

The moss flora of Mt. Deogyu in Korea

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ABSTRACT: The objective of this study was to discuss the characteristics of the moss flora of Mt. Deogyu located on the border of the Jeonbuk and Kyungnam provinces in Korea. A total of 21 field surveys were carried out at various sites in the mountain area from August 2007 to September 2008. All the collected materials were processed into voucher specimens and were currently deposited in the herbarium at Chonbuk National University (JNU). In this study, we collected and identified 158 moss taxa, which included 156 species, 1 subsp. and 1 var. of 96 genera and 37 families. Unconfirmed taxa in this study, but previously recorded, belonged to 25 taxa, which included 13 families, 19 genera and 25 species. In addition, 183 taxa were found on Mt. Deogyu, which belonged to 37 families, 101 genera, 1 subsp. and 1 var. The habitat of each collection was examined and the classification system of Ignatov et al. (2006) was used. New vernacular names of 6 families and 11 genera were then determined. Six species, formerly thought to be only in North Korea, were shown to be present on Mt. Deogyu, which included *Bucklandiella laeta*, *Anomobryum filiforme* var. *concinatum*, *Herzogiella turfacea*, *Brachythecium rutabulum*, *Eurhynchium angustirete* and *Campylidium hispidulum*.

Keywords: Mosses, Bryophyte, Moss Flora, Mt. Deogyu National Park

Mosses are the most diverse among the three major groups of nonvascular land plants (mosses, liverworts, and hornworts) and inhabit a great number of ecological niches (Simpson, 2007). Most mosses grow on wet soil, rocks or bark of trees. Mosses (Musci) can be readily distinguished from liverworts (Hepaticae) by capsule and seta that are persistent after spores are shed. Usually, their sporangium (capsule) opens by an apical lid (operculum) that covers the mouth of the capsule and there is a columella in the center of the capsule, which houses only spores (whereas in liverworts it also contains elaters) (Choe, 1980; Simpson, 2007). Mosses are widely distributed and it was reported that they can live in extreme environments where other plants would not be able to exist (Bold et al., 1987). Mosses include approximately 10,000 species of nearly 700 genera (Schofield, 1985). There are about 2,500 species in China (Gao et al., 1999), 1,200 species in Japan (Tomas and Nick, 2000) and 450–650 species in Korea (Choe, 1980; Park, 2007). This number corresponds to nearly 6.5% of all the mosses currently recognized in the world. The first collector of mosses on the Korean Peninsula was Urban Faurie. His collections were identified by Cardot, a French bryologist. Later, in the 1940's, Japanese botanists including

Okamura, Horikawa, Sasaoka, Kasimura, Noguchi, and Osada studied bryophytes of Korea (Song and Yamada, 2001, 2003). Afterwards, Korean botanists began to study Korean bryophytes and the results of their investigations were published in “The bryophytes of Mt. Gwanak with some new additions to the Korean flora (Hong, 1960a)”, “The moss flora of Mt. Chiri with some new additions to the Korean flora (Hong and Ando, 1961)”, “The bryophytes of Mt. Soyo with some new additions to the Korean flora (Hong, 1960b)”, “Illustrated Flora and Fauna of Korea (Choe, 1980)”, “New list of bryophytes of Korea (Park, 2007)”. One of the main difficulties behind comprehending the moss flora of Korea is that most of the voucher specimens of previous studies were lost and therefore cannot be reexamined currently.

Mt. Deogyu National Park is located in the middle of the Korean peninsula with the high peak Hyangjeokbong (1,614 m). Floristically, this mountain belongs to the southern part of the Korean region where southern and northern elements of plants come together and occupy habitats at high elevations in the mountains. Therefore, this region has great species diversity (Lee, 1978). The vascular flora of Mt. Deogyu was well studied and about 540 taxa were reported (Yook and Ahn, 1972; Yim et al., 1994). However, the moss flora of Mt. Deogyu has never been studied comprehensively till now. There have been only

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some reports regarding regional distribution of species of the mountain with regards to the general characteristics of moss flora of Korea.

This study intended to comprehend the moss flora of Mt. Deogyu as a part of preparing for the whole moss flora of Korean Peninsula.

Materials and Methods

In the course of this study, a total of 21 field surveys were carried out at various sites on the mountain from August 2007 to September 2008 (Fig. 1). All materials collected were processed into voucher specimens and were then deposited in the herbarium at Chonbuk National University (JNU). The taxa were identified using the available literature (Choe, 1980; Crum and Anderson, 1981; Noguchi, 1987, 1988, 1989, 1991, 1994; Hwang, 1991; Gao et al., 1999; Li et al., 2001; We et al., 2002; Cao et al., 2003; Jia et al., 2005; Li et al., 2007; Iwatsuki, 2001; Smith, 2004). The specimens were observed under stereoscopic and optical microscopy. Plant size was measured using a vernier caliper and cells and spores were measured by an eyepiece micrometer on an optical microscope.

The list of identified taxa was compiled according to the

classification system proposed by Ignatov et al. (2006). In addition, their distribution in Korea and in the world as well as habitat characteristics is also provided.

Results and Discussion

A total of 183 moss taxa which included 181 species, 1 subspecies and 1 variety were identified as belonging to 101 genera, 37 families, 13 orders, and 3 classes (Table 1). This number corresponds to 28.4% of the total number of mosses (645 taxa) currently recognized from the Korean peninsula.

Of the 183 taxa, 102 taxa were first recorded from Mt. Deogyu in this study and the remaining 81 taxa were reported by Park and Choi (2007) in their check list "New list of bryophytes of Korea". However, 25 taxa were reported in previous studies. Only regarding the number of moss species distributed in Mt. Jiri, Hong and Ando (1961) reported 132 taxa of 79 families; in our study, 183 taxa were found to be distributed in the mountain district of Mt. Deogyu.

Thus, the species diversity in the studied area was high. These species included *Climacium japonicum* Lindb., which collected on a semi-shady slope of Gucheondong valley above the Baekryeon Temple and on a rock covered with humus soil

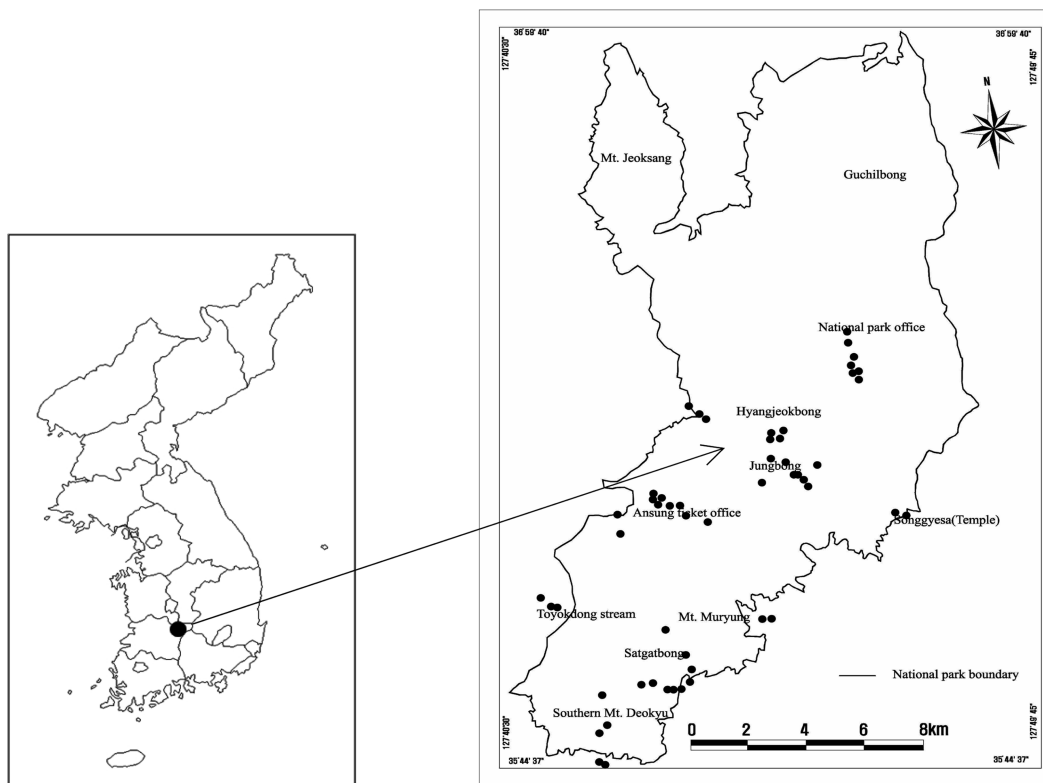


Fig. 1. The studied area of Mt. Deogyu.

Table 1. Number of taxa recognized on Mt. Deogyu.

Class	Order	Family	Genera	Subsp.	Var.	Species	Total		
Polytrichopsida	1	Polytrichaceae	4			11	11		
Tetraphidopsida	1	Tetraphidaceae	1			1	1		
		Diphysciaceae	1			1	1		
		Funariaceae	2				2	2	
		Bryoxiphiaceae	1	1				1	
		Grimmiaceae	5				8	8	
		Ptychomitriaceae	1				2	2	
		Leucobryaceae	3				4	4	
		Bruchiaceae	1				1	1	
		Dicranaceae	2				8	8	
		Rhabdoweisiaceae	3				3	3	
		Ditrichaceae	2				2	2	
		Pottiaceae	6				9	9	
		Fissidentaceae	1				4	4	
		Orthotrichaceae	3				5	5	
		Hedwigiaceae	1				1	1	
		Bryaceae	3			1	4	5	
		Mielichhoferiaceae	1				4	4	
		Mniaceae	4				12	12	
		Bryopsida	11	Bartramiaceae	2			3	3
				Hookeriaceae	1			1	1
				Plagiotheciaceae	2			4	4
				Leucodontaceae	1			1	1
				Hypnaceae	3			8	8
				Entodontaceae	1			8	8
				Pylaisiadelphaceae	2			3	3
				Anomodontaceae	3			8	8
				Neckeraceae	4			9	9
Climaciaceae	2					2	2		
Hylocomiaceae	7					8	8		
Lembophyllaceae	2					2	2		
Meteoriaceae	1					1	1		
Brachytheciaceae	9					16	16		
Pylaisiaceae	5					9	9		
Leskeaceae	3					3	3		
Thuidiaceae	6			11	11				
Amblystegiaceae	2			2	2				
Total	13	37	101	1	1	181	183		

on a semi-shady spot of Deokgok Valley. At present, the three taxa, *C. americanum* Brid., *C. dendroides* (Hedw.) F. Weber and D. Mohr. and *C. japonicum* Lindb. were shown to be present

in the Korean Peninsula, and *C. japonicum* Lindb. was reported to grow on Mt. Deogyu by Choe (1980). This species is characterized by an upright tree-like growth form and can reach

about 5–10 cm in height. In addition, this moss species is of very high ornamental value. Until now, *Bucklandiella heterosticha* (Hedw.) Bednarek-Ochyra and *Ochyra* has only been known to be present in the mountains of North Korea, but during our research this species was collected on an exposed rock in the mountainous district of Mt. Deogyu. *Didymodon rigidulus* Hedw. collected in the same area was recorded in the New List of Bryophytes of Korea (Park, 2007), but its related literature and specimens could not be confirmed, and its location was indicated just as Korea. However, in this study, it was shown to be present on Mt. Deogyu. *Brachythecium rutabulum* (Hedw.) Schimp. was previously believed to be only on Mt. Baekdu (Mt. Changbai); however, in this study, this species was also found on Mt. Deogyu. Based on the above results, this region was found to contain a more abundant diversity of mosses than the neighboring Mt. Jiri National Park, and species previously thought to be present in North Korea only, were found on Mt. Deogyu. High level of species diversity found on Mt. Deogyu can be explained by the presence of a great number of large and small moist valleys and many rock bed exposed areas, which are characteristic of the peaks and plateaus located over 1,000 m above sea level.

Distribution pattern

The numbers of taxa collected on different kinds of substrates along the valleys and ridges of Mt. Deogyu are presented in the Table 2. Most species grow in several habitats with no limitations to the property of substrate, but *Grimmia* Hedw. and *Hedwigia ciliata* (Hedw.) P. Beauv. mostly grow only on specific substrates. They mainly grow on exposed rocks in the mountainous district.

The representatives of Polytrichaceae Schwgr. mostly grow on soil that can be penetrated by rhizomes or on rocks covered with humus soil or gaps between rocks filled with soil. *Pylaisiadelphina tenuirostris* (Bruch and Schimp. ex Sull.) W. R. Buck and *Fauriella tenuis* (Mitt.) Cardot were collected mostly on trees, and remaining taxa were usually distributed throughout the ridges and valleys areas. Especially, *Entodon concinnus* (De Not.) Paris and *Pohlia elongata* Hedw. were distributed at only ridge of high elevations. Thus, it is clear that several species are restricted to the ridge area at high altitudes.

Species new to South Korea

Six taxa that were previously distributed only in North Korea were discovered on Mt. Deogyu in South Korea for the first time. These species included *Bucklandiella laeta* (Besch. and Cardot) Bednarek-Ochyra and *Ochyra*, *Anomobryum filiforme* var. *concinatum* (Spruce) Loeske, *Herzogiella turfacea* (Lindb.) Z. Iwats., *Brachythecium rutabulum* (Hedw.) B. S. G., *Eurhynchium angustirete* (Broth.) T. J. Kop., and *Campylidium hispidulum* (Brid.) Ochyra. Previously, collection site of *Ptychomitrium dentatum* (Mitt.) A. Jaeger and *Didymodon rigidulus* Hedw. were noted as “Korea” with no indication of any particular location. In this study, we found them in Mt. Deogyu.

Following are the brief characteristics of these taxa.

1) *Bucklandiella laeta* (Besch. and Cardot) Bednarek-Ochyra and *Ochyra* 산검정서리이끼 : This species were distributed in both the valley and ridge areas and collected on rocks. This species was larger in size than *B. heterosticha* (Hedw.) Bednarek-Ochyra and *Ochyra* and its laminal cells are rectangular or quadrate.

2) *Didymodon rigidulus* Hedw. 곧은쌍둥이이끼 : This species was found on rocks in the valley area of Southern Deogyu Mountain (Mt. Nam-Deogyu). The species is characterized with acute apex, 2- or 3-stratose margins, transparent rectangular cells of the leaf base and asexual reproduction by axillary, ovate to elliptic or globose, multicellular gemmae.

3) *Anomobryum filiforme* var. *concinatum* (Spruce) Loeske 처녀걸은이끼 : It was collected in semi-shady spots on rocks and sandy soil of the Chilyeon and Myeongcheon Valleys. On rocks and sandy soil. It was found on rocks and sandy soil. It can be distinguished by the costal lengths of the leaves and gemmae on axils of leaves.

4) *Herzogiella turfacea* (Lindb.) Z. Iwats. 누운이끼주목이끼 : It was collected in several valleys, including the Gucheondong and Songgye Valleys. It grows on soil and rocks covered with fine soil. Previously, its collection site was noted as “Korea” with no indication of any particular location.

5) *Brachythecium rutabulum* (Hedw.) Schimp. 장백양털이끼 : This species was collected in Gucheondong Valley and in Mt. Nam-Deogyu valley areas. It was present on rocks. Previously,

Table 2. The number of taxa collected from different kinds of substrates along the valleys and ridges of Mt. Deogyu.

Site	*Collection							Total
	A	B	C	D	E	F	G	
Valley	64	20	56	31	123	30	15	339
Ridge	5	5	10	5	25	3	-	53
Total	69	25	66	36	148	33	15	392

*A. on soil; B. on humus; C. tree trunks; D. on decaying wood; E. on rocks; F. on wet rocks; G. on moist rocks.



Fig. 2. Plant of the taxa new to South Korea. a. *Bucklandiella laeta* (Besch. and Cardot) Bednarek-Ochyra and Ochyra; b. *Anomobryum filiforme* var. *concinnatum* (Spruce) Loeske; c. *Herzogiella turfacea* (Lindb.) Z. Iwats.; d. *Brachythecium rutabulum* (Hedw.) Schimp.; e. *Eurhynchium angustirete* (Broth.) T. J. Kop.; f. *Campylidium hispidulum* (Brid.) Ochyra.

it had only been found on Mt. Baekdu.

6) *Eurhynchium angustirete* (Broth.) T. J. Kop. 산부리이끼 : This species was collected in Gucheondong Valley and Mt. Nam-Deogyu valley areas, where it was found on rocks.

7) *Campylidium hispidulum* (Brid.) Ochyra 버들변덕이끼 : The species was collected on rocks in the Gucheondong Valley. The species was previously only found in North Korea.

8) *Ptychomitrium dentatum* (Mitt.) A. Jaeger. 물가곱슬이끼 : This species was collected near Inwoldam, Songgye and Wolseong Valleys, where it grow on semi-dry and moist rocks. Mt. Deogyu is the only locality where this species has been reported in the Korea peninsula.

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2. *Atrichum rhystophyllum* (Mll. Hal.) Paris 아귀주름솔이끼; Yoon Y. J. 10624, 10678, 10863 (JNU)
3. *Pogonatum inflexum* (Lindb.) Sande Lac. 아귀들솔이끼; Yoon Y. J. 10012, 10048, 10075 (JNU)
4. *Pogonatum spinulosum* Mitt. 침들솔이끼; Yoon Y. J. 10001, 10143, 10857 (JNU)
5. *Pogonatum urnigerum* (Hedw.) P. Beauv. 산들솔이끼; Yoon Y. J. 11664, 11681, 12019 (JNU)
6. *Polytrichastrum formosum* (Hedw.) G. L. Sm. 큰솔이끼; Yoon Y. J. 10672, 11218, 11241 (JNU)
7. *Polytrichum commune* Hedw. 솔이끼; Yoon Y. J. 10347, 10481 (JNU)

Tetraphidaceae (네삭치이끼과)

8. *Tetraphis pellucida* Hedw. 네삭치이끼; Yoon Y. J. 10612, 12807 (JNU)

Diphysciaceae (보리알이끼과)

9. *Diphyscium lorifolium* (Card.) Magombo 곶이끼; Yoon Y. J. 0847, 11821, 12053 (JNU)

Funariaceae (표주박이끼과)

10. *Funaria hygrometrica* Hedw. 표주박이끼; Yoon Y. J. 10327, 12401, 12441 (JNU)
11. *Physcomitrium japonicum* (Hedw.) Mitt. 풍경이끼; Yoon Y. J. 10809 (JNU)

Bryoxiphiaceae (새우이끼과)

12. *Bryoxiphium norvegicum* (Brid.) Mitt. subsp. *japonicum* (Berggr.) A. Lve and D. Lve 새우이끼; Yoon Y. J. 12637 (JNU)

Grimmiaceae (고깔바위이끼과)

13. *Bucklandiella heterosticha* (Hedw.) 검정서리이끼; Yoon Y. J. 13019, 13023, 13039 (JNU)
14. *Bucklandiella laeta* (Besch. and Cardot) Bednarek-Ochyra and Ochyra 산검정서리이끼; Yoon Y. J. 10146, 10148, 13027 (JNU)
15. *Codriophorus anomodontoides* (Cardot) Bednarek-Ochyra and Ochyra 갈색민서리이끼; Yoon Y. J. 10002, 10016, 10020 (JNU)
16. *Codriophorus carinatus* (Cardot) Bednarek-Ochyra and Ochyra 접찐민서리이끼; Yoon Y. J. 10852, 12043, 12048 (JNU)
17. *Codriophorus fascicularis* (Hedw.) Bednarek-Ochyra and Ochyra 민서리이끼; Yoon Y. J. 11635, 12229, 12419 (JNU)
18. *Grimmia pilifera* P. Beauv. 흰털고깔바위이끼; Yoon Y. J. 10013, 10022, 10206 (JNU)

Appendix 1. The list of the moss species collected from Mt. Deogyu

Polytrichaceae (솔이끼과)

1. *Atrichum flavisetum* Mitt. 넓은주름솔이끼; Yoon Y. J. 10007, 10025, 10064 (JNU)

19. *Niphotrichum canescens* (Hedw.) Bednarek-Ochyra and Ochyra 서리이끼; *Yoon Y. J.* 10348, 11052, 11058 (JNU)

20. *Schistidium apocarpum* (Hedw.) Bruch and Schimp. 고갈바위이끼; *Yoon Y. J.* 10428, 10853, 11077 (JNU)

Ptychomitriaceae (곱슬이끼과, New)

21. *Ptychomitrium dentatum* (Mitt.) A. Jaeger 물가곱슬이끼; *Yoon Y. J.* 10430, 10844, 10862 (JNU)

22. *Ptychomitrium linearifolium* Reimers and Sakurai 돌주름곱슬이끼; *Yoon Y. J.* 10043, 10046, 10050 (JNU)

Leucobryaceae (흰털이끼과)

23. *Brothera leana* (Sull.) Mill. Hall 사자이끼; *Yoon Y. J.* 10344, 10469, 10484 (JNU)

24. *Campylopus japonicus* Broth. 붓이끼; *Yoon Y. J.* 10017, 10149, 10150 (JNU)

25. *Leucobryum glaucum* (Hedw.) Aongstr. 흰털이끼; *Yoon Y. J.* 10821, 10829, 10835 (JNU)

26. *Leucobryum juniperoideum* (Brid.) Mell. Hal 가는흰털이끼; *Yoon Y. J.* 10301, 10338, 10351 (JNU)

Bruchiaceae (두루미이끼과, New)

27. *Trematodon longicollis* Michx. 두루미이끼; *Yoon Y. J.* 10304, 10323, 10325 (JNU)

Dicranaceae (꼬리이끼과)

28. *Dicranella heteromalla* (Hedw.) Schimp. 역새이끼; *Yoon Y. J.* 10019, 10024, 10138 (JNU)

29. *Dicranum nipponense* Besch. 큰꼬리이끼; *Yoon Y. J.* 10479, 10483, 10657 (JNU)

30. *Dicranum scoparium* Hedw. 비꼬리이끼; *Yoon Y. J.* 10312, 10353, 10357 (JNU)

Rhabdoweisiaceae (주름꼬마이끼과, New)

31. *Dichodontium pellucidum* (Hedw.) Schimp. 갈고리이끼; *Yoon Y. J.* 11661 (JNU)

32. *Oncophorus crispifolius* (Mitt.) Lindb. 곱슬혹이끼; *Yoon Y. J.* 10147, 10350, 10466 (JNU)

33. *Rhabdoweisia crispata* (Dicks. ex With.) Lindb. 주름꼬마이끼; *Yoon Y. J.* 13618, 14004 (JNU)

Ditrichaceae (금실이끼과)

34. *Ceratodon purpureus* (Hedw.) Brid. 지붕빨간이끼; *Yoon Y. J.* 11003, 11005, 11006 (JNU)

35. *Ditrichum pallidum* (Hedw.) Hampe 금실이끼; *Yoon Y. J.* 11239, 11834, 12446 (JNU)

Pottiaceae (침꼬마이끼과)

36. *Barbula unguiculata* Hedw. 참꼬인이끼; *Yoon Y. J.* 10828 (JNU)

37. *Bryoerythrophyllum recurvirostre* (Hedw.) Chen. 빨간담배잎이끼; *Yoon Y. J.* 10680 (JNU)

38. *Didymodon rigidulus* Hedw. 곧은쌍둥이이끼; *Yoon Y. J.* 10034 (JNU)

39. *Hyophila involuta* (Hook.) A. Jaeger 말린담배잎이끼; *Yoon Y. J.* 10031, 10436, 10490 (JNU)

40. *Hyophila propagulifera* Broth. 담배잎이끼; *Yoon Y. J.* 10417, 10420 (JNU)

41. *Oxystegus tenuirostris* (Hook. and Taylor) A. J. E. Sm. 통수염이끼; *Yoon Y. J.* 10027, 10097, 11222 (JNU)

42. *Weissia controversa* Hedw. 꼬마이끼; *Yoon Y. J.* 10326, 10681, 10815 (JNU)

43. *Weissia longifolia* Mitt. 흡구슬이끼; *Yoon Y. J.* 11090 (JNU)

44. *Weissia planifolia* Dixon 납작꼬마이끼; *Yoon Y. J.* 11423 (JNU)

Fissidentaceae (봉황이끼과)

45. *Fissidens bryoides* Hedw. 꼬마봉황이끼; *Yoon Y. J.* 10458, 10461 (JNU)

46. *Fissidens dubius* P. Beauv. 벼슬봉황이끼; *Yoon Y. J.* 10110, 10221, 10226 (JNU)

47. *Fissidens gymnogymus* Besch. 작은봉황이끼; *Yoon Y. J.* 10077, 10235, 10242 (JNU)

48. *Fissidens taxifolius* Hedw. 주목봉황이끼; *Yoon Y. J.* 10067, 10076, 10082 (JNU)

Orthotrichaceae (선주름이끼과)

49. *Macromitrium ferriei* Cardot et Thr. 들긴금털이끼; *Yoon Y. J.* 13621 (JNU)

50. *Macromitrium japonicum* Dozy and Molk. 긴금털이끼; *Yoon Y. J.* 10037, 10496 (JNU)

51. *Orthotrichum consobrinum* Cardot 아기선주름이끼; *Yoon Y. J.* 10003, 10078 (JNU)

52. *Ulota crispa* (Hedw.) Brid. 금털이끼; *Yoon Y. J.* 10845, 12803 (JNU)

Hedwigiaceae (툇이끼과)

53. *Hedwigia ciliata* (Hedw.) P. Beauv. 툇이끼; *Yoon Y. J.* 10008, 10044, 10202 (JNU)

Bryaceae (참이끼과)

54. *Anomodon julaceum* var. *concinatum* (Spruce) J.E. Zetterst. (*A. filiforme* var. *concinatum* (Spruce) Loeske) 처녀걸은이끼; *Yoon Y. J.* 10282, 12602 (JNU)

55. *Brachymenium nepalense* Hook. 노란참외이끼; *Yoon Y. J.* 10204, 10210, 10442 (JNU)

56. *Bryum argenteum* Hedw. 은이끼; *Yoon Y. J.* 10023, 10433, 11091 (JNU)

57. *Bryum capillare* Hedw. 철사이끼; *Yoon Y. J.* 10804, 11015, 11016 (JNU)

58. *Bryum cyclophyllum* (Schwgr.) Bruch et al. 꼬인물가철사이끼; *Yoon Y. J.* 13606 (JNU)

Mielichhoferiaceae (수세미이끼과, New)

59. *Pohlia camptotrachela* (Renauld and Cardot) Broth. 들수세미이끼; *Yoon Y. J.* 11238, 11651 (JNU)

60. *Pohlia elongata* Hedw. 긴수세미이끼; *Yoon Y. J.* 10311, 14020, 14023 (JNU)

61. *Pohlia longicollis* (Hedw.) Lindb. 긴목수세미이끼; *Yoon Y. J.* 10865, 12817 (JNU)

62. *Pohlia proligera* (Kindb.) Broth. 흙들수세미이끼; *Yoon Y. J.* 10336, 10337, 10601 (JNU)

Mniaceae (초롱이끼과)

63. *Mnium laevinerve* Cardot. 납작맥초롱이끼; *Yoon Y. J.* 10058, 10102, 10314 (JNU)

64. *Plagiomnium confertidens* (Lindb. and Arnell) T. J. Kop. 즙름덩굴초롱이끼; *Yoon Y. J.* 13230, 13239 (JNU)

65. *Plagiomnium acutum* (Lindb.) T. J. Kop. 아기들덩굴초롱이끼; *Yoon Y. J.* 10094, 10113, 10129 (JNU)

66. *Plagiomnium cuspidatum* (Hedw.) T. J. Kop. 들덩굴초롱이끼; *Yoon Y. J.* 10015, 10047, 10119 (JNU)

67. *Plagiomnium japonicum* (Lindb.) T. J. Kop. 긴잎덩굴초롱이끼; *Yoon Y. J.* 12429, 13227 (JNU)

68. *Plagiomnium maximoviczii* (Lindb.) T. J. Kop. 덩굴초롱이끼; *Yoon Y. J.* 10274, 10293, 10297 (JNU)

69. *Plagiomnium vesicatum* (Besch.) T. J. Kop. 큰잎덩굴초롱이끼; *Yoon Y. J.* 11248, 11249, 11403 (JNU)

70. *Rhizomnium striatulum* (Mitt.) T. J. Kop. 줄미선초롱이끼; *Yoon Y. J.* 10052, 10087, 10475 (JNU)

71. *Trachycystis flagellaris* (Sull. and Lesq.) Lindb. 털아기초롱이끼; *Yoon Y. J.* 12831, 13013, 13247 (JNU)

72. *Trachycystis ussuriense* (Maack and Regel) T. J. Kop. 꼬인아기초롱이끼; *Yoon Y. J.* 12825 (JNU)

Bartramiaceae (구슬이끼과)

73. *Bartramia pomiformis* Hedw. 구슬이끼; *Yoon Y. J.* 11075, 11828, 11838 (JNU)

74. *Philonotis falcata* (Hook.) Mitt. 낫물가이끼; *Yoon Y. J.* 10866 (JNU)

75. *Philonotis thwaitesii* Mitt. 아기물가이끼; *Yoon Y. J.* 10310, 13631 (JNU)

Hookeriaceae (기름종이이끼과)

76. *Hookeria acutifolia* Hook. and Grev. 기름종이이끼;

Yoon Y. J. 10269, 10294, 11656 (JNU)

Plagiotheciaceae (산주목이끼과)

77. *Herzogiella turfacea* (Lindb.) Z. Iwats. 누운아기주목이끼; *Yoon Y. J.* 10126, 10231, 10803 (JNU)

78. *Plagiothecium denticulatum* (Hedw.) Schimp. 가는잎산주목이끼; *Yoon Y. J.* 10619, 10683, 12802 (JNU)

79. *Plagiothecium neckeroideum* Schimp. 큰산주목이끼; *Yoon Y. J.* 10806 (JNU)

80. *Plagiothecium nemorale* (Mitt.) A. Jaeger 산주목이끼; *Yoon Y. J.* 10011, 10065, 10069 (JNU)

Leucodontaceae (족제비이끼과)

81. *Leucodon sapporensis* Besch. 참족제비이끼; *Yoon Y. J.* 10444, 10495, 12448 (JNU)

Hypnaceae (털깃털이끼과)

82. *Hypnum erectiusculum* Sull. and Lesq. 편평털깃털이끼; *Yoon Y. J.* 10608 (JNU)

83. *Hypnum oldhamii* (Mitt.) A. Jaeger 가는털깃털이끼; *Yoon Y. J.* 10279, 10319, 10485 (JNU)

84. *Schwetschkeopsis fabronia* (Schwgr.) Broth. 개털이끼; *Yoon Y. J.* 10068, 10092, 10228 (JNU)

85. *Schwetschkeopsis robustula* (Broth.) Ando. 큰개털이끼; *Yoon Y. J.* 11630 (JNU)

86. *Taxiphyllum aomoriense* (Besch.) Z. Iwats. 겹친주목이끼; *Yoon Y. J.* 10118 (JNU)

87. *Taxiphyllum taxirameum* (Mitt.) M. Fleisch. 주목이끼; *Yoon Y. J.* 10053, 10098 (JNU)

Entodontaceae (윤이끼과)

88. *Entodon flavescens* (Hook.) A. Jaeger 가지윤이끼; *Yoon Y. J.* 10036, 10063, 10356 (JNU)

89. *Entodon calycinus* Cardot 아기윤이끼; *Yoon Y. J.* 10623 (JNU)

90. *Entodon challengerii* (Paris) Cardot 넓은잎윤이끼; *Yoon Y. J.* 10004, 10039, 10207 (JNU)

91. *Entodon concinnus* (De Not.) Paris 둥근잎윤이끼; *Yoon Y. J.* 13004 (JNU)

92. *Entodon diversinervis* Cardot 긴줄윤이끼; *Yoon Y. J.* 13419 (JNU)

93. *Entodon scabridens* Lindb. 지이윤이끼; *Yoon Y. J.* 10122, 13001, 13002 (JNU)

94. *Entodon sullivantii* (Mll. Hal) Lindb. 가는윤이끼; *Yoon Y. J.* 10009, 10010, 10018 (JNU)

Pylaisiadelphaceae (털겨울이끼과, New)

95. *Fauriella tenuis* (Mitt.) Cardot 수염이끼; *Yoon Y. J.*

10621, 10625, 10636 (JNU)

96. *Pylosiadelpha tenuirostris* (Bruch and Schimp. ex Sull.) W. R. Buck 털거울이끼; Yoon Y. J. 10014, 10033, 10049 (JNU)
 97. *Pylosiadelpha tristoviridis* (Broth.) Afonina, Tsubota and Ignatova 실털깃털이끼; Yoon Y. J. 10638, 10668, 12409 (JNU)

Anomodontaceae (명주실이끼과)

98. *Anomodon abbreviatus* Mitt. 산명주실이끼; Yoon Y. J. 10511, 10514 (JNU)
 99. *Anomodon giralduii* Mll. Hal. 큰명주실이끼; Yoon Y. J. 10074, 10096, 10105 (JNU)
 100. *Anomodon rugelii* (Mll. Hal.) Keissl. 곱슬명주실이끼; Yoon Y. J. 10073, 10222, 10366 (JNU)
 101. *Anomodon solovjovii* Laz. 북명주실이끼; Yoon Y. J. 13202 (JNU)
 102. *Haplohymenium longinerve* (Broth.) Broth. 긴줄바위실이끼; Yoon Y. J. 13655 (JNU)
 103. *Haplohymenium sieboldii* (Dozy and Molk.) Dozy and Molk. 깃털바위실이끼; Yoon Y. J. 10124, 10360, 13018 (JNU)
 104. *Haplohymenium triste* (Ces.) Kindb. 바위실이끼; Yoon Y. J. 10079, 10123, 10144 (JNU)
 105. *Herpetineuron toccocae* (Sull. and Lesq.) Cardot 나선이끼; Yoon Y. J. 10127, 10133, 10419 (JNU)

Neckeraceae (납작이끼과)

106. *Forsstroemia cryphaeoides* Cardot 가는실방울이끼; Yoon Y. J. 10368, 11436, 13648 (JNU)
 107. *Forsstroemia japonica* (Besch.) Paris 실방울이끼; Yoon Y. J. 13222, 13805, 13836 (JNU)
 108. *Forsstroemia neckeroides* Broth. 긴방울이끼; Yoon Y. J. 10510 (JNU)
 109. *Homalia trichomanoides* (Hedw.) Schimp. 윤납작이끼; Yoon Y. J. 10234, 10236, 10240 (JNU)
 110. *Neckera pennata* Hedw. 날개납작이끼; Yoon Y. J. 12821, 13642 (JNU)
 111. *Thamnobryum coreanum* (Cardot) Nog. and Z. Iwats. 고려대호꼬리이끼; Yoon Y. J. 13415 (JNU)
 112. *Thamnobryum plicatulum* (Sande Lac.) Z. Iwats. 그늘대호꼬리이끼; Yoon Y. J. 10339, 10408, 10414 (JNU)

Climaciaceae (나무이끼과)

113. *Climacium japonicum* Lindb. 나무이끼; Yoon Y. J. 10664, 10671, 13224 (JNU)

Hylocomiaceae (수풀이끼과)

114. *Hylocomiastrum pyrenaicum* (Spruce) M. Fleisch. 비룡수풀이끼; Yoon Y. J. 10627, 13226, 13828 (JNU)
 115. *Hylocomiopsis ovicarpa* (Besch.) Cardot 아기호랑꼬

리이끼; Yoon Y. J. 10626, 10682, 13009 (JNU)

116. *Hylocomium himalayanicum* (Mitt.) A. Jaeger 활수풀이끼; Yoon Y. J. 10660 (JNU)
 117. *Loeskeobryum brevirostre* (Brid.) M. Fleisch. 큰비룡수풀이끼; Yoon Y. J. 10486, 12657, 13250 (JNU)
 118. *Rhytidadelphus squarrosus* (Hedw.) Warnst. 걸굽은이끼; Yoon Y. J. 13234, 13241, 13246 (JNU)

Lembophyllaceae (호랑꼬리이끼과)

119. *Dolichomitriopsis diversiforme* (Mitt.) Nog. 걸호랑이꼬리이끼; Yoon Y. J. 10489, 12811, 12827 (JNU)

Meteoriaceae (누운끈이끼과)

120. *Meteorium subpolytrichum* (Besch.) Broth. Yoon Y. J. 11083 (JNU)

Brachytheciaceae (양털이끼과)

121. *Brachythecium buchananii* (Hook.) A. Jaeger 긴양털이끼; Yoon Y. J. 10137, 10243, 10324 (JNU)
 122. *Brachythecium helminthocladum* Broth. and Paris 끈양털이끼; Yoon Y. J. 10813 (JNU)
 123. *Brachythecium moriense* Besch. 참양털이끼; Yoon Y. J. 10208 (JNU)
 124. *Brachythecium rivulare* Schimp. 물가양털이끼; Yoon Y. J. 10059, 10473, 10647 (JNU)
 125. *Brachythecium rutabulum* (Hedw.) Schimp. 장백양털이끼; Yoon Y. J. 10145, 10497, 10679 (JNU)
 126. *Bryhnia novae-angliae* (Sull. and Lesq.) Grout 곱슬세모양털이끼; Yoon Y. J. 10062, 10411, 12001 (JNU)
 127. *Cirriphyllum piliferum* (Hedw.) Grout 걸끈양털이끼; Yoon Y. J. 13414 (JNU)
 128. *Eurhynchium angustirete* (Broth.) T. J. Kop. 산부리이끼; Yoon Y. J. 10109 (JNU)
 129. *Myuroclada maximoviczii* (GG Borshch.) Steere and W.B. Schofield 쥐꼬리이끼; Yoon Y. J. 10099, 10104, 10409 (JNU)
 130. *Okamuraea hakoniensis* (Mitt.) Broth. 걸양털이끼; Yoon Y. J. 10432, 11031, 11231 (JNU)
 131. *Oxyrrhynchium hians* (Hedw.) Loeske 물가침부리이끼; Yoon Y. J. 10057, 10859 (JNU)
 132. *Rhynchostegium pallidifolium* (Mitt.) A. Jaeger 아기양털부리이끼; Yoon Y. J. 10055, 10085, 10244 (JNU)
 133. *Rhynchostegium riparioides* (Hedw.) Cardot 물가부리이끼; Yoon Y. J. 10320, 10470, 10838 (JNU)
 134. *Sciuro-hypnum brotheri* (Paris) Ignatov and Huttunen 큰양털이끼; Yoon Y. J. 10265, 10266 (JUN)
 135. *Sciuro-hypnum plumosum* (Hedw.) Ignatov and Huttunen 날개양털이끼; Yoon Y. J. 10070, 10211, 10214 (JNU)

136. *Sciuro-hypnum populeum* (Hedw.) Ignatov and Huttunen 양털이끼; *Yoon Y. J.* 10227, 10421, 10423 (JNU)

Pylaisiaceae (명주이끼과, New)

137. *Callicladium haldanianum* (Grev.) H. A. Crum 풀이끼; *Yoon Y. J.* 13213, 13217, 14014 (JNU)

138. *Calliargonella lindbergii* (Mitt.) Hedens 물가털깃털이끼; *Yoon Y. J.* 11216, 12210, 12220 (JNU)

139. *Gollania ruginosa* (Mitt.) Broth 주름시슴뿔이끼; *Yoon Y. J.* 10238, 10263, 10280 (JNU)

140. *Pylaisia brotheri* Besch. 명주이끼; *Yoon Y. J.* 10493 (JNU)

141. *Stereodon dieckii* (Renauld and Cardot) Broth. 고산털깃털이끼; *Yoon Y. J.* 12816, 13006, 13033 (JNU)

142. *Stereodon plumaeformis* (Wilson) Mitt. 털깃털이끼; *Yoon Y. J.* 10203, 10209, 10212 (JNU)

143. *Stereodon sakuraii* (Sakurai) Broth. 붉은털깃털이끼; *Yoon Y. J.* 13831, 13838 (JNU)

Leskeaceae (고깔검정이끼과)

144. *Miyabea fruticella* (Mitt.) Broth. 꼬마나무이끼; *Yoon Y. J.* 10090, 10367, 10512 (JNU)

145. *Pseudoleskeopsis zippelii* (Dozy and Molk.) Broth. 물바위이끼; *Yoon Y. J.* 11411, 11641, 12023 (JNU)

Thuidiaceae (깃털이끼과)

146. *Boulaya mittenii* (Broth.) Cardot 아기방울이끼; *Yoon Y. J.* 12248, 13040, 13604 (JNU)

147. *Bryonoguchia molkenboeri* (Sande Lac.) Z. Iwats. and Inoue 참깃털이끼; *Yoon Y. J.* 10290, 11040, 11060 (JNU)

148. *Haplocladium angustifolium* (Hampe and Mll. Hal.) Broth. 침작은명주실이끼; *Yoon Y. J.* 10038, 10040, 10042 (JNU)

149. *Haplocladium microphyllum* (Hedw.) Broth. 작은명주실이끼; *Yoon Y. J.* 10032, 10056, 10060 (JNU)

150. *Haplocladium strictulum* (Cardot) Reimers 물가작은명주실이끼; *Yoon Y. J.* 10006, 10029, 10035 (JNU)

151. *Pelekium versicolor* (Mll. Hal.) Touw 큰깃털이끼; *Yoon Y. J.* 10107, 10213, 10216 (JNU)

152. *Raiiella fujisana* (Paris) Reimers 걸아기방울이끼; *Yoon Y. J.* 10121, 10132, 10136 (JNU)

153. *Thuidium delicatulum* (Hedw.) Schimp. 작은잎깃털이끼; *Yoon Y. J.* 10100, 13214, 13235 (JNU)

154. *Thuidium kanedae* Sakurai 깃털이끼; *Yoon Y. J.* 10051, 10246, 10288 (JNU)

155. *Thuidium pristocalyx* (Mll. Hal.) A. Jaeger 푸른깃털이끼; *Yoon Y. J.* 10833, 13032, 13207 (JNU)

156. *Thuidium submicropteris* Cardot 실깃털이끼; *Yoon Y. J.* 10095, 10114, 10130 (JNU)

Amblystegiaceae (버들이끼과)

157. *Campyladelphus chrysophyllus* (Brid.) R. S. Chopra 가는노란변덕이끼; *Yoon Y. J.* 10271, 11012, 11250 (JNU)

158. *Campylidium hispidulum* (Brid.) Ochyra 버들변덕이끼; *Yoon Y. J.* 10676 (JNU)

Appendix 2. The list of plants that were not found in this study but recorded in literatures.

Polytrichaceae (솔이끼과)

1. *Atrichum undulatum* (Hedw.) P. Beauv. 주름솔이끼

2. *Bartramiopsis lescurii* (James.) Kindb. 풍령이끼

3. *Pogonatum japonicum* Sull. and Lesq. 큰들솔이끼

4. *Polytrichum alpinum* (Hedw.) G.L. Sm. 산솔이끼

Dicranaceae (꼬리이끼과)

5. *Dicranum flagellare* Hedw. 처녀꼬리이끼

6. *Dicranum majus* Turner 고산나무꼬리이끼

7. *Dicranum mayrii* Broth. 곱슬꼬리이끼

8. *Dicranum viride* (Sull. and Lesq.) Lindb. 큰비꼬리이끼

Rhabdoweisiaceae (주름꼬마이끼과, New)

9. *Oncophorus wahlenbergii* Brid. 산목혹이끼

Mniaceae (초롱이끼과)

10. *Rhizomium punctatum* (Hedw.) T. J. Kop 미선초롱이끼

11. *Trachycystis microphylla* (Dozy and Molk.) Lindb. 아기초롱이끼

Orthotrichaceae (선주름이끼과)

12. *Orthotrichum sordidum* Sull. and Lesq. 선주름이끼

Neckeraceae (납작이끼과)

13. *Thamnobryum alopecurum* (Hedw.) Nieuwl. ex Gangulee 여우꼬리이끼

14. *Thamnobryum subseriatum* (Mitt. ex Sande Lac.) B. C. Tan. 대호꼬리이끼

Climaciaceae (나무이끼과)

15. *Pleuroziopsis ruthenica* (Weinm.) Kindb. ex E. Britton 깃털나무이끼

Lembophyllaceae (호랑꼬리이끼과)

16. *Isothecium subdiversiforme* Broth. 앞뿔호랑꼬리이끼

Leskeaceae (고깔검정이끼과)

17. *Rigodiadelphus robustus* (Lindb.) Nog. 여우이끼

Entodontaceae (윤이끼과)

18. *Entodon luridus* (Griff.) A. Jaeger 물가윤이끼

Hypnaceae (털깃털이끼과)

19. *Hypnum fujiyamae* (Broth.) Paris 황갈털깃털이끼
20. *Hypnum plicatulum* (Lindb.) A. Jaeger 주름털깃털이끼

Pylaisiaceae (명주이끼과, New)

21. *Pylaisia cristata* (Cardot) Z. Iwats. and Nog. 벼슬명주이끼

22. *Pylaisia intricata* (Hedw.) Grout 용단명주이끼

Hylocomiaceae (수풀이끼과)

23. *Hylocomium splendens* (Hedw.) Schimp. 수풀이끼
24. *Pleurozium schreberi* (Willd. ex Brid.) Mitt. 걸창밭이끼
25. *Rhytidium rugosum* (Ehrh. ex Hedw.) Kindb. 굵은이끼