. Hirayama, Feb. 23, 1994)	32(1)	2n = 123 (1)
<b>Okinawa pref.</b>		
[Okinawa-nanbu-1] Katsuren-son, White-Beach (B-10, 12)	32(2)	
Same loc. (B-11)	32(1)	2n = n = 123 (1), 19 III + 24 II + 18 I
[Kukou-jima-3] Tamagusuku-son, Gyokusen-do (calcareous cave), on rocky and woody ground (B-9, 188 ~ 190, SM74313-C, SM911201-5 ~ 10)	32(11)	
Same loc. (B-8, 187)	32(2)	n = 123 (2)
[Kukou-jima-3] Chinen-son, Kishiya (S. Matsumoto, Mar. 13, 1974)	32(2)	2n = n = 123 (2)
[Naha-2] Naha-shi, Shurei-mon (B-16, T. Nakaïke)	32(1)	
[Nanboku-daito-jima-1] Kita-daito Isl., Nagamaku, on rock-wall (B-275, T. Nakamura)	32(1)	2n = 123
[Iriomote-jima-seibu-4] Iriomote Isl., Funaura, on calcareous rock-wall of seaside (B-2, T. Konishi)	32(1)	
Same loc. (B-1)	32(1)	n = ca.123 (1)
[Iriomote-jima-hokubu-4] Iriomote Isl., Sumiyoshi (B-7, T. Nakaïke)	32(1)	
Same loc. (B-3 ~ 6)	32(4)	2n = 123 (4)
Total	115 localities (830 individuals)	82 localities (127 individuals)

\*(N): a number of individuals, s/s: spore number per sporangium (64: 64 haplo-spores, 32: 32 diplo-spores), 2n: chromosome number in mitosis, n: a number of bivalent in meiosis.

Appendix 4. List of locality and the cytological data on C type of *Cyrtomium falcatum* complex

Locality ([ ]: mapping index, C-: stock-culture number, SM: Matsumoto collection number)	Cytological Data* (N)	
	S/S	2n or n
<b>Chiba pref.</b>		
[Mobara-2] Ichinomiya-cho, on forest floor along river (S. Matsumoto, Sept. 13, 1971)	64 (2)	
[Kamogawa-1] Amatsu-kominato-cho, Mt. Kiyosumi, forest edge in valley (TBG13197)	64 (1)	
<b>Tokyo pref.</b>		
[Tokyo-tohokubu-4] Chiyoda-ku, Hibiya Park on banks of stream (S. Matsumoto, Oct. 10, 1972)	64 (12)	n = ca. 82 (3)
[Tokyo-tohokubu-4] Taito-ku, Ueno Park, on rock-wall in forest floor (SM921001-1, C-33, 34)	64 (3)	
[Tokyo-seinanbu-1] Minato-ku, Shizen-kyoiku-en, on forest floor along stream (S. Matsumoto, Jan. 20, 1973)	64 (2)	
<b>Kanagawa pref.</b>		
[Yokosuka-1] Yokosuka-shi, Kannon-zaki, on rock-wall in forest near sea (S. Matsumoto, July 14, 1971)	64 (4)	
[Misaki-1] Miura-shi, Matsuwa, on forest floor of hill side (S. Matsumoto, July 18, 1972)	64 (2)	n = 82 (1)
<b>Shizuoka pref.</b>		
[Numazu-2] Ohito-cho, Mt. Jo-yama, on forest floor of the valley (C-5)	64 (1)	
[Shimoda-1] Kawazu-cho, Onabe, on mountain slope in forest (C-22, S. Matsumoto, Nov. 4, 1974)	64 (2)	2n = 164 (1)
[Shimoda-1] Kawazu-cho, Otaki, on mountain slope in forest (S. Matsumoto, May 5, 1973)	64 (3)	
[Shimoda-2] Shimoda-shi, Shikine, Mamushiga-kubo, on rocky forest floor (C-2, 3, 23)	64 (3)	n = 82 (3)
[Shimoda-2] Shimoda-shi, Shimoda-cho, Kasuga-yama, on rocky forest floor (C-4, SM811005-4, 15, 20, SM880510-6 ~ 8)	64 (6)	
[Shimoda-2] Shimoda-shi, Soto-ura, on bank of stream (C-6)	64 (12)	2n = 164 (1)
[Shimoda-2] Shimoda-shi, Shiro-yama-koen, on rock-wall in forest floor (C-8, 25)	64 (2)	2n = 164 (1)
[Shimoda-2] Shimoda-shi, Kaki-saki, on cutting slope of roadside in forest (C-24)	64 (1)	
[Shimoda-2] Shimoda-shi, Shimoda-machi 1-chome (S. Matsumoto, Oct. 4, 1981)	64 (3)	
[Shimoda-2] Shimoda-shi, Shimoda-machi 6-chome (S. Matsumoto, Oct. 6, 1981)	64 (3)	
[Shimoda-2] Shimoda-shi, Shimoda-machi Hachiman-jinja (S. Matsumoto, Oct. 7, 1981)	64 (2)	
[Shimoda-2] Shimoda-shi, Kami-osawa to Takohma (S. Matsumoto, Oct. 7, 1981)	64 (3)	
[Shimoda-2] Shimoda-shi, mouth of Kami-osawa, left-side stream, on cutting slope of mountain road (C-39, 40)	64 (2)	
[Shimoda-2] Shimoda-shi, Naka (S. Matsumoto, Dec. 31, 1972, Oct. 11, 1981)	64 (5)	
[Shimoda-3] Matsuzaki-cho, Ikeshiro to Mt. Chokuro, on mountain slope (C-47)	64 (1)	
Same loc. (C-26)	64 (1)	2n = 164 (1)
[Shimoda-3] Nishiizu-cho, Miyagahara, on mountain slope (C-1)	64 (1)	2n = 164 (1)
[Mikomoto-jima-1] Shimoda-shi, Ora, on rocky forest floor (C-9, 11 ~ 13, 15 ~ 21, 35, 36, S. Matsumoto, Mar. 14, 1982, Oct. 4, 1981)	64 (24)	
Same locality (C-10, 14)	64 (2)	2n = 164 (2)
[Mikomoto-jima-1] Shimoda-shi, Tatado, on forest floor of the small valley (C-7)	64 (1)	2n = 164 (1)
[Mikomoto-jima-4] Minami-izu-cho, Ose, on bank of valley and forest floor (frond specimen: SM760516-5, 6, 8, 9, 11 ~ 13, 17, 31, pinna specimen: 41 samples)	64 (50)	
[Shizuoka-1] Shizuoka-shi, Hiramatsu, on artificial rock-wall near sea (SM730421-1, 2, S. Matsumoto, May 20, 1973)	64 (12)	2n = 164 (1)
[Shizuoka-2] Shizuoka-shi, Sokusawa, on rocky bank of stream (SM730712-7, 12 ~ 14)	64 (4)	
[Shizuoka-3] Shizuoka-shi, Makigaya to Ubume, on rocky mountain slope in forest (S. Matsumoto, Apr. 29, 1973, May 3, 1973)	64 (10)	2n = 164 (1)
Same loc. (SM730429-11)	64 (1)	n = 82 (1)
[Shizuoka-4] Shizuoka-shi, Sekibe, on artificial rock-wall along stream near sea (C-31)	64 (1)	n = 82, 2n = 164

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## App. 4.

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[Hamamatsu-1] Inasa-cho, Kanazashi (M. Yamamoto, Dec. 14, 1975)	64 (5)	
<b>Kyoto pref.</b>		
[Kyoto-tonanbu-3] Kyoto-shi, Kiyomizu-dera (S. Matsumoto, Jan. 15, 1973)	64 (1)	
<b>Tottori pref.</b>		
[Hamasaka-3] Iwami-cho, Uratomi-kaigan, on rocky, grassy woody grounds of seashore (SM730513-2)	64 (1)	n = 82 (1)
<b>Hiroshima pref.</b>		
[Hiroshima-2] Hiroshima-shi, Ujina-jima, on woody ground (C-32)	64 (1)	2n = 164 (1)
<b>Fukuoka pref.</b>		
[Sefuri-san-1] Nakagawa-cho, Tsukushi-yabakei, on stone wall (C-42)	64 (1)	
[Fukuoka-4] Fukuoka-shi, Jochu, on stone wall (C-43)	64 (1)	
<b>Nagasaki pref.</b>		
[Nagasaki-4] Nagasaki-shi, around of Kosedo-cho, on rock-wall and rocky, grassy, woody grounds (S. Matsumoto, Nov. 24, 1989, Nov. 26, 1989, pinna specimens)	64 (29)	
Same loc. (C-27, 29, 30)	64 (3)	2n = 164 (3)
[Nomo-zaki-3] Nomo-zaki, on cutting slope of roadside near sea (S. Matsumoto, Nov. 25, 1989, pinna specimens)	64 (3)	
[Nomo-zaki-3] Kaba Isl., Gyoja-yama to Tojinse, on mountain slope in forest (cutting slope of roadside (S. Matsumoto, Nov. 25, 1989)	64 (1)	
Same loc. (C-28)	64 (1)	2n = 164 (1)
[Tomie-3] Fukue-shi, between Osako and Kodomari (C-41)	64 (1)	
<b>Oita pref.</b>		
[Saeki-3] Honjo-mura, Onagara limestone cave, on rock-wall near stream (C-37, 38)	64 (2)	
<b>Kumamoto pref.</b>		
[Touchi-4] Itsuki-mura, Takenokawa, on calcareous rocky slope (SM750504-21, 24)	64 (2)	2n = 164 (1)
[Sajiki-3] Kuma-mura, Siroishi, Iwado-lime stone cave (SM750503-21, 22)	64 (2)	2n = 164 (1)
[Hitoyoshi-4] Hitoyoshi-shi (Mitui 1965)	64	n = 82
<b>Korea</b>		
Cheju do (Quelpart Isl.) (C-44, 45, T. Nakaïke )	64 (2)	
<b>China</b>		
Jiangsi prov., Guashan, on stone wall in administer house of Guanshan Forest Reserve (C-46)	64 (1)	
Zhejiang Prov., Zhoushan Qundao Isls, Putuo shan, on valley of Hou-ji temple (C-48 ~ 50, S. Matsumoto & J.-H. Gu)	64 (3)	
<b>Taiwan</b>		
Taitung Prov.: Tianlong Bridge (天龍吊橋), Wulu (霧鹿), Haiduan Xiang (海端鄉), alt. 750-850 m, on calcareous rock-wall (C-51)	64 (1)	
Taitung Prov.: Xhiaoguihu (小鬼湖), Beinan Xiang (卑南鄉), alt. 1600-2000 m [SM00-127, 129, Jinn-Fen Chen (陳進分)]	64 (2)	
Taitung Prov.: Lanyu Isl. [SM00-130, Jinn-Fen Chen (陳進分)]	64 (1)	
Total	49 localities (246 individuals)	19 localities (27 individuals)

\*(N): a number of individuals, s/s: spore number per sporangium (64: 64 haplo-spores), 2n: chromosome number in mitosis, n: a number of bivalent in meiosis.



Appendix 5. Locality on herbarium specimens of **A1** type having the 64 spored sporangium and the single color type of indusium in *Cyrtomium falcatum* complex

[Mapping Index]	Locality	IC*
<b>Hokkaido</b>		
[Horo-izumi-4]	Samani-cho, Horoman (Y. Takahashi, 1970, TNS)	○
[Horo-izumi-4]	The foot of Mt. Apoi, on the cliff of seaside (T. Nakai, Aug. 1928, TI)	○
[Horobetu-onsen-1]	Shiraoui-cho, Kojou-hama (M. Hara, 1973, TNS)	○
[Abuta-4]	Coast of Abuta-cho (T. Kashiwagi, 1966, TNS, TOFO)	○
[Esan-1]	Todohokke-mura, Esan (M. Hara, 1980, TNS)	○
[Esan-1]	Todohokke (Esan-misaki), among rock on the cliff faced sea (Siro Matsumoto, Aug. 13, 1967, TI)	○
[Hakodate-2]	Hakodate-shi, Tachimachi-misaki (M. Hara, 1976, TNS)	○
[Shima-kotan-2]	Iwauchi-cho, Katanakake-misaki (M. Hara, 1979, TNS)	○
[Kuoan-4]	Taisei-cho, Horokoshi-misaki (M. Hara, 1979, TNS)	○
[Toshima-oshima-2]	Matsumae-cho, Rito-kojima (K. Kimura, 1957, TNS)	○
<b>Aomori pref.</b>		
[Hachinohe-toubu-4]	Hachinohe-shi, Tanesashi (M. Neichi, 1984, TNS)	○
[Kaijo-dake-1]	Hachinohe-shi, Kane-hama (M. Neichi, 1984, TNS)	○
[Shiriyu-zaki-1]	Higashi-dori-mura, Shiriyu-zaki Lighthouse (H. Usui, 1951, TNS)	○
[Ohma-2]	Oma-cho (T. Sudo, 1972, TNS)	○
[Tappi-saki-2]	Tairadate-mura, Yazou-gama (N. Saito, 1980, TNS)	○
[Tappi-saki-3]	Minmaya-mura, Tappi-saki (N. Saito, 1972, TNS)	○
[Fukaura-2]	Iwasaki-mura, Matsu-ura (M. Neichi, 1984, TNS)	○
[Iwadate-1]	Iwasaki-mura, Itagai (N. Saito, 1970, TNS)	○
	Cited from Yamamoto & Nakaie 1988 (9 sites, 41 samples)	○
[Hachinohe-tobu-4]	Hachinohe-shi, Osuka-kaigan (A. Yamamoto & T. Nakaie, 1987, no. 6, 7, 9 ~ 11, TNS)	○
[Hachinohe-tobu-4]	Hachinohe-shi, Fukakubo-kaigan (A. Yamamoto & T. Nakaie, 1987, no. 12 ~ 16, TNS)	○
[Kaijo-dake-1]	Hachinohe-shi, Kane-hama (A. Yamamoto & T. Nakaie, 1987, no. 15 ~ 19, TNS)	○
[Mutsu-yokohama-1]	Higashi-dori-mura, Monomi-saki (A. Yamamoto & T. Nakaie, 1987, no. 44 ~ 57, TNS)	○
[Ohata-1]	Ohata-cho, Tsuriya-hama (A. Yamamoto & T. Nakaie, 1987, no. 66, TNS)	○
[Sai-4]	Sai-mura, Gankake-iwa (A. Yamamoto & T. Nakaie, 1987, no. 95, TNS)	○
[Sai-4]	Sai-mura, Iso-dani (A. Yamamoto & T. Nakaie, 1987, no. 96, 97, TNS)	○
[Tappi-saki-2]	Imabetsu-cho, Oku-hirabu (A. Yamamoto & T. Nakaie, 1987, no. 100 ~ 104, TNS)	○
[Tappi-saki-2]	Imabetsu-cho, Horotsuki-kaigan (A. Yamamoto & T. Nakaie, 1987, no. 105, 106, TNS)	○
<b>Iwate pref.</b>		
[Todoga-saki-3]	Miyako-shi, Shigemo (T. Sudo, 1985, TNS)	○
[Todoga-saki-3]	Miyako-shi, Shigemo U-iso (H. Okuyama, 1950, TNS)	○
[Kuji-3]	Kuji-shi, Samurai-hama-cho, Yoko-numa (Y. Nakajima, 1982, TNS)	○
[Kuji-4]	Kuji-shi, Samurai-hama-cho, Yoko-numa (Y. Oda 1976, TNS)	○
[Rikuchu-noda-2]	Fudai-mura (M. Takahashi, 1967, TNS)	○
[Kesen-numa-1]	Ofunato-shi, Goishi-kaigan (Koyama & Hotta, 1967, TNS)	○
<b>Akita pref.</b>		
[Fukura-3]	Kisagata-cho, Kosuna-gawa (H. Obata, 1982, TNS)	○
<b>Yamagata pref.</b>		
[Fukura-4]	Yusa-cho, Hiratsu (N. Kato, 1984, TNS)	○
[Atami-3]	Atami-cho, around Atami station (A. Yamamoto, 1981, TNS)	○
<b>Miyagi pref.</b>		
[Kinkazan-1]	Oshika-cho, Kinkazan Isl. (M. Kikuchi, 1967, TNS)	○
<b>Tokyo pref.</b>		
[Miyake-jima]	Kamitsuki-mura (Y. Jotani, 1934, TNS)	○
[Miyake-jima]	Kamitsuki-mura (K. Hayashi, 1937, TNS)	○
[Mikura-jima]	Mikura-jima-mura, Sato (Kurokawa & Tamaoki, 1975, TNS)	○

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## App. 5.

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[Mikura-jima] Mikura-jima-mura (Y. Jotani, 1934, TNS)	○
[Hachijo-jima] Hachijo-cho, Mihara-yama (H. Endo, 1983, TNS)	○
[Hachijo-shozoku-shoto] Tori-shima Isl. (I. Fujiyama, 1950, TNS)	○

**Niigata pref.**

[Kashiwazaki-4] Kashiwazaki-shi, Higashino-wa (I. Oozu, 1984, TNS)	○
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**Shizuoka pref.**

[Mikomoto-jima-2] Shimoda-shi, Mikomoto Isl. (K. Inoue, 1982, TNS)	○
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**Tottori pref.**

[Tottori-hokubu-4] Seijo-mura (N. Hiraoka, June 8, 1930, TI)	U
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No. of locality: 47

\*IC: Indusium's colour, ○ : graish white, ● : blackish, U: unknown.

Appendix 6. Locality on herbarium specimens of **A2** type having the 64 spored sporangium and the two color types of indusium in *Cyrtomium falcatum* complex

[Mapping Index]	Locality	IC*
<b>Tokyo pref.</b>		
[Hahajima-retto]	Between Sekimon-san to Kita-minato (T. Tsuyama, Apr. 4, 1936, TI).	●
[Kazan-retto]	Kita-iwo-jima Isl. (Nakai, June 1919, TI).	U
[Kazan-retto]	Kita-iwo-jima Isl., the ruins of a Ishino-mura (T. Yasui, July 10, 1986, Yasui collection)	U
[Kazan-retto]	Kita-iwo-jima Isl. (TNS456496, TNS456497)	U
<b>Kochi pref.</b>		
[Kashiwa-jima-4]	Sukumo-shi, Okino-shima (K. Yamaoka, 1980, TNS)	●
<b>Nagasaki pref.</b>		
[Tomie-3]	Fukue Isl. (in Goto Isls), southern foot of Mt. Hino-dake (M. Futoh, Apr. 11, 1956, KYO)	●
<b>Kagoshima pref.</b>		
[Sata-misaki-2]	Sata-cho, Sata-misaki (Y. Shimada, Oct. 10, 1954, KYO)	○
[Sata-misaki-3]	Yamakawa-cho, Nagasaki-bana (K. Kawahara, 1982, TNS)	○
[Nomadake-1]	Kasasa-cho, Hanayama (K. Takesako, 1977, TNS)	●
[Bo-1]	Bonotsu-cho, Kushi (K. Kawahara, 1979, TNS)	●
[Satsuma-kuro-shima]	Mishima-mura, Kuro-shima (K. Takesako, 1981, TNS)	●
[Satsuma-kuro-shima]	Kusagaki Isls. (K. Daicho, 1980, TNS)	○
[Tanega-shima-nanbu-4]	Mimami-tane-cho, Suna-saka (T. Nakaike)	○
[Yaku-shima-seihokubu-2]	Kamiyaku-cho, Nagata (M. Kawabata, 1967, TNS)	○
[Yaku-shima-seinanbu-1]	Yaku-cho, Nakama (M. Kawabata, 1959, TNS)	○
[Yaku-shima-seinanbu-1]	Yaku-cho, Kurio-tsukasaki (M. Kawabata, 1959, TNS)	○
[Yaku-shima-seinanbu-1]	Yaku Isl., Kurio, around the river mouth of Kurio-gawa, alt. 0-20 m (T. Yamazaki, H. Ohba, J. Murata & S. Akiyama, 2295, TI)	○
[Yakushima-seinanbu-2]	Yaku-cho, Yudomari (M. Kawabata, 1959, TNS)	○
[Okino-erabu-4]	Okino-erabu Isl., China-cho, Kami-shiro, along mountain path (M. Tagawa & K. Iwatsuki, Aug. 2, 1958, KYO)	○
[Yoron-to-2]	Yoron-cho (N. Kurosaki, Mar. 28, 1966, KYO)	U
[Yoron-to-2]	Yoron-cho, Imae (K. Takesako, 1984, TNS)	●
<b>Okinawa pref.</b>		
[Oku-2]	Kunigami-son, Mt. Hetona (R. Yoroi, 1973, TNS)	●
[Oku-2]	Kunigami-son. (M. Takara & T. Takara, 1980, TNS)	○
[Oku-2]	Kunigami-son, near sea shore of Oku (K. Shimabuku, 1973, TNS)	●
[Oku-4]	Kunigami-son, Ibu (M. Takara & T. Takara, 1981, TNS)	●
[Hetona-1]	Kunigami-son, Henoki (M. Takara & T. Takara, 1981, TNS)	○
[Hetona-2]	Kunigami-son, Noha (M. Takara & T. Takara, 1982, TNS)	○
[Hetona-3]	Ogimi-son, Nejime (M. Kawabata, 1985, TNS)	○
[Kunigami-taira-1]	Higashi-son, Izena (M. Takara & T. Takara, 1984, TNS)	○
[Kunigami-taira-4]	Nago-shi, Meiji-yama (M. Takara & T. Takara, 1982, TNS)	○
[Iheya-jima]	Iheya Isl. (T. Takara, 1982, TNS)	○
[Nakasone-4]	Nakijin-son, Ama-soko (M. Takara & T. Takara, 1977, TNS)	●
[Jejima-2]	Ie-jima Isl., Mt. Shiro-yama (K. Shimabuku, May 4, 1974, RYU, KYO, TNS)	●
[Nago-3]	Sezoko Isl. (K. Shimabuku, Apr. 19, 1974, RYU, TNS)	●
[Nago-3]	Sezoko Isl. (M. Takara & T. Takara, 1977, TNS)	●
[Tonaki-jima-1]	Aguni Isl. (T. Takara, 1982, TNS)	○
[Tonaki-jima-2]	Tonaki Isl. (T. Takara, 1982, TNS)	○
[Kerama-retto-1]	Tokashiki Isl., Tokashiki (M. Takara & T. Takara, 1978, TNS)	●
[Kerama-retto-1]	Tokashiki Isl. (Y. Miyagi & Oyadomari, May 4, 1973, Y. Miyagi & Takashima, May 16-19, 1974, RYU)	●
[Kerama-retto-3]	Zamami Isl. (M. Takara & T. Takara, 1980, TNS)	●
[Kerama-retto-3]	Zamami Isl. (K. Shimabuku, July 1, 1972, RYU)	○
[Kerama-retto-3]	Kerama Isls., Aka Isl. (Y. Miyagi & Kaba-shima, May 23-26, 1974, RYU)	●
[Kerama-retto-3]	Kerama Isls., Aka Isl. (K. Shimabuku, Nov. 27, 1978, RYU)	○
[Kerama-retto-4]	Geruma Isl. (K. Shimabuku, 1977, TNS)	●

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## App. 6.

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[Kerama-retto-4] Kerama Isls., Geruma Isl. (Y. Miyagi, no. 7829, no. 7591, RYU)	○
[Miyako-jima-3] Mt. Oshikawa (K. Shimabuku, 1974, TNS)	●
[Yonaguni-jima] Yonaguni Isl., Agari-saki (San aisati) (K. Shimabuku, Oct. 3, 1973, RYU)	○
[Yonaguni-jima] Kubura (K. Tamaoki, 1973, TNS)	●
[Yonaguni-jima] Kubura (M. Furuse, Sept. 28, 1972, RYU)	○

No. of locality: 49

\*IC: Indusium's colour, ○ : graish white, ● : blackish, U: unknown.

Appendix 7. Locality on herbarium specimens of **B** type having the 32 spored sporangium and the two color types of indusium in *Cyrtomium falcatum* complex

[Mapping Index]	Locality	IC*
<b>Aomori pref.</b>		
[Shiriyazaki-2]	Higashi-dori-mura, Shirikari (T. Sudo, 1972, TNS)	●
[Tappisaki-4]	Kodomari-mura, Kayobe-sawa (N. Saito, 1980, TNS)	○
	(Shimokita-hanto, Shiriya-zaki (cited from Yamamoto & Nakaïke, 1988))	U
		U
<b>Iwate pref.</b>		
[Rikutyu-noda-3]	Kuji-shi, Ube-cho, Kosode (Y. Oda, 1977, TNS)	●
[Iwaizumi-1]	Tanohata-mura, Raga (Y. Oda, 1981, TNS)	U
[Taro-2]	Taro-cho, Masaki (T. Sudo, 1985, TNS)	U
[Otsuchi-1]	Yamada-cho, Funakoshi-oshima (M. Takahashi, 1978, TNS)	●
[Ayari-3]	Sanriku-cho, Yoshi-hama (Y. Takano, 1983, TNS)	●
<b>Akita pref.</b>		
[Iwadate-2]	Yamori-cho, Takinoma-kaigan (S. Okita, 1982, TNS)	○
[Funakawa-4]	Oga peninsula, Ohama (J. Takada, 1983, TNS)	○
[Kisakata-1]	Kaneura-cho, Kaneura (J. Takada, 1983, TNS)	○
[Toga-2]	Oshika-shi, Kamo-aosuna (Y. Horii, 1979, TNS)	U
<b>Yamagata pref.</b>		
[Fukura-1]	Yusa-cho, Meshika (N. Kato, 1984, TNS)	○
[Fukura-2]	Yusa-cho, Fukura (N. Kato, 1984, TNS)	○
[Sakata-3]	Yusa-cho, Hiko (N. Kato, 1984, TNS)	○
[Tobishima]	Sakata-shi, Tobi-shima Isl. (N. Kato, 1967, TNS)	○
[Mitsuse-1]	Tsuruoka-shi, Kamo (N. Kato, 1984, TNS)	●
[Mitsuse-1]	Tsuruoka-shi, Yuno-hama (T. Nagasawa, 1906, TNS)	●
[Mitsuse-2]	Tsuruoka-shi, Yura (N. Kato, 1984, TNS)	○
[Atami-3]	Atami-cho, Kuretsubo (N. Kato, 1984, TNS)	●
[Atami-4]	Atami-cho, Nezuga-seki (N. Kato, 1984, TNS)	●
<b>Miyagi pref.</b>		
[Kesen-numa-1]	Karakuwa-cho, Tate (Y. Nakajima, 1980, TNS)	●
[Kesen-numa-1]	Hirota-cho, Aomatsu Isl. (M. Takahashi, 1978, TNS)	●
[Kesen-numa-2]	Karakuwa-cho, Misaki (Y. Nakajima, 1979, TNS)	●
[Yori-iso-4]	Oshika-cho, Yori-iso (M. M. Takeichi, 1981, TNS)	●
[Yori-iso-4]	Onagawa-cho, E-jima Isl. (Y. Ueno, 1970, TNS)	●
[Kinkazan-1]	Oshika-cho, Ohara-hama (K. Matsunaga, 1979, TNS)	●
[Kinkazan-3]	Oshika-cho, Amiji Isl. (K. Takahashi, 1976, TNS)	●
[Shiogama-3]	Shichiga-hama, Hanabuchi-hama (O. Asano, 1981, TNS)	●
<b>Fukushima pref.</b>		
[Onahama-3]	Iwaki-shi, Ona-hama, Otsurugi (S. Sugano, 1982, TNS)	○
<b>Ibaraki pref.</b>		
[Otsu-3]	Kita-ibaraki-shi, Tenhi-san (I. Otani, 1978, TNS)	○
[Choshi-3]	Hasaki-cho, Yatabe (M. Yasu & N. Wada, 1976, TNS)	●
[Takahagi-2]	Juo-cho, Ishi-hama (N. Wada, 1970, TNS)	○
[Hitachi-1]	Hitachi-shi, Higashi-cho (N. Wada, 1975, TNS)	○
[Hitachi-2]	Hitachi-shi, Mizuki-cho, Mizuki-kaigan (N. Wada, 1975, TNS)	●
[Naka-minato-4]	Naka-minato-shi, Ajiga-ura (M. Yasu, 1980, TNS)	●
[Isohama-3]	Oarai-cho, Narita-cho (K. Kawana, 1980, TNS)	●
[Hokota-3]	Taiyo-mura, Kami-sawa (Y. Nakasaki, 1979, TNS)	●
[Itako-1]	Kashima-cho, Kashima shrine (I. Ooya, 1978, TNS)	●
[Itako-3]	Itako-cho, Mizuhara (N. Wada, 1973, TNS)	●
[Mitsukaido-4]	Iwai-shi, Arakyo, Amida temple (Y. Kimizuka, 1980, TNS)	●

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## App. 7.

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<b>Tochigi pref.</b>	
[Utsunomiya-2] Utsunomiya-shi, Oso, Onishiki bridge, right side of the river (M. Usui, 1983, TNS)	●
[Oyama-3] Oyama-shi, Shiroyama-cho (M. Usui, 1981, TNS)	●
<b>Saitama pref.</b>	
[Omiya-3] Ina-cho, Maru-yama (M. Shimosegawa, 1983, TNS)	○
[Tokyo-seihokubu-1] Koshigaya-shi, Mitsukata-guchi (M. Shimosegawa, 1982, TNS)	○
<b>Chiba pref.</b>	
[Youka-ichiba-1] Choshi-shi, Shimousa-toyosato (K. Nakamura, 1983, TNS)	●
[Togane-1] Naruto-cho, Namikiri (K. Nakamura, 1982, TNS)	●
[Togane-4] Oami-shirasato-cho (K. Nakamura, 1982, TNS)	○
[Mobara-3] Mobara-shi, Honno, Takino-tani (K. Nakamura, 1983, TNS)	○
[Katsura-3] Katsura-shi, Ubara (K. Kawana, 1979, TNS)	○
[Ryugasaki-4] Abiko-shi, Neto-shinden (Y. Saito, 1982, TNS)	○
[Kamogawa-1] Amatsu-kominato-cho, Hama-ogi (Y. Saito, 1982, TNS)	●
[Tateyama-2] Shirahama-cho, Kawashimo (K. Kawana, 1980, TNS)	●
<b>Tokyo pref.</b>	
[Tokyo-seihokubu-2] Bunkyo-ku, Mejiro-dai (M. Shimosegawa, 1984, TNS)	●
[Oshima] Oshima-cho, Okada (K. Kumakiri, 1979, TNS)	○
[Toshima] Toshima-mura (K. Tamaki, 1975, TNS)	○
[Nii-jima] Nii-jima, Moto-mura, Omi-yama (H. Yokouchi, 1981, TNS)	○
[Miyake-jima] Miyake-mura, Tsubota (A. Yamamoto, 1981, TNS)	○
[Hachijo-jima] Hachijo-cho, Mihara-yama (H. Endo, 1983, TNS)	○
[Hachijo-jima] Hachijo Isl. (K. Shirai, 1887, TNS)	●
[Hachijo-jima] Hachijo Isl. (K. Hayashi, 1927, TNS)	○
[Hachijo-jima] Hachijo Isl. (K. Hayashi, 1928, TNS)	○
[Hachijo-syozoku-syoto] Aoga-shima Isl., Ikeno-sawa (M. Kato & E. Miki, 1977, TNS)	○
[Hachijo-syozoku-syoto] Tori-shima Isl., Otoko-hama (Y. Jotani, 1961, TNS)	○
<b>Kanagawa pref.</b>	
[Yokohama-1] Yokohama-shi, Naka-ku, Noge-cho (T. Hino, 1983, TNS)	●
[Yokosuka-1] Yokohama-shi, Kanazawa-ku, Nojima-cho (E. Fukushi, 1982, TNS)	○
[Misaki-1] Miura-shi, Tsurugi-saki (H. Hirabayashi, 1978, TNS)	●
[Misaki-3] Miura-shi, Moro-iso (M. Mase, 1977, TNS)	○
[Hiratsuka-1] Fujisawa-shi, Eno-shima (M. Mineyama, 1979, TNS)	○
[Hiratsuka-1] Fujisawa-shi, Eno-shima (T. Yamagata, 1952, TNS)	●
[Hiratsuka-3] Oiso-cho, Ikusawa (K. Tanaka, 1981, TNS)	○
<b>Niigata pref.</b>	
[Sasagawa-2] Sanpoku-cho, Hama-shinpo (S. Sugawara, 1982, TNS)	○
[Awashima-1] Awashima-ura-mura, Kamatani to Hatiman-bana (T. Nakaike, 1982, TNS)	○
[Kamo-4] Shimoda-mura, Yagi-bana (T. Takahashi, 1982, TNS)	○
[Yahiko-3] Maki-cho, Kakuta-misaki (T. Takahashi, 1981, TNS)	○
[Kashiwazaki-3] Kashiwazaki-shi, Miyakawa (S. Sugawara, 1984, TNS)	○
[Anegasaki-1] Anegasaki-cho, Kamiwa (I. Ootu, 1984, TNS)	○
[Itoigawa-1] Nou-cho (T. Iwano, 1948, TNS)	○
[Washizaki-2] Ryotu-shi, Waki (M. Saito, 1979, TNS)	○
[Washizaki-3] Aikawa-cho, Seki, Kanto-misaki (M. Saito, 1979, TNS)	●
[Ryotsu-2] Ryotsu-shi, Shii-domari (M. Saito, 1980, TNS)	○
[Ryotsu-3] Ryotsu-shi, Shirase (M. Saito, 1978, TNS)	○
[Aikawa-1] Aikawa-cho, Katabe (M. Saito, 1979, TNS)	○
[Aikawa-4] Aikawa-cho (M. Saito, 1978, TNS)	○
[Kawarada-1] Sawata-cho, Futami (M. Saito, 1983, TNS)	○
[Ogi-3] Ogi-cho, Sawasaki (M. Saito, 1979, TNS)	●

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## App. 7.

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<b>Toyama pref.</b>	
[Tomari-3] Asahi-cho, Miyazaki (T. Ooshima, 1982, TNS)	●
[Abuga-shima-3] Himi-shi, Nakata to Nakanami (T. Ooshima, 1982, TNS)	○
[Abuga-shima-4] Himi-shi, Kosakai (S. Komaki, 1981, TNS)	○
<b>Ishikawa pref.</b>	
[Suzu-misaki-2] Suzu-shi, Kiura (S. Komaki, 1974, TNS)	○
[Suzu-misaki-4] Suzu-shi, Takaya (S. Komaki, 1975, TNS)	●
[Noto-iida-3] Suzu-shi, Kodomari (S. Kodomari, 1974, TNS)	○
[Noto-iida-4] Uchiura-cho, Kurin (S. Komaki, 1981, TNS)	●
[Horyu-zan-1] Suzu-shi, Nagahashi (S. Komaki, 1975, TNS)	●
[Horyu-zan-2] Uchiura-cho, Shika-domari (S. Komaki, 1979, TNS)	○
[Horyu-zan-3] Wajima-shi, Sosoki (S. Okuyama, 1960, TNS)	○
[Ushitsu-1] Noto-cho, Ushitsu (S. Komaki, 1981, TNS)	○
[Ushitsu-3] Noto-cho, Hanami (S. Komaki, 1981, TNS)	○
[Ushitsu-4] Anamizu-cho, Kabuto (S. Komaki, 1981, TNS)	●
[Oguchi-seto-4] Nanao-shi, Iori-cho (S. Komaki, 1981, TNS)	●
[Abuga-shima-3] Nanao-shi, Odomari (S. Koaki, 1972, TNS)	○
[Wajima-2] Wajima-shi, Okazaki (S. Komaki, 1974, TNS)	○
[Wajima-3] Wajima-shi, Hekura Isl. (S. Komaki, 1979, TNS)	○
[Wajima-3] Wajima-shi, Nanatsu-shima, Oshima Isl. (S. Komaki, 1978, TNS)	○
[Anamizu-2] Anamizu-cho, Kanami (S. Komaki, 1981, TNS)	●
[Nanao-1] Notojima-cho, Mukan (S. Komaki, 1981, TNS)	○
[Nanao-2] Tatsuru-hama-cho, Kawajiri (S. Komaki, 1981, TNS)	●
[Nanao-4] Shika-cho, Abuya (S. Komaki, 1981, TNS)	●
[Himi-4] Hagui-shi, Ichinomiya-cho (S. Komaki, 1981, TNS)	●
[Kenchi-1] Monzen-cho, Kaiso (S. Komaki, 1978, TNS)	○
[Kenchi-2] Togi-cho, Shishizu (S. Komaki, 1981, TNS)	○
[Togi-1] Togi-cho, Ikigami (S. Komaki, 1981, TNS)	○
[Togi-2] Shika-cho, Akazumi (S. Komaki, 1978, TNS)	●
[Tsubata-1] Takamatsu-cho, Takamatsu (S. Komaki, 1981, TNS)	●
[Tsubata-2] Nanatsuka-cho, Shirao (S. Komaki, 1981, TNS)	●
[Kanazawa-2] Kanazawa-shi, Kanazawa castle (S. Komaki, 1981, TNS)	●
[Komatsu-4] Kaga-shi, Hashidate (S. Komaki, 1981, TNS)	●
<b>Fukui pref.</b>	
[Fukui-3] Fukui-shi, Ayukawa (A. Komaki, 1982, TNS)	○
[Umeura-1] Echizen-cho, Tamagawa (H. Haneda, 1982, TNS)	○
[Obama-3] Takahama-cho, Wakasa-wada (S. Watanabe, 1980, TNS)	○
<b>Shizuoka pref.</b>	
[Atami-2] Atami-shi, Hatsu-shima Isl. (T. Shimakawa, 1985, TNS)	○
[Ito-1] Ito-shi, Kawana bay (Y. Kimizuka, 1978, TNS)	○
[Ito-1] Ito-shi, Kusumi, Shiofuki-zaki (A. Suzuki, 1980, TNS)	○
[Ito-2] Ito-shi, Jogasaki-kaigan (T. Okawa, 1974, TNS)	○
[Ito-4] Higashi-izu-cho, Okawa (T. Shimakawa, 1981, TNS)	○
[Inatori-3] Higashi-izu-cho, Inatori (A. Suzuki, 1977, TNS)	●
[Inatori-3] Higashi-izu-cho, Atagawa (H. Okuyama, 1956, TNS)	○
[Inatori-4] Kawazu-cho, Mitaka (T. Sato, 1982, TNS)	○
[Gotenba-4] Numazu-shi, Momozawa valley (T. Hosokura, 1984, TNS)	○
[Numazu-2] Nirayama-cho, Moriyama (A. Suzuki, 1980, TNS)	●
[Numazu-4] Numazu-shi, Ose-zaki (A. Suzuki, 1976, TNS)	○
[Shuzenji-3] Heta-mura, Ida (T. Hosokura, 1974, TNS)	●
[Shimoda-2] Shimoda-shi, Shirahama, Mt. Takane (M. Sakakibara, 1973, TNS)	●
[Shimoda-3] Nishi-izu-cho, Dogashima-onsen (Y. Kimizuka, 1983, TNS)	○
[Mikomoto-jima-1] Shimoda-shi, Suzaki (T. Sato, 1983, TNS)	●
[Mikomoto-jima-3] Minami-izu-cho, Iruma (T. Sato, 1981, TNS)	○

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[Shizuoka-4] Yaizu-shi, Taira (T. Sugino, 1980, TNS)	○
[Shizuoka-4] Shizuoka-shi, Okuzure (M. Nakagawa, 1979, TNS)	●
[Omae-zaki-2] Omaezaki-cho, Omaezaki (I. Yamashita, 1963, TNS)	●
[Hamamatsu-1] Hamamatsu-shi, Kurematsu-cho (T. Nakura, 1982, TNS)	●
[Hamamatsu-4] Kosai-shi, Moto-cho (T. Sugino, 1983, TNS)	●

**Aichi pref.**

[Toyohashi-3] Gamagori-shi, Sagara-cho, Kannon-do (K. Inugai, 1980, TNS)	●
[Toyohashi-4] Tahara-cho, Haze (K. Inugai, 1980, TNS)	●
[Tahara-3] Tahara-cho, Joho temple (K. Inugai, 1980, TNS)	●
[Toyota-3] Nagoya-shi, Tenpaku-ku, Araiike (M. Fukuhara, 1985, TNS)	●
[Okazaki-2] Nishio-shi, Kami-hasumi-cho (K. Inugai, 1982, TNS)	○
[Okazaki-3] Chiryu-shi, Nishinaka-cho (K. Inugai, 1979, TNS)	○
[Gamagori-3] Kira-cho, Tshira (K. Inugai, 1979, TNS)	○
[Gamagori-4] Minami-chita-cho, Himaka Isl. (K. Inugai, 1981, TNS)	○
[Irakozaki-1] Atsumi-cho, Senfuku temple (K. Inugai, 1980, TNS)	○
[Irakozaki-3] Atsumi-cho, Yamada (K. Inugai, 1980, TNS)	●
[Gihu-2] Inuyama-shi, Zenshi-no (M. Fukuhara, 1977, TNS)	●
[Nagoya-nanbu-2] Tokai-shi, Arao-cho, Kan-non temple (K. Inugai, 1980, TNS)	○
[Nagoya-nanbu-4] Yatomi-cho, Masaki (K. Inugai, 1983, TNS)	○
[Handa-2] Handa-shi, Hakusan-cho (K. Inugai, 1980, TNS)	●
[Morozaki-1] Mihama-cho, Kowa (K. Inugai, 1979, TNS)	●
[Morozaki-3] Mihama-cho, Noma (K. Inugai, 1979, TNS)	●

**Mie pref.**

[Toshi-2] Toba-shi, Toshi Isl. (M. Inada, 1953, TNS)	○
[Namikiri-1] Ago-cho, Ichigo (H. Yamauchi, 1982, TNS)	●
[Namikiri-3] Daio-cho, Funakoshi (H. Yamauchi, 1983, TNS)	●
[Nieura-1] Nansei-cho, Hasama (H. Yamauchi, 1981, TNS)	●
[Shima-katsu-ura-3] Kii-nagashima-cho, Oshima (Y. Higuchi, 1972, TNS)	●
[Shima-katsu-ura-4] Owase-shi, Kukizaki (Y. Higuchi, 1958, TNS)	●
[Owase-2] Owase-shi, Shirahama (R. Ito, 1982, TNS)	●
[Kimoto-4] Mihama-cho, Kaminoki, Fudo-dani (H. Manago, 1982, TNS)	○
[Atawa-3] Kihou-cho, Ida (Y. Nakamura, 1982, TNS)	●
[Atawa-4] Udono-mura (Y. Nakanura, 1982, TNS)	●

**Wakayama pref.**

[Singu-4] Kumanogawa-cho, Oguchi-unehata (K. Oohora, 1979, TNS)	●
[Nachi-katsu-ura-1] Nachi-katsu-ura-cho, Katsu-ura (K. Oohora, 1980, TNS)	●
[Kushimoto-3] Kushimoto-cho, Oshima-kashino (H. Manago, 1975, TNS)	●
[Kurusu-gawa-1] Daito-mura, Tomisato, Shimo-kawakami (H. Manago, 1971, TNS)	○
[Tanami-1] Kushimoto-cho, Tanami (H. Manago, 1975, TNS)	●
[Tanabe-3] Minamigawa-mura, Nishi-honjo, Suga shrine (H. Manago, 1976, TNS)	●
[Kainan-4] Arita-shi, Miyazaki-cho, Yagi (H. Manago, 1978, TNS)	●
[Gobo-4] Hidaka-cho, Ao (H. Manago, 1983, TNS)	●
[Inami-1] Inami-cho, Kirime, Nawashiro-gawa-dani (H. Manago, 1976, TNS)	●

**Kyoto pref.**

[Kyoto-seinanbu-1] Obarano-mura, Sakamoto (H. Yamamoto, 1933, TNS)	●
[Shioe-2] Amino-cho, Shioe (H. Endo, 1983, TNS)	○

**Hyogo pref.**

[Takasago-1] Izumi-mura, Oshima (H. Yamamoto, 1938, TNS)	●
[Takasago-4] Takasago-shi, Sono, on bank near coast (M. Imada, 1957, TNS)	●
[Himeji-4] Ie-shima-cho, Ie-shima, Maura (N. Kurosaki, 1989, TNS)	●

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App. 7.

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<b>Tottori pref.</b>		
[Kurayoshi-1] Hawai-cho, Kami-hashizu (A. Tanaka, 1983, TNS)		●
[Yonago-2] Mizoguchi-cho, Udai (M. Aoto, 1984, TNS)		●
<b>Shimane pref.</b>		
[Gotsu-2] Gotsu-shi, Kato (K. Oka, 1979, Y)		●
[Hamada-3] Hamada-shi, Shomokou-cho, Tatamiga-ura (K. Oka, 1979, Y)		U
[Urago-4] Oki Isl. Chibu-mura, Ninpu (K. Oka, 1967, Y)		○
<b>Okayama pref.</b>		
[Banshu-akao-3] Bisen-shi, Yaki-yama (K. Morimoto, 1984, TNS)		●
[Shusou-4] Saeki-cho, Shioda (Y. Obata, 1984, TNS)		●
[Tamano-1] Tamano-shi, Nagai-ue (Y. Obata, 1984, TNS)		●
[Tamano-3] Kurashiki-shi, Mukuchi Isl. (T. Saito, 1985, TNS)		●
[Tamashima-2] Kurashiki-shi, Tsurajima-cho, Heratori shrine (K. Oka, 1982, TNS)		○
[Yosejima-1] Kurashiki-shi, Shimo-mizu-shima (Y. Obata, 1985, TNS)		●
<b>Hiroshima pref.</b>		
[Ihara-4] Fukuyama-shi, Gobun-cho (T. Takeda, 1976, TNS)		●
[Fukuyama-1] Fukuyama-shi, Tajiri-cho (T. Takeda, 1976, TNS)		○
[Fukuyama-2] Fukuyama-shi, Hashiri Isl. (T. Takeda, 1975, TNS)		●
[Fukuyama-3] Fukuyama-shi, Akasaka-cho, Suzutani (T. Takeda, 1977, TNS)		●
[Fukuyama-4] Utsumi-cho, Tajima (T. Takeda, 1975, TNS)		○
[Onomichi-2] Mihara-shi, Kihara-cho, Hachiga-mine (T. Takeda, 1975, TNS)		●
[Onomichi-4] Mihara-shi, Saki-shima, Mukoda (T. Takeda, 1977, TNS)		○
[Habu-1] Inno-shima-shi, Muku-ura (T. Takeda, 1975, TNS)		●
[Habu-3] Setoda-cho, Fukuda (T. Takeda, 1975, TNS)		●
[Imabari-seibu-3] Toyohama-cho, Ohama (T. Takeda, 1976, TNS)		●
[Kure-2] Gamakari-cho, Tado (T. Takeda, 1974, TNS)		●
[Kurahashi-jima-3] Kurahashi-cho, Uwaki-machi (T. Takeda, 1976, TNS)		●
[Kurahashi-jima-4] Kurahashi-cho, Shika-jima (T. Takeda, 1976, TNS)		○
[Itsuku-shima-1] Eda-jima-cho, Shoyo (T. Takeda, 1976, TNS)		●
[Otake-2] Otake-shi, Mae-ii-dani (T. Takeda, 1978, TNS)		●
<b>Yamaguchi pref.</b>		
[Hashira-jima-2] Iwakuni-shi, Hotaka Isl. (A. Minami & S. Umemoto, 1988, Y)		●
[Hashira-jima-2] Iwakuni-shi, Akijo Isl. (A. Minami & S. Umemoto, 1989, Y)		●
[Kuga-1] Towa-cho, Mitsu Isl. (A. Minami, 1988, Y)		○
[Kuga-1] Towa-cho, Uchi-iri (A. Minami, 1980, TNS)		●
[Kuga-3] Iwakuni-shi, Kurakake Isl. (A. Minami & S. Umemoto, 1988, Y)		●
[Kuga-3] Iwakuni-shi, Kuro-shima Isl. (T. Nakamura, 1984, Y)		U
[Kuga-4] Towa-cho, north of Mamiya Isl. (A. Minami, 1989, Y)		●
[Kuga-4] Tachibana-cho, Tatsu-jima Isl. (A. Minami, 1979, Y)		○
[Ao-shima-1] Towa-cho, Ominase Isl. (A. Minami, 1980, TNS)		●
[Iwakuni-2] Yanai-shi, Hizumi, Nakayama (A. Minami, 1980, TNS)		●
[Murotsu-1] Yanai-shi, Hando Isl. (A. Minami, 1989, Y)		●
[Murotsu-4] Kamino-seki-cho, Uwa-jima Isl. (A. Minami, 1989, Y)		○
[Iwai-jima] Kamino-seki-cho, Ko-jima Isl. (A. Minami, 1989, Y)		●
[Iwai-jima] Kamino-seki-cho, Iwai Isl. (A. Minami, 1980, TNS)		○
[Susa-3] Susa-cho, Takayama (S. Miyake, 1963, Y)		●
[Susa-4] Susa-cho, San-ya (A. Minami, 1982, Y)		●
[Hofu-2] Shin-nanyou-shi, Kurokami Isl. (A. Minami, 1979, Y)		●
[Mishima-1] Mishima-mura (K. Oka, 1951, Y)		●
[Ube-1] Onoda-shi, Motoyama-zaki (S. Miyake, 1971, Y)		●
[Ube-1] Onoda-shi, Ryuo-zan (T. Yamada, 1976, Y)		○
[Agawa-4] Hohoku-cho, Tsunojima (S. Miyake, 1956, Y)		●
[Yasuoka-2] Shimono-seki-shi, Yoshimi (S. Miyake, 1956, Y)		●

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**Tokushima pref.**

- [Awa-tomioka-1] Haneno-ura-cho, Kannon-yama (T. Nakayama, 1979, TNS) ○  
 [Hiwasa-1] Yuki-cho, Abu (T. Nakayama, 1980, TNS) ○  
 [Hiwasa-4] Hiwasa-cho, Okugata (T. Nakayama, 1977, TNS) ●  
 [Kou-ura-1] Mugi-cho, Oshima Isl. (K. Abe, 1933, TNS) ●  
 [Kou-ura-4] Shishikui-cho, Takega-shima Isl. (T. Nakayama, 1971, TNS) ●

**Kagawa pref.**

- [Sanbon-matsu-2] Hiketa-cho, Homareda shrine (S. Mita, 1976, TNS) ●  
 [Takamatsu-1] Tonosho-cho, Fuchizaki shrine (S. Mita, 1976, TNS) ○  
 [Takamatsu-4] Takamatsu-shi, Yashima Isl. (S. Mita, 1979, TNS) ●  
 [Takamatsu-nanbu-3] Takamatsu-shi, Mineyama (S. Mita, 1983, TNS) ●  
 [Tamano-1] Naoshima-cho, Nao-shima Isl. (Y. Kimizuka, 1984, TNS) ●  
 [Marugame-3] Marugame-shi, Iino-cho, Mt. Iino (S. Mita, 1983, TNS) ●  
 [Nio-2] Takuma-cho, Mt. Myoken (S. Mita, 1976, TNS) ●  
 [Kannon-ji-3] Kannon-ji-shi, Ibuki Isl. (Y. Kimizuka, 1981, TNS) ●

**Ehime pref.**

- [Uo-jima-4] Uo-jima-mura, Uo-jima Isl. (Y. Kimizuka, 1981, TNS) ●  
 [Imabari-tobu-4] Imabari-shi, Imabari castle (Y. Kimizuka, 1981, TNS) ●  
 [Matsuyama-hokubu-3] Hojo-shi, Kashima (Y. Kimizuka, 1981, TNS) ●  
 [Gunchu-4] Futami-cho, Karazaki (M. Hyoudo, 1982, TNS) ●  
 [Sukumo-3] Nishiumi-cho, around Funakoshi (M. Hyoudo, 1981, TNS) ●  
 [Sukumo-4] Nishiumi-cho, Shimohisaya (Y. Kimizuka, 1985, TNS) ○  
 [Uogami-yama-1] Tsushima-cho, Nezumi-naki, Nagao (Y. Kimizuka, 1985, TNS) ●  
 [Iyo-kashima-1] Nishiumi-cho, Gongen-yama (Y. Kimizuka, 1985, TNS) ●  
 [Iyo-kashima-2] Nishiumi-cho, Fuku-ura to Komo-misaki (Y. Kimizuka, 1985, TNS) ●

**Kochi pref.**

- [Nabari-4] Muroto-shi, Hane-cho, Hanezaki (Y. Yamamoto, 1983, TNS) ●  
 [Muroto-misaki-1] Muroto-shi, Mutsugaya (K. Yamaoka, 1979, TNS) ●  
 [Muroto-misaki-3] Muroto-shi, Gyoto-zaki (K. Yamaoka, 1982, TNS) ●  
 [Tei-4] Aki-shi, Akano (Y. Yamamoto, 1984, TNS) ○  
 [Aki-1] Tano-cho, Ono (Y. Yamamoto, 1982, TNS) ●  
 [Kubokawa-1] Naka-tosa-cho, Yamauchi (S. Miyazaki, 1979, TNS) ●  
 [Kubokawa-2] Naka-tosa-cho, Yaika (S. Miyazaki, 1985, TNS) ●  
 [Tosa-saga-1] Saga-cho, Nono-ura (K. Yamaoka, 1979, TNS) ●  
 [Tanono-3] Towada-mura, Shirai-gawa (S. Miyazaki, 1985, TNS) ●  
 [Tosa-nakamura-1] Nakamura-shi, Taga (S. Miyazaki, 1985, TNS) ●  
 [Tosa-shimizu-2] Tosa-shimizu-shi, Matsuo (K. Yamaoka, 1981, TNS) ●  
 [Tosa-shimizu-3] Tosa-shimizu-shi, Misaki (K. Yamaoka, 1981, TNS) ●  
 [Sukumo-2] Sukumo-shi, Tano-ura (K. Yamaoka, 1983, TNS) ●  
 [Kashiwa-jima-1] Otsuki-cho, Daido-kaigan (K. Yamaoka, 1980, TNS) ●

**Fukuoka pref.**

- [Ube-3] Kita-kyushu-shi, Moji-ku, Shiranoe (S. Tsutsui, 1983, TNS) ○  
 [Ube-4] Kita-kyushu-shi, Moji-ku, Hishakuda (S. Kobayashi, 1982, TNS) ○  
 [Minoshima-4] Gyobashi-shi, Minoshima (S. Kobayashi, 1982, TNS) ○  
 [Nakatsu-3] Shiida-cho, Tsunashiki-tenmangu shrine (S. Tsutsui, 1985, TNS) ●  
 [Kokura-4] Kita-kyushu-shi, Wakamatsu-ku, Aikawa (S. Tsutsui, 1979, TNS) ●  
 [Orio-1] Kita-kyushu-shi, Wakamatsu-ku, Shiro-shima, Otoko Isl. (S. Tsutsui, 1984, TNS) ●  
 [Orio-4] Genkai-cho, Kyodomari (S. Tsutsui, 1977, TNS) ●  
 [Amaki-3] Tsukushino-shi, Kamishima (H. Inoue, 1978, TNS) U  
 [Kaminato-2] Oshima-mura, Kayo (N. Inoue, 1982, TNS) ●  
 [Tsuyazaki-1] Tsuyazaki-cho, Watari (S. Tsutsui, 1983, TNS) ●  
 [Tsuyazaki-2] Shingu-cho, Minato (S. Tsutsui, 1974, TNS) ●  
 [Tsuyazaki-4] Fukuoka-shi, Higashi-ku, Shiga Isl., Katsuma (S. Tsutsui, 1982, TNS) ●

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[Fukuoka-2] Fukuoka-shi, Chuo-ku, Fukuoka castle (S. Tsutsui, 1978, TNS)	○
[Sehuri-san-3] Fukuoka-shi, Hayara-ku, Uchino (S. Tsutsui, 1965, TNS)	●
[Saga-2] Chikugo-shi, Mizuta, Kamikita-shima (S. Masumura, 1966, TNS)	○
[Genkai-jima-2] Fukuoka-shi, Nishi-ku, Genkai Isl. (S. Tsutsui, 1976, TNS)	○
[Maebara-1] Shima-cho, Hazama-koji (T. Hirano, 1982, TNS)	●
[Maebara-3] Shima-cho, Chaya (T. Hirano, 1982, TNS)	●
[Maebara-4] Shima-cho, Tateishi-yama (T. Hirano, 1982, TNS)	●
[Hamazaki-1] Nijo-cho, Arakawa-toge-dani (T. Nagai, T. Hirano & S. Tsutsui, 1983, TNS)	●
[Kashima-1] Shiraishi-cho, Yokote, Eisho temple (H. Koike, 1976, TNS)	●
[Kashima-2] Kashima-shi, Kaseno-ura (N. Niwaki, 1982, TNS)	○
[Isahaya-1] Tara-cho, Takebashi (M. Iwamura, 1975, TNS)	●

**Nagasaki pref.**

[Isahaya-4] Isahaya-shi, Mitarai-kannon (S. Koga, 1985, TNS)	○
[Katsumoto-2] Ishikawa-cho, Tsutsushiro, Higashi-fure (S. Tsutsui, 1980, TNS)	○
[Katsumoto-3] Ashibe-cho, Moroyoshi, Naka-fure (S. Tsutsui, 1980, TNS)	●
[Katsumoto-4] Gono-ura-cho, Hirouto-fure (S. Tsutsui, 1980, TNS)	○
[Katsumoto-4] Gono-ura-cho, Konya-cho (T. Shinagawa, 1969, TNS)	●
[Souki-3] Sasebo-shi, Kikaze-cho (S. Koga, 1985, TNS)	○
[Omura-1] Omura-shi, Ichino-go, Kajio (S. Koga, 1985, TNS)	●
[Omura-2] Tarami-cho, Higashi-zono (S. Koga, 1985, TNS)	●
[Omura-3] Nishi-sonogi-cho, Kame-ura-go (S. Koga, 1985, TNS)	●
[Omura-4] Kinkai-cho, Nishi-umi-go, Katsura-yama (S. Koga, 1985, TNS)	○
[Nagasaki-4] Nagasaki-shi, Siebolt House (S. Okuyama, 1958, TNS)	○
[Nomo-zaki-4] Nomo-zaki-cho, Gongen-yama (S. Koga, 1985, TNS)	○
[Sasebo-1] Kosaza-cho, Oshige (S. Tsutsui, 1983, TNS)	U
[Sasebo-4] Kosaza-cho, Hirabaru-men (S. Koga, 1985, TNS)	●
[Kamiura-2] Oseto-cho, Tsuka-do (S. Koga, 1985, TNS)	○
[Ikutsuki-2] Hirato-shi, Shushi-cho (A. Minami & U. Fujiyama, 1984, TNS)	○
[Shishiki-1] Hirado-shi, Fukagawa-cho (A. Minami & U. Fujiyama, 1984, TNS)	○
[Shishiki-2] Hirado-shi, Tsuji-cho to Mt. Byobu-dake (A. Minami & U. Fujiyama, 1984, TNS)	U
[Izumi-2] Tsu-shima Isls., Kami-tsu-shima-cho, Ebi Isl. (H. Koyama, 1968, TNS)	○
[Sasuna-3] Tsu-shima Isls., Kami-agata-gun, northern part of Minato (H. Koyama, Sept. 29, 1968, TNS)	○
[Nin-i-3] North island of Tsu-shima Isls., Kisaka (F. G. Meyer & J. L. Creech, 1978, TNS)	○
[Nin-i-4] Mitsu-shima-cho, Ashi-ura (S. Tsutsui, 1979, TNS)	●
[Izuhara-3] Mitsu-shima-cho, Mt. Shira-take (S. Tsutsui, 1978, TNS)	●

**Oita pref.**

[Hoto-jima-4] Tsukumi-shi, Hoto Isl. (Y. Takaoka, 1981, TNS)	○
[Tsuru-misaki-3] Yonouzu-mura, Hazako (Y. Takaoka, 1981, TNS)	○
[Usuki-1] Tsukumi-shi, Okimuku Isl. (Y. Takaoka, 1978, TNS)	●
[Kabae-4] Kabae-cho, Hatouzu (Y. Goto, 1984, TNS)	●
[Himeshima-4] Himeshima-mura (M. Hatano, 1961, TNS)	○
[Tsurukawa-1] Kunisaki-cho, Fukae (M. Sato, 1953, TNS)	●
[Bungo-kitsuki-3] Tada-mura, Tabara, Mt. Nokogiri (M. Hatano, 1965, TNS)	●
[Oita-4] Oita-shi, Dannoharu (Y. Goto, 1984, TNS)	●
[Toyo-oka-2] Hiji-cho, Toyo-oka, Koura (Y. Takaoka, 1984, TNS)	●

**Miyazaki pref.**

[Kabae-4] Kitaura-cho, Furue-goe (T. Minamitani, 1981, TNS)	●
[Shimaura-3] Nobeoka-shi, Shimanoura (T. Minamitani, 1984, TNS)	●
[Hyuga-aoshima-2] Nichinan-shi, Fuji (K. Minamitani, 1982, TNS)	●
[Hyuga-aoshima-3] Tano-cho, Motono (T. Minamitani, 1982, TNS)	○
[Obi-1] Nichinan-shi, Udo (K. Minamitani, 1982, TNS)	●
[Obi-2] Nango-cho, Meitsu (K. Minamitani, 1982, TNS)	●
[Shibushi-1] Kushima-shi, Takamatsu (K. Minamitani, 1982, TNS)	●

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**Kumamoto pref.**

[Tamana-1] Kao-cho, Iwahara (M. Ishisaka, 1982, TNS)	○
[Tamana-3] Arao-shi, Hirayama, Mt. Kotai (M. Ishisaka, 1982, TNS)	○
[Tamana-4] Tensui-cho, Hachikubo (M. Beppu, 1978, TNS)	○
[Kumamoto-1] Kumamoto-shi, Ezuko (M. Beppu, 1981, TNS)	○
[Yatsushiro-3] Misumi-cho, Oguchi (M. Beppu, 1984, TNS)	○
[Yatsushiro-3] Udo-shi, Akase (M. Ishisaka, 1985, TNS)	●
[Hinaku-3] Yatsushiro-shi, Mizushima-cho, Mizushima (S. Watanabe, 1982, TNS)	○
[Misumi-2] Matsushima-cho, Maeshima (M. Beppu, 1977, TNS)	○
[Misumi-4] Ariake-cho, O-ura (M. Beppu, 1979, TNS)	○
[Kyoragi-2] Himeto-cho, Ko-jiro (M. Beppu, 1984, TNS)	●
[Kyoragi-4] Sumoto-cho, Kuki-yama (M. Beppu, 1984, TNS)	○
[Minamata-2] Minamata-shi, Yunoko (M. Kido, 1963, TNS)	○
[Minamata-4] Minamata-shi, Modo (M. Kido, 1981, TNS)	○
[Hondo-4] Amakusa-cho, Kikai-ura (M. Kido, 1978, TNS)	●
[Ushibuka-1] Kawaura-cho, Miyano-kochi (M. Kido, 1978, TNS)	○
[Ushibuka-4] Ushibuka-shi, Tomi-yama (M. Kido, 1978, TNS)	●

**Kagoshima pref.**

[Sueyoshi-3] Matsuyama-cho, Miyata-yama (K. Takesako, 1977, TNS)	○
[Shibushi-1] Shibushi-cho, Taguri-saki (K. Takesako, 1976, TNS)	●
[Shibushi-4] Takayama-cho, Mt. Gongen (K. Takesako, 1976, TNS)	○
[Kokubu-4] Fukuyama-cho, Kamewari-toge (K. Takesako, 1976, TNS)	●
[Iwakawa-2] Kihoku-cho, Takao (K. Takesako, 1980, TNS)	○
[Iwakawa-3] Fukuyama-cho, Isowaki (K. Takesako, 1976, TNS)	○
[Iwakawa-4] Tarumizu-shi, Bishago-dake (K. Takesako, 1976, TNS)	●
[Kanoya-3] Kanoya-shi, Hanasato (K. Takesako, 1982, TNS)	○
[Kanoya-4] Kanoya-shi, Takamaki-cho (K. Takesako, 1982, TNS)	○
[O-nejime-1] Aira-cho, Kanayama (K. Takesako, 1982, TNS)	○
[O-nejime-3] O-nejime-cho, Chojiro waterfall (K. Takesako, 1975, TNS)	○
[Hetsuka-3] Nejime-cho, Nikawa (K. Kawahara, 1981, TNS)	○
[Kurino-1] Yoshimatsu-cho, Ayaori (K. Takesako, 1980, TNS)	●
[Kurino-2] Yokokawa-cho, Akamizu, Iwado-kannon (K. Takesako, 1980, TNS)	○
[Kajiki-3] Kamo-cho, Akashi (K. Takesako, 1981, TNS)	○
[Kagoshima-3] Kagoshima-shi, Shiro-yama (K. Kawahara, 1980, TNS)	○
[Kagoshima-4] Kagoshima-shi, Shimo-fukumoto-cho, Jigan temple (T. Shimozono, 1981, TNS)	○
[Tarumi-1] Tarumi-shi, Ueno-miya (K. Takesako, 1976, TNS)	○
[Tarumi-3] Kiire-cho, Sesegushi (K. Kawahara, 1979, TNS)	○
[Tarumi-4] Chiran-cho, Ikeno-kochi (M. Kawabata, 1985, TNS)	○
[Kaimon-dake-4] Yamakawa-cho, Unagi-ike (K. Kawahara, 1978, TNS)	○
[Sata-misaki-2] Sata-cho, Izashiki (K. Takesako, 1975, TNS)	○
[Izumi-3] Takaono-cho, Nishi-heta (M. Kido, 1980, TNS)	○
[Miyanojo-2] Kedoin-cho, Mt. Takakura (M. Kawabata, 1985, TNS)	●
[Sendai-2] Higashi-ichiki-cho, Shigehira-yama (K. Takesako, 1974, TNS)	○
[Sendai-4] Ichiki-cho, Funakawa (K. Kawahara, 1980, TNS)	●
[Ijuin-2] Fukiage-cho, Tashiro-no (K. Takesako, 1974, TNS)	○
[Ijuin-3] Higashi-ichiki-cho, Miyama (T. Shimozono, 1981, TNS)	○
[Ijuin-4] Fukiage-cho, Izaku (T. Nakaike, 1977, TNS)	○
[Kaseta-1] Kagoshima-shi, Hirakawa-cho, Mt. Eboshi-dake (K. Kawahara, 1983, TNS)	●
[Kaseta-2] Chiran-cho (K. Takesako, 1977, TNS)	○
[Kaseta-3] Kinpo-cho, Ota (K. Kawahara, 1982, TNS)	○
[Kaseta-4] Kinpo-cho, Shirakawa-nishi (K. Kawahara, 1982, TNS)	○
[Makurazaki-1] Ei-cho, Fuchi-beppu (K. Kawahara, 1981, TNS)	●
[Makura-zaki-2] Ei-cho, Nakamura (K. Kawahara, 1981, TNS)	○
[Akune-2] Akune-shi, Akune (M. Kido, 1977, TNS)	○
[Akune-3] Nagashima-cho, Sashie (K. Kawahara, 1975, TNS)	●
[Nishikata-1] Akune-shi, Nishime (M. Kido, 1984, TNS)	○

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[Hashima-1] Sendai-shi, Hashima (K. Takesako, 1980, TNS)	●
[Nomadake-2] Kasasa-cho, Mt. Noma-dake (K. Takesako, 1977, TNS)	●
[Naka-koshiki-1] Sato-mura, Sato (M. Kido, 1978, TNS)	●
[Teuchi-1] Shimo-koshiki-mura, Mt. Odake (H. Endo, 1984, TNS)	●
[Teuchi-4] Shimo-koshiki-mura (K. Takesako, 1974, TNS)	○
[Tanega-shima-hokubu-1] Nishino-omote-shi, Kunigami, Kungami shrine (T. Kariyazaki, 1984, TNS)	●
[Tanega-shima-hokubu-3] Mage Isl. (Sasaki & Ouchiyama, 1953, TNS)	●
[Tanega-shima-nanbu-2] Minami-tane-cho, Kukinaga (T. Kariyazaki, 1984, TNS)	●
[Yaku-shima-tohokubu-3] Kamiyaku-cho, Shitoko (K. Mimoro <i>et al.</i> , 1980, TNS)	○
[Yaku-shima-seihokubu-1] Kamiyaku-cho, Isso (M. Kawabata, 1964, TNS)	●
[Kuchino-erabu-jima -1] Kuchino-erabu (K. Takesako, 1980, TNS)	●
[Kasari-saki-2] Kasari-cho, around Sani-gawa river (A. Minami & U. Fujiyama, 1985, TNS)	○
[Akagi-na-1] Kasari-cho, Kawakami (A. Minami & U. Fujiyama, 1985, TNS)	●
[Akagi-na-2] Tatsugo-mura, Akaogi (M. Nakajima, 1971, TNS)	●
[Akagi-na-3] Naze-shi, Tatsugo (A. Yamamoto, T. Nakaïke & M. Ishizuka, 1977, TNS)	○
[Akagi-na-4] Naze-shi, Urakami to Honcha-toge (A. Minami & U. Fujiyama, 1985, TNS)	○
[Kominato-3] Naze-shi, Oshima, Maegachi (A. Minami & U. Fujiyama, 1985, TNS)	●
[Yuwan-4] Uken-mura, Nakara (A. Yamamoto, T. Nakaïke & M. Ishizuka, 1977, TNS)	○
[Nishikomi-2] Kakeroma Isl., Satsukawa (K. Tamaoki, 1978, TNS)	●
[Kametsu-3] Tokuno-shima-cho, Kedoku, around Shimoda river (A. Minami & U. Fujiyama, 1985, TNS)	●
[Okinoerabu-jima-1] Okinoerabu Isl., Nishihara (K. Shimabuku, 1974, TNS)	○
<b>Okinawa pref.</b>	
[Izena-jima] Izena Isl. (T. Takara, 1981, TNS)	●
[Nago-1] Nago-shi, Umosa (M. Takara & T. Takara, 1980, TNS)	●
[Koza-hokubu-1] Kin-cho, Kin (M. Takara & T. Takara, 1982, TNS)	●
[Koza-hokubu-2] Yonagusuku-son, Miyagi-shima (M. Takara & T. Takara, 1981, TNS)	●
[Koza-hokubu-4] Katena-cho, Yara (M. Takara & T. Takara, 1980, TNS)	●
[Koza-hokubu-4] Katena-cho (H. Ito, 1936 TI)	●
[Koza-nanbu-1] Katsuren-cho, ruin of Katsuren-gusuku castle (M. Takara & T. Takara, 1982, TNS)	●
[Koza-nanbu-3] Kita-naka-gusuku-son, ruin of Naka-gusuku castle (M. Takara & T. Takara, 1982, TNS)	●
[Koza-nanbu-4] Nishihara-cho, Tanabaru (M. Takara & T. Takara, 1981, TNS)	●
[Kudaka-jima-1] Kudaka Isl. (K. Tamaoki, 1978, TNS)	○
[Kudaka-jima-3] Chinen-son, Chinen (K. Tamaoki, 1977, TNS)	●
[Naha-2] Naha-shi, Ou-yama (M. Takara & T. Takara, 1981, TNS)	●
[Naha-2] Naha-shi, Shurei-no-mon (T. Nakaïke & A. Nakanishi, 1988, TNS)	○
[Itoman-1] Kochinda-cho, Mt. Haeju-dake (M. Takara & T. Takara, 1981, TNS)	○
[Tonaki-jima-1] Aguni Isl. (K. Shimabuku, 1974, TNS)	●
[Kume-jima-3] Nakasato-son, Maja (M. Takara & T. Takara, 1978, TNS)	○
[Miyako-jima-hokubu-3] Miyako Isls. Ogami Isl. (K. Shimabuku, 1974, TNS)	○
[Miyako-jima-2] Agari-henna-zaki (K. Shimabuku, 1974, TNS)	●
[Miyako-jima-3] Mt. Nohara-dake (K. Shimabuku, 1973, TNS)	●
[Miyako-jima-4] Painagama (K. Shimabuku, 1973, TNS)	●
[Tarama-jima] Miyako Isls., Tarama Isl., Nakasuji (K. Tamaoki, 1974, TNS)	●
[Iriomote-jima-hokubu-3] Sumiyoshi (T. Nakaïke & A. Nakanishi, 1988, TNS)	●
[Iriomote-jima-hokubu-4] Funaura (H. Koyama <i>et al.</i> , 1973, TNS)	○

No. of locality: 426

\*IC: Indusium's colour, ○ : graish white, ● : blackish, U: unknown.

Appendix 8. Locality on herbarium specimens of C type in *Cyrtomium falcatum* complex

[Mapping Index]	Locality	s/s*
<b>Iwate pref.</b>		
[Ohasama-4]	Miyamori-mura, Tasobe (S. Tamagawa, 1974, TNS)	-
<b>Ibaraki pref.</b>		
[Daigo-3]	Daigo-cho, Daigo (M. Yasu, 1983, TNS)	-
[Mito-2]	Mito-shi, Bizen-cho (M. Yasu, 1980, TNS)	-
[Ishioka-3]	Iwama-cho, Yamane (E. Fukushi, 1983, TNS)	-
<b>Tochigi pref.</b>		
[Mooka-2]	Mashiko-cho, Amemaki-san (M. Yoshikawa, 1980, TNS)	-
[Utsunomiya-3]	Utsunomiya-shi, Takaragi 2-chome (M. Usui, 1981, TNS)	-
<b>Gunma pref.</b>		
[Kiryu & Ashikaga-3]	Kiryu-shi, foot of Mt. Azuma (S. Kojima, 1983, TNS)	-
<b>Saitama pref.</b>		
[Konosu-4]	Shobu-cho, Shobu (M. Shimosegawa, 1984, TNS)	-
[Omiya-2]	Omiya-shi, Takahana-cho (M. Shimosegawa, 1982, TNS)	-
[Omiya-4]	Omiya-shi, Kushibiki-cho (M. Shimosegawa, 1982, TNS)	-
[Fukaya-4]	Kumagaya-shi, Kami-chujo (S. Kobayashi, 1980, TNS)	-
[Kawagoe-4]	Hanno-shi, Kusumi (S. Kobayashi, 1976, TNS)	-
[Takasaki-4]	Kamikawa-mura, Watarase (S. Kojima, 1981, TNS)	-
[Yorii-1]	Misato-mura, Otsuki-yama (S. Kojima, 1984, TNS)	-
[Yorii-2]	Ogawa-cho, Furutera (S. Kobayashi, 1982, TNS)	-
[Chichibu-1]	Ogose-cho, Mugihara (S. Kobayashi, 1982, TNS)	-
<b>Chiba pref.</b>		
[Itako-4]	Sahara-shi, Katori, Katori shrine (K. Ito, 1979, TNS)	-
[Yoka-ichiba-2]	Choshi-shi, Saruta (K. Nakamura, 1983, TNS)	-
[Narita-2]	Tako-cho, Higashi-sano (Y. Koike, 1978, TNS)	-
[Mobara-4]	Ichinomiya-cho, west side of Torami temple (Y. Kimizuka, 1977, TNS)	-
[Kazusa-ohara-1]	Misaki-cho, Mikado (K. Nakamura, 1983, TNS)	64
[Kazusa-ohara-2]	Ohara-cho, Yose (K. Nakamura, 1983, TNS)	-
[Kazusa-ohara-3]	Misaki-cho, Shiigi (K. Nakamura, 1983, TNS)	-
[Kazusa-ohara-4]	Onjuku-cho, Seirin temple (T. Nakaike, 1976, TNS)	-
[Anegasaki-1]	Nagatsuka-cho, Osakabe (K. Nakamura, 1982, TNS)	-
[Anegasaki-2]	Ichihara-shi, Shuku, Suwa shrine (K. Nakamura, 1982, TNS)	-
[Otaki-2]	Otaki-cho, Outo (Y. Kimizuka, 1976, TNS)	-
[Otaki-4]	Kimitsu-shi, Mt. Mitsuishi (H. Hirabayashi, TOFO, chromosome counted by the collector)	64(1)
[Tokyo-tohokubu-2]	Ichikawa-shi, Kokufu-dai, Satomi park (Y. Kimizuka, 1979, TNS)	-
[Tokyo-tonanbu-1]	Urayasu-shi, Horie, Shinfuku temple (Y. Kimizuka, 1979, TNS)	-
[Futtu-2]	Futtu-shi, Uego (K. Kawana, 1979, TNS)	-
[Futtu-4]	Futtu-shi, Shiro-yama (Y. Saito, 1982, TNS)	-
[Nako-1]	Tomiyama-cho, Hekuri (K. Nakamura, 1983, TNS)	-
[Nako-3]	Futtu-shi, Kanaya (K. Nakamura, 1983, TNS)	-
[Nako-4]	Tateyama-shi, Nako-kannon (K. Nakamura, 1983, TNS)	-
[Tateyama-1]	Chikura-cho, Takatsuka-yama (K. Kawana, 1979, TNS)	-
[Tateyama-3]	Tateyama-shi, Menuuma (Y. Saito, 1982, TNS)	-
[Tateyama-4]	Shirahama-cho, Takiguchi, Shimotate, Matsubara shrine (K. Kawana, 1980, TNS)	-
<b>Tokyo pref.</b>		
[Tokyo-tohokubu-1]	Kita-ku, Showa-cho, 2-chome (M. Shimosegawa, 1982, TNS)	-
[Tokyo-tohokubu-3]	Chiyoda-ku, Hitotsu-bashi, Nihonbashi river (Y. Kimizuka, 1983, TNS)	-
[Tokyo-tohokubu-4]	Kita-ku, Showa-cho (M. Shimosegawa, 1982, TNS)	-
[Tokyo-tonanbu-3]	Minato-ku, Shiba, north of Toshogu shrine (Y. Kimizuka, 1981, TNS)	-

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[Tokyo-seihokubu-3] Higashi-kurume-shi, Saiwai-cho (H. Endo, 1982, TNS)	-
[Tokyo-seihokubu-4] Fuchu-shi, Tama-cho (M. Misu, 1980, TNS)	-
[Tokyo-seinanbu-1] Ota-ku, Den-en-chofu (K. Fukushima & M. Takahashi, 1983, TNS)	-
[Tokyo-seinanbu-2] Ota-ku, Unoki (M. Shimosegawa, 1984, TNS)	-
[Ome-2] Kunitachi-shi, Naka (Y. Kimizuka, 1981, TNS)	-
[Ome-3] Ome-shi, Nagafuchi-cho (H. Endo, 1983, TNS)	-
[Hachioji-1] Tama-shi, Umeaoka (N. Sone, 1980, TNS)	-
[Hachioji-3] Hachioji-shi, Shiro-yama (K. Tanaka, 1982, TNS)	-
[Itsuka-ichi-1] Ome-shi, Shazan-kei (H. Endo, 1980, TNS)	-
[Itsuka-ichi-2] Hinode-cho, Mt. Katsumine (H. Tokashiki, 1980, TNS)	-
<b>Kanagawa pref.</b>	
[Tokyo-seihokubu-2] Yokohama-shi, Tsurumi-ku, Komaoka-cho (E. Fukushi, 1982, TNS)	-
[Tokyo-seinanbu-4] Yokohama-shi, Minato-kita-ku, Katsuta-cho (C. Hino, 1983, TNS)	-
[Yokohama-2] Yokohama-shi, Kanazawa-ku, Kanazawa-bunko, Shomyo temple (E. Fukushi, 1982, TNS)	-
[Yokohama-3] Yokohama-shi, Asahi-ku, Yasashi-cho (H. Kobayashi, 1981, TNS)	-
[Yokohama-4] Kamakura-shi, Imaizumi (R. Sato, 1981, TNS)	-
[Yokosuka-3] Kamakura-shi, Zaimoku-za (H. Kobayashi, 1976, TNS)	-
[Yokosuka-4] Hayama-cho, Maeda-hashii (Y. Kimizuka, 1978, TNS)	-
[Hachioji-4] Aikawa-cho, Kami-mimase (K. Tanaka, 1982, TNS)	-
[Fujisawa-3] Isehara-shi, Mt. Oyama (J. Moriya, 1981, TNS)	-
[Fujisawa-4] Isehara-shi, Zennami (J. Moriya, 1982, TNS)	-
[Hatano-2] Matsuda-cho, Nakatsu river (K. Tanaka, 1982, TNS)	-
[Odawara-1] Odawara-shi, Numashiro (K. Tanaka, 1984, TNS)	-
[Odawara-2] Odawara-shi, Nebukawa (K. Tanaka, 1982, TNS)	-
[Odawara-3] Minami-ashigara-shi, Kano (K. Tanaka, 1984, TNS)	-
[Odawara-4] Hakone-cho, Hatajuku (K. Tanaka, 1982, TNS)	-
[Atami-3] Yugawara-cho, Hirogawara (K. Tanaka, 1982, TNS)	-
[Yamanaka-ko-2] Yamakita-cho, Yuzuku river (K. Tanaka, 1982, TNS)	-
<b>Niigata pref.</b>	
[Yahiko-4] Foot of Mt. Yahiko (T. Hirota, 1973, TNS)	64
[Itoigawa-1] Nou-cho, Hakusan shrine (K. Hirano, 1952, TNS)	-
[Itoigawa-1] Nou-cho (T. Iwano, 1958, TNS)	-
<b>Toyama pref.</b>	
[Himi-2] Himi-shi, Moridera (T. Ooshima, 1979, TNS)	-
<b>Ishikawa pref.</b>	
[Oguchi-seto-3] Notoshima-cho, Nozaki (S. Komaki, 1981, TNS)	-
<b>Fukui pref.</b>	
[Mikuni-1] Ashihara-cho, Namimatsu (S. Watanabe, 1982, TNS)	-
[Mikuni-2] Mikuni-shi, Ajima (S. Watanabe, 1982, TNS)	-
[Sabae-2] Nanjo-cho, Imonoshi (S. Watanabe, 1981, TNS)	-
[Sabae-3] Echizen-cho, Michi-guchi (S. Watanabe, 1981, TNS)	-
[Sabae-4] Echizen-cho, Gyuboga-daira (S. Watanabe, 1981, TNS)	-
[Imajo-3] Kono-mura, Kono (S. Watanabe, 1982, TNS)	-
[Imajo-4] Tsuruga-shi, Urazoko (S. Watanabe, 1982, TNS)	-
[Nishitsu-1] Mikata-cho, Suisho-zan (Y. Saito, 1975, TNS)	-
[Nishitsu-3] Mikata-cho, Umiyama (S. Watanabe, 1977, TNS)	-
[Kumakawa-3] Obama-shi, Ike-gochi (S. Watanabe, 1979, TNS)	-
<b>Shizuoka pref.</b>	
[Atami-3] Atami-shi, Izumi (T. Shimakawa, 1982, TNS)	-
[Ito-1] Ito-shi, Kawana, Hiranone (T. Shimakawa, 1981, TNS)	-
[Ito-3] Ito-shi, Ippeki lake (T. Shimakawa, 1976, TNS)	-

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[Inatori-3] Higashi-izu-cho, Inatori (T. Sugino, 1970, TNS)	64
[Numazu-1] Mishima-shi, Kitazawa (A. Suzuki, 1980, TNS)	-
[Numazu-3] Numazu-shi, Nishi-sawada (T. Sato, 1983, TNS)	-
[Shuzenji-1] Shuzenji-cho, Yubune, Okuno-in (A. Suzuki, 1983, TNS)	-
[Shimoda-1] Kawazu-cho, Kami-mine (T. Sato, 1982, TNS)	-
[Shimoda-2] Shimoda-shi, Nakamura (T. Sato, 1982, TNS)	-
[Shimoda-3] Nishi-izu-cho, Shirakawa (A. Suzuki, 1979, TNS)	-
[Shimoda-4] Matsuzaki-cho, Michibu (H. Kobayashi, 1982, TNS)	-
[Fujinomiya-2] Fuji-shi, Iwamoto, Jisso temple (T. Sato, 1984, TNS)	-
[Yoshihara-1] Fuji-shi, Kamiya (T. Hosokura, 1983, TNS)	-
[Yoshihara-3] Yui-cho, Fukuzawa (M. Nakagawa, 1982, TNS)	-
[Yoshihara-4] Yui-cho, Kurasawa (M. Nakagawa, 1984, TNS)	-
[Shimizu-1] Shizuoka-shi, Gou-jima (M. Nakagawa, 1979, TNS)	-
[Shimizu-2] Shimizu-shi, Yamahara (M. Nakagawa, 1979, TNS)	-
[Shizuoka-1] Shizuoka-shi, Kunou-zan (T. Sugino, 1975, TNS)	-
[Shizuoka-4] Yaizu-shi, Takasaki (H. Suzuki, 1981, TNS)	-
[Ieyama-1] Fujieda-shi, Takino-tani (T. Sugino, 1980, TNS)	-
[Ieyama-4] Kakegawa-shi, Matsubano-taki (T. Sugino, 1970, TNS)	-
[Kakegawa-1] Haibara-cho, Makinohara (T. Sugino, 1984, TNS)	-
[Kakegawa-2] Sagara-cho, Nishi-ogima (T. Sugino, 1976, TNS)	-
[Kakegawa-3] Kakegawa-shi, Masago (T. Sugino, 1981, TNS)	-
[Kakegawa-4] Kakegawa-shi, Mt. Ogasa (T. Sugino, 1969, TNS)	-
[Omaezaki-1] Sagara-cho, Jito-kata (T. Sugino, 1976, TNS)	-
[Omaezaki-3] Hamaoka-cho, Ike-shinden (T. Sugino, 1964, TNS)	64
[Tenryu-1] Haruno-cho, Nishi-ryoke (T. Sugino, 1983, TNS)	-
[Tenryu-2] Mori-machi, Kan-jima (T. Sugino, 1970, TNS)	64
[Tenryu-3] Tatsuyama-mura, Shimo-hinata (I. Yamashita, 1979, TNS)	-
[Tenryu-4] Tenryu-shi, Yonezawa (H. Suzuki, 1983, TNS)	-
[Iwata-1] Kakegawa-shi, Sakashita (T. Sugino, 1970, TNS)	-
[Iwata-3] Hamakita-shi, Miyaguchi (T. Sugino, 1984, TNS)	-
[Mikawa-ono-2] Hamamatsu-shi, Washisawa (T. Sugino, 1979, TNS)	-
[Hamamatsu-1] Inasa-cho, Iino-tani (I. Yamashita, 1975, TNS)	-
[Hamamatsu-2] Hamamatsu-shi, Hirosawa-cho (T. Hosokura, 1965, TNS)	-
[Hamamatsu-3] Mikkabi-cho, Shimo-ona (T. Sugino, 1976, TNS)	-
<b>Aichi pref.</b>	
[Toyohashi-1] Toyohashi-shi, Suse-cho (M. Fukuhara, 1973, TNS)	-
[Toyota-2] Toyota-shi, Kokai-cho (K. Inugai, 1980, TNS)	-
[Gamagori-1] Hazu-cho, Onoga-tani (K. Inugai, 1978, TNS)	64
[Gamagori-2] Tabara-cho, Shira-tani (K. Inugai, 1979, TNS)	-
[Irako-zaki-4] Irako-zaki (H. Okuyama, 1949, TNS)	-
[Gifu-4] Kisogawa-cho, Sato-komaki (K. Inugai, 1983, TNS)	-
[Handa-3] Chita-shi, Okusa (K. Inugai, 1982, TNS)	-
[Handa-4] Tokoname-shi, Sakae-cho (K. Inugai, 1980, TNS)	-
[Moro-zaki-2] Minami-chita-cho, Nishi-mura (K. Inugai, 1981, TNS)	-
[Moro-zaki-4] Minami-chita-cho, Utsumi (K. Inugai, 1980, TNS)	-
[Tsushima-2] Yakai-mura, Kyubu (K. Inugai, 1983, TNS)	-
<b>Gifu pref.</b>	
[Arimine-ko-4] Kamioka-cho, Wasaho (H. Nagase, 1984, TNS)	-
[Tanigumi-4] Kuse-mura, Otsuhara valley (T. Ogiyama, 1981, TNS)	-
[Tsushima-3] Yoro-cho, Kashiwao (K. Inugai, 1984, TNS)	-
<b>Shiga pref.</b>	
[Hikone-tobu-3] Hikone-shi, Sawa-yama (T. Tatebe, 1981, TNS)	-
[Hikone-tobu-4] Omi-hachiman-shi, Hakuo-cho, Isaki-yama (T. Tatebe, 1982, TNS)	-
[Kyoto-tohokubu-4] Otsu-shi, Sakamoto-honmachi, Omiya valley (T. Tatebe, 1981, TNS)	-

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## App. 8.

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<b>Mie pref.</b>	
[Toba-4] Isobe-cho, Amano-iwado (H. Yamauchi, 1979, TNS)	-
[Kuwana-3] Dian-cho, Katahi (M. Kawazoe, 1985, TNS)	-
[Yokkaichi-3] Yokkaichi-shi, Komo-cho (K. Kada, 1984, TNS)	-
[Tsu-tobu-3] Kawage-cho, Ueno (H. Yamauchi, 1976, TNS)	-
[Hikone-tobu-2] Fujiwara-cho, Yamaguchi, Hiekawa valley (M. Kawazoe, 1982, TNS)	-
[Gozaisho-yama-1] Fujiwara-cho, Sakamoto (M. Kawazoe, 1982, TNS)	-
[Nihongi-1] Ureshino-cho, Morimoto (H. Yamauchi, 1978, TNS)	-
[Nyu-2] Odai-cho, Choja-no (H. Yamauchi, 1980, TNS)	-
[Nyu-3] Iitaka-cho, Okuyama (H. Yamauchi, 1982, TNS)	-
 <b>Wakayama pref.</b>	
[Shingu-3] Hongu-cho, Hongu (K. Oohora, 1979, TNS)	-
[Nachi-katsuura-2] Nachi-katsuura-cho, Urugami (H. Manago, 1975, TNS)	-
[Gojo-4] Hashimoto-shi, Kimi, Tenno shrine (H. Manago, 1981, TNS)	-
[Koya-san-3] Hashimoto-shi, Kamuro (H. Manago, 1981, TNS)	-
[Ezumi-2] Kozagawa-cho, Kurozu, Utsuo (H. Manago, 1977, TNS)	-
[Kishiwada-2] Katsuragi-cho, Shigo-go, Higashi valley (H. Manago, 1978, TNS)	-
[Kokawa-1] Katsuragi-cho, Hirokuchi (H. Manago, 1978, TNS)	-
[Kokawa-2] Naka-cho, Iimori (H. Manago, 1978, TNS)	-
[Todoroki-1] Misato-cho, Ui valley (H. Manago, 1974, TNS)	-
[Todoroki-3] Kanaya-cho, Oishi (H. Manago, 1971, TNS)	-
[Todoroki-4] Kanaya-cho, Sogetsu-dani, Tsugino waterfall (H. Manago, 1975, TNS)	-
[Kawara-go-2] Nanbugawa-mura, Karui-gawa, Shirakio valley (H. Manago, 1976, TNS)	-
[Kawara-go-4] Kawabe-cho, Yamano, Ootaki-gawa (H. Manago, 1976, TNS)	-
[Tanabe-1] Tanabe-shi, Kamihaya, Kotsune (H. Manago, 1979, TNS)	-
[Tanabe-2] Kami-tomita-cho, Ikuma, Shimo-daki (H. Manago, 1975, TNS)	-
[Susami-1] Shirahama-cho, Mikusa (H. Manago, 1972, TNS)	-
[Kainan-1] Shimotsu-cho, Choho-ji (H. Manago, 1977, TNS)	-
[Kainan-2] Kibi-cho, Tadono (H. Manago, 1977, TNS)	-
 <b>Nara pref.</b>	
[Osaka-tonanbu-1] Ikoma-shi, Daimon-cho (Z. Tsujimoto, 1978, TNS)	-
 <b>Kyoto pref.</b>	
[Tango-yura-2] Maizuru-shi, between Nakagawa and Kawabe-naka (T. Nakaike, 1982, TNS)	-
[Tango-yura-3] Miyatsu-shi, between Satohami and Iwagahana (T. Nakaike, 1982, TNS)	-
[Kizaki-1] Amino-cho, Hamazume (H. Endo, 1983, TNS)	-
[Tajima-takeda-1] Yakuno-cho, Sue (T. Nakaike, 1982, TNS)	-
 <b>Osaka pref.</b>	
[Kyoto-seinanbu-4] Ibaraki-shi, Kuruma-tsukuri, Mt. Ryo-sen (M. Harada, 1985, TNS)	-
 <b>Hyogo pref.</b>	
[Deishi-3] Hidaka-cho, Kami-ishi (Y. Hayashi, 1984, TNS)	-
[Yura-3] Mihara-cho, Seiso temple (T. Shiraiwa, 1977, TNS)	-
[Kasumi-1] Takeno-cho, Kirihama (Y. Hayashi, 1984, TNS)	-
[Kasumi-3] Kasumi-cho, Nakano (Y. Hayashi, 1984, TNS)	-
 <b>Tottori pref.</b>	
[Tottori-hokubu-2] Tottori-shi, Kyusho-zan (Y. Hiratsuka, 1946, TNS)	-
[Yonago-3] Yonago-shi, Shiro-yama (A. Tanaka, 1981, TNS)	-
 <b>Shimane pref.</b>	
[Edomo-2] Hirata-shi, Chiai-cho, Inoura (H. Inoue, 1979, Y)	-
[Imaichi-4] Izumo-shi, Nishi-zaimoku-cho (H. Inoue, 1979, TNS)	-
[Iwami-ota-3] Taki-cho, Oda (Y. Kikumura, 1985, TNS)	-

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[Hamada-1] Gotsu-shi, Uya-gawa (K. Oka, 1979, Y)	-
[Nichihara-3] Masuda-shi, Inokidani (K. Oka, 1978, Y)	-
[Nichihara-4] Nichihara-cho, Nichihara (S. Miyake, 1965)	64
[Saigo-2] Saigo-cho (T. Yamada, 1978, Y)	-
[Urago-4] Nishino-shima, Takuhi-yama (T. Yamada, 1978, Y)	-

**Hiroshima pref.**

[Onomichi-3] Mihara-shi, Nakano-cho, Hikari-dani (T. Takeda, 1972, TNS)	-
[Mitsu-2] Kinoe-cho, Tenman (T. Takeda, 1977, TNS)	-
[Mitsu-4] Yutaka-cho, Kubi (T. Takeda, 1977, TNS)	-
[Kabe-4] Kabe-cho, Naka, Daimo temple (T. Takeda, 1978, TNS)	-
[Kaida-ichi-3] Hiroshima-shi, Koyo-cho, Nakafuka-gawa (T. Takeda, 1978, TNS)	-
[Kure-1] Kure-shi, Hiro-machi, Shihaku (T. Takeda, 1979, TNS)	-
[Kure-3] Kure-shi, Nishi-sozuke-cho (Y. Nishimura, 1976, TNS)	-
[Kure-4] Kure-shi, Aga-cho, Oiri (T. Takeda, 1977, TNS)	-
[Hiroshima-1] Hiroshima-shi, Gion-cho, Nishi-yamamoto (T. Takeda, 1976, TNS)	-
[Itsuku-shima-2] Valley of water supply on Okimi-cho (T. Takeda, 1976, TNS)	-
[Itsuku-shima-3] Miyajima-cho (T. Takeda, 1979, TNS)	-
[Hashira-jima-1] Ogaki-cho, Ohara (T. Takeda, 1977, TNS)	-

**Yamaguchi pref.**

[Kuga-4] Tachibana-cho, Genmei-kyo (M. Wada, 1969, Y)	-
[Otake-2] Iwakuni-shi, Kawara valley (A. Minami, 1985, TNS)	-
[Iwakuni-1] Iwakuni-shi, Kanou-gi to Dadoko (H. Masaki, 1992, Y)	-
[Murotsu-1] Yanai-shi, Heigun Isl., around Kanna-zaki (A. Minami, 1987, Y)	-
[Hikari-3] Kudamatsu-shi, Kasado Isl., Moto-ura (H. Masaki, 1990, Y)	-
[Iwai-jima] Kamiseki-cho, Iwai Isl. (K. Oka, 1948, Y)	64
[Susa-1] Tamagawa-cho, Yoko-daki to Kamigumi (K. Inoue, 1979, Y)	-
[Susa-2] Tamagawa-cho, Higashibun, Ohara (T. Yamada, 1978, Y)	-
[Susa-4] Abu-cho, Uda (O. Kunio, 1978, Y)	64
[Nagato-kyo-2] Tokuchi-cho, Mitani, Kita-tanigawa river (H. Masaki, 1992, Y)	-
[Hofu-1] Tokuyama-shi, Obata, Takeyama (H. Masaki, 1991, Y)	-
[Hagi-1] Hagi-shi, Kasayama (S. Miyake, 1956, Y)	64
[Hagi-3] Sanmi-mura, Saba-shima (K. Oka, 1950, Y)	-
[Ube-tobu-3] Ube-shi, Kawakami, Sannou-sama (T. Yamada, 1978, Y)	-
[Asa-3] Kikugawa-cho, Shimo-hogi (T. Imada, 1980, TNS)	-

**Kagawa pref.**

[Kankakei-4] Utsumi-cho, Kanka-kei valley (S. Mitani, 1976, TNS)	-
[Kusakabe-3] Utsumi-cho, Kankake-dori (S. Mitani, 1983, TNS)	-
[Takamatsu-2] Mure-cho, Yakuri-san (S. Mitani, 1975, TNS)	-
[Takamatsu-3] Dosho-cho, Toyo-shima (S. Mitani, 1982, TNS)	-
[Takamatsu-nanbu-1] Shido-cho, Tawa shrine (S. Mitani, 1976, TNS)	-
[Takamatsu-nanbu-4] Kagawa-cho, Higashi valley (S. Mitani, 1976, TNS)	-
[Marugame-1] Sakaide-shi, Ome-cho, Hakuhou-zan (S. Mitani, 1976, TNS)	-
[Marugame-2] Ayagami-cho, Nishi-bun (S. Mitani, 1976, TNS)	-
[Marugame-4] Kotohira-cho, Kotohira-san (S. Mitani, 1974, TNS)	-
[Ikeda-3] Takase-cho, Omizukami shrine (S. Mitani, 1976, TNS)	-
[Kannonji-1] Kannonji-shi, Kinogo-cho, Chihiro shrine (S. Mitani, 1976, TNS)	-

**Tokushima pref.**

[Naruto-kaikyo-4] Naruto-shi, Kitadomari (K. Abe, 1973, TNS)	-
[Tokushima-4] Tokushima-shi, Mayuyama (K. Abe, 1971, TNS)	-
[Awa-tomioka-2] Anan-shi, Tachibana-cho (K. Abe, 1971, TNS)	-
[Awa-tomioka-4] Anan-shi, Hosono (K. Abe, 1971, TNS)	-
[Kawashima-3] Ichiba-cho, Kirihata (K. Abe, 1973, TNS)	-
[Kumoso-yama-1] Kamikatsu-cho, Kancho waterfall (K. Abe, 1970, TNS)	-

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[Kumoso-yama-2] Wajiki-cho, Hyochu-kannon (K. Abe, 1982, TNS)	-
[Kumoso-yama-3] Kamiyama-cho, Mitsuki (K. Abe, 19 , TNS)	-
[Sakuradani-1] Aioi-cho, Takegaya (T. Nakayama, 1970, TNS)	-
[Sakuradani-3] Kaminaka-cho, Cho-an dam (T. Nakayama, 1967, TNS)	-
[Wakimachi-2] Yamakawa-cho, Okunoi-gawa (K. Abe, 1973, TNS)	-
[Tsurugi-san-1] Anabuki-cho, Furumiya (K. Abe, 1978, TNS)	-
[Tsurugi-san-3] Sadamitsu-cho, Haba-yama (K. Abe, 1946, TNS)	-
[Ikeda-2] Mikamo-cho, Gomyo (T. Nakayama, 1979, TNS)	-
[Ikeda-4] Ikeda-cho, Satogawa valley (T. Nakayama, 1979, TNS)	-
<b>Kochi pref.</b>	
[Otochi-1] Monobe-mura, Sasagami (A. Minami, U. Fujiyama & Y. Suehiro, 1984, TNS)	-
[Otochi-4] Kahoku-cho, Kawano-uchi mountain road (K. Yamaoka, 1982, TNS)	-
[Tei-3] Kahoku-cho, Birafu (K. Yamaoka, 1979, TNS)	-
[Kochi-1] Tosa-yamada-cho, Shingai (A. Minami, U. Fujiyama & Y. Suehiro, 1984, TNS)	-
[Kochi-2] Noichi-cho, Otani (K. Yamaoka, 1983, TNS)	-
[Kochi-3] Kagami-mura, Taniguchi to Sadanaga (K. Yamaoka, 1978, TNS)	-
[Kochi-4] Kochi-shi, Jikoku valley (K. Yamaoka, 1979, TNS)	-
[Ino-3] Gohoku-mura, streambranch of Kamiya river (Y. Yamamoto, 1984, TNS)	-
[Suzaki-3] Tosa-shi, Kitahara, Chisho valley (K. Yamaoka, 1978, TNS)	-
[Ishigabae-4] Nakatosa-cho, Kaezaki (S. Miyazaki, 1979, TNS)	-
[Kamidoi-2] Niyodo-mura, Mori (K. Yamaoka, 1982, TNS)	-
[Kamidoi-4] Agawa-mura, Oku valley (K. Yamaoka, 1984, TNS)	-
[Nitta-1] Hayama-mura, Kaino-kawa (K. Yamaoka, 1978, TNS)	-
[Oyo-3] Nishi-tosa-mura, Kitano-kawa mountain road (S. Miyazaki, 1985, TNS)	-
[Iwamatsu-2] Sukumo-shi, around Sakamoto (K. Yamaoka & Y. Yamamoto, 1978, TNS)	-
[Sukumo-1] Sukumo-shi, Nagahata (K. Yamaoka, 1983, TNS)	-
<b>Ehime pref.</b>	
[Ishizuchi-yama-3] Tanbara-cho, Kono-se (M. Hyodo, 1982, TNS)	-
[Kami-doi-4] Yanadani-mura, Eiju (M. Hyodo, 1981, TNS)	-
[Matsuyama-hokubu-2] Tanbara-cho, Yanaso (M. Hyodo, 1980, TNS)	-
[Matsuyama-hokubu-4] Matsuyama-shi, Jikiba (M. Hyodo, 1982, TNS)	-
[Matsuyama-nanbu-4] Tobe-cho, Miyauchi (M. Hyodo, 1981, TNS)	-
[Tanono-3] Hiyoshi-mura, Kami-honmura (M. Hyodo, 1982, TNS)	-
[Mitsuhama-2] Matsuyama-shi, Oyama-dera (Y. Miyoshi, 1978, TNS)	-
[Mitsuhama-3] Nakajima-cho, Nakajima (Y. Miyoshi, 1978, TNS)	-
[Gunchu-1] Iyo-shi, Mitani (M. Hyodo, 1982, TNS)	-
[Oozu-1] Uchiko-cho, Kami-yokohira (M. Hyodo, 1983, TNS)	-
[Oozu-3] Futami-cho, Houshi (M. Hyodo, 1980, TNS)	-
[Oozu-4] Oozu-shi, Shinya (M. Hyodo, 1981, TNS)	-
[Iyo-takayama-2] Uwakai-mura, Yagahama (M. Hyodo, 1981, TNS)	-
[Uogami-yama-2] Tsushima-cho, Suge (M. Hyodo, 1981, TNS)	-
<b>Fukuoka pref.</b>	
[Uji-4] Kita-kyushu-shi, Moji-ku, Kitaku-kaigan (M. Ohno, 1983, TNS)	-
[Nakatsu-1] Toyomae-shi, Tsunetomi, Nisho-gu shrine (S. Tsutsui, 1982, TNS)	-
[Kokura-1] Kita-kyushu-shi, Moji-ku, Kazashi-yama (M. Ohno, 1983, TNS)	-
[Gyobashi-1] Kita-kyushu-shi, Kokura-minami-ku, Hirao-dai, Senbutsu-do (S. Tsutsui, 1972, TNS)	-
[Gyobashi-3] Kita-kyushu-shi, Yahata-nishi-ku, Kongo-san (H. Ochiai, H. Harada & S. Tsutsui, 1985, TNS)	-
[Gyobashi-4] Kawara-cho, Ryuga-bana (S. Tsutsui, 1975, TNS)	-
[Tagawa-1] Tsuiki-cho, Shimo-fukaya (S. Tsutsui, 1983, TNS)	-
[Yoshii-4] Haki-cho, Otoishi-gawa (H. Inoue, 1983, TNS)	-
[Hida-3] Ukiha-cho, Saji-barai (H. Inoue, 1983, TNS)	-
[Hida-4] Yabe-mura, Hyuga-gami dam (S. Tsutsui, 1981, TNS)	-
[Orio-1] Kita-kyushu-shi, Wakamatsu-ku, Iwaya (S. Kobayashi, 1982, TNS)	-
[Nogata-2] Miyata-cho, Mutsu-dake (S. Tsutsui, 1976, TNS)	-

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- [Nogata-3] Fukuma-cho, Yatsunami (S. Watanabe, 1983, TNS) -
- [Nogata-4] Koga-cho, Taniyama (S. Tsutsui, 1984, TNS) -
- [Dazaihu-1] Iizuka-shi, Dainichi temple (S. Tsutsui, 1982, TNS) -
- [Dazaihu-3] Shinokuri-cho, Yamate (S. Tsutsui, 1976, TNS) -
- [Amaki-1] Amaki-shi, Akizuki, Fuh-fu-iwa (H. Inoue, 1976, TNS) -
- [Amaki-2] Amaki-shi, Minagi (S. Kurashige, 1976, TNS) -
- [Kurume-1] Tanushimaru-cho, Kuma (S. Tsutsui, 1982, TNS) -
- [Kurume-4] Hirokawa-cho, Kami-hirokawa (S. Masumura, 1966, TNS) -
- [Yamaga-1] Tachibana-cho, Yamanaka (S. Tsutsui, 1981, TNS) -
- [Fukuoka-3] Fukuoka-shi, Higashi-ku, Shika Isl. (S. Tsutsui, 1975, TNS) -
- [Sefuri-yama-1] Nakagawa-cho, Ichinose (S. Tsutsui, 1985, TNS) -
- [Hamazaki-3] Nijo-cho, Mt. Uki-dake (T. Hirano, 1983, TNS) -
- Saga pref.**
- [Saga-1] Kita-shigeyasu-cho, Chiguri (Y. Kuranari, 1981, TNS) -
- [Hamazaki-2] Fuji-cho, Shimo-oseo-kawa (Y. Kuranari, 1969, TNS) -
- [Hamazaki-3] Shichiyama-mura, Imasaka, Takeo shrine (Y. Kuranari, 1982, TNS) -
- [Takeo-1] Taku-shi, Taku-cho, Kishikawa (Y. Kuranari, 1982, TNS) -
- [Takeo-2] Ushizu-cho, Tokawa temple (Y. Kuranari, 1975, TNS) -
- [Takeo-3] Imari-shi, Okawa-cho, Tachikawa-hondani (N. Niwaki, 1981, TNS) -
- [Takeo-4] Takeo-shi, Asahi-cho, Nakano (N. Niwaki, 1979, TNS) -
- [Kashima-3] Ureshino-cho, Shikinami (T. Baba, 1963, TNS) -
- [Kashima-4] Kashima-shi, San-gocho (T. Baba, 1975, TNS) -
- [Karatsu-1] Karatsu-shi, Sashi (Y. Tanno, 1976, TNS) -
- [Karatsu-2] Kitahata-mura, Yamabiko (M. Kawanami, 1976, TNS) -
- [Karatsu-3] Bizen-cho, Shinkyu (Y. Kuranari, 1970, TNS) -
- [Karatsu-4] Imari-shi, Hatatsu-cho, Benga (M. Kawanami, 1983, TNS) -
- [Imari-1] Imari-shi, Ima-dake (M. Sadamatsu, 1976, TNS) -
- [Imari-2] Yamauchi-cho, Sangen-zaka (Y. Kuranari, 1982, TNS) -
- [Imari-4] Nishi-arita-cho, Karafune-yama (Y. Kuranari, 1978, TNS) -
- [Souki-2] Ureshino-cho, Kami-iwaya, Shimizu (H. Koike, 1975, TNS) -
- Nagasaki pref.**
- [Isahaya-2] Takaki-cho, Kozu-kura (S. Koga, 1985, TNS) -
- [Isahaya-3] Takaki-cho, Todorokino-taki waterfall (S. Koga, 1985, TNS) -
- [Hizan-ohama-1] Chijiwa-cho, Kizu (S. Koga, 1985, TNS) -
- [Hizen-ohama-3] Iimori-cho, Kobana (S. Koga, 1985, TNS) 64
- [Katsumoto-1] Ashibe-cho, Moroyoshi-nakafure, Ryuzo temple (S. Tsutsui, 1980, TNS) -
- [Katsumoto-4] Gono-ura-cho, Konya-cho (T. Shinagawa, 1969, TNS) -
- [Imari-3] Sechibaru-cho, Kurikoshi-men (S. Koga, 1985, TNS) -
- [Souki-2] Higashi-sonogi-cho, Ryuto-sen (S. Koga, 1985, TNS) -
- [Nagasaki-1] Nagasaki-shi, Une-betto (S. Koga, 1985, TNS) -
- [Nagasaki-2] Nagasaki-shi, around water supply of Onokura (S. Koga, 1985, TNS) -
- [Nagasaki-3] Nagasaki-shi, Inasa-yama (S. Koga, 1985, TNS) -
- [Nagasaki-4] Shikao-cho, around mid stream of Shikao river (S. Koga, 1985, TNS) -
- [Sasebo-2] Kosasa-cho, Kosaka-men, Shinden (S. Koga, 1985, TNS) -
- [Sasebo-3] Kosasa-cho, Takekoba (S. Tsutsui, 1983, TNS) -
- [Sasebo-nanbu-1] Sasebo-shi, Fukuishi-kannon (S. Koga, 1985, TNS) -
- [Sasebo-nanbu-2] Saikai-cho, Nakaura (B. Matsubayashi, 1963, TNS) -
- [Kamiura-1] Seihi-cho, Torikago (B. Matsubayashi, 1961, TNS) -
- [Izumi-2] Kami-tushima-cho, Izumi (S. Tsutsui, 1979, TNS) -
- [Fukue-3] Fukue-shi, Kokuzou to Takada (S. Tsutsui, 1980, TNS) -
- Oita pref.**
- [Sagano-seki-1] Sagano-seki-cho, Takashima (Y. Takaoka, 1981, TNS) -
- [Usuki-2] Tsukumi-shi (M. Hadano, 1962, TNS) -
- [Usuki-4] Yayoi-cho, Mt. Shakuma (M. Hadano, 1960, TNS) -
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[Saeki-3] Honjo-mura, Onagara (M. Sato, 1975, TNS)	-
[Tsurukawa-3] Kakaji-cho, Ebisu (M. Hadano, 1965, TNS)	-
[Tsurukawa-4] Bungo-takada-shi, Hinata-daira (Y. Takaoka, 1965, TNS)	-
[Oita-3] Oita-shi, Takasaki-yama (M. Hadano, 1961, TNS)	-
[Inukai-2] Notsu-cho, Furen (T. Oda, 1978, TNS)	-
[Mie-machi-1] Honjo-mura, Inao (M. Hadano, 1940, TNS)	-
[Mie-machi-4] Mie-machi, Oshiro-dani (M. Hadano, 1977, TNS)	-
[Beppu-1] Beppu-shi, Otobaru (Y. Takaoka, 1984, TNS)	-

**Kumamoto pref.**

[Happoga-take-4] Kikuchi-shi, Furukawa (M. Beppu, 1977, TNS)	-
[Kikuchi-2] Otsu-cho, Hata (M. Beppu, 1976, TNS)	-
[Mifune-4] Kousa-cho, Rokugo (M. Ishisaka, 1982, TNS)	-
[Toyo-1] Kousa-cho, Mt. Kousa (M. Beppu, 1978, TNS)	-
[Toyo-3] Toyono-mura, Mt. Suisho (M. Ishisaka, 1983, TNS)	-
[Toyo-4] Izumi-mura, Hitotsu-uji (M. Beppu, 1973, TNS)	-
[Tochi-3] Itsuki-mura, Kozuru, Shiro waterfall (T. Kariyazaki, 1970, TNS)	-
[Hitoyoshi-1] Sue-mura, Kurohi-chi (M. Beppu, 1984, TNS)	-
[Yamaga-2] Yamaga-shi, Fudo-iwa (M. Ishisaka, 1982, TNS)	-
[Kumamoto-3] Kumamoto-shi, Chikou-zu (M. Ishisaka, 1982, TNS)	-
[Kumamoto-4] Udo-shi, Amizu-cho, Mt. Nozoe (M. Ishisaka, 1982, TNS)	-
[Yatsushiro-1] Shiranui-cho, Kazuhara (M. Beppu, 1978, TNS)	-
[Yatsushiro-4] Yatsushiro-shi, Oshima (M. Beppu, 1971, TNS)	-
[Hinaku-4] Taura-cho, Kasayama (M. Ishisaka, 1981, TNS)	-
[Sajiki-3] Ashikita-cho, Sajiki (M. Kido, 1977, TNS)	-
[Sajiki-4] Kuma-mura, Takemoto (M. Beppu, 1984, TNS)	-
[Arao-1] Arao-shi, Mizushima (M. Ishisaka, 1982, TNS)	-
[Misumi-1] Misumi-cho, Mt. Misumi (M. Ishisaka, 1982, TNS)	-
[Kyoragi-3] Sumoto-cho, Kochi (Y. Kobayashi, 1983, TNS)	-
[Minamata-1] Taura-cho, Umi-ura (M. Ishisaka, 1982, TNS)	-

**Kagoshima pref.**

[Kirishima-yama-4] Makizono-cho, Todoroki (K. Takesako, 1979, TNS)	-
[Kokubu-3] Kokubu-shi, Ogano waterfall (K. Takesako, 1976, TNS)	-
[Awano-3] Satsuma-cho, Kanayama (K. Takesako, 1980, TNS)	-
[Awano-4] Aira-cho, Do-yama (M. Kawabata, 1983, TNS)	-
[Kajiki-1] Kajiki-cho, Oyamada (K. Kawahara, 1977, TNS)	-
[Kajiki-2] Kajiki-cho, Mt. Zao (K. Takesako, 1980, TNS)	-
[Kajiki-4] Kamo-cho, Akashi (K. Takesako, 1981, TNS)	-
[Izumi-1] Izumi-shi, Nitto, Mt. Yahazu (M. Kido, 1959, TNS)	-
[Sendai-3] Sendai-shi, Hyakuji-cho, Kami-beppu (K. Kawahara, 1980, TNS)	-
[Ushibuka-2] Higashi-cho, Takanosu (K. Kawahara, 1975, TNS)	-
[Akune-1] Higashi-cho, Hino-ura (K. Kawahara, 1975, TNS)	-

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No. of locality: 369

s/s\*: Spores per sporangium.

## Appendix 9. The charactor of gross morphology on fresh specimens

## A1 type on Hokkaido District

No.	Locality (population)	Fronde length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
SM921022- 1	Todohokke-mura,								
	Choshi-misaki		660	0	0	47		3.1	○
2	Ibid.	240	670	4	3	61	23	2.7	○
3	Ibid.	150	590	2	0	31	22	1.4	○
4	Ibid.	185	670	5	2	41	18	2.3	○
5	Ibid.	620	710	11	0	95	37	2.6	○
6	Moto-mura	290	600	3	0	62	26	2.4	○
7	Ibid.	125	660	2	0	20	18	1.1	○
8	Ibid.	125	500	2	0	18	11	1.6	○
9	Ibid.	170	410	1	0				○
10	Ibid.	85	420	1	0				○
11	Ibid.	133	700	2	0	24	21	1.1	○
12	Ibid.	205	620	2	0	25	22	1.1	○
13	Ibid.	65	700	1	0				○
14	Esan-misaki	290	590	5	0	52	24	2.2	○
15	Ibid.	95	500	1	0				○
16	Ibid.	110	530	2	0	25	17	1.5	○
18	Ibid.	120	550	2	0	41	23	1.8	○
19	Ibid.	100	550	2	0	25	21	1.2	○
20	Ibid.	164	540	2	0	34	22	1.5	○
21	Ibid.	190	850	6	0	33	17	1.9	○
22	Ibid.	226	700	5	0	56	25	2.2	○
SM921023- 1	Hakodate-shi,								
	Tachimachi-misaki	100	760	4	0	17	13	1.3	○
2	Ibid.	101	730	3	0	21	15	1.4	○
3	Ibid.	173	930	6	0	37	23	1.6	○
4	Ibid.	125	740	3	0	29	21	1.4	○
5	Ibid.	126	670	3	0	30	25	1.2	○
6	Ibid.	210	860	6	0	40	26	1.5	○
7	Ibid.	200	750	5	0	37	21	1.8	○
8	Ibid.	225	650	4	0	32	18	1.8	○
9	Ibid.	132	880	4	0	23	18	1.3	○
10	Ibid.	146	710	4	0	25	22	1.1	○
11	Ibid.	77	710	2	0	20	17	1.2	○
12	Ibid.	90	610	6	0	21	15	1.4	○
13	Ibid.	90	720	2	0	21	22	1.0	○
14	Ibid.	177	660	3	0	22	16	1.4	○
15	Ibid.	125	660	4	1	22	12	1.8	○
16	Ibid.	69	740	2	0	12	11	1.1	○
17	Ibid.	80	710	3	0	17	18	0.9	○
18	Ibid.	60	800	3	0	14	14	1.0	○
19	Ibid.	50	760	2	0	16	18	0.9	○
20	Ibid.	75	740	3	0	12	13	0.9	○
21	Ibid.	50	770	2	0	13	12	1.1	○
22	Ibid.	420	790	9	0	62	33	1.9	○
23	Ibid.	245	720	5	0	52	23	2.3	○
SM921024- 1	Okushiri Isl.,								
	Gakeno-misaki	142	950	5	0	23	16	1.4	○
2	Ibid.	250	940	8	0	38	21	1.8	○
3	Ibid.	240	910	6	0	47	20	2.4	○
4	Ibid.	220	850	7	0	36	16	2.3	○
5	Hoya-ishi	60	730	3	0	25	11	2.3	○
6	Ibid.	80	640	4	0	22	10	2.2	○

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App. 9.

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7	Ibid.	270	690	8	0	36	17	2.1	○
8	Ibid.	492	660	6	0	71	34	2.1	○
	MAX	620	950	11	3	95	37	3.1	○:100%
	MIN	50	410	1	0	12	10	0.9	●: 0%
	AVERAGE	168	695	4	0	33	19	1.7	
	STDEV	109	121	2	0	17	6	0.5	
	COUNT	51	52	51	52	48	48	48	52

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

**AI type on Kanto District**

No.	Locality (population)	Fronde length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
SM831120- 1	Ibaraki pref., Hitachi-shi, Tajiri-hama	275	990	5	0	57	27	2.1	○
2	Ibid.	220	760	6	0	45	19	2.4	○
3	Ibid.		980		0				○
4	Ibid.	435	860	7	0	60	26	2.3	○
5	Ibid.	310	825	5	0	55	22	2.5	○
6	Ibid.	42	600	1	0				○
7	Ibid.	390	800	8	0	68	23	3.0	○
8	Ibid.	390	800	7	0	66	30	2.2	○
SM800716- 1	Ibid.	74		4	0	30	11	2.7	○
SM720718- 5	Kanagawa pref., Miura-shi, Ken-zaki	105		5	3	27	19	1.4	○
6	Ibid.	90		4	0	21	15	1.4	○
8	Ibid.	80		3	0	38	20	1.9	○
9	Ibid.	153		7	0	33	15	2.2	
14	Ibid.	147		6	6				
	MAX	435	990	8	0	68	30	3.0	○:100%
	MIN	42	600	1	0	30	11	2.1	●: 0%
Tajiri-hama	AVERAGE	267	827	5	0	54	23	2.5	
	STDEV	137	116	2	0	12	6	0.3	
	COUNT	8	8	8	0	7	7	7	7
	MAX	153		7	6	38	20	2.2	○:100%
	MIN	80		3	0	21	15	1.4	●: 0%
Ken-zaki	AVERAGE	115		5	2	30	17	1.7	
	STDEV	30		1	2	6	2	0.3	
	COUNT	5		5	5	4	4	4	5
	MAX	435	990	8	6	68	30	3.0	○:100%
	MIN	42	600	1	0	21	11	1.4	●: 0%
Kanto District	AVERAGE	209	827	5	1	45	21	2.2	
	STDEV	132	116	2	2	16	5	0.5	
	COUNT	13	8	13	14	11	11	11	11

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

**AI type on Jogasaki, Ito-shi, Shizuoka pref.**

No.	Locality (population)	Fronde length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
SM770508- 1	Mizuga-saki	465	846	8	0	65	27	2.4	○
2	Ibid.	315	770	4	0	63	29	2.2	○
3	Ibid.	420	750	13	0				○
4	Ibid.	240	679	5	0	62	22	2.8	○
5	Ibid.	215	605	3	0	38	23	1.7	○
6	Ibid.	440	873	11	0	79	29	2.7	○
7	Ibid.	265	875	8	0	56	21	2.7	○

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8	Ibid.	310	735	7	0	67	27	2.5	○
10	Ibid.	510	772	10	0	61	24	2.5	○
11	Ibid.	422	750	9	0	65	27	2.4	○
12	Ibid.	185	730	7	0	32	21	1.5	○
13	Ibid.	132	875	4	0	27	17	1.6	○
14	Ibid.	185	830	7	0	31	20	1.6	○
15	Ibid.	245	760	11	0	30	15	2.0	○
16	Ibid.	150	808	4	0	22	13	1.7	○
17	Ibid.	220	709	4	0	37	19	1.9	○
18	Ibid.	113	640	3	0	19	12	1.6	○
19	Ibid.	139	706	3	0	32	16	2.0	○
20	Ibid.	210	723	5	0	21	19	1.1	○
21	Ibid.	105	648	3	0	24	18	1.3	○
22	Ibid.	86	845	3	0	15	9	1.7	○
23	Ibid.	180	893	4	0	46	20	2.3	○
24	Ibid.	309	751	9	0	53	25	2.1	○
25	Ibid.	275	888	8	0	39	18	2.2	○
26	Ibid.	310	643	9	0	43	23	1.9	○
27	Ibid.	165	793	3	0	36	18	2.0	○
28	Ibid.	242	685	7	0	37	19	1.9	○
30	Ibid.	98	705	3	0	14	10	1.4	○
31	Ibid.	242	679	6	0	48	24	2.0	○
32	Ibid.	162	800	6	0	34	17	2.0	○
33	Ibid.	410	652	6	0	70	39	1.8	○
34	Ibid.	365	735	6	0	50	25	2.0	○
36	Ibid.	80	650	3	0	15	14	1.1	○
37	Ibid.	125	650	5	0	29	19	1.5	○
38	Ibid.	190	733	5	0	40	25	1.6	○
39	Ibid.	260	615	7	0	50	21	2.4	○
40	Ibid.	87	560	2	0	21	19	1.1	○
41	Ibid.	460	810	9	0	67	25	2.7	○
42	Ibid.	235	778	6	0	47	22	2.1	○
43	Ibid.	585	836	12	0	102	36	2.8	○
44	Ibid.	550	765	9	0	78	30	2.6	○
45	Ibid.	560	848	14	0	70	28	2.5	○
46	Ibid.	355	942	9	0	49	24	2.0	○
47	Ibid.	630	880	10	0	80	27	3.0	○
48	Ibid.	570	753	9	0	72	25	2.9	○
49	Ibid.	520	950	8	0	90	30	3.0	○
50	Ibid.	550	875	14	0	70	29	2.4	○
51	Ibid.	430	963	10	0	72	27	2.7	○
52	Ibid.	215	758	5	0	55	17	3.2	○
53	Ibid.	705	910	12	0	94	34	2.8	○
54	Ibid.	400	655	6	0	72	25	2.9	○
55	Ibid.	475		6	0	72	32	2.3	○
56	Ibid.	453	816	9	0	68	25	2.7	○
57	Ibid.	545	763	9	0				○
58	Ibid.	410	775	10	0	75	24	3.1	○
59	Ibid.	225	785	5	0	49	22	2.2	○
60	Ibid.	320	725	7	0	50	21	2.4	○
61	Ibid.	405	842	12	0	51	22	2.3	○
62	Ibid.	127	665	5	0	40	19	2.1	○
63	Ibid.	290	565	3	0	62	25	2.5	○
64	Ibid.	620	580	6	0	84	40	2.1	○
65	Ibid.	162	665	3	0	20	16	1.3	○
66	Ibid.	290	683	4	0	65	24	2.7	○
67	Ibid.	550	685	6	0	92	30	3.1	○
68	Ibid.	510	700	9	0	70	32	2.2	○
69	Ibid.	100	835	3	0	14	10	1.4	○

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70	Ibid.	150	753	3	0	34	16	2.1	○
72	Ibid.	775	824	10	0	84	31	2.7	○
73	Ibid.	700	850	8	0	78	30	2.6	○
76	Ibid.	605	888	9	0	80	31	2.6	○
82	Ibid.	390	642	4	0	60	30	2.0	○
95	Ibid.	245	482	3	0	38	29	1.3	○
	MAX	775	963	14	0	102	40	3.2	○:100%
	MIN	80	482	2	0	14	9	1.1	●: 0%
	AVERAGE	333	755	7	0	53	23	2.2	
	STDEV	176	101	3	0	22	7	0.5	
	COUNT	72	71	72	70	70	70	70	71

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

A1 type on Shimoda-shi, Shizuoka pref.

No.	Locality (population)	Fronnd length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
SM720818- 3	Akane-jima	115	846	5	0	23	12	1.9	○
4	Ibid.	90	770	3	0	24	13	1.8	○
5	Ibid.	90	750	4	0	19	15	1.3	○
7	Ibid.	130	679	5	0	23	17	1.4	○
11	Ibid.	133	605	4	0	37	18	2.1	○
12	Ibid.	98	873	3	0	20	17	1.2	○
15	Ibid.	90	875	6	0	18	10	1.8	○
18	Ibid.	137		5	0	20	13	1.5	○
SM880509- 1	Ibid.	85		4	0	28	13	2.2	○
2	Ibid.	130		3	0	28	17	1.6	○
13	Ibid.	133		4	0	30	16	1.9	○
14	Ibid.	205		7	0	35	13	2.7	○
15	Ibid.	110		4	0	28	16	1.8	○
16	Ibid.	110		4	0	32	14	2.3	○
23	Ibid.	120		4	0	32	15	2.1	○
27	Ibid.	75		2	0	14	15	0.9	○
28	Ibid.	60		3	0	12	10	1.2	○
SM730527-14	Tsumeki-saki	140		6	0	34	12	2.8	○
15	Ibid.	242		5	0	52	26	2.0	○
21	Ibid.	150		6	0	31	16	1.9	○
31	Ibid.	120		5	0	22	15	1.5	○
SM730708- 2	Ibid.	155		6	0	33	13	2.5	○
4	Ibid.	227		6	0	46	25	1.8	○
6	Ibid.	75		3	0	17	12	1.4	○
7	Ibid.	90		3	0	18	16	1.1	○
8	Ibid.	117		4	1	27	18	1.5	○
9	Ibid.	80		5	3	17	10	1.7	○
SM750713- 7	Ibid.	235		5	0	50	21	2.4	○
10	Ibid.	225		4	0	52	20	2.6	○
SM811011-35	Ibid.	90		7	0	20	11	1.8	○
34	Ibid.	220		7	1	40	20	2.0	○
SM860504- 1	Ibid.	245		7	0	40	22	1.8	○
SM890625- 4	Ibid.	105		2	1	26	24	1.1	○
SM780521- 1	Hosoma	180		9	0	30	18	1.7	○
SM720818-35	Irita-hama	40		3	0	10	9	1.1	○
36	Ibid.	85		4	0	12	15	0.8	○
37	Ibid.	67		4	1	11	7	1.6	○
SM890625-91	Kisami	92		4	0	25	12	2.1	○
92	Ibid.	96		2	0	26	20	1.3	○
93	Ibid.	75		3	0	21	9	2.3	○
94	Ibid.	75		3	0	20	10	2.0	○

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MAX	245	9	3	52	26	2.8	○:100%
MIN	40	2	0	10	7	0.8	●: 0%
AVERAGE	125	4	0	27	15	1.8	
STDEV	54	2	1	11	4	0.5	
COUNT	41	41	41	41	41	41	41

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

## A1 type on southern Kii peninsula

No.	Locality (population)	Fronde length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
SM920919- 6	Shirahama-cho,								
	Sandan-peki	330	625	5	0	64	22	2.9	○
7	Ibid.	130	690	4	0	41	20	2.1	○
8	Ibid.	160	780	6	0	37	14	2.6	○
9	Ibid.	115	760	5	0	40	20	2.0	○
10	Ibid.	140	730	4	0	45	17	2.6	○
11	Ibid.	75	610	1	0				○
12	Ibid.	130	800	5	0	30	16	1.9	○
13	Ibid.	150	710	7	0	34	17	2.0	○
14	Ibid.	180	750	7	1	50	16	3.1	○
SM920920- 4	Kushimoto-cho,								
	Siono-misaki	160	690	3	0	52	19	2.7	○
5	Ibid.	63	780	3	0	30	16	1.9	○
6	Ibid.	100	630	3	1	40	19	2.1	○
7	Ibid.	73	630	4	0				○
8	Ibid.	160	500	2	0	33	22	1.5	○
9	Ibid.	90	580	2	0	17	15	1.1	○
10	Ibid.	100	720	4	0	21	13	1.6	○
11	Ibid.	40	490	1	1				○
19	Taichi-cho,								
	Kantori-saki	133	800	6	0	40	20	2.0	○
20	Ibid.	125	900	6	0	30	12	2.5	○
21	Ibid.	75	720	4	0	33	20	1.7	○
22	Ibid.	95	920	4	0	27	16	1.7	○
23	Ibid.	45	1030	3	0	20	12	1.7	○
24	Ibid.	100	700	5	0	23	13	1.8	○
25	Ibid.	100	750	5	0	25	13	1.9	○
26	Ibid.	34	530	1	0				○
	MAX	330	1030	7	1	64	22	3.1	○:100%
	MIN	34	490	1	0	17	12	1.1	●: 0%
	AVERAGE	116	713	4	0	35	17	2.1	
	STDEV	59	124	2	0	11	3	0.5	
	COUNT	25	25	25	25	21	21	21	25

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

## A1 type on Izu Isls.

No.	Locality (population)	Fronde length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
SM720723- 1	Kozu Isl.	130		6	0	22	13	1.7	○
SM810711-13	Ibid.	220		8	0	42	19	2.2	○
14	Ibid.	280		8	0	60	23	2.6	○
30	Ibid.	300		9	0	57	24	2.4	○
SM801010- 1	Miyake Isl.	315		9	0	72	30	2.4	○
2	Ibid.	375		5	2	80	40	2.0	○

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	3	Ibid.	335	11	0	60	25	2.4	○
	4	Ibid.	320	7	0	80	31	2.6	○
	5	Ibid.	245	4	0	78	35	2.2	○
SM810706-39		Ibid.	235	4	1	53	21	2.5	○
	38	Ibid.	340	9	0	70	22	3.2	○
	45	Ibid.	285	8	0	55	20	2.8	○
SM810709-7		Mikura Isl.	315	6	0	85	40	2.1	○
	9	Ibid.	255	7	0	63	38	1.7	○
	10	Ibid.	180	4	0	34	19	1.8	○
	11	Ibid.	220	6	0	57	25	2.3	○
	12	Ibid.	185	6	0	40	21	1.9	○
	13	Ibid.	230	6	0	52	27	1.9	○
	14	Ibid.	195	5	0	40	20	2.0	○
		MAX	375	11	2	85	40	3.2	○:100%
		MIN	130	4	0	22	13	1.7	●: 0%
		AVERAGE	284	7	0	63	26	2.4	
		STDEV	62	2	1	17	8	0.4	
		COUNT	13	13	13	13	13	13	13

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

AI type on Hachijo Isl.

No.	Locality (population)	Fron length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
SM890127- 1	Borawa-zawa	395		10	0	80	30	2.7	○
2	Ibid.	200		11	0	50	23	2.2	○
4	Ibid.	570		10	0	100	28	3.6	○
5	Ibid.	490		11	0	80	30	2.7	○
6	Ibid.	340		16	1	55	21	2.6	○
7	Ibid.	145		6	0	40	17	2.4	○
8	Ibid.	110		4	0	43	19	2.3	○
10	Ibid.	750		12	0	110	40	2.8	○
11	Ibid.	630		12	0	102	33	3.1	○
12	Ibid.	905		10	0	125	40	3.1	○
13	Ibid.	760		15	0	100	40	2.5	○
14	Ibid.	1010		13	0	125	37	3.4	○
15	Ibid.	570		9	0	92	32	2.9	○
SM890129- 2	Kashitate	425		9	0	75	30	2.5	○
3	Ibid.	165		8	0	47	23	2.0	○
4	Ibid.	460		11	0	70	39	1.8	○
5	Ibid.	200		7	0	45	23	2.0	○
6	Ibid.	255		9	1	60	25	2.4	○
SM890130- 6	Nakanogo	270		8	1	62	26	2.4	○
7	Ibid.	210		4	3	45	29	1.6	○
8	Ibid.	420		10	0	51	30	1.7	○
9	Ibid.	475		10	0	63	30	2.1	○
	MAX	1010		16	3	125	40	3.6	○:100%
	MIN	110		4	0	40	17	1.6	●: 0%
	AVERAGE	443		10	0	74	29	2.5	
	STDEV	246		3	1	27	7	0.5	
	COUNT	22		22	22	22	22	22	22

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

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## App. 9.

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## A2 type on southern Kyushu

No.	Locality (population)	Frond length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
SM901208- 1	Kasasa-cho, Okuzure	740	470	11	2	110	34	3.2	●
2	Ibid.	630	490	11	2	92	35	2.6	●
3	Ibid.	650	400	13	5	90	28	3.2	●
4	Ibid.	800	410	17	2	80	26	3.1	●
5	Ibid.	750	600	19	3	100	30	3.3	●
6	Ibid.	710	420	12	3	100	31	3.2	●
7	Ibid.	260	440	5	3	65	22	3.0	●
8	Ibid.	540	470	9	2	100	34	2.9	●
9	Ibid.	340	470	11	3	75	23	3.3	●
10	Taniyama	620	460	14	2	115	46	2.5	●
11	Ibid.	560	550	12	1	79	31	2.5	●
12	Ibid.	620	510	15	2	105	35	3.0	○
13	Ibid.	790	520	14	0	100	35	2.9	●
14	Ibid.	600	480	11	3	120	38	3.2	○
15	Ibid.	640	530	14	2	90	30	3.0	○
16	Ibid.	700	550	15	3	108	42	2.6	○
17	Ibid.	580	500	13	4	113	46	2.5	○
18	Ibid.	590	500	13	4	85	30	2.8	●
19	Noma-zaki	630	400	10	3	95	40	2.4	●
20	Ibid.	810	380	13	3	110	38	2.9	○
21	Ibid.	710	380	11	4	100	40	2.5	●
22	Ibid.	450	570	8	2	100	32	3.1	○
23	Ibid.	430	520	9	2	95	32	3.0	○
24	Ibid.	670	470	15	4	85	35	2.4	●
25	Ibid.	580	470	9	2	105	40	2.6	●
26	Ibid.	910	450	13	3	110	40	2.8	●
27	Ibid.	800	400	16	0	135	45	3.0	●
28	Ibid.	660	470	13	4	90	32	2.8	●
29	Ibid.	650	500	12	2	110	38	2.9	●
30	Ibid.	630	500	13	1	90	40	2.3	○
31	Ibid.	460	540	9	2	92	29	3.2	●
32	Ibid.	650	470	12	1	120	36	3.3	○
33	Ibid.	720	510	13	1	125	50	2.5	○
34	Ibid.	540	460	10	2	110	40	2.8	●
35	Ibid.	600	530	11	3	100	40	2.5	●
36	Ibid.	830	470	15	3	120	40	3.0	○
37	Ibid.	590	540	10	2	102	43	2.4	○
38	Ibid.	590	450	10	3	92	27	3.4	●
SM901209- 1	Makurazaki-shi,								
	Yama-tatsugami	420	570	15	2	75	23	3.3	●
2	Ibid.	240	440	9	2	60	26	2.3	○
5	Ibid.	510	440	14	2	70	24	2.9	●
6	Ibid.	480	500	12	2	54	24	2.3	●
9	Ibid.	640	500	17	2	100	30	3.3	●
10	Ibid.	950	500	15	3	105	33	3.2	●
11	Ibid.	1000	430	12	5	125	44	2.8	●
12	Ibid.	800	520	13	4	105	42	2.5	●
13	Ibid.	720	540	13	4	85	30	2.8	●
14	Ibid.	670	490	10	3	80	30	2.7	○
SM901210- 8	Sata-cho, Sata-misaki	520	430	12	0	120	45	2.7	○
9	Ibid.	500	550	11	2	90	40	2.3	○
10	Ibid.	330	480	7	3	82	28	2.9	○
11	Ibid.	330	430	8	3	78	31	2.5	○
12	Ibid.	560	410	11	10	100	30	3.3	○

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13	Ibid.	750	490	9	3	120	35	3.4	●
14	Ibid.	630	490	15	5	90	30	3.0	●
15	Ibid.	490	510	8	3	120	45	2.7	○
16	Ibid.	740	480	14	2	110	40	2.8	○
17	Ibid.	630	540	15	2	95	40	2.4	○
18	Ibid.	300	500	8	0	70	27	2.6	○
19	Ibid.	600	520	13	5	95	33	2.9	○
20	Ibid.	400	590	14	2	60	24	2.5	●
22	Ibid.	600	520	13	5	100	35	2.9	●
23	Ibid.	400	520	8	1	82	30	2.7	○
24	Ibid.	670	570	13	1	120	40	3.0	○
25	Ibid.	510	500	15	2	85	36	2.4	●
26	Ibid.	710	520	16	5	107	36	3.0	○
27	Ibid.	460	500	14	2	75	35	2.1	○
28	Ibid.	440	450	12	5	70	26	2.7	○
29	Ibid.	360	530	9	3	62	26	2.4	○
	MAX	1000	600	19	10	135	50	3.4	○ : 45%
	MIN	240	380	5	0	54	22	2.1	● : 55%
	AVERAGE	600	489	12	3	96	34	2.8	
	STDEV	158	50	3	2	18	7	0.3	
	COUNT	69	69	69	69	69	69	69	69

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

A2 type on Northern Okinawa Isl.

No.	Locality (population)	Fronde length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
SM911126- 4	Kunigami-son, Awa	650	470	10	4	115	45	2.6	○
5	Ibid.	435	360	6	2	103	36	2.9	○
6	Ibid.	432	430	5	3	114	35	3.3	●
7	Ibid.	520	330	7	3	105	35	3.0	●
8	Ibid.	445	340	8	2	85	30	2.8	○
9	Ibid.	635	390	9	3	125	42	3.0	●
SM911127- 1	Nago-shi, Kushibaru	765	410	13	4	88	32	2.8	●
2	Ibid.	345	320	7	4	72	33	2.2	○
4	Ibid.	775	440	15	3	120	40	3.0	●
5	Ibid.	935	430	17	2	115	35	3.3	●
6	Ibid.	905	430	11	2	140	35	4.0	●
7	Ibid.	770	410	13	4	120	36	3.3	●
10	Ogimi-son, Miyagi-shima	600	440	9	3	90	36	2.5	○
12	Ibid.	390	360	10	1	68	20	3.4	○
13	Ibid.	275	420	8	1	72	22	3.3	○
14	Ibid.	775	400	8	3	95	30	3.2	○
15	Ibid.	595	430	8	3	113	38	3.0	●
16	Ibid.	580	420	12	2	95	31	3.1	○
17	Ibid.	500	380	10	2	85	29	2.9	○
18	Ibid.	650	390	12	2	100	38	2.6	●
19	Ibid.	700	450	8	3	115	44	2.6	●
20	Ibid.	710	390	10	3	118	38	3.1	●
21	Nerome	820	440	10	2	118	45	2.6	○
22	Ibid.	440	370	9	2	88	32	2.8	○
23	Ibid.	630	330	11	3	70	28	2.5	○
24	Ibid.	625	440	11	3	85	32	2.7	○
29	Kunigami-son, Iji	670	450	9	2	110	42	2.6	○
30	Ibid.	650	450	13	2	130	40	3.3	○
31	Ibid.	755	450	16	3	130	38	3.4	●
32	Ibid.	765	450	15	4	135	44	3.1	○

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## App. 9.

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33	Ibid.	680	420	15	2	97	29	3.3	●
34	Ibid.	610	360	11	2	90	35	2.6	●
35	Ibid.	495	410	9	4	110	38	2.9	●
36	Ibid.	460	430	6	3	110	37	3.0	●
37	Ibid.	380	400	6	3	90	38	2.4	○
39	Uka	680	450	13	2	110	41	2.7	●
40	Ibid.	700	430	11	3	115	45	2.6	●
41	Ibid.	930	420	12	2	140	47	3.0	○
42	Ibid.	365	420	7	2	80	33	2.4	●
43	Ibid.	580	460	10	3	102	40	2.6	○
44	Ibid.	785	500	17	2	118	45	2.6	●
45	Ibid.	535	460	11	2	114	40	2.9	●
46	Ibid.	550	450	12	2	105	40	2.6	●
47	Ibid.	615	390	9	3	95	39	2.4	○
48	Ibid.	775	440	10	2	115	61	1.9	○
49	Ibid.	815	380	14	2	113	45	2.5	●
50	Ibid.	690	400	9	1	107	35	3.1	●
51	Ibid.	700	460	8	2	100	44	2.3	○
52	Ibid.	825	430	10	2	110	45	2.4	○
53	Ginama		350	10	2	130	34	3.8	●
55	Ibid.	375	440	5	3	82	25	3.3	●
56	Ibid.	490	400	8	3	100	39	2.6	●
57	Ibid.	630	430	10	1	100	38	2.6	●
58	Hedo-misaki	510	380	9	3	98	30	3.3	●
59	Ibid.	710	480	14	3	93	29	3.2	●
60	Ibid.	775	330	12	4				○
61	Ibid.	745	410	13		92	27	3.4	○
62	Ibid.	635	470	14	4	85	30	2.8	○
63	Ibid.	325	480	5	2	77	31	2.5	○
64	Ibid.	555	400	10	3	92	34	2.7	●
65	Oku		390		1	93	26	3.6	●
66	Ibid.	650	430	10	7	100	42	2.4	●
67	Ibid.	320	380	7	2	65	29	2.2	●
68	Ibid.	365	490	10	2	86	35	2.5	○
69	Ibid.	445	520	10	3	88	35	2.5	●
70	Higashi-son, Izena	265	420	7	4	55	20	2.8	●
71	Ibid.	405	470	8	3	101	30	3.4	●
72	Ibid.	515	530	12	2	101	23	4.4	●
73	Ibid.	310	500	7	2	88	29	3.0	●
74	Ibid.	270	490	6	3	57	20	2.9	●
75	Ibid.	350	480	8	1	81	25	3.2	○
76	Ibid.	350	500	7	3	85	35	2.4	○
77	Ibid.	450	450	9	4	90	35	2.6	○
78	Ibid.	455	380	8	3	60	22	2.7	○
79	Ibid.	445	520	9	3	85	33	2.6	○
80	Ibid.	190	450	4	2	52	22	2.4	○
	MAX	935	530	17	7	140	61	4.4	○ : 46%
	MIN	190	320	4	1	52	20	1.9	● : 54%
	AVERAGE	574	425	10	3	98	35	2.9	
	STDEV	176	47	3	1	20	7	0.4	
	COUNT	74	76	75	75	75	75	75	76

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*:IC: Indusium's color

## A2 type on Ogasawara (Bonin) Isls.

No.	Locality (population)	Fronnd length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
890702-1	Chichi-jima Isl., Sakai-ura	760		15	5.0	92	40	2.3	○

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App. 9.

-(continued)-

2	Ibid.	650		15	9.5	85	37	2.3	○
890703-3	Ibid.	425		11	4.0	70	24	2.9	○
4	Ibid.	660		13	4.0	83	32	2.6	○
5	Ibid.	650		12	7.5	98	33	3.0	●
6	Ibid.	450		13	1.0	67	21	3.2	●
10	Ibid.	540		12	2.0	70	37	1.9	●
13	Ibid.	770		14	9.5	110	54	2.0	●
14	Ibid.	580		14	9.5	71	40	1.8	●
890705-1	Ibid.	305		11	1.0	46	24	1.9	○
2	Mikazuki-yama	550		10	5.0	85	40	2.1	●
3	Ibid.	450		11	6.0	77	37	2.1	●
940113-1	Sakai-ura	475	310	10	9.0	65	31	2.1	●
2	Ibid.	417	300	12	5.5	75	30	2.5	○
3	Ibid.	355	390	10	5.0	86	41	2.1	●
4	Ibid.	355	370	11	8.0	76	34	2.2	●
5	Ibid.	372	310	15	5.0	66	30	2.2	●
6	Kopepe-kaigan	300	330	11	4.0	58	33	1.8	●
7	Ibid.	560	280	11	1.7	90	40	2.3	●
8	Ibid.	315	280	13	7.5	55	29	1.9	●
9	Ibid.	290	250	8	3.0	57	26	2.2	●
10	Ibid.	323	300	9	3.0	64	24	2.7	●
940117-1	Tenno-ura	600	200	12	6.0	90	34	2.6	●
2	Ibid.	570	320	19	6.0	52	18	2.9	○
3	Nishi-kaigan 1	605	220	13	1.5	70	40	1.8	●
4	Ibid.	535	200	9	4.0	80	40	2.0	●
5	Ibid.	580	200	9	3.0	70	29	2.4	●
6	Ibid.	535	280	10	3.0	85	37	2.3	●
7	Nishi-kaigan 2	750	300	17	2.0	95	35	2.7	●
8	Ibid.	580	310	10	1.0	85	32	2.7	○
9	Ibid.	700	280	18	2.0	85	37	2.3	○
10	Ibid.	670	300	13	2.0	67	32	2.1	●
11	Ibid.	485	320	10	6.0	70	29	2.4	●
12	Ibid.	545	310	8	1.0	100	33	3.0	●
13	Nishi-kaigan 3	420	310	10	1.0	60	30	2.0	●
14	Ibid.	420	260	13	5.0	66	35	1.9	○
15	Ibid.	420	330	10	1.0	60	30	2.0	●
16	Ibid.	450	300	7	0.5	60	40	1.5	○
17	Ibid.	470	250	9	4.5	75	37	2.0	●
18	Ibid.	505	300	10	2.0	87	33	2.6	●
19	Ibid.	490	360	7	4.0	82	30	2.7	●
T. Yamamoto	Haha-jima Isl.,								
1978	Kuwanoki-yama	685		13	4.5	105	39	2.7	●
940114-1	Yashi-hama	445	280	11	10.9	81	34	2.4	●
2	Ibid.	420	280	11	3.0	75	27	2.8	●
3	Ibid.	360	280	10	2.0	78	32	2.4	●
4	Ibid.	690	300	14	4.3	83	29	2.9	○
5	Ibid.	525	270	13	2.5	64	28	2.3	○
6	Ibid.	570	340	10	3.5	100	39	2.6	○
7	Ibid.	435	340	9	2.5	85	37	2.3	○
8	Ibid.	500	330	10	4.0	74	31	2.4	●
9	Ibid.	480	320	11	6.0	92	45	2.0	●
10	Ibid.	445	330	8	1.7	67	23	2.9	●
11	Ibid.	575	330	12	5.5	88	34	2.6	○
12	Ibid.	555	350	11	3.5	90	41	2.2	○
13	Ibid.	690	410	11	5.0	94	30	3.1	●
14	Ibid.	705	330	11	3.5	85	40	2.1	●
15	Ibid.	590	370	13	6.8	98	35	2.8	●
16	Ibid.	790	440	14	8.0	110	50	2.2	○
17	Ibid.	580	340	14	5.0	80	35	2.3	●

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## App. 9.

-(continued)-

18	Ibid.	520	300	11	5.0	90	36	2.5	●
19	Ibid.	425	260	13	4.0	67	26	2.6	●
20	Ibid.	545	390	8	5.0	75	35	2.1	○
21	Ibid.	415	290	10	6.0	60	22	2.7	○
22	Kuwanoki-yama	535	390	14	3.0	63	30	2.1	●
23	Ibid.	510	310	13	5.0	65	32	2.0	○
24	Ibid.	475	330	9	8.5	85	30	2.8	●
25	Ibid.	515	330	13	4.0	85	38	2.2	●
26	Ibid.	520	300	11	6.5	82	32	2.6	●
27	Ibid.	365	330	11	4.0	58	33	1.8	○
940115-1	Inokuma-dani	485	220	9	2.5	90	30	3.0	●
2	Ibid.	420	270	7	3.0	61	29	2.1	●
3	Ibid.	570	390	13	2.0	90	42	2.1	●
4	Ibid.	485	210	5	3.0	78	35	2.2	●
5	Sekimon-san	585	320	13	3.0	82	38	2.2	●
6	Ibid.	760	390	13	9.0	93	45	2.1	●
7	Ibid.	810	290	12	3.0	90	34	2.6	●
8	Ibid.	710	380	15	6.0	110	40	2.8	●
9	Ibid.	565	380	11	5.0	85	42	2.0	●
10	Ibid.	530	330	11	7.0	90	36	2.5	●
11	Ibid.	760	280	12	8.0	95	31	3.1	●
12	Ibid.	835	360	14	7.0	113	42	2.7	○
940116-1	Omoto-hama	330	290	11	7.5	50	24	2.1	○
2	Ibid.	455	300	8	4.0	80	42	1.9	●
3	Ibid.	700	220	12	5.0	95	36	2.6	●
4	Ibid.	750	250	13	3.8	85	37	2.3	○
5	Ibid.	400	270	8	3.5	55	27	2.0	○
6	Ibid.	510	320	12	4.5	68	35	1.9	○
7	Ibid.	420	300	9	4.0	72	34	2.1	●
8	Ibid.	480	270	10	3.0	70	34	2.1	●
9	Ibid.	550	380	11	8.0	67	30	2.2	○
10	Ibid.	475	300	13	2.0	71	28	2.5	○
11	Horai-kaigan	460	300	10	2.0	45	22	2.0	○
	MAX	835	440	19	11	113	54	3.2	○ : 33%
	MIN	290	200	5	1	45	18	1.5	● : 67%
	AVG	530	308	11	4	78	34	2.3	
	STD	128	50	2	2	15	6	0.4	
	COUNT	92	79	92	92	92	92	92	92

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

## B type on Jogasaki-kaigan, Ito-shi, Shizuoka pref.

No.	Locality (population)	Fronde length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
SM770508-31	Mizuga-saki	630	591	11	2	78	26	3.0	●
35	Ibid.	350	631	6	1	64	24	2.7	●
71	Ibid.	830	520	14	2	87	30	2.9	●
74	Ibid.	780	615	11	3	100	28	3.6	●
75	Ibid.	700	650	10	0	118	45	2.6	●
77	Ibid.	560	565	8	3	103	37	2.8	●
78	Ibid.	690	541	12	0	90	28	3.2	●
79	Ibid.	715	585	8	0	104	32	3.3	●
80	Ibid.	780	445	9	0	115	30	3.8	●
81	Ibid.	590	653	6	2	140	33	4.2	○
83	Ibid.	770	695	17	0	80	30	2.7	●
84	Ibid.	965	550	13	3	110	33	3.3	●
85	Ibid.	1020	593	14	4	140	33	4.2	●
86	Ibid.	555	490	6	1	93	27	3.4	●

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App. 9.

-(continued)-

87	Ibid.	680	515	7	2	103	30	3.4	●
88	Ibid.	945	612	10	3	122	32	3.8	●
89	Ibid.	940	590	10	1	105	26	4.0	●
90	Ibid.	697	550	5	3	125	31	4.0	●
91	Ibid.	965	636	16	2	107	32	3.3	●
92	Ibid.	825	580	12	1	87	26	3.3	●
93	Ibid.	830	660	12	4	117	35	3.3	●
94	Ibid.	520	567	8	0	75	28	2.7	●
96	Ibid.	430	408	6	0	70	24	2.9	●
97	Ibid.	685	568	12	0	98	31	3.2	●
98	Ibid.	475	496	5	0	86	30	2.9	●
99	Ibid.	370	570	8	0	85	30	2.8	●
100	Ibid.	1270	548	20	0	142	42	3.4	●
101	Ibid.	665	490	12	2	95	31	3.1	●
102	Ibid.	640	565	9	4	120	34	3.5	●
103	Ibid.	720	410	9	3	116	40	2.9	●
	MAX	1270	695	20	4	142	45	4.2	○: 4%
	MIN	350	408	5	0	64	24	2.6	●: 96%
	AVERAGE	720	563	10	2	103	31	3.3	
	STDEV	199	69	4	1	20	5	0.5	
	COUNT	30	30	30	30	30	30	30	30

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

B type on Shimoda-shi, Shizuoka pref.

No.	Locality (population)	Fronde length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
SM720818- 1	Inubashiri Isl.	305		8	0	70	23	3.0	○
2	Wakano-ura	300		6	0	65	24	2.7	●
13	Akane Isl.	560		10	2	90	30	3.0	○
20	Ibid.	210		7	4	42	15	2.8	○
21	Ibid.	235		6	3	70	24	2.9	○
22	Ibid.	465		10	3	55	24	2.3	○
23	Ibid.	405		7	4	80	19	4.2	○
24	Ibid.	200		8	3	50	16	3.1	○
25	Ibid.	200		7	0	55	23	2.4	○
26	Shidaga-ura	580		10	3	85	26	3.3	●
31	Tatado	282		5	1	75	30	2.5	●
32	Ibid.	800		15	2	110	36	3.1	○
33	Ibid.	420		10	2	82	25	3.3	●
34	Ibid.	445		7	0	90	23	3.9	●
38	Ibid.	730		9	4	130	50	2.6	○
41	Ibid.	145		5	0	35	16	2.2	○
SM720819- 1	Yangyo	560		14	4	105	33	3.2	○
2	Ibid.	335		10	1	75	23	3.3	○
SM730103- 1	Suzaki	380		9	0	77	21	3.7	●
SM730115- 2	Ebisu Isl.	200		9	2	47	18	2.6	●
SM730506-28	Hachiman shrine	775		16	4	120	36	3.3	○
SM730527- 2	Tatado	552		9	5	77	27	2.9	●
3	Ibid.	970		18	3	110	32	3.4	●
4	Ibid.	1330		19	0	130	34	3.8	●
5	Ibid.	1150		16	1	140	35	4.0	●
6	Tsumeki-saki	830		12	0	120	36	3.3	○
7	Ibid.	340		5	1	54	22	2.5	○
8	Ibid.	460		9	0	65	22	3.0	○
9	Ibid.	940		13	5	135	40	3.4	●
10	Ibid.	800		16	3	105	35	3.0	○
11	Ibid.	710		15	2	50	30	1.7	○

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## App. 9.

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12	Ibid.	590		12	3	90	35	2.6	○
13	Ibid.	610		17	3	80	29	2.8	○
17	Ibid.	225		5	1	45	17	2.6	●
22	Ibid.	700		19	0	80	30	2.7	○
23	Ibid.	400		8	2	75	25	3.0	●
25	Ibid.	425		16	0	50	19	2.6	○
28	Ibid.	1010		13	3	110	32	3.4	●
29	Ibid.	630		14	1	60	29	2.1	○
30	Ibid.	490		10	0	75	25	3.0	●
SM750713- 8	Ibid.	550		14	2	95	36	2.6	○
9	Ibid.	390		9	2	80	28	2.9	○
11	Ibid.	410		9	5	75	31	2.4	○
12	Ibid.	330		9	3	75	27	2.8	○
SM780521- 4	Suzaki	950		11	2	95	31	3.1	●
SM800211- 6	Sotoura	340		12	2	90	28	3.2	●
7	Ibid.	390		11	2	80	28	2.9	○
SM811004- 2	Oura	515		14	0	60	25	2.4	●
3	Ibid.	610	600	12	0	95	29	3.3	●
4	Ibid.	450		11	1	68	23	3.0	●
5	Ibid.	450	510	9	2	87	35	2.5	●
14	Oura-kaigan	310	510	9	0	45	19	2.4	●
21	Wakano-ura	765	530	12	2	120	40	3.0	○
24	Ibid.	945	550	11	8	150	42	3.6	○
25	Ibid.	480	560	13	5	50	22	2.3	○
SM811005- 5	Kasuga-yama	810	510	10	3	120	32	3.8	●
11	Ibid.	1300	550	14	5	140	57	2.5	○
12	Ibid.	810	450	9	0	110	35	3.1	●
13	Ibid.	790	410	7	2	110	40	2.8	○
17	Ibid.	1135	480	15	3	140	43	3.3	○
18	Ibid.	1060		9	4	100	34	2.9	●
19	Ibid.	640	650	12	2	90	29	3.1	○
SM811006-14	Shimoda 6-choume	540	550	9	7	92	32	2.9	●
SM811009- 6	Ueno-yama	700	670	14	2	80	30	2.7	●
SM811011-18	Fuku-ura	490	700	10	1	72	30	2.4	●
19	Ibid.	450	480	12	3	80	30	2.7	○
20	Ibid.	150	670	7	0	32	15	2.1	○
21	Ibid.	775	460	11	7	120	31	3.9	●
SM811011-29	Ebisu Isl.	300	800	10	0	50	19	2.6	○
30	Ibid.	210	600	8	0	40	16	2.5	○
31	Ibid.	390	600	13	5	90	28	3.2	○
32	Ibid.	510	600	13	7	80	30	2.7	○
33	Ibid.	288	670	9	0	53	22	2.4	○
36	Ibid.	855	570	16	3	140	35	4.0	○
	MAX	1330	800	19	8	150	57	4.2	○ : 58%
	MIN	145	410	5	0	32	15	1.7	● : 42%
	AVERAGE	565	568	11	2	85	29	2.9	
	STDEV	278	88	3	2	29	8	0.5	
	COUNT	74	25	74	74	74	74	74	74

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

## B type on Irozaki, Minami-cho, Shizuoka pref.

No.	Locality (population)	Frond length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
SM760516- 4	Ose	760	542	12	4	112	32	3.5	●
30	Ibid.	1020	550	17	4	138	36	3.8	●
19	Ibid.	1010	579	18	0	90	25	3.6	●
23	Ibid.	550	612	9	1	87	27	3.2	●

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25	Ibid.	620	555	12	0	78	25	3.1	●
24	Ibid.	730	472	12	5	115	39	2.9	●
21	Ibid.	670	545	16	0	77	28	2.8	●
26	Ibid.	270	535	6	0	42	24	1.8	○
18	Ibid.	830	538	19	3	80	30	2.7	●
	MAX	1020	612	19	5	138	39	3.8	○: 11%
	MIN	270	472	6	0	42	24	1.8	●: 89%
	AVERAGE	718	548	13	2	91	30	3.0	
	STDEV	219	35	4	2	26	5	0.6	
	COUNT	9	9	9	9	9	9	9	9

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

C type on Shimoda-shi, Shizuoka pref.

No.	Locality (population)	Frond length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
SM710716- 1	Hachiman shrine	790		14	10	120	38	3.2	○
SM710717- 1	Shikine	1480		12	1	175	40	4.4	●
SM720729- 1	Takouma	935		8	1	115	30	3.8	●
SM720818-51	Shikine	875		9	0	138	39	3.5	●
SM721231- 1	Naka	740		13	2	130	39	3.3	●
2	Ibid.	1055		13	0	140	38	3.7	●
3	Ibid.	810		14	0	130	33	3.9	●
4	Ibid.	825		10	4	115	29	4.0	●
SM730506- 9	Shikine	985		11	1	142	41	3.5	●
10	Ibid.	1150		12	3	130	35	3.7	●
21	Takouma	600		11	1	97	28	3.5	●
22	Hachiman shrine	860		11	1	150	34	4.4	●
24	Ibid.	1230		12	2	195	31	6.3	●
25	Ibid.	1095		14	0	145	40	3.6	●
26	Ibid.	670		11	5	160	36	4.4	●
SM780521- 1	Suzaki	640		12	0	115	38	3.0	●
3	Ibid.	870		13	0	145	40	3.6	●
5	Ibid.	550		9	0	85	22	3.9	●
6	Ibid.	740		13	1	95	27	3.5	●
SM800211-15	Shikine	500		11	1	110	37	3.0	●
16	Ibid.	560		10	1	96	30	3.2	●
SM800606- 1	Oura	585		10	4	130	38	3.4	●
SM811004- 1	Oura	1100	430	14	0	130	28	4.6	●
6	Ibid.	730	390	13	1	110	23	4.8	●
8	Oura-hachiman	1040	420	13	0	125	40	3.1	●
9	Ibid.	900	380	14	0	120	31	3.9	●
10	Ibid.	1165	400	14	0	125	32	3.9	●
11	Ibid.	985		11	1	125	29	4.3	●
12	Ibid.	960	410	13	1	100	30	3.3	●
16	Wakano-ura	900	480	11	3	128	44	2.9	●
18	Ibid.	720		10	3	105	39	2.7	●
20	Ibid.	1150		10	2	155	44	3.5	●
22	Ibid.	710	380	11	3	150	29	5.2	●
23	Ibid.	720	420	8	2	135	40	3.4	●
26	Ibid.	670	510	12	0	85	25	3.4	●
27	Takouma	800		12	1	140	43	3.3	●
32	Choraku temple	355	470	8	4	85	17	5.0	●
33	Ryosen temple	1055		13	0	130	30	4.3	●
SM811005- 6	Kasuga-yama	1035	440	13	0	160	40	4.0	●
15	Ibid.	820		8	0	140	30	4.7	●
16	Ibid.	745		9	0	115	30	3.8	●
20	Ibid.	490	450	8	1	118	34	3.5	●

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SM811006- 5	Kaizen temple	890	390	14	0	105	26	4.0	●
8	Ibid.	990	380	13	0	125	32	3.9	●
12	Shimoda 6-chome	525	400	7	2	122	35	3.5	●
13	Ibid.	450		8	0	100	28	3.6	●
19	Ibid.	645		14	0	100	20	5.0	●
SM811007-13	Kami-osawa	840		12	2	125	35	3.6	●
19	Takouma	1140		12	0	175	35	5.0	●
20	Ibid.	775		13	2	117	22	5.3	●
23	Ibid.	675	370	11	0	110	28	3.9	●
SM811009- 1	Hachiman shrine	920		13	0	120	40	3.0	●
2	Ibid.	880		9	0	150	50	3.0	○
SM811011-13	Shikine	815	350	11	0	132	35	3.8	●
16	Naka	630	400	8	1	140	40	3.5	●
24	Kakisaki	655		11	0	110	30	3.7	●
27	Suzaki	650		12	0	112	31	3.6	●
28	Ibid.	555		9	1	110	34	3.2	●
SM890625- 7	Kisami	825		10	2	105	26	4.0	●
	MAX	1480	510	14	10	195	50	6.3	○ : 3%
	MIN	355	350	7	0	85	17	2.7	● : 97%
	AVERAGE	821	414	11	1	125	33	3.8	
	STDEV	220	41	2	2	23	7	0.7	
	COUNT	59	19	59	59	59	59	59	59

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

## C type on Iro-zaki, Minami-izu-cho, Shizuoka pref.

No.	Locality (population)	Fronde length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
SM760516- 5	Ose	830	393	13	0	110	29	3.8	●
6	Ibid.	900	447	10	1	146	39	3.7	●
8	Ibid.	845	402	14	1	130	34	3.8	●
9	Ibid.	980	406	15	0	129	31	4.2	●
11	Ibid.	785	406	7	0	143	38	3.8	●
12	Ibid.	540	455	9	1	108	24	4.5	●
13	Ibid.	810	463	8	4	163	33	4.9	●
17	Ibid.	965	472	13	4	133	28	4.8	●
31	Ibid.	700	411	11	0	150	27	5.6	●
	MAX	980	472	15	4	163	39	5.6	○ : 0%
	MIN	540	393	7	0	108	24	3.7	● : 100%
	AVERAGE	817	428	11	2	135	31	4.3	
	STDEV	128	29	3	2	17	5	0.6	
	COUNT	9	9	9	3	9	9	9	9

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

## A1 type under cultivation in greenhouse

No.	Locality (population)	Fronde length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
A1-1	Tokyo pref., Mikura Isl.	225	680	5	0	39	29	1.3	○
2	Ibid.	205	720	5	0	45	28	1.6	○
3	Ibid.	213	660	6	0	47	25	1.9	○
6	Miyake Isl.	55	750	3	0	16	17	0.9	○
7	Kozu Isl.	70	690	1	0	20	15	1.3	○
9	Miyake Isl.	175	700	5	0	34	20	1.7	○
10	Ibid.	185	660	5	0	36	22	1.6	○
11	Ibid.	270	670	5	0	43	25	1.7	○

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13	Shizuoka pref., Shimoda-shi	325	760	5	0	60	25	2.4	○
14	Ibid.	175	810	6	0	35	17	2.1	○
15	Ito-shi	154	660	6	0	26	24	1.1	○
16	Ishikawa pref., Nanaura-kaigan	182	750	4	0	42	22	1.9	○
19	Shizuoka pref., Ito-shi	87	810	1	0	18	20	0.9	○
21	Ibid.	95	640	1	0	23	21	1.1	○
24	Ibid.	241	800	7	0	52	21	2.5	○
25	Ibid.	275	750	5	0	48	28	1.7	○
26	Ibid.	280	760	9	0	34	25	1.4	○
27	Ibid.	265	750	8	0	53	28	1.9	○
28	Ibid.	166	750	5	0	25	18	1.4	○
30	Ibid.	160	710	6	1	49	22	2.2	○
31	Ibid.	202	750	4	0	45	28	1.6	○
32	Ibid.	265	740	4	0	50	30	1.7	○
33	Ibid.	290	860	8	0	45	37	1.2	○
34	Ibid.	220	700	6	0	44	38	1.2	○
35	Ibid.	209	750	5	0	47	21	2.2	○
39	Ibid.	170	670	5	0	42	32	1.3	○
44	Ibid.	200	770	3	0	46	31	1.5	○
45	Ibid.	150	770	3	1	37	21	1.8	○
51	Mie pref., Daio-zaki	135	770	3	0	41	26	1.6	○
55	Shizuoka pref., Shimoda-shi	205	870	7	0	55	18	3.1	○
63	Niigata pref., Sado Isl.	200	760	5	0	50	26	1.9	○
64	Ibid.	230	770	7	0	51	22	2.3	○
65	Ibid.	243	850	6	0	55	30	1.8	○
66	Ibid.	210	750	5	0	56	30	1.9	○
67	Ibaraki pref., Izura-kaigan	285	870	8	0	56	30	1.9	○
68	Ibid.	360	820	8	0	70	32	2.2	○
69	Ibid.	230	790	4	0	47	28	1.7	○
70	Aomori pref., Tanesashi-kaigan	188	830	7	0	43	20	2.2	○
71	Ibid.	152	650	2	1	41	25	1.6	○
72	Ibid.	135	750	5	0	44	18	2.4	○
74	Ibid.	205	590	5	0	50	24	2.1	○
75	Ibid.	225	770	4	0	40	22	1.8	○
76	Ibid.	270	750	7	0	45	27	1.7	○
77	Ibid.	275	940	3	0	42	28	1.5	○
78	Ibid.	200	750	7	0	31	24	1.3	○
79	Ibid.	169	1040	5	0	25	21	1.2	○
80	Ibid.	206	970	5	0	42	27	1.6	○
81	Ibid.	149	810	2	0	31	19	1.6	○
82	Ibid.	255	760	8	0	45	28	1.6	○
83	Ibid.	172	860	3	0	50	29	1.7	○
84	Ibid.	219	820	5	0	52	29	1.8	○
88	Wakayama pref., Asizuri-misaki	85	865	3	0	25	15	1.7	○
	MAX	360	1040	9	1	70	38	3.1	○:100%
	MIN	55	590	1	0	16	15	0.9	●: 0%
	AVERAGE	202	767	5	0	42	25	1.7	
	STDEV	63	84	2	0	11	5	0.4	
	COUNT	52	52	52	52	52	52	52	52

\*: The pinus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

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## App. 9.

-(continued)-

## A1' type under cultivation in greenhouse from Hachijo Isl.

No.	Locality (population)	Fronde length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
A1-56	Borawa-zawa	475	690	8	0	75	33	2.3	○
57	Ibid.	575	640	10	0	85	26	3.3	○
58	Ibid.	450	770	7	0	96	45	2.1	○
59	Ibid.	870	680	12	0	82	31	2.6	○
60	Nakano-go	540	620	10	0	80	32	2.5	○
61	Kashitate	320	610	8	0	57	29	2.0	○
90	Borawa-zawa	635	560	11	0	91	33	2.8	○
91	Ibid.	660	750	11	0	94	35	2.7	○
92	Ibid.	560	710	11	0	81	30	2.7	○
93	Sueyoshi	530	670	9	0	91	32	2.8	○
94	Borawa-zawa	522	550	7	0	81	45	1.8	○
95	Kashitate	550	660	11	0	95	46	2.1	○
96	Nakano-go	510	690	7	0	96	37	2.6	○
	MAX	870	770	12	0	96	46	3.3	○:100%
	MIN	320	550	7	0	57	26	1.8	●: 0%
	AVERAGE	554	662	9	0	85	35	2.5	●: 0%
	STDEV	122	63	2	0	11	6	0.4	
	COUNT	13	13	13	13	13	13	13	13

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

## A2 type under cultivation in greenhouse

No.	Locality (population)	Fronde length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
A2-1	Tokyo pref., Chichi-jima Isl., Mt. Mikazuki	460		11	1	65	32	2.0	●
2	Ibid.	580	420	13	2	63	33	1.9	●
3	Takayama	590	450	13	2	76	32	2.4	●
4	Tatsumi-dani	550	520	13	1	72	36	2.0	●
5	Nishi-kaigan	460	480	7	1	80	32	2.5	●
6	Nagahama-minami	465	380	13	2	90	33	2.7	●
8	Hatsune	705	430	16	4	74	35	2.1	●
9	Kopepe-kaigan	565	400	15	2	95	36	2.6	●
10	Okinawa pref., Ichi	825	520	14	1	110	45	2.4	●
11	Ibid.	565	460	10	2	77	36	2.1	●
12	Ibid.	610	440	9	2	101	38	2.7	●
13	Kagoshima pref., Sata-misaki	345	480	6	2	77	35	2.2	●
14	Taiwan, Lanyu Isl.	350		8	2	55	20	2.8	
15	Tokyo pref., Chichi-jima Isl., Sakai-ura	710	400	13	3	90	44	2.0	●
17	Hatsune	695	410	8	5	115	52	2.2	●
18	Sakai-ura	505	390	8	2	87	41	2.1	○
19	Mt. Mikazuki	520	390	9	3	70	34	2.1	●
20	Kagoshima pref., Okuzure	310	470	9	3	70	22	3.2	●
22	Ibid.	310	450	7	5	55	23	2.4	●
26	Noma	423	380	9	2	74	27	2.7	○
32	Yamatatsu-gami	280	460	7	4	53	21	2.5	●
38	Sata-misaki	230	450	6	4	59	27	2.2	○
44	Okinawa pref., Awa	450	360	9	3	105	36	2.9	●
46	Kushibaru	310	450	6	4	65	30	2.2	●

-(continued)-

App. 9.

-(continued)-

49	Miyagi-shima	420	430	7	2	96	28	3.4	○
50	Ibid.	340	410	7	3	63	25	2.5	●
51	Nerome	390	440	7	1	92	31	3.0	●
52	Ibid.	355	400	5	2	91	34	2.7	●
53	Ichi	407	440	6	2	83	28	3.0	●
54	Ibid.	490	410	9	2	92	28	3.3	●
55	Uka	435	440	7	2	77	28	2.8	●
56	Ginama	392	460	7	2	83	22	3.8	●
57	Ibid.	335	480	5	3	76	32	2.4	●
58	Hetona	302	460	7	3	72	26	2.8	●
59	Oku	350	450	7	2	80	25	3.2	●
61	Awa	388	390	8	6	60	21	2.9	●
66	Tokyo pref., Haha-jima Isl., Yashi-hama	660	370	14	2	105	45	2.3	●
67	Ibid.	625	430	11	3	98	43	2.3	●
68	Ibid.	545	420	10	2	100	40	2.5	●
69	Kwanoki-yama	690	390	13	5	113	55	2.1	○
70	Inokuma-dani	770	400	14	2	125	40	3.1	●
71	Sekimon-san	610	450	13	3	90	35	2.6	●
73	Omoto-hama	535	370	11	2	73	31	2.4	●
75	Ibid.	750	400	13	7	108	46	2.3	●
77	Nishi-kaigan	435	330	7	2	96	33	2.9	●
84	Kagoshima pref., Yoron Isl.	490	480	7	1	90	33	2.7	●
86	Okino-erabu Isl.	395	450	6	2	95	29	3.3	○
87	Nagasaki pref., Fukue Isl.	325	540	8	0	83	28	3.0	●
88	Ibid.	400	500	11	2	69	30	2.3	●
89	Okinawa pref., Yonaguni Isl.	465	480	8	3	105	42	2.5	●
90	Ibid.	400	450	7	1	93	35	2.7	●
91	Ibid.	385	480	6	2	83	26	3.2	○
94	Nagasaki pref., Fukue Isl., Kami-sakiyama	420	530	8	0	90	31	2.9	●
95	Ibid.	465	450	10	1	100	29	3.4	●
96	Ibid.	450	500	9	2	90	31	2.9	●
97	Muko-machi	415	540	11	0	70	32	2.2	●
98	Sakiyama-bana	415	500	8	1	90	31	2.9	●
99	Ibid.	470	560	12	3	87	30	2.9	●
100	Ibid.	510	530	11	3	65	31	2.1	●
101	Ibid.	400	480	8	1	88	29	3.0	●
102	Ibid.	370	470	9	2	80	28	2.9	●
103	Mino-dake	415	450	6	2	97	34	2.9	●
104	Ibid.	415	520	9	2	90	34	2.6	●
105	Usu-dake	440	470	9	3	100	35	2.9	●
106	Abunze	535	540	9	3	88	32	2.8	●
107	Nagamine	470	550	13	2	97	30	3.2	○
108	Osezaki	430	510	7	1	103	30	3.4	○
109	Ibid.	490	520	10	2	81	30	2.7	○
110	Ibid.	290	530	9	3	45	31	1.5	●
111	Arakawa	365	540	10	2	90	26	3.5	○
	MAX	825	560	16	7	125	55	3.8	○: 16%
	MIN	230	330	5	0	45	20	1.5	●: 84%
	AVERAGE	467	455	9	2	85	32	2.6	
	STDEV	126	53	3	1	16	7	0.4	
	COUNT	70	68	70	70	70	70	70	69

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

-(continued)-

## App. 9.

-(continued)-

## B type under cultivation in greenhouse

No.	Locality (population)	Fronde length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
B-8	Okinawa pref., Gyokusen-do	500	650	10	0	91	30	3.0	●
9	Ibid.	340	660	5	0	67	22	3.0	●
10	White Beach	505	450	7	1	88	29	3.0	●
11	Ibid.	475	560	8	0	87	19	4.6	●
12	Ibid.	365	500	8	1	80	29	2.8	●
16	Shurei-no-mon	505	640	10	2	95	40	2.4	●
17	Kagoshima pref., Yaku Isl., Ono-aida	480	520	12	1	77	39	2.0	●
20	Ibid.	270	600	3	2	52	28	1.9	●
22	Kumamoto pref., Kawachi-cho	540	590	8	1	120	42	2.9	○
23	Ibid.	480	450	14	0	70	26	2.7	○
24	Ibid.	515	410	9	0	82	33	2.5	○
25	Ibid.	535	440	11	0	74	30	2.5	○
26	Nagasaki pref., Shikimi-machi	430	530	7	2	72	27	2.7	●
27	Tokushima pref., Hiwasa-cho	550	550	10	1	100	40	2.5	●
28	Kochi pref., Oyama-zaki	545	610	11	0	95	35	2.7	●
29	Ari-saki	375	660	10	0	62	32	1.9	○
30	Mie pref., Oniga-jo	635	560	11	1	92	35	2.6	●
31	Ibid.	405	640	12	0	52	23	2.3	○
32	Tokyo pref., Mikura Isl.	245	590	7	2	42	23	1.8	○
33	Ibid.	460	670	8	3	94	40	2.4	○
34	Ibid.	535	610	12	0	80	33	2.4	○
36	Kozu Isl., Kaeri-hama	280	630	3	0	72	30	2.4	○
37	Ibid.	350	670	6	1	75	32	2.3	○
38	Miyake Isl., Usuki	365	670	9	0	63	30	2.1	○
39	Ibid.	480	510	7	1	95	35	2.7	●
40	Ibid.	490	550	14	6	78	30	2.6	●
41	Ibid.	480	530	11	1	80	26	3.1	●
42	Shizuoka pref., Minami-izu-cho, Ose	300	600	8	1	55	32	1.7	○
43	Ibid.	230	630	6	0	50	31	1.6	○
44	Ishikawa pref., Nanaura-kaigan	260	580	7	3	50	25	2.0	○
45	Ibid.	400	620	9	0	58	31	1.9	○
47	Ibid.	135	570	2	0	32	22	1.5	○
48	Shizuoka pref., Shimoda-shi, Sotoura	650	590	5	1	37	25	1.5	○
49	Ibid.	490	530	7	2	90	35	2.6	●
50	Ibid.	535	480	9	2	85	28	3.0	●
51	Ito-shi, Oshimaga-ne	450	550	9	0	67	22	3.0	●
52	Ibid.	380	670	9	0	80	29	2.8	○
53	Ibid.	195	460	4	0	42	16	2.6	●
54	Shimoda-shi, Oura	320	510	8	0	45	12	3.8	●
55	Ibid.	575	530	13	1	70	25	2.8	●
56	Ibid.	515	480	9	0	75	25	3.0	●
57	Ebisu Isl.	510	580	12	0	81	35	2.3	●
58	Fuku-ura	300	540	8	0	57	22	2.6	●

-(continued)-



## App. 9.

-(continued)-

59	Tatado	530	570	13	1	80	28	2.9	●
60	Ibid.	670	520	13	3	85	34	2.5	●
61	Ibid.	600	480	10	7	110	40	2.8	○
62	Ibid.	450	510	9	0	82	25	3.3	●
63	Ibid.	390	500	11	0	60	20	3.0	●
64	Ibid.	550	550	12	0	70	25	2.8	●
65	Ibid.	405	530	11	0	65	18	3.6	●
66	Ibid.	400	630	11	0	47	23	2.0	●
67	Ibid.	435	560	11	0	70	22	3.2	○
68	Ibid.	480	500	16	0	56	19	2.9	●
69	Ibid.	460	570	13	0	65	23	2.8	●
70	Ibid.	345	660	9	0	50	33	1.5	○
71	Shizuoka-shi, Ishibu	390	610	11	0	70	30	4.6	●
72	Ibaraki pref., Tajiri-hama	480	610	8	2	85	42	2.0	●
73	Ajiga-ura	290	550	8	1	55	23	2.4	○
74	Ibid.	250	690	6	0	80	30	2.7	○
75	Ibid.	430	600	10	2	92	38	2.4	○
76	Ibid.	490	670	12	0	82	33	2.5	○
77	Ibid.	420	630	10	1	83	33	2.5	○
78	Fukui pref., Umiyama	475	550	12	1	75	25	3.0	●
80	Ishikawa pref., Nanaura-kaigan	370	500	13	2	72	18	4.0	○
83	Miyagi pref., Kinkazan Isl.	305	630	8	3	50	32	1.6	○
84	Ibid.	250	550	8	0	50	25	2.0	○
86	Kagoshima pref., Yaku Isl., Ono-aida	440	480	10	1	70	27	2.6	●
87	Mie pref., Daio-zaki	530	530	12	2	73	25	2.9	●
88	Ibid.	560	540	10	2	85	32	2.7	●
89	Ibid.	370	680	8	1	90	30	3.0	●
90	Ibid.	440	550	9	1	62	26	2.4	●
91	Ibid.	300	530	5	3	57	25	2.3	●
93	Ibid.	490	520	13	0	65	25	2.6	●
96	Shizuoka pref. Shimoda- shi, Kakisaki	330	610	10	0	52	32	1.6	○
97	Mie pref., Daio-zaki	340	580	9	3	58	34	1.7	○
100	Ibid.	250	560	7	0	65	30	2.2	○
101	Tokyo pref., Hachijo Isl., Borawa-zawa	605	630	13	0	83	33	2.5	●
103	Nakano-go	580	540	12	2	94	32	2.9	●
104	Kashitate	630	540	12	1	112	38	2.9	○
105	Nakano-go	460	530	11	2	82	28	2.9	○
106	Ibaraki pref., Izura-kaigan	355	580	8	0	81	30	2.7	●
107	Ibid.	405	560	10	0	65	25	2.6	●
108	Ibid.	335	530	7	0	60	25	2.4	●
109	Niigata pref., Sado Isl., Tassha	370	540	12	0	54	24	2.3	○
110	Ibid.	380	580	11	0	60	22	2.7	○
111	Ibid.	455	570	11	2	96	33	2.9	●
112	Shizuoka pref., Shimoda- shi, Tsumeki-saki	390	690	7	4	70	34	2.1	○
113	Ibid.	495	680	12	2	75	32	2.3	○
114	Ibid.	440	740	7	1	85	35	2.4	○
144	Kagoshima pref., Amami- oshima Isl., Imari	525	520	8	1	92	32	2.9	●
145	Kuninao	415	570	7	1	81	40	2.0	●
146	Nittan	615	570	7	2	114	40	2.9	●
147	Nishi-komi	470	510	7	1	85	34	2.5	●

-(continued)-

## App. 9.

-(continued)-

148	Setsugo	475	590	7	1	90	45	2.0	●
149	Kasari-zaki	445	590	6	1	101	39	2.6	●
150	Kominato	570	540	7	3	105	41	2.6	●
151	Imai-zaki	570	570	6	2	120	43	2.8	●
152	Ushuku	445	560	5	1	90	37	2.4	●
	MAX	670	740	16	7	120	45	4.6	○ : 41%
	MIN	135	410	2	0	32	12	1.5	● : 59%
	AVERAGE	436	570	9	1	75	30	2.6	
	STDEV	109	63	3	1	18	7	0.6	
	COUNT	98	98	98	98	98	98	98	98

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

## C type under cultivation in greenhouse

No.	Locality (population)	Fronde length (mm)	Pinnus thickness* ( $\mu$ m)	Nos. of side-pinnus	Nos. of side-sterile pinnus	Length of pinnus : L* (mm)	Width of pinnus : W* (mm)	L*/W*	IC**
C-1	Shizuoka pref., Nishi-izu-cho, Miyagahara	710	440	10	0	130	32	4.1	●
2	Shimoda-shi, Shikine	635	480	10	0	107	35	3.1	●
3	Kasuga-yama	545	350	10	0	100	31	3.2	●
4	Ibid.	643	470	10	1	123	36	3.4	●
6	Soto-ura	607	430	10	0	120	34	3.5	●
7	Tatado	615	410	11	0	113	26	4.3	●
8	Shiroyama park	595	410	9	0	123	33	3.7	●
9	Oura-hachiman	605	500	10	0	87	27	3.2	●
10	Ibid.	625	450	11	0	105	33	3.2	●
12	Ibid.	510	440	8	0	73	22	3.3	●
13	Ibid.	705	430	10	0	102	35	2.9	●
14	Ibid.	800	490	10	0	111	41	2.7	●
15	Ibid.	440	375	9	2	81	23	3.5	●
16	Ibid.	670	440	13	2	105	33	3.2	●
17	Ibid.	580	440	8	0	73	24	3.0	●
18	Ibid.	695	480	10	0	98	31	3.2	●
19	Ibid.	725	470	13	0	98	31	3.2	●
20	Ibid.	667	500	12	0	98	25	3.9	●
21	Ibid.	545	485	10	0	103	32	3.2	●
22	Kawazu-cho, Onabe	560	500	12	0	80	20	4.0	●
35	Shimoda-shi, Oura-hachiman	790	490	10	0	120	38	3.2	●
36	Ibid.	735	440	10	0	125	32	3.9	●
	MAX	800	500	13	2	130	41	4.8	○ : 0%
	MIN	440	350	8	0	73	20	2.7	● : 100%
	AVERAGE	636	451	10	0	103	31	3.4	
	STDEV	87	40	1	1	16	5	0.4	
	COUNT	22	22	22	22	22	22	22	22

\*: The pinnus of 1/3 under site of Lamina is measured. \*\*IC: Indusium's color

Appendix 10. Guard cell and exospore size ( $\mu$  m) on *Cyrtomium falcatum* complex

Strain	Length of guard cell (N = 30 or 20)	Exospore length (N = 30)
<b>Sexual Diploid</b>	<b>2 x</b>	<b>x</b>
A1-11 Miyake	(35.1) 38.1 $\pm$ 1.9 (42.5)	(30.0) 34.9 $\pm$ 2.5 (40.0)
A1-15 Jogasaki	(35.0) 38.1 $\pm$ 1.7 (40.0)	(27.5) 31.3 $\pm$ 2.3 (35.0)
A1-77 Tanesashi	(35.0) 37.7 $\pm$ 1.6 (40.0)	(27.5) 30.0 $\pm$ 2.0 (35.0)
A1-104 Shiono-misaki	(35.0) 37.3 $\pm$ 1.4 (40.0)	(27.5) 31.2 $\pm$ 1.7 (35.0)
A1-121 Choshi-saki	(32.5) 36.5 $\pm$ 1.5 (40.0)	(25.0) 26.8 $\pm$ 1.6 (30.0)
Average of A1 type (A1-13 Shimoda N = 200)	37.5	30.8 (25.0) 34.7 $\pm$ 3.1 (42.5)
A1'-93 Sueyosi	(32.5) 35.4 $\pm$ 1.9 (40.0)	(25.0) 29.1 $\pm$ 2.0 (32.5)
A2-10 Ichi	(35.0) 38.9 $\pm$ 1.5 (42.5)	(25.0) 27.2 $\pm$ 1.4 (30.0)
A2-18 Sakaiura	(35.0) 38.0 $\pm$ 1.5 (40.0)	(27.5) 30.2 $\pm$ 1.9 (35.0)
A2-20 Okuzure	(37.5) 38.9 $\pm$ 1.2 (40.0)	(27.5) 29.0 $\pm$ 1.4 (32.5)
A2-35 Sata-misaki	(35.0) 38.9 $\pm$ 1.4 (40.0)	(25.0) 28.4 $\pm$ 1.5 (32.5)
A2-66 Yashi-hama	(35.0) 40.0 $\pm$ 2.0 (42.5)	(27.5) 28.9 $\pm$ 1.7 (32.5)
A2-84 Izen	(37.5) 39.6 $\pm$ 1.9 (42.5)	(27.5) 31.1 $\pm$ 2.2 (35.0)
A2-88 Siozu	(37.5) 39.8 $\pm$ 1.9 (42.5)	(25.0) 28.2 $\pm$ 1.8 (30.0)
A2-89 Kindahana	(40.0) 41.5 $\pm$ 1.4 (45.0)	(27.5) 30.3 $\pm$ 1.8 (35.0)
Average of A2 type (A2-1 Ogasawara N = 200)	39.5	29.2 (20.5) 30.0 $\pm$ 2.3 (34.9)
A2'-1 Awa	(35.0) 40.3 $\pm$ 2.5 (45.0)	(30.0) 32.8 $\pm$ 1.8 (37.5)
A2'-2 Awa	(37.5) 42.3 $\pm$ 2.3 (47.5)	(30.0) 37.5 $\pm$ 3.0 (42.5)
A2'-3 Awa	(35.0) 40.5 $\pm$ 2.6 (45.0)	(30.0) 34.0 $\pm$ 2.4 (40.0)
Average of A2' type	41	34.8
<b>Apogamous Diploid</b>	<b>2 x</b>	<b>2 x</b>
A1 $\times$ B -5 64 apo -1 2n = 82	(32.5) 37.1 $\pm$ 2.3 (42.5)	(32.5) 39.6 $\pm$ 3.8 (52.5)
A1 $\times$ B -5 64 apo -3 2n = 82	(32.5) 36.3 $\pm$ 1.5 (37.5)	(32.5) 36.8 $\pm$ 1.8 (40.0)
A1 $\times$ B -5 64 apo -32 2n = 83	(32.5) 35.5 $\pm$ 2.1 (40.0)	(40.0) 43.1 $\pm$ 2.5 (47.5)
A1 $\times$ B -5 64 apo -34 2n = 84	(35.0) 38.3 $\pm$ 2.3 (42.5)	(27.5) 38.2 $\pm$ 3.0 (45.0)
A1 $\times$ B -6 64 apo -4 n = 84	(40.0) 42.5 $\pm$ 1.8 (45.0)	(35.0) 38.6 $\pm$ 2.0 (42.5)
A1 $\times$ B -6 64 apo -12 2n = 84	(37.5) 38.8 $\pm$ 1.7 (42.5)	39.3
Average of Dihaploid	38.1	
<b>Apogamous Triploid</b>	<b>3 x</b>	<b>3 x</b>
B-8 Gyokusen-do	(40.0) 45.8 $\pm$ 2.8 (52.5)	(35.0) 39.1 $\pm$ 2.8 (45.0)
B-11 White Beach	(42.5) 45.9 $\pm$ 1.9 (50.0)	(37.5) 45.2 $\pm$ 3.4 (50.0)
B-24 Kumamoto	(40.0) 43.5 $\pm$ 1.7 (45.0)	(37.5) 42.8 $\pm$ 2.6 (47.5)
B-28 Oyama-zaki	(37.5) 44.0 $\pm$ 3.2 (50.0)	(40.0) 49.1 $\pm$ 4.4 (60.0)
B-33 Mikura	(45.0) 46.5 $\pm$ 1.7 (50.0)	(42.5) 48.3 $\pm$ 3.7 (57.5)
B-38 Usuki	(42.5) 44.1 $\pm$ 1.4 (47.5)	(40.0) 44.4 $\pm$ 2.8 (50.0)
B-42 Ose	(40.0) 44.1 $\pm$ 1.8 (47.5)	(35.0) 42.7 $\pm$ 4.6 (52.5)
B-44 Nanaura	(42.5) 45.1 $\pm$ 2.3 (50.0)	(42.5) 45.9 $\pm$ 3.0 (55.0)
B-84 Kinkazan-to	(37.5) 44.1 $\pm$ 3.4 (50.0)	(37.5) 44.1 $\pm$ 3.8 (55.0)
Average of B type (B-71 Shizuoka N = 200)	44.8	44.6 (27.5) 45.5 $\pm$ 4.6 (57.5)
<b>Sterile Triploid</b>		
A1 $\times$ C -1	(40.0) 44.6 $\pm$ 2.3 (47.5)	Sterile
A2 $\times$ C -1 Kokuzo	(40.0) 43.8 $\pm$ 2.3 (50.0)	Sterile
A2 $\times$ C -2 Nagate	(42.5) 44.0 $\pm$ 1.2 (45.0)	Sterile
Average of A2 $\times$ C	44.1	
<b>Apogamous Triploid Species</b>		
<i>C. atrovirens</i> 3x apo (D: SM730603-9 Shizuoka N = 200)		
<i>C. fortunei</i> var. <i>clivicola</i> 3x apo		

-(continued)-

## App. 10.

-(continued)-

(E: SM730603-20 Shizuoka N = 200)		(32.5) 42.9 ± 4.2 (57.5)
<b>Sexual Tetraploid</b>	<b>4 x</b>	<b>2 x</b>
C-9 Oura	(52.5) 55.0 ± 1.9 (57.5)	(32.5) 36.7 ± 2.4 (42.5)
C-22 Onabe	(47.5) 52.5 ± 2.2 (55.0)	(27.5) 31.2 ± 1.9 (35.0)
C-28 Kaba-shima	(50.0) 51.6 ± 1.8 (55.0)	
C-31 Sekibe	(50.0) 52.5 ± 1.8 (57.5)	(30.0) 33.6 ± 2.0 (37.5)
C-32 Hiroshima	(45.0) 54.0 ± 2.7 (60.0)	
C-41 Fukue	(50.0) 52.5 ± 2.4 (57.5)	(32.5) 34.8 ± 2.2 (40.0)
C-1101 Chingansan (China)	(50.0) 52.6 ± 2.2 (57.5)	(35.0) 37.2 ± 2.4 (42.5)
Average of C type	53	34.7
(C-31 Sekibe N = 200)		(25.0) 36.1 ± 4.2 (47.5)
<b>Apo &amp; Sex Tetraploid</b>	<b>4 x</b>	<b>2 x + 4 x</b>
A1 × B -5 Jogasaki	(50.0) 51.0 ± 1.2 (52.5)	
A1 × B -6 Tsumeki-saki	(47.0) 51.0 ± 2.0 (55.0)	(32.5) 40.6 ± 5.2 (55.0)
A1-27 × B -51 no. 6	(50.0) 53.6 ± 2.7 (57.5)	(30.0) 33.6 ± 2.6 (37.5)
A1-27 × B -51 no. 18	(47.5) 51.9 ± 2.4 (57.5)	(30.0) 35.8 ± 2.4 (40.0)
Average of A1 × B	51.9	36.7
(A1 × B -6 Tsumeki-saki N = 200)		(27.5) 45.5 ± 10.1(72.5)
<b>Sexual Tetraploid</b>	<b>4 x</b>	<b>2 x</b>
A1 × B -5 64 sex -10 2n = ca.161	(37.5) 39.7 ± 1.5 (42.5)?	(27.5) 30.4 ± 1.6 (32.5) ?
A1 × B -5 64 sex -17 2n = ca.165	(47.5) 51.2 ± 2.6 (57.5)	(30.8) 40.0 ± 3.5 (45.1)
A1 × B -5 64 sex -25 2n = 166		(32.8) 40.3 ± 4.0 (51.3)
A1 × B -6 64 sex -2 2n = 164		(32.8) 42.6 ± 5.3 (65.6)
Average of A1 × B 64 sex	51.2	41
<b>Sterile Tetraploid</b>	<b>4 x</b>	<b>4 x</b>
C × (A1 × B) -29 H1	(47.5) 52.4 ± 1.3 (55.0)	Sterile
C × (A1 × B) -56 H1	(52.5) 56.6 ± 2.5 (62.5)	Sterile
<b>Apogamous Tetraploid</b>		
C × (A1 × B) -58 H2	(50.0) 51.9 ± 1.9 (57.5)	(35.0) 44.8 ± 4.3 (50.0)
C × (A1 × B) -64 H2	(52.5) 55.8 ± 2.1 (60.0)	(40.0) 48.0 ± 4.5 (55.0)
Average of C × (A1 × B)	54.2	46.4
(C × (A1 × B) -43 H2 N = 200)		(34.9) 50.8 ± 5.9 (67.7)
(C × (A1 × B) -58 H2 N = 200)		(34.9) 49.3 ± 5.6 (63.6)
<b>Apogamous Pentaploid</b>	<b>5 x</b>	<b>5 x</b>
C × B -1 Matsuwa	(55.0) 57.8 ± 2.2 (62.5)	
C × B -2 Hiramatsu	(50.0) 53.9 ± 2.4 (57.5)	(37.5) 47.4 ± 5.7 (60.0)
C × B -3 Sekibe	(52.5) 55.9 ± 2.5 (62.5)	(45.0) 51.3 ± 3.3 (57.5)
Average of C × B	55.9	49.4
(C × B -2 Hiramatsu N = 200)		(40.0) 56.4 ± 7.7 (75.0)
(C × D -1 Ohito N = 200)		(27.5) 44.7 ± 9.2 (72.5)
(C × E1 -2 Shizuoka N = 200)		(27.5) 47.5 ± 9.0 (67.5)
(C × E2 -3 Shizuoka N = 200)		(30.0) 46.3 ± 7.4 (65.0)
(C × E3 -8 Itsuki N = 200)		(30.0) 49.9 ± 8.4 (72.5)
<i>Cyrtomium pseudocaryotideum</i> Shimura, S. Matsumoto & M. Yamamoto in shed.		
(C × F -1 Sokusawa N = 250)		(25.0) 34.2 ± 5.2 (52.5)
C × G -1 Yokohama	(51.3) 60.0 ± 4.9 (69.7)*	(26.7) 42.6 ± 8.9 (61.5)

\* Refresh sample from dried specimen treated by hot water.

Appendix 11. A number of samples analyzed on cytotoxic studies of *Cyrtium falcatum* complex

Strain	Cytological data	Samples counted chromosome				Samples counted spore number (s/s)				Herbarium specimens (TNS, TI, RYU)	Localities for Mapping	Total samples counted spore number
		Localities		Specimens		Localities		Specimens				
		Localities	Specimens	Localities	Specimens	Localities	Specimens	Localities	Specimens			
Basic 4 types												
A1	2x sex	33	115	34	515	47	47	52	562			
A2	2x sex	52	72	57	337	50	50	42	387			
B	3x apog	82	127	115	830	426	426	333	1256			
C	4x sex	19	27	49	246	16	16	373	262			
Total		186	341	255	1928	892	892	800	2467			
Natural hybrid origin												
A1 × B	4x sex & apog	2	6	3	9	0	0	0	9			
A2 × C	3x sterile	2	2	2	2	0	0	2	2			
C × B	5x sterile & apog	6	9	6	9	2	1	10	10			
C × D	5x sterile & apog	5	7	8	10	0	0	10	10			
C × E	5x sterile & apog	7	9	10	14	7	4	18	18			
C × F	5x sterile & apog	2	3	4	5	0	0	5	5			
C × G	5x? sterile & apog	-	-	1	1	0	0	1	1			
Total		24	36	34	50	9	5	55	55			
D ( <i>C. fortunei</i> var. <i>fortunei</i> )												
	3x apog	2	2	10	11	-	-	-	-			
E ( <i>C. fortunei</i> var. <i>chivicola</i> )												
	3x apog	5	5	14	29	-	-	-	-			
F ( <i>C. caryotideum</i> )												
	3x apog	3	4	14	21	-	-	-	-			
G ( <i>C. fortunei</i> var. <i>intermedium</i> )												
	3x apog	1	1	3	3	-	-	-	-			
Total		11	12	41	64							
F2 from A1 × B												
	4x sex & apog	1	1	1	44	0	0	44	44			
F2 yielded from 32 spores												
	2x apog (dihaploid, inc. many aneuploid)	2	37	2	48	0	0	48	48			
F2 yielded from 64 spores & apogamous gametophyte												
	4x sex (weakly habit, incl. many aneuploid)	2	25	2	32	0	0	32	32			
F2 yielded from 64 spores & sexual gametophyte												
	many aneuploid)	5	63	5	124	0	0	124	124			
Total		5	63	5	124	0	0	124	124			
Artificial hybrid												
A1 × A2												
	2x sex	1	5	1	11	0	0	11	11			
C × A1												
	3x sterile	1	1	1	1	0	0	1	1			
C × A1 × B (H1)												
	4x sterile	1	4	1	9	0	0	9	9			
C × A1 × B (H2)												
	4x sterile & apog	1	2	1	6	0	0	6	6			
Total		4	12	4	27	0	0	27	27			



*Cyrtomium falcatum* (L.) Oakes  
 日本産植物標本  
 Shizuoka Pref., Shimoda-shi, Tsumeki-saki  
 1955, No. 1085  
 1955, No. 1087-1090  
 1955, No. 1086  
 1955, No. 1088



*Cyrtomium falcatum* (L.) Oakes  
 Tokyo Pref., Iriomote-jima, Borawazawa-kaigan  
 1955, No. 1091  
 1955, No. 1092

**A1** type (sexual diploid, Shizuoka pref. Shimoda-shi, Tsumeki-saki, **A1** -55 ).

**A1'** type (sexual diploid, Hachijo Isl., Borawazawa-kaigan, **A1'** -90 ).

Appendix 12. Specimen's photographs of cytotypes on *Cyrtomium falcatum* complex. Including natural and artificial hybrids.



*Cyrtomium falcatum* (L.) Oakes  
 日本産植物標本  
 Tokyo Pref., Bonin Is., Chichi-jima Is., northern slope of Mt. Mikazuki  
 1955, No. 1093  
 1955, No. 1094



*Cyrtomium falcatum* (L.) Oakes  
 日本産植物標本  
 Okinawa pref., Iriomote Isl., Funa-ura  
 1955, No. 1095  
 1955, No. 1096

**A2** type (sexual diploid, Tokyo pref., Bonin Is., Chichi-jima Is., northern slope of Mt. Mikazuki, **A2** -2).

**B** type (sexual diploid, Okinawa pref., Iriomote Isl., Funa-ura, **B** -1).





9  
NATIONAL BOTANICAL MUSEUM  
 CURTISIA GARDNER II, 5.3 Pl.  
 4. 177777  
 Shizuoka pref., Ito-shi, Jogasaki,  
 alt. 70, on rockfall of woods.  
 Natural hybrid between A1 and B types.  
 No. 21 x 8 (42000 1)  
 coll. Matsuno  
 1964. 25. 1965

**A1 × B type (natural tetraploid hybrid with black indusium, Shizuoka pref., Ito-shi, Jogasaki, A1 × B-5).**

App. 12.



7  
NATIONAL BOTANICAL MUSEUM  
 CURTISIA GARDNER II, 5.3 Pl.  
 4. 177777  
 Shizuoka pref., Shimoda-shi, Tsumeki-saki,  
 alt. 70, on rockfall of woods.  
 Natural hybrid between A1 and B types.  
 No. 21 x 8 (42000 2)  
 coll. Matsuno  
 1964. 25. 1965

**A1 × B type (natural tetraploid hybrid with white indusium, Shizuoka pref., Shimoda-shi, Tsumeki-saki, A1 × B-6).**

-(continued)-



22  
NATIONAL BOTANICAL MUSEUM  
 CURTISIA GARDNER II, 5.3 Pl.  
 4. 177777  
 Sexual hypo tetraploid from reduced spores  
 of natural tetraploid hybrid, A1 × B-5.  
 No. 21 x 8 (42000 3)  
 coll. Matsuno  
 1964. 25. 1965

**Sexual hypo tetraploid (2n = 160) of F2 generation by intragametophytic selfing from reduced spores (64 spored sporangium) of natural tetraploid hybrid (A1 × B-5: 2n = 164), A1 × B-5 haplo-sex - 8.**

App. 12.



22  
NATIONAL BOTANICAL MUSEUM  
 CURTISIA GARDNER II, 5.3 Pl.  
 4. 177777  
 Apogamous hyper dihaploid from reduced spores  
 of natural tetraploid hybrid, A1 × B-5.  
 No. 21 x 8 (42000 4)  
 coll. Matsuno  
 1964. 25. 1965

**Apogamous hyper dihaploid (2n = 83) on F2 generation by apogamy from reduced spores (64 spored sporangium) of natural tetraploid hybrid (A1 × B-5: 2n = 164), A1 × B-5 haplo-apo - 8.**

-(continued)-





16 NATIONAL SCIENCE MUSEUM  
Oryzom falcatum (L.) P. B.  
オシダノリ  
Dihaploid (2n=84; hyper diploid) from reduced spores of natural tetraploid hybrid, A1 x B-5 (2n=164).  
Nov. 22, 1968  
S. S. Kawano  
AA 4714



17 NATIONAL SCIENCE MUSEUM  
Oryzom falcatum (L.) P. B.  
オシダノリ  
C x B type (natural pentaploid hybrid, Shizuoka-shi, Hiramatsu near Suruga Bay, C x B-2).  
Nov. 14, 1968  
S. S. Kawano  
AA 4715

Apogamous hyper dihaploid (2n = 84) on F2 generation by apogamy from reduced spores (64 spored sporangium) of natural tetraploid hybrid (A1 x B-5: 2n = 164), A1 x B-6 haplo-apo - 12.

C x B type (natural pentaploid hybrid, Shizuoka-shi, Hiramatsu near Suruga Bay, C x B-2).

App. 12.

-(continued)-



19 NATIONAL SCIENCE MUSEUM  
Oryzom falcatum (L.) P. B.  
オシダノリ  
C x D type (natural hyper pentaploid hybrid, 2n = 206, Shizuoka pref., Ohito-cho, Mt. Jo-yama, C x D-1).  
Nov. 22, 1968  
S. S. Kawano  
AA 4716

C x D type (natural hyper pentaploid hybrid, 2n = 206, Shizuoka pref., Ohito-cho, Mt. Jo-yama, C x D-1).

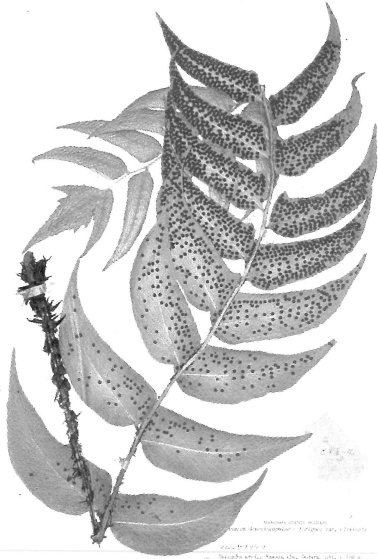
App. 12.



22 NATIONAL SCIENCE MUSEUM  
Oryzom falcatum (L.) P. B.  
オシダノリ  
C x E type (natural pentaploid hybrid, 2n = 205, Shizuoka-shi, Ubume to Makigaya, C x E-2).  
Nov. 14, 1968  
S. S. Kawano  
AA 4717

C x E type (natural pentaploid hybrid, 2n = 205, Shizuoka-shi, Ubume to Makigaya, C x E-2).

-(continued)-



23  
**C × E2** type (natural pentaploid hybrid,  $2n = 205$ , Shizuoka pref., Kawazu-cho, Otaki waterfall, **C × E2 -4**).

App. 12.



24  
**C × F** type (natural apogamous pentaploid hybrid,  $2n = 205$ , Kumamoto pref., Itsuki-mura, Takeno-kawa, **C × F -2**).

-(continued)-



25  
**C × G** type (natural apogamous pentaploid hybrid ?, Kanagawa pref., Miura-shi, Kanazawa-hakkei, **C × G -1**).

App. 12.

-(continued)-



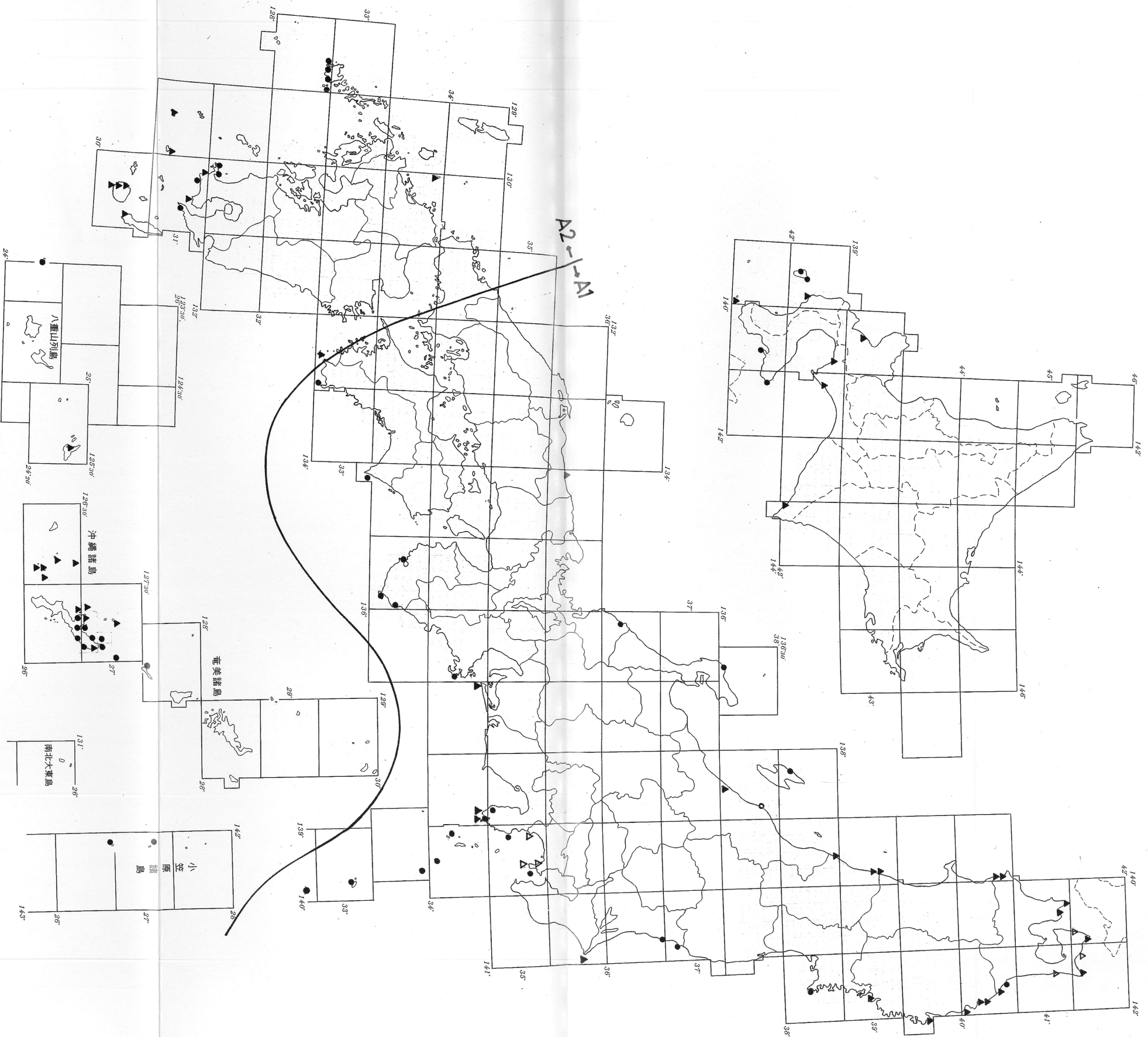


Fig. 1-19. Distribution map of diploid sexual (A1 and A2) types on *Cyrtium falcatum* complex in Japan.  
 ● : indicate individuals (or populations) observed both reproductive type and chromosome count.  
 ▲ : indicate individuals (or populations) observed reproductive type. ○, △: cited from the reference.

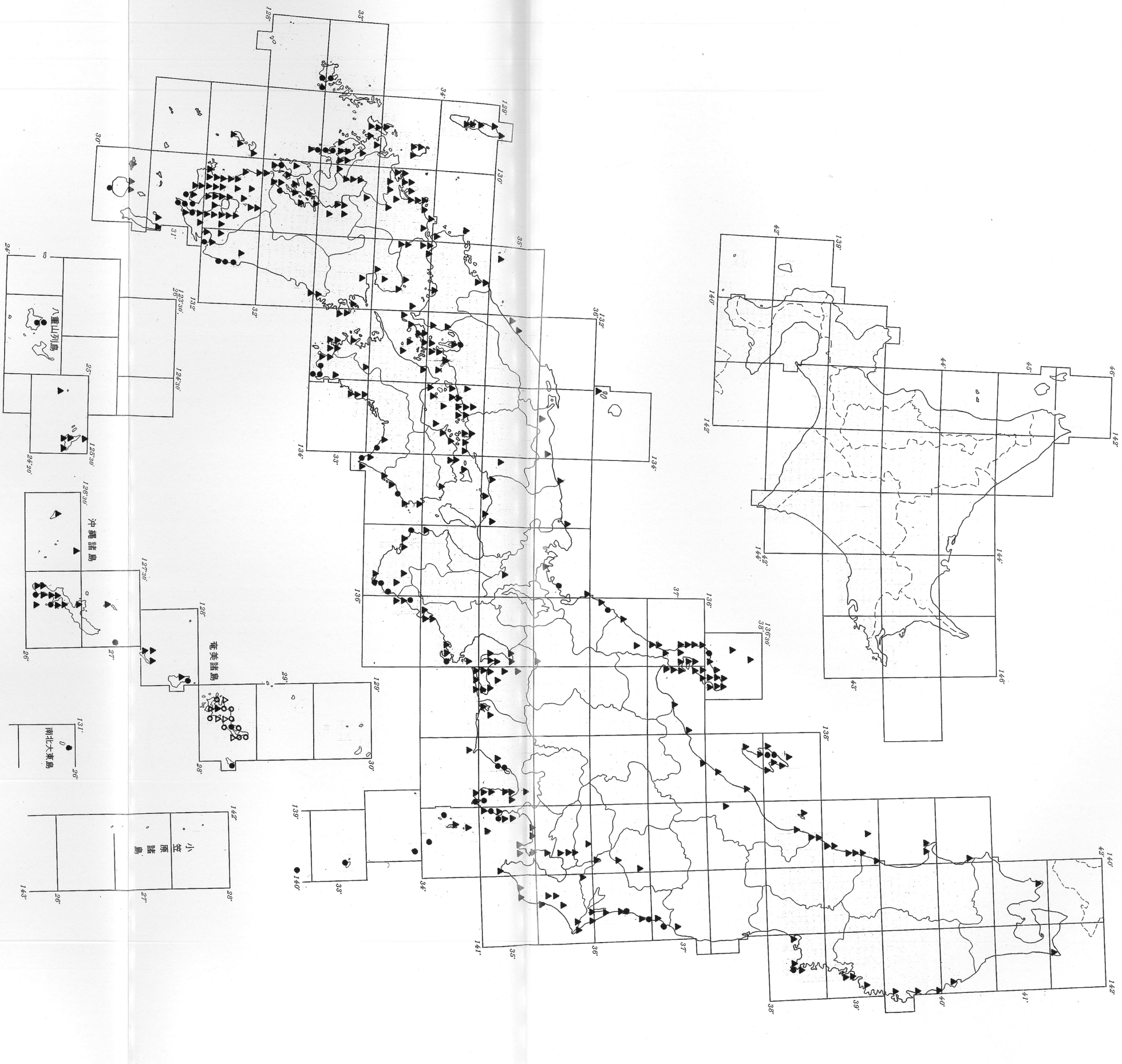


Fig. 1-20. Distribution map of triploid apogamous (B) type on *Cyrtium falcatum* complex in Japan.

- : indicate individuals (or populations) observed both reproductive type and chromosome count.
- ▲ : indicate individuals (or populations) observed reproductive type. ○, △: cited from the reference.



Fig. 1-21. Distribution map of tetraploid sexual (C) type on *Cytromium falcatum* complex. ● : indicate individuals (or populations) observed both reproductive type and chromosome count. ▲ : indicate individuals (or populations) observed reproductive type. ○ : cited from the reference. — : indicate individuals (or populations) morphologically identified.

Page	Line (up to down)		Errata
36	6	Miura-shi	→ Yokohama-shi
36	8	Miura-shi	→ Yokohama-shi
41	6	(Total) 6	→ 9
41	7	(Total) 1	→ 3
41	8	(Total) 4	→ 9
41	9	(Total) 11	→ 15
41	10	(Total) 15	→ 17
42	28	29II	→ 29I
52	2	<i>C. atrovirens</i>	→ <i>C. laetevirens</i>
68	16	<i>C. atrovirens</i>	→ <i>C. atropunctatum</i>
70	31	<i>C. atrovirens</i>	→ <i>C. laetevirens</i>
133	53	<i>C. atrovirens</i>	→ <i>C. laetevirens</i>
135	20	<i>C. fortunei</i> var. <i>fortunei</i>	→ <i>C. laetevirens</i>
136	under right side	sexual diploid	→ apogamous triploid
140	under side	Miura-shi	→ Yokohama-shi