The ESD Newsletter is a monthly newsletter involving ALL members of ESD. Members are encouraged to forward materials, authored papers on Environmental and Environmental Systems topics, and comments on newsletter topics or current events to the Editor. Your participation is greatly appreciated.

The ESD newsletter features **Five** Sections:
(Please use the blue links below to navigate within the newsletter)

1. ESD DIVISION NEWS
   - ASME Student/Early Career Competition - General Topic
   - Dixy Lee Ray Award

2. ENVIRONMENTAL TECHNOLOGIES
   - Worker-dependent gut symbiosis in an ant
   - Plant from plastics: Bio-based polymers can be transformed into fertilizer

3. ENVIRONMENTAL REGULATIONS
   - Global Waste Recycling and Circular Economy Outlook 2021: Increasing Adoption of Smart Technologies Will Boost Decarbonization and the Digital Sustainability of Supply Chains
   - The EU's Green Deal: opportunities, threats and risks for South African agriculture

4. EDITORIAL BOARD SELECTIONS
   - Mitigating the Impact of Insecticides with New Crystalline Advances
   - By 2030, the U.S. plastic industry will pollute more than coal
   - Decision support systems halve fungicide use compared to calendar-based strategies without increasing disease risk
   - Why Augmentative Biological Control Holds Promise for Advancing Agriculture in Developing Countries

5. READER COMMENTS TO THE EDITOR
   - None received this month
ASME Student/Early Career Competition - General Topic

The Environmental System Division (ESD) in conjunction with 2022 ASME eFest will be holding its 2nd Annual Student/Early Career Competition. The Competition will take place March 25 – 26, 2022 and will be similar to 2021, it will be divided into three levels:

**Participation Requirements**
- Undergraduate Students
- Graduate Students
- Early Career Engineers

**Prizes**
- 1st Place $250
- 2nd Place $150
- 3rd Place $100

There are some minor changes in the rules for 2022 including the ability for all participants to choose which of four topics they want to compete on. The topics include:

<table>
<thead>
<tr>
<th>TOPIC #</th>
<th>TOPICS</th>
<th>FOCUS AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Powering the Future</td>
<td>The environmental impact of the infrastructure needed to provide power to support a non-hydrocarbon future</td>
</tr>
<tr>
<td>2</td>
<td>Turning Trash into Useful Products</td>
<td>Converting of organic and inorganic waste (e.g., food, plastic, wood, metal, and others) into useful products.</td>
</tr>
<tr>
<td>3</td>
<td>Effects on Environment in the times of COVID-19</td>
<td>Impact/Trends due to increased biomedical wastes, mitigation measures, management plan on the same.</td>
</tr>
<tr>
<td>4</td>
<td>Access to clean drinking water for low-income groups</td>
<td>Low-cost technologies, water management plans to ensure access to clean water for low-income groups</td>
</tr>
</tbody>
</table>

For more information, please contact Arnold Feldman at jjdsenv@att.net.
ASME Dixy Lee Ray Award

The Dixy Lee Ray Award, established in 1998 "for outstanding engineering achievement in environmental protection through improvements in technology, science and policy" recognizes significant achievements and contributions in the broad field of environmental protection. Achievement in the following areas will be recognized:

- Environmental engineering, including environmental technology and related topics;
- Other environmental areas, including environmental health, environmental sciences, environmental management and policy, and related topics.

The award was established in honor of Dixy Lee Ray’s advocacy to the development of those technologies that serve humanity. She believed that the engineering profession was uniquely qualified to develop and implement environmentally acceptable technologies.

The person winning this award will be presented with:
- a $1000 honorarium, a bronze medal, a certificate, and will also receive a travel grant (not to exceed $750) to attend the presentation ceremony.

Click here for nomination instructions. Nominations should be submitted by January 15, 2022.

Those seeking additional information should contact the Award Committee Chair. A list of past winners of this award is available on the ASME website (https://www.asme.org/about-asme/honors-awards/achievement-awards/dixy-lee-ray-award).

Questions?
Contact the Dixie Lee Ray Award Committee Chair, Arnie Feldman at jidsenv@att.net.
Worker-dependent gut symbiosis in an ant

The hallmark of eusocial insects, honeybees, ants, and termites, is division of labor between reproductive and non-reproductive worker castes. In addition, environmental adaption and ecological dominance are also underpinned by symbiotic associations with beneficial microorganisms. Microbial symbionts are generally considered to be maintained in an insect colony in two alternative ways: shared among all colony members or inherited only by a specific caste. Especially in ants, the reproductive caste plays a crucial role in transmission of the symbionts shared among colony members over generations. Here, in this study, the researchers report an exceptional case, the worker-dependent microbiota in an ant, Diacamma cf. indicum from Japan. By collecting almost all the individuals from 22 colonies in the field, they revealed that microbiota of workers is characterized by a single dominant bacterium localized at the hindgut. The bacterium belonging to an unclassified member within the phylum Firmicutes, which is scarce or mostly absent in the reproductive castes. Furthermore, they show that the gut symbiont is acquired at the adult stage. Collectively, their findings strongly suggest that the specific symbiont is maintained by only workers, demonstrating a novel pattern of ant-associated bacterial symbiosis, and thus further their understanding of host-microbe interactions in the light of sociobiology.

The most remarkable evolutionary innovation of eusocial insects is the reproductive division of labor between the castes, wherein each caste is dedicated to different types of tasks including reproduction, nursing, cleaning, defending, and foraging. Considering diverse biological functions of insect symbionts, it might not be too surprising if there are caste (task)-associated symbiotic bacteria that are maintained and transmitted in a caste-dependent manner. In addition, while previous studies have reported the regulation of reproductive division of labor in D. cf. indicum, it would be of great interest to investigate a potential role of the firmicute symbiont in the maintenance of social system. Further studies on D. cf. indicum would contribute to a better understanding of the society-microbe relationship in ants and moreover, of what role microorganisms play in the evolution of eusociality. (Ref. 1)

Plant from plastics: Bio-based polymers can be transformed into fertilizer

Plastics have taken the world by storm over the last century, finding applications in virtually every aspect of our lives. However, the rise of these synthetic polymers, which form the basis of plastics, has contributed to many serious environmental issues. The worst of these is the excessive use of petrochemical compounds and the disposal of non-biodegradable materials without recycling; only 14% of all plastic waste is recycled, which hardly puts a dent in the problem. To solve the plastic conundrum, we need to develop "circular" systems, in which the source materials used to produce the plastics come full circle after disposal and recycling. At
Tokyo Institute of Technology, a team of scientists is pioneering a novel concept. In their new environmentally friendly process, plastics produced using biomass (bioplastics) are chemically recycled back into fertilizers. This study will be published in Green Chemistry, a journal of the Royal Society of Chemistry focusing on innovative research on sustainable and eco-friendly technologies. First, the scientists investigated how well the complete ammonolysis of PIC could be conducted in water at mild conditions (30°C and atmospheric pressure). The rationale behind this decision was to avoid the use of organic solvents and excessive amounts of energy. The team carefully analyzed all the reaction products through various means, including nuclear magnetic resonance spectroscopy, the Fourier transform infrared spectroscopy, and gel permeation chromatography.

Although they managed to produce urea in this way, the degradation of PIC was not complete even after 24 hours, with many ISB derivatives still present. Therefore, the researchers tried increasing the temperature and found that complete degradation could be achieved in about six hours at 90°C! "The reaction occurs without any catalyst, demonstrating that the ammonolysis of PIC can be easily performed using aqueous ammonia and heating. Thus, this procedure is operationally simple and environmentally friendly from the viewpoint of chemical recycling." Finally, as a proof-of-concept that all PIC degradation products can be directly used as a fertilizer, the team conducted plant growth experiments with Arabidopsis thaliana, a model organism. They found that plants treated with all PIC degradation products grew better than plants treated with just urea. The overall results of this study showcase the feasibility of developing fertilizer-from-plastics systems. The systems can not only help fight off pollution and resource depletion but also contribute to meeting the world's increasing food demands. "The researchers are convinced that our work represents a milestone toward developing sustainable and recyclable polymer materials in the near future. The era of 'bread from plastics' is just around the corner". (Ref. 2)

3. ENVIRONMENTAL REGULATIONS

Global Waste Recycling and Circular Economy Outlook 2021: Increasing Adoption of Smart Technologies Will Boost Decarbonization and the Digital Sustainability of Supply Chains

The "Global Waste Recycling and Circular Economy Outlook, 2021" report has been added to ResearchAndMarkets.com's offering. Revenue was $457.14 billion in 2020, and it is expected to expand to $517.26 billion in 2021 at a growth rate of 13.3%. This study focuses on the global waste recycling and circular economy market across the following market segments: municipal solid waste (MSW), industrial waste, hazardous waste, WEEE, construction and demolition (C&D) waste, and plastic packaging waste. The study examines sorting and the process of turning waste into valuable resources for a more sustainable future while creating new business opportunities for market participants. Growth is mainly attributed to stringent
regulations for waste reuse and recycling, the greater circulation of materials, and limited waste volumes directed to landfills, driven by accelerating digitalization, decarbonization, increased efficiency, and cost optimization. Opportunities for a sustainable waste recycling market vary by region, with Europe and North America reaching high levels of waste collection, sorting, reuse, and recycling.

Important investment areas and top trends in 2021 include AI-based smart sorting, emerging solutions for the recycling of cardboard and paper packaging waste, the digital sustainability of supply chains, circular economies for used oil recycling, the building as material banks (BAMBS) concept, chemical recycling of plastic waste, decarbonization, and circular economies for IT asset disposal (ITAD). 2021 is defined by a continued market reaction to the COVID-19 pandemic, implying that recycling facilities are still adjusting to market fluctuations. Digitalization and decarbonization will gain momentum and companies will strive to achieve sustainability goals and will continue to focus on innovative technologies. The market is pushing for a further reduction of greenhouse gas emissions, and it is exploring every opportunity to get emissions to net zero and net negative. It is also integrating new business models and changing carbon-intensive enterprises into circular carbon businesses. Digital technologies and smart solutions for waste management are firmly established in the market; however, only highly connected and fully integrated systems with the ability to effectively transform data into valuable information will drive the integrated digital transformation of the waste industry and move it closer to a sustainable and circular economy. Circular supply chains are gaining momentum, along with a growing focus on material and product circularity, which impacts new production models that close the loop on material sourcing and drive cross-industry collaboration and the increased efficiency of reuse, recycling, and repurposing (these trends will be supported by the incorporation of advanced technologies).

The COVID-19 pandemic has significantly changed the material stream of waste volumes (for example, an increase in the generation of organic waste and packaging waste, especially paper, cardboard, single-use plastic, and WEEE), impacting entire supply chains and production cycles. The growing generation of pandemic waste, especially personal protective equipment waste, such as face masks, plastic face shields, rubber gloves, and safety uniforms, and biohazardous waste from medical facilities has resulted in increased demand for special measures necessary to handle potentially contaminated waste. (Ref. 3)

Back to Newsletter’s Page 1

The EU's Green Deal: opportunities, threats and risks for South African agriculture

The European Union (EU) – among a host of other countries – is seeking to implement urgent policy measures to combat the effects of climate change. In its 2030 climate target plan, the EU aims to reduce greenhouse gas emissions by 55% from 1990 levels. To that end, the EU has crafted the “Farm to Fork strategy”. Launched in 2020, it is a new approach that ensures that agriculture, fisheries, and the entire food system effectively contributes to achieving the
target. The strategy is at the core of a broader initiative, the European Green Deal. Its aim is to reduce the environmental and carbon footprint in the way food is produced and consumed. The strategy lists 27 actions. These cover food production, processing, retailing, and waste. They aren't expected to be implemented until 2022, to give regulators and food system actors time to transition into the new policy regime. It has four broad pillars:

- Consumer demand. This focuses on nutritional labelling and creating a sustainable labelling framework that covers nutrition, climate, environment and social aspects of food products. The labelling requirements are intended to empower consumers to make conscious decisions about health and sustainability.
- Food production. This sets out the fundamentals for sustainable production by setting targets that reduce the use of fertilisers and pesticides and the revision of legislation covering feed additives and animal welfare.
- Industry behaviour. This seeks concrete commitments from agribusiness and other food-system actors concerning health and sustainability. The EU will develop a code of conduct on the development of business and marketing practices and require agribusiness to integrate sustainability into their corporate strategies.
- Trade policy. This seeks commitment from third countries on the use of pesticides and animal welfare and the fight against microbial resistance.

The EU is seeking to compel other countries, including South Africa, to adhere to new regulations if they want to continue to access its lucrative market. This raises questions about the capacity and potential for South Africa to adapt, as well as the risks and opportunities that the regulations present to future access to the EU market. The EU and the private sector may need to provide significant technical and financial support to facilitate South Africa’s transition and align its regulatory environment with the focus on health and sustainability. In the long run, the expectation is that with the harmonisation of standards and practices will also come structural change of the food system in such a way that value chain profits are not disproportionately accumulated at the expense of farmers. This will require higher levels of transparency across all parts and aspects of the South African food system. (Ref. 4)

**4. EDITORIAL BOARD SELECTIONS**

**Mitigating the Impact of Insecticides with New Crystalline Advances**

Many insects kill food crops. Insecticides mitigate against this damage. The world population will be well on the way to 10 billion by 2050. Few agricultural experts believe that we can grow enough food in the near term for so many people without controlling some insects chemically, especially in the face of invasive species that are increasing in range due to climate change. However, as with all things that humans use, they are subject to overuse and abuse. Alternative farming practices wholly free of pesticides and chemical fertilizers should be a goal. In the
meanwhile, less is more. If molecules were pedestrians on a boulevard, imidacloprid would not turn any heads. In any of its crystal forms, it is a colorless solid. An imidacloprid molecule is of medium size. It has got nine carbon atoms, some hydrogen, nitrogen, and oxygen plus one chlorine atom – no exotic elements. It is rather ordinary in all things except in its ability to poison insects. Imidacloprid is a so-called neonicotinoid insecticide; because its mechanism of action is related to that of nicotine, it interferes with an important neuro-enzyme called acetylcholinesterase. Neonicotinoids are a comparatively new group of compounds introduced in the 1990s, because older insecticides invariably fail when insects develop resistance. Imidacloprid is extremely toxic to bees. It may also change bee behavior which is embraced by the term colony collapse disorder.

The science underlying colony collapse disorder is complex, and the last word has not been written, but the precautionary principle argues that if something bad could happen – even if you don’t know if it is going to happen nor why it may be happening – you ought to do what you can to prevent that thing. Given the acute toxicity of imidacloprid to bees, it has been banned in the European Union, but not in North America. Worldwide, it is the most popular insecticide, registered in more than 120 countries. While imidacloprid was invented to protect the food supply, ironically, it may be threatening the food supply by endangering pollinators. The loss of bees would qualify as a very bad thing.

Imidacloprid is a systemic insecticide. It gets into the soil and into plants and then into bees where it may affect their immune systems. This study applies to the fewer applications where imidacloprid functions as a contact insecticide, where insects come into direct contact with solid, sometimes crystalline particles. What these researchers did wouldn’t affect the systemic use of imidacloprid, unfortunately. Other scientists are thinking about better ways to wet leaves with smaller quantities of active ingredients. Many crystalline molecular compounds exist in more than one structural form.

These forms are called polymorphs. Finding new polymorphs of common substances often requires nothing more than looking more carefully with our eyes and with analytical instruments than those who looked previously. When they began their research, two crystalline forms of imidacloprid had been identified. At a given temperature, different polymorphs will have different energies. In the lower energy forms the molecules pack together more comfortably – they “fit” better, and their mutual associations are strong. In the higher energy forms, the molecules can’t find their best positions with respect to one another. The melting points drop. Molecules in the higher energy forms are more easily liberated from the crystal. When an insect steps on an imidacloprid crystal, the molecules diffuse from the crystal surface through the cuticle of the insect, a process about which we could and should learn more. Nevertheless, when a contact insecticide functions, it requires the meeting of a crystal surface and the tarsi (feet) of insects. (Ref. 5)
By 2030, the U.S. plastic industry will pollute more than coal
When you think of plastic pollution, your first thought is probably of plastic waste dirtying the ocean’s surface. And while the industry is also a major contributor to climate change, the conversation about how to deal with the climate crisis often leaves out plastic as a cause. By the end of the decade, according to a new report that looks at every part of the plastic life cycle, emissions from the plastics industry in the U.S. could outpace emissions from coal power plants. Plastic industry emissions start with fracking. When the energy industry fracks for oil and gas, it also produces ethane, methane, and other gases that are used to make plastic. By 2025, the report estimates, hydrofracking for plastic production could release 45 million tons of greenhouses gases a year—that’s more than the pollution produced by 22 coal power plants. Transporting and processing fracked gases releases more methane, a potent greenhouse gas. At ethane “cracker” facilities, fracked gases are superheated to release components used in plastic production. Although some brands are now taking steps away from single-use plastic packaging, the plastic industry as a whole continues to grow. Globally, plastic production could triple by 2050, according to the World Economic Forum. We know that because of increased investment in renewable energy and electrification of the transportation sector, the demand for fossil fuels is declining. It’s critical, for governments and businesses to think about plastic in their climate plans. As coal power plants have been closing in the U.S., plastic emissions are simultaneously growing. The experts at COP [the global climate conference] have to recognize that they have to deal with plastics, “because it’s going to eclipse coal as a greenhouse gas emission source.” (Ref. 6)

Decision support systems halve fungicide use compared to calendar-based strategies without increasing disease risk
The European Green Deal aims to reduce the use of chemical pesticides by half by 2030. Decision support systems are tools to help farmers schedule fungicide spraying based on disease risk and can reduce fungicide application frequency and overall use. However, the potential benefit of decision support systems compared to traditional calendar-based strategies has not yet been rigorously quantified. In this study they synthesise 80 experiments and show that globally decision support systems can reduce fungicide treatments by at least 50% without compromising disease control. For a given fixed number of fungicide sprays, decision support systems were as effective as calendar-based programs in reducing disease incidence. When the number of sprays was halved, the increase in disease incidence was lower for decision support system-based strategies than calendar-based strategies. Their findings suggest that decision support systems can reduce fungicide use while limiting the risk to plant health and resistance development. (Ref. 7)
Why Augmentative Biological Control Holds Promise for Advancing Agriculture in Developing Countries

A sustainable agricultural system could make the economies of developing countries more stable and self-dependent, and augmentative biological control provides such an opportunity. The aim of augmentative biological control is to manage a crop pest through inoculation and inundation of biological control agents, or natural enemies of the pest. These can include predator or parasitoid insects or microbial organisms. A focused effort and investment to enhance the commercial production of biocontrol agents can improve the human and institutional capacity of developing countries. The establishment of augmentative biological control requires extensive dissemination of appropriate information and capacity building. One of the major priorities of the Feed the Future Innovation Lab for Integrated Pest Management—located at Virginia Tech’s Center for International Research, Education, and Development and funded by the U.S. Agency for International Development—is improving the human and institutional capacity of its host countries in Africa and Asia. The three major types of biological control are classical, conservation, and augmentative. Classical biological control (also identified as inoculation of an exotic natural enemy) involves importing a natural enemy of a pest to the infested region and working to establish a sustained local population. Conservation biological control focuses on maintaining conditions favorable to native natural enemies. Augmentative biological control involves mass rearing of natural enemies and actively releasing or dispersing them to control a pest.

Each approach has its limitations and strengths. For instance, while classical biological control requires longer implementation periods and provides lasting control of a pest, augmentative approaches are comparatively quicker and can control targeted nuisance organisms (insect pests, diseases, weeds) for an extended period but certainly not permanently. Within augmentative biological control, an inoculative approach uses only living organisms (biocontrol agents), including predators, parasites, and microbials (fungus, bacteria, nematodes, and virus), whereas an inundative approach uses living organisms as well as non-living components extracted from living organisms such as neem products, pyrethrins, and Bacillus thuringiensis. The non-living components that are extracted from living organisms are known as biologically based pesticides and function by inundating the system. Currently, highly potent synthetic biochemical pesticides are also available in the market, such as pyrethroids. Since synthetic biochemical and chemical pesticides also require a repetitive application, therefore they can also be identified as an inundative augmentative approach. The categorizations for all these different approaches may overlap in different ecosystems and circumstances. For instance, Pediobius foveolatus, an introduced parasitoid of the Mexican bean beetle (Epilachna varivestis) in the northeastern United States, does not overwinter and hence does not provide permanent management. It is released every summer in the crop fields as a source of “inoculative augmentation,” a combination of classical and augmentative forms of biological control. The establishment of production and rearing units of biological control...
agents in developing countries enable local technicians and scientists to be trained, making institutes and universities of these countries equipped with appropriate skills and facilities. Production of the beneficial fungus Trichoderma spp., which is used as a seed treatment to protect crops from soil-inhabiting fungal pathogens, and mass rearing and releasing Trichogramma spp. for control of pestiferous species of Lepidoptera (for example, Spodoptera spp.) are examples of some of the IPM Innovation Lab’s most effective capacity-building programs. Appropriate scaling and pricing as well as active networks of communication among businesses, research institutions, government extension agents, farmer organizations, and farmers can all increase the chances of success of this venture. Augmentative biological control creates opportunities for the local population, small- and large-scale farmers, and industries to work together and harvest monetary benefits, besides human and environmental safety. It is indeed money well spent. (Ref. 8)

Back to Newsletter’s Page 1

5. ESD NEWSLETTER READER COMMENTS

None received this month.

Back to Newsletter’s Page 1

ESD NEWSLETTER BOARD

Editor: DR. K. J. SREEKANTH – (sreekanthkj@kisr.edu.kw)
Assoc: DR. JAMES ZUCCHETTO – (jimzuc@comcast.net)

NEWSLETTER ARTICLE REFERENCES

1. https://www.nature.com/articles/s43705-021-00061-9
7. https://www.nature.com/articles/s43247-021-00291-8
ENVIRONMENTAL ENGINEERING features the application of environmental technologies to engineering systems to attain optimal performance according to established standards. The Newsletter of the Environmental Systems Division (ESD) will attempt to highlight a variety of environmental technology applications aimed at enhancing engineering systems performances in accordance with the latest standards by presenting excerpts of and links to selected articles from a variety of websites.

DISCLAIMER

Disclaimer: This newsletter may contain articles that offer differing points of view. Any opinions expressed in this publication do not represent the positions of the ESD Executive Board members of the American Society of Mechanical Engineers (ASME).
Upcoming ASME Conferences

IMECE®
International Mechanical Engineering Congress & Exposition®
November 1 – 5, 2021
The International Mechanical Engineering Congress and Exposition (IMECE) is ASME's largest research and development conference focused primarily on mechanical engineering, but encompasses perspectives from many engineering disciplines. IMECE is THE place for you to present your technical research and expertise, while also learning from and connecting with thousands of your peer researchers on a global level.

Gas Turbine India Conference
December 2 – 3, 2021
The 2-day virtual event attracts the industry's leading professionals and key decision makers, whose innovation and expertise are shaping the future of turbomachinery. Authors and presenters are invited to participate in this event to exchange ideas on research, development and best practices on Gas Turbines and allied areas. The conference is an excellent opportunity to initiate and expand international co-operation.

ICEM® 2023
International Conference on Environmental Remediation and Radioactive Waste Management®
International Conference Centre Stuttgart
Stuttgart, Germany
CALL FOR ABSTRACTS
SUBMIT BY JANUARY 29, 2023
ENVIRONMENTAL SYSTEMS DIVISION
NEWSLETTER

01 NOVEMBER 2021

ASME ENVIRONMENTAL SYSTEMS DIVISION (ESD)
Executive Committee

Ryan Neil, Chair

Karen Vallar, Co-Chair

Scott Walter, Treasurer/Secretary

Arnold Feldman, Past Chair
JJDS Environmental

Steven Unikewicz, Member at Large
Idaho National Lab

Hebab Quazi, Member at Large

Sreekanth K. J; Newsletter Editor
Kuwait Institute for Scientific Research
Laura Herrera, Staff Liaison
ASME