Entomology in the Fine Arts: A Voice for the Little Guys

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About the Author

My name is Puttichai Kupadakvinij. I have a degree in studio art and art history with a minor in ecology and evolutionary biology. After graduating from University of Colorado Boulder I plan to pursue a career in entomology. Ever since I found my passion for insects, I have been honing my understanding in entomology in order to promote environmental sustainability through entomology research and art.

Abstract

Insects are vital to an ecosystem. They pollinate fruit blossoms and vegetables; insects feed on an endless range of food, which helps an ecosystem with decomposition; some insects are even used as a form of pest-control. Unfortunately many people tend to overlook the importance of insects and the study of entomology. In this paper each section will introduce reader to the insect(s) involved in each artwork; the end will discuss how my artwork reflects the research of the insect, thus giving the readers a new understanding of the insect involved. My five projects used the intersection of art and entomology to present issues of habitat-loss, and to introduce to viewers a new perspective on and hopefully an appreciation of insects.

Keywords: Pest-control, entomology, insects, habitat-loss, pollution, art

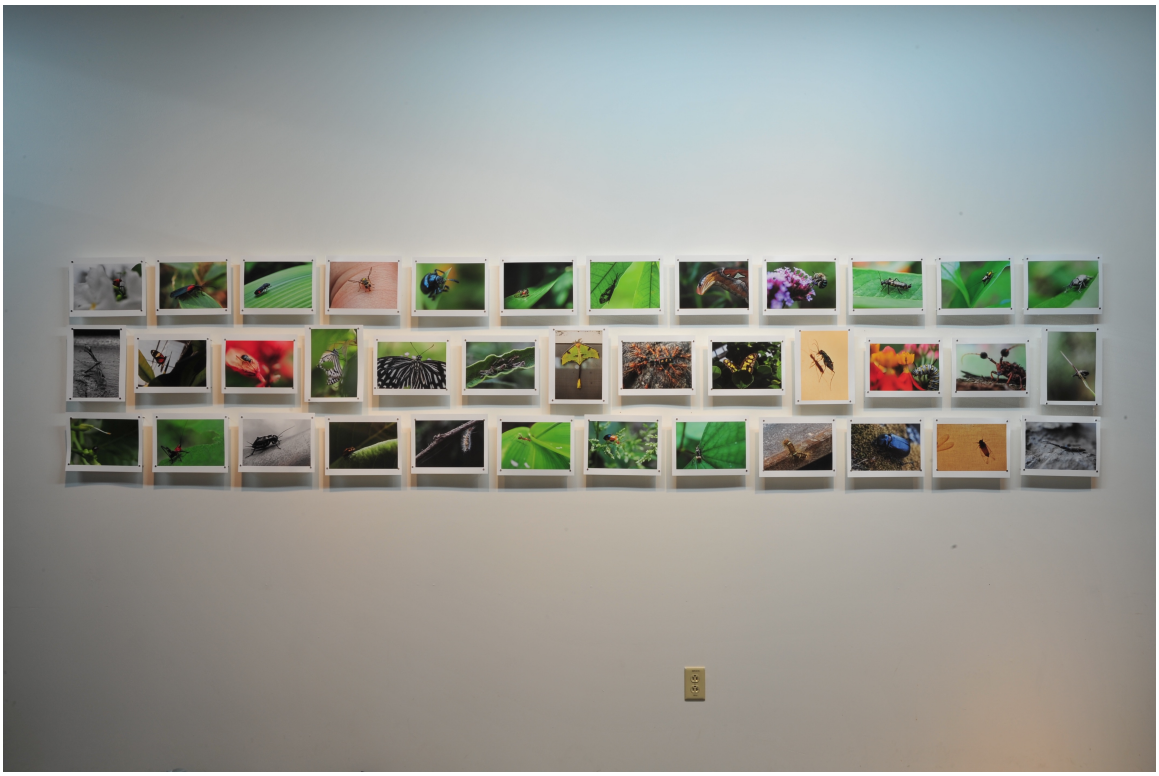
Take a Closer Look

Before I found my passion for photography and biology, I had a fascination with insects. I was captivated by the idea that a creature so small could have such complex details and textures to their form. I would draw them up to my face to take a closer look, but when I held one up to my friends they'd walk away after noticing a tiny dot crawling in their peripheral vision. It is rare to see someone take his or her time to closely observe a something so minuscule let alone an insect. I believe that photography can change the stigma people have of insects.

Photography in science has brought about numerous discoveries. It is the extension of the human eye that enables us to see far beyond earth's atmosphere and allows us to enlarge our view of microscopic organisms. With the invention of fixed images, which helped to endorse the flow of knowledge, we are able to absorb visual information from all around the world, and soon the things that seem unfamiliar to us become familiar. Insects are small and thus are unfamiliar to many humans. The only interaction a person might have with an insect is when they become a pest in someone's home, yard or farm. If people were asked what they thought of insects, many would say that insects are no more than what they have experienced: pests. With these ideas in mind, I began my first piece titled, *Take a Closer Look*.

Over the past summer (2017) I traveled to Thailand and Peru where I began a photography project to document the insects I encountered. With a camera and a background in entomology, I was able to closely observe and study the insects I once looked at with my naked eye. The goal for this project is to introduce insects the way I see them, as intricate and remarkable organisms. When installing, I used leading lines to

order the images in order to create a flow for viewers to follow. All of the insects are facing toward the center, where I placed my best work. The large prints allow viewers to take a closer look at an insect's form without having to be around the insect itself. By creating the separation between people from actual insects and replacing them with well-composed images, this project can help people positively reconfigure their image of insects.



*Take a Closer Look***,** 2017. Inkjet prints on glossy paper.

Hemiptera

Insects are extremely diverse; out of all 1,032,000 described species of animals on earth 751,000 species belong to insects, which is around 72.8% of the total animal species.[1] The reason for their diversity is because of their ability to fly and their fast rate of reproduction. Flight gives an insect the ability to travel long distances, and with the combination fast reproduction they are able to expand in a large radius. Fast reproduction also helps with an increased rate of mutations; this means that insects are able to evolve and adapt to different habitats, which brings about their great diversity in form. However, due to their ability to adapt with ease, they are seen as a problem through the human eye.

The term *pest* is a label we put on animals that interfere with human activities, but we tend to forget that these other animals have no other choice but to adapt to their changing environment as we have. There is a constant tension between humans and nature, which forces people to tag the undesired organisms as threatening or obnoxious. Rather than seeing pests as simply unpleasant, we should acknowledge their remarkable evolutionary development and their potential in scientific research and development.

I chose a specific group of insects called *Hemiptera* to study and base my eight illustrations on because of their diversity and reputation. They are known to be one of the worst agricultural pests; but despite their status, they are considered a hyperdiverse group of insects, with a vast collection of characteristics. Among Hemipterans there are certain families that are seen as pests, but can contribute to pest-control and environmental research. The focus for my next work is to compare the different groups of Hemipterans and hopefully bring a better understand and familiarity with this diverse group.

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[1] Sabura S. Mohamed Ramlath. "Insect Diversity of Some Selected Species in Three Agricultural Lands in Tirunelveli District." *GTRP: Int. J. Applied Bio Research*, vol. 18, 15, April 2013, pp. 45 – 46.

The order Hemiptera is more commonly known as *true bugs*; the term *bug* only refers to this specific order of insects. All insects that fall under this order have straw-like mouths called *stylets*. They are ranked the fourth most species-rich order of insects after Hymenopterans (wasps, ants and bees), Coleopterans (beetles) and Dipterans (flies). Hemipterans can live in nearly all ecosystems including deserts, rainforests and even in aquatic habitats. Because of their large distribution and sensitivity to environmental disturbances, they are perfect organisms for researchers to study the health of various ecosystems. [2] There are three main suborders in Hemiptera: Auchenorrhyncha, Sternorrhyncha, and Heteroptera.

The group Auchenorrhyncha is comprised of cicadas, spittlebugs (or froghoppers), leafhoppers, treehoppers, and planthoppers. Some species of Auchenorrhyncha feed on the plant tissue called mesophyll and others prefer plant phloem, which is the fluid that contains vital nutrients for plants. Hoppers that feed on phloem tend to be more detrimental to agriculture than those that feed on tissue.[3] Auchneorrhynchans, such as those from the *Membracidae* or *Cicadellidae* family, are also notable for their unique communication. They can exhibit both acoustic and or substrate-mediated communication. Acoustic communication involves specialized organs called *tymbals* located on the abdomen of cicadas and hoppers. Tymbals are comprised of both stiff and flexible membranes, which rapidly get pushed in and out to make noise. Muscles control the movement of the membranes and each inversion creates a click. This organ works the same way as pushing the side of a plastic water bottle in and out.

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[2] Verne C. Nole, "Using Bugs (Hemiptera as Ecological and Environmental Indicators." *Forest Ecology Research Horizons*, Nova Science Publishers, 2007, page 205 – 226.

[3] Beirne P. Bryan, "Leafhoppers (Homoptera: Cicadellidae) of Canada and Alaska." *The Memoirs of the Entomological Society of Canada*, vol. 88, no. S2, 1956.

Substrate-mediated communication also uses tymbals, but rather than creating audible sounds, the vibration signals travel through the plant and are received by other individuals in the proximity. Some Auchenorrhynchans males and females will play duets in order to locate one another.[4]

Whiteflies, psyllid and aphids are families under the suborder called Sternorrhyncha. They are *phytophagous*, meaning that they only feed on the plant material (in this case they feed on the nutritious phloem). Sternorrhynchans can deliver pathogens, which can be detrimental to a plant.[5] I chose to depict the family *Aphididae*, or aphids, because of their unique and successful life cycle. They are known to do both sexual and asexual reproduction, lay eggs or give birth to live young, and in some cases their young can be born already carrying offspring of their own. They are also capable of excreting honeydew to pay ants for protection. However, with great numbers, aphids become a vital food source for many predators; wasps, ladybugs, praying mantises, lacewings and even some Heteropterans will help reduce aphid populations.

Heteroptera is the largest suborder under Hemiptera. Some of the members in this suborder are the lace bugs, stink bugs, shield bugs, large bugs, flat bugs, assassin bugs and water striders. The Heteropterans were grouped together for having a unique part of the cuticle (or exoskeleton) called the *gula* located behind the base of the stylet.[6] This organ gives the stylets more mobility, offering them a greater variety of foods, including

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[4] Kuhelj A, de Groot M, Blejec A, Virant-Doberlet M (2015) The Effect of Timing of Female Vibrational Reply on Male Signalling and Searching Behaviour in the Leafhopper Aphrodes makarovi. PLoS ONE 10(10): e0139020.

[5] Thao MyLo, Linda Baumann, Paul Baumann, "Organization of the mitochondrial genomes of whiteflies, aphids, and psyllids (Hemiptera, Sternorrhyncha)." *BMC Evolutionary Biology*, 2004, vol. 4, no. 1.

[6] Dolling W.R., *The Hemiptera*. Oxford University Press, 1991.

plant and animal tissue and or fluids. With a large range in diet, Heteropterans are able to adapt various habitats. In my project I represented seven Heteropteran families: *Tingidae*, *Pentatomidae*, *Scutelleridae, Tessaratomidae, Aradidae, Reduviidae*, and *Gerridae*.

Tingidae is the family of lace bugs. They get their nickname from the lacy texture on their dorsal side. Lace bugs are small and delicate, but display a variety of defensive adaptations. The parents of this group provide maternal care. In some species the nymphs (or young) have alarm pheromones and bristles on their cuticle to deter predators and parasites.[7]

The *Pentatomidae* is one of the largest families in *Heteroptera* under *Reduviidae* and *Miridae*. Their ability to feed on multiple plant species makes them a major pest.[8] They look similar to the *Scutelleridae* family, but one can recognize this group by the separation of five dorsal sections, giving them prefix in their name: *penta*-tomidae. These bugs are commonly known as *stink bugs* due to their production of a displeasing odor from scent glands found on the dorsal side of their abdomen.

Scutelleridae are also called shield bugs because of their uniquely broad *scutellum*; this refers to the prolonged section behind the head that can cover the entire abdomen (within a few species). Compared to other *heteropteran* families, *Scutelleridae* are more vibrant in color and can display metallic iridescence. This family is

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[7] Neal W John., Jr. and Carl W. Schaefer, "Lace Bugs (Tingidae)." *Heteroptera of Economic Importance*, edited by Carl W. Schaefer, Antonio Ricardo Panizzi, 2000, page 85 – 137.

[8] Antonio R. Panizzi, J.E. McPherson, David G. James, M. Javahery and Robert M. McPherson, "Stink Bugs (Pentatomidae)." *Heteroptera of Economic Importance*, edited by Carl W. Schaefer, Antonio Ricardo Panizzi, 2000, page 421 – 474.

phytophagous and can even feed on developing seeds. Out of all the subfamilies, the specie *Scutiphora pedicellata* is known to help pollinate.[9]

The *Tessaratomidae* is a family of large bugs. They demonstrate the unusual and rare behavior of maternal care. This bug would lay her eggs in a compacted group and would sit on top of them until they hatched. While she guards her eggs she does not feed. Some species may even continue to care for their young until they are mature enough to fend for themselves. The female of the rare specie named *Peltocopta crassiventris* has a large abdominal cavity created by the downward slopping edges of her abdomen. After her eggs hatch, she will harbor all the nymphs in her abdominal cavity. One study observed a mother carrying up to 22 nymphs.[10]

Aradidae are commonly referred to as flat bugs or bark bugs. Their flat body allows most species to live under or in between decaying trees and bark. The majority of flat bugs are *mycetophagous*, meaning that they feed on the fungi underneath tree bark. Many individuals in *Aradidae*, like *Dysodius magnus*, have rough cuticle that collects dirt and debris for camouflage.[11] When disturbed they can drop to the ground and disappear into the leaves and dirt using their clever disguise.

The *Reduviidae* family is composed of the assassin bugs, wheel bugs and kissing bugs. Many of these bugs are *hematophagous*, meaning that they feed on blood. The

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[9] Javahery M., Carl W. Schaefer and John D. Lattin, "Shield Bugs (Scutelleridae)." *Heteroptera of Economic Importance*, edited by Carl W. Schaefer, Antonio Ricardo Panizzi, 2000, page 475 – 503.

[10] Monteith G.B., "Maternal care in Australian oncomerine shield bugs (Insecta, Heteroptera, Tessaratomidae)". Denisia 19, zugleich Kataloge der OÖ. Landesmuseen Neue, no. 50, 2006, pp. 1135 – 1152.

[11] Coscaron del C. Maria and Eugenia F. Contreras, "Flat Bugs (Aradidae)." *True Bugs (Heteroptera) of the Neotropics*, edited by Antōnio R. Panizzi, Jocélia Grazia, 30 September 2015, pp. 423 – 458.

pests of *Reduviidae* are in the subfamily *Triatominae,* or the kissing bugs. Kissing bugs are potential vectors of Chagas Disease, which causes swelling around the bite area and in some cases may cause heart, colon and or esophagus inflammation and heart rhythm abnormalities.[12] Other bugs in *Triatominae*, called *assassin bugs,* are ravenous predators. The interesting behavior that they exhibit is that they will kill more prey than they can eat. They are polyphagous, which implies their ability to feed on various foods. This makes them poor candidates for pest-control; however, they have potential because a single species is capable of feeding on a diverse pool of pests.[13]

Gerridae is the family of the aquatic and semi-aquatic infraorder of insects called *Gerromorpha* (but is grouped under Heteroptera). *Gerridae*, or water striders, are semi-aquatic because they stand on the surface of water. Their ability to stand on water comes from the dense layer of hairs that covers their body and legs. The hairs create enough surface area so that their thin legs won't break the surface tension of the water. This layer also gives a sliver luster or matte to the cuticle.[14] *Gerridae* among other Gerromorphans are predators to the world's worst pest and number one cause of global death, mosquitoes. With the help from this group of bugs, there is high potential for Gerromorphans to help control mosquito populations.

The project titled Hemiptera is comprised of both illustrations and information plaques. The large laser engraved images on wood aim to help viewers familiarize

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[12] Center for Disease Control and Prevention. "Parasites - American Trypanosomiasis (also known as Chagas Disease)." *Center for Disease Control and Prevention,* 2 November, 2010. Accessed 23 March 2017.

[13] Dunston P. Ambrose, "Assassin Bugs (Reduviidae excluding Triatominae)." *Heteroptera of Economic Importance*, edited by Carl W. Schaefer, Antonio Ricardo Panizzi, 2000, page 695 – 712.

[14] Perez-Goodwyn Pablo, "Anti-Wetting Surfaces in Heteroptera (Insecta): Hairy Solutions to Any Problem." *Functional Surfaces in Biology*, edited by Stanislav N. Gorb, 2009, pp. 55-76.

themselves with the different Heimpteran families. The addition of text aims to help the audience achieve a deeper understanding and appreciation of each family. In order to change people's view of insect pests, they need to first understand how they've come to be considered pests. People need to recognize that insects are extremely diverse, thus making groups like Hemipterans a large gray area in terms of benefits and drawbacks. Hemipterans can cause much damage to human health and development, but on the other hand they can help resolve many anthropogenic problems. Through, entomological education, research and development, Hemipterans can achieve higher potential for improving our environment and society.

Hemiptera, 2017. Insect illustrations laser engraved onto plywood. Each illustration used real images of insects as reference.

Blinding Lights

In elementary school I did a research project on *Attacus atlas* (or the *atlas moth*s) because of their lifecycle. I was so captivated by the fact that they are the largest moths in the world and that they have elaborate wing patterns that resembles snakes to ward off predators. With further research I found that atlas moths also have an interesting life cycle; they only feed during their caterpillar stage and once they become moths they loose their digestive tract. This adaptation means that they can only live for a week with one goal in mind: to reproduce. This short period of time requires adaptations that would make their search for a mate efficient. These moths are able to use scent glands to emit pheromones to attract other mates. Like many nocturnal moths, the atlas moth uses moonlight for navigational efficiency and long distance travel. But these adaptations were nulled by human interference.

I grew up in the rural areas of Chiang Mai, Thailand. 15 years ago, the neighboring areas around my house had a couple of farm that grew flowers and rice but other than that it was covered with vegetation. The foliage wasn't as dense, but the area still had rich insect diversity. The insect I vividly remember growing up with was the atlas moth. As I grew up I noticed more farms sprouting up around my house and as the farms shifted to planting flowers, I observed fewer and fewer insects, including the atlas moths. These farms would turn on lights all night to increase production causing light-pollution.

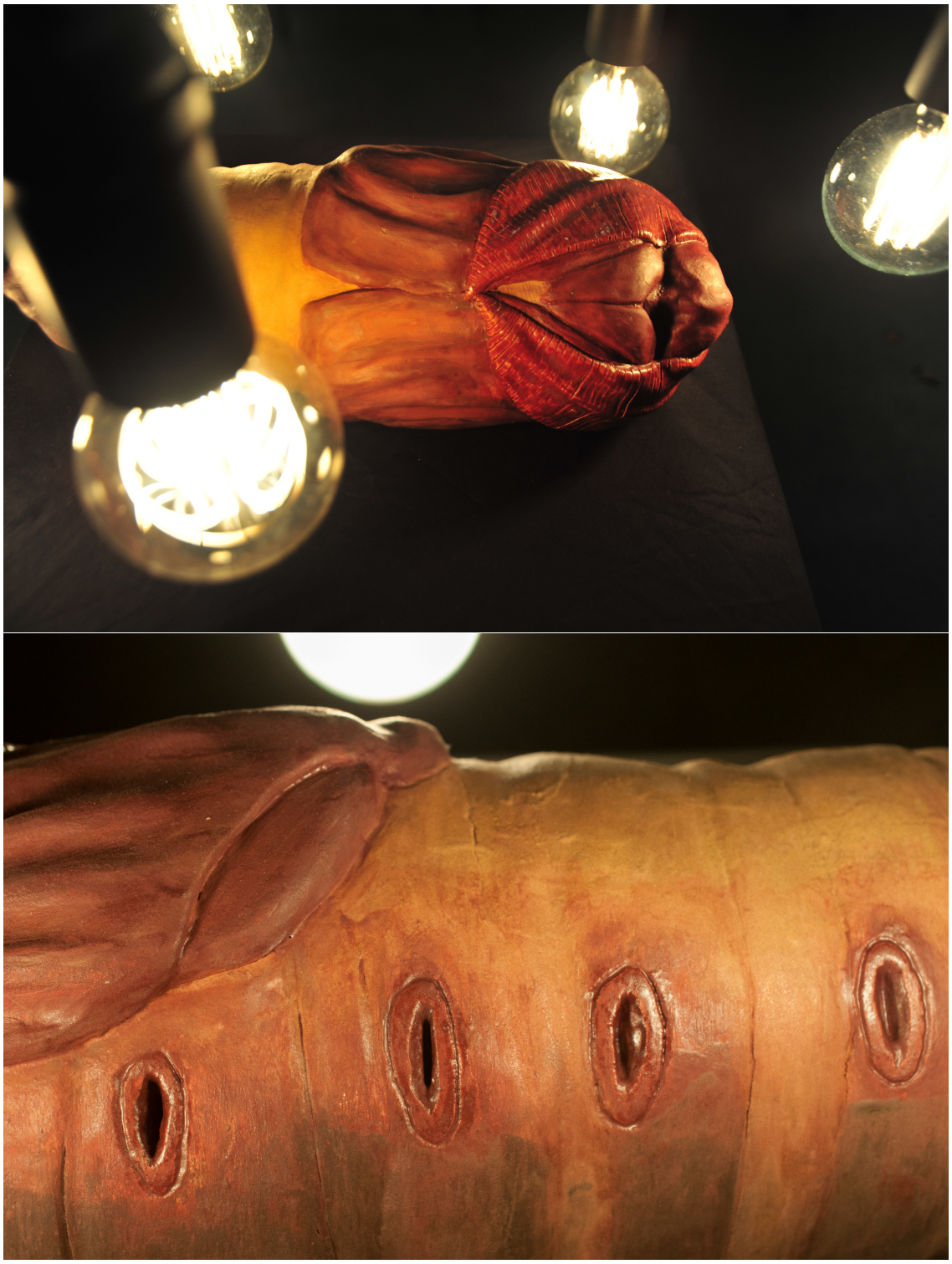
Light-pollution is a form of pollution caused by artificial light. It can disrupt nocturnal animals' natural cycles by replacing natural light. Nocturnal insects rely on a behavior called transverse orientation, which allows them to use moonlight to maintain a

fixed angle for flight.[15] However, the interference from artificial light disrupts their navigation, taking crucial time away from their short lives.

The sculpture titled *Blinding Lights,* introduces issue of *light-pollution* through my research and observation of the atlas moths growing up. The sculpture is of the moth as a pupa outside of its cocoon. I used ceramics for two reasons: the medium offers more flexibility with form and color but it also involves a meticulous process that reflects on the fragility of the insect. The light-pollution is implied through the light bulbs intrusively hanging in-between the viewer and the sculpture.

Blinding Lights, 2017.

[15] Gillett P.T. Michael, Andrew S. Gardner. "An unusual observation – attraction of caterpillars to mercury vapour light in the Abu Dhabi desert (Lepidoptera: Pyralidae)." *Tribulus*: vol. 18, 2009, page 56.



Blinding Lights, 2017. The pupa ceramic sculpture used *cone-04* clay. In order to accurately depict the pupa, I had to study an *Attacus atlas* pupa specimen at the Butterfly Pavilion Westminster. The glazing process took 2 months of trial and error of mixing metals and dyes to achieve realistic colors.

Homopalpia

Freshwater habitats contain a majority of aquatic insects. The interaction between both insects and their habitat helps to maintain a stable flux of energy and nutrients for all life in an aquatic system. A major group of aquatic insects comes from the order *Trichopteran* or the group of *caddisflies*. Due to their enormous specie diversity they can live in various aquatic systems and can present a spectrum of behaviors, which is what makes this group of insects an ideal candidate for studying the health of aquatic ecosystems.[16]

There are nearly ten thousand known species of caddisflies. Their adult from look similar from specie, to specie however the physical and behavioral diversity is apparent through their larval stage. There are three suborders to *Trichopterans*: *Integripalpia*, *Annulipalpia* and *Spicipalpia*. These three groups are all separated by the variations on the larval cases they create around their body for protection. The *Integripalpia* larvae create transportable cases from materials they find in their ecosystem, such as leaves, pebbles, twigs and wood. They are able to piece their materials together using their strong waterproof silk. Their mobility allows them to safely forage for food. Families under the *Annulipalpia* suborder also create homes out of silk and debris, but are stationary. Because their homes are fixed they tend to live in flowing water where food can simply float by for them to catch. The third suborder is called *Spicipalpia* and families under this group have varying lifestyles.[17] Some are free-living

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[16] Dohet Alain, "Are caddisflies an ideal group for biological assessment of water quality in streams?" *Proc. 10th Int. Symp. Trichoptera – Nova Suppl. Ent., Keltern*, 2002, pp. 507 – 520.

[17] Wiggins B. Glenn, *The Caddisfly Family Phryganeidae (Trichoptera),* edited by R.H. Haynes, University of Toronto Press, 1998.

predators that do not make cases and others will create funnel-shaped nets to trap algae, detritus and smaller invertebrates.[18]

The sculpture titled *Homopalpia* introduces a new suborder, *the human caddisfly*. The title is nuanced in meaning; first, the name is the combination of *Homo sapiens* (contemporary humans) and the last portion of the three suborders of caddisfly. Both names are rooted in Latin (as is many scientific names in biology); the prefix *Homo* means "man" and suffix *palpus* means "feel," implying "human sensation." *Palpia,* is also reminiscent of the word palpitation, which can mean a rapid and irregular heart beat in medical terms or a shaky motion such as quivering or trembling; in terms of this sculpture *palpia* appropriately suggests a "painful sensation."

When people see a dead insect lying on the ground, they usually dismiss it as a common occurrence without thinking twice about how it died. I chose to depict the caddisfly with human body parts because it offers the viewer a chance to reflect on the human sensation of agony implied by the gesture of the hands and face. Plaster-gauze was used to partially cover the wire sculpture signifies the body's deterioration. The wire used for this sculpture is prone to rust, thus reinforcing the concept of deterioration due to waste. The waste used to line the case reflects the unique way the organism creates its case; but it is also significant in that all the waste was collected along Boulder Creek, giving the sculpture a meaningful and beneficial process.

My sculpture ties the research of Trichopteran biology with the issue of water-pollution. With agricultural run off and poor waste management, many aquatic organisms are threated by habitat-loss. However, through the diversity of *Trichopterans*, researchers

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[18] Gillott Cedric, "The Panorpoid Orders." *Entomology*, Springer publishing co, 2005, pp. 217 – 264.

are able to study a blend of behavioral and physical responses from environmental stress in order to identify and resolve ecological issues.

Homopalpia, 2017. The skeleton was created using my proportions, wire and pliers. Plaster gauze was used to cover the wire sculpture. Over the period of a week I was able to accumulate more than enough garbage from Boulder Creek in order to create the casing for this sculpture. For exhibiting purposes I had to partially clean the trash using a bath of soap and a sponge. The found materials were then organized and glued onto chicken wire.

Danaus plexippus

Around 80 percent of flowering plants rely heavily on pollinators, a majority of which are insects. However, there has been a steady decline in pollinators around the world.[19] One of the major pollinators in Central and North America are the monarch butterflies.

Monarch butterflies (*Danaus plexippus*) play a huge role in their ecosystem. Other than pollination they are also a food source for certain birds, small animals and other insects. Predators that feed on monarchs require a tolerance to the toxins, called cardiac glycosides, stored in the butterfly's body.[20] They accumulate toxins during their caterpillar stage feeding on toxic milkweed. Most animals will avoid eating monarch when they recognize their vivid coloration. Most people may see Monarch caterpillars as pests, however they can benefit farmers. Farms that raise cattle in parts of the United States and Mexico want to avoid fields with milkweeds because some species can cause a form of insanity when ingested. Thus from an agricultural point of view, monarch caterpillars can help farms to reduce the amount toxic weeds.

The benefits of monarch scientific research and biomimetics (the mimicry and adaptation of biological forms and functions for human development) are extensive. Here are a few: Monarch butterflies are a great source for studying their specialized fats used to fuel their long journey. [21] Their compound eyes can be used to study the nature of

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[19] Chan Carita, "Conserving Monarch Butterflies and their Habitats." *U.S. Department of griculture,* USDA, 16 June, 2015.

[20] Holzinger, F., M. Wink, "Mediation of cardiac glycoside insensitivity in the monarch butterfly (Danaus plexippus): Role of an amino acid substitution in the ouabain binding site of Na+,K+-ATPase." *Journal of Chemical Ecology*, vol. 22, no. 10, 1996, pp. 1921 – 1937.

[21] Urquhart A. Fred, *The Monarch Butterfly International Traveler*, William Caxton Ltd, 1987, pp. xix.

polarized light.[22] Monarchs are iconic, which makes them the perfect candidates for introducing people to entomology. Their unique behavior of migrating and hibernating in large clusters is a part of Mexico and the United States' ecotourism. But despite their protective adaptation and benefits to humans, monarchs are an endangered species as a result of habitat-loss.

The monarch butterflies undergo their long journey south to escape the cold of winter and to hibernate in warmer climate. The monarch population is separated into two: the western and eastern population. The western population can be found traveling from areas west of the Rockies down to the 100 different areas along the California coast.[23] The eastern population is greater in number and can the travel over 4000 kilometers (2485 miles). Their journey beings from the Great Lakes region in Canada down east of the Rocky Mountains through the United States to central Mexico.[24] There are two main conditions that allow monarchs to travel long distances: the first is the availability of milkweed as a food source and second are the rest areas they use before reaching their final destination, both of which are under attack by humans.

Habitat-loss can come in many forms, but in the case of monarch butterflies, it is caused by herbicide, genetic modification, climate change, and deforestation.

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[22] Stalleicken Julia, Thomas Labhart, Henrik Mouritsen, "Physiological characterization of the compound eye in monarch butterflies with focus on the dorsal rim area." *Journal of Comparative Physiology A*, vol. 192, no. 3, pp. 321-331.

[23] Jepsen, Scott Hoffman Black, Eric Mader, and Suzanne Granahan, "Western Monarchs at Rish: The Plight of Monarch Butterflies Along the West Coast." *The Xerces Society for Invertebrate Conservation,* 2010.

[24] Vidal Omar, José López-García, Eduardo Renón-Salinas. "Trends in Deforestation and Forest Degradation after a Decade of Monitoring in the Monarch Butterfly Biosphere Reserve in Mexico." *Conservation Biology,* vol. 28, no. 1, February 2014, pp. 177-186.

Milkweeds fields are the primary source of food and breeding grounds for monarchs. Studies have estimated that 92% of the monarchs that have reached Mexico fed on the common milkweed called *Asclepias syriaca*.[25] But common milkweed fields in the Midwest have been greatly diminished due to their presence in corn and soy farms. These weeds reduce the farmer's crop yield and in order to combat their invasion farmers have been increasing the use of herbicides called glyphosate, or Monsanto's Roundup, resulting in the degradation of the monarch's habitat. The herbicide had negative effects on the crop plants thus began the development of genetically modified glyphosate-tolerant plants; With the introduction of this genetic modification in 1999, studies from Iowa in 2010 showed a great reduction of the common milkweed from 23 percent to 4.29 percent density.[26] As a result there has been an 81% decline in monarch egg production in the Midwest on agricultural land from 1999 and 2010.[27]

The process of migration and hibernation is called overwintering. Monarch overwintering sites are the areas in which the butterflies congregate in clusters on tall trees. Habitat-loss through deforestation and degradation has significantly diminished monarch populations. From 1971 through 1999, illegal logging in Mexico had reduced 44% of high quality forests belonging to monarch reserves. This large-scale deforestation

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[25] Pleasants M. John, Karen S. Oberhauser, "Milkweed loss in agricultural fields because of herbicide use: effect on the monarch butterfly population." *Insect Conservation and Diversity*, vol. 6, no. 2, March 2013, pp. 135.

[26] Pleasants M. John, Karen S. Oberhauser, "Milkweed loss in agricultural fields because of herbicide use: effect on the monarch butterfly population." *Insect Conservation and Diversity*, vol. 6, no. 2, March 2013, pp. 138.

[27] Pleasants M. John, Karen S. Oberhauser, "Milkweed loss in agricultural fields because of herbicide use: effect on the monarch butterfly population." *Insect Conservation and Diversity*, vol. 6, no. 2, March 2013, pp. 140.

had greatly reduced their population, if not eliminated entire colonies.[28] The study conduced by Omar Vidal, José Lòpez-García, Eduardo Rendón-Salinas showed that from 2001 to 2012, a total of 2179 hectare of major overwintering lands were significantly affected; 1254 hectares were caused by deforestation and 925 hectares were degraded. 2057 hectares were directly linked to illegal logging and 122 hectares by floods, strong winds, drought and fire. From 2008 to 2011 in Mexico, monarch reserves were affected by extreme drought resulting in the vegetation's stress increasing susceptibility to diseases. The World Wildlife Fund's latest study in Mexico showed a 27 percent decrease of Monarch populations from last year alone.[29] These environmental conditions along with deforestation undoubtedly pose major threats to monarch butterflies.[30]

The sculpture titled, *Danaus plexippus,* ties my research on the endangered monarch butterflies with Shel Sliverstein's *The Giving Tree. The Giving Tree* is a short story that denotes the issues of the overconsumption of natural resources. The story begins with the young main character playing with a tree that gave him anything he wanted. As the story progresses the tree keeps giving the boy parts of itself, but as he grows so do his demands. In the last scene the main character grows old and sits on the stump of the tree he cut down as an adult.

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[28] Vidal Omar, José López-García, Eduardo Renón-Salinas. "Trends in Deforestation and Forest Degradation after a Decade of Monitoring in the Monarch Butterfly Biosphere Reserve in Mexico." *Conservation Biology,* vol. 28, no. 1, February 2014, pp. 178 – 179.

[29] Mizejewski David, (2017 February 20). Monarch Populations Plummet: 27% Decrease From Last Year. *EcoWatch*. Received from http://www.ecowatch.com/monarch-butterfly-populations-2265703408.html

[30] Vidal Omar, José López-García, Eduardo Renón-Salinas. "Trends in Deforestation and Forest Degradation after a Decade of Monitoring in the Monarch Butterfly Biosphere Reserve in Mexico." *Conservation Biology,* vol. 28, no. 1, February 2014, pp. 180 – 182.

With my sculpture, I wanted to expand on the story so that it explicitly shows the ramifications of human consumption through monarch butterflies. The tree stump that had been pulled out of the ground with the rootball still intact is suggestive of deforestation. The shriveled milkweed flower is symbolic of the consequences of herbicides and uses of certain genetic modifications. The butterflies sitting on the wire figure were cyanotype prints on orange cloth; the interaction between the figure and butterflies implies the monarchs' struggle with habitat-loss because, without the tree they would use for overwintering, the monarchs have to rely on humans for a solution.

Danaus plexippus, 2017.

Danaus plexippus, 2017. The wire sculpture used chicken wire molded onto my body. I used my head's proportions for the bust. The butterflies used a photographic process called *cyanotype*, where emulsion is painted onto cloth; negative film is then exposed onto the emulsion-covered cloth under UV light for 40 minutes (per side). The images printed onto the orange came from CU Boulder's entomology special collections department. To gain high definition images, the butterflies were photographed using a process called *image stacking.* After cutting out the wings, super glue was carefully applied along the edges of the wings to prevent the cloth from fraying. I used 4 different variations of monarchs; there are males and females with 2 different sizes per gender. There are a total of 40 butterflies in this sculpture (ten were lost to experimentation). The tree stump required the help of a friend and two weekends to dig up, clean off and relocated to the exhibition space.

Conclusion

Every time my family finds an insect in the house, my mom prefers to drop a cup over it, slide a sheet of paper underneath it and released it outside. She always told me that all living things have a purpose, which is why they exist; but I'd get confused when she'd spare certain insects, but slapped mosquitos. Insects are like anything or anyone else in this world, there are some good ones, and there are bad ones, and there are types that have yet to come. But evolutionarily speaking, they all have adapted to a specific niche in the world that gives them a purpose for existence. Whether or not that adaptation brings joy or misery, we can still learn from them. We can use the knowledge gained from entomology to better our lives and to help manage and conserve theirs.

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