RHODES UNIVERSITY

AN AFRICAN HERITAGE OF FISHES

Inaugural lecture delivered at

RHODES UNIVERSITY

on 11 June 1997

by

PROFESSOR PAUL H. SKELTON

BSc(Hons), PhD(Rhodes)

GRAHAMSTOWN

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Preamble and Acknowledgements

Mr Vice-Chancellor and Mrs Woods, colleagues, ladies and gentlemen, it is now almost 70 years since Professor JLB Smith began to organise the fish collection in the Albany Museum - a hobby that led through the exciting discovery of the living coelacanth in 1938 to the founding of the original Department of Ichthyology at Rhodes University in 1946/7. The past 50 years have seen much development and growth in the discipline, to the point where the study and training of ichthyology in Africa is synonymous with this University and its progeny the JLB Smith Institute.

In 1973 I enrolled as the first post-graduate student in ichthyology and, in 1980, graduated as its first Ph.D. Since that time no fewer than 150 post-graduate students have registered and 18 Ph.D. degrees have been awarded. I follow in the footsteps of five quite outstanding Professors so, all-told, a fine tradition has been established. I am therefore especially proud to have been honoured by the University in this appointment and so to be able to deliver this lecture this evening.

Heritage, in the title of this lecture, is a word loaded with meaning, and one that is very much in vogue within South African cultural circles at present. Heritage denotes something of value, that is passed from one generation to the next. It is not only material items but is also things like literature, oral traditions, behavioural customs and other cultural attributes and values. This is the way I intend using it here, implying something received from an earlier generation, held in trust during our own lifetime and passed on, preferably enhanced in value, to the next generation.

A heritage can also be lost, or irreparably damaged through neglect. This tends to happen when society undergoes upheaval as in times of war or revolution or when new socio-political or economic forces come into play. Taking a possible recent example of this from ichthyology is the case of Thatcherite Britain in the 1980s when a tradition of research excellence in African

freshwater ichthyology at the British Museum of Natural History, spanning at least six or seven generations of world-class scientists over a period of about 130 years, came to an abrupt end.

Science, as we all know, is an activity embracing philosophies, investigative processes and derived knowledge of cosmic nature. It is a heritage of humanity. We absorb and learn about science and scientific knowledge from our elders, and then improve upon that knowledge through research and observation, and pass on an enhanced product to the next generation. Sometimes the scientific inheritance is improved only in small measure, at other times quantum leaps are made - or the paradigm shifts as the expression goes.

I arrived on the systematic scene in the early 1970s, at a time when a major paradigm shift was taking place - the established philosophy of evolutionary systematics, where organisms are classified on the basis of general similarities (for example crocodiles with lizards and other reptiles rather than with birds to whom they are more closely related), was being challenged by what is now known as Phylogenetics or cladistics, a philosophy where the relationships of taxa are determined on the basis of shared derived similarities. I was fortunate to be thrust headlong as the first student into a vibrant, young organization (the fledgling JLB Smith Institute of Ichthyology) where there was no entrenched view to impede or confuse the exposure to the new order.

At the outset of my career I experienced the best of both worlds, on the one hand to be introduced in a fatherly sort of way to the fascinating richness of southern African freshwater fish fauna by my mentor Dr Rex Jubb, the pre-eminent authority on the fauna at the time, and a honorary graduate of Rhodes University. Jubb's enthusiasm for, and first hand knowledge of the fauna was unequalled as was his unselfish determination to pass on that knowledge to the next generation.

I also received excellent, more formal tuition in ichthyology from my lecturers and supervisors, all three highly respected ichthyologists: Dr Thomas Fraser, Dr Richard Winterbottom and Dr (later Professor) Michael Bruton.

Richard Winterbottom was a graduate of UCT who then did his Ph.D. at Queen's University in Canada and post-doctorate fellowships at the Smithsonian Institution in Washington and the National Museum in Canada, during which time he kept company with cladist revolutionaries. He returned full of revolutionary enthusiasm for cladistics which he proceeded to instill on a small student band in the Institute. He was an inspiring tutor and it was as exciting a post-graduate education as one could wish for and I am grateful to him for that.

Mike Bruton, who is well known to many of you, guided my Ph.D. write-up and thereafter continued to influence me through his dedicated industry and uncompromising search for excellence during our years together at the JLB Smith Institute.

There were others, both before and after this, who have influence my education and professional development: in particular Professor Brian Allanson for his educational baptism of fire during my honours year, and Dr Humphry Greenwood, who for many years from 1974 until his death in 1995, was a real professional friend and wise counsellor, the sort we all need at some or other stage of our careers. It is with gratitude and pleasure I thank all of these friends and colleagues for their input into my education and professional development.

I naturally owe a great deal of appreciation to my parents, who were of a generation that through circumstances were denied the privileges of an education like I enjoyed at Rhodes.

I am also extremely grateful for the support I receive from my wife, Anne, and my children - they are very tolerant of a preoccupied mind.

Finally I would like to thank the Vice-Chancellor and the Registrar and his team for all the arrangements made for this occasion.

Introduction

Because I am concerned with heritage the first aspect I will explore is the tradition itself, by touching on the cultural relevance of fishes in traditional African societies and presenting

snippets of the history of discovery of our natural heritage of freshwater fishes. Systematic collections are a tangible record and a valuable tool for investigating biodiversity. As a professional curator I want to expose the value of our collections and the need to maintain and develop them. From this base I will provide an outline of the nature of the freshwater fish fauna and provide, through the example of a lineage of fishes I have studied more than most, some scientific measures of the value of this fauna. I will attempt to show the depth of their evolutionary history and the way that is tied to the evolution of the landscape itself. My purpose is to demonstrate something of the treasure that the world, and South Africa in particular, has in its freshwater fish fauna. Finally I will turn to the concern I have for the erosion and decline of the legacy, and what perhaps needs to be done to ensure its survival for future generations.

My primary research discipline is **Systematics**, which in broad terms, is the study of the diversity of life. It includes **Taxonomy**, the science that deals with the theory and practice of identifying, describing and classifying organisms. Systematic biology uses comparative observation rather than laboratory experimentation on animals as its primary method of investigation. My approach to systematics has been within the philosophy of **Phylogenetics** through which genealogical relationships between taxa are considered on the basis of shared derived characters. I have also been largely concerned with historical **Biogeography** that considers the explanations of animal and plant distributions through time and in turn draws on a wide range of disciplines such as geomorphology, geography, biology and ecology.

Historical snippets - the establishment and development of a cultural heritage

Freshwater fishes, like many other animals, were well known to the Khoisan and Bantu peoples of South Africa long before Europeans arrived in the 16th and 17th Centuries. Archaeological records show that fishes were caught and consumed by people of both stone-age and iron-age cultures in South Africa. But animals have never only been a food resource for man, they have always been carefully observed and their characteristics and traits absorbed into the religious and cultural lives of people. This is a universal aspect of humanity but sometimes in our sophistication and arrogance we don't always acknowledge it. If you doubt this consider for a

moment only the names given to sports teams or the use of animals in modern advertising, both are richly endowed with animals used as metaphors.

Recent interpretations of San rock art depicting fishes and fishing scenes consider that fishes were often used by shamans as metaphors for the trance, as symbols of potency (especially the electrogenic mormyrid fishes) and of shamanist capture of that potency[1,2]. The fact that mormyrid fishes are found painted at sites well beyond their natural distribution is interpreted as indicating the prestige of the shaman and the extracorporeal experience of the trance. In a section of the famous Linton panel from the North-East Cape now in the South African Museum the trance is most dramatically depicted as an 'underwater' experience with the shaman surrounded and gently touched on by a variety of fishes[1] (Figure 1.).

It has long been known that, at least traditionally, the Xhosa disdain fishing and the eating of fish[3]. This custom can be traced to the folklore belief of the '**river people**' who are related to the tribe's ancestors and who live and farm underwater[4]. Everything found underwater belongs to the river people and it would disturb their peace to take anything from there, hence the taboo on fishing.

In tribes for which fishing is a strong cultural activity, such as the Thongas of Maputaland, or the Unga from the Bangweulu swamps in Zambia, there is a rich heritage of linguistic proverbs and beliefs and customs relating to fishes[5,6,7]. The Shona proverb "The power of the fish in water" captures the essence of 'Ubuntu' the African philosophy of collective solidarity or organization, that increasingly permeates our own society[8]. The fact that this proverb is perfectly featured on the Zimbabwe currency is a strong indication of the cultural value of fishes in African society.

European attitudes to the natural resources of Africa were exploitative from the outset. Hunting and fishing were activities both to secure food and animal products for private or commercial gain, as well as for leisure and recreation. For the first 175 years or so after European settlers arrived at the Cape, i.e. until the British occupation at the beginning of the 19th Century, there were only sporadic incidental reports of freshwater fishes in travel journals and published books. In the abundance of large game and birdlife, freshwater fishes were of minor interest to the early

Figure 1

A shaman in trance - from the Linton Panel. From Lewis-Williams (1988) (Reference No. 1)

explorers. Descriptions were rarely provided but in accordance with European traditions of art some paintings of fishes were made. The earliest on record for southern Africa are those done by Claudius during Simon Van der Stel's expeditions[9,10].

It is not surprising that initially the names given to the few fishes that were encountered were the same as those used in Europe, but gradually names with a distinct South African flavour came into use. Examples are rooivlerkie, ghieliemienkie, and, my favourite, the moggel. Most of these names like rooivlerk (redfin) or ghieliemienkie (geel-mannetjie) are readily explained by the attributes of the fishes themselves, but so far I have failed to derive 'moggel' satisfactorily and its story is worth repeating here as an example of how closely our natural history is linked to cultural history.

The first mention of 'moggel' that I am aware of is on one of two identical paintings of a fish done by an artist, probably a man by the name of Johannes Schumacher[11], accompanying two well known early explorers, Robert Jacob Gordon and William Paterson, on an expedition to the mouth of the Orange River in 1779. One of the paintings is in the Gordon Atlas preserved in the Rijksmuseum in Amsterdam, the other is part of the Paterson portfolio in the Brenthurst Library in Johannesburg (Figure 2).

Gordon is remembered for much more than bestowing the name moggel on a fish, he named the Orange River (the local inhabitants called it the Gariep River, a name that has recently been restored to one of the great dams built on this river). As the Commander of the Cape Garrison in 1795 he has the dubious distinction of surrendering to the British, an action that resulted in him taking his own life[11].

Paterson, a Scottish explorer after whom the nearby Eastern Cape town is named, visited the Cape and undertook four expeditions between 1777 and 1779. He became the Lieutenant-Governor of New South Wales from 1794-5 and is famous for the paintings of natural history that were made on his expeditions, but he was not the artist[12].

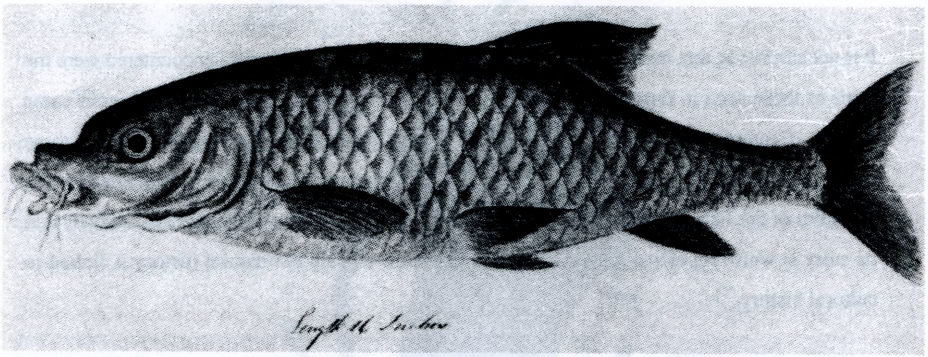

Figure 2

Painting of a smallmouth yellowfish from near the mouth of the Orange River, in the Paterson Album, Brenthurst Library, Johannesburg. From Forbes & Rourke (1980) (Reference No. 12) Figure 54, p. 155. Published with permission, the Brenthurst Library

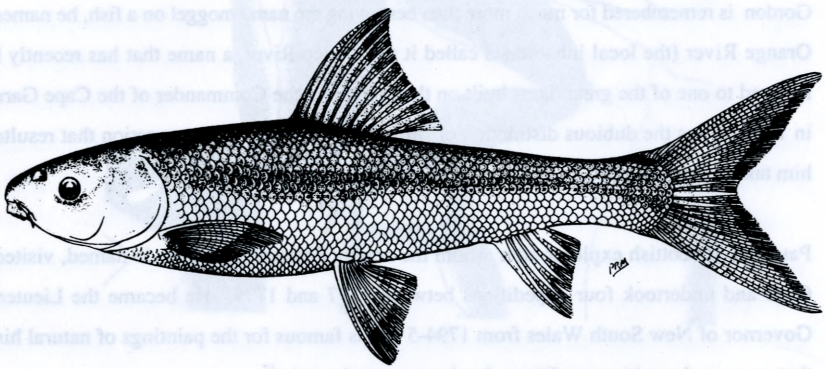

Figure 3

The moggel, *Labeo umbratus* (Smith, 1841). Drawn by Penny Meakin

The most interesting point about these paintings of the 'moggel' made near the mouth of the Orange River in 1779 is that they are not of the fish we now give that name! The paintings clearly depict the smallmouth yellowfish, which was, incidentally, the first freshwater fish species formally described from southern Africa, by another famous explorer, William Burchell in 1822[13]. The fish we now call 'moggel' (Figure 3) is also called a mudfish, and has the scientific name *Labeo umbratus*, and was described formally by Dr Andrew Smith in 1841, under the name *Abrostomus umbratus* meaning "soft-mouthed shady fish". *Labeo umbratus* does occur in the Orange River but not as far as we know in its lower reaches near the mouth. The first time it was called 'moggel' was, it seems, by Keppel Barnard in 1943[14] but I have not yet been able to determine how or why this name was switched from the yellowfishes (*Barbus* species) to the mudfish.

The other question that is not yet settled is where the distinctly South African name 'moggel' in use since the 18th Century at least, is derived. The linguistic experts I have consulted all refer back to the Dutch word 'mokkel' meaning, roughly, a plump girl. Apparently there is a dialect form 'machel' from the Waasch area in Flanders that denotes a freshwater fish, but I have not been able to confirm this.

Collections

Before proceeding I need to make a few comments on the matter of collections for they are the documentation of the living heritage of our land. They are the tangible representations of the living fauna and constitute a scientific resource of great value.

There were no descriptions or known collections of South African freshwater fishes made prior to the early 19th Century, when the British occupied the Cape. This is in contrast to the situation for plants, and animal groups like the mammals and birds where there are dry collections in the major European museums and species described from the latter half of the 18th Century. Part of the reason for the late start would be the difficulty of preserving and transporting wet specimens of fishes in wagons through the veld, and especially before formalin came into use as a fixative (carrying quantities of alcohol was a risk for other obvious reasons). Dry skins of fishes

were made (see Figure 4), but they are very unsatisfactory for taxonomic descriptive purposes, and there are not many in collections.

The first descriptions of our freshwater fishes were that of the smallmouth yellowfish (*Barbus aeneus*) and of the sharptooth catfish (*Clarias gariepinus*) by Burchell in 1822[13]. There are no specimens collected by Burchell to support the descriptions and it is suspected they ended up as food. We do have excellent knowledge of his whereabouts at the time, and his watercolour sketches in the Africa Museum in Johannesburg, from which the vignettes in the published accounts of his travels were taken, leave no doubt as to the species he was discussing[15,16].

Figure 4

Dry skin, syntype of *Gnathendalia vulnerata* Castelnau, 1961. Photograph courtesy of the Natural History Museum, London.

The earliest fish specimens collected from South Africa that I am aware of are of two species made by Ludwig Krebs in about 1820-22, now in the Humboldt Museum in Berlin. The two species are the Eastern Cape redfin (*Pseudobarbus afer*) most probably from the Swartkops River near Uitenhage, and the sawfin (*Barbus serra*) from the (Clanwilliam) Olifants River[17]. These species were described by Professor W. Peters in 1864. Another early collection is of two specimens of the Cape kurper (*Sandelia capensis*) described by the great French zoologist George Cuvier in 1831, but there is some doubt as to who the collector was (possibly Delalande) and exactly in the Cape where the specimens came from.

Dr Andrew Smith, the founder of the South African Museum[18] made collections of fishes in the 1830s and described several species including the Breede River redfin (*Pseudobarbus burchelli*), and, of greater renown, the banded tilapia (*Tilapia sparrmanii*). The name tilapia is one of the best known African fish names around the world and comes from the Tswana word 'thlape' meaning fish. Smith's collections were taken back to England or Scotland when he returned in 1837. A few of Smith's specimens survive in the Natural History Museum, London collection.

So these and most other collections made in South Africa during the 19th Century were sent to European museums. It was only on the appointment of Dr John Gilchrist as the first marine biologist in South Africa in 1896 that a collection of freshwater fishes was finally established in a South African institution, the South African Museum. Several other collections were started at about the same time including the one in the Albany Museum and the Transvaal Museum. The freshwater fish collection of the Transvaal Museum is now in the Smith Institute[18].

The story of the fish collections in Grahamstown is full of drama[18,19,20] but the key events are simply these: JLB Smith began to organise the collection in the Albany Museum where he was the honorary curator in the late 1920s . His career as ichthyologist received a major boost with the capture of the living coelacanth in December 1938, but that specimen remains the property of the East London Museum. In 1941 a fire in the Albany Museum forced the evacuation of the fish collection to the University where it formed the core of the collection of the Department of Ichthyology that is today the JLB Smith Institute. The Department was established in 1946/47

and became the Institute in 1968 after the death of JLB Smith. The Institute gained independence in 1980 as a Declared Cultural Institution.

This is not the complete story because as we are well aware there is today a fine fish collection in the Albany Museum. The reason for this is that in the 1950s Rex Jubb joined the Department and began building up a freshwater fish collection. Due to space constraints and, no doubt, the tensions this produced between Jubb and Smith, Jubb removed the freshwater fishes to the Albany Museum where it has grown and remains to the present day.

The Grahamstown fish collections are now top-class national and international collections, well curated and documented and fully computerised. They are now sufficiently large and mature to represent the best long-term data base of fish biodiversity in southern Africa with application well beyond just systematics. They are research tools in their own right and we are beginning to use them for purposes other than taxonomy, e.g. they have been used to identify hotspots of fish biodiversity that help focus conservation efforts. By linking the collection data to a South African Development Community (SADC) Geographic Information System programme we will soon be able to compile a dynamic distribution atlas of the species that will be a huge asset in biogeographic and impact assessment studies.

Good collections are heritage resources of immense value but they don't just happen, they require committed champions to become rooted and then sustained, first class curatorship, to grow. They remain fragile heritage resources that even once established are not easily, or cheaply, maintained, and therefore they should never be taken for granted by the nation. It takes but one act of ignorance as to the value of such a resource for them to be lost forever.

In many ways Grahamstown is an odd place to locate a major ichthyology research institute and to teach the discipline. It is not on any major river system nor is it a great coastal city where the fishing industry operates. There are voices that would remove these collections from here - and ever since I took over the reins of the Institute I have been involved in negotiating the future of the Institute and its collection in Grahamstown as part of the process of rationalisation of museums and collections in the new South Africa. It is with some satisfaction that I can say that,

at this point in time, our arguments based on the International stature of the Institute and its synergy with the University, to retain the national status within the Department of Arts, Culture, Science & Technology under the Science & Technology division, would seem to be holding ground.

South African freshwater fishes - perceptions of provenance

With an estimated 25 000 or more species fishes are the most diverse vertebrate group on earth, by far[21]. Of these about 10#000, or 40%, are freshwater species, a gross disproportion in terms of available aquatic habitats - freshwater lakes and rivers cover about 1% of the earths surface and account for less than 0.01% of the water resources. There are over 3#000 freshwater fishes in Africa, again making them by far the most diverse vertebrate assemblage. But that diversity is not evenly spread over the continent. There are 94 indigenous freshwater dispersant fishes in South Africa and about 220 in southern Africa (including the catchment basins of the Kunene, Okavango and Zambezi rivers).

To put this into perspective, in southern Africa there are as many as 2#200 marine fishes, 130 amphibians, 400 reptiles, 920 birds and 340 mammals. We could bolster the freshwater fish numbers by adding at least 22 alien species that are known to have been introduced and 37 species of marine species that have been recorded from freshwater systems to give a grand total of around 280 species, but that is still significantly less that any other major vertebrate group. At present I estimate that about 90% of the fauna is recorded[22], so we have a reasonable idea of the nature of the fauna and of its distribution.

There is a marked decline in the numbers of fishes in river basins from the Zambezi south to the Cape. The fauna can be divided into two major components, a large (80%) tropical division, and a smaller (20%, 33 species) southern temperate division[23]. The tropical fishes are found in the Zambezian region that extends south to the Phongolo River in the east, with a tapering off south to the eastern Cape along the eastern seaboard. The divisions overlap in the Orange and Limpopo rivers and in KwaZulu-Natal but, before man started to move fishes around, none of the tropical species extended south of the Orange system. The southern temperate fauna reaches as far north

as the southern tributaries of the Limpopo and includes a number of Cape Fold Mountain endemics. The climatic situation, which is neatly summarised by Stuckenberg's Effective Temperature map[24], shows that the 15° ET isotherm circumscribes the temperate ecofaunal division of the freshwater fishes extremely well and also delineates the southern extremes for many tropical species.

Freshwater fishes are more-or-less rigidly tied to the environment in which they are found, viz. rivers and lakes. In southern Africa these aquatic systems are relatively restricted and most of our rivers have at most one or two closely related species in them, and usually the nearest relative is in a different, adjacent, or historically adjacent, system. With the exception of the Zambezi system, our rivers are too small for significant intra-system speciation to have occurred.

Apart from phylogenetic speciation the only way to increase diversity would be through immigration - but, in the case of freshwater fishes this process depends on suitable physical connections between the systems. Such linkages and recombinations between adjacent river systems take place naturally in hydrographical and geomorphological evolution. My studies show that the broad patterns of freshwater fish distribution in southern Africa are generally matched to instances of hydrographic change through river captures or linkages through changes in sea level[23]. However these geomorphological processes take place over long periods of time and faunal evolution is not as rapid as, for example, large-scale climatic shifts. The hydrographic system in southern Africa is old and the major rivers can be traced directly or indirectly back to even Cretaceous times[25]. Consequently the evidence suggests that the basic elements of the freshwater fish fauna trace back to those times when the subcontinent was isolated through the dynamics of global geomorphological evolution.

A second major factor why there are so few fishes in the region is the conformation of the region itself. Africa south of the equator projects along a north-south axis like a huge tapering peninsular into the Indian-South Atlantic oceans but the major rivers run along the east-west axis. This means that north-south penetration of the fauna is severely hindered. In addition there is a distinct climatic change with increasing latitude and the cooler southern climate extends northwards into the interior of the subcontinent as a result of elevated altitudes. The "peninsular

effect" is clearly shown by the sharp tapering off in the number of species in the different rivers proceeding from north to south.

The long-standing view of the provenance of the fauna is that, with the exception of *Galaxias zebratus*, a Gondwanoid species, it is derived by dispersal from the north[26]. Under this dispersalist paradigm it is suggested that the earliest arrivals, including the ancestors of species from the Cape rivers, date to the Miocene (7-17 MYBP)[26,27,28]. Subsequent invasions in the Pliocene and Pleistocene brought the ancestors of remaining species.

However, I believe that there are major problems with this hypothesis and have suggested an alternative model that proposes that the fauna has evolved largely within the region since the breakup of Gondwanaland[23]. I argue that there were originally three evolutionary arenas, the eastern tropical, western tropical and southern temperate, and that the modern situation is a result of the partial mixing of these original faunas as a result of drainage changes. The model accords well with the modern understanding of hydrographic evolution of the subcontinent since the Mesozoic.

The Maluti minnow and the redfins

The best evidence we have of the age of the fauna and how it has evolved *in situ* in southern Africa comes from studies made on a group of small redfin minnows found in the streams of the Cape Fold mountains. The key to the phylogeny of the group and its biogeography came from recognising the relationships of the Maluti minnow (Figure 5), a species that occurs in high altitude streams in the Drakensberg and Maluti Mountains in Lesotho.

The Maluti minnow was described, as *Labeo quathlambae*, by Dr Keppel Barnard of the South African Museum in 1938[29]. It was supposedly collected in a small KwaZulu-Natal Drakensberg stream, the Umkomazana, from which it has never again been collected in spite of a concerted search by officials of the Natal Parks Board[30]. It is a strange little fish that confused the best ichthyologists of the day as to its relationships. Barnard described it as a *Labeo* on account of its very small scales. Greenwood and Jubb[31], both authorities on African freshwater fishes,

investigated its anatomy in fair detail but were unable to place its relationships and gave it the unique and lovely name *Oreodaimon*, meaning 'spirit of the mountains'. The name was very apt at the time because it had not been seen alive since its discovery and was thought to be possibly extinct[32]. In 1971, to great relief, fishery officers conducting a fish survey in Lesotho came across the species in the Tsoelikane River, a high altitude tributary of the Orange River[33], and it has subsequently been found in at least five or six other high altitude Drakensberg streams.

In 1973 I accompanied the late Dr Amy Jacot-Guillarmod on an expedition to the Sehlabathebe National Park through which the Tsoelikane River flows and saw the Maluti minnow alive for the first time. With its bright red fin patches I immediately made the connection between this species and the redfin minnows from the Cape which I was investigating and therefore included it in my study[34]. My initial hunch turned out to be correct and a cladistic analysis indicated that the Maluti minnow is the most derived redfin - which resulted in its generic name changing again to *Pseudobarbus*.

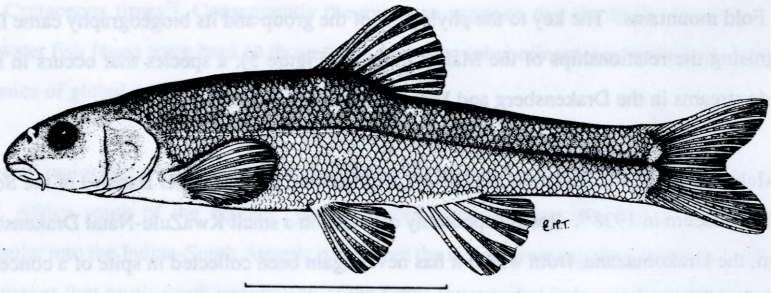

Figure 5

The Maluti minnow, *Pseudobarbus quathlambae* (Barnard, 1938). Drawn by Elizabeth Tarr.

Redfin minnows are extraordinary African cyprinid fishes. Cyprinid fishes - goldfish and koi carp are familiar species for many people - include as many as 480 species in Africa and 1700 species worldwide, making it the largest vertebrate family on earth. There are seven redfin species described including the Maluti minnow, and they occur in the streams of the Cape Fold Mountains from the Olifants (Cedarberg) in the west to the Sundays (Suurberg) in the east[34]. They are small fishes - reaching 135 mm length maximum, and apart from their distinct coloration have several other overt features such as males with large breeding tubercles, unusual pharyngeal teeth and some have elongated intestines. In addition, as a result of studies by my student Daksha Naran, we now know them to have a karyotype of 100 chromosomes, which is considered to be of tetraploid origin[35].

Polyploidy occurs in plants and certain lower vertebrates only. In cyprinid fishes it is of relatively minor occurrence - only 12-14 % of the karyotyped species have polyploid complements. Several levels of ploidy have been described for cyprinids, including triploidy, tetraploidy, hexaploidy and, rarely, octaploidy. In our laboratory we have now karyotyped all 23 barbine species of the temperate fauna from southern Africa, and it turns out that 18 (78%) of these are polyploid, including five hexaploids and 13 tetraploids[35]. At this point in time, because so few African cyprinids have been karyotyped, we are not sure what to make of these discoveries. Because different phylogenetic lineages are included in the phenomenon it does suggest that there might be a common precipitating factor - such as an environmental disturbance - in the history of this southern temperate fauna.

Knowledge of redfin relationships immediately posed the question of how to explain the extraordinary distribution of the Maluti minnow in the uppermost extremities of the Orange River and its relatives in the Cape Fold Mountains. The solution to the problem lay in the phylogeny of the lineage and the drainage evolution of the area which also provides the means to determine of the age of the lineage[24] (Figure 6). The sister species to the Maluti minnow is the slender redfin from the Gourits and Keurbooms rivers. The sister species to these redfins is the fiery redfin from the Olifants River. The other species are distributed in distinct catchments between the Olifants and the Orange in a manner that supports that support this historical connection.

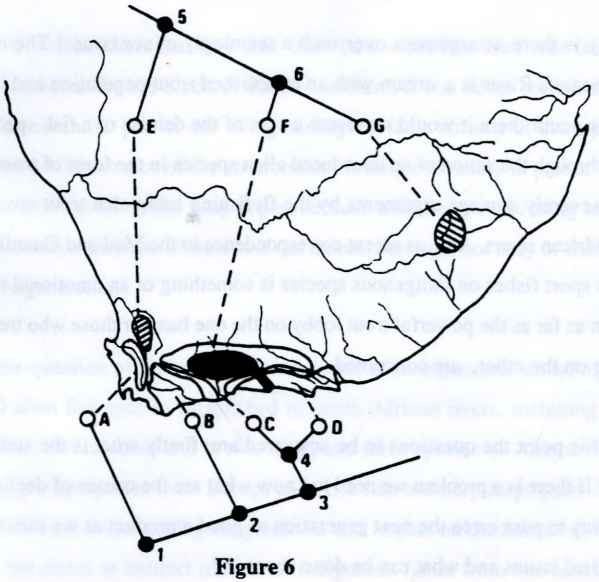

Figure 6

The phylogeny of the redfin minnows, genus *Pseudobarbus*, plotted against the distribution of the species. A - *P. Burgi*, B- *P. burchelli*, C-P . *asper*, D - *P. afer*, E - *P. phlegethon*, F - *P. tenuis*, G - *P. quathlambae*.

Whither conservation ?

This brings me back to the original discovery of the Maluti minnow in the Umkomazana River in KwaZulu-Natal. Since the species was rediscovered in Lesotho in 1971 there are two schools of thought as to whether it ever did occur in the Umkomazana. The one school argues that it could well have occurred there - firstly because the collectors said that was where they fished the original specimens, and secondly because the Umkomazana abuts the Sani River tributary in Lesotho and has unquestionably been extending its catchment at the expense of the Sani catchment over the eons, undoubtedly with its fauna. The second school argues that because the species has not been found in the Umkomazana since its reported capture here in 1938 there is no proof that it ever occurred there in the first place, and the more logical explanation is that the collections were actually made in the Sani River where the species is known to occur and brought down to Natal over the Sani Pass[36]. The Sani Pass is a long established trade route from Lesotho to KwaZulu Natal.

But why is there an argument over such a seemingly minor issue ? The reason is simple - the Umkomazana River is a stream with an established trout population and if the Maluti minnow did once occur there it would represent a case of the demise of a fish species in South African waters through the action of an introduced alien species in the form of trout. Such an admission would severely damage arguments by the flyfishing lobby that trout are a benign presence in South African rivers. And, as recent correspondence in the Mail and Guardian shows, the impact of alien sport fishes on indigenous species is something of an emotional issue and not a trivial question as far as the powerful trout lobby on the one hand or those who treasure the indigenous heritage on the other, are concerned.

So, at this point the questions to be answered are, firstly what is the status of our heritage of fishes ? If there is a problem we need to know what are the causes of decline ? And thirdly as it is our duty to pass on to the next generation as good a product as we can, we should ask - what are the real issues and what can be done about it ?

A list of threatened fishes (known as the redlist) has been produced for South Africa since the 1970s and is now in its third generation. Species are rated in categories of threat according to criteria established by the International Union for the Conservation of Nature and Natural Resources (the IUCN). The hierarchy of categories is Data Deficient (DD), Lower Risk (LR), Vulnerable (V), Endangered (EN) and Critically Endangered (CR). A species is considered Critically Endangered on several criteria, including if the probability of its extinction is at least 50% in the next 10 years or three generations. At present there are 23 species on the list in the following categories: CR-7; EN-6, VU-9; LR-1; DD-1. This means that about 25% of the indigenous species in South Africa have declined sufficiently to warrant serious conservation attention if they are to survive long-term. I would say that our heritage is in tatters and the next generation has got a problem rather than a enhanced product to look forward to.

What are the causes of decline ? On the one hand there is the perhaps obvious factor of human population pressure. Few rivers, if any, are unaffected by man's actions[37], and the habitat of most has been damaged or at least changed through direct physical action such as dams being built, water extraction and large-scale land-use changes in the catchments, such as afforestation, agriculture, urban and industrial development. Wetlands have been seen as wasteland rather

than the most valuable system filters that they are. Until now water has been seen only as an exploitable resource and not as the life-blood of the environment. It was never seen as a habitat for living creatures, an essential part of our living heritage. Man's attitude of disrespect and neglect and his actions of disturbance of the environment is unquestionably in part at the root cause of decline of our heritage of fishes. I say in part because attitudes are one thing and basic needs are another, and both need to be addressed if our natural heritage, not only of fishes, is to be sustained for future generations.

In addition there is the question of the impact of introduced alien organisms including fishes. There are at least 20 alien fish species established in South African rivers, including several species of top predators like rainbow and brown trout, and three species of American bass[38]. There are several major carp species from Europe and Asia like ordinary carp, grass carp and silver carp, all of which have major ecological presence, and impact on the habitat in one way or other. In addition the direct or indirect transfer of indigenous fishes from one catchment to another has, and is still taking place on an extensive scale. As a result the sharptooth catfish or barber, which is also a species of high ecological impact, has invaded a large number of rivers in the Eastern and Western Cape.

Barnard[14,29] echoed warnings first issued in the 1920s by Sidney Hey, a great angler and father of one of South Africa's leading conservationists of the previous generation, Dr Douglas Hey, that South Africa's indigenous river fishes were declining under the impact of introduced alien sportfishes. The surprising thing was that Sidney Hey was a prime mover to introduce black bass, which proved to be the real threat and prime agent that Barnard was reacting to. This decline of indigenous species was amply confirmed by observant anglers like A.C. Harrison in the subsequent decades. The nature conservation authorities were extremely slow to react to the tide of evidence - and did so only when their own surveys in the 1960s and 70s showed that the early warnings were correct and the indigenous fauna had declined drastically.

For a number of reasons the Cape fishes have suffered far more from the impact of alien sportfishes than those from other regions. Among these reasons are that the streams of the Cape Fold Mountains are both clear and cool - well suited to trout and other visual predators, but at the same time they are streams of low productivity that support short, direct food chains. Fish

diversity is extremely low, and endemicity is high. Apart from the (Clanwilliam) Olifants system that has 10 indigenous species, nine of which are endemic, Cape rivers from the Sundays to the Berg have at most three or four indigenous freshwater dispersant fish species. Coupled to this is the fact that these systems have evolved in isolation for a long period of time and the communities were, until western man arrived on the scene, in a state of fragile stability.

Recognising that a great deal of damage has been done to the indigenous fish fauna, especially in the Cape, what can be done about it ?

The problem of human impact on the natural aquatic environment is being addressed to some extent and as far as it is practical by a host of skilled environmental scientists and resource managers in this country. Evidence of this are the extensive fundamental changes that are part of the new Water Act. That aspects of the act are being opposed by powerful lobbies such as the agricultural sector is not surprising; entrenched attitudes are difficult to change overnight. The Act could have great beneficial results on the natural water systems in the country - this is its intention, but just how effective it proves to be will depend on the attitudes and actions of those who manage or use these precious resources.

Concerning the introduction of alien fishes - it is true that one cannot turn back the clock and merely wish away the presence of alien animals. There is a big demand for sportfishing involving trout and bass, and this demand will almost certainly increase in time as the inevitable further development of the landscape takes place. What is called for is a balance between providing for that demand and the conservation of indigenous legacies. There are many rivers and lakes where aliens are well established and provide good fisheries. It is well realised that such fisheries will endure only if the environment itself is cared for and so there is considerable common ground between angling and aquacultural interests and conservation interests. There are probably not as many rivers where indigenous fishes are left unscathed by human attention. These systems need to be identified and conserved in ways that will ensure the long-term survival of communities. But for all this to happen there needs to be respect for the indigenous heritage by anglers and aquaculture and likewise respect and accommodation for those interests by conservationists.

Rhodes University and its associated institutions embrace both these interests and as academic leaders in society we all have an important role to play, to ensure that we conduct our research and dispense advice with the right attitudes and within the framework of the laws of the land.

Conclusions

I have tried to give you a glimpse of the value that I believe lies within our heritage of freshwater fishes in southern Africa and to make the point that, whilst this may not be a rich fauna in terms of quantity or even of the size attained by most of the species, those are not the true measure of a heritage's value - the true measure is quality. As far as determining the quality or the history and evolutionary significance of our freshwater fish fauna is concerned it is a treasure of which we have only just scratched the surface. In contrast to most other vertebrate groups fishes remain incompletely discovered by man and Africa is one of the regions where the fauna is not yet fully explored[39].

So if I was asked the question - Is there a future for systematic ichthyology in South Africa, or more pertinently, in Grahamstown ? And could answer it purely in terms of a task to be done, the answer is clearly yes. When it is realised that there are few other centres of research and no other training centre for ichthyology in Africa as we have here in Grahamstown the responsibility of carrying out the task is that much greater.

But in my introduction you will recall I noted that science, the process and the products, undergoes change, sometimes rapidly, at other times gradually. Systematic biology has undergone great changes in recent times and for the most part hardly resembles what it was like even twenty five years ago. Darwin's theory of evolution announced in the 1850s was arguably the greatest revolution or paradigm shift that biology has undergone in history. In comparison Huxley's New Systematics in the 1930s and Hennig's phylogenetic systematics that revolutionised thinking since the 1950s, are matters of fine tuning.

At one time, in the 19th Century, systematics was biology. Systematics today is a relatively minor discipline if judged by the number of scientists involved and the amount of money spent

on it in relation to the rest of biology. The late Humphry Greenwood lamented the poverty of good systematists as one of the major non-environmental threats to the world of fishes[39].

Part of the problem is that systematics is an old discipline and is perceived as out of date and unfashionable[39]. In some ways modern methods and techniques such as molecular genetics and computerised phylogenetic analysis have maintained the interest and involvement of younger scientists. But still these are means to an end and the end of systematic biology is still to provide the framework and foundation on which all other disciplines can build - especially those that have application to man and his well being. Without a relevant systematic framework it would be very difficult to extrapolate pertinently or apply the results of much of biological research to maximum benefit.

As we approach the end of the decade, century and millennium, there is this paradox around systematics and its survival in society. On the one hand there is a great questioning the value of collections, museums and of systematic research itself, and of financial support for the science. But on the other hand there is the growing evidence of environmental decline and of a biodiversity crisis to a degree that threatens the whole of nature, man included, that has forced society to concede the value of systematics to human knowledge. If we need to assess biodiversity where are we going to find the scientists and the means (finances) to do this ?

I suggest that there is an urgent need to re-establish respect and tradition for systematics in tertiary education. The idea is not that everyone should rush out and do systematics, no, but rather that the value of good systematics as a foundation to do good comparative biology is indispensable. An example of just how appropriate and successful this can be is given by Mayden's (1992) volume on the historical ecology of North American freshwater fishes[40].

I do know that the combination we have here at Rhodes of a strong and vigorous teaching department acting in concert with a research institute of ichthyology is a very good combination to build on.

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