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The Buzz on Bees

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Apis mellifera, more commonly known as the honeybee, plays a truly vital role in the ecosystem and in the survival of the planet Earth. Unbeknownst to most, honeybees do not merely provide sweets, like the delicious honey used in the typical American breakfast, but offer a wide array of products and services essential to life and have done so for thousands of years.

Alarmingly, honeybees have become endangered at a time when their presence is vital, and as scientists realize that they have the potential to provide sustainable alternatives in a myriad of areas. Honeybees may be the key to a more sustainable future for our planet and every effort must be made to ensure their survival.

A voluminous amount of literature has been dedicated to the tiny *Apis mellifera*. It is known that life on Earth would change radically if honeybees were to disappear. This paper will deal with the role of honeybees as: pivotal assets to medical advances, as essential participants in global economics, and as the key to the development of more eco-friendly and sustainable products.

According to scientists, bees lived in 100,000,000 B.C. during the age of the dinosaurs. Their presence has been recorded throughout history and there is evidence indicating their importance in most cultures. There are cave paintings dating back to 6,000 B.C. “that clearly depict humans robbing bee hives of honey” (Berenbaum). It is believed that ancient Egyptians were the first organized beekeepers and evidence indicates that they kept honeybees in clay mud hives. The ancient Greeks studied new ways of raising bees and Romans are known to have used melted beeswax in order to paint pictures. From the 5th to 15th century, known as the Middle Ages, beekeepers started using straw masks and hoods to be protected from bee stings. Later, pilgrims brought the first honeybees to America and there were honeybees in California by 1820. As far as bees have come, so have the ways in which humans have learned to adapt to them and

the ways in which we have learned to utilize their invaluable resources. Since ancient times, the honeybee has been a vital factor in human and animal food production and, in order to clearly appreciate their importance, one must understand the process known as pollination.

Pollination, which can be defined as “the vital method of sexual reproduction in plants, involves the transfer of pollen₂ from the male part of a plant (in flowers, this is the ‘stamen’) to the female part of the plant (the ‘carpel’) (“The Plant Pollination Process”). “It [pollination] enables a plant to bear fruit and seeds, many of which are not only eaten by humans, but also by other living species from birds to mammals” (“The Plant Pollination Process”). Eventually, birds and mammals distribute the seeds of the fruit-bearing plants through their droppings and the process starts all over again. Pollination is so vitally important because, without it, many plants would not come to bear fruit. In fact, one-third of the food humans consume depends on pollination.

To state the obvious, the honeybee has produced honey for thousands of years and humans have learned to utilize this product in many different ways. In order to produce honey, the bees collect sugar-rich nectar from flowers, “which is a clear liquid consisting of nearly 80% water and complex sugars” (Ediriweera). Once back at their hives, the bees regurgitate the nectar from their ‘honey stomachs’ until it is partially digested. “They continue this process until the product reaches desired quality” (Ediriweera). After the final regurgitation, the honeycomb is left unsealed and the raw honey is stored there so that the cells will dry. This process is quickened by the bees fanning their wings (up to 26,400 times a minute). Once the honeycomb has dried it is sealed with wax in order to preserve the newly made honey. Honey production, collection and distribution represent an enormous industry. “The price of honey in the US is rising more than 6% annually, and the market globally is expected to hit \$12 billion by 2015” (Kalan). Beekeeping

sustains the livelihoods of over 200,000 people in the U.S. alone. One can deduce the pivotal importance honey has on the global market. As a billion dollar global industry, it provides employment to millions and provides billions of pounds of honey worldwide. These are used for medical advances, and product sale in the traditional food, cosmetic, and environmental industries.

Many pollinator species (honey bees, bumblebees, butterflies, humming birds, moths, and flies) are in decline all around the world. In the case of bees, “the first well publicized indication of this was the Colony Collapse Disorder, which made world-wide headlines in 2006 when the populations of tens of thousands of honey bee colonies "disappeared" in the matter of months” (“Midwestpollinatorconservation.org”). What is so astonishing is that beekeepers during this time went out to the beehives and, not only did they find that their bees were dead, but some of their hives were simply vacant. The bees would be in their hives one day and gone the next, never to be seen again. Beekeepers from around the globe, with both big and small beekeeping companies, were tremendously impacted by the mass decline in bee population and, hence, bee productivity. A family business in western New York owned and operated by Jim Doan, “has experienced repeated losses, his bees growing sick and dying” (The Plight of the Honeybee). In order to “replace lost hives, Doan needs to buy new queens and split his remaining colonies, which reduces honey production and puts more pressure on his few remaining healthy bees” (The Plight of the Honeybee). Eventually it all became unsustainable and Doan ended up having to sell his 122 acres and start saving for retirement. He also plans to sell all of his beekeeping equipment assuming someone is willing to buy it. Doan’s options are now extremely limited, one being to work at his local Walmart. Since the abrupt loss of bees occurred, scientists have been determined to discover the truth behind their disappearance. This is because the

disappearing of honeybees has a major dramatic effect on pollination and will affect the other processes that filter from it, mainly food production worldwide.

Today, biologists are still puzzled as to why 70% of the honey bee population has decreased in recent years. They have termed the problem “colony collapse disorder” or CCD. However, they suspect that there are 3 main culprits linked to the bees’ disappearance. The first are the chemicals used on crops, including pesticides and herbicides. Honeybees ingest these chemicals on their daily pollination rounds and die within 2-3 days. According to environmental journalist, James Harris, “commercial beehives are also subjected to direct chemical fumigation at regular intervals to ward off destructive mites” (“Why Are the Honeybees Disappearing?”). Genetically modified crops are said to be to blame because they may generate pollen with compromised nutritional value. Also, the development of synthetic chemicals and genetically modified crop pollen has reached a point where bee populations literally become too stressed and, therefore, collapse. The second suspect in the decline is radiation. Bee population may be decreasing because of the recent increase in atmospheric electromagnetic radiation. It is thought that the increasing radiation given off by communication towers throws off bees’ navigation abilities. It’s hard to believe that the growing numbers of cell phones and wireless communications could have an effect on natural ecosystems; however, the evidence is overwhelmingly abundant. A study conducted by Germany’s Landau University found that “bees would not return to their hives when mobile phones were placed nearby” (“Why Are the Honeybees Disappearing?”). More studies are currently underway in the U.S in order to determine the effects of radiation on other insect populations. The final suspected problem is global warming and it may play a large role in the bees’ disappearance. Higher temperatures may be exponentially increasing the growth rates of pathogens such as the mites, viruses and fungi that are known to take their toll on bee colonies. “The unusual hot-and-cold

winter weather fluctuations in recent years, also blamed on global warming, may also be wreaking havoc on bee populations accustomed to more consistent seasonal weather pattern” (Why Are Honeybees Disappearing?). The leading bee experts have not come up with a general consensus, however, they do agree that combinations of these three factors are the most probable components causing CCD. One thing that is certain is that funding must be put into researching the problem. The federal government estimates allocating around 80 million dollars to the project. Clearly, a definite threat has been presented to the bees and the problem needs to be resolved as today, more than ever, honeybees have the ability to create a more sustainable future. Consequently every effort must be made to save these magnificently complex and vital creatures.

Bees have been used for natural remedies throughout history. Apitherapy is the ancient art and use of bee products medicinally. It is documented that humans have been practicing apitherapy since 7,000 B.C. “In fact, a Sumerian tablet, possibly dated 3,000 B.C., prescribes honey to treat an infected skin ulcer. Muhammad, the Muslim prophet, recommended honey to treat diarrhea, and the Koran mentions the curative properties of honey” (“The Honorable Honeybee and Her Helpful Products”). “Bee venom has increasingly been used as medicine to treat a variety of illnesses, including multiple sclerosis (MS), arthritis, fibromyalgia, and tendonitis” (“Venom from Bee Stings Used to Relieve Arthritis and Multiple Sclerosis”). In 12 European countries, bee venom solution, or BVS, is categorized as a drug and can be seen in everything from salves, liniments, creams, and injectibles. Some ailments that bee venom has been known to treat include poison ivy, cystitis, urticaria, eczema, herpes, and meningitis. Another product the bee offers is known as royal jelly. Royal jelly is a secretion from the hypopharyngeal gland in the head of the nurse bee and it is believed to improve the health of the skin, heal wounds, and may stave off skin aging and wrinkles. It also has potential to be an anti-

cancer and anti-tumor agent as it has the power to stimulate the production of spleen and lymph cells, which, in turn, make more antibodies that fight the spread of disease. Finally, there is Apis, a BVS, which is used in acute illnesses, such as colds and flu to help lower fevers. As previously stated, bee venom solution has been used to treat MS since the 1980s. There have been numerous studies, including one in Thessaloniki, Greece, reporting that the venom therapy reduces inflammation of an arthritis-like disease found in rats. The study showed that the bee venom slowed down the production of the compound that causes arthritis pain, called interleukin-1. Another study in South Korea revealed that a compound called melittin, found in bee venom, blocks the inflammation that causes arthritic pain. Honey has also been sought out to help patients suffering from diabetes mellitus. "Bee's honey is beneficial for diabetic patients in two ways. One is; honey being three times sweeter than sugar, one may need a much smaller quantity of honey as a sweetener and honey contains lesser calories than sugar" (Ediriweera). The other benefit is that it provides vitamins B₂, B₄, B₅, B₆, B₁₁ and vitamin C, and minerals like calcium, iron, zinc, potassium, phosphorous, magnesium, selenium, chromium and manganese. Another astounding product provided by the honeybee is termed propolis. "Propolis, often called bee glue, is a resin collected by the bees from trees" ("The Honorable Honeybee and Her Helpful Products"). The bees use propolis to glue holes in their hives. In humans they can be used for medical purposes. "Propolis offers antiseptic, antibiotic, antibacterial, antifungal, and even antiviral properties. It is the strongest antibiotic known to man. It has no toxic side effects, no contraindications, nor upper limits of ingestion" ("The Honorable Honeybee and Her Helpful Products"). For this reason, it can be mixed with grain alcohol and used to make a tincture that treats minor cuts, abrasions and rashes. As one can see, bee venom has many medical benefits, one of which is a more natural solution to arthritis treatment, diabetes and skin conditions. Bee venom has become an invaluable

tool in medical research, advances, and treatments, and discoveries such as these can continue if there is more economic support for such research. Economics play a primary role in this field and, in turn, the research of the utilization of bees aids in providing a solid economic backbone for several parts of the world.

Honeybees carry tremendous economic pressure on their small backs. Many do not realize the vast economic importance of bees; without them life would cease all around the world. Albert Einstein is believed to have said "if the bee disappeared off the surface of the globe then man would only have four years of life left. No more bees, no more pollination, no more plants, no more animals, no more man" ("The Plight of the Honeybee"). The decreasing number of bees does not only pose a threat for conversationalists, but for the whole agricultural economy of the planet. Fewer bees translate to less honey and fewer plants that undergo pollination. If the trend continues, food industries will be forced to raise prices, possibly to the highest they've ever been. A perfect example of how much we rely on bees for food comes from TIME Magazine. This past June, a Whole Foods store in Rhode Island removed all of its products that relied on bee pollination. Of 453 items, 237 were gone. Some of the products included apples, lemons, zucchini and other kind of squash. One product in particular, the almond, relies solely on bee pollination. "There were just barely enough viable honeybees in the U.S to service this spring's vital almond pollination in California, putting a product worth nearly \$4 billion at risk" ("The Plight of the Honeybee"). Due to disease and fluctuations in weather, bees have dramatically decreased in number, almost doubling the cost of some honeys. Last year, about "one-third of U.S honeybee colonies died or disappeared during the past winter, a 42% increase over the 10% to 15% losses beekeepers used to experience in normal winters" ("The Plight of the Honeybee").

Across the Atlantic, a similar problem persists and in 2007, the United Kingdom National Audit Office decided to investigate the economic impact of bees. “The value of the bees’ services was estimated at £200m a year. According to Simon Potts, head of pollination research at Reading University, if we had a serious loss of honeybees in the UK, then inevitably food prices would have to increase” (“The Economic Value of Honeybees”), and in most cases the price would double. The reasoning behind this is that fruit and vegetables, normally pollinated by bees, would have to be imported from other countries. The alternative would be that the UK switches its diet from fruits and vegetables to more grains and starches. Other countries have also become aware of the unfortunate consequences surrounding the decline in honeybee populations. For example, China is already looking into solutions should the bee populations continue to decline. In areas where bees are already extinct, people are being employed to go around with feather dusters, brushing the insides of plants with pollen. Reading University is currently researching the feasibility and cost; if people were to hand pollinate plants for minimum wage. It is estimated that, once again, the price would nearly double. However, if one considers the number of bees that pollinate at half a million per day, it is clearly not a realistic solution to the problem.

A problem that faces the U.S agricultural economy is the variety of mites that kill bees and lower their numbers each year. Two kinds of mites, tracheal and varroa, were accidentally introduced into the U.S in 1984 and 1987, respectively, and most likely brought from South America. “Mature varroa females feed on hemolymph, the bees' blood. The mites also carry viruses and actively inhibit the hosts' immune responses” (Honeybee Colony Collapse Disorder | Pesticides | US EPA). Beekeepers have since then struggled to deal with the mites, either infesting the hives or killing the bees. The cost of treating said infestation can reach around 20% of the produced honey value. According to TIME magazine, bee pollination is worth \$15 billion to the

U.S. farming industry and \$215 billion worldwide. The decline in honeybees populations will also affect the beef and dairy industries by reducing pollination of clover and other hay and forage crops. Similarly to Britain's predicament, the U.S would have to import fruits, vegetables and nuts from other countries overseas where colony collapse syndrome does not exist.

Bees have become a distinguished part of the environmental movement. Honeybees are essential to many eco-friendly product lines and industries. The idea of being green can be seen as a marketing tool to seem more sustainable; however, when the correct efforts are implemented, true sustainable practices are being led by a number of companies and bees play a huge role in the success of such companies. One in particular is the well known franchise, Burt's Bees. Burt Shavitz, the co-founder of Burt's Bees, was a beekeeper and it was his bees that made the wax in Burt's Bees first Beeswax Lip Balm. Bees are not only a part of Burt's Bees past, but the foundation for its existence.

Burt's Bees is one of many companies that claim to be environmentally-friendly. The requirements to be considered environmentally-conscience differ from person to person and, therefore, there is no set definition. However, one thing is certain; that these companies aim to be or appear as natural as possible. Honeybees pollinate millions of plants per year around the world; plants that are eventually used in the green product industry. The green product industry includes natural and/or organic food and beverage products, healthy and wellness products, personal care products and finally, sustainable products. Honeybees have a direct impact on the natural food industry because they provide pollination for the plants that go into natural diet supplements and, not to mention, honey that is used in numerous foods products, personal care and beauty products. Statistics point to the growth and desire for natural products meaning pollinating bees are crucial to the green industry's prosperity. The organic food and beverage

industry had an 85% growth rate between the years 2005-2009. In the U.S, sales of organic food and beverages have grown from \$1 billion in 1990 to 24.8 billion in 2009. A recent UNFI (United Natural Foods Incorporated) survey stated that 65% of consumers express a desire for organic or natural foods. Non-consumable natural products also seem to appeal to consumers. In 2009, these products topped \$56.7 million, a 9.7% annual growth. Economists have estimated that the overall growth of non-food natural products will average just over 12% in 2014. In general, four in ten consumers “recently tried a new brand or switched brands, specifically because the new brand had more earth friendly packaging” (“pcgadvisors.com/marketstatistics”). A significant number of consumers have become environmentally aware in recent years and with this demand for eco-friendly products comes a higher need for natural ingredients. Honeybees will be an imperative component to the growth and success of all-natural based businesses.

In correspondence with the arising consumer industry awareness, the federal government has taken steps to better understand the drivers behind honeybee loss. The loss of honeybees will decline the sustainable advances that are currently being made. That being said, the loss of honeybee populations is not only an extremely worrisome issue for beekeepers, but federal governments as well. The U.S. Department of Agriculture (USDA) is leading the federal government response to CCD (colony collapse syndrome). In 2007, USDA established a CCD Steering Committee with representatives from other government agencies. One of the leading groups is the EPA, an active participant in the CCD Steering Committee. This committee has developed the Colony Collapse Disorder Action Plan which consists of four main components. The first is survey/data collection in order to determine the extent of CCD and the current status of honeybee colony production and health. The second goal is to analyze bee samples to determine the prevalence of various pests and pathogens, bee immunity and stress, and exposure

to pesticides. The plan addresses hypothesis-driven research on four candidate factors including new and reemerging pathogens, bee pests, environmental and nutritional stresses, and pesticides; and finally, it plans to instill preventive measures to improve bee health and habitat and to counter mortality factors. In 2010, The Apiary Inspectors of America took their annual spring survey in order to determine winter colony loss, and it was expected to be higher than the previous year, maybe even higher than the worst year's results of 35%. Since then, the USDA has set up four permanent labs charged with studying the honeybee. One of these labs is located near DC in Beltsville, Maryland. Another lab is located in Baton Rouge, Louisiana, and one in Weslaco, Texas. The last one is in Tucson, Arizona. The labs work in a collaborative effort; however, they conduct research more specialized to the skills of each individual scientific team. The U.S Congress decided to fund CCD research shortly after the phenomena presented a threat. In particular, Congress funds the AreaWide Project to Improve Honey Bee Health. The goals for this project include increasing colony strength for pollination of almonds and subsequent crops; demonstrating that resistant bee stocks reduce operating costs and increase survival; demonstrating improved parasitic mite control with proper timing of application; improving the content and delivery methods for carbohydrate and protein diets; and finally, improving the integrated use of controls for pests and diseases including non-chemical beekeeping methodology.

In order to accomplish these defined goals, each of the labs has undertaken a somewhat specific task. For example, the Baton Rouge lab focuses on bee stock improvement. They are doing this by using genetic selection and colony size. The scientists are also looking at the two USDA developed honeybee stocks; the Russian honeybees and the varroa sensitivity hygiene trait (VSH) bees. The lab in Beltsville aims to improve queen longevity, *Nosema* controls, and

nonchemical varroa limiters, such as plastic drone comb and screen bottom boards. They also hope to identify stressors associated with migratory beekeeping. The Tucson lab aims to modify a relatively new product called Megabee, a pollen substitute for the honeybees. The lab is also studying the miticidal properties of a naturally occurring hive product called 2-heptanone. The Weslaco lab's tasks include working on improved "management techniques for varroa including the miticide Hivastan, along with new controls for *Nosema*, stock improvements with Africanized bees, and mitigating stress associated with migratory beekeeping" ("What's Being Done to Study Honey Bee Health"). As can be seen, top notch scientists are being appointed to discover the truth behind CCD. The real question is whether or not they will be able to find a solution in time.

Honeybees have sustained themselves for hundreds of thousands of years. With the help of innovation and technological progress, they can be an answer to sustainability today. These tiny, yet sophisticated, creatures have proven to advance knowledge in the medical field where they can offer natural remedies in place of man-made chemical medicines. They also work free of charge in a multi-million dollar industry; the global food industry. Finally, bees are the key to the production of numerous eco-friendly products that have, as of late, skyrocketed in customer demand. Millions of dollars are going into bee research to discover why they are disappearing ("Why Are Honeybees Disappearing?") "The loss of the honeybees would leave the planet poorer and hungrier, but what's really scary is the fear that bees may be a sign of what's to come, a symbol that something is deeply wrong with the world around us" ("The Plight of the Honeybee"). With hope and science, this creature will be saved and, in turn, save the world from spiraling into mass economic chaos and, instead, bring a new level of sustainability to the front.

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