Determination Of Sex And Gonad Maturity In Saline Tilapia (*Oreochromis mossambicus*) Using Ultrasound Technique

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Background

Ultrasound technology has been used as a noninvasive tool for fish sex determination and maturation monitoring in salmon and sturgeon[1,2]. The use of ultrasound reduces handling stress and eliminates the need to sacrifice valuable broodstocks during reproductive monitoring. A recent study also demonstrated its potential for assessing the ovarian maturation in nile tilapia broodstock[3]. The present study aimed to explore the use of an ultrasound for determining the sex and maturation stages of saline tilapia *Oreochromis mossambicus* in Singapore.

Methods

Data on body weight, gonad weight and standard length were collected from 33 female and 17 male tilapias. Gonad development was assessed using a portable ultrasound apparatus with a L12-4 transducer (Philips Lumify). Egg diameter was measured and gonad width were estimated from ultrasound images with ImageJ. The gonadosomatic index (GSI) was calculated as the ratio of gonad weight (Wg) to the total fish weight (Wt); GSI = Wg/Wt × 100%.

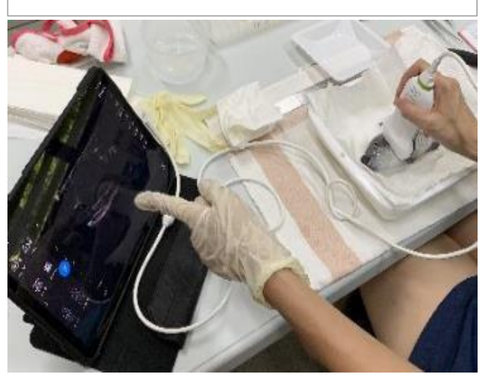
Sexing



Ultrasound scanning



Measurement/photography



Egg diameter measurement



Image/data processing



Results

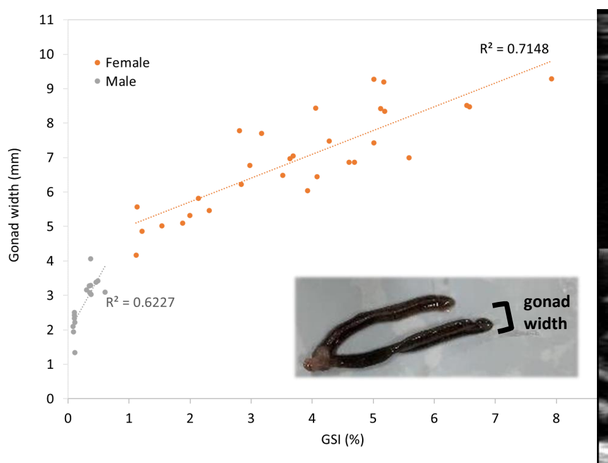


Figure 1: Positive relationships between gonadosomatic index (GSI) and gonad width for female and male saline tilapia.

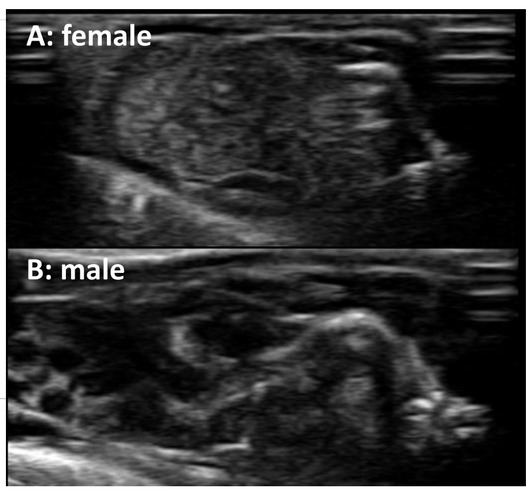


Figure 2: Determination of sex of saline tilapia from ultrasound images: (A) female (B) male.

A: Female **B: Male**

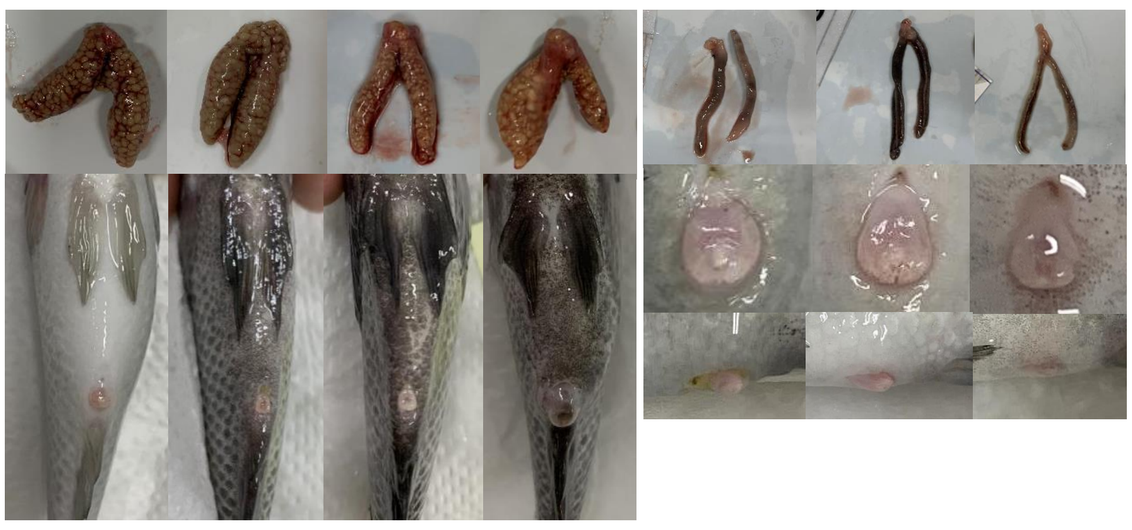


Figure 3: Determination of the sex of saline tilapia from macroscopic observations: (A) female (B) male

Table 1: Reproductive conditions and maturation stages were identified based on GSI, macroscopic observations of fish and testis from male saline tilapia *O. mossambicus*.

Male

Stage of maturation	GSI (%)	Testis length (mm)	Testis width (mm)	Descriptions
Not ready to spawn	0.08 - 0.11	29.11 - 36.64	1.34 - 2.51	Papilla was white to translucent and flat in appearance.
Maturing	0.31 - 0.38	34.64 - 40.15	3.03 - 4.07	Papilla was white to pink, protruding and slightly enlarged.
Ready to spawn	0.46 - 0.61	28.89 - 38.15	3.09 - 3.38	Papilla was white to pink, enlarged and protruding, with slight red pigmentation. Milt was readily released upon gentle pressure on the fish abdomen.

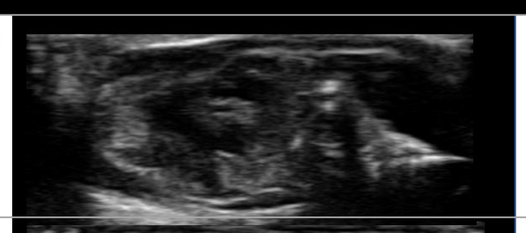
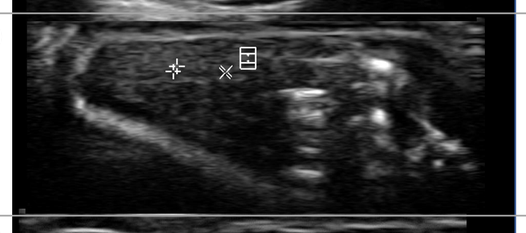
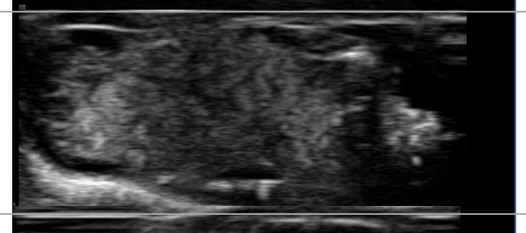
Table 2: Reproductive conditions and maturation stages were identified based on GSI, macroscopic observations of fish and ovary from saline tilapia *O. mossambicus*.

Female

Stage of maturation	GSI (%)	Ovary length (mm)	Ovary width (mm)	Ova diameter (mm)	Descriptions
Early maturing	1.12 - 1.99	24.43 - 34.07	4.17 - 5.58	0.55 - 1.34	Normal abdomen. Ovaries predominantly contained small whitish and/or yellowish oocytes.
Developing	2.14 - 4.69	26.26 - 38.81	5.82 - 7.78	1.15 - 1.81	Slightly distended abdomen. Ovaries appeared slightly enlarged. Oocytes were slightly larger and yellowish in color.
Developed	3.92 - 7.92	27.63 - 45.79	6.05 - 9.28	1.60 - 2.55	Distended abdomen. Ovaries appeared enlarged with thin, nearly transparent wall. The oocytes were distinctively large, spherical, and golden in color.
Abnormal	3.17 - 5.12	25.40 - 30.56	7.05 - 8.42	0.60 - 1.51	Most fish appeared abnormal abdomen shape. Ovaries appeared pale and contained rotten, hardened and/or degenerated oocytes.

Table 3: Ultrasound images of female saline tilapia *O. mossambicus*.

Female

Stage of maturation	GSI (%)	Ultrasonic observations	Descriptions
Early maturing	1.12 -1.99		Ovaries appeared a heterogenous echogenic texture. Oocytes appeared as speckled granules within the ovaries.
Developing	2.14 -4.69		Ovaries appeared enlarged, with small visible oocytes embedded within a heterogenous echogenic texture.
Developed	3.92 -7.92		Ovaries appeared enlarged and extended. Oocytes were prominent, large, highly and organized with a discernible boundary.
Abnormal	3.17 -5.12		Oocytes appeared irregular in shape, size and echogenic appearance. Some oocytes exhibited higher image intensity.

Conclusion

Ultrasound technology offers an alternative approach for determining sex and the stage of maturity in saline tilapia. The technique is nonlethal and non-invasive, thereby eliminating the need to sacrifice fish and improves animal welfares in the broodstock management. In addition, an ultrasound provides immediate results, unlike conventional methods that require sample processing and laboratory analysis.

References

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Acknowledgements

We wish to thank the Marine Aquaculture Centre, Singapore Food Agency for kindly sharing the ultrasound unit. The study was funded by the Temasek Life Sciences Laboratory.