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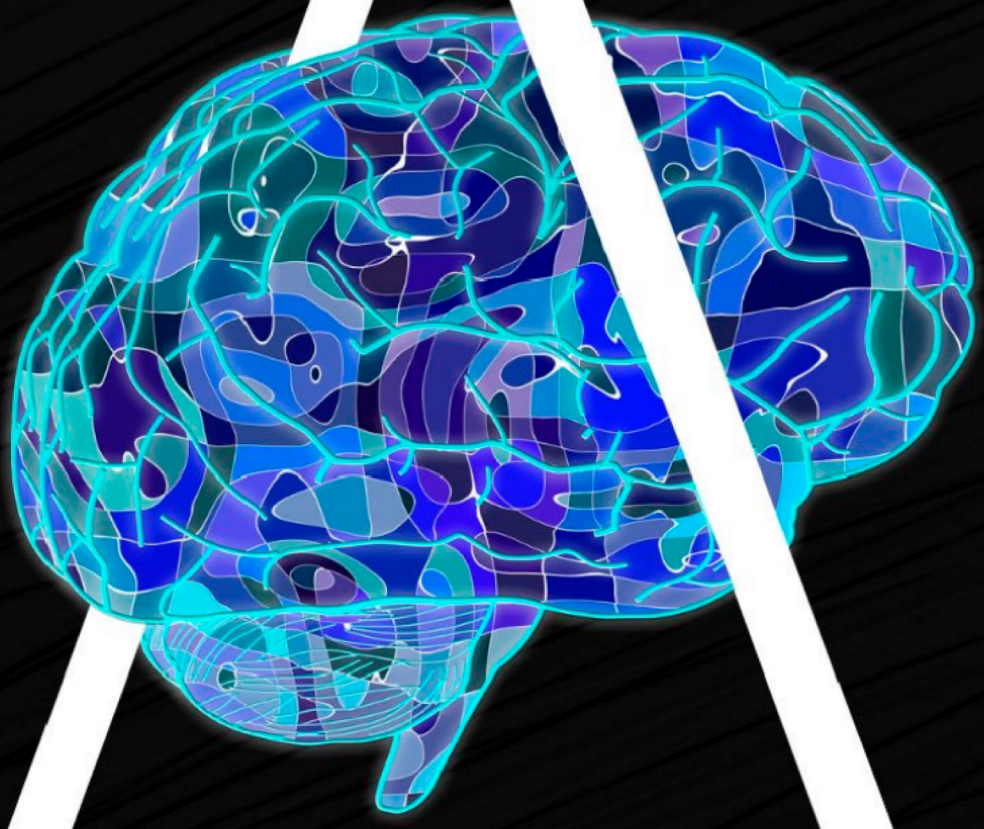

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What 2021 Looks Like for the Environment

We can all agree that 2020 was not a good year for us. But how was it for the environment? Although we ended up reducing the yearly waste that humans lay to the world, will there be a backlash in 2021? We can already see the astoundingly large amount of single-use medical waste being created in the form of masks, gloves and the like. Let's try to look at a few aspects of how the coming year could fare for the environment.

The recently announced union budget showed ups and downs compared to the funds allocated towards the environment, pollution control, Climate Change Action Plan, Green India and other policies. While the general trend does seem to be decreasing, the environment ministry has allocated 10 crores more than usual to control pollution. It seems like this year's primary focus is on coastal projects, as the budget for the national coastal mission has nearly been doubled from 103 crores to 200 crores.

The planet we live on has seen incredible developments. Millions of years of dynamic environmental factors have led to the diversification of flora and fauna, many of which are still undiscovered by humankind. Scientists discovered a staggering 364 new species of animals, and 253 species of plants in India in 2019. Many new species were described worldwide in 2020 too, including several snakes, frogs, insects, whales, and even primates. A new green pit viper species was found in the Himalayas and named *Trimeresurus salazar,* or the Salazar's pit viper, taking after Salazar Slytherin from the Harry Potter series. A new species of tree-spider crab, Leptarma biju, was found on the pillars of a bridge near mangroves at Chithari river's mouth in Kerala, India. Purple in colour and measuring only 14 mm by 13 mm, this is the country's first species from this genus. Iran is home to a species of velvet spider measuring just 8 mm, with a striking red-and-white pattern resembling the iconic grin of the Joker, Batman's nemesis, portrayed by actor Joaquin Phoenix in 2019 and hence the tiny spider was named Loureedia phoenixi. The Royal Botanical Gardens, Kew, named 156 plants and fungi from Africa, Asia, the Americas, and the U.K. An astounding 19 species of newly described tree-dwelling orchids were found on the richly biodiverse island of New Guinea by an orchid specialist from the Royal Botanical Gardens.

Looking at this trend, there are still many species yet to be described and as the world emerges from the lockdown, the amount of work done in this field is bound to increase.

As the population of the world continues to grow at an unprecedented rate, it is natural for more and more resources to be brought under human use, fragmenting forested areas. 2020 saw a significant increase in environmental awareness with the public getting involved in movements to protect the last remaining pristine forests. Here is a small list of the environmental movements that occurred in India in 2020.

1. The Dehing Patkai movement is a protest against the April 2020 decision by the National Board of Wildlife (NBWL) to allow North-Eastern Coal Fields (NEC) to do opencast mining in 98.59 hectares of Dehing-Patkai Wildlife Sanctuary. The 'Amazon of the East,' the 111.19-hectare sanctuary is home to over 40 species of fauna, over 300 species of birds, 40 species of reptiles and 100 varieties of orchids with the highest diversity of wildcats anywhere in the world.
2. The Dibang hydropower project in Arunachal Pradesh is pegged at a capacity to yield 2,880 megawatts, the proposed largest hydropower venture of India would reach the elevation of a staggering 278 metres–also making it the world's tallest concrete gravity dam, submerging and affecting 413 plant, 159 butterfly, 113 spiders, 14 amphibian, 31 reptile, 230 bird and 21 mammalian species within the study area of a survey conducted by the Wildlife Institute of India.
3. Mollem National Park in Goa has come into the limelight lately due to being exposed to three development projects, namely a railway line expansion, a national highway and a powerline running through the protected area that houses 128 plants, birds, butterflies, reptiles and a variety of wild mammals found nowhere else.
4. In other news, the Environment Minister announced that from this year onwards the ten best National Parks, five coastal and marine parks and top five zoos in the country would be ranked and awarded every year. This move motivates to maintain the quality of conservation and management of protected areas under the central government.

At this juncture of time, where the country needs to improve its standing in the global economic stage, developmental projects are bound to occur, and they should. The important thing is that development and conservation need to be balanced well to ensure long-term benefits.

—J. Vishwathiga (B '19), Siddharth Kurne (B '18), Anumit Saralkar (B '17)

Sources: [1], [2], [3], [4]

One Nation, One Subscription

Scientific journals form the most well-known repositories of research literature, and most of them come at exorbitant prices. Students are required to refer to hundreds of papers during their formative years, and they come across paywalls every time they find relevant abstracts. It is a well-known fact that publishers barely pay anything to authors, which makes this pricing even more incredulous. Vigilante ventures like Sci-Hub, which remove barriers in the way of science, were started to combat this unfair commercialization of knowledge.

In this light, the Indian government's idea of 'One Nation, One Subscription' becomes even more radical. They are pushing a proposal wherein everyone in the country will get free access to scientific literature, and all publicly-funded research will be freely available. The government wants to strike up deals with some of the biggest scientific publishers for nationwide subscriptions, instead of individual institutes that only offer access to their scholars. The government will purchase a unified subscription from a myriad of publishers, after which the articles will be available to government-funded institutes as well as tax-payers. It has the potential to be a game-changer for the scientific community. Research institutes in Uruguay and Egypt have subscriptions that allow all citizens to read international research, and Germany has established similar nationwide subscription programmes. It must be mentioned that Uruguay and Egypt required loans from the World Bank to make the deals. The success of this venture largely depends on the publishers' willingness to negotiate, but if it is successful, India will be the biggest country (population of 1.3 billion) to break through the paywalls.

Instead of researchers publishing under open-access journals ('gold' open access), the researchers advising the government want them to go the route of 'green' open access—archiving copies of their accepted articles in public repositories. The proposal of this subscription came from talks about whether India should join Plan S—an initiative to publish publicly funded scientific research in open access journals. However, advisors are largely in agreement that in a country where resources for research are already scarce, paying up-front article processing charges is not the best course of action. According to the US National Science Foundation, India published more than 135,000 articles in 2018, which might carry weight while negotiating deals with large publishers.

As of right now, India spends Rs. 1,500 crores per year to read papers via journal subscriptions. A discounted, amalgamated deal could significantly reduce this expenditure; however, it is imperative to make sure that this subscription is across disciplines and covers a wide range of journals and publishers. Elsevier and Springer, two of the biggest publishers, have remained ambiguous about their willingness to participate in this deal, which sets a concerning precedent for the future.

Even if this subscription becomes a reality, there will be several logistical and technical challenges to overcome, especially because of the sheer size of our country. Moreover, this does not combat the problem of paywalls around knowledge, merely circumvents them. The system of 'green' open access might be contested by publishers under copyright claims, where the authors will have to wait for several years before making their work accessible to the public. It seems absurd that the rights to their own work are taken away from them during publishing, which has led to a large number of 'right-retention policies' being introduced, so that researchers can share their papers in open access repositories without fear of legal action. In an ideal world, perhaps India would helm the fight for open access and reform the publishing system, but even a deal that makes research free-for-all in the country would be a good start.

—Shreya Venkatesan, B '19

Sources and Further Reading:
Science Mag, Nature, Plan S
The Wire, Indian Express

Climate Change in 2021

In 2020, several extreme events occurred as a result of global warming—wildfires in the Amazon, Australia, the US, and Siberia, Atlantic hurricanes and typhoons in the Philippines. According to the UN, we now have ten years to limit climate change. However, temperatures and greenhouse gas emissions climb ever higher each month.

The 2010s have seen temperatures that were the hottest recorded in the past several centuries. 2020 was among the three warmest years on record, despite the cooling effect of the La Niña phenomenon, which refers to cooler surface temperatures that occur once in two to seven years in parts of the Pacific Ocean. Though the La Niña climate cycle passed its peak in early February, it is expected that its effects will still be observed in the coming months. Above-normal temperatures are expected this year. La Niña also affected hurricane season in the Americas, making them more destructive and deadly. As temperatures increase, the need for cooling also increases and the use of chlorofluorocarbons in appliances leads to added pollution. Thermal pollution is also caused by cooling, as the water used to cool machinery in large industrial establishments is released back at slightly higher temperatures.

Plastic pollution has been driven by the rapid growth of plastic production and the rise of single-use plastics. There is a dire need for waste management systems at a global level that can safely dispose or recycle plastics. Plastic is ingested by a large number of terrestrial organisms, including human beings. 2020 saw a sharp rise in the use of single-use plastics, owing to the COVID-19 pandemic, as the plastics industries and lobbyists pushed for the use of disposable masks, bags, and containers, advertising these as more sanitary. However, the studies cited by them involve other contaminants, mostly bacteria such as *E. coli*, whereas SARS-CoV-2 survives as long on plastic as it does on other surfaces. Some experts say that plastics actually amplify the risk of COVID transmission as reusable metal or glass wares are typically sterilized with soap and hot water as soon as possible, whereas plastics facilitate a higher risk of spread through waste management workers. Several countries have planned to considerably reduce plastic waste by 2030—Mexico City's ban on single-use plastic came into effect this January, and Germany and Canada are also slated to enforce laws by the end of this year.

In August 2020, the Environment Impact Assessment draft was met with widespread concern and criticism from the public, since the proposals weakened environmental protection policies. A major change is the proposed ability of industrial units and other projects in violation of the Environmental (Protection) Act, 1986, to apply for clearance. Violations can only be reported by the government, and clearance can be obtained on presenting "two plans for remediation and resource augmentation corresponding to 1.5-2 times *the ecological damage assessed and economic benefit derived due to violation*". Amid ongoing protests and online petitions against the draft, the government was criticized this January by the High Court for refusing to translate the draft into 22 languages. The EPA, in many cases, is the last barrier between the rich biodiversity and environmental habitats of India, and our efforts must be redirected to strengthen it.

The coronavirus crisis briefly decreased the amount of greenhouse gases being released but did not do much to reduce the impact of the carbon dioxide already accumulated in the atmosphere over decades as a result of fossil fuel combustion. A statistical link between the number of COVID-related deaths and poor air quality was established in a study conducted by Harvard scientists. Climate change has also been shown to exacerbate the spread of communicable diseases such as malaria, dengue fever, and Lyme disease. A general trend of more diseases is on the rise as animals that can house pathogens, due to habitat loss, are finding food and shelter close to humans, and thus disease spread occurs—the recent Ebola epidemic, for example, was caused in part due to the movement of bats into new habitats as the old forests had been cut down for palm oil trees. Similarly, a study further suggests that global bat migration played a role in the emergence of both SARS-CoV-1 and SARS-CoV-2. The coming decades will only see an increase in diseases and pandemics such as COVID-19, among several other disasters, if serious steps are not taken to combat climate change. A significant shift

that coronavirus does seem to have created is in the minds of people—it serves as a reminder that we are not invulnerable, and that climate change will not be incremental, but a butterfly-effect sudden and stupendous strike.

2020 also witnessed powerful movements in several regions against police brutality and systemic injustice. Climate change intersects with racial inequality, financial insecurity, poor water quality, and civil unrest. This demonstrates that environmental protection and action against climate change are necessary not only for *a* future, but also a *good* future.

2021 is a pivotal opportunity for creating a sustainable future. Many countries such as China and the UK have already pledged to reach carbon neutrality, and renewable energy sources are becoming cheaper. Though greenwashing persists, more businesses and ventures are picking sustainable options, and movements such as zero-waste and slow fashion gain a larger audience daily. The United Nations Climate Change Conference, the successor to the landmark 2015 convention in Paris, will be held this year in November—world leaders have to be persuaded to make decisions that promote sustainability, conservation, and transparency in climate policy.

—Rithika Ganesan, B '19

References: [1], [2], [3]

ESI Species of the Month: Common Jezebel

India celebrated '**The Big Butterfly Month**' during the month of September 2020. It was a first of its kind event aimed at conducting a nationwide citizen science survey to assess the health of our environment [1]. *Delias eucharis* (Drury, 1773)—**Indian Jezebel**, also called **common Jezebel** was in the list of the top-three voted butterflies in a nationwide citizen poll for the tag of the national butterfly organised by the National Butterfly Campaign Consortium, a collective of 50 butterfly experts and enthusiasts [2]. During mid-October, these three butterfly species were submitted to the Ministry of Environment, Forests and Climate Change, and they are likely to announce the national butterfly in 2021 [3].

The common Jezebel butterfly belongs to the Pieridae (Whites and Yellows) family of butterflies which are mostly medium-sized butterflies. They have a wingspan of 66 to 83 mm. The upperside wings are white with black veins, and this side is paler compared to the underside wings. The underside forewings are white with black veins. The underside hindwings have a bright yellow colour, and the margins have orange-red spots. The females are more heavily marked compared to males.

Jezebel populations are found all around the Indian subcontinent year-round. These are well adapted to a broad range of habitats including temperate hill forests, tropical rainforests, dry open woodland and beach hinterlands. You can also find them in cities and towns, often foraging around flowering plants. They breed all around the year. They have bright colouration on their underside wings to indicate that they are unpalatable due to toxins accumulated during the larval stage from the host plants. The males show an aggressive territorial behaviour.

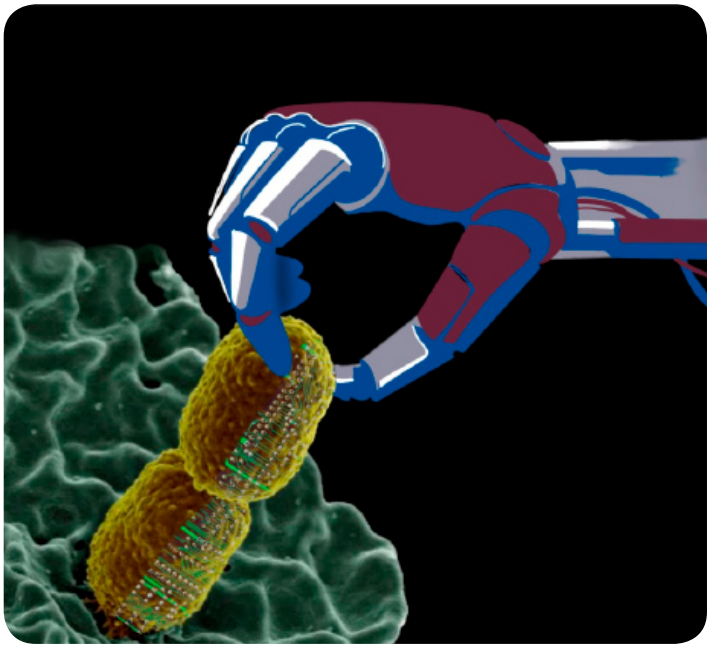
Painted Sawtooth (non-toxic species), also a butterfly from the Pieridae family mimics (Batesian mimicry) the common Jezebel. They can be distinguished by looking at the margins of their underside hindwings. The common Jezebel has an orange red coloured arrow headed shaped markings, while the painted sawtooth has a similar marking but with a curved-rectangular shape.

They lay eggs in batches. Each batch consists of ten to twenty eggs and is usually laid on the underside of the host plant's leaves. The eggs are oval, shiny and bright yellow in colour. The caterpillars show gregarious behaviour and feed on parasitic plants that grow on the branches of woody trees [5]. The larva has been recorded on varieties of common host plants [6].

—Artwork and Article by C. L. Dheeraj, B '17

The Age of Computational Biology

One of the first chemical reactions that we get to do at school is probably the displacement reaction. We put an iron nail in a blue solution of copper sulphate and slowly watch the color of the solution turn green and copper deposit on the nail. Its mechanism involves the substitution of copper by iron in the solution causing the formation of green iron sulphate. Sounds pretty simple, right? But if you were to take a dive into that test tube to watch things happen at a molecular level, you would end up seeing absolute chaos. Trillions of atoms and subatomic particles hitting each other at astounding speed or being hurled away, others clumping together to form aggregates, creation and destruction of pockets of heat and what not. The point is, even the simplest of reactions hide immense complexity beneath their surface. Just like the color change we saw in that displacement reaction, everything that is observable to us in a living thing is an 'emergent property'—it is the result of an unfathomable number of molecular interactions taking place. A well-established fact about biology is that it is an informational science which means that the purpose of all cells and processes that happen within them is to store and transfer information. For thousands of years scientists had no choice but to make assumptions and approximations that were not completely accurate so that they could interpret various systems in a humanly possible way. While computational power is essential in nearly all sciences today, it has brought about a paradigm shift where things get complicated beyond our imagination–biological systems.



The beginnings of computational biology can be traced back to the father of computing himself, Alan Turing and his group at the Los Alamos National Laboratory who used one of the first computers to study biological morphogenesis. The next hurdle that was tackled by computers was in the field of protein crystallography, in which scientists found them indispensable for carrying out laborious Fourier analyses to determine the three-dimensional structure of proteins. In the 1950s, taxonomists began using the machines to assist in the classification of organisms by grouping them together based on similarities of sets of traits. This further helped in phylogenetic studies and discovery of important evolutionary links between organisms. In the 1960s, a whole new set of computational methods was developed in support of molecular phylogenetics. These computational methods entailed the creation of increasingly sophisticated techniques for the comparison of strings of symbols that benefited from the formal study of algorithms and the study of dynamic programming in particular. Indeed, efficient algorithms always have been of primary concern in computational biology, given the scale of data available, and biology has in turn provided examples that have driven much advanced research in computer science. In the 1980s, aspects of computer science like artificial intelligence (AI) came into the picture. It was used for knowledge representation, which contributed to the development of ontologies that code biological knowledge into a computer-readable form, as well as natural-language processing, which provided a technological means for mining information from text in the scientific literature. In fact, such algorithms came in handy last year, when a call was made to annotate research papers that might be relevant to Covid-19 using Natural Language Processing (NLP), to enable us to mine existing literature for clues to aid in the global coronavirus response. The subfield of machine learning also found wide use in biology, from modeling sequences for purposes of pattern recognition to the analysis of data from large-scale gene-expression studies. Today computational biology has come into close proximity with systems biology, which attempts to analyze the workings of large interacting networks of biological components, especially biological pathways. Biochemical, regulatory, and genetic pathways

are highly branched and interwoven, calling for sophisticated computational tools for their modeling and analysis. Modern technology platforms for the rapid, automated generation of biological data have allowed for an extension from traditional hypothesis-driven experimentation to data-driven analysis, by which computational experiments can be performed on genome-wide databases of unprecedented scale. As a result, many aspects of the study of biology have become unthinkable without the power of computers. As the boundaries between various fields of science grow thinner every day, it is not surprising that two fields thought to be previously unrelated are now bound to each other and take examples from each other to progress. With the advent of computers and their immense capabilities to solve millions of calculations in a fraction of seconds, the dream of unlocking the secrets of the universe suddenly seems plausible.

—Artwork by Riya Sheokand, B '17
—Article by Adarsh Jay, B ' 18
Sources: [1], [2], [3], [4], [5]

Our Team:

We hope you enjoyed this month's edition of *Exhibit A*

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