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

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1 Using fiction to engage audiences with infectious disease: the effect of the coronavirus
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11 bookclub

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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.

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 behaviour 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 et al., 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, 2015) and poetry (Illingworth, 2020) are used to engage audiences with science: both the scientists and their audiences benefit from 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 popularisation 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 minutes 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 2015, 2010b): the format has of course been used successfully elsewhere in science education (Aaronson, 2008, Calman et al., 1988).

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 – 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 behaviour in more modern literature provided a rich resource for public engagement.

By 2019, ten 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 1a). 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 organisers 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 a 90 minute 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

151 Kirkwall library identified five novels from the bookclub canon (Table 1), and promoted
152 these locally to encourage potential audience members to read one (or all) in advance.

153 *Other events*

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

158 **2020 Activities and events**

159 *Regular bookclub meetings*

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

165 *Online bookclub meetings*

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

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

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

177 *Influenza*

178 A suggested read for the next (May) meeting was *The Eyes of Darkness* by Dean Koontz
179 (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=PLaBp7JEYEInzScAQd5U7WDYG4XykuD2Ba&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 et al., 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 organisations (Society for Applied Microbiology, Microbiology Society, British Society for Antimicrobial Chemotherapy), and through the author contacting individual academics and organisations 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 ten 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 organised, whether the website could be improved, and what their favourite/least favourite books had been. Respondents were also 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 anonymising 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 organised 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

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

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

284 *Online meetings*

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

293 *Influenza*

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

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

304 Tuberculosis

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

309 AMR

310 With regards to coronavirus, the group was able to reflect on the segregation of older
311 members of the population in care homes, and the heartlessness of the ‘herd immunity’
312 debate, whereby the more susceptible populations were isolated, and the virus could ‘let rip’
313 through the rest of the population (the Great Barrington Declaration was noted
314 [<https://gbdeclaration.org>]). The impact of social distancing (non-touching) was relevant for
315 AMR as well as for during the pandemic, and the reminder that AMR remains a significant
316 and increasing ‘silent pandemic’ was pertinent (Spinney, 2017).

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

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

326 *Other events*

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

330 *Author participation*

331 An unexpected benefit in the shift to online bookclub meetings was that two authors offered
332 to take part in the discussion (another two had been invited to join in meetings prior to the
333 pandemic). We arranged that they join with us half way through the session, so that the group

1
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3 334 could enjoy their normal conversations, and also identify topics they might want to explore
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5 335 with the author.
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7 336 Author feedback showed that they appreciated the meetings as much as the bookclub
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9 337 members valued their contributions. For example, Eve Smith, author of *The Waiting Rooms*
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11 338 said: ‘As a debut author who has written a book based on disease and antibiotic resistance, it
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13 339 was hugely helpful for me to hear what a community of microbiology experts thought about
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15 340 the book, how true to scientific life it was, and how effectively (or not!) it engaged readers in
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17 341 important health issues, during the bookclub discussion. The questions were both useful and
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19 342 enjoyable. The following Twitter Q&A then enabled a broader engagement with members of
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21 343 the public via social media, who were able to join in the discussion about AMR, disease and
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23 344 other topics that came up, in a way that was both entertaining and accessible: something I
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25 345 believe to be important, as people can struggle with scientific concepts that they find hard to
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27 346 grasp. The Q&A enabled readers from different backgrounds, cultures and countries to come
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29 347 together and explore the ideas of the book with input from experts as well as the author. From
30
31 348 the responses I saw on Twitter, the Q&A went down very well’.

32 349 For John Ironmonger, author of *Not Forgetting the Whale*: ‘It felt a little intimidating to be
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34 350 meeting with a group who deal only with pandemic stories, and I was expecting to have my
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36 351 fictional pandemic roundly demolished by the experts. Thankfully this didn’t happen. The
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38 352 group quizzed me in some detail about the nature of the crisis and the biology of the ‘flu’ bug
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40 353 in the story, but they were broadly generous about the ideas, and not at all critical about the
41
42 354 general conceit. In the event, the group was as curious about the non-pandemic aspects of the
43
44 355 story as they were about the disease, and once the conversation around the pandemic had
45
46 356 been exhausted, it could have been any book group anywhere with an interest in character
47
48 357 development, and storyline, and all of the other features of a modern novel. Overall it was
49
50 358 great fun, and I enjoyed meeting the group (virtually, of course)’.

51
52 359 Subsequent to these meetings, emails from bookclub members noted how privileged they
53
54 360 felt to have been able to discuss the books with the authors.

55 361 *Overview of page views*
56
57 362 There was a clear increase in website page views (via Google Analytics) between 2017 and
58
59 363 2020 (Figure 1). Despite the very low numbers for 2017 (data not available prior to
60
364 September), there was a slight increase in October, perhaps due to attention via the
365 Manchester Science Festival. Otherwise, across subsequent years, small increases in views

were apparent co-incident with bookclub meetings (typically January, March, May, July, September, November). The largest increases in page views co-incident 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 (ie anonymous). Of those, eleven 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 utilised. ‘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.

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

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

408 From scientists, the fictional aspect had proved useful:

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

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

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

418 Since so many books had been read, further questions searched for most memorable meeting
419 (since on many occasions, additional events took place), favourite book and worst book.

420 Responses reflected the diverse interests and experiences of members. There were 16
421 different books listed for 'most memorable meeting' (one book with three votes, two books
422 with two); again (a different) 16 favourite books were listed three books with two votes).
423 There were even twelve different 'least favourite' books (two books with two votes).

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

428 Discussion

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

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

456 To satisfy national and international interest, the Bad Bugs Bookclub will continue as an
457 online presence, but the face-to-face local meetings will also likely return in due course.
458 Demand remains for the meetings amongst its members, and the amount of available relevant
459 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 the two 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.

Acknowledgements

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>).

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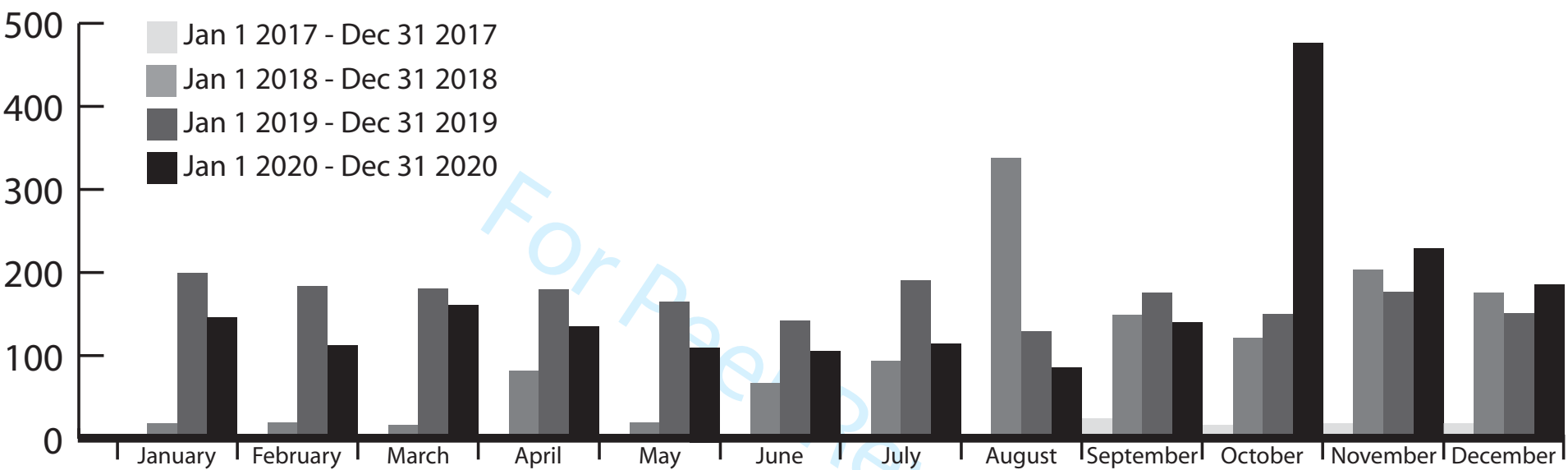
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- Table 1: Books read by the Bad Bugs Bookclub 2019 – 2020, plus additional novels noted in the text. Books read at the end of 2018 and the beginning of 2021 are included for context.
- Table 2: Events where the Bad Bugs bookclub was discussed 2019 - 2020
- Figure 1: Page views for the Bad Bugs Bookclub website 2017 - 2020

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.

Table 2: Events where the Bad Bugs bookclub was discussed 2019 - 2020

Figure 1: Page views for the Bad Bugs Bookclub website 2017 - 2020

For Peer Review



Page views per month for Bad Bugs Bookclub

Fig. 1

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	
	The Death of Grass	John Christopher	1956	Plant pathogen apocalypse	
	The Health of Strangers	Lesley Kelly	2017	Influenza pandemic	'Influenza: in fact and in fiction'. FEMS/Sfam Congress public event with author https://fems2019.org/scientific-programme/public-event
	Station Eleven	Emily St John Mandel	2014	Influenza apocalypse	
	Oryx and Crake	Margaret Atwood	2003	Post-apocalypse	In partnership with Kirkwall library for Orkney International Science festival.
	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	Victoria Hislop	2005	Leprosy	
	Nemesis	Philip Roth	2010	Polio	FEMS Education summer school topic
	The Killing Snows	Charles Egan	2012	Plant pathogen, Irish potato famine	At Irish Centre Manchester, coupled with talk by author
	Nemesis	Philip Roth	2012	Polio	Cornish 'Junior' bad

					bugs bookclub
	The Health of Strangers	Lesley Kelly	2017	Influenza pandemic	ESRC festival of Social Science, discussion joined by author (Skype)
2020	Contagion	Robin Cook	1995	Nosocomial infections, murder	
	The Island	Victoria Hislop	2005	Leprosy	Cornish 'Junior' bad bugs bookclub
	Fever 1793 Arthur Mervyn, or Memoirs of the year 1793	Laurie Halse Anderson Charles Brockden Brown	2000 1799	Yellow fever	World Book Day, National Science Week, Manchester Museum location for 'Beauty and the Beast' exhibition about insects.
	Eyes of Darkness Pale Rider Pale Horse, Pale Rider	Dean Koontz Laura Spinney Katherine Anne Porter	1996 2017 1938	1918 , influenza (plus 'experimental Chinese virus'[Koontz])	First Zoom meeting
	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		<i>Streptococcus pyogenes</i>	Zoom meeting
	The Bone Garden	Tess Gerritsen			
	Moloka'i	Alan Brennert		Leprosy	Zoom meeting
Additional novels noted in text					
	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		

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.

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	https://issuu.com/cheltenhamfestivals/docs/science_festival_2019_brochure
	Cheltenham Science Festival	Bad Bugs Bookclub: I am Legend. 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=LgUjvfjw8zo
	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.libsync.com Episodes 7 and 12.
	JDBU Xmas		
	Learning and Teaching in Higher Education #LTHEchat	Twitter discussion: the value of fiction in learning and teaching	LTHEchat.com LTHEchat186 (Wakelet.com)

For Peer Review

Response to Reviewers

Many thanks for these comments and useful suggestions. It was not easy to write a paper about something rather different from the usual submissions, and I am really grateful for their help. I have made some minor corrections throughout (as seen on track changes), and have addressed their specific remarks below.

Reviewer: 1

Comments to the Author

This is a very exceptional publication, one of the few which combine science and art. Unfortunately, this branch is strongly underappreciated and the study is documenting encouragingly that it develops. That is beautiful and wets the appetite to join.

Thank you!

As most of the readers of FEMS Microbiology Letters will not be aware of the Bad Bug Book Club, it would have been good to mention the origin and concept of this club as an introduction into the abstract in one or two sentences.

The abstract was amended (within word limit): 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.

Furthermore, why only the bad bugs? Because there is no fiction on the good ones? Or something in between, e.g., "Mutant fifty-nine, the plastic eater" by Davis and Pedler (1974). That would deserve a

The following text has been added to the introduction: 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]).

Thank you for the suggested book – since the bookclub consider the next book at each meeting, this will be added to our list!

Occasionally, it would be helpful to give an idea on the content in a sentence or two, e.g., of the 'zombie condition in literature'.

The following text has been added to the introduction: 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 behaviour in more modern literature provided a rich resource for public engagement.

The idea that the authors join the meetings is great, this brings so much more intensity into the discussions.

Please see response to reviewer 2 below.

Activities and events begin 2019 while the book club exists since 2009. A brief history of the bookclub would have been appropriate.

The following text has been added to the introduction: 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.

In the reports on the normal meetings, information about the books which had been discussed would have been interesting, not only about the "surprisingly pleasant cakes", or the Greek food and the sanitizer (hopefully separated). That sounds a bit like garden gnome club reports.

The website provided detailed information about the discussion for every book and the context of the meetings; this is a lot of information. More reference to this resource has been made throughout the paper (eg 'see meeting report'). More specifically in response to your comments, changes have been made in the text to reduce the apparent trivialisation of meeting activities as follows:

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).

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

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continuing growth of the pandemic in the UK, ventilation was increased, social distancing observed and sanitizers provided.

It would have been interesting which books stimulated the discussion in the tuberculosis session (here, the ‘Magic Mountain’ by Thomas Mann, Nobel-prize winner for literature, might also be interesting). Somehow, the reports look a bit too much like protocols.

As noted above, the website provides detailed information on the discussion, including scientific aspects, for each book. The tuberculosis session described in the text focused only on The Constant Gardener. Emphasis is given in the text to the relationship between the discussion and the coronavirus pandemic (within the frame of the paper). Thank you for the additional reading suggestion! This will be added to our list!

Particularly interesting would have been to know which books were most and which least favourite. This could easily be marked in the table.

Unfortunately the list of books in the table only focuses on 2019 and 2020. The survey encompassed more than 70 books, so I cannot mark most and least favourable books on the list. In addition, the fact that there were so many different favourites and least favourites, with so few respondents, reveals primarily the diverse range of interests of the readership - as noted in the text: Responses reflected the diverse interests and experiences of members.

I hope this response is OK for you.

In general, this is a very interesting paper, stimulating more bug book clubs, bad or not. Therefore, a little instruction how to rig them up would fit very well into the manuscript.

I have included in the text: 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’.

Reviewer: 2

Comments to the Author

This article provides a timely commentary on how a book clubs can be a medium to facilitate public engagement with science - in this case microbiology- scientists and members of the public. As the author points out, there has never been more interest in or desire for more information about microbiology than at the current time. The global pandemic has shown that the boundary between fiction and fact can blur substantially and in almost unimaginable ways...unless you happen to be a microbiologist when a pandemic always seems like a distinct possibility. I do have a few suggestions that I feel would add additional clarity to the manuscript.

The author states that 'The Penzance Literary Festival celebrated its tenth anniversary in July 2019. Although a 115 bookclub meeting was suggested to complement a talk, it was not possible to schedule within 116 the festival programme, so the talk was presented alone, in a 90 minute slot' does this mean that it did not take place during the festival itself or it did take place during the festival but the talk was not accompanied by a book club event?

I have clarified the text: A talk about the bookclub was presented in a 90 minute slot as part of the festival programme, but it was not possible to schedule a more informal bookclub meeting.

I also think a description of how the bookclubs were held on line may be appropriate in the methods section. For example what platform was used? How was information provided about the book groups before hand/ was this done through Twitter and did this include joining instructions?

I have provided more information in the text: 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).

And: 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.

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(There is also information regarding advertising on Twitter at other points in the text).

Can I just double check that In July, 'John Ironmonger offered to join our discussions on his novel Not Forgetting the Whale (2015) was in 2020? Did he do this through twitter or the online medium of Zoom or teams?

I have amended the text: 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.

Another point is that the Microbiology Society is identified within the body of the text but it isn't clear why they have been included. Perhaps this can be clarified?

I agree with this lack of clarity. I have deleted the reference in this place, and added the Microbiology Society to the acknowledgements: their bookclub was inspired by, but separate from, my bookclub. I acknowledge their support in helping to promote my bookclub.

The author of the manuscript states that on occasion the authors attended or participated in the book groups. Perhaps the impact of this could be discussed in more detail. Did this add anything to the group discussions? Did the author learn anything from participating in the book group at all.

Thanks for suggesting this! I have added a new section in the results

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 didn’t 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 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.

Did the book group develop a better understanding of COVID19 pandemic from reading about a previous pandemic in a fictional medium?

See text below

Finally the discussion states that the pandemic has been a driver for a more critical review of its value and success. However I feel that the author could be more explicit about what these are. For example ‘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. It has been heartening and comforting to engage in these conversations.’ But were these opportunities that would not have happened otherwise? Were fears or misconceptions set aside or addressed?

I tried throughout the 2020 ‘results’ narrative, to describe how the book under discussion triggered discussion about specific aspects of the pandemic that were taking place at the time. I have included the following in the discussion: The contributions of members of different ages, and from different countries at different stages of the pandemic, enabled different

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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.

Does the author think that the book group will continue to attract a wider audience and does the online delivery present opportunities that would not have happened otherwise?

I have included in the text: 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.

My final point is to ask whether in the conclusions the author would be prepared to pass a judgement on whether this type of public engagement is a format to be picked up and used by others? Finally would the author recommend it?

I have added the following text to the conclusion: 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.

Finally, I have added an ethics statement:

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 anonymising 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.

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

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Key words: bookclub; public engagement; fiction; infectious disease; science literacy; online bookclub

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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. ~~However, the number of page views was low (in 2017, around 20 page views per month).~~ 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 ~~up~~ 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.

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 behaviour 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 et al., 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, 2015) and poetry (Illingworth, 2020) are used to engage audiences with science: both the scientists and their audiences benefit from 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 popularisation 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 minutes duration, take place around six times a year, and ~~discussion-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 2015, 2010b): the format has of course been used successfully elsewhere in science education (Aaronson, 2008, Calman et al., 1988).

The Bad Bugs bookclub website provides a ~~record of meeting discussions and reading guides/questions, as 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 – 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 behaviour in more modern literature provided a rich resource for public engagement.

By 2019, ten 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 1a). 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 organisers 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 a 90 minute slot as part of the festival programme, but it was not

~~possible to schedule a more informal bookclub meeting. Although a bookclub meeting was suggested to complement a talk, it was not possible to schedule within the festival programme, so the talk was presented alone, in a 90 minute slot.~~

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.

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

181 ~~Online bookclub meetings~~

182 Influenza

183 A suggested read for the next (May) meeting was The Eyes of Darkness by Dean Koontz
184 (1996), the cover noting ‘did this thriller predict the coronavirus outbreak?’ However, as
185 members began to read offline, it became apparent that the headline relied essentially on a
186 few sentences towards the end of the novel. Thus, via email discussion, it was decided to
187 supplement reading with two additional publications: Laura Spinney’s non-fiction account of
188 the 1918 influenza pandemic Pale Rider (2017), and Pale Horse, Pale Rider by Katherine
189 Anne Porter (1938), a fictional account of an individual’s experience of influenza during that
190 time.

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

195 Tuberculosis

196 As a break from virus pandemics, the next read was John Le Carre’s The Constant Gardener
197 (2001), a tale of espionage, clinical trials, murder, love, and tuberculosis in Africa. The
198 meeting took place on International Microorganism Day ([https://fems-](https://fems-microbiology.org/international-microorganism-day-2020/)
199 [microbiology.org/international-microorganism-day-2020/](https://fems-microbiology.org/international-microorganism-day-2020/)), an event promoted by FEMS, and
200 was advertised during a livestream video
201 ([https://www.youtube.com/watch?v=Y8H5_Ub5CFU&list=PLaBp7JEYEInzScAQd5U7WD](https://www.youtube.com/watch?v=Y8H5_Ub5CFU&list=PLaBp7JEYEInzScAQd5U7WDYG4XykuD2Ba&index=26&t=15s)
202 [YG4XykuD2Ba&index=26&t=15s](https://www.youtube.com/watch?v=Y8H5_Ub5CFU&list=PLaBp7JEYEInzScAQd5U7WDYG4XykuD2Ba&index=26&t=15s)). The bookclub meeting was advertised by FEMS, who
203 also offered a livestream platform so that the discussion could be viewed. However, it was
204 decided that this might inhibit discussion: instead, the FEMS audience was encouraged to
205 read the book, then join a Twitter discussion (#badbugsbookclub) hosted immediately after
206 the bookclub meeting. Early in pandemic lockdown, the author had joined a dynamic Twitter
207 chat about Spinney’s Pale Rider (#sschatreads). The format requires the host to release
208 around seven questions at regular intervals across an hour, which are then open for discussion
209 (Urban et al., 2020).

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210 Antimicrobial Resistance (AMR)

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

222 *Other events*

223 Before coronavirus lockdown, the author (JV) was invited to attend the second meeting of the
224 Cornish ‘Junior’ bookclub, established in 2019. This meeting was facilitated by kick-start
225 funding awarded to the secondary school teacher from the British Science Association. The
226 bookclub was also ~~mentioned-promoted~~ during a number of online events during the latter
227 part of 2020 (Table 2). ~~Throughout the year, the Microbiology Society was celebrating its~~
228 ~~75th anniversary, and had, in collaboration with the author (JV), adapted the Bad Bugs~~
229 ~~Bookclub format to promote its own bookclub ([https://microbiologysociety.org/our-](https://microbiologysociety.org/our-work/75th-anniversary-microbiology-book-club.html)~~
230 ~~work/75th-anniversary-microbiology-book-club.html).~~

232 *Member survey*

233 After ten years of bookclub meetings, in 2020 it was decided to review members’ attitudes
234 towards the bookclub, and to decide how best to proceed with future meetings. A brief online
235 survey was circulated (<https://mmu.onlinesurveys.ac.uk>). The author (JV) had maintained a
236 small database of email addresses of past and present members, so that details of forthcoming
237 bookclub meetings could be sent. Each contact was emailed individually by the author, who
238 asked permission to send the survey. Questions asked what kept current members attending,
239 why previous members left, how future meetings could be organised, whether the website

could be improved, and what their favourite/least favourite books had been. Respondents were also 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 anonymising 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’.

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

277 *Other events*

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

281 **2020 Activities and events**

282 *Normal meetings*

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

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

294 *Online meetings*

295 The bookclub became more international, having members from California (one of whom
296 had made contact via the Facebook page of the Irish author Charles Egan after the 2019
297 event) and the Netherlands joining the discussion, as well as from other parts of the UK. As
298 news of the bookclub spread through social media and online events, more contacts were
299 made and numbers attending the meetings increased. The maximum number joining a

successful and interactive Zoom discussion was twelve. ~~After each meeting, participants were asked if they found the online format acceptable: all responses were positive.~~ 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 Barrington 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. The Microbiology Society altered their website information to facilitate the transition of bookclubs from face to face to online meetings. They counted 1721 unique page views in 2020. The peak counts (more than 300) were in March when the activity was launched (on National Book Day), and in August (500), with more than 200 in September and October (personal communication from the Microbiology Society).

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 didn’t 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 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 (Figure 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, November). The largest increases in page views co-incident 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. ~~I~~However, in 2020, ~~after the March meeting~~, 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 (ie anonymous). Of those, eleven 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 utilised. '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 behaviour 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.
- 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.

423 - Wider appreciation of interactions between outbreaks and community.

424 From scientists, the fictional aspect had proved useful:

425 - I do think it has enriched the way I teach, as I can bring the human stories behind
426 infectious diseases into my lessons and make it more accessible, relevant and
427 interesting to my students.

428 - My understanding has not really changed because I was in the field anyway but I am
429 more aware of its use in literature and whether it has been used well or not.

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

431 - I have now read books that I would not have otherwise come across and I feel like I
432 am reading fiction more critically

433 - I think that it expands your reading list outside of books you would usually read

434 Since so many books had been read, further questions searched for most memorable meeting
435 (since on many occasions, additional events took place), favourite book and worst book.

436 Responses reflected the diverse interests and experiences of members. There were 16
437 different books listed for 'most memorable meeting' (one book with three votes, two books
438 with two); again (a different) 16 favourite books were listed three books with two votes).

439 There were even twelve different 'least favourite' books (two books with two votes).

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

444 Discussion

445 The impact of the coronavirus pandemic on the Bad Bugs Bookclub has been significant,
446 forcing a complete change in the mode of delivery, as well as driving a more critical review
447 of its value and success. A wide variety of delivery methods and analytic tools were used to
448 investigate reach and impact, but information acquired in this context tended to be
449 quantitative. It is perhaps not surprising that the use of social media and online events
450 increased the reach of the bookclub. The survey carried out to assess the value of the
451 bookclub to its members generated more qualitative data, providing a subjective and
452 emotional dimension to feedback from both scientists and non-scientists (as well as to authors

~~Quote Ironmonger and Smith~~). 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.

478 Conclusion

~~The Bad Bugs Bookclub continues to provide a valuable resource and activity to its members.~~ Both reach and impact of the bookclub increased across the two 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.

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- 558 Table 1: Books read by the Bad Bugs Bookclub 2019 – 2020, plus additional novels noted in
559 the text. Books read at the end of 2018 and the beginning of 2021 are included for context.
- 560 Table 2: Events where the Bad Bugs bookclub was discussed 2019 - 2020
- 561 Figure 1: Page views for the Bad Bugs Bookclub website 2017 - 2020