A REVIEW OF ESTUARINE ICHTHYOLOGY IN SOUTH AFRICA OVER THE PAST 50 YEARS

By

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ABSTRACT

Progress in South African estuarine ichthyology between 1946 and 1995 is reviewed. The early estuary surveys of the 1950s and 1960s resulted in the compilation of species lists for individual systems, but contained very little biological or ecological information on fishes. These surveys were superseded by both autecological and synecological studies in the 1970s and 1980s, which yielded descriptive and process-orientated information on a wide variety of species. Estuarine research during the 1990s has focused increasingly at the community level, with several review papers on the life-history styles of groups of estuarine-associated fishes being published. The last decade has also seen the departure of a number of senior estuarine ichthyologists from the field. This decline in available expertise has coincided with increased demand for ichthyological information to be used in decision support systems for the wise management and conservation of estuaries. It is suggested that these demands be seen as a challenge, with studies being directed towards providing the type of information needed for the maintenance of vital ecological processes within these systems.

INTRODUCTION

The origin of estuarine ichthyology in South Africa can be traced back to the turn of the century and the perceived problems being experienced by anglers in the Swartkops estuary. These anglers claimed that the netting of fishes in the Swartkops estuary, which was permitted by an Act promulgated in 1883, was causing marked reductions in the fish available to recreational fishermen. In 1912 it was resolved to close the estuary for three years to netting and "to attempt to discover by a series of experimental nettings and other observations what were the real facts of the case" (Gilchrist, 1918). Unfortunately, no experimental netting was conducted during 1912 because of financial constraints.

Towards the end of 1913 "it was represented to the Government that there had been a great falling off of the fish in the river, and this was alleged to be so marked as to necessitate some restriction even on angling operations" (Gilchrist, 1918). At a meeting of anglers and netters at Zwartkops on 25 June 1915, "it was mutually agreed that the estuary should remain closed to netting for a period of twelve months, during which regular experimental netting should take place". Two days later the first comprehensive ichthyological survey of a South African estuary commenced (Figure 1), and was repeated monthly until July 1916. A total of nine questions were addressed by the study and the results published as a Union of South Africa Marine Biological Report (Gilchrist, 1918).

Between 1919 and 1945, very little dedicated estuarine fish research appears to have been conducted along the South African coast. However, well-known ichthyologists such as Dr K.H. Barnard and Professor J.L.B. Smith (Figure 2) sampled extensively in a number of estuaries during this period (e.g. Barnard, 1925; Smith, 1935) in order to document marine fish diversity or resolve taxonomic issues.

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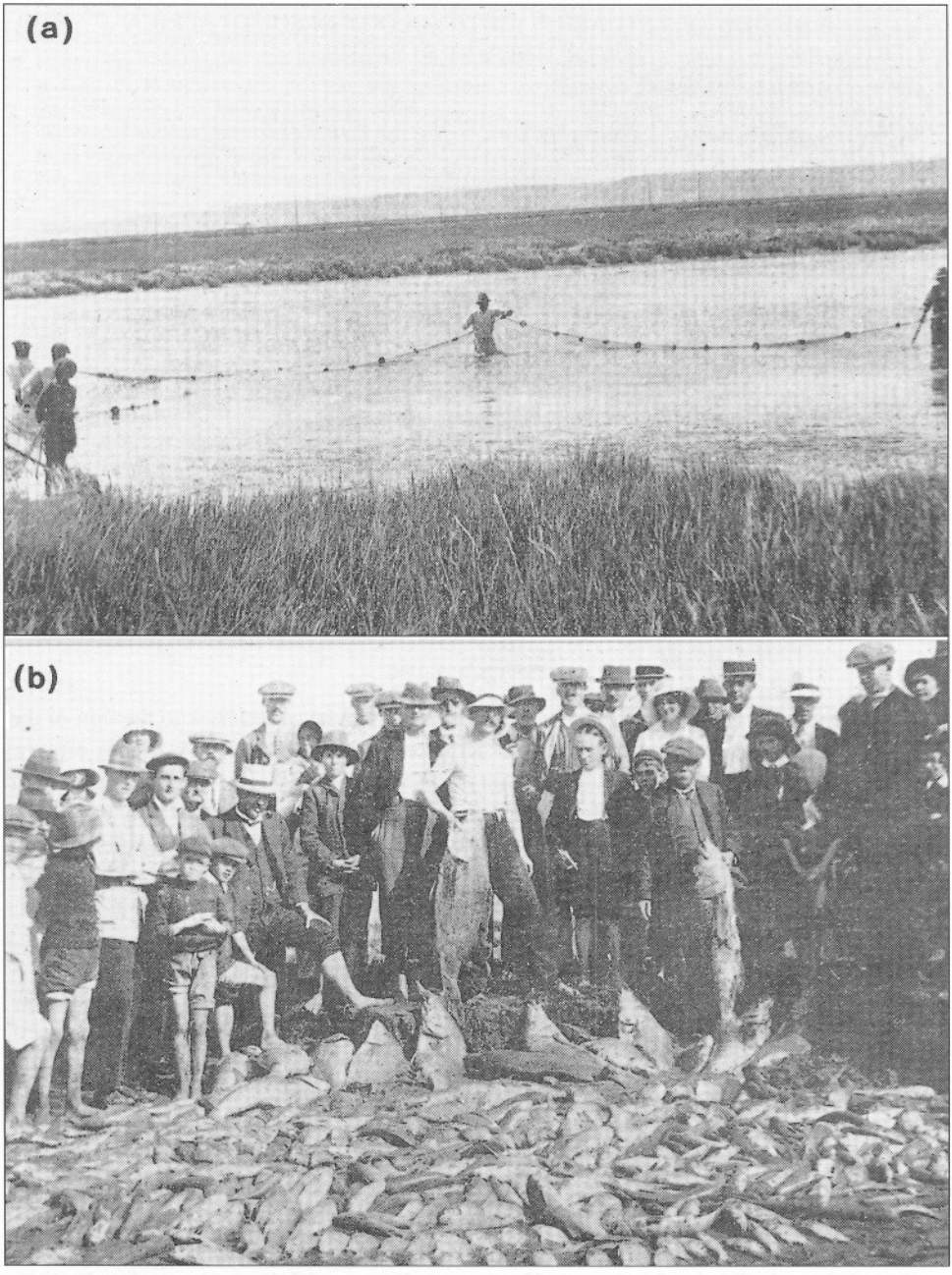

Figure 1. The first comprehensive fish survey in a South African estuary (June 1915). These two photographs from the Swartkops estuary were first published by Gilchrist (1918). The caption for (a) reads "Netting No. 20 at Telegraaf Spruit" and (b) "Results of Netting No. 1 at Modder Spruit, comprising 123 Steenbras (one, shown in the centre, weighing 34 lbs.), 270 Springer, etc.; in all 413 fish".

Figure 2. The origins of estuarine 'sampling' in the J.L.B. Smith Institute of Ichthyology can be traced back to the Knysna system where the Smiths' had a holiday home. The photograph on the left shows Smith with a 20 lb (9 kg) white steenbras (*Lithognathus lithognathus*) captured on rod and line in the Knysna estuary. On the right is a leervis (*Lichia amia*) which swallowed a hooked Cape stumpnose (*Rhabdosargus holubi*) that Smith is holding in his left hand. The title for this photograph read "Your supper or your life!".

PERIOD 1946 - 1955

This decade marked the beginning of a number of estuarine surveys undertaken by Professor J.H. Day and his research team from the University of Cape Town. According to Day (1977) the reason for this move was "that research funds were very limited and it was cheaper to make an ecological survey of estuaries than to hire fishing boats". The fish fauna formed only one component of these surveys and in some cases only very limited information was obtained, e.g. in the Knysna estuary Day *et al.*, (1952) stated "We ourselves have done a certain amount of netting, but our nets were small and the catches accordingly restricted to small species or the fry of larger ones".

In contrast to the lack of even a species checklist for the Knysna estuary, the later survey of the St Lucia system (Day *et al.*, 1954) contained a list of over 70 fish taxa together with notes on the relative abundance, distribution, breeding and feeding biology of the more common species. Already, these authors had identified the importance of freshwater supplies to the lake ecology and suggested that "Unless the circulation through the lakes is maintained, the salinity may rise to such high values that the fish and bottom fauna may die". Prophetic words indeed. Richards Bay was next on the Zululand list, with Millard & Harrison (1954) conducting a detailed survey of this system which then resembled an estuarine lake rather than the bay it is today.

Back in the Western Cape, Scott *et al.*, (1952) investigated the fishes of the Klein estuary, and this was followed by the first cool temperate estuarine survey (Rietvlei/Diep system) on the Atlantic west coast (Millard & Scott, 1954). Once again attention was given to the distribution, diet and recorded salinities in which the various fish species were captured. During this period the first autecological study on an estuarine-associated fish species was conducted by Talbot (1955) in the Klein estuary. He examined almost 2 000 specimens of the white stumpnose *Rhabdosargus globiceps* and was able to glean important scientific information, particularly on the feeding, growth and breeding biology of this species.

PERIOD 1956 - 1965

The trend of collecting increasingly useful ichthyofaunal information during the University of Cape Town estuarine studies was carried over into the Durban Bay survey (Day & Morgans, 1956), primarily because the Natal Parks Board financed the study and specifically requested the scientists to pay special attention to the fish fauna. Thousands of fish were caught, identified, measured, weighed and dissected to determine what they had been feeding on, the size at sexual maturity and the spawning season. Altogether, 186 fish taxa were collected and a preliminary analysis of the habitats occupied by the ichthyofaunal components was attempted, viz. pelagic, demersal and mangrove fish groups. Biological notes on all the important species appeared in Day & Morgans (1956) but the "voluminous statistical data" arising from this study was never published.

The detail gleaned from the above study contrasted to that in the Orange River estuary (Brown, 1958) where only limited information on the fish species of the area was collected. Similarly, the fish survey by Broekhuysen & Taylor (1959) of the Kosi estuarine system was also incomplete and limited to "a little seining when time permitted". However, by combining their information with that of Campbell & Allanson (1952), a Kosi estuary checklist comprising more than 60 fish species was compiled.

PERIOD 1966 - 1975

This decade was characterised by increasing involvement in estuarine fish research by universities and research institutions beyond the Western Cape. Dr B.J. Hill from Rhodes University published the first detailed checklist of fish species from the Mlalazi Estuary in Zululand (Hill, 1966). The advent of hypersaline conditions in the nearby St Lucia system necessitated the appointment of a Commission of Enquiry by the State President. Millard & Broekhuysen (1970) conducted detailed surveys in 1964 and 1965, with emphasis being placed on the recorded salinity ranges of fish species found in the lake.

In the late 1960s scientists from the Oceanographic Research Institute, under the leadership of Dr J.H. Wallace, embarked on a major estuarine fish research programme centred in Natal (Wallace, 1975a, 1975b; Wallace & van der Elst, 1975). These ichthyologists presented a detailed analysis of the species composition, reproduction, recruitment, migrations, length distribution, seasonal abundance and ecology of estuarine-associated marine fishes along the east coast of South Africa.

The pioneering autecological research of Talbot (1955) on the white stumpnose *Rhabdosargus globiceps* was followed in 1970 by Dr S.J.M. Blaber's field and laboratory

study on another estuarine-associated sparid, the Cape stumpnose *Rhabdosargus holubi*. His investigation focused on the salinity and temperature tolerance, population dynamics, growth, food and feeding ecology of *R. holubi* in the temporarily open/closed West Kleinemond estuary in the Eastern Cape (Blaber, 1973a, 1973b, 1974a, 1974b). For the first time, comprehensive information was available on the juvenile life-history stages of an estuarine-dependent fish species on the subcontinent.

PERIOD 1976 - 1985

The autecological and synecological approach of the previous decade gained momentum, with major studies being initiated in all the coastal provinces. The family Mugilidae came under the spotlight, with particular emphasis on the feeding ecology of this group of fishes (Masson & Marais, 1975; Marais & Erasmus, 1977; Blaber, 1976, 1977; Blaber & Whitfield, 1977; Bok, 1979). This focus was broadened at Lake St Lucia where the Natal University research team investigated the food and feeding ecology of detritivorous, planktivorous and piscivorous fish species (Whitfield & Blaber, 1978a, 1978b; Blaber, 1979). In addition, the diet of piscivorous birds and crocodiles in a southern African estuarine system was assessed for the first time (Whitfield & Blaber, 1978c, 1979a, 1979b, 1979c).

Studies by Cyrus & Blaber (1982a, 1982b, 1983a, 1983b, 1984a, 1984b) on the Gerreidae, Martin & Blaber (1983, 1984) on the Ambassidae, and Blaber & Cyrus (1983) on the Carangidae, resulted in detailed biological and ecological information being collected on these estuarine-associated families. During this period single species studies were continued, with the estuarine roundherring *Gilchristella aestuaria*, Natal stumpnose *Rhabdosargus sarba* and great barracuda *Sphyraena barracuda* all coming under the spotlight (Blaber, 1982, 1984; Blaber *et al.*, 1981; Melville-Smith *et al.*, 1981; Talbot & Baird, 1985a, 1985b). In addition, fish assemblage studies in a variety of South African estuaries (e.g. Whitfield, 1980a, 1980b; Marais, 1981, 1983; Beckley, 1984; Hanekom & Baird, 1984; Plumstead *et al.*, 1985) gained momentum, with increasing attention being given to aspects such as distribution, seasonality and variation in community structure. A number of more specific biological and ecological issues were also being addressed (e.g. Wallace & Schleyer, 1979; Whitfield *et al.*, 1981; Marais, 1982, 1984; Whitfield, 1984; Beckley, 1985; Bennett, 1985; Bennett *et al.*, 1985; Whitfield, 1985), thus providing the basis for a more comprehensive understanding of the factors influencing estuarine-associated fish diversity and abundance (Blaber, 1981; Day *et al.*, 1981; Whitfield, 1983; Marais, 1988).

PERIOD 1986 - 1995

The earlier work on ichthyoplankton in the Swartkops estuary by Melville-Smith & Baird (1980) and Beckley (1985), gained momentum during this period (e.g. Whitfield, 1989a; Harrison & Whitfield, 1990; Martin *et al.*, 1992), with emphasis on the composition, distribution and abundance of these early life stages. In addition, particular attention was given to recruitment processes of fish larvae and juveniles entering estuaries for the first time, and the factors influencing their abundance (Whitfield, 1989b, 1989c, 1994a; Harrison & Cooper, 1991; Harris & Cyrus 1995; Harris *et al.*, 1995).

Work conducted by Blaber (1981) suggested that many southern African estuarine-asso-

ciated fishes are essentially "turbid-water" species that evolved in turbid areas of the Indo-Pacific. This hypothesis was put to the test in a series of field and laboratory studies which showed that the distribution of most juvenile marine fish in estuaries is significantly influenced by turbidity (Cyrus & Blaber, 1987a, 1987b, 1987c). More recently, Hecht & van der Lingen (1992) have investigated the influence of turbidity on the feeding strategies of several fish species in estuaries, and concluded that visual predators are more affected by high suspensoid levels than macrobenthic invertebrate feeders.

Fish community studies continued to receive attention, with emphasis being placed on resource utilization (Whitfield, 1988; Bennett & Branch, 1990), anthropogenic impacts (Plumstead, 1990; Kyle, 1993; Bennett, 1994), recruitment and seasonality (Bennett, 1989; Whitfield & Kok, 1992; Harrison & Whitfield, 1995). It was also an era where fish communities were used as a major component in the Estuarine Health Index developed by the Catchment and Coastal Environment Programme of the CSIR (Ramm, 1990; Cooper *et al.*, 1994). There was a definite decline in single family and single species studies during this period, with Martin (1988, 1989, 1990) wrapping up his earlier work on the Ambassidae.

The 1990s have been a 'coming of age' for estuarine ichthyology in South Africa. The previous two decades had resulted in the accumulation of a significant information source which needed synthesis and analysis. Reviews of the life-history styles of fishes in estuaries on the subcontinent were explored by Potter *et al.*, (1990), Whitfield (1990, 1994b) and Cyrus & Martin (1991), with the whole question of estuarine dependence being reviewed by Cyrus (1991) and Whitfield (1994c). The 1990s also saw the first attempt at modelling the energy flow through the fish assemblage of a southern African estuarine system (Heymans & Baird, 1995).

The 1980s and 1990s also marked the departure of several senior ichthyologists (e.g. Professors Blaber and Martin, Drs Beckley and Bennett) from the South African estuarine research scene. These moves resulted in a lack of available expertise in areas such as the Western Cape, and considerably reduced the trained scientific manpower in regions such as KwaZulu-Natal.

THE FUTURE

Although much has been achieved over the last 50 years, a lot of work remains to be done. The words of Day (1977) are as valid now as they were then - ".... we need quantitative studies of the estuarine flora and fauna with the ultimate aim of assessing energy flow through the whole estuarine ecosystem". In addition he stated "We know the dominant plants and animals that live in our estuaries. We must now study them individually and in great detail - their rates of recruitment, their tolerance to environmental conditions, how much food they consume, their biomass and their productivity". Although a number of research programmes during the last two decades have addressed some of the issues raised above (e.g. Bennett & Branch, 1990; Whitfield, 1993; Heymans & Baird, 1995), we still have a long way to go before we can adequately predict the consequences of human induced disturbances on the ichthyofauna in particular and estuarine ecosystems in general.

Very few of the older generation of ichthyologists (Figure 3) are still actively involved in estuarine studies along the South African coast. To a large extent they have been replaced by a new generation of young scientists who are working under the supervision of individuals such as Professor D.P. Cyrus and Dr A.K. Whitfield. In KwaZulu-Natal, Shael Harris is

Figure 3. The major role players involved in the development of South African estuarine ichthyology (1915-1995). The periods when these individuals were most actively involved in estuarine research is shown below each photograph.

involved in research on the ichthyoplankton component in estuarine lakes and bays. Also working at the University of Zululand is Leon Vivier, who is studying the ichthyofauna of the Siyaya and Nhlabane systems. At the University of Natal, Michelle Graham has recently completed her work on the dominant zoobenthos feeders of Durban Bay. Trevor Harrison has now published his M.Sc. study on the fish assemblages of the smaller estuaries of KwaZulu-Natal (Harrison & Whitfield, 1995) and is currently involved in research on the use of fishes as indicators of estuarine health. Further south at Rhodes University, Angus Paterson has completed his fieldwork on the utilization of Kariega estuary saltmarshes by fish, and Leslie Ter Morshuizen is finalising his fish assemblage study at the head of the Great Fish estuary. Also at Rhodes University, Paul Cowley is studying the population dynamics of the dominant species within the temporarily closed East Kleinemond estuary.

During the next decade, new demands will be placed on the shoulders of scientists working in estuaries, with funding being more closely linked to human orientated management issues than ever before. However, these demands should also be seen as a challenge, and our

research should be geared towards providing the type of information needed for the maintenance of vital ecological processes within estuaries, which will benefit both humans and the biota of these valuable ecosystems.

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