All About Decomposition
Leon Higley

Many years ago I answered an inquiry about the process of decomposition in cows and horses from a TV researcher in England. Ultimately it emerged that there was interest in carcasses in Colorado found with most internal organs removed. What follows is my (slightly edited) response to the general process of decomposition and some specific comments pertaining to carcasses without major organs. My discussion is detailed but wandering, which parallels my in-person lecture style, for good or bad. I don't have pictures of decomposing cows or horses, but I have lots of pictures of decomposing pigs at different stages of decomposition. I've put in some of these to illustrate the decomposition stages. If you are mostly interested in human decomposition, just substitute the word "body" for any time I say "carcass" – the process is essentially the same. And spoiler alert, you don't have to look for satanists or aliens to explain why decomposing cows in Colorado may be missing body organs.

While there is any soft tissue on a body (i.e., before complete skeletonization), all decompositional processes depend on temperature. Higher temperatures - faster decomp, cooler temps - slow decomp, cold temps (near and below freezing) usually no decomp. (Interestingly, my former student Tim Huntington and I did work to show that morgue temps are not sufficient to stop maggots from continuing to feed on corpses, although bacterial activity is delayed). Decomposition rate also depends on geography, topography, and climate (mostly elevation and latitude, but also rainfall and RH). For instance a dead cow at elevation in a dry area (for instance, in the high deserts of the American West) may partially mummify, and the role of insects will be diminished. Another point is substrate. Animals decomposing on soil decompose faster than animals decomposing on rock or concrete (apparently this is associated with the role of soil microbes in decomposition). A further, very important, point is that all decomposition is faster with oxygen than without. With oxygen, microbes, insects, etc. chow down rapidly, without oxygen it's mostly anaerobic microbes (which are slow). Besides being slow, these anaerobic bacteria make some horrible smelling metabolic products, lots of mercaptans and other sulfur-containing molecules. So, as a summary, the simple rules for animal decomposition are that wetter=faster, warmer=faster, tropical=faster, soil=faster, and oxygen=faster.

[Aside #1
Here's an important fact you were never taught in school (at least my kids and I weren't). Rotting anything exposed to air has a bad odor. Rotting anything without exposure to air has a very bad…opps, I mean, a

"OH MY GOD WHAT IS THAT I'M GOING TO VOMIT!"

smell. This is why I tell cops to always volunteer to be the first to sample and photograph decomposing bodies at crime scenes. Do the (supposedly stinky) work, then, when it's time to move the body (and expose the underside where there's lots of anaerobes), you get one of your buddies to do the moving. You can then stand aside, and laugh at your buddy's expense when they want to vomit but can't, because they are holding a dead body. At homicides, you have to make your own fun.]

The biochemistry of decomposition is rather cool and(or) profoundly disgusting depending on your perspective. Part of decomposition (autolysis) just involves the body automatically breaking down as chemical processes go to hell (a technical term) when life ends. But most decomposition of soft tissues involves things (bacteria, fungi, insects, birds, mammals, etc.) feeding on the body. Final breakdown, of the skeleton, mostly involves physical action (weathering from rainfall, freezing, and the like). Different tissues breakdown at different rates, and tissues may change (for instance bacterial hydrolysis of fat converts it to a waxy substance called adipocere; stinky and horrible, in my opinion, but not unlike some of the more expensive cheeses. Not surprisingly, the adipocere-creating bacteria are anaerobes.)

Ok, on to your real question, a typical cow decomposition process (spring, summer, fall; temperate region, and as you are in the UK, I'll imagine a pasture near Saffron Walden, Essex, where I spent some happy years of my childhood). I'll refer to stages of decomposition, but please understand that these "stages" are really just a means of categorizing parts of a continuous process.

1. Fresh. Bessie (the cow) is recently dead (a day or two). Autolysis begins as well as the start of bacterial and fungal breakdown. Blow flies (a few species in the Family Calliphoridae) find the body and lay eggs. Interestingly, flies only lay eggs at holes in the body, so with Bessie (as with humans) there are naturally 9 or 10 holes (females having an "extra" hole or males "lacking" a hole depending on what you think is normal): 2 ears, 2 nares (nose holes), mouth, 2 eyes (yep, eyes are holes to flies), 1 anus, 1 genital opening and 1 urethral opening or 1 genital/urethral opening. Bessie has 10 holes, unless you count teats (and maybe you should if Bessie was lactating before her death) in which case there are 14. Typically, all egg laying is at the head (usually mouth, nares, and eyes), but if Bessie got crossways with the Mob, and was "taken out" with a shotgun blast to the torso, flies will definitely be all over the wound.

How long after death does it take for flies to find the body? Absent complicating conditions (e.g., freezing, wrapping in aluminum foil, thunderstorms, volcanic eruptions, and the like), blow flies will find a body shortly after death, typically in minutes. Eggs are laid shortly thereafter, and some species use chemical attractants to attract more flies to lay eggs. (It is thought that some species benefit through faster growth rates after achieving some minimum total number of larvae). It can

take much longer than minutes for flies to find a carcass, and many factors can cause a delay. In working homicide cases ovipositional (egg laying) delays can be an important complication in estimating the time of death. However, I doubt this will be a complicating factor with Bessie. Although there is a bit of a debate among researchers, I think the evidence is conclusive that blow flies will not look for carrion or lay eggs at night, so flies will reach Bessie's body during daylight. Before leaving this issue, what is the very shortest time after death that blow flies find a body? The answer here is 40 seconds (demonstrated by observations immediately after killing a pig).

[Aside #2
Note that blow flies do not (typically) lay eggs on sleeping animals, therefore they distinguish between live cows (or pigs, humans, etc.) and dead cows (or pigs, humans, etc.) Two important possibilities emerge from this finding.

First, assuming blow flies evolved to find carrion by detecting decompositional chemicals from bacteria metabolism (research shows behavioral responses of blow flies to such chemicals), then bacteria must start breaking down bodies seconds after death. This conclusion further implies that while we are alive, decompositional bacteria are in/on our bodies and constantly trying to eat us. Ouch.

Alternatively, I read that many/most Americans do not accept the biological concept of evolution, therefore, the evolution of blow flies to detect decompositional chemicals is apparently off the table for these people. From this viewpoint, the only alternative I can think of is that flies must detect the departure of the soul from the body. This interpretation would imply that Catholic dogma is incorrect, and animals do have souls. Also, it leaves open the issue of why flies should be able to detect bodiless souls. Are they agents of Satan (Lord of the Flies, after all) trying to capture souls for Hell, or are they, perhaps, agents of Heaven guiding souls to their final reward? I am disappointed that the theological implications of this question have not received any attention, but when I get time, it's a question I'd like to take up (probably as a paper for the Journal of Irreproducible Results).

Incidentally, I think one of these two alternatives is likely and the other is crap.]

2. Bloat. Put your hooves in the air like you just don't care – the abdominal cavity fills with decompositional gases, blood and other fluids pour out of mouth and nares, and maggots are feeding away. The decompositional fluids are called purge (or purge fluid), but I've also heard them called stink juice. In the pasture, a black circle will form around the Bessie's carcass, as stink juice spreads. This black circle occurs because body fluids contain lots of nitrogenous compounds, so plants around Bessie are killed from "nitrogen burn", in the same way over fertilization can kill a lawn. Through time, nitrogen will leach and otherwise decrease in concentration, eventually diminishing to a concentration where nitrogen content of the soil actually increases plant growth. So, spots of lush grass growth can be an indicator of clandestine gravesites. How long do changes in soil chemistry last in the pasture from Bessie's death? Years (I think recent research would suggest at least a decade, but possibly longer depending on rainfall and soil characteristics).

[Aside #3
Writing about purge makes me think that this is a good place to make pertinent observations relative to fictional depictions of crime and decomposition.

One: crime scene tape says "Crime Scene Do Not Cross" because NO ONE should cross the tape, especially the police! A properly managed crime scene has a single point of entry to allow recording all movement to and from the scene, and to avoid inadvertent destruction of evidence. If anyone crosses the tape, the integrity of the scene has been violated, and on that point alone a judge can throw out all evidence from the scene. I have never seen a TV show or movie get this right.

Two: I have seen naked people in film and on TV doing things naked people do (some of which I really didn't need to know about), and I have seen people tortured, quartered, stabbed, shot, poisoned, strangled, burked, bludgeoned, disemboweled, and dismembered in film and on TV, but I have never seen a "decomposed" body on film or TV with maggots. Moreover, the very few times I have seen "maggots" on TV or film they are almost always beetle larvae, not maggots. [I think I have seen actual maggots on the screen twice, and both times my heart sang – once was on a dead deer in the first episode of Game of Thrones – real maggots in a fantasy program, go figure.] My conclusion from Hollywood's aversion to showing maggots when they will show anything else, no matter how tasteless or horrific: baby flies (maggots) are more shocking to people than graphic sex or graphic violence. Other supporting evidence: I gave a workshop to some FBI agents who'd been joking about a crime scene where human brains were splattered everywhere. Yet, when I showed pictures of maggots, the same agents looked away. Jim Morrison and *The Doors* were correct, people *are* strange.

Three: Way back many paragraphs ago, I mentioned that during decomposition stink juice flows around a body. Look at the shoes of all TV and film detectives and notice how those detectives walk right up to the corpse and inspect the body. In the real world the stink of stink juice doesn't wash off, and it's expensive to buy new shoes after every case.]

Back to the bloat stage, with a true story:
As undergrads look at a bloated, decomposing pig, one asks, "Hmm, if the body is filled with gas, doesn't that mean there is pressure on the tissues, Dr. Higley? So will it eventually pop?"
Before I can answer, another student (who apparently believes experience is the best teacher) gently kicks the pig.

POP

Pig decomp fluids all over kicking student? Check.
Screaming students running away from popping pig? Check.
Dr. Higley laughing his fool head off? Check.

People often say that teaching is a thankless task, but I find it surprisingly rewarding.

3. Active decay. This is the post-pop stage. The head becomes mostly to completely de-fleshed inside and out from maggot feeding, and a huge mass or masses of maggots will be feeding away on the torso. During this stage many bones become disarticulated. For instance, the mammalian mandible is connected to the skull only with ligaments, so we can expect Bessie's jaw to separate from the rest of her head. (Separation of the mandible and its appeal as a gnawing toy by vertebrate scavengers is one reason finding teeth can be problematic in the recovery of human remains.) At this point, beetles also will be feeding on the body or on the maggots, other insects will feed on decomposition fluids (wasps and butterflies are occasional visitors), and in total a new ecological community develops on Bessie, including different insects and other invertebrates as well as lots of different kinds of microbes. Depending on the temperatures and general density of flies, this "stage" can be days to weeks. Also, through the study of fresh through active decay we learn that the idiom "Rot begins at the head" is not only figuratively true, but also literally true.

4. Advanced decay. The soft tissue is mostly gone but skin (do we call it a cowhide?) and ligaments/tendons are still present. These are eaten by dermestid beetles, nature's forgotten recyclers, or feral dogs, and other scavengers. Again, depending on climate, this stage lasts days to weeks to months (but typically weeks to months).

[Aside #4
Dermestid beetles are one of the most common insects to occur in homes where they once fed on wool carpeting, but now feed mostly on other sorts of dead bugs. Before dermestid larvae molt into pupae, they "like" to wander around. As the larvae are covered with weird spines, people tend to freak out when they see spiny "worms" crawling up the walls of their homes. In contrast to this perspective, most entomologists (like me) love stories about people becoming hysterical over harmless insects in their homes – proving yet again (1) how important schadenfreude is as a key to understanding human behavior and (2) how strange it is that the rich vocabulary of the English language must borrow from German to describe so basic an emotion.]

5. Remains stage. Dem bones, dem bones, dem dry bones. People wandering in the pasture find Bessies's skull and take it home because it'd look good in their back garden; Indiana Jones uses Bessies's leg bone to make a torch; after the pasture is sold and turned into row houses, someone finds one of Bessie's ribs while digging and calls the police; and so on. It is extremely unusual to find all the bones from a body in the remains stage. Very small bones can be moved by wind and water, and in most circumstances, scavengers move tissue and bones (as they may at any point in decomposition). This "stage" lasts months to years, but if you are in a sufficiently dry environment (desert) or cold (arctic) environment remains can last decades to centuries (even to a couple millennia).

As I mentioned earlier, although everyone (well most textbooks) describe decomposition in either these stages or something like them, actually the "stages" are an abstraction. For instance, if there are any holes in the body cavity, bloat doesn't occur. Also as scavengers feed on a body, parts are spread out and rates of decomposition increase.

Ah, scavengers. With large carrion, (like Bessie, but also like dead people) vertebrate scavengers are likely to be key factors in decomposition. At almost any point after death, various scavengers may feed on a body, and they will rapidly accelerate tissue loss. Chiefly, the type of scavenger depends on where you are, but crows and "varmints" (rats, foxes, raccoons, etc.) are common. With larger carrion like a cow, in Nebraska we'd expect vultures, crows, coyotes, raccoons, and possibly feral dogs. In Essex, I think I'm on safe ground with crows but beyond that, I don't remember enough of the common English varmints, if indeed you have varmints, to list them off the top of my head. (By the way, I don't believe I have ever actually heard someone use the word "varmint", and I believe this is the first time in my life I've found an excuse to write the word "varmint". Writing "varmint" makes me feel like Yosemite Sam.)

A final question, which I can't answer but would like to, is "where do we go when we die" (by the way, "Where do we go when we die" is the title of a scientific paper I am determined to write). Where did Bessie go?

The water part of Bessie went everywhere. Part of Bessie's water may have gone into the soil or been taken up by insects and other organisms, but this is just the first step of returning to the ocean-atmospheric cycle of water on Earth. Based on rates of molecular diffusion, Bessie's water molecules will eventually disperse everywhere water occurs (yes, in you too).

Regarding the rest of Bessie, she was largely a combination of various biological molecules many/most of which devolve into their elemental components. Although Bessie includes many elements, after water (hydrogen and oxygen) are removed, Bessie is mostly carbon followed by nitrogen and a plethora of elements in smaller quantities (including phosphorus, potassium, calcium, sodium, iron, magnesium, and others). We think the heavier elements stay closest to

where Bessie died, either as components of the soil or components of the organisms feeding on Bessie. Eventually these elements will either be recycled to the soil (or oceans, through soil erosion from wind and water) through the feces, urine, and similar waste products of Bessie's diners (microbes, insects, and scavengers) or through the diner's themselves as they die. Bessie's calcium will mostly return to the soil as her bones weather or are gnawed on, although some small proportion will be taken up by her diners.

That black circle from stink juice tells us that much of Bessie's nitrogen went into the soil, where it will eventually be taken up by microbes and plants or returned to the atmosphere. Ironically, although the air is mostly nitrogen, lack of available nitrogen is a key issue in plant and animal nutrition. As yet, I don't think we know enough to say exactly what proportion of Bessie's nitrogen ends up in plants, animals, soil, air, and ocean; or at least I don't know enough to divide up Bessie's nitrogen. I do know that eventually the nitrogen goes into the atmosphere, but I don't know how long eventually is.

Finally, where did Bessie's carbon go – carbon, which we usually think of as the core of Bessie's (and our own) substance? It is tempting to say that Bessie just went into everything that ate her, that Bessie becomes bacteria and fungi and flies and birds and varmints. But this notion ignores how food actually is incorporated into organisms. Converting food into mass is called metabolic conversion, and for most animals the metabolic conversion rate is at most about 10%. The rest of the mass is mostly respired, burned up to provide energy. The product of respiration is, of course, carbon dioxide. So at least 90% of Bessie ends up in the atmosphere, but the balance sheet is actually much more than 90% of Bessie's carbon ending up in the atmosphere (because the things that ate Bessie are themselves eaten or decompose). Fates of atmospheric carbon are tremendously important for understanding and predicting climate change, and lots of questions regarding details of these processes remain. I can say that eventually, some of Bessie's carbon will end up in plants, and because of molecular diffusion through the atmosphere, it is literally true that "parts" of Bessie will be in every plant on Earth, and ultimately most animals. At this point, feel free to make your own spiritual/philosophical/religious observation.

I do wish I knew more about the details of this process, especially the timeframe during which these events occur. I suspect some of this information is available, but I haven't seen it summarized in detail. So I guess I either need to get researching the literature or researching the processes. As it happens, we are looking at carbon cycling with maggots in my lab, so I'm not completely behind the curve.

After all this lot, I learned that there was interest in some specific horse and cattle deaths. One was a horse in Rush, Colorado in August, and the others were cattle deaths near Trinidad, Colorado in March, August, and September. What follows is my discussion of decomposition and tissue loss for these specific circumstances.

Dead Horse, Dead Cows

Although both situations are with somewhat different elevations and different months, because the carcasses were found a day after death, the decomposition issues are generally the same. Basically, no stink juice, no immediate signs of tissue deterioration, the animals mostly just look

dead. The slightly subtle indicators we expect of death and decomposition (beyond laying on the ground and not moving when poked) are that:

(1) the conjunctiva of the eyes will have become clouded,

(2) livor mortis occurs. Livor mortis is settling of the blood by gravity in lower parts of the body – it turns out to be a good indicator when bodies have been moved because livor "sets" (becomes permanent) just a few hours after death.

[Higley's fun facts about livor mortis, blood color, and random related topics

(1) As long as I'm talking about livor mortis, it is worth noting that all blood in the body/carcass becomes blue because all the oxygen is used up. Livor is one reason corpses are pale, de-oxygenation is why nail beds, bottom of legs, back, etc. look bruised (basically wherever the de-oxygenated blood pools, looks blue). If the blood in a dead body remains red, the body is said to be "cyanotic". Actually, red blood in dead bodies is a strong indicator of cyanide or carbon monoxide poisoning. In both instances, something (cyanide or carbon monoxide) irreversibly bind with the respiratory protein cytochrome P450, cellular respiration is blocked so there is no "demand" for red blood cells to give up their oxygen. Losing oxygen is why the blood changes from red to blue – the color change being associated with the change in the oxidation state of the iron molecule at the center of the hemoglobin (haemoglobin, in English English) protein. (And at this point, even I recognize that I'm not providing useful information, I'm just trying to show off and convince myself that I deserved receiving my chemistry degree from Cornell University 30 year ago.) Best livor mortis examination in the movies – there's a great scene in *The Andromeda Strain* where one of the doctors pulls the pants off a victim to see if his butt is blue (spoiler alert: it isn't, Andromeda causes the blood to coagulate within seconds).

(2) A day or two after death the "blue" blood becomes "black" blood as all the blood cells breakup and bacterial action takes off (this is why the ethnicity of decomposed corpses is not always apparent – everyone become black in time).

(3) [Really an aside of an aside]
Why is/was plague the "Black Death"? The plague bacillus releases a toxin that blasts human cells, killing them. Areas where this occurs (typically fingers and other extremities), turn black and, literally, die. So even today, some plague survivors lose limbs. More commonly plague victims just die: unless you catch the infection early, even though plague is easily treated with tetracycline and related antibiotics, the antibiotic can kill you. How good intentions go wrong: (1) high dose antibiotic given to stop raging infection before it kills patient, (2) most plague bacteria in body suddenly die from antibiotic, (3) toxins in the now dead bacteria are released in mass, and (4) the body's natural detoxification mechanisms (biochemical, vomiting, excretion, etc.) are inadequate to massive flush of bacterial toxins, and (5) the patient dies from "toxic shock" – the whole-scale poisoning of multiple bodily systems.

People can survive plague if treatment is timely. I met a plague survivor, an entomology professor, after a seminar I gave in Florida. Although he was working in the Four Corners Area (the conjunction of Utah, Arizona, Colorado, New Mexico, a notorious plague hotspot) when he became ill in the summer, he thought he just had the flu. His wife made him see a doctor, who must have been a good diagnostician, and recognized plague. So, wife and doctor saved the professors life. And we have more evidence that women are smarter than men, as if we need more evidence. Plague in the US was gift of the third pandemic and of government idiots in San Francisco (ca. 1905), who refused to act to eliminate the disease (an interesting historical story with great parallels to modern governmental stupidity, but I'll spare you that digression).

(4) [[Aside of an aside of an aside]
If you are from Essex (Alice, the TV researcher was), you should be pleased to know that your family must be survivors, as I believe Essex has the dubious distinction of having been one of the most plague-ridden counties in Britain, and either the last or one of the last counties before plague disappeared [in the 1700s]. Interestingly, I am homozygous for the ERAP2 gene for plague resistance, showing my English forebearers clearly were exposed to selection by plague. My ancestor, John Higley, from whom all the American Higleys are descended, left Surrey for America in the mid-1600s to escape plague (before the Great Plague and subsequent Great Fire of London), although I suspect he also may have wanted to escape his fate as a glove maker's apprentice. And what happened with indentured servant John Higley, you ask? Marries the boss's daughter, becomes a trader to the West Indies (you know, African slaves growing sugar in the Caribbean, sugar to America for rum, rum to Britain for public intoxication, with everyone but the slaves getting a piece of the action), becomes a respected member of the colonies, Captain in the militia, and sires lots of kids. This classic success story also has a classic ending: after John's death subsequent generations dissipate the wealth (leaving none for my grandfather, father, or me to dissipate).

So dead horses and cows in Colorado, fast death, could it be plague? Nope, little to no opportunity for exposure to infected fleas.

Back to decomposition of horses and cows…

(3) possibly rigor mortis (stiffening of the muscles, which is caused by loss of calcium and cross linkage of a couple muscle fiber proteins), which later goes away as the muscle fibers breakdown. Rigor is a transient phenomenon, and I don't know how long it lasts in cows or horses (mostly the same as in humans?). In humans rigor is a function of fitness (more fit: fast formation, stronger rigor; less fit: slow formation, weak rigor; dead Leon Higley: ragdoll mortis, term I just invented to describe what happens to fat, out of shape 54-year olds, in whom rigor will never form),

(4) the presence of blow fly eggs on eyes, nares, mouth, and, if warm enough, some hatched eggs with small, barely visible larva OR nothing. At these elevations in Colorado (which has a very dry climate), not finding blow flies during the first day is not entirely unexpected (basically the warmer the daytime temperatures, the more likely that blow flies should find dead horses or cows), and

5) reduced blood pH, who knew (I just heard a talk about this); however the relationship of blood pH and PMI (remember?, post mortem interval) is still being researched, and the data presented were from rabbits.

6) Carcass cooling down to ambient temperatures (days later the "body" temperature will rise from bacterial and maggot metabolic heat). Temperature has been tried for PMI, but bodies cool, in a mostly variable pattern (based on body mass among other factors). I just learned that if you don't mind poking eyes with temperature probes apparently eye temperatures diminish linearly (stuff from another presentation I saw this morning from a Polish researcher). Interesting idea, but in US death investigations, you get in trouble for poking at the victims eye's – eye poking rights are reserved for pathologists and morgue technicians at autopsy [yep, they do poke eyes to extract fluid for drug screening, etc.] Every time I go to the doctor they take infrared ear temperature (non-invasive), so why hasn't anyone looked at that for estimating PMI? Good question.

This discussion brings me to the key point: if one day dead horses and cows have missing "internal organs, eyes, tongue, and sex organs", can these losses be from decomposition?

Ah ha, the pieces start to fall into place! Are your questions related to the "mutilated cow" stories (from the late 70s, or whenever). Mutilated cows in rural American! Evidence of juvenile delinquents run amok? Reemergence of the Thugee (after being exterminated throughout India over a 180 years ago by the British, who didn't regard randomly strangling people as a religious right even if it was a religious rite [I couldn't resist])? Sacrifices for evil rituals by covens of witches (wait, that's Massachusetts not Colorado) or by devil-worshiping Satanic sects (maybe a redundant phrase, I don't actually know if devil-worshipers are exclusive to Satan, or if worshipping Baal, Cthulhu, Kali, or Justin Beiber are also possibilities)? Or, and I think this was the favorite of the tabloids back in the day, aliens practicing their autopsy skills?

Ok, whatever the basis of your questions, the surprising answer to the decomposition in a day question is yes, natural decomposition causing organ loss in a day is possible. The secret decompositional ingredients I didn't mention are scavengers (specifically, vertebrate scavengers). We may not typically think of feeding by vultures, coyotes, hyenas, etc. as part of decomposition, they are decomposers because they feed on dead animals. In this case, vultures and coyotes are common throughout Colorado (as they are in Nebraska), and they certainly can get to a carcass shortly after death. The eyes are a favorite of vultures, and all scavengers go for an easy meal. So, if the tongue is swollen out of the mouth (as it can be after death) or if genitals are accessible, the scavenger doesn't have to tear through the hide to eat. If vultures or coyotes do tear open the torso, they will preferentially eat accessible organs, rather than tougher muscles.

As an example, on one of my Brazilian adventures (I teach and do cooperative research in Brazil) we came across a recently killed dog by the road. Naturally, we stopped, watched, and took stills and video. We knew it was recently killed because a vulture was pulling out its eyeball as we watched, and there was a pack of vultures around the carcass (hmm, is "pack" right? What about "flock", "covey", "murder" – no that's crows? I guess I don't know if there is a word meaning "a lot of ugly

looking vultures who smell worse than they look"). When we came back the next day, the body cavity was empty, and maggots were feeding on what was left. Superficially, it looked like the body had been there a week, but of course we knew otherwise.

It is possible to distinguish scavenger feeding from other mechanisms of tissue loss. Both birds and mammals will leave distinctive bites marks and, if you are lucky, distinctive marks on bones. With time and money, DNA from the scavenger (well, from scavenger spit) can be will be identified from the feeding site. From what I can tell, these determinations are very much the province of experts. I am aware of more than one homicide where the perpetrator was accused of "depravity" over makings on corpses, when the actual causes were feeding by vultures or crawfish. (The "depravity" issue involves post-mortem mutilations of a body, which in some U.S. states, is a requirement for the death penalty. Personally, I think murder alone is sufficiently depraved, but as I'm mostly a death penalty opponent perhaps I can't appreciate the more nuanced view.)

Let's get back to cattle mutilations. Is it reasonable to suppose that scavengers would reach carcasses so quickly and so rapidly consume body organs? To routinely arrive at carrion within a day of death I think is surprising, but to occasionally have scavengers reach a carcass in a day doesn't strike me as exceptional. Regarding the cattle mutilation reports, are all dead cattle being considered, or only those that have signs of "mutilation"? For instance, if the "mutilated" carcasses only represent 10% of dead animals, then the occurrence of scavenging within a day seems commonplace, compared to 100% of all dead animals being rapidly scavenged. But even if all carcasses are being "mutilated" in day, what (in the absence of direct evidence) is most likely? As I tell my students, I shave with Occam's razor, and mutilation by scavengers is vastly more likely than mutilation by cultists or extraterrestrials interested in bovine anatomy.

Before I close, I can offer my own take on alien activity in Colorado. Naturally, like all good Americans I know the government is out to get me (I think my taxes and lack of meaningful health care policy demonstrate that point), I know the government is composed of pathological liars (Iraq war anyone?), and the only reason I don't accept all Area 51 and JFK death conspiracy stories is that the repeated demonstrations of government incompetence convinces me that they could never keep a secret so long. So, I am prepared to believe (a la The X-Files), but I never found the mutilated

cow stuff very convincing. Now that I actually know something about decomp, I think scavengers make much more sense. On the other hand...

Phyllis (my beloved wife) and I were travelling all over Colorado on vacation many years ago (in the '80s), and we kept seeing single people (sometimes with a backpack or bag but often carrying nothing) literally in the middle of nowhere -- miles and miles from towns. Just walking along the road. At first we thought they were Soviet agents, airdropped away from civilization with orders to infiltrate decadent American society, but I argued that the Soviets couldn't secretly penetrate US airspace. Once Phyllis accepted my argument, the logical alternative (creatures who could secretly penetrate US airspace) was obvious: alien agents dropped by UFOs in isolated rural areas, with orders to open anal probing clinics or tattoo and body piercing parlors, while preparing for the invasion. To this day, Phyllis and I half expect to see tentacles appear when we drive by wanderers on lonely highways.