

Virginia Tech Aquaculture Group Cobia Research 2005-6

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Summary

The following provides a brief overview of research activities undertaken at Virginia Tech upon cobia larvae and juveniles. Described research was supported by CFAST and Virginia Sea Grant for the 2005/6 funding cycle. Research with larval animals was undertaken at the Virginia Seafood AREC, Hampton facility (VSAREC), whereas that with juveniles was executed at the Virginia Tech Aquaculture Center (VTAC) located in Blacksburg. The described activities represent a cohesive effort, with VTAC researchers being present during the VSAREC larval rearing trials and *vice versa*. The 2005/6 period represented a watershed year in terms of animal production and research output. Over 50 publications (primary, secondary and trade) and presentations (domestic and international meetings and symposiums) upon cobia were made as a direct result of this funding. Additionally, funding enabled both the VSAREC and VTAC facilities to train graduate and undergraduate students and to host international scientists.



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Research activities

The research goals of the 2005/6 research cycle were:

- 1 *Determine the necessity of live algae in cobia larviculture.*
- 2 *Examine methods to assess egg quality.*
- 3 *Investigate alternate proteins for cobia feeds.*
- 4 *Evaluate cobia growth in VA-based production systems.*

i) Is a live alga necessary for larval cobia production?

The ability to replace live algae with paste preparations, without impacting survival, growth or viability of cobia larvae was demonstrated. This represents a significant finding since savings in terms of labor, time, equipment and other costs associated with live algae production in cobia hatcheries may be reduced substantially. During this research, production protocols with respect to all stages of larval development were optimized. These studies resulted in the highest reported level of cobia larval survival being consistently attained (~2.4 weanlings per liter). This technological innovation has already been passed on to commercial producers who will benefit through cheaper and more efficient larval cobia production. As well, preliminary observations upon the use of dietary mannan oligosaccharides (MOS) to assist larval gut development were completed. The use of MOS increased animal production and their ability to withstand salinity challenge. Overall, this research has enhanced the VSAREC's ability to produce a greater number of fingerlings for distribution to the Commonwealth's developing mariculture industry.

ii) Can we assess egg quality using biochemical analyses?

The availability of cobia eggs during the 2005 season was interrupted due to hurricane activity in the Florida Keys. This resulted in loss of stored samples due to the interruption of the municipal electrical supply and negated biochemical analyses. Nevertheless, baseline data, via a collaborative run in Reunion Island which was replicated at the VSAREC, was collected in terms of developmental processes of cobia larvae from 2 days post-hatch to death in an unfed condition. This developing dataset will provide us with an indication of egg quality based upon availability and quality of endogenous energy supplies and will be utilized in all future trials.

iii) Can juvenile cobia use non-fishmeal-based diets?

A series of nutritional studies were undertaken to study the potential for replacing fishmeal in cobia diets. A major twist from usual feeding trials was the use of organically certifiable alternative proteins both with and without amino acid supplementations. Research investigated soybean meal, soybean isolate, hemp meal and a yeast-based product. These trials were tremendously successful and illustrated that substitution of 40% of the fish meal component with yeast-based protein had no negative impacts upon growth. Additional studies with the yeast protein together with amino acid supplementation further reduced fishmeal requirements for cobia diets. Methionine (0.3% diet), tryptophan (0.2% diet) and taurine (0.5% diet) supplementation were examined with positive outcome. Even at 75% fishmeal replacement animal growth was similar to that observed for controls. The last finding is highly exciting since it opens a door for even greater levels of fishmeal replacement in marine carnivore diets. The implications of this are clear. The demand for fishmeal presently exceeds supply. This has resulted in increased global market prices for fishmeal. An ability to effectively employ alternative sustainable (plant- and single cell-based) protein sources would substantially reduce aquafeed costs. Moreover, the production of organically certified cobia would provide a unique niche product for the aquaculture industry.

iv) Is there variability in cobia performance by system and location?

This is an on-going trial, the success of which will be dependent upon commercial producers and conclusion of grow-out. Preliminary indications are that customized system technology will need to be incorporated into commercial settings.

Communications and outreach

Research undertaken during the 2005-2006 research cycle resulted in the production of several peer reviewed publications and included book chapters and reports in proceedings. As a component of our extension and outreach activities, brief articles were also constructed for trade and related journals and as an industry information sheet.

Twenty-nine presentations were made relating to cobia research at international, national and regional meetings and workshops. An information brief was provided for the US Congressional Committee on Agriculture covering the VTAC involvement in cobia aquaculture development.

Training was also incorporated into the research activities with cobia for five Virginia Tech graduate students, and an undergraduate derived from the Departments of Fisheries and Wildlife Sciences and Biological Sciences, as well as industrial technicians from France and Brazil. Additionally an international training workshop which included a student from Brazil and technician from the EU was conducted, enhancing research results as well as international collaborations.

A) Primary publications and book chapters

1. Craig, S.R. and McLean, E. (2005). The organic aquaculture movement: a role for NuPro as an alternative protein source. pp. 285-293, In: *Nutritional Biotechnology in the Food and Feed Industry* (K. Jacques and P. Lyons, Eds.). Nottingham University Press, UK. ([printed and electronic versions](#)).
2. Craig, S.R. and McLean, E. (2006). Sustainable aquaculture of cobia: A case study with organically certified alternate proteins. In: *Nutritional Biotechnology in the Food and Feed Industry* (K. Jacques and P. Lyons, Eds.). Nottingham University Press, UK. ([printed and electronic versions](#)).
3. Lunger, A.N., Craig, S.R. and McLean, E. (2006). Replacement of fish meal in cobia diets using an organically certified protein. *Aquaculture*, **255**, in press. ISSN: 0044-8486.
4. McLean, E. and Craig, S.R. (2006). Nutrigenomics in aquaculture research: a key in the 'Aquanomic' revolution. In: *Nutritional Biotechnology in the Food and Feed Industry* (K. Jacques and P. Lyons, Eds.). Nottingham University Press, UK. ([printed and electronic versions](#)).
5. Schwarz, M.H., McLean, E. and Craig, S.R. (2006). Research experience with cobia: larval rearing, juvenile nutrition and general physiology. Book Chapter In *Cobia Aquaculture: Research, Developments and Commercial Production*. (I.C. Liao, ed). Co-Published by the Asian Fisheries Society, Fisheries Society of Taiwan, and World Aquaculture Society, in press.
6. Schwarz, M.H., Mowry, D., McLean, E. and Craig, S.R. (2006). Performance of advanced juvenile cobia reared under different thermal regimes: a method for cold banking. *Journal of Applied Aquaculture*, in press.

B) Manuscripts in review or under preparation

1. Craig, S.R., Schwarz, M.H., Delbos, B., Harris, W., Russell, D. and McLean, E. (2006). Haematological characteristics of cobia, *Rachycentron canadum* maintained under various salinities. *Journal of Applied Ichthyology*, in preparation.

2. Duncan, M., Kuhn, D., Lunger, A.N., Salze, G., Silva, M., Craig, S.R. and McLean, E. (2006). Bioimpedance analysis as a non-lethal method for examining body composition of growing cobia. *Aquaculture*, in review.
3. Holt, J.G., C. Faulk, and M.H. Schwarz. (2006). Larviculture of the Warm Water Marine Species Cobia (*Rachycentron canadum*). *Aquaculture* (In review).
4. Lunger, A., McLean, E. and Craig, S.R. (2006). Growth performance and fillet quality characteristics of juvenile cobia fed diets containing various levels of alternate proteins. *Aquaculture Nutrition*, in review.
5. McLean, E. and Craig, S.R. (2006). Cobia – A promising candidate for aquaculture? *Ribarstvo*, invited review.
6. McLean, E., Schwarz, M.H., Zimmerman, J. and Craig, S.R. (2006). Bio-packaging of mannan oligosaccharide in live feeds enhances survival and stress resistance in larval cobia. *Aquaculture*, in preparation.
7. Schwarz, M.H., Craig, S.R., Delbos, B. and McLean, E. (2006). Cobia larviculture protocols effectively replace live algae with commercially available algal paste concentrate during greenwater phase. *Aquaculture*, in preparation.

C) Secondary and trade communications

1. Carvalho, M.B., Hamilton, S., Smith, S.A., Craig, S.R., McLean, E., Delbos, B.C., Zimmerman, J.K., Babet, M.C., King, N.4., and Schwarz, M.H. (2005). Towards commercially realistic levels of production for cobia (*Rachycentron canadum*) fingerlings. XIV Congresso Brasileiro de Engenharia de Pesca (XIV CONBEP)". Centro de Convenções de Fortaleza, Brasil, CE. October 18-22, 2005.
2. Craig, S.R. and McLean, E. (2006). Cobia. *Aqua Feeds: Formulation & Beyond*, **2**, in press.
3. Craig, S.R. and McLean, E. (2006). Alternative protein source for organic aquaculture. *Feed Technology Update*, **1**, 13-17 (cover photo credit).
4. Craig, S.R. and McLean, E. (2005). In search of an alternative protein source. *Feedtech*, **9**, 18-21.
5. Craig, S.R. and McLean, E. (2005). Dietary replacement of fish meal with NuPro™ for carnivorous fish: experiments with cobia. NuPro Technical Update, 054-eng.RT, August 2005. Industry Circular Alltech Inc., Kentucky. 2 pp.
6. Craig, S.R., Schwarz, M.H. and McLean, E. (2005). Nutrition Research with Cobia. *Global Aquaculture Advocate* 8(1): 76-78. ISSN: 1018-3166
7. King, N. and Schwarz, M.H. (2005). INVE Solutions in Cobia Rearing. *Panorama da Aquicultura Magazine*. December, 2005.
8. King, N. and Schwarz, M.H. and Delbos, B. (2006). Hatchery trials a success. *Fish Farming International*. January, 2006.
9. Schwarz, M.H. (2005). New initiative to develop cobia. *Fish Farming International*. July, 2005.

10. Schwarz, M.H. (2006). Cobia Update: Fast-growing species first focus of international initiative. *Global Aquaculture Advocate*. April/May, 2006

D) Presentations at meetings and workshops

1. Craig, S.R., McLean, E. and Gaylord, T.G. (2006). Are cobia "aquacats"?: taurine requirement of a marine carnivore. XII International Symposium on Fish Nutrition & Feeding (*12ème Symposium International Nutrition et Alimentation des Poissons*). 28 May - 1 June 2006, Biarritz, France.
2. Craig, S.R., McLean, E. and Schwarz, M.H. (2005). Juvenile cobia nutrition and immunostimulation: A three year review. *2nd International Marine Fish Culture Conference and Workshop*, HBOI, Ft. Pierce, Florida, October 19-21st 2005.
3. Craig, S.R., Reid, B., Fegan, D. and McLean, E. (2006). NuPro – a multi-species evaluation of a fully sustainable alternate protein source for organic aquaculture production. XII International Symposium on Fish Nutrition & Feeding (*12ème Symposium International Nutrition et Alimentation des Poissons*). 28 May - 1 June 2006, Biarritz, France.
4. Craig, S. R., Schwarz, M.H. and McLean, E. 2005. Use of a purified carbohydrate source in diets for juvenile cobia *Rachycentron canadum*. *World Aquaculture Society Meeting '05*. Nusa Dua, Bali, Indonesia. May 9 – 13.
5. Craig, S.R., Schwarz, M.H. and McLean, E. (2006) Amino acid supplementation of an alternative protein source in diets for juvenile cobia *Rachycentron canadum*. *Aquaculture 2006*, Florence, Italy, May 9-13 2006.
6. Delbos, B.C., Mowry, D., McLean, E., Craig, S.R. and Schwarz, M.H. (2005). Cobia express growth variance following changes in rearing temperatures. *2nd International Marine Fish Culture Conference and Workshop*, HBOI, Ft. Pierce, Florida, October 19-21st 2005.
7. Dhert, P., King, N., Schwarz, M.H., Carvalho, M., Deblos, B. and Zimmerman, J. (2006). Nutritional adaptation of *Artemia* for cobia culture. *World Aquaculture 2006*, Florence, Italy, May 9-13.
8. Duncan, M., Kuhn, D., Lunger, A.N., Salze, G., Silva, M., Craig, S.R. and McLean, E. (2006). Can bioimpedance technologies be used to assess fish quality down on the farm? XII International Symposium on Fish Nutrition & Feeding (*12ème Symposium International Nutrition et Alimentation des Poissons*). 28 May - 1 June 2006, Biarritz, France.
9. King, N., Dhert, P., Schwarz, M.H., Carvalho, M., Delbos, B. and Zimmerman, J. (2006). Nutritional adaptation of *Artemia* for cobia culture. *World Aquaculture Society Aquaculture America Meeting '06*. Las Vegas, NV. February 13-16.
10. Lunger, A., Schwarz, M.H., McLean, E. and Craig, S.R. (2005). Use of a certified organic protein source in diets for cobia *Rachycentron canadum*. *World Aquaculture Society Aquaculture America Meeting '05*. New Orleans, LA. January 17-20.

11. Lunger, A.N., McLean, E., Schwarz, M.H. and Craig, S.R. (2006) Use of organically certified protein sources as a replacement for fish meal in aquafeeds for juvenile cobia *Rachycentron canadum*. *Aquaculture 2006*, Florence, Italy, May 9-13 2006.
12. Lunger, A.N., McLean, E., Schwarz, M.H. and Craig S.R. (2006). Further investigations into organic alternative protein sources as replacement for fish meal in diets for juvenile cobia (*Rachycentron canadum*). *Aquaculture America 2006*, Las Vegas, Nevada, Feb 13-16 2006.
13. McLean, E., Schwarz, M.H. and Craig, S.R. (2006). Cobia research at the Virginia Tech Aquaculture Center. Franco-US Cobia Workshop, Montpellier, France, March 22-24th 2006.
14. McLean, E. and Craig, S.R. (2006). Presentation to the U.S. Congressional Committee on Agriculture. April 14th 2006.
15. McLean, E., Schwarz, M.H., Craig, H.C. and Craig, S.R. (2005). An integrated approach to cobia larval development: Gene expression, structural change and physiological response. 2nd *International Marine Fish Culture Conference and Workshop*, HBOI, Ft. Pierce, Florida, October 19-21st 2005.
16. McLean, E. S. R. Craig, A. Lunger, and M. H. Schwarz. 2005. Yeast by-products as accredited proteins for organic production of a marine carnivore. *World Aquaculture Society Meeting '05*. Nusa Dua, Bali, Indonesia. May 9 – 13.
17. Schwarz, M.H., Bosc, P., Carvalho, M.B., Craig, S.R., Delbos, B.C., Gaumet, P., Hamilton, S., Hazin, F.H.V., King, N., Lunger, A., McLean, E., Rene, F., Smith, S. and Zimmerman, J.K. (2005). International collaborative cobia larviculture research review 2005. 2nd *International Marine Fish Culture Conference and Workshop*, HBOI, Ft. Pierce, Florida, October 19-21st 2005.
18. Schwarz, M.H., Babet, M.C., Bosc, P., Carvalho, M., Craig, S.R., Lunger, A., McLean, E., Rene, F., Smith, S. and Zimmerman, J. (2006). Global overview of cobia *Rachycentron canadum* production and 2005 Virginia Tech-IISBA research review. *Aquaculture 2006*, Florence, Italy, May 9-13 2006.
19. Schwarz, M.H., McLean, E. and Craig, S.R. (2006). Virginia Tech Aquaculture Group (VTAG) larviculture review. Franco-US Cobia Workshop, Montpellier, France, March 22-24th 2006.
20. Schwarz, M.H. and Craig, S.R. (2005). Larviculture Optimization for Cobia (*Rachycentron canadum*). Virginia Academy of Science. Harrisonburg, VA. May 18-20.
21. Schwarz, M.H., M.C. Babet, P. Bosc, M. Carvalho, S. Craig, B. Delbos, F. Gaumet, S. Hamilton, F. Hazin, N. King, A. Lunger, E. McLean, F. Rene, S. Smith, J. Zimmerman. (2006). Virginia Tech – IISBA comprehensive international cobia larviculture review, 2005. *World Aquaculture Society Aquaculture America Meeting '06*. Las Vegas, NV. February 13-16.
22. Schwarz, M. H., McLean, E., Zimmerman, J. and Craig, S.R. (2005). Cobia: Research update at Virginia Tech; global status of research/production; and IISBA overview. *World Aquaculture Society Meeting '05*. Nusa Dua, Bali, Indonesia. May 9 – 13.

23. Schwarz, M.H., McLean, E. and Craig, S.R. (2006). Update of the Virginia Tech mariculture program. *32nd East Coast Commercial Fishermen's and Aquaculture Trade Exposition*, January 27-30, Ocean City, MD.
24. Schwarz, M.H., McLean, E. and Craig, S.R. (2006). Status of cobia (*Rachycentron canadum*) research, aquaculture, and stock enhancement initiatives. Invited Presentation, Fish Culture Section, AFS Annual Meeting, New York, NY.
25. Schwarz, M.H. and Kauffman, D. (2006). Mariculture Diversification in the US. Alabama Aquaculture Association. January 5.
26. Schwarz, M.H. and Kauffman, D. (2006). Mariculture Diversification in the US. Auburn University; FIW Departmental Seminar. Auburn, AL. January 6.
27. Zimmerman, J.K., Craig, S.R. and McLean, E. (2006). Salinity tolerance of larval cobia during feed transitions: A comparison of DHA and DHA-mannan oligosaccharide fortified diets. *Aquaculture America 2006*, Las Vegas, Nevada, Feb 13-16 2006.
28. Zimmerman, J.K., and Schwarz, M.H. (2005). Transport of juvenile cobia. *World Aquaculture Society Aquaculture America Meeting '05*. New Orleans, LA. January 17-20.
29. Zimmerman, J.K., Schwarz, M.H., Mowry, D. and King, N. (2005). Live prey size and type as factors in cobia larval culture. *World Aquaculture Society Aquaculture America Meeting '05*. New Orleans, LA. January 17-20.