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Effect of Tropical Storm Agnes on setting of shipworms at Gloucester Point, Virginia

Marvin L. Wass

The Effects of Tropical Storm Agnes on the Chesapeake Bay Estuarine System

The Chesapeake Research Consortium, Inc.

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THE CHESAPEAKE RESEARCH CONSORTIUM, INC.

The Johns Hopkins University
Smithsonian Institution
University of Maryland
Virginia Institute of Marine Science

Project Coordinator, Jackson Davis (VIMS)
Volume Coordinator, Beverly Laird (VIMS)

Section Editors

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Preface

During June 1972 Tropical Storm Agnes released record amounts of rainfall on the watersheds of most of the major tributaries of Chesapeake Bay. The resulting floods, categorized as a once-in-100-to-200-year occurrence, caused perturbations of the environment in Chesapeake Bay, the nation's greatest estuary.

This volume is an attempt to bring together analyses of the effects of this exceptional natural event on the hydrology, geology, water quality, and biology of Chesapeake Bay and to consider the impact of these effects on the economy of the Tidewater Region and on public health.

It is to be hoped that these analyses of the event will usefully serve government agencies and private sectors of society in their planning and evaluation of measures to cope with and ameliorate damage from estuarine flooding. It is also to be hoped that the scientific and technical sectors of society will gain a better understanding of the fundamental nature of the myriad and interrelated phenomena that is the Chesapeake Bay ecosystem. Presumably much of what was learned about Chesapeake Bay will be applicable to estuarine systems elsewhere in the world. Most of the papers comprising this volume were presented at a symposium held May 6-7, 1974, at College Park, Maryland, under the sponsorship of the Chesapeake Research Consortium,Inc., with support from the Baltimore District, U.S. Army Corps of Engineers (Contract No. DACW 31-73-C-0189). An early and necessarily incomplete assessment, *The Effects of Hurricane Agnes on the Environment and Organisms of Chesapeake Bay* was prepared by personnel from the Chesapeake Bay Institute (CBI), the Chesapeake Biological Laboratory (CBL), and the Virginia Institute of Marine Science (VIMS) for the Philadelphia District, U.S. Army Corps of Engineers. Most of the scientists who contributed to the early report conducted further analyses and wrote papers forming a part of this report on the effects of Agnes. Additional contributions have been prepared by other scientists, most notably in the fields of biological effects and economics.

The report represents an attempt to bring together all data, no matter how fragmentary, relating to the topic. The authors are to be congratulated for the generally high quality of their work. Those who might question, in parts of the purse, the fineness of the silk must keep in mind the nature of the sow's ears from which it was spun. This is not to disparage the effort, but only to recognize that the data were collected under circumstances which at best were less than ideal. When the flood waters surged into the Bay there was no time for painstaking experimental design. There were not enough instruments to take as many measurements as the investigators would have desired. There were not enough containers to obtain the needed samples or enough reagents to analyze them. There were not enough technicians and clerks to collect and tabulate the data. While the days seemed far too short to accomplish the job at hand, they undoubtedly seemed far too long to the beleaguered field parties, vessel crews, laboratory technicians, and scientists who worked double shifts regularly and around the clock on many occasions. To these dedicated men and women, whose quality of performance and perseverance under trying circumstances were outstanding, society owes an especial debt of gratitude.

It should be noted that the Chesapeake Bay Institute, the Chesapeake Biological Laboratory, and the Virginia Institute of Marine Science, the three major laboratories doing research on Chesapeake Bay, undertook extensive data-gathering programs, requiring sizable commitments of personnel and equipment, without assurance that financial support would be provided. The emergency existed, and the scientists recognized both an obligation to assist in ameliorating its destructive effects and a rare scientific opportunity to better understand the ecosystem. They proceeded to organize a coordinated program in the hope that financial arrangements could be worked out later. Fortunately, their hopes proved well founded. Financial and logistic assistance was provided by a large number of agencies

that recognized the seriousness and uniqueness of the Agnes phenomenon. A list of those who aided is appended. Their support is gratefully acknowledged.

This document consists of a series of detailed technical reports preceded by a summary. The summary emphasizes effects having social or economic impact. The authors of each of the technical reports are indicated. To these scientists, the editors extend thanks and commendations for their painstaking work.

Several members of the staff of the Baltimore District, U.S. Army Corps of Engineers, worked with the editors on this contract. We gratefully acknowledge the helpful assistance of Mr. Noel E. Beegle, Chief, Study Coordination and Evaluation Section, who served as Study Manager; Dr. James H. McKay, Chief, Technical Studies and Data Development Section; and Mr. Alfred E. Robinson, Jr., Chief of the Chesapeake Bay Study Group.

The editors are also grateful to Vickie Krahn for typing the Technical Reports and to Alice Lee Tillage and Barbara Crewe for typing the Summary.

The Summary was compiled from summaries of each section prepared by the section editors. I fear that it is too much to hope that, in my attempts to distill the voluminous, detailed, and well-prepared papers and section summaries, I have not distorted meanings, excluded useful information or overextended conclusions. For whatever shortcomings and inaccuracies that exist in the Summary, I offer my apologies.

Jackson Davis
Project Coordinator

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U. S. Navy

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- Coastal River Squadron Two, Little Creek, Virginia
- Assault Creek Unit Two, Little Creek, Virginia
- Explosive Ordnance Disposal Unit Two, Fort Story, Virginia
- Naval Ordnance Laboratory, White Oak, Maryland

U. S. Coast Guard

- Reserve Training Center
- Coast Guard Station, Little Creek, Virginia
- Portsmouth Supply Depot
- Light Towers (Diamond Shoal, Five Fathom Bank, and Chesapeake)

National Oceanic and Atmospheric Administration

- National Marine Fisheries Service (Woods Hole, Massachusetts and Sandy Hook, New Jersey)

The National Science Foundation

Food and Drug Administration

Environmental Protection Agency

U. S. Office of Emergency Preparedness

State of Maryland, Department of Natural Resources

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EFFECT OF TROPICAL STORM AGNES ON SETTING OF SHIPWORMS AT GLOUCESTER POINT, VIRGINIA[1]

Marvin L. Wass[2]

ABSTRACT

Surveillance of shipworm infestation at Gloucester Point, Va., began in 1958. Borer attack by *Bankia gouldi* occurred in July to early October each year until the passage of Agnes greatly reduced setting. Populations returned to near normal in 1975. Salinity was shown to vary with watershed rainfall.

INTRODUCTION

Structural damage to wooden vessels and piers by shipworms has been a continuing problem in estuaries above 5 ppt salinity (Turner 1974). Since the shipworm, *Bankia gouldi*, the only teredinid mollusk that occurs commonly in Chesapeake Bay (Scheltema & Truitt 1954), is limited by about 10 ppt, wooden structures are relatively safe in oligohaline waters. Salinity at Gloucester Point is usually between 15 and 20 ppt, but has ranged from 7.2 to 25.2 ppt.

METHODS

Panels of clear pine have been exposed monthly at the Virginia Institute of Marine Science (VIMS) pier since September 1958, to determine the annual period and magnitude of infestation. Initially, panels were exposed at the request of the Clapp Laboratories, Duxbury, Mass., the exposed panels being sent to the laboratory for identification of boring and fouling organisms until VIMS assumed responsibility in 1966. Long-term "test panels" were first exposed for 8 months, while "controls" were down for 1 month. Test panels were changed to a 6-month rotation in 1969. All dates given are for the month in which the panel was last out. Panels were considered riddled if borer holes occurred in every inch of a split panel.

Test panels were originally 3/4 x 6 x 12-inch loblolly pine panels. Recently, "inch" boards have been only 5/8 inch in thickness. Formerly attached to a vertically hung pipe, they were later tethered to a horizontal galvanized pipe hung about 2 feet off the bottom. The latter system, using nylon cord through two holes in the board to tie to the pipe, has largely prevented further panel loss. Prior to then, numerous panels were lost, partly due to heavy infestations. Panels were usually changed on the first day of each month. After prominent fouling organisms are recorded, the panels are split finely enough to reveal all borer holes. If pallets of borers are evident, counts are made before the panels are split.

RESULTS

Setting of larval borers at Gloucester Point occurs from at least the first week in July through the first week in October. Intensive peak setting occurred during months of warmest water temperatures. Setting data may be compared by

[1] Contribution No. 778, Virginia Institute of Marine Science.
[2] Virginia Institute of Marine Science, Gloucester Point, Va. 23062

years and by months. Over the 18-year period, sets occurred in July in 73% of the recovered panels; August, 80%; September, 73% and October, 44%. On a monthly basis, average sets of shipworms for the 4 months were: July, 3.5 (6.8%); August, 12.5 (24.3%); September, 27 (52.5%) and October, 8.4 (16.4%).

From the inception of the project through December 1972, test panels removed from September through February were virtually always riddled. The heaviest borer set in a control was 92 individuals in September 1971 (Table 1). Furthermore, 1971 was the only year in which the test panel retrieved at the end of July was riddled as were all test panels through February 1972 (Table 2). Although Agnes occurred before the known setting time, test panels held 16 borers in July and 6 in August, whereas only 2 *Bankia* occurred in controls, 1 each in July and September. Yet, all test panels retrieved in the last 4 months of 1972 were riddled.

Table 1. Numbers of *Bankia gouldi* in control panels before and after Agnes.

	June	July	August	September	October
1971	0	1	3	92	14
1972	0	1	0	1	0
1973	0	0	2	0	0
1974	0	1	0	0	0
1975	0	7	1	0	0

Table 2. Riddled or numbers of *Bankia* in test panels put out 6 months earlier.

	June	July	August	September	October
1971	0	riddled	riddled	riddled	riddled
1972	0	16	6	riddled	riddled
1973	0	pl*	few	11	pl*
1974	0	0	6 med.	7 large	3 large
1975	0	3	30 med.	35 large	25 large

*Panel lost

Continuing wet years kept subsequent test panels from becoming riddled until September 1975. In 1973, test panels held 12 borers in February and 2 in March. Although controls continued to have low sets through 1975, test panels nearly always held some borers and in 1975 were virtually back to normal.

Climate

In this decade, the climate has been increasingly more maritime, i.e., warmer in winter, cooler in summer. Not only have temperatures been well above average each winter, but rainfall has also been high. The average precipitation for the York River drainage basin towns of Ashland, Partlow, Walkerton, West Point, and Williamsburg combined was 37.15 inches for the 6 dry years 1963-1968; whereas in 1971 through 1975, it averaged 52.05 inches, a mean difference of 14.9 inches. In 1975, rainfall exceeded records of the previous 15 years by at least 4 inches, except at Ashland. Williamsburg had 17.9 more inches than it had in 1960, due largely to 18.45 inches in September, about 2/3 of which fell on September 1.

During the same period, salinity for the York River at Gloucester Point averaged 19.5 ppt, while average annual rainfall was 44.85 inches. A linear regression analysis (Fig. 1) gave a 74% correlation, using yearly mean salinities and mean annual rainfall for the five localities above. Following Agnes, surface salinity dropped to as low as 7.2 ppt at Gloucester Point and cross-sections below the York River bridge ranged below 13.8 ppt through July (Andrews 1973). Since 1970, salinity has continued below average; whereas for 9 years, 1962 through 1970, it averaged 20.3 ppt.

DISCUSSION

The effect of Tropical Storm Agnes on *Bankia gouldi* illustrates the plight of many species disrupted by the low salinity (Andrews 1973; Boesch, Diaz & Virnstein, in press). Adult *Bankia* survived but were largely unable to recolonize new panels until 1975 in significant numbers, whereas many other invertebrates, mainly epifauna, have still not returned to Gloucester Point.

The evidence indicates that the panels longest in the water are most likely to be penetrated by *Bankia* larvae. Culliney (1973) has shown that *Teredo navalis* is extremely sensitive to humic acids (Gelbstoff) and *Bankia* somewhat less so. One might conjecture that new, well-dried panels may not exude as much humic acid as would panels submerged longer. Or perhaps larvae are better able to survive where fouling organisms are present. There is some indication that panels only partly fouled are optimal for larval penetration. The July and August panels (down 6 months) had only 16 and 6 *Bankia* respectively, whereas the last 4 months of the year had riddled test panels.

The negative correlation of rainfall with salinity was best when data from all five gauge stations were combined, probably because precipitation often varied greatly between stations during the warmer months. The finding of only two larvae in control boards in 1972 could be due to one or more reasons: 1) low salinity, 2) low oxygen, 3)unfavorable habitat due to lack of certain fouling organisms, or 4) excess turbidity. A combination of low salinity and low oxygen would seem most likely. More perplexing is the riddling of test panels during the last 4 months of 1972. Since there is no record of shipworms setting in June over the entire study, the presence of riddled test panels through December would seem to indicate a set in early July before the effect of Agnes was felt. A few shipworms did set after salinity rose again, since test panels put down in September and October 1972, held 12 and 2 borers respectively when retrieved in February and March 1973.

Since 1970, late summer and autumn have trended to wet weather. The resultant lowered salinity, in addition to a dearth of adult shipworms, apparently resulted in the lack of a late summer set adequate to produce riddled panels until 1975. So great was their recovery, that stakes put out to suspend oyster trays broke off at the base from *Bankia* attacks, worse in 1975 than for many years (Jay D. Andrews, pers. comm.). As further testimony to the possible effect of fouling, or perhaps "wood leaching", as an aid to setting, nearly riddled panels were retrieved in January and February 1976. Placed in August and September these boards obtained a good set while the controls had one borer set in August and none later.

While salinity had begun dropping in 1971 before the onslaught of Agnes, fouling organisms of many species still competed for space on the panels. In winter, the hydroid, *Gonothyraea loveni*, quickly spread a network over new panels. Barnacles often set heavily in spring and less so in autumn. By April heavy fouling by *Polydora ligni* occurred (Orth 1971). This small polychaete captures fine particles and sediments them around its tube, the multitude of adjoining tubes covering the upper panel surface with a heavy layer of fine dark clay. Little of this soft encrustation survives until mid-May. The serpulid, *Hydroides dianthus*, has returned to the panels, but in far lower numbers than in the 1960's.

Three tunicates have been associated with the panels. Most prominent of all the fouling organisms is the solitary sea squirt *Molgula manhattensis*. This large species has a phenomenal reproductive potential, and although it briefly disappeared following the storm, it quickly reappeared in greater numbers. Now back to normal, it heavily fouls panels down over 2 months. The colonial ascidians, *Perophora viridis* and *Botryllus schlosseri*, have not occurred on the panels since the storm, and it seems unlikely that they will until a sustained salinity near 20 ppt occurs.

Newly placed panels (Fig. 2) are usually covered with a layer of eggs deposited by the toadfish, *Opsanus tau*, or more often, the skilletfish, *Gobiesox strumosus*. The tightly placed ova and parental care preclude setting of invertebrates until the eggs hatch. However, fouling is normally much less on the undersides of panels where these fish eggs are deposited.

In spite of competition from fouling animals, wherever salinity and temperature conditions are favorable, shipworm infestation of wood seems inevitable. From the view of man's activities, it would seem that the decreasing use of wooden boats and the trend toward using salt-treated or creosoted piles and bulk heading would tend to reduce the shipworm habitat in the future. Countering this trend is the placement of many new pound net poles and oyster-ground marking stakes annually.

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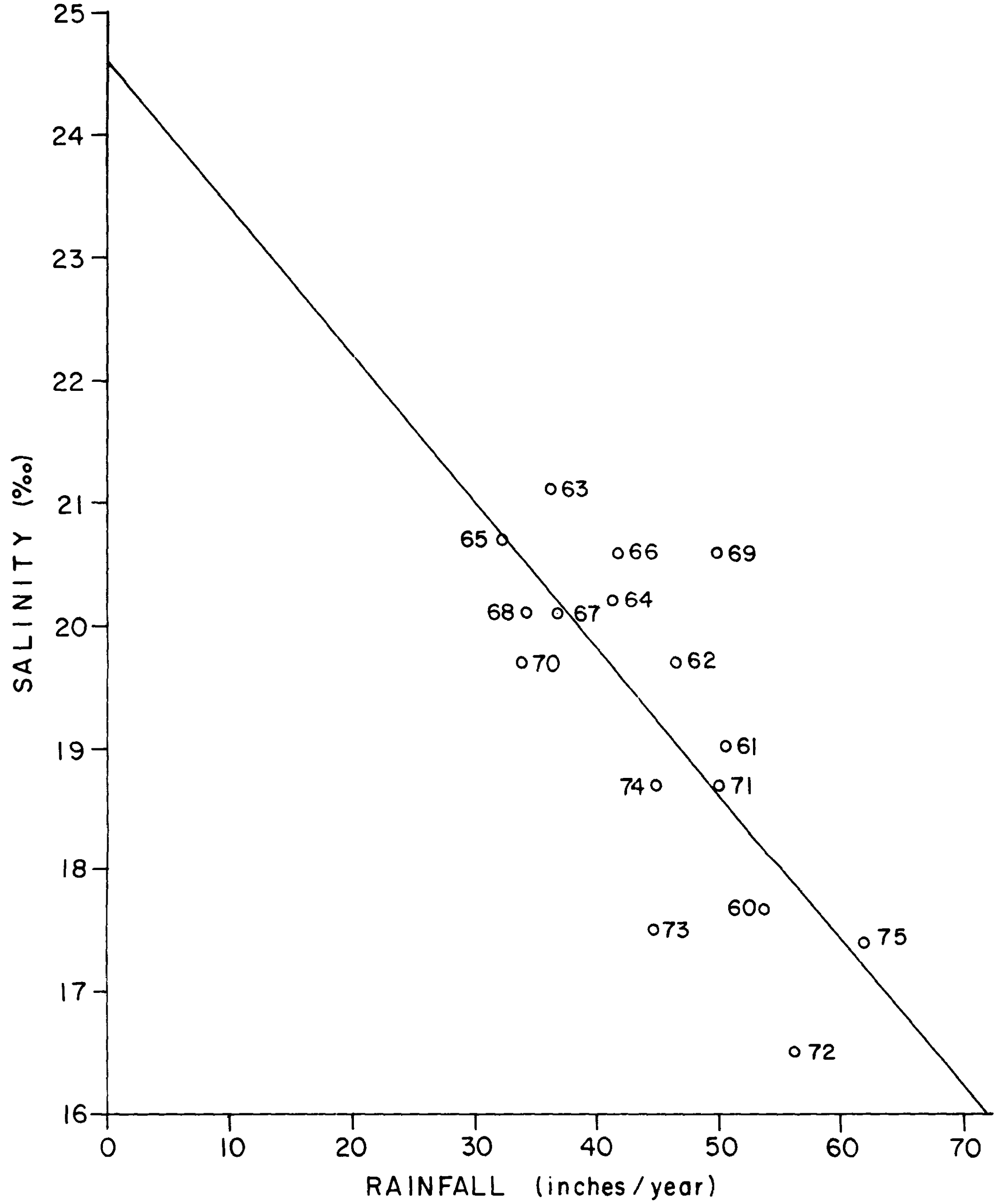

Figure 1. Correlation of Gloucester Point, Va., salinity with rainfall in the York River drainage basin, 1960-1975.

Figure 2. Eggs of oyster toadfish on underside of shipworm panel.