

WOODS HOLE OCEANOGRAPHIC INSTITUTION

Woods Hole, Massachusetts

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REPORT ON THE BOTTOM SAMPLING AND SELF-  
CONTAINED DIVING SURVEY IN THE NEW YORK  
BIGHT

R/V CARYN cruise 108

October 19, 1956 - October 24, 1956

by

David M. Owen

\* See also 57-19  
Supplement

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APPROVED FOR DISTRIBUTION

*Bostwick H. Ketchum*

Bostwick H. Ketchum, Senior  
Oceanographer

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I

DESCRIPTION OF THE PROBLEM AND QUALIFIED CONCLUSIONS

During the period 19-24 October, 1956, the W.H.O.I. Research Vessel CARYN was employed by the National Lead Company of New York to make a self-contained diving and bottom sampling survey in their present industrial waste disposal area in the New York Bight.

The present dumping area, defined below and on the attached chart (Plate 1), has been used continuously for nearly seven years, though dumping commenced on the original site in April 1948. The waste, consisting of approximately ten percent ferrous sulfate ( $\text{FeSO}_4$ ) and 8.5 percent sulfuric acid ( $\text{H}_2\text{SO}_4$ ) dissolved in fresh water, originates at the titanium plant of the National Lead Company at Sayreville, New Jersey. The disposal barge carries 3,200 tons of the waste, and when operating on full schedule discharges one load every fifteen hours in the designated area.

A study of the local effects of the discharge of this waste in the New York Bight (original dumping site), sponsored by the National Research Council and financed by the National Lead Company, was described by Redfield and Walford (1951). The rate of dilution caused by the turbulence of the passage of the barge and by the normal turbulence of the sea was established by Ketchum and Ford (1952).

In the summer of 1956 the National Lead Company engaged the W.H.O.I. to make a skindiving and bottom sampling survey of present conditions in the dumping area used since January 1950. The object of the survey, as outlined by the National Lead Company, was to determine (1) the extent of iron deposits, if any, on the ocean floor which may have resulted from disposal operations over the past seven years, and (2) the effect, if any, of the disposal operations upon marine life - especially vegetation - in the area.

Unfortunately, for purposes of comparison, no determination of the ambient iron content of the ocean floor and extent of marine life and vegetation was made in the present dumping area prior to the beginning of disposal operations in 1950. However, many of the divers' visual observations, particularly of living organisms, may serve to curb the suspicions of the more severe critics in the commercial and sports fishing interests.

The established directions for discharging the Barge "Moran 102" in the New York Bight are:

"Commence discharge in area SOUTH of Latitude  $40^{\circ} 20'$  North and EAST of Longitude  $73^{\circ} 43'$  West. Steer on Southeasterly course until one-half of load has been discharged. When course may be reversed to complete the discharge; return course to be parallel to but not closer than one-half mile to original course. Steam at greatest practical speed during discharge. Under adverse weather conditions, the above course may be altered as required. In any case, complete discharge is to be accomplished SOUTH and EAST of point of origin."

A total of thirty stations was occupied by the R/V CARYN, straddling the dumping area per se. On twenty-three of these stations the "orange peel" dredge sampled the bottom and occasional underwater photographs in color were made with a camera lowered "blind" from the vessel, while on the remaining nine stations four Aqua-Lung divers (David M. Owen, Richard S. Edwards, Robert G. Weeks, and George M. Cresswell) of the Woods Hole Oceanographic Institution made direct observations of the ocean bottom and took occasional underwater color photographs.

The divers descended in pairs (one pair at each station), and remained approximately nine minutes at the bottom on the deeper stations. The divers' first observation, on reaching the bottom of the descending line, was a visibility range measurement - consisting of noting the distance at which a white "Secchi" disk of eight inches diameter disappeared horizontally into the haze. The visual observations, photographs, and samples of the bottom were made generally within a 15-ft. radius of the descending-line

anchor, except at Stations 19-A, 21-B, and 22-A, where the divers drifted free with the CARYN (while holding a weighted line suspended from the vessel overhead). The latter stations were attempts to relocate Stations 19, 21, and 22 respectively, and to determine if the 15-ft. search radius gave a sufficiently representative view of the bottom. On each drifting station the ocean bottom did not change character appreciably during the dive.

The first station was made approximately  $3\frac{1}{2}$  miles south of Jones Inlet, Long Island, well off the dumping area, and the succeeding observations were taken in a southerly direction - approaching and intersecting the lines of dumping at a right angle. By this approach the divers were given the opportunity of perfecting their techniques before reaching the more "critical" area, while at the same time a possible change in the bottom at the dumping site might be more easily detected.

The observations extended beyond the dumping area - across the original site used in 1948 (where analyses for iron content of the ocean bottom exist from previous surveys in March and May 1948) and toward the New Jersey shore. In addition, Plate 1 plots the line of stations made in the dumping area at right angles to the first approach, or supposedly following the line of actual disposal by the barge. The length of this section was based upon the knowledge that the barge released its waste on a southeasterly course for a distance of five or six miles before returning on a parallel course. Of course the vagaries of weather could easily result in the disposal of the waste anywhere within the limits drawn on Plate 1.

It will be noted from the detailed observations following that generally throughout the entire survey the ocean bottom consisted of fine to medium-grained sand, with color tints varying from brown to green to gray. Greenish-gray sand predominated in the observations within the dumping area

limits; a dark or greenish ooze occurred in the samples on Stations 19,21 (see Figure 8), and 22 - all on the theoretical line of disposal. At present no special significance is attached to this observation.

Since the results of the chemical analyses of the bottom sediments for this cruise are not yet available, they will be incorporated later as an appendix. The diver primarily responsible for the descriptions of the sediments collected was geologist George M. Cresswell, while shore-based chemist Nathaniel Corwin of W.H.O.I. is performing the analyses for iron content.

The divers' visual observations, perhaps of limited value when dealing with a possible microscopic or negligible residue from the disposal operations, suggest nothing detrimental in the present dumping procedure. From the biological viewpoint, the divers observed a school of approximately twenty young scup on the bottom at Station 13, the very middle of the disposal area (see Figure 2), and nearby Station 15 also produced many subjects for underwater photography. Life of some sort was noted at nearly all stations. Maximum underwater visibility, nearly 40 feet, was observed at Station 15.

It will interest some readers to know the time interval between the observations made at each station, and the last visit of the disposal barge to its designated area. The following table presents the discharge time of the Barge "Moran 102" during the period in which the R/V CARYN was conducting the investigation. The computed interval will be found with the notes of each station, regardless of location.

<u>Date</u>	<u>Trip#</u>	<u>Dumping Time</u>	
		<u>Start</u>	<u>Finish</u>
10-19-56	4456	5:05PM	6:30PM
10-20-56	4457	7:00AM	8:25AM
10-20-56	4458	9:45PM	11:10PM
10-21-56	4458	12:30PM	1:55PM
10-22-56	4460	2:30AM	3:55AM
10-22-56	4461	4:20PM	5:50PM
10-23-56	4462	6:30AM	7:55AM
10-23-56	4463	9:20PM	10:45PM
10-24-56	4464	5:55PM	7:20PM

References

Buller, R.J., and H.S. Spear (1950)

"A Survey of the Sport Fishery of the Middle Atlantic Bight  
in 1948"

Special Scientific Report Fisheries No. 7, Fish &  
Wildlife Service, U.S. Dept. of the Interior

Arnold, E.L., Jr. and Wm. F. Royce (1950)

"Observations of the Effect of Acid-iron Waste Disposal at  
Sea on Animal Populations"

Special Scientific Report Fisheries No. 11, Fish &  
Wildlife Service, U.S. Dept. of the Interior.

Redfield, A.C., and L.A. Walford (1951)

"A Study of the Disposal of Chemical Waste at Sea"  
N.R.C. - N.A.S. Publ. 201, 49 pp.

Ketchum, B.H., Redfield, A.C., and J.C. Ayers (1951)

"The Oceanography of the New York Bight"

Papers in Physical Oceanography and Meteorology, Published  
by Mass. Inst. of Technology and W.H.O.I., Vol. 12, No. 1,  
46 pp.

Ketchum, B.H., and W.L. Ford (1952)

"Rate of Dispersion in the Wake of a Barge at Sea"

Transactions of Amer. Geophysical Union, Vol. 33, No. 5, 5 pp.

II

DETAILED OBSERVATIONS FOR EACH STATION

STATION 1

Date: 20 October 1956  
Position: 40° - 32' N 73° - 35.9' W

OBSERVATIONS FROM SHIP:

- 1) Time - 0830
- 2) Sea surface - moderate swell, scattered whitecaps
- 3) Secchi transparency reading - 11 feet
- 4) Depth - 50 feet
- 5) Bottom sample - Phleger corer unsuccessful in four tries; "orange peel" recovered good sample on third try. Sediment was dark gray, fine to medium-grained sand.

OBSERVATIONS BY DIVERS

- 1) Time - 0940 (1 hr. 15 min. after last discharge)
- 2) Depth - 68 feet
- 3) Visibility - 5 feet Secchi (horizontal on bottom)
- 4) Bottom description - dark gray, fine to medium-grained, well-compacted sand. Common shell fragments up to 4mm in size on surface. Hummocks up to 6 inches high, 4 feet long, and 1 foot wide are spaced irregularly on bottom. Hummocks are formed by phoronid worm tubes. Ripples  $\frac{1}{2}$  inch high and 4 inches long poorly developed on sand between hummocks. No evidence of surficial bottom deposit. No direct evidence of plant or animal life other than hummocks, and  $\frac{1}{2}$  inch shrimp-like arthropods in sand sample. Sample taken of surface layer of hummocks and sand between them.
- 5) Underwater color photos - #1, #2, #5, #6
- 6) Aqua-Lung divers' names - Owen & Cresswell

STATION 2

Date: 20 October 1956  
Position: 40° - 30.5' N 73° - 35.6' W

OBSERVATIONS FROM SHIP:

- 1) Time - 1045 (2 hr. 20 min. after last discharge)
- 2) Depth - 73 feet
- 3) Bottom sample - "orange peel" sample of dark gray, fine to medium-grained sand containing some worms and shrimp-like arthropods; sample also contained black, fine-grained,

STATION 2 (Continued)

OBSERVATIONS FROM SHIP:

- 3) soft material which smelled very slightly foul.

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS

STATION 3

Date: 20 October 1956

Position: 40° - 28.9' N 73° - 35.9' W

OBSERVATIONS FROM SHIP:

- 1) Time - 1200
- 2) Secchi transparency reading - 23 feet
- 3) Depth - 80 feet

OBSERVATIONS BY DIVERS:

- 1) Time - 1155 (3 hr. 35 min. after last discharge)
- 2) Depth - 80 feet
- 3) Visibility - 15 feet Secchi (horizontal on bottom)
- 4) Bottom description - gray, fine to medium-grained sand, with hummocks composed of phoronid worm tubes. Sand layer - with ripples - thin between hummocks, sometimes exposing underlying gray, stiff clay. Several Skate-egg cases, one 4 inch fish, two skates, several crabs sighted. Tiny gastropods, along with shell fragments, contained in bottom sample.
- 5) Underwater color photos - #9 through #12, #14 through #18 (see Figure 1)
- 6) Aqua-Lung divers' names - Edwards & Weeks

STATION 4

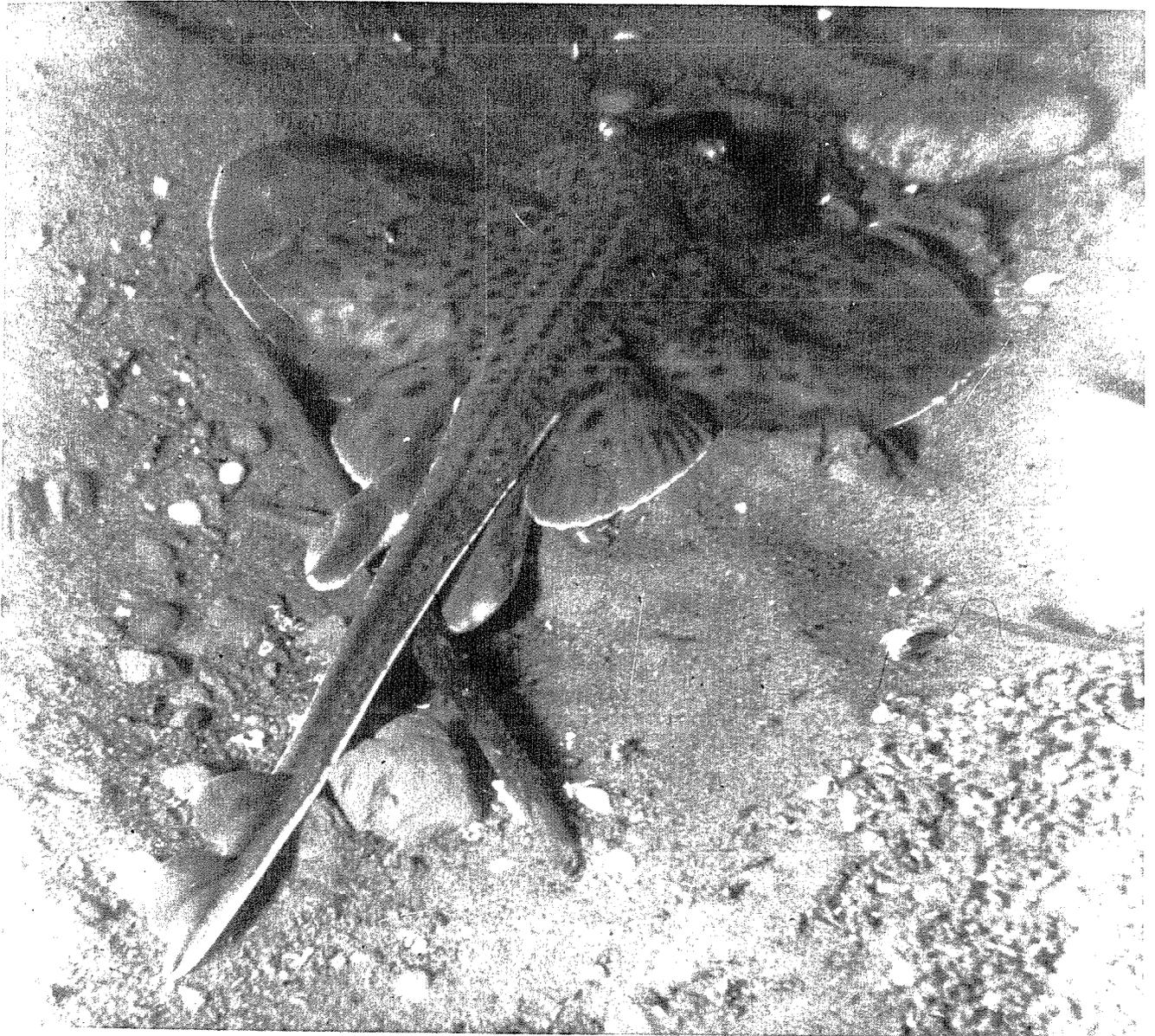
Date: 20 October 1956

Position: 40° - 27.2' N 73° - 35.9' W

OBSERVATIONS FROM SHIP:

- 1) Time - 1230 (4 hr. 5 min. after last discharge)
- 2) Depth - 70 feet
- 3) Bottom sample - "orange peel" sample of light, gray-brown, medium to coarse-grained sand, granules, and fine pebbles. Coarser grains slightly iron-stained and well-rounded. No animals or shell fragments.
- 4) Underwater color photos - #19, #20

NO OBSERVATIONS BY DIVERS



FROM COLOR SLIDE NO. 9, STATION 3

DEPTH: 80 FEET

SKATE ON SANDY BOTTOM.

FIG. 1

STATION 5

Date: 20 October 1956

Position: 40° - 25.8'N 73° - 36.4'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1415 (5 hr. 50 min. after last discharge)
- 2) Depth - 70 feet
- 3) Bottom sample - "orange peel" sample of gray-brown, medium to coarse-grained sand with many granules, common shell fragments, and few small worms  $\frac{1}{4}$  inch long.
- 4) Underwater color photos - #21, #22

NO OBSERVATIONS BY DIVERS

STATION 6

Date: 20 October 1956

Position: 40° - 24.4'N 73° - 37'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1435 to 1450 (6hr. 10 min. after last discharge)
- 2) Depth - 66 feet
- 3) Bottom sample - no bottom sample taken in five passes with "orange peel"; only one small piece of cinder recovered. (see descriptions of color slides)
- 4) Underwater color photos - #23, #24

NO OBSERVATIONS BY DIVERS

STATION 7

Date: 20 October 1956

Position: 40° - 22.9'N 73° - 37.1'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1530 (7 hr. 5 min. after last discharge)
- 2) Depth - 72 feet
- 3) Bottom sample - "orange peel" sample of medium to coarse-grained light brown sand with abundant granules and some fine pebbles. Abundant shell fragments. Living and dead 1 inch sand dollars, living worms.
- 4) Underwater color photos - #25

NO OBSERVATIONS BY DIVERS

STATION 8

Date: 20 October 1956

Position: 40° - 21.3'N 73° - 37.3'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1600 (7 hr. 35 min. after last discharge)
- 2) Depth - 75 feet
- 3) Bottom sample - "orange peel" sample of fine to medium-grained light brown-gray sand. Some granules and shell fragments. Few  $\frac{1}{2}$  inch diameter dark gray spots - reducing material?

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS

STATION 9

Date: 20 October 1956

Position: 40° - 20.2'N 73° - 37.9'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1620 (7 hr. 55 min. after last discharge)
- 2) Depth - 76 feet
- 3) Bottom sample - "orange peel" sample of medium-grained, brown-gray sand, with abundant shell fragments of sand dollars and small clams, and living worms.

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS

STATION 10

Date: 20 October 1956

Position: 40° - 19.8'N 73° - 38.3'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1715 (8 hr. 50 min. after last discharge)
- 2) Depth - 76 feet
- 3) Bottom sample - "orange peel" sample of medium to fine-grained, light brownish-gray sand, with many shell fragments

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS

STATION 11

Date: 21 October 1956

Position: 40° - 19.0' N 73° - 39.2' W

OBSERVATIONS FROM SHIP:

- 1) Time - 0930 (10 hr. 20 min. after last discharge)
- 2) Sea surface - low swell, no whitecaps, wind gentle N.E.
- 3) Depth - 91 feet

OBSERVATIONS BY DIVERS:

- 1) Time - 0930
- 2) Depth - 91 feet
- 3) Visibility - 16 feet Secchi (horizontal on bottom)
- 4) Bottom description - fine to medium-grained, green-gray sand with some granules and shell fragments. Hummocks of phoronid worm tubes up to 10 inches high, 1  $\frac{1}{2}$  feet wide, and 6 feet long. Sand contains small flatworms and  $\frac{1}{2}$  inch shrimp-like arthropods; ripples to 1  $\frac{1}{2}$  inches high, about 1 to 2 feet long. Small starfish common. Worm tubes about  $\frac{1}{4}$  inch inside diameter, with common shell fragments and stringy material in wall.
- 5) No photographs
- 6) Divers' names - Owen & Cresswell

STATION 12

Date: 20 October 1956

Position: 40° - 18.3' N 73° - 39.7' W

OBSERVATIONS FROM SHIP:

- 1) Time - 1740 (9 hr. 15 min. after last discharge)
- 2) Depth - 76 feet
- 3) Bottom sample - "orange peel" sample of medium-grained, brownish-gray sand, with abundant shell fragments.

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS

STATION 13

Date: 21 October 1956

Position: 40° - 17.9' N 73° - 40.5' W

OBSERVATIONS FROM SHIP:

- 1) Time - 1030
- 2) Sea surface - low swell, no whitecaps, wind gentle N.E.
- 3) Secchi transparency reading - 32 feet
- 4) Depth - 93 feet
- 5) Bathythermograph lowering - 60 degrees F isothermal

STATION 13 (Continued)

OBSERVATIONS BY DIVERS:

- 1) Time - 1030 (11 hr. 20 min. after last discharge)
- 2) Depth - 93 feet
- 3) Visibility - 20 feet Secchi (horizontal on bottom)
- 4) Bottom description - medium to fine-grained, green-gray sand. Hummocks like Station 11, starfish, and small  $\frac{1}{2}$  inch hermit crabs common. School of approximately twenty young 4 to 5 inch scup sighted (see Figure 2)
- 5) Underwater color photos - #26, #27, #28
- 6) Aqua-Lung divers' names - Edwards & Weeks

STATION 14

Date: 20 October 1956

Position: 40° - 17.8'N

73° - 41.2'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1805 (9 hr, 40 min. after last discharge)
- 2) Depth - 83 feet
- 3) Bottom sample - "orange peel" sample of silty, fine-grained well-compacted light brown sand, with common shell fragments and  $\frac{1}{2}$  inch shrimp-like arthropods.

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS

STATION 15

Date: 21 October 1956

Position: 40° - 16.9'N

73° - 41.8'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1115
- 2) Sea surface - low swell, no whitecaps, wind gentle N.E.
- 3) Depth - 97 feet
- 4) Bottom sample - "orange peel" sample of fine to medium-grained, green-gray sand with some shell fragments. Same as divers' sample.



FROM COLOR SLIDE NO. 27, STATION 13                      DEPTH: 93 FEET  
(CENTER OF DUMPING AREA)

THREE SCUP , SANDY BOTTOM , SCATTERED  
PHORONID WORM TUBES.

FIG. 2

STATION 15 (Continued)

OBSERVATIONS BY DIVERS:

- 1) Time - 1115 (12 hr. 5 min. after last discharge)
- 2) Depth - 97 feet
- 3) Visibility - at least 38 feet Secchi (horizontal on bottom)
- 4) Bottom description - sand as described above, with hummocks composed of phoronid worm tubes distributed in groups of three to four large hummocks (up to 1 foot high, 3 feet wide, 8 feet long) with many small hummocks (averaging 4 inches high, 6 inches wide, 12 inches long) in between. Digging open hummock 18 inches long revealed mushy inside - much water and little sand. Tubes apparently continue to inside. Ripples 3 inches high and approximately 12 to 15 inches wave-length covered sand between hummocks. Starfish common, up to 4 inches in size. Several active worm borings seen on bottom.
- 5) Underwater color photos - #29 through #32, #34 through #39 (see Figures 3,4,5 and 6)
- 6) Aqua-Lung divers' names - Owen & Cresswell

STATION 16

Date: 20 October 1956

Position: 40° - 16.4'N 73° - 42.5'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1830 (10 hr. 5 min. after last discharge)
- 2) Depth - 88 feet
- 3) Bottom sample - "orange peel" sample of silty, fine-grained, well-compacted, light brown sand with occasional clam shells and small worm tubes. More than 10% of volume is splotchy dark gray - reduced?

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS

STATION 17

Date: 20 October 1956

Position: 40° - 16.0'N 73° - 42.9'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1900 to 1910 (10 hr. 45 min. after last discharge)
- 2) Depth - 92 feet
- 3) Bottom sample - "orange peel" sample of silty, very fine-grained, greenish-gray sand, containing layers of black silt. Phleger corer brought up only black silt - perhaps superficial layer. No plants or animals seen in sample.

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS



FROM COLOR SLIDE NO. 29, STATION 15 .

DEPTH: 97 FEET

CLOSEUP OF SANDY BOTTOM, WITH SMALL CLUMP OF  
PHORONID WORM TUBES, AND STARFISH FEEDING IN  
BLACK QUAHOG SHELL.

FIG. 3



FROM COLOR SLIDE NO. 32, STATION 15

DEPTH: 97 FEET

EXTREME CLOSEUP OF SANDY BOTTOM, WITH DIVER'S  
FINGER POINTING TO SMALL BORING IN SAND.

FIG. 4



FROM COLOR SLIDE NO. 37, STATION 15

DEPTH: 97 FEET

CLOSEUP OF SKATE EGG CASE, ON SANDY BOTTOM  
WITH RIPPLES, FEW WORM TUBES.

FIG. 5



FROM COLOR SLIDE NO.39 , STATION 15

DEPTH: 97 FEET

SAND, RIPPLES , DIVER'S HAND NEAR CLUMP OF PHORONID  
WORM TUBES. NOTE SECOND CLUMP NEARBY.

FIG. 6

STATION 18

Date: 20 October 1956

Position: 40° - 16.1' N 73° - 44.6' W

OBSERVATIONS FROM SHIP:

- 1) Time - 1935 (11 hr. 10 min. after last discharge)
- 2) Depth - 105 feet
- 3) Bottom sample - "orange peel" sample of medium-grained, gray-green sand with some sand dollar fragments.

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS

STATION 19

Date: 21 October 1956

Position: 40° - 19.3' N 73° - 42.1' W

OBSERVATIONS FROM SHIP:

- 1) Time - 1230
- 2) Secchi transparency reading - 26 feet
- 3) Depth - 86 feet
- 4) Bottom sample - "orange peel" sample of medium to fine-grained, green-gray sand with shell fragments, flat-worms,  $\frac{1}{2}$  inch sand dollars and clams. Some dark splotches of dark ooze in the sand.

OBSERVATIONS BY DIVERS:

- 1) Time - 1225 (13 hr. 20 min. after last discharge)
- 2) Depth - 86 feet
- 3) Visibility - 5 feet Secchi (horizontal on bottom)
- 4) Bottom description - sand as described above, with hummocks of phoronid worm tubes, and ripples. Black ooze exposed in ripple troughs as irregular areas, apparently covered by sand. No odor to ooze;  $\frac{1}{2}$  inch sized clams living in it.
- 5) Underwater color photos - #40 through #43 (see Figure 7)
- 6) Aqua-Lung divers' names - Edwards & Weeks

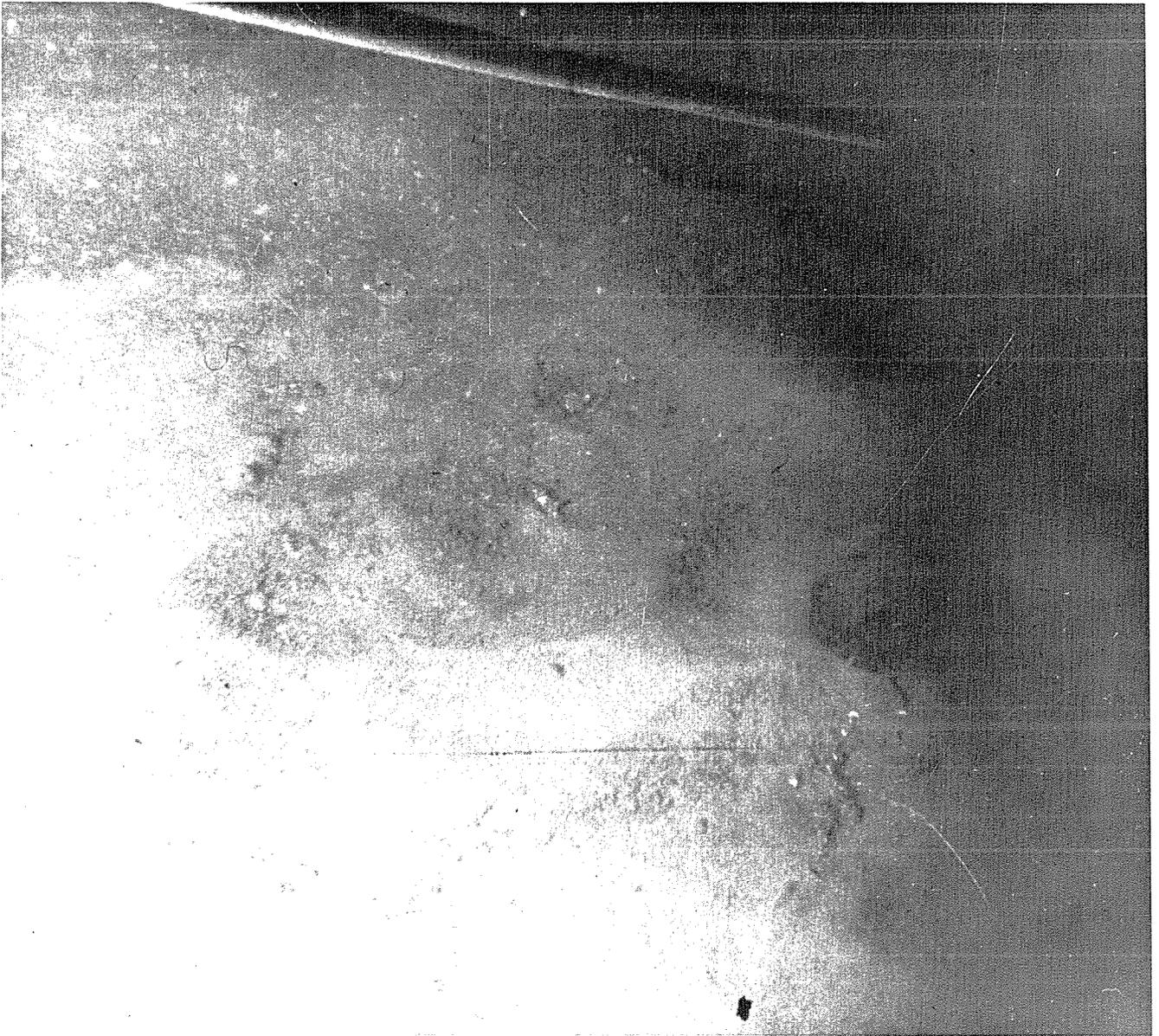
STATION 19 -A

Date: 23 October 1956

Position: 40° - 19.4' N 73° - 42.3' W

DRIFT

40° - 19.3' 73° - 43.2'



FROM COLOR SLIDE NO. 43, STATION 19

DEPTH: 86 FEET

SAND AND RIPPLES.

FIG. 7

STATION 19 - A (Continued)

OBSERVATIONS FROM SHIP:

- 1) Time - 1115
- 2) Sky - overcast, with no direct sunlight
- 3) Depth - 95 feet
- 4) Bottom sample - "orange peel" sample of medium to fine-grained, green-gray sand with shell fragments and small arthropods.

OBSERVATIONS BY DIVERS:

- 1) Time - 1115 (3hr. 20 min. after last discharge)
- 2) Depth - 95 feet
- 3) Visibility - 5 feet Secchi (horizontal on bottom)
- 4) Bottom description - sandy bottom with irregular ripples of about 5 inches wave length and 1 inch height. Many starfish up to 5 inches across. Small (4 to 6 inch) hummocks at crests and junctions of ripples; larger hummocks covered with tubes occurred occasionally (up to 15 inches high, 2  $\frac{1}{2}$  feet wide, and about 6 to 8 feet long). One Polynices seen. Total distance covered, drifting with CARYN, was approximately 800 feet (eight minutes on bottom at 1 knot drift).
- 5) No underwater photographs
- 6) Divers' names - Owen & Cresswell

STATION 20

Date: 21 October 1956

Position: 40°-18.6' N 73° - 41.0' W

OBSERVATIONS FROM SHIP:

- 1) Time - 1340 (simultaneous with discharge, though not in immediate vicinity)
- 2) Depth - 89 feet
- 3) Bottom sample - "orange peel" sample of medium to fine-grained, green-gray sand. Some splotches of black sand, no ooze. Small arthropods and worms in sample, also tubes from hummocks.
- 4) Underwater color photos - #44, #45

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS

STATION 21

Date: 21 October 1956

Position: 40° - 17.5' N 73° - 39.6' W

OBSERVATIONS FROM SHIP:

- 1) Time - 1430 (35 minutes after last discharge)
- 2) Depth - 91 feet
- 3) Bottom sample - "orange peel" sample of blue-green ooze, with slight earthy odor, and medium-grained tan sand. Small crab in sample.
- 4) Underwater color photos - #46, #47, #48 (see Figure 7)

NO OBSERVATIONS BY DIVERS

STATION 21 - A

Date: 22 October 1956

Position: 40° - 17.1' N 73° - 39.6' W

OBSERVATIONS FROM SHIP:

- 1) Time - 1140 (7 hr. 45 min. after last discharge)
- 2) Depth - 87 feet
- 3) Bottom sample - "orange peel" sample of medium to fine-grained, light greenish-gray sand. Shell fragments and small worms.

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS

STATION 21 - B

Date: 23 October 1956

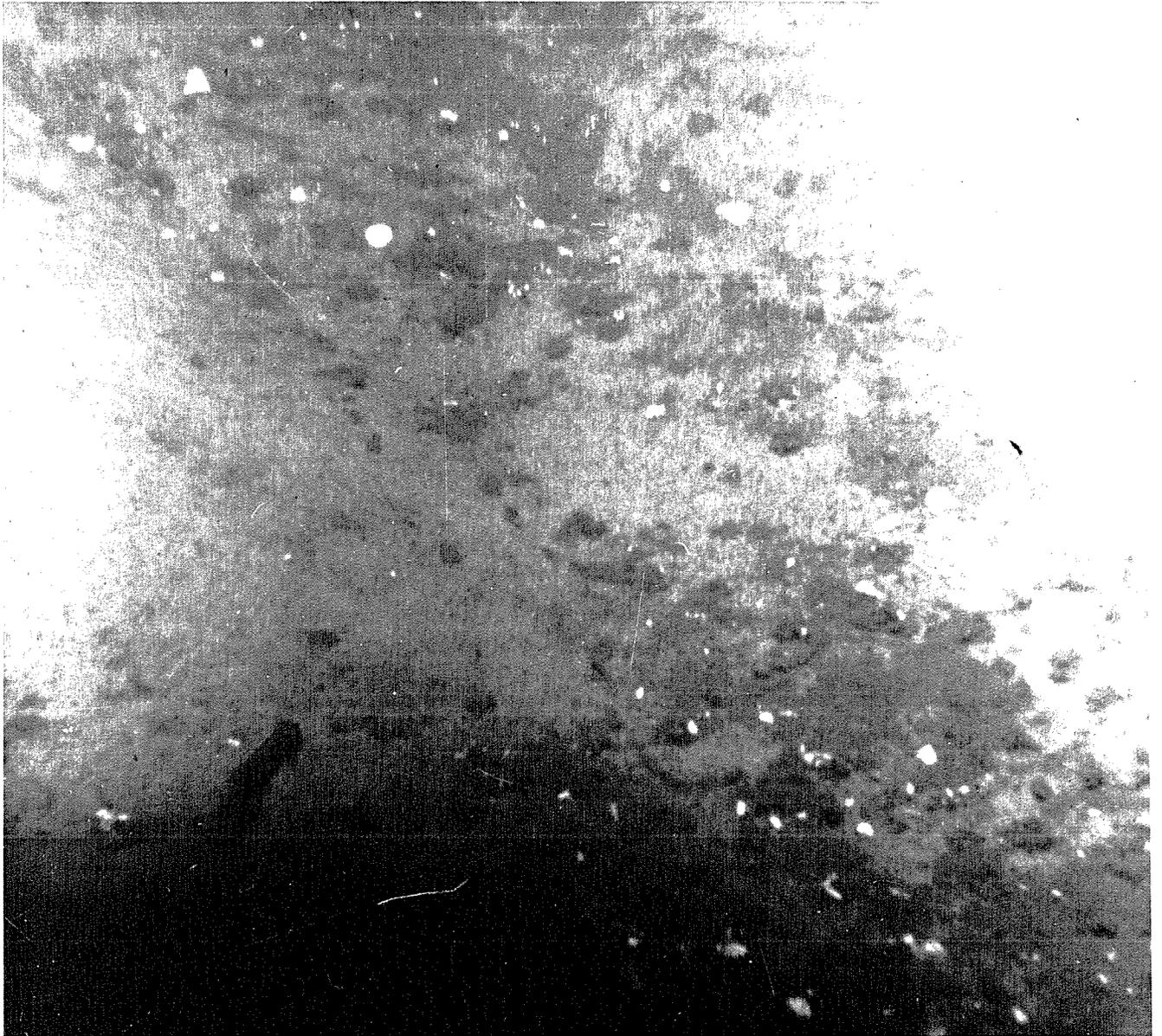
Position: 40° - 17.5' N 73° - 39.2' W

OBSERVATIONS FROM SHIP:

- 1) Time - 1220
- 2) Sea surface - moderate swell, no whitecaps, light N breeze
- 3) Depth - 92 feet
- 4) Bottom sample - "orange peel" sample of medium to fine-grained, light green-brown sand with shell fragments of sand dollars and pelecypods.

OBSERVATIONS BY DIVERS:

- 1) Time - 1220 (4 hr. 25 min. after last discharge)
- 2) Depth - 92 feet
- 3) Visibility - 6 inches Secchi (horizontal on bottom)
- 4) Bottom description - sandy bottom with ripples of 18 inches length and 4 inches height. 1 inch pelecypods in sand sample. Bottom screened by layer of suspended material. Estimated distance covered in drift - 400 feet.



FROM COLOR SLIDE NO. 46, STATION 21

DEPTH: 91 FEET

SANDY BOTTOM, WITH APPARENT SHELL FRAGMENTS.  
DARK MATERIAL IN TROUGH MAY BE BLUE-GREEN OOZE  
COLLECTED WITH SAND IN "ORANGE PEEL" BOTTOM  
SAMPLER.

FIG. 8

STATION 21 - B (Continued)

OBSERVATIONS BY DIVERS:

- 5) No underwater photographs
- 6) Aqua-Lung divers' names - Edwards & Weeks

STATION 22

Date: 22 October 1956

Position: 40° - 16.4'N 73° - 38.5'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1015 (6 hr. 20 min. after last discharge)
- 2) Depth - 84 feet
- 3) Bottom sample - "orange peel" sample of medium to fine-grained, light green-gray sand containing shrimp-like arthropods, round and flatworms, and  $\frac{1}{2}$  inch crabs. A layer about 1 inch thick of dark green ooze occurs in the sand.

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS

STATION 22 - A

Date: 23 October 1956

Position: 40° - 16.6'N 73° - 38.8'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1300
- 2) Depth - 92 feet
- 3) Bottom sample - medium-grained light tan sand with shell fragments and small arthropods

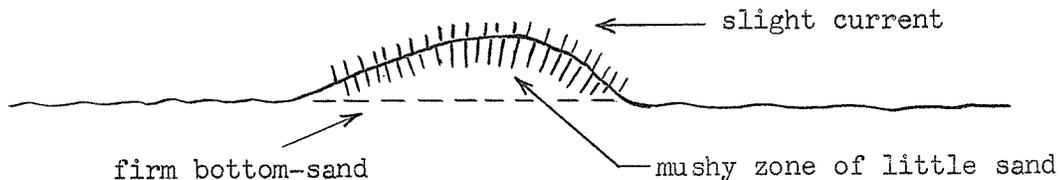
OBSERVATIONS BY DIVERS:

- 1) Time - 1300 ( 5 hr. 5 min. after last discharge)
- 2) Depth - 92 feet
- 3) Visibility - 8 to 12 inches Secchi (horizontal on bottom)  
8 feet Secchi (horizontal, 3 feet above bottom)
- 4) Bottom description - sandy bottom with irregular pattern of ripples about 4 inches apart. Low clusters of phoronid worm tubes among ripples, and occasional hummocks about 6 to 8 inches high and 1 to 2 feet wide.  $\frac{1}{4}$  inch inside diameter worm tubes common - walls of stringy, fibrous material with many shell fragments. Also skate egg cases. Distance covered, drifting with CARYN, about 400 feet.

STATION 22 - A (Continued)

OBSERVATIONS BY DIVERS:

Hummock cross-section:



- 5) No underwater photographs
- 6) Aqua-Lung divers' names - Owen & Cresswell

STATION 23

Date: 22 October 1956

Position: 40° - 15.8'N 73° - 37.6'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1100 (7 hr. 5 min. after last discharge)
- 2) Depth - 87 feet
- 3) Bottom sample - "orange peel" sample of medium to fine-grained sand ranging from light green-gray to light tan, and containing shell fragments, small arthropods, and a single living *Polynices heros* of 3 ½ inches maximum dimensions.

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS

STATION 24

Date: 22 October 1956

Position: 40° - 16.0'N 73° - 46.6'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1320 (9 hr. 25 min. after last discharge)
- 2) Depth - 180 feet
- 3) Bottom sample - Phleger core 8½ inches long. Medium to fine-grained light tan sand near surface of core, becoming streaked with dark green, sandy ooze which continues to bottom of core. Small crustaceans on top surface of core.

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS

STATION 25

Date: 22 October 1956

Position: 40° - 16.1'N 73° - 47.9'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1400 (10 hr. 5 min. after last discharge)
- 2) Depth - 110 feet
- 3) Bottom sample - "orange peel" sample of medium through coarse sand, granules, and pebbles up to 2 inches in long diameter. Pebbles are well-rounded, some with bristling algal growth, to  $\frac{1}{4}$  inch in length.

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS

STATION 26

Date: 22 October 1956

Position: 40° - 15.9'N 73° - 50.9'W

OBSERVATIONS FROM SHIP:

- 1) Time - 1450 (10 hr. 55 min. after last discharge)
- 2) Depth - 82 feet
- 3) Bottom sample - "orange peel" sample of medium to coarse-grained, dark gray sand (many heavy minerals) and fine to medium sized pebbles (maximum long diameter  $1\frac{1}{2}$  inches) and shells.

NO OBSERVATIONS BY DIVERS OR BOTTOM PHOTOS

III

LISTING AND SUBJECT MATTER OF COLOR SLIDES ACCOMPANYING  
THE REPORT

These slides were made on 35 mm Anscochrome film, with a ROBOT camera and electronic flash at a distance of nearly  $3\frac{1}{2}$  feet. Each entire slide covers an area of approximately 4.4 square feet.

Selected photographs marked with an asterisk (\*) are reproduced in this report in black-and-white; in some of these cases a small part of the transparency is enlarged to a high degree.

Station 1

- Slide No. 1) Turbid water, sandy bottom, phoronid worm tubes, diver's hand, red foot-rule on bottom for scale
- 2) Same bottom, with diver holding bottom sampler (fruit juice container). Note underwater slate in yellow for writing observations.
- 5) Red foot-rule near hummock of worm tubes
- 6) Another view of worm tubes on sandy bottom

Station 3

- \* 9) Skate on sandy bottom, with phoronid worm tubes. (Figure 1)
- 10) Worm tubes
- 11) Skate leaving scene
- 12) Worm tubes, underlying gray stiff clay
- 14) Worm tubes
- 15) Worm tubes, starfish, skate egg case, clay
- 16) Worm tubes, sand
- 17) Worm tubes, sand, shell fragments
- 18) Worm tubes, sand, shell fragments

Station 4

- 19) Sand, ripples, starfish, shells
- 20) Sand, ripples, shells

Station 5

- 21) Sand, ripples, shell fragments
- 22) Sand, ripples, shell fragments

Station 6

- 23) Sand, ripples, shell fragments, starfish
- 24) Sand, ripples, shell fragments

Station 7

- 25) Very little shown - camera not aimed correctly

Station 13

- 26) Diver-disturbed sediment clouding water, sandy bottom, phoronid worm tubes, ripples
- \* 27) Three scup, sandy bottom, ripples, few worm tubes. (Figure 2)
- 28) Diver-disturbed sediment clouding water, sand, ripples, worm tubes.

Station 15

- \* 29) Sand, ripples, worm tubes, opened black quahog shell - note starfish inside. (Figure 3)
- 30) Sand, ripples, worm tubes (diver grasping several), diver-disturbed sediment clouding water.
- 31) Sand, ripples, worm tubes
- \* 32) Sand, ripples, worm tubes, diver pointing to small worm boring in sand. (Figure 4)
- 34) Sand, edge of hummock composed of heavy concentration of phoronid worm tubes.
- 35) Sand, ripples, diver scooping top surface of bottom with fruit juice container.
- 36) Diver's hand on hummock of worm tubes

Station 15 (Continued)

- Slide No. \* 37) Sand, ripples, few worm tubes, skate egg case.  
(Figure 5)
- 38) Diver (Cresswell) near surface following dive: note streaks caused by bubbles from breathing apparatus, when ambient light became stronger than the flash and a slow shutter speed was used on the camera.
- \* 39) Sand, ripples, diver's hand near clump of worm tubes. (Figure 6)

Station 19

- 40) Sand, ripples
- 41) Sand, ripples, diver-disturbed sediment clouding the water.
- 42) Sand, ripples, diver-disturbed sediment clouding the water.
- \* 43) Sand, ripples. (Figure 7)

Station 20

- 44) Sand, ripples, few worm tubes
- 45) Sand, ripples, few worm tubes, shell fragments

Station 21

- \* 46) Sand, large trough with greenish material collected, apparent shell fragments. (Figure 8)
- 47) Sand, greenish material in patches, shell fragments.
- 48) Sand, ripples, greenish material in patches, shell fragments.

