DEVELOPMENT OF TILAPIA FOR SALINE WATERS IN THE PHILIPPINES

M. M. Tayamen, T. A. Abella,
R. A. Reyes, Ma. J. C. Danting,
A. M. Mendoza, E. B. Marquez, A. C. Salguet,
M. M. Apaga, and R. C. Gonzales

COLLABORATORS

- National Freshwater Fisheries Technology Center of the Bureau of Fisheries and Aquatic Resources (NFFTC/BFAR)
- Freshwater Aquaculture Center of the Central Luzon State University (FAC/CLSU)

Funded by:

Bureau of Agricultural Research (BAR)

Objective

- To develop a saline tolerant breed of tilapia for sustainable brackishwater aquaculture.

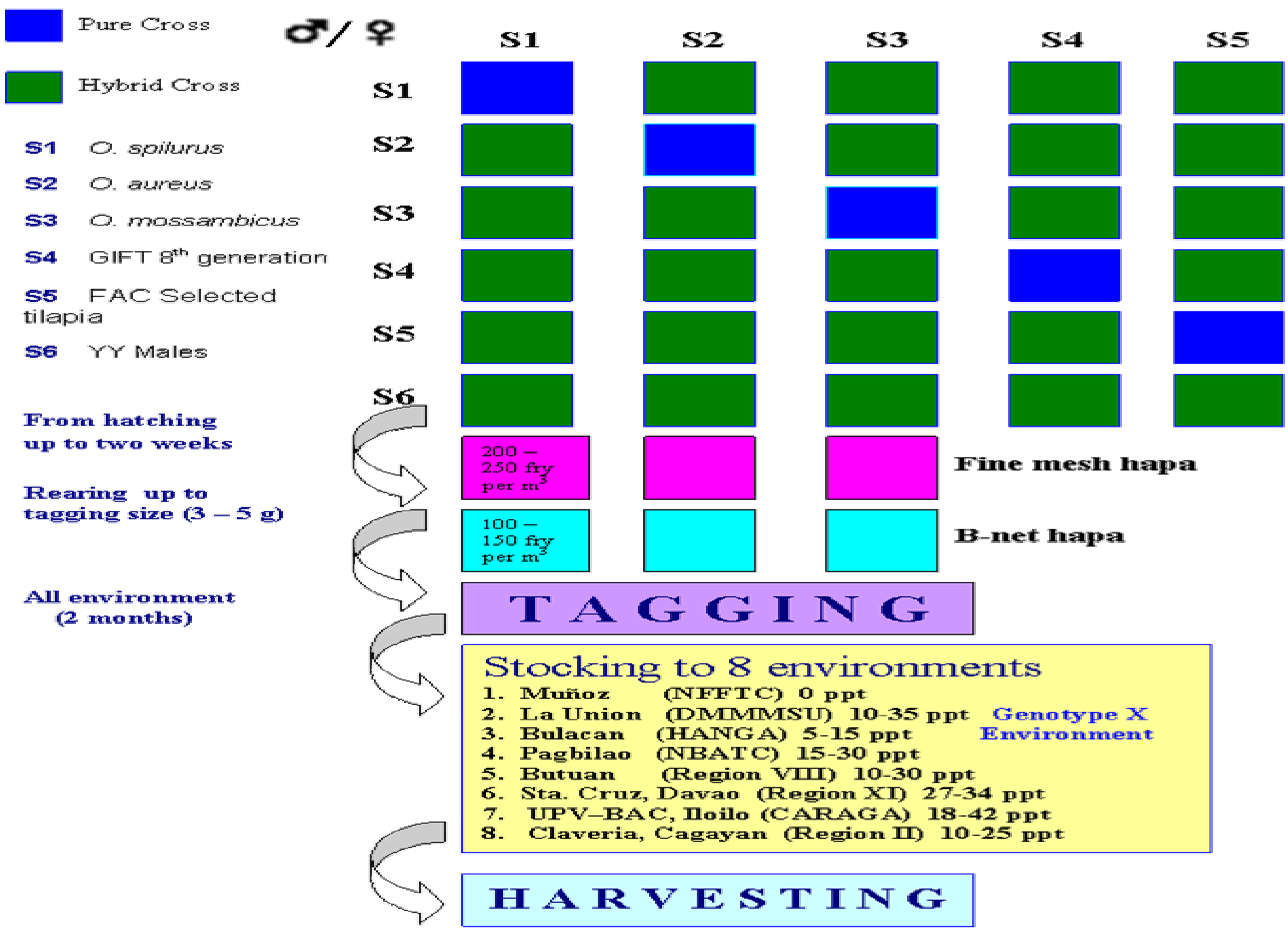
Specific Objectives:

- To document and evaluate existing tolerant tilapia stocks in the Philippines;
- To assess the reproductive performance of improved breeds in brackishwater based environment;
- To assess the culture performance of new breeds of tilapia in brackishwater conditions; and
- To disseminate information through training manual to competent breeders and culture operators.

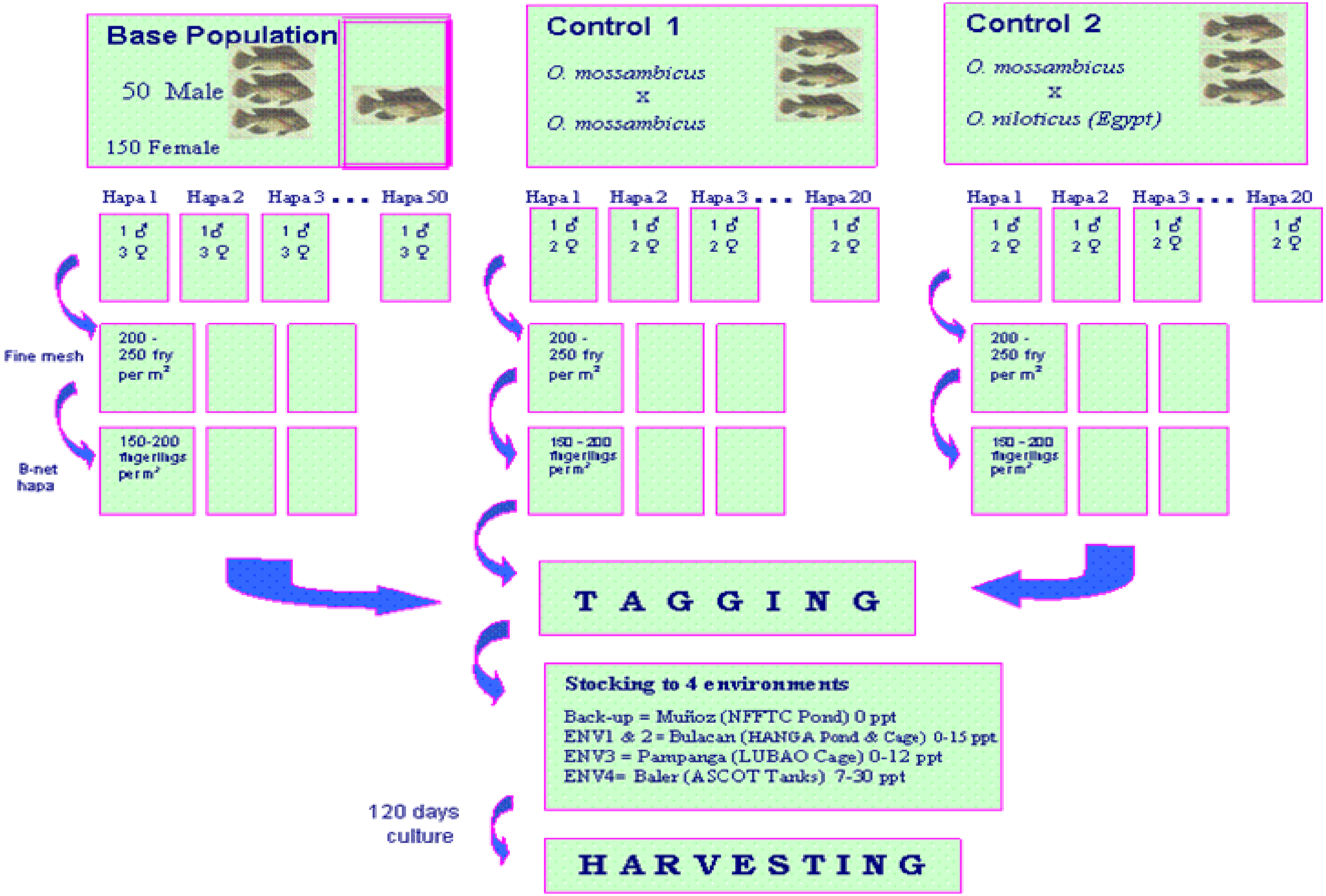
Methods

- ***O. aureus*** – originated from Israel. Obtained in 1977 through the Freshwater Aquaculture Center Central Luzon State University (FAC-CLSU).
- ***O. spilurus*** - introduced in 1998 from Mariculture and Fishery Development, Kuwait Institute for Science Research.
- ***O. mossambicus*** – obtained from BFAR-NIFTC, Bonuan, Pangasinan and from the wild in Bulacan.
- ***O. niloticus* (GIFT 8th Generation)** – was developed by combining the best performing genetic groups from eight diverse Nile tilapia strains and their crosses.
- ***O. niloticus* (FAC Selected Tilapia - FAST)** – this strain was a product of within family selection (based on body weight) of *O. niloticus* in a rotational mating scheme at FAC.
- ***O. niloticus* (YY males)** – developed in the Egypt Swansea strain of *O. niloticus* obtained from the School of Biological Sciences, University of Wales, Swansea (UWS) in 1988.

Phase 1 Breeding Plan



Phase 2 Breeding Plan



Results

Table 1. Mean gain in weight at harvest across test stations of 27 cross combinations

SIRE STRAIN	DAM STRAIN				
	O. spilurus	*O. aureus*	*O. mossambicus*	GIFT	FaST
O. spilurus	102.478 cd	96.436 de	48.546 k	99.802 de	105.045 bcd
O. aureus	106.427 bcd	77.626 gh	65.279 ij	-	58.796 j
O. mossambicus	60.712 j	-	36.604 l	-	90.345 ef
GIFT	74.686 ghi	104.747 bcd	64.266 ij	113.537 ab	115.127 ab
FaST	67.786 hij	82.212 fg	75.279 ghi	102.410 cd	**118.779 a**
YY	89.950 ef	64.373 ij	64.348 ij	111.32 abc	89.710 ef
Mean weight across environments					82.06g

Means with the same letter are not significantly different ($P<0.05$)

Table 2. Mean survival across test stations of 27 cross combinations

SIRE STRAIN	DAM STRAIN				
	O. spilurus	*O. aureus*	*O. mossambicus*	GIFT	FaST
O. spilurus	53.112 ab	46.188 ef	47.449 def	48.433 cdef	48.951 bcdef
O. aureus	46.866 def	46.254 ef	47.548 def	-	46.459 ef
O. mossambicus	52.834 ab	-	37.243 h	-	48.304 cdef
GIFT	46.487 ef	**55.290 a**	44.793 fg	52.765 ab	41.225 g
FaST	51.014 abcd	45.688 ef	47.431 def	53.146 ab	49.679 bcde
YY	48.291 cdef	52.130 abc	46.229 ef	52.435 abc	52.531 abc
Mean survival across environments					48.45%

Means with the same letter are not significantly different (P<0.05)

Table 3. Heterotic effects on different crosses among five strains of tilapia for growth and survival

INDICES	CROSSES						
	O. spilurus x O. aureus	*O. spilurus x O. mossambicus*	*O. spilurus x O. niloticus (GIFT)*	*O. spilurus x O. niloticus (FaST)*	*O. aureus x O.niloticus (FaST)*	*O. mossambicus x O.niloticus (FaST)*	*O.niloticus (GIFT) x O.niloticus (FaST)*
Growth Mean value of Pure breed 1/	94.15 ± 35.27	77.37 ± 45.90	106.26 ± 42.15	108.11 ± 44.72	98.68 ± 48.07	74.53 ± 58.82	116.18 ± 53.06
Mean value of Crossbred 2/	101.34 ± 41.65	55.26 ± 32.65	86.68 ± 37.79	83.85 ± 38.70	70.68 ± 34.49	82.00 ± 42.56	105.20 ± 42.65
Mean difference	7.19***	22.11***	19.58***	24.26***	28.00***	7.47***	10.98***
Strain Heterosis	+ 7.64	- 28.58	- 18.43	- 22.44	- 28.37	+ 10.02	- 9.45
Average Heterosis							-12.80

*** indicate highly significant differences between pure bred and crossbred at 0.05 level

INDICES	CROSSES						
	O. spilurus x O. aureus	*O. spilurus x O. mossambicus*	*O. spilurus x O. niloticus (GIFT)*	*O. spilurus x O. niloticus (FaST)*	*O. aureus x O.niloticus (FaST)*	*O. mossambicus x O.niloticus (FaST)*	*O.niloticus (GIFT) x O.niloticus (FaST)*
Survival Mean value of Pure breed [1/]	50.81 ± 19.03	47.06 ± 18.35	52.99 ± 22.73	51.93 ± 21.72	48.00 ± 24.50	42.98 ± 22.54	51.21 ± 28.91
Mean value of Crossbred [2/]	46.52 ± 18.94	50.42 ± 13.04	47.42 ± 18.35	50.12 ± 20.86	46.07 ± 19.67	47.82 ± 20.59	47.72 ± 23.90
Mean difference	4.29***	3.36***	5.57***	1.81***	1.93***	4.84***	3.49***
Strain Heterosis	- 8.44	+ 7.14	- 10.51	- 3.48	- 4.02	+ 11.26	- 6.82
Average Heterosis							- 14.87

*** indicate highly significant differences between pure bred and crossbred at 0.05 level

Table 4. Number of male and female breeders of the 16 best performing strain combination used to build the base population.

RANK	CROSS	MALE (n)	FEMALE (n)	% Composition to Base Population
1	S2 x S1	6	17	11.5
2	S5 x S5	6	16	11
3	S1 x S1	5	15	10
4	S5 x S1	5	15	10
5	S4 x S4	4	14	9
6	S4 x S2	4	14	9
7	S1 x S5	4	12	8
8	S4 x S5	3	10	6.5
9	S6 x S4	3	-	1.5

Table 4. Number of male and female breeders of the 16 best performing strain combination used to build the base population.

RANK	CROSS	MALE (n)	FEMALE (n)	% Composition to Base Population
10	S5 x S4	2	9	5.5
11	S1 x S4	2	8	5
12	S6 x S5	2	-	1
13	S3 x S5	1	8	4.5
14	S1 x S2	1	6	3.5
15	S5 x S3	1	4	2.5
16	S5 x S2	1	2	1.5
		50	150	100

Table 5. Combining ability for growth (g) and survival (%) of the different tilapia strains

	Combining Abilities *	
	Growth (g)	Survival (%)
Fish was used as Maternal Strain		
O. spilurus	+ 0.515 [c]	+ 1.6173 [ab]
O aureus	+ 4.228 [c]	+ 0.2549 [bc]
O. mossambicus	- 21.615 [d]	- 2.8854 [d]
O. niloticus (GIFT)	+ 23.726 [a]	+ 2.8107 [a]
O. niloticus (FaST)	+ 11.190 [b]	- 0.2581 [c]

Means within parental groups in the same column with the same letter are not significantly different ($P<0.05$)

Table 5. Combining ability for growth (g) and survival (%) of the different tilapia strains

Fish was used as Paternal Strain	Growth (g)	Survival (%)
O. spilurus	+ 7.634 [a]	+ 0.4717 [ab]
O aureus	- 4.390 [d]	- 1.6010 [c]
O. mossambicus	- 17.971 [e]	- 0.7855 [bc]
O. niloticus (GIFT)	+ 6.241 [ab]	- 0.5058 [abc]
O. niloticus (FaST)	+ 2.270 [bc]	+ 0.5992 [ab]
O. niloticus (YY)	- 1.079 [cd]	+ 1.2812 [a]

Means within parental groups in the same column with the same letter are not significantly different ($P<0.05$)

Table 6. Phase 2; rank-order and significant of ranks for final body weight corrected for sex effect of the different cross combinations across and within environments

Crosses	Group cross	ENV1 CAGE	ENV2 POND	ENV3 CAGE	ENV4 TANK	Across ENV
(S1S5)x(S5S3)	9	10^{bcdef}	3^{bc}	1^{a}	$12^{abcdefgh}$	1^{a}
(S1S4)x(S4S4)	6	3^{bc}	$16^{bcdefghi}$	24^{bcde}	1^{a}	2^{ab}
(S5S1)x(S1S4)	27	9^{bcde}	-	2^{ab}	18^{defgh}	3^{ab}
(S4S4)x(S2S1)	20	2^{ab}	$25^{cdefghi}$	34^{de}	-	4^{abc}
(S5S5)x(S4S2)	36	13^{cdefg}	4^{bc}	10^{bcde}	22^{defgh}	5^{abcd}
(S1S1)x(S4S4)	3	8^{bcd}	$20^{cdefghi}$	8^{abcd}	$8^{abcdefg}$	6^{abcd}
(S4S4)x(S5S4)	23	4^{bc}	30^{defghi}	19^{bcde}	$11^{abcdefgh}$	7^{abcd}
(S5S5)x(S3S5)	35	12^{cdefg}	1^{a}	37^{de}	$14^{abcdefgh}$	8^{abcde}
(S1S1)x(S4S5)	4	11^{bcdef}	11^{bcdef}	13^{bcde}	$7^{abcdefg}$	9^{abcdef}
(S4S4)x(S4S5)	21	$18^{cdefghij}$	$15^{bcdefghi}$	6^{abcd}	3^{abc}	10^{abcdef}
O. mossambicus	39	37^{m}	$22^{cdefghi}$	28^{bcde}	24^{defgh}	37^{lmn}
O. mossambicus x *O. niloticus* Egypt	40	34^{klm}	6^{bcd}	3^{abc}	$13^{abcdefgh}$	$19^{defghij}$
MEAN WT. (g)		101.13	85.54	100.89	60.21	91.10

Ranks within test environment sharing the same superscript are not significant different (P<0.05)

Table 6. Phase 2; rank-order and significant of ranks for survival of the different cross combinations across environments

Crosses	Group cross	Mean SURV
(S4S5)x(S1S2)	24	1 [a]
(S1S1)x(S4S5)	4	2 [b]
(S1S1)x(S4S2)	2	3 [bc]
(S5S5)x(S1S5)	33	4 [bc]
(S2S1)x(S1S2)	10	5 [bcd]
(S1S5)x(S1S1)	7	6 [bcd]
(S1S1)x(S4S4)	3	7 [cd]
(S2S1)x(S4S2)	13	8 [cde]
(S1S5)x(S5S1)	8	9 [cdef]
(S5S1)x(S1S2)	26	10 [defg]
O. mossambicus	39	21 [ghij]
O. mossambicus x *O. niloticus* Egypt	40	27 [hijkl]
MEAN SURV. (%)*		53.56 (1,396)

Ranks within test environment sharing the same superscript are not significant different (P<0.05)

Conclusion

- Phase 1
  - purebreds performed better than the hybrids in almost all crosses indicating no hybrid vigor for growth and survival in crossbred progenies except for *O. spilurus* x *O. aureus* and *O. mossambicus* x FaST for growth and *O. spilurus* x *O. mossambicus* and *O. mossambicus* x FaST for survival
  - average negative heterosis reflects the minimal non-additive genetic variance and therefore does not justify a crossbreeding approach
  - it is possible to improve the trait for salinity tolerance of this species through selection that exploits the additive effects of genes controlling this trait

Conclusion

- Phase 2
  - an increased in terms of growth and survival was achieved through selection
  - Salinity tolerance in terms of growth and survival was influenced by the male parent *O. spilurus* while the female parent *O. niloticus* FaST influenced the growth rate
  - All hybrids cross with pure *O. spilurus* was included in the top ranking families based on survival but not all top ranking families based on body weight were included in the top ranking families based on survival


Thank you and
MABUHAY!!!