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BUREAU OF COMMERCIAL FISHERIES

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ANNUAL PROGRESS REPORT

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PROJECT TITLE A MULTIDISCIPLINARY STUDY OF THE SCYPHOZOAN JELLYFISHES OF LOWER CHESAPEAKE BAY
PERIOD COVERED 1 July 1968 - 30 June 1969

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INTRODUCTION

At the beginning of the fiscal year covered by this report the scope of the present study was restricted to an ecological consideration of the jellyfish, Chrysaora quinquecirrha. During the winter of 1968 the project proposal was amended broadly to include physiological, biochemical and developmental aspects and the taxonomic base was expanded to include the clover leaf jellyfish Aurelia aurita and the lions mane jellyfish Cyanea capillata.

It was not possible to initiate those physiological and developmental aspects that required the medusae of the two summer species until the last month covered by this report. However some activities on all phases were begun during the past winter and spring. In addition, these months were used effectively to recruit an excellent staff and to acquire and assemble the necessary equipment. At the end of the fiscal year all personnel had joined the staff and all phases were underway.

Since the ecological phases, which are the direct responsibility of Dexter Haven, have been in progress throughout the fiscal year these phases will be reported much more fully than those phases just begun.

The ecological phases continue to be hampered by the difficulties in separating the polyps of the three species in field samples. We are now convinced that all three species of jellyfish do set polyps in lower Chesapeake Bay. This adds a major complication in this area that does not exist in upper Chesapeake Bay where supposedly only Chrysaora is able to complete its life cycle.

In order to surmount this difficulty, we have expended considerable time and effort in obtaining the polyp stages in culture from known parents of all three species. By having this material of known origin we are now able to differentiate mature polyps of the three species with an acceptable level of accuracy. However, this does not entirely solve the problem as many of the polyps examined from field samples are immature and the differentiating characteristics are not yet apparent. This aspect of the problem is continuing to receive high priority.

Because of the problems of identification just mentioned, all physiological and developmental studies are being designed to utilize only material of known origin.

I. ECOLOGICAL STUDIES

PHASE 1 - NUMBER OF JELLYFISH POLYPS ATTACHING TO OYSTER SHELL SUBSTRATE IN VARIOUS RIVERS.

During the summer of 1968, shell bags were set at a number of stations in the James, York and Rappahannock rivers and in several tributary creeks. Stations were also located in the lower Bay, Mobjack Bay and in the Poquoson River.

At each station one or two small wire bags containing oyster shells were suspended in the water for approximately two weeks. At the end of this period the shells were replaced and the exposed shells returned to the laboratory for examination and polyp enumeration.

The results of these summer surveys were included in the quarterly report that covered the period 1 July - 30 September 1968. In brief, these surveys showed that almost no polyps attached to the shells in the open portions of the York, James and Rappahannock rivers

or in Mobjack Bay. In contrast, many of the small creeks tributary to the rivers received sets of polyps. The maximum number recorded was 25 polyps per shell in Sarah's Creek. These results differ somewhat from information obtained prior to initiation of this contract. At the present time we cannot account for the year to year variation encountered thus far.

Despite difficulties that we have encountered in polyp identification, we are confident that most of the polyps examined in the summer of 1968 were those of Chrysaora.

During the fall period, we attempted to clarify the problems of differentiating the polyps of Chrysaora and Aurelia. Polyps that were obtained in the previous summer survey were compared with polyps obtained from known Aurelia parents. The most useful recognition characteristic that emerged from this examination was mouth shape. Chrysaora polyps show an irregular and most often a cruciform mouth shape, while Aurelia polyps show a circular mouth even when the mouth opening is constricted. This has proven to be a useful diagnostic feature, except when the polyps are newly set. It is most probably a function of the height of the radial septa within the polyp. This information was included in the quarterly report for the period of October 1 through December 31.

During February and March 1969, wire bags holding 25 clean oyster shells were suspended at 37 selected stations in the lower Chesapeake Bay and tributaries. These were set out early in the year to catch a possible set of Cyanea larvae. Bags were suspended at 24 additional stations at later dates. Station locations are

shown in Figure 1.

By May 1969, we were able to recognize and identify the larval cysts formed by Cyanea planulae immediately after setting (prior to formation of a polyp). McMurrich (1891) described encystment in Cyanea arctica. His studies were confirmed by laboratory experiments at the Virginia Institute of Marine Science, in which larvae of Cyanea were "set" on shells. The larval cysts were circular and planoconvex as described by McMurrich. They are very small with a pale yellow coloration; the covering appears to be chitinous and very shiny. The cyst surface frequently appears slightly speckled. We refer to these as larval cysts to distinguish them from podocysts. Podocysts of Cyanea arise from polyps. Larval cysts have not been reported from Chrysaora or Aurelia and almost certainly are not part of their life cycles. Consequently, we will be referring to Cyanea whenever we use the term larval cyst.

Most examinations of bottom substrate reported for the January and February period were made before we became aware of the presence and identity of larval cysts. Consequently, if they were present on the shells during these two months, they were overlooked. Thereafter during March, April, May and June, all larval cysts observed were recorded. The term cysts as used in the preceding quarterly reports refers exclusively to podocysts. Podocysts found on shells during this quarter were, with one exception, of a red-brown color and resembled those described for Chrysaora. In only one instance (at Wilson Creek) were the large yellow cysts characteristic of Cyanea observed.

Table 1 summarizes the results of examination of shells from suspended wire bags for the period covered by this report.

Shellbags set out in February and March 1969 were not lifted until May to allow any Cyanea planulae time to attach and grow on the substrate. Although we had planned to change bags regularly after May, weather conditions in most instances prevented us from doing this on schedule.

Periods of exposure between February and May ranged from 69 to 90 days, with the exception of the Bay Shore Point sample which was exposed for 139 days. Fouling on shells was not heavy and did not hamper our examination.

Cyanea larval cysts were found on shells from stations in the Chesapeake Bay proper, all tributaries studied, and on the ocean-side of Virginia's Eastern Shore. Twenty-six of the 37 stations where bags were set out in February and March had larval cysts on shells when examined in May and June. On subsequent examination dates, larval cysts were also found at seven additional stations. Twelve of 14 stations established in the Great Wicomico River on 21-22 April showed larval cysts on shells when examined on 19-21 May. By the end of June 1969, there was a decrease in numbers of Cyanea larvae attaching to shells at nearly all stations, and it is believed that "setting" of this species was largely over after this period.

The stations where Cyanea larval cysts were found represent a range in salinity from 14‰ upriver in the Great Wicomico River (Public Landing Route 707) to 34‰ at Wachapreague on the Eastern Shore ocean-side (Table 2). Temperatures ranged between 4 and 5° C in February

and March to between 15° C (Tue Marsh, Chesapeake Bay) and 28° C (Poquoson River) in June.

Larval cysts were found more frequently and in greater concentrations in the Rappahannock River than in the York and James. The highest average number per shell was 21.40 on 14 May at Millenbeck (Corrotoman River) in the Rappahannock. Next highest concentrations were 10.04 at the VIMS Ferry Pier at Gloucester Point (York River) and 9.40 at Broad Creek (Rappahannock River). Concentrations were relatively low at most other stations.

Podocysts occurred on shells exposed after 1 May. Most of them were red-brown in color and were thought to be those of Chrysaora.

Casual examination of 25 eelgrass leaves collected in front of the laboratory yielded two larval cysts attached to this substrate.

The widespread occurrence of Cyanea larval cysts in lower Chesapeake Bay raises the possibility that Cyanea polyps may populate the area and give rise to medusae. Samples of larval cysts are being kept in the laboratory and at field stations to determine if they are able to survive the high summer temperatures at some of the different salinities common to the region. Some are being kept at Gloucester Point in the York River, Time Point in the Great Wicomico River, Kiptopeke on the Eastern Shore Bayside near the mouth of Chesapeake Bay, and Wachapreague on the Eastern Shore Seaside.

The first set of polyps (3 individuals) was recorded from Nandua Creek (Eastern Shore Bayside) on 7 May. No other polyps were found until 17 June when 131 were recorded from West Point (Corrotoman River, Rappahannock). From this date on, polyps were recorded from 18 other stations. No other set of polyps, however,

was recorded from Nandua Creek after 7 May.

With the exception of the Rappahannock and Poquoson rivers, set of polyps through the end of June has been very small. Polyps have been found settling at only two stations in the York River. Both stations, Gloucester Point and Sarah Creek, are near the mouth of the river. No set was recorded from the James River before the 19 June to 2 July period. In the Great Wicomico River at Glebe Point and at Dixie in the Piankatank River, a moderate set of polyps occurred between 19 May and 23 June.

At the Bayside stations on the Eastern Shore, set of polyps was low. No set was recorded from Mobjack Bay, Ware River (Wilson Creek), Back River, or Eastern Shore Seaside during February, March, April, May and June 1969.

The first set of polyps occurred in the Poquoson River between 12 and 27 June when there were 45.7 polyps per shell.

Stations in the Rappahannock and Corrotoman rivers showed relatively high concentrations of polyps, and polyps were found at seven of the eight stations. The highest set was found in the Corrotoman River.

The range in salinity was only 3.45‰ between the station opposite Smoky Point and that at Broad Creek near the mouth at the time of the last examination reported here (1 July).

Podocysts were observed for the first time on shells exposed during the 13 February to 30 April period at the Dixie station in the Piankatank River. Color of these cysts was not recorded. In the middle of May, podocysts were observed more frequently at scattered

locations in all river systems. Numbers observed were never high. In the Ware River at Wilson Creek, 21 of the podocysts observed had the yellow coloration characteristic of Cyanea. All other podocysts observed had the red-brown coloration characteristic of Chrysaora.

The small number of Chrysaora podocysts found is probably due to the short time of immersion of the shells before examination.

As mentioned in the quarterly report for the period 1 October to 31 December 1968, the possibility exists that Chrysaora and Aurelia polyps may be distinguished from each other by the shape of the mouth; the mouth of all Aurelia polyps from known parents was round or nearly so, while the mouth of Chrysaora polyps is cruciform or dactyloid (i.e., with finger-like indentations in the margins).

As many as possible of the polyps found on shells from natural substrate samples and from shells suspended in wire bags are being examined for mouth shape (Table 3). A substantial number of the polyps examined have round mouths. The greatest number so far has been found at Dixie in the Piankatank River where 70% of the polyps had round mouths. Most of the polyps with round mouths were very small and had not fully developed. It was felt that their size and immaturity might make it difficult to discern between a round and a dactyloid mouth. Therefore, polyps are being saved and will be re-examined at a later date when they will have reached a larger size.

PHASE II - DISTRIBUTION OF JELLYFISH POLYPS ON NATURAL SUBSTRATE DURING THE WINTER MONTHS.

During the winter of 1968-69, thirty-eight stations in lower Chesapeake Bay and its tributaries were sampled for polyp

abundance. Oyster shells were dredged from the bottom and transported to the laboratory in containers of water obtained at the site of collection. At the laboratory each shell was examined with the aid of a dissecting scope and all polyps and cysts recorded. The data resulting from this series were presented in the quarterly report for the period ending 31 March 1969.

Cysts were more abundant than polyps on shells at all locations with the exception of the York River. In the York and Rappahannock rivers, totals for cysts and polyps showed no obvious trends. In the James River, totals for cysts and polyps reached maximum values in the mid-portion of the river. No polyps were found in the lower Bay.

On the Bayside of the Eastern Shore, polyps were found from Saxis near the Maryland - Virginia line to Nassawadox 29 miles up bay from Cape Charles.

Over 550 polyps were examined for mouth shape in order to determine if Aurelia polyps contributed significantly to the numbers collected. Only three of those examined appeared to be typical of Aurelia. We now know from cultured material that Cyanea as well as Chrysaora has a cruciform mouth so at this time we cannot allocate the reported polyp numbers between the latter two species. It may turn out that most of the polyps from the higher salinities were in fact Cyanea.

Dredged and tonged samples of oyster and clam shells from natural bottom beds from six locations were obtained between 21 and 25 April, 1969 and were examined for presence and abundance of polyps and cysts to conclude our winter survey of bottom substrate.

Table 4 summarizes the results of these examinations. Of three stations in the York River, polyps and podocysts were found only in Sarah Creek near the mouth of the river. The other two stations are in lower-salinity waters upriver near what appears to be the distribution boundary for polyps.

Samples from two stations in the Great Wicomico River showed a high concentration of polyps and podocysts. No larval cysts of Cyanea were observed at any of the stations in the York and Great Wicomico rivers. The mean number of podocysts per shell at Glebe Point was much higher than at any other station previously investigated and that for Haynie Point was of a magnitude similar to the highest figures previously reported by us.

Two shells collected with a dredge from the vicinity of York Spit light yielded an unexpectedly high number of polyps and podocysts and an even higher number of Cyanea larval cysts.

These studies of the distribution of polyps on natural substrate will have to be continued until a clear statement on distribution of the several species is possible.

PHASE III - PREDATORS, COMPETITORS AND OTHER CAUSES OF MORTALITY ASSOCIATED WITH POLYPS AND MEDUSAE

Work on this phase was initiated in later summer of 1968. The early efforts were concerned with the effect of red water organisms on the medusae of Chrysaora and Aurelia. It was found that high concentrations of red water organisms, chiefly Parocentrum micans and Ceratum furca, had a marked detrimental affect on both species of jellyfish. These results were included in the first quarterly report for this fiscal year.

In all instances, it was found that the pulse rate of medusae decreased on introduction to test aquaria containing red water organisms. Within about 30 minutes, pulse rate had halved. Complete cessation occurred within 15-60 minutes. If medusae were removed from the test aquaria before their pulse rate had halved and placed in the control aquaria, pulse rate would return to normal in about 60 minutes. However exposure for longer periods resulted in death of the medusae.

Studies of polyp predators was begun in late spring of 1969 and continues in progress.

Oyster shells containing polyps were placed in 12-inch fingerbowls with a suspected predator. The number of polyps used in each test varies, the average number being 20-30. In most tests the number of predators was five. Tests were run for 24-72 hours, and if the initial number of polyps decreases significantly (by at least 20%), the test is considered to have yielded a positive indication of predation.

In the case of a positive initial test, further observations were made. A second series of tests consists of monitoring under the microscope the behavior of the suspected predator in the presence of polyps. Confirmation of predation is established when the predator is actually seen ingesting polyps.

Observations to date have been limited to invertebrate animals (other than the nudibranch Cratena), especially those which appear by their behavior, habitat and protective adaptations against polyp nematocysts as most likely to feed on polyps.

Results so far have been encouraging. Observations have shown four predators -- two, however, are still in question. The two positively proven predators are an amphipod Caprella sp. and the pycnogonid Callipalene brevirostris. The pycnogonid appears to have difficulty ingesting large polyps--a problem not found in the case of Caprella.

The two questionable predators are the hermit crab Pagurus longicarpus and the mud crab Neopanope texana. All tests appear to indicate that these two animals eat polyps. The problem has been that although the crabs were observed to rip the polyps from the substrate by means of the large chelipeds and move the polyps toward the buccal region, actual ingestion has not been verified. Further observations will more than likely show definite ingestion of the polyps.

Observations continue on the effect of "red tide" dino-flagellate blooms on medusae.

PHASE IV - CENSUS OF JELLYFISH

Efforts to ascertain the seasonal distribution and relative abundance of medusae in different areas have been conducted throughout the year. Counts such as those obtained are very difficult to treat in any acceptable quantitative fashion; however, they are useful in providing gross estimates of season to season and year to year variation. Data resulting from these efforts have been included in three previous quarterly reports and will not be repeated.

Medusae counts were made on a frequent basis from the VIMS pier during the last quarter and have not been previously reported. These counts are presented in table 5.

Cyanea medusae were present in the area with relative consistency through 6 June. Although they were very abundant at times, for the most part their numbers were low.

The first Chrysaora medusae seen at the VIMS pier appeared on 6 June when five ranging from 0.5 to 1.5 inches in diameter were counted. Only three more were seen during the remainder of June.

Only three Aurelia have been seen through the end of June -- one on 20 June and two on 30 June, all very small.

Medusae counts from a moving boat were continued at all shellbag stations and other areas when weather conditions permitted them. Results are presented in Table 6.

Our counts were made at irregular intervals and on different dates at different stations. Therefore, they are not accurately indicative of abundance and distribution of the medusae. However, certain general trends may still be perceived.

Cyanea

Cyanea medusae were not seen in the areas of the James River and tributaries studied nor at the stations on either side of the Eastern Shore. In the York River only six were seen at two stations, Gloucester Point and Sarah Creek. Many more than the one medusa reported here for Gloucester Point have been seen in the area at different times (Table 5).

With the exception of Tue Marsh on 12 May, very few Cyanea medusae were seen at the Chesapeake Bay stations. Few or none were found in the Back, Poquoson and Ware rivers and Mobjack Bay.

The highest concentrations of medusae were seen at the Piankatank, Rappahannock and Great Wicomico rivers. In April and May,

large numbers (210-350) were seen at Dixie in the Piankatank. The fact that these counts were made from the abandoned ferry pier and between the slip fenders may have accounted for the high concentrations. No Cyanea medusae were seen on the next visit to the station in June.

In the Rappahannock River Cyanea medusae were seen at all stations below Urbanna Creek while none were seen above. Concentrations at Urbanna Creek and Grinels were very high (610 and 420, respectively), while at the other stations they were much lower than this. No Cyanea medusae were seen in the Rappahannock on the next time the stations were visited in June.

Although 27 medusae were counted on 30 April at the station farthest upriver (below Public Landing on Route 707) in the Great Wicomico River, numbers seen at other stations were much lower. Reports received at VIMS from fishing interests in this river indicate that high concentrations of Cyanea medusae have been present in the river at different times.

No Cyanea medusae were seen at any station in the latter part of June.

Chrysaora

The first Chrysaora medusae seen in 1969 were found in the Piankatank and Great Wicomico rivers on 19 May. Fifty-five medusae, mostly 1 inch in diameter, were counted at Dixie in the Piankatank, and 101 ranging between 0.5 and 4 inches were counted at three stations upriver in the Great Wicomico.

Three days later 27 medusae ranging between 1 and 4 inches were counted at West Point in the Corrotoman River.

By the latter part of June, Chrysaora medusae were seen at almost all stations in the region with the notable exception of those

in the Chesapeake Bay proper and the Eastern Shore Seaside. Relatively few were seen in the James and York rivers and Eastern Shore Bayside stations, while they were abundant in the Rappahannock, Great Wicomico, Piankatank, Poquoson and Ware rivers. The numbers seen in the Corrotoman River stations of the Rappahannock exceeded by much those seen elsewhere.

Aurelia

No Aurelia medusae have been seen to date at the Great Wicomico, Eastern Shore (both Bayside and Seaside), or the Chesapeake Bay proper. Only a few have been seen at the James, York, Piankatank and Rappahannock rivers and Mobjack Bay.

The first Aurelia medusae were seen at the Wilson Creek station in the Ware River on 25 May when 170, mostly around 6 inches, were counted. They were also found to be very abundant at the end of June in the Poquoson and Back rivers. These are the only stations where Aurelia have been abundant to date.

II DEVELOPMENTAL STUDIES

The developmental studies are being conducted by Dr. Robert Black, professor of Biology at the College of William and Mary, and an associate staff member of VIMS. During the spring of 1969, Dr. Black began preliminary work on development while still at the main campus. Since June 1, 1969, Dr. Black has devoted full time to the project, working on the VIMS campus. Although this work has been in progress only a few months, significant progress is being made.

Preliminary data have been obtained on the levels of RNA, DNA, protein and respiration in Chrysaora before, during and after strobilation.

The stages chosen were as follows: (1) Well-fed polyps 1-3 mm in length, which had not strobilated for at least 2 weeks; (2) early strobilae having 1-3 constrictions at the base of the tentacles; (3) mid-strobilae still possessing feeding tentacles, but with 8-12 constrictions; (4) late strobilae having lost the feeding tentacles, and with 8-15 constrictions, of which the topmost were showing some pulsating movement; (5) ephyrae which had been released 0-24 hours prior to measurement; and (6) polyps which had completed strobilation and regenerated 12 tentacles.

Polyps were cultured at 25° C. in York River water at 20-21‰, and were fed Artemia larvae at 48-hour intervals. Oxygen consumption measurements were made on 20-50 polyps or 150-500 ephyrae larvae. The measurements were made in Warburg vessels of 5-6 ml capacity. In a preliminary experiment to determine the effect of starvation on respiratory rate, 30 large polyps were fed 10-15 Artemia larvae each, and oxygen consumption was measured immediately and at 24-hour intervals thereafter for 4 days. The results, indicated that after 48 hours of starvation the respiratory rate has reached a fairly stable level. All subsequent measurements were made on polyps starved for 48 hours.

Measurements of DNA and RNA were made according to the method of Schneider (1957). Protein was determined by the method of Lowry, et. al., (1951). Approximate levels of these compounds in

polyps of different sizes and stages are given in Table 7. In Table 8 the levels of respiration, RNA and protein have been expressed on the basis of total DNA per organism, since DNA per cell is nearly constant, whereas the other values would be more variable.

These preliminary experiments permit only tentative conclusions, which are as follows: (1) There is probably a marked drop in the RNA DNA ratio during strobilation. This may be taken to indicate that polyps are capable of storing RNA and protein in preparation for strobilation. In this respect they resemble early embryonic systems of other animals. It is unlikely that strobilation can be inhibited using standard inhibitors of RNA synthesis, such as actinomycin D. (2) There is no significant change in the rate of oxygen consumption per unit DNA during strobilation. This is probably of some interest, since the polyps are undergoing rapid cell division (Tcheou-Tai-Chun, 1930), and hence probably rapid DNA synthesis. Respiration must therefore increase during strobilation; however, methods for induction of synchronous strobilation of large numbers of polyps must be worked out before this can be determined.

Biochemical analyses of the several stages of the jellyfish life cycle, closely related to and supportive of the developmental studies, are being conducted by Dr. Robert Schmidt. Dr. Schmidt, a natural products biochemist, joined the staff on June 1, 1969, therefore only one month of activity can be included in this report.

The first step in this work is to obtain freeze-dried material for subsequent analysis. During June, large numbers of medusae, both Chrysaora and Aurelia, were obtained for freeze-drying. Sex was determined for each medusa, which was then frozen solid with dry

ice, the sexes being maintained separately. The frozen material is later placed in a lyophilizer and the water evacuated under vacuum. This procedure produces a dry, chemically stable material from which organic compounds can be extracted by several techniques. The extracted compounds will further be separated and analyzed with thin-layer chromatography.

PHYSIOLOGICAL STUDIES

The goals of the physiological phase are to determine, under laboratory conditions, the roles of several environmental parameters on the survival and setting of planulae, the development and survival of polyps, and the formation of stolons and cysts.

Unfortunately, the contract was broadened to include this work during the winter, when medusae of Chrysaora and Aurelia were not available. Because of the uncertainties of identification of polyps brought in from the field, we decided that it would be prudent to delay certain activities until material of known origin was available. This decision was further augmented by unavoidable delays in the acquisition of controlled conditions facilities and equipment. In spite of these difficulties some progress has been made, and some preliminary results can be reported.

Cyanea medusae were collected from the VIMS pier on 6 March 1969. Microscopic examination showed that the gonads of the females contained round, brownish opaque eggs 200 - 250 u in diameter with a clear nucleus 50 u in diameter. A nucleolus was clearly evident in each ovum. Immature eggs were smaller transparent and colorless. The general color of the gonad was brown. In the males, gonadal

tissue was white to pale pink. Numerous white, oval sperm sacs could be seen under magnification. These were small near the center of the gonad and progressively larger towards the edges with a maximum diameter of about 750 μ .

Planulae appear as round multicellular yellowish bodies enclosed in a thin membrane attached to the oral arms of mature medusae of both sexes. These were first observed when the water temperature reached 9° C. The setting of the planulae is similar to that described for Cyanea arctica by McMurrich (1891). The developing planulae detach from the oral arms of the medusae, become oval, and after swimming for several days, form ivory colored plano-convex discs on the bottom of the container. Setting occurred on both surfaces of glass slides, set at an angle, on the under surface of clean shells, on the surface film as well as on the bottom of the container. Several days after setting some of the discs developed into polyps.

Polyps on shells maintained in York River water developed up to 20 tentacles and when water temperature reached 15° they began to form podocysts, forming several at once. The podocysts were greenish-yellow when fresh but became brownish yellow with age. The podocysts were round with sloping sides and flat tops but the sides did not slope as steeply as in Chrysaora. When the water temperature reached 20° the polyps disappeared leaving the podocysts. However, some polyps transferred to standing water at room temperature did not form podocyst, but survived the early summer as actively feeding polyps. This observation requires further clarification.

Preliminary experiments to determine the effects of salinity and temperature in setting and development of Cyanea planulae and

polyps were conducted. Although the results are of considerable interest it must be remembered that they were conducted prior to the time that carefully controlled conditions were available. Therefore we consider these data to be preliminary and tentative.

Approximately equal numbers of planulae were placed into each compartment of plastic boxes containing natural sea water diluted to 10, 20, and 30‰ salinity. The boxes were kept at 5, 17, 21 and 24° C. Unfortunately there was no place available with a constant temperature between 5° and 17°. In addition, finger bowls containing water of the three salinities were kept at ambient temperature. At weekly intervals the boxes were inspected and the water was changed by pipetting out most of the water and adding fresh water. The salinity varied \pm 5‰ due to evaporation and other uncontrollable factors. The temperature was constant at 5, 17 and 21° but varied \pm 2° at 24°.

At 5° development was very slow with no set at 10‰, but after one month polyps developed at 20 and 30‰. No podocysts or buds were formed. At 17° polyps developed within four days at 20‰. Setting occurred at 10‰ and 30‰ but no polyps developed. At 21° polyps developed in two weeks at 10‰ but there were no polyps at 20 or 30‰. At 24° there was very little setting and no polyp development. At that temperature planulae disintegrated at 10‰ after two weeks. An ambient temperature polyps developed within four days at 20‰ and 15° and within ten days at 30‰. Podocysts were formed at 30‰ after one month when the temperature reached 18° but were not formed at 20‰. Planulae disintegrated within ten days at 10‰. These preliminary data suggest that optimal conditions for the setting and development of Cyanea are approximately 20‰ and between 5 and 17° C.

Observations suggest that strobilation in Cyanea occurs in late February when the water temperature is still about 4° C. Medusae produce planulae in mid-March as the water temperature begins to rise and setting occurs from then until mid-May when the water temperature reaches 20°. Polyps begin forming podocysts at 15° and become encysted at 20° under natural conditions.

Several thousand Cyanea polyps set 30 April 1969 have been maintained at 5° in filtered York River water and are in good condition. They have been feeding on Cyanea planulae that did not set and occasionally have been fed Artemia larvae. These polyps will be used for temperature and salinity tolerance studies.

COORDINATION

Two meetings have been held during the last fiscal year with the jellyfish research group of Chesapeake Biological Laboratory. In October 1968, Dr. Schultz, Messrs. Cargo and Reber of CBL visited VIMS. In April 1969 the VIMS group traveled to Solomons and had an opportunity to review the Maryland program and attempt to effect as close coordination as possible. Both meetings were very helpful to the VIMS jellyfish staff.

Another coordination meeting, this time at VIMS, has been scheduled for late August. In addition to the CBL group, an invitation has been extended to Dr. Gordan Gunter to have a representative of the Mississippi program meet with us.

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Figure 1. Location of principal shellbag stations excluding the Eastern Shore Seaside.

Key:

1. Deep Water Shoal
2. Wreck Shoal
3. Warwick River
4. Deep Creek
5. Brown Shoal
6. Nansemond Ridge
7. Nansemond River
8. Hampton Flats
9. Hampton River
10. Bell Rock
11. Roane Point
12. Opposite Purtan Bay
13. Off Carter Creek
14. Pages Rock
15. Gloucester Point
16. Sarah Creek
17. Dixie, Piankatank River
18. Bowlers Rock
19. Opposite Smoky Point
20. Robinson Creek
21. Urbanna Creek
22. West Point, Corrotoman River
23. Corrotoman Point, Corrotoman River
24. Millenbeck, Corrotoman River
25. Grinels
26. Beacon 7
27. Broad Creek
28. Glebe Point, Great Wicomico River
29. Bundick, Coan River
30. Messongo Creek
31. Nandua Creek
32. Kings Creek
33. Back River
34. Poquoson River
35. Wilson Creek
36. Bay Shore Point
37. Tue Marsh
38. York Spit, Near R18
39. York Spit, Near R10
40. Fort Wool

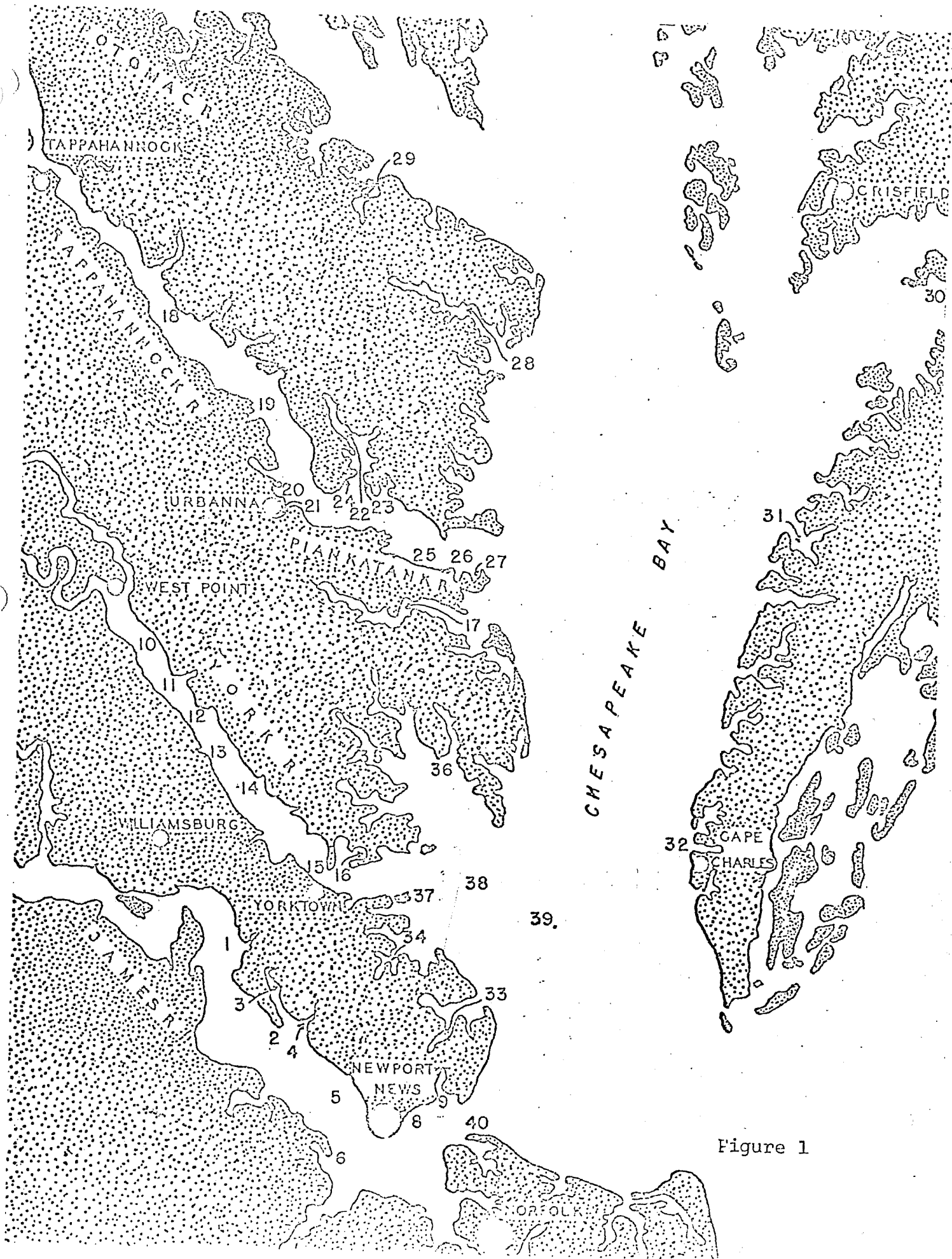


Figure 1

Table 1

Abundance of Jellyfish Polyps and Cysts Setting on Shells in Suspended Wire Bags,
Spring 1969

River and Station	Miles From Mouth	Date**	No. Days Exposed	No. Shells	No. Polyps	No. Podocysts	No. <u>Cyanea</u> <u>Larval</u> Cysts	\bar{x} Polyps	\bar{x} <u>Cyanea</u> <u>Larval</u> Cysts
<u>James River</u>									
Deep Water Shoal X		28 Feb							
		15 May	76	25	0	5 (?)	0		
		3 Jul	49	10	0	0	0		
Warwick River* X		2 Jul							
Deep Creek* X		14 Feb							
		9 May	84	25	0	0	0		
		22 May	13	10	0	0	1		0.10
		19 Jun	28	25	0	0	37		1.48
		2 Jul	13	25	10	0	0	0.40	
		(Station discontinued)							
Wreck Shoal ✓		28 Feb							
		15 May	76	25	0	0	0		
		19 Jun	35	25	0	0	0		
		2 Jul	13	Lost					
Brown Shoal I X		28 Feb							
		15 May	76	25	0	0	2		0.08
		2 Jul	48	10	0	0	0		
Brown Shoal II X		19 Jun							
		2 Jul	13	25	53	10	0	2.12	
		(Station discontinued)							

* Tributary

** First date at each station is the date bags placed in the river.

Table 1 continued

River and Station	Miles From Mouth	Date Coll.	No. Days Exposed	No. Shells	No. Polyps	No. Podocysts	No. <u>Cyanea Larval Cysts</u>	\bar{x} Polyps	\bar{x} <u>Cyanea Larval Cysts</u>
Nansemond River* (Opposite Newman's Pt.) X		28 Feb							
		6 May	67	25	0	0	0		
		20 Jun	45	10	0	0	0		
		2 Jul	12	10	0	0	0		
Nansemond Ridge X		28 Feb							
		6 May	67	25	0	0	0		
		20 Jun	45						
		3 Jul	13	10	2	0	0	0.20	
Hampton Flats ✓		28 Feb							
		6 May	67	25	0	0	4		0.16
		20 Jun	45	10	0	0	0		
		2 Jul	12	10	1	0	0	0.10	
Hampton River* X		28 Feb							
		6 May	67	25	0	0	0		
		2 Jul	57	25	2	0	0	0.08	
<u>York River</u> Bell Rock ✓		12 Feb							
		5 May	82	25	0	0	0		
		13 Jun	39	25	0	0	0		
		26 Jun	13	20	0	0	0		
		14 Jul	18	10	0	0	0		
Roane Point X		12 Feb							
		5 May	82	25	0	0	0		
		13 Jun	39	25	0	0	0		
		26 Jun	13	25	0	0	0		
		(Station discontinued)							
Opposite Purtan Bay ✓		26 Jun							

* Tributary

Table 1 continued

River and Station	Miles From Mouth	Date Coll.	No. Days Exposed	No. Shells	No. Polyps	No. Podocysts	No. <u>Cyanea Larval Cysts</u>	\bar{x} Polyps	\bar{x} <u>Cyanea Larval Cysts</u>
Off Carter Creek (Below Ferry Pt.)		12 Feb							
		5 May	82	25	0	0	0		
		26 Jun	13	25	0	0	0		
		(Station discontinued)							
Pages Rock		12 Feb							
		5 May	82	Lost					
		13 Jun	39	25	0	0	0		
		26 Jun	13	10	0	0	0		
Off King Creek		12 Feb							
		12 May		25	0	0	2		0.08
Gloucester Point		11 Feb							
		12 May	90	25	0	0	3		0.12
		28 May	16	25	0	0	0		
		12 Jun	15	25	0	0	0		
		25 Jun	13	10	0	0	0		
		10 Jul	15	25	14	0	0	0.56	
VIMS Ferry Pier		7 Apr							
		25 Apr	18	25	0	0	1		0.04
		13 May	35	25	0	0	251		10.04
(VIMS eelgrass)		14 May	--	25 leaves	0	0	2		-
Sarah Creek* (NE Branch)		11 Feb							
		2 May	80	25	0	0	0		
		16 May	14	25	0	0	7		0.28
		28 May	12	25	0	0	0		
		25 Jun	28	25	1	2	2	0.04	0.08
		10 Jul	14	25	29	0	0	1.16	

* Tributary

Table 1 continued

River and Station	Miles From Mouth	Date Coll.	No. Days Exposed	No. Shells	No. Polyyps	No. Podocysts	No. <u>Cyanea Larval Cysts</u>	\bar{x} Polyyps	\bar{x} <u>Cyanea Larval Cysts</u>
<u>Piankatank River</u>									
Dixie		13 Feb							
		30 Apr	76	25	0	11	28		1.12
		19 May	19	25	0	0	151		6.04
		23 Jun	35	25	38	0	6	1.52	0.24
<u>Rappahannock River</u>									
Bowlers Rock		1 Jul							
Opposite Smoky Point		14 May							
		17 Jun	34	10	0	0	0		
		1 Jul	14	25	23	0	0	0.92	
Robinson Creek*		25 Feb							
		8 May	72	25	0	0	94		3.76
		22 May	14	10	0	0	0		
		18 Jun	27	25	1	8	2	0.04	0.08
		1 Jul	13	25	16	0	2	0.64	0.08
<u>Corrotoman River*</u>									
West Point.		25 Feb							
		9 May	73	25	0	0	59		2.36
		22 May	13	10	0	0	1		0.10
		17 Jun	26	25	131	20	12	5.24	0.48
		1 Jul	14	25	625	0	0	48.93	
Corrotoman Point		25 Feb							
		14 May	78	25	0	0	179		7.16
		17 Jun	21	10	0	0	0		
		1 Jul	14	25	293	0	0	11.72	
Millenbeck		25 Feb							
		14 May	78	25	0	0	535		21.40
		17 Jun	21	25	0	0	0		
		1 Jul	14	10	196	0	0	19.60	

(Station discontinued)

* Tributary

Table 1 continued

River and Station	Miles From Mouth	Date Coll.	No. Days Exposed	No. Shells	No. Polyps	No. Podocysts	No. <u>Cyanea Larval Cysts</u>	\bar{x} Polyps	\bar{x} <u>Cyanea Larval Cysts</u>
Grinels X		6 Mar							
		14 May	69	25	0	4	67		2.68
		18 Jun	35	10	0	0	0		
		(Station discontinued)							
Beacon 7 ✓		14 May							
		18 Jun	35	6	0	0	0		
		1 Jul	13	10	89	0	0	8.90	
Broad Creek* ✓		6 Mar							
		14 May	69	25	0	0	235		9.40
		18 Jun	35	10	0	0	0		
		1 Jul	13	10	120	0	0	12.00	
<u>Great Wicomico River</u>									
Public Landing Route 707 X		19 May	19	10	0	0	2		0.20
Above Blackwell Creek X		19 May	19	25	0	0	3		0.12
Below Coopers Landing X		19 May	19	10	0	0	9		0.90
Glebe Point ✓		22 Apr							
		19 May	27	25	0	1	51		2.04
		23 Jun	35	25	38	0	0	1.52	
Off Barrett Creek X		19 May	19	10	0	0	11		1.10
Rogue Point X		19 May	19	10	0	0	3		0.30
Off Warehouse Creek X		21 May	21	10	0	0	5		0.50
Opposite Sandy Point X		21 May	21	10	0	0	3		0.30
Opposite Bussel Point X		21 May	21	10	0	0	0		
Bussel Point X		21 May	21	10	0	0	47		4.70
Cockrell Creek* X									
(Tim Point) X		21 May	21	25	0	0	1		0.04
Fleet Point X		21 May	21	10	0	2	4		0.40
(Glebe Point is the only active station in the Great Wicomico at present.)									
<u>Coan River</u>									
Bundick ✓		23 Jun							

* Tributary

Table 1 continued

River and Station	Miles From Mouth	Date Coll.	No. Days Exposed	No. Shells	No. Polyyps	No. Podocysts	No. <u>Cyanea Larval Cysts</u>	\bar{x} Polyyps	\bar{x} <u>Cyanea Larval Cysts</u>
<u>Mobjack Bay</u>									
Bay Shore Point (off East River)		6 Feb 25 Jun	139	10	0	0	0		
<u>Ware River</u>									
Wilson Creek*		24 Feb 8 May 22 May 10 Jun 25 Jun	69 14 19 15	25 25 25 25	0 0 0 0	0 21 0 0	0 58 8 0		2.32 0.32
<u>Poquoson River</u>									
Below Patricks Creek		6 Feb 1 May 23 May 12 Jun 27 Jun	83 22 19 15	25 25 25 25	0 0 0 1142	0 0 0 0	0 4 0 0	45.68	0.16
<u>Back River</u>									
SW Branch, Opposite Willoughby Point		11 Feb 1 May 23 May 27 Jun	79 22 34	25 25 10	0 0 0	0 0 0	1 4 0		0.04 0.16
<u>Chesapeake Bay</u>									
Tue Marsh		6 Feb 2 May 16 May 28 May 12 Jun 25 Jun	85 14 12 15 13	25 25 25 25 25	0 0 0 0 0	0 0 0 0 0	2 43 0 0 0		0.08 1.72

* Tributary

Table 1 continued

River and Station	Miles From Mouth	Date Coll.	No. Days Exposed	No. Shells	No. Polyyps	No. Podocysts	No. <u>Cyanea Larval Cysts</u>	\bar{x} Polyyps	\bar{x} <u>Cyanea Larval Cysts</u>
York Spit, Near Buoy R18		11 Feb							
		2 May	80	25	0	0	3		0.12
		(Station discontinued)							
York Spit, Near Buoy R10		11 Feb							
		12 May	90	25	0	0	0		
		30 Jun	49	10	0	0	0		
Off Back River, Beacon N4		6 Feb							
		1 May	84	25	0	0	0		
		23 May	22	25	0	0	4		0.16
		27 Jun	34	10	0	24	0		
Fort Wool		8 Apr							
		20 Jun	73	10	0	0	0		
<u>Eastern Shore</u> Bayside Messongo Creek		4 Mar							
		7 May	74	25	0	0	0		
		2 Jun	26	25	0	0	12		0.48
		24 Jun	22	25	5	0	24	0.20	0.96
Nandua Creek		4 Mar							
		7 May	74	25	3	0	27	0.12	1.08
		2 Jun	26	25	0	4	66		2.64
		24 Jun	22	25	0	0	0		

Table 1 continued

River and Station	Miles From Mouth	Date Coll.	No. Days Exposed	No. Shells	No. Polyps	No. Podocysts	No. <u>Cyanea Larval Cysts</u>	\bar{x} Polyps	\bar{x} <u>Cyanea Larval Cysts</u>
Kings Creek ✓		4 Mar							
		7 May	74	25	0	0	0		
		2 Jun	25	Lost					
		24 Jun	22	25	6	0	2	0.24	0.08
Seaside Cedar Island X		10 May							
		24 Jun	45	10	0	0	2 (?)		
Custis Creek X		11 Mar							
		7 May	67	25	0	1**	1		
		3 Jun	27	25	0	0	1		0.04
		24 Jun	21						
Wachapreague Inlet Tower X		11 Mar							
		7 May	67	25	0	0	2		0.08
		2 Jun	26	25	0	0	2		0.08
		(Station discontinued)							
Wachapreague ✓		11 Mar							
		24 Jun	67	10	0	0	1 (?)		

** 14 other large convex "cysts" found.

Table 2

Temperature and Salinity at Shellbag Stations,
Spring 1969

Station	Date	Temperature °C	Salinity o/oo
<u>James River</u>			
Deep Water Shoal	28 Feb	5.5	7.54
	15 May	19.0	7.8
	3 Jul	28.8	5.46
Warwick River	2 Jul	29.5	11.99
Deep Creek	14 Feb	1.1	10.44
	9 May	21.2	14.82
	22 May	20.8	14.22
	19 Jun	26.0	10.79
	2 Jul	30.0	11.84
Wreck Shoal	28 Feb	5.5	14.88
	15 May	18.5	16.23
	19 Jun	24.8	12.58
	2 Jul	29.0	15.02
Brown Shoal I	28 Feb	4.5	18.28
	15 May	17.9	20.58
	2 Jul	28.9	19.56
Nansemond River (Opposite Newman's Pt.)	28 Feb	5.0	12.10
	6 May	20.8	17.15
	20 Jun	25.5	17.16
	2 Jul	28.9	18.97
Nansemond Ridge	28 Feb	4.5	11.83
	6 May	-	18.75
	20 Jun	24.2	18.61
	3 Jul	28.2	19.92
Hampton Flats	28 Feb	4.7	17.54
	6 May	-	21.98
	20 Jun	24.2	21.48
	2 Jul	27.8	22.50
Hampton River	28 Feb	5.8	19.77
	6 May	20.8	21.66
	2 Jul	28.1	20.13

Table 2 continued

Station	Date	Temperature °C	Salinity o/oo
<u>York River</u>			
Bell Rock	12 Feb	4.5	12.99
	5 May	19.2	13.01
	13 Jun	-	-
	26 Jun	25.1	13.38
Roane Point	12 Feb	4.5	13.76
	5 May	19.5	14.96
	13 Jun	26.8	14.94
	26 Jun	25.1	14.14
Opposite Purtan Bay	26 Jun	25.8	14.99
Off Carter Creek	12 Feb	4.3	16.87
	5 May	20.8	18.65
	26 Jun	25.5	16.42
Pages Rock	12 Feb	4.8	18.01
	5 May	19.8	20.30
	13 Jun	24.8	20.22
	26 Jun	24.1	20.11
Off King Creek	12 Feb	-	18.48
	12 May	16.5	20.15
Gloucester Point	11 Feb	4.5	19.93
	12 May	17.4	21.41
	28 May	-	21.06
	12 Jun	-	-
	25 Jun	25.6	23.0
Sarah Creek	11 Feb	6.6	19.72
	2 May	16.5	20.23
	16 May	20.0	21.38
	28 May	22.8	21.59
	25 Jun	29.6	20.99
<u>Piankatank River</u>			
Dixie	13 Feb	3.8	14.77
	30 Apr	17.0	15.73
	19 May	20.8	17.78
	23 Jun	25.0	18.18
<u>Rappahannock River</u>			
Bowlers Rock	1 Jul	-	17.51

Table 2 continued

Station	Date	Temperature °C	Salinity o/oo
Opposite Smoky Point	14 May	-	15.56
	17 Jun	24.1	15.25
	1 Jul	28.4	15.63
Robinson Creek	25 Feb	4.8	14.32
	8 May	20.5	16.33
	22 May	22.2	17.20
	18 Jun	24.8	16.51
	1 Jul	29.1	17.08
<u>Corrotoman River</u>			
West Point	25 Feb	4.0	15.55
	9 May	20.2	16.71
	22 May	21.0	16.44
	17 Jun	25.9	17.20
	1 Jul	30.1	17.58
Corrotoman Point	25 Feb	3.8	16.10
	14 May	18.2	17.44
	17 Jun	23.5	17.71
	1 Jul	29.0	17.61
Millenbeck	25 Feb	3.8	16.49
	14 May	18.0	17.43
	17 Jun	24.4	17.59
	1 Jul	28.6	17.51
Grinels	6 Mar	-	16.74
	14 May	17.5	18.16
	18 Jun	24.0	18.00
Beacon 7	14 May	17.5	18.23
	18 Jun	23.8	18.21
	1 Jul	27.5	19.11
Broad Creek	6 Mar	4.0	16.50
	14 May	18.0	18.51
	18 Jun	24.0	18.61
	1 Jul	27.8	19.08
<u>Great Wicomico River</u>			
Public Landing Route 707	30 Apr	18.4	13.99
	19 May	22.3	13.89
Above Blackwell Creek	30 Apr	-	15.38
	19 May	21.8	15.09

Table 2 continued

Station	Date	Temperature °C	Salinity o/oo
Below Cooper's Landing	30 Apr	-	15.88
	19 May	21.4	16.06
Glebe Point	22 Apr		15.68
	19 May	21.2	16.83
	23 Jun	25.2	16.76
Off Barrett Creek	30 Apr	-	17.19
	19 May	21.0	17.11
Rogue Point	30 Apr	17.2	17.40
	19 May	20.5	17.40
Off Warehouse Creek	30 Apr	-	17.68
	21 May	21.5	17.39
Opposite Sandy Point	30 Apr	-	17.38
	21 May	21.1	17.90
Opposite Bussel Point	21 Apr	15.2	17.78
	21 May	22.0	17.95
Bussel Point	30 Apr	-	17.22
	21 May	20.8	17.92
Cockrell Creek (Tim Point)	22 Apr	15.2	17.55
	21 May	22.8	17.55
<u>Goan River</u>			
Bundick	23 Jun	25.0	14.49
<u>Mobjack Bay</u>			
Bay Shore Point	6 Feb	4.5	20.94
	25 Jun	26.0	22.08
<u>Ware River</u>			
Wilson Creek	24 Feb	5.0	18.22
	8 May	22.8	19.62
	22 May	22.2	19.75
	10 Jun	24.5	21.12
	25 Jun	27.1	20.80

Table 2 continued

Station	Date	Temperature °C	Salinity o/oo
<u>Poquoson River</u>			
Below Patricks Creek	6 Feb	6.2	18.58
	1 May	17.8	21.35
	23 May	21.7	22.48
	12 Jun	26.0	23.03
	27 Jun	28.1	22.41
<u>Back River</u>			
SW Branch, Opposite Willoughby Point	11 Feb	4.5	16.76
	1 May	16.8	20.63
	23 May	21.5	22.27
	27 Jun	27.2	21.44
<u>Chesapeake Bay</u>			
Tue Marsh	6 Feb	4.5	21.60
	2 May	15.2	21.79
	16 May	17.8	22.60
	28 May	20.8	21.64
	12 Jun	24.0	22.54
	25 Jun	25.9	21.86
York Spit, Near Buoy R18	11 Feb	-	-
	2 May	14.8	21.76
York Spit, Near Buoy R10	11 Feb	-	21.94
	12 May	16.6	24.17
	30 Jun	26.0	23.14
Off Back River, Beacon N4	6 Feb	3.8	20.79
	1 May	15.8	21.68
	23 May	20.0	23.04
	27 Jun	26.1	23.13
Fort Wool	8 Apr	-	-
	20 Jun	23.5	22.64
<u>Eastern Shore</u>			
<u>Bayside</u>			
Messongo Creek	4 Mar	4.8	17.93
	7 May	19.8	17.97
	2 Jun	-	-
	24 Jun	30.7	20.70

Table 2 continued

Station	Date	Temperature °C	Salinity o/oo
Nandua Creek	4 Mar	6.0	16.26
	7 May	20.2	20.77
	2 Jun	-	-
	24 Jun	28.8	22.41
Kings Creek	4 Mar	6.0	20.62
	7 May	18.8	24.13
	2 Jun	-	-
	24 Jun	29.1	24.57
Seaside			
Cedar Island	10 May	-	-
	24 Jun	23.8	32.55
Custis Creek	11 Mar	-	-
	7 May	19.6	32.82
	2 Jun	-	-
	24 Jun	24.9	32.77
Wachapreague Inlet Tower	11 Mar	-	-
	7 May	19.2	32.82
	2 Jun	-	-
Wachapreague	11 Mar	-	-
	24 Jun	27.0	33.94

Table 3

Percent Distribution of Mouth Shapes in Polyps Examined During Spring of 1969

Station	Source	Date Collected	No. Examined	Cruciform		Mouth Shape Not Round		Round	
				No.	%	No.	%	No.	%
<u>York River</u>									
Sarah Creek	B	21 Apr	6	1	16.67	5	83.33	0	
	S	25 Jun	1	0		0		1	100.00
<u>Piankatank River</u>									
Dixie	S	23 Jun	30	0		9	30.00	21	70.00
<u>Great Wicomico River</u>									
Glebe Point	B	22 Apr	34	4	11.76	29	85.29	1	2.94
	S	23 Jun	37	10	27.03	20	54.05	7	18.92
Haynie Point	B	22 Apr	37	3	8.11	31	83.78	1	2.70
<u>Poquoson River</u>									
Below Patricks Creek	S	27 Jun	30	8	26.67	18	60.00	4	13.33
<u>Chesapeake Bay</u>									
York Spit Light	B	25 Apr	11	5	45.45	6	54.54	0	
<u>Eastern Shore</u>									
Messongo Creek	S	24 Jun	4	0		2	50.00	2	50.00
Kings Creek	S	24 Jun	6	0		3	50.00	3	50.00

B = On shells from bottom sample.

S = On shells from wire bags.

Table 4

Number of Polyps and Cysts on Shells from Bottom Samples, April 1969

Station	No. Shells	No. Polyps	No. Podocysts	No. Larval Cysts	\bar{x} Polyps & Podocysts
<u>York River</u>					
Goff Point	50	0	0	0	-
Bell Rock	25	0	0	0	-
Sarah Creek	50	6	35	0	0.82
<u>Great Wicomico River</u>					
Glebe Point	25	452	1101	0	62.12
Haynie Point	50	162	220	0	7.64
<u>Chesapeake Bay</u>					
York Spit Light	2	11	13	183	12.00

~~water depth of about 1/2 m~~
 (Counts were made to a water depth of about 1/2 m; therefore, volume of water on which counts were made equals $194 \times 0.5 = 397 \text{ m}^3$)

Table 5

Medusae Counts at VIMS Pier, Gloucester Point,

April Through June 1969

(~~285 ft~~ long x 50 ft. wide, twice - counted on both sides)

Date	<u>Chrysaora</u>		<u>Aurelia</u>		<u>Cyanea</u>	
	No.	Size*	No.	Size	No.	Size
April 1					0	
2					0	
3		No <u>Chrysaora</u> or <u>Aurelia</u>			0	
4		medusae seen before			-	
5		6 June.			-	
6					-	
7					1	2
8					0	
9					0	
10					-	
11					41	1-5 (2)
12					-	
13					-	
14					-	
15					0	
16					-	
17					-	
18					-	
19					-	
20					-	
21					2	2
22					0	
23					26	1-4 (2.5)
24					21	1-3 (2.5)
25					108	1-5 (1.5)
26					-	
27					-	
28					3	1-3
29					1	3
30					17	1-3 (2)
May 1					52	1-3 (2)
2					13	1-3 (2)
3					-	
4					-	
5					6	1-3 (2)
6					1	1
7					0	
8					0	
9					0	

* Mode in parentheses.

Table 5 continued

Date	<u>Chrysaora</u>		<u>Aurelia</u>		<u>Cyanea</u>	
	No.	Size*	No.	Size	No.	Size
May 10					-	
11					-	
12					12	1-5 (3)
13					103	1-5 (2.5)
14					29	1-3 (2.5)
15					0	
16					3	1-3
17					-	
18					-	
19					-	
20					0	
21					1	2
22					0	
23					2	2
24						
25						
26					0	
27					6	1-3
28					0	
29					6	
30					9	
31					-	
June 1					-	
2					0	
3					0	
4					0	
5					2	1-2
6	5	0.5-1.5	0		15**	
7	-		-		-	
8	-		-			
9	0		0			
10	0		0			
11	0		0			
12	0		0			
13	0		0			
14	-		-			
15	-		-			
16	-		-			
17	0		0			
18	0		0			
19	0		0			
20	2	2-5	1	3.5		
21	-		-			
22	-		-			
23	0		0			
24	1	4	0			

No Cyanea medusae
seen after 6 June.

** Appeared sickly or dead.

Table 5 continued

Date	<u>Chrysaora</u>		<u>Aurelia</u>		<u>Cyanea</u>	
	No.	Size*	No.	Size	No.	Size
June 25	0		0			
26	0		0			
27	0		0			
28	-		-			
29	-		-			
30	0		2	0.5-1		

Table 6

in *April Report also*

Medusae Counts at VIMS Shellbag Stations in Lower Chesapeake Bay, Spring 1969
(Number observed from moving boat in area 1000' long by 10' wide)

Station	Date	<u>Chrysaora</u>		<u>Aurelia</u>		<u>Cyanea</u>	
		No.	Size**	No.	Size	No.	Size
<u>James River</u>							
Deep Water Shoal	8 Apr	0		0		0	
	15 May	0		0		0	
	3 Jul	0		0		0	
Wreck Shoal	8 Apr	0		0		0	
	15 May	0		0		0	
	19 Jun	1	5	0		0	
Warwick River*	2 Jul	12	1-5	0		0	
Deep Creek*	9 May	0		0		0	
	22 May	0		0		0	
	19 Jun	6		0		0	
Brown Shoal	8 Apr	0		0		0	
	15 May	0		0		0	
	2 Jul	0		0		0	
Nansemond Ridge	8 Apr	0		0		0	
	6 May	0		0		0	
	20 Jun	8	5-6	0		0	
	3 Jul	7	2-5	0		0	
Nansemond River*	6 May	0		0		0	
	20 Jun	2	6	0		0	
	2 Jul	33	1-5 (5)	9	4-5	0	

* Tributary

** Range; mode in parentheses; in inches

Table 6 continued

Station	Date	<u>Chrysaora</u>		<u>Aurelia</u>		<u>Cyanea</u>	
		No.	Size**	No.	Size	No.	Size
Hampton Flats	8 Apr	0		0		0	
	20 Jun	0		0		0	
Hampton River*	6 May	0		0		0	
	2 Jul	2	(4)	0		0	
<u>York River</u>							
Goff Point	23 Apr	0		0		0	
Bell Rock	23 Apr	0		0		0	
	5 May	0		0		0	
	26 Jun	1	6	0		0	
Roane Point	5 May	0		0		0	
	26 Jun	5	5-7	0		0	
Poropotank River	13 Jun	0		0		0	
Opposite Purtan Bay	26 Jun	0		0		0	
Off Carter Creek	5 May	0		0		0	
	26 Jun	4	5-6	0		0	
Carter Creek	13 Jun	17	2-5	0		0	
Pages Rock	5 May	0		0		0	
	26 Jun	0		0		0	
Gloucester Point	12 May	0		0		1	6
	25 Jun	0		1	3	0	
Sarah Creek*	21 Apr	0		0		1	5
	2 May	0		0		3	2-3
	16 May	0		0		0	
	28 May	0		0		0	
	25 Jun	27	1-6 (4.5)	0		0	

* Tributary

Table 6 continued

Station	Date	<u>Chrysaora</u>		<u>Aurelia</u>		<u>Cyanea</u>	
		No.	Size**	No.	Size	No.	Size
<u>Piankatank River</u>							
Dixie**	17 Apr	0		0		350	2-5
	19 May	55	(1)	0		210	1.5-4
	23 Jun	84	0.5-7 (5)	8	3-6	0	
<u>Rappahannock River</u>							
Bowlers Rock	1 Jul	"many"					
Opposite Smoky Point	14 May	0		0		0	
	17 Jun	5		0		0	
Robinson Creek*	8 May	0		0		0	
	22 May	0		0		0	
	18 Jun	31	-	0		0	
<u>Urbanna Creek*</u>							
Mouth, Public Landing	14 May	0		0		610	1-5
	17 Jun	12	5-6	0		0	
<u>Corrotoman River*</u>							
West Point	9 May	0		0		9	-
	22 May	27	1-4	0		7	1-3
	17 Jun	30	0.5-6 (2)	0		0	
	1 Jul	283	1-7 (4.5)	1	6	0	
Corrotoman Point	14 May	0	many	0		31	2-4
	17 Jun	45	1-6 small	0		0	
	1 Jul	438	1-8 (5.5)	0		0	
Millenbeck	17 Jun	8	-	0		0	
Grinels	14 May	0		0		420	0.5-5
Beacon 7	18 Jun	122	3-5 (5.5)	0		0	

* Tributary

** Counts made from old ferry pier.

Table 6 continued

Station	Date	<u>Chrysaora</u>		<u>Aurelia</u>		<u>Cyanea</u>	
		No.	Size**	No.	Size	No.	Size
Broad Creek	14 May	0		0		54	0.5-2.5
	18 Jun	8	5-6	0		0	
	1 Jul	27	4-6	1	4	0	
<u>Great Wicomico River</u>							
Below Public Landing	30 Apr	0		0		27	2-6 (5)
	19 May	11	0.5-2.5	0		0	
Below Cooper's Landing	19 May	60	1-4	0		7	4
Glebe Point	21 Apr	0		0		5	2-5
	22 Apr	0		0		0	
	30 Apr	0		0		0	
	19 May	30	1-3	0		0	
	23 Jun	100	4-5	0		0	
Off Warehouse Creek	21 May	97	1-4	0		2	3
Beacon 8	21 May	0		0		2	2
Bussel Point	21 May	0		0		0	
<u>Cockrell Creek*</u>							
Tim Point	21 Apr	0		0		0	
	21 May	0		0		0	
Mouth	21 May	0		0		0	
Fleet Point	21 Apr	0		0		0	
<u>Coan River</u>							
Bundick	23 Jun	8	5-6	0		0	

* Tributary

Table 6 continued

Station	Date	<u>Chrysaora</u>		<u>Aurelia</u>		<u>Cyanea</u>	
		No.	Size**	No.	Size	No.	Size
<u>Eastern Shore</u>							
<u>Bayside</u>							
Messongo Creek	24 Jun	0		0		0	
Nandua Creek	24 Jun	0		0		0	
Kings Creek	24 Jun	6	2-4	0		0	
<u>Seaside</u>							
Wachapreague	24 Jun	0		0		0	
Custis Creek	7 May	0		0		0	
	24 Jun	0		0		0	
Wachapreague Inlet							
Tower	7 May	0		0		0	
Cedar Island	24 Jun	0		0		0	
<u>Back River</u>							
SW Branch, Opposite							
Willoughby Point	7 Apr	0		0		1	-
	1 May	0		0		3	-
	23 May	0		0		0	
	27 Jun	3	5-6	136	1-9 (4.5)	0	
<u>Poquoson River</u>							
Below Patricks Creek	23 May	0		0		0	
	27 Jun	65	1-6	242	2-8 (5)	0	
<u>Ware River</u>							
Wilson Creek*	8 May	0		0		7	2-5
	22 May	0		0		0	
	25 May	45	3-6 (4.5)	170	2-8 (6)	0	
<u>Mobjack Bay</u>							
Bay Shore Point	25 Jun	1	6	1	5	0	

* Tributary

Table 6 continued

Station	Date	<u>Chrysaora</u>		<u>Aurelia</u>		<u>Cyanea</u>	
		No.	Size**	No.	Size	No.	Size
<u>Chesapeake Bay</u>							
Tue Marsh	7 Apr	0		0		0	
	7 May	0		0		0	
	12 May	0		0		27	1.5-6 (4)
	16 May	0		0		0	
	28 May	0		0		0	
	25 Jun	0		0		0	
York Spit, Near Buoy R18	7 Apr	0		0		3	5
	2 May	0		0		0	
York Spit, Near Buoy R10	7 Apr	0		0		2	5-6
	12 May	0		0		0	
	30 Jun	0		0		0	
Fort Wool	8 Apr	0		0		0	

Table 7

Approximate levels of DNA, RNA and Protein in polyps of different stages and sizes. Values are in micrograms per organism.*

<u>Stage</u>	<u>n</u>	<u>DNA</u>	<u>RNA</u>	<u>Protein</u>
Unstrobilated polyp:				
1-2 mm	3	0.5	5.2	27.3
2-3 mm	2	1.2	9.3	18.7
Early strobila:				
1-2 mm	1	0.7	7.2	8.5
2-4 mm	2	1.3	12.9	43.3
Mid-strobila:				
1-2 mm	2	1.2	9.0	17.0
Late strobila:				
2-4 mm	2	0.8	4.7	13.6
Ephyra	4	0.08	0.39	1.90

* The size measurements are only approximate, since the polyps can change the length of the stalk. In addition, it should be noted that strobilation causes a considerable increase in length, and that occasionally terminal ephyrae are lost from the late strobilae during transfer.

Table 8

Levels of oxygen consumption, total RNA and total protein per mg DNA in polyps of various stages. Standard deviations are given and the number of determinations is given in parentheses after each value.

Stage	O ₂ consumption microliters/hr./ mg DNA	RNA Mg/mg DNA	Protein mg/mg DNA
Unstrobilated polyp	142.0 ± 39.8 (6)	10.1 ± 1.9 (8)	30.5 ± 11.7 (8)
Early strobila	121.2 ± 48.5 (3)	11.0 ± 1.1 (4)	33.8 ± 11.6 (4)
Mid-strobila	141.7 ± 40.1 (4)	7.3 ± 1.7 (5)	18.1 ± 9.0 (5)
Late strobila	144.8 ± 42.5 (3)	7.8 ± 1.1 (4)	21.1 ± 8.2 (4)
Ephyra	160.2 (1)	5.5 ± 1.5 (5)	22.7 ± 10.0 (5)
Polyps after strobilation	---	5.4 ± 1.3 (2)	18.0 ± 10.5 (2)