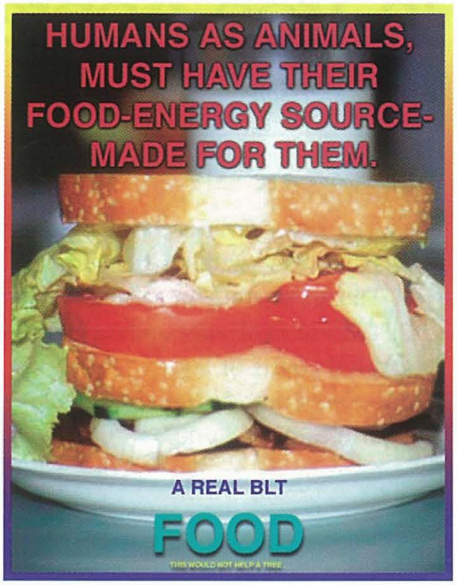
Trees & Humans

General Similarities, Specific Differences

By Dr. Alex L. Shigo

Believe it or not, most people, including some arborists and tree researchers, get trees and humans mixed up! Impossible, you say. Then why do so many specific human terms continue to be used for trees? Here I will try to discuss only a few of the major ones.



Living systems

Trees and humans are living systems. In general terms the systems are alike. Yet, in specific terms, they are very different. If this were not so, we would not have trees *and* humans, but only one type of living system.

Have you ever thought about why the term *species* is used for organisms? It is a term that indicates that groups of organisms having specific characteristics are similar enough to reproduce their own kind. No tree species will ever produce a human as a species.

Trees are *generating* systems. This means that as cells die, the dead cell parts, and cells, remain in place. As growth continues, new cells with new parts form in new spatial positions. Every leaf or needle that develops in the next growth period will be in a spatial position different from those that formed in previous growth periods.

Humans are *regenerating* systems. As cell death repeats, new cells and cell parts develop in the same spatial positions as those that died.

Cells only live so long, in trees and in humans. If you as a human live to be 70 or more, over 300 billion cell parts and cells will die. However, when new parts continue to replace the dead parts at the same rate, you will continue to stay alive. Further, when cell death exceeds development of new parts, or when new parts start to form faster than old parts are dying, problems will start.

It was a "brilliant move" of nature to find a way to connect living cells in ways that the complete organism could survive for long periods. Single-celled organisms live for a short time. Some reproduce every 20 minutes. The connection of many single cells had to be a great moment for life. In theory, trees as generating systems can continue to live forever. The same could be said for humans. Then why don't they?

Move

In humans, in time, a law of physics called friction begins to take its toll. Humans move. Anything that moves will eventually wear out. And, we do just that. We wear out.

Trees move as they sway, but they do not move from place to place. Yet, they still do not live forever either. Again, why? Do they "wear out?"

Trees must "obey" another law of physics called the mass-energy ratio. As the mass of any system increases, the amount of energy required to maintain order in the mass follows a parabolic curve. This means that as the tree increases in mass, the amount of energy increases and increases. Then, why don't trees die sooner than they do? Again, trees have "found ways" to "live" with physics.

Trees keep shedding parts that could take more energy than they give. Not a nice thought for us, but that's the way it is. When a branch no longer produces enough energy to supply roots, trunk, and itself, the branch dies. As trees age, the apical buds abort and side buds grow. This reduces mass, and the tree begins to have a flat top. Trees also reduce mass as protection wood forms and as infections are walled off.

One more very important action is that as more and more twigs and branches die, the tree "kicks in" its reserves – sprouts.

As trees get older and cannot move, they suffer more wounds. Trees cannot stop infections. Every wound will be infected; but again trees have "come up with" a way to deal with infections. Boundaries surround infected tissues. As new cells form in new positions, infected tissues are buried deeper and deeper in the tree.

Defense

Humans and trees are similar in that they both have genetically controlled ways to defend themselves in order to survive. Humans and other animals move as a first response to threats against their survival. Humans mount moving chemical substances that cluster about a wound, and the substances usually, but not always, prevent infections. Note the importance of movement. Humans move, and their first chemical defense processes have substances that move to the site of injury.

Trees sway but do not move away from their problems. Yet most trees far outlive humans. How do they do it?

Council Of Tree & Landscape Appraisers

Forensic Science in Tree Appraisal

By Russ Carlson

Forensics
Fo-ren-sics f-rnsks, -zks
NOUN: (used with a sing. verb)
1. The art or study of formal debate; argumentation.
2. The use of science and technology to investigate and establish facts in criminal or civil courts of law.
The American Heritage® Dictionary of the English Language, Fourth Edition, 2000.

Forensic science has been referred to as "the product of an uneasy and unholy mating of Science, the objective seeker of truth and knowledge, and Forensics, the argumentative persuader of courtroom advocacy." The full concept of forensic science is to take facts discovered by the application of science and apply them, in a courtroom or legal situation, to the process of proving a case.

When arborists are involved in litigation cases of any type, forensics comes into play. We serve the role of scientist, the investigator, seeking truth and knowledge. But we must also recognize the continuation of that role once we leave the field and the laboratory and walk into the courtroom.

Forensic science has become the realm of the detective shows on television. Here you can watch a criminal case unfold as clues are sought and discovered, and deductive logic leads through a series of theories and tests to establish facts. While the average tree appraisal case will not likely make it to "Court TV" or "CSI," the process of investigation is very much the same.

The common thread throughout any forensic investigation is the process of starting with limited facts, finding more information through observation and testing, and careful and logical analysis to establish the pattern of facts. In many cases information may be missing. Part of the investigator's assignment is to fill in the missing facts, not with guesses but with verifiable data. When information is missing, the arborist must seek that information, or find comparable information that can be reliably used in its stead.

One example of this would be the case of a tree already removed. The diameter at standard height can't be measured directly on that tree, but reliable comparisons can be made by measuring the stump diameters and standard height diameters of similar trees of the same species nearby, and applying that information to the stump measurement of the removed tree. Another example might be measuring and comparing photographs of the removed tree to estimate its size. Forensic science does not always entail new, expensive or cutting edge technology. Sometimes it is as simple as a tape measure. The key to successful application is to use logic and deductive reasoning, combined with a bit of insight and imagination, to find ways to discover and validate the facts.

The other part of forensic science in tree care occurs in the preparation of reports to communicate the findings of the arborist, and in the courtroom where the case is presented. This is where advocacy can sneak in if the appraiser isn't careful. It is too easy to fall prey to pressures to produce a desired result, or to take the client's side when the facts show otherwise. The appraiser must remain unbiased and impartial in determining values of plants and landscapes, as stated in the American Society of Consulting Arborists Standards of Professional Practice.

Forensics in arboriculture, and in tree appraisal, are not a special activity used only on special occasions or high-profile cases. Forensics are applied every time you conduct an investigation based on scientific fact and present those facts in a logical and coherent way.

Russ Carlson is a registered consulting arborist with Tree Tech Consulting in Bear, Del.

TCI

I believe that because they cannot move from place to place, individuals adapted or mutated to have superior defense processes. The boundaries surrounding infections are an example. The generating system is another example. And, consider the tough bark as a protection feature, and the anatomy or construction of a tree. There is more, much more.

Humans and trees are similar in that they are both made up of cells. A cell is the basic unit of life. Cells contain many working bodies within them. Each body is surrounded by a boundary that "gives" each body a chance to exercise its own activities. Again, these features are similar for trees and humans.

Humans have boundaries about their cells that are very flexible. The boundaries are called membranes. The membranes are made up of lipids mostly. Lipids are made up of carbon and hydrogen atoms that connect in long strands.

Trees also have cell boundaries. The boundary is made up of cellulose with some hemicelluloses, and the "magic natural cement" – lignin. Lignin gives the cells the strength to support themselves.

Humans require a bone skeleton to support their cells. Tree cells are self-supporting. The cell wall feature makes it possible for trees to grow upright over 100 meters. Some plants, such as brown algae, may grow longer but they do not support themselves.

Energy

Trees and humans must have an energy source. The laws of physics are there again for both. The 2nd law of thermodynamics states that no system will remain orderly unless it receives a continuous supply of energy. Trees and humans must obey the laws of physics, or else.

Humans must get their energy source prepared in compounds that can release glucose. The most common group of compounds are those made up of carbon, hydrogen and oxygen, known as carbohydrates. Carbohydrates are much more than CHO. The C, and H, and O must be connected in very special ways. Humans also take in compounds that contain CHO and N, or nitrogen. These compounds are called proteins.

Trees and humans are made up of four major types of compounds: carbohydrates, proteins, lipids, and nucleic acids. Nucleic acids are similar to proteins plus phosphate groups. The differences are that humans are proteins, mostly. Trees are carbohydrates, mostly.

Remember, it is not the atoms but how they are connected that counts. H, C, and N are important, but in some connected compounds (cyanide) they will kill you, and C,H,O (formaldehyde) will embalm you!

80 +/- 10

Trees and humans are very similar in general and specifics when it comes to another natural law; the law of 80 +/- 10. This means that 70 percent to 90 percent of individuals will be similar in their genetic make up. But, there will always be some extremes. Think of the bell-shaped curve. Most fit the middle, but some individuals will "hang" to the left and some to the right. This law seems to be one that favors life on earth. For example, if some abiotic or even biotic catastrophe strikes

the middle, or most of the individuals, the extremes from the left or right will reproduce. After this situation goes on several times, it will be difficult to identify those that were in the middle several rounds back.

Natural living systems have many safety features. Individuals have the capacity to adapt, and some individuals have mutant genes. Note: The aboriginal people in Australia call all other humans, mutants!

Some people say humans may kill all things on earth. This is the most arrogant statement I have ever heard. Humans may be able to kill and torture other humans (and other living things), but humans do not have the power to destroy life. That is not only silly, it is a stupid statement. Simply because it is repeated often does not make it so.

Trees and humans have genetic codes. Some codes may have slight differences that could be very important for survival.

When trees are planted in nurseries, they are treated as individuals, and when they are planted in an urban setting, again they are treated as individuals. When you treat a tree as an individual, you take away its group defense and group protection. Take the American elm, for example. The pathogens "helped" the species by "pruning" some trees from a thicket. However, when the trees were planted as individuals, and with asphalt or concrete at their bases, the trees' defense systems were destroyed. In time, some people will begin to understand. Maybe!

Pathogens: good or bad

Humans think of infection and pathogens as bad. Are they? When you think of individuals, the answer for pathogens is yes, they can be very bad. But, natural systems did not come as individuals, they came in groups. If every individual of a group stayed alive, there would soon be no space for anyone, and all would die. Use any word you like, but there must be some design or absolute force behind all of this.

Infection is a connecting process between two species, where substances move between the two. When one individual takes more than it gives, the taker will live and the giver will die. With plants, there are types of infections where both give and take at equal rates. This is called *mutualism*, a type of symbiosis, which means two species living together in harmony.

Another type of infection in trees and in many other plants is the infection of a fungus with a non-woody root. The result is a different structure that is an organ. The organs are called mycorrhizae. Here infection benefits both and the result is called *synergy*. Synergy is another way that many organisms work effectively with the laws of physics.

Pathogens are detrimental to individuals, but to groups they may be beneficial. I believe that humans have not been around long enough to really exist as individuals. Maybe in time the genetic codes will make it happen.

Heal and compartmentalize

Back to trees as generating systems and

humans as regenerating systems. When an individual human is injured and infected, processes start that may or may not lead to continual survival. Because humans are regenerating systems, they survive so long as injured and infected tissues are restored to their previous healthy state. This process is called healing.

Trees are not regenerating systems. They cannot restore injured and infected tissues to their previous healthy state because trees can only grow parts in new spatial places. Instead of healing, trees have boundaries, and the boundary forming process is called compartmentalization. The process has two parts:

1. Boundaries surrounding infections in tissues present at the time of infection – reaction zones;

2. Boundaries that separate the tissues present at the time of infection form new tissues that will continue to form during the present or next growing period. This boundary is the barrier zone.

I do not understand how a generating system can grow a regenerated root! When I hear a person say or write about regenerating roots, I know there is confusion.

Food and tubes

Trees "make" their food by a process called photosynthesis. Humans must get their food already made. This is very well understood. The part that is poorly understood is that humans absorb essential substances from the inside outward, while trees absorb from the outside inward.

Trees, and humans are really tubes. In humans, appendages called legs take the tube to food while other appendages called hands put the food into the tube. A brain tells the appendages where to go for food. I know it sounds silly, but think about it. Humans have two types of tubes. The main tube receives the food, and the smaller tubes move the food energy to the cells.

Trees also have two types of tubes. One group of tubes moves liquids with dissolved essentials from roots toward tips. (Never say up or down.) Other tubes move essentials from tips toward roots.

My main point here is that absorption in humans goes from the inside outward, while in trees absorption goes from the outside inward. With humans the absorbing boundaries are membranes made up of lipids, while with trees the absorbing boundaries can be cellulose as in root hairs, or boundaries containing chitin as with the hyphae in the fungi that form the organs called mycorrhizae.

Sex and compatibility

Sex is a morphological distinction between individuals of a species that produce haploid gametes of different types that can produce a diploid when connected. Compatibility is different in that there is no morphological distinction between the two haploid forming individuals.

You cannot draw A Human. We come in morphologically distinct pairs – males look different from females. With trees, you can have male and female parts in the same flower, or male flowers and female flowers on the same tree, or on separate trees.

The living and the dead

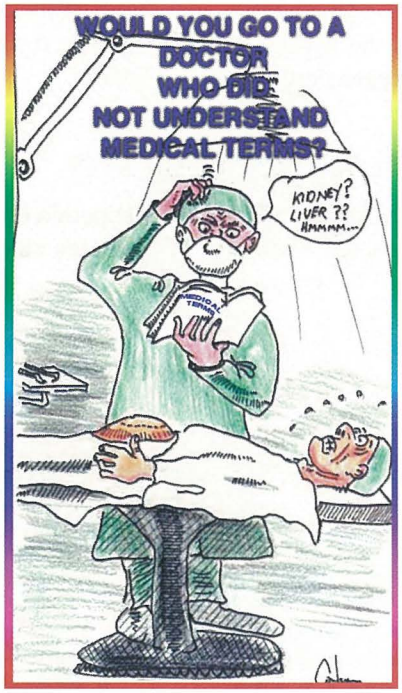
Humans are made up of living cells almost entirely. They are one big "symplast" with a small bone "apoplast."

Trees are made up of living, dying and dead cells. The cells have walls. Wood is a highly ordered arrangement of living, dying and dead cells with walls of cellulose, hemicellulose and lignin. Not only are trees unique in that wood has living, dying and dead cells, but in many cases the living cells maintain some control over the dead cells. The vessels function as transport tubes only after they die. The vessels are surrounded by living cells that squeeze or release the diameter of the vessels and in this way avoid embolisms, and maintain a steady flow. The fibers act as support features only after they die and they die as they use their cell contents to form a thick secondary wall.

Trees as a group of species are different in many ways from humans. Until correct terms are used for specifics, confusion will continue. TCI

Nutrients, Fertilizers and Foods

There is hope. Some good tree people are thinking. And angry!



Remember the song – "He is dan—ger—ous!"? People who think are dangerous. Even more dangerous are people who stimulate others to think. History tells us in gruesome terms what happened to people who stimulated others to think. Think about it: fire, crucifixion and torture.

The subject that is making some thinking arborists angry is the use of sloppy terms – especially when the terms are used by people who should know better. The usual response is that everybody uses the terms in that way.

The list of sloppy terms is very long. Here I will try, again, to clarify only a few: nutrient, fertilizer and food.

Please, do something Shigo

In one day I got four requests by mail and phone to please try to do something. As I said, I will try. No guarantees.

Humpty Dumpty said a word means only what

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he wants it to mean.

Socrates said; please just tell us what you want your words to mean.

Voltaire said, once we know what your words mean, arguments and confusion will cease.

Further, Socrates said, know the person by the words he uses. When you hear a person say "He don't" and "irregardless" it tells you something.

The problem

The problem is that many people really do not know the specific differences between plants and animals. Animal specifics are commonly used for plant specifics, and, believe it or not, some plant specifics are used for animals. Yes, in basic ways all living forms are similar. They all require energy, water, elements, and space. They all respond to threats against their survival. However, every living form is different in its specific ways.

Terms defined

Nutrients are substances that contain an energy source (hence just energy), elements, and other compounds in types and amounts that are essential for a healthy life. We speak about a nutritious food or meal.

Foods are substances that contain energy mostly, and in some cases elements. Foods may or may not contain other substances essential for life. (Think; if this were not so, why all the diet books about junk foods, fatty foods, and the "right foods?")

Fertilizers are substances that contain elements. The elements are in forms, usually salts, that ionize in water or require organisms to alter them to forms that be absorbed by trees.

Think! If you could really "feed" a tree with "plant food" you would almost put the sun out of business.

Good arborists do not use sloppy terms

A person who called said that he did ask an author why he used the terms nutrients and "tree food". The author answered, "everybody does it and I just wanted to be like everybody." I know that there are many people, myself included, that resent being put into the "everybody" class. To me it says that it is best to remain with the problem because everybody else has one. When you think about it, it should make you angry. It makes me very angry.

A thinking arborists asked me why are we told to "deep feed" and then told that all tree roots are shallow? He is dangerous.

From plants to animals

Here is an added note about fertilizers. Farmers knew that certain substances they put in soil stimulated plant growth. The plants were usually those used for food. Consider that it was not long ago when people really did not know where babies cam from (Don't laugh). The belief was that females were born with very small, incomplete forms. Further, when a male added some "magic" ingredients a form began to grow. The keyword here is grow. If certain substances stimulates plants to grow, then if some substances stimulates a baby to grow, then both substances must be a type of fertilizer. Right? So even today we say the male fertilizes the female and a new living form results. Here we have a plant term that has made its way into animal territory!

Sad ending

Let me end with a true story. After a long day on stage I shared a cab to the airport with another person. We talked, and he said his company had just lost a big case in court. A large manufacturing business wanted to give employees who could not speak much English a chance to learn English better on company-paid time. The workers said they didn't want to learn better English. The man in the cab said the workers agreed they were ignorant of proper English and they felt they had a right to stay that way. They won!

The theme repeats for balance of nature, heartrot, regenerating roots, healing wounds, root flares, callus, and many more. Get really angry. Let's stop the use of sloppy terms.

Dr. Alex L. Shigo is the owner of Shigo & Trees, Associates in Durham, N.H. TCI