

RESEARCH LETTER – Professional Development

Using fiction to engage audiences with infectious disease: the effect of the coronavirus pandemic on participation in the Bad Bugs Bookclub

Joanna Verran^{*,†}

Department of Life Sciences, Manchester Metropolitan University, Manchester, UK

^{*}Corresponding author: Department of Life Sciences, Manchester Metropolitan University, Manchester, UK. E-mail: j.verran@mmu.ac.uk**One sentence summary:** The 'bad bugs bookclub' engages scientists and non-scientists in discussion about infectious disease, and meetings continued online during the coronavirus pandemic with more engagement than previously.

Editor: Beatrix Fahnert

[†]Joanna Verran, <http://orcid.org/0000-0002-5539-6896>

ABSTRACT

During Bad Bugs Bookclub meetings, scientists and non-scientists discuss novels in which infectious disease forms part of the plot in order to encourage public understanding of, and engagement with, microbiology. The website presents meeting reports and reading guides for over 70 novels. The aim of this work was to raise awareness of the bookclub and increase website engagement. In 2019, events designed to reach new audiences maintained an increase in page views from the end of 2018 (around 200 per month). In 2020, the coronavirus pandemic forced bookclub meetings online (Zoom). These, with podcasts and some Twitter discussion, increased page views with a peak of 400 per month. Membership increased, and global 'attendance' was facilitated. Feelings and observations related to each book and the pandemic were noted in meeting reports. A survey of current and previous bookclub members carried out early in lockdown with the aim of determining the future direction of the bookclub revealed the continuing value of both literary and scientific experiences to members. The bookclub has engaged scientists and non-scientists in meaningful discussion about infectious disease. Reach is modest, but the resource is significant, with potential impact in education and engagement.

Keywords: bookclub; public engagement; fiction; infectious disease; science literacy; online bookclub

INTRODUCTION

Perhaps there has never been a time where microbial science literacy (Timmis *et al.* 2019) is more important. Public audiences are faced with much, often contradictory, information regarding the coronavirus pandemic, as well as new language and terminologies. They are required to sift through a variety of outputs, and modify their behavior in accordance with their understanding of the risks involved.

Science capital—the science related knowledge and experience that an individual has—underpins (Archer *et al.* 2015) how new knowledge is assimilated, thus strong foundations

are essential. Working across disciplines such as art and literature provides a valuable means to enable science communication and audience engagement, making science more accessible and helping to build those foundations (Lesen, Rogan and Blum 2016).

The focus of this paper is on linking microbiology with fiction literature. Bookclubs enable discussion and engagement, often with focus on particular outputs/topics or genres, for example 'lab lit' focuses on realistic portrayals of scientists and related professions (lablit.com). Similarly, storytelling (Dahlstrom 2014) and poetry (Illingworth 2020) are used to engage audiences with science: both the scientists and their audiences benefit from

Received: 5 April 2021; Accepted: 8 June 2021

© The Author(s) 2021. Published by Oxford University Press on behalf of FEMS. All rights reserved. For permissions, please e-mail: journals.permissions@oup.com

these activities. Work of this nature encourages scientists to meditate on their subject (Dubos 1952) and enhances communication beyond their discipline. The shared interactions also help allay fears of science popularization and over-simplification (Scharrer *et al.* 2016).

The Bad Bugs Bookclub was established in 2009, with the intention of engaging scientists with non-scientists in discussion about infectious disease in an informal and supportive environment. It originated from teaching practice whereby art (including literature) was used as a medium to help undergraduate microbiology students to communicate their science (Verran 2010a), echoing the premise that fostering effective communication is integral to supporting deeper forms of learning (Brookfield 2015). The decision to launch the bookclub was taken with the support of the Manchester Beacon for Public Engagement (www.publicengagement.ac.uk/nccpe-projects-and-services/completed-projects/beacons-public-engagement) and the Society for Applied Microbiology (www.sfam.org.uk). The first events comprised a screening of the movie *Outbreak* (dir: Petersen 1995) during National Science Week 2009, followed by a discussion about *The Hot Zone* by Richard Preston (1994), held during the Society's Summer Conference. These two events were promoted via various email lists and websites. Around 60 people attended the screening, and eight came to the bookclub meeting, comprising a mix of microbiologists and non-microbiologists: the core of the subsequent reading group. Around half of this original group have remained members, with others attending for varying periods of time.

It was decided from the outset that the books read would be primarily fiction (in 2021, of 74 books, nine are non-fiction). Thus for all participants, the novel is the common denominator, providing a level platform with all members able to contribute to discussion, whether it be about the author, the plot or the disease. The focus has been on 'bad' bugs primarily due to the lack of fiction about 'good' ones. Pathogens provide a key plot device, and without aggression, there is little jeopardy. However, we did read appreciate the significant contribution made by microorganisms to the different ecological habitats in the spaceship en route to Aurora (by Kim Stanley Robinson [2015]).

Bookclub meetings, typically comprising up to eight members, are of around 90 min duration, take place around six times a year and meeting notes and reading guides are posted on the bookclub website (<https://www.mmu.ac.uk/engage/what-we-do/bad-bugs-bookclub/>). At any meeting, the date for the next meeting is agreed, along with the selected book. Anyone can suggest the next book: if more than one book is suggested, a vote is held (on-site or online). Email invitations for meetings are sent to existing bookclub members, but an open invitation is made on the website. The meeting format has remained unchanged. Questions are prepared by the bookclub leader (the author of this paper, JV), and are used to guide the discussion. When books have been suggested by other bookclub members, they preferred this structure, rather than leading the discussion themselves. The questions explore both the literary and scientific aspects of the novel, particularly focusing on the pathogen of concern (Verran 2019a). These questions are refined and then posted on the website as the 'reading guide'. The location, context and content of each meeting is written as a prose narrative, and posted on the website as a 'meeting report'. On occasion, meetings are coupled with other public engagement events, such as for World AIDS Day (Verran and Settingington 2010), Manchester Science Festival (Redfern *et al.* 2018) and National Science Week (Harper 2009). Joint meetings with other bookclubs have been hosted where appropriate (Verran *et al.* 2014). The bookclub format has also

been used to encourage literacy and discussion amongst biology and biomedical science undergraduates (Verran 2013; Verran 2019a), and for children's literature (Verran 2010b, 2015): the format has of course been used successfully elsewhere in science education (Calman *et al.* 1988, Aaronson 2008).

The Bad Bugs bookclub website provides a resource for those wishing to join the bookclub, set up their own bookclub, or use some of the suggested reading for existing bookclubs. Although the intended primary audience for the bookclub itself is adults interested in both science and reading fiction, the audience for the website would likely also include (science) academics or educators interested in using this route for science education/communication. The most obvious route for reaching this academic audience would be peer-reviewed articles, articles in professional magazines, conferences or social media. However, little proactive effort was made to promote the site (since there was no wish to increase the size of bookclub meetings), and page views were relatively few (in 2017, only around 10–20 per month). In 2018, numbers had increased, particularly if there were a bookclub meeting, and, spectacularly following a podcast entitled 'the zombie condition in literature' (wwwnc.cdc.gov/eic/podcasts/volume-24) complementing an article published in the journal *Emerging Infectious Disease* (Verran and Aldana Reyes 2018) where page views increased from 50 to 100 per month to almost 400. The article and podcast considered the value of using the zombie as a model pathogen and as a vehicle for discussing infectious disease with lay audiences. The absence of subclinical infection, combined with 100% transmission and 100% 'mortality' as well as changing zombie behavior in more modern literature provided a rich resource for public engagement.

By 2019, 10 years after the bookclub launch, it was felt that the resource, and format, should be promoted more widely as a tool for microbiology education and to encourage public engagement/science literacy. The aim of this work was to raise awareness of the bookclub and increase engagement. This paper reports on which activities (face-to-face activities in 2019, and online/social media—due to the coronavirus pandemic—in 2020) best improved reach and impact.

METHODS

2019 Activities and events

Regular bookclub meetings

The usual bookclub meetings took place throughout the year (Table 1). A more formal event comprised an author (Charles Egan) presentation (*The Killing Snows* [2012]) at the World Irish World Heritage Centre (www.iwhc.com) subsequent to the bookclub meeting.

Targeting isolated communities

Bookclub meetings and related events usually took place in more densely populated areas, predominantly cities, or in towns where science and literature festivals were well established. Meeting attendance is intentionally low, to enable discussion amongst the participants. To encourage engagement with more isolated communities, via discussion with a funding sponsor (www.sfam.org.uk), two festivals hosted at the extreme ends of the United Kingdom were selected, and organizers were asked if the bookclub could host an event (pre-funded).

The Penzance Literary Festival celebrated its tenth anniversary in July 2019. A talk about the bookclub was presented in

Table 1. Books read by the Bad Bugs Bookclub 2019–2020, plus additional novels noted in the text. Books read at the end of 2018 and the beginning of 2021 are included for context.

Year	Title	Author	Year	Focus	Event
2018	The Last Days of Smallpox	Mark Pallen	2018	Smallpox Birmingham outbreak	Discussion joined by author (Skype)
	The Last Man	Mary Shelley	1826	Apocalypse	
	Aurora	Kim Stanley Robinson	2015	Extended space travel	
2019	The Samurai's Garden	Gail Tsukiyama	1994	Leprosy	'Influenza: in fact and in fiction'. FEMS/Sfam Congress public event with author https://fems2019.org/scientific-programme/public-event
	The Death of Grass	John Christopher	1956	Plant pathogen apocalypse	
	The Health of Strangers	Lesley Kelly	2017	Influenza pandemic	
	Station Eleven	Emily St John Mandel	2014	Influenza apocalypse	
	Oryx and Crake	Margaret Atwood	2003	Post-apocalypse	
	A Lovely Way to Burn	Louise Welsh	2014	Post-apocalypse	
	World War Z	Max Brooks	2006	Zombies	
	Star of the Sea	Joseph O'Connor	2002	Irish potato famine	
The Island Nemesis	Victoria Hislop Philip Roth	2005 2010	Leprosy Polio		
The Killing Snows	Charles Egan	2012	Plant pathogen, Irish potato famine	FEMS Education summer school topic	
Nemesis	Philip Roth	2012	Polio	At Irish Centre Manchester, coupled with talk by author	
The Health of Strangers	Lesley Kelly	2017	Influenza pandemic	Cornish 'junior' bad bugs bookclub ESRC festival of Social Science, discussion joined by author (Skype)	

Table 1. Continued

Year	Title	Author	Year	Focus	Event
2020	Contagion	Robin Cook	1995	Nosocomial infections, murder	
	The Island	Victoria Hislop	2005	Leprosy	Cornish 'junior' bad bugs bookclub
	Fever 1793	Laurie Halse Anderson	2000	Yellow fever	World Book Day, National Science Week, Manchester Museum location for 'Beauty and the Beast' exhibition about insects.
	Arthur Mervyn, or Memoirs of the year 1793	Charles Brockden Brown	1799		
	Eyes of Darkness	Dean Koontz	1996	1918, influenza (plus 'experimental Chinese virus' [Koontz])	First Zoom meeting
	Pale Rider	Laura Spinney	2017		
	Pale Horse, Pale Rider	Katherine Anne Porter	1938		
	Not Forgetting the Whale	John Ironmonger		Influenza	Zoom discussion joined by author
	The Constant Gardener	John Le Carre		'bad pharma', tuberculosis, HIV	Zoom meeting followed by Twitter discussion
	The Waiting Rooms	Eve Smith		AMR	World Antimicrobial Awareness Week, Zoom discussion (2 meetings) and Twitter discussion joined by author
2021	Little Women	Louisa M Alcott			
	The Bone Garden	Tess Gerritsen		<i>Streptococcus pyogenes</i>	Zoom meeting
Additional novels noted in text	Moloka'i	Alan Brennert		Leprosy	Zoom meeting
	No Dominion	Louise Welsh	2018		
	Summer	Ali Smith	2020		
	The End of October	Lawrence Wright	2020		
The Animals in that Country	Laura Jean McKay	2020			

a 90 min slot as part of the festival programme, but it was not possible to schedule a more informal bookclub meeting.

The Orkney International Science Festival is one of the oldest science festivals in the UK, attracting international speakers and visitors across several days in early September. The Kirkwall library identified five novels from the bookclub canon (Table 1), and promoted these locally to encourage potential audience members to read one (or all) in advance.

Other events

The bookclub, and the links between infectious disease, history and literature, were discussed at several other festivals and events during the year (Table 2), as well as at conferences and the Summer School for Education of the Federation of European Microbiology Societies (FEMS).

2020 Activities and events

Regular bookclub meetings

The year began with two 'normal' bookclub meetings (Table 1). At the second meeting, early in March, there was a recognition that future meetings would likely be different due to the impending pandemic. In fact, of necessity, subsequent meetings took place online. Email invitations were sent to bookclub members with scheduled time links (Zoom), and a request to indicate if attendance was planned (in order to monitor numbers).

Online bookclub meetings

The format of the online bookclubs was similar to that of the face to face meetings, using pre-prepared questions to stimulate discussion. The number attending online tended to be slightly higher, but discussion flowed (with participants on 'mute' unless speaking), curated by the bookclub lead and there was no need to implement a 'hands up' protocol. The date for the following meeting was identified online, but the book selection was voted for over the next week, via email. Each member was always contacted individually, and was always asked if they felt they had contributed sufficiently to discussion (responses were always positive).

In all cases, meeting reports and reading guides were posted on the bookclub website as usual.

Since online meetings could accommodate a larger audience, meetings were also posted on Twitter as well as on the bookclub website.

Influenza

A suggested read for the next (May) meeting was *The Eyes of Darkness* by Dean Koontz (1996), the cover noting 'did this thriller predict the coronavirus outbreak?' However, as members began to read offline, it became apparent that the headline relied essentially on a few sentences towards the end of the novel. Thus, via email discussion, it was decided to supplement reading with two additional publications: Laura Spinney's non-fiction account of the 1918 influenza pandemic *Pale Rider* (2017), and *Pale Horse, Pale Rider* by Katherine Anne Porter (1938), a fictional account of an individual's experience of influenza during that time.

Online meetings were promoted through Twitter (in addition to the website), and facilitated author participation (the authors were tagged in meeting announcements). For example, in July (2020), John Ironmonger offered to join our discussions on his novel *Not Forgetting the Whale* (2015) as a result of seeing the Tweet.

Tuberculosis

As a break from virus pandemics, the next read was John Le Carre's *The Constant Gardener* (2001), a tale of espionage, clinical trials, murder, love and tuberculosis in Africa. The meeting took place on International Microorganism Day (<https://fems-microbiology.org/international-microorganism-day-2020/>), an event promoted by FEMS, and was advertised during a livestream video (https://www.youtube.com/watch?v=Y8H5_Ub5CFU&list=PLBp7JEYEInzScaQd5U7WDYG4XykuD2Ba&index=26&t=15s). The bookclub meeting was advertised by FEMS, who also offered a livestream platform so that the discussion could be viewed. However, it was decided that this might inhibit discussion: instead, the FEMS audience was encouraged to read the book, then join a Twitter discussion (#badbugsbookclub) hosted immediately after the bookclub meeting. Early in pandemic lockdown, the author had joined a dynamic Twitter chat about Spinney's *Pale Rider* (#sschatreads). The format requires the host to release around seven questions at regular intervals across an hour, which are then open for discussion (Urban, Morales and Kennedy 2020).

Antimicrobial Resistance (AMR)

World Antimicrobial Awareness Week (November) provided a perfect vehicle for advertising a discussion about AMR using *The Waiting Rooms* by Eve Smith (2020). Set in a fictional near-contemporary England, the novel provides a harrowing narrative about how governments cope with global antimicrobial resistance—for example by denying antibiotics to anyone over the age of 70. Again, the author offered to join the meeting, having seen it advertised (and her name tagged) on Twitter. The bookclub and subsequent Twitter discussion was promoted by FEMS and other organizations (Society for Applied Microbiology, Microbiology Society, British Society for Antimicrobial Chemotherapy) and through the author contacting individual academics and organizations known to be active in public engagement around AMR, encouraging them to set up their own bookclubs for the event.

Other events

Before coronavirus lockdown, the author (JV) was invited to attend the second meeting of the Cornish 'Junior' bookclub, established in 2019. This meeting was facilitated by kick-start funding awarded to the secondary school teacher from the British Science Association. The bookclub was also promoted during a number of online events during the latter part of 2020 (Table 2).

Member survey

After 10 years of bookclub meetings, in 2020 it was decided to review members' attitudes towards the bookclub, and to decide how best to proceed with future meetings. A brief online survey was circulated (<https://mmu.onlinesurveys.ac.uk>). The author (JV) had maintained a small database of email addresses of past and present members, so that details of forthcoming bookclub meetings could be sent. Each contact was emailed individually by the author, who asked permission to send the survey. Questions asked what kept current members attending, why previous members left, how future meetings could be organized, whether the website could be improved, and what their favorite/least favorite books had been. Respondents were also

Table 2. Events where the Bad Bugs bookclub was discussed 2019–2020.

Year	Event	Type of event	Link/ref
2019	Penzance Literary Festival	Talk	https://www.pzlitfest.co.uk/event/the-bad-bugs-bookclub-using-fiction-to-engage-with-science-with-joanna-verran-pch31/
	Orkney International Science Festival	Talk and discussion	http://oisf.org/fest-event/the-bad-bugs-book-club/
	Bradford Literature Festival	Panel discussion on ‘inevitable epidemics’ with Mark Honigsbaum and John Mitchinson	https://www.bradfordlitfest.co.uk/event/inevitable-epidemics/
	Cheltenham Science Festival	Radio Gloucester broadcast for Jo Durrant’s beautiful universe, and Bad Bugs Bookclub: I am Legend.	https://issuu.com/cheltenhamfestivals/docs/science_festival_2019_brochure
	Cheltenham Science Festival	Drop-in session.	https://issuu.com/cheltenhamfestivals/docs/science_festival_2019_brochure
	MIF panel	Panel discussion on ‘sanitizing the working class’	https://mif.co.uk/the-origins-of-a-drunk-pandemic/
	Gothic Manchester Festival	Workshop for young people: Bad Bugs –zombie outbreak	https://www.visitmanchester.com/whats-on/bad-bugs-zombie-outbreak-play-and-read-p423911
2020	Dr Jenner’s House Discovery Day	Science Communication 101 panel discussion (video)	https://www.youtube.com/watch?v=LgUjvfw8z0
	Small screen science	Podcast	Season 2 episode 2 ‘zombie apocalypse science’. https://www.smallscreenscience.co.uk/ep2-walking-apocalypse-dead-apocalypse-science
	Jo Durrant’s Beautiful Universe	Podcast	Jodurrantsbeautifuluniverse.libsyn.com
	JDBU Xmas		Episodes 7 and 12.
	Learning and Teaching in Higher Education #LTHEchat	Twitter discussion: the value of fiction in learning and teaching	LTHEchat.com LTHEchat186 (Wakelet.com)

asked whether their knowledge of infectious disease, or of literature had changed.

Ethics statement

The survey was not carried out as part of a research project, but to help plan the future of the bookclub. Therefore, advice regarding secondary use of data provided by the British Educational Research Association Ethical Guidelines for Educational Research (BERA 2018) was implemented: this included anonymizing data and seeking consent for inclusion of findings in this paper. Each of the survey recipients was sent the text used in this paper, and was asked if they had any objections to its inclusion. There were no objections.

RESULTS

2019 Activities and events

Regular Bookclub meetings

Bookclub meetings took place as usual—a small group meeting in a public venue—with reports and reading guides posted on the bookclub website. The author presentation at the World Irish Centre in Manchester attracted around 70 people, but numbers for the preceding bookclub meeting were small.

Targeting isolated communities

At the Penzance Literary Festival, the venue was comfortably busy, with around 25 in the audience. The talk was well-received with some markers of engagement. The host of the event noted ‘how welcome it was to see literature and science linked once more as they would have been until the 19th century separation’

(Verran 2019b). All commemorative bookmarks were taken; one person took notes, another suggested the talk should be made into a book; questions included ‘do you ever get authors fact-checking?’; ‘what is AMR?’ A spinoff ‘Junior’ bookclub was established for Years 10 and 11 students at the local secondary school. Its first meeting (Nemesis by Philip Roth [2010]) was held in November, with JV in attendance: student feedback was positive, for example ‘you can meet other people and discuss the same book because everyone interprets the book differently and it’s interesting to see what other people thought. And also because we’re reading about science books I’ve learnt about polio which is pretty cool. A book club is a great idea because you can find new books, learn new things and other ideas’.

The advertising that the Kirkwall library organized attracted an audience of around 30. The first half of the event comprised a summary of the bookclub aims and progress, and in the second part each of the five suggested books was considered. This prior reading experience provided a useful hook for discussion during the hour-long session. Representatives of a local bookclub brought suggestions for further reading, in particular recommending the remainder of the Louise Welsh trilogy because the third book (No Dominion [2017]) was set on Orkney. There was no evidence of any subsequent related activity.

Other events

Despite the many direct encounters (estimated total audience approaching 300) with audiences across the year, and despite their obvious enjoyment and active participation, it was not easy to assess any major impact.

2020 Activities and events

Normal meetings

In total, two new members joined the group for the second bookclub meeting that focused on yellow fever, learning about the event via the Manchester Museum. Despite the general but vague concern circulating about coronavirus, this was a pleasant face to face social event, with refreshments provided by the Manchester Museum and cakes cooked according to a 1793 recipe (described in one of the books).

The Cornish 'Junior' Bad Bugs Bookclub hosted its second meeting two weeks prior to lockdown, discussing *The Island* by Victoria Hislop (2005). Funding from the British Science Association's kick-start grant enabled purchase of multiple copies of the book, JV's attendance and the provision of a Greek meze. Aware of the continuing growth of the pandemic in the UK, ventilation was increased, social distancing observed and sanitizers provided.

Online meetings

The bookclub became more international, having members from California (one of whom had made contact via the Facebook page of the Irish author Charles Egan after the 2019 event) and the Netherlands joining the discussion, as well as from other parts of the UK. As news of the bookclub spread through social media and online events, more contacts were made and numbers attending the meetings increased. The maximum number joining a successful and interactive Zoom discussion was twelve. In addition, for each book, the group was able to identify aspects that mapped onto the phase of the pandemic being experienced at the time (see website meeting reports for more details).

Influenza

The first Zoom meeting proved successful: the format enabled all participants to speak (occasionally face-to-face meetings in pubs broke down into smaller discussions), and of course it was easy to 'get to' the meeting, irrespective of where home was. There was a general sense of mutual support during the meeting: experiences of the early stages of coronavirus lockdown were exchanged, and compared with those of the 1918 pandemic described in Spinney's book *Pale Rider*.

When discussing *Not Forgetting the Whale*, the story of how a small isolated Cornish community coped with an influenza pandemic, really resonated with the group. In particular, it was heartening to read about, and discuss, how communities and individuals were supporting one another.

Tuberculosis

A committed and enthusiastic readership ensured interactive and stimulating discussion. For the bookclub meeting, clinical trials provided an interesting and timely discussion as new treatments and vaccines for SARS-CoV-2 were being developed. For the Twitter discussion however, participation was limited.

AMR

With regards to coronavirus, the group was able to reflect on the segregation of older members of the population in care homes, and the heartlessness of the 'herd immunity' debate, whereby the more susceptible populations were isolated, and the virus

could 'let rip' through the rest of the population (the Great Barington Declaration was noted [<https://gbdeclaration.org>]). The impact of social distancing (non-touching) was relevant for AMR as well as for during the pandemic, and the reminder that AMR remains a significant and increasing 'silent pandemic' was pertinent (Spinney 2017).

Not only did an overspill Zoom meeting have to be arranged, but a parallel bad bugs bookclub was hosted in Vienna. The Twitter discussion (#badbugsbookclub) was vibrant, with several participants from scientific and/or literature/publishing backgrounds, and a very clear peak in hashtag hits was observed, with 1 003 101 impressions, a reach of 270 289, 74 users and 227 posts (<https://keyhole.co/hashtag-tracking/dashboard/PwfpT8/badbugsbookclub?shareHash=NtrMvr>).

It was interesting to note that through sharing the Twitter discussion with the author, the format of questions needed to be changed: previously the host asked questions, but this time questions were also invited from participants—to the author as well as to the scientists.

Other events

It was not easy to source the numbers of listeners/downloads from the various podcasts, in some cases because the owners wished to keep the information confidential, but there were certainly a few hundred audience members in total.

Author participation

An unexpected benefit in the shift to online bookclub meetings was that two authors offered to take part in the discussion (another two had been invited to join in meetings prior to the pandemic). We arranged that they join with us half way through the session, so that the group could enjoy their normal conversations, and also identify topics they might want to explore with the author.

Author feedback showed that they appreciated the meetings as much as the bookclub members valued their contributions. For example, Eve Smith, author of *The Waiting Rooms* said: 'As a debut author who has written a book based on disease and antibiotic resistance, it was hugely helpful for me to hear what a community of microbiology experts thought about the book, how true to scientific life it was, and how effectively (or not!) it engaged readers in important health issues, during the bookclub discussion. The questions were both useful and enjoyable. The following Twitter Q&A then enabled a broader engagement with members of the public via social media, who were able to join in the discussion about AMR, disease and other topics that came up, in a way that was both entertaining and accessible: something I believe to be important, as people can struggle with scientific concepts that they find hard to grasp. The Q&A enabled readers from different backgrounds, cultures and countries to come together and explore the ideas of the book with input from experts as well as the author. From the responses I saw on Twitter, the Q&A went down very well'.

For John Ironmonger, author of *Not Forgetting the Whale*: 'It felt a little intimidating to be meeting with a group who deal only with pandemic stories, and I was expecting to have my fictional pandemic roundly demolished by the experts. Thankfully, this did not happen. The group quizzed me in some detail about the nature of the crisis and the biology of the 'flu' bug in the story, but they were broadly generous about the ideas, and not at all critical about the general conceit. In the event, the group was as curious about the non-pandemic aspects of the story as they were about the disease, and once the conversation around the pandemic had been exhausted, it could have been any book

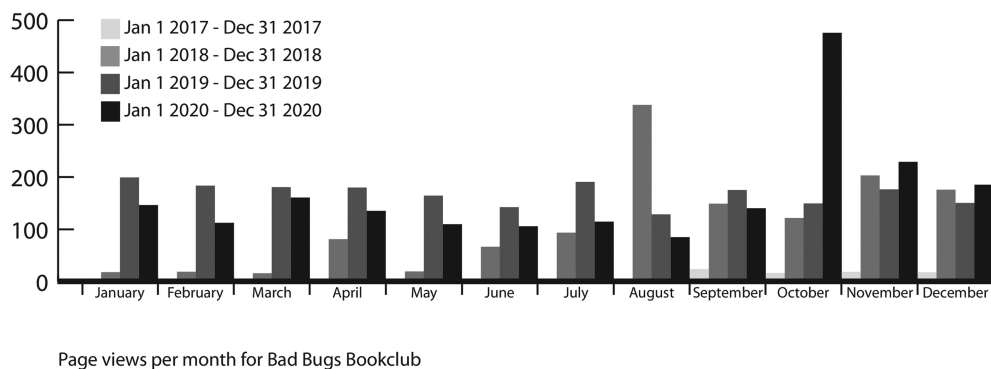


Figure 1. Page views for the Bad Bugs Bookclub website 2017–2020.

group anywhere with an interest in character development, and storyline, and all of the other features of a modern novel. Overall it was great fun, and I enjoyed meeting the group (virtually, of course).

Subsequent to these meetings, emails from bookclub members noted how privileged they felt to have been able to discuss the books with the authors.

Overview of page views

There was a clear increase in website page views (via Google Analytics) between 2017 and 2020 (Fig. 1). Despite the very low numbers for 2017 (data not available prior to September), there was a slight increase in October, perhaps due to attention via the Manchester Science Festival. Otherwise, across subsequent years, small increases in views were apparent co-incident with bookclub meetings (typically January, March, May, July, September and November). The largest increases in page views coincided with online events, in August 2018 with a CDC podcast (vide supra), in July 2019 probably with the Bradford, Penzance and Cheltenham festivals, in September with the Orkney festival, and conference/summer school presentations. In 2020, there was a significant October peak, likely corresponding to a series of podcasts and Twitter discussions that took place then. Overall, since the end of 2018 and through 2019 and 2020, page views were consistently around 200 per month.

Members survey—qualitative/impact

In total, 33 surveys were dispatched, and 19 responses were received, collected and presented to the author on an Excel spreadsheet so that responders could not be identified (i.e. anonymous). Of those, 11 were scientists and eight non-scientists (when asked for identifiers). Overall, responses were positive. When asked why they had joined the bookclub, ten responses included the word ‘interest’—in addition ‘enjoy’, ‘love’ and ‘fascination’ were utilized. ‘I always had a great time surrounded by good company in a convivial and respectful atmosphere’.

For those past members who no longer attended, two had moved from the area, and two encountered travel difficulties (‘What a group! Real experts and ideas for new books. I stopped because of travel difficulties’). Another left temporarily due to caring responsibilities.

Almost predicting the forthcoming changes, suggestions for online sessions were made: ‘seeing how easy it is to do things remotely I would continue to attend if they were run remotely’, and ‘I think if there were options for Skype/Zoom meetings too that might help those who would struggle to meet face to face’.

When asked what kept them coming to meetings, ‘interest’ (three responses), ‘enjoyment’ (five), ‘encouragement’ (one) and ‘social aspects’ (four) were noted. In more detail:

- I enjoy the conversations and diversity of perspectives from the group.
- It’s a delightful atmosphere and we’ve met in some interesting venues. And educational too—what more could I wish for!
- I really enjoyed hearing from microbiologist experts what was invented/real.

A particular focus for the survey was what non-scientists had learned about microbes, diseases, infection and infection control. Has their understanding or behavior changed in any way?

- I learned things at the time which I’m sure I’ve forgotten the majority of! Though occasionally I’ll have a little nugget of insight on microbiology which could only have come from BBBC (‘Bad Bugs Bookclub’).
- Probably stuff that’s specific to individual viruses (rabies, flue [sic]). I certainly have a much better understanding of contagion patterns and containment than I did before.
- I learned that the challenges of the past are still very much the challenges of the present and are likely to be the challenges of the future.
- Wider appreciation of interactions between outbreaks and community.

From scientists, the fictional aspect had proved useful:

- I do think it has enriched the way I teach, as I can bring the human stories behind infectious diseases into my lessons and make it more accessible, relevant and interesting to my students.
- My understanding has not really changed because I was in the field anyway but I am more aware of its use in literature and whether it has been used well or not.

Indeed, for many respondents, the bookclub had had some impact on reading of fiction:

- I have now read books that I would not have otherwise come across and I feel like I am reading fiction more critically
- I think that it expands your reading list outside of books you would usually read

Since so many books had been read, further questions searched for most memorable meeting (since on many occasions, additional events took place), favorite book and worst book. Responses reflected the diverse interests and experiences of members. There were 16 different books listed for ‘most memorable meeting’ (one book with three votes, two books with

two); again (a different) 16 favorite books were listed three books with two votes). There were even twelve different 'least favorite' books (two books with two votes).

Finally, although six respondents felt that the website was acceptable, there were useful suggestions for improvement: an improved search function, a more interesting home page (less HEI-focused, more interactive), mobile optimized; brief introduction to each book; star-ratings for each book. A request for more online events was satisfied courtesy of coronavirus.

DISCUSSION

The impact of the coronavirus pandemic on the Bad Bugs Bookclub has been significant, forcing a complete change in the mode of delivery, as well as driving a more critical review of its value and success. A wide variety of delivery methods and analytic tools were used to investigate reach and impact, but information acquired in this context tended to be quantitative. It is perhaps not surprising that the use of social media and online events increased the reach of the bookclub. The survey carried out to assess the value of the bookclub to its members generated more qualitative data, providing a subjective and emotional dimension to feedback from both scientists and non-scientists (as well as to authors). At meetings, participants have been able to discuss their experiences of social distancing, lockdown, isolation and community spirit in the context of the (non-coronavirus) novels being discussed, alongside more scientific and even political concerns around clinical trials, prejudice, population segmentation and the news. The contributions of members of different ages, and from different countries at different stages of the pandemic, enabled different perspectives of the pandemic to be considered, for example regarding lockdown and vaccine implementation. This unique and unwanted global situation meant that we were all learning together, as a diverse group that would otherwise not have met. It has been heartening and comforting to engage in these conversations.

As yet only one novel has dealt directly with coronavirus, although there has been a flurry of related publications: Ali Smith's *Summer* (2020) is set in a world where coronavirus lockdown, sanitizers and social distancing are background to the plot. Some excellent non-fiction publications about emerging diseases have been updated (Honigsbaum 2020); experts in accessible narratives about the 1918 influenza pandemic are in great demand from the media (Spinney 2017); and some publications arrived just in time for a coronavirus slant to be included (for example Roberts 2020). Otherwise, new novels about influenza pandemics have provided a more familiar backdrop to fiction of interest to the Bad Bugs Bookclub (McKay 2020; Wright 2020). Reading about microorganisms other than viruses does however, provide a welcome break!

To satisfy national and international interest, the Bad Bugs Bookclub will continue as an online presence, but the face-to-face local meetings will also likely return in due course. Demand remains for the meetings amongst its members, and the amount of available relevant reading material is still significant. It is hoped that the higher profile and reach of the bookclub that have occurred as an indirect result of the coronavirus pandemic will attract a larger and broader audience, and encourage the formation of more bookclubs.

CONCLUSION

Both reach and impact of the bookclub increased across 2 years of this study, but social media and online activities enabled

much wider reach on an international basis, providing evidence and opportunity for planning future direction.

The Bad Bugs Bookclub continues to provide a valuable resource to its members, whose positive feedback (and continuing membership) shows that the bookclub is a useful platform for intense, intimate discussion about pathogenicity, epidemiology and treatment of infectious disease, as well as a vehicle for discovering new literature. For a bookclub leader, despite the current relatively small but loyal audience that is directly impacted by the bookclub, the quality of these interactions are significant and enriching. There are many rewards associated with running a bookclub of this sort, in terms of science literacy, microbial literacy—and literacy in general. The website resource is freely available.

ACKNOWLEDGMENTS

The author would like to thank the Society for Applied Microbiology for funding for the key 2019 events (travel to Penzance Literary Festival, and Orkney International Science Festival, author Charles Egan travel and presentation, purchases of multiple copies of books etc.) through its Public Engagement grant scheme. In addition, funding received from the AAAS for the 2019 Mani L Bhaumik Public Engagement with Science award supported various additional related activities. Thanks also to the Microbiology Society, who celebrated its 75th anniversary in 2020, and, in collaboration with the author (JV), adapted and promoted the Bad Bugs Bookclub format whilst setting up its own version (<https://microbiologysociety.org/our-work/75th-anniversary-microbiology-book-club.html>). Special thanks to all bookclub members, past and present.

FUNDING

As noted in Acknowledgments.

Conflicts of interest. None declared.

REFERENCES

- Aaronson L. The 'novel' approach: popular fiction as a teaching tool in undergraduate microbiology courses. *Focus Microbiol Educ* 2008;15:2–3.
- Archer L, Dawson E, DeWitt J et al. 'Science Capital': a conceptual, methodological, and empirical argument for extending bourgeois notions of capital beyond the arts. *J Res Sci Teach* 2015;52:922–48.
- BERA, *Ethical Guidelines for Educational Research* London: British educational Research Association, 2018.
- Brookfield SD. Teaching students to think critically about social media. *New Direct Teach Learn* 2015;2015:47–56.
- Calman KC, Downie RS, Duthie M et al. Literature and medicine: a short course for medical students. *Med Educ* 1988;22:265–9.
- Dahlstrom MF. Using narratives and storytelling to communicate science to non-expert audiences. *Proc Natl Acad Sci* 2014;111:13614–20.
- Dubos RJ. Microbiology in fable and art. *Bacteriol Rev* 1952;16:145–51.
- Harper L. Bad Bugs Bookclub. *Microbiologist* 2009;10:26.
- Honigsbaum M. *The Pandemic Century: A history of global contagion from Spanish flu to covid-19*, 2020, London: Penguin.
- Illingworth S. Creative communication – using poetry and games to generate dialogue between scientists and non-scientists. *FEBS Lett* 2020;594:2333–8.

- Lesen AE, Rogan A, Blum MJ. Science communication through art: objectives, challenges and outcomes. *Trends Ecol Evol* 2016;**31**:657–60.
- Redfern J, Bowater L, Crossley M et al. Spreading the message of antimicrobial resistance: a detailed account of a successful public engagement event. *FEMS Microbiol Lett* 2018;**365**. DOI: 10.1093/femsle/fny175.
- Roberts A. *It's the End of the World. But What are We Really Afraid Of?* 2020, London: Elliott and Thompson Limited.
- Scharrer L, Rupieper Y, Stadler M et al. When science becomes too easy: science popularisation inclines lay people to underestimate their dependence on experts. *Pub Underst Sci* 2016;**1**–16, DOI: 10.1177/0963662516680311.
- Timmis K, Cavicchioli R, Garcia JL et al. The urgent need for microbiology literacy in society. *Environ Microbiol* 2019;**21**:1513–28.
- Urban D, Morales I, Kennedy K. #Sschatreads: creating a Twitter book club for social studies teachers. *J Mid State Council Soc Stud* 2020;**2**:8–14. 9A Publication for the Middle States Council for the Social Studies, ISSN 0739-80690.
- Verran J, Aldana Reyes X. Emerging infectious literatures and the zombie condition. *Emerg Infect Dis* 2018;**24**:1774–8.
- Verran J, Crossley M, Carolan K et al. Monsters, microbiology and mathematics: the epidemiology of a zombie apocalypse. *J Biol Educ* 2014;**48**:98–104.
- Verran J, Settingington L. Stitch in time saves lives. *Microbiol Today* 2010;**37**:54–5.
- Verran J. Encouraging creativity and transferable skills in undergraduate microbiologists. *Trends Microbio* 2010a;**18**:56–8.
- Verran J. The Bad Bugs Bookclub: science, literacy and enjoyment. *J Microbio Biol Educ* 2013;**14**:110–2.
- Verran J. The Bad Bugs Bookclub: tenth anniversary celebrations. *Microbiologist* 2019b;**20**:38–41.
- Verran J. The microbiology of vampires. *Microbiol Today* 2010b;**37**:248–9.
- Verran J. The tale of the 13-week-old cheese and pickled egg sandwich. *Microbiol Today* 2015;**42**:17.
- Verran J. The use of a bookclub to enhance science literacy and understanding of infectious disease epidemiology. In: Jarvis C, Gouthro P (eds), *Professional Education with Fiction Media: Imagination, Engagement and Empathy in Learning*. London: Palgrave Macmillan. 2019a, 129–57.