1995

Introduction to the Proceedings of the Blue Crab Recruitment Symposium

EJ Olmi

RJ Orth
Virginia Institute of Marine Science

Recommended Citation

Olmi, EJ and Orth, RJ, Introduction to the Proceedings of the Blue Crab Recruitment Symposium (1995). *Bulletin of Marine Science*, 57(3), 707-712.
https://scholarworks.wm.edu/vimsarticles/1538

BULLETIN OF MARINE SCIENCE, 57(3): 707–712, 1995

INTRODUCTION TO THE PROCEEDINGS OF THE BLUE CRAB RECRUITMENT SYMPOSIUM

Eugene J. Olmi, III and Robert J. Orth
Symposium Organizers, Guest Editors

The blue crab, *Callinectes sapidus* Rathbun, is found in all major coastal habitats along the mid-Atlantic, South Atlantic and Gulf of Mexico coasts of the United States, including large embayments, barrier island-lagoonal systems, and coastal marsh, mangrove and seagrass systems. Ecologically important, blue crabs may control abundances of other estuarine benthic species (Hines et al., 1990). The blue crab also supports valuable commercial and recreational fisheries from New Jersey to Texas; commercial landings of 249.3 million pounds of hard blue crabs in 1993 had a dockside value of 126.6 million dollars (NMFS, 1994). Blue crab stocks vary interannually within and between regions as reflected in fishery catch records, which have been compiled since the early 1900s, and in fishery-independent data sets. This variability apparently is unrelated to fishing pressure and has been attributed to environmental influences on blue crab recruitment.

Published studies of blue crab biology date back to the turn of the century (Hay, 1905), but our understanding of the early life history of the species has been markedly refined over the past 3 decades. The complete larval development (7 zoea and 1 megalopa) of the blue crab was not described until 1959 (Costlow and Bookhout, 1959), and early accounts of blue crab life history suggested that the larval stages were retained within estuaries (Churchill, 1919; Van Engel, 1958). During the 1960s and early 1970s, however, studies of larval/postlarval distributions indicated that blue crab larvae might not be retained in estuaries but instead are exported to coastal waters with subsequent return by postlarvae (megalopae) or juveniles (Nichols and Keney, 1963; Tagatz, 1968; Dudley and Judy, 1971; King, 1971; Williams, 1971; Sandifer, 1975).

The possibility that blue crab larvae are exported from estuarine systems has profound implications for the ecology, population structure, and fishery management of the species, and has spurred considerable research focused on understanding blue crab recruitment dynamics. Since the late 1970s, studies have shown convincingly that zoeal behavior promotes upward movement to surface waters (Sulkin et al., 1980), and that the vast majority of larvae are flushed out to coastal waters where development to the megalopa stage occurs (Stuck and Perry, 1981; Dittel and Epifanio, 1982; Provenzano et al., 1983; McConaugha et al., 1983; Epifanio et al., 1984; Brookins and Epifanio, 1985; D. F. Johnson, 1985). Boicourt (1982) suggested that wind-driven surface currents during summer in the mid-Atlantic Bight may be responsible for retaining blue crab larvae in the vicinity of their natal estuary against the general drift of shelf waters. This hypothesis was supported by subsequent observational and modelling studies (Johnson et al., 1984; D. R. Johnson, 1985; Epifanio et al. 1989). The megalopa stage appeared to be the stage that returned to the estuary, but the mechanism(s) by which this is accomplished remained problematic (D. R. Johnson, 1985; Maris, 1986; Sulkin and Epifanio, 1986; Sulkin and van Heukelem, 1986).

Our understanding of blue crab ecology has benefited from interactions among blue crab researchers over the past decade, beginning with the Portunid Ecology Workshop, hosted by the Smithsonian Environmental Research Center in 1987. The following year, Old Dominion University, the Virginia Institute of Marine

Science, the Virginia Sea Grant College Program and NOAA's Office of Estuarine Programs hosted The Blue Crab Conference in Virginia Beach, VA. During this conference, papers were presented on blue crab morphology, physiology, ecology and life history. The proceedings were published in the Bulletin of Marine Science, Volume 46, Number 1 (1990). Several papers addressed aspects of blue crab recruitment, including estimates of fecundity (Prager et al., 1990), spawning-stock size (Jones et al., 1990), larval transport (Johnson and Hess, 1990), settlement of megalopae (Olmi et al., 1990; van Montfrans et al., 1990), juvenile habitat utilization (Orth and van Montfrans, 1990; Ryer et al., 1990; Thomas et al., 1990; Wilson et al., 1990; Wolcott and Hines, 1990), and stock-recruit relationships (Lipcius and van Engel, 1990).

A subset of participants from the Virginia Beach meeting recognized that studies of blue crab recruitment could benefit from a more coordinated approach, possibly including a cooperative program to provide a broader perspective on factors influencing population dynamics. A steering committee from the Virginia Institute of Marine Science and the Virginia Sea Grant Program developed a plan to promote a coordinated research effort.

In February 1989, a workshop was held at the Virginia Institute of Marine Science to explore an inter-regional, cooperative research strategy aimed specifically at understanding recruitment processes and population dynamics of blue crab. The primary goal of this workshop was to outline a research program on blue crab recruitment by identifying short and long term research priorities. Key accomplishments of the workshop were: 1) an assessment of current knowledge across regions and estuary types, 2) an assessment of the critical information gaps, and 3) development of an inter-regional cooperative research plan to examine spatial and temporal patterns of postlarval settlement (Smith et al., 1989). Workshop participants (the Blue Crab Recruitment Group) adopted a standardized protocol to examine relative settlement of megalopae in estuaries based on methodology modified from van Montfrans et al. (1990). In addition, the group agreed to protocol for sharing data, proprietary rights of data, data management, and publication. Researchers at the Virginia Institute of Marine Science agreed to assume responsibility for data management and, with Virginia Sea Grant, program coordination.

Data for this collaborative effort were first collected in 1989 in three estuaries (Delaware Bay, Chesapeake Bay, and Charleston Harbor, SC). Over the next several years, comparable settlement data were acquired in 12 estuaries from Delaware Bay to Galveston Bay (Sea Grant Programs in several states are acknowledged for partial support of these studies). The group, including state, federal, and university researchers, met annually (usually in conjunction with the Marine Benthic Ecology Meetings) to share information and chart directions. Despite the lack of comprehensive funding for the program, the participants displayed notable cooperation in aquiring a unique data set with fine temporal resolution (daily) and broad geographical scope. Efforts to understand the recruitment ecology of blue crabs was not limited to the megalopa stage, however, and the group has studied all life stages in an attempt to construct a clear picture of blue crab ecology, which can be used for management of the species.

In November 1993, at the Estuarine Research Federation Conference in Hilton Head, SC, we chaired a symposium entitled "Blue Crab Recruitment: Environmental Control and Population Regulation." This issue of the Bulletin of Marine Science presents the proceedings of that symposium. Twenty-three papers were presented during the symposium, the abstracts of which appear after the full papers in this issue. Thirteen full papers are presented herein, organized within three topics: larval/postlarval transport, settlement of postlarvae, and post-settlement processes.

Epifanio (1995) provides a review of efforts to understand transport of blue crab zoeae and megalopae, while the three other papers in this group focus on transport of megalopae into estuaries. These papers do not achieve consensus on what processes are important for transporting megalopae into estuaries. Epifanio argues that southward-blowing winds are important for ingress into Delaware Bay. Blanton et al. (1995) hypothesize that downwelling-favorable (southward) winds are also important in South Carolina, but the data do not support their hypothesis. Johnson (1995) concludes that wind was not an effective transport mechanism for returning megalopae to Chesapeake Bay. Finally, Olmi (1995) argues that ingress of megalopae in Chesapeake Bay/York River is facilitated by westward winds and spring tides. Clearly, there is need of additional work to understand the processes that influence immigration of megalopae to estuaries.

The second group of papers report settlement of megalopae on artificial settlement substrates (the Blue Crab Recruitment Group studies mentioned above). Metcalf et al. (1995) provide a comparison of substrate designs and deployment positions in the water column. Temporal settlement data are presented for sites in North Carolina (Mense et al., 1995), Georgia (Wrona et al., 1995) and Mississippi (Perry et al., 1995). Further, van Montfrans et al. (1995) and Rabalais et al. (1995) provide comparisons among sites on the Atlantic and Gulf of Mexico coasts, respectively. Settlement is episodic at all sites examined. Patterns of settlement (timing and magnitude) appear to be largely site-specific, although meteorological events may synchronize peak settlement across broad geographic areas. Lunar/tidal influences on settlement are apparent at some, but not all, sites. Average numbers of megalopae on artificial settlement substrates are considerably greater along the Gulf of Mexico coast than along the Atlantic coast.

While larval/postlarval supply sets the upper limits of recruitment, post-settlement processes act on the initial settlers to determine eventual demographics of the population. Papers by Heck and Coen (1995), Hines and Ruiz (1995), and Dittel et al. (1995) report studies of predation on juvenile blue crabs. Predation rates on recently settled juveniles are extremely high, and may be higher along the Gulf of Mexico Coast than along the Atlantic Coast because of higher settlement rates and a broader suite of predators (Heck and Coen, 1995). Even larger juveniles (>20 mm) experience high predation mortality, largely resulting from cannibalism. In areas where sea grasses are not available, juvenile blue crabs may find partial refuge from predation in shallow waters (Dittel et al., 1995; Hines et al., 1995).

Advances in our understanding of blue crab recruitment ecology have coincided with, and benefitted from, a great deal of recent attention to recruitment ecology in diverse marine and estuarine systems. We hope these proceedings in the Bulletin of Marine Science contribute to the stimulating work on recruitment in marine systems. We view this symposium proceedings as a "progress report" in our understanding of blue crab population dynamics.

ACKNOWLEDGMENTS

We express our gratitude to the authors for their contributions to the symposium and to the proceedings, and to the many reviewers who provided comments to improve the quality of papers in this issue. We gratefully acknowledge R. Lipcius and J. van Montfrans for their input during the initial planning of the symposium, the ERF '93 organizing committee (R. DeVoe, L. Handal, and E. Knight) for their helpful assistance in making the symposium a reality, and to W. J. Richards and the Bulletin of Marine Science for publishing the proceedings. Finally, thanks to W. L. Rickards and the Virginia

Sea Grant College Program for supporting efforts to advance our understanding of blue crab recruitment. This is contribution No. 1950 from the School of Marine Science, Virginia Institute of Marine Science, College of William and Mary.

Literature Cited

Blanton, J., E. Wenner, F. Werner and D. Knott. 1995. Effects of wind-generated coastal currents on the transport of blue crab megalopae on a shallow continental shelf. Bull. Mar. Sci. 57: 917–921.

Boicourt, W. C. 1982. Estuarine larval retention mechanisms on two scales. Pages 445–457 *in* V. Kennedy, ed. Estuarine comparisons. Academic Press, New York. 709 pp.

Brookins, K. G. and C. E. Epifanio. 1985. Abundance of brachyuran larvae in a small inlet over six consecutive tidal cycles. Estuaries 8: 60–67.

Churchill, E. P., Jr. 1919. Life history of the blue crab. Bull. U.S. Bur. Fish. 36: 95–128.

Costlow, J. D., Jr. and C. G. Bookhout. 1959. The larval development of *Callinectes sapidus* Rathbun reared in the laboratory. Biol. Bull. (Woods Hole) 116: 373–396.

Dittel, A. I. and C. E. Epifanio. 1982. Seasonal abundance and vertical distribution of crab larvae in Delaware Bay. Estuaries 5: 197–202.

———, A. H. Hines, G. M. Ruiz and K. K. Ruffin. 1995. Effects of shallow water refuge on behavior and density-dependent mortality of juvenile blue crabs in Chesapeake Bay. Bull. Mar. Sci. 57: 902–916.

Dudley, D. L. and M. H. Judy. 1971. Occurrence of larval, juvenile and mature crabs in the vicinity of Beaufort Inlet, North Carolina. NOAA, Tech. Rep. NMFS, SSRF 637: 1–10.

Epifanio, C. E. 1995. Transport of Blue Crab (*Callinectes sapidus*) larvae in the waters off mid-Atlantic states. Bull. Mar. Sci. 57: 713–725.

———, A. K. Masse and R. W. Garvine. 1989. Transport of blue crab larvae by surface currents off Delaware Bay, U.S.A. Mar. Ecol. Prog. Ser. 54: 35–41.

———, C. C. Valenti and A. E. Pembroke. 1984. Dispersal and recruitment of blue crab larvae in the Delaware Bay. Estuar. Coast. Shelf Sci. 18: 1–12.

Hay, W. P. 1905. The life history of the blue crab, *Callinectes sapidus*. Rep. U.S. Bur. Fish. 1905: 395–413.

Heck, K. L., Jr. and L. D. Coen. 1995. Predation and the abundance of juvenile blue crabs: a comparison of selected east and gulf coast (USA) studies. Bull. Mar. Sci. 57: 877–884.

Hines, A. H., A. M. Haddon and L. A. Wiechert. 1990. Guild structure and foraging impact of blue crabs and epibenthic fish in a subestuary of Chesapeake Bay. Mar. Ecol. Prog. Ser. 36: 55–64.

——— and G. M. Ruiz. 1995. Temporal variation in juvenile blue crab mortality: nearshore shallows and cannibalism in Chesapeake Bay. Bull. Mar. Sci. 57: 884–901.

Johnson, D. F. 1985. The distribution of brachyuran crustacean megalopae in the waters of the York River, lower Chesapeake Bay and adjacent shelf: implications for recruitment. Estuar. Coast. Shelf Sci. 20: 693–705.

——— and K. W. Hess. 1990. Numerical simulations of blue crab larval dispersal and recruitment. Bull. Mar. Sci. 46: 195–213.

Johnson, D. R. 1985. Wind-forced dispersion of blue crab larvae in the Middle Atlantic Bight. Cont. Shelf Res. 4: 1–14.

———. 1995. Wind forced surface currents at the entrance to Chesapeake Bay: their effect on blue crab larval dispersion and post-larval recruitment. Bull. Mar. Sci. 57: 726–738.

———, B. S. Hester and J. R. McConaugha. 1984. Studies of a wind mechanism influencing the recruitment of blue crabs in the Middle Atlantic Bight. Cont. Shelf Res. 3: 425–437.

Jones, C. M., J. R. McConaugha, P. J. Geer and M. H. Prager. 1990. Estimates of spawning stock size of the blue crab, *Callinectes sapidus*, in Chesapeake Bay 1986–1987. Bull. Mar. Sci 46: 159–169.

King, B. D., III. 1971. Study of migratory patterns of fish and shellfish through a natural tidal pass. Texas Parks and Wildlife Dept., Tech. Ser. 9: 1–54.

Lipcius, R. N. and W. A. van Engel. 1990. Blue crab population dynamics in Chesapeake Bay: variation in abundance (York River, 1972–1988) and stock-recruit functions. Bull. Mar. Sci. 46: 180–194.

Maris, R. C. 1986. Patterns of diurnal vertical distribution and dispersal—recruitment mechanisms of decapod crustacean larvae and postlarvae in the Chesapeake Bay, Virginia and adjacent offshore waters. Ph.D. Dissertation, Old Dominion Univ., Norfolk, Virginia. 222 pp.

McConaugha, J. R., D. F. Johnson, A. J. Provenzano and R. C. Maris. 1983. Seasonal distribution of larvae of *Callinectes sapidus* (Crustacea; Decapoda) in the waters adjacent to Chesapeake Bay. J. Crust. Biol. 3: 582–591.

Mense, D. J., M. H. Posey, T. West and K. Kinchloe. 1995. Settlement of brachyuran postlarvae along the North Carolina coast. Bull. Mar. Sci. 57: 793–806.

Metcalf, K. S., J. van Montfrans, R. N. Lipcius and R. J. Orth. 1995. Settlement indices for blue crab megalopae in the York River: temporal relationships and statistical efficiency. Bull. Mar. Sci. 57: 781–792.

National Marine Fisheries Service. 1994. Fisheries of the United States, 1993. Current Fishery Statisitics No. 9300. Dept. of Commerce, National Oceanographic and Atmospheric Administration. Washington, D.C. 121 pp.

Nichols, P. R. and P. M. Keney. 1963. Crab larvae (*Callinectes*) in plankton collections from M/V Theodore N. Gill, south Atlantic coast of the United States, 1953–54. U.S. Fish Wild. Serv. Spec. Sci. Rep.—fish. 448: 1–14.

Olmi, E. J., III. 1995. Ingress of blue crab megalopae in the York River, Virginia, 1987–1989. Bull. Mar. Sci. 57: 753–780.

———, J. van Montfrans, R. N. Lipcius, R. J. Orth and P. Sadler. 1990. Variation in planktonic availability and settlement of blue crab megalopae in the York River, Virginia. Bull. Mar. Sci. 46: 230–243.

Orth, R. J. and J. van Montfrans. 1990. Utilization of marsh and seagrass habitats by early stages of *Callinectes sapidus*: a latitudinal perspective. Bull. Mar. Sci. 46: 126–144.

Perry, H. M., C. K. Eleuterius, C. B. Trigg and J. R. Warren. 1995. Settlement patterns of *Callinectes sapidus* megalopae in Mississippi Sound: 1991, 1992. Bull. Mar. Sci. 57: 821–833.

Prager, M. H., J. R. McConaugha, C. M. Jones and P. J. Geer. 1990. Fecundity of blue crab, *Callinectes sapidus*, in Chesapeake Bay: biological, statistical, and management considerations. Bull. Mar. Sci. 46: 170–179.

Provenzano, A. J., J. R. McConaugha, K. B. Phillips, D. F. Johnson and J. Clark. 1983. Vertical distribution of first stage larvae of the blue crab, *Callinectes sapidus*, at the mouth of the Chesapeake Bay. Estuar. Coast. Shelf Sci. 16: 489–499.

Rabalais, N. N., F. R. Burditt, Jr., L. D. Coen, B. E. Cole, C. Eleuterius, K. L. Heck, Jr., T. A. McTigue, S. Morgan, H. M. Perry, F. M. Truesdale, R. Zimmer-Faust and R. J. Zimmerman. 1995. Settlement of *Callinectes sapidus* megalopae on artificial collectors in four Gulf of Mexico estuaries. Bull. Mar. Sci. 57: 855–876.

Ryer, C. H., J. van Montfrans and J. J. Orth. 1990. Utilization of a seagrass meadow and tidal marsh creek by blue crabs *Callinectes sapidus*. II. Spatial and Temporal patterns of molting. Bull. Mar. Sci. 46: 95–104.

Sandifer, P. A. 1975. The role of pelagic larvae in recruitment to populations of adult decapod crustaceans in the York River estuary and adjacent lower Chesapeake Bay, Virginia. Estuar. Coast. Mar. Sci. 3: 269–279.

Smith, D. E., R. J. Orth, E. J. Olmi, J. van Montfrans and R. N. Lipcius. Blue Crab Recruitment Workshop, February 5–7 1989: Summary of Activities. Virginia Sea Grant College Program report. 12 pp.

Stuck, K. C. and H. M. Perry. 1981. Observations on the distribution and seasonality of portunid megalopae in Mississippi coastal waters. Gulf Res. Rep. 7: 93–95.

Sulkin, S. D. and C. E. Epifanio. 1986. A conceptual model for recruitment of the blue crab, *Callinectes sapidus* Rathbun, to estuaries of the Middle Atlantic Bight. Can. Spec. Publ. Fish. Aquat. Sci. 92: 117–123.

——— and W. van Heukelem. 1986. Variability in the length of the megalopal stage and its consequence to dispersal and recruitment in the portunid crab *Callinectes sapidus* Rathbun. Bull. Mar. Sci. 39: 269–278.

———, ———, P. Kelly and L. Van Heukelem. 1980. The behavioral basis of larval recruitment in the crab *Callinectes sapidus* Rathbun: a laboratory investigation of ontogenetic changes in geotaxis and barokinesis. Biol. Bull. 159: 402–417.

Tagatz, M. E. 1968. Biology of the blue crab, *Callinectes sapidus* Rathbun, in the St. Johns River, Florida. U.S. Fish Wildl. Serv., Fish. Bull. 67: 17–33.

Thomas, J. L., R. J. Zimmerman and T. J. Minello. 1990. Abundance patterns of juvenile blue crabs (*Callinectes sapidus*) in nursery habitats of two Texas bays. Bull. Mar. Sci. 46: 115–125.

Van Engel, W. A. 1958. The blue crab and its fishery in the Chesapeake Bay. Part 1—reproduction, early development, growth, and migration. Commer. Fish. Rev. 20: 6–17.

van Montfrans, J., C. E. Epifanio, D. M. Knott, R. N. Lipcius, D. J. Mense, K. S. Metcalf, E. J. Olmi III, R. J. Orth, M. H. Posey, E. L. Wenner and T. L. West. 1995. Settlement of blue crab megalopae in western Atlantic estuaries. Bull. Mar. Sci. 57: 834–854.

van Montfrans, J., C. A. Peery and R. J. Orth. 1990. Daily, monthly and annual settlement patterns by *Callinectes sapidus* and *Neopanope sayi* megalopae on artificial collectors deployed in the York River, Virginia. Bull. Mar. Sci. 46: 214–229.

Williams, A. B. 1971. A ten year study of meroplankton in North Carolina estuaries: annual occurrence of some brachyuran developmental stages. Ches. Sci. 12: 53–61.

Wilson, K. A., K. W. Able and K. L. Heck, Jr. 1990. Habitat use by juvenile blue crabs: a comparison among habitats in southern New Jersey. Bull. Mar. Sci. 46: 105–114.
Wolcott, T. G. and A. H. Hines. 1990. Ultrasonic telemetry of small-scale movements and microhabitat selection by molting blue crabs (*Callinectes sapidus*). Bull. Mar. Sci. 46: 83–94.
Wrona, A. B., R. G. Wiegert and T. D. Bishop. 1995. Initial report of settlement patterns of brachyuran megalopae at Sapelo Island, Georgia, U.S.A. Bull. Mar. Sci. 57: 807–820.

DATE ACCEPTED: May 17, 1995.

ADDRESSES: (EJO) *Virginia Graduate Marine Science Consortium, University of Virginia, 170 Rugby Road, Charlottesville, Virginia 22903;* (RJO) *College of William and Mary, School of Marine Science, Virginia Institute of Marine Science, Gloucester Point, Virginia 23062.*