Species identification, distribution and abundance of Gerreidae (Teleostei) Bleeker, 1859 in the estuaries of Natal

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Comparison of published meristic and taxonomic data with measurements taken from specimens collected from Natal estuaries have provided information for an identification key to the *Gerres* of southern Africa. Body markings were different on each species of fry (< 40 mm S.L.) as well as immatures and adults (> 40 mm S.L.). A comparison of otoliths from the different species showed that they can be used to identify specimens from a standard length of 20 mm. Turbidity may be a factor limiting the distribution of the genus in estuaries. The known distribution of *Gerres* species in the estuaries of southern Africa is given. The species of *Gerres* which is dominant in a particular locality depends on the salinity.

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Vergelyking van gepubliseerde taksonomiese data met afmetings van eksemplare vanaf breë riviermonde in Natal het inligting verskaf vir 'n identifikasiesleutel tot die *Gerres*-soorte van suidelike Afrika. Vlekke op die lyf was verskillend vir die jong vissies van elke spesies (< 40 mm S.L.) sowel as onvolwassenes en volwassenes (> 40 mm S.L.). 'n Vergelykende studie van die otoliete van die verskillende spesies dui daarop dat hulle gebruik kan word vir die identifikasie van eksemplare met 'n standaardlengte van 20 mm of meer. Die soutgehalte van die water bepaal watter *Gerres*-spesies in 'n spesifieke lokaliteit oorheers. Troebelheid van die water mag moontlik die distribusie van die genus in breë riviermonde beperk. Die verspreiding van *Gerres*-soorte in suidelike Afrika word ook beskryf.

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During a study of the Gerreidae in the estuaries of Natal (Cyrus 1980) it was found that available keys to species identification were inadequate and inaccurate. In order to draw up a suitable key for the species occurring in southern Africa a number of taxonomic papers were consulted and details of synonyms and meristic data noted. The latter were then compared with measurements taken from specimens collected in Natal estuaries. This lead to a review of methods of species identification and a revised key to the members of the genus *Gerres* occurring in southern Africa but not a taxonomic revision. Once a method of species identification had been established, information on the distribution and abundance of *Gerres* in estuaries was collected from July 1978 to July 1980. These results were compared with salinities and turbidities within the estuaries investigated and species' preferences established.

Materials and Methods

Owing to the confused state of the taxonomy of the genus *Gerres* numerous publications were consulted as well as specimens examined in order to establish the nomenclature of the species in southern Africa. Species were initially identified using keys from Munro (1955 & 1967) and Smith (1972), but these were found to be inadequate. A key to *Gerres* of southern Africa was therefore drawn up from the published keys and from measurements on collected specimens. Otoliths were removed by dissection from adults and juveniles of each species as an aid to species identification. The otoliths were cleaned, dried and photographed.

The distribution of the *Gerres* species occurring in the estuaries of southern Africa was determined by consulting published works and by sampling estuaries in Natal between July 1978 and July 1980 (Figure 1). Results from seine-netting within the Kosi system were used to determine the distribution within the system of the various species (Figure 2). The salinity tolerances and turbidity preferences of each *Gerres* species were assessed from their distribution patterns in the Kosi and St Lucia systems, the Mlalazi, Fafa and Mtamvuna estuaries. Salinities were measured in parts NaCl per thousand (‰), with a Goldberg Optical Salinometer, and turbidities were measured in Nephelometric Turbidity Units (N.T.U.) using a Hach 16800 Turbidimeter.

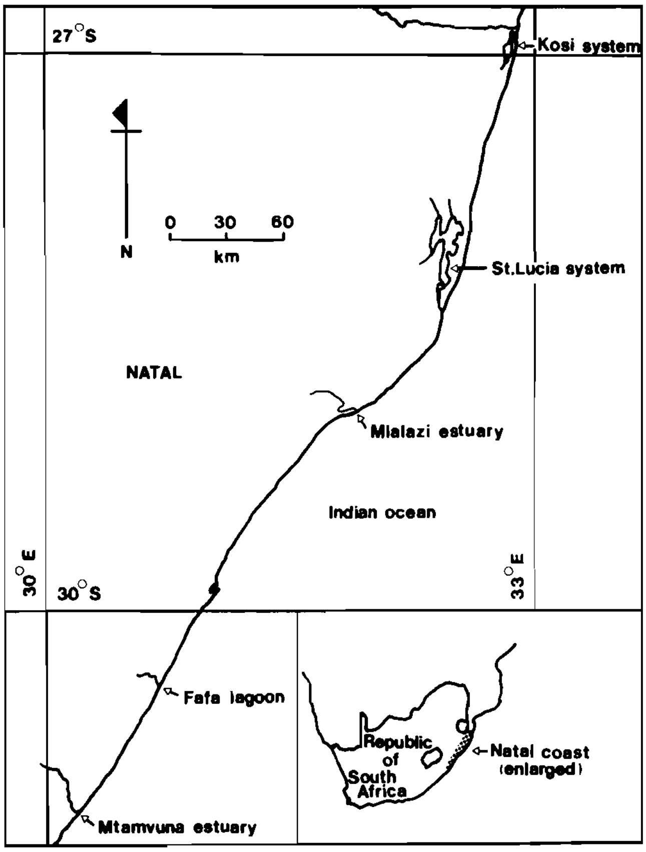


Figure 1 Sampling sites on the Natal coast.

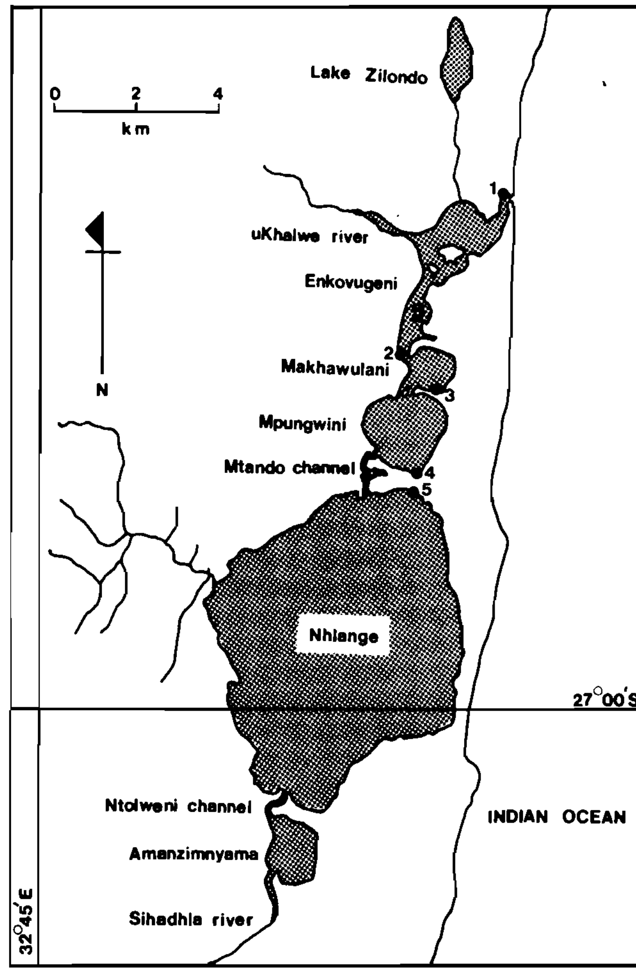


Figure 2 The Kosi system (● = sampling sites; 1 = Estuary; 2 = Water Level Recorder; 3 = Makhawulani; 4 = Mpungwini; 5 = Nhlange).

Results and Discussion

Classification

The family Gerreidae, commonly known as pursemouths, mojarras or silver-biddys, are marine, although occasionally found in brackish and fresh water, and inhabit warm seas (Nelson 1976). The former family name Gerridae is pre-occupied by the water striders of the insect order Hemiptera (Melville 1971) and hence the name was changed to Gerreidae. Nelson (1976) gives the following genera: *Diapterus, Eucinostomus, Gerres, Parequula, Pentaprion, Ulaema* and *Xystaema;* stating that the family comprises some 40 species. Austin (1971) stated that 'The Gerreidae are New World fishes, with the exception of two species found in Africa'. This is incorrect as F.A.O. (1974) lists 12 species (plus a further 13 which are possibly synonyms) as occurring in the east Indian and west central Pacific oceans and does not include *G. rappi* (west Indian ocean) or *G. ovatus* (east coast of Australia). Only the genus *Gerres,* of which six species have been recorded, occurs along the coast of southern Africa (Smith 1972). They are tropical species which reach the southern limit of their distribution in this region. During this study five of the six species were recorded in Natal estuaries. The nomenclature of the Gerreidae is confused. Some species have been described more than once, usually from different parts of the world, while a number of species have been placed in different genera by different authors. The six species occurring in southern Africa are listed below, using the name which is considered to hold priority. A full synonomy is given together with any incorrect generic classifications. For the latter only the first author to use the classification has been listed. The numbers follow Smith (1972) while scientific, with the exception of *G. poieti* (spelt *poeti* in Smith), and common names are those from Smith (1975). As it was impossible to consult all original descriptions and classifications, data were drawn from the following works:- Gilchrist & Thompson (1917), Fowler (1925, 1928, 1933 & 1934), Barnard (1927), Munro (1955 & 1967), Smith (1972), F.A.O. (1974) and Venkataraman & Badrudeen (1975). Figure 3 shows similar sized individuals (for comparison of shape) of five species of *Gerres* from Natal estuaries.

628. *Gerres filamentosus* Cuvier. Threadfin pursemouth

Gerres filamentosus Cuvier 1829
Gerres punctatus Cuvier 1830
Catochaenum filamentosus Cantor 1849
Gerres macracanthus Bleeker 1854
Sparus edentulus Günther 1859
Geores filamentosum Mason 1860 (misprint)
Gerres philippinus Günther 1862
Diapterus filamentosus Bleeker 1868
Diapterus philippinus Bleeker 1873
Diapterus macracanthus Bleeker 1873 – 77
Gerres cheverti Alleyne and Macleay 1876
Xystaema punctatum Jordan and Seale 1905
Xystaema macracantha Fowler 1918
Pertica filamentosa Munro 1955

Munro (1967) and Venkataraman & Badrudeen (1975) considered *G. macracanthus* to be distinct from *G. filamen-*

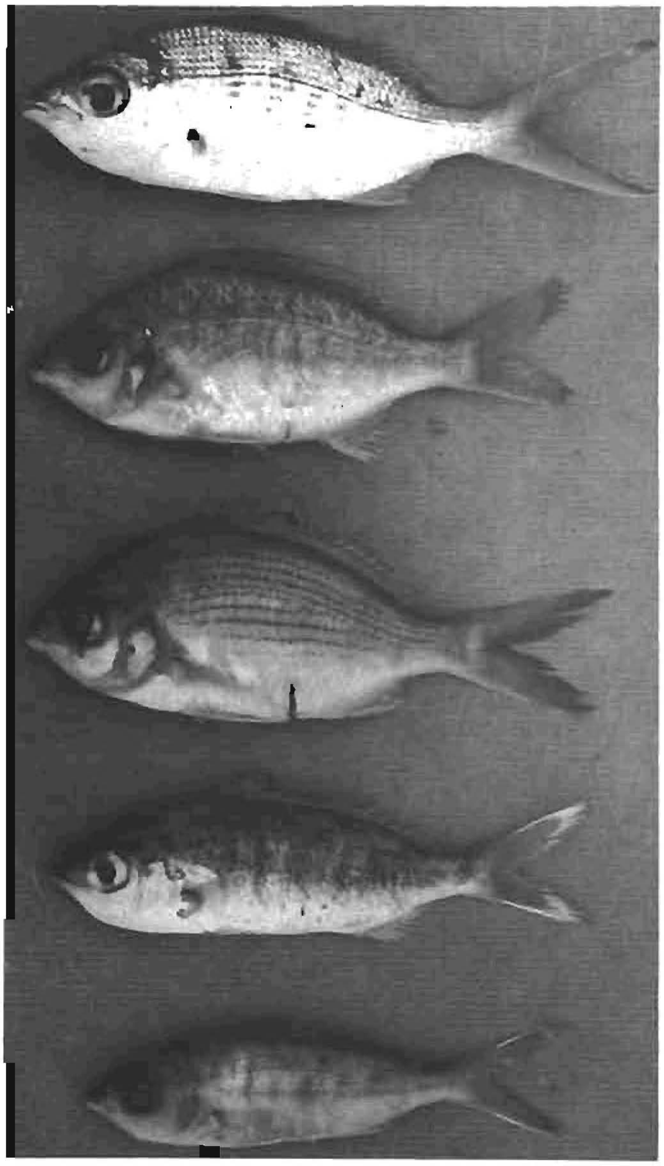


Figure 3 The five species of *Gerres* occurring in Natal estuaries; top to bottom, *G. acinaces* (110 mm S.L.), *G. filamentosus* (117 mm S.L.), *G. rappi* (111 mm S.L.), *G. oyena* (108 mm S.L.), *G. oblongus* (95 mm S.L.).

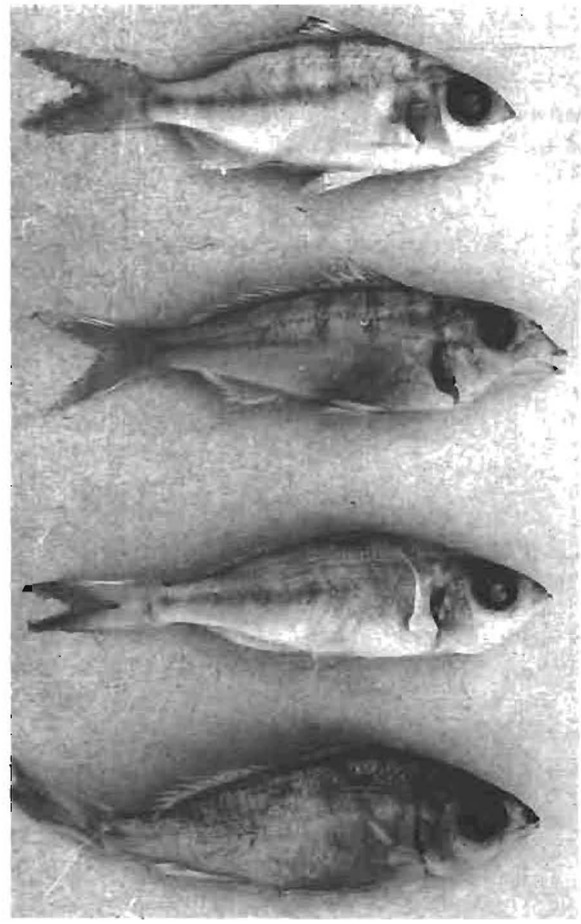


Figure 4 Four species of *Gerres* fry from the Kosi system; top to bottom, *G. rappi* (33 mm S.L.), *G. filamentosus* (34 mm S.L.), *G. acinaces* (34 mm S.L.), *G. oyena* (38 mm S.L.).

tosus based mainly on different scale counts of 42 – 44 and 46 – 48 respectively and the presence of 5 – 10 brownish diffuse bars across the back of *G. macracanthus* compared with 6 – 11 regular rows of greyish black spots above and below the lateral line of *G. filamentosus*. Fowler (1928) considered that the description of *G. macracanthus* 'was evidently based on immature examples, more slender and with dark vertical bars'. The specimens examined by Venkataraman & Badrudeen (1975) between 114 and 156 mm total length were obviously immature (Cyrus & Blaber, in press). Both 'types' were found during this study. Those of the *G. macracanthus* 'type' were all under 100 mm standard length. All fry (< 40 mm S.L.) collected during this study (Figure 4) were similar to those illustrated by Fowler (1933) and had 5 – 7 vertical bars on the dorsal half of the body. After consulting published works and examining collected specimens it was decided that the barred fish were immatures of *G. filamentosus* and therefore the classification given by Fowler (1933) has been adopted.

629. *Gerres oyena* (Forskål). Slenderspine pursemouth

Labrus oyena Forskål 1775
Sparus erythcorus Bloch 1790
Labrus longirostris Lacépède 1802
Sparus britannus Lacépède 1802
Smaris oyena Ruppell 1828
Gerres oyena Cuvier 1830
Gerres equula Schlegel 1844
Gerres oblongus (not Cuvier) Bleeker 1845
Gerres longicaudis Alleyne and Macleay 1876
Diapterus oyena Bleeker 1876 – 77
Gerres rhombeus (not Cuvier) Schmeltz 1881
Gerres ruppellii Klunzinger 1884
Gerres splendens de Vis 1885
Gerres oyena Saville-Kent 1893 (error)
Eucinostomus equula Jordon and Snyder 1901
Xystaema oyena Smith and Pope 1906
Xyxtaema oyena Seale and Bean 1907 (misprint)
Xystaema erythrourum Jordan 1907
Gerres erythrourus Jordan and Hubbs 1925
Xystaema erytrourum Schmidt 1931 (error).

Fowler (1933) treated *G. acinaces* as a synonym of *G. oyena*, mentioning however, that colouration and appearance in this species were quite variable as a result of the preparation of museum specimens. After examination of over 600 *G. acinaces* and 100 *G. oyena* during this study, it was obvious that they are completely different species (see Tables 1 & 2 and Figures 3 & 4), and therefore following Smith (1972) we have accepted them as such for this work. F.A.O. (1974) listed *G. argyreus* (Bloch & Schneider 1801) as a synonym of *G. oyena* which is still in use. However, apart from the differences in L.1. scale count (45 – 46 for the former and 35 – 38 for the latter) literature searches did not reveal any other author who has even suggested this synonym.

630. *Gerres poieti* Cuvier. Strongspine pursemouth
Gerres poieti Cuvier 1829
Gerres poeti Cuvier 1830
Gerres poetie Bleeker 1853
Diapterus poeti Bleeker 1876 – 77
Diapterus poetie Bleeker 1876 – 77
Xystaema poieti Fowler 1918
Xystaema kapas (not Bleeker) Fowler 1918
Xystaema oyena (not Forskål) Fowler 1918
Gerres methueni Regan 1920

This species was not found during the study period and no records of it entering estuaries in southern Africa can be found. A record from Durban (Smith 1972) probably refers to a specimen collected by Bell-Marley in 1919 (Fowler 1934) which had a (? total) length of 225 mm. Smith (1972) states that this species is doubtfully distinct from *G. oyena*. F.A.O. (1974) stated that the two species can be separated by pectoral fin length; in *G. oyena* they reach beyond the anal origin while in *G. poieti* they do not. This criterion is not valid since all specimens of the former, examined during this study, had pectoral fins not reaching the anal origin. Munro (1967) states that in neither species do the pectorals reach the anal origin.

This species has been seen in Australia and is quite unlike *G. oyena* (see Table 2 for differences). Two specimens (each 64 mm S.L.) were examined from Trinity Inlet, Cairns, Queensland, Australia. These fish key to *G. poieti* using Munro (1967) with the following features being noted:- D IX 10, A III 7, L.1.39/40, depth 2,4 and predorsal length subequal to body depth but much less than dorsal base (in *G. oyena* predorsal length greater than body depth). Although all works consulted (except Fowler 1933) mention the very strong and broad dorsal and anal spines, this feature was not noted in the above specimens. However, as this species is said to attain a standard length of over 200 mm (Munro 1967) the two from Trinity Inlet (64 mm S.L.) must be immatures. Another feature illustrated in Munro (1967) and Fowler (1933) and shown by the Trinity Inlet specimens but not mentioned by any authors is the post-cranial profile which is flat rather than convex. No other species shows this distinct feature. From the above it was decided that the specific status of *G. poieti* is valid and should be retained.

631. *Gerres acinaces* Bleeker. Smallscale pursemouth
Gerres acinaces Bleeker 1854
Diapterus filamentosus (not Cuvier) Bleeker 1863
Gerres lineolatus Playfair 1866
Diapterus acinaces Bleeker 1876 – 77
Gerres socotranus Steindachner 1902
Xystaema acinaces Kendall and Goldsborough 1911.

G. acinaces was considered a synonym of *G. oyena* by Fowler (1933) and suggested as such by Smith (1972). However, after examination of specimens (as discussed

Table 1 Standard length/depth ratios of five *Gerres* species from southern African estuaries.

Species	Sample number	Size range (S.L.mm)	Range S.L./ depth ratio	$\bar{X}$	Standard deviation
G. acinaces	23	77 – 197	2,605 – 2,887	2,740	0,084
G. filamentosus	34	59 – 175	2,097 – 2,792	2,435	0,171
G. oblongus	20	79 – 98	3,175 – 3,489	3,351	0,085
G. oyena	31	69 – 119	2,844 – 3,087	3,004	0,062
G. rappi	32	71 – 160	2,126 – 2,435	2,307	0,075

Table 2 Comparative features of six *Gerres* species occurring in southern Africa

Species	*n*	Dorsal spines/ rays	Anal spines/ rays	Attachment of scales	Second dorsal	Pectorals reach beyond anal origin	Lateral line scale count	S.L./depth ratio Munro (1967) Smith (1972)	S.L./depth ratio This study (see Table 1)	Dorsal/ anal spines very strong
G. acinaces	23	IX 10	III 7	firm	normal	Yes	42 – 45	2,6 – 2,75 about 2,75	2,6 – 2,9	No
G. filamentosus	34	IX 10 – 11	III 7 – 8	firm	elongate into free filament	Yes	40 – 48	2,0 – 2,8[a] 2,0 – 2,5	2,0 – 2,8	No
G. oblongus	20	IX 10	III 6 – 7	firm	normal	No	43 – 48	3,0 – 3,5 3,25 – 3,5	3,15 – 3,5	No
G. oyena	31	IX 10 – 11	III 7	easily shed	normal	No	35 – 38	2,5 – 3,0 2,3 – 2,75	2,8 – 3,1	No
G. poieti[b]	–	IX 10	III 6 – 7	easily shed?	normal	No	35 – 42	2,1 – 2,5 2,25 – 2,5	–	Yes ? adult only
G. rappi	32	IX 10 – 11	III 7	firm	normal	Yes	45 – 48	– about 2,5	2,1 – 2,5	No

[a]Range includes *G. macrocanthus* - synonym
[b]All data from Munro (1967) and Smith (1972)
n = number

under *G. oyena* above), it was concluded that *G. acinaces* is a valid species (compare Figures 3 & 4 and features given in Tables 1 & 2).

632. *Gerres rappi* (Barnard). Evenfin pursemouth
Gerres longirostris (not *Labrus longirostris* Lacépède, 1803) (Rapp) Günther 1861
Xystaema rappi Barnard 1927

Some consider that *G. abbreviatus* Bleeker and *G. rappi* are the same species, the main difference being the L.1 scale count. Smith (1972) suggests that *G. rappi* (L.1. 45 – 48) is probably identical to *G. abbreviatus* (L.1. 38 – 40), Munro (1967) states that *G. abbreviatus* has L.1. 32 – 35 and F.A.O. (1974) does not list any synonyms for *G. abbreviatus* in current use. An examination of *G. abbreviatus* in Queensland, Australia, showed that apart from the differences in scale count it appears identical to *G. rappi*. Blaber (1980) in fact shows *G. abbreviatus* as equal to *G. rappi*. If they are indeed the same species then *G. abbreviatus* is senior and has priority. However, in the absence of substantiating evidence *G. rappi* is considered a separate species.

633. *Gerres oblongus* Cuvier. Oblong pursemouth
Gerres oblongus Cuvier 1830
Gerres gigas Günther 1862
Gerres macrosoma (not Bleeker) Kner 1868
Gerres carinatus Alleyne and Macleay 1876
Gerres oblongatus Pearson 1914 (error)
Xystaema oblongus Barnard 1927

This species has been least affected by problems of nomenclature. It is the most slender *Gerres* species and has a depth of 3,15 – 3,50 (Tables 1 & 2).

Identification of species occurring in southern Africa

From the beginning of this study it was found that the key to the *Gerres* in Smith (1972) was inadequate and confusion was caused by the illustration of *G. acinaces* (No. 631 — Plate 35 of Smith) which is labelled *G. oyena* (No. 629). Data from collected specimens, now deposited with the J.L.B. Smith Institute for Ichthyology, as well as other keys on *Gerres* were consulted in order to establish correct identification of the species in the estuaries of Natal. Works used included: Munro (1955 & 1967) and the United Nations F.A.O. species identification sheets — F.A.O. (1974).

Other workers on the east coast of southern Africa who used Smith's (1972) key and illustrations probably misidentified most species. The major problem with Smith's (1972) key is that not all *G. rappi* have the last dorsal spine equal to the first ray, thus a *G. rappi* which has the last dorsal spine shorter than the first ray will key to *G. acinaces*, while the incorrect illustration of *G. oyena* could lead to all *G. acinaces* being identified as *G. oyena*. The main features of the six species occurring in southern Africa are shown in Table 2, and the following key should permit their rapid identification.

Key to *Gerres* of southern Africa

1. Second dorsal spine longer than head .... *filamentosus*
Second dorsal spine not longer than head 2
2. Depth 2,1 – 2,5 3
2,6 – 3,1 4
3,15 – 3,5, pectorals do not reach beyond anal origin,
L.1. 43 – 48 .... *oblongus*
3. L.1. 45 – 48, pectoral fins reach beyond origin of anal .... *rappi*
L.1. 35 – 42, pectoral fins do not reach beyond origin of anal .... *poieti*
4. L.1. 42 – 45, pectoral fins reach beyond origin of anal .... *acinaces*
L.1. 35 – 38, pectoral fins do not reach beyond origin of anal .... *oyena*

Body marking of *Gerres* species

In addition to the features shown in Tables 1 and 2, the body markings of the species differ to some extent, while those of the fry (< 40 mm S.L.) differ from those of the immatures and adults (specimens) > 40 mm S.L.) and further aid identification.

Body markings of Gerres longer than 40 mm *S.L. (Figure 3)*

G. filamentosus — adults and some immatures with longitudinal rows of oval blotches in vertical series, immatures with 5 – 10 diffuse bars across the back. After preservation in formalin the blotches fade while the bars show up more strongly.
G. oyena — dark blotches on dorsal part of body with a series of faint chevrons.
G. poieti — more or less distinct dark lines along horizontal scale rows, Trinity Inlet specimens and Munro (1967).
G. acinaces — longitudinal rows of oval blotches arranged in vertical series.
G. rappi — distinct dark lines along horizontal scale rows.
G. oblongus — row of faint chevrons along side of body.

Body markings of Gerres fry(<40 mm *S.L.) (Figure 4)*

G. filamentosus — second spine of dorsal fin not elongate as in adults. Distinct row of five to seven vertical bars on dorsal part of body, inner web of tail unmarked.
G. oyena — dark marking over head and along base of dorsal fin with faint series of diagonal bars along dorsal half of body, inner web of tail dark.
G. poieti — not established.
G. acinaces — dark markings along base of dorsal fin with faint diagonal blotches (5 to 6) along dorsal half of body, inner web of tail dark.
G. rappi — four to six light vertical bars along dorsal half of body, inner web of tail dark.
G. oblongus — distinct crossbands (Munro 1967).

Otoliths as an aid to species identification

The morphology of otoliths is known to be species specific (Botha 1971), and in recent years has become an important taxonomic aid (Hecht 1978; Hecht & Hecht 1978 & 1979). Fish otoliths are structures of the nervous system buried in the cranium and their evolution may be independent of natural selection. They may, therefore, be of greater value in interpreting evolutionary relationships and lineages than adaptive structures (Frizzel 1965, quoted in

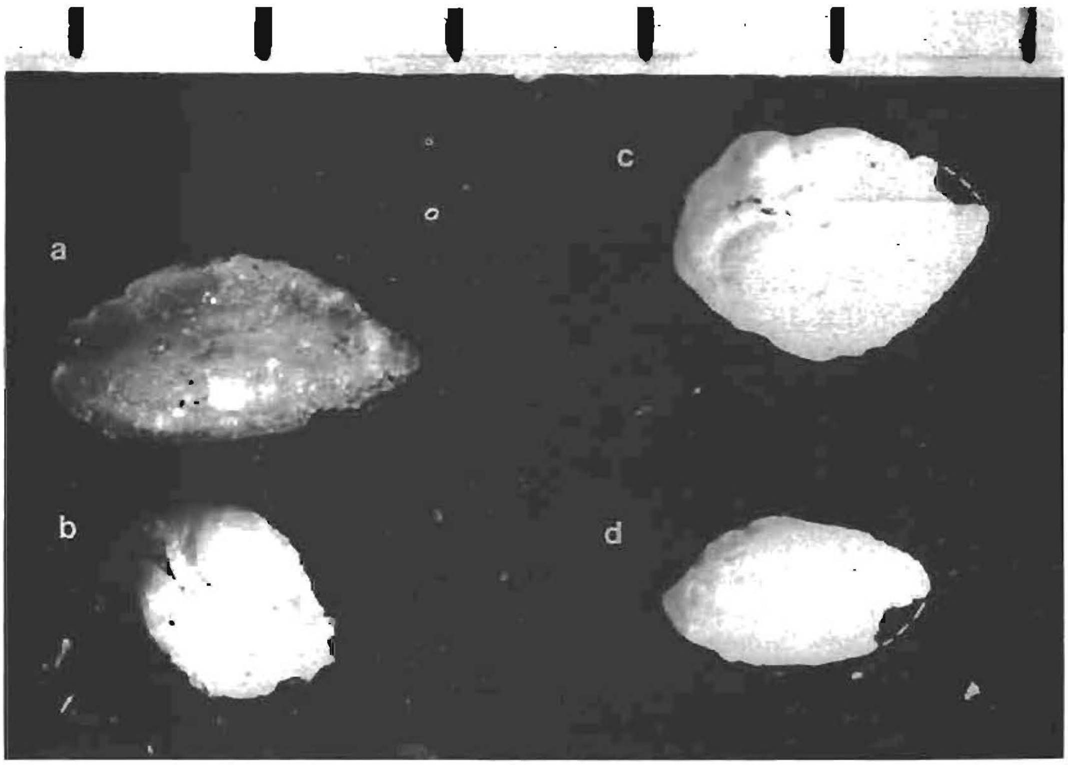


Figure 5 Otoliths from the fry of four species of *Gerres* from the Kosi system: a. *G. oyena* (S.L. 35 mm); b. *G. filamentosus* (S.L. 27 mm); c. *G. acinaces* (S.L. 27 mm); d. *G. rappi* (S.L. 27 mm); scale: each division represents 1 mm.

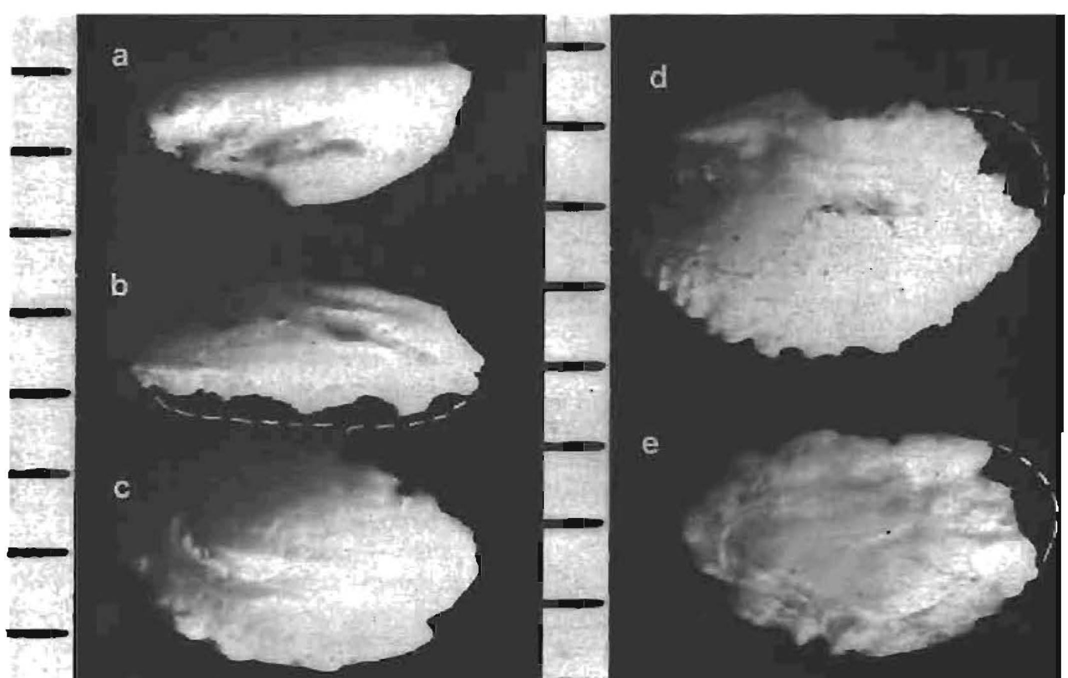


Figure 6 Otoliths of five species of *Gerres* from the Kosi system: a. *G. oyena* (S.L. 115 mm); b. *G. rappi* (S.L. 115 mm); c. *G. oblongus* (S.L. 118 mm); d. *G. acinaces* (S.L. 116 mm); e. *G. filamentosus* (S.L. 114 mm); scale: each division represents 1 mm.

Fitch & Schultz 1978). Methods estimating fish length from otolith size have been devised by Baird (1970) and Jonsson & Stenseth (1977). Otoliths can also be used to identify decomposed prey items found during stomach analyses (Whitfield 1977) and to estimate the size of prey.

The different species of *Gerres* could be identified using otolith shape. Although changes take place with growth, the basic form is present from an early age and otoliths of fry of *G. acinaces*, *G. filamentosus*, *G. oyena* and *G. rappi* were distinguishable from a standard length of 20 mm. Figure 5 shows the otoliths of four species of *Gerres* fry while Figure 6 shows the otoliths of five species of *Gerres* of similar size. The following specific features were noted.

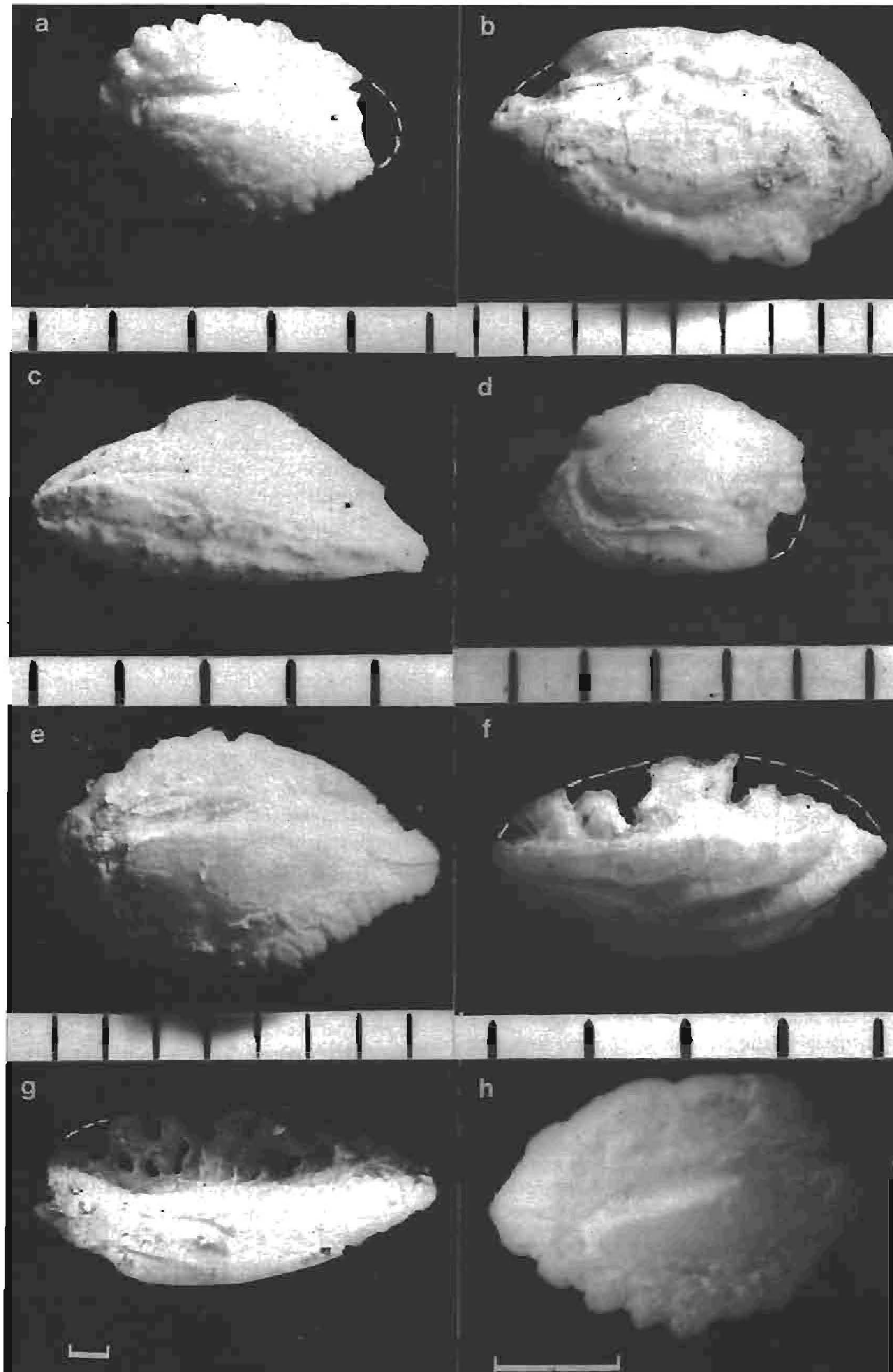


Figure 7 *Gerres* otoliths from the Kosi system: a. *G. filamentosus* (S.L. 81 mm); b. *G. filamentosus* (S.L. 168 mm); c. *G. oyena* (S.L. 130 mm); d. *G. acinaces* (S.L. 99 mm); e. *G. acinaces* (S.L. 219 mm); f. *G. rappi* (S.L. 96 mm); g. *G. rappi* (S.L. 203 mm); h. *G. oblongus* (S.L. 65 mm).

G. filamentosus (Figures 5, 6, 7a & 7b).

Young individuals have distinctly rounded otoliths (up to 90 mm S.L.) (Figure 5) while those of larger specimens are more oval (Figure 7b). A single groove is present just off the midline of the long axis. The radial lobes of the opposite side are irregular in shape. Figure 8c shows a cross section of a *G. filamentosus* otolith. No differences were noted between the otoliths of *'macracanthus'* and *'filamentosus'* fish.'

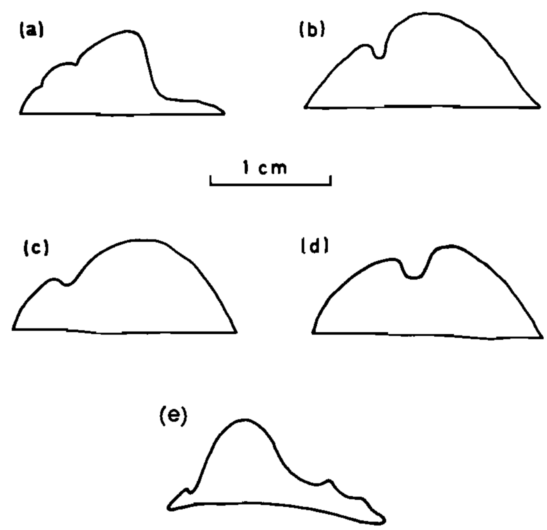


Figure 8 Cross-sections of *Gerres* otoliths (a) *G. rappi*, (b) *G. acinaces* (c) *G. filamentosus*, (d) *G. oblongus*, (e) *G. oyena*

G. oyena (Figures 5, 6 & 7c)

The otoliths are oblong shaped (Figure 7c), with one half of the long axis thinner than the other. In cross section (Figure 8e) it is similar to that of *G. rappi* (Figure 8a), except that the thin half has two small ridges and the slope is not as steep. A shallow groove running parallel to the long axis is present on the outer edge of the thicker half of the otolith. The margin of the thin half consists of two more or less straight sections which converge to a point midway along the long axis (Figure 7c).

G. acinaces (Figures 5, 6, 7d & 7e).

Throughout its size range the otoliths of this species retain a diamond-like shape, a single groove is present along the long axis, situated to the one side of the mid-line. The radial lobes of the opposite side are irregular in shape. Figure 8b shows a cross sectional view of a *G. acinaces* otolith.

G. rappi (Figures 5, 6, 7f & 7g).

The otoliths of this species are oblong in shape with one side of the long axis thinner than the other (see cross section of otolith Figure 8a). The thicker side has two grooves running parallel on the long axis. Shape appears to change little with age but from about 100 mm, small holes appear in the thin portion of the otolith. The largest fish examined (203 mm) had numerous small holes in this portion (Figure 7g).

G. oblongus (Figures 6 & 7h).

The otoliths were diamond-like in shape with a single groove running down the long axis almost in the mid-line (Figure 8d). The most distinct features were the radial lobes, which are large and regularly shaped and situated along one side (Figure 7h).

Distribution and abundance

Kosi system

Seine-netting during 1979 (Table 3) showed the following:-

G. filamentosus occurred throughout the system and was most common during summer and autumn. It was present throughout the year only at the estuary and was almost completely absent from the other seining sites during winter and spring. Fry were collected only during the summer and winter at the estuary. The size range collected was from 14 to 168 mm with individuals over 100 mm uncommon.

G. oyena was found in the tidal basin of the estuary during autumn and winter with only three individuals collected higher up the system. Only four specimens of fry were collected (during autumn) from the Water Level Recorder (W.L.R.) and Makhawulani. The size range collected was from 27 to 143 mm. Those between 95 and 120 mm were most common.

G. acinaces was abundant at all times of the year throughout the system except in Nhlange. Fry were present during all four seasons from the estuary to Mpungwini. The sizes ranged from 9 to 230 mm with individuals over 160 mm uncommon.

G. rappi occurred throughout the system. It was rare in the estuary basin but abundant in Nhlange during summer and autumn. Large pre-spawning shoals occurred in the channel area between the W.L.R. and the mouth (not the tidal basin) during summer and autumn (Cyrus & Blaber, in press). Fry were present at all seasons except summer and were found throughout the system. The size range collected was from 14 to 224 mm with individuals over 200 mm uncommon.

G. oblongus was present in small numbers throughout the year but only in the tidal basin of the estuary. No fry were found. Sizes ranged from 76 to 122 mm.

Table 3 Catch per unit effort from seine-netting of *Gerres* (> 40 mm S.L.) at five sites in the Kosi system during 1979. (S = summer; A = autumn; W = winter; Sp = spring)

	G. acinaces				*G. filamentosus*				*G. rappi*				*G. oyena*				*G. oblongus*			
	S	A	W	Sp	S	A	W	Sp	S	A	W	Sp	S	A	W	Sp	S	A	W	Sp
Estuary	13,0	7,5	6,5	4,0	1,8	10,3	15,7	0,2	0,1	-	1,0	-	-	4,1	5,0	-	0,5	1,7	0,8	0,6
Water Level Recorder	5,4	3,7	3,8	9,5	4,8	3,0	-	-	77,7	3,7	-	-	-	0,2	-	-	-	-	-	-
Makhawulani	8,0	7,0	9,1	17,3	22,0	3,8	0,1	-	16,0	4,0	-	-	-	0,1	-	-	-	-	-	-
Mpungwini	8,8	5,6	6,2	14,8	5,6	0,1	0,1	-	6,8	-	-	-	-	-	-	-	-	-	-	-
Nhlange	0,1	0,3	-	0,9	2,9	0,5	-	1,6	22,1	10,8	-	11,6	-	-	-	-	-	-	-	-

Lake St Lucia, Mlalazi, Fafa and Mtamvuna estuaries

During the study period St Lucia was sampled three times, Mlalazi twice and the last two once. Table 4 lists the species recorded at each locality and their relative abundance.

Distribution and salinity

Table 5 shows the salinity ranges in which five *Gerres* species have been recorded in southern African estuaries.

Kosi system

Table 6 shows the percentage composition by species of seine catches at each sampling locality. *Gerres acinaces* were abundant from 35 to 3‰ but were rare in Nhlange where salinities were between 0,5 and 1‰. *G. filamentosus* were commonest in higher salinities while *G. rappi* was only abundant in the low salinities of Nhlange. *G. oyena* (Blaber & Blaber 1980) and *G. oblongus* may not be euryhaline as they only occurred in small numbers at the estuary (35 – 20‰). *G. oyena* was recorded once in Makhawulani at a salinity of 8‰.

Lake St Lucia, Mlalazi, Fafa and Mtamvuna estuaries

The salinities from which *Gerres* were collected in these estuaries are shown in Table 7. The salinities for these localities were within the ranges from which *Gerres* were recorded in the Kosi system with the exception of *G. rappi* in 39‰ in Lake St Lucia.

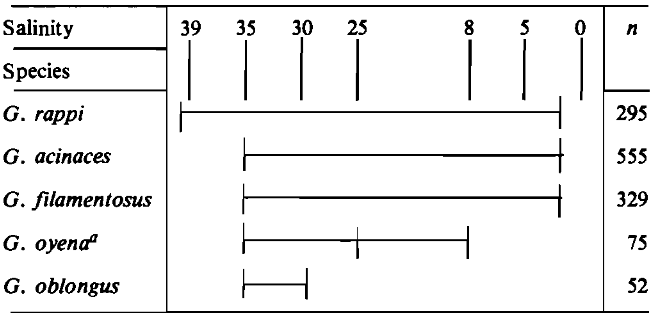
Distribution and turbidity

Turbidity in the systems sampled varied but Kosi was exceptionally clear with turbidity always less than 5 Nephelometric Turbidity Units (NTU) (Table 8), while St Lucia was very turbid, often exceeding 100 NTU depending on weather conditions (Table 9). The other three estuaries sampled had intermediate to high turbidities (Table 9). The small differences in turbidity between localities in Kosi (Table 8) appeared not to influence the distribution of *Gerres* in the system.

Table 4 Relative abundance of *Gerres* in four Natal estuaries (F = Fry; Imm. = Immature; A = Adult)

Species	Age	St Lucia	Mlalazi	Fafa	Mtamvuna
G. acinaces	F	Present/ estuary	– Present	–	–
	Imm.& A.	–			
G. rappi	F	Common/E. shores	–	–	–
	Imm.& A	Present	Present	Common	Common
G. filamentosus	F	–	Present	–	–
	Imm.& A	–	Abundant	–	Present

Table 5 Observed salinity (‰) ranges of *Gerres* species in southern Africa



[a]Only three specimens recorded between 25 and 8‰ — this study
n = number

Table 6 Percentage of each species of *Gerres* present in the different parts of the Kosi system during 1979
(G. acin. = G. acinaces; G. filament. = G. filamentosus)

Locality (see Figure 2)	*G. acin.* %	*G. filament.* %	*G. rappi* %	*G. oyena* %	*G. oblongus* %
Estuary salinities 35 – 20‰	43	39	1	12	5
Makhawulani salinities 14 – 7‰	47	30	22	<1	0
Mpungwini salinities 6 – 3‰	74	12	14	0	0
Nhlange salinities 1 – 0,5‰	3	9	88	0	0

Table 7 Salinities and ranges in which *Gerres* were recorded at four Natal Estuaries (see Figure 1)

Species	St Lucia	Mlalazi	Fafa	Mtamvuna
G. filamentosus	–	30 – 35	–	4,5 – 34,5
G. acinaces	31,5	30 – 35	–	–
G. rappi	36,5 – 39	30 – 35	0,5	4,5 – 34,5
Range recorded in estuary	18 – 45	18 – 35	0 – 1	1 – 34,5

Table 8 Turbidities (N.T.U.) recorded at seining sites in the Kosi system during 1980

Locality (see Figure 2)	January	April	July	September
Estuary	0,5	1,0	1,4	1,6
Water Level Recorder	2,0	2,2	0,8	1,3
Makhawulani	0,4	1,1	0,6	0,9
Mpungwini	0,5	1,6	1,6	2,2
Nhlange	3,0	3,8	2,6	4,7

Table 9 Turbidities (N.T.U.) recorded in four estuarine systems during 1980 and observed turbidity ranges of *Gerres* species

Locality	Turbidity range in system	Turbidity range from which *Gerres* were collected	No. of fish
Lake St Lucia	2,7 – 244,0	4,2 – 26,0 and 63 – 71 (3 specimens)	112
Mlalazi Est.	4,4 – 36,0	6,3 – 21,5	437
Fafa Est.	11,7 – 29,5	12,5 – 25,0	37
Mtamvuna Est.	6,3 – 86,0	6,3 – 24,0	30

Distribution of *Gerres* in the estuaries of southern Africa

Table 10 summarizes the published records of *Gerres* in the estuaries of southern Africa as well as those from this study. Distribution records were obtained from the following:- Day, Millard & Broekhuysen (1954); Millard & Harrison (1954); Day & Morgans (1956); Broekhuysen & Taylor (1959); Millard & Broekhuysen (1970); Wallace (1970 & 1975); Hemens *et al.* (1972 & 1973); Day (1974 & 1981); Wallace & van der Elst (1975); Branch & Grindley (1979) and Whitfield (1980a & b).

The distribution of *Gerres* in Kosi is similar to that found by Blaber (1978). They differ, however, from those of Broekhuysen & Taylor (1959) who gave no records of *Gerres* further up the system than the W.L.R., up to which locality (from the Ukhalwe river) they found *G. oyena* common. They make no mention of *G. filamentosus* or *G. oblongus* and only refer to *G. acinaces* as present. Wallace *et al.* (1971) obtained results which differed from all the above. They found *G. acinaces* and *G. oyena* abundant from Nhlange to the sea, giving records of catches of 308 *G. acinaces* (35 – 223 mm) and 14 *G. oyena* (98 – 222 mm) from Nhlange over a three-day period in August 1971. They also recorded the other three species and gave a record of *G. oblongus* from Makhawulani.

The differences in *Gerres* distribution in the Kosi system during the three surveys are puzzling. There are two possible reasons for the differences; firstly, changes in salinity regimes and, secondly, problems of identification. The Kosi system has a freshwater inflow and shows patterns typical of an estuarine system where salinities vary according to freshwater inflow, tidal state and distance from the sea. Table 11 shows salinities recorded in different parts of the system during the three surveys. More details on salinity changes in the Kosi system are given in Blaber & Cyrus (1981). Problems of misidentification could have arisen as a result of the misleading key in Smith (1972) and all editions since 1949.

Austin (1971) studied three species of *Diapterus* (Gerreidae) in Puerto Rico and found that, although all were feeding on similar food items, interspecific competition was reduced because each was dominant in a different salinity. The situation in the Kosi system may be similar but not as definite (Table 6). Salinity apparently affects the distribution of *Gerres* species in Kosi and may thus help the five species to coexist.

The results show that *G. filamentosus, G. acinaces* and *G. rappi* are fully adapted to estuarine salinities while *G. oyena,* although appearing from recorded tolerances to be able to exist in estuarine conditions, is usually absent cor-

Table 10 Distribution of *Gerres* species in estuaries of southern Africa (F + J = Fry and Juveniles; I + A = Immatures and Adults; ( ) = this study; M = Mocambique; N = Natal; T = Transkei; C = Cape; *G. acin.* = *G. acinaces; G. fil.* = *G. filamentosus; G. ob.* = *G. oblongus)*

Species		*G. acin*		*G. fil.*		*G. ob.*		*G. oyena*		*G. rappi*	
Estuary		F+J	I+A	F+J	I+A	F+J	I+A	F+J	I+A	F+J	I+A
Morrumbene	M		X		X		X		X		
Kosi	N	(X)	(X)	(X)	(X)		(X)	(X)	(X)	(X)	(X)
St Lucia	N	(X)	X	(X)	X		X	X	X	(X)	(X)
Richards Bay	N		X	X	X		X	X	X		X
Mlalazi	N		(X)	(X)	(X)		X		X	(X)	(X)
Matigulu	N			X	X						
Tongati	N			(X)							
Zinkwazi	N		X		X		X		X		X
Mdloti	N									(X)	
Mhlanga	N									(X)	(X)
Durban Bay	N	X	X	X	X		X	X	X		X
uMgababa	N		X		X				X		X
Mkomazi	N		X								
Fafa	N										(X)
Mtentweni	N		X		X				X		X
Mtamvuna	N		X		(X)				X		(X)
Mtentu	T				X						
Msikaba	T				X						X
Ntafufu	T	X		X				X			
Umzimvubu	T		X		X						X
Umgazi	T		X		X						X
Mngazana	T		X								
Bashee	T				X						X
Keiskama	C				X						X
West Kleinemond	C				X						
Bushmans	C				X						X
Sundays	C										X
Zwartkops	C										X

Table 11 Salinities (‰ recorded by different authors in the Kosi system (see Figure 2)

Locality	Broekhuysen & Taylor (1959). July 1949	Wallace *et al.* August 1971	This study whole year 1979
Makhawulani	7,4 – 18,3	18,9 – 25,7	7,0 – 14,0
Mpungwini	6,6 – 7,6	13,1 – 27,0	3,0 – 6,0
Nhlange	3,3 – 3,5	5,0 – 5,6	0,5 – 1,0

responding with the findings of Blaber & Blaber (1980). *G. oblongus* was only found in the tidal basin of the Kosi estuary. *G. poieti* may be unable to enter estuaries or is exceptionally rare in Natal. The latter is more likely as Munro (1967) states that this species is found in river mouths. *Gerres* are evidently a clear water genus being abundant in areas with turbidities lower than 5 NTU and progressively less common in more turbid waters. They are rare in exceptionally turbid areas such as St Lucia. The largest numbers of *Gerres* from St Lucia were fry collected from the eastern shore of South Lake, where turbidities seldom exceed 25 NTU and depending on weather conditions drop as low as 2,7 NTU.

In the United States turbidity has been shown to exert a major influence on the distribution of freshwater fish in certain areas (van Oosten 1945; Swenson & Matson 1976; Swenson 1978) operating both directly, through effects on food organisms, and indirectly on a wide range of fish species. No work was undertaken on the effects of turbidity in the marine environment until Moore (1973) showed its overwhelming importance in the kelp beds of Britain. Recently Blaber (1980) and Blaber & Blaber (1980) have indicated that turbidity is a key factor determining the distribution and recruitment of fishes in subtropical and tropical estuaries. The distribution and abundance of *Gerres* in estuaries of southern Africa may also be governed to some extent by turbidity. However, the distribution of Gerreidae is probably not influenced only by a single factor. For example, the distribution of this tropical genus south of Natal may be restricted by water temperature.

Conclusion

The six species of *Gerres* occurring in southern Africa are apparently valid species, but the exact taxonomic status of some *Gerres* species is confused and the Gerreidae as a whole need revision on a worldwide basis. Results from otolith analyses show that they may be used as a positive means of species identification.

Gerres rappi, G. filamentosus and *G. acinaces* are euryhaline species which are abundant in estuaries, while *G. oyena* and *G. oblongus* have only been recorded in the sea and mouths of estuaries. It is significant that although the former three species may be found together in most areas of the Kosi system, each is most common within a certain salinity range. *Gerres filamentosus* in the more saline areas (20 – 35‰), *G. rappi* in the more freshwater areas (0,5 – 1,0‰) and *G. acinaces* in the intermediate salinities. In smaller estuaries only one species is dominant according to salinity. At Mlalazi estuary salinities of 30 – 35‰ were recorded and *G. filamentosus* was dominant; at Fafa where the salinity was 0,5‰, *G. rappi* was dominant and at Mtamvuna where salinities ranged from 4,5 to 34,5‰ and an Equinox tide and strong outflow caused low salinities (3 – 6,5‰), almost to the mouth of the estuary, *G. rappi* was dominant. Whitfield (1980b) recorded only *G. rappi* from the Mhlanga estuary where, although salinities fluctuated from 0 to 34‰, they were usually less than 10‰. It is probable that salinity plays an important role in the distribution and ecological separation of *Gerres*.

Although there are many estuaries for which no fish records exist (Begg 1978), the pattern in Table 10 reflects the geographical distribution of *Gerres* in this region. Fry and juveniles have been recorded as far south as Durban Bay (Table 10), while adults and immatures are recorded further south. The record from Ntafufu estuary, Transkei, of three species of fry (Wallace & van der Elst 1975) is exceptional.

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