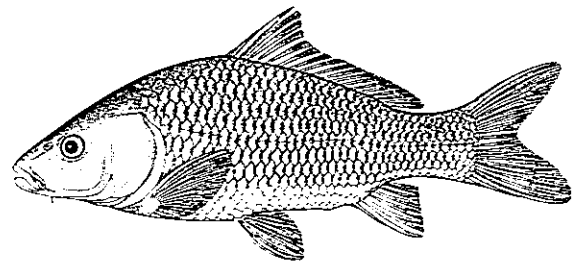


Alien and translocated aquatic animals in southern Africa : a general introduction, checklist and bibliography

M N Bruton and S V Merron

A report of the Committee for
Nature Conservation Research
National Programme for
Ecosystem Research



SOUTH AFRICAN NATIONAL SCIENTIFIC PROGRAMMES REPORT NO

113
1985

Issued by
Foundation for Research Development
Council for Scientific and Industrial Research
P O Box 395
PRETORIA
0001

from whom copies of reports in this series are available on request.

Printed in the Republic of South Africa
by N K B, Port Elizabeth

ISBN 0 7988 3672 5

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PREFACE

This bibliography on alien and translocated aquatic animals in southern Africa is part of a national research programme on the ecology of biological invasions. The programme is administered by the Nature Conservation Research Section of the National Programme for Ecosystem Research of the CSIR, and forms part of an international project undertaken by SCOPE (Scientific Committee on Problems of the Environment). A description of South Africa's participation in the SCOPE project has been published as number 72 in this series.

The need for a bibliography of research and records of alien and translocated aquatic animals in southern Africa was recognized at the meeting of the Working Group for Invasive Biota in May 1983. The compilation of the bibliography was made possible by funding from the National Programme for Ecosystem Research.

The Invasive Biota programme is intended to relate primarily to nature conservation problems, and to limit its relevance to invasions of natural and semi-natural habitats. The introduction of aquatic animals into entirely artificial environments eg fish culture ponds, ornamental ponds or aquaria, has not been considered unless these translocations are implicated in the wider distribution of the invasive species in natural habitats. Small and large impoundments are regarded as semi-natural habitats which are part of the permanent landscape, and invasions of these environments are therefore considered here.

ACKNOWLEDGEMENTS

We are particularly grateful to Irene de Moor, Dr P H Skelton, I A W Macdonald, Dr O Bourquin, Dr C C Appleton, Professor J G van As and P B N Jackson for assistance with the species lists.

We also thank the following for their assistance with the compilation of the bibliography:

Dr C C Appleton (University of Natal, Pietermaritzburg)
Dr P Ashton (National Institute for Water Research, CSIR, Pretoria)
Dr O Bourquin (Natal Parks, Game and Fish Preservation Board, Pietermaritzburg)
Mr D G Broadley (National Museum, Bulawayo, Zimbabwe)
Mr R K Brooke (Percy Fitzpatrick Institute of African Ornithology, University of Cape Town)
Mr J A Cambray (Albany Museum, Grahamstown)
Mrs M Crampton (J L B Smith Institute of Ichthyology, Grahamstown)
Mr R S Crass (Pietermaritzburg)
Dr J Day (University of Cape Town)
Dr G de Graaff (National Parks Board, Pretoria)
Dr F de Moor (Albany Museum, Grahamstown)
Mrs I de Moor (J L B Smith Institute of Ichthyology, Grahamstown)
Mr A A Ferrar (Foundation for Research Development, CSIR, Pretoria)
Professor I G Gaigher (University of Venda, Sibasa)
Captain S K B Godschalk (S A Defence Force, Pretoria)
Dr H J Goldner (National Zoological Gardens, Pretoria)
Dr K C D Hamman (Cape Department of Nature and Environmental Conservation, Stellenbosch)
Dr T Hecht (Department of Ichthyology and Fisheries Science, Rhodes University, Grahamstown)
Dr C H Hocutt (University of Maryland, Maryland, USA)
Mr B J Huntley (Foundation for Research Development, CSIR)
Mr P B N Jackson (J L B Smith Institute of Ichthyology, Grahamstown)
Dr R A Jubb (Port Alfred)
Dr C J Kleynhans (Transvaal Nature Conservation Division, Pretoria)
Dr R Kluge (Plant Protection Institute, Stellenbosch)
Dr F J Kruger (South African Forestry Research Institute, Pretoria)
Mr P le Roux (Division of Nature Conservation, Orange Free State, Bloemfontein)
Mr I A W Macdonald (Percy Fitzpatrick Institute of African Ornithology, University of Cape Town)
Mrs S Muller (East London Museum)
Mr R Newbery (Transvaal Nature Conservation Division, Pretoria)
Professor J F Prinsloo (University of the Transkei, Umtata)
Dr U de V Pienaar (Kruger National Park, Skukuza)
Mr T Pike (Natal Parks, Game and Fish Preservation Board, Pietermaritzburg)
Dr J C Sinclair (Durban Museum, Durban)
Dr C J Skead (Grahamstown)
Dr P H Skelton (J L B Smith Institute of Ichthyology, Grahamstown)
Professor J G van As (Rand Afrikaans University, Johannesburg)
Dr B C W van der Waal (University of Venda, Sibasa)

We are also grateful to Morny Andersen who processed the document and provided considerable editorial assistance.

ABSTRACT

A list of references to research and records of alien and translocated aquatic animals in southern Africa is given, as well as a general introduction to the problem of invasive aquatic animals. Reference is made to 587 publications. The genera of invasive species are listed as keywords, and a keyword index is provided.

At least 93 species of alien and translocated indigenous aquatic animals have established populations in southern Africa. Fishes, which constitute the majority (68.8%) of the invasive species, may have several deleterious effects on aquatic communities, including habitat alterations, removal of vegetation, reduction of water quality, introduction of parasites and diseases, trophic alterations (eg competition and predation), hybridization, extinction of endemic species and overcrowding. In some cases the introduction of alien fishes may have beneficial effects, as in the establishment of recreational and commercial fisheries and the culture of fishes for food or for the aquarium trade.

All major southern African river systems are inhabited by alien animal species, especially fishes, and the intricate network of intercatchment irrigation canals, pipes and tunnels will further facilitate their transfer. There is therefore an urgent need to assess the impact of invasive animals and to control those populations which are causing damage. There are fewer known invasive animals in the seas surrounding southern Africa (4 species), but this aspect has received little attention and more invasive species may be found in future.

SAMEVATTING

'n Lys van navorsingsverwysings en verslae van uitheemse en verplaaste akwatiese diere in suidelike Afrika word weergegee, asook 'n algemene inleiding tot die probleem van akwatiese indringerdiere. Daar word verwys na 587 publikasies. 'n Lys van sleutelwoorde en 'n sleutelwoordopgawe word voorsien.

Daar is gevestigde bevolkings van ten minste 93 spesies uitheemse en verplaaste inheemse akwatiese diere in suidelike Afrika. Visse, wat die meerderheid (68.8%) indringerspesies verteenwoordig, kan verskeie skadelike gevolge op akwatiese gemeenskappe hê. Dit sluit in habitatveranderings, verwydering van plante, verlaging van waterkwaliteit, hibridisering, uitwissing van endemiese spesies, oorbevolking, trofiese veranderings (bv kompetisie en predasie) en die verspreiding van siektes en parasiete. In sommige gevalle kan die verspreiding van uitheemse visse 'n voordelige uitwerking hê, soos met die daarstelling van ontspannings en kommersiële visbedrywe, asook met die kweek van visse as voedsel, of in die akwariumbedryf.

Alle groot suidelike Afrikaanse rivierstelsels word bewoon deur uitheemse spesies, veral visse, en die ingewikkelde netwerk van besproeiingskanale, pype en tunnels tussen opvanggebiede, sal hulle verplasing vergemaklik. Daar bestaan derhalwe 'n dringende behoefte om die uitwerking van indringerdiere te bepaal en om die bevolkings wat skade aanrig, te beheer. Daar is minder bekende indringerdiere in die see wat suidelike Afrika omring (4 spesies), maar hierdie aspek het min aandag ontvang en meer indringerspesies mag in die toekoms gevind word.

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NOTES ON THE DESIGN OF THE BIBLIOGRAPHY

This bibliography is selective in that publications are included only if they provide information on the biology, distribution, introduction and/or impact of alien or translocated aquatic animals in South Africa and South West Africa/Namibia. The quality of the record is important and not the medium of publication. References are therefore given to international scientific journals and books as well as to magazines and newspaper articles when relevant. As many alien fishes were introduced or indigenous fishes translocated for angling purposes, many angling publications are included as they provide valuable information on the distribution of aquatic invasives. References in the angling, aquarist or aquaculture literature which do not give new information on the biology, distribution or impact of invasive animals are not included. Although the Working Group for Invasive Biota is mainly concerned with alien invasive species, we have included references to translocated indigenous species as well, as many of them pose the same threat to invaded habitats as alien invasives. The bibliography includes references to species which established wild populations for a short time and subsequently became locally extinct or have not as yet established populations in the wild as they have been confined to ponds. Certain genera are therefore mentioned as keywords but do not appear in the checklist of invasive animals (Table 1). A full classification of all invasive species is given in Table 1 as the taxonomic relationships of these species are often difficult to determine. In general, references to the taxonomy of invasive aquatic animals are excluded. Although this report deals mainly with freshwater invasive animals, certain marine invasives have been included (eg Bedeva paivae, Carcinus maenas, Mytilus galloprovincialis, Thais haemostoma).

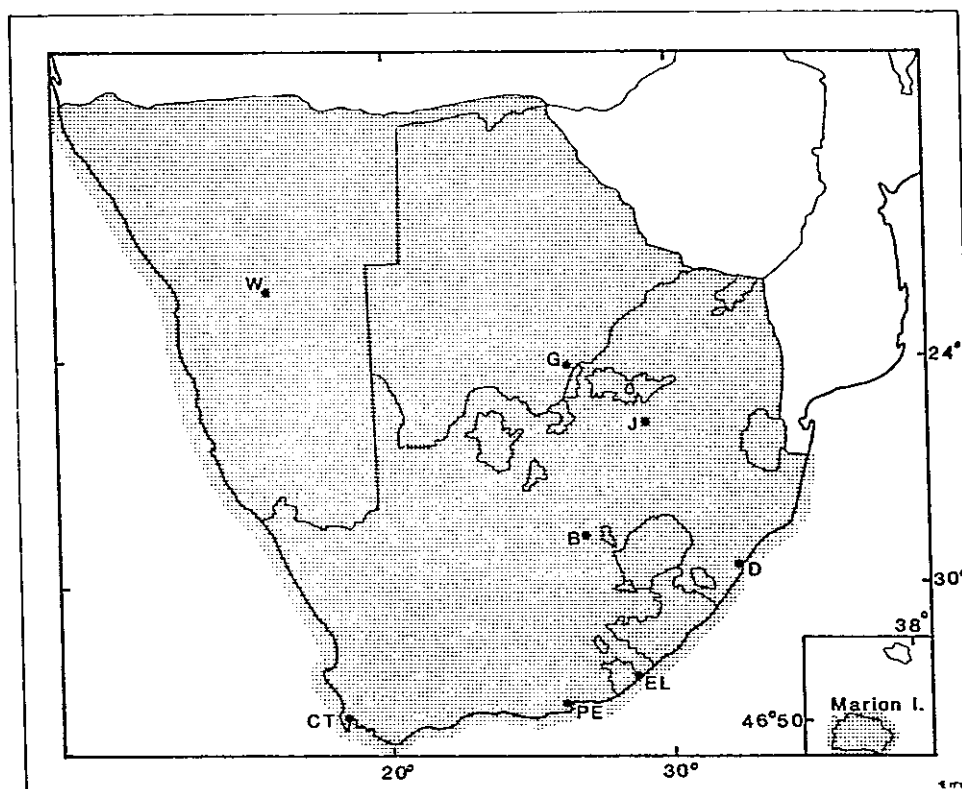


Figure 1: Map of southern Africa and the Prince Edward Islands showing the geographic area covered by this report (shaded).

Published reports by provincial and national conservation bodies are included if they are generally accessible, but unpublished internal reports are omitted unless they contain valuable information, in which case copies have been lodged in the library of the JLB Smith Institute of Ichthyology, Grahamstown, whenever possible.

The bibliography includes all publications which we have been able to trace which were published before June 1985. Readers are requested to bring additional literature to our attention.

The geographical area covered in this report includes South Africa and the recently independent Black states, as well as South West Africa/Namibia, Botswana, Swaziland and Lesotho, but not Zimbabwe or Mozambique (see Figure 1).

The references in the bibliography are listed alphabetically by author and numbered separately within six sections: invertebrates, Osteichthyes, Amphibia, Reptilia, Aves and Mammalia. The generic names of invasive animals have been provided as keywords for all references, and are indexed by reference number. A reference may occur in more than one section.

DEFINITIONS

The definitions of terms used in this report are given below:

alien species - a species remote from its natural distribution, usually from a different continent or major water catchment northwards of the Cunene and Zambezi systems in the southern African context.

translocated indigenous species - a species naturally found within southern Africa but translocated either intentionally or unintentionally by man into catchments in which it was not naturally distributed.

invasive species - a species which has the ability to establish self-sustaining populations in natural or semi-natural communities, and to cause an ecological imbalance there. Invasives may be alien or translocated indigenous species.

endemic species - a species that is restricted in its distribution to a particular lake, drainage system or biogeographical region.

indigenous species - a native species which is not (as compared to an endemic) necessarily restricted in its distribution to a particular lake, drainage system or biogeographic region.
A species which naturally occurs in southern Africa as well as in other parts of Africa is therefore indigenous to southern Africa but not endemic.

established species - a reproductively successful species.

The above definitions were derived after consideration of the various proposals made by Ferrar and Kruger (1983), Courtenay and Stauffer (1984), Laurenson (1984), Shafland and Lewis (1984) and Hocutt (1985).

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INTRODUCTION

The first record of an alien aquatic animal in South Africa was provided by Valentyn in 1726 : 'In the Governor's house I saw Japanese gold-fish and silverfish in a tank or cistern, which thrived very well there. There is also yet another kind of gold-fish and silverfish, being a sort of lovely bream, as also carp...' (Raidt, 1971). Borchers (1861) recorded the presence of carp in the Eerste River in the western Cape in the early nineteenth century, well before the generally accepted date of introduction (1896). Brown trout and rainbow trout, as well as several other European fish (and bird) species, were introduced into the Cape in the late nineteenth century, and during the twentieth century many additional introductions and translocations were made, mainly for recreational fishing but also for fish culture, mosquito control and through the aquarium trade. Recently there has been an increasing awareness that southern Africa has a rich and valuable aquatic biota, and attempts have been made to curb the importation and distribution of alien aquatic animals. The threat which invasive aquatic animals pose is, however, poorly defined. No comprehensive checklist of invasive aquatic animals has been produced, and little is known about their distribution or impact on indigenous species or communities. A survey was therefore initiated to produce a bibliography on invasive aquatic animals (this project), and a synthesis of current knowledge on the distribution, biology and impact of these species (in preparation).

The survey has revealed that at least 93 established aquatic animal species have been introduced into or translocated within southern Africa, of which 44 are alien species and 49 are translocated indigenous species (Tables 1 and 2). Some important invasive species are illustrated in Figures 2 and 3.

Aquatic animals have been introduced into or translocated within southern Africa for a number of reasons (Table 3), including accidental invasions (fish parasites, free-living crustaceans, snails, fishes), aquaculture (crustaceans, fishes, frogs, crocodiles, a mammal), sport fishing (fishes), hunting (birds), restocking of natural and artificial water bodies (fishes), biological control of nuisance plants and animals (fishes and insects), decoration of ornamental ponds (fishes, birds, reptiles) and through the aquarium trade (fish parasites, snails, crustaceans, fishes, a reptile).

Other aquatic invasives

Besides the established invasive species mentioned above, there are other groups of aquatic invasives which should be considered as they may provide valuable information on the ecology of biological invasions. Six species of alien fish species were previously introduced into southern Africa but have since died out locally (Table 4). A further 10 invasive species are suspected to inhabit southern African inland waters (Table 5) but their presence needs to be confirmed. Eleven suspected alien aquatic species occur in the subcontinent but their status as aliens needs to be confirmed (Table 6). Finally, 19 alien aquatic species which occur in captivity in southern Africa are regarded as a potential threat to indigenous species or ecosystems in the event of their escape (Table 7).

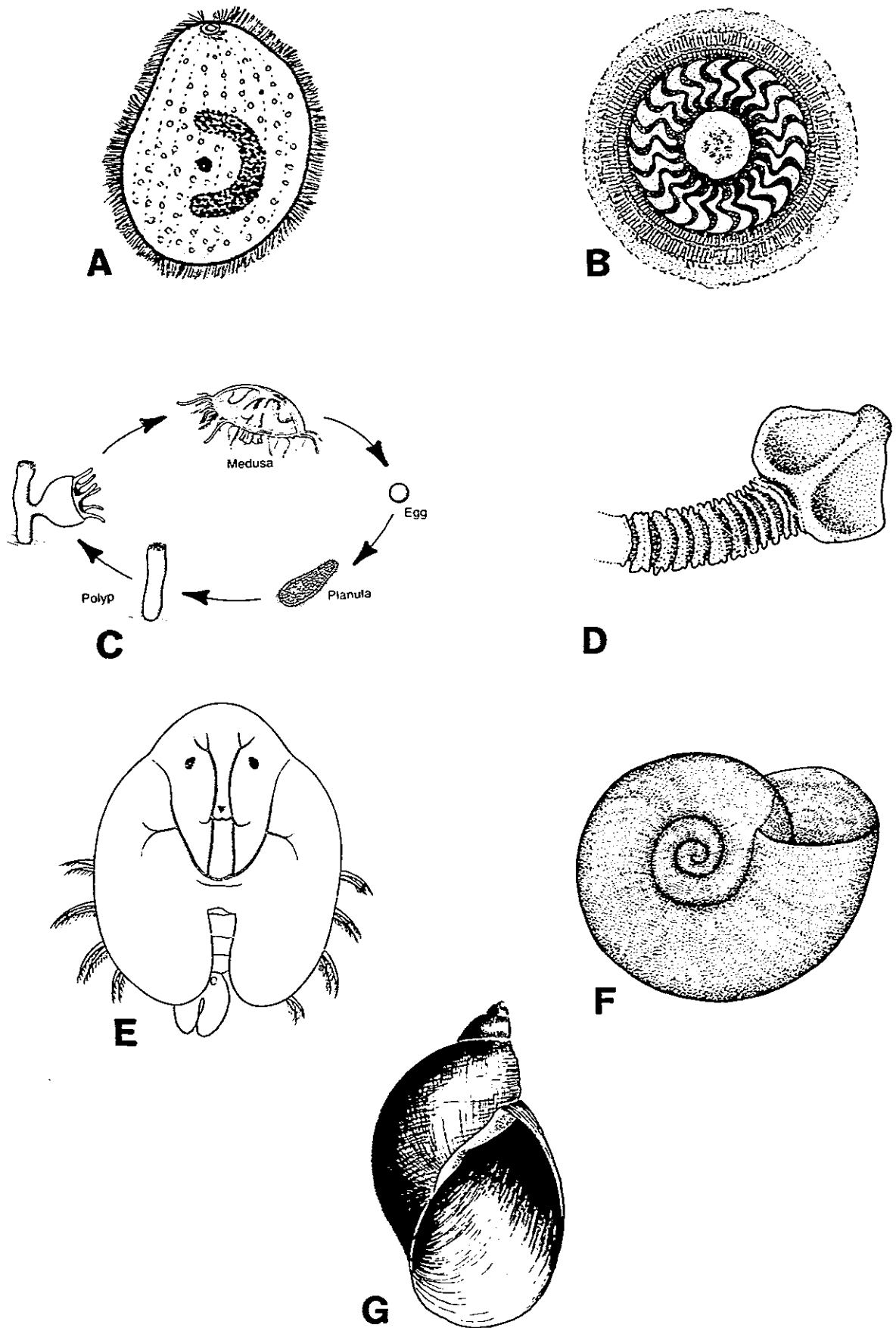


Figure 2: Representative invasive aquatic invertebrates in southern Africa.
A. Ichthyophthirius multifiliis; B. Trichodina acuta;
C. Craspedacusta sowerbyi; D. Bothriocephalus acheilognathi;
E. Argulus japonicus; F. Biomphalaria sp.; G. Lymnaea columella.

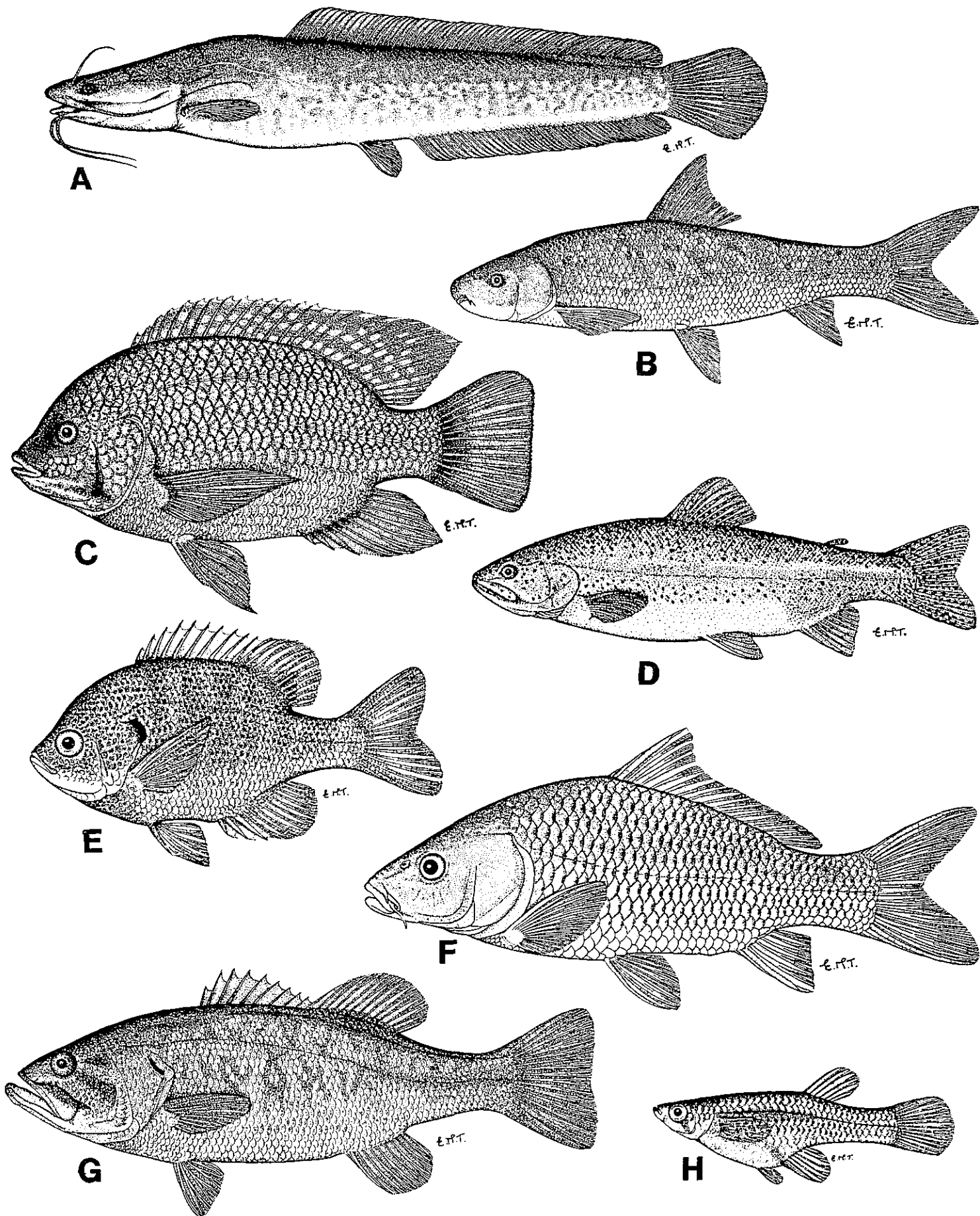


Figure 3: Representative invasive fish species in southern Africa.
A. Clarias gariepinus; B. Labeo umbratus; C. Oreochromis macrochirus;
D. Salmo gairdneri; E. Lepomis macrochirus; F. Cyprinus carpio;
G. Micropterus salmoides; H. Gambusia affinis.
Illustrations by E M Tarr.

Impact of aquatic invasives

Of the 20 alien fish species which have established populations in southern Africa, four are regarded internationally as pests ie they are known to cause damage to natural communities, and twelve are regarded as nuisance animals under certain circumstances ie their disadvantages may partly outweigh their advantages (Table 8). The rainbow trout Salmo gairdneri is an example of an invasive species which may be both beneficial and detrimental. The rainbow trout is extensively cultured in southern Africa and is also of considerable value as a sport fish, yet this species has also been implicated in the local extinction of rare and endangered minnows and knerias. A reptile (Chrysemys scripta) introduced through the aquarium trade has been responsible for Salmonella infections in human beings and is internationally regarded as a pest (Ernst and Barbour, 1972; Newbery, 1984). Several of the alien fish parasites, especially Argulus japonicus, Bothriocephalus acheilognathi and Ichthyophthirius multifiliis, have been associated with outbreaks of diseases in fish in aquaculture systems or aquaria in southern Africa (Paperna, 1980; J van As, pers comm, 1985).

Very little is known about the harmful effects of invasive aquatic animals in southern Africa, although trout and bass have been implicated in the reduction or local extinction of populations of Oreodaimon quathlambae, Barbus burchelli, B. burgi, B. callidus, B. phlegathon, B. tenuis, B. treurensis, B. trevelyani and Kneria auriculata in southern Africa (Jubb, 1972; Gaigher et al, 1980; Skelton, 1977, 1983; Kleynhans, 1982, 1984; Cambray and Stewart, 1985).

Studies in the USA and elsewhere have revealed the following harmful effects of invasive fishes (Taylor et al, 1984):

- I. Habitat alterations
 - A. Removal of vegetation
 1. by consumption
 2. by uprooting
 3. by increasing turbidity (which reduces light penetration and hence photosynthesis)
 - B. Degradation of water quality
 1. by siltation
 2. by substrate erosion
 3. by eutrophication
- II. Introduction of parasites and diseases
- III. Trophic alterations
 - A. Forage supplementation
 - B. Competition for food
 - C. Predation (which may lead to reduced numbers or local extinction of prey)
- IV. Hybridization (which may reduce the fitness of indigenous stocks)
- V. Spatial alterations
 - A. Aggressive effects
 - B. Overcrowding

Of the above effects, the most damaging in the long term may be genetic pollution as a result of hybridization (Bruton and Safrieli, 1985).

Discussion

The introduction and translocation of aquatic animals is a powerful tool for the managers of aquatic ecosystems, but must be employed with extreme caution. Alien fishes offer the opportunity to provide new food and sport fishing species, to control pests, and to help reverse environmental mismanagement, as in the control of problem plants. However, the ease of introduction and the apparent lack of fixed culpability have often led to abuse of the practice, often with disastrous results. Whereas man can control chemical pollution and can, to a certain extent, undo physical damage to the aquatic environment, it is usually impossible or impractical to remove an alien species once it has established breeding populations.

There are many examples around the world of alien or translocated animals, both aquatic and terrestrial, which have caused irreparable damage to natural communities and habitats. In Africa, one of the most disastrous introductions has been that of the Nile perch Lates niloticus into Lake Victoria, where it has decimated the haplochromine species, which were once the basis of a lucrative fishery (Barel et al, 1985). The damages and costs caused by the introduction of an undesirable species may mount to astronomical figures after a few years, and may alter patterns of utilization of water bodies by man and the socio-economic structure of adjacent human communities.

It is important, therefore, that the introduction or translocation of alien and indigenous aquatic animals must be regarded in a serious light, and the advantages and disadvantages of each case should be evaluated carefully through experimental and field research. Criteria must be developed for the assessment of the potential impact of an introduced organism, and a protocol must be laid down for assessing each species. These decisions must be based on a thorough scientific knowledge of the species or group involved, or, if the taxon is poorly studied, on the known life history characteristics of closely related forms. Whenever uncertainty exists, the taxon concerned should not be introduced until it has been evaluated. It is also important to determine whether an indigenous species could perform the same economical or recreational function as the introduced form before the introduction is made eg for aquaculture or sport fishing.

It is hoped that this bibliography and the accompanying checklists will help to stimulate an interest in the problems of alien and translocated indigenous aquatic animals in southern Africa, and to encourage research on their natural history and ecological impact.

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TABLE 1

Checklist of alien and translocated aquatic animals in southern African inland waters (A = alien, T = translocated indigenous species)

Ciliophora

- Class: Oligohymenophorea
 - Order: Hymenostomatida
 - Family: Ichthyophthiriidae
 - Ichthyophthirius multifiliis Fouquet, 1876 (A)
 - Suborder: Mobilina
 - Family: Trichodinidae
 - Trichodina acuta Lom, 1961 (A)

Cnidaria

- Class: Hydrozoa
 - Order: Hydroida
 - Suborder: Limnomedusae
 - Craspedacusta sowerbyi Lankester, 1880 (A)

Platyhelminthes

- Class: Cestoda
 - Order: Pseudophyllidea
 - Family: Bothriocephalidae
 - Bothriocephalus acheilognathi (= gowkongensis) Yamaguthi, 1934 (A)

Arthropoda

- Class: Crustacea
 - Order: Branchiura
 - Family: Argulidae
 - Argulus japonicus Thiele, 1900 (A)
 - Order: Malacostraca
 - Family: Portunidae
 - Carcinus maenas (A) (marine)
- Class: Insecta
 - Order: Orthoptera
 - Family: Acrididae
 - Paulinia acuminata de Geer (A)

Order: Coleoptera

Family: Curculionidae

Cyrtobagous salviniae (Caulder & Sands, 1985) (A)

Cyrtobagous singularis (Hustache, 1929) (A)

Neochetina eichhorniae Warner, 1970 (A)

Mollusca

Class: Gastropoda

Order: Neogastropoda

Family: Muricidae

Thais haemostoma Linnaeus, 1758 (A) (marine)

Bedevea paivae Crosse, 1864 (A) (marine)

Order: Basommatophora

Family: Physidae

Physa acuta Draparnaud, 1805 (A)

Family: Planorbidae

Biomphalaria sp. (A)

Helisoma duryi Weatherby, 1879 (A)

Family: Lymnaeidae

Lymnaea columella Say, 1817 (A)

Class: Bivalvia

Family: Mytilidae

Mytilus galloprovincialis (A) (marine)

Chordata

Subphylum: Vertebrata

Class: Osteichthyes

Order: Dipnoi

Family: Lepidosirenidae

Protopterus annectens brieri Poll, 1961 (T)

Order: Mormyriiformes

Family: Mormyridae

Marcusenius macrolepidotus (Peters, 1852) (T)

Petrocephalus catostoma (Günther, 1866) (T)

Order: Salmoniformes

Family: Salmonidae

Salmo gairdneri Richardson, 1836 (A)

Salmo salar Linnaeus, 1758 (A)

Salmo trutta Linnaeus, 1758 (A)

Salvelinus fontinalis (Mitchell, 1815) (A)

Order: Gonorhynchiiformes

Family: Kneriidae

Kneria auriculata (Pellegrin, 1905) (T)

Order: Characiformes

Family: Characidae

Alestes lateralis Boulenger, 1900 (T)

Hydrocynus vittatus Castelnau, 1861 (T)
Rhabdalestes maunensis (Fowler, 1935) (T)
Family: Citharinidae
Hemigrammocharax machadoi Poll, 1967 (T)

Order: Cypriniformes

Family: Cyprinidae

Barbus aeneus (Burchell, 1822) (T)
Barbus anoplus Weber, 1897 (T)
Barbus barnardi Jubb, 1965 (T)
Barbus bifrenatus Fowler, 1935 (T)
Barbus eutaenia Boulenger, 1904 (T)
Barbus gurneyi Günther, 1868 (T)
Barbus mattozi Guimaraes, 1884 (T)
Barbus natalensis Castelnau, 1861 (T)
Barbus tangandensis Jubb, 1954 (T)
Carassius auratus (Linnaeus, 1758) (A)
Carassius carassius Linnaeus, 1758 (A)
Coptostomabarbus wittei David & Poll, 1937 (T)
Cyprinus carpio Linnaeus, 1758 (A)
Labeo capensis (Smith, 1841) (T)
Labeo cylindricus Peters, 1852 (T)
Labeo umbratus (Smith, 1841) (T)
Mesobola brevianalis (Boulenger, 1908) (T)
Tinca tinca Linnaeus, 1758 (A)

Order: Siluriformes

Family: Bagridae

Austroglanis sclateri (Boulenger, 1901) (T)

Family: Clariidae

Clarias gariepinus (Burchell, 1822) (T)

Family: Schilbeidae

Eutropius depressirostris (Peters, 1852) (T)

Family: Mochokidae

Synodontis leopardinus Pellegrin, 1914 (T)

Synodontis macrostigma Boulenger, 1911 (T)

Synodontis woosnami Boulenger, 1911 (T)

Order: Cyprinodontiformes

Family: Aplocheilidae

Nothobranchius orthonotus (Peters, 1844) (T)

Family: Poeciliidae

Gambusia affinis (Baird & Girard, 1854) (A)

Poecilia reticulata (= Lebistes reticulatus) Peters, 1859 (A)

Xiphophorus helleri Heckel, 1840 (A)

Order: Perciformes

Family: Centrarchidae

Lepomis cyanellus Rafinesque, 1819 (A)

Lepomis macrochirus Rafinesque, 1819 (A)

Micropterus dolomieu Lacépède, 1802 (A)

Micropterus punctulatus (Rafinesque, 1819) (A)

Micropterus salmoides (Lacépède, 1802) (A)

Family: Percidae

Perca fluviatilis Linnaeus, 1758 (A)

Family: Cichlidae

Oreochromis andersonii (Castelnau, 1861) (T)

Oreochromis macrochir (Boulenger, 1912) (T)

Oreochromis mossambicus (Peters, 1852) (T)
Pharyngochromis darlingi (Boulenger, 1911) (T)
Pseudocrenilabrus philander (Weber, 1897) (T)
Serranochromis (Sargochromis) codringtoni (Boulenger, 1908) (T)
Serranochromis (Sargochromis) giardi (Pellegrin, 1903) (T)
Serranochromis (Sargochromis) cf steindachneri
(Boulenger, 1913) (A)
Serranochromis (Serranochromis) macrocephalus
(Boulenger, 1899) (T)
Serranochromis (Serranochromis) robustus jallae
(Boulenger, 1896) (T)
Serranochromis (Serranochromis) robustus robustus
(Günther, 1864) (A)
Serranochromis (Serranochromis) thumbergi (Castelnaud, 1861) (T)
Tilapia rendalli rendalli Boulenger, 1896 (A)
Tilapia rendalli swierstrae Gilchrist & Thompson, 1917 (T)
Tilapia sparrmanii Smith, 1840 (T)

Family: Mugilidae

Mugil cephalus Linnaeus, 1758 (T)

Myxus capensis (Valenciennes in C & V, 1836) (T)

Family: Anabantidae

Sandelia capensis (Cuvier in C & V, 1831) (T)

Class: Amphibia

Order: Anura

Family: Pipidae

Xenopus laevis (Daudin, 1802) (T)

Family: Microhylidae

Phrynomerus bifasciatus (Smith, 1847) (T)

Class: Reptilia

Order: Chelonia

Family: Testudinidae

Chrysemys scripta (= Pseudemys scripta) (Schoepff, 1792) (A)

Order: Crocodylia

Family: Crocodylidae

Crocodylus niloticus Laurentus, 1768 (T)

Class: Aves

Order: Anseriformes

Family: Anatidae

Anas platyrhynchos Linnaeus, 1758 (A)

Anas rubripes Brewster, 1902 (A)

Aythya fuligula Linnaeus, 1758 (T)

Cairina moschata Linnaeus, 1758 (A)

Cygnus atratus Latham, 1790 (T)

Cygnus olor (Gmelin, 1789) (A)

Tadorna tadorna Linnaeus, 1758 (A)

Class: Mammalia

Order: Rodentia

Family: Capromyidae

Myocastor coypus Molina (A)

TABLE 2

Summary of the number of alien and translocated indigenous aquatic species in southern Africa.

<u>Taxonomic category</u>	<u>Common name</u>	<u>Alien species</u>	<u>Translocated indigenous species</u>
Ciliophora	ciliates	2	0
Cnidaria	coelenterates	1	0
Platyhelminthes	flatworms	1	0
Arthropoda	arthropods	6	0
Mollusca	molluscs	7	0
Chordata			
Osteichthyes	bony fish	20	44
Amphibia	frogs and toads	0	2
Reptilia	reptiles	1	1
Aves	birds	5	2
Mammalia	mammals	<u>1</u>	<u>0</u>
	Total:	44	49

Grand total: 93

TABLE 3

Original reasons for the introduction and translocation of alien and indigenous aquatic animals which have established populations in natural or semi-natural waters in southern Africa (A = alien, T = translocated indigenous species, A? = species is thought to be an alien invasive but further taxonomic research may reveal that it is indigenous).

Common names are given where known.

INVERTEBRATA

Parasites of fishes and bivalves (accidental introductions)

Achtheres macropteri (A?)
Apiosoma piscicola (A?)
Argulus japonicus fish louse (A)
Bothriocephalus acheilognathi (= gowkongensis) Asian tapeworm (A)
Chilodonella cyprini (A?)
Chilodonella hexasticha (A?)
Ichthyobodo necator costia (A?)
Ichthyophthirius multifiliis white spot (A)
Lernaea cyprinacea (A?)
Polydora sp. bristleworm oyster drill (A?)
Trichodina acuta trichodina (A)
Trichodina nigra trichodina(A?)
Trichodinella epizootica trichodina (A?)
Urosalpinx sp. oyster drill (A?)

Free-living invertebrates (accidental introductions)

Bedeva paivae (A) (marine)
Biomphalaria sp. (A)
Carcinus maenas European shore crab (A) (marine)
Craspedacusta sowerbyi (A) freshwater medusa
Helisoma duryi (A)
Lymnaea columella (A)
Physa acuta (A)
Thais haemostoma (A) (marine)

Introduced for aquaculture

Mytilus galloprovincialis black-brown mussel (A)

Translocated as food for fish in culture

Daphnia magna giant daphnia (A?)

Biological control of Salvinia molesta and Eichhornia crassipes by insects

Cyrtobagous salviniae (A)
Cyrtobagous singularis (A)
Neochetina eichhorniae (A)
Paulinia acuminata (A)

CHORDATA

Osteichthyes

Fish culture

Clarias gariepinus sharptooth catfish (T)
Cyprinus carpio common carp (A)
Mugil cephalus grey mullet (T)
Myxus capensis freshwater mullet (T)
Oreochromis andersonii three-spot tilapia (T)
Oreochromis macrochir greenhead tilapia (T)
Oreochromis mossambicus Mozambique tilapia (T)
Salmo gairdneri rainbow trout (A)
Tilapia sparrmanii banded tilapia (T)

Sport fishing (including forage fish for bass)

Astatotilapia brevis orange-fringed largemouth (T)
Barbus aeneus smallmouth yellowfish (T)
Cyprinus carpio common carp (A)
Labeo umbratus moggel (T)
Lepomis cyanellus green sunfish (A) (forage fish)
Lepomis macrochirus bluegill sunfish (A) (forage fish)
Micropterus dolomieu smallmouth bass (A)
Micropterus punctulatus spotted bass (A)
Micropterus salmoides largemouth bass (A)
Mugil cephalus grey mullet (T)
Oreochromis macrochir greenhead tilapia (T)
Oreochromis mossambicus Mozambique tilapia (T)
Perca fluviatilis European perch (A)
Salmo gairdneri rainbow trout (A)
Salmo salar salmon (A)
Salmo trutta brown trout (A)
Salvelinus fontinalis brook trout (A)
Serranochromis codringtoni green happy (T)
Serranochromis robustus jallae nembwe (T)
Serranochromis robustus robustus sungwa (A)
Serranochromis thumbergi brownsport largemouth (T)
Tilapia rendalli rendalli northern red-breasted tilapia (A)
Tilapia rendalli swierstrae southern red-breasted tilapia (T)
Tilapia sparrmanii banded tilapia (T) (forage fish)
Tinca tinca European tench (A)

Translocated intentionally for various reasons (eg stocking man-made lakes, increasing the range of rare fishes)

Alestes imberi imberi (T)
Astatotilapia brevis orange-fringed largemouth (T)
Barbus aeneus smallmouth yellowfish (T)
Barbus anoplus chubbyhead barb (T)
Barbus gurneyi redtail barb (T)
Barbus marequensis largescale yellowfish (T)
Barbus natalensis scaly (T)
Barbus polylepis smallscale yellowfish (T)

Clarias gariepinus sharptooth catfish (T)
Cyprinus carpio common carp (A)
Kneria auriculata southern kneria (T)
Labeo rosae rednose labeo (T)
Labeo rubropunctatus redspotted labeo (T)
Oreochromis macrochir greenhead tilapia (T)
Oreochromis mossambicus Mozambique tilapia (T)
Sandelia capensis Cape kurper (T)
Serranochromis codringtoni green happy (T)
Serranochromis meridianus lowveld largemouth (T)
Serranochromis robustus jallae nembwe (T)
Serranochromis thumbergi brownspot largemouth (T)
Tilapia rendalli swierstrae southern red-breasted tilapia (T)
Tilapia sparrmanii banded tilapia (T)

Translocated unintentionally via intercatchment connections

Alestes lateralis striped robber (T)
Austroglanis sclateri rock catfish (T)
Barbus aeneus smallmouth yellowfish (T)
Barbus anoplus chubbyhead barb (T)
Barbus barnardi blackback barb (T)
Barbus bifrenatus hyphen barb (T)
Barbus eutaenia orangefin barb (T)
Barbus mattozi papermouth (T)
Barbus tangandensis redspot barb (T)
Clarias gariepinus sharptooth catfish (T)
Coptostomabarbus wittei upjaw barb (T)
Hemigrammocharax machadoi dwarf citharine (T)
Labeo capensis Orange River labeo (T)
Labeo cylindricus redeye labeo (T)
Labeo umbratus moggel (T)
Marcusenius macrolepidotus bulldog (T)
Mesobola brevianalis river sardine (T)
Petrocephalus catostoma Churchill (T)
Pharyngochromis darlingi Zambezi happy (T)
Rhabdalestes maunensis Okavango robber (T)
Serranochromis giardi pink happy (T)
Serranochromis macrocephalus purpleface largemouth (T)
Serranochromis cf steindachneri Cunene happy (T)
Serranochromis thumbergi brownspot largemouth (T)
Synodontis leopardinus leopard squeaker (T)
Synodontis macrostigma large-spot squeaker (T)
Synodontis woosnami Upper Zambezi squeaker (T)
Tilapia rendalli swierstrae southern red-breasted tilapia (T)
Tilapia sparrmanii banded tilapia (T)

Introduced or translocated through the aquarium trade

Nothobranchius orthonotus spotted killifish (T)
Carassius auratus goldfish (A)
Carassius carassius Crucian carp (A)
Poecilia reticulata guppy (A)
Xiphophorus helleri swordtail (A)

Biological control of nuisance plants and animals

Gambusia affinis mosquito fish (A)
Poecilia reticulata guppy (A)
Pseudocrenilabrus philander southern mouthbrooder (T)
Tilapia rendalli swierstrae southern red-breasted tilapia (T)
Tilapia sparrmanii banded tilapia (T)

Amphibia

Phrynomerus bifasciatus rubber banded frog (T) (accidental translocation associated with timber transport)
Xenopus laevis clawed toad (T) (translocation associated with fish culture)

Reptilia

Chrysemys scripta red-eared terrapin (A) (aquarium trade)
Crocodylus niloticus Nile crocodile (T) (aquaculture and stocking of farm dams)

Aves

Escapees from private collections

Anas platyrhynchos mallard duck (A)
Anas rubripes American black duck (A)
Aythya fuligula tufted duck (T)
Cairina moschata muscovy duck (A)
Cygnus atratus black swan (T)
Cygnus olor mute swan (A)
Tadorna tadorna European shelduck (A)

Mammalia (fur trade)

Myocastor coypus South American water rat, nutria or coypu (A)

TABLE 4

Alien aquatic animals which have died out locally since their
introduction into southern Africa

Chordata

Subphylum: Vertebrata

Class: Osteichthyes

Order: Salmoniformes

Family: Esocidae

Esox lucius Linnaeus, 1758. northern pike

Order: Cypriniformes

Family: Cyprinidae

Idus idus Linnaeus, 1758. ide

Leuciscus leuciscus Linnaeus, 1758. dace

Rutilus rutilus Linnaeus, 1758. roach

Scardinius erythrophthalmus Linnaeus, 1758. rudd

Order: Perciformes

Family: Percichthyidae

Morone saxatilis (Walbaum in Artedi, 1792). striped bass

TABLE 5

Alien aquatic animals whose presence in southern African natural and semi-natural waters is suspected but requires proper confirmation

Platyhelminthes

Class: Trematoda
Order: Monogenea
Family: Dactylogyridae
Dactylogyrus sp.
Pseudacolpenteron sp.

Arthropoda

Class: Crustacea
Order: Ostracoda
Family: Cypridae
Cypris latissima Muller, 1898
Hemicypris sp.
Stenocypris sp.

Chordata

Subphylum: Vertebrata
Class: Osteichthyes
Order: Cyprinodontiformes
Family: Poeciliidae
Phalloceros caudomaculatus (Hensell, 1868)

In addition, there are unconfirmed reports of four indigenous fish species being translocated beyond their natural range, and establishing populations there:

Family: Anguillidae
Anguilla mossambica Peters, 1852. longfin eel
Family: Cyprinidae
Labeo ruddi Boulenger, 1907. silver labeo
Family: Lutjanidae
Lutjanus argentimaculatus (Forsskal, 1775). river snapper
(marine)
Family: Cichlidae
Serranochromis (Sargochromis) mellandi (Boulenger, 1905). mbilia

TABLE 6

Aquatic animals whose presence in southern African natural or semi-natural waters is confirmed but whose status as alien or indigenous animals requires confirmation

Sarcomastigophora

Class: Zoomastigophorea
Order: Kinetoplastida
Family: Tetramitidae
Ichthyobodo necator Henneguy, 1883. costia

Ciliophora

Class: Kinetofragminophorea
Order: Cyrtophorida
Family: Chilodonellidae
Chilodonella cyprini Moroff, 1902
Chilodonella hexasticha Kiernik, 1909

Class: Oligohymenophorea
Order: Peritrichida
Family: Epistylididae
Apiosoma piscicola Blanchard, 1885
Family: Trichodinidae
Trichodina nigra Lom, 1960. trichodina
Trichodinella epizootica (Raabe, 1950). trichodina

Annelida

Class: Polychaeta
Family: Spionidae
Polydora sp. bristleworm oyster drill.

Arthropoda

Class: Crustacea
Order: Branchiopoda
Family: Daphnidae
Daphnia magna Straus, 1820. giant daphnia
Order: Copepoda
Family: Lernaeidae
Lernaea cyprinacea Linnaeus, 1758
Family: Lernaeopodidae
Achtheres macropteri Wright, 1882

Mollusca

Class: Gastropoda
Order: Neogastropoda
Family: Muricidae
Urosalpinx sp. oyster drill.

TABLE 7

Alien aquatic organisms currently in captivity in southern Africa
which have the potential to cause problems if they escape and
establish populations in natural or semi-natural waters

Myxozoa

Class: Myxosporea
Order: Bivalvulida
Family: Myxosporidae
Myxosoma cerebralis whirling disease.

Arthropoda

Class: Crustacea
Order: Malacostraca
Family: Astacidae
Astacus sp. European crayfish
Pacifastacus leniusculus (Dana). signal crayfish
Family: Cambaridae
Procambarus clarkii (Girard). red swamp crayfish
Family: Palaemonidae
Macrobrachium rosenbergii de Man. giant freshwater prawn
Family: Parastacidae
Cherax tenuimanus Smith. marron

Mollusca

Class: Gastropoda
Order: Mesogastropoda
Family: Ampullariidae
Pila wernei (Philippi, 1851)

Chordata

Subphylum: Vertebrata
Class: Osteichthys
Order: Characiformes
Family: Characidae
Serrasalmus nattereri Knew, 1859. Natterer's piranha

Order: Cypriniformes
Family: Cyprinidae
Aristichthys nobilis (Richardson, 1844). bighead carp
Ctenopharyngodon idellus Valenciennes, 1844. grass carp
Hypophthalmichthys molitrix Cuvier & Valenciennes, 1844.
silver carp
Mylopharyngodon piceus Richardson, 1844. black carp

Order: Siluriformes
Family: Clariidae
Clarias batrachus (Linnaeus, 1758). walking catfish

Family: Ictaluridae

Ictalurus punctatus (Rafinesque, 1818). channel catfish

Order: Perciformes

Family: Cichlidae

Oreochromis aureus (Steindachner, 1869). Israeli tilapia

Oreochromis niloticus (Linnaeus, 1758). Nile tilapia

Oreochromis spilurus niger Günther, 1894

Sarotherodon galilaeus Artedi, 1757. Galilee St Peter's fish

Tilapia zillii (Gervais, 1848). Jordan St Peter's fish

In addition, several freshwater fishes which are imported into southern Africa from the subtropics and tropics of America, Africa and Asia for the aquarium trade may establish populations in the wild and become a threat, eg certain gouramies (Anabantidae), live-bearers, swordtails (Poeciliidae), cichlids (Cichlidae), catfish (various families) and barbs (Cyprinidae).

Various hybrid tilapias, such as the red tilapia (Oreochromis niloticus X O. mossambicus) have been introduced into southern Africa and pose a threat to indigenous fish stocks. The four Chinese carp species produce pelagic eggs and only breed in very large rivers. It is unlikely that they will breed in the wild in southern Africa, but their long lifespan (10-15 years) means that even non-breeding fishes could have a significant ecological impact.

TABLE 8

Established invasive aquatic animals in southern Africa (excluding parasites) which are internationally regarded as pests or nuisance animals. A = alien, T = translocated indigenous species (Paperna, 1980; Newbery, 1984; Taylor et al, 1984; O Bourquin and W R Courtenay, pers comm, 1985)

Pathogens

Pests

Original reason for introduction or translocation

<u>Chrysemys scripta</u> (A)	aquarium trade
<u>Oreochromis mossambicus</u> (T)	fish culture
<u>Poecilia reticulata</u> (A)	mosquito control
<u>Tilapia rendalli</u> (T)	weed control
<u>Xiphophorus helleri</u> (A)	aquarium trade

Nuisance animals

<u>Carassius auratus</u> (A)	aquarium trade
<u>Cyprinus carpio</u> (A)	fish culture
<u>Gambusia affinis</u> (A)	mosquito control
<u>Lepomis macrochirus</u> (A)	sport fishing
<u>Micropterus dolomieu</u> (A)	sport fishing
<u>Micropterus punctulatus</u> (A)	sport fishing
<u>Micropterus salmoides</u> (A)	sport fishing
<u>Perca fluviatilis</u> (A)	sport fishing
<u>Salmo gairdneri</u> (A)	sport fishing
<u>Salmo trutta</u> (A)	sport fishing
<u>Salvelinus fontinalis</u> (A)	sport fishing
<u>Tinca tinca</u> (A)	sport fishing

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