Onderstepoort J. vet. Res., 56, 271–275 (1989)

GEOGRAPHICAL DISTRIBUTION AND HABITAT PREFERENCES OF THE INVADER FRESHWATER SNAIL SPECIES *LYMNAEA COLUMELLA* (MOLLUSCA: GASTROPODA) IN SOUTH AFRICA

K. N. DE KOCK[(1)], P. H. JOUBERT[(2)] and S. J. PRETORIUS[(2)]

ABSTRACT

DE KOCK, K. N., JOUBERT, P. H. & PRETORIUS, S. J., 1989. Geographical distribution and habitat preferences of the invader freshwater snail species *Lymnaea columella* (Mollusca: Gastropoda) in South Africa. *Onderstepoort Journal of Veterinary Research*, 56, 271–275 (1989).

The present geographical distribution of *Lymnaea columella*, as recorded in the National Freshwater Snail Collection, is described and discussed. It appears that *L. columella* is the most successful colonist of all the freshwater snail species in South Africa, and, together with *Bulinus tropicus* and *Lymnaea natalensis*, it forms the most widely distributed freshwater snail species in the region.

Data regarding the 2 341 discovery sites of *L. columella* recorded by collectors during surveys are analysed. *L. columella* cluster mainly in rivers or streams with perennial, slow flowing, or stagnant freshwater with many plants and a mud substrate.

L. columella is regarded as a more effective intermediate host for the transmission of fascioliasis than the indigenous snail species. The economical implications of this are discussed briefly in the light of its success as an invader species.

INTRODUCTION

According to several sources (Van Eeden & Brown, 1966; Brown, 1967; 1978; 1980), it is reasonably certain that *Lymnaea columella* was extremely rare in South Africa before 1944. The species was not mentioned by Connolly (1939), who thoroughly revised the freshwater molluscs of South Africa from extensive material collected by himself and many other researchers. According to Brown (1980), however, this species had already been found in 1942 by J. Omer-Cooper near Somerset West. Brown (1980) strongly suspected that this snail had been imported with aquatic plants or fish, since the species is known as a traveller that has become established in many parts of the world with the aid of man.

By 1966, Van Eeden & Brown (1966) had already pointed out that over the course of about 20 years *L. columella* had succeeded in becoming one of the most numerous snail species in many parts of South Africa. They reported discovery sites in 132 loci ($\frac{1}{16}$ square degrees) in South Africa and predicted that the geographic distribution of *L. columella* will increase considerably, owing to the completion of several irrigation schemes which will change the ecology of extended dry areas in South Africa.

In this paper we take a brief look at the geographic distribution of *L. columella* in South Africa at present, i.e. about 2 decades after the investigation of Van Eeden & Brown (1966). The habitat types and associated freshwater snail fauna will also be discussed. In other parts of the world, *L. columella* plays an important role in the transmission of *Fasciola hepatica*, and consequently, the economical implications of its success as an invader species will also be assessed.

METHODS

The data for this study were drawn from the data base of the National Freshwater Snail Collection, which encompasses information from 1956–1988. Only collections of *L. columella* that contained sufficient information to localize the collection site on the South African 1:250 000 topocadastral map were included. From the more than 19 000 records in this data base, only 2 341 collection sites of *L. columella* satisfied this requirement.

RESULTS

The loci recorded in the National Freshwater Snail Collection are indicated in Fig. 1. A distinction is made between the 132 loci present in the Collection at the time of the investigation by Van Eeden & Brown (1966) and the 225 additional loci found since 1966.

Of the 2 341 collection sites of *L. columella*, 863 (36,9 %) were in rivers, 717 (30,6 %) in dams and 391 (16,7 %) in streams. The remaining 370 (15,8 %) came from a variety of other habitats, including springs, vleis (swamps), marshes and other habitats created by man, such as gravel quarries, cement and galvanized iron reservoirs, cattle troughs and fishponds.

As far as water velocity at the 2 341 collection sites is concerned, 825 (35,2 %) were noted as stagnant, 738 (31,5 %) as slow flowing, 209 (8,9 %) as fast flowing, while this information was omitted in 569 (24,3 %) of the cases.

The various types of substrate and water conditions at the collection sites as noted by the collectors during the surveys are summarized in Tables 1 and 2. The data in Table 1 indicate that *L. columella* was found 422 times in a habitat of which the substrate was predominantly muddy. In 200 cases, the substrate was sandy/muddy and in 93 cases as sandy/muddy, with rotting material. A muddy substrate was encountered in the descriptions a total of 1 137 times, either alone or in combination with 1 or 2 other substrate types (Table 1).

The majority of recoveries were from clear, fresh, perennial water sources (Table 2).

The vegetation at the 2 341 collection sites of *L. columella* was noted by the collectors as plentiful in 1 210 (51,7 %) of the cases, sparse in 703 (30,0 %) of the cases, absent in 21 (0,9 %) of the cases, while no information in this respect was given for 407 (17,4 %) of the collections.

The diversity of freshwater snail species and the number of times they were found in the same habitat as *L. columella* is shown in Table 3.

(1) Department of Zoology, University of Potchefstroom for CHE, Potchefstroom 2520, South Africa

(2) Research Institute for Diseases in a Tropical Environment of the South African Medical Research Council, P.O. Box 634, Nelspruit 1200, South Africa. To whom correspondence should be addressed

Received 28 August 1989—Editor

TABLE 1 Types of substrate found in habitats of *Lymnaea columella* as described by collectors during surveys.
A: Substrate type alone or mentioned together with one other type for a specific site
B: Three substrate types mentioned together for a specific site
C: Total number of times that each substrate type was mentioned in descriptions

A

*	K	S	M	R
K	193	197	78	20
S		231	200	57
M			422	210
R				29

B

KMR	34
KSM	100
KSR	15
SMR	93

C

K	637
S	893
M	1 137
R	458

* K: stony
S: sandy
M: muddy
R: rotting material

TABLE 2 Water conditions in the habitats of *Lymnaea columella* as described by collectors during surveys

Water supply	N*	%
Perennial	606	68,6
Seasonal	207	8,8
Not indicated	528	22,6

Water salinity	N	%
Brackish	58	2,5
Fresh	1 437	61,4
Not indicated	846	36,1

Water colour	N	%
Clear	1 420	60,7
Muddy	339	14,5
Not indicated	582	24,9

* N: number of samples

TABLE 3 The number of samples in which *Lymnaea columella* was the only species present, as well as the number of samples in which other freshwater snail species were found in more than 1 % of the 2 341 collection sites in association with *Lymnaea columella*

Species	Number of samples	%
Lymnaea columella (alone)	492	21,0
Bulinus africanus sp. group	50	2,1
Bulinus tropicus	709	30,3
Bulinus depressus	184	7,8
Bulinus natalensis	54	2,3
Bulinus forskali	133	5,7
Biomphalaria pfeifferi	254	10,9
Lymnaea truncatula	53	2,3
Physa acuta	267	11,4
Ceratophallus natalensis	205	8,8
Gyraulus costulatus	220	9,4
Gyraulus connollyi	102	4,4
Burnupia capensis	178	7,6

DISCUSSION

An inspection of the frequencies of annotated habitats of *L. columella* does not reveal a large difference between rivers (36,9 %) and dams (30,4 %) (Table 1), or between stagnant water (35,2 %) and slow flowing water (31,5 %). However, when the occurrences in rivers and streams are pooled, this type of habitat (53,6 %) appears fairly frequently. Habitats with perennial (68,6 %) fresh (61,4 %) and clear (60,7 %) water, and water with a mud substrate (18,0 %) and abundant plant growth (51,7 %) were the most frequently noted by collectors. It is clear that many habitat types in widely different climatic conditions were successfully colonized by *L. columella.* The species is widespread in the winter and summer rainfall areas, in the cold Highveld region of the Transvaal and Orange Free State, and in the hot subtropical regions of the Transvaal Lowveld and Natal. However, it is absent in extremely dry climatic regions, such as the Karoo, where only freshwater snail species, such as *Bulinus tropicus* with special survival strategies, can become successfully established.

In 21,0 % of the cases, *L. columella* was the only freshwater snail species found in samples analysed from the habitat. *Lymnaea natalensis* Krauss (34,8 %) occurred the most frequently in conjunction with *L. columella* in the same habitat, and *B. tropicus* (30,1 %) the second most frequently. *L. natalensis* and *B. tropicus* have widely different requirements for optimal existence (De Kock, 1973; Brown, 1980; De Kock & Van Eeden, 1985) and the fact that *L. columella* can share the habitats of these two species shows how adaptable and tolerant it is. According to these authors, *L. natalensis* is usually abundant in habitats with perennial, oxygen-rich water, with little organic enrichment, while *B. tropicus* usually occurs in non-perennial, organically enriched water where high daily fluctuations in temperature and oxygen levels occur.

Van Eeden & Brown (1966) Brown (1978; 1980) put forward theories on how *L. columella* reached South Africa. In a revision of the freshwater molluscs of Natal, Brown (1967) stated that *L. columella* proved to be the most successful colonist among the invader freshwater species to enter South Africa. It is now even more evident than in 1967. *Physa acuta,* regarded as the 2nd most successful invader species, has been collected from only 43 new loci (Fig. 2) since the report of Hamilton-Attwell, De Kock & Van Eeden (1970). This contrasts with the 225 new loci of *L. columella* (Fig. 1) noted since the report by Van Eeden & Brown (1966).

According to the records of the National Freshwater Snail Collection, *L. columella* is the 3rd most widely distributed freshwater snail species in South Africa, surpassed only by *L. natalensis* and *B. tropicus.* The reasons for its success as an invader species may partly be ascribed to a well-developed ability for self-fertilization, as was demonstrated experimentally by Colton & Pennypacker (1934). Apart from an analysis of its reproduction cycle relative to that of other freshwater gastropods in a natural habi-

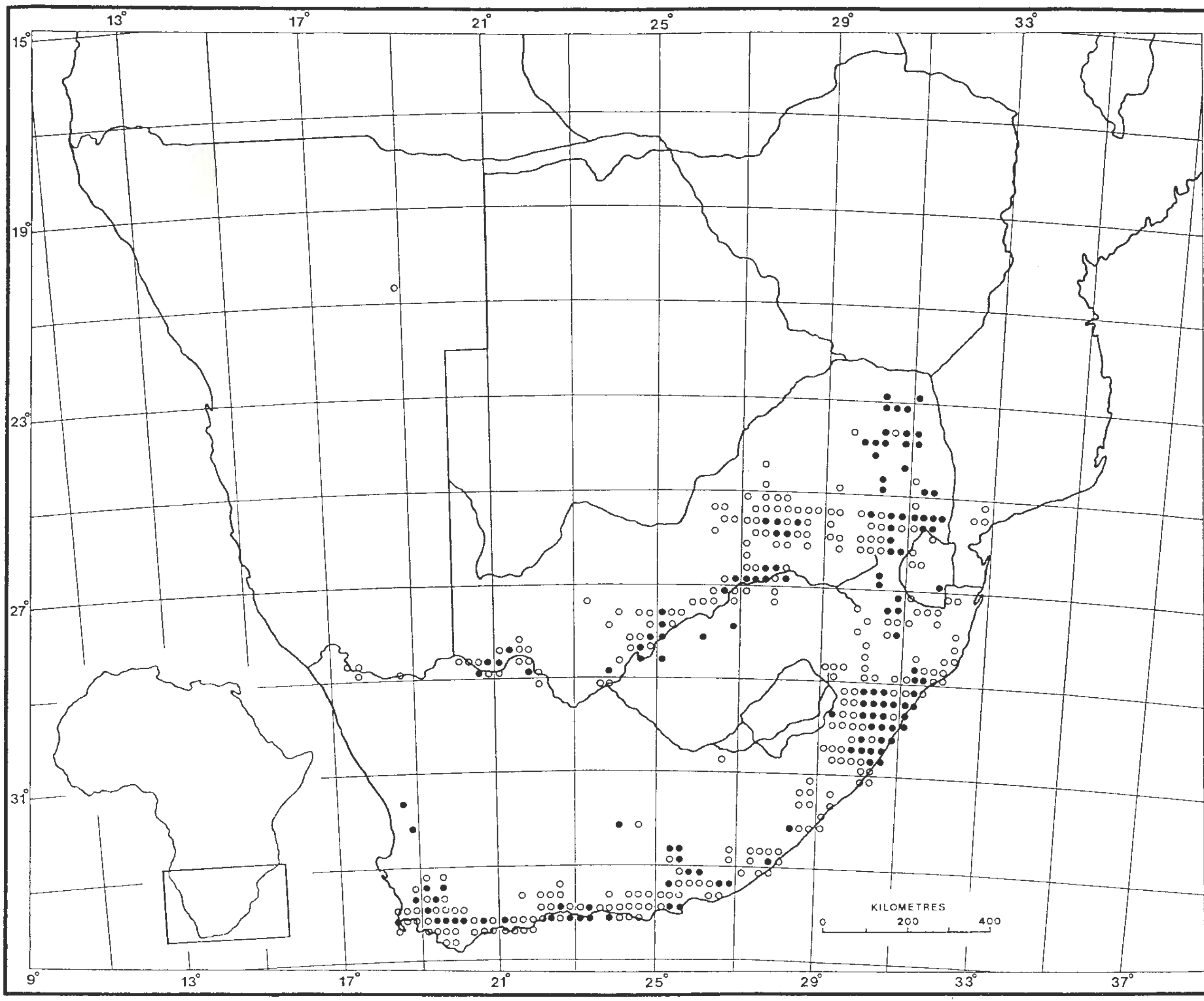

FIG. 1 Geographic distribution of *Lymnaea columella* in $\frac{1}{16}$th square degree loci. The 132 loci recorded in the National Freshwater Snail Collection at the time of the investigation by Van Eeden & Brown (1966) are represented by dots, while the 225 additional loci found since 1966 are indicated by circles.

tat (Appleton, 1974), little is known about the population dynamics of *L. columella*. During an experimental investigation of the effect of constant temperature on the population dynamics of several economically important freshwater snail species (De Kock, 1973), life tables for *L. columella* and *L. natalensis* at a constant temperature of 26 °C have been constructed. According to these findings, the innate capacity of reproduction of *L. columella* (r_m = 2,17) was higher than that of *L. natalensis* (r_m = 1,8) and the mean cohort generation time (T = 4,67 fourteen day periods) was shorter than that of *L. natalensis* (T = 5,0 fourteen day periods). This implies that *L. columella* is theoretically better able than *L. natalensis* to establish itself in suitable habitats, but should also under relatively unsuitable conditions be able to increase its population size faster and maintain this size longer. Van Eeden & Brown (1966) also regarded the ability of *L. columella* to exist on damp mud beyond the water's edge not occupied by any other species as another factor contributing toward its success as a colonist.

The present investigation confirmed that *L. columella* succeeded in markedly extending the boundaries of its geographical distribution in South Africa, as predicted by Van Eeden & Brown (1966). Judged by its higher reproduction rate and shorter generation time at 26 °C in the laboratory when compared with *L. natalensis*, its ability to utilise a larger variety of niches, and its successful dispersal over the past few decades, *L. columella* can be expected to achieve an even more extensive geographical distribution than *L. natalensis* in future.

The introduction and extent of the distribution that *L. columella* reached in Africa over the past 3 to 4 decades is, according to Brown (1980) a complication in the transmission of fascioliasis. In South Africa *L. columella* was experimentally shown to be susceptible to both liver fluke species *Fasciola gigantica* and *Fasciola hepatica* (Brown, 1980). Brown (1980) is furthermore of the opinion that the prevalence of fascioliasis has increased since the arrival of this invader snail species. According to Brown (1980), one of the possible reasons for the increase may be that *L. columella* as a potential intermediate host of *F. hepatica* is more widely distributed geographically than the traditional intermediate host *Lymnaea truncatula* (Müller). *L. truncatula* is limited to very specific habitats in the cooler parts of the country and thus has a limited and very discontinuous distribution. Another reason for the increase in prevalence of fascioliasis is suggested by Brown (1980), namely, that in his opinion, *L. columella* causes more effective transmission of *F. gigantica*

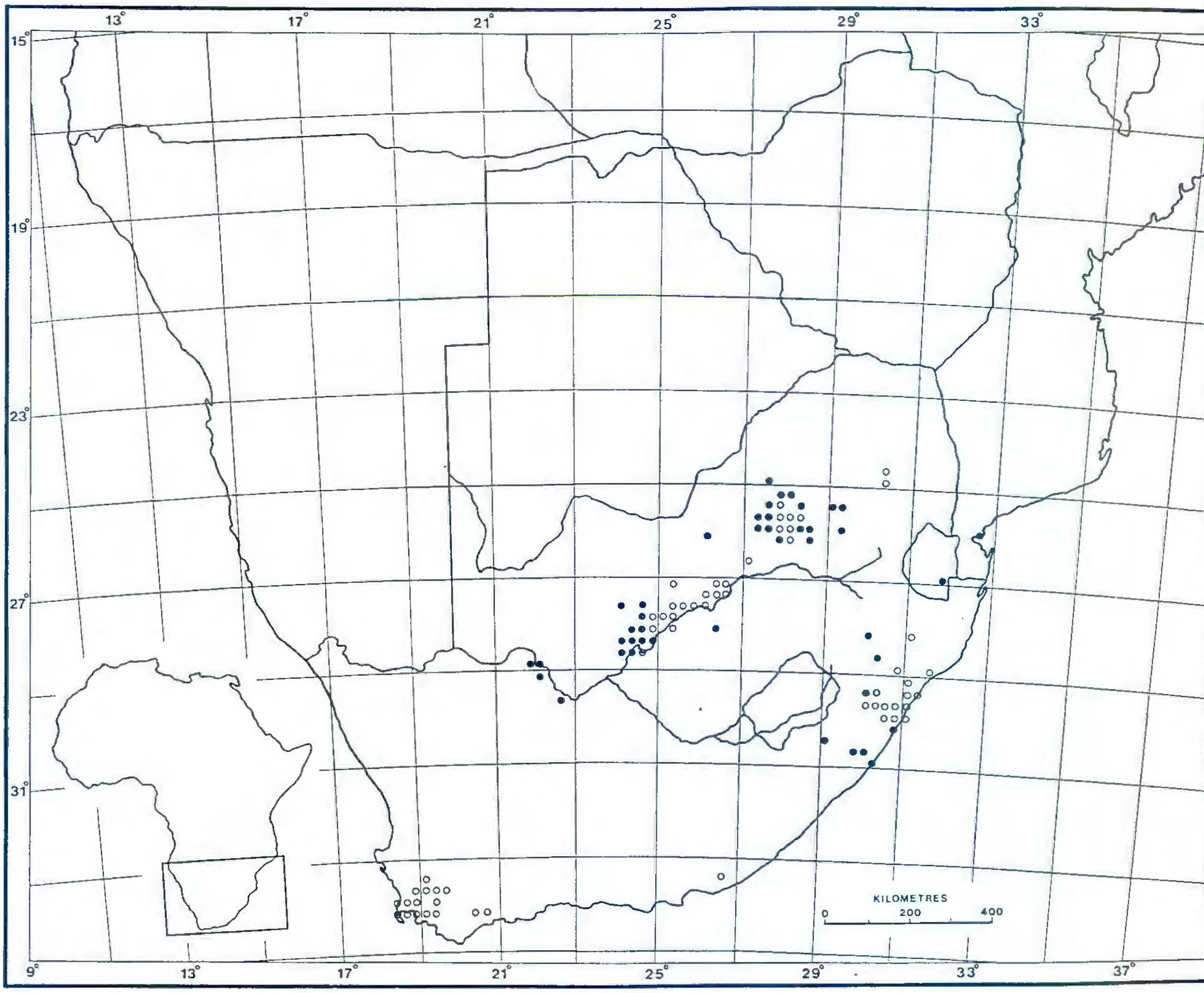

FIG. 2 Geographic distribution of *Physa acuta* in 1/16th square degree loci. The 58 loci recorded in the National Freshwater Snail Collection at the time of the investigation by Hamilton-Attwell, De Kock & Van Eeden (1970) are represented by circles, while the 43 additional loci found since 1970 are indicated by dots.

than the traditional intermediate host, *L. natalensis,* because of the semi-amphibian habit of *L. columella* of climbing up against shore plants above the water line. Metacercariae are thus more easily ingested together with these plants by grazing animals.

Liver fluke infections in humans are rare in Africa, according to Goldsmid (1975). However, Schutte, Eriksson, Anderson & Lamprecht (1981) found *F. hepatica* infections in 22 out of 7 569 black school children examined in northern KwaZulu. These authors do not state whether they have considered the possibility that the *F. hepatica* ova excreted by these school children could be due to spurious infection. According to Goldsmid (1975) one has to check against false fascioliasis and the passing of "transit eggs" due to the ingestion of infected cattle liver—a condition commonly recorded in Rhodesia.

Financial losses due to fascioliasis are serious enough in parts of Africa to necessitate regular dosing of animals (Brown, 1980). Although the present status of *L. columella* in the epidemiology of fascioliasis in South Africa is not clear, this snail possesses attributes that make it an ideal intermediate host for both local *Fasciola* spp. Until now, the Karoo, with its extensive sheep farming, was unfavourable for the transmission of fascioliasis, because of the scarcity of perennial water where snails could get established.

Big irrigation schemes, such as the Orange River project, drastically changed the extent of habitats with perennial water in large areas of the country. As the water supply to drier areas improve, more habitats will be created where *L. columella* can become established. If this happens, fascioliasis will threaten the health of humans and animals to an increasing degree.

With the present level of knowledge, it may be practical and economical to manipulate habitats that are created so that they may be less favourable for the establishment of snail intermediate hosts of economically important parasites. This could limit expenses for therapeutic drugs and losses of valuable protein from diseased sheep and cattle livers. Should such measures prove to be unpractical, efforts should at least be made to localize transmission areas, and to identify such areas to producers and people intending to use these areas for food production or recreational purposes.

ACKNOWLEDGEMENTS

We thank the South African Medical Research Council and the Potchefstroom University for CHE for financial support and permission to publish this article.

REFERENCES

APPLETON, C. C., 1974. The population fluctuations of five freshwater snail species in the eastern Transvaal lowveld and their relationship to known bilharzia transmission patterns. *South African Journal of Science,* 70, 145–150.

BARNARD, K. H., 1948. Addendum to Connolly, 1939.

BROWN, D. S., 1967. A review of the freshwater Mollusca of Natal and their distribution. *Annals of the Natal Museum,* 18, 477–494.

BROWN, D. S., 1978. Freshwater molluscs. *In:* WERGER, M. J. A. (ed.). Biogeography and ecology of Southern Africa. 2. 1 155–1 180. The Hague: Junk.

BROWN, D. S., 1980. Freshwater snails of Africa and their medical importance. London: Taylor and Francis Ltd.

COLTON, H. S. & PENNYPACKER, M., 1934. The results of twenty years of selffertilization in the pond snail *Lymnaea columella* Say. *American Naturalist,* 68, 129–136.

CONNOLLY, M., 1939. A monographic survey of the South African non-marine Mollusca. *Annals of the South African Museum,* 33, 1–660.

DE KOCK, K. N., 1973. Die Bevolkingsdinamika van vyf medies en veeartsenykundig belangrike varswaterslakspesies onder toestande van beheerde temperatuur. Proefskrif, Potchefstroomse Universiteit vir CHO, Potchefstroom.

DE KOCK, K. N. & VAN EEDEN, J. A., 1985. Effect of constant temperature on population dynamics of *Bulinus tropicus* (Krauss) and *Lymnaea natalensis* Krauss. *Journal of the Limnological Society of Southern Africa,* 11, 27–31.

GOLDSMID, J. M., 1975. Ecological and cultural aspects of human trematodiasis (excluding schistosomiasis) in Africa. *Central African Journal of Medicine,* 21, 49–53.

HAMILTON-ATTWELL, V. L., DE KOCK, K. N. & VAN EEDEN, J. A., 1970. The occurrence and distribution of *Physa acuta* Draparnaud in the Republic of South Africa. *Wetenskaplike Bydraes van die PU vir CHO. Reeks B: Natuurwetenskappe,* 26, 1–11.

SCHUTTE, C. H. J., ERIKSSON, I. M., ANDERSON, C. B. & LAMPRECHT, T., 1981. Intestinal parasitic infections in Black scholars in northern KwaZulu, *South African Medical Journal,* 60, 137–141.

VAN EEDEN, J. A. & BROWN, D. S., 1966. Colonization of fresh waters in the Republic of South Africa by *Lymnaea columella* Say (Mollusca: Gastropoda). *Nature,* 210, 1 172–1 173.