Kunio MITUI*: **A cytological survey on the Pteridophytes of the Bonin Islands**

三井邦男*: 小笠原産シダ植物の細胞学的研究

(Plates X—XI)

Up to the present time, approximately 72 species in pteridophytes have been reported in the Bonin Islands, out of which 27 species are considered to be endemic (Ito 1969, Ohba 1971). However, cytological studies have not been hitherto carried out.

In January through February in 1972, I had an opportunity to travel in the Bonin Islands as a member of the expedition led by Prof. Hirosi Ito of Tokyo Kyoiku University. This article is the preliminary report on the chromosome numbers of the pteridophytes in the Bonin Islands.

The materials were collected in Isl. Hahajima and Isl. Chichijima. The fronds bearing young sporangia were fixed in Newcomer solution and the usual aceto-carmine squash technique was used for the chromosome counts. The table 1 shows the haploid chromosome numbers and the localities of the investigated species. Voucher specimens are located in the herbarium of Botanical Department of National Science Museum, Tokyo (TNS).

I am grateful to Emeritus Prof. Hirosi Ito of Tokyo Kyoiku University for allowing me to participate in his expedition and for identifing the materials.

Notes on species

1) **Cyrtomium falcatum** Two cytotypes, triploid apogamous and tetraploid, are reported in Japan (Mitui, 1965), and in other countries only the triploid apogamous species is known. Although Winge (1917 cited in Fabbri 1963) and Delitardiere (1921 cited in Fabbri 1963) reported 2n=ca. 80 for this species, the reproductive type has not been known yet. The present spe-

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Table 1. Species examined for chromosome number

Species	Voucher and locality	Haploid chromosome number	Ploidy
Psilotum nudum	TNS 290701, Sekimon, H.	104	4X
Ophioglossum petiolatum	TNS 290702, Tsutsujiyama, C.	480	8X
Schizaea boninensis	TNS 290703, Chuozan, C.	140	?
Abrodictyum boninense	TNS 290704, Tsutsujiyama, C.	36	2X
Crepidomanes acuto-obtusum	TNS 290705, Kuwanokizawa, H.	36	2X
Vandenboschia radicans var. *orientalis*	TNS 290706, Chibusayama, H.	irreg. meiosis	3X
Histiopteris incisa	TNS 290707, Okimura, H.	48	2X
Lindsaea repanda	TNS 290708, Chuozan, C.	'94'	2X (Apog.)
Microlepia speluncae	TNS 290709, Kuwanokizawa, H.	86	4X
M. strigosa	TNS 290710, Okimura, H.	43	2X
Pteridium aquilinum var. *latiusculum*	TNS 290711, Chuozan, C.	52	2X
Pteris boninensis	TNS 290712, Okimura, H.	29	2X
Sphenomeris chusana	TNS 290713, Chuozan, C.	'94'	4X (Apog.)
S. biflora	TNS 290714, Yashihama, H.	ca. '47'	2X (Apog.)
Bolbitis boninensis	TNS 290715, Sekimon, H.	41	2X
Ctenitis lepigera	TNS 290716, Sekimon, H.	41	2X
Cyrtomium falcatum	TNS 290717, Yashihama, H.	41	2X
Lunathyrium bonincola	TNS 290718, Chuozan, C.	40	2X
Thelypteris ogasawarensis	TNS 290719, Sekimon, H.	31	2X
Lepisorus boninensis	TNS 290720, Tsutsujiyama, C.	25	2X
Leptochilus deccurrens	TNS 290721, Sekimon, H.	ca. 70	4X
Loxogramme boninensis	TNS 290722, Fukiagedani, C.	35	2X
Microsorium fortunei	TNS 290723, Kuwanokizawa, C.	37	2X

Abbrebiation: H. Isl. Hahajima, C. Isl. Chichijima cimens are considered to be sexual diploid species, because they showed 41 bivalent chromosomes in meiosis and produced 64 spores in a sporangium. Consequently, it becomes clear that three cytotypes and two reproductive types are present in this species. Such different reproductive types within one species are reported in *Adiantum lunulatum* (2X sexual, 2X apogamous, 3X apogamous and 4X sexual types, Mehra and Verma 1963), in *Phegopteris polypodioides* (2X sexual, 3X apogamous type, Hirabayashi 1969, Mitui 1970) and in *Pteris inaequalis* var. *aequata* (2X sexual, 2X apogamous and 3X apogamous types, Nakato and Kawasaki 1972). Among these species triploid apogamous plants seem to be distributed more widely than others. The gross morphology of each species suggests autoploid series.

2) **Histiopteris incisa** Walker (1966) reported the gametic chromosome number of 96 for the materials from Jamaica, and Manton and Sledge (1954) and Brownlie (1961) previously showed approximately 96 bivalents for the materials from Ceylon and New Zealand respectively. Recently Kurita (1972) quoted a count of n=96 and 2n=ca. 192 for the Japanese material. On the other hand, one specimen from Okimura showed approximately 48 bivalent chromosomes at meiosis and produced normal 64 spores in a sporangium. From this result, it may be clear that the basic chromosome number of this genus should be X=48 or 24 as Kurita suggested (1972). Unfortunately, I could not count the chromosome numbers of this species from other localities in the Bonin Islands, and so it is not clear whether two cytotypes grow in these islands.

3) **Microlepia speluncae** The Bonin specimens showed 86 bivalents at meiosis and contained 64 spores in a sporangium. Until the present time, three cytotypes in this species have been known in the world. The diploid specimen (n=43) was collected from Himalaya (Mehra and Khanna 1959), the tetraploid (n=86) was reported from Ceylon and Malaya (Manton and Sledge 1954, Manton 1954) and furthermore Abraham et al. (in Fabbri 1963) quoted a count of n=88 for the Indian materials. The hexaploid (n=129) was observed only for West African specimen (Manton 1958). At present, the tetraploid type seems to be distributed more extensively than other cytotypes of this species.

4) **Ophioglossum petiolatum** Kurita (1965) observed four cytological races in this species; the first type had n=480 producing seemingly available

spores, the second type had n=ca. 510 but did not produce normal tetrads showing an irregularity at meiosis. The third and the fourth type showed irregular meiosis, and the former is considered to have 2n=ca. 960 from the numbers of bivalents and univalents at meiosis and the latter had 2n=ca. 1100. Only one cytotype was found in the Bonin Islands and these specimens showed the normal meiosis and had n=480.

5) **Pteris boninensis** The specimens of the genus *Pteris* in the Bonin Islands have been identified either as *P. fauriei* or *P. oshimensis* by some authors. Recently, however, Ohba (1971) described those specimens as a new species, *P. boninensis*. This treatment seems to be reasonable from the point of the present cytological study, because the specimens of the Bonin Islands were sexual diploid with n=29, while *P. fauriei* and *P. oshimensis* in Japan were triploid apogamous species (n=87, Mitui 1966, 1968). On the other hand it is very interesting that Walker (1962) reported n=29 for *P. quadriaurita* from Ceylon, and also for *P. "quadriaurita"* from Australia and West Himalaya. For the elucidation of *P. quadriaurita* complex, more detailed comparative studies on the Bonin species and the specimens from Ceylon, Australia and Himalaya, which belong to this complex having the same chromosome number, should be required.

6) **Vandenboschia radicans** var. **orientalis** Manton (1950) and Mehra and Singh (1957) quoted a count of n=72 for this species from Ireland and India respectively, while two cytotypes have been known in Japan; one is sexual tetraploid (n=72) and the other is triploid (2n=108) which shows 36 bivalents and 36 univalents at meiosis (Mitui 1968). The diploid specimen has never been known from any localities in Japan, although it was collected from Taiwan (Mitui 1968). The triploid specimens are noticed more frequently than the tetraploid in Japan. The Bonin plants of this species are considered to be triploid because they showed approximately 36 bivalents and 36 univalents at meiosis. However any diploids and tetraploids were not found also in the Bonin Islands.

General discussion At first it is interesting that the proportion of polyploid species to diploid ones and the grade of polyploidy as well are lower in the Bonin Islands than in other localities. Out of 23 species investigated, only 7 species (30%) were polyploids of which the majority was tetraploids. It is also interesting that the new diploid cytotype was found in *Cyrtomium* *falcatum* and *Histiopterts incisa* in the present study.

The correlation between the relative percentage of polyploids in a certain flora and its geographical latitude is clear in some cases of the Spermatophyta (Löve and Löve 1943), while it is not so evident in the Pteridophyta. According to Manton (1958), the proportion of polyploids is 53% out of the 38 species studied in British Islands (50°-61°N) and it is 42% in 38 species in Madeira (32°N), while it is 60% in 132 species in Ceylon (5.5°-9.5°N). Furthermore the grade of polyploidy is higher in the fern flora of Ceylon than those of other two localities. In addition, in the fern flora of Ceylon the numbers of hybrids and apogamous species are more than in the fern flora of the other two. From these results, she concluded that the evolution was proceeding faster in the tropics than in temperate latitudes, and mentioned three favourable factors for the fern flora in the tropics. First, there is a more rapid growth and larger period of vegetation available in tropics compared with the highly seasonal climates, second, there is greater wealth of habitats in a more closely populated and stratified vegetation and lastly, there is the greater erosion by frequent landslides which provides more frequent opportunities for recolonization of ecological sites. Walker (1966) reported that out of 256 Jamaican fern species, approximately 60% were polyploids and that the grade of polyploidy was strikingly similar to that of Ceylon. On the other hand, in cool regions, Sorsa (1958, 1961) reported that out of 17 species, only 8 species were polyploids in Finland and that usualy only one low numbered cytotype could be found in most species which had two or three cytotypes in other parts of Europe In Japanese fern flora 51% is polyploid out of approximately 300 species (Mitui 1970). These results seem to support Manton's opinion.

On the contrary, in spite of subtropical regions, the proportion of polyploid is curiously lower and the grade of polyploidy is also relatively lower in the fern flora of the Bonin Islands than in any other tropics mentioned above, although the exact comparison may be difficult because of the lack of available materials. This result seems to show that the environment of the Bonin Islands is somewhat different from that of other tropical islands: Namely, the complete tropical favourable factors for the fern vegetation mentioned by Manton may not be present there, although a complete explanation is not available at present. At any rate, it seems to me that there are certain factors which should work to maintain diploid species rather than to promote polyploids in this islands. This may be supported by the facts that diploid cytotype is found in *Cyrtomium falcatum* and *Histiopteris incisa* in the Bonin Islands which are in polyploid states in other localities. Concerning with this result, nine endemic species are diploids (one is diploid apogamous) and have the same chromosome numbers as their related species from other localities. For example, *Bolbitis boninensis* has n=41 as *B. subcordata*, and *Crepidomanes acuto-obtusum* has n=36 as *C. makinoi* and *Loxogramme boninensis* has n=35 as *L. salixifolia*. If these species are truely endemic, it may be concluded that the speciation in the fern flora of Bonin Islands has not arisen by the polyploidization, but by some other genetic means.

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Explanation of Plates X—XI

Pl. X. A. *Sphenomeris chusana*, B. *Sphenomeris biflora*, C. *Microlepia speluncae*, D. *Microlepia strigosa*, E. *Pteris boninensis*, F. *Pteridium aquilinum* var. *latiusculum*, G. *Histiopteris incisa*, H. *Lindsaea repanda*, I. *Abrodictyum boninense*, J. *Vandenboschia radicans* var. *orientalis*, K. *Crepidomanes acuto-obtusum*.

Pl. XI. A. *Bolbitis boninensis*, B. *Lunathyrium bonincola*, C. *Ctenitis lepigera*, D. *Cyrtomium falcatum*, E. *Thelypteris ogasawarensis*, F. *Loxogramme boninensis*, G. *Microsorium fortunei*, H. *Lepisorus boninensis*, I. *Schizaea boninensis*.

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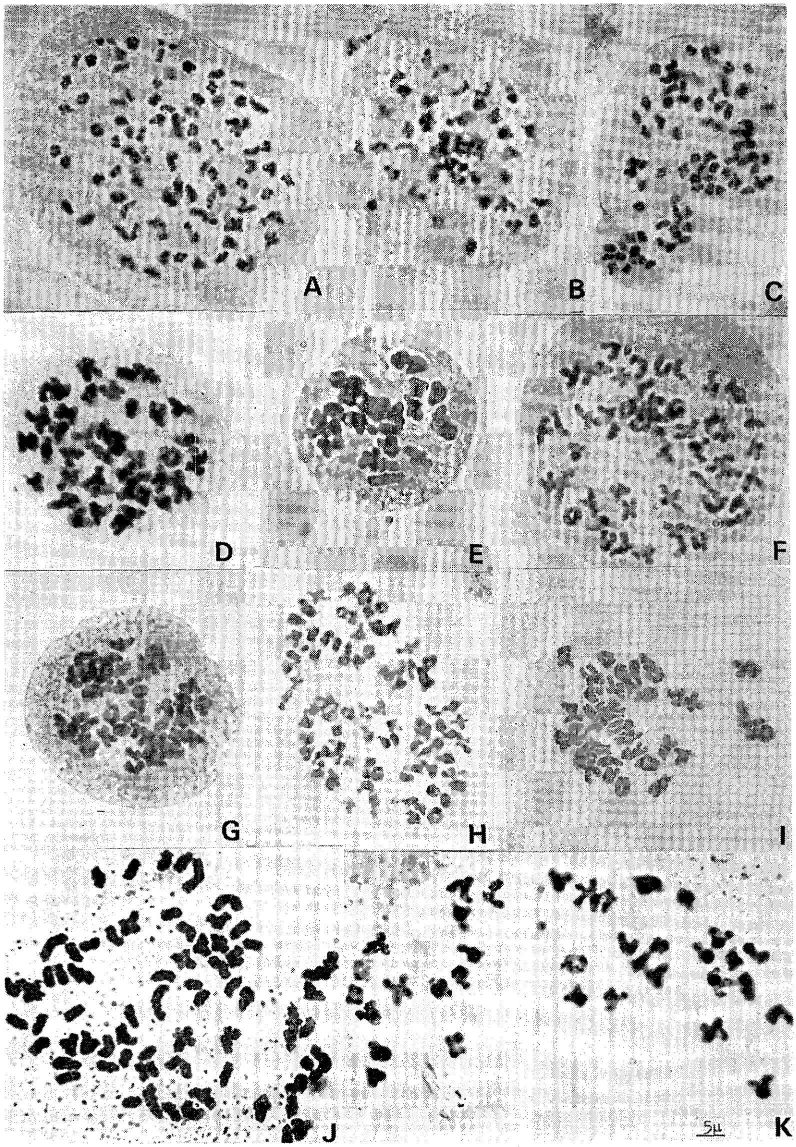
小笠原産のシダ植物23種の染色体数について報告した。これらのうち7種だけが倍数体でしかもその大部分は4倍体であった。シダ植物では温帯地域に比較して熱帯地域でのシダフロラ内の倍数体の割合は高くしかも倍数性の程度も6倍体や8倍体等のように高くなる傾向にあることが報告されている。マントンはこの原因として熱帯地域の環境がシダ植物の生長に適していることをあげている。しかし今回の調査では小笠原のシダフロラ内の倍数体の割合は低く，倍数性の程度も4倍体と低く他の熱帯地域とは異なっているようである。小笠原の環境は倍数体を誘引するよりもむしろ2倍体種の存続を保つ傾向にあるように思われる。このことはオニヤブソテツとユノミネシダで今回新たに2倍体種が発見されたことにより裏付けされるように思われる。

□Tang-Shui Liu (劉 棠瑞): **A monograph of the genus *Abies*.** 608 pp., 66 pls., 42 maps. Dec. 1971. Department of Forestry, National Taiwan University. US $25.00. *Abies* (モミ属) の世界的モノグラフで，著者が欧米日本の主要研究所で標本を自ら検討し，又できるだけ生品を観察してまとめた労作である。本属の分類にこれまで用いられてきた性質の外に，果柄の長さ，果軸の形態，実片の厚さ，葉の解剖学的諸性質，花粉の大きさなども重要であることを指摘している。その結果モミ属を2亜属15節39種27変種と9雑種に分類し，検索表と各種について詳しい文献の引用，記載，図（葉の断面も），分布図がつけられている。日本産としてはモミ，ウラジロモミ，シラビソ（変種シコクシラベ），トドマツ（変種アオトドマツ），オオシラビソが認められ，ミツミネモミはモミとオオシラビソの雑種と見なされている。著者が最も苦心したのは地中海・中米地域産の種の分類であり，地理分布，他属との関連や節相互の系統関係についての見解も示されている。その他化石種や利用に至るまでモミ属に関する多くの資料が集められているので今後の研究に役立つ文献である。 (原 寛)



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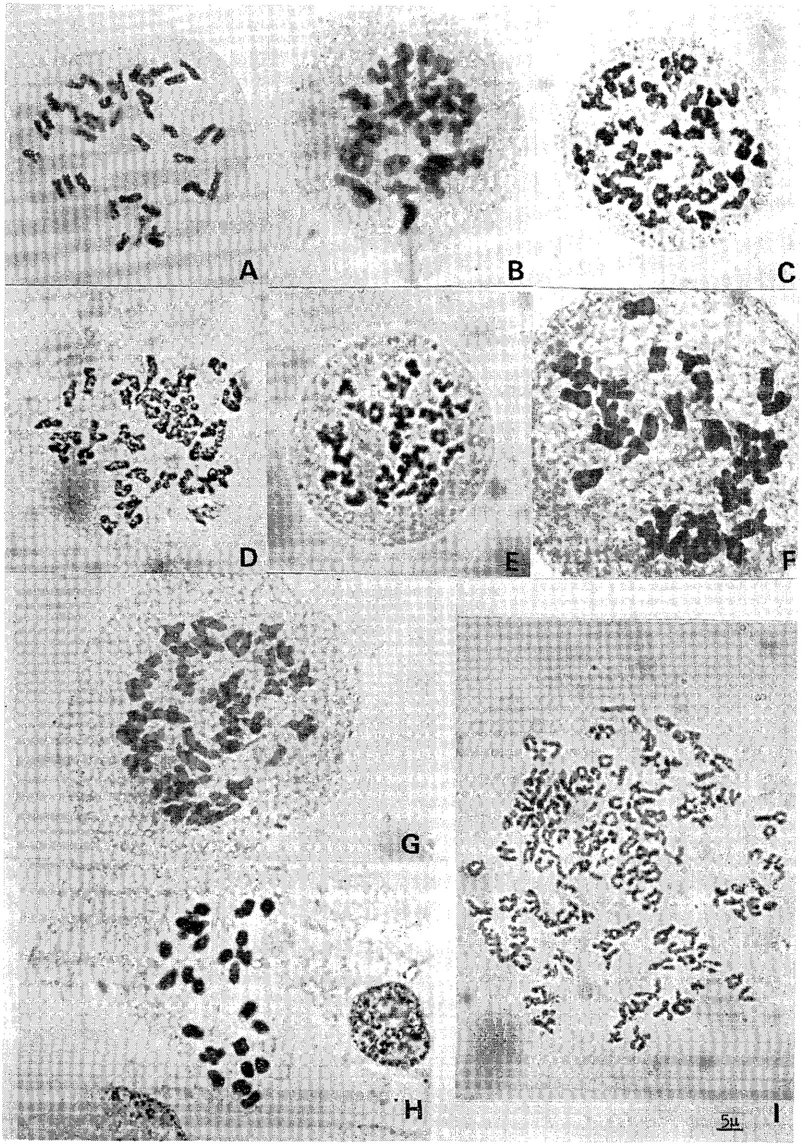

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