Report on the EBNet Green Stories Short Story Competition

Prepared by: Dr Louise Byfield

Contact: The Environmental Biotechnology Network ebnet@ebnet.ac.uk

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1 Background

The **Environmental Biotechnology Network** (EBNet, www.ebnet.ac.uk) is a community of academic and industry participants dedicated to engineering microbial systems for environmental protection, bioremediation and resource recovery. Examples of these include microbes in anaerobic digestion (AD), wastewater treatment (WWT) and those that biodegrade oil, plastics or other emerging pollutants. In 2023 EBNet sponsored a short story competition with **Green Stories** (www.greenstories.org.uk) – a university-led initiative which runs a series of free writing competitions across various formats to solicit stories that showcase what a sustainable society might look like. The theme was **Microbes to the Rescue!**

The purpose was dual. Firstly, to act as outreach: this was seen as an opportunity to engage members of the public in thinking about what Environmental Biotechnology (EB) is and what it can do. Secondly, to provide the Network with an indication of the public's understanding of the term EB. Writers were given guidance on the competition remit which was to write stories that involved EB in a broadly positive manner and a scientifically accurate way. Entries were between 1000-3000 words with an optional short note on the rationale or motivation for the story. A pre-competition briefing webinar was held to answer questions from potential writers, and a recorded version was made available online.

The prize funding was nominal (top prize £500) but extensive promotional efforts were made to reach beyond the Network and into wider society to solicit entries. These included circulating information on the competition through the channels normally used by the Green Stories initiative; and by newsletter and website promotion to EBNet members, alongside targeted emails to writing groups and to master's courses in Environmental Science and Engineering.

This was primarily a writing competition. EBNet was involved at the first sift to eliminate any stories which failed to meet the remit of including EB in a positive way, which could be low-key or indirect but should not be scientifically implausible. Entries were then judged and shortlisted based on literary merit by a Green Stories panel of professional writers.

2 Response and Results

The response was larger than anticipated with 161 entries. There was extensive international reach with entries from 36 Countries. Roughly one third (33%) were from the UK followed by India (11%), USA (10%), Nigeria (5%) and as far afield as South Sudan, Vietnam and the Philippines.

At the first sift, nine out of the original 161 entries were eliminated for reasons unrelated to the story content. Such reasons included: being a duplicate, being a late entry, having an undownloadable format, or having a self-declared conflict of interest. This left 152 in contention.

The initial sift rules were to score entries out of 7, with those achieving less than 4 intended for elimination. Eight volunteer judges were involved, ensuring that each bid had between 3 and 5 marks. Whilst scoring did vary between judges, most assessments were broadly similar in outlook.

Examination of the remaining 152 bids identified 70% (*106*) where the averaged judges' score was below 4 (Figure 1). Of these, less than 10% (10) had scoring disparities – defined as where a single judge had scored at least 2 marks above the combined average.

After careful consideration a threshold average score of 4.4 was agreed as the cut-off point for entries to proceed to the next stage. This comprised the top 20% (*31*) of entries, which were passed for

assessment by the professional judges for writing quality. Perhaps predictably the percentage of entries from non-UK and non-native English-speaking countries declined at this stage: the proportion of UK entries increased from one third to nearly 60% (*18*). Of the remainder about a quarter (*8*) were from countries where English is unlikely to have been a first language.

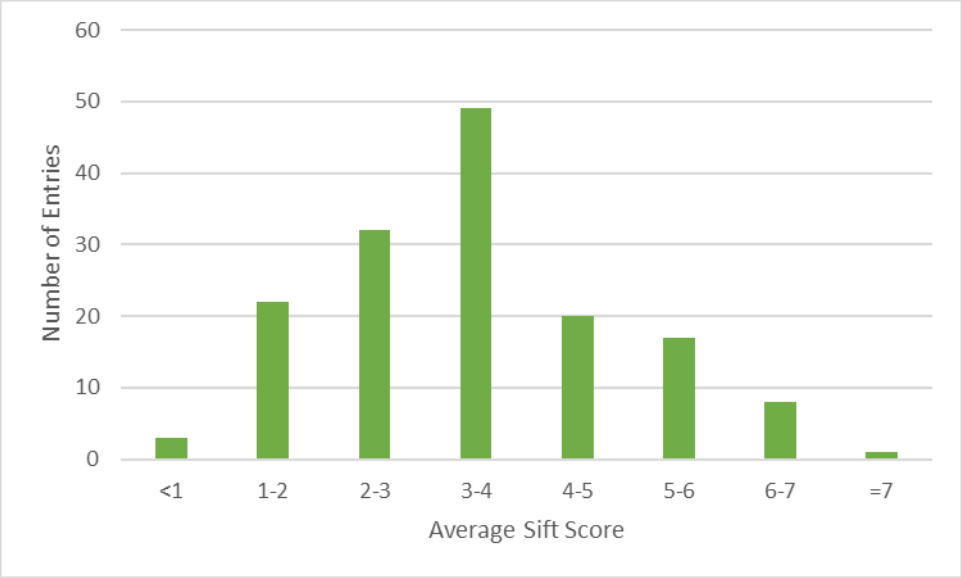

Figure 1: Distribution of averaged judges' scores in sift stage

The professional judges selected three stories as 1st, 2nd and 3rd prize winners. All three were members of the top 10 at first sift in 5th, 7th and 1st place respectively.

3 Observations on Entries

The competition simultaneously demonstrated a willingness on the part of writers to engage with the topic and highlighted some clear issues with understanding of the term 'environmental biotechnology'.

Many entries incorporated an EB element in an appropriate and sympathetic way integral to the story. Conversely, a small number of entries were out of remit for having made no effort to incorporate a microbial process (*3*) or breaching the requirements by, for example, submitting something other than a short story (*1*). A majority, however, demonstrated various misunderstandings and biases about EB. These are of interest to EBNet as they serve to indicate public attitudes to EB. After scoring it was therefore decided to look at the entries in a little more detail.

Entries were assessed by three methods. Firstly, for stories which scored low in the sift stage - below 4.4 (*121*) - the issue leading to this was identified (e.g. non-environmental focus/gross scientific inaccuracy). Secondly, all scored entries (*152*) were categorised according to the EB application appearing in the story (e.g. bioremediation, WWT, AD etc). Thirdly, for all available entries scored or unscored (*155*) a keyword search was carried out, noting terms ranging from the general ('environmental biotechnology') to the specialist/technical (e.g., 'mycorrhizal', 'heavy metal' etc).

The methods applied were very simple, and several caveats apply. The criteria used to define whether an entry is out-of-remit are least partly subjective, and judges' opinions differed in some cases. Some in-remit stories referred to multiple types of EB applications or processes, while others resisted

classification as they mentioned microbes in more general or artistic ways. In the keyword search, common terms could arise as part of the general background rather than referring to a specific EB context. Comments and categories are thus indicative only, but provided some interesting insights.

3.1 Remit

Stories that failed to progress to the second sift (121) could be clustered into major groups by primary story component as follows:

3.1.1 Medical focus

Approximately 17% (*21*) of these entries featured medicine and/or disease as the primary component. This rises to 20% if the three stories featuring eco-burials (microbes applied to biodegradation of human remains) are included.

Having sign-posted entrants towards information on what the term EB does and does not cover, it was surprising to see so many who clearly believed that catastrophic medical emergencies or pharmaceutical/human pro-biotic scenarios were within scope. This may indicate a confusion amongst the public about the primary goal of EB which is to protect both public health *and* the environment by preventing or remediating pollution, including from microbial pathogens. This misconception of equating EB with medicine and health care was widespread.

3.1.2 Profoundly negative view of microbes

Approximately 8% (10) of these entries gave a wholly or profoundly negative view of microbes or microbially-based technologies. This rises to approximately 12% (15) if the stories previously identified as 'medical' which were also profoundly negative are included. In addition, several hard-to-categorise stories were also quite negative in tone (e.g., fungi dissolving vandals or death caused by brain amoeba). Altogether about 15% could be considered as having a negative overall view. Given the nature of the competition and the briefing webinar, there was every incentive for entrants to endeavour to write positive stories. Despite that strong upfront guidance, many evidently simply could not conceive of EB in this way and persisted in writing primarily negative scenarios of microbes in general.

Previous Green Stories competitions have attempted to counter a perceived bias against microbes in, for example, use of sustainable green detergent. It appears, however, that there may be deeply embedded confusion and biases in the public mind concerning 'germs' and 'microbes'. The attempt to show good microbes dealing with bad pollutants requires more thought and effort, as the ideas of microbes and disease seem deeply entwined in a significant proportion of entrants' minds.

There were numerous examples of microbially-induced devastation of some kind. Some stories in this category then relied on a miraculous microbe to counteract a previous microbe-precipitated disaster. Others were simply wholly negative. It is interesting to speculate whether coverage of the science around Covid-19, or unease about the power of synthetic biology, have contributed to increase this in any way, or if the microbial disaster scenario has a longer history.

An outright hostile attitude was exemplified by one author who took the time to explain of a deeply nihilistic story: "I appreciate that this might not meet the tone of your anthology, I simply wish to

temper the enthusiasm for revolutionary technology when it may just as easily land in the hand of bloody minded counter-revolutionaries" – extract from story entitled 'Scum of the Earth'.

3.1.3 Unrealistic expectations

This grouping focused on unrealistic expectations including those which are simply impossible based on timescale or approach. Approximately 19% (23) of all entries used microbes and EB in an unrealistic way to solve complex problems almost magically. Other stories, whilst highly speculative, showed sufficient contextual understanding of the timescales and capabilities of EB to be at least nominally plausible.

In many stories with a 'hero'-style protagonist an all-purpose unspecified microbe is utilised which is able rapidly to fix all types of pollution. This may well reflect a lack of confidence/knowledge on the author's part, leading to a poor application of science within the story. In some cases, it could be seen as an example of the plot device known as a MacGuffin – where the EB element exists simply to drive the plot forward. There was no requirement for the story to feature in depth scientific knowledge and so such examples tell us little about the underlying assumptions of the author. In some cases, however, there were incorrect beliefs about the capacity of microbial systems to function in engineered systems and/or in the wider environment. Examples of impossible EB approaches are where a microbe rapidly degrades something like radiation or heavy metals or works instantly. The widespread occurrence of this issue begs the question: what other unrealistic beliefs do the public hold about EB? Determining this may have implications for future outreach/education efforts.

3.1.4 Irresponsible scientist/science

A small but concerning number of stories, comprising 7% (8), featured grossly unethical behaviour by scientists as if it were desirable/laudable or the norm. This was distinct from those stories where such behaviour was attributed to an antagonist or "baddie". To what extent this view of scientists and their activities is generally held by the public is unknown. It may in part reflect a storyteller's desire for an underdog/rebel protagonist. However future competitions of this nature might benefit from clarifying at the start what behaviours and expectations are considered the norm in scientific contexts so that outliers can be excluded from contention.

Such stories were a clear minority compared to the more common 'heroic scientist' trope. Nonetheless the ideas aired regarding reckless release of genetically modified organisms (GMO), deliberate evasion of regulations/laws, prioritising bioremediation over human lives, or unethical experimentation practices were a concerning minority presence. Whilst real-life practitioners are very aware of the tight regulations and ethical norms around topics like GMO release, it appears that some members of the public may hold a number of false beliefs which it would be helpful to identify in order to combat.

3.2 Applications of EB

Whether or not the term was explicitly used, bioremediation of existing contamination dominated, comprising about 40% of all entries. Most of these involved very broad or generalised applications, based on direct release of microbes into the soil/oceans and/or addressing multiple types of pollutant. Where the bioremediation efforts were specified more narrowly these were, from most to least common: plastic & microplastics/river pollution/oil pollution/air pollution.

After bioremediation the next most popular EB applications were in WWT settings, comprising approximately 10% of all entries. Minority applications of 5% or less were, from most to least common: GMOs/Biorefineries/AD/Landfill/Green House Gas (GHG) mitigation and Biomining. Some stories implied genetic modification in a non-specific way without it being essential to the plot: this may indicate a lack of understanding of the very wide range of processes and pathways that ordinary microbes can carry out, as well as of the limitations (both fundamental and regulatory) associated with the use of GM organisms and materials. It seems a section of the public finds microbes and microbial systems exciting and full of potential in some circumstances, but only when this involves genetic manipulation: this may represent an opportunity for education and outreach to offer a view that is both more positive and more realistic.

3.3 Keywords

A series of keywords and keyword clusters examined the mention of EB technology and applications more closely. To register, a word merely had to appear at least once within a story. For clusters of similar words usage varied within stories hence the breakdown quantities do not sum exactly. Some terms, whilst considered potentially useful, proved either non-specific and/or too common to search for using this basic technique (e.g., microbe/farm/plant).

155 stories were included in this analysis. A percentage (and absolute number) of stories in which the term appeared are reported for the following terms:

- Plastic (49)/microplastic (11) – **32%** (49)
- Waste water (7)/wastewater (17)/sewage (27) – **26%** (40)
- Mining (9)/metal (27) – **22%** (34)
- Medic (26)/pharma (6)/probiotic (2) – **21%** (32)
- Gene (4)/genetic (25)/GMO (2) - **18%** (28)
- Agric (for agricultural/agriculture) – **17%** (27)
- Environmental Biotechnology - **17%** (26)
- Fungi (23)/mycorrhizal (7) – **15%** (24)
- Bioremediation - **15%** (24)
- Compost – **14%** (21)
- Algae – **12%** (19)
- Anaerobic – **8%** (12)
- Radiation (5)/uranium (2) – **4%** (6)

Plastic and metal are examples of two potentially problematic terms as they are also used for some occasional non-EB sentences (e.g. a plastic bucket/ a metal spoon). Nonetheless this breakdown gives an indication of the range and frequency of terms employed by authors for this topic.

4 Conclusions and Future Lines of Enquiry

What have we learnt about the public perception of EB, as reflected by the contributions of the competition entrants? Firstly, when thinking about the environment, it was generalised bioremediation applications which dominated the pool of stories rather than specific process technologies. There are many opportunities in the waste chain where EB can be applied to prevent or reduce harm, with bioremediation of dispersed pollution being the least optimal point of intervention (Figure 2). Well established and effective EB technologies that intercept waste at intermediate points on the journey (such as WWT, AD, bioleaching, biorefineries, biosubstitution etc.) seem relatively unknown despite being core components of the discipline. This indicates some clear knowledge gaps for the EB community to fill.

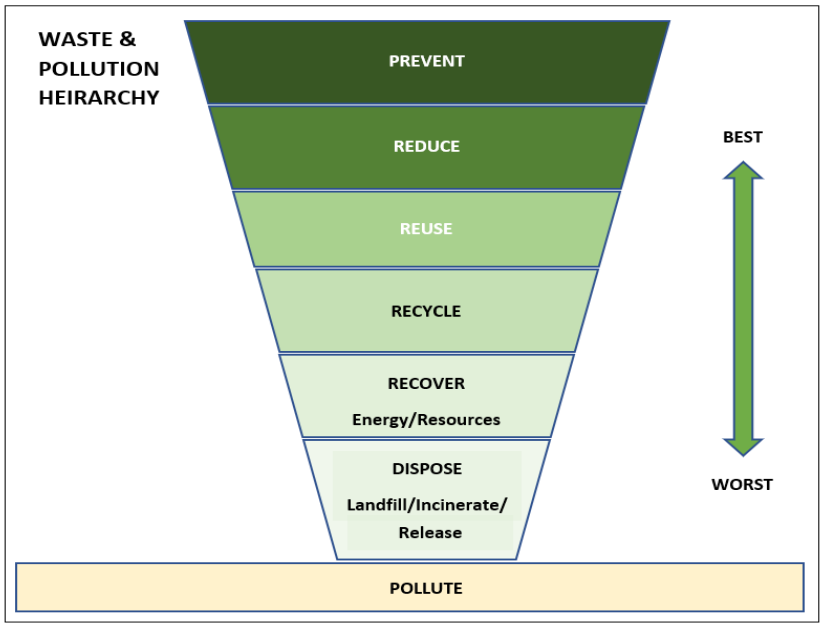

Figure 2: Illustration of the waste/pollution hierarchy.

The results reported here are from a small sample of writers and the context – an open competition – was not designed to collect statistically representative and robust information. The format of storytelling lends itself to conflict resolution and drama, so plots with a strong dynamic were to be expected. Nonetheless the aim was clearly stated in the title: *Microbes to the Rescue!*, and in all supporting guidance. That microbes were so frequently portrayed as the antagonist/antihero is therefore noteworthy. There seems to be a strong tendency amongst the public to conflate EB with medical biotechnology. In addition, many authors struggled with the idea of, or refused to come up with, positive storylines. And, where used, EB often tended to be ascribed almost magical powers rather than being grounded in a more realistic interpretation of the science.

The question is whether these observations reveal a unique insight into the perception of EB or whether they might occur in any unfamiliar scientific topic. Seen through this lens, perhaps unrealistic

expectations and lack of awareness about the science can be regarded as topic-independent. But the negative associations both with EB/microbes and scientific conduct, along with much confusion of EB with medical biotechnology, could be indicative of genuine public misunderstanding. If we want to quantify the prevalence and impact of such attitudes, it will require a more rigorous approach involving the social sciences.

Having identified potential errors in public understanding is there anything we can do to rectify this? Advances in the biosciences continue apace and EB – already a large sector of the economy through wastewater treatment, sustainable processes and biorefineries - will be expanding in capacity and capability in the future. Communication strategies based on robust social sciences research into the causes and impacts of these misapprehensions can only be beneficial. Our sector as a whole has a responsibility to increase public understanding of EB and to counter incorrect beliefs. It is ironic that the Green Stories project, which uses fiction to convey sustainability messages, is a good way to convey the non-fiction reality of the term EB.

Looking ahead we therefore see a need to identify the knowledge gaps/false beliefs and expectations/perceptions held towards the term EB (Appendix 1). The usefulness at a professional and scientific level of the term depends on a shared understanding. As the sector seeks to expand its reach, we should aim to tailor our outreach intelligently in response to pre-existing views and opinions.

Appendix 1 - Questions

1. Unexamined questions

This report is a brief overview of the results of the Green Stories competition and the analysis presented covers only some of a wide range of possible points of interest. Amongst the interesting questions left unexamined which might be of relevance to some members of the network were:

- How many stories could be allocated to other NIBBs?
- How many focused upon pollutants in the marine/river/soil/air environment?
- How many mentioned food waste?
- How many mentioned biosensors/biosurveillance/ or other specific related technologies?
- How many featured agriculture/agro-forestry, rather than EB?

Further work related to the short stories could include:

- To what extent can the impact of reading these themed stories be measured and quantified?
-

2. Outstanding questions

Based on this report EBNet are left with several outstanding questions of broad relevance to the network.

- To what extent do the public understand what the term EB means?
  - if the term EB does not have widespread recognition, what do people think it means?
  - do people recognise EB as a discipline?
  - do people recognise waste management and wastewater treatment as EB?
  - why do some people confuse EB with medicine/pharma?
  - do people assume EB deals predominantly with bioremediation?
  - do people think EB has to involve Genetic Modification (GM)?
- To what extent do the public understand how the various EB technologies work; or what they can and can't do?
- To what extent are the public misinformed about what scientists actually do in this sector?
- How might the sector better explain the term EB?

3. Suggested future activity

Two main points for future consideration by EBNet arise from this report.

The first is a renewed impetus to raise awareness on the part of the public about environmental protection and remediation in general. Intrinsic to this is to identify/counteract incorrect ideas and unrealistic expectations, which can be investigated further as exemplified in the questions above.

The second is to investigate further whether the term EB has any widespread recognition or accepted definition. How can the sector benefit from building a stronger recognition of the term to ensure it encompasses only relevant activities?