THE NICHE

Your magazine from the British Ecological Society

SPIRIT BEARS

Indigenous-led research reveals their genetic secret

Plastic Pollution
Green sea turtles and plastic ingestion

Black History Month
The contributions of Black British naturalists

Learning with Nature
Home-schooling under lockdown

THE NICHE

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White "Kermode bear" also known as the spirit bear eating mussels at low tide.

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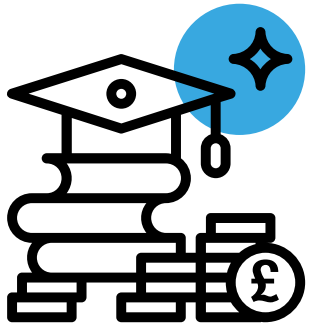

COMMUNITY

WELCOME

Welcome to another jam-packed edition of *The Niche*. October in the UK is Black History Month, a month to remember important people and events. Sara Middleton is beginning the work to uncover the contributions on Black British naturalists (p20). Holly McKelvey highlights how ecologists can support Black Lives Matter (p17) and we are pleased to launch a new network for Black, Asian and minority ecologists (p14).

Ecological Solutions and Evidence, the BES' newest journal has published it's first issue and is already turning out fascinating research, including an Indigenous-led study into the genetic rarity of white-coated Spirit bears in Canada (p10).

We're all aware of plastic pollution and it's detrimental impact on the environment. What's less known are the chronic effects on organisms when plastic builds up in their digestive systems. Robson Santos explores plastic ingestion in green sea turtles (p26).

As Jane Memmott mentions in her editorial (p6), creativity is important in science. Lauren Cook explores the long rich history of art and science, from Leonardo da Vinci to Mae Jemison (p32). Our younger members have also been getting creative in our Learning With Nature competition (p50)!

As always, happy reading!

Kate

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THE HIDDEN EFFECTS OF PLASTIC INGESTION

An amount of plastic as small as 0.5g can block the digestive tract of juvenile turtles

PLASTIC IS EVERYWHERE

Plastic is everywhere, in the places we live, but also in our salt, seafood, fruits and vegetables, in the water we drink and even in the air we breathe. Not to mention the absurd amount of plastic which has been accumulating in natural environments. Plastic is so ubiquitous on Earth that it has been used as one of the markers for a new geological epoch, the Anthropocene.

Marine ecosystems are the natural environment most affected by plastic pollution. It is not a matter of aesthetic impact, as was considered by many back in the early 60s, neither a problem of few charismatic species that occasionally eat some shopping bags or straws. Now, plastic can be found circulating in every marine food web, affecting the health of individuals that have ingested them, but also disrupting key ecological proceses. The threats posed by plastic pollution are continuously revealed by science.

Despite five decades of studies and thousands of papers on plastic ingestion, we still lack knowledge on the factors that lead to this behaviour and its potential consequences. Sea turtles mistaking shopping bags for jellyfish are a popular example and is mainly attributed to the mimic of plastics with foods. However, this seems an oversimplification that is not always in agreement with the variety of debris found in turtles and other organisms.

As a first step, to be eaten, plastics must be perceived. In visual foragers the colour is likely to play a role in the form of background matching. For animals like sea turtles that perceive a floating piece from below, darker plastics are more conspicuous due to their contrast with a bright sky. Paler plastics are easier to detect when seen from above, by seabirds for example, where they contrast with a darker background. Although ideas of a perfect match with a food item, such as the jellyfish hypothesis, are more likely to be exceptions, prey resemblance is a key factor to understand plastic ingestion.

Plastic can smell like food. After a period floating around in oceans, they accumulate biofouling and an odour signature like a keystone infochemical sign used by seabirds, sea turtles and fishes to find food. In our new plastic world, good habits in the past can mean modern pitfalls. That is the case for generalist feeders and opportunistic feeding behaviour in general, such as scavenging, both are linked with higher chances of plastic ingestion.

Once plastic is ingested another door to uncertainties is open. There is no doubt that ingesting plastic has a deleterious effect, whether it is physical impairment or chemical contamination of the organism, or indeed death as the ultimate consequence. However, the more common threats are posed as chronic effects, which are difficult to evaluate under natural conditions. And it is on this topic that our study jumped in.

Our goal was to understand one of the main cited chronic effects of plastic ingestion – plastic-induced satiety. To circumvent this topic, we created a multidisciplinary team to combine proxies of behaviour, physiology and fitness measurements: Ryan Andrades, Guilherme Ramos Demetrio, Gabriel E. Machovsky-Capuska, Mañana Felix Sobral, Gabriela Miki Kuwai and Júlia de Souza Vieira. Ryan added his expertise in isotopic ecology and niche-based processes, while Guilherme contributed a strong numerical ecology background. Additionally, Gabriel brought expertise in nutrition, physiology, and ecology.

Plastic debris on a Brazillian beach

We used the green turtle, *Chelonia mydas*, as a model and divided our study in three parts: i) establishing the relationship of food intake with plastic accumulation in the oesophagus, stomach and intestine; ii) evaluating if plastic ingestion influences the diet composition; iii) investigating the fitness consequences of plastic consumption. We used diet and plastic ingestion data from over 200 stranded animals found along the Brazilian coast.

During the initial phase of consumption, when plastic reaches the stomach, there is an increase in the feeding activity of green turtles, though we didn't find differences in diet composition between individuals that ingested plastic and those that did not. At first glance, the increase of intake rates seems to be a counterintuitive consequence, but it is probably linked to an effort made by the turtles to compensate for the nutritional dilution caused by the accumulation of plastic in the stomach. The ingested plastic continues to move toward the intestine, but in a slower pace than food items, and eventually they accumulate throughout the entire digestive system. At this point, a second change in behaviour occurs, there is a decrease in the feeding activity leading to what is called 'plastic-induced satiety'.

We may see the plastic-induced satiety as cascading events, where the accumulation of plastic in the gastrointestinal tract influences foraging success and limits the ideal nutritional intake of the turtles. The combination of these effects impairs digestive processes and leads to a false feeling of fullness.

For each gram of plastic ingested, we may expect an increase in the probability (250–450%) of a turtle becoming underweight or emaciated

PLASTIC POLLUTION IS A GLOBAL ISSUE

Stranded dead emaciated green turtle

As a consequence of the decrease in feeding activity, we should expect harmful impacts at cellular and systemic levels. In our study we evaluated fitness consequences using body condition. We found that high loads of plastic were related with poor health conditions. For each gram of plastic ingested, we may expect an increase in the probability (250–450%) of a turtle becoming underweight or emaciated when compared to those that did not have plastic in their gastrointestinal tracts.

Our study established a framework that can be translated to marine, freshwater and terrestrial animals. From now on, we hope that researchers use this framework in other animals, encouraging future experiments to examine the effects of plastic ingestion on foraging behaviour, nutritional balance, and health. Unveiling the effects of plastic is crucial to understand the magnitude of this global threat. Although more studies are needed to understand the problems caused by plastic pollution, the actions needed to minimise the impacts of this long-lasting threat are known. Indeed, a range of policies have already been suggested including: reducing and banning disposable plastic; reducing the use of plastic fibres in clothes; and classifying the most harmful plastics as hazardous materials. Plastic pollution is a global issue that needs global steadfast commitment. ✺

FURTHER READING

Santos et al. Exploring plastic-induced satiety in foraging green turtles, *Environmental Pollution* (doi.org/d4vn)

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There is no doubt that ingesting plastic is harmful, whether it causes physical impairment or chemical contamination