INCIDENCE OF CANCER IN ENUGU STATE, NIGERIA

CHRISTY U. EZE

Department of Medical Radiology and Radiological Sciences, Faculty of Health Sciences and Technology, College of Medicine, University of Nigeria, Enugu Campus, Nigeria

SUMMARY

Between 1980 and 1990, 1546 cancer cases were registered from 20 hospitals in Enugu State in Nigeria. Frequency analysis revealed that breast cancer was the commonest cancer accounting for 22.3% of the total, followed by cancer of the extremities (16.7%), lymphoid tissue (8.0%), prostate (7.1%), cervix (6.3%), gastrointestinal tract (5.6%), ovary and uterus (5.2%).

41.9% of the cancers occurred in males whilst 58.1% were women giving a male to female ratio of 1:1.4. Analysis of the data according to cancer types revealed the following: carcinoma (66.4%), soft tissue sarcoma (11.5%), malignant melanoma (4.6%), histocytoma (0.1%). While carcinoma and sarcoma were most prevalent in the 40-49 years age group, sarcoma was least prevalent in the over 70 years of age group and carcinoma least prevalent in the 10-19 years age group. A clear trend of increasing frequency in recent years was demonstrated by the seven-fold increase in the average yearly figures between 1980 and 1990.

INTRODUCTION

The realisation of cancer as a major health problem in Nigeria dates to the early 1960s. However, the poor facilities existing in Nigerian hospitals at that time made diagnosis difficult, hence the estimation of the affliction and mortality rates due to this disease was almost impossible. During the last couple of decades or so, it has become possible to diagnose the disease with some degree of precision using different techniques, including x-rays, radioisotopes, histopathology, etc. Information is therefore becoming available from different parts of the country.

The prevalence of cancer in Enugu State of Nigeria, has been a common knowledge over the years and there are indications that its incidence is on the increase. However, unlike some of the other States 1,2,3,4,5,6, no scientific evidence is available to support the seemingly high incidence of cancer in this State. Such information is useful and necessary in the planning of research and treatment protocols in the crusade against this deadly disease. It was against this background that the present investigation was undertaken to study the incidence of cancer in selected hospitals in Enugu State of Nigeria.
MATERIALS AND METHODS

From August 1991 to July 1992, a retrospective review of hospital registry for different types of cancer diagnosed between 1980 and 1990 was performed. Twenty hospitals in Enugu State with admitting facilities were originally targeted. After six months from the start of the survey, it became evident that all the suspected cancer cases were referred to two of the hospitals for final diagnosis and treatment, namely: University of Nigeria Teaching Hospital and National Orthopaedic Hospital, both in Enugu. The rest of the investigations therefore centered on these two hospitals.

From the hospital medical records, the following information on the patients were retrieved for analysis:

1. Anatomical sites afflicted by the disease;
2. Sexes of the patients;
3. Types of cancer;
4. Ages of the patients; and
5. Year of diagnosis.

An analysis of the incidence of cancer according to anatomical sites was carried out, followed by the determination of the ratio of male to female in relationship to each site. The occurrence of the cancer types was then established and out of the results obtained, the cancer types observed were re-analysed according to age-groups. Finally, the annual variation in the incidence of the disease was determined. The recorded information on the patients retrieved for analysis was not complete in all cases. Consequently, the number of patients considered in the different analysis was not always the same.

RESULTS

As depicted in Fig. 1, of all the anatomical sites which were affected by cancer, breast cancer registered the highest incidence (22.3%), followed by the extremities (16.7%), lymphoid tissue (8%), prostate (7.1%), cervix (6.3%), gastrointestinal tract (5.6%), and ovary and uterus (5.1%). The lowest occurrences included the lips (1%), the pancreas (0.9%), the eye (0.8%), the lungs (0.7%), and the external genitalia (0.6%).

A re-analysis of the above results, according to sex ratio (Table 1) revealed a preponderance of breast cancer in females (97.2%) than in males (2.8%) while the reverse was true for cancer of the extremities; 61.1% in males and 38.9% in females. All the nine patients afflicted with cancer of the external genitalia were females. Gastrointestinal cancer, cancer of the pancreas and oral cavity/nasopharynx cancer also showed higher incidence in females than in males 62.5%, 61.5% and 60.6% respectively. Apart from prostate cancer which occurs only in males, some of the anatomical sites with higher male affinity included the kidney (83.9%), the urinary bladder (71%) and the lungs (70%). Overall, the analysis revealed a high incidence of cancer in females than in males ($\chi^2 = 687.63$, d.f. = 20, p<0.001).

The most frequent cancer type in both sexes combined was carcinoma which occurred in 66.4% of the 1499 cancer cases analysed. Soft tissue sarcoma had a modest occurrence of 11.5% followed by malignant melanoma (4.6%) and leukaemia (3.7%). The least frequent cancers were meningioma (0.2%), osteochondroma (0.2%) and histocytoma (0.1%). See Fig. 2.

The age frequency distribution of the two main cancer types presented in Fig. 3 reveals the highest incidence of sarcoma (20.5%) in the 40-49 years age-group and the lowest (1.2%) in the 70+ years age-group. The highest incidence (19.7%) of carcinoma also occurred in the 40-49 years age-group, while the lowest (5.5%) occurred in the 10-19 years age-group.

Analysis of annual variations in incidence of cancer (Fig. 4) indicates that from an incidence of 3.3% in
1980, a remarkable drop to 1.1% was observed in 1981, followed by a slight increase the following year, to 2.6%. From 1983, when an incidence of 1.9% cases was recorded, a consistent increase was observed peaking in 1989 with 27.7% cases. The years 1988 and 1990 also recorded relatively high cancer cases - 23% and 22.4% respectively.

Figure 1: Incidence of Cancer According to Anatomical Sites

![Graph showing incidence of cancer by anatomical site]

N = 1431

ANATOMICAL SITE

Breast  Extremities  Lymphoid tissue  Prostate  Cervix
Gastrointestinal tract  Ovary & Uterus  Leukopoietic tissue  Head & Neck  Mandible/Maligna
Brain  Bladder  Urethral bladder  Kidney  Liver
Salivary glands  Pancreas  Eye  Lungs  External genitalia
Table 1: Sex Distribution of Cancer According to Anatomical Site

<table>
<thead>
<tr>
<th>Anatomical Site</th>
<th>Male (%)</th>
<th>Female (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast</td>
<td>9 (2.8)</td>
<td>310 (97.2)</td>
<td>319</td>
</tr>
<tr>
<td>Kidney</td>
<td>26 (83.9)</td>
<td>5 (16.1)</td>
<td>31</td>
</tr>
<tr>
<td>Liver</td>
<td>18 (60)</td>
<td>12 (40)</td>
<td>30</td>
</tr>
<tr>
<td>Cervix</td>
<td>0 (0)</td>
<td>9 (100)</td>
<td>9</td>
</tr>
<tr>
<td>External genitals</td>
<td>0 (0)</td>
<td>9 (100)</td>
<td>9</td>
</tr>
<tr>
<td>Prostate</td>
<td>101 (100)</td>
<td>0 (0)</td>
<td>101</td>
</tr>
<tr>
<td>Urinary bladder</td>
<td>22 (71)</td>
<td>9 (29)</td>
<td>31</td>
</tr>
<tr>
<td>Eye</td>
<td>6 (54.5)</td>
<td>5 (45.5)</td>
<td>11</td>
</tr>
<tr>
<td>Pancreas</td>
<td>5 (38.5)</td>
<td>8 (61.5)</td>
<td>13</td>
</tr>
<tr>
<td>Gastrointestinal tract</td>
<td>30 (37.5)</td>
<td>59 (62.5)</td>
<td>80</td>
</tr>
<tr>
<td>Brain</td>
<td>24 (52.2)</td>
<td>22 (47.8)</td>
<td>46</td>
</tr>
<tr>
<td>Ovary and Uterus</td>
<td></td>
<td>75 (100)</td>
<td>75</td>
</tr>
<tr>
<td>Lungs</td>
<td>7 (70)</td>
<td>3 (30)</td>
<td>10</td>
</tr>
<tr>
<td>Oral cavity/nasopharynx</td>
<td>13 (39.4)</td>
<td>20 (60.6)</td>
<td>33</td>
</tr>
<tr>
<td>Extremities</td>
<td>146 (61.1)</td>
<td>93 (38.9)</td>
<td>239</td>
</tr>
<tr>
<td>Leukopoietic tissue</td>
<td>33 (60)</td>
<td>22 (40)</td>
<td>55</td>
</tr>
<tr>
<td>Salivary gland</td>
<td>14 (83.6)</td>
<td>8 (16.4)</td>
<td>22</td>
</tr>
<tr>
<td>Lymphoid tissue</td>
<td>72 (62.7)</td>
<td>43 (37.3)</td>
<td>115</td>
</tr>
<tr>
<td>Mandible/Maxilla</td>
<td>32 (62.7)</td>
<td>19 (37.3)</td>
<td>51</td>
</tr>
<tr>
<td>Head/Neck</td>
<td>33 (60)</td>
<td>22 (40)</td>
<td>55</td>
</tr>
<tr>
<td>Lips</td>
<td>9 (60)</td>
<td>6 (40)</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>680 (41.9)</strong></td>
<td><strong>821 (58.1)</strong></td>
<td><strong>1431 (100)</strong></td>
</tr>
</tbody>
</table>

Fig. 2 - Occurrence of cancer types in Enugu State

648
Figure 3: Occurrence of Two Main Cancer Types in Different Age-Groups in Enugu State

(a) Sarcoma N=171

(b) Carcinoma N=898
DISCUSSION

Recent epidemiological review suggests that breast cancer is the most common cancer among US blacks. In Jamaica, Trinidad and Tobago, it is ranked second only to cancer of the uterine cervix. In South Africa, breast cancer is ranked third after uterine cervix and oesophageal cancers. Elsewhere in black Africa, the disease is the second commonest female malignancy after cancer of the uterine cervix, according to reports from East Africa, Rwanda, Botswana, Nigeria, Ghana, Liberia, Senegal and Zaire. Cancer of the breast was the most frequent tumour in Libya. Similar reports are available from the Middle East, for instance, in Iraq, Kuwait, Iran and Saudi Arabia. From the foregoing, it is clear that equivocal reports exist on the incidence of cancer of different anatomical sites. However, within black Africa, cancer of the uterine cervix seems to be the commonest malignancy, followed by breast cancer. From the results of the present study based on 1431 patients, the breast, the extremities, the lymphoid tissue, the prostate and the cervix, in that order, seem to be the commonest anatomical sites afflicted by cancer in Enugu State.

Apart from the sex-specific cancers, a high ratio of the disease was found in the various anatomical sites in females as compared to males but it varied markedly for site as previously reported. As already documented, in Anambra State of Nigeria and in Tanzania, the incidence of breast cancer in male was observed also in the present study. Out of the 319 cases of breast cancer diagnosed in Enugu State 9 (2.8%) were male.

As previously observed, most of the figures from developing countries on occurrences of cancer have
not been adjusted to reflect age-specific incidence. Only isolated reports are therefore available on the subject. Carcinoma mostly affected older male in Ibadan, Nigeria, and the peak incidence of the malignancies occurred in the 51-60 years age-group. The present results are close to these observations as the 40-49 years age-group registered the highest incidence of the cancer (19.7%) followed closely by the 50-59 years age-group (17.8%). Furthermore, malignant lymphoma (which is a type of carcinoma) has been observed as one of the childhood malignancies but with a low frequency in Libya, contrary to the present observations. Reports are unavailable on the occurrence of sarcoma in different age-groups in developing countries. From the present study, however, the highest incidence in this cancer type was observed in the 40-49 years age-group and the lowest in the age-group of 70 years and above.

Data on annual variation in incidence of cancer are also lacking due, probably, to the general acceptance of the increasing incidence of the disease worldwide. Consequently, current efforts are directed towards the combat against the different types of the disease rather than the study of the general trends. However, the recent limited information which tangentially deal with the issue report of increased annual variations in the occurrence of cancer. The present observation in Enugu State, where after a gradual increase in the incidence of cancer from 1980 to 1987, a sudden, very remarkable increase has occurred between 1988 and 1990 with a peak in 1989, representing a seven-fold average increase during the last three years (1988-1990), over the subsequent eight years (1980-1987), is generally in agreement with earlier reports. These results strongly suggest that a major explanation for the increase in the cancer incidence in recent years in Enugu State may well be the increased availability of cancer screening facilities. Consequently, the results of the present investigations must be viewed and interpreted against the background of the possibility of under-reporting, under-diagnosis or a true ethnic variation in the incidence of the various cancers.

ACKNOWLEDGEMENTS

I am grateful to the University of Nigeria Senate Research Grant Committee for funding this project.

REFERENCES


Figure 1: Map of the Study Area — The Weija Lake
was done monthly over a 12 month period (October 1991 - October 1992). Each sampling schedule involved collecting snails in the habitat with a scoop-net over a specified period of time, usually one hour. All snails collected were identified and recorded. Snail population densities were computed as numbers collected per “man-hour”.

Intermediate-host snails were isolated singly in 20 ml transparent bottles filled with dechlorinated tap water and were exposed to the sun or artificial light for one hour. The water was then examined for cercariae. Snails not shedding cercariae were crushed and examined under the compound or dissecting microscope for juvenile trematodes. Infection rate was expressed as the percentage of infected snails of the total number of the species examined. Furcocercous cercariae especially the brevifurcate types were used as indicators of schistosomiasis transmission in the lake. Records were also made of other trematodes. Host snail species examined included Bulinus truncatus and Biomphalaria pfeifferi.

RESULTS

Nine species of snails were encountered in the lake (Table 1). Four of these transmit trematodes of medical and veterinary importance in Ghana viz. Bulinus truncatus, B. (Physopsis) globosus, Biomphalaria pfeifferi and Lymnaea natalensis. Within this group B. pfeifferi and B. truncatus were predominant in density and distribution.

There was seasonal fluctuation in the densities of snails in the lake with high numbers of all species occurring during the dry season (December to March), followed by a marked reduction in their numbers with the onset of the rainy season in early April (Fig. 2). There was an inverse relationship between the level of rainfall and the population density of snails. This was indicated by the occurrence of higher numbers of all species during the drier and warmer periods of the year than during the wet season.

There was species succession in the lake. B. (Physopsis) globosus, the original Schistosoma haematobium transmitting snail in the River Densu basin (Odei, 1975) was rare and sporadic in occurrence in the main body of the lake (Fig. 3). B. truncatus, the other S. haematobium transmitting snail, was the most abundant bulinid with densities ranging between 21 - 280 snails/man-hr.

Compared with bulinids, B. pfeifferi however occurred over a wider range of habitats and had the highest population densities, ranging between 10 - 320 snails/man-hr. (Table 2).

<table>
<thead>
<tr>
<th>Species</th>
<th>Family</th>
<th>Vector Status</th>
<th>Parasite Hosted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomphalaria pfeifferi</td>
<td>Planorbidae</td>
<td>Vector</td>
<td>Schistosoma mansoni</td>
</tr>
<tr>
<td>Bulinus globosus</td>
<td></td>
<td>Vector</td>
<td>Schistosoma haematobium</td>
</tr>
<tr>
<td>Bulinus truncatus</td>
<td></td>
<td>Vector</td>
<td>Schistosoma haematobium</td>
</tr>
<tr>
<td>Bulinus forskali</td>
<td></td>
<td>Non-vector</td>
<td>—</td>
</tr>
<tr>
<td>Gyraulus costulatus</td>
<td></td>
<td>Non-vector</td>
<td>—</td>
</tr>
<tr>
<td>Melanoïdes tuberculata</td>
<td>Thianidae</td>
<td>Non-vector</td>
<td>—</td>
</tr>
<tr>
<td>Aplexa waterloti</td>
<td>Physidae</td>
<td>Non-vector</td>
<td>—</td>
</tr>
<tr>
<td>Lanistes sp.</td>
<td>Ampullariidae</td>
<td>Non-vector</td>
<td>—</td>
</tr>
<tr>
<td>Lymnaea natalensis</td>
<td>Lymnaeidae</td>
<td>Vector</td>
<td>Fasciola gigantica</td>
</tr>
</tbody>
</table>
Figure 2: Monthly Fluctuation in the Population of *B. pfeifferi* and *B. truncatus* in Relation to Rainfall

Table 2: Monthly Fluctuation in Numbers of Snails in the Weija Lake

<table>
<thead>
<tr>
<th>Species</th>
<th>Density (Snails/Man-Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Biomphalaria pfeifferi</em></td>
<td>40</td>
</tr>
<tr>
<td><em>Bulinus globosus</em></td>
<td>48</td>
</tr>
<tr>
<td><em>Bulinus truncatus</em></td>
<td>-</td>
</tr>
<tr>
<td><em>Bulinus forskali</em></td>
<td>2</td>
</tr>
<tr>
<td><em>Aplexa waterloti</em></td>
<td>18</td>
</tr>
<tr>
<td><em>Lymnaea natalensis</em></td>
<td>8</td>
</tr>
<tr>
<td><em>Melanoides tuberculata</em></td>
<td>400</td>
</tr>
<tr>
<td><em>Lanistes sp.</em></td>
<td>2</td>
</tr>
</tbody>
</table>
Figure 3: Changes in the Population of *B. (physopsis) globosus* under impoundment

*Melanoides tuberculata*, a melaniid snail occurred at all the water-contact sites on the lake making it the most widely distributed snail in the Weija lake. It also had the highest population density which averaged (1000 snails/man-hr) during the warm and dry periods of the year. The population of *M. tuberculata* also experienced a crash as did the other species encountered in the rainy season.

Infection rates of between 1% and 3% of brevifurcate cercariae were recorded for both *B. truncatus* and *B. pfeifferi*. Other types of cercaria encountered included xiphiocercous, gymnocephalous, and gymnothallus types. Gymnocephalous (distome) cercariae were most abundant. Higher levels of trematode infection were recorded within a period of declining snails population.

**DISCUSSION**

**Composition of Snail Species in the Lake**

With the exception of *B. pfeifferi* and *L. natalensis* all snails encountered (Table 1) were originally either in the River Densu or its tributaries notably the Rivers Nsaki and Doboro (Odei, 1975). Fig. 1).

Though it was originally the dominant host snail for *Schistosoma haematobium* in the River Densu, *B. (Physopsis) globosus* has been unsuccessful in
colonising the lake. It’s highest density of 3 snails per man-hour is very low compared with the 10-200 snails/man-hr recorded by Odei (unpublished data) in 1978 and 1979 during the formative years of the Weija lake (Fig. 3) and negligible when viewed against the background that it was the main bulinid in the River Densu (Odei 1975, Grant 1969) before the present impoundment in 1977.

This phenomenon shown by B. (Physopsis) globosus is not unique to the Weija, it also occurred in the Volta lake (Odei 1972). He suggested that certain inimical ecological factors created by lacustrination might have prevented B. (Physopsis) globosus from colonising the main body of the Volta lake in spite of its existence in the River Volta and even in some tributaries after impoundment. In both the Weija and Volta lakes B. truncatus became the dominant bulinid snail in post-impoundment conditions.

It is to be noted that, before the present Weija lake was formed B. truncatus occurred mainly in the River Nsaki the only permanent tributary of the River Densu. This then suggests a species succession in the lake.

The factors that have influenced the success of B. truncatus and not B. (Physopsis) globosus in the Weija lake are still not clearly understood. However, it was observed that the response of population of B. truncatus to adverse environmental factors like rainfall was better than the other planorbid encountered. For instance, during the minor rainy season in September when the density of B. pfeifferi and other dominant planorbids was low, about 165 snails/man-hr, B. truncatus averaged 34 snails/man-hr (Fig. 2).

B. truncatus thus showed a faster recovery from and better adaptation to the population-crash induced by the rainy season compared with the other host snails. Brown et al. (1974) also consider B. truncatus as a successful colonist of artificial waterbodies considering the varieties of habitats in which it was found in the Kano plain in Kenya. They suggested that the species has a high level of ecological tolerance.

Furthermore, it has been reported by McCullough (1962), that B. truncatus in Ghana does not barrow into mud to escape desiccation contrary to observations made by other workers from Egypt, Iran and the Sudan (Chu et al. 1967). It appears therefore that compared with other planorbid, B. truncatus is generally hardier. The health implications of this observation is foreboding.

For most part of the year, B. truncatus would maintain high densities in water-contact sites of the riparian population, a factor which could enhance schistosomiasis transmission in the communities. An earlier study showed that communities bordering the main body of the Weija lake where large populations of B. truncatus had been established, had higher prevalence rates of urinary schistosomiasis than those in the upper riverine sections of the lake (Zuta, 1994).

The transmission of intestinal schistosomiasis, hitherto unproven in the River Densu (Odei 1975) could also be on the ascendancy with the proliferation of B. pfeifferi. The origin of B. pfeifferi in the lake is however obscure and a matter of speculation since it was not mentioned in earlier literature on the river Densu (Grant 1969, Odei 1975). It could have been introduced by the fishing gear of migrant fishermen (Odei 1978), migratory water birds or possibly existed in some inaccessible section of the river Densu since it was detected in the Weija as early as 1978 when the lake was still in its formative stages. Evidence for the presence in the riparian population of S. mansoni the fluke which it transmits was provided by the occurrence of five cases of mixed infection in Galilea, Danchira and Old Domiabra (Zuta, 1994). Intestinal schistosomiasis could henceforth be considered as one of the public health problems associated with the Weija lake.
Melanoides tuberculata was present in the old water-works at Weija before the creation of the present dam (Odei, 1975). Currently this thiarida/melanid has become the most common snail in the lake. The population of M. tuberculata declined drastically during the rainy season from about 1000 snails/man-hr in February it recorded to about 10 snails/man-hr in August. It was also observed that high numbers of M. tuberculata did not inhibit the development of large populations of the other snails encountered. Thus, observations made so far do not suggest that M. tuberculata could be a biological control agent (competitor) for host snails. This was not apparent, especially with reference to populations of either B. pfeifferi or B. truncatus the commonest intermediate host snails in the lake.

Lanistes sp. the other prosobranch encountered is of unproven medical importance in Ghana. It occurred in large numbers mostly in the upper riverine extremities of the Weija lake. However, it was encountered only sporadically and in reduced numbers in the lower lacustrine zones of the lake.

**Seasonal Abundance**

The major factor that influenced the fluctuation of the density of snails in the lake was the rainfall of the Weija area. Rainfall has a detrimental effect on snail populations by influencing wave action, current velocity and generating floods; factors which are deleterious to snails (WHO, 1957).

Flooding in particular influences seasonal fluctuations in snail populations described as “flushing out” by Jordan et al (1982). It also interferes with or entirely prevents breeding (WHO, 1957), resulting in the occurrence of higher numbers of snails in the dry rather than the rainy season. Rainfall has therefore, singularly been a very important ecological factor markedly regulating the size of snail populations in the lake.

The present pattern seasonality of snail populations in the lake has epidemiological consequences. During the dry season when snail populations are high more people enter the lake for water when their source of water from the seasonal streams dry up. Peasant farmers also crop the draw down area and engage in fishing which bring them into contact with the lake water during the dry season. Consequently, during the period there is high human water-contact activity around the lake which enhances disease transmission. The seasons thus influence snail population dynamics which also influence disease transmission patterns.

**Trematode Infection**

Both Bulinus truncatus and Biomphalaria pfeifferi snails were shedding brevifurcate cercariae at rates varying between 1% and 3%. These types of cercaria are of schistosome origin (Cheng, 1986) and so were indicators of schistosomiasis transmission in the lake. However, compared with other cercariae encountered the brevifurcate infection rates were low. Distomes were dominant with recorded infection rates in the range of 0.8% to 15% in both B. pfeifferi and B. truncatus. There was no distinct pattern in the frequency of occurrence of these trematodes in the two species of host snails examined. However, B. pfeifferi carried more brevifurcate cercariae during the dry season than at other times of the year. On the whole, more infected snails were encountered during times of declining population. The level of infection in these two host snails indicates that they are susceptible hosts for the trematodes occurring in the lake.

Different trematodes competing for the same host snails species could have beneficial effect on disease transmission. Chu et al. (1972) suggested that competing cercariae might be used to control other trematodes by introducing them into an area to suppress the target species. Considering the level of interspecific competition prevalent among the trema-
todes, some form of natural control is apparently operating in the Weija lake.

This could be further exploited to control schistosome cercaria in the water-contact sites of the lake.

**CONCLUSIONS**

With the exception of Bulinus (Physopsis) globosus, the Weija lake has been successfully colonised by species of snails that were either present in the River Densu, its tributaries and the old dam or possibly introduced. The densities of snails in the lake were high during the dry season and low throughout the rainy season. The peak population density for all species encountered occurred in February. The presence of large numbers of Melanoides tuberculata did not inhibit the populations of host snails in the sampled sites.

The recovery of populations of snails in the lake following the crash induced by the rainy season, varied with species. B. truncatus was least affected, it also maintained a higher density during the minor rainy season. The success of B. truncatus is part of a succession phenomenon in the lake. This succession that has taken place in the lake could promote the transmission of schistosomiasis.

Both B. truncatus and B. pfeifferi served as intermediate hosts for brevifurcate cercaria rates varying between 1% and 3%. No incidence of mixed cercarial infections were encountered. More snails were found infected during periods of declining populations. The occurrence of different cercariae competing for the same host snail could be used as a method of biological control of trematodes.

**ACKNOWLEDGEMENT**

I am grateful to the Institute of Aquatic Biology for the facilities provided for the project. Special thanks also go to Dr. M. A. Odei for his advice.

**REFERENCES**


8. McCullough, F.S. Snail control in relation to a strategy for reduction of morbidity due to schi-


