



## Cytotaxonomic Study of *Hypodematium* (Hypodematiaceae) from China

RENXIANG WANG<sup>1,2,\*</sup>, WEN SHAO<sup>3,\*</sup> & LING LIU<sup>1,2</sup>

<sup>1</sup>College of Life Sciences, Guangxi Normal University, Guilin 541004, China

<sup>2</sup>Key Laboratory of Ecology of Rare and Endangered Species and Environmental Protection (Guangxi Normal University), Ministry of Education, Guilin 541004, China

<sup>3</sup>Shanghai Chenshan Plant Science Research Center, CAS, Shanghai Chenshan Botanical Garden, Shanghai 201602, China

Author for corresponding: E-mail: 13977397428@126.com

\* Both first and second author contribute equally to this paper

### Abstract

Chromosome numbers and reproductive biology of nine species of the fern genus *Hypodematium* (Hypodematiaceae) from China were investigated. The chromosome numbers of eight species are reported here for the first time: *H. daochengensis* n=41 (41 II); *H. fordii* n=40 (40 II), n=80 (40 II+40 I), 2n=120; *H. glanduloso-pilosum* n=41 (41 II), 2n=82, 2n=123; *H. gracile* n=41 (41 II); *H. hirsutum* n= 41 (41 II); *H. microleptoides* n=41 (41 II); *H. sinense* n= 40 (40 II) and *H. squamuloso-pilosum* n=41 (41 II). Two cytotypes, n=82 (41 II+41 I) and 2n=123 in *H. crenatum*, are reported for the first time. Our results showed that the species with these cytotypes are agamosperous triploids: *H. crenatum* n = 82 (41 II +41 I), *H. glanduloso-pilosum* n = 82 (41 II +41 I) and *H. fordii* n = 80 (40 II +40 I), based on the unequal size and presence of aborted spores in the sporangium, and the allotriploid hybrid chromosomes in the spore mother cell at the diakinesis stage of meiosis I. The remaining species are sexual diploids and tetraploids, based on the chromosome number n = 41 and n =82 at the diakinesis stage of meiosis I of spore mother cells. The relationships among habitat preferences, frond hairs and reproductive modes in *Hypodematium* are discussed and illustrated. It appears that plants with large fronds and sparse, thin hairs, living in humid and shady places undergo sexual reproduction, while small plants living in sunny and dry conditions with thick hairs undergo agamosperous reproduction. The distribution pattern and basic chromosome number all indicated the basic chromosome number x= 41 was plesiomorphic, whereas x=40 was apomorphic. Chromosome aneuploid changes occurred in this genus. The distribution of the sexual diploids and tetraploids and agamosperous triploids suggests that the genus might have originated in the Himalayas and dispersed from there to northeast Asia and Japan.

**Key words:** *Hypodematium*, chromosome number, cytotaxonomy, reproductive mode, China

### Introduction

The fern genus *Hypodematium* Kunze (Hypodematiaceae) consists of limestone endemics distributed in subtropical and warm temperate Asia and Africa. It includes 18 species, of which 14 species are distributed in the limestone areas of eastern (Shandong province) and southwestern (Yunnan, Sichuan, Guangxi and Guangdong provinces) China, which are the distribution centers of this genus (Tsai & Shieh, 1994; Shing *et al.*, 1999; Wang *et al.*, 2010).

Species of *Hypodematium* grow in rock crevices in limestone areas. Rhizome dictyostele; lamina 3-4 pinnate, setose with long, soft, acicular and glandular hairs throughout the petiole, rachis and lamina; sorus round with hairy indusium, which is reniform, usually asymmetrical, and attached by a deep sinus. The characteristics of *Hypodematium* (vascular bundles, hairs, sorus, indusium, gametophyte and chromosome) caused the genus to be confused with those of Athyriaceae (Pichi Sermolli, 1977), Thelypteridaceae (Ching, 1963) and Dryopteridaceae (Loyal, 1960; Nayar & Nisha, 1970; Tryon & Tryon, 1982; Kramer & Green, 1990). Ching (1975) treated this genus as a monotypic family Hypodematiaceae, which was supported by Christenhusz (2011) and Zhang (2012) based on molecular analysis. While *Hypodematium* was thought to be close to *Leucostegia* Presl (Tsutsumi & Kato,

### Systematic position of the genus *Hypodematium*

*Hypodematium* has been included in Athyriaceae (Pichi Sermolli, 1977), Thelypteridaceae (Ching, 1963) and Dryopteridaceae (Loyal, 1960; Nayar & Nisha, 1970; Tryon & Tryon, 1982; Kramer & Green, 1990), because its characteristics (vascular bundles, hairs, sorus, indusium, gametophyte and chromosome) were confused with those of other families. Ching (1975) treated this genus as a monotypic family Hypodematiaceae, which was supported by Christenhusz (2011) and Zhang (2012), the last two also included *Leucostegia* Presl in Hypodematiaceae. Based on molecular analysis, *Hypodematium* was considered to be closely related to *Leucostegia* Presl (Tsutsumi & Kato, 2006; Smith *et al.*, 2006; Schuettpelz & Pryer, 2007; Liu *et al.*, 2007), however, this is not supported by evidence from macro-morphology and microcharacteristics of the epidermis (Wu *et al.*, 1991; Wang *et al.*, 2012).

The plesiomorphic basic chromosome numbers of *Hypodematium* is  $x = 41$ , which is the same as that of *Leucostegia* Presl. Based on the chromosome evidence, our study supports the close relationship of *Hypodematium* with *Leucostegia* Presl. However, the systematic position of *Hypodematium* is still unclear and further study is still needed.

### Acknowledgements

We would like to thank Prof. W. M. Chu and Dr. Z. R. He of Yunnan University and Dr. L. Y. Guo of National Taiwan University for providing valuable references cited in this paper. We sincerely thank Ms B. F. Lv of Taiwan Society of Plant Systematics and Ms Y. L. Niu of Jiangxi Lushan Botanical Garden for providing some materials of this paper. The first author would also thank Prof. Allen Coombes of Benemerita Universidad Autónoma de Puebla for helpful suggestions of the manuscript. This study was supported by the National Natural Science Foundations of China, Grant No. (31060030, 31200162), and the Natural Science Foundation of Guangxi (2011GXNSFA018089).

### References

- Ching, R.-C. (1963) A reclassification of the family Thelypteridaceae from the mainland of Asia. *Acta Phytotaxonomica Sinica* 8: 289–335.
- Ching, R.-C. (1975) Two new fern families. *Acta Phytotaxonomica Sinica* 13(1): 96–98.
- Christenhusz, M.J.M. Zhang, X.-C. & Schneider, H. (2011) A linear sequence of extant families and genera of lycophytes and ferns. *Phytotaxa* 19: 7–54.
- Gibby, M. (1985) Cytological observations on Indian subcontinent and Chinese *Dryopteris* and *Polystichum* (Pteridophyta: Dryopteridaceae). *Bulletin of the British Museum (Natural History), Botany Series* 14: 1–42.
- Iwatsuki, K. (1964) On *Hypodematium crenatum* Kunze. *Acta Phytotaxonomica et Geobotanica* 21: 43–54.
- Kato, M. Nakato, N. & Cheng, X. (1992) A cytotaxonomic study of ferns of Yunnan, southwestern China. *Botanical Magazine (Tokyo)* 105: 105–124.  
<http://dx.doi.org/10.1007/bf02489407>
- Kramer, K.U. & Green, P.S. (1990) Vol. I. Pteridophytes and gymnosperms. In: Kubitzki K ed. The families and genera of vascular plants. *Springer-Verlag*, Berlin, 172pp.  
<http://dx.doi.org/10.1002/fedr.19921030317>
- Kurita, S. (1965) Chromosome numbers of some Japanese ferns IV. *Journal of Japanese Botany* 40: 234–244.
- Lin, S.J. Kato, M. & Iwatsuki, K. (1990) Sporogenesis, reproductive mode, and cytotaxonomy of some species of *Sphenomeris*, *Lindsaea*, and *Tapeinidium* (Lindsaeaceae). *American Fern Journal* 80: 97–109.  
<http://dx.doi.org/10.2307/1547175>
- Liu, H.-M. Zhang, X.-C. Wang, W., Qiu, Y.-L. & Chen, Z.-D. (2007) Molecular phylogeny of the fern family Dryopteridaceae inferred from chloroplast *rbcL* and *atpB* genes. *International Journal of Plant Sciences* 168: 1311–1323.  
<http://dx.doi.org/10.1086/521710>
- Loyal, D.S. (1960) Some observations on the gametophyte of *Hypodematium crenatum* (Forsk.) Kuhn with a note on the phyletic affinities of the genus. *Journal of the Indian Botanical Society* 39: 133–139.
- Manton, I. (1950) Problems of Cytology and Evolution in the Pteridophyta. *Cambridge University Press*, Cambridge, 151pp.
- Mehra, P.N. & Loyal, D.S. (1956) Some observations on the cytology and anatomy of *Hypodematium crenatum* (Forsk.) Kuhn. *Current Science* 363–364.
- Mitui, K. (1970) Chromosome studies on Japanese ferns IV. *Journal of Japanese Botany* 45: 84–90.
- Nayar, B.K. & Nisha, B. (1970) A Reinvestigation of the Morphology of *Hypodematium crenatum*. *American Fern Journal*

60(3): 107–118

<http://dx.doi.org/10.2307/1546088>

- Pichi Sermolli, R.E.G. (1977) Tentamen pteridophytorum genera in taxonomicum ordinem redigendi. *Webbia* 31: 313–512.  
<http://dx.doi.org/10.1080/00837792.1977.10670077>
- Roy, R.P. Sinha, B.M.B. & Sakya, A.B. (1971) Cytology of some ferns of Kathmandu valley. *British Fern Gazette* 10(4): 193–199.
- Schuettpelz, E. & Pryer, K.M. (2007) Fern phylogeny inferred from 400 leptosporangiate species and three plastid genes. *Taxon* 56: 1037–1050.  
<http://dx.doi.org/10.2307/25065903>
- Shing, K.S. Chiu, P.S. Lin, Y.X. *et al.* (1999) Hypodematiaceae. In Shing, K.S. eds, *Flora Reipublicae Popularis Sinicae. Vol. 4(1) Science Press*, Beijing, 1–14 pp.
- Smith, A.R. Pryer, K.M. Schuettpelz, E. *et al.* (2006) A classification for extant ferns. *Taxon* 55: 705–731.  
<http://dx.doi.org/10.2307/25065646>
- Tryon, R.M. & Tryon, A.F. (1982) Ferns and allied plants, with special reference to tropical America. Springer, New York, 183pp.
- Tsai, J.L. & Shieh, W.C. (1994) Aspidiaceae. In Huang, T.C. 2ed, Flora of Taiwan, Volume 1. *Editorial Committee of the Flora of Taiwan*, 32pp.
- Tsutsumi, C. & Kato, M. (2006) Evolution of epiphytes in Davalliaceae and related ferns. *Botanical Journal of the Linnean Society* 151: 495–510.  
<http://dx.doi.org/10.1111/j.1095-8339.2006.00535.x>
- Walker, T.G. (1979) The cytogenetics of ferns. In Dyer AF, eds, *The Experimental Biology of Ferns. Academic Press*, London, 65pp.
- Wang, F.-G. Liu, D.-M. & Xing, F.-W. (2010) Two new species of *Hypodematium* (Hypodematiaceae) from limestone areas in Guangdong, China. *Botanical Studies* 51: 99–106.
- Wang, R.-X. Shao, W. Deng, X.-C. *et al.* (2012) Leaf epidermis micromorphology of *Hypodematium* Kunze and its taxonomic significance. *Guihaia* 32(4): 452–456.
- Wang, Z.-R. & Zhang, Z.-X. (1981) Cytological observation on some Chinese ferns. *Acta Botanica Sinica* 23: 26–34.
- Wu, S.-H. & Ching, R.-C. (1991) Fern families and genera of China. *Science Press*, Beijing, 127pp.
- Zhang, X.-C. (2012) Lycophytes and ferns of China. Beijing, *Beijing University Press*, Beijing, 211pp.