Hypothetical Intelligent Plants, or, What Kind of Terminal Could a Tulip Use?

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Abstract

What would the dominant species of a world be like if it were a plant instead of an animal? Examining existing plants, we suggest a plausible intelligent plant. It is definitely *not* humanoid. Our intelligent plant is stationary, senses the environment mainly by smell, acts on the environment chemically, and lives hundreds of years.

We explore the plants' language and how they think of the universe. We speculate on how they could communicate and how they might dominate their environment. We end by describing what kind of computer terminal a sightless and limbless species could use.

1 Introduction

Science fiction has long speculated on the endless possibilities throughout the universe. In this paper we describe what an intelligent plant might be. To make our hypothetical species more believable, we take features from existing plants. For interest's sake, we emphasize those features which are unique to plants, rather than merely creating a "green animal."

Intelligent plants have been used in science fiction before, but were often just unusual animals. In 1954 J.R.R. Tolkein first published *The Lord of* *the Rings*, but he had finished it in 1948. In it wise, slow-moving trees, called Ents, appeared as minor characters. A few years before publication in 1951 *The Day of the Triffids* by John Wyndham told about experimental, moving plants which escaped and attacked people. Appendix A is a brief bibliography of intelligent plants in science fiction.

The intelligent plants here are *not* just animals evolved from plants. Instead we take the most obvious plant attributes, such as immobility, and theorize what they might be and their view of the universe. Sect. 2 describes what they are like and how they evolved. Sect. 3 discusses how they communicate and, from that, their view of the world. Finally in Sect. 4 we see what technology is to them and, more specifically, explore what kind of computer terminal an intelligent plant could use. Here then is the species we refer to as *Flora Famanidora* or loosely, "plants that chat using smells."

2 An Intelligent Plant

We first explain what senses our species has, what effectors ("output devices," in computer lingo) they have, then the nervous system and brain. We hope our evolutionary basis convinces you that this species is not altogether fantastic. Last we explain their physical structure.

2.1 Senses

One of the biggest impacts a plant has on the world around it is with chemicals or, more particularly, airborne chemicals or smells. We humans are profoundly moved by the scent of a pine forest, the tang of freshly-ground nutmeg, or the smell of lilacs after a rainstorm. There are reports that plants react to chemicals given off by neighboring plants, say, when they are attacked by insects. Thus smells are a good medium for plant communication: airborne chemicals are often used by plants, the plant doesn't need to use much material to make smells, and they may travel long distance.

Chemical communication may not be that far fetched. Losick and Kaiser [2] relate nontrivial "dialogs" among bacteria and between bacteria and plants. The signalling molecules belong to a group of chemicals called secondary metabolites which are not essential to cell maintenance and growth. They suggest that "the need for varied communiqués may well help explain why, over the aeons, bacteria have continued to make a vast array of seemingly expendable chemicals."

Some plants, such as the Venus Flytrap, are also slightly touch sensitive. Thus *Flora Famanidora* is able to sense some vibration or touch. These senses are limited in the plants, like our senses of taste and smell are poor compared with those of bloodhounds and sharks.

Most plants are "phototropic," that is, they follow light, so *Flora Famanidora* can sense light. However since they can't flee or pursue, they never evolved vision, which most animals use for hunting, watching for pedators, or finding mates or food. Their light sense is underdeveloped, like our sense of air pressure. Some people can sense a storm coming by feeling the effect of pressure changes on knee, hip, or shoulder joints.

2.2 Effectors

The main effectors or "output devices" are organs to synthesize chemical compounds. These chemosynthesizers combine simple molecules to create complex, tailored substances. Just as we learn to use our muscles for handwriting, speaking, or running, they learn to make chemicals. Some members of *Flora Famanidora* are good at making exotic compounds and inventing new molecules, like human dancers or athletes are good at using their muscles. Others are not.

These chemosynthesizers evolved to drive off or kill predators and to attract helpful creatures. Rather than making strong chemicals all the time, the chemosynthesizers became triggered by contact to save resources. However predators soon became immune to the chemicals. So in an evolutionary "arms race," these organs came to make hundreds of different substances, like the immune system of mammals reacts to thousands of different invaders.

2.3 Nervous System

The nervous system evolved from specialized transport cells. You may ask if anything in plants moves fast enough to be nerve cells. Although flowering hormones move at a maximum of about half a centimeter an hour, water movement in xylem is up to 4,360 cm/hr: more than a centimeter per second [4, page 103]. This is still slow compared with fast nerve fibers, which can conduct an impulse at 20 meters per second [5], but shows that fast enough mechanisms are only a few orders of magnitude away. In some plant structures (not the xylem), the cytoplasm, or "soup" within cells, circulates and chemicals are passed between cells [4, page 109]. This "cytoplasmic streaming" evolved into specialized nerve cells.

Without the ability of "flight or fight," few emotions evolved. The brain structures which deal with emotion, especially the amygdala, are underdeveloped or nonexistent. Having few emotions these plants seem very logical and almost fatalistic; rather like Star Trek Vulcans. Without a sense of boredom and having little need for novelty, they are quite determined and are willing to plan and carry out projects lasting years or even decades.

Why did a nervous system evolve in *Flora Famanidora* where it hasn't in any terrestrial plants? While the chemosynthesis organella were evolving, the nervous system evolved to quickly carry signals from senses. This let the plants trigger many chemosynthesizers when there is only a single, localized intrusion. The primitive nervous system further developed to refine reactions to sensations. Thus the scent of a predator is met with a pungent repellent, while the smell of a helpful species brings an attractive perfume.

With a sophisticated nervous system and chemosynthesizers, animals were controlled or influenced by attractive or offensive odors. In extreme cases, poisons were used. Other plant species were controlled by the equivalent of weed killers. Thus *Flora Famanidora* became the dominant species.

2.4 Brain

Having mastered the environment, these plants became long lived, like the California redwoods. Also like the redwoods, a single living root ball developed underground which lived far longer than the sprouting of above-ground leaves and blossoms. Within the bulbous underground case the brain developed, protected from heat and damage. It evolved to produce sophisticated reactions to attacks. As it grew more sophisticated, the brain could remember chemical formulas and invent new ones for novel situations.

2.5 Structure

The physical structure of a young plant is simple (Figure 1). The brain is in an underground, bulbous case. Above ground is a "bush" with spiny leaves, for passive protection, and sense and chemosynthesis organs on long, flexible stems. The sense organs are on long stems to catch the slightest breeze.

As the plant matures, it starts new "bushes" around its circumference, and the older bushes in the middle die. This is like an underground version of strawberry runners. With this spreading, a mature plant appears above ground as a roughly circular cluster of bushes (Figure 2).

3 Communication and World View

Communication between plants arose as new generations of plants noticed by chance chemicals drifting by which were used by successful, mature plants. In time this learning-by-observation became two way communication by scents floating on the breezes.

Because smells spread out and mix in the air, quick sequences of odors could get jumbled, so the number of smells-per-minute is limited. With the limit of speed the language instead grew in complexity. Complicated scents and scent groups represent words or entire concepts similar to Chinese ideographs. The syntax, or order of "words," has little meaning.

How then does *Flora Famanidora* view the world? Humans divide the world into things, corresponding to nouns, and actions, or verbs. Without much physical action or high-speed perception of the world, the plants have few verbs. These verbs are limited to simple concepts such as "To Be" (in a state), "Make" (something change), "Go," etc. Also they have little need for or concept of distance, being limited to "here," "close by," and "far away" or gone. What little they know about anything more than a few meters away comes through messages passed from one plant to another. They wouldn't know about distant events unless they "heard it through the grapevine."

Since communication is by smells wafted in the air, anything downwind is nearly invisible! Thus a good translation of "the hidden mysteries of my kingdom" (D&C 76:7) is "the downwind things close to God."

3.1 Crime, Punishment, and the Law

The concepts of laws, nations, crimes, and punishment are nearly unknown to the plants. Consider what little importance the United States Bill of Rights would have.

The right of assemble, Amendment I, is meaningless: these plants don't move. Without technology, there are no arms to keep and bear (II). However there *are* chemical formulas which are kept secrets. The third amendment, about quartering soldiers, is moot: there are no soldiers, that is, someone to send to fight for you, and no houses! The protections against illegal search and seizure (IV) also has little meaning without "houses, papers, and effects."

Crime means almost nothing. One plant might manage to murder its neighbor or pollute its neighborhood, but that is the extent. Certainly any punishment except excommunication is difficult to imagine, so amendments V, VI, and VII have little meaning. The eighth amendment, about bail, fines, and "cruel and unusual punishments," fares no better. How would one plant put another plant in prison? Without assemble, police, soldiers, or conventional arms, there isn't much power that would need to be restricted as in the ninth and tenth amendments.

Although plants could certainly declare their allegiance to some group based on beliefs or interests, the notions of physical groups, such as states, borders, and nations, are quite strange. Perhaps one group could systematically kill adjoining members and colonize the area, but to what end?

3.2 Descriptions

Intelligent beings finely distinguish things in the world which are important to them, and gloss over distinctions which are not. Thus most Americans know many words for cars, vans, trucks, etc.; horsebreeders have various names for breeds, sizes, and ages of horses, and printers have many different names for different fonts[3]. Similarly *Flora Famanidora* have many words for smells, odors, scents, perfumes, chemical make ups, and the like. In fact, the "words" for smells can be, and often are, the smells themselves.

With such elaborate descriptions, the arts are highly developed. An aromal joke is a juxtaposition of unusual scents. Puns are a series of smells indicating a story with one or more of the smells being ambiguous. A symphony is a series of perfumes, and a complex scent sequence is analogous to a dance. A human potpourri is a "sculpture" to them: a long lasting, static, aesthetic construct.

4 The Mechano-floral Interface

We've seen how *Flora Famanidora* communicate and what they talk about. To address the title of this paper, how can they use machines? The first communication device among the plants released a single odor for each impulse, like the first telegraphs used a simple click.

The next invention was a more sophisticated output mechanism. This produced many different odors. The different smells had to be triggered separately, leading to something which served as both typewriter and sculpture: the "stinkjet" printer. Then some floral genius worked on sensors to directly detect the different smells a plant produced. Combining this wide-spectrum sensor on one end with the versatile printer on the other end, this green Alexander Graham Bell invented the first "smellephone."

4.1 I Heard it through the Grapevine?

If the plants can't move, how are communication lines from plant to plant built? Some components are grown, but the connections are fashioned another way. The plants learned to breed or bioengineer colonies of bacteria and ants for the purpose. The bacteria, for instance, lay communication lines as they move toward a particular smell given off by the destination plant.

These communication lines are faster and more efficient than just passing information from plant to plant and hoping the wind is with you. With these lines a plant can communicate with distant plants, say to ask an expert for a new compound, even on calm days.

4.2 Building a Terminal

Finally to answer our original question, Figure 3 shows a useful terminal. Since a plant moves very slowly, it cannot reasonably turn around to see a screen and put its hands on a keyboard. On the other hand, it has many "noses" and chemosynthesis organs, so it devotes at least one pair to the terminal. The figure has a cut-away section showing two chemosynthesizers in a pair of input units or sensors (like hands on a keyboard), and a "nose" stuck in an output unit (like a display screen), which is capable of a rich bouquet of smells.

5 Conclusions

A floral intelligence would likely have a very different view of the world, and an extraordinary structure. The interfaces which we expect in our computers, like color monitors, a mouse, keyboard, and speakers, are bizarre to *Flora Famanidora* . But they could still plug in, and after all, on the Internet, nobody knows you're a plant.

References

[1] Theodore Delevoryas, *Plant Diversification*, Holt, Rinehart and Wilson, New York, 1977.

[2] Richard Losick and Dale Kaiser, WHY AND HOW BACTERIA COMMUNICATE in *Scientific American*, 276(2): 68–73; February 1997.

[3] Geoffrey K. Pullum, *The Great Eskimo Vocabulary Hoax*, The University of Chicago Press, Chicago, Illinois 60637, 1991; page 165.

[4] Frank B. Salisbury and Robert V. Parke, *Vascular Plants: Form and Function*, Waadsworth Publishing Company, Inc., Blemont, CA, 1964.

[5] Monica Tuttle, *PAIN - Of The Phantom Limb*, http://www.macalester.edu/~psych/whathap/diaries/diariess96/Monica/phantompain.html, accessed 28 Feb 1997.

[6] Charles Morrow Wilson, *Roots: Miracles Below*, Doubleday & Company, Inc., Garden City, NY, 1968.

[7] *Antiviral Proteins in Higher Plants*, CRC Press, Boca Raton, 1995.

A Intelligent Plants in Science Fiction

Jack L. Chalker, *Midnight at the Well of Souls*, Ballantine Books, 1989.
One of the main races is the Czillian (page 77, etc.) which are a plant race, but with typical animal senses. They reproduce by fission, and the dual brains are in their feet. They feed and drink via foot rootlets. It also mentions

the Slelcronian (page 249, etc.) which are flowers with a brain in the root, but no senses. Subservient bees sense the environment and carry or share the collective memory/mind. They/it have a single collective experience – no real individual identity since there are no unshared experiences.

Gordon R. Dickson, *Flat Tiger*, in Guided Tour, a TOR Book, Tom Doherty Associates, New York. First published 1956 by Galaxy Publishing.

While describing why intelligent creatures should only eat energy, an amiable alien says (page 205), "I hate to think what a Snurlop would say if he happened to see a loaf of your bread and imagined a child of his own being harvested, threshed, ground and even *baked*!"

Robert L. Forward, Martha Dodson Forward, and Margaret Dodson, *Marooned on Eden*, Baen Books, 1993.

The dominant species is a slow moving tree. Symbiotic birds are flying eyes. Simian creatures are the hands to bring food to mouth.

Murray Leinster, *Proxima Centauri*, in Before the Golden Age, edited by Isaac Asimov, Doubleday & Co., New York, 1974, pages 606–648. First published 1935.

The major race, Centaurians, evolved from plants. They value any animal product above gold. Structures (even spaceships) are grown, not built.

Little Shop of Horrors, movie in 1960, made into a musical play, then into another movie in 1986.

A weird bulb grows into a flower which brings fame to an obscure florist clerk. As it grows, it develops intelligence, tentacles, and a taste for people.

J. R. R. Tolkein, *The Two Towers*, Houghton Mifflin, 1987, (III):4, pages 75–81.

The Ents are a race of old, wise, very slow moving, tree-like creatures.

A. E. van Vogt, *Process*, The Magazine of Fantasy and Science Fiction, December 1950, pages 565–571.

A world is coverd by a few enormous, sentient forest/trees fighting each other for land. They discover how to make atomic explosions by piling enough radioactive material together. The ensuing nuclear war reduces them to near nonsentience, only remembering that radioactives can be useful.

John Wyndham, *The Day of the Triffids*, book, 1951, movie, 1962.

A meteor shower produces a glow that blinds most of the population. This chaos results in the escape of some Triffids: experimental plants that can move and attack people. (Summary adapted from Murray Chapman muzzle@cs.uq.oz.au)