Verspreiding en habitats van *Lymnaea natalensis*, tussengasheerslak van die lewerbot *Fasciola gigantica*, in Suid-Afrika

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Uittreksel

Hierdie artikel fokus op die geografiese verspreiding en die habitats van Lymnaea natalensis, *die slaktussengasheer van die lewerbot*, Fasciola gigantica, *soos gereflekteer deur die vindplekke van sy 4 552 monsters wat tans in die Nasionale Varswaterslakversameling (NVV) van Suid-Afrika op rekord is. Alhoewel hierdie spesie in'n verskeidenheid van waterliggame aangetref is, was die meerderheid van die monsters (±70%) afkomstig vanuit riviere, spruite en damme en is die water in 70.8% van die gevalle as standhoudend en in 71.8% van die gevalle as stadigvloeiend, of staande beskryf. Die resultate van lewenstabeleksperimente deur verskeie outeurs het daarop gedui dat temperatuur 'n minder belangrike bepalende faktor in sy geografiese verspreiding blyk te wees, maar dat die beskikbaarheid van standhoudende water deurslaggewend vir sy voorkoms in 'n gegewe habitat mag wees. Hierdie resultate strook met die bevinding dat slegs 7.5% van die monsters van hierdie spesie in die NVV in habitats wat as seisoenaal beskryf is, versamel is. Verder bied dit'n logiese verklaring vir die sporadiese voorkoms, of totale afwesigheid van hierdie spesie in die droër streke van Suid-Afrika. Opgaardamme en besproeiingsnetwerke dra grootliks by tot die skepping van permanente habitats wat geskik sou wees vir* L. natalensis. *As tussengasheer vir een van die lewerbotspesies wat reeds 'n ekonomiese faktor in Suid-Afrika is, is dit 'n aspek waarmee beslis rekening gehou behoort te word in die beplanning en konstruksie van nuwe besproeiingsprojekte.*

Abstract

Distribution and habitats of Lymnaea natalensis, *snail intermediate host of the liver fluke* Fasciola gigantica, *in South Africa*

This paper focuses on the geographical distribution and the habitats of Lymnaea natalensis*, the snail intermediate host of the liver fluke,* Fasciola gigantica*, as reflected by the collection sites of its 4 552 samples currently on record in the National Freshwater Snail Collection (NFSC) of South Africa. Although this species was represented in a variety of waterbodies, the majority of samples (±70%) came from rivers, brooks and dams and in 70.8% of the cases the water was described as permanent and in 71.8% as slow flowing or standing. The results of life-table studies conducted by various authors indicated that temperature should be a relatively unimportant factor in determining its geographical distribution, but that the availability of permanent water should be decisive for its presence in a given habitat. These results are in agreement with the finding that only 7.5% of the samples of this species in the NFSC were collected in habitats which were described as seasonal. Furthermore, it gives a logical explanation for the sporadic occurrence, or total absence of this species in the more arid regions of South Africa. Water impoundments and irrigation networks contribute to a large extent towards creating perennial habitats which would be suitable for* L. natalensis*. As intermediate host for one of the liver fluke species which already is an economic factor in South Africa, this certainly is an aspect which ought to be reckoned with in the planning and construction of new irrigation schemes.*

INLEIDING

Lymnaea natalensis is oorspronklik in 1848 aan die hand van eksemplare uit KwaZulu-Natal beskryf, Die spesie het volgens die rekords in die Nasionale Varswaterslakversameling (NVV) die wydste geografiese verspreiding van die drie *Lymnaea*-spesies wat tans in Suid-Afrika aangetref word. Die oudste rekord van *L. natalensis* wat in die databasis van die NVV opgeneem is, dateer uit 1953. Hierdie spesie is ekonomies belangrik omdat dit as tussengasheer vir *Fasciola gigantica* kan optree, wat volgens Brown[1] die algemeenste lewerbot in Afrika is en wyd verspreid voorkom. In hierdie ondersoek word die geografiese verspreiding van *L. natalensis* in Suid-Afrika, soos gereflekteer deur die 4 554 monsters wat tans in die NVV opgeneem is, bespreek in die lig van die resultate van bevolkingsdinamikastudies, onder laboratoriumtoestande, wat deur verskeie outeurs gerapporteer is. Besonderhede van habitats, soos deur versamelaars tydens versameling opgeteken is en die gemiddelde jaarlikse reënval en temperatuur van die versamellokusse ($^1/_{16}$ vierkantegraad) word in tabelle weergegee.

METODE

Die getal lokusse waarin die versamelpunte voorgekom het, is in intervalle van gemiddelde jaarlikse reënval en temperatuur ingedeel en getabelleer om die frekwensie van voorkoms van vindplekke by 'n gegewe interval aan te dui.

RESULTATE

Slegs monsters waarvan die vindplekke sodanig deur die versamelaars beskryf is dat dit agterna op die 1:250 000 topo-kadastraal-kaartreeks van Suid-Afrika gelokaliseer kon word, is in hierdie ondersoek ingesluit. Die lokusse van die 4 552 monsters wat aan hierdie kriterium voldoen het, word in figuur 1 weergegee.

**** Outeur aan wie korrespondensie gerig kan word***

Lymnaea natalensis is in 'n wye verskeidenheid waterliggaamtipes aangetref, maar slegs daardie waarin 1% of meer van die totale getal monsters versamel is, word in tabel 1 gelys. Dit is duidelik dat daar nie veel te kies was tussen riviere, damme en spruite betreffende die getal monsters wat daarin versamel is nie en dat nagenoeg 70% van die totale getal monsters uit hierdie drie tipes afkomstig is. Die teenwoordigheid van waterplante ten tye van versameling is in bykans 80% van die gevalle deur versamelaars vermeld. In 70.6% van die lokaliteite is die water as standhoudend en in 71.8% van die gevalle as staande, of stadigvloeiend aangedui, terwyl die water in onderskeidelik 60.3% en 64.6% van die gevalle as helder en vars deur die versamelaars beskryf is. Alhoewel die meerderheid monsters in waterliggame versamel is waarvan die substratum as oorwegend modderig beskryf is, was klipperige en sanderige substratums ook goed verteenwoordig in die versamelpunte van hierdie spesie (tabel 3).

Net meer as 70% van die vindplekke het in die gemiddelde jaarlikse temperatuurinterval wat van 15-19ºC strek, geval, terwyl net minder as 60% van die vindplekke in die gemiddelde jaarlikse reënvalinterval wat van 600-899 mm strek, geval het (tabel 4).

Tabel 1 Tipes waterliggame waarin *Lymnaea natalensis* aangetref is in 1% of meer van die 4 552 versamelpunte wat deur versamelaars tydens versameling opgeteken is

Tipe waterliggaam	n	%
Dam	1050	23.1
Dammetjie	123	2.7
Fontein	42	1.0
Kanaal	26	1.0
Moeras/vlei	204	4.5
Pan	29	1.0
Rivier	1110	24.4
Sementdam	75	1.6
Sloot	59	1.3
Spruit	987	21.7
Nie aangedui	793	17.4

n = getal versamelpunte

BESPREKING

Volgens die inligting in die databasis van die NVV is *L. natalensis* die spesie waarvan die tweede meeste monsters op rekord is en toon dus ook die tweede wydste geografiese verspreiding, te oordeel aan die 616 verskillende lokusse waarin die vindplekke van die 4 552 monsters geleë is. Waardes vir die demografiese paramerter r_m (ingebore vermoë om te vermeerder) wat eksperimenteel deur verskeie outeurs by 'n reeks konstante temperature bepaal is, het daarop gedui dat temperatuur, as sodanig, 'n minder belangrike rol in die geografiese verspreiding van hierdie spesie speel.[2,3] Die implikasie van die relatief lae r_m-waardes en die langer generasietye wat verkry is, is dat *L. natalensis* hoofsaaklik op stabiele habitats aangewese sal wees.[2,3,4] Volgens Brown[1] kom dit meer algemeen in permanente strome en opgaardamme voor en is dit volgens McCullough[5] en Cridland[6] nie besonder weerstandbiedend teen desikkasie nie. Hierdie bevindinge is in ooreenstemming met die omstandigheid dat 70.6% van die monsters van *L. natalensis* wat in die NVV op rekord is, in habitats met standhoudende water versamel is. Daarbenewens toon die geografiese verspreiding wat in figuur 1 weergegee word ook dat hierdie spesie sporadies versprei, of selfs totaal afwesig is in die droër gebiede van Suid-Afrika. Die skulpvorm as sodanig kan as een van die belangrike redes aangevoer word vir die beperkte vermoë van *L. natalensis* om uitdroging as gevolg van die habitat te kan oorleef. Die skulpopening van *L. natalensis* is relatief groot en die skulpspiraal relatief kort, met die implikasie dat veral die voetgedeelte van die sagtemateriaal nie diep in die skulp opgetrek kan word om ongunstige toestande

Tabel 3 Substratumtipes in the habitats van *Lymnaea natalensis* soos tydens versamelings beskryf

	Substratumtipes				
	M	K	S	V	NA
n	1462	1080	929	104	977
%	32.1	23.7	20.4	2.3	21.5

M = modderig, K = klipperig, S = sanderig, V = verrottende materiaal, NA = nie aangedui en n = getal versamelpunte

Tabel 2 Watertoestande in the habitats van *Lymnaea natalensis* soos tydens versamelings opgeteken

Tipe	n	%	Snelheid	n	%	Kleur	n	%	Saliniteit	n	%
Standhoudend	3213	70.6	Vinnig	315	6.9	Helder	2745	60.3	Vars	2939	64.6
Seisoenaal	343	7.5	Stadig	1470	32.2	Modder	670	14.7	Souterig	115	2.5
Nie aangedui	996	21.9	Staande	1803	39.6	Nie aangedui	1137	25.0	Nie aangedui	1498	32.9

n = getal versamelpunte

Tabel 4 Frekwensie verspreiding van die 4 552 versamelpunte van *Lymnaea natalensis* in geselekteerde intervalle van gemiddelde jaarlikse temperature en reënval in Suid-Afrika

Temperature (ºC)				Reënval (mm)				
	10-14	15-19	20-24	0-299	300-599	600-899	900-1199	1200-1499
n	17	3203	1332	72	1660	2591	226	3
%	0.4	70.4	29.3	1.6	36.5	56.9	5.0	0.07

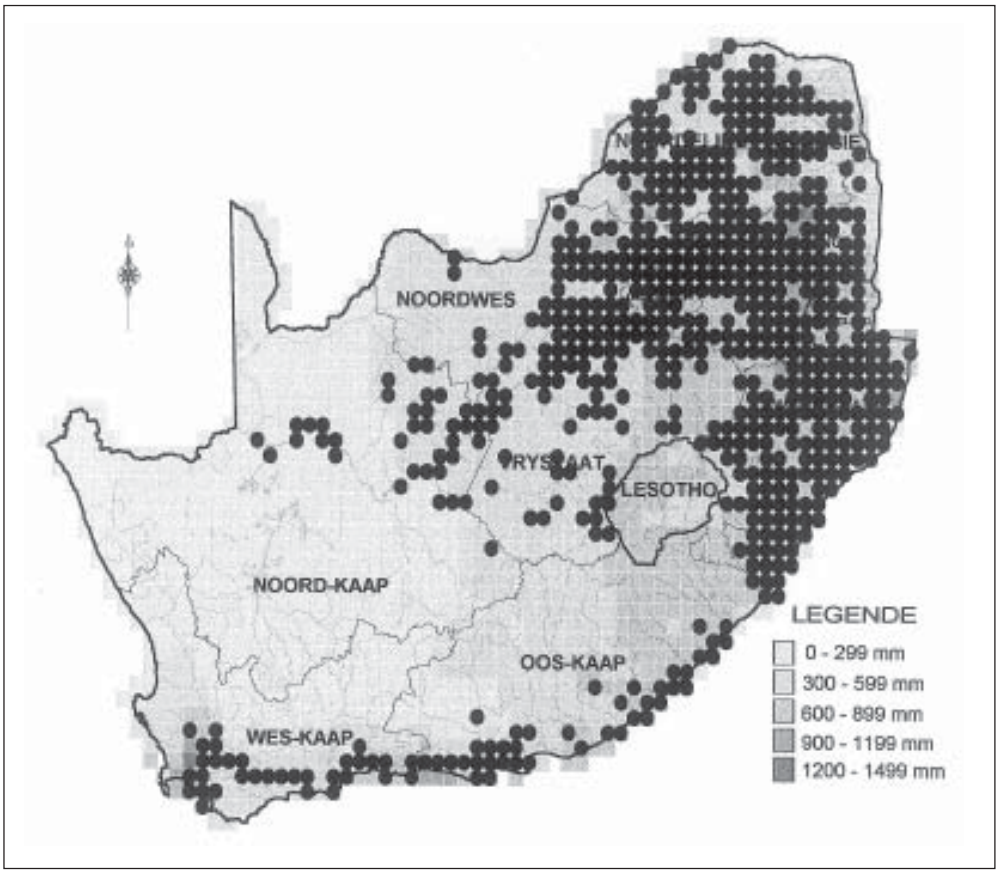
n = getal versamelpunte

te vermy nie. Daarbenewens is dit ook moeiliker om die groot skulpopening doeltreffend teen uitdroging af te seël. Hierteenoor is die skulpopening in verhouding tot die spiraal baie kleiner by *Lymnaea truncatula*, wat volgens Brown[1] die derde hoogste op die ranglys van Afrika-varswaterslakke is wat betref hulle vermoë om desikkasie te kan oorleef.

Die bevinding van Combrinck en Van Eeden[7] dat *L. natalensis* tydens lewenstabel-eksperimente in die laboratorium die hoogste bevolkingsaanwas getoon het in akwariums met substratums van of modder, of klip, of sand, bied 'n logiese verklaring vir die resultate in tabel 3. Die resultate toon dat die die grootste persentasie monsters van hierdie spesie wat in die NVV opgeneem is in habitats met dié drie substratumtipes versamel is.

Die afleiding van De Kock [2] en De Kock en Van Eeden[3] dat temperatuur nie 'n belangrike rol in die geografiese verspreiding van *L. natalensis* speel nie, word ondersteun deur sy geografiese verspreiding wat in figuur 1 weergegee word. Dit toon dat die spesie in van die warmste, sowel as van die koudste streke in die land versamel is. Dit wil dus voorkom asof die beskikbaarheid van permanente water een van die vernaamste bepalende faktore vir die aan- of afwesigheid van hierdie spesie in 'n bepaalde habitat mag wees. Jennings[8] het op grond van 'n reeks lewenstabel-eksperimente in die laboratorium tot die slotsom gekom dat die saliniteit van die water, teen vlakke wat onder natuurlike toestande aangetref kan word, egter ook beperkend vir die voorkoms van verskeie varswaterslakspesies in 'n gegewe habitat kan wees. Geleidingsvermoëwaardes wat 500FS oorskry, is nie meer gunstig vir eierproduksie of oorlewing van *L. natalensis* in die laboratorium nie.[8] Dit strook dan ook met die bevinding dat slegs 2.5% van die monsters van hierdie spesie wat in die NVV opgeneem is, uit habitats waarvan die water as brak aangedui is, afkomstig was (tabel 2). Alhoewel die integument van alle varswaterslakspesies deurlatend is vir elektroliete in die water, besit die genus *Lymnaea*, volgens Van Aardt[11] 'n besonder lae osmotiese potensiaal in die hemolimf in vergelyking met sommige ander varswaterslakspesies, byvoorbeeld 127 mOsm/Kg$^{-1}H_20$ (milli-osmole) in die geval van *L. stagnalis*. Volgens hierdie outeur sal 'n verhoging van die belangrikste fisiologiese elektroliete in die water wat 'n geleidingsvermoë van hoër as 500µS tot gevolg het, veroorsaak dat meer energie benodig sal word om die osmotiese druk van die hemolimf konstant te hou. Hierdie relatiewe hoër energieverbruik sal teenproduktief op voortplanting en oorlewing inwerk.

Groot opgaardamme met die gepaargaande besproeiingsnetwerke dra grootliks by tot die totstandkoming van meer standhoudende akwatiese habitats in hulle opvangsgebiede. Die skep van bykomende potensiële habitats vir *L. natalensis* wat as tussengasheer vir die lewerbot *F. gigantica* optree, het finansiële implikasies, veral in gebiede waar kommersieel met skape geboer word en waar hierdie spesie tans nog 'n beperkte voorkoms het. Alhoewel lewerbotinfeksies by die mens, volgens Goldsmid[9] uitsonderlik is, is infeksies by 22 skoolkinders in KwaZulu-Natal gerapporteer.[10] Omsigtigheid behoort dus tydens alle fases in die beplanning en konstruksie van opgaardamme en besproeiingskemas aan die dag gelê te word om te voorkom dat die huidige bedreiging van die lewerbot vir die gesondheid van mens en dier in Suid-Afrika vererger word. In Zimbabwe word reeds pogings van stapel gestuur om besproeiinstelsels so aan te pas of vooraf te beplan dat dit ongunstig sou wees vir die vestiging van slakke.[12] Volgens hierdie outeur is die vernaamste doelwitte waarna gestreef word, die volgende: om die watervloei in kanale te verhoog, skommeling in watervlakke van opgaardamme te bewerkstellig



Figuur 1: *Die geografiese verspreiding van* Lymnaea natalensis per $^{1}/_{16}$ *vierkantegraadlokus en gemiddelde jaarlikse reënval in Suid-Afrika.*

en om 'n strategie van periodieke drooglegging te volg. Die moontlike vestiging van akwatiese plantegroei, wat gunstige nisse vir varswaterslakke skep, word ook op verskeie maniere bekamp.

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SUMMARY

Lymnaea natalensis from a locality in KwaZulu-Natal was originally described in 1848. According to the records in the National Freshwater Snail Collection (NFSC), this species has the most extensive geographical distribution of the three *Lymnaea* species currently present in South Africa. The oldest record of *L. natalensis* in the database of the NFSC dates back to 1953. This species is of economic importance on account of its ability to serve as intermediate host for *Fasciola gigantica*, which is the most common liver fluke in Africa with an extensive geographical distribution. This report focuses on the geographical distribution of *L. natalensis*, as reflected by the 4 552 samples currently on record in the NFSC. The bearing of the results of studies on the population dynamics reported by several authors on the distribution of this species is discussed. Details of the habitats as recorded by collectors during surveys and the mean annual rainfall and temperature of the loci ($^1/_{16}$ square degree) in which the collections were made, are also given.

The number of loci in which the collection sites were located, was divided in intervals of mean annual rainfall and temperature and tabled to illustrate the frequency of occurrence in specific intervals.

Only those samples of which the collection sites were described in such a way by collectors that they could afterwards be located on the 1: 250 000 topo cadastral map series of South Africa, were included in this investigation and the loci of the 4 552 samples which complied to this criterion, were depicted in a map.

Lymnaea natalensis was reported from a wide variety of waterbodies, but the largest number of samples was recovered from rivers (24.4%), dams (23.1%) and brooks (21.7%). The presence of aquatic plants at the time of survey was reported by collectors in ± 80% of the sampling sites and the habitat described as perennial in 70.6% of the cases. The majority of samples (71.8%) were recovered from habitats with either standing, or slow flowing water, while the water was described as clear and fresh in respectively 60.3% and 64.6% of the localities. Although the largest number of samples came from waterbodies of which the substratum was described as predominantly muddy, sandy and stony substrata were also well represented in the sampling sites of this species.

Just over 70% of the sampling sites fell within the mean annual temperature interval, which ranged from 15- 19ºC, while just less than 60% fell in the mean annual rainfall interval which ranged from 600- 899 mm.

According to the data in the database of the NFSC, *L. natalensis* is the species with the second largest number of samples on record and judged by the 616 different loci in which the sampling sites of the 4 552 samples are located, also displays the second widest geographical distribution. Values reported by several authors for the demographic parameter r_m (innate capacity of increase) for this species at a range of constant temperatures indicated that temperature was of less importance in governing its geographical distribution. The relatively low r_m values and longer generation times recorded for *L. natalensis* imply that it would be largely dependent on stable habitats. This is in agreement with the fact that 70.6% of the samples of *L. natalensis* in the NFSC were recovered from perennial habitats and its sporadic distribution, or virtual absence in the more arid areas of South Africa. The shape of the shell can be put forward as one of the most important reasons for the limited capacity of *L. natalensis* to survive conditions of desiccation. The aperture of the shell is relatively large and the spiral relatively short, consequently the soft material and especially the foot part, cannot be withdrawn deeply into the shell to avoid unfavourable conditions. It is also more difficult to seal off the large aperture effectively against loss of moisture. By comparison the shell aperture in relation to the spiral is much smaller in *L. truncatula*, which is placed third on the list of African freshwater snails in terms of its ability to survive desiccation.

The conclusion from the results of life-table studies that temperature is relatively unimportant in governing the geographical distribution of this species, is borne out by its current distribution in South Africa, which shows that it was recovered from some of the warmest, as well as some of the coldest regions in the country. It therefore appears as if the availability of perennial water would be one of the most important determining factors for the occurrence of this species in a specific habitat. It was, however, established in life-table studies that the salinity of the water, at levels deviating from natural conditions, could also be a limiting factor, both when too high or too low, for the occurrence of various freshwater snail species in a given habitat. This is in agreement with the finding that only 2.5% of the samples of *L. natalensis* in the NFSC were recovered from habitats of which the water was described as brackish.

Large impounding reservoirs with their irrigation networks contribute largely towards the establishment of aquatic habitats of a more perennial nature in their catchment areas. The creation of additional potential habitats for *L. natalensis,* which acts as intermediate host for the liver fluke, *F. gigantica*, has economic implications especially in areas utilised for commercial farming with livestock. Although liver fluke infections in humans are rare, a number of cases where school children have been infected was reported in KwaZulu-Natal. The planning and construction of reservoirs and irrigation schemes should therefore be done with circumspection in order to prevent exacerbation of the current threat posed by the liver fluke to the health of people and their domestic animals in South Africa. Efforts are underway, particularly in Zimbabwe, to make irrigation systems unfavourable for the establishment of snail populations, by modifications in design and operation.

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