Food ecology of the snipefish (Macroramphosus spp.) in the Upwelling region between latitudes 26°N (Cap Bojdour) and 20°50’N (Cap Blanc)

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Small Pelagic Fish: New Frontiers in Science and Sustainable Management
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Background

- ✓ Cyclic appearance and reappearance of snipfish schools in exploitable areas and shallow waters;
- ✓ Seasonal variability of its spatial distribution in the central and southern Moroccan Atlantic;

- ✓ These species, which inhabit large parts of the pelagic ecosystem, constitute competitive organisms for the other indigenous small pelagic resources in terms of space occupancy and food, they affect then their dynamics.

2020

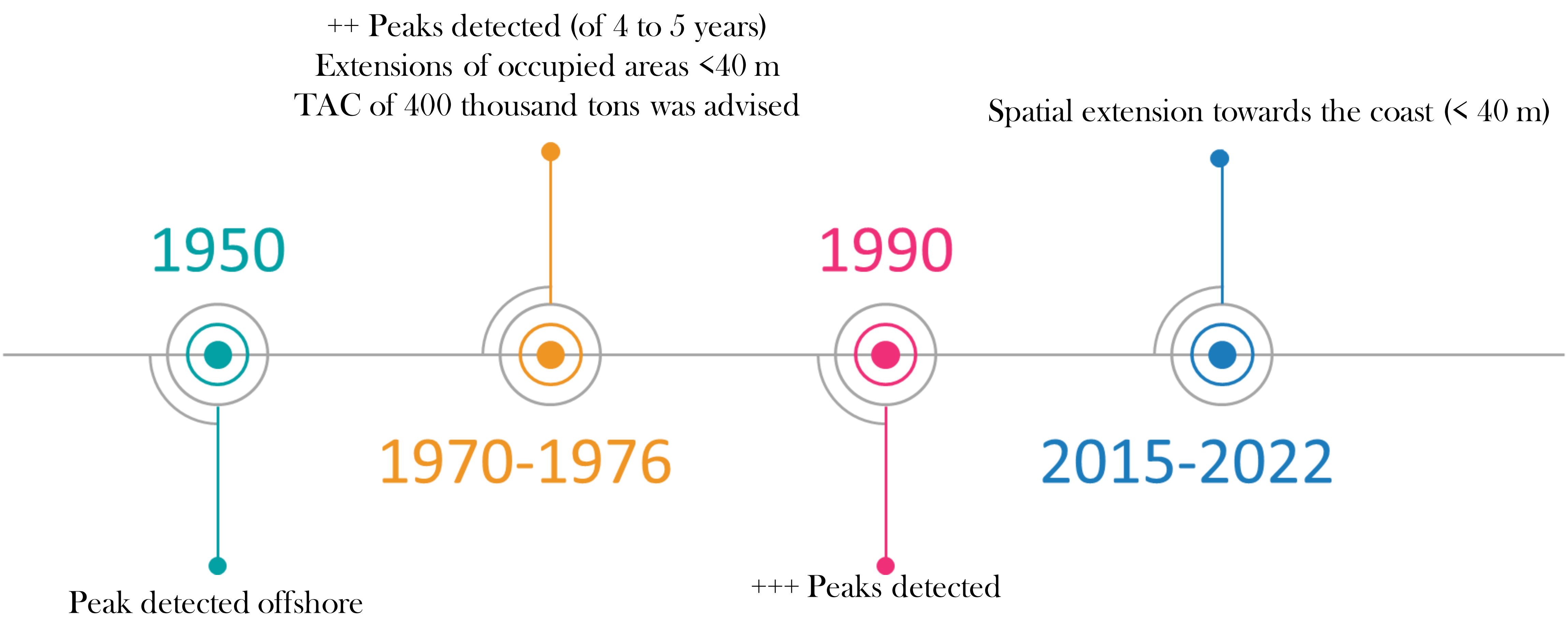
Background

The dynamics and the occurrence frequency of the snipefish seems to be partly governed by its food ethology that represents a crucial factor in the stock development.

▼

This work aims to deepen the understanding of the trophic behavior of the snipefish through an analysis of its diet in relation to the pelagic ecosystems parameters (Zoo)

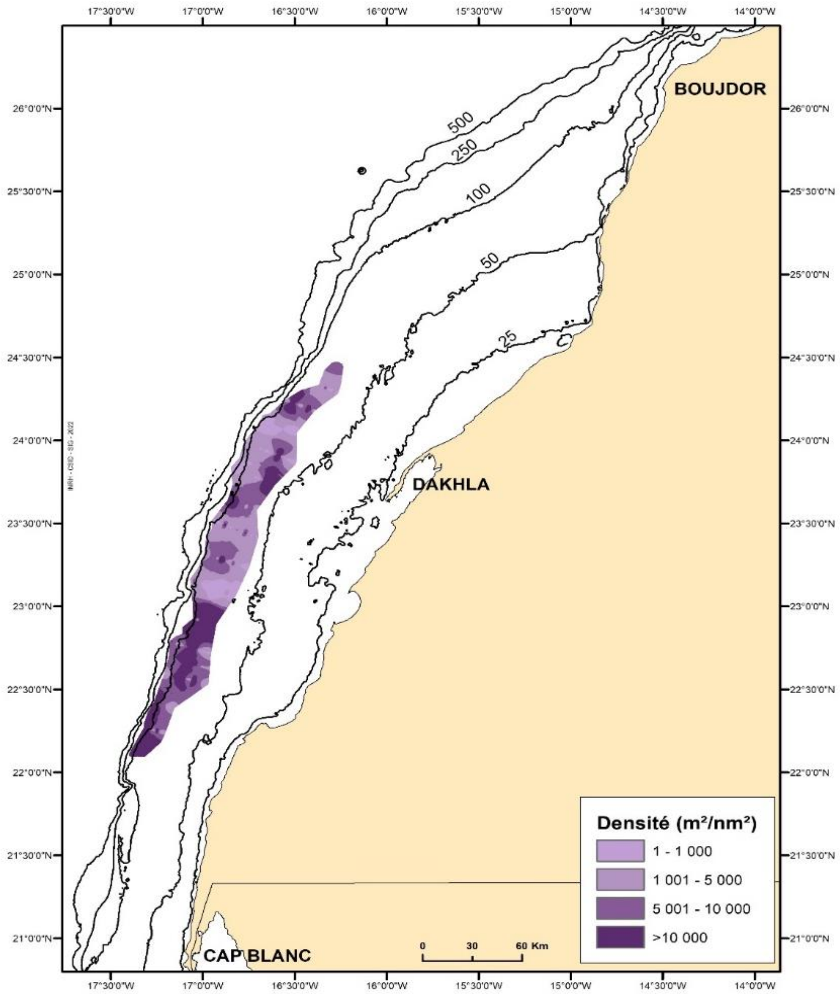
History of *Macroramphosus spp.* appearance in Moroccan waters



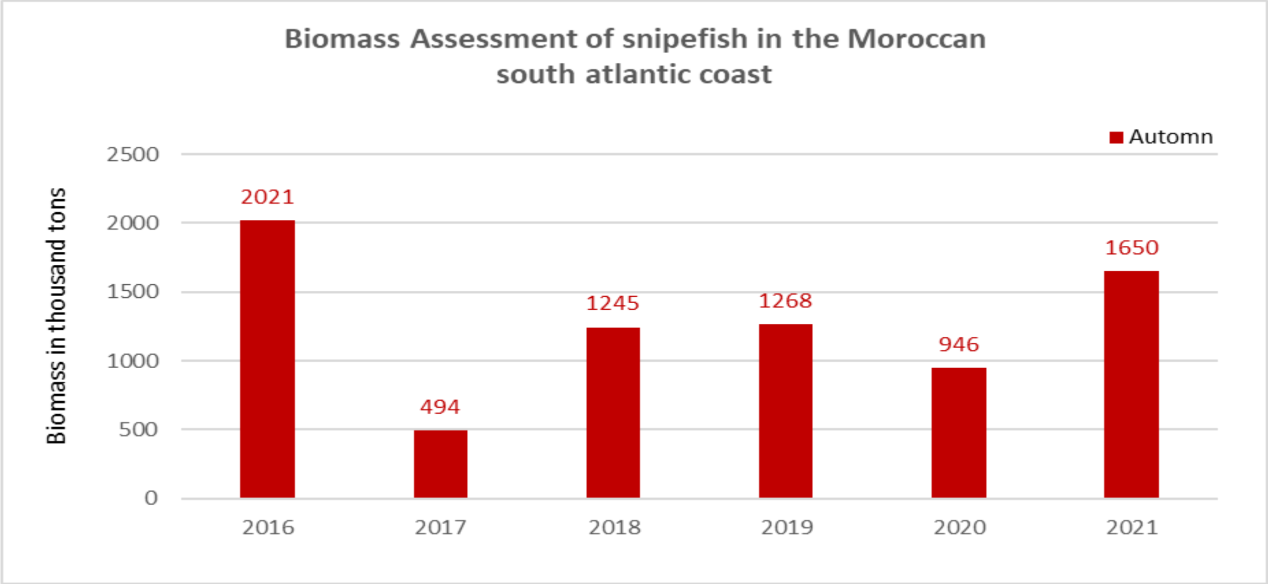
Recent situation of *Macroramphosus spp.* in Moroccan waters

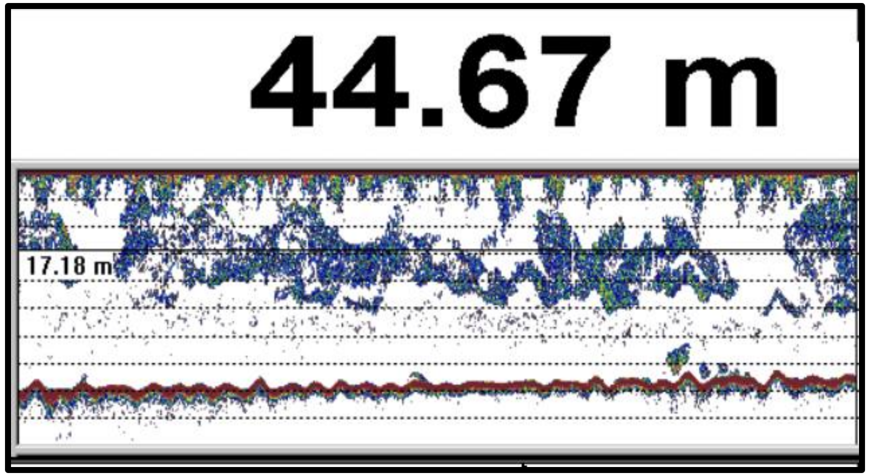
2019

Recent situation of *Macroramphosus spp.* in Moroccan waters



Spatial distribution of snipefish in South Moroccan coast (autumn 2021)

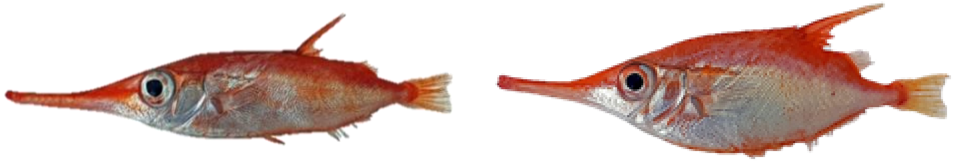




Snipefish schools paterns detected on an echosonder in depth 45 meters (easy to identify)

Few small pelagics individuals in snipfish catchs

Identity



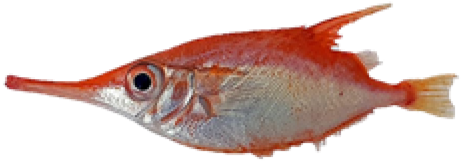
- ✓ The snipefish is one of the indicator species of the edge of the continental shelf, related mainly to temperate waters

- ✓ Its seasonal distribution is greatly influenced by the hydrological conditions of the habitats deployted

- ✓ It inhabits a boundary band between oceanic (warm and salty) and coastal (cold and desalinated) waters (Villegas et al., 1976)

- ✓ Species with two feeding strategies (burrowing and planktivorous)

Identity



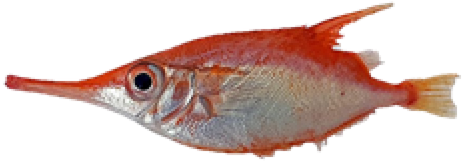
***Macroramphosus gracilis* (Lowe, 1839)** En. Slender snipefish

Species with pelagic behavior, lives at depths between (50 and 500 m), common in (50 and 150 m). It frequents different types of habitats and can extend into more coastal waters.

***Macroramphosus scolopax* (Linnaeus, 1758)** En. Longspine snipefish

Demersal species, close to the sea floor, colonizes the edge of the continental shelf and the slope, lives at depths between 25 and 600 m, generally between 50 and 350 m, more abundant between the latitudes (25°N) and (50°N), adults normally live near the bottom.

The Biological caracteristics and assets



- **Fast growth**

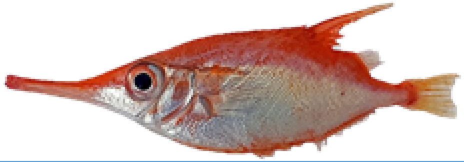
- **Size-weight relationship:** differential growth (Morocco)

- **Short life span :** 5 years for *M. gracilis* - 6 years for *M. scolopax*,

- **Maximum size** recorded is 22 cm (Morocco)

- **Reproduction :** Two spawning seasons (Morocco)
  Main in winter (December - February)
  another one in early summer (June- July)

The Biological caracteristics and assets



- **Trophic behaviour :** The snipefish is a fish of the Syngnathiformes order "pipette fish".

It feeds by « aspiration » or « succion ».

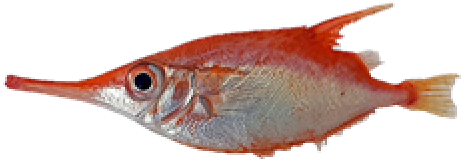
Feeding technic "pivotal feeding": Capture prey efficiently by a rapid rotation. It accelerates the water sucked inside the snout.
(Lingo et al., 2018) the record time of *M. scolpax* is only **2 thousandths of a second**, this attack time is considered among the fastest values recorded for fish.

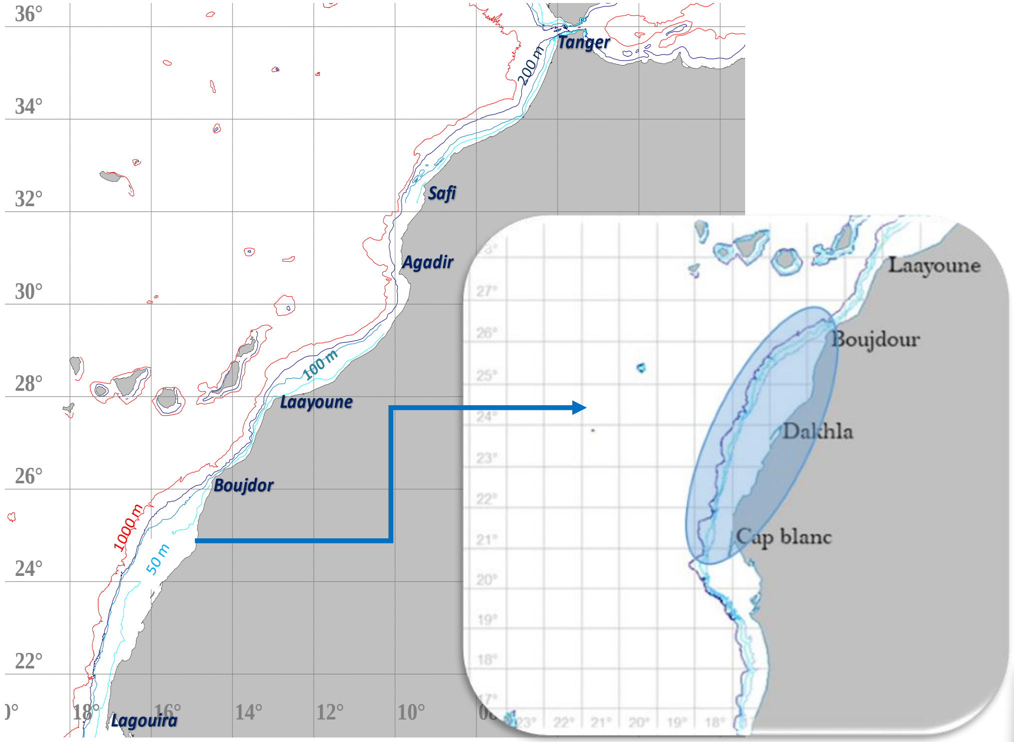
- **The predators of sniperfish:** dont have the systematic predators

Observed in morocco,

Spanish mackerel,
Black seabream,
Lesser spotted dogfish
Rhizostoma luteum

Sampling methodology





“Amir Moulay Abdelah”

2018- 2020

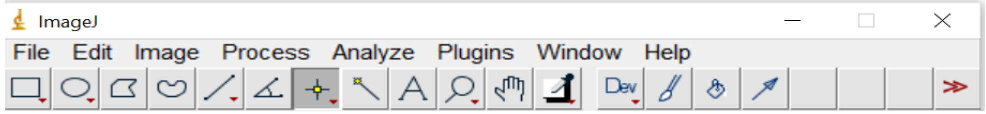
The zooplankton samples processed and scanned

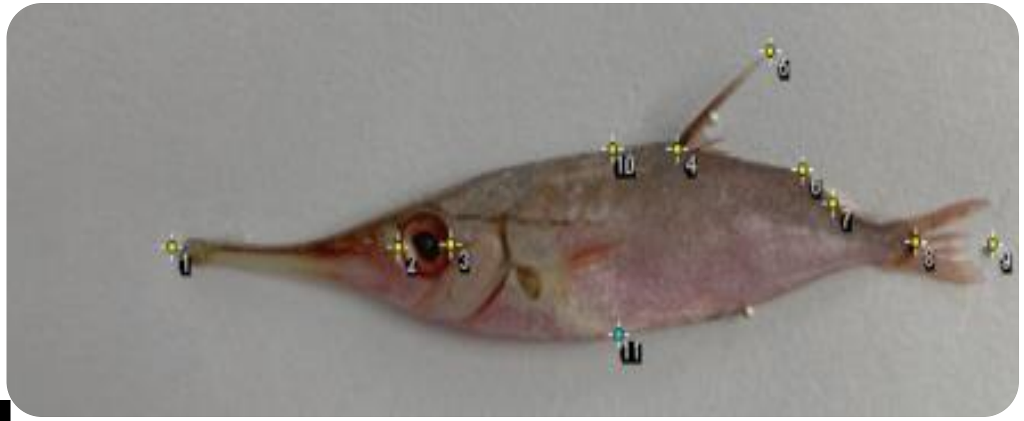
I N R H
المعهد الوطني للبحث في الصيد البحري
Institut National de Recherche Halieutique

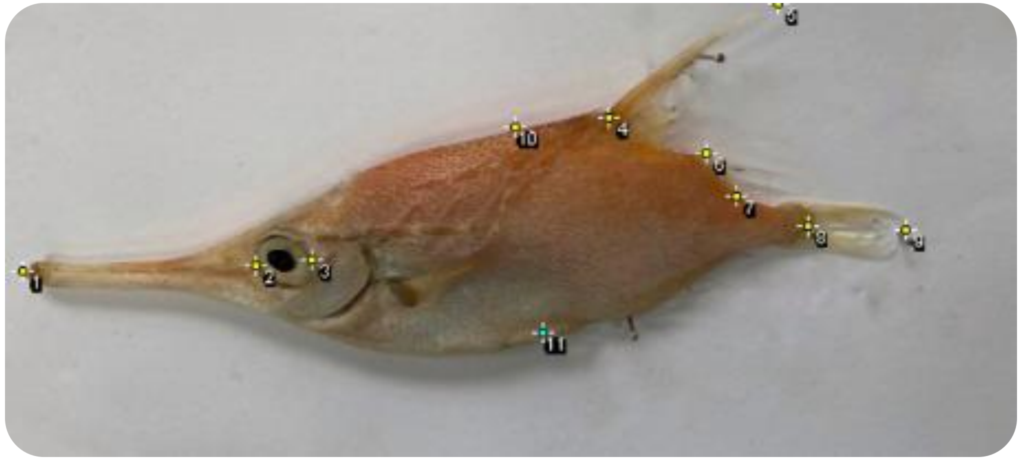
Measuring protocol

Compagne	Date	Station	Identifiant	taille	Poids	Sexe	Stade de maturité	length_1-2	length_2-3	length_4-5	length_6-7	length_1-8	length_1-9	length_10-11
AMA	9/12/2019	60	1	10,5	4,45	Femelle	I	14,5	3,7	8,6	2,7	51	55,9	10,9
			6	11,2	6,78	Femelle	IV	20	4,8	8,5	2,3	67,4	73,7	13,9
			7	11,3	7,54	Femelle	II	19,8	5,2	9	4,1	65,4	72,4	13
			8	11	6,28	Mâle	II	20,4	4,8	7,7	3,7	64,9	71,9	12
			9	10,4	5,03	Femelle	I	14,5	3,8	6,6	2,9	57	62,1	10,7
			12	11,5	5,96	Femelle	II	17,2	4,9	8,1	2,4	50,5	51,7	10
			16	11	5,5	Femelle	II	17,2	4,6	6	3,1	58,4	63,9	11,1
			18	11	5,61	Non identifié	0	20,6	6	9,5	3,6	68	74	14,4
			21	10,8	7,44	Femelle	III	17,9	5,6	8,6	2,9	58,3	64,3	11,8
			26	11,4	5,65	Non identifié	0	18,9	4,7	9,2	2,5	58	63,9	11,6
			31	11	5,36	Femelle	II	19,3	5,8	9,4	3,3	65,6	71,3	13,6
			32	10,5	4,93	Femelle	II	14,2	3,9	5,9	1,9	45,1	48,6	8
			45	10,5	3,78	Femelle	II	16,7	4,2	7,6	2,1	51	53,8	9,4
			47	11,4	5,97	Non identifié	I	23,2	5,5	8,6	2,7	68,2	74,4	12,6
			50	10,5	4,02	Femelle	I	14,5	3,9	7,1	3,3	48,3	52,8	9,1
AMA	4/2/2022	6	3	14	12,26	Femelle	III	23,3	5,1	10,2	3,4	77	84,7	16
			4	10,5	6,78	Femelle	II	20,8	5,8	9,8	3,2	70	76,6	13,8
			5	12,5	8,91	Femelle	I	22,6	5,8	10,5	3,2	74,9	82,6	15,1
			7	11	6,32	Femelle	I	22	5,6	11,5	2,8	76,5	84,3	14,7
			8	11,2	7,48	Femelle	II	21,4	5,8	12,2	3,1	75,3	84,3	15
			11	11	6,33	Femelle	I	22,4	5,8	13,1	3,9	76,8	84,5	14,8
			12	11,4	7,38	Femelle	I	21,8	6,4	11,6	3,9	75,5	84,7	14,8
			13	11,5	6,72	Non identifié	0	21,2	5,5	11,6	3,2	76	83,7	14,1
			14	12,7	9,08	Femelle	I	22,5	5,7	9,8	3,2	74,3	82	14,3
			15	12,9	10,86	Femelle	I	18	4,6	7,2	3,2	62,8	69,9	13,3
			16	14	14,2	Femelle	III	22,7	5,2	7,7	7,4	71,9	79,4	14,7
			17	10,6	8,36	Femelle	I	21,2	5,6	8,5	4,2	75,8	83,7	15,4
			20	11,9	8,89	Femelle	I	21,1	6,2	11,3	3,1	76	84,5	15
			21	11,9	7,77	Femelle	I	21,2	6,1	11,3	2,5	73,9	81,7	15,3
			23	10,2	5,15	Femelle	I	20,1	5,4	9,1	2,7	67,1	73,9	12,8
			24	11	5,8	Femelle	I	23,8	5,8	10,2	2,9	76	83,9	13,7
			26	10,4	5,65	Femelle	I	22,3	6,4	9,4	3,6	75,9	84,3	14,9
			27	13,8	11,98	Femelle	IV	22,9	5,8	8,7	3,6	74,5	82	13,9
			28	11,2	6,97	Femelle	II	20,6	5,4	9	3,2	74,7	81,4	13,3
			29	10,5	5,81	Femelle	I	19,2	5,8	11,8	3,8	71,7	79,1	13,9
			30	12,4	8,41	Femelle	I	21,8	5,8	10,8	3	76,1	84,2	15,4
			31	12	7,98	Femelle	I	20,5	5,6	9,5	2,3	71,1	77,8	13,1
			33	13,5	12,68	Femelle	III	21,1	5,4	9,9	2,9	77,6	85,9	16,7

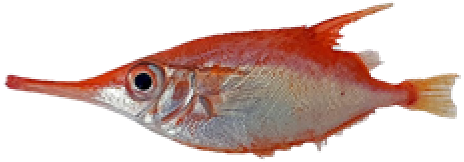
```
// Begin length macro
requires("1.51i");

points = 11;

run( "Set Measurements...", " redirect=None decimal=3" );
roiManager ( "multi-measure measure_all" );
wait(100);
selectWindow( "ROI Manager" );
run( "Close" );

x = newArray( points );
y = newArray( points );
for ( i = 0; i<points; i++ ) {
x[i] = getResult( "X", i );
y[i] = getResult( "Y", i );
}
selectWindow( "Results" );
run( "Close" );

//lengths
print( "length_1-2 = ", d2s( length( x[0], y[0], x[1], y[1] ), 1) );
print( "length_2-3 = ", d2s( length( x[1], y[1], x[2], y[2] ), 1) );
print( "length_4-5 = ", d2s( length( x[3], y[3], x[4], y[4] ), 1) );
print( "length_6-7 = ", d2s( length( x[5], y[5], x[6], y[6] ), 1) );
print( "length_1-8 = ", d2s( length( x[0], y[0], x[7], y[7] ), 1) );
print( "length_1-9 = ", d2s( length( x[0], y[0], x[8], y[8] ), 1) );
print( "length_10-11 = ", d2s( length( x[9], y[9], x[10], y[10] ), 1) );


exit();
//-
function length( x_0, y_0, x_1, y_1 ) {
return sqrt( pow( x_0 - x_1, 2 ) + pow( y_0 - y_1, 2 ) );
}
// End
```







Diet analysis process



Frequency index (Fp): $$Fp = \frac{np}{N} \times 100$$

Percentage by number (Cn) $$Cn = \frac{Np}{Ntp} \times 100$$

Percentage by weight (Cp) $$Cp = \frac{Pp}{Pt} \times 100$$

Index of relative importance (IRI) $$IRI = F_p \times (C_n + C_p)$$

Percent Index (%IRI) $$\%IRI = \frac{IRI}{\sum IRI} \times 100$$

IRI >50% : Preferred prey.

10 < IRI <50%: Secondary prey.

1< IRI <10%: Complementary prey.

IRI <1%: Incidental prey.

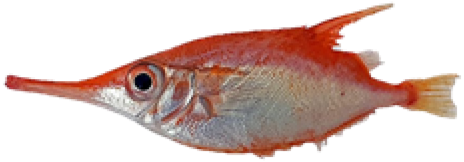
Estimation of trophic level (TL)

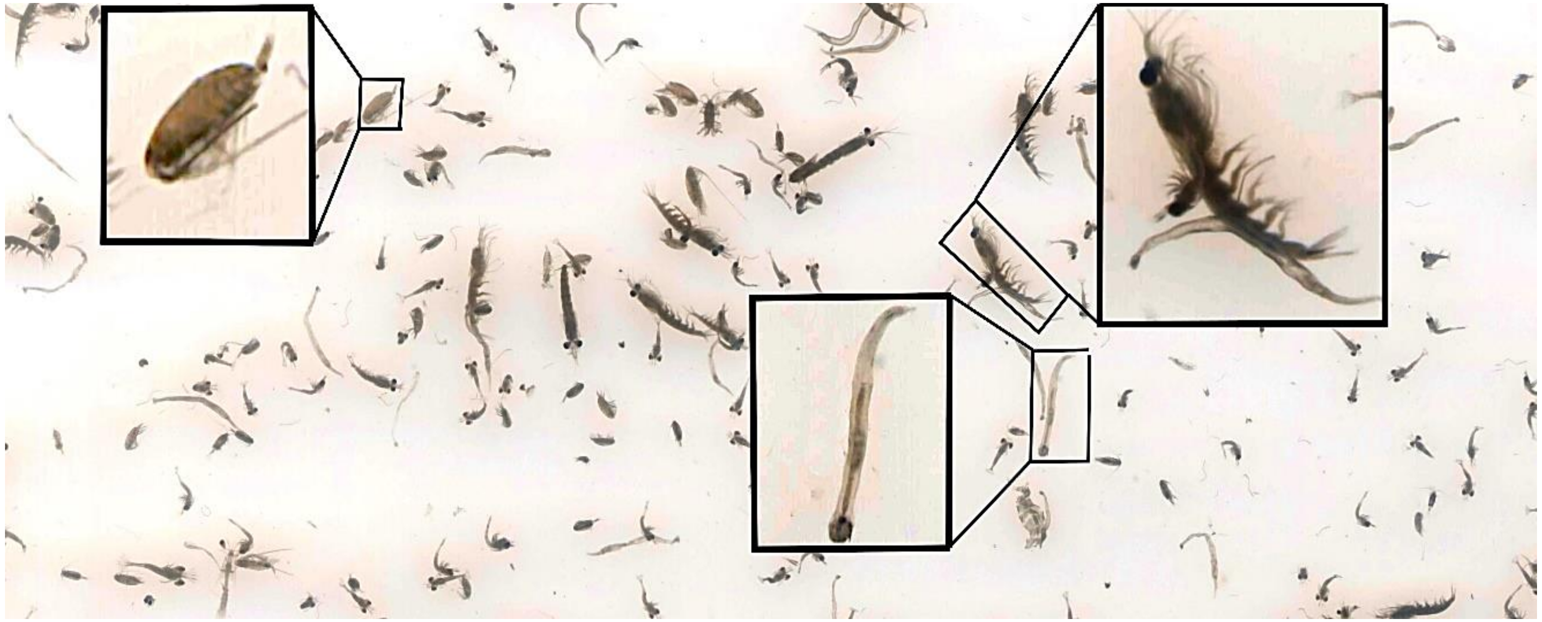
$$TL_j = 1 + \sum_{i-1}^{n} DC_{ij} \times TL_i$$

Omnivory index (OI)

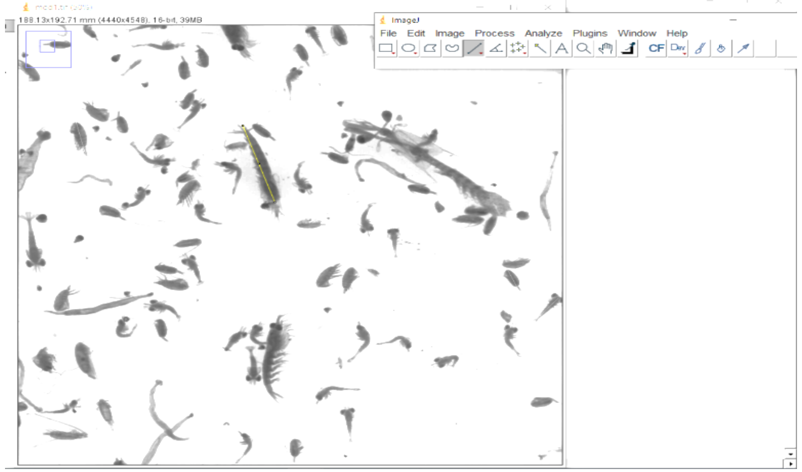
$$IO_j = \sum_{j=1}^{n} [TL_i - (TL_j - 1)]^2 \times DC_{ij}$$

Size analysis of Zooplancton





Sample a zooplanctonscan by Vuescan, from left to right : copepod, chaetognath and eupahsiid



Results

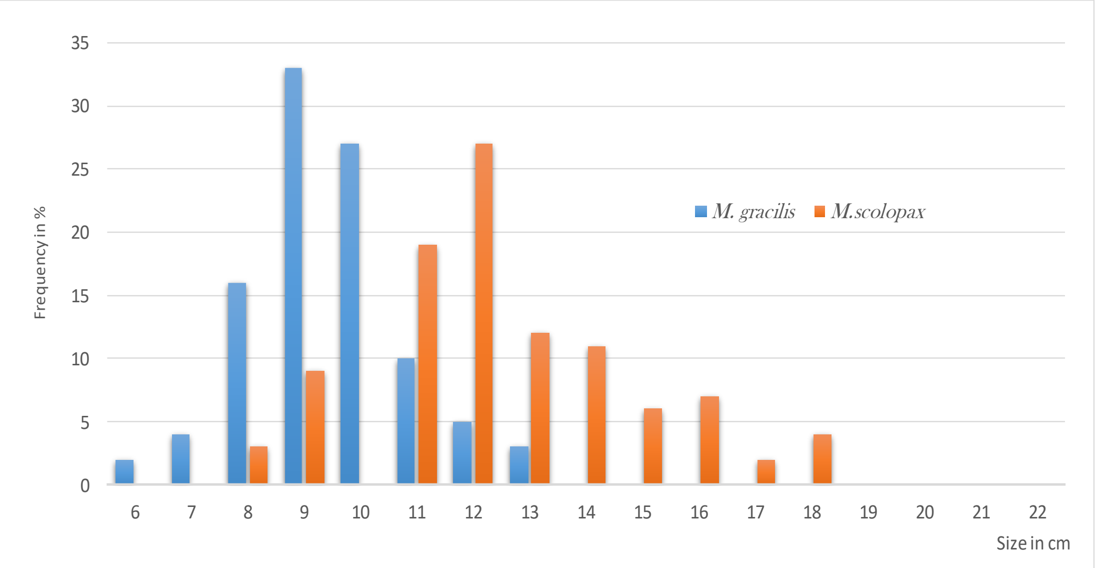
File Edit Font Results

	Area	Mean	Min	Max	Angle	Circ.	AR	Round	Solidity	Length
1	0.109	227.155	207.235	251	-94.185	0.051	0.000	0.000	NaN	5.182
2	0.030	218.961	213.000	231.412	-61.189	0.185	0.000	0.000	NaN	1.439
3	0.031	221.981	219.195	234.000	-70.017	0.181	0.000	0.000	NaN	1.475
4	0.049	219.897	214.000	231.000	-141.582	0.114	0.000	0.000	NaN	2.333
5	0.086	216.885	209.000	234.697	-71.003	0.065	0.000	0.000	NaN	4.066
6	0.102	205.437	202.000	241.000	98.973	0.055	0.000	0.000	NaN	4.849
7	0.052	220.177	208.515	233.690	168.111	0.108	0.000	0.000	NaN	2.447
8	0.115	203.022	197.324	216.000	-153.138	0.049	0.000	0.000	NaN	5.440
9	0.031	220.052	210.584	237.000	-72.350	0.183	0.000	0.000	NaN	1.455
10	0.029	215.715	212.950	218.231	127.405	0.198	0.000	0.000	NaN	1.349

The scanned photos of zooplankton were processed and analyzed by Image-J software to have a size structure of a panoply of organisms that live suspended in the water column.

The protocol adopted is to measure the total length (Lt) of the well-spread and unfolded species (> 30 specimens per section per photo, per station and per year)
.

Results (Biometry)



Total length frequency distribution of two of the *snipefish Macroramphosus spp*

LT min = 6 cm
LT max = 13,5cm
LT mean= 11,75 cm

LT min = 8cm
LT max = 18cm
LT mean= 13,5 cm

Snout length of Macroramphosus spp

measure	*Macroramphosus gracilis*			*Macroramphosus scolopax*		
	Min	Max	Mean ± Et	Min	Max	Mean ± Et
L_M/L_S	25,44	34,07	30,07±1,53	25,00	36,34	29,78±2,16

T – student de Welch			
	p-value calculée	DDL	$Z_{0,05}$
length of the snout	0.223	147	1.645

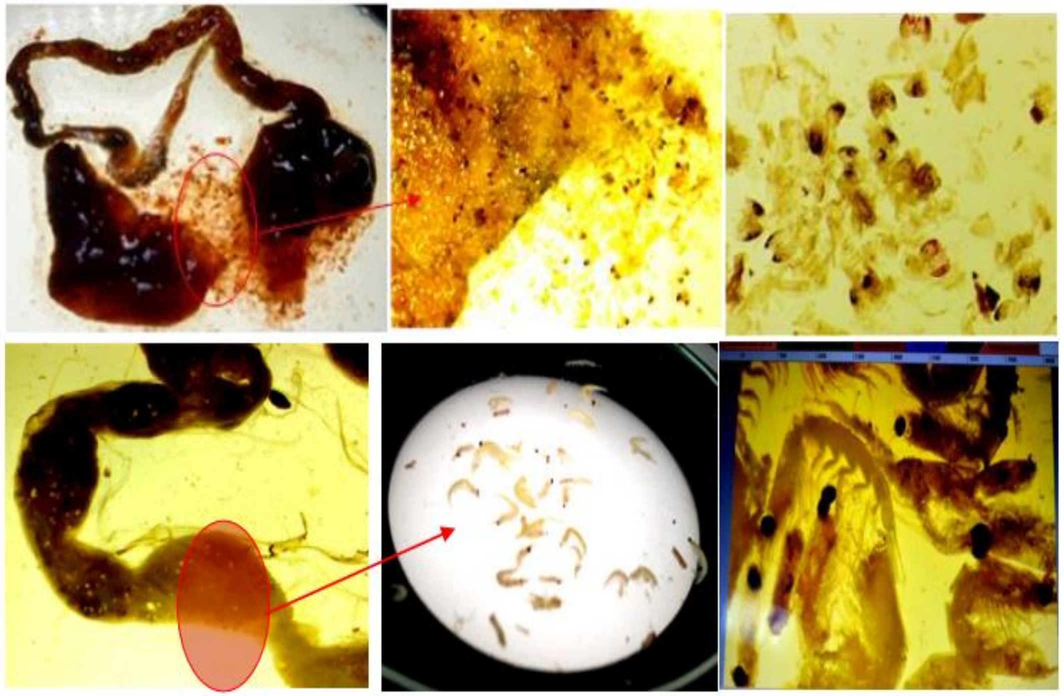
Results (Diet)

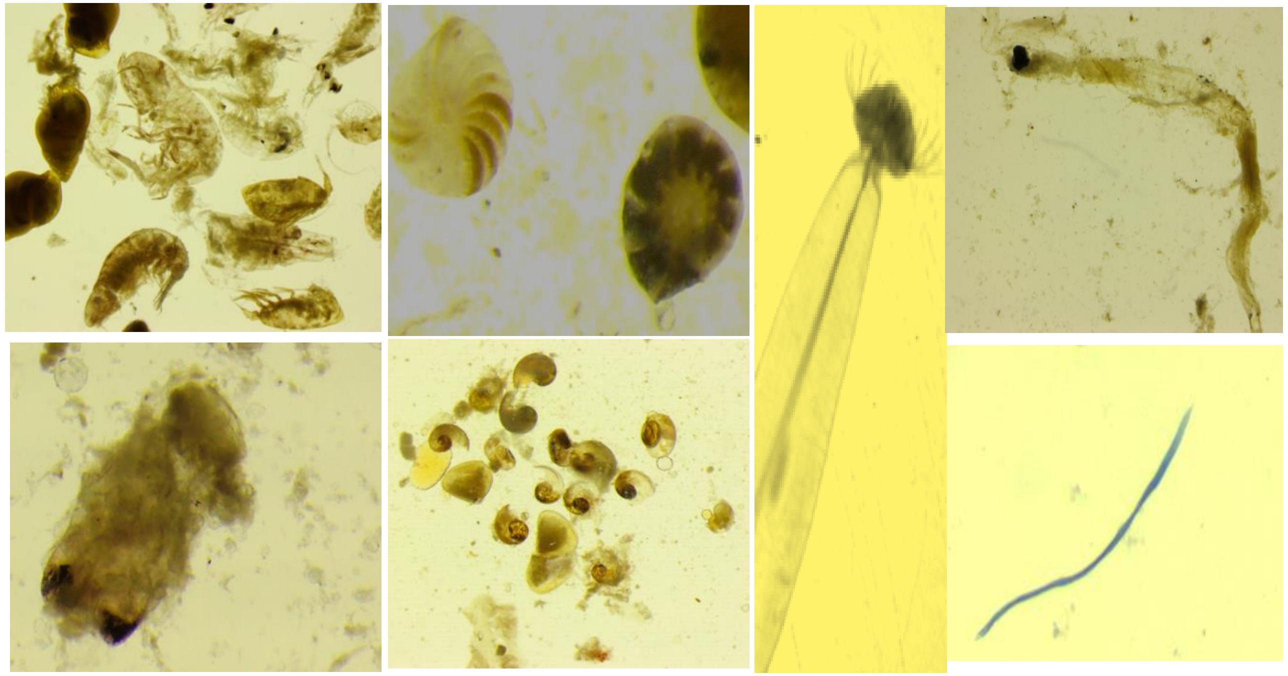
M.gracilis	IRI% 2018	IRI% 2019	IRI% 2020	IRI% 2021
Annelids	3,5	0,5	3,07	3,5
Appendicularians	3,04	0,02	2,14	0,66
Chaetognaths	2	0,8	7,14	8,1
Crustaceans	**51,12**	**63,5**	**57,8**	**49,5**
Fish	2	1,02	1,34	2,19
Fish net	**0,02**	**0,22**	**0,36**	**2,33**
Foraminifera	21,03	1,12	2,13	2,44
Molluscs	**0,7**	**26,05**	**18,09**	**16,3**
Noctulica	9	0,9	1,23	2,15
Ophiuroids	2	1,2	0,29	2,86
Salpids	2,5	3,66	0,66	1,45
Siphonophores	3		0,59	4,02
Others	0,09	1,01	5,16	4,5

M. scolopax	**IRI% 2018**	**IRI% 2019**	**IRI% 2020**	**IRI% 2021**
Annelids	4,15	1,02	9,15	5,9
Appendicularians	3,06	1,9	2,14	2,88
Chaetognaths	2	3,74	7,14	6,09
Crustaceans	**58,78**	**71,02**	**61,55**	**59,33**
Fish	**0,58**			
Fish net	**0,02**	**0,22**		**3,01**
Foraminifera	6,77	2,55	2,13	2,71
Molluscs	**12,19**	**11,12**	**8,1**	**8,54**
Noctulica	1,2			
Ophiuroids	2,01	1,18	0,29	2,86
Salpids	0,84			1,45
Siphonophores	0,9			4,02
Others	7,5	7,25	9,5	3,21

Macroramphosus spp. Contribution (%) of prey groups and species in *M. gracilis* and *M. scolopax* (IRI%)

Results (Diet)

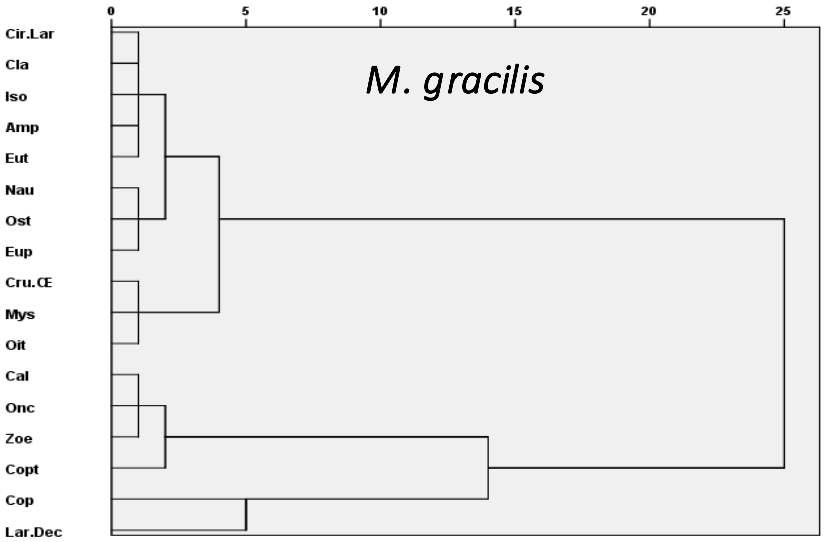


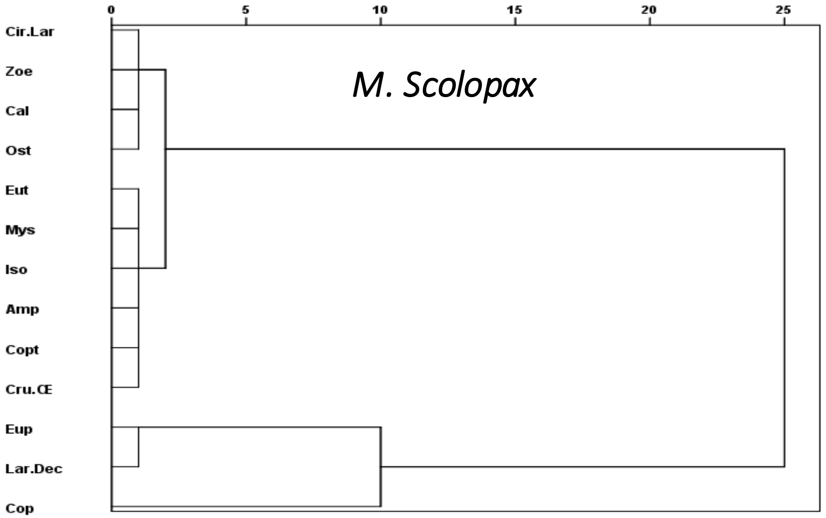


Two patterns in food composition. 1. ***Mr. gracilis***: Food is dominated by decapod larvae. ***M. scolopax:*** most of the content analyzed is based on Euphausiids

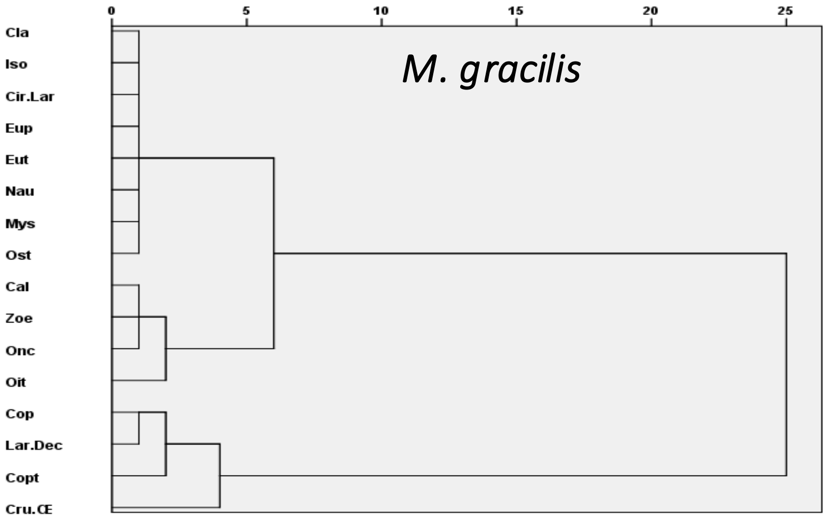
Results (Diet)

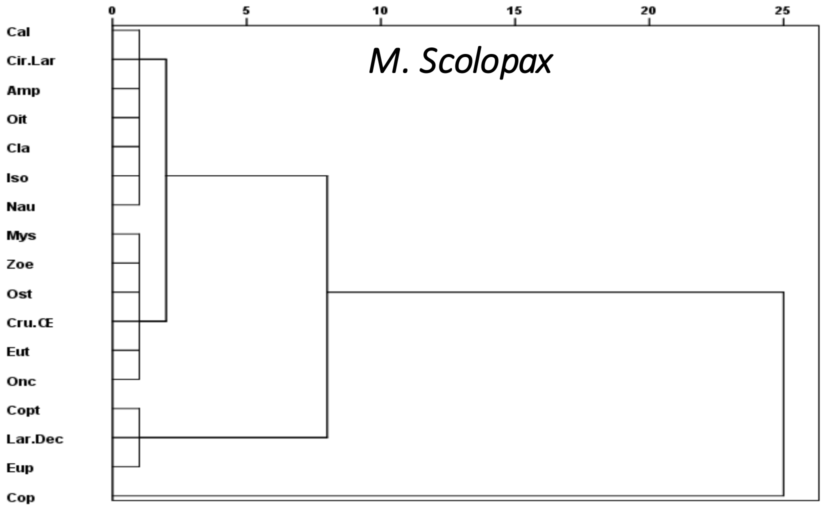
2018





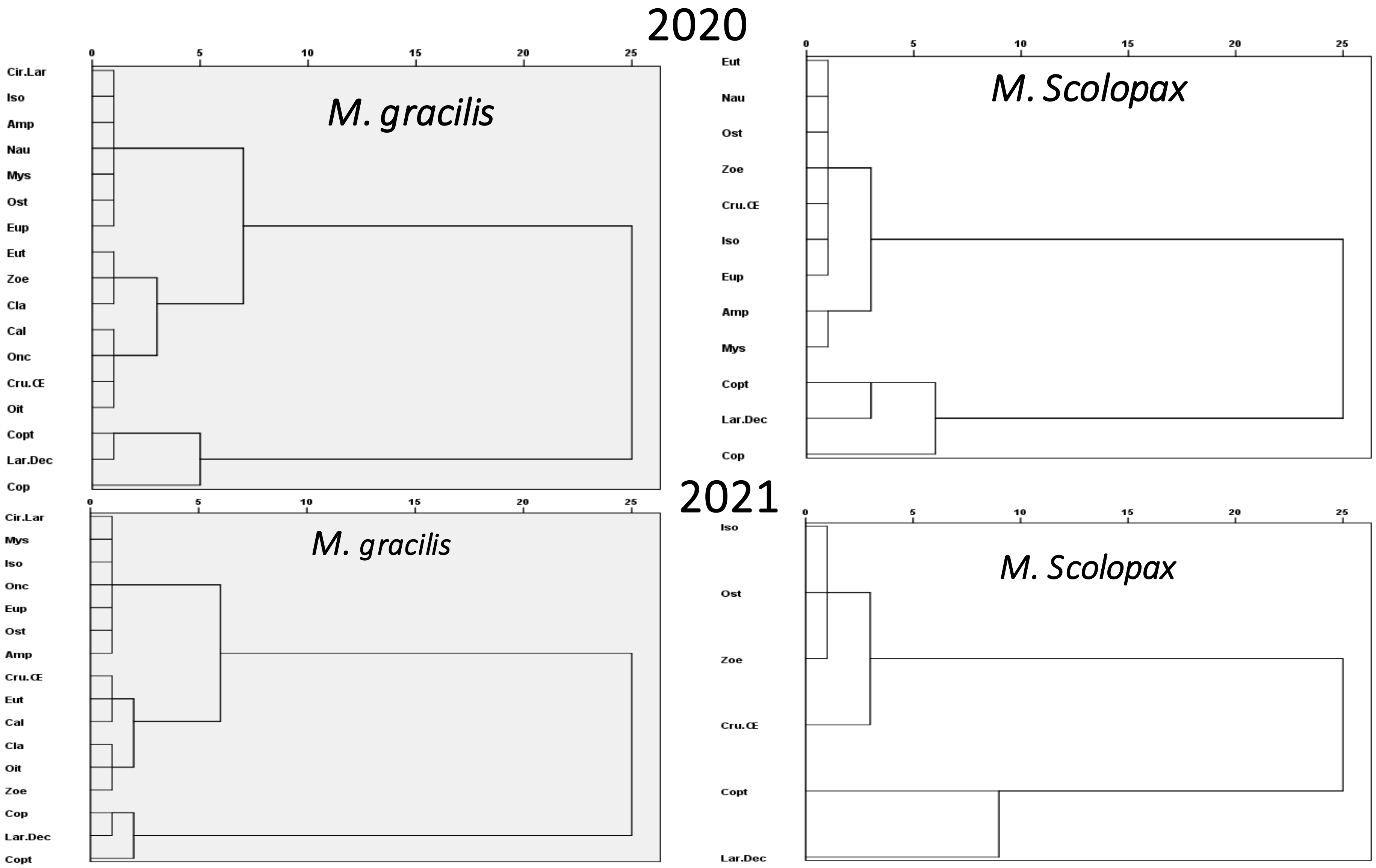
2019





	Main group
Amp	Amphipods
Cal	Calanus spp
Cir.Lar	Cirripedean larvae
Cla	Cladocerans
Cop	Copepods
Copt	Copepodites
Cru.Œ	Crustacean eggs
Eup	Euphausiids
Eut	Euterpina spp
Iso	Isopods
Lar.Dec	Decapod larvae
Mys	Mysidae
Nau	Nauplii of copepods
Oit	Oithona spp
Onc	Oncaea spp
Ost	Ostracods
Zoe	Zoe
BivV	Bivalve veligers
GasV	Gastropod veligers
Pte	Pteropods

Results (Diet)



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BivV	Bivalve veligers
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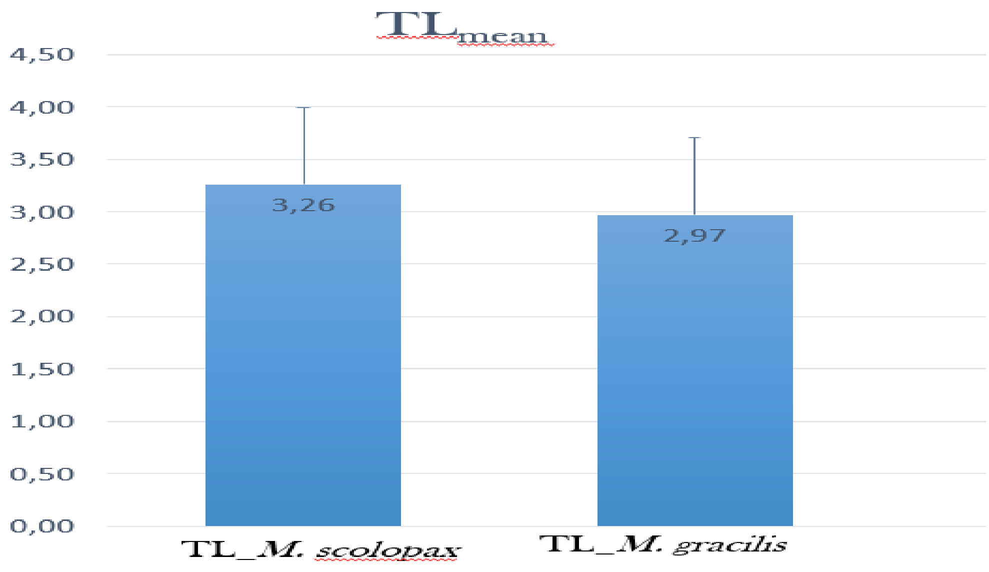
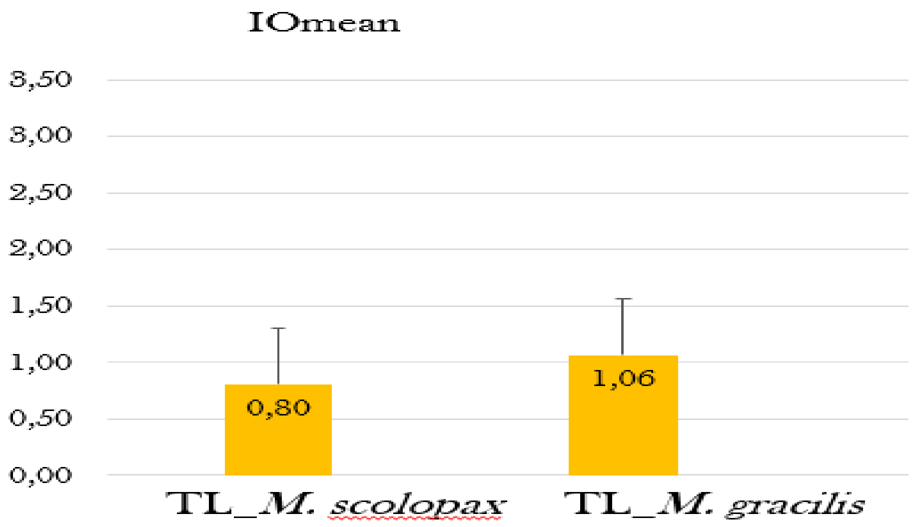
Pte	Pteropods

Results (Calculated diet indicators)

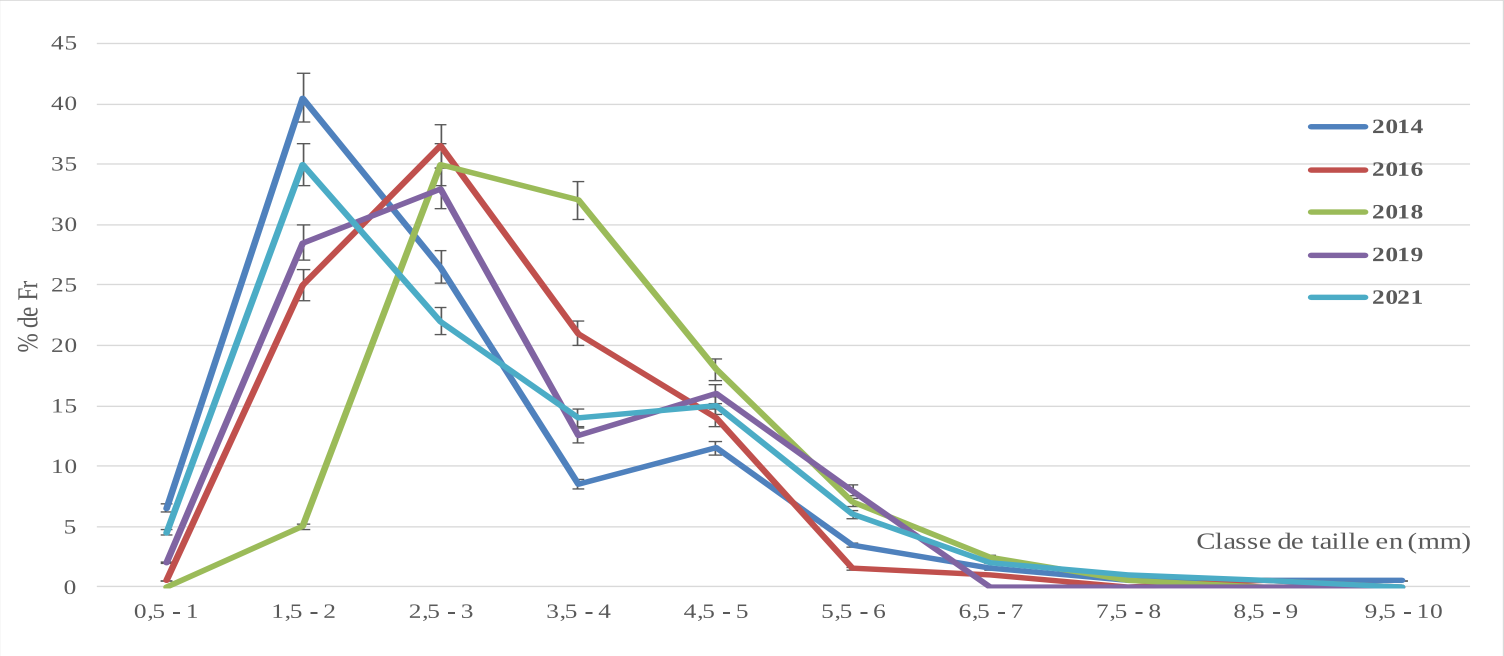


Trophic level



Omnivory

Results (size of zooplancton)



Total lengths for zooplankton (main groups) from the southern Moroccan zone

- In 2014 and 2021, the modes are at the size class levels below [1.5- 2] mm and represent 40.5% in 2014; 28.5% in 2019 and 35% in 2021, respectively.
- In 2016, 2018 and 2019, the mode structure shifts to the [2.5 - 3] mm size class fraction with significant percentages of 36.5%, 35% and 33% respectively.

South Atlantic ; (alpha,0.01)	Pearson Coeff (absolute value)	Tr (absolute value)	T mu (alpha/2)
Size 1 (ZOO) / Size 2 (Zoo prey)	0.43	3.152	0.376

- The two variables are significantly correlated, and Pearson's test showed that the correlation between the size of zooplankton that make up the habitat deployed by the snipefish and its preferred prey

Preliminary conclusions

- A multi-specific composition of prey was identified, which attests to a preferential hunting of the most abundantly dispersed prey, especially zooplanktonic communities with a small size. These prey must be able to pass through the snout

- The prey identified was remarkably similar in size.

- The area of study is known by an intense and permanent upwelling, so the Zooplankton does not have the time to take advantage of the primary production (Villegas et al., (1976) and so small sizes are available

Preliminary conclusions

Snipefish proliferation is most probably related to Zoophagous trophic behavior, due to the avaibality of adequate plankton in terms of sizes.

The upwelling dynamics seems to be a main factor generating this variability

Thank you for your attention