Determining an *Amanita* to section without a microscope—a synopsis

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http://eticomm.net/~ret/amanita/mainaman.html

Suggestions for improvement are welcome.

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Introduction

For many years I've given a lecture on this topic, but I've never written down a text that would supplement the slides (of long ago) or the Powerpoint presentation of today. I hope this will serve to fill the gap.

The basic concept is that with a few directions and a set of "typical" images of key species, it is feasible to determine a fresh specimen to section using the naked eye. Without the ability to test for amyloidity of spores (by placing a drop of an iodine-containing solution on a small pile of spores gathered from a spore print), the greatest difficulty is in separating taxa of sections *Amanita* and *Validae*. The availability of tincture of iodine and aqueous KOH solution (about 5% to 10% concentration) in a collector's field gear should raise the accuracy of the following method to over 85%.

Of course, you need to know when you have an *Amanita* in the first place. Unfortunately, all the usual field guide rules are generalizations that are not universally true. For example, there are amanitas with non-white gills; there are amanitas with gills attached to the stem apex; there are amanitas with forked gills. However, combining a mental or printed set of pictures of typical amanitas of various sections, sizes, and shapes (especially the "rule-breakers") with the generalities of most field guides should be quite adequate to prepare a collector for identification at the level of genus.

The reader should obtain good illustrations of the following sorts of taxa that may occur in their collecting region. Readers with broad travel plans will have to collect pictures for more regions. I will try to make this list of "typical pictures," both relatively short and adjustable to a wide variety of regions. I will introduce the lists throughout this note to back up and strengthen the reader's understanding of each section of the genus.

The subgenera—*Amanita* and *Lepidella*

Here we are starting with concepts that may be unfamiliar to some readers, but they ought to make sense to all.

It is estimated that there are 900–1000 species in the genus *Amanita*. Possibly there are more than 1000. Of these, something less than 600 have been named according the research of Dr. Cornelis Bas (Leiden), Dr. Zhu L. Yang (Kunming Institute of Botany, Yunnan Province, China), and myself. Both from morphological studies of about the last 90 years and molecular studies of about the last 10 years, the genus is a natural grouping of species very likely to have descended from a single ancestor.

Within the genus, there appear to be two groupings that are called "subgenera." A genus could have any number of subgenera; however, there seems to be a very natural division into two in the case of *Amanita*.

One subgenus includes all the known species with spores that do not become dark in iodine solution (called "inamyloid" spores); and this subgenus includes the defining species (or type) of the genus—*Amanita muscaria*. According to nomenclatural rules, this subgenus must have the same name as does the genus; so the subgenus including taxa with inamyloid spores is called "*Amanita* subgenus *Amanita*." Notice that the naming system has two parts (just as in the name of a species).

The second genus, in which are placed all the taxa with spores that do darken when placed in an iodine solution, is called *Amanita* subgenus *Lepidella*. To date, this method for segregating the genus into two subgenera has been shown to be very likely to represent the actual genealogy of *Amanita*, through molecular studies.

The two subgenera do not evenly divide the known taxa of *Amanita*, but both subgenera are still large enough and diverse enough to be unwieldy. At present, morphological taxonomists generally agree on dividing the two subgenera into seven sections. There are very few of us. We do not always use the same names for these divisions. I am in favor of a stable framework that is offered by the work of doctors E. J. H Corner and C. Bas as published in 1962. This framework included six

sections. It became evident toward the end of the Twentieth Century that we needed to add a seventh; but this involved dividing one of the Corner-Bas sections in two, with no impact on any other sections. In this sense we have preserved a workable, stable structure...at least so far.

The sections of *Amanita* subgenus *Amanita*

The basic technical division here is based on ontogeny (the process of development of the "fruiting body" or mushroom). It's our good luck that the relevant results of the development process can usually be seen in an unopened button (a good reasons to look for specimens showing varying stages of fruiting body expansion) or (slightly less so) in maturing mushrooms.

Amanita section *Amanita*

The first key separating character can be seen by cutting an incompletely expanded button of an amanita longitudinally (top to bottom) through its center. If you cut a button of *A. muscaria* in this manner, the ghostly outlines of the mushroom cap, gills, and stem will be crowded into the upper part of the cross-section you've made. The position of the developing fruiting body is "eccentric upward." Most of the button is not participating in making the above ground parts of the eventual mushroom. That "uninvolved" part of the button is going to be a bulb. The bulb may shrink in width with water loss during further development; but much of the time, the bulb is going to be easily detectable at the base of the stem in the mature mushroom. Species of *Amanita* belonging to subgenus *Amanita* that develop so as to produce such a bulb include the defining species of the genus (just used as an example). Nomenclature rules required that we name the section including *Amanita muscaria*, *Amanita* section *Amanita*. Again, note that the name has two parts (is "binomial"), just like a species name. We have now defined our first section. Six to go.

Amanita section *Caesareae*

If the reader were to find a button of a species similar to *A. vaginata* and another similar to *A. jacksonii*, similarly sectioning the button would show the outlines of the maturing fruiting body approximately centered in the button; and there would be no "uninvolved" region. In the two cited species, the whole stem elongated without any bulb present at all. Oddly enough, the stems in such taxa are called "totally elongating stems." I chose to use two examples for this form of fruiting body development, because there are two sections that have this character. EXCEPT WHEN A SPECIMEN WITH AN ANNULUS HAS LOST THAT ANNULUS (also called "skirt," "ring," or "partial veil"), the two sections appear at present to be separable very simply. If there is never any partial veil (heavy flocculence at the top of a specimen's stem doesn't count as an annulus), then the specimen in question belongs in *Amanita* section *Vaginatae*. On the other hand, if there is an annulus on a specimen's stem and the mushroom meets the other conditions we have just discussed, the specimen can be assigned to *Amanita* section *Caesareae*.

Amanita section *Vaginatae*

You will notice that I've said nothing about the sort of volva that may appear on a specimen of any of the three sections of subgenus *Amanita*. This is because, the more we learn, the more we find that the form of a volva (or "universal veil") on a given specimen is NOT a good indicator of the sectional placement of that specimen. Studies in South America and Australia have produced several examples of species with a bulb at the base of the stem (species of sect. *Amanita*) that have that bulb enclosed in a membranous to submembranous saccate volva. Many of the readers of this article will be experienced with a species similar to *A. ceciliae* which has a totally elongating stem, but lacks a saccate volva enclosing that stem's base. Note that what may look like a bulb at the base of the stem in some species of the "*ceciliae*-type" is actually the cup-like base of the volva.

We have finished with the job of cutting three sections out of subgenus *Amanita*. This subdivision was developed from entirely morphological information. At present, it appears to be supported by results of molecular studies.

In order to fix a broad set of species images in the reader's mind ain association with the sectional names, I will make some suggestions of species images for each of the three sections. The purpose of the suggestions is to provide as broad a perspective of species color and habit as is necessary with a relatively small number of examples.

> Authorial citations are omitted for readability. Authors' citations are available on the pages dedicated to the cited species on *Amanita* Studies website: http://eticomm.net/~ret/amanita/mainaman.html

Amanita section *Amanita*—gestalt

This list of taxa will cover section *Amanita* rather well no matter where in the world the reader happens to collect. The individual taxa are usually restricted to a specific content unless they have been moved by human means (usually as symbionts with a transplanted tree): (1) *A. muscaria*, (2) *A. xylinivolva*, (3) *A. pantherina*, (4) *A. farinosa*, (5) *A. roseitincta*, (6) *A. mira*, (7) *A. parcivolvata*, (8) *A. concentrica*, (9) *A. sinensis* [these latter two, east Asian species are quite unusual in that they could

be mistaken for taxa in sect. *Lepidella* (see below)], (10) *A. umbrinella* [as a representative of taxa with a bulb and a weak, sack-like volva—known from Australia and from Southern Beech (*Nothofagus*) forest in southern South America], and (11) *A. lanivolva* [as a representative of taxa with a bulb and a membranous, sack-like volva—known from South America].

Amanita section *Caesareae*—gestalt

With the same caveats as in the case of section *Amanita*: (1) *A. spreta*, (2) *A. caesarea*, (3) *A. jacksonii*, (4) *A. princeps*, (5) *A. egregia*, (6) *A. virginiana* [representing a group restricted to eastern North America], (7) *A. tanzanica*, and (8) *A. calyptroderma* [representing a group restricted to western N. America]. The *Amanita* entrants in the "puff-ball on a stick" parade are presently classified in the genus *Torrendia*. The *Amanita* entrants in the "let's be a truffle" reality program are classified in the genus *Amarrendia.* Tulloss and Yang believe that both of these genera comprise taxa that are assignable to section *Caesareae*.

Amanita section *Vaginatae*—gestalt

With the same caveats as in the case of section *Amanita*: (1) *A. fulva*, (2) *A. pachyvolvata*, (3) *A. ceciliae*, (4) *A. colombiana*, (5) *A. flammeola*, (6) *A. crocea*, (7) *A. sinicoflava*, (8) *A. liquii*, (9) *A. umbrinolutea*, and (10) *A. punctata*. This section appears to be very large, and a great majority of the taxa have not been formally described.

The sections of *Amanita* subgenus *Lepidella*

The existing technical division of this subgenus begins by segregation of two pairs of sections. The first pair (*Amanita* sect. *Lepidella* and *Amanita* section *Amidella*) is segregated by the presence of material of the universal veil on the margin of the cap ("appendiculate material"). However, this is a bit difficult to use because of the minimal and/or varying amount of appendiculate material that can appear on the cap margin in individual specimens. For example, it is very challenging to find appendiculate material on older specimens or on small, fragile specimens. To add to the difficulty, there has been some concern expressed about the dividing lines between the two sections traditionally said to have appendiculate margins. I propose to confront the situation as it stands and leave the necessary rethinking of section boundaries for another day.

Amanita section *Amidella*

This section contains three taxa that are not very similar to the section's type species—*A. volvata*. Of those three taxa, one (*A. ovoidea*) could fit rather well in sect. *Lepidella*; and proper placement of the other two (similar) taxa—*A. neoovoidea* and *A. proxima* has not been sufficiently addressed to date. *Amanita ovoidea* and *A. proxima* are taxa of southern Europe, north Africa, and western Asia. *Amanita neoovoidea* is east Asian. I am simply going to state that regardless of the following approach to recognizing section *Amidella*, the above three taxa are also included in the section at present.

There are two major characters that are common to the remainder of taxa in the present section, (1) the stem is totally elongating or would be if not for a brief flaring at the very base of the stem suggesting the open end of a bell and (2) the base of the stem is enclosed in a sack-like volva that is usually complexly layered and is often thick enough to suggest the presence of a basal bulb unless the mushroom is longitudinally sectioned...and the truth revealed.

In many species flocculent material on the stem bruises/oxidizes brick red or brownish red. In very fresh material (especially in rainy weather) pink staining of cut flesh may be noticed, although the color often fades rapidly. The volva often separates from the cap by the breakage of a powder layer that is usually the intermost layer of the volva or the next to innermost layer (in which latter case, the innermost layer is thin and fibrous). While a large piece of the entire volva may remain on the cap in some species and the cap in a few species may seem completely clear of volval material, it is often the case that the powdery or fibrillose remnants mentioned above will oxidize to red-brown and form delicate decorations on the cap surface (sometimes even suggesting cuneiform writing).

Amanita section *Lepidella*

This section is a diverse collection groupings within *Amanita*. Many of the groups include only one or a small number of species. None are very large. Some of the larger ones appear to be restricted in occurrence to a single continent. The most primitive seem to represent a relatively successful group that are the surviving descendants of saprobic species with many morphological similarities to the sister genus of *Amanita* in the family *Amanitaceae—Limacella*. The latter group includes taxa that are now thought of as pasture or lawn mushrooms because they are very well adapted to living on cellulose—grass clippings.

Exclude those species of section *Amidella* in which an appendiculate is visible. The remaining *Amanita* species having caps with appendiculate margins belong in section *Lepidella*. There are a few small species in which the appendiculate margin may be hard to see, and I'll address that in a moment. The appendiculate matter about which I'm speaking normally does not include parts of a broken partial veil that may hang from the cap margin, although such pieces may be present in addition to

the appendiculate parts of the volva. The parts of the volva may those that are connected directly to the flesh of the cap, connected directly to the skin of the cap, or belonged originally to that portion of the volva that was originally included between the gill edges (or annulus) and the stipe when the mushroom was in the button stage. Sometimes the volval material appears as small crumbs; sometimes (as in *A. cinereoconia*) the appendiculate matter hangs like flocculent icicles from the cap margin.

Because the species of sect. *Lepidella* represent the present day relict descendants of what was probably an ancient period of great diversity of *Lepidella*-like ancestors, they are like the few groups of leaves on the many still living branches of a great evolutionary bush that, with the utter lack of fossil history for the *Amanitaceae*, we will never know. There are lepidells with bulbs and lepidellas without bulbs. There are lepidellas with skirt-like rings on the stipe. There are lepidellas that are exannulate. The are odorless lepidellas, but a lot of them have very, um, "distinctive" odors. Most have white, cream or yellowish cream gills, but some have café-au-lait, brown, grass green, brilliant pink, various shades of ochraceous, or bright yellow gills. Many have a skin on the cap; however, a significant number have the volva directly connected to the cap flesh without an intermediate skin. Several well known taxa will leave flocculent volval material on your hands when you touch them. The variation in the microscopic structure of the volva is also great resulting in a wide range of the sizes and shapes of warts that are left on caps and/or basal bulbs. At least two have volvas that bruise blue-green. One species bruises raspberry red (and, to top it off, smells of anise). In a way, studying section *Lepidella* is like taking a world tour of the ruins of all known ancient, human cultures

Let's return to the species that may be the hardest to place in sect. *Lepidella*. In my personal experience, these taxa all fall into one group called *Amanita* subsection *Limbatulae* by Dr. Bas. These taxa have, at least, a marginate bulb or, at most, a thin membrane of hyphae standing up from the top of their stipes' basal bulbs. In both cases, the volva left on the cap is, at least, a thin layer of powder or, at most, that thin layer topped by a bit (or bits) of the hyphal layer that originally covered the powder and the rest of the fruiting body. It is the thin powdery layer and whatever remains there may be of the volval portion that once segregated the stipe from underside of the annulus (which is usually present in the species of subsection *Limbatulae*) that is responsible for what appendiculate matter may be found on the edges of their caps. To be utterly frank, sometimes the powdery layer is not very easily seen on the cap. For example, rain can wash it off. If you want to be sure that the powder is present on the inside of the membranous limb standing from a stipe's bulb, you will have to use a microscope. Indeed, without a microscope, it will often be difficult to tell a very depauperate specimens of *A. bisporigera* from these strange little beauties. Indeed, the extremely long and thin spores, which several of them produce, simply cannot be appreciated fully until viewed under an oil immersion lens at magnification of 1000× or more. It may help the non-microscopist, that these taxa are often found in deep sandy or gravelly soil of coastal plains. In addition, they are often deeply inserted (or even completely buried, although with caps largely expanded) in the soil. My wife, Mary, once found a cluster of *A. cylindrispora* accidentally by kicking sand...and, coincidentally, exposing the tops of the caps of the expanding, long-stemmed mushrooms.

Amanita* section *Phalloideae

Amanita* section *Validae

***Amanita* section *Amidella*—gestalt**

The species for which images would be especially helpful to the reader are as follows: *A. ovoidea, A. neoovoidea*, *A. proxima*, *A. volvata*, *A. peckiana*,

***Amanita* section *Lepidella*—gestalt**

The species for which images would be especially helpful to the reader are as follows:

***Amanita* section *Phalloideae*—gestalt**

The species for which images would be especially helpful to the reader are as follows: *A. bisporigera*, *A. verna*, *A. elliptosperma*, *A. phalloides*, *A. fuliginea*, and *A. pseudoporphyria*.

***Amanita* section *Validae*—gestalt**

The species for which images would be especially helpful to the reader are as follows: *A. citrina*, *A. brunnescens*, *A. rubescens*, *A. rubescens* var. *congolensis*, *A. excelsa*, *A. morrisii*, *A. perphaea*, *A. submaculata*, *A. cyanopus*, *A. squamosa*,

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