Availability, Distribution and Infectivity of Freshwater Snails with Helminth Parasites in Selected Sites of Sokoto State, Nigeria

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ABSTRACT

Distribution of snails was determined from six collection sites of Kware and Wamakko Local Government Areas of Sokoto State. The sampling sites for snail collection were sides or edges of freshwater ponds, slow moving streams, lakes, irrigation canals and rivers found around the villages and towns in which the sampling sites were located. Scoop net was employed in the collection of freshwater snail samples, the collected snails were counted and expressed as the number of snail species per 10 scooping. The snails were identified by the Museum of Natural History, Department of Zoology, ABU, Zaria and using the key to freshwater biology. The snails were taken to laboratory, placed in aquaria with tap water for acclimatization in 48 hours before screening for infectivity with cercariae. Different freshwater snails found from sites of the study were identified as Bulinus globosus, Biomphalaria glabrata, Radix natalensis, Melanoides maculatus, Bellamya cascarillas, Bellamya crawshayi and Lanistes ovum. B. globosus was the species with high number of 46% and distribution while, B. crawshayi was species with low number of 2.8% and least population. The snails were screened for infectivity with cercariae by placing them individually in glass jars (about 10 snails) per aquarium and were exposed to day light for 6 hours. Additional illumination of 100w electrical bulb was provided. The snails were subjected to abrupt reduction of temperature by at least 5^{o}C by placing ice block in the aquarium to facilitate the emergence of cercariae. Three of the seven snail species collected (Bulinus globosus, Biomphalaria glabrata and Redis natalensis) shed cercariae of different morphological characteristics, swimming behaviours and resting positions. Out of the 117 cercariae released, 67 (57.3%) of S. haematobium were isolated from B. globosus, 38 (32.5%) of F. hepatica were isolated from R. natalensis, 12 (10.2%) of S. mansoni were isolated from B. glabrata and non were isolated from M. merculatus the result of the study indicated infectivity of the three snail species and thus, confirmation of their roles as vectors of schistosomiasis and fascioliasis in the study area. Chemical and phytol-molluscicides are therefore recommended to control population of snail vectors as well as the prevalence of schistosomiasis and fascioliasis. Further research on freshwater snail vectors of helminth disease agents is also recommended.

Keywords: Availability, Distribution, Infectivity, Snails, Helminth, Parasites

INTRODUCTION

Freshwater snails have been known to play significant roles in public and veterinary health. About 350 freshwater snail species were estimated to be the intermediate host for medical and veterinary importance to human and animals mostly belong to 3 genera Bulinus, Biomphlaria and Oncomelania (Jordan et al., 1993). For example, Oguta Local Government Area of Imo State, Nigeria, like many other communities in Nigeria, has been endemic of schistosomiasis and fascioliasis. This may be as a result of the presence of B. globosus and L. natalensis from Lake Oguta that may serve as intermediate host for urinary schistosomiasis (B. globosus) and for fasciolosisis (L. natalensis) (Ejehu et al., 2017).

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The transmission of schistosomiasis depends on the intermediate host. The construction of numerous largescale projects, irrigation canals and other smaller water reservoirs create ideal vegetation/environment for snails to thrive. There are only few snails that can act as host, restricting the diseases to tropical and subtropical areas. In most schistosomiasis endemic areas, the disease is characterized by seasonal transmission pattern; though this is also linked to the source of transmission (Nour, 2010).

The distribution and density of the intermediate snail host is an important determinant that account to a large extent for the observed variability in rates of helminth like Schistosoma and Fasciola infections. When people and animals infected with Schistosoma and Fasciola parasites urinate or defecate in fresh water, parasite eggs pass from the body, hatch and infect fresh water snails that serve as an intermediate host. The parasites develop and multiply inside the snails. After completing the snail phase of the life cycle, the free-swimming larvae leave the body of intermediate host and search for definitive (human and animal) hosts. Free-swimming larvae penetrate a person's skin in case of Schistosoma and may encyst on herbage as metacercaria, which may be consumed by herbivorous animals in case of Fasciola. Once in the body, the larvae develop into adult male and female schistosomes which can live, mate, and multiply in blood vessels for as long as seven years. Female parasite release thousands of eggs, some of which passed out in the urine, in the case of urinary Schistosomiasis, or faeces in the case of intestinal Schistosomiasis, some eggs remain trapped in the body tissues (WHO, 2011). As for Fasciola, the hermaphroditic juveniles will migrate from stomach via intestine and other tissues to the bile duct where they mature and lay eggs.

Schistosomiasis is an acute and chronic parasitic disease caused by blood flukes (trematode worms) of genus Schistosoma (WHO, 2022). It is a disease of poverty with high rate of infection, morbidity and is difficult to control in poor nations, it is still considered as one of the major health, socio-economic and developmental challenges facing most of poor endemic nations of the world (Utzinger et al., 2009). It is caused by six species of trematode: S. haematobium, S. japonicum, S. intercalatum, S. mekongi, S. mansoni and S. guinensis. The predominant causative agents are S. haematobium and S. mansoni. There are two major fomrms of schistosomiasis intestinal and urogenital (WHO, 2022). It is often neglected tropical disease caused by a parasite, trematode blood fluke of the genus Schistosoma (Umar et al., 2023). It has been reported that in 2019 alone 236 million people were at risk of schistosomiasis worldwide and 90% of them live in Africa (WHO, 2022). Most of the world endemic countries with schistosomiasis were under developed with poor political commitment, poor infrastructure, poor basic primary health care and high cost of synthetic molluscicides (Chitsulo et al., 2017). Nigeria is the most prevalent country in sub-saharan Africa with schistosomiasis regarding its distribution, prevalence, diagnosis, prevention, orthodox, traditional treatment and control strategies in 36 States and FCT but, North-West is the most endemic geo-political zone in the country (Umar et al., 2023). In Nigeria 30 million people were at risk of schistosomiasis with the highest people infected with the disease to became the most prevalent country in Africa (Nduka et al., 2019). However, Sokoto State had the high prevalence of disease among school-aged children, farmers, fishermen and women around the riverine sites of the state (Yunusa et al., 2021). On the other hand, fascioliasis is an acute and chronic liver disease, commonly referred to as liver rot that affects ruminants like cattle, sheep, goats and other ruminants. Previous research reports indicated higher prevalence in cattle with 21.5%, sheep with 13.5% and goats with 10.2% (Bunza et al., 2008).

Plant derived molluscicides are highly recommended and are widely used as experimental models in the programme to investigate and control schistosomiasis by killing the intermediate host snail and disrupting its lifecycle (Wang et al., 2018), this can be achieved by the use of synthetic molluscicides which is costly and caused high environmental impacts. The major intervention used to control this disease is treatment with praziquantel, accompanied by the provision of safe water, adequate sanitation and snail control. Attention is being drawn to the use of natural plant products for medical molluscan control, because they are inexpensive and are environmentally safe. High cost of importation and toxicity of synthetic molluscicides has stimulated the renewal interest and attention of control managers in plant molluscicides (Massoud, and Habib, 2003). Schistosomiasis control programme through the plant derived molluscicides provide great potentials with low toxicity that is suitable for snail control programme and development of indigenous molluscicides (Labe et al., 2012). Despite centuries of control effort and the introduction of highly effective anti-Schistosomal drug therapy in 1980's the disease still exists in tropical countries (Bakry, 2009). WHO estimated that 65-80% of developing

world's population relies solely on plant derived medicine in order to meet their basic primary health care needs (Umar et al., 2023).

The high cost of synthetic molluscicides, their toxic effects to non-target aquatic biota including man as well as the complex organization required in its application are the major setback in the continued effort of schistosomiasis control programme (Okeke and Ubachukwu, 2011). Search of plant molluscicides with no effect to non-target organisms, easily biodegradable has become panacea for scientists in the control of snail intermediate hosts of schistosomiasis. It is appropriate, inexpensive technology for snail vector control in the endemic poor nations of the world which make it to be receiving greater attention (Labe et al., 2012). Schistosomiasis has been ranked second to malaria and is among the most important parasitic diseases in terms of morbidity, mortality, socio-economic and public health importance in the tropics (Ogbe, 2002). Fascioliasis endemicity in the area on the other hand, has not been so intense; however, series of reports have confirmed the presence of the disease. The study area has been endemic for schistosomiasis over decades as a result of flow of River Sokoto in the area that harboured freshwater snails intermediate host for the disease. In Sokoto state farmers, fishermen, irrigation workers, children and women whose domestic tasks bring them into contact with infested water containing cercariae in the endemic areas are at risk of Schistosoma infection. Based on the occurrences, epidemiology, prevalence, intensity and the status of schistosomiasis in Kware, Wamakko and other part of the State as reported by (Mungadi and Malami, 2007; Kabiru et al., 2013; Bello et al., 2014; Singh and Mudassiru, 2014 and Singh et al., 2016). Different factors contribute to the rapid increase of schistosomiasis such as food production, irrigation projects, inadequate safe water, lack of awareness about the disease and insufficient trained health workers (Kindki, 2014). Migration to urban areas and movemement of regugee introduce schistosomiasis to new areas and increase in population size, correspond with needs for power and water, often and increased disease transmission (WHO, 2013). It has been reported that about 200 million people in some 74 countries are infected with the schistosomiasis worldwide and at least 600 million people are at risk of infection. High cost of synthetic Niclosamide (Bayluscide) molluscicides and their effects to non-target organism including man, difficulty in its mode of application are serious challenges especially in schistosomiasis control programme. Plant derived molluscicides would be cheaper, easily biodegradable, environment friendly thus, available (Adedotun and Odaibo, 2009).

MATERIALS AND METHODS

The study was based on the report that abundant number of freshwater snails with transmission potentials of helminth diseases like schistosomiasis and fascioliasis, with paucity of information regarding adaptable and dependable control measures. Secondly, although there were many reports of helminth disease prevalence such as schistosomiasis, with a few reports on fascioliasis, there were limited reports of studies linking the helminth diseases with the availability and distribution of freshwater snail vectors. This is why the present research is intended, to indicate the link between the helmith disease prevalence among humans and animals and the availability and distribution of freshwater snails and their infectivity with the cercariae of major helminth parasitic species, aiming at recommendation of major control strategies such use of both chemical and plant molluscicides, to join hand with the global vector control response adopted by World Health Organization calling on member states to adopt national vector control strategies (WHO, 2020).

This study is to determine the Availability and distribution of potential freshwater snail vectors of helminth parasites in Kware and Wamakko LGAs of Sokoto State, Nigeria, determine the availability in (%) of freshwater snail species in Kware and Wamakko Local Government Areas of Sokoto State, determine the distribution (in %) of freshwater snails in the study area and to determine the infectivity of the freshwater snail species with cercariae of helminth parasites.

The study was carried out in six communities of (Kwalkwalawa, Dundaye, Gidan gara, More, Rugar liman and Gidan manomi) of Kware and Wamakko Local Government areas Sokoto State, North-West Nigeria. The areas were located between latitude $6^{o}120$ and $5^{o}180$ north of equator and longitude $13^{o}20$ and $13^{o}80$ east of Greenwich. Sokoto State has the land mass of about 25, 973 km^2 and a total of 662,173 people as projected from census (2016) within 23 Local Government Areas. Kware and Wamakko Local Government Areas are located in Sokoto Central Senatorial District and Kware/Wamakko Federal Constituency in Sokoto State of North-West

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zone of Nigeria. The two areas shared boundaries in the North-South of the state and are known for their farming and fishing activities in the State. Kware is situated in the North-West of the State on a total area of 554-kilometer squares and has the total population of 133,899 NPC, 2006 census. Research conducted by National Bureau of Statistics in the year 2010, showed that estimated rural-urban migration in the area is about 181,000. Wamakko is located in North-South of the State with an area of 697-kilometer squares and a population of 179,619 NPC, 2006. Similar research conducted by National Bureau of statistics in the year 2010 showed that the estimated rural-urban migration in the area is about 4,536 and is increasing at the rate of 10% annually.

The areas are in Sudan Savanna zone with the temperature ranges between 24^{o}C-42^{o}C and were characterized with two seasons mainly (rainy and dry season). Rainy season start around April and ends in October, while dry season starts ending of October and end around April. The two Local Government Areas (Kware and Wamakko) are the major parts of Sokoto metropolis where administrative, academics and commercial centres are located which include Usmanu Danfodio University Sokoto (U.D.U.S), Usmanu Danfodio University Teaching Hospital Sokoto (U.D.U.T.H), Cement Company of Northern Nigeria (C.C.N.N), Federal Neuro Psychiatric Hospital Kware, Shehu Shagari College of Education Sokoto (S.S.C.O.E), Umari Ali Shinkafi Polytechnic, College of Administration, College of Legal and Islamic Studies, Orthopaedic Hospital Wamakko, N.Y.S.C permanent orientation camp Wamakko, Bowa Cement Company Wamakko, Kware Fertilizer Company Sokoto, Sokoto Central Market (S.C.M), Federal Secretariat, State Secretariat (FIVE STARS), Usman Faruk Secretariat, Government House Sokoto, State House of Assembly among others. The popular Sokoto Rima River flow through Kware to Wamakko areas of the state. Kware and Wamakko Local Government Areas has about fifty tribes, with Hausa, Fulani, Sullubawa, Zabarma and Buzaye as the dominant tribes in the two areas. They are mostly Muslim. Farming, fishing, mining and rice milling are predominated economic activities of the people in the two areas. Other occupations are pottery, animal rearing, leather works among others (Figure 3.1).

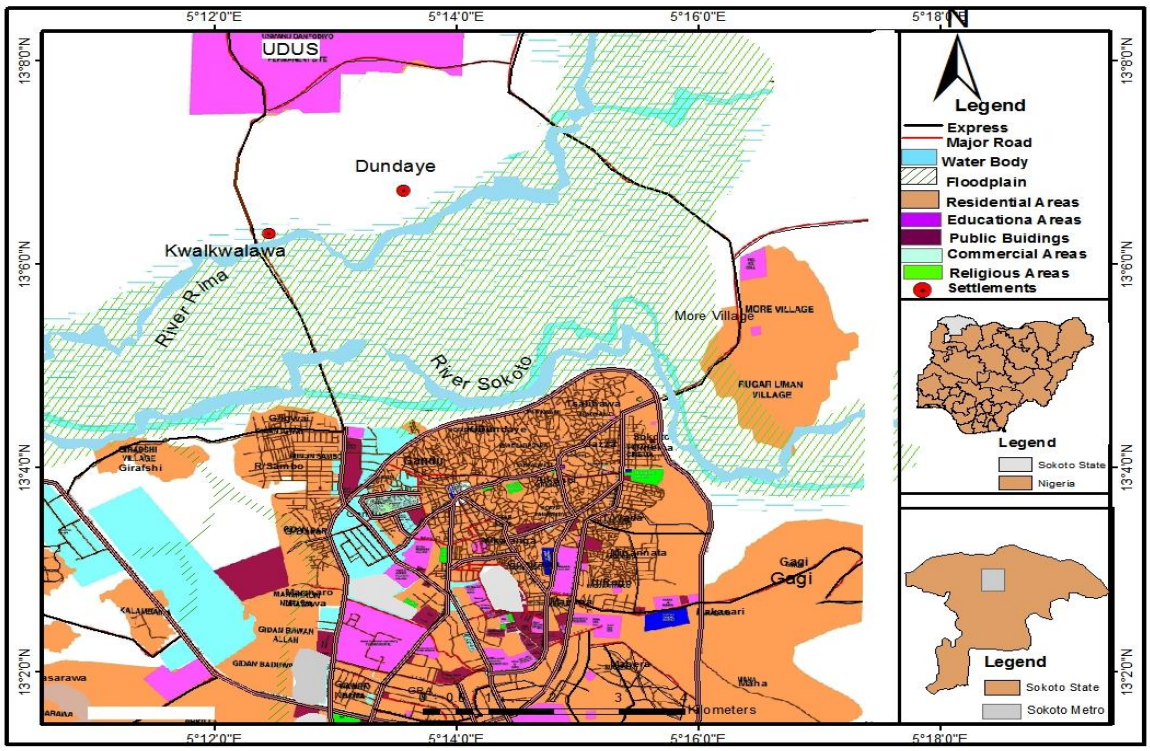

Figure 1 Map of Sokoto State, Nigeria Showing River Sokoto More in Kware and Kwalkwalawa in Wammako Local Government areas Sokoto State, Nigeria (Source: GIS, 2020).

Ethical Approval and Informed Consent

Prior to the commencement of the study, an introductory letter was obtained from the Head of Department Animals and Environmental Biology Kebbi State University of Science and Technology Aliero, Nigeria, and submitted to the Sokoto State Ministry of Health for ethical clearance and permission. The protocol of the study was reviewed and permission was granted to conduct the study. It conveyed to the Ministry for Local Government

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and Community Development; two Local Government area chairmen and community leaders of the affected villages were sought with written consent from the village heads and parent of volunteers who have participated in the study from Kware and Wamakko Local Government areas. (Assigned Number: SMH/1580/V/IV).

Survey, Collection and Identification of Freshwater Snails

The survey was conducted between March, 2020 to July,6 2021 from six potential transmission sites of Kwalkwalawa, Dundaye and Gidan gara of Wamakko and. More, Rugar liman and Gidan manomi of Kware Local Government areas of Sokoto State, Nigeria. Different freshwater snails were collected with the aid of long wooden scoop net from the streams of the study sites. The collected freshwater snails were taken to General Biology Laboratory in the Department of Animal and Environmental Biology, KSUSTA and placed into an open wide container with dechlorinated tap water and fed with grounded lettuce for 48h for acclimatization (WHO, 2012). Seven samples were taken to the Museum of Natural History, Department of Biological Science Ahmadu Bello University Zaria, Kaduna State, Nigeria and Department of Zoology University of Jos, Plateau State, Nigeria for identification (Voucher No: 7B).

Snail Cercarial Shedding Examination

Snails were placed individually in 5ml glass bottle and exposed to artificial light for 2 hours (11:00am to 01:00pm) to induce shedding of cercariae. The water in each bottle is examined under dissecting microscope for the presence of cercariae. The snails that did not shed cercariae during the exposure period were kept in glass aquaria in the laboratory and rechecked for cercarial shedding and fed with grounded lettuce in water. Cercariae released by the snails were isolated on slides and stained with haematoxylin. The types of cercariae observed were to be described base on morphological characteristics, swimming behaviour and resting position (Christensen et al.,1984).

RESULTS

Distribution of Freshwater Snails in the Study Area

About 1000 freshwater snail samples were collected from the study areas of Kware and Wamakko Local Government of Sokoto State, Nigeria as Bulinus globosus, Biompharia glabrata, Radix natalenisis, Melanoides maculatus, Bellamya crass spiralis, Bellamya crawshayi and Lanites ovum. They were evenly distributed across the six collection sites of the two Local Government Areas where Kwalkwalawa collection site (Wamakko Local Government Area) had the highest number of snails collected 252 while Gidan Manomi collection site (Kware Local Government Area) was the least number of snails collected 129 by sites collections. However, by species collection B. globosus recorded the highest of snail collected with the total number of 460, while B. craawshay became least with the total number of 28 freshwater snails by species collection (Table 1).

Table 1 Distribution of Snail Species by Site of Collections in Selected Communities of Sokoto State

Sampling Site	B. globosus	R. natalensis	B. glabrata	M. maculatus	B. crass spiralis	B. crawshayi	L. ovum	Site Total
Rugar Liman	51	29	21	14	10	4	7	136
Gida Manomi	4	23	22	17	8	3	7	129
More	-	96	142	67	55	460	46	26
Kwalkwalawa	41	27	27	23	25	22	23	136
Dundaye	16	23	15	17	102	10	2	28
Gidan Gara	6	7	8	41	6	4	5	60
Total	179	252	154	151	1000	17.3	25	15.5

Infectivity of Freshwater Snails with Cercariae of Helminth Parasites

Out of the seven species of freshwater snails collected and examined for infectivity, only three were found infected, shedding cercariae of different morphological characteristics, swimming behaviours and resting positions. Out of the 117 cercariae released, 67 (57.3%) of S. haematobium were isolated from B. globosus, 38 (32.5%) of F. hepatica were isolated from R. natalensis, 12 (10.2%) of S. mansoni were isolated from B. glabrata and non were isolated from M. merculatus (Plate 1; Table 2)

Redix natalensis **Bulinus globosus** **Melanoides merculatus** **Biomphalaria glabrata**

Plate 1 Snail Samples Collected from the Selected Sampling Sites of Sokoto State

Table 2 Prevalence of Freshwater Snails Infectivity with Cercariae of Helminth Parasites

Snail Species	**B. globous**	**R. natalensis**	**B. glabrata**	**M. maculates**	
Cercarial spp.	**S. haematobium**	**F. hepatica**	**S. mansoni**	**Nil**	**Total**
No. of Cercariae	67	38	12	0	117
Prev. (%)	57.30%	32.50%	10.20%	0%	100%

Plate 1: Cercaria of Schistosoma haematobium released by Bulinus globosus Freshwater Snail from the

Plate 2: Cercaria of Fasciola gigantic released Radix natalensis Freshwater Snail from the Study Area (Approx. x 10) magnification

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Plate3: Cercaria of Schistosoma mansoni released by Biomphlaria glabrata Freshwater Snail from the study area (Approx. x 10) magnification

DISCUSSION

Highest prevalence of B. globosus 460(46%) confirm the area as schistosomiasis endemic area. This is in line with the report of Taufiq et al., (2017) who revealed that B. globosus was the highest snail collected with total of 229 out 814 from Kwalkwalawa. This is in agreement with Idris and Ajanusi, (2002) who reported that abundance of gastropod freshwater intermediate snail host and human water-contact activities with contaminated water increased the rate of infection with S. haematobium in Katsina State Nigeria. Sam Wobo et al., (2017). It also agreed with the report of Mungadi and Malami (2007), Kabiru et al., (2013), Singh and Mudassiru, (2014) and Singh et al., (2016) who reported different health complications of schistosomiasis due to presence of B. globosus in freshwater around Sokoto State. This is also in agreement with the report of Malann et al., (2017), Adeleke, (2017), Abubakar et al. (2019) and Rabone et al., (2019), who reported the presence of freshwater snail of B. globosus in Katsina, Abuja, Osun and Niger State. It is however, contrary to the findings of Abdullahi et al., (2018) who reported that B. globosus was the least freshwater snail collected from Kwanar Areh Dam in Rimi Local Government Area, Katsina State, Nigeria when compared with Melanoides tuberculate and Gabiella tchadiensis. This may be due to the certain ecological factors that promote their growth and development as reported by Appleton, (1997) and Taofiq et al., (2017).

Highest infectivity of B. globosus 67(57.3%), followed by R. natalensis 38(32.5%) and B. glabrata 12(10.2%) with cercariae of S. haematobium, F. gigantic and S. haematobium respectively, confirmed the area as schistosomiasis and fascioliasis endemic area. This confirmed the report Taofiq et al., 2017 that Kware Local Government and Wamakko Local Government Areas of Sokoto State were endowed with freshwater snails of medical and veterinary importance including the intermediate hosts for urogenital schistosomiasis, intestinal schistosomiasis in human and fascioliasis (Liver flukes or Liver rot) disease of livestock, which may be as a result of human-water contact activities of fishing, farming and animal grazing.

Additionally, the presence of freshwater snails B. globosus, B. glabrata, and R. natalensis, indiscriminate defecation and grazing around the riverine areas, with low level of formal education among the people were some of the risk factors of the disease in the study area (Taofiq et al., 2017).

CONCLUSION

In conclusion, the results of this study revealed the presence of freshwater snails; higher abundance of B. globosus and higher infectivity with S. haematobium followed by R. natalensis with F. gigantic and B. glabrata with S. mansoni, followed by lower frequency of M. maculates with no any evidence of infectivity. It is hereby recommended to the government and other human and animal healthcare agencies to consider application of molluscicides to reduce the population of freshwater snails, in order to control Schistosomes and Fasciola infections. It is also recommended that the government and other stakeholders should consider use of plant derived molluscicides from local plants (Khaya snsgalensis, Azadhracta indica), which are abundant in the rural endemic areas to stimulate the growth of small-scale industries in the manufacturing of drugs for the control of snail vector. Researches on M. maculatus, B. crawshayi and L. ovum, whose information is not available in the study area are

hereby recommended. Government agencies and other stakeholders should provide portable drinking water, health education, toilet facilities and other social amenities to the study area to reduce the number of risk factors of infection with the helminth parasites prevalent in the area.

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