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POPULATION DYNAMICS OF AQUATIC SNAILS IN PAMPULHA RESERVOIR

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An attempt was made to determine more accurately the density of molluskan populations in the Pampulha reservoir, using the quadrate method, intending to detect the fluctuation of the populations density, the habitat conditions and the possible competitive interactions among Biomphalaria tenagophila, Melanoides tuberculata, Pomacea haustrum *and* Biomphalaria glabrata, *through the analysis of populational parameters. Among the most significative facts observed in the reservoir it has to be mentioned: the almost disappearance of* B. glabrata; *the invasion, colonization, fixation and fast growing of* M. tuberculata *population until reaching about 11.000 individuals/m^2; the density fluctuations of* B. tenagophila, P. haustrum *and* M. tuberculata *alives and deads; differences on the habitat preference of these three molluskan species at the edge (at the limit earth-water, at 0.70m and 1.40m from the shore line); monthly mortality rates and reproduction seasons of the species.*

Since it's construction, fifty years ago, the Pampulha dam contains today about 10 molluskan species, 4 of them considered of high epidemiologic significance. Their occurrence area and densities have been modified due to changes in their habitat conditions, with the increasing input of industrial residue and sewage produced in the basin for about 200.000 people.

The major alterations are reflected in the changes on the molluskan species structure: *Biomphalaria glabrata, B. tenagophila, Pomacea haustrum* and *Melanoides tuberculata* which have been succeeding in the reservoir, with generally temporary dominance of each of these species.

One year after the construction of the reservoir there has been a populational explosion of *B. glabrata*. Hundreds of snails/m^2 were observed, in all its 18 km perimeter and in the mouth of the 7 streams. The total population was estimated by 12 to 15 million snails (Martins & Versiani, 1939).

The presence of *P. haustrum* was also noted in the recently built reservoir. In the 50 th decade, while *B. glabrata* became scarce, with the apparently occasional occurrence, this piliid increased in the occupied area, and was found in high densities in 72 collecting sites all around the lake (Andrade, 1969). The population spreaded rapidly, and during five years the ratio *P. haustrum*/planorbids was of about 100:1 to 200:1 (Guimarães, 1978).

In 1970 the presence of *B. tenagophila* was registered in the lake (Andrade, 1972), and from 1972 until 1976, its number was superior to *B. glabrata*, in a 2:1 ratio (Guimarães, 1978).

In 1980, routine collects were initiated, alowing to follow more systematically the substitution of *B. glabrata* by *B. tenagophila* (Carvalho et al., 1985). During 1984/85, the proportion of collected snails were about 500 *B. tenagophila* to 1 *b. glabrata* (SUDECAP/ Pampulha, 1986).

In 1986, another mollusk invaded the dam. The thiarid *Melanoides tuberculata* (Carvalho, 1986).

Despite the existence of informations and some data about the invader species, there are no simultaneous research about these snails populations dynamic and environmental quality. There is necessity of more studies about the populational parameters and adequate methodology to determine the densities and spatial distribution patterns. We intended to know the habitat conditions and the possible competitive interactions among the species, through the study of populational parameters with the adoption of a collecting methodology capable of providing more accurate measures of the species density. The major objective is to known the preponderant

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role of each species and/or the role of the environment in their surviving conditions. Thus, we tryed to determine which type of environmental changes has made the habitat favorable or adverse to a species of host snails or to their competitors, and if there were really these competitive relations among the snails.

MATERIALS AND METHODS

Two fixed collect sites, or stations, were choosed as study area. Both were distinguished for they exhibited high densities of *B. tenagophila* and *P. haustrum* and ocacionaly, *B. glabrata* (Carvalho et al., 1985; SUDECAP/Pampulha, 1986). These stations were situated at the entrance of the streams, in places more filled up with debris of the dam. The station number 15/16 was placed about 100m from the entrance of the streams Água Funda (Zoológico); and the number 22/23, close to the entrance of the stream Olhos d'Água (Céu Azul). The 15/16 in front of the number 6778 in Av. Otacílio Negrão de Lima and the 22/23 in front of the number 12.400, in the same Avenue.

The vegetation of these sites consists of some grasses, *Miriophillum* sp., *Eleocharis* sp. and *Eichornia crassipes.* Besides these, were also registered, *Sagitaria* sp. at the 15/16 and *Jussiaeua* sp. at the 22/23 station.

It was used the quadrate method. At each fixed collect station were distributed randomly 15 collect points, distant 10m among themselves, on a line of 150m along the edge. In each collect point were placed 3 metal cylinders with an area of 300cm^2. One cylinder was put at the limit earth-water (shoreline); the second one at 0.70 m from the margin and the third at 1.40m from the margin, bringing up to 45 cylinders in monthly collect. The inside water of the cylinder was removed with the ground and benthonic materials. These materials were immediately washed, on the same collect place in a 1mm mesh metal sieves. The mollusks were set apart the sediment through the use of a metalic forceps. All these materials were placed in a plastic bottle covered with a lid. The selection of the snails was made in the laboratory, after washing them again in sieves. All the snails were identified, counted and measured in diameter or length of shells.

RESULTS

Biomphalaria tenagophila

At the 15/16 collect station the alive and dead snails density was in a great part of the year lower than 10 individual per m^2, but it has risen from Aug. to Oct. when it has reached the peak of 170 snails/m^2. Either the density and the density flutuations were very similar for alive and dead snails during the whole year of 1986. The density decreased under the rainfall influence and it has rised in the months that preceded the rainfall: Aug.-Oct. (Fig).

The deads density from Jan. to Mar. 87 however were quite higher than that of the alive's one, in this period it has varied from 57 to 80 snails/m^2. For this the total number of deads that was similar to the alives in 1986, became a little bit higher than these.

The most salient peak of alive snails has coincided with the peak of the youngs with 2 mm diameter which have represented about 41% from the whole alive snails that have been collected in Oct.

At the station 22/23 the densities were very low each month (0 to 17 individuals/m^2), but with a peak of 27 snails/m^2 in Sep. Despite the fluctuation of populational density has been less accentuated than that at 15/16 station, it could be noted some influence of the period which preced the rainfall upon the snail population. They have reached from 0 to 5 until Jul., and from 12 to 27 snails/m^2 in the month of Aug. to Nov.

There was no correlation between density and rainfall. At 22/23 station, the proportion of dead and alive snails was about 3:1 for the most part of the months. The largest number of young snails (3 mm diameter) took place in Oct., but it was very low (about 17% of the total) to permit any conclusion about the best period for breeding.

At both stations, *B. tenagophila* presented higher densities close to the shore at the 22/23 station at the earth-water limit and at the 15/16, at the point 0.70m far from the edge. In both stations the lowest density have occurred at the point 1.40 m distant from the shoreline.

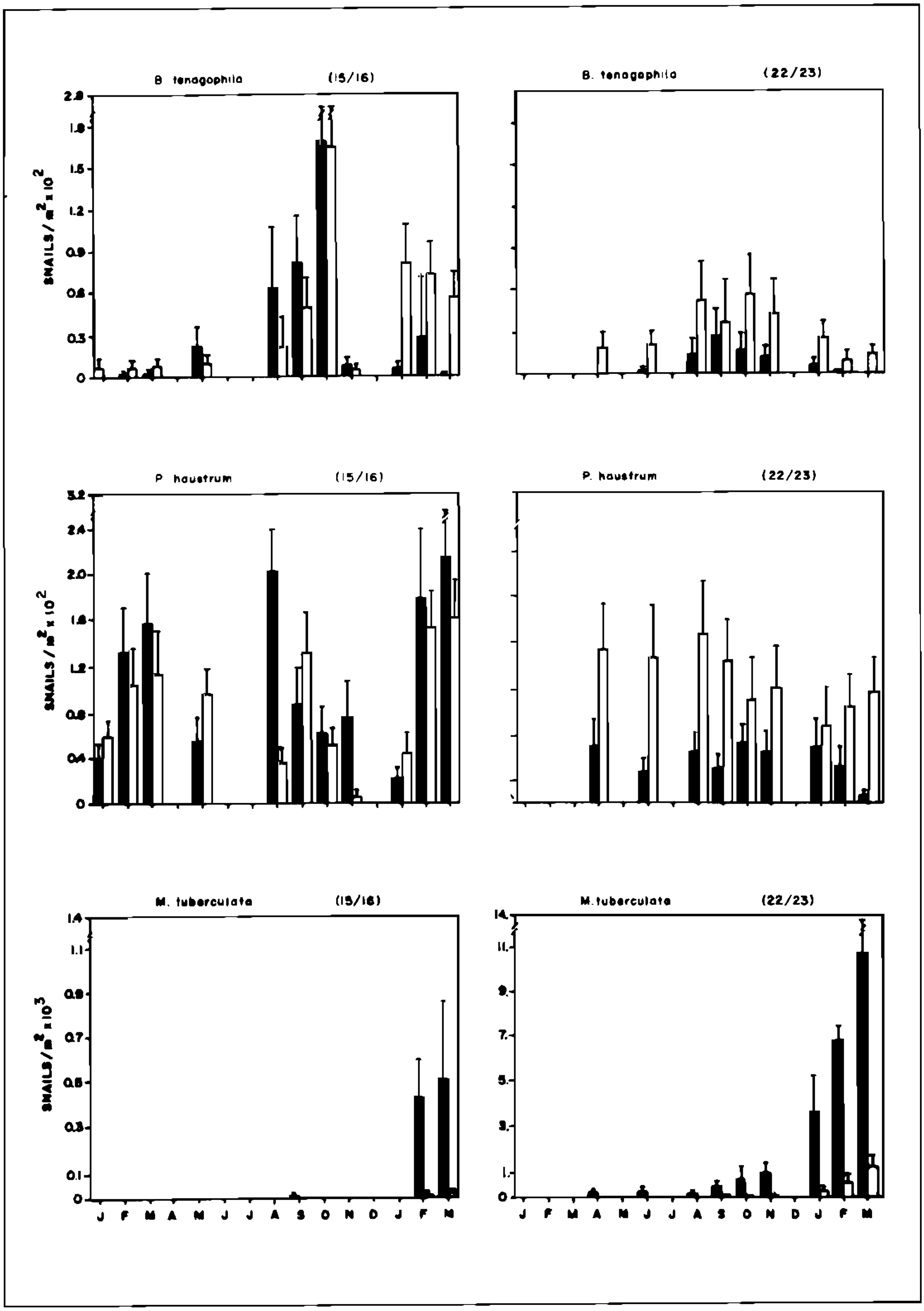

Fig. 1: monthly variation of the population densities (snails/m^2) *Biomphalaria glabrata*, *Pomacea haustrum* and *Melanoides tuberculata*, alive ■ and dead □ at the stations (15/16) and (22/23) from Jan. 86 to Mar. 87 at the Pampulha reservoir.

Pomacea haustrum

At the station 15/16 there were two peaks of high density of alive *P. haustrum:* one in the summer, in the rainy season, Feb.-Marc. 86; and another at the end of the winter (Aug., 86). In this period they reached the peak of 156 and 202 snails/m^2. The first peak repeated in the Summer, 87, with 215 alive pillids/m^2. It was remarkable that in the Summer the 4 to 6 mm length alive snails rate reached about 70% of the alive snails collected.

The deads were lower than that of the alives, but they reached the peak in Mar. 86, Mar. 87 and Sep. 86; thus one or two months after the peak of alives (Fig.).

At the 22/23 station, during all the year of 1986, the density of alives was much lower (up to 54/m^2) than those densities of the 15/16 station. There was not outstanding peaks for alives but it was possible to register a peak of deads in Aug. (148 snails/m^2).

The highest rate of young alive and dead snails (4-6 mm) at the 22/23 station occured in Apr., and the proportion of these snails with this length was only 16% among alives and 33% for deads. In the other months the rates were lower.

At the 22/23 station high densities of *P. haustrum* occurred at the shoreline of the man made lake at the earth-water limit and at the 15/16 station at 0.70 m from the margin. The lowest densities were registered at 1.40 m from the margin.

Melanoides tuberculata

At the 15/16 station, the first organisms of this species came up only in Sep. 86 with 4.3 snails/m^2. The density remained low until Dec. and increased in Feb. when it reached a peak of 434 organisms/m^2. At this station the deads density was very low (2-3%) and was represented mainly by young snails.

The 22/23 station that was invaded in Sep. 85 by the *M. tuberculata,* showed a density of 163 snails/m^2 in Apr. 86. The number remained stable until Aug., but from Sep. there was an exponential growth, reaching an average of 10.693 individuals/m^2 in Mar. 87 (Fig.). The rate of dead snails was about 10%. In relation to margin preference, *M. tuberculata* has shown a different behavior from the two other species. They prefered a further collect point from the margin (1.40 m).

DISCUSSION

At both collect stations *B. tenagophila* showed higher densities of alive snails during the dryer months in the year, Aug. to Oct., which precede the begining of the raining season. The decline of the densities coincided with the first raining months. This fact confirms the effect of the pluviousity upon populations (Paraense & Santos, 1953; Cridland, 1958; Pinotti et al., 1960; Freitas, 1976; Grisolia & Freitas, 1985). However, the reverse occurred at some other regions, where were observed the increase in the number of the population during the raining season, and decrease at the dryer months. In these cases the density fluctuations were more intense due to the drought effect upon the snails, as occurred at northeastern Brazil and Porto Rico (Oliver, 1955; Jobin, 1970) or at Sta. Lúcia, where "the catastrophic population declines in the banana drains, generally during droughts" (Sturrock, 1973), as well as at Hong Kong (Dudgeon, 1983).

At flowing waters as streams, the rainfall carry out the snails by the flooding effect. But in reservoirs or lakes (Lagoa Santa) the sudden density fall many times at the beginning of the raining season, this may be related to the rise on the water level, by covering in the margins the places where the snails were naturally found. In this case, one can assume that lots of snails will still remain at the same place of the shoreline where they lived before the flood and where there are available periphyton and organic matter. The density in this case becomes lower precisely at the places recently covered by the water, because the snails did not become displaced. One of us (Bedê, L. C.) is trying now to elucidate this fact, by the use of transects in the area.

By the way, the rains and water level fluctuations effect seemed to be clearer upon *B. tenagophila,* mainly at the 15/16 station, which has a gently sloping marginal zone. Thus, with the rise in the reservoir level with the rainfall, the water moves forward about 5-6 metters the ancient margin line. As the 22/23 station is higher sloping, the effect of water level fluctuation seemed to be less evident.

P. haustrum seems to have suffered the influence of two seasonal periods at its growth, during the year of 1986, at the 15/16 station. It has a peak during the raining season that coincided with the peak at the number of the smaller individuals in the population (70% of the snails). The other peak occurred in the months which antecede the rainfall (Aug.-Oct.).

At the 22/23 station, peaks on the density were not so clear. Both species showed preference to the margin zones till 0.70 m from it. This fact may have contributed to the *B. tenagophila* density fall during the raining season, but the same didn't occur with *P. haustrum.*

The snail *M. tuberculata* showed many trends of invader species: high birth and growth rates; predominance of youngs in the population during the whole year; high migratory and spreading capacity, getting stablished at every kind of shoreline and substrate as well very low mortality rates, being the proportion alives/deads of 8:1 to 9:1, during almost all the year.

This species was collected by the first time on the reservoir in 1985 (Carvalho, 1986), and reached the first streams, possibly in the interval between Jan. and Apr. 1986, and the last streams (in the invasion sequence) in Sep. 1986. Occupying therefore, in about 2 years, all the reservoir shoreline and many points far from the shore 20-30m and showing population densities much higher than those presented by Dudgeon (1985) or by Prentice (1983) for *Thiara granifera.*

At the Pampulha reservoir, *M. tuberculata* showed rather different trends than those related by Dudgeon (1983; 1985) in Hong Kong, which were more adapted to the habitat. It showed seasonal density fluctuations and alives/deads rate compatible with those habitats.

At the Pampulha, the thiarid seemed have not suffered marked influence from the rains, chemical alterations in the water, predators or parasites, possibly responsible to the high alive/dead proportions of *B. tenagophila* and *P. haustrum.*

In the population, there was predominance of youngs during almost all the year, as mentioned above, specially in Jan. and Feb. 87 (5-10mm in the shell length), despite the fact the samples were made close to the shoreline until 1.40m, what may have contributed to the high youngs density in our data, as stated by Dudgeon (1983). According to this author, there were higher number of youngs in the places closer to the shoreline, at Cover Plove reservoir.

The biotic potential showed is tipical of a autochthonous species, at a recently made reservoirs or of exotic species at an environment disturbed by man. Several authors referred to the capacity of this species in colonizing new areas and reaching high populational densities (Lévêque, 1972; Upathan, 1981; Al-Dabbagh et al., 1985; Dudgeon, 1984, 1986). Thomas & Tait (1984) have found 9.800 ind/m^2 in Nigeria. They have recomended its introduction as a competitor to the biologic control of hosts species of bilharziasis. The high percentage of dead individuals of the other two molluskan species, from Jan. to Mar. both collect stations, with high densities of *M. tuberculata,* could suggest the competitive action of this species upon the others. But it is necessary more studies about these populations and more accuracy in the measures of populational parameters.

The use of adequate and quantitative collect methods like dredges, cylinders, corer, suction pumps, labelling and recollect methods (Brown, 1979; Makyra et al., 1981; Prentice, 1983; Dudgeon, 1983; Thomas & Tait, 1984; Coelho et al., 1986) may contribute for the improvement of the dynamic population study methods.

To make a better interpretation of populational parameters data, it is indispensable to have previous knowledge about the possible spatial distribution patterns of the population and its preference on the vegetation and depth, in order to obtain comparable results. Collects near to the shoreline (until 1.40m) for example, possibly sampled with more accuracy *P. haustrum* and *B. tenagophila* than *M. tuberculata* which has a wider occupation area, more fastened from the shore and at more depth, than the area of the two other species.

In the new dams, it seems that there are no limiting factors against the uncontrolled growth of the invader molluskan species. The possible competitive biotic agents may exhibit in the new habitat some features that obstruct them to

have a quick action against the invader snails, due two mainly specific atributes: first the biotic potential is lower than that of the invader species, thus they don't reach quickly competite density levels; second, they are incapable to identify immediatly the invader, thus they don't achieve such a mechanism to provide them a strategy for the invader species control.

The *B. glabrata* have inhabited the Pampulha dam from the streams that supply it. In a little time this snail have covered all its shoreline with high densities in the three first years. In the following years the population fell back and disappeared for many years. It seems that the dam turned out to be a sporadic habitat for this mollusc. This event has been hapenning in several others dams like Ibirité, Santa Lúcia, Serra Verde, Araxá, etc., and may constitute by itself a habitual fact in several areas of *B. glabrata* distribution.

The appearance and disappearance of *B. glabrata* from several sites of the Pampulha dam, without apparent reason (Martins & Versiani, 1939; Andrade, 1969; 1972; Guimarães, 1978; Carvalho et al., 1985; SUDECAP/Pampulha, 1986) certify that this man made lake doesn't present favorable habitat conditions for this species. By the way, since 1984 it hasn't been collected by our group any *B. glabrata* inside the cylinders, in both collect sites. However these sites have presented some snails in a density considered moderate for this species, several times before 1984. In 1984/87 period, no *B. glabrata* were found in the 15/16, although a few individuals were collected out the cylinders samples at the 22/23 station (15 snails). While only 15 *B. glabrata* were collected at 22/23 station, using the scoop method, the number of *B. tenagophila* has reached more than 4.400 individuals/1.000 scoops, and no *B. glabrata* were found in the 15/16 station (SUDECAP/Pampulha, 1986), by scoop method also.

In the same way, *B. tenagophila* and *P. haustrum*, both seeming to have favorable habitats conditions in the dam, have showed different death rates and unlike values of density at these two branches of the dam, despite the similirity of the water chemical caracteristics. At last, in spite of *B. glabrata* have been lived in a instable way, in the dam, during 50 or 20 years, with *P. haustrum* and *B. tenagophila*, this reservoir seemed to serve as a cemetery for the *B. glabrata*, that arrives each year, in rainfall period, from the streams and dies at the dam. In this case, the role of the habitat conditions or that of the competitive action of the others molluskan species, doesn't remain well determined.

It is possible that the whole biotic and or physical habitat features, can give conditions for the survival or disappearance of one species. These characteristics need to be better known, measured and analyzed jointly with the population parameters. This way, the main purpose of a dynamic population study may consist in determining the importance and the role of the biotic and physichal factors in the competitive action and on the population control, thus, even nowadays the known results about biological control in field are very polemics and generaly unsatisfatory.

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