



SHORT COMMUNICATION

Implementation of the QR Code system in the Medical Malacology Collection of the René Rachou Institute, Oswaldo Cruz Foundation

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<https://zoobank.org/7334CB32-80FE-4416-8B34-5F0E7FE124F1>

ABSTRACT. The Medical Malacology Collection (Fiocruz-CMM) was inaugurated in 1993 and is located at the René Rachou Institute in Fiocruz (Belo Horizonte, MG, Brazil). The collection has about 16,000 limnic mollusks of medical and veterinary importance. Information about each specimen is stored in an electronic Microsoft Excel spreadsheet and is available on the Centro de Referência em Informação Ambiental (CRIA) webpage. A QR Code system was implemented for convenience: it can be printed in reduced format with flexible representation on different surfaces and has a low cost of implantation. A script in PHP language was developed to load the spreadsheet in XLS format using an open-license library, PHP-ExcelReader. A PHP script was created to read and process this spreadsheet line by line and generate individual HTML pages, which were formatted with the Bootstrap tool. Then, the PHP QR code was used to create the images of the QR codes corresponding to each specimen. The QR codes were printed and affixed to the lids of the bottles containing each specimen. Using a device with a camera and internet access, the QR code redirects to the file with the information for each mollusk. The use of QR codes at Fiocruz-CMM facilitates the organization of the collection and allows quick and easy access to information about each specimen.

KEY WORDS. *Biomphalaria*, curation, FIOCRUZ-CMM, medical malacology collection, QR codes, zoological collection.

The Medical Malacology Collection (Fiocruz-CMM) is in the René Rachou Institute (IRR-Fiocruz Minas) under the responsibility of the Helminthology and Medical Malacology Research Group (HMM) and has about 16,000 mollusks of medical and veterinary importance. Most of them belong to *Biomphalaria* and Lymnaeidae, which are intermediate hosts of *Schistosoma mansoni* Sambon, 1907 and *Fasciola hepatica* Linnaeus, 1758, respectively.

The collection was inaugurated in 1993, and it includes samples from most Brazilian states and from other countries such as Germany, France, Argentina, Bolivia, Chile, Colombia, Costa Rica, Cuba, Ecuador, Mexico, Paraguay, the Dominican Republic, Uruguay, and Venezuela (Aguiar-Silva et al. 2014). This collection stands out for keeping

each specimen individually, with body and shell separated for morphological identification. In addition, a fragment of tissue from the cephalopodal region is stored in a freezer at -80 °C (a tissue bank) to perform molecular assays for identification and use in research projects. Data about each specimen (mollusk code, date of receipt, data from the collection point (geographical coordinates, city, state, country), date of collection, name of the collector, result of the examination for infection, taxonomic data (order, family, genus, species, subspecies), responsible for morphological and molecular identification, drawer number in which they are stored, receipt protocol number, and geographic coordinates) are stored in an electronic inventory book and made available online at the Centro de Referência em Informação

Ambiental (CRIA) website (<http://splink.cria.org.br/manager/detail?resource=Fiocruz-CMM>).

Throughout the years and with the addition of new data, the search for information from the specimens in the inventory book became a laborious and time-consuming process. To ease and speed up access to the information in the collection, a two-dimensional bar code system or QR Codes (Quick Response Codes) was implemented.

QR Codes can be read by any smartphone or tablet that has a camera and internet access and can store a large amount of numerical and alphanumeric information in a reduced print format with shapes and colors that can be customized according to user needs (Diazgranados and Funk 2013). These codes were developed in 1994 by Masahiro Hara, General Manager of Denso Wave Incorporated (<https://www.qrcode.com/en/history/>).

Using the PHP (Hypertext Preprocessor) programming language, we created computer programs called scripts that can manage the artifacts that perform specific tasks.

The content of the inventory book, with the data for each sample, uses spreadsheets in the XLS format, processed by the Microsoft Excel program. The processing of this file was done using the open-license library PHP-ExcelReader, which reads the Excel file line by line. To generate the individual HTML (HyperText Markup Language) pages of each sample, which can be read by any internet browser, the Bootstrap v5.1.0 tool (Bootstrap Team 2021) was used, which is responsible for the visual presentation of the web page with which the user interacts. In each generated HTML page, the PHP QR Code application (SourceForge 2021) was used, which transformed them into QR Code images corresponding to each sample in the inventory book.

To ensure confidentiality and data security, all files were stored on an internal server. The generated QR codes were extracted from the system for printing and subsequent fixation in the corresponding flasks containing the shell and body of each mollusk in Fiocruz-CMM. Thus, reading the QR codes redirects to the page with data about each specimen (Fig. 1).

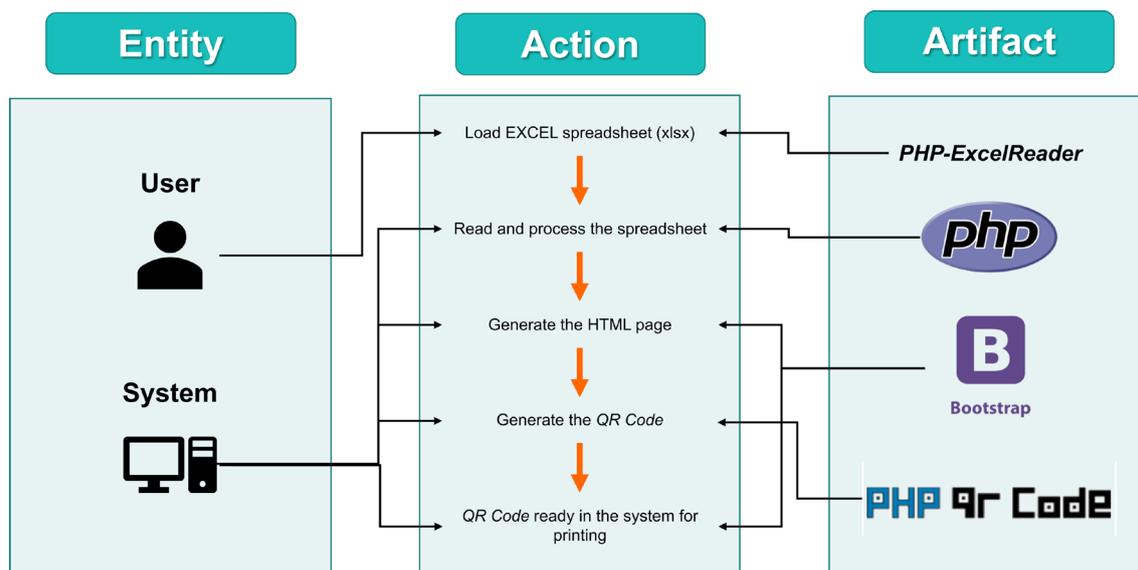


Figure 1. Schematic representation of the system developed for reading the inventory book of the Medical Malacology Collection and compiling the specimen data for individual QR Codes affixed to the recipients containing the specimens.

After the development of the data compilation system, the QR codes were printed and affixed to the recipients containing copies of the Medical Malacology Collection (Fig. 2).

Access to information is currently carried out via the René Rachou Institute's intranet, respecting data confidentiality. Using QR codes is simple: using a smartphone or tablet with a camera and internet access, the user scans the

code and accesses data related to the specimen of interest (Figs 3, 4).

The modernization of biological collections is a universal and necessary trend to ease availability and access to information. Also, QR codes can have other functionalities in biological collections such as storing digital resources (photos, videos, maps, and documents) of the specimen, ensuring



Figure 2. QR code used in Fiocruz-CMM. Flask containing specimen 17003, labeled with the QR code that redirects the user to data related to this specimen (A). QR Code that redirects to data related to sample 17003 (B).



Figure 3. Use of the QR Code in Fiocruz-CMM. Carrying a cell phone with a camera and internet access, the user photographs the QR Code and has access to a spreadsheet with all the data related to the specimen of interest.

the accessibility of information in many languages, and providing supplementary information such as laboratory tests, bibliographic citations, and type status (Diazgranados and Funk 2013).

The implementation of a QR Code system is low-cost, and the production and maintenance of the database are simple when compared to other systems with similar functionality (Ashford 2010). Therefore, its adoption in museums,

bookstores, and even collections should be encouraged. Literature records the use of QR Codes in museums and libraries to connect a collection item with its electronic description (MacKinnon and Sanford 2010, Hicks and Sinkinson 2011, Kane and Schneidewind 2011), guide visitors through exhibitions (Mia Museum 2017), give access to supplemental item information (Barker et al. 2012), and use it in marketing to promote materials or displays (Pulliam and Landry 2010).

Número de registro	17003
Gaveta (via úmida)	Gaveta 49
Gaveta (via seca)	Gaveta 42
Freezer -20°C	
Freezer -70°C	Caixa 119
Ordem	Basommatophora
Família	Planorbidae
Gênero	<i>Biomphalaria</i>
Epíteto específico	<i>glabrata</i>
Subespécie	
<u>Nome científico</u>	<i>Biomphalaria glabrata</i>
Observação do hospedeiro/parasita	Negativo
Município	Aratu
Estado	BA
Pais	Brasil
Localidade	Ponto 2: Vala, Distrito Sanitário Subúrbio Ferroviário, estrada da base naval
Longitude	-38.469611
Latitude	-12.817250
Altitude	
Data de início da coleta	18/8/2015
Data de término da coleta	
Nome do Coletor	Fabiano M. Simões
Determinador	
Responsável Identificação molecular	
Data de entrada	21/8/2015
Data de depósito da coleção	6/10/2015
Local da coleta (c = campo e L = laboratório)	C
Nome do laboratório	
Número de entrada	066-15
Observação	Corpo arrebentou.

Figure 4. Spreadsheet with data retrieved by reading the QR Code for a specimen with the data available in the digital Inventory Book of the Medical Malacology Collection.

QR codes allow, in addition to greater agility in accessing information on copies, an expansion of didactic activities and ease in the development of research involving samples made available by the collections.

However, despite the development of the system in the early 1990s, the use of QR codes was only popularized in the mid-2000s (Schultz 2013). Although there has been an expansion of the use of QR codes in the past few years, there are few records of the use of this technology in biological collections (Blagoderov et al. 2012, Mantle et al. 2012, Schuh 2012, Diazgranados and Funk 2013).

The implementation of this procedure in the mollusk collection of the René Rachou Institute/Fiocruz facilitated access to the collection data, in addition to expanding many other facilities for the biological collections, such as an on-line catalog with multiple functions and information about the Fiocruz-CMM collection.

Added to the reduced cost of implementation, QR Code technology is universal and can be used for the various digital platforms of modern cell phones, turning it into a very valuable alternative with potential for use in other research segments.

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LITERATURE CITED

- Aguiar-Silva C, Mendonça CL, da Cunha Kellis Pinheiro P, Mesquita S, Carvalho O dos, Caldeira R (2014) Evaluation and updating of the Medical Malacology Collection (Fiocruz-CMM) using molecular taxonomy. *Springer-Plus* 3: 446. <https://doi.org/10.1186/2193-1801-3-446>
- Ashford R (2010) QR codes and academic libraries: Reaching mobile users. *College & Research Libraries News* 71: 526–530. <https://doi.org/10.5860/crln.71.10.8454>
- Barker KR, Attridge E, Bennett J, Hiserman T, Horne AS, Moody D, Ramsey EC, Son IK, Vaughn P (2012) The implementation of embedded quick response codes into library resources to improve service delivery. *Journal of the Medical Library Association* 100: 68–71. <https://doi.org/10.3163/1536-5050.100.1.013>
- Blagoderov V, Kitching I, Livermore L, Simonsen T, Smith V (2012) No specimen left behind: industrial scale digitization of natural history collections. *ZooKeys* 209: 133–146. <https://doi.org/10.3897/zookeys.209.3178>
- Bootstrap Team (2021) Bootstrap. Available online at: <https://getbootstrap.com> [Accessed: 10/08/2021]
- Diazgranados M, Funk V (2013) Utility of QR codes in biological collections. *PhytoKeys* 25: 21–34. <https://doi.org/10.3897/phytokeys.25.5175>
- Hicks A, Sinkinson C (2011) Situated Questions and Answers. *Reference & User Services Quarterly* 51: 60–69. <https://doi.org/10.5860/rusq.51n1.60>
- Kane D, Schneidewind J (2011) QR Codes as Finding Aides: Linking Electronic and Print Library Resources. *Public Services Quarterly* 7: 111–124. <https://doi.org/10.1080/15228959.2011.623599>
- MacKinnon P, Sanford C (2010) Snap & Go: a QReative case in point. *Library Hi Tech News* 27: 5–8. <https://doi.org/10.1108/07419051011083163>
- Mantle B, LaSalle J, Fisher N (2012) Whole-drawer imaging for digital management and curation of a large entomological collection. *ZooKeys* 209: 147–163. <https://doi.org/10.3897/zookeys.209.3169>
- Mia Museum (2017) Canadian Museum of Inuit Art. Available from: http://www.miamuseum.ca/?option=com_content&view=article&id=139:interact-with-the-collection&catid=35:visitor [Accessed: 07/07/2021]
- Pulliam B, Landry C (2010) Tag, You're It! Using QR Codes to Promote Library Services. *The Reference Librarian* 52: 68–74. <https://doi.org/10.1080/02763877.2011.521883>
- Schuh R (2012) Integrating specimen databases and revisionary systematics. *ZooKeys* 209: 255–267. <https://doi.org/10.3897/zookeys.209.3288>
- Schultz MK (2013) A case study on the appropriateness of using quick response (QR) codes in libraries and museums. *Library & Information Science Research* 35: 207–215. <https://doi.org/10.1016/j.lisr.2013.03.002>
- SourceForge (2021) PHP QR Code – QR code generator, an LGPL PHP library. Available from: <http://phpqrcode.sourceforge.net/> [Accessed: 10/08/2021]

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Author Contributions

ADA: Data curation, Formal Analysis, Investigation, Methodology, Visualization and Writing – original draft. RG: Formal Analysis, Investigation, Methodology, Software and Writing – review & editing. RLC: Funding acquisition, Resources, Supervision and Writing – review & editing. CLFM: Data curation, Resources, Validation and Writing – review & editing. OSC: Conceptualization, Data curation, Funding acquisition, Investigation, Project administration, Resources, Supervision and Writing – review & editing.

Competing Interests

The authors have declared that no competing interests exist.

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