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AQUATIC VEGETATION HARVEST AND SCREENING: A MALACOLOGICAL SURVEY TECHNIQUE FOR DETERMINING SNAIL PRESENCE IN AQUATIC ECOSYSTEMS

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Abstract

Schistosomiasis is a neglected tropical disease whose transmission dynamics are partly driven by the presence of freshwater snails infected with *Schistosoma* parasites. A scheduled malacological survey in a urogenital schistosomiasis endemic community (Siluko) in Edo State, Nigeria, was cancelled due to heightened security concerns that restricted access to the field site. To address this limitation, an alternative approach, Aquatic Vegetation Harvest and Screening (AVHS), was developed. Aquatic vegetation were collected from the banks of Siluko River and transported to the laboratory with the help of residents. The harvested vegetation was subsequently screened for freshwater snails using the AVHS protocol. A total of 49 snails representing five genera and six species were recovered. Six species [*Biomphalaria pfeifferi* (07), *Bulinus forskalii* (08), *Bulinus truncatus* (21), *Melanoides tuberculata* (06), *Radix natalensis* (01), and *Segmentorbis angustus* (02)] and two species [*B. pfeifferi* (01) and *R. natalensis* (03)] were identified from the first and second waybill, respectively. Notably, *B. pfeifferi* and *S. angustus* represent new records for Siluko. None of the collected snails shed schistosome cercariae. However, the presence of *Biomphalaria pfeifferi*, the intermediate host of *Schistosoma mansoni*, suggests a potential risk of intestinal schistosomiasis transmission. Species richness detected through AVHS was comparable to previous surveys, supporting its value for presence–absence monitoring. Although AVHS may underestimate abundance and favor vegetation-associated species, it offers a practical, community-based approach for identifying snail hosts where conventional sampling is challenging. Further standardization and validation are needed.

Keywords: Malacology, Schistosomiasis, Insecurity

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INTRODUCTION

Schistosomiasis is a chronic and acute parasitic disease caused by trematodes of the genus *Schistosoma* and remains one of the most important neglected tropical diseases endemic to sub-Saharan Africa. In the region, *Schistosoma haematobium* and *Schistosoma mansoni* are the principal etiological agents, responsible for urogenital and intestinal schistosomiasis, respectively. Consequently, the spatial distribution, density, and infection status of intermediate host snails are central determinants of schistosomiasis transmission dynamics at the community level (Colley *et al*., 2014).

Malacological surveys therefore constitute a critical component of schistosomiasis surveillance and control programs, providing essential data for identifying transmission sites, targeting snail control interventions, and anticipating disease emergence or re-emergence (Wood *et al*., 2019). Such surveys typically involve the systematic identification, collection, enumeration, and ecological characterization of molluscan fauna within aquatic or terrestrial habitats. A wide range of malacological survey techniques has been described in the literature, reflecting differences in study objectives, habitat types, and logistical constraints (Abdel Azim and Ayyad, 1948; Olivier and Schneiderman, 1956; Hairston *et al*., 1958; Crossland, 1962; Coppolino, 2010; Clergeau *et al*., 2011). There is general consensus that no single survey protocol is universally optimal; rather, the choice of method is largely dictated by the ecological context and the specific goals of the investigation (Hairston *et al*., 1958; Geiger *et al*., 2007; Coppolino, 2010). Among these approaches, time-based snail sampling has been widely applied in schistosomiasis epidemiological studies across Africa. This method typically entails the active collection of snails from aquatic vegetation, debris, and benthic substrates along freshwater margins within a defined area over a standardized sampling period, commonly 30 minutes (Olivier and Schneiderman, 1956; Opisa *et al*., 2011; Perez-Saez *et al*., 2019; Olkeba *et al*., 2021; Oso and Odaibo, 2021).

In Nigeria, both urogenital and intestinal schistosomiasis is endemic. However, research efforts have disproportionately focused on human infection prevalence, with comparatively fewer studies examining the presence, abundance, and spatial distribution of intermediate host snails in endemic settings (Saidu *et al*., 2023). Siluko, a rural community in Edo State, southern Nigeria, is recognized as hyperendemic for urogenital schistosomiasis (Adeyemi *et al*., 2014). Previous malacological investigations in the community documented several *Bulinus* species implicated in the transmission of *S. haematobium* (Adeyemi *et al*., 2025), whereas *Biomphalaria* species, the intermediate hosts of *S. mansoni*, were not reported.

The present study was originally designed to conduct a follow-up malacological survey in Siluko using a conventional time-based sampling protocol to reconfirm the presence and distribution of schistosomiasis vector snails. However, escalating security challenges limited field access to the community. In response to these constraints, we developed an alternative snail sampling approach, the Aquatic Vegetation Harvest and Screening (AVHS) protocol. Here, we report the findings of AVHS implementation in Siluko and evaluate its utility as a practical malacological survey tool in settings where direct field access is restricted.

MATERIALS AND METHODS

Study Site

Siluko is a rural riverine community located in Ovia South West Local Government Area, Edo State, Nigeria (Fig. 1). The Siluko River constitutes the principal freshwater body in the community and is the primary site of human water-contact activities, including fishing and recreational swimming, through which schistosomiasis transmission occurs. The community has previously been classified as endemic for schistosomiasis (Adeyemi *et al*., 2014; Noriode *et al*., 2018).

MODIFICATION OF SNAIL SAMPLING APPROACH

The study was initially designed to employ a conventional time-based malacological survey to assess the presence and distribution of schistosomiasis vector snails in Siluko (Olivier and Schneiderman, 1956). However, heightened security concerns, including kidnapping, robbery, and banditry, restricted field access and necessitated the cancellation of the planned survey. To overcome these constraints, an alternative snail sampling method, the Aquatic Vegetation Harvest and Screening (AVHS) protocol was developed to assess freshwater snail presence through laboratory screening of aquatic vegetation harvested from the Siluko River.

Aquatic Vegetation Harvest and Screening (AVHS) Protocol

i. Vegetation Harvest and Transport

Sampling was conducted on two separate occasions in February 2025 (15th and 22nd). Four residents of Siluko, with no prior malacological training, were recruited to harvest and transport aquatic vegetation from the banks of the Siluko River to the laboratory in two separate consignments. Aquatic vegetation was randomly collected along the riverbanks by manual hand-pulling before sunrise (Fig. 2A), targeting vegetation likely to harbor freshwater snails. Approximately 7 kg of harvested vegetation was transported per waybill in jute bags to the laboratory (Fig. 2B and C).

ii. Laboratory Screening of Vegetation for Snails

In the laboratory, each waybill was weighed and unpacked, and the harvested vegetation was identified as *Eichhornia crassipes* (water hyacinth), an invasive aquatic macrophyte commonly associated with freshwater snail habitats. All plant components (leaves, petioles/stalks, flowers, and roots) were systematically examined under an electric light source for attached snails (Fig. 2D and E). Following visual inspection, the plant material was submerged in a large container of tap water to dislodge any remaining snails. The resulting water was sieved through fine-mesh trays to recover snails. Recovered snails were sorted, enumerated, and identified to genus and species level based on shell morphology using standard taxonomic keys (Brown, and Kristensen, 1989; Brown, 1994). Consistent with the study objective, the AVHS protocol was applied primarily as a presence–absence and species richness assessment rather than a quantitative estimate of snail abundance.

DATA ANALYSIS

Descriptive and diversity metrics were calculated using PAST v.5.0.2 software (Hammer *et al*., 2001). Differences in the proportional representation of snails (planorbid versus non-planorbid) between each waybill were evaluated using Fisher's exact test applied to a 2 × 2 contingency table. A two-sided test was used, and statistical significance was assessed at $\alpha = 0.05$. Each snail was screened for trematode infection in a Petri dish containing tap water, exposed to light, and visually checked under a stereo microscope.

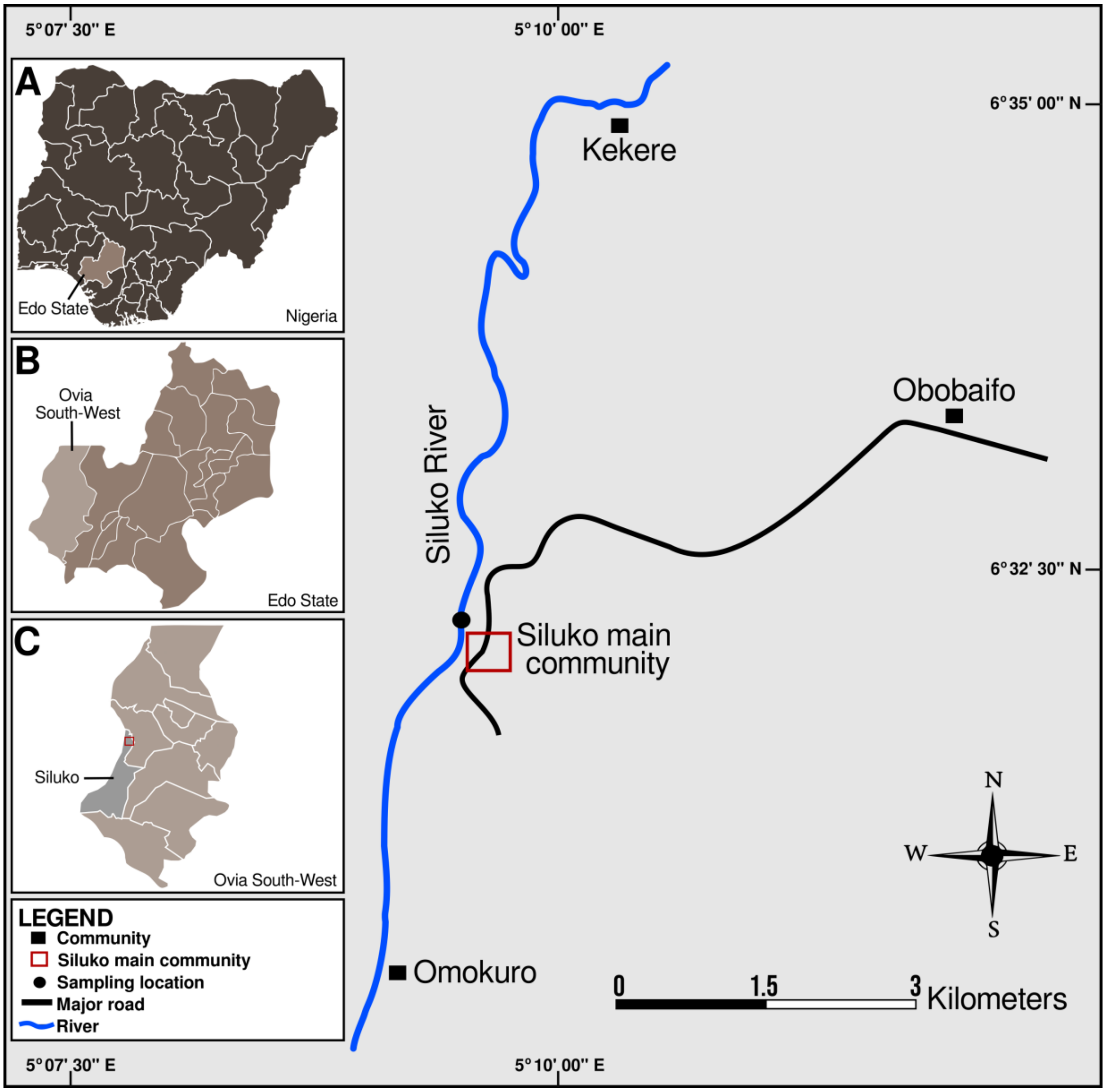

Figure 1 title should read: "Map of snail sampling location in Siluko, Ovia South-West Local Government Area of Edo State Nigeria. A, insert map of Nigeria showing Edo State. B, insert map of Edo State showing Ovia South-West Local Government Area. C, insert of Ovia South-West Local Government Area showing Siluko community".

Figure 2. Vegetation from the banks of Siluko River in Edo State, Nigeria. A, Siluko River bank predominated by water hyacinth. B, Jute bag used for transporting harvested plants. C, Water hyacinth in jute bag. D & E, Screening of water hyacinths for freshwater snails

RESULTS

A total of 49 freshwater snails were recovered from two consignments (waybills) of aquatic vegetation harvested from the Siluko River using the Aquatic Vegetation Harvest and Screening (AVHS) protocol (Table 1). The recovered snails comprised five genera and six species (Figure 3) of medical and veterinary importance, including known intermediate hosts of human schistosomes. Species richness declined from six species (N = 45, 91.8% of the total collection) in Waybill I to two species (N = 4, 8.2% of the total collection) in Waybill II. Waybill I yielded all six recorded species (*Biomphalaria pfeifferi*, *Bulinus forskalii*, *Bu. truncatus*, *Melanoides tuberculata*, *Radix natalensis*, and *Segmentorbis angustus*) whereas waybill II yielded only two species (*Biomphalaria pfeifferi* and *Radix natalensis*). Diversity indices reflected this shift, with Shannon diversity decreasing from H′ = 1.44 to 0.56 and Simpson diversity from 0.71 to 0.38. Presence–absence analysis showed low similarity between sampling events (Jaccard = 0.33), while abundance-based Bray–Curtis dissimilarity was high (0.92), indicating pronounced short-term community turnover between both waybills.

Given the difference in snail species counts between both Waybills, an aggregation approach of snail groups; planorbid (*Biomphalaria*, *Bulinus* and *Segmentorbis*) and non-planorbid (*Melanoides* and *Radix*) was used for Fisher tests. Fisher's exact test revealed a significant difference ($P < 0.05$) in the proportion of planorbid snails between Waybills (odds ratio = 16.3, $p = 0.023$), with Waybill I exhibiting strong dominance of planorbid taxa compared to Waybill II. Overall, *Bulinus truncatus* was the dominant species, comprising 21 individuals and representing 42.86% of all snails recovered. *Bulinus forskalii* and *Biomphalaria pfeifferi* were the next most abundant species, each contributing eight individuals (16.33%). *Melanoides tuberculata* accounted for six individuals (12.24%), while *Radix natalensis* and *Segmentorbis angustus* were comparatively less abundant, representing four (8.16%) and two (4.08%) individuals, respectively (Table 1).

Marked differences in species composition were observed between waybills. Waybill I was dominated by *B. truncatus*, which accounted for nearly half of the snails recovered from this consignment (46.67%), followed by *B. forskalii* (17.78%) and *B. pfeifferi* (15.56%). In contrast, waybill II was dominated by *R. natalensis*, which constituted 75.0% of snails recovered from that consignment, with *B. pfeifferi* accounting for the remaining 25.0%.

Table 1. Abundance of Snail Species Recovered in Siluko, Edo State, Nigeria using the Aquatic Vegetation Harvest and Screening (AVHS) protocol

Snail species	Waybill I	Abundance (%)	Waybill II	Abundance (%)	Overall Total	Abundance (%)
Biomphalaria pfeifferi	07	15.56	01	25.0	08	16.33
Bulinus forskalii	08	17.78	-	-	08	16.33
B. truncatus	21	46.67	-	-	21	42.86
Melanoides tuberculata	06	13.33	-	-	06	12.24
Radix natalensis	01	2.22	03	75.0	04	8.16
Segmentorbis angustus	02	4.44	-	-	02	4.08
Total	45		04		49	

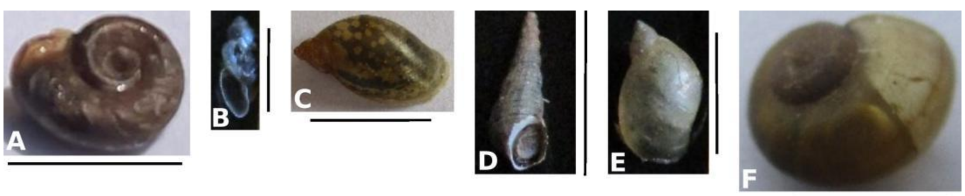

Figure 3. Freshwater snails collected from Siluko River in Edo State, Nigeria. Scale are in parenthesis. A, *Biomphalaria pfeifferi* (10 mm). B, *Bulinus forskalii* (5 mm). C, *Bulinus truncatus* (5mm). D, *Melanoides tuberculata* (10mm). E, *Radix natalensis* (10 mm). F, *Segmentorbis angustus* (5 mm).

DISCUSSION

Six species of freshwater snails, all previously reported in Nigeria, were recovered from the Siluko River using the Aquatic Vegetation Harvest and Screening (AVHS) protocol. The species richness observed is comparable to that reported in an earlier malacological survey conducted in Siluko (Adeyemi *et al*., 2025) using the widely applied time-based sampling protocol (Olivier and Schneiderman, 1956), indicating that AVHS can provide a representative snapshot of snail species presence in the study area. None of the recovered snails shed trematode cercariae following light exposure, indicating the absence of patent infections at the time of sampling; however, the lack of cercarial shedding does not exclude prepatent infections or low transmission intensity, which are limitations of single-point shedding observations (Curtis and Hubbard, 1990). It is however important to note that all recovered snails were relatively small (approximately 5 mm in shell size), suggesting that the sampled population was dominated by juvenile or recently recruited individuals.

The predominance of juvenile snails has important implications for parasite detection and transmission interpretation. Schistosome development within the snail requires a prepatent period, during which infected snails do not yet shed cercariae (Curtis and Hubbard, 1990; Brown, 1994). Consequently, the absence of cercarial shedding observed in this study is likely influenced by the immature size structure of the snail population rather than the absence of parasite transmission within the habitat. It is however noteworthy that the recovery of predominantly juvenile snails suggests that AVHS may be especially useful for early detection of emerging transmission risk, before cercarial shedding and human infection become established. Early identification of competent intermediate hosts at juvenile stages provides a critical window for preventive public health action, including intensified surveillance and environmental management, prior to the amplification of transmission (Starkloff *et al*., 2022).

Two snail species previously reported from Siluko, *Bulinus globosus* and *Lanistes varicus* (Adeyemi *et al*., 2025) were not detected in the present study, whereas *B. pfeifferi* and *S. angustus* were recorded in the community for the first time. The detection of *B. pfeifferi*, a principal intermediate host of *Schistosoma mansoni*, is of particular epidemiological relevance (Brown, 1994). Although Siluko has historically been classified as endemic for urogenital schistosomiasis caused by *S. haematobium* (Adeyemi *et al*., 2014; Noriode *et al*., 2018), the presence of juvenile *B. pfeifferi* suggests that ecological conditions suitable for intestinal schistosomiasis transmission may exist. It is also possible that it is a recent colonization or active recruitment of the species in the Siluko River. Such early-stage establishment of competent intermediate hosts for schistosomiasis may precede detectable transmission in human populations and therefore represents a critical window for preventive intervention (Anderson *et al*., 2021). Consequently, the possibility of concurrent or emerging transmission of mixed schistosome infections (*S. haematobium* and *S. mansoni*) in Siluko cannot be excluded and warrants further epidemiological investigation.

From a public health perspective, these findings reinforce the importance of routine malacological surveillance as an early warning system for shifts in schistosomiasis transmission dynamics. Monitoring intermediate host snail populations is a core component of integrated schistosomiasis control strategies and provides critical ecological context for interpreting human infection patterns (Colley *et al*., 2014; Anderson *et al*., 2021; Starkloff *et al*., 2022; WHO, 2022). The identification of new intermediate host species prior to documented human infection presents an opportunity for proactive interventions, including targeted health education, environmental management, and refinement of preventive chemotherapy strategies in line with evolving transmission risks (WHO, 2022).

The AVHS protocol provided a rapid assessment of vegetation-associated snail fauna in the Siluko River; however, several methodological limitations should be acknowledged. The protocol is not designed to produce precise quantitative estimates of snail abundance and is biased toward vegetation-associated taxa. Juvenile snails, which preferentially colonize aquatic macrophytes, may therefore be overrepresented, while benthic or larger adult snails may be under-sampled (Hairston *et al*., 1958; Geiger *et al*., 2007). These methodological characteristics likely contributed to the recovery of predominantly small-sized individuals and should be considered when interpreting infection status and species composition. These limitations may also partly explain the absence of some species previously reported in the community. The observed differences in species composition and abundance between the two vegetation consignments further indicates spatial and temporal heterogeneity within the habitat and suggests that a single vegetation harvest may be insufficient to fully characterize snail diversity. Protocol standardization, including guidance on the number of vegetation samples, sampling frequency, and spatial coverage is therefore required to enhance reproducibility, comparability, and interpretability of AVHS-derived data across sites and seasons.

Despite these limitations, AVHS represents a practical, adaptive, and community-engaged surveillance approach that is particularly valuable in settings where conventional field-based malacological surveys are constrained by security or logistical challenges. When integrated with parasitological surveys and seasonal monitoring, AVHS has the potential to strengthen schistosomiasis risk assessment and support timely, evidence-based public health interventions. It can be applied as a preliminary screening tool prior to more intensive, field-based malacological surveys. The AVHS protocol as an adaptive surveillance tool aligns with current global recommendations that emphasize flexible, context-specific approaches to schistosomiasis monitoring and control (WHO, 2022).

CONCLUSION

Although the AVHS protocol cannot replace conventional quantitative malacological sampling methods, it represents an effective adaptive surveillance approach for ecological and epidemiological studies when direct field access is constrained. Using AVHS, six freshwater snail species were recorded from the Siluko River, including first reports of *Biomphalaria pfeifferi* and *Segmentorbis angustus* in the community. Given that *B. pfeifferi* is an intermediate host of intestinal schistosomiasis, the findings raise the possibility that both urogenital and intestinal schistosomiasis transmission may be occurring concurrently in Siluko. These results highlight the need for integrated malacological and epidemiological investigations to better define transmission dynamics and inform control strategies in the area.

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REFERENCES

Abdel Azim, M., and Ayyad, N. (1948). A preliminary report on the value of palm-leaf traps in the survey and treatment of streams infested with snails, *Transactions of The Royal Society of Tropical Medicine and Hygiene*, 42(3): 231–246. https://doi.org/10.1016/0035-9203(48)90004-2

Adeyemi, E., Aisien, M. S. O. and Sam-Wobo S. O. (2014). Evaluation of Questionnaire, Reagent Strip and Egg Count as Diagnostic Techniques for Confirming Urinary Schistosomiasis in School Children, Edo State, Nigeria. *Nigerian Journal of Parasitology*. 35 (1-2): 47-52.

Adeyemi E. E, Aisien M. S. O. and Enabulele E. E. (2025). Freshwater Snails in Schistosomiasis Endemic Communities in Ovia South-West Local Government Area in Edo State, Nigeria. *Nigerian Journal of Parasitology*. 46 (2): 406-414.

Anderson, L. C., Loker, E. S., and Wearing, H. J. (2021). Modeling schistosomiasis transmission: the importance of snail population structure. *Parasites and Vectors*, 14(1): 94. https://doi.org/10.1186/s13071-021-04587-8

Brown, D. S. and Kristensen, T. K. (1989). A field guide to African freshwater snails. 8. South African Snail species. Danish Bilharziasis Laboratory. 30pp.

Brown, D. S. (1994). Freshwater snails of Africa and their medical importance. 2nd ed. London: Taylor and Francis. 609pp.

Clergeau, P., Tapko, N., and Fontaine, B. (2011). A simplified method for conducting ecological studies of land snail communities in urban landscapes. *Ecological Research*, 26(3): 515-521. https://doi.org/10.1007/s11284-011-0808-5

Colley, D. G., Bustinduy, A. L., Secor, W. E., and King, C. H. (2014). Human schistosomiasis. Lancet (London, England), 383(9936): 2253–2264. https://doi.org/10.1016/S0140-6736(13)61949-2

Coppolino, M. L. (2010). Strategies for Collecting Land Snails and Their Impact on Conservation Planning. *American Malacological Bulletin*, 28(2): 97-103. https://doi.org/10.4003/006.028.0225

Crossland, N. O. (1962). A mud-sampling technique for the study of the ecology of aquatic snails, and its use in the evaluation of the efficacy of molluscicides in field trials. *Bulletin of the World Health Organization*, 27(1): 125–133.

Curtis, L. A., and Hubbard, K. M. (1990). Trematode infections in a gastropod host misrepresented by observing shed cercariae. *Journal of Experimental Marine Biology and Ecology*, 143(1–2): 131-137. https://doi.org/10.1016/0022-0981(90)90115-S

Geiger, D. L., Marshall, B. A., Ponder, W. F., Sasaki, T. and Warén, A. (2007). Techniques for collecting, handling, preparing, storing and examining small molluscan specimens. *Molluscan Research*, 27(1): 1–50.

Hairston, N. G., Hubendick, B., Watson, J. M., and Olivier, L. J. (1958). An evaluation of techniques used in estimating snail populations. *Bulletin of the World Health Organization*, 19(4): 661–672.

Hammer, Ø., Harper, D. A., and Ryan, P. D. (2001). PAST: Paleontological statistical software package for education and data analysis. *Palaeontologia electronica*, 4: 1-9.

Noriode, R. M., Idowu, E. T., Otubanjo, O. A., and Mafe, M. A. (2018). Urinary schistosomiasis in school aged children of two rural endemic communities in Edo State, Nigeria. *Journal of Infection and Public Health*, 11(3): 384–388. https://doi.org/10.1016/j.jiph.2017.09.012

Olivier, L., and Schneiderman, M. (1956). A method for estimating the density of aquatic snail populations. *Experimental Parasitology*, 5(2): 109–117. https://doi.org/10.1016/0014-4894(56)90008-x

Olkeba, B. K., Boets, P., Mereta, S. T., Mandefro, B., Debesa, G., Ahmednur, M., Ambelu, A., Korma, W., and Goethals, P. L. M. (2021). Malacological and Parasitological Surveys on Ethiopian Rift Valley Lakes: Implications for Control and Elimination of Snail-Borne Diseases. *International Journal of Environmental Research and Public Health*, 19(1): 142. https://doi.org/10.3390/ijerph19010142

Opisa, S., Odiere, M. R., Jura, W. G., Karanja, D. M., and Mwinzi, P. N. (2011). Malacological survey and geographical distribution of vector snails for schistosomiasis within informal settlements of Kisumu City, western Kenya. *Parasites and Vectors*, 4: 226. https://doi.org/10.1186/1756-3305-4-226

Oso, O. G., and Odaibo, A. B. (2021). Land use/land cover change, physico-chemical parameters and freshwater snails in Yewa North, Southwestern Nigeria. *PLOS ONE*, 16(2): e0246566. https://doi.org/10.1371/journal.pone.0246566

Perez-Saez, J., Mande, T., Zongo, D., and Rinaldo, A. (2019). Comparative analysis of time-based and quadrat sampling in seasonal population dynamics of intermediate hosts of human schistosomes. *PLoS Neglected Tropical Diseases*, 13(12): e0007938. https://doi.org/10.1371/journal.pntd.0007938

Saidu, U., Ibrahim, M. A., de Koning, H. P., McKerrow, J. H., Caffrey, C. R. and Balogun, E. O. (2023). Human schistosomiasis in Nigeria: present status, diagnosis, chemotherapy, and herbal medicines. *Parasitology Research*, 122(12): 2751–2772. https://doi.org/10.1007/s00436-023-07993-2

Starkloff, N. C., Hartman, R. B., and Civitello, D. J. (2022). Snail juvenile growth rate as a rapid predictor of the transmission potential of parasitizing human schistosomes. *Experimental Parasitology*, 242: 108378. https://doi.org/10.1016/j.exppara.2022.108378

Wood, C. L., Sokolow, S. H., Jones, I. J., Chamberlin, A. J., Lafferty, K. D., Kuris, A. M., *et al*. (2019). Precision mapping of snail habitat provides a powerful indicator of human schistosomiasis transmission. *Proceedings of the National Academy of Sciences of the United States of America*, 116(46): 23182–23191. https://doi.org/10.1073/pnas.1903698116

World Health Organization (WHO). (2022). Ending the neglect to attain the Sustainable Development Goals: A road map for neglected tropical diseases 2021–2030. WHO Press, Geneva. https://www.who.int/publications/i/item/9789240010352