Review

From Black Open Access to Open Access of Color: Accepting the Diversity of Approaches towards Free Science

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From Black Open Access to Open Access of Color: Accepting the Diversity of Approaches towards Free Science

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Abstract: The aim of this article is to shed some light on 'black open access' model, that still remains poorly understood and largely neglected in the literature, despite being widely adopted in practice. I give an overview of the historical development of black OA and its most important projects: Sci-Hub and Library Genesis. Arguments are provided for why the term 'black OA' is misleading and the term 'RGB OA' (red, green and blue) would better describe a diverse landscape of open access projects that emerged after 2001. While practical approaches towards OA evolved dramatically in the past 20 years, theoretical discussion is still operating the same two-color scheme of 'green' and 'gold' open access from BOAI declaration of 2001: novel approaches are either not recognized as OA at all or are neglected as 'black'. A new and more inclusive OA declaration might be needed to account for greater diversity of approaches.

Keywords: Sci-Hub;shadow libraries;open access;scholarly communication

1. Introduction

In late XX century scientific literature has been becoming increasingly inaccessible due to growing subscription costs [1]. At the same time, information technologies have seen a rapid breakthrough with the emergence of modern Internet and World Wide Web. The latter instilled a hope in many that soon the whole system of research communication will be completely transformed, leading to the future where research publications will be accessible online to every person completely free of charge [2]. This 'free online scholarship' movement was steadily growing among librarians and researchers during 90s, but evaded strict definition until 2001, when the first Open Access declaration was signed at the conference held in Budapest [3]. Budapest Open Access Initiative (BOAI) emphasized the need for removing access barriers to scientific knowledge, making peer-reviewed academic journals freely accessible online 'without financial, legal, or technical barriers'. Two general approaches towards implementing this vision were described:

- self-archiving: researchers are to deposit their articles in a publicly accessible online Internet repositories, or archives;
- open access journals: new academic journals are to be developed that do not charge subscription costs and are completely free to read.

It should be emphasized that these approaches were not invented by the authors of BOAI but rather reflected ongoing discussions and described practices that were already adopted in some disciplines by 2001. The first approach, later came to be known as 'green' open access was pioneered by arXiv project developed by P. Ginsparg in 1991. The project started as an electronic mail server that acted as a centralized archive for research article preprints. The practice of circulating preprints among colleagues by email before publication was well established in the physics community. The arXiv eventually evolved into a web site allowing everyone to upload their preprints to make them available to wide readership completely free of charge [4].

Free electronic scholarly journals started to appear as early as in 1989 [5]; by 1996 the number of such journals in circulation was estimated to be from 77 to 115 [6]. These publications were non-commercial and the majority of them were funded by institutions. However, these early attempts did

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not succeed to become a standard model for OA journal publishing: instead, a commercial model that charged authors rather than readers, pioneered by BioMed central publisher in 1999, became widespread [7,8]. That model came later to be known as 'gold' OA, and that term was most likely to be selected because author processing charges (APC) were relatively high, approaching a few thousand US dollars.

Even though APC became the gold standard for open access journals, BOAI declaration never identified any specific model, but simply enumerated alternative sources of funding, such as foundations and government agencies, university and institutional endowments. This is important, because later discussion on OA will turn to a novel 'platinum' or 'diamond' journals that do not charge authors but are funded directly by organization instead [9]. However, these publications still fit in the broad 'open access journal' category defined in BOAI and can be considered a subset of gold [10].

To summarize, the open access landscape by 2001 was a picture of two colors: green and gold. The 'green' self-archiving initiatives have probably been named after similarity with 'grass-roots' movements, where transition towards better future happens by self-organization of individual researchers, contrary to the 'gold' top-down approach when the main role is assigned to the publisher.

However, the landscape remained small: as the study by Laakso et al. has shown, even though the number of research papers freely available online in repositories and publisher websites have been steadily growing since early 90s, the total share of OA publications in Scopus database in 2009 remained less than 7% [11]. Another study have estimated that only 11.9% of all scholarly articles published in 2008 were archived [12]. Ten years after BOAI declaration, the access to literature still remained limited, until the emergence of a completely different open access methodology, represented by Sci-Hub project.

2. The Emergence of Sci-Hub

Sci-Hub [13,14] have been compared to Napster in the media and research publications [15], even though algorithms and technologies behind two projects are completely different; except from being popular and sued for copyright violation, Sci-Hub and Napster have nothing in common. The role model for Sci-Hub was provided by following projects instead:

- shadow libraries i.e. AvaxHome [16], Natahaus [17] and Gigapedia [18];
- online forums for researchers.

Shadow libraries have reached the peak of popularity in the period from 2000 to 2010. Technically these were centralized file-sharing websites that accumulated content uploaded by users. AvaxHome (2008-2016) was a general-purpose website with a special section for books; Natahaus (2008-2012) website had a motto 'knowledge without borders' and was dedicated to books only. None of these websites provided access to academic journals, but large numbers of books were shared for free; the books were either scanned or downloaded from publishers' website. The financial support was provided by ads, user donations or premium accounts. Because these projects operated without regard for copyright, they were routinely targeted by lawsuits from publishing companies. However, content shared on these websites often preserved online even after the project was shut down, because it had a backup on a decentralized BitTorrent network [19].

The Gigapedia, also known as ebooksclub.org and libraru.nu (2004-2012) was destroyed after a lawsuit filed by 17 academic publishers. The library had about 1 million books available for free, and reportedly reached audience of half a million readers [20].

Library Genesis started in 2008 as an initiative to make 'KOLXO3', a famous digital offline collection of 59,000 scientific ebooks, that was distributed on 64 manually-copied DVD drives, available online [22]. An open-source indexing and search engine were developed. After that LibGen continued to grow by accepting uploads from users and absorbing collections of other shadow libraries, including Natahaus and Library.nu — but unlike these websites, LibGen did not emphasize community features and positioned itself as a kind of index or meta-library project instead. The project produced a number

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of mirrors and forks i.e. Z-Library and turned out to be the most resilient shadow library that still remains functional and updated with new literature, even though most of its mirrors got shut down.

Before Sci-Hub was launched in 2011, shadow libraries provided access only to academic books. Paywalled journal articles had to be accessed on online research forums instead, and the process was much more complicated. These forums can be divided into two broad categories:

- 'librarian' forums dedicated specifically to solve the problem of access such as Myescience [23], TechYou [24], expaper [25] and others;
- professional research forums intended for discussions related to a specific field of science such as MolBiol [26] or ChemPort [27].

The main function of the first type of academic forums was to share or sell student or faculty accounts. Using these accounts, one could enter VPN and proxy servers located at university libraries and access subscribed content on websites such as ScienceDirect. There were also sections where scientific literature could be uploaded and requested. These communities were organized in a hierarchical way, and newly registered members could access only a limited number of resources.

Professional research forums often had a dedicated 'Full Text' section, where forum member could request help in getting access to some paywalled paper [28]. Those who were lucky enough to have access could fulfill the request by sending or uploading paper PDF. Several years later the same approach was implemented in social media by #icanhazpdf Twitter tag [29].

To summarize, by 2011 three general approaches to access scientific literature online were established: shadow libraries, account-sharing and article request. There is a common feature to all three: they are different types of online communities. Shadow libraries provided immediate access, but were limited to books, while account sharing and request methods were slow and indirect, and the number of people who could get access was limited by design.

Sci-Hub became an essential step forward, because it combined the best of those methods while at the same time leaving their shortcomings behind: it was a standalone website that could provide an immediate and direct access to research articles on user request; the articles were downloaded automatically by Sci-Hub engine using a database of university library accounts [30]. The novel approach implemented in Sci-Hub was application of existing censorship-circumvention methodology to access restricted content in scientific journals [31]. An important fact that is not yet well understood and articulated in other studies is that Sci-Hub was not simply the largest or the most popular shadow library: it was the first website ever that could provide direct free access to articles published in paywalled academic journals, to an unlimited numer of users. What also set Sci-Hub apart is that communal, or volunteer tradition was completely abandoned: Sci-Hub would run as an autonomous robot and required minimal human participation.

I'm aware of two projects that implemented ideas similar to Sci-Hub, but never reached maturity: in particular, it seems that molbiol forum had a collection of scripts at some point, that would be installed on forum members' computer and run in the background, checking 'Full Text' forum section for new requests. When new request was found and computer had access, i.e was inside the university network, the paper would be automatically downloaded and sent by email. However, all scripts were outdated already by 2011 and I never seen this system in action.

There was also a 'super-mega-downloader' website set up by a student from MIPT [32]. The application would take a DOI and provide PDF downloaded through university proxy server. Here the access was limited to a single Russian university, while Sci-Hub accumulated accounts from more than 400 universities worldwide. That project had an original authorisation system: a visitor had to complete a random sentence, using an indigenous knowledge specific to Russian and post-Soviet culture. From this it can be assumed that the website was never intended for large audience.

Sci-Hub implemented functionality to scan academic publisher websites and Crossref for new research articles and download them, accumulating the database of more than 88 million papers in 10 years, and was estimated to provided access to more than 90% of paywalled scientific journals

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[33,34]. The content of Sci-Hub was mirrored in Library Genesis repository and uploaded to BitTorrent network to ensure articles provided by Sci-Hub will remain permanently open [35].

3. Many Shades of Black

In current research literature Sci-Hub, Library Genesis and other shadow libraries are refereed to as 'black' or 'pirate' open access [15,37]. The label is meant to emphasize the illegal nature of these projects, since they operate without regard for intellectual property rights. I would like to argue that such coloring scheme is not only questionable from ethical point of view, but also unscientific, as it serves to neglect the phenomenon rather than understand it.

The rogue grouping of Sci-Hub and other projects under the 'pirate' label fails to capture important differences between them. Using the same optic, someone would not be able to tell the difference between self-archiving and open access journals: they would appear to be the same 'white open access'. Therefore I propose using the following color codes instead: dark green, cardinal red, and qīng blue — to describe novel practices in open access that emerged after 2001 Figure 1.

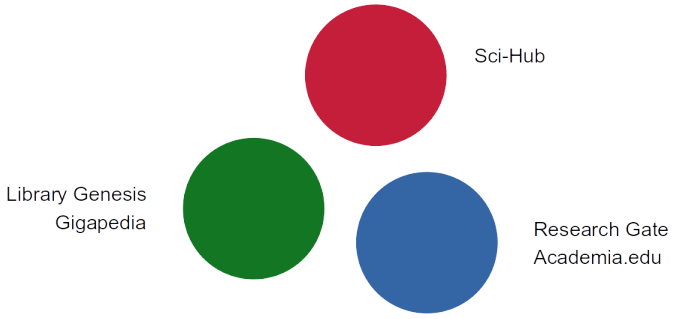

Figure 1. Red, green and blue open access and corresponding projects.

3.1. Dark Green

The operation of 'shadow libraries' is very similar to preprint archives, as they rely on content uploaded by users: the only difference being that, while classical green approach to open access appeals to authors, shadow library websites are mostly maintained by readers — but in both cases community remains the main actor of change.

In 1994 S. Hanrad published 'The Subversive Proposal' urging the authors of scientific works to take advantage of FTP technology to make knowledge free [38]:

> If every esoteric author in the world this very day established a globally accessible local ftp archive for every piece of esoteric writing from this day forward, the long-heralded transition ... would follow suit almost immediately.

14 years later A. Swartz would publish his much more radical 'Guerilla Open Access Manifesto' urging everyone: scientists, librarians and ordinary men who have been 'locked out' of knowledge — to take part in breaking the barriers [39]:

> ... trading passwords with colleagues, filling download requests for friends ... We need to download scientific journals and upload them to file sharing networks. We need to fight for Guerilla Open Access. With enough of us, around the world, we'll not just send a strong message opposing the privatization of knowledge — we'll make it a thing of the past.

The same spirit of a collective transformative action can be seen in both.

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3.2. Cardinal Red

While green open access relies on mobilization of large masses of people, automated approach towards OA implemented by Sci-Hub makes technology the central actor of change. That reminds of early discussions, when technologies were thought to play the most important role in transforming scholarly communications. The first sentence in BOAI declaration reads [3]:

'An old tradition and a new technology have converged to make possible an unprecedented public good'

From this point of view, Sci-Hub can be thought of as a 'pure implementation' of Open Access ideal and a demonstration of a superior transformative power of technology over manual work. I propose using cardinal red color (#C41E3A) to identify automated pathway towards open access pioneered by Sci-Hub project. Red color is one of two main colors used on Sci-Hub website, the other being black. In the past cardinal color represented the power of Pope [40]: indeed among students and researchers I often noticed a cult-like reverence of Sci-Hub, which is quite uncommon for a website, especially in science.

3.3. Qīng Blue

Academic social networking websites, namely Research Gate and Academia.edu, both established in the year 2008, are also mentioned in the literature under black open access label [41,42]. In addition to standard social networking functions, these websites provide functionality for registered authors to upload their work and make it available on the profile page. ASNs became about twice as popular among researchers than institutional repositories. However, most uploads were not preprints, but copyright-protected, camera-ready manuscripts formatted by publisher [43]. Unlike typical shadow libraries though, ASNs do not disregard copyright law openly, and have been removing copyrighted content after lawsuits from academic publishers.

These websites can also be categorized as a variant of the green OA [**?**], but I would propose using a different color: while green open access projects focus on sharing academic works published in traditional format, such as journal article or a book, academic social networks serve a more general purpose. There is a future potential for technology to radically transform scientific communication in the same way as social media made classic newspapers obsolete.

I propose using blue color here, a color used by major social media platforms such as Twitter and Facebook. Furthermore, it has been found that in many languages green and blue colors are denoted by same word [45], such as an Mandarin Chinese, where the word qīng can mean green, blue or sometimes even black color [46].

4. Discussion

I have argued above that current discussion of OA in literature would benefit from having more categories to illuminate the rich diversity of 'black open access' landscape. There are, however, some categories that are excessive: gratis and libre [47], as well as hybrid and bronze OA [48]. Many toll-access journals today operate in hybrid mode, allowing some articles to be published open access given that APC was provided. This is clearly a subset of gold OA, since publisher of a journal remains an actor of change. The same applies to 'bronze OA' term coined by Piwowar et. al. for those publications that are available for free on publisher's website, but without any clearly identifiable license.

The confusion is introduced by an attempt to use license, or some other legal criteria for categorization, especially when this criteria is applied inconsistently, so that some approaches are identified by their essential features, such as green vs. gold OA, while others are viewed from an external perspective of being legal or not, as in the case of black OA. When analysis of a phenomenon is based upon accidental features rather than essential, it becomes flawed. For example, black OA is considered to have advantages such as being more convenient for users and more comprehensive in coverage, while in fact shadow libraries did not provide any coverage of scholarly journals for many years until Sci-Hub was invented. That is, convenience and comprehensive coverage provided by Sci-Hub

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cannot be attributed to copyright violation only, but rather a result of completely novel technical ideas implemented in Sci-Hub.

Similarly, Sci-Hub and LibGen are introduced in most studies with a phrase 'websites such as Sci-Hub', an implicit statement there are many of them. That is a misrepresentation: there are no other independent shadow libraries that are not connected to Sci-Hub and Library Genesis that would provide similar access. For example, content of Z-Library originated from LibGen.

Another important fact currently omitted in discussions of black open science is that it addressed the problem that classic green and gold approaches are unable to solve by design: opening access to those articles that have been already published, but not in OA journals, and do not have a preprint version deposited in a repository.

5. Conclusions

By 2001, two general approaches to open access were practiced in research community: green self-archiving and gold open academic journals. These novel practices of self-archiving and open access publishing in science were described and accepted in Budapest Open Access declaration. After 2001, web technologies have faced a rapid development and open access landscape became much more diverse. Science witnessed an emergence of RGB open access (cardinal red, dark green and qīng blue) superseding classical green and gold approaches to OA by a large margin. Even though these new approaches have been widely accepted in practice, they continue to be neglected and marginalized in theoretical discussion as a 'black' open access type. This needs to be changed, and the diversity of approaches towards free science must be acknowledged. A possible solution might be to sign a new declaration on open access to knowledge in sciences and humanities, where recent technological advances will be recognized and challenges discussed, such as legal status of new platforms; there is an urgent need for an updated intellectual property legislation, that would protect the operation of open access, online research libraries.

Conflicts of Interest: The author of the present article Alexandra Elbakyan is a creator of Sci-Hub website.

Abbreviations

The following abbreviations are used in this manuscript:

BOAI	Budapest Open Access Initiative
ASN	Academic Social Networks
APC	Article Processing Charges
OA	Open Access
RGB	Red Green Blue
LibGen	Library Genesis
DOI	Digital Object Identifier
PDF	Portable Document Format

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