figure 1

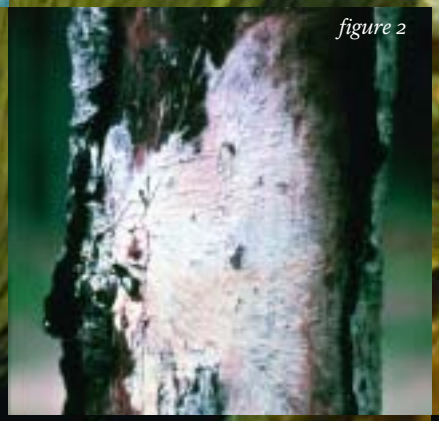

figure 2

figure 3

figure 4

Wood Inhabiting Fungi in Alaska: Their Diversity, Roles, and Uses

By Gary A. Laursen, Harold H. Burdsall, Jr., and Rodney D. Seppelt

Wood-inhabiting, rotting and/or decomposing fungi from Alaska include representatives from an assortment of fungal groups (cup, jelly, pored, coral, tooth, puffball, gilled, and lichenized fungi) and one fungus-like group (the slime molds). Of the more than 1,500 species recorded for North America, over 250 species of wood-inhabiting fungi have been reported from Alaska. In Alaska, more than 102 genera of gilled, shelf or bracket fungi with pores, jelly fungi, and flat paint-smear-like fungi are known. Most, if not all, of these fungi are known to fruit in Alaska national parks; however, it is important to note, as most of the fungi reported here were collected in national parks, that to collect in any national park necessitates obtaining relevant permits. It is against the law to collect natural objects from national parks without the necessary permits. As with green plant species, some of these fungi are common, some rare, some large and obvious, while others are small and inconspicuous, and some are edible and others poisonous. In this presentation of research on fungi, we make several references to edibility. In so doing, we do not encourage anyone to eat fungi without first consulting a professional.

These fungi are the great recyclers of wood and woody material in the forest ecosystem. They alter the wood structure to produce material with properties that are necessary for inhabitation by other forest biota, both plant and animal and even other fungi. Hence, there is a successional pattern to the work they perform. Some species have been used by indigenous Alaskan peoples for centuries as components of smoking mixtures, curry combs for brushing animals, medicinals, punks to carry fire long distances, and even as leather-like material for clothing.

Amidst dynamic and continually changing cycles of life, death, and decay, significant roles are played by fungi in diseases such as root-rot and heart-rot of trees. They alter organic substrates on the forest floor and recycle nutrients. Fungi are opportunists. They gain access to woody tissues beneath the bark on the bodies of wood-boring beetles. In the process, they leave spores behind in the many galleries produced by the boring insects. Fungi also enter their hosts through woodpecker holes *(Figure 1)* or through bark disruptions caused by moose, bears, porcupines, and rabbits. The invading fungus subsequently spreads out over the substrate as mycelial fans *(Figure 2)*. Entrance may also be gained through wounded and exposed roots, or through wounds created by broken branches, by nibbling rodents, or by heavy winds that can cause excessive movement of tree limbs.

Each fungus is physiologically specific to its particular decay type and ecologically specific where it impacts standing live and dead wood—in the bole of a tree as a heart-rot, in the sapwood as a sap-rot, or in the roots as a root-rot. Wood decay occurs as two primary processes, white rots and brown rots. The activity of white rot fungi results in a white, punky/spongy rot *(Figure 3)*. These fungi are more numerous than

Fungal Features: Ecology

Figure 1. Woodpecker hole with a fungal porch roof

Figure 2. Invading mycelial fan

Figure 3. White spongy rot

Figure 4. Brown cubical rot

Background: Gilled fungi are common and often poisonous. This *Pholiota squarrosa* should be admired for its beauty, not necessarily its taste.

Photographs courtesy of Gary A. Laursen

those causing brown rots and make up about 80% of all wood-rotting species of fungi. White rot fungi primarily break down the lignin, but also some cellulose. However, brown rot fungi leave a brown, cubical, dry, crumbly decay *(Figure 4)*. Brown rot fungi cause the chemical breakdown of cellulose and hemicellulose substrates leaving behind primarily the brown lignins that "glue" cellulose fibers together. In North America, there are at least 1,500 white rot and 250 brown rot species of fungi. In Alaska, these figures are substantially lower because of the limited number of tree species present.

Wood-rotting fungi are widespread and common in Alaska boreal forests and in alpine and tundra habitats as well *(Volk et al. 1993)*. Listed in Table 1 are 102 genera containing some of the common wood-inhabiting/rotting fungi found in Alaska. The large assemblage of wood-inhabiting/rotting fungi contains representatives found in many Orders and Families. An Order in the club fungi, the *Aphyllophorales*, now split into several Orders, once contained the majority of Alaska's wood-rotting fungal species. Volk et al. *(1994)* have compiled a checklist of more than 254 species of wood-rotting fungi. This listing is far from complete, hence, the enormity of the taxonomic task to be dealt with in Alaska mycology.

Alaska's wood-inhabiting fungi are made up of species that represent many classes. They include slime molds; cup fungi; jelly, resupinate (form fitted to a substrate like a coat of paint), pored polypores (pored fungi), coral, tooth, puffball, and agaric (gilled) fungi; in addition to several Ascolichenes and a few Basidiolichenes (the two main divisions of lichens) in many lichen or lichenized fungal groups. Members of each of these groups demonstrate nature's beauty in their life forms, color, biological roles played, and human uses.

The most primitive class of Alaska wood-inhabiting fungi is the slime molds. These may be seen in the forest after a rain as brightly colored slimy plasmodial 'blobs' on woody substrates. Some of the more common slime mold forms inhabiting

ASCOMYCETES	BASIDIOMYCETES				
Helotiales	***Uredinales***	***Stereales***	***Stereales(cont.)***	***Hericiales***	***Agaricales***
Bisporella	*Chrysomyxa*	*Aleurodiscus*	*Stereum*	*Gloeocystidiellum*	*Clitocybe*
Bryoglossum	*Xenodochus*	*Amphinema*	*Trechispora*	*Hericium*	*Flammulina*
Dasyscyphus		*Athelia*	*Tubulicrinis*	*Lentinellus*	*Hypholoma*
Helotium	***Tremellales***	*Botryobasidium*	*Xenasma*		*Marasmius*
Hyaloscypha	*Bourdotia*	*Ceraceomerulius*		***Gomphales***	*Mycena*
Mollisia	*Ductifera*	*Ceraceomyces*	***Poriales***	*Lentaria*	*Omphalia*
Neolecta	*Exidia*	*Columnocystis*	*Antrodia*	*Macrotyphula*	*Pholiota*
	Heterotextus	*Crustoderma*	*Cerenna*	*Ramaria*	*Pluteus*
Sphaeriales	*Sebacina*	*Cyphella*	*Ceriporia*		*Resupinatus*
Daldinia	*Tremella*	*Cystostereum*	*Coniophora*	***Thelephorales***	*Tricholomopsis*
Hypoxylon		*Cytidia*	*Daedaleopsis*	*Sarcodon*	
	Dacrymycetales	*Dendrothele*	*Fomitopsis*	*Thelephora*	***Boletales***
Pezizales	*Calocera*	*Echinodontium*	*Gloeophyllum*	*Tomentella*	*Hygrophoropsis*
Otidia	*Dacrymyces*	*Hyphoderma*	*Hapalopilus*		
Peziza	*Dacrypinax*	*Hyphodontia*	*Panus*	***Lachnocladiales***	***Lycoperdales***
		Laeticorticium	*Perenniporia*	*Scytinostroma*	*Lycoperdon*
	Auriculariales	*Peniophora*	*Pleurotus*		
	Auricularia	*Phanerochaete*	*Polyporus*	***Cortinariales***	***Nidulariales***
		Phlebia	*Spongipellus*	*Alnicola*	*Nidula*
	Tulasnellales	*Phlebiella*	*Spongiporus*	*Cyphellopsis*	*Nidularia*
	Tulasnella	*Phlebiopsis*	*Trichaptum*	*Crepidotis*	
		Piloderma		*Flamulaster*	
	Cantherellales	*Plicatura*	***Hymenochaetales***	*Gymnopilus*	
	Albatrellus	*Steccherinum*	*Coltricia*		
	Clavulina		*Hymenochaete*		
	Multiclavula		*Phellinus*		

Table 1. Common Wood Inhabiting/Rotting Fungi Genera Found in Alaska

Slime Molds: Plasmodial

Figure 5. *Craterium* yellow plasmodium

Figure 6. *Lycogala epidendrum*

Figure 7. *Stemonitis splendens*

Figure 8. *Trichia varia*

Ascomycetes: Cup fungi

Figure 9. *Bisporella citrina*

Figure 10. *Daldinia concentrica*

Figure 11. *Peziza repanda*

Basidiomycetes: Jelly fungi

Figure 12. *Calocera cornea*

Figure 13. *Dacrymyces palmatus*

Figure 14. *Ductifera* sp.

Figure 15. *Exidia glandulosa*

Figure 16. *Tremella lutescens*

Basidiomycetes: Pored fungi

Figure 17. *Coltricia perennis*

Figure 18. *Cytidia salicina*

Figure 19. *Daedaleopsis confragosa*

Photographs courtesy of Gary A. Laursen

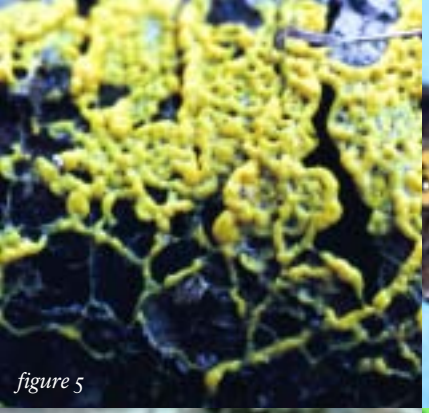
figure 5


figure 9

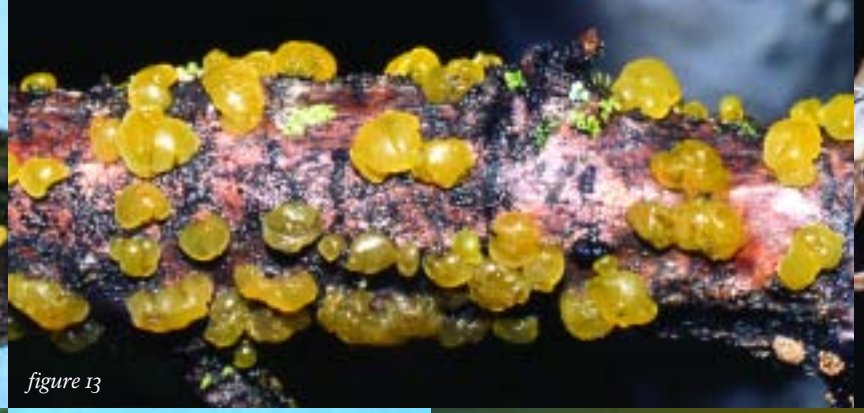
figure 13


figure 17


figure 6


figure 10


figure 14


figure 16


figure 7


figure 11

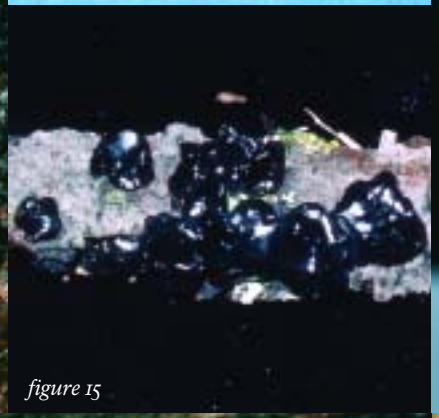
figure 15


figure 8


figure 12


figure 18

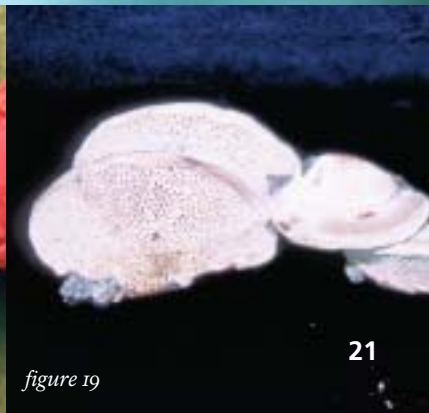
figure 19


figure 20


figure 24


figure 28


figure 33


figure 36


figure 21


figure 25


figure 30


figure 34


figure 37


figure 22


figure 26

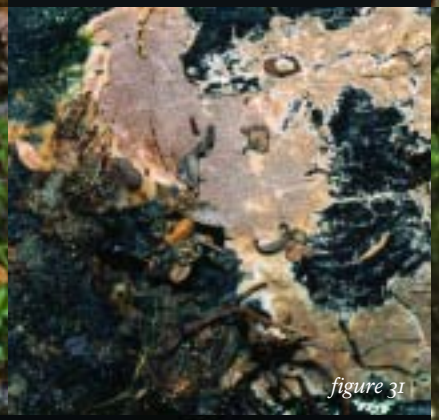
figure 31

figure 35


figure 23


figure 27

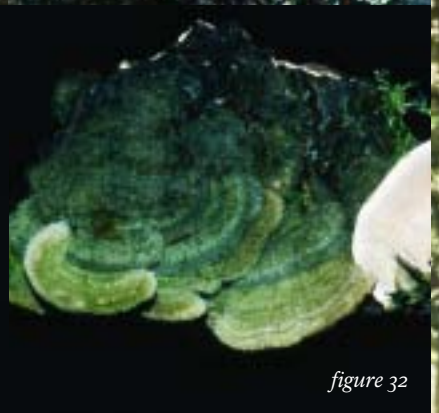
figure 32

Basidiomycetes: Pored fungi (Continued)

Figure 20. ***Fomes fomentarius***

Figure 21. ***Fomitopsis pinicola***

Figure 22. ***Ganoderma applanatum***

Figure 23. ***Gloeophyllum sepiarium***

Figure 24. ***Laetiporus conifericola***

Figure 25. ***Phaeolus schweinitzii***

Figure 26. ***Phellinus tremulae***

Figure 27. ***Piptoporus betulinus***

Figure 28. ***Polyporus* sp.**

Figure 29. ***Polyporus badius*** **(Photo page 23)**

Figure 30. ***Pycnoporus cinnibarinus***

Figure 31. ***Tomentella* sp.**

Figure 32. ***Trametes hirsuta***

Figure 33. ***Trichaptum abietinus***

Basidiomycetes: Coral fungi

Figure 34. ***Clavicorona pyxidata***

Basidiomycetes: Tooth fungi

Figure 35. ***Echinodontium tinctorum***

Figure 36. ***Hericium racemosum***

Basidiomycetes: Puffball fungi

Figure 37. ***Lycoperdon pyriforme***

Photographs courtesy of Gary A. Laursen

northern boreal forests are first seen as white, yellow (Figure 5) and/or as red plasmodia. In the assimilative or 'feeding' stages they engulf bacteria that actually live on the wet and rotting wood. Their plasmodia ultimately mature to form fruit bodies that appear upon 'drying'. Slime molds include *Craterium leucocephalum, Lycogala epidendrum* (Figure 6), *Mucilago crustacea, Stemonitis splendens* (Figure 7), *Trichia varia* (Figure 8), and *Wilkoumlangiella reticulata*.

The sac or cup fungi (Ascomycetes) are higher up the chain of fungal life forms. They may have dull to bright colors, stalked or sessile cups, 'saddled' stalks, or may have black carbon-like 'fingers', globs, or layers containing small pinhead-like bumps. Examples of cup fungi found in Alaska are: *Bisporella citrina* (Figure 9), *Bryoglossum gracile, Daldinia concentrica* (Figure 10), *Neolecta irregularis, Peziza repanda* (Figure 11), and *Peziza sylvicola*. All play significant roles, but as with the slime molds, growing on wood debris may not contribute directly to wood decomposition. The fungi may merely find a woody substrate convenient, or they may demonstrate roles not yet fully understood.

Higher up the fungal life form chain are the club fungi (Basidiomycetes), as denoted by their microscopic spore producing club-shaped cells. They include groups such as the jelly fungi, pored fungi, coral fungi, tooth fungi, puffballs, and gilled mushrooms.

The jelly fungi, besides often being brightly colored, feel like the bottom tip of an earlobe when hydrated and fresh. Alaskan examples are *Calocera cornea* (Figure 12), *Dacrymyces palmatus* (Figure 13), *Ductifera* sp. (Figure 14), *Exidia glandulosa* (Figure 15), *Tremella* sp., *Tremella lutescens* (Figure 16) and *Tremella mesenterica*.

THERE ARE POISONOUS (EVEN DEADLY) FUNGI THAT OCCUR ON WOOD. Care should be taken in selecting fungus for the table. It is best to consult a mycologist for accurate identification.

The sometimes fleshy, but mostly corky to woody and pored, 'bracket or shelf' fungi show tremendous variation as seen in *Coltricia perennis, Cytidia salicina, Daedaleopsis confragosa, Fomes fomentarius, Fomitopsis pinicola, Ganoderma applanatum, Gloeophyllum sepiarium, Laetiporus conifericola, Phaeolus schweinitzii, Phellinus tremulae, Piptoporus betulinus, Polyporus* sp., *Polyporus badius, Pycnoporus cinnibarinus, Tomentella* sp., *Trametes hirsuta,* and *Trichaptum abietinum* (Figures 17-33).

Laetiporus conifericola (Figure 24) is a lemon-flavored edible species and can be found in significant quantities. White and brown heart-rot and sap-rot fungi such as *Fomitopsis pinicola* and *Phellinus pini* contribute greatly toward the ultimate demise of live trees. *Fomes fomentarius* (Figure 20) and *Piptoporus betulinus* (Figure 27) fruit abundantly on standing dead trees and predispose them to being hollowed out by nesting birds and mammals (Figure 1). They also serve a human function. Indigenous peoples collect these two fungi as an additive to pipe tobacco and for their analgesic properties. Still other varieties, such as *Phellinus tremulae* (Figure 26), are first dried, then ashed. The ashes are then mixed with chewing tobacco to decrease tobacco acidity and to enhance the stimulus of nicotine. *Ganoderma applanatum* (Figure 22), the Artist's Conk, is used by artists for etchings. Other *Ganoderma* spp. are said to have medicinal properties and are used by people around the world.

The coral fungi, such as *Clavicorona pyxidata* (Figure 34) and *Ramaria stricta,* also members of the club fungus

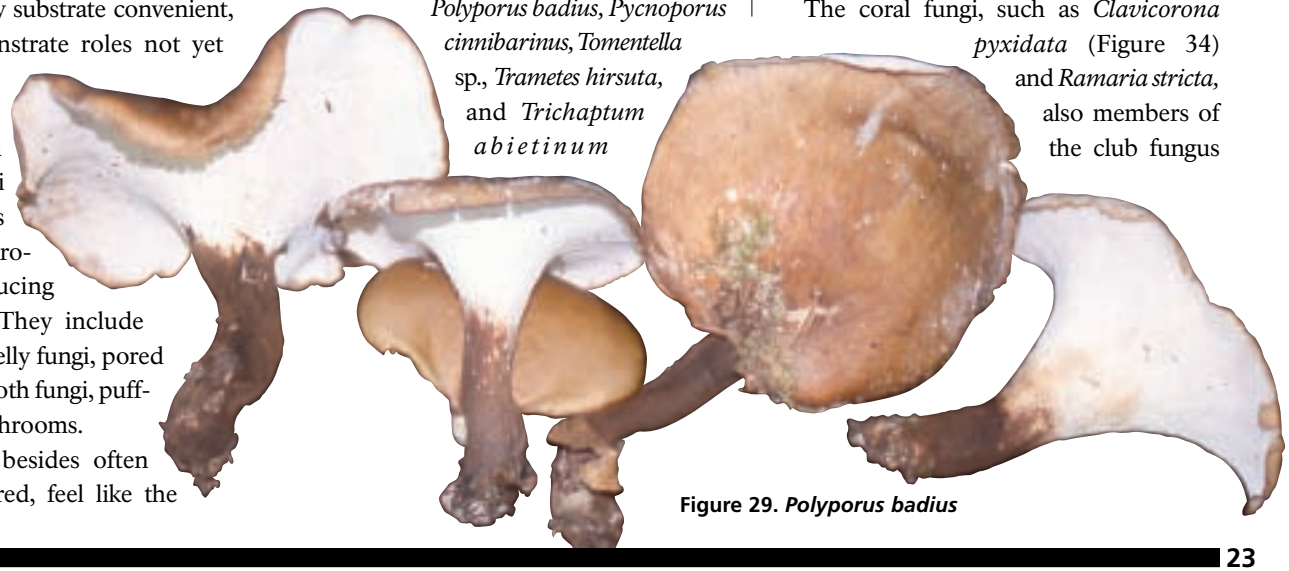

Figure 29. ***Polyporus badius***

Collecting of natural objects from National Park Service areas is restricted by law and regulations. Always check with local managers before collecting plants or other objects from park or monument areas. Regulations may vary between areas.

group, often look just like the corals found in tropical waters. Several are poisonous, that is, gastro-intestinally upsetting or simply not palatable. Others are edible, but not deliciously so. This group in Alaska is best left to the squirrels!

The perennial heart-rot tooth fungus *Echinodontium tinctorum* (Figure 35) that grows on western hemlock was used by indigenous peoples for its red ochre color. First dried and then ground to a powder, the internal tissue of the conk was used for making red ochre paint. *Hericium racemosum* (Figure 36), an annual tooth fungus, is a delicious edible.

Even the puffball fungi, such as *Lycoperdon molle* and *L. pyriforme* (Figure 37), are edible if you get to them before they begin turning color (from pure white to an olive green inside) and you beat the bugs or other parasitizing fungi.

Many wood-inhabiting gilled (lamellate or agaric fungi) mushrooms are NOT considered to be edible. In fact, *Galerina autumnalis* (Figure 38) is DEADLY POISONOUS and extreme care must be taken not to confuse this with other less- or non-poisonous species. Other species in different wood-inhabiting genera are actually edible. Particularly notable as edibles are *Armillaria gallica* (Figure 39), a virulent root-rotting fungus, *Flammulina fennae* (Figure 40), *F. velutipes* (Figure 41) and *Pluteus cervinus* (Figure 42). Others may cause significant gastrointestinal upset if eaten. Species of *Alnicola, Crepidotus mollis* (Figure 43), *Flammulaster muricata* (Figure 44), *Hygrophoropsis aurantiaca* (Figure 45), *Lentinellus cochleatus* (Figure 46), *Panus crinitis* (Figure 47), *Pholiota elongatipes* (Figure 48), *P. squarrosa* (Figure 49), *P. squarroso-adiposa* (Figure 50), *Pleurotus dryinus* (Figure 51), *Tricholomopsis platyphylla* (Figure 52), and *Xeromphalina cauticinalis* (Figure 53) are best photographed and left on the log!

The Ascolichenes and Basidiolichenes are abundant on all types of wood in various stages of decomposition. Lichens are symbiotic associations between fungi (mycobionts) and algae (photobionts). The fungal partners may "decompose" woody substrates to which they attach in part, but to our knowledge this has never been documented. Wood associated ascolichen and basidiolichen species are represented by *Ichmadophila ericetorum* (Figure 54) and *Lichenomphalia hudsoniana* (Figure 55).

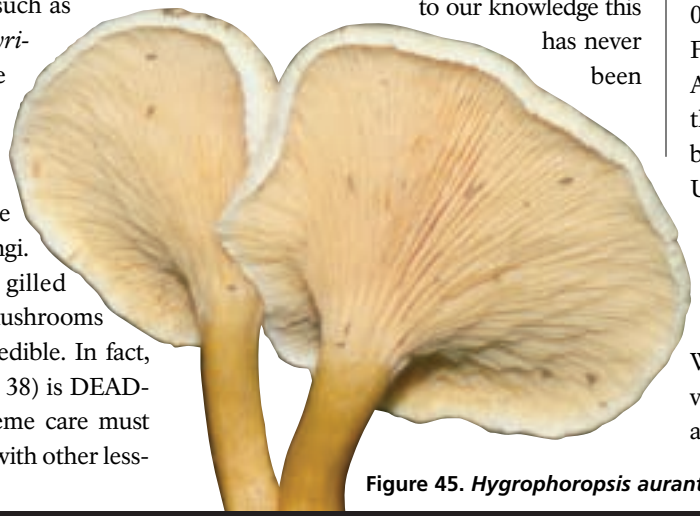

Figure 45. *Hygrophoropsis aurantiaca*

Significance

Several of the wood-inhabiting fungi are edible forest products not requiring the destruction of the forest. Many fungi occur annually and are thus considered sustainable and renewable resources that can supplement the tables of connoisseurs. While most wood-inhabiting fungi are not desirable for food either because of size (the thin crusts) or texture (tough or woody), most are not poisonous. However, THERE ARE POISONOUS (EVEN DEADLY) FUNGI THAT OCCUR ON WOOD. Care should be taken in selecting any fungus for the table. It is best to consult a mycologist for accurate identification.

Acknowledgments

Research was supported in part by grants from the National Park Service (Nos. PX9830-93-062, PX9830-92-385, PX9830-0-0451, PX9830-0-0472, and PX9830-0-0512) made to the University of Alaska Fairbanks (UAF), Institute of Arctic Biology. Additional funding was made available through the University of Alaska Fairbanks, Cooperative Extension Service under UAA Sustainable Development Grant # G000000268, made to the University of Alaska Fairbanks through the UAF College of Science, Engineering, and Mathematics as sub-grant #65089-360163. We extend thanks to all agencies and individuals that helped with logistical, material, and informational support.

REFERENCES

Volk, T.J., H.H. Burdsall, and K. Reynolds. 1993. *Wood-Inhabiting Fungi of Alaska.* Center for Forest Mycology Research, FPL Report. Madison, WI.

Volk, T.J., H.H. Burdsall, and K. Reynolds. 1994. *Checklist and Host Index of Wood-Inhabiting Fungi of Alaska.* Mycotaxon 52(1): 1-46.

Basidiomycetes: Gilled fungi

Figure 38. *Galerina autumnalis*

Figure 39. *Armillaria gallica*

Figure 40. *Flammulina fennae*

Figure 41. *Flammulina velutipes*

Figure 42. *Pluteus cervinus*

Figure 43. *Crepidotus mollis*

Figure 44. *Flammulaster muricata*

Figure 45. *Hygrophoropsis aurantiaca* **(Photo page 24)**

Figure 46. *Lentinellus cochleatus*

Figure 47. *Panus crinitis*

Figure 48. *Pholiota elongatipes*

Figure 49. *Pholiota squarrosa*

Figure 50. *Pholiota squarroso-adiposa*

Figure 51. *Pleurotus dryinus*

Figure 52. *Tricholomopsis platyphylla*

Figure 53. *Xeromphalina cauticinalis*

Asco- & Basidiolichens: The Lichenized fungi

Figure 54. *Ichmadophila ericetorum*

Figure 55. *Lichenomphalia hudsoniana*

Photographs courtesy of Gary A. Laursen


figure 38


figure 42


figure 46


figure 48


figure 52


figure 39


figure 44


figure 49


figure 53


figure 40


figure 50


figure 54


figure 41


figure 43


figure 47


figure 51


figure 55

Alaska park science, Vol. 4, No. 1, June 2005; pp. 18-25