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The limited ability of *Lymnaea natalensis* to survive drought conditions

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RÉSUMÉ

Survie limitée de *Lymnaea natalensis* dans des conditions de sécheresse

L'auteur étudie dans la région de Zaria (nord de la Nigéria) les possibilités de survie à la sécheresse de *Lymnaea natalensis*. Ses observations portent sur une période de 5 ans (de 1971 à 1975) englobant deux années (1973 et 1974) durant lesquelles la saison sèche s'est prolongée anormalement (8 mois au lieu de 6). Les Limnées adultes ne survivent pas plus de 2 semaines. Les individus plus jeunes et les pontes sont capables de survivre plus longtemps (6 semaines), à condition qu'ils soient à l'abri du soleil, sous des feuilles de nymphéas notamment, et qu'ils puissent disposer d'une certaine humidité. L'auteur envisage les conséquences de cet état de choses. Dans les zones sahélo-soudaniennes, après une période de sécheresse prolongée, le repeuplement des collections d'eau peut s'effectuer de deux façons :

— partiellement à partir des Limnées ayant survécu sur place ;

— la plupart du temps, à partir des mollusques peuplant les habitats-réservoirs situés en amont (mares permanentes creusées dans le lit des rivières entre autres) et dispersés par le courant lors de la remontée des eaux en saison des pluies.

INTRODUCTION

Studies on the epidemiology of fascioliasis in the Zaria area of northern Nigeria during 1971-1977 were hampered by the droughty conditions during the years of the « Sahel-drought » 1972-1974. Many snail habitats used to study the population dynamics of *L. natalensis*, the snail intermediate host of *F. gigantica*, dried up due to evaporation and over-utilisation by man and animals. On the other hand, however, this situation provided an opportunity to make some observations on the ability of this snail to survive prolonged periods of drought.

The reports on drought resistance and aestivation of *L. natalensis* in Africa (1, 3, 6, 7) are rather controversial and it appears usefull to communicate some observations made during the 1972-74 drought in the northern Nigerian savanna.

MATERIALS AND METHODS

Field Observations

Snail habitats were visited at two-weekly-, and after 1974, monthly intervals. The aquatic snails found were collected by handpicking for 5 mn.

The sites visited were three streams in the Yakawada area, 25 km west of Zaria and three streams in the Maska area, 40 km west of Zaria. The streams were all, in normal years, containing

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water throughout the year. Parts of these streams were eroded and gullied and showed some fairly deep pools, of which some were further dug out by man to create drinking-sites for livestock or washing places. Snails were collected from a stretch of approximately 100 m. Within these 100 m, however, a different site was chosen for each sampling in order to reduce the effect of the twoweekly withdrawal of snails from the environment.

The vegetation in the streams and pools consisted mainly of waterlilies (*Nymphaea* sp.) and floating grasses (*Leersia hexandra*). Other plants found in and around the habitats were *Commelina* sp., *Jussiaea* sp., and *Echinochloa* grass. Larger vegetation like *Rhaphia*, *Vitex* and *Ficus* spp., as well as *Syzigium guineense* were often providing some shade over the stream and pools.

Laboratory Observations

Mud samples of approximately 1 kg were collected from recently dried up stream beds and pools in the Zaria area which were known to have been harbouring *L. natalensis* before desiccation. The samples were brought to the laboratory and placed in plastic buckets which were filled up with 5 l of water. The buckets were kept in the laboratory and were examined daily for the presence of snails over a period of three weeks.

Egg clusters of *L. natalensis* obtained from the field were placed in 2 l tanks which were partly filled with a mud layer. The clusters were placed on the mud either directly or still attached to *Nymphaea* leaves. The tanks were placed outside and were only exposed to direct sunlight for the last three hours of the day.

After respectively 1, 2, 3, 4, 5 and 6 weeks, the tanks were refilled with water and examined for young snails over a period of two weeks. All experiments were carried out in the dry season (February-March) when the relative humidity at 10 a. m. ranged between 5 and 20 p. 100.

RESULTS

The length of the single dry season increased from 6 months in 1971-72 to 8 months during 1973-74. After 1974, the rains showed a fairly normal pattern and the dry season lasted 5-6 months. During 1971-72, certain stretches of the streams dried up in March or April but were soon reflooded when the rains started in April. In the 1972-73 dry season, however, the rains stopped very early and the streams dried up in January, except for some deeper pools. Many of the pools, however, were also dry towards the end of the dry season in May. Only very few pools kept some water until the rains started, and most of these were further dug out by livestock owners during which process most of the snails disappeared.

The sequence in the disappearance of aquatic snails in the survey area is demonstrated in table I. *L. natalensis* was the first species which disappeared, followed by *Biomphalaria* and *Bulinus* species.

There was no evidence that a particular age or size group of the snails survived best. In 1974-75, the length of the dry season decreased but still no snails except a few *B. forskalii* were observed. At the end of the wet season in October 1975, the first *Lymnaea* snail was observed again. Unfortunately, further observations could not be made as most of the survey points were destroyed or disturbed by road construction activities.

The mud samples collected in February and March 1972 from desiccating pools all contained shells of *Lymnaea*. The survival ability of these snails in mud after respectively 2, 4 and 6 weeks is demonstrated in table II.

TABLE I-Presence of *Lymnaea* snails in streams in the Maska area.

Year	Jan/Feb	Mar/Apr	May/Jun	Jul/Aug	Sep/Oct	Nov/Dec
1971	++	++	++	++	++	++
1972	+	0	+	++	+	+
1973	0	0	0	0	0	0
1974	0	0	0	0	0	0
1975	-	-	-	0	+	+

++ = Snails found in most survey points ; + = Snails found in few survey points ;
0 = No snails found ; - = No observations made.

TABLE II-Recovery of live *L. natalensis* after respectively 2, 4 and 6 weeks desiccation in the field and subsequent immersion in water.

	Duration of Desiccation	Observations 2 Weeks After Immersion
Pool 1	2 weeks	Few juvenile (2-3 mm)
	4 weeks	No live snails
	6 weeks	No live snails
Pool 2	2 weeks ex	No live snails
	2 weeks sh	Two adult (9 & 12 mm), many juvenile (2-3 mm)
	4 weeks ex	No live snails
	4 weeks sh	Few juvenile (2-3 mm)
	6 weeks ex	No live snails
	6 weeks sh	Two juveniles (3 & 4 mm)

(Pool 2 was partly overshadowed by *Rhaphia* palms and samples were taken from the shaded (sh) as well as from the exposed (ex) parts of the pool).

The number of egg clusters found in these nearly dry pools was high as demonstrated in Figure 1 and it appeared that the eggs and/or juvenile snails showed some ability to survive short periods of drought. These observations were confirmed by the experiments in which *Lymnaea* egg clusters were left to dry out. Especially the clusters which were covered with *Nymphaea* leaves survived fairly well (table III).

TABLE III-Number of juvenile *Lymnaea* snails recovered from egg clusters (with a total of approximately 50 eggs) after respectively 1, 2, 3, 4,5 and 6 weeks desiccation and subsequent immersion in water.

Weeks of Desiccation	Free Cluster	Clusters on Nymphaea Leaves	Clusters Under Nymphaea Leaves
1	2	6	22
2	0	2	14
3	0	0	10
4	0	0	4
5	0	0	5
6	not done	0	0

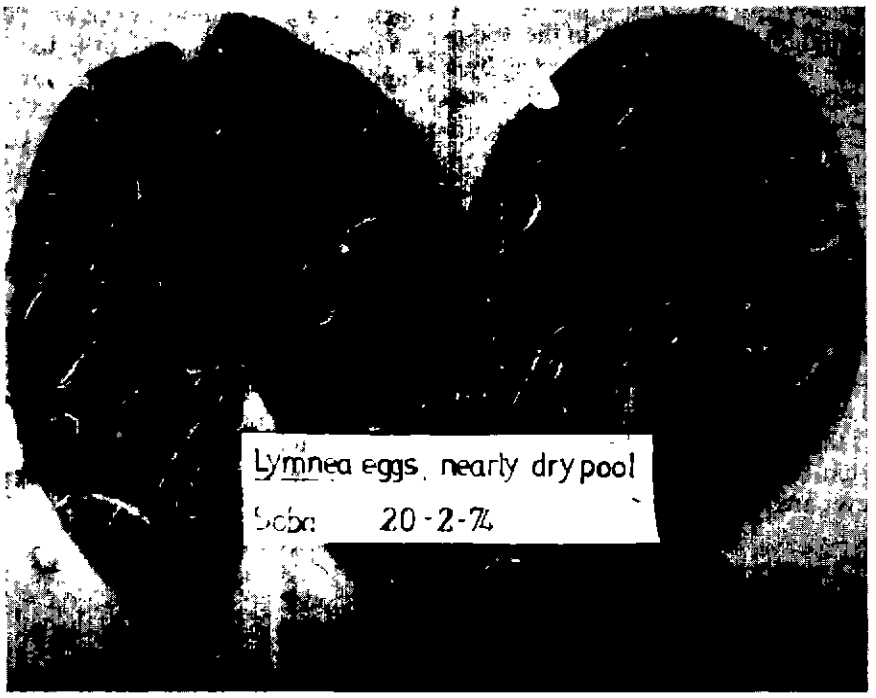

Fig. 1. — *Lymnaea* egg clusters on waterlily leaf.

DISCUSSION

The ability of *L. natalensis* to survive dry conditions has been demonstrated in south and east Africa (1, 4). McCULLOUGH (2) in Ghana (West Africa) however found that adult *Lymnaea* seldom survived for more than a few days when kept out of water, and considered the presence of *L. natalensis* as an indication that the habitat did not dry up. After comparing his observations in Ghana with the observations (4) in East Africa, McCULLOUGH suggested that the biological characteristics of the west african *L. natalensis* could be different from the east african species.

Recently VASSILIADES (7) reported that *L. natalensis* from Senegal was able to survive dry conditions for 15-90 days. His experiments, however, were carried out under very humid conditions (relative humidity in the morning varied between 86 and 95 p. 100 in which green algae were reported to thrive. It is pertinent that snails survive such conditions as in some laboratories *L. natalensis* is normally cultured on non-immersed mud with green algae (3).

BITAKARAMIRE (1) does not state the humidity under which his experiments were carried out but the southern Ugandan conditions are fairly humid and never reach the prolonged dryness experienced in the west african savanna.

The importance of a humid (micro-) environment is also demonstrated by the prolonged survival of eggs and very young snails, in the field as well as in the laboratory when protected by a cover of *Nymphaea* leaves. The leaves protected the eggs and snails from direct sunlight and probably created a small micro-environment in which the humidity was sufficient for survival and probably for some development of eggs and juvenile snails. However, after exposure for more than 4 weeks, the leaves started to disintegrate and the microclimate was not able to maintain itself. Although no quantitative evaluation was performed, it appeared from the large numbers of clusters deposited under such *Nymphaea* leaves that the numbers of snails surviving this way could be considerable. Further experiments however are necessary to establish if these periods of non-aquatic circumstances do affect the long-term survival potential, as well as the (*Fasciola*) transmission potential of snails. The successful culturing of *L. natalensis* on clay-plates with algae cultures (2) indicates that non-aquatic breeding does neither affect the snail's life-cycle nor its ability to transmit fascioliasis.

However, the survival of eggs and snails in the Nigerian field rarely lasted for more than one month, and was apparently not sufficient to withstand the very dry conditions during 1972 and 1973.

Re-establishment of the snail populations after the drought took considerable time. Mainly because the streams originated from even drier areas and repopulation had to occur either from downstreams or by contamination. The few snails found in 1975 suggests that contamination was probably the major source of re-infestation. Also newly created dams in arid areas where snails have never occurred before became infested within a year after creation, by contamination by birds or mammals (5).

It is of interest to compare this situation with the rivers and streams in more hilly areas like those around the Jos Plateau of Nigeria. Here the lowland streams also dried out during the 1972-73 dry season. The streams were rapidly repopulated in the rainy season with snails which survived the dry season in the hills upstreams in rock-pools and deeper parts of the streambed and were flushed downwards with the first rains. A similar situation was observed in the rivers and streams along the Adamawa plateau in Eastern Nigeria (SCHILLHORN VAN VEEN, own observations). In normal years also the pools in the streams in the plains were probably the major source of « overwintering » snails. And this type of dry season survival may, from an epidemiological point of view, be more important than the survival of a few young snails and eggs.

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SUMMARY

Field observations in Northern Nigeria during 1971-1975 indicated a limited survival of *Lymnaea natalensis* under drought conditions. Juvenile snails in a shady and humid environment survived for at least 6 weeks, but larger snails rarely survived more than two weeks.

RESUMEN

Supervivencia limitada de *Lymnaea natalensis* en condiciones de sequia

El autor estudia en la región de Zaria (norte de la Nigeria) las posibilidades de supervivencia a la sequia de *Lymnaea natalensis*. Sus observaciones van sobre un periodo de 5 años, de 1971 a 1975 durante los cuales dos años, 1973 y 1974 se prolonga anormalmente la estación seca (8 meses en lugar de 6).

Las limneas adultas no sobreviven más que durante dos semanas. Los individuos más jovenes y los recien puestos pueden sobrevivir mucho más tiempo (6 semanas) con tal que sean protegidos del sol, bajo hojas de ninfeas principalmente y que puedan disponer de cierta humedad.

El autor examina las consecuencias de este estado de cosas. En las zonas sahelo-sudanesas, después de un periodo de sequia prolongado, la repoblación de las colecciones puede efectuarse de dos modos :

— parcialmente desde las limneas habiendo sobrevivido en su lugar ;

— la mayor parte del tiempo, a partir de los moluscos poblando las áreas-viveros situadas río arriba (charcas permanentes cavadas en el lecho de los ríos entre otras cosas) y dispersados por la corriente en el momento de la subida de las aguas durante la estación de las lluvias.

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