Impact of an introduced predator (Micropterus salmoides, Centrarchidae) on native estuarine fish elucidated through fatty acid analyses

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IMPACT OF AN INTRODUCED PREDATOR (*Micropterus salmoides*, Centrarchidae) ON NATIVE ESTUARINE FISH ELUCIDATED THROUGH FATTY ACID ANALYSES

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Background & objectives

- The introduction of alien fish species can have contrasting impacts on local aquatic communities. The largemouth bass *Micropterus salmoides* (Centrarchidae; Fig.1) was introduced in 1928 in South Africa for recreational anglers. Concerns about its impact on local indigenous freshwater and estuarine fish populations are raised (Gratwicke & Marshall, 2001; Weyl & Lewis, 2006; Wasserman et al., 2011). In particular, the predatory impact of *M. salmoides* on estuary-associated juveniles of marine fish species must be elucidated.

- Previous work based on stomach content and stable isotope analyses emphasized the assimilation by *M. salmoides* of fish and invertebrate prey, consumed in variable proportions depending on season and predator size (Table 1, Fig.2). Seasonal movements of the largemouth bass into upper reaches of estuaries was also evidenced through acoustic telemetry studies (Murray et al., 2015). Here we investigate *M. salmoides'* predatory impact on estuarine fish species through an additional biomarker approach: **fatty acids**.

Table 1: Results from stomach content analyses of *Micropterus salmoides*, from Magoro et al. (2015).

Prey category				Prey abundance, occurrence and importance					
Class	Order	Family	Species	*N*	%N	%F	%M	%V	%IRI
Actinopterygii	Mugiliformes	Mugilidae	*Myxus capensis*	8	3.4	11.9	1.5	0.9	0.88
	Perciformes	Centrachidae	*Micropterus salmoides*	6	2.6	6.0	5.9	8.8	2.75
		Gobiidae	*Caffrogobius* sp.	2	0.9	3.0	0.6	2.9	0.33
			Glossogobius callidus	3	1.3	4.5	0.8	4.7	0.76
		Monodactylidae	*Monodactylus falciformis*	10	4.3	13.4	11.9	11.7	9.96
		Sparidae	*Rhabdosargus holubi*	1	0.4	1.5	0.8	4.7	0.26
Amphibia	Anura			1	0.4	1.5	4.5	8.4	0.60
Insecta	Hemiptera	Belostomatidae		1	0.4	1.5	0.0	0.2	0.01
		Naucoridae		3	1.3	3.0	0.1	0.3	0.04
	Odonata	Aeshnidae		54	23.2	10.4	0.6	1.5	0.69
		Coenagrionidae		1	0.4	1.5	0.0	0.0	0.002
		Libellulidae		3	1.3	3.0	0.3	1.1	0.13
Malacostraca	Decapoda	Potamonautidae	*Potamonautes sidneyi*	32	13.7	26.9	47.7	49.9	82.21
Other			Fish remains	1	0.4	1.5	0.2	0.3	0.02
			Plant leaves	4	1.7	7.5	0.4	0.8	0.29
			Stones	2	0.9	1.5	0.4	0.6	0.05
			Unidentified organic matter	–	–	4.5	0.4	1.3	0.24

Fig.1: *Micropterus salmoides* (Centrarchidae) Lacepède 1802.

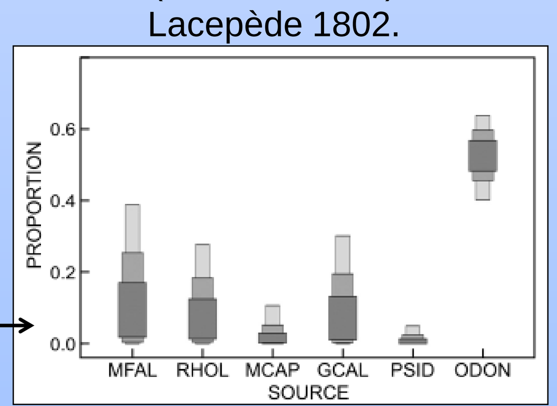

Fig.2: Results from Bayesian mixing models based on stable isotope data identifying the relative contribution of invertebrate and fish prey to the diet of *M. salmoides*, from Magoro et al. (2015) (see Fig.5 for species codes).

Methods

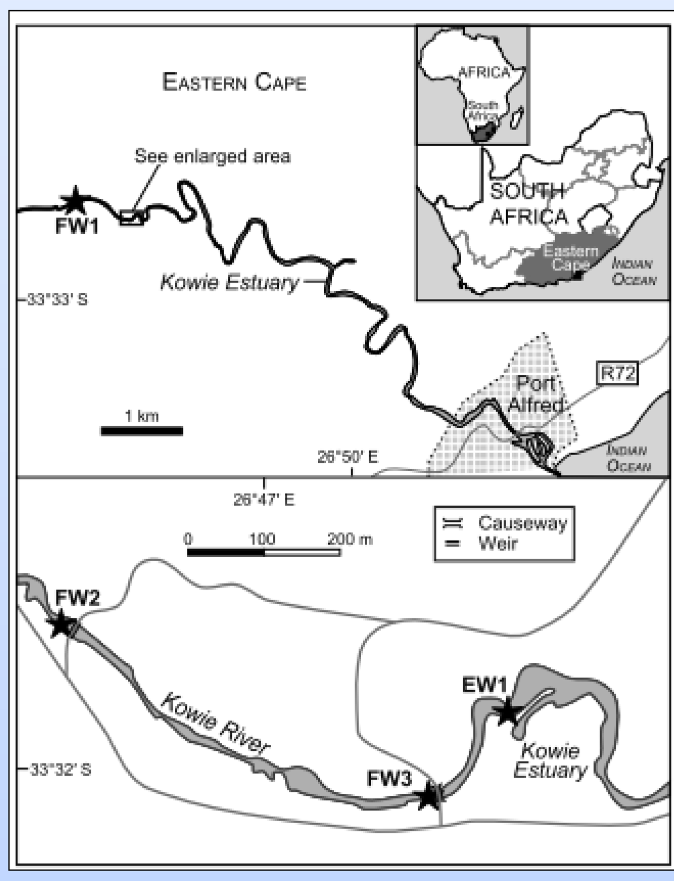

Fig.3: The Kowie river-estuary interface area where *M. salmoides* and its potential prey were sampled.

Fig.4: Fishing methods used for capturing fishes in the Kowie River.

Fishes and invertebrates were collected in the Kowie system during 4 seasons in 2012-2014 (Fig.3 & Fig.4). Dorsal muscle samples were used for fish, while invertebrates were analyzed whole. Lipids were extracted and fatty acids transformed into fatty acid methyl esters following protocols modified from Folch et al. (1957), Indarti et al. (2005) and Budge et al. (2006). Fatty acid data were expressed as proportions of total lipids and of total neutral lipids for invertebrates and fishes, respectively.

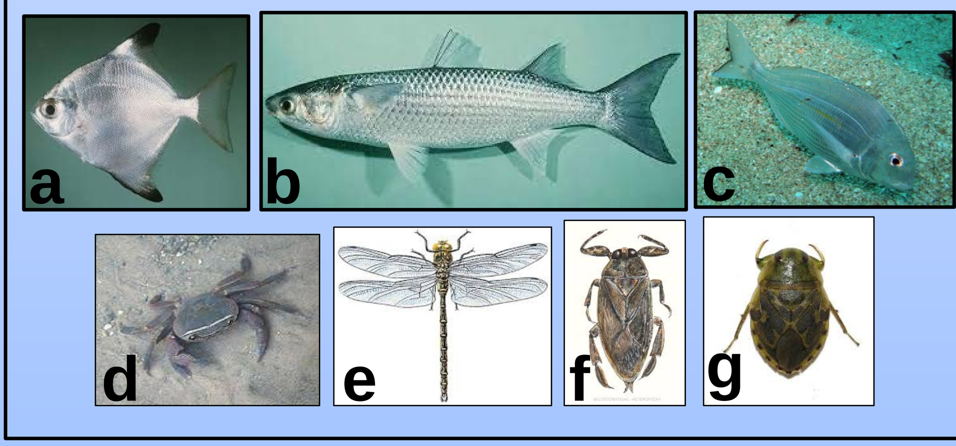

Fig.5: Fish and invertebrate prey for which fatty acids were measured and analyzed to address *M. salmoides*' diet, with
a: *Monodactylus falciformis,*
b: *Myxus capensis,*
c: *Rhabdosargus holubi,*
d: Pomatomonautidae,
e: Odonata,
f: Belostomatidae,
g: Naucoridae.

Preliminary results

- A total of 35 fatty acids was identified as common to *M. salmoides* and all invertebrate and fish prey species sampled (Table 2).
- The fatty acid composition of *M. salmoides* and its invertebrate and fish prey varied seasonally (Fig.6).

Table 2: List of 35 fatty acids identified in all fish and invertebrates analyzed (including *M. salmoides*).

Saturated	Monounsaturated	Polyunsaturated
C10:0	C14:1ω5	C16:2ω4
C12:0	C16:1ω7	C16:3ω4
C14:0	C17:1ω7	C18:2ω6
iC15:0	C18:1ω9	C18:3ω6
aiC15:0	C18:1ω7	C18:3ω3
C15:0	C20:1ω9	C18:4ω3
C16:0	C22:1ω11	C20:2ω6
C17:0	C22:1ω9	C20:3ω6
C18:0		C20:4ω6
C20:0		C20:3ω3
C22:0		C20:4ω3
		C20:5ω3
		C22:4ω6
		C22:5ω6
		C22:5ω3
		C22:6ω3

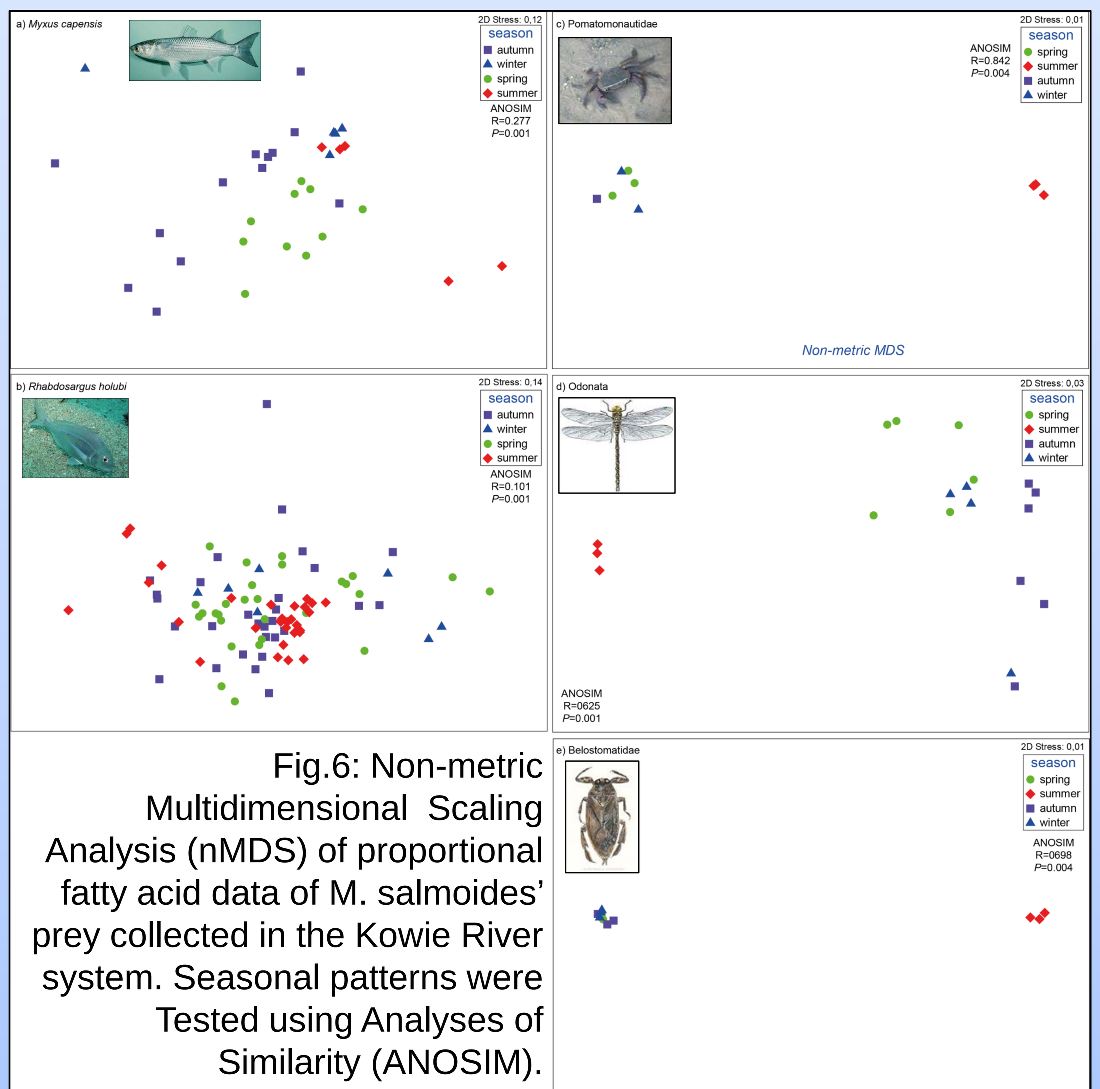

Fig.6: Non-metric Multidimensional Scaling Analysis (nMDS) of proportional fatty acid data of M. salmoides' prey collected in the Kowie River system. Seasonal patterns were Tested using Analyses of Similarity (ANOSIM).

All fatty acid profiles were fully interpreted for invertebrates and fish prey, results were published independently: Bergamino et al. (2014), Bergamino & Richoux (2015), Carassou et al. (2016), Carassou et al. (2017), Moyo et al. (2017).

Limits, discussion and perspectives

- **Limits**

The interpretation of chromatographs is challenging…still ongoing for *M. salmoides* and *M. falciformis* samples due to issues with purification and extraction process detected during the analysis (i.e., abnormally low C16:0 quantities, as compared with other fish species analyzed, and with the literature of fish fatty acid profiles) – corrected interpretation under progress (N=59 for *M. salmoides*; N=14 for *M. falciformis*).

- **Discussion**

The fatty acid composition of all *M. salmoides'* prey markedly varied with seasons. A similar pattern characterized stable isotope and stomach content data for *M. salmoides* (Magoro et al., 2015). This suggests a marked seasonal variability in the relative importance of invertebrate vs. fish prey in the largemouth bass diet.

- **Perspectives**

Next step is to compare the structures of fatty acid proportion matrices of *M. salmoides* and all its fish and invertebrate prey using multivariate methods (e.g., PCA with supplementary observations, coinertia or canonical correspondance analyses).

Our expectation is to confirm results from stomach contents and stable isotopes, which emphasized the predation by small and medium-sized *M. salmoides* on small juveniles of indigenous estuarine-dependent fish species during periods of high river discharge, during which *M. salmoides* is able to move down into the estuarine upper reaches (Wasserman et al., 2011; Magoro et al., 2015).

Several methods will be tested for processing fatty acid data (full composition, prey-specific fatty acids, or composite indices) so as to propose a straightforward biomarker approach for studies assessing the impact of introduced species in aquatic ecosystems.

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