Distribution of Higher Fungi in NaeJangSan National Park

Seog-Ki Jang*

Major in Forest Environmental Landscape, College of Life Science & Natural Resource, Wonkwang University, Iksan 570-749, Korea (Received May 14, 2007)

ABSTRACT: This study was conducted to investigate the diversity of higher fungi in NaeJangSan National Park from April 2004 to November 2006. The obtained results from investigation were as follows. The total of 5 classes, 19 orders, 60 families, 168 genera and 418 species (including 10 families, 13 genera and 15 species unrecorded) including saprophytic and ectomycorrhizal fungi was investigated. The higher fungi were classified into 47 families, 143 genera and 384 species in Basidiomycotina, 9 families, 19 genera and 28 species in Ascomycotina and 4 families, 6 genera and 6 species in Myxomycota. It was turned out that most of the higher fungi belong to Hymenomycetidae in Basidiomycotina, for which 34 families 122 genera, and 353 species were observed. Dominant species belonged to Tricholomataceae(64 species) Russulaceae(39 species), Polyporaceae(36 species) and Boletaceae(36 species). The mushroom occurrence of higher fungi was closely related to climatic conditions such as high air temperature and lots of rainfall from July to September. The environment which has a favorable influence of mushroom occurrence was air temperature, relative humidity and rainfall of climatic environment.

KEYWORDS: Boletaceae, Higher fungi, NaeJangSan National Park, Polyporaceae, Russulaceae, Tricholomataceae
고 있어 대부분 교목층은 참나무속(Quercus sp.)의 수종들인 우영고양으로 나타났다. 교목 및 관목층은 신갈나무, 흔하나무, 서나무, 층층나무, 산벚나무 (Prunus sargentii), 당당나무(Acer pseudosieboldianum), 패족나무(Syra japonica), 촉백나무(Syrax obassia) 및 개활나무(Rhiz Kylellochrana) 등이 많이 우영하고 있는 것으로 나타났다.

토양환경의 경우 평균 토양 pH는 4.7(±0.1), 양여저치 환경량(EC)는 1082.6(±2.2)μs/cm이고 유 효인산은 328.1(±0.2)mg/kg, 유기물 함량은 14.7(±0.03), 침실성 양이온 마그네슘(Mg)은 43.819(±0.2)mg/kg, 칼륨(K)은 249.59(±0.9)mg/kg, 칼슘(Ca)은 354.152(±282.6)mg/kg인 것으로 조사하였다(오, 2006).

기후
조사 기간 동안 기후자료는 조사 지역의 경유 기상관측소의 월 평균 자료를 참고하였다(Table 1).
조사기간 동안 평균 온도는 2006년 8월이, 상태습도는 2005년 7월에 가장 높게 나타났다.
특히 2004년의 상태습도는 70%가 넘지 않아 최근 5년간 평균 상태습도는 70%(1999~2003년)보다 낮은 것으로 나타났다. 강수량의 경우 연 평균 강수량의 40% 정도가 시중되는 7월 및 8월의 경우 2004년에는 38%로 연 평균 강수량과 비슷하였으나, 2005년은 59%로 매우 많은 강수량을 나타냈다.

버섯 채집 및 방법
모든 근류는 생명체에 따라 형태가 달라지므로 어린 자실체와 성숙한 자실체를 모두 채집하였다. 채집한 버섯은 채집장소, 기주석류, 채집일 등을 기입한 다음 손상되지 않도록 봉투에 넣어 실험실로 운반하였다. 분류 동정이 어려운 종들은 Melzer 용액, KOH 또는 Guaiacol 등에 의한 화학반응 및 현미경을 이용하여 담저기, 담자포자, 납생체 등을 관찰한 후 종의 분류, 동정하는데 참고하였다.


자료분석
조사된 고등균류를 대상으로 기후환경의 요인에 따라 고등균류의 발생에 미치는 영향이 있는지 상관분석을 통해 분석하였다(SAS, 1989).

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<thead>
<tr>
<th>Table 1. Climatic data in Jeongeup city from April 2004 to November 2006</th>
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결과 및 고찰

고등균류의 다양성
고등균류를 조사한 결과 총 2종 5값 60과 168종(기록종 10과 13종 포함)이 조사 되었으며, 이에 대한 결과는 Table 2 및 Appendix 1과 같다.

조사 결과 진균문의 담자균아문은 11목 47과 143속 384종이, 자낭균아문은 4목 9과 19속 28종이었으며 진균 문은 4목 4과 6속 6종이 조사되었다. 담자균아문의 경우 진정담자균강의 원생포균아강(Protohymenomycetae)은 3목 4과 6속 12종, 포균아강(Hymenomycetae)은 2목 34과 122속 353종 및 복균강(Gasteromycetes)은 6목 9과 145속 122종으로 조사되었다. 자낭균아문은 반균강(Discomyces) 2목 7과 15속 18종, 약균강(Pyrenomycetes)은 2목 2과 4속 10종으로 대부분의 고등균류는 담자균아문 중 포균아강에 속하는 것으로 나타났다.

이를 분류군렬로 구분하면 주름버섯목이 18과 72속 275종이, 풍현자버섯목은 16과 50속 78종으로 2목의 종 수가 353종으로 전체 발생 종수의 84.4%로 대부분을 차 지한 것으로 조사되었다. 가장 많이 발생된 균류는 송이 버섯과로 64종이었으며, 무당버섯과(29종), 고립버섯과 (36종), 구명장이버섯과(36종) 순으로 나타났다. 이 중 미 기록종이 판단되는 종은 송이버섯과 5종(Armillariella gallica, Armillariella ostoyae, Mycena filipes, Omphalina sp, Xeromphalina tenuipes), 고립버섯과 1종(Tylopius valens), 근적버섯과 1종(Cortinarius galoideus) 무당버섯 2종(Lactarius ochrogalactus, Lactarius quietus), 외짜 버섯과 1종(Entoloma japonicum), 갓버섯과 1종(Lepiota acutesquamosa), 구명장이버섯과 1종(Penicillium minitissima), 싸리버섯과 1종(Ramaria flavescens), 관리버섯과 1종(Morchella angusticeps) 및 동충하초과 1종(Isaria sinclairii) 등 총 10과 13속 15종의 것으로 나타났다 (Fig. 1).

동정렬 버섯 종 중 외생균근성버섯은 17과 36속 418종

Table 2. List of higher fungi collected from 2004 to 2006 in NaeJangSan National Park

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<th>Family</th>
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<th>Species</th>
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<tr>
<td>Xeromphalina tenuipes</td>
<td>Mycena filopes</td>
<td>Armillariella gallica</td>
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<tr>
<td>Armillariella ostoyae</td>
<td>Orphalina sp.</td>
<td>Tylophillus valens</td>
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<td>Cirtolarius galeroides</td>
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<td>Lactarius quietus</td>
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<td>Entoloma japonicum</td>
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<td>Perenniporia minutissima</td>
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<td>Ramaria flavescens</td>
<td>Morchella angusticeps</td>
<td>Isaria sinclairii</td>
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Fig. 1. Unrecorded of higher fungi collected from 2004 to 2006 in Naejangsan National Park.

(40.4%), 낙엽 및 목재부류균은 37과 96속 164종(39.2%), 지상균은 18과 40속 77종(18.4%) 및 기타 2과 3속 8종(1.9%)이 것으로 나타났다. 이는 서식산에서 조사된 고둥 균류 131속 274종 중 외생균균성버섯 32.7%, 부생균 63% 및 기생균 4% 이었다는 보고(박, 2003)와 비교했을 때 외생균균성버섯의 발생이 높게 나타났으며, 서식산에서 조사된 고둥균류 168속 358종 중 외생균균성버섯 45.8%, 부생균 53.1% 및 기생균 1.1% 이었다는 보고(정, 2006)와 대비된다고 고둥균류 75속 281종 중 외생균균성버섯 49.1%, 부생균 49.5% 및 기생균 1.4%이었다는 보고(김, 2006) 보다는 낮은 것으로 조사되었다. 이는 조사지의 임황, 지황, 기상환경 및 조사 시기 등에 따른 차이 때문인 것으로 판단된다.

또한 외생균균성버섯을 대상으로 천연에 관한 연구에서 초기단계는 Hebeloma속, Laccaria속, Inocybe속이, 진행 단계는 Tricholoma속과 Cortinarius속이, 완성단계는 Russula속, Lecinimum속, Amanita속의 발생이 높았다는 결과(Dighton et al., 1986; Fleming et al., 1986; Last et al., 1983; Mason et al., 1982)와 비교하였을 때 초기단계인 Hebeloma속은 2종, Laccaria속은 3종, Inocybe속은 11종이고 진행단계인 Tricholoma속은 2종, Cortinarius 속은 13종이 조사되었으며 완성단계인 Russula속은 22종, Lecinimum속은 3종, Amanita속은 24종이 조사되어 완성단계의 균류 발생이 높은 것으로 나타났다(Appendix 1).
조사시기별 고등균류 분포

연도별에 따른 고등균류 발생(Fig. 2)을 보면 2004년이 총 53과 134속 332종으로 가장 높았고 2005년은 총 56과 135속 301종이, 2006년은 총 45과 99속 170종으로 조사 기간 동안 가장 적은 균류가 발생되었다.

종(Species)수는 2004년 8월이 139종으로, 과(Family) 및 속(Genus)수는 2004년 9월이 73종으로 가장 많

이 조사되었으며 2004년 11월은 1종도 조사되지 않았다. 이는 월별로 종합한 결과(Fig. 3), 9월이 45과 102속 203 종으로 가장 발생이 많았으며, 8월 42과 97속 200종, 7월 41과 91속 198종의 순이었으며 11월의 경우 5과 5속 5종이 조사되어 가장 적게 조사되었다. 이 같은 결과는 조사 시기 중간 온도, 습도 및 강수량 등 기후환경 변화가 고등균류의 발생에 큰 영향을 미친 것으로 판단된다. 이는 배양균균성 바릿 발생에 기후조건(Ohenoja, 1993)이 영향을 미친다는 보고와 유사한 결과를 보였다.

월별에 따른 발생 균류(Table 3)를 보면, 광대버섯과, 그물버섯과, 큰버섯과, 구멍장이버섯과, 무당버섯과 및 송이버섯과 등 6과는 6월부터 10월까지 지속적으로 조사되었으며, 특히 송이버섯과, 무당버섯과, 구멍장이버섯과 및 그물버섯과는 35종 이상이 조사되어 기타 균류에 비해 우점하고 있는 것으로 나타났다. 이는 지리산(조, 2006)과 지악산(박 등, 2004)에서 조사된 고등균류 중 송이버섯과, 무당버섯과, 구멍장이버섯 등이 가장 다양하게 발생되는 보고와 유사한 결과를 보였다.

고등균류 분포

고등균류에 따른 고등균류 분포(Fig. 4)를 보면 2005년 200~299 m 사이에서 52과 111속 204종으로 가장 많이 조사되었으며, 2006년 600~699 m에서 1과 1속 1종으로

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Amanitaceae</td>
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<td>14</td>
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<td>35</td>
<td>30</td>
<td>32</td>
<td>17</td>
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</tbody>
</table>

Note : ( ) : No. of Family.
가장 적게 나타냈다. 이를 고도별로 중합(Fig. 5)한 결과, 200-299 m에서 56과 149속 307종으로 가장 많았고 500-599 m에서 37과 81속 185종, 400-499 m 사이 41과 87속 152종으로 순으로 나타났으며, 700 m 이상에서 8과 11속 17종으로 가장 적게 조사되었다. 이상의 결과 고도가 높아짐에 따라 종수 및 속수의 감소가 나타났으며, 경상부에 할 수 있는 700 m 이상에서는 현저히 종의 감소가 나타났다. 이는 고도에 따라 종의 품부도 및 다양성이 감소한다는 보고(Kernaghan and Harper, 2001)와 일치하는 것으로 나타났다.

특히 300-399 m의 경우 400-599 m에 비해 적은 균류 발생은 이 지역이 많은 암반 및 바위들이 위치해 있어 고등균류의 서식환경에 영향을 주었기 때문인 것으로 판단된다.

고도별에 따른 발생 균류(Table 4) 분포를 보면 대부분 지역에서 광대버섯과, 그물버섯과, 구멍버섯과, 무당 버섯과 및 송이버섯과의 발생이 기타 균류에 비해 높았으며, 특히 700 m 이상인 경상부 지역에서 대부분의 균류의 발생이 현저히 적어지는 반면 상대적으로 무당버섯과의 발생이 가장 많은 것으로 나타나 이점, 지형 및 기상 환경 변화에 대한 서식환경의 폭이 넓은 것으로 판단된다. 이는 우리나라 12개 지역의 하이킹 장소별 버섯 종에 대한 기준 선정을 조화한 결과 광대버섯, 무당버섯, 철새 버섯 등이 기후장류가 넓은 종이었다는 보고(이·김, 1987)와 유사한 결과를 보였다.

기후환경 상관

고등균류의 발생과 기후환경 요인과의 상관관계를 분석한 결과, 고등균류의 속수, 종수 및 종수 발생에 밀접한 경의 상관관계가 있는 것으로 나타났다. 이를 살펴보면(Table 5), 최고온도에서는 속수(r = 0.710**), 종수(r = 0.702**) 및 종수(r = 0.686**)에서, 최

---

**Table 4. Distribution of species of higher fungi according to the altitude in NaeJangSan National Park**

<table>
<thead>
<tr>
<th>Family</th>
<th>Altitude (m)</th>
<th>100-199</th>
<th>200-299</th>
<th>300-399</th>
<th>400-499</th>
<th>500-599</th>
<th>600-699</th>
<th>700-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amanitaceae</td>
<td>8</td>
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<td>9</td>
<td>15</td>
<td>13</td>
<td>12</td>
<td></td>
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<tr>
<td>Boletaceae</td>
<td>8</td>
<td>23</td>
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<td>11</td>
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</tr>
<tr>
<td>Cortinariaceae</td>
<td>9</td>
<td>20</td>
<td>4</td>
<td>14</td>
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</tr>
<tr>
<td>Polyporaceae</td>
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<td>14</td>
<td>15</td>
<td>23</td>
<td>20</td>
<td></td>
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</tr>
<tr>
<td>Russulaceae</td>
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<td>18</td>
<td>25</td>
<td>28</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tricholomataceae</td>
<td>32(61)</td>
<td>(50)145</td>
<td>(22)39</td>
<td>(36)72</td>
<td>(31)69</td>
<td>(21)30</td>
<td>(6)7</td>
<td></td>
</tr>
</tbody>
</table>

Note : ( ) ; No. of Family.
Table 5. Correlation coefficients among climatic conditions and occurrence of higher fungi family, genus and species (n=24)

<table>
<thead>
<tr>
<th></th>
<th>Max.</th>
<th>Min.</th>
<th>Mean</th>
<th>Relative humidity</th>
<th>Rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. temperature</td>
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<td>0.991</td>
<td>0.628</td>
<td>0.677</td>
</tr>
<tr>
<td>Mean temperature</td>
<td>0.991</td>
<td>0.995</td>
<td>1</td>
<td>0.745</td>
<td>0.786</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>0.628</td>
<td>0.754</td>
<td>0.699</td>
<td>0.747</td>
<td>0.746**</td>
</tr>
<tr>
<td>Rainfall</td>
<td>0.677</td>
<td>0.786</td>
<td>0.747</td>
<td>0.707</td>
<td>0.700**</td>
</tr>
<tr>
<td>No. of family</td>
<td>0.710**</td>
<td>0.767**</td>
<td>0.746**</td>
<td>0.682</td>
<td>0.679**</td>
</tr>
<tr>
<td>No. of genus</td>
<td>0.702**</td>
<td>0.771**</td>
<td>0.744**</td>
<td>0.682</td>
<td>0.707**</td>
</tr>
<tr>
<td>No. of species</td>
<td>0.686**</td>
<td>0.763**</td>
<td>0.732**</td>
<td>0.629</td>
<td>0.719**</td>
</tr>
</tbody>
</table>

** : P<0.01.

저온도는 과수(r = 0.767**), 속수(r = 0.771**), 및 종수(r = 0.763**)에서, 평균온도는 과수(r = 0.746**), 속수(r = 0.744**) 및 종수(r = 0.732**)에서, 상대습도는 과수(r = 0.700**), 속수(r = 0.682**) 및 종수(r = 0.629**)에서, 강수량은 과수(r = 0.679**), 속수(r = 0.707**) 및 종수(r = 0.719**) 중 모든 기후환경 요인에서 유의성을 있는 것으로 나타났다. 이 같은 결과는 오영균-근경 버섯의 균집 구성 요인으로 음도와 습도(Lange, 1978, Eveling et al., 1990) 및 강수량(Rosenzweig and Abramsky, 1993) 등의 영향이 있다는 보고와 유사하였다.

적 요

2004년 4월부터 2006년 11월까지 내장산 국립공원 고등균류를 조사한 결과는 다음과 같다.

조사기간 동안 고등균류는 총 5장 19목 60과 168속 418종(미기록종 10과 13속 15종 포함)이 조사 되었으며, 담자균아문은 47과 143속 384종이, 자장균아문은 9과 19속 28 종이었으며, 침균아문은 4과 6속 6종이 조사되었으며, 담자균 아문의 모균아강(Hymenomycetidae)이 34과 122속 353종 으로 대부분을 차지하였다. 가장 많이 발생한 균류는 속이 버섯과로 64종이었으며, 무당버섯과(39종), 구렁빵버섯과(36종), 크물버섯과(36종) 순으로 나타났다. 고등균류 버섯 발생은 강수량 및 대기온도가 낮은 시기인 기후환경 요인과 밀접한 관계가 있는 것으로 7월, 8월 및 9월에 집중하였다. 고등균류 버섯 분포에 영향을 기후환경 요인은 강수량, 상대습도 및 대기온도가 중요한 인자로 나타났다.

감사의 글

이 논문은 2004-6년도 국립공원관리공단 내장산국립공원 자연자원조사 및 자원관리팀 조사비 지원에 의해 연구되었음.

인용문헌


## Appendix 1. Detailed list of higher fungi collected from 2004 to 2006 in NaeJangSan National Park

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Korean name</th>
<th>Surveyed species</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EUMYCOTA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basidiomycota</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Furbasidiomycteces</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Hymenomycetidae</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agaricales</td>
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<td></td>
</tr>
<tr>
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<td>0</td>
</tr>
<tr>
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<td>0</td>
</tr>
<tr>
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<td><em>Agaricus silvaticus</em></td>
<td>숲주름버섯</td>
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</tr>
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<td><em>Agaricus subrutilescens</em></td>
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</tr>
<tr>
<td><em>Cystagaricus strobilomyces</em></td>
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<tr>
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</tr>
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</tr>
<tr>
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<td></td>
</tr>
<tr>
<td><em>Amanita farinosa</em></td>
<td>애우산대버섯</td>
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</tr>
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<td><em>Amanita fuliginea</em></td>
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<td>달갈버섯</td>
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<td>Korean name</td>
<td>Surveyed species</td>
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<td>----------------------------------</td>
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</tr>
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<td>2004 2005 2006</td>
</tr>
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<td>2004 2005 2006</td>
</tr>
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<td>우산가모마버섯</td>
<td>2004 2005 2006</td>
</tr>
<tr>
<td>Amanita vaginata var. fulva</td>
<td>고등가모마버섯</td>
<td>2004 2005 2006</td>
</tr>
<tr>
<td>Amanita verna</td>
<td>원일가모마버섯</td>
<td>2004 2005 2006</td>
</tr>
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<td>2004 2005 2006</td>
</tr>
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<td>Amanita virosa</td>
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<td>2004 2005 2006</td>
</tr>
<tr>
<td>Amanita volvacea</td>
<td>큰두가모마버섯</td>
<td>2004 2005 2006</td>
</tr>
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<td>2004 2005 2006</td>
</tr>
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<td>Agrocybe farinacea</td>
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<td>2004 2005 2006</td>
</tr>
<tr>
<td>Agrocybe praecox</td>
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<td>2004 2005 2006</td>
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<td>수원가모마버섯</td>
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<td>Boletus edulis</td>
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<td>2004 2005 2006</td>
</tr>
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<td>Boletus erythropus</td>
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<td>Boletus grisaeus var. fuscus</td>
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### Appendix 1. Continued

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## Appendix 1. Continued

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**Aphyllophorales**

**Cantharellaceae**

Cantharellus cibarius  
Cantharellus cinereus  
Cantharellus cinnabarinus  
Cantharellus cornucopioides  
Cantharellus friesi  
Cantharellus minor

**Clavariaceae**

Clavaria fragilis (=C. vermicularis)  
Delexula fascicularis  
Ramariopsis kurotszei  
Typhula erythrosp  
Clavariadelphaceae

Clavicornia pyxidata  

**Clavariadelphaceae**

Clavicornia pyxidata  

[Table containing scientific and common names of fungi, along with survey species counts for 2004, 2005, and 2006.]

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23 Distribution of Higher Fungi in NaeJangSan National Park
### Appendix 1. Continued

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### Appendix 1. Continued

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