COMMUNITY DYNAMICS OF AN INVADED ECOSYSTEM: PRELIMINARY INVESTIGATION OF A PTERYGOPLICHTYS DISJUNCTIVUS INVASION

Hill JM1, Jones RW2, Weyl OLF3, Hill MP1

1Dept. Zoology & Entomology, Rhodes University, PO Box 94 Grahamstown, 6140, South Africa
2Ezemvelo KZN Wildlife PO Box 10416 Meerensee 3901, South Africa
3Centre for Invasion Biology, South African Institute for Aquatic Biodiversity, Private Bag 1015, Grahamstown 6140, South Africa
Pterygoplichthys disjunctivus

- *Pterygoplichthys disjunctivus* is native to South America (Brazil & Bolivia).

- It's the main nuisance species in the USA, Mexico and the Philippines

**INVASION NOTE**

Using a unified invasion framework to characterize Africa’s first loricariid catfish invasion

Ray W. Jones · Olaf L. F. Weyl · Ernst R. Swartz · Martin P. Hill

Abstract This paper presents evidence of establishment of a loricariid population in the Nkosi River in South Africa and uses a unified framework to determine its invasion stage. Specimens were identified morphologically as *Pterygoplichthys disjunctivus* (Valenciennes 1847), but genetic barcoding results indicated close association with specimens that may have a hybrid inter-basin water transfer. Using a unified framework for invasions this invasion was categorized as a self-sustaining population in the wild with individuals surviving and reproducing a significant distance from their original point of introduction. Containment is suggested as a potential management strategy.

Africa’s first Loricariid invasion can be characterized as a “self-sustaining population in the wild, with individuals surviving and reproducing a significant distance from their original point of introduction (D2)”

The only barrier to it becoming a fully invasive species (stage “E”) is its inability to cross catchments without human assistance.
Invasion history of *P. disjunctivus* in the Richards Bay area of KwaZulu-Natal, South Africa.

Reproduced from Jones et al., 2013 Biol Invasions


2004: 1st specimen record - Mhlathuze River
(SAIAB voucher specimen: SAIAB83643)

2006: 2nd specimen record - Mposa River tributary of the Nseleni River
(SAIAB voucher specimen: SAIAB83178)

2010-12: Community donations and intensive sampling of Nseleni River system obtained 365 fish.
ESTABLISHMENT

Length frequency of *P. disjunctivus* collected (January 2011–May 2012) from the Nseleni River, South Africa.
Reproduced from Jones et al., 2013 Biol Invasions
Pterygoplichthys disjunctivus

Potential Ecological impacts include:
• Dietary resource competition with native fish
• direct predation on bottom-attached eggs of other fish
• bank destabilization due to tunnelling
• increased turbidity
• economic loss to local fisheries
(Devick, 1989; Hoover et al., 2004; Nico et al., 2009a, 2009b, 2012, Wu et al. 2011)

Aims:

➢ Assess the establishment of *Pterygoplichthys disjunctivus* in the Nseleni River System (see Jones et al. 2013 Biol Invasions)

➢ Investigate direct competition for dietary resources between native fish species and the invader using niche width comparisons via stable isotope analysis (SIA).

➢ Investigate the diet of *Pterygoplichthys disjunctivus* via stable isotope analysis (SIA).
NICHE WIDTH COMPARISONS

• Defining an ecological niche based on its isotopic “space” (Bolnick et al. 2003; Bearhop et al., 2004; Newsome et al., 2007).


### Fish Species Collected

<table>
<thead>
<tr>
<th>Fish Species</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudocrenilabrus philander</td>
<td>10</td>
</tr>
<tr>
<td>Clarias gariepinus</td>
<td>10</td>
</tr>
<tr>
<td>Barbus paludinosis</td>
<td>12</td>
</tr>
<tr>
<td>Glossogobius callidus</td>
<td>12</td>
</tr>
<tr>
<td>Marcusensis macrolepidotus</td>
<td>23</td>
</tr>
<tr>
<td>Oreochromis mossambicus</td>
<td>23</td>
</tr>
<tr>
<td>Pterygoplicthys distjuntivus</td>
<td>50</td>
</tr>
</tbody>
</table>

### SIA Methods
NICHE WIDTH COMPARISONS

Convex Hull Area
• Entire isotopic space occupied by a species.
• Very sensitive to sample size.

(SEA_c)
• Core niche space
• Approx. 40% of the data
• 95% C. I.
• More robust to variation in sample size.
NICHE WIDTH COMPARISONS

Mean (•), 25%, 50%, 75% credible intervals.

P. disjunctivus SEA > G. callidus, O. mossambicus, P. philander (p < 0.05)
Schoener (1968) designated niche overlap criteria. Typically values of > 0.6 indicate significant dietary overlap.

Invader VS *B. paludinosus* = 0.17
Invader VS *C. gariepinus* = 9.90E-17
Invader VS *G. callidus* = 0.49
Invader VS *M. macrolepidotus* = 0.48
Invader VS *O. mossambicus* = 0.25
Invader VS *P. philander* = 8.95E-16

*P. disjunctivus* = no significant dietary overlap with native fish species.

Indirect competition?
DIET

So the invasive fish diet does not appear to overlap significantly with those of the native fish.

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- Investigate the diet of *Pterygoplichthys disjunctivus* via stable isotope analysis (SIA).
DIET

Stable Isotope Analyses

- Fish community
- Plant community (including riparian and floating vegetation and submerged aquatic species)
- POM
- Pelagic inverts
- Detritus

Pterygoplicthys disjunctivus biplot

\[ \delta^{15}N = 5.13 \]‰
\[ \delta^{13}C = -0.1 \]‰

(German & Miles 2010)
Fractionation factors:
\[ \delta^{15}N = 5.13 \% \]
\[ \delta^{13}C = -0.1\% \]
(German & Miles 2010)

All C4 plants were decomposing individuals rather than fresh living matter
PRELIMINARY FINDINGS

- Assess the establishment of *Pterygoplichthys disjunctivus* in the Nseleni River System (see Jones et al. 2013 Biol Invasions)

- Africa’s first Loricariid invasion can be characterized as a “self-sustaining population in the wild, with individuals surviving and reproducing a significant distance from their original point of introduction (D2)”

- Investigate direct competition for dietary resources between native fish species and the invader using niche width comparisons via stable isotope analysis (SIA).

- Very little direct dietary competition seems to be taking place between the invasive and native fish species….BUT indirect competition?

- Investigate the diet of *Pterygoplichthys disjunctivus* via stable isotope analysis (SIA).

- SIA mixing models suggest *P. distjunctivus* seems to feeding mostly on degrading C4 plants, predominantly *Azolla* sp. and *Barrington racemosa* in the Nseleni River system.
ACKNOWLEDGMENTS
ACKNOWLEDGMENTS

• Thanks to W. Kadye and M. Alexander for their timely rescues with R.
• Research & Postdoctoral Fellowship funded by the Working for Water Program (http://www.dwaf.gov.za/wfw/)
• Isotope Analyses completed at IsoEnvironmental, Dept. Botany @ Rhodes University (http://www.isoenviron.co.za)
REFERENCES

- Ferraris CJ (2007) Checklist of catfishes, recent and fossil (Osteichthyes, Siluriformes) and catalogue of siluriform primary types. Zootaxa 1418:1–628
Extra - *Pterygoplichthys disjunctivus*

- Species were identified as *Pterygoplichthys disjunctivus* (Weber 1991) based on morphology and ventral surface coloration (Armbuster & Page 2006).

- BLAST searches done in Genbank and subsequent phylogenetic analysis revealed that sequences from Nseleni River specimens matched 100% (same haplotype) with individuals referred to as *Pterygoplichthys disjunctivus* & *Pterygoplichthys pardalis* (FISH-BOL project, described by Swartz et al. 2008)

- Results consistent with Wu et al. (2011), suggesting that there could be confusion with the identification of introduced loricariid populations and/or that hybridisation has occurred between closely related species (especially considering potential mixing and/or misidentification in the ornamental trade).

Loricariid Nseleni River 2011, J. Hill

http://silurus.acnatsci.org/ACSI/field/Venezuela2004-05/fishes/Loricariidae/1index.html