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MARYLAND SEA GRANT EXTENSION•4321 HARTWICK ROAD, SUITE 300•UNIVERSITY OF MARYLAND•COLLEGE PARK, MD 20740•(301) 403-4220

Issue 2000-02 **Spring, 2000**

In This Issue:

Aquatic Plants and Ponds: Managing and Controlling Growth

Jackie Takacs, Regional Marine Specialist

Pictured Above: Submerged vegetation, Brazilian Elodea. Credit: IFAS, University of Florida, Gainesville

Aquatic plants are important to the natural ecology of a pond: primary producers at the base of the food web, plants are major producers of oxygen; they also serve other functions, providing shelter for aquatic organisms, aiding in the removal of suspended sediments from the water column, and stabilizing bottom sediments. Unfortunately, however, when their growth begins to interfere or deter from the pond's intended use, they become "weeds" that often need to be controlled and managed.

Identification

Since various control methods for aquatic plants can be type specific, it is critical that they be identified accurately. Aquatic plants can be grouped into five categories based on their structure and where they grow in the water column. The following table gives a general description of each category along with an example of the more commonly identified plants that can be problematic to Maryland ponds.

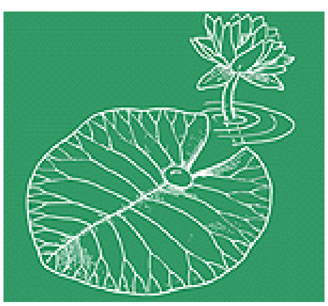
Type of Aquatic Plant	Description	Examples

Algae	Non-vascular plants that are found in three basic forms: microscopic, filamentous, or macrophytic, throughout the water column.	*Pithophora, Hydrodictyon*
Floating	Vascular plants that are not rooted in the sediment but are found floating in or on the water's surface	Duckweed, Watermeal
Submerged	Vascular plants that are rooted in the sediment, found completely submerged underwater, and lack a rigid structure.	Pondweeds, Hydrilla, Elodea
Emergent	Vascular plants that are rooted in the sediment, found floating at and extending above the surface of the water, and have a rigid structure.	Waterlilies, Water Chestnut
Marginal	Vascular plants that are rooted to the bottom, found along the fringes of a pond typically in less than two feet of water, and have a rigid structure.	Cattails, Phragmites

Control

Aquatic plants can be controlled in various ways, mechanically, biologically or chemically - it is important to recognize that the chosen method can affect not only the pond but the surrounding environment. For this reason, in choosing an optimum method, pond owners must consider not only the type of plant but also the cause of the problem, the primary use of the pond and the cost of control. The table below describes some of the more commonly used control methods for aquatic weeds in Maryland ponds.

The easiest and least expensive means of controlling such weeds is to prevent the problem before it starts. An integrated pest management program that uses a combination of control methods coupled with proper pond and watershed management can save pond owners from a lot of headaches in the future.



Floating Vegetation: White Water Lily
Drawing by Karen Teramura

Emergent Vegetation: Cattail
From *A Manual of Aquatic Plants*

Floating Vegetation: Duckweed
Drawing by Karen Teramura

Control Method	Description	Examples
Mechanical	The use of physical mechanisms (man or machine) to control aquatic plants	Raking, seining, pulling, dredging, plastic lines, drawdowns

Biological	The use of animals or other living organisms to control aquatic plants	Fertilization, fish, barley straw
Chemical	The use of herbicides to control aquatic plants	Copper sulfate, diquot

For Information on Ponds

The Maryland Cooperative Extension (MCE) Home and Garden Information Center is now handling information requests on pond management. This new endeavor will provide assistance to citizens who have questions concerning pond construction, aquatic weed control, or fish management issues through direct contact with MCE consultants, new fact sheets, 24-hour audiotapes (currently in production), and referrals. Residents of Maryland can call toll-free to speak to a consultant or access the library of audiotapes by dialing 1-800-342-2507. From outside Maryland, call 410-531-1757.

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Improve Crab Shedding Success: Support Available from UMES

Steven G. Hughes, University of Maryland Eastern Shore

All systems for holding peeler crabs aim at reducing the levels of nitrogenous waste products while maintaining high oxygen levels. Though there are many ways to design such systems, most designs incorporate some method of removing suspended solids (solid wastes). These designs, however, usually do not seek to remove other dissolved waste products, for instance, proteins and short chain carbon compounds, which have been shown to impair the growth and survival of aquatic animals and may inhibit the crabs from shedding. Very few crab shedders either have experience with assaying water quality parameters or with the equipment necessary to do these tests.

Studies over the past three years at the University of Maryland Eastern Shore (UMES), with support by the UMES Rural Development Center, have demonstrated that significant increases in crab survival and condition in commercial facilities can be obtained by training owners of these facilities on how to maintain proper water quality parameters and by aiding them with relatively minor changes in system design. Many crab shedders have not learned how to manipulate water quality in their systems and others are dependent on flow-through designs which use surface waters of questionable quality (e.g., low oxygen levels, high silt levels, high contaminant levels). Less than optimal conditions can lead to high levels of peeler crab mortality. The actual levels of this mortality have never been accurately determined but the need for data of these kind has been identified by the Blue Crab Fishery Management Plan Workgroup in its 1997 Chesapeake Bay Blue Crab Fishery Management Plan as an important research need.

During the coming season, staff from UMES will be working with peeler operations to provide training and technical support in the lower three counties of the Eastern Shore: Wicomico, Somerset, and Worcester. With a large number of the peeler operations located in this region, UMES support will provide two major benefits to the industry. First, if continued improvements in system design and water quality management can be realized, then the economic well-being of these operations should show an increase in the number of crabs available for sale. Second, with lower peeler mortalities, there should be less harvest pressure because fewer crabs will have to be removed from the wild to provide a given number of saleable crabs.

Peeler operators in Wicomico, Somerset and Worcester counties who would like to receive assistance or more information should contact Steven Hughes at 410-651-7664.

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Oyster Anatomy and the Internet: An Interactive Lesson

Adam Frederick, Sea Grant Education Specialist

Development of the internet to facilitate interactivity for the web user beyond "point and click" has enabled Maryland Sea Grant Extension to develop a hands-on lesson for use as a tutorial on oyster anatomy. The lesson showcases the power of the internet as a learning tool and serves as an indicator of the direction that distance education is headed.

Sea Grant Extension specialists developed the *Oyster Anatomy Lab* (on the web at www.mdsg.umd.edu/oysters/anatlab/index.htm) to experiment with the "user-friendly" nature of the web for the classroom teacher. It includes three basic elements that assist users with the fundamentals of oyster anatomy:

- Photographic images of each stage of exploration, starting with the valves, the orientation of the animal within the shell, and the internal anatomy.
- A glossary of key terms that can be accessed at any point during the lab.
- Self-check questions throughout the lab that help make the connection between structure and function.

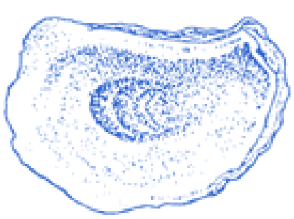
In addition, a section on teacher resources provides comprehensive guidelines for a range of education activities that move beyond anatomy so students can develop scientific projects in the context of environmental and social issues. An important feature of the anatomy lab is that it can be downloaded for free from the website for a PC or Mac. This feature has made it very popular not only with Maryland teachers but educators from other states and in a dozen other countries from Mexico to Australia. Since July 1999, the lesson has been downloaded some 75 times.

On entering the *Oyster Anatomy Lab,* you'll be given a simple list of equipment that can be used for the live laboratory or, if you prefer, a completely virtual lab. We have found great success with students and teachers being able to follow the steps of the lab as they observe and dissect a real oyster at their desk or lab bench. A section at the start (Aquarium Set-up) provides advice on how to prepare an aquarium to temporarily maintain oysters if the lab is to be done over a period of time. The Anatomy Lab engages users by starting with the basics of observing the paired dry valves of an oyster.

After the brief introduction a section describes the artifacts left behind by commensal and parasitic organisms that can be found on the oyster valves. The exploration of these artifacts helps dramatize the oyster's importance as a habitat itself for other organisms. Photographs in this section include macro and microscopic shots that help with the identification process for each organism.

On completing work with the dried oyster shells, you can then move to the internal anatomy of a live oyster. There is a description and depiction of the "hinge method" for shucking an oyster for dissection; the remainder of the lab provides an alternative to live dissection. At this point, you can examine the internal anatomy from the mantle to the heart – there are questions along the way to assist in the link between structure, function, and comparative anatomy.

The *Oyster Anatomy Lab* lesson is a model that can be built upon and expanded to include many other sections that explore in greater detail issues related to anatomy, ecology, and disease. Many of these concepts are currently under development by Maryland Sea Grant specialists.



Kudos for the Oyster Anatomy Laboratory

The Maryland State Department of education has recognized the *Oyster Anatomy Lab* and its activities as a model lesson – the Department will link directly to the *Oyster Anatomy Lab* on their new website and in the production of their new website CD for statewide distribution to science teachers. Model 5E lessons support the development of the High School Assessment and are used to develop MSPAP tasks. Maryland Sea Grant has the distinction of being the only informal education organization to garner this recognition. Congratulations to Adam Frederick, Jackie Takacs and Dan Jacobs who wrote and designed the lab; Gary Hedges who with Adam Frederick did the photography; and Don Meritt, Shellfish Specialist at the University of Maryland Center for Environmental Science Horn Point Laboratory, who was technical and scientific advisor.

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RESEARCH UPDATE

Level of Calcium in the Water Can Improve Transport Survival of Striped Bass

Steven Hughes, University of Maryland Easter Shore

It has long been recognized that fish are capable of absorbing calcium directly from the water by way of the gills and recent studies have indicated that the addition of calcium to soft waters may relieve some of the stresses of handling and transportation for striped bass. The Aquaculture Research and Demonstration Project at the University of Maryland Eastern Shore and the University of Maryland Center for Environmental Science Horn Point Laboratory have been conducting studies to quantify the amount of calcium required and the physiological impacts of the absence and presence of adequate levels of calcium. Research to date indicates a significant positive impact on survival, blood calcium levels and the levels of other blood ions when the fish are transported into water with calcium levels above 250 mg/L. Fish placed into receiving waters containing either 30 or 100 mg/L calcium experienced very high mortality rates and showed greatly depressed levels of blood calcium and other ions. This research indicates that the previous striped bass guidelines for aqueous calcium may in fact be too low and that higher levels are required for optimum survival rates. Additional research has also indicated that the physiological stress induced by low aqueous calcium levels could not be relieved by increasing the intake of dietary calcium and that aqueous calcium levels had a direct positive relationship with blood clotting times. All of these findings when applied to hauling systems should lead to striped bass being transported with fewer transport-related mortalities and with better survival after delivery.

For more information, contact Steven Hughes at 410-651-7664.

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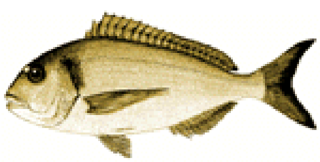

Growing Fish Indoors

A Conversation with Yonathan Zohar

Yonathan Zohar is the Director of the University of Maryland Biotechnology Institute's Center of Marine Biotechnology (COMB). An international leader in the field of finfish reproductive endocrinology, he has directed the development of COMB's Aquaculture Research Center, a facility of large-scale, computer-controlled recirculating tanks that is enabling Zohar and his colleagues to advance on-demand spawning techniques and new methods of maintaining viable broodstock and juvenile striped bass and other species. In this conversation with Merrill Leffler, he speaks about the prospects for the industry, its challenges and opportunities.

ML - Merrill Leffler **YZ** - Yonathan Zohar

ML: When we think of finfish aquaculture, many of us naturally think of growing fish in ponds or netpens in open waters. But aquaculture is also making use of closed sytems, tanks for commercially rearing fish for market. What is the future for such systems?

YZ: Eventually, aquaculture will have to be completely contained – this is so for a number of reasons. First and foremost is the environment: concentrating fish in netpens can lead to water quality problems; it has also led to objections on aesthetic grounds from coastal residents. Secondly, with the growing interest in genetically-modified species, there is a great deal of concern over their escape and the potential for dilution of natural gene pools. This is already happening. A similar worry goes for raising non-native species. With closed-loop systems, we'll be able to farm such fish without those worries. Finally, contained systems favor the production of high quality fish. In such systems, we'll be able to tailor the environment to fit the conditions that different species require in order to promote optimum performance. As such, the contained or recirculating system is going to be more profitable and more economical than flow-through ponds or floating netpens. The reason is that you are growing fish in optimal conditions of temperature, salinity, water quality and food. You cannot do this when fish are in netpens or ponds. As a result, fish will perform much better in terms of growth rate – if we rear them in recirculating systems, we can eliminate disease while still maintaining high densities.

ML: Another obvious advantage for closed or containerized systems is that potentially you can raise fish almost anywhere.

YZ: That's right. You can even place systems in urban environments to take advantage of facilities that are already in place. In cities such as Baltimore, there are unused warehouses and other buildings. The problem of investing in recirculating systems in a large way right now is that the start-up, operations and maintenance costs are relatively high – you need to rear high quality fish that you know are going to be profitable.

ML: One problem seems to be an economic boom and bust in aquaculture. Tilapia, for example, has been reared profitably in recirculating systems. But supply has become so great that the price has dropped significantly – this plunge in price has impacted at least one operation in Maryland that has been raising tilapia.

YZ: To start with, tilapia is not a very pricey fish; nor is striped bass, which has been a major focus of aquaculture efforts in the mid-Atlantic. The aquaculture industry needs to be able to diversify and add high value new species. Here at COMB, for example, we have spawned sea bream – it is the first time a marine fish of such high value has been bred in a completely closed indoor system. We are rearing them in recirculated "instant" sea water. In fact, we are working with Offspring Marine, which has a Maryland Industrial Partnership grant from the University of Maryland – the goal is to assess the economics of closed-loop high density aquaculture systems for producing sea bream at industrial levels.

ML: Has sea bream been grown out in closed systems?

YZ: No – we are the first to do that. More than 90 percent of sea bream worldwide are reared in floating netpens. My hope is to produce sea bream juveniles here on a year-round basis and to have a city-based industry using a closed non-polluting system under optimal conditions. We could bring the fish to market size in 12 to 14 months, which is extremely fast – netpens would take two years.

ML: What needs to be done next? What will it take to get entrepreneurs excited enough about the prospects of making a profit to invest in urban-based systems?

YZ: There are two main issues, particularly for urban aquaculture systems: water exchange and biofiltration. I don't think we can yet work in entirely-recirculated systems – currently, for high density rearing there needs to be some water exchange, perhaps 5 to 10 percent daily, though that depends on biofilters. Some operations require 30 percent exchange. So we need to combine high densities of production with very low water exchange.

The real heart of recirculating systems is biofilters, which are based on microorganisms that remove chemical wastes. However, there are other toxic compounds such as nitrates and carbon dioxide that become a major concern with high fish densities. The biofilter in recirculating systems is a big "black box" and the future success and economic feasibility will rely on scientific breakthroughs in understanding and improving the microbial communities that are essential for maintaining high water quality and for reducing exchange rates in such systems. I have a great deal of confidence that we will make those breakthroughs over the next several years.

For more information about COMB and the Aquaculture Research Center, contact Steve Berberich 410-385-6315; berberic@umbi.umd.edu or visit COMB at www.umbi.umd.edu/~comb/

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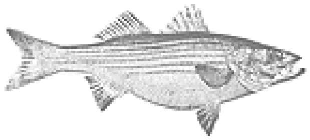
RESEARCH UPDATE



Producing Striped Bass on Demand

Merrill Leffler, Maryland Sea Grant College

Striped bass aquaculture has expanded considerably over this last decade; still, the industry faces numbers of challenges if it is to sustain growth and move to new levels of cost-effective production. In particular, the lack of year-round stocks of inexpensive seed fish has been a major barrier to continue expansion. Though mature striped bass have been maintained and spawned in hatcheries, captivity often disrupts their hormonal systems. Consequently, suppliers of larval fish have largely had to rely on the capture of gravid striped bass; in the hatchery, they are injected with a hormone to induce spawning in order to obtain eggs and sperm. Not only are such processes costly and unreliable, in some years wild broodstock may not be available. Yonathan Zohar's research has focused on the molecular processes controlling the pituitary gland's release of gonadotropin hormones – his work has led to a number of important discoveries, among them that hormones (gonadotropin releasing hormone, GnRH) in the fish brain regulating ovarian development are blocked when fish are confined in netpen tanks. Zohar's discovery has led to the development of new spawning technologies that should be far more cost-effective and could revolutionize the striped bass industry by enabling growers to reliably plan their production. In a Maryland Sea Grant-supported research project, Zohar and his colleagues will continue to refine chemical analogs of GnRH that he recently discovered and will detail its regulation and release. Recent studies indicate that the gonadotropin system in striped bass is widely spread among other popular fish, among them, snappers, flounders and black seabass. The aquaculture industry has a critical need for flexibility in producing a diversity of species that are economically viable – the technology being developed in this research should be applicable to achieving this goal.

For more information, contact Yonathan Zohar 410-234-8824.

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Contending with Exotic Species

Non-indigenous species are those plants, animals or microbes that have been transported from one region of the world to another. While some organisms may be transported intentionally, many find their way into aquatic ecosystems through other means, particularly in the ballast water of big ships where large volumes of water taken up in one port are discharged with their now-foreign organisms in another. Numbers of non-indigenous or exotic species have become established in aquatic systems throughout the world as a result of such discharges. While such species can sometimes prove to be beneficial, others have had significant environmental impacts and economic costs. Zebra mussels are the most recent, prominent example: first released into the Great Lakes in the 1980s with ballast water, they have spread widely through aquatic systems.

There has been a good deal of concern in the Chesapeake Bay region about the potential impact of non-indigenous species in the billions of gallons of ballast water discharged annually in Baltimore and Norfolk harbors. In conjunction with research support through national funding initiatives which aim at better determining the potential impact of invasive species and assessing means of control, Maryland Sea Grant has been producing materials to help educate citizens about the implications of introductions. These efforts include the following videos, produced and directed by Michael W. Fincham, and education briefs written by Jack Greer and Dan Terlizzi.

Videos on Exotics

Alien Ocean. Thirty-minute broadcast video that tells the dramatic story of scallop fishermen, cargo ship captains and pilots and the scientists who are pioneering the new field of "invasion ecology." $24.95.

Alien Estuary. Twelve-minute video that introduces the issue of exotic species and describes efforts to track their movement toward the Chesapeake and its 6,000 square mile watershed. $7.50.

Alien Rivers: The Threat of Zebra Mussels. Nine-minute video that describes how zebra mussels arrived in the U.S. and details the steps that boaters can take to prevent their spread into the Chesapeake watershed. $5.00.

Education Briefs: Exotics in the Chesapeake

An Introduction to Exotic Species. An overview of marine invasive organisms and how federal and state agencies are trying to minimize the threats of such exotics. Free.

Exotic Animals. Examines several of the Bay's non-indigenous species, for instance, the mute swan, nutria, the rapa whelk, the debate over purposeful introductions such as the grass carp and Pacific oyster, and assesses prospects for the future. Free.

Exotic Plants. Surveys the numbers of exotic plants in the Chesapeake watershed, for instance, the common reed Phragmites, an aggressive invader of wetlands all along the east coast, water milfoil, purple loosestrife, hydrilla and elodea. Free.

To order and for more information, contact Jeannette Connors at 301-405-7500 or connors@mdsg.umd.edu. Visit *Exotics in the Chesapeake* at www.mdsg.umd.edu/exotics to learn more about exotic species. You can also order the videos on-line at www.mdsg.umd.edu/store.

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New Publications

Oyster Reef Habitat Restoration: A Synopsis and Synthesis of Approaches
Editors: Mark W. Luckenbach, Roger Mann and James A. Wesson

The collection of papers in this volume is a must for anyone with interests in shellfish and fisheries management, oyster ecology, and habitat restoration. *Oyster Reef Habitat Restoration* grows out of a symposium to examine the basis for restoring reef habitats as a means for enhancing oyster populations. While the symposium was in 1995, the chapters have been updated, particularly those related to research on reef functions. As the editors point out, the importance of oyster reefs has been gaining widespread adherence among resource managers, scientists and commercial watermen, for their importance as ecological habitats that also have the potential for restoring sustainable populations of oysters.

The book's 24 chapters are divided into five parts: (1) historical perspectives, from the Holocene to the 20th century; (2) snapshots of ongoing restoration efforts, for instance, in Alabama, North Carolina and Virginia; (3) a round-up of research efforts that range from reef design to their function as fish habitats to their role in nutrient cycling; (4) alternative substrates for creating oyster habitats; and (5) management and economic considerations.

Oyster Reef Habitat Restoration is dedicated to William Hargis, former director of the Virginia Institute of Marine Science (1959-1981), and a passionate and tireless advocate for oyster reef restoration. His paper, "The Evolution of the Chesapeake Oyster Reef System During the Holocene Epoch" opens the book and, with Dexter Haven in a chapter at the end, he details the importance of reefs in the Bay, the effects of their destruction and sets out guidelines for restoring them.

To order, contact Wanda Cohen at the VIMS Publications Center 804-684-7011. (Softbound $29.95 plus $2.10 shipping and handling; Hardbound $49.94 plus 2.50 shipping and handling; Virginia residents add 4.5% sales tax.)

Chesapeake Bay Program Oyster Restoration: Workshop Proceedings

A gathering of more than 100 Chesapeake Bay scientists, managers, watermen and other stakeholders met on January 13 and 14, 2000 to try and reach consensus on oyster restoration that will ultimately inform revisions of the Chesapeake Bay Program's Aquatic Reef Habitat Plan and the Oyster Management Plan. The *Workshop Proceedings* is the result. Among the issues considered were components of oyster reef design; the need for sanctuaries in restoration strategies (understanding that reserve areas are necessary to oyster restoration, and that reserve areas should include managed harvests); the importance of and strategies for minimizing the spread of oyster disease; research and monitoring priorities; the economic and ecological benefits of osyter restoration; and the need to conserve shell supply.

To obtain a copy of the consensus report (CBP/TRS 238-00), contact the Chesapeake Bay Program Office, U.S. Environmental Protection Agency, 410 Severn Avenue, Annapolis, Maryland 21402, 1-800-Your-Bay. It is also available as a PDF file at: www.chesapeakebay._net/pubs/oysterworkshop.pdf.

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Upcoming Conferences

East Coast Live! 2000: The Business of Marketing Live Aquatic Products
Annapolis, Maryland, November 1-4, 2000

The transport and sale of live aquatic products is a growth industry nationwide – such products include hundreds of species or varieties of marine and freshwater fish, shellfish and aquatic plants. Growth of the industry has brought with it challenges, opportunities and problems, which East Coast Live! 2000 will address. A concurrent trade show will bring together suppliers to the industry, airline representatives, state, regional and federal agencies and other businesses relevant to the live aquatics industry.

Registration fee: $175 until August 31 and $195 afterwards. Registration for one day: $75 until August 31 and $90 afterwards. For registration information, contact Don Webster, Maryland Sea Grant Extension Program, 410-827-8056 or dw16@umail.umd.edu. For program and trade show information, contact John Ewart, Delaware Sea Grant Marine Advisory Service, ewart@udel.edu. You can register via the web and get more detailed information and updates at www.eastcoastlive.seagrant.org.

Fourth International Conference on Shellfish Restorations
Hilton Head, South Carolina, November 15-18, 2000

Throughout the world, there is a growing commitment to restoration of degraded coastal ecosystems. This conference will explore the successes and challenges of shellfish restoration, focusing on how public/private partnerships have been enhancing these capabilities. Sessions will be organized around three themes:

- Shellfish Resource Habitat Management, Enhancement, and Restoration;
- Shellfish/Habitat Restoration through Coastal and Watershed Management; and
- Community-based Strategies to Restore Shellfish/Habitat.

For more information about participating, contact Elaine Knight at 843-727-2078 or knightel@musc.edu. For information about submitting an abstract, contact Rick DeVoe at 843-727-2078 or devoemr@musc.edu.

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