Online resource 1

Electronic supplementary material to:

Journal: Theoretical Ecology

Title: Trophic niche-space imaging, using resource and consumer traits

Authors: Leopold A. J. Nagelkerke [1,*] and Axel G. Rossberg [2,3]

[1] *Aquaculture and Fisheries Group, Wageningen University, Wageningen Institute of Animal Sciences (WIAS), De Elst 1, 6708 WD Wageningen, The Netherlands, e-mail: Leo.Nagelkerke@wur.nl, Tel: +31 317 483940, fax: +31 317 483937*

[2] *Lowestoft Laboratory, Centre for Environment, Fisheries and Aquaculture Science (Cefas), Pakefield Road, Lowestoft, Suffolk NR33 0HT, United Kingdom*

[3] *School of Biological Sciences, Queen's University Belfast, Belfast BT9 7BL, Northern Ireland, United Kingdom, e-mail: axel@rossberg.net, Tel: +44 28 9097 5859, fax: +44 28 9097 5877*

[*] Author for correspondence

Table S1. Consumer species and resource categories. The 14 consumer species (*Labeobarbus* fish species from Lake Tana, Ethiopia), and the 11 resource categories (Sibbing and Nagelkerke 2001). Abbreviations that are used in figures and text are also given.

consumers		**resources**	
species name	abbreviation	category name	abbreviation
L. acutirostris	Ac	phytoplankton	Phy
L. brevicephalus	Br	sessile algae	Alg
L. crassibarbis	Cr	macrophytes	Pla
L. dainellii	Da	seeds	See
L. gorgorensis	Go	detritus	Det
L. gorguari	Gu	zooplankton	Zoo
L. longissimus	Lo	macro-crustaceans	Cru
L. macrophthalmus	Ma	benthic invertebrates	Ben
L. megastoma	Me	macro-insects	Ins
L. nedgia	Ne	mollusks	Mol
L. platydorsus	Pl	fish	Fis
L. surkis	Su		
L. truttiformis	Tr		
L. tsanensis	Ts		

Table S2. Consumer traits. Data adapted from Nagelkerke (1997). Traits as defined as in Nagelkerke (1997) and Sibbing and Nagelkerke (2001). All lengths are measured in units of fork length (FL), areas in units of fork length squared, etc. Fork length itself is measured in cm. Reference numbers refer to Figure S1, in some cases expressing how variables were calculated. For instance, body depth / width ratio is a division of measurement 4 and 5 and indicated as (4 / 5).

	General size	*Search and detection*		*Approach*				
Trait description	**Fork length**	**Anterior barbel length**	**Eye diameter**	**Body depth**	**Body depth / width ratio**	**Oral gape / body area ratio**	**Caudal peduncle depth**	**Anal fin area**
Abbreviation [a]	**FL**	**ABaL**	**ED**	**BD**	**BD/BW**	**OGAr/Bar**	**CPD**	**AfiAr**
Reference number in figure S1	–	–	**7**	**4**	**(4 / 5)**	**(17 x 18) / (4 x 5)**	**6**	**(2 x 3)**
***Labeobarbus* species**								
L. acutirostris	21.8	0.028	0.048	0.219	1.99	0.272	0.085	1.07
L. brevicephalus	16.6	0.037	0.049	0.238	2.14	0.111	0.099	1.21
L. crassibarbis	20.3	0.058	0.041	0.243	1.93	0.218	0.103	1.24
L. dainellii	26.6	0.038	0.039	0.215	1.87	0.358	0.088	1.19
L. gorgorensis	38.1	0.050	0.036	0.269	1.99	0.115	0.102	1.32
L. gorguari	23.3	0.035	0.043	0.224	1.71	0.282	0.091	1.19
L. longissimus	32.9	0.023	0.035	0.221	1.82	0.241	0.098	1.12
L. macrophthalmus	15.8	0.029	0.059	0.239	2.00	0.209	0.095	1.28
L. megastoma	26.0	0.029	0.041	0.215	1.90	0.285	0.090	1.13
L. nedgia	22.4	0.051	0.042	0.236	1.91	0.112	0.100	1.25
L. platydorsus	21.3	0.043	0.044	0.243	1.88	0.231	0.093	1.24
L. surkis	23.3	0.038	0.045	0.270	2.14	0.083	0.098	1.23
L. truttiformis	17.2	0.029	0.037	0.242	1.83	0.248	0.106	1.30
L. tsanensis	21.3	0.047	0.044	0.253	1.99	0.145	0.102	1.19

	Intake							*Size selection*			*Digest-ion*
Trait description	**Oral gape axis**	**Protrusion length**	**Lower jaw length**	**Pharyngo-opercular volume** [b]	**Head length**	**Post-orbital length**	**Gill arch resistance**	**Oral gape diameter**	**Gill raker length**	**Gill raker profile**	**Gut length**
Abbreviation [a]	**OGAx**	**ProtL**	**LJL**		**HL**	**POrL / OpD**	**GiAR**	**OGD**	**GiRL**	**GiRP**	**GuL**
Reference number in figure S1	**16**	**26**	**13**	–	**11**	**(25 / 19)**	–	**18**	**9**	**10**	–
***Labeobarbus* species** *L. acutirostris*											
L. brevicephalus	65.8	0.041	0.109	0.487	0.271	1.657	1.09	0.082	0.0061	1.89	1.698
L. crassibarbis	50.6	0.040	0.077	0.354	0.206	1.149	1.61	0.060	0.0068	4.75	2.054
L. dainellii	46.9	0.066	0.108	0.710	0.250	1.237	1.00	0.076	0.0054	1.20	2.273
L. gorgorensis	46.2	0.051	0.110	0.576	0.274	1.490	0.98	0.090	0.0053	1.50	1.516
L. gorguari	52.7	0.047	0.082	0.605	0.222	1.201	1.29	0.065	0.0060	2.67	3.399
L. longissimus	63.5	0.047	0.107	0.774	0.267	1.449	1.22	0.090	0.0070	1.40	1.655
L. macrophthalmus	77.6	0.038	0.109	0.588	0.250	1.431	1.01	0.086	0.0056	1.22	1.708
L. megastoma	68.0	0.048	0.104	0.569	0.251	1.260	1.39	0.084	0.0075	3.25	1.821
L. nedgia	79.6	0.039	0.110	0.488	0.248	1.449	1.06	0.083	0.0056	2.46	1.908
L. platydorsus	47.5	0.051	0.092	0.595	0.247	1.177	1.43	0.073	0.0066	3.10	2.412
L. surkis	65.8	0.040	0.100	0.710	0.253	1.333	1.19	0.086	0.0066	2.30	1.831
L. truttiformis	58.7	0.037	0.075	0.413	0.205	1.114	1.64	0.057	0.0065	3.93	2.898
L. tsanensis	67.1	0.031	0.095	0.631	0.238	1.409	1.13	0.084	0.0071	2.50	1.916
	49.6	0.051	0.090	0.619	0.237	1.230	1.45	0.071	0.0070	3.57	2.277

[a] in Sibbing and Nagelkerke (2001): Table 4

[b] defined in Nagelkerke (1997)

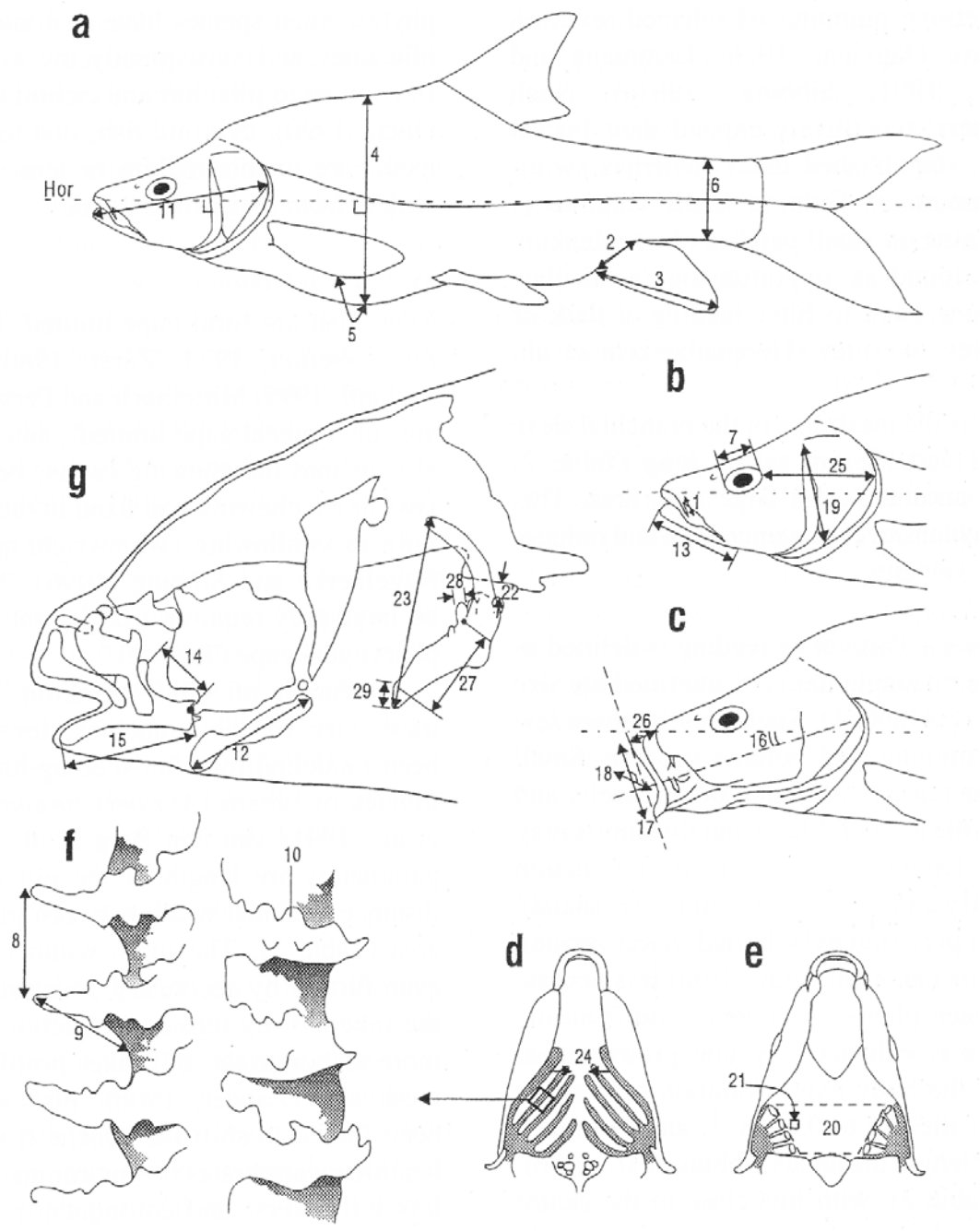

Figure S1. Measurements of phenotypic traits in the Lake Tana *Labeobarbus* species: (a) external traits (Hor: Horizontal line as reference for angular measurements); (b) head with the mouth closed; (c) head with open, protruded mouth; (d) oro-pharyngeal floor; (e) oro-pharyngeal roof; (f) detail of gill arch showing a raker profile (10), coded as value 3 (on a scale from 1 to 5); (g) elements of the head skeleton (not used in this study). Numbers of used traits can be found in Table S2. Figure reproduced with permission from Sibbing and Nagelkerke (2001).

Table S3. Resource traits. Data adapted from Nagelkerke (1997). Data are ordinal and adaptations from the original tables from Sibbing and Nagelkerke (2001).

Resource	Maximum diameter	Escape velocity	Shape (elongation)	Habitat (pelagic)	Chemical composition (protein	Strength	Compliance	Fibrousness	Toughness	Requiring macro-reduction	Requiring micro-reduction
Phytoplankton	1.0	0.0	0	1	0	0	1.5	0	0	0	3
Sessile algae	2.0	0.0	0	0	0	0	1.5	0	0	1	2
Macrophytes	3.5	0.0	1	0	0	2	2	2	2	4	3
Seeds	3.5	0.0	0	0	0	3	1	1	2	4	1
Detritus	2.0	0.0	0	0	0	0	2	1.5	1	2	1
Zooplankton	1.5	1.5	0	1	1	0	2	1	1	0	1
Macro-crustaceans	4.5	3.5	0	0	1	0	1.5	1	1	3	0
Benthic invertebrates (larvae / worms)	2.0	1.0	1	0	1	0	3	1.5	2	1	1
Macro-insects	3.5	4.0	1	0	1	2	2.5	2	3	3	0
Molluscs	3.5	1.0	0	0	1	3	0	1	2	3	0
Fish	5.0	5.0	1	1	1	2	4	3	5	3	0

Table S4. Consumer diets. Data adapted from Nagelkerke (1997). Volume-% of food categories in the gut. Data per species do not add up to 100% due to a rest category of unidentified particles in the gut.

***Labeobarbus* species**	**Phytoplankton**	**Sessile algae**	**Macrophytes**	**Seeds**	**Detritus**	**Zooplankton**	**Macro-crustaceans**	**Benthic invertebrates (larvae/worms)**	**Macro-insects**	**Molluscs**	**Fish**
L. acutirostris	3.2	0.1	2.0	0.0	2.6	0.6	0.0	7.9	3.5	0.7	76.0
L. brevicephalus	7.4	0.2	14.6	0.0	3.9	34.0	0.0	9.4	23.2	5.2	0.2
L. crassibarbis	10.4	0.3	0.7	0.3	28.2	8.8	0.0	28.8	7.3	11.8	2.1
L. dainellii	2.1	0.0	8.5	0.0	1.0	0.0	2.4	5.7	7.3	1.6	69.2
L. gorgorensis	8.5	0.1	31.6	0.1	14.6	0.0	3.3	1.6	0.0	27.0	11.5
L. gorguari	6.9	0.2	15.8	0.7	3.4	1.4	2.4	6.5	1.2	3.6	55.4
L. longissimus	3.8	0.1	12.9	0.7	2.9	0.0	2.6	2.5	0.1	0.8	71.0
L. macrophthalmus	9.6	1.8	8.4	0.3	3.2	6.5	0.5	13.0	10.4	0.3	45.3
L. megastoma	1.3	0.1	13.9	0.0	0.7	1.3	0.3	6.8	6.9	0.3	66.8
L. nedgia	5.0	0.3	4.7	0.3	18.9	3.2	1.1	32.5	10.8	16.3	5.6
L. platydorsus	9.4	0.0	10.3	0.0	3.2	1.2	0.1	17.6	3.6	4.0	49.0
L. surkis	7.9	0.3	70.9	0.6	2.8	5.2	0.2	4.9	4.3	0.4	2.1
L. truttiformis	4.2	0.0	3.3	0.0	3.7	2.8	5.1	1.3	0.0	1.6	72.3
L. tsanensis	6.3	0.2	4.6	0.8	14.2	6.2	0.0	42.6	4.9	17.7	1.3

References

Nagelkerke LAJ (1997) The barbs of Lake Tana, Ethiopia: morphological diversity and its implications for taxonomy, trophic resource partitioning, and fisheries. Wageningen Agricultural University, Experimental Animal Morphology and Cell Biology, Wageningen, The Netherlands

Sibbing FA, Nagelkerke LAJ (2001) Resource partitioning by Lake Tana barbs predicted from fish morphometrics and prey characteristics. Reviews in Fish Biology and Fisheries 10 (4):393-437. doi:10.1023/A:1012270422092