AUTOMATED TELLER MACHINE (ATM) AND TRANSMISSION OF PARASITE

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DEDICATION

This project is dedicated to the Almighty Allah, the Supreme Being, and the Alpha and Omega, the giver of wisdom, knowledge and understanding.

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ABSTRACT

This study is an attempt to examine Automated Teller Machine and transmission of parasite. The reason for embarking on this research is therefore, to know Automated Teller Machine and transmission of parasite in Ijebu-Igbo, the objectives of the study is to determine the occurrence of parasite, cyst and ova on bank automated teller machine facilities in Ogun State. Consequences upon study the following recommendation is to improved sanitary measures should be put in place in banks to reduce and or eliminate the occurrence of resistant stages of parasitic organisms on their facilities and also persons entering and leaving the bank should wash their hands. This research study focused on Automated Teller Machine and transmission of parasite.

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CHAPTER ONE

Parasites are organisms that live upon or within another living organism known as the host, at whose expense they obtain some advantages such as food, water, heat, habitat and dispersal as well as shelter, and in the process increase their fitness by exploiting the host for resources necessary for their survival (Blood and Virginia, 2018). Parasites reduce hosts fitness in many ways, ranging from general or specialized pathology such as parasitic castration and impairment of secondary sex characteristics, to the modification of host behaviour (Blood and Virginia, 2011).

According to Kathleen and Arthur (2012), intestinal parasites occur worldwide among all human ages and socioeconomic groups. In the 1993 World Development Report, intestinal helminthes rank first as the main cause of disease burden in children aged 5 – 14 years where they constitute formidable health problems resulting in malnutrition, anaemia and disturbed appetite. These may ultimately result in retarded physical and cognitive development in children. Parasites have been identified as the cause of morbidity and mortality throughout the world particularly in underdeveloped countries and in persons with Comorbidities (Adeyeba and Akinlabi, 2012). It is known that individuals often exposed to and infected with multiple parasitic organisms and their harmful effects often aggravated by coexistence of malnutrition or micronutrient deficiencies (Adeyeba and Akinlabi, 2012).

The prevalence of intestinal parasitic infections is most significant because several of the enteric parasites have direct life cycles and do not need any intermediate host to infect a new host as they are spread via faecal contamination of food, drinks and other substances/surfaces. These faecal contaminative infections are often said to be caused by faecal-orally transmitted parasites (Hoeprich, 2009; Awodi *et al.,* 2010). Infections acquired through direct ingestion of infective ova and/or cyst of parasites are intimately linked with the level of personal hygiene of individuals and sanitation in such an environment which most times can be transmitted by fingers/hands directly to other persons or to food from contaminated clothing and perianal area or other potential surfaces (Hoeprich, 2009).

Within the bank environments, opening of automated bank doors using the door button, shaking of hands within and outside the bank premises, filling of deposit and withdrawal slips for paying and withdrawal of money, use of currency counting machines and touching other contaminated surfaces in the banks make the banks repositories and important avenues for the spread of the cysts, oocysts and ova of important parasites. Paper money, especially in the Nigerian environment and elsewhere, presents a particular risk to public health since communicable diseases can be spread through contact with fomites (Hosen *et al.*, 2012; Xu and Moore 2015; Basavuvapappa and Suresh, 2015; Ogbu and Uneke, 2017; Lalonde, 2007; Umeh *et al.*, 2017). The high cravings for bank notes as means of depositing and saving wealth in banks necessitate different categories of people moving into the banks at one point or another and inadvertently contaminating bank facilities such as surfaces of automated teller machines (ATMs), counters, keyboards of computers, currencies, other bank surfaces and even the hands of the bankers when used for counting the money or touching contaminated surfaces within these banks (Hoeprich, 2009; Awodi *et al.*, 2010).

This leaves the surfaces of bank facilities without an exemption of being contaminated with the cysts and ova of parasites. More so that these parasites are just about everywhere in our environment, making it easy to become infected (WHO, 2008). Thus surfaces of bank facilities could be major potentially biologically contaminated vehicles for the spread of cysts and ova of parasites. Therefore, the aim and objective of this study is to determine the occurrence of parasite cysts and ova on bank automated teller machine facilities in Ogun State.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Species of Parasitic Organisms Producing Contaminative Cysts, Oocysts and Ova in the Environment

A Parasite is a term applied to any infectious agent, however, by convention it is generally restricted to infections caused by protozoa (which are microorganisms that multiply within their vertebrates host), and helminths (which are macro parasites) (Taylor et al 2017; Suleiman, 2015). Intestinal parasites are acquired through contact with and or ingestion of contaminated cysts, ova or immature larval stages produced by different species of parasites. Almost all of these intestinal parasites have their infective stages transmitted by faecal-oral route. Faecal-oral transmission involves the ingestion of food or water contaminated with cysts or oocysts available in the immediate environment. These cysts and eggs are excreted with the faeces and are somewhat resistant to the environment as entry points to human infections. Human societies have always been challenged by infectious diseases caused by helminth and protozoan parasites, especially the pathogenic parasites producing cysts, oocysts and ova on contact surfaces (Awodi et al., 2010; Dyck, 2001; Nock and Geneve, 2002; Apichai et al., 2015).

Species of parasites producing cysts in the human environments include such pathogenic protozoans as C. parvum, E. histolytica, G. intestinalis and B. coli inhabiting the gastrointestinal tracts of humans (Baqui et al., 2012; Kathleen and Arthur, 2012). These pathogens cause human disorders worldwide (Fontanet et al., 2010; Apichai et al., 2015). Human intestinal helminths include *S. stercolaris, E. vermicularis, T. saginata and T. solium*among others. The common round worm known scientifically as *A. lumbricoides*, the whipworm or *T. trichiura*and the hookworms *Necatoramericanus*and *Ancylostomaduodenale*are regarded as the four most important soil transmitted helminths (STHs) because they have the highest prevalence rates and they cause the greatest burden on human health (Hotez*et al.*, 2018), with their major public health significance being the chronic morbidities they cause in their hosts (WHO, 2012).

2.1.1 Protozoa

The name ‗protozoa literally means ‗first animals' as they are believed to be primitive relatives of animals. There are four major groups of protozoans traditionally classified according to their means of locomotion; they include amoeboid, sporozoids, flagellates and ciliated protozoans.

Protozoans are eukaryotic organisms (with a membrane-bound nucleus) which exist as structurally and functionally independent individual cells (including those species which are gregarious or form colonies). Most species of protozoa are microscopic organisms, only a few grow to a size large enough to be visible to the naked eye. As unicellular eukaryotes, protozoans display all the same essential life activities as higher metazoan eukaryotes, they move about to survive, feed and breed (www.carolina.com), retrieved 13th April, 2014). Protozoans live as predators and parasites with their developed relatively complex subcellular features (membranes and organelles) that enable them to survive the rigors of their environments. As parasites they have adjusted to attack and live in cells and tissues of other organisms. They live inside humans in the bloodstream, in the tissue and in the intestinal tract (Hardeep, 2009).

2.1.2 *Cryptosporidium* Species

Cryptosporidium is a protozoan parasite, originally described by Tyzzer in 2007, (Fayer*et al.*, 2017; USEPA, 2001). *Cryptosporidium* species were regarded as commensals, until their association with diarrhoea in young turkeys (*Cryptosporidium meleagridis*) in the 1950s, and with large outbreaks of diarrhoea in calves (*Cryptosporidium parvum*) in the 1970s (Fayer*et al.*, 2017). In 1976, it was identified at John Hopkins School of Medicine in the United State of America involving a 3 year old girl from rural Tennessee as the causative agent of a human disease called cryptosporidiosis (USEPA, 2011 and Arora

and Arora, 2019). However, the pathogenic potential of *C. parvum*as an intestinal protozoan affecting humans was not fully appreciated until 1982. This was when it started gaining recognition as a result of the onset of HIV/AIDS and its prevalence in the number of some other severely immunocompromised individuals due to cancer chemotherapy and organ transplant (Anonymous, 2017 and Oyibo*et al.,* 2019).
Current classification of *Cryptosporidium* is based upon a variety of parameters including host preference, cross-transmissibility, morphological differences, sites of infection and molecular taxonomic methods (Smith *et al.,* 2017).

Cryptosporidium is transmitted between individuals through oocysts that are already eliminated in the infectious form (O'donoghue, 2015). Transmission can occur via any mechanism by which materials contaminated with viable oocysts can be ingested by any susceptible host (Smith, 2004; Oyibo*et al.,* 2009). The environmental routes of transmission include all vehicles that contain sufficient infectious oocysts (Smith *et al.,* 2007). However, oocysts are most commonly transmitted by faecal-oral route of host-to-host contact and indirect contamination of food or water as aerosol transmission of oocysts has also been reported (Hojlyng*et al*, 2017.

2.1.3 *Entamoeba histolytica*

Amoeba is a single-celled protozoan belonging to the class Rhizopoda, possessing organs of locomotion known as pseudopodia. Several protozoan species of the genus *Entamoeba* exist, they may be parasitic (for example *E. histolytica*), commensal or free living. Eight amoeba (*E nana, E. coli, E. histolytica, E. dispar, E. hartmanni, E. moshkovskii, E. polecki,* and *I. bütschlii)* reside in the human intestinal lumen as evident commensals, deriving a niche and sustenance (Diamond and Clark 2013; Tanyuksel and Petri 2013; Mehmet and Petri, 2013).The recent reclassification of *E. histolytica* into different species as pathogenic *E. histolytica* and the non-pathogenic *E. dispar*and *E. moshkovskii* has further added to the complexity of the epidemiology (Samie and Ra'ed., 2012).

Although the reclassification is of great value because all invasive disease before now was known to be caused by *E. histolytica,* but then it requires various techniques such as ELISA and PCR (Pillai*et al.,* 1999; Verweij*et al.,* 2010), as this species cannot be differentiated by mere microscopy which is the most commonly used diagnostic method particularly in tropical countries where resources are limited (Samie and Ra'ed, 2012).

Entamoebahistolytica is a tissue-lysing luminal protozoan parasite of the family *Entamoebae*. It is the most prevalent of the intestinal protozoa pathogens found throughout the world (McLaughlin and Aley, 2015). *Entamoebahistolytica was* recognized since 1875 by Losch in the dysenteric faeces of a patient in St. Petersburg, Russia (Jayaram, 2012; Obadiah, 2012). The name *E. histolytica (*first used by Schandinn in 1903 and amended by Walker in 1911) has been retained for the protozoan parasite that causes invasive intestinal and extra intestinal amoebiasis (Atu, 2008). The life cycle of *E. histolytica is* simple, it includes two stages, the infectious (cyst) stage and the pathogenic (trophozoite) stage. Infection is through the ingestion of the infective microscopic cysts, where infected food handlers with poor sanitation habits can easily pass cysts on to others and fomites. Contaminated drinking water and mechanical vectors such as cockroaches and flies are also potential sources of infection.

2.1.4 *Giardia intestinalis*

Giardia is a flagellate, bi-nucleated protozoan parasite discovered by Van Leeuwenhoek in 1681 (Ali and Hill, 2013). The genus *Giardia* belongs to the phylum Sarcomastigophora, class Zoomastigophorasida, order Giardiida and family Giardiidae. It contains at least six species that infect animals and/or humans. In most mammals, giardiasis is caused by *G. duodenalis*, which is also called *G. intestinalis*. Two older names for the organism, *Giardia lamblia*and *Lambliaintestinalis,* are no longer considered to be taxonomically valid (USEPA, 1999; CDC, 2010).

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Giardia spp. has two stages, cysts and trophozoites. It is transmitted by the cyst form of about 10–12 mm long and infectious immediately upon excreted in faeces. The infectious dose is low and ingestion of 10 cysts has been reported to cause infection. In the encysted stage the organism is relatively resistant to chlorination and ozonolysis and can remain viable for several weeks especially in cold surface water. The acquisition of *Giardia* occurs most commonly through ingestion of the cyst in contaminated water, but person-to-person spread is common, particularly in settings of poor faecal–oral hygiene. Filth flies can carry potentially viable *G. intestinalis*cysts on their exoskeleton, which they have acquired naturally from unhygienic sources to contaminate other vulnerable surfaces (Graczyk*et al*., 2013).

2.2 Helminths

The word helminth is a general term meaning _worm'. Helminths are multicellular eukaryotic invertebrates with tube-like or flattened bodies exhibiting bilateral symmetry. Many helminths are free-living organisms in aquatic and terrestrial environments, others occur as parasites in most animals and some plants. Parasitic helminths are almost universal feature of vertebrate animals with most organisms having worms in them somewhere. According to Ojha*et al.* (2014), the major groups of parasitic helminths include nematohelminths (nematodes) and platyhelminths (flatworms), the latter subdivided into trematodes (flukes) and cestodes (tapeworms). Helminths are a group of intestinal parasites causing human infection through contact with parasite eggs or larvae that thrive in warm and moist soils of the world's tropical and subtropical countries. Helminths belonging to the phylum Nematoda that are of particular worldwide importance are the roundworms (*A. lumbricoides*), whipworms (*T. trichiura)*, and two hookworms (*A. duodenale*and *N. americanus),* which are morphologically indistinguishable by mere microscopic observation (CDC, 2013; Ojha*et al.*, 2014). As adult worms, soil-transmitted helminths live for years in the human gastrointestinal tract with more than a billion people infected with at least one species (Bethony*et al*., 2012).

2.2.1 *Ascaris lumbricoides*

Ascaris lumbricoides, also known as roundworm, is one of the largest (measuring 30 to 50 cm in length and 3 to 6 mm in diameter) of the parasites that infest the human bowel and is common in regions with poor faecal sanitation, particularly in developing countries in the tropics and subtropics (Ping, 2012 and Raina*et al*, 2013). *Ascaris*has a direct life-cycle where mature male and female adult worms reside in the lumen of the small intestine infecting humans that ate food contaminated with matured ova (Raina*et al*, 2013).Transmission of these infective ova occurs by an infected person defecating outside indiscriminately and or if the faeces of an infected person are used as fertilizer, the eggs are then deposited on the soil where they can then mature into a form that is infective.

Ascariasis is caused by ingesting the infective eggs when hands or fingers that have contaminated dirt on them are put in the mouth or by consuming contaminated vegetables or fruits that have not been carefully cooked, washed or peeled (Raina*et al.*, 2013; CDC, 2013). Larvae hatch in the small intestine, penetrate the intestinal wall, migrate to the lungs to become fourth-stage larvae, and then migrate up the trachea back into the oesophagus and ultimately the small intestine. In about 60 days from the point of infection, females will start to produce up to 200,000 fertilized eggs a day (Kathleen and Arthur, 2012).

2.2.2 *Trichuris trichiura*

*Trichuris trichiura*is a soil-transmitted roundworm commonly called the human whipworm due to its characteristic thin, long, whip-like appearance. Of the roundworms that infect humans, the whipworm is the third most common soil transmitted helminths, with a cosmopolitan distribution, more common in tropical climates (Anon, 2007, CDC, 2010). It has been estimated to infect 604 – 795 million people worldwide resulting in an expected 6.4 million disability adjusted life-years lost globally (Hansen *et al.*, 2013).

Trichuriasis is transmitted when the infective eggs of the whipworm are unintentionally ingested, usually through consuming soil that has been contaminated with human faeces via dirt covered foods or hands. The spread of the barreled shaped eggs, measuring 50μm to 54μm, of human whipworm usually occurs in areas where outside defecation takes place or human faeces is used as fertilizer (CDC, 2010). After the eggs are ingested, they move to the small intestine where they hatch and grow into juveniles. Hookworms are blood sucking roundworms living in the small intestine and the second most common human worms (parasitesinhumans.org). They are prevalent throughout the tropics and subtropics, wherever there is faecal contamination of the environment (WHO, 2019). Taxonomically, hookworms are nematodes belonging to the family Ancylostomatidae, a part of the super family Strongy loidea. There are thousands of hookworm species but the two major genera that affect humans are *N. americanus* (causing necatoriasis) and *A. duodenale* (causing ancylostomiasis) (WHO, 2019, Simon *et al*., 2014) which are characterized by the presence of either teeth or cutting plates that line the adult parasites buccal capsule (Hotez, 2015) whose geographical distributions overlap (WHO, 2019).

The life cycle of *N. americanus* commences with eggs being shed in the faeces of infected people deposited indiscriminately in open places or used as fertilizers in the soil. Eggs embryonate in soil under favourable conditions and the first-stage larvae hatch afterwards, feeding on environmental microbes and molt twice to become infective third-stage larvae (iL3).

2.3 Intensity of Parasite's Cysts and Ova in Human

Intensity of parasitic infection is usually measured by the number of eggs per gram (epg) of faeces, generally by the Kato-Katz faecal thick-smear technique (Bethony, 2016). In study conducted in China, among people of Hainan Province, revealed that the peak mean intensity for *Ascaris* infection was 665 epg (95% CI=109–1220) and for *Trichuris* infection was 242 epg (95% CI=242–363) which occurred during the first decade of life for the age range of 1–9 years (Bethony *et al*., 2012). Earlier workers also presented similar findings (Anderson, 1985; Labiano *et al.*, 2019). The mean egg count per gram of stool for *Necator* infection in the sample was 971 epg (95% CI=639–1304). The range of egg count was 24–66,432 epg while peak egg counts occurred among persons in the oldest age intervals. Female subjects (1332 epg, 95% CI=724–1939 epg) had significantly higher egg counts than did male subjects (615 epg, 95% CI=340–890 epg) (Bethony *et al.*, 2012).

In Ecuador, in the city of Portoviejo, a study that examined stool samples of 151 school children revealed that seven (7.8%) of the children had high intensity of *A. lumbricoides* out of mean egg value of 13217 (± 1540). The respective high intensities of *T. trichiura* occurred in five (3.3%) of the children with mean egg value of 7168 (± 1074). Hookworm was reported to be of low intensity with mean egg value of 4800 (± 960) (Andrade *et al.*, 2011).

In Côte d'Ivoire, infection intensities expressed as group arithmetic mean faecal egg counts among school children in rural AzaguiéM'Bromé/AzaguiéMakouguié for hookworm, *T. trichiura* and *A. lumbricoides* were mainly light (Coulibaly*et al.*, 2012). Most of the children were heavily infected with intestinal protozoa. In peri-urban Abbé-Bégnini, 97.0% of the infected school children showed light helminth infection intensities. In urban AzaguiéGare, all helminth infections were of light intensities. Intestinal protozoan infections were light (58.4%) or moderate (36.5%) and only 13 children showed heavy infection (Coulibaly *et al.*, 2012). In Ethiopia, stool samples obtained from children attending 14 primary schools in Jimma have shown infection intensity of soil transmitted helminths to be of mean arithmetic means of 2,411epg (0–176,000), 295 epg (0–19,350) and 35 epg (0–950) for *A. lumbricoides*, *T. trichiura*and hookworm respectively. In Nigeria, a study carried out among residents of Era-Awori village located in a Lagos suburb showed highest mean parasite egg count (epg) for people aged 11 – 20 years as 2841.12 followed by those aged with 1 – 10 years with similar findings (Anderson, 1985; Labiano *et al.*, 2019). The mean egg count per gram of stool for *Necator* infection in the sample was 971 epg (95% CI=639–1304). The range of egg count was 24–66,432 epg while peak egg counts occurred among persons in the oldest age intervals. Female subjects (1332 epg, 95% CI=724–1939 epg) had significantly higher egg counts than did male subjects (615 epg, 95% CI=340–890 epg) (Bethony *et al.*, 2012).

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1893.1 epg (Ibidapo and Okwa 2018). There was a drop in the mean epg value from age group of 21 – 30 years (860.66 epg) down to the 51 – 60 years age group (392.64 epg). For males, there was no significant difference in egg counts among all the age groups except for the 51 – 60 years group, which was significantly lowest ($P < 0.05$). Adeyeba and Akinlabi (2012) have also reported high prevalence and intensity of soil transmitted helminths (STHs) among rural school age children in Nigeria. Awolaju and Morenikeji (2019) reported intensity of *A. lumbricoides*as light (100 - 3,000 epg) among school children in both primary and post-primary schools, although those aged 13-15 years recorded moderate intensity of 5000-6000 epg. The differences recorded in the prevalence and intensities of the intestinal parasites in all the study locations were attributable to the level of sanitation prevailing in these areas.

CHAPTER THREE

3.1 Materials and Methods

3.1.1 Study Area

The study was conducted among commercial banks in Ijebu-Igbo in Ogun State, Ijebu North, Nigeria. Ogun State lies between latitudes 27.2046°N and longitudes 77.4977°E. A total of 30 samples of bank ATM consisting of 3 pieces of each parts of the machine was collected from different ATM machines.

3.2 Collection of Samples

Using a sterile cotton wool as swab materials 30 ATMS facility were swabbed to obtain samples. The cotton wool was inserted into a polytheme bag and transported to the laboratory for parasitological analysis.

3.3 Sample Collection

Sterile cotton wool was used to wipe clean the surface of the keyboard of key panel, selection buttons and cash dispensing interface. The cotton wools were separated into sterile polythene bags and transported to the microbiology laboratory for parasilogical examination and analysis. Each cotton wools was placed into a sample bottle and normal saline was added to it and was left to stand for 30minutes, after which the cotton wool was removed using a pair of sterile forces and transferred to sterile polythene bags the content of each bottle was centrifuged in a 15ml centrifuge at 1500 revolutions per minutes for two minutes. The resultant sediment was stirred with a clean applicable stick and a drop of lugols iodine (5%) and examined microscopically at x40 and x100 for the presence of parasite eggs and cysts under a binocular microscope.

3.4 Laboratory Examination

The working bench was swabbed with 70% ethanol to sterilize it the cotton swab were removed from the polythene bags and transferred using a forced into conical flask containing 10ml of 0.85% normal saline. Each flask was covered and shaken vigorously to ensure maximum soaking of the cotton swab. After which it was left to stand for 30 minutes, then it was shaken again after sometime, the cotton wool was removed from the conical flask. The content of the flask was poured into centrifuge bottles and centrifuged at 1500 revolution per minute for 2 minutes.

The supernatant was discarded and the residue was transferred unto a clean microscope slide and viewed under the microscope using x10 and x40 objective lenses.

CHAPTER FOUR

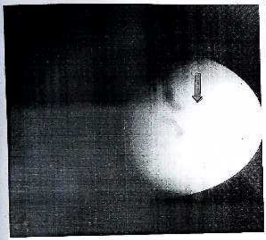
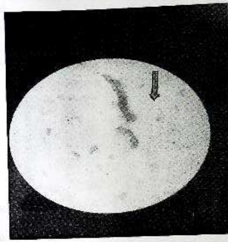
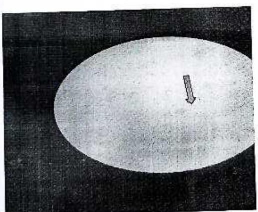
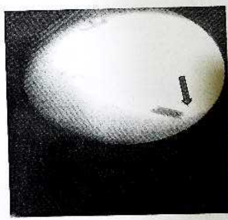
4.1 RESULT

SPECIES OF PARASITIC ORGANISM WITH CYSTS, OOCYSTS, AND OVA ON ATM FACILITIES.

The cysts or oocysts and ora of sixteen parasite organisms made up of eight helminths were recovered from the surfaces of various Atm facilities in this study (table 4.1), these in order of magnitude, included those of: Out of 30 facilities screened, the cysts/oocysts of five parasitic protozoans lucie isolated including Entamoeba histolytical(50%), entamoeba coli (10%), crypto sporidium(10.6%),culardiaintestinalis (10%), Isopora species (10%) 0.Ova of eight species of parasites helminths encountered on the screen facilities included those of 6.60 ascaris lumbricontes:- 2/30 6%, 3.33 Trichuristrichunra :- 1/2/30 = 6.66, 3.33 Hookwarm :- 1/30 = 6.66, 0 Taenia Species :- 0/30, 6.66 Entorobius vermiculars :- 25/30, 6.66 capillana species:- 2/30.

Table 1: PREVALANCE OF PARASITE OBSERVED ON ATM.

	ATM FACILITIES EXAMINED			
PARASITE OBSERVED (EGG)	**SELECTION BUTTON**	**KEYBOARD**	**CASH DISPENSER**	**TOTAL**
Entamoeba histolytica	22(61.11)	21(58.33)	33.(91.67)	76(211.11)
Crystospostidon	9(25.00)	17(47.22)	29(80.56)	55(152.78)
Entamoeba coli	3(8.33)	4(11.11)	6(16.67)	13(36.11)
Giardis intestinal	0(0.00)	3(8.33)	7(19.44)	10(27.77)
Coccidiasi	0(0.00)	1(2.78)	0(0.00)	1(2.78)
Balantidium coli	0(0.00)	1(2.78)	6(16.67)	7(19.45)
Cydospora species.	0(0600)	0(0.00)	1(2.78)	1(2.78)
Isosposa species	0(0.00)	0(0.00)	0(0.00)	0(0.00)
Ascaris lymbricoides	16(44.44)	5(13.89)	14(38.89)	35(97.22)
Trichuris trichiara	3(8.33)	0(0.00)	1(2.78)	4(11.11)
Taenia species	1(2.78)	0(0.00)	0(0.00)	1(2.78)
Hookworm	1(2.78)	0(0.00)	2(5.56)	3(8.34)
Dicrocoelium denariticum	0(0.00)	1(2.78)	0(0.00)	1(2.78)
Capillania species	0(6.00)	1(2.78)	0(0.00)	1(2.78)
Taxocara species	0(0.60)	0(0.00)	0(0.00)	0(0.00)
Enterobuis vermicularis	0(0.00)	0(0.00)	0(0.00)	0(0.00)
Total No of Facilities examines	27(75.0) 30	21(58.3) 30	31(86.1) 30	76(219.4) 90

Types and diversity of bank facilities on which cysts, oocysts, and Ova of parasites were recovered. The distribution of the occurrence of the cysts, oocysts and and ova of each of the 16 parasites on each of the three bank facilities in Ogun State, Nigeria is presented in table 4.1. the cysts, oocysts and ova of E. histolytica, E. Colt, cryphosporidium S.P and A. Lumbricoide were encountered and recovered from all the three ATM facilities.

CHAPTER FIVE

5.1 DISCUSSION

This study has revealed the occurrence of the cysts, oocysts and ova of several parasitic protozoans and helminths on bank facilities in parts of Ogun State, Nigeria. The study appears to be pioneering to have focused on extensive parasitological audit of bank Automated Teller Machine environments. The only other similar study of this nature cited was not as extensive and only focused on microbial (bacteria and fungi) contamination of currency counting machines and counting room environment in banks (Enemuor *et al.*, 2012).

However, several studies from various countries have consistently isolated parasites' cysts and ova from currency notes, which are the major exchange materials emanating from banks, although some of the notes were those in circulation and were not obtained directly from bank environments (Awodi *et al.*, 2000; Basavarajappa and Suaresh, 2005; Ekejindu, 2005; Ogbu and Uneke, 2007; Matur*et al.*, 2010; Orji *et al.*, 2012). These bank notes would however circulated in, out, through and among banks in one way or the other. Fourteen of the sixteen parasites whose resistant stages were isolated from banks in this study, including *E. histolytica, E. coli, Cryptosporidium* sp., *B. coli, Isospora*sp., *Cyclospora*sp. *G. intestinalis, A. lumbricoides, Toxocara*sp., *Taenia*sp., hookworm, *T. trichiura, Capillaria*sp. and *E. vermicularis,* are infective to humans and cause varying pathogenic conditions such as in intestinal and extra intestinal sites. Such diseases as amoebiasis, cryptosporidiosis, giardiasis, ascariasis, visceral and ocular larval migrans, *Capillaria*sis, and several more caused by the listed parasites, could be contracted from bank environments. These are amongst the leading enteric parasitic diseases (WHO, 1997), killing about 100,000 people yearly and infecting about 50 million more (Robert and Janovy, 2009). About 85% of people infected with these parasites are healthy carriers (Noble et al., 1989), with consequences of more transmission by faecal - oral route or human - to -human (Hojlyng, 1987; Current and Garcia, 1991). Few of the parasitic species, including Capillaria sp., D. dendriticum and Toxocara sp., parasitize domesticated animals and wildlife; and could also be zoonotic (Despommier, 2003; Alli et al., 2011; Omowaye and Toluhi, 2011).

5.2 CONCLUSIONS

Cysts, oocysts and Ova of all the parasitic protozoans and helminths occurred on and were isolated from Automated teller machines facilities (Keyboards, Selection buttons and cash dispenser.

Cysts, Oocystsand Ova of eight parasitic protozoans and eight parasitic helminthswere isolated from bank Automated Teller Machine facilities in three major banks within Ijebu-Igbo. The protozoan, *Entamoebahistolytica, Cryptosporidium* sp. *Ascarislumbricoides*and *Entamoeba coli* were the most dominant parasites encountered in this study. Intensities of cysts, oocysts and ova of the parasites are generally low, did not differ significantly ($P < 0.05$) amongst the banks and amongst the towns where the banks are located.

5.3 RECOMMENDATIONS

Improved sanitary measures should be put in place in banks to reduce and or eliminate the occurrence of resistant stages of parasitic organisms on their facilities. Persons entering and leaving the bank should wash their hands. Other control measures such as internal control policy for routine disinfection and the choice of disinfectants as well as treating contaminated facilities by installing secondary disinfection systems (ultraviolet lamps or ozone disinfection systems) is important. Given the potential of transmission of enteric parasites amongst human subjects in banks, extra personal hygienic measures should be adopted by bank users. Further studies should be conducted on bank workers to determine their enteric parasitic profile as a way to determining occupational hazards in bank environments.

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