PRNC182

PRNC - 182

PUERTO RICO NUCLEAR CENTER

7 PUNTA MANATI

ENVIRONMENTAL STUDIES

Propared for the Puerto Rico Water Resources Authority,

By the Staff of Puerto Rico Nuclear Center of the

University of Puerto Rico

April 15, 1975

?OPERATED BY UNIVERSITY OF PUERTO RICO UNDER CONTRACT

NO. AT (40411888 FOR US ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

---Page Break---

PUNTA MANATI ENVIRONMENTAL STUDIES

by

E.D, Wood, M.J. Youngbluth, M.E. Nutt, M.N. Yeaman,

Paul Yoshioka, and M.J. Canoy

---Page Break---

PREFACE

This report stems from investigations carried on by the Puerto Rico Nuclear Center. The studies were designed to provide data upon which to judge the suitability of a site for the construction of power generating facilities and to allow the determination of the impact of such construction and operation upon the environnent.

The report represents the combined effort of the scientists, technicians and support staff of the Site Selection Survey Project.

The authors who contributed to the Punta Manati Site

Selection Survey are:

E.D. Wood, Project Leader Physical, Chemical and

Geological Parameters

Marsh J. Youngbluth Zooplankton Studies 1973

Mary E. Nutt and Zooplankton Studies 1974

Marian N, Yeaman

Paul Yoshioka Benthic Invertebrates and

Fish Studies

Michael J. Canoy Plant Associations

Report Coordinator: £. D. Wood

Technical Editor: Ferne Galantai

Project Secretary: Pauline Oretega de Cabassa

Data Processing Rosa Asencio

---Page Break---

wa

2a

INTRODU

PHYSICAI

2.41

CHEMIST!

Bet

GEOLOGI

ZOOPLANI

ated

anna

ZOOPLANI

4.24

412)

?TABLE OF CONTENTS

iCTION

\L_AND CHEMICAL PARAMETERS

---Page Break---

TABLE OF CONTENTS continued

7?

---Page Break---

1.1 INTRODUCTION

?The Puerto Rico Nuclear Center of the University of Puerto Rico has been under contract to the Puerto Rico Water Resources Authority since 1972 to conduct site se- lection surveys and environmental research studies of seven coastal sites. Experience gained from these investigations Will add to the knowledge about these areas, and provide useful data which will aid in the assessment of the desira- bility and practicability of locating power generating plants on one or more of these sites.

Puerto Rico Nuclear Center scientists have studied the physical, chemical and geological paraneters of the sites, and the ecological paraneters of zooplankton, benthic intertebrate and fish communities. Plant associations, except for the Cabo Rojo Platform site, have been included.

The sites chosen for study were: Tortuguero Bay,

Punta Manati, Punta Higuero, Cabo Rojo Platform, Punta

Verraco, and?Cabo Mala Pascua. The seventh site, Barrio

Islote, was studied and reported under a separate contract.

?The first site reported was Tortuguero Bay on the

north coast of Puerto Rico. The present site reported is

Punta Manati, also on the north coast, west of Tortuguero

Bay (see Figure 4.1-F1).

---Page Break---

?unoys a0u oats oa0rs7 ofsseg (anc) enosed TEN oqeo

Pu :CaAd) orerz0a Paung £(q¥2) wz0318T4 Ofoy ogey !(IHd) ossNTEH wound

(vwia) FaeueN eaung f(yOs) Keg orsn¥naxoy ?soays ApmIg MOAN wortoateg sere ?qgeTy ?Sty

v3s Nvageuvo

Moos

NW390 SILNYTLv

---Page Break---

2.1 PHYSICAL AND CHEMICAL PARAMETERS AT PUNTA MANATI by

ED, Wood

2.1.1 INTRODUCTION

Most of the physical, chemical and geological measurements at the Punta Manati site were made at or near the stations shown in Figure 2.1-F1, The transects were spaced at one nautical mile with the "A" stations located as near to shore as it was safe to sample with the RMV R.F. Palumbo. The "B" stations were located in excess of 125 meters and the "C" stations on latitude 18°31.8'N in excess of 325 meters.

2.1.2 TIDES

?The tidal waves that affect the north coast of Puerto Rico have their anphidromic point in the Central North Atlantic Ocean with the crest of the cotidal line moving in a counter-clockwise direction (Anikouchine and Steinberg, 1973), that {sy from west to cast past Punta Manati. The tides ate pre-

digted for San Juan by the National Oceanic Survey. An ex-
sple of the tidal pattern over a lunar cycle has been plotted in Wood, et al. (1975b) for Tortuguero Bay. The north coast tides ave semi-diurnal with a maximun excursion of about 75 cm and a mininun daily excursion of about 32 cm. The mean daily tidal excursion is 40 em. The tides for the period of current measurement at Punta Manati have been plotted in Figure 2.1-F2.

2.1.3 CURRENTS

The general current pattern on the north coast of Puerto Rico is to the west with the highest flows during ebb currents (PRWRA, 1975). The usually strong afternoon winds

from the east-northeast tend to increase the velocity of the surface currents to the west. There is a strong correlation between the current patterns and the tides with modification by the local winds, the North Equatorial Current and the

direction and amplitude of sea swells impinging on the shoreline. Measurements at the Islote (PRWRA, 1975) and Tortuguero Bay

(Wood et al., 1975b) sites west and east of Punta Manati, respectively, indicate that currents of nearshore surface

Waters reach? about 30 cm/sec both east and west parallel to

the coast with a net flow to the west of about 5 cn/sec. There appears to be some seasonal variation to this pattern (PRNRA, 1975).

---Page Break---

Fig. 2.1-F1 Punta Manati site with depth contour lines and hydro-graphic sampling transects each with three stations.

---Page Break---

?2161 ?11 1990320 23 g 1990220 woay uene wes aos suoviStpatd uosy possord yaeuey eaung 4 Sopty 2a-1°2 ?Bra

oz-

Ob:

po noonnornennnnencnenen ~Suswsansoem °

wousn3

Le o

spovs04 oz

oe

ov

oS

ve eb ve L ve a ve

ecéet ue on 6 4990390

Tide Level for Pta. Manati (cm)

---Page Break---

The currents at Punta Manati were measured on two cgcasions, Ortaber, 10, 192, using dye drops and aertal photography. The first drop was intended to coincide with Peak flood current, but was delayed until almost high slack tide (0940-1230). "The second drop was made at 1600°and photo- ETgpMed guey2 1920 foward the end? of the/ period of falting tide. The results are shown plotted in Figures 2.1-F3 and Fé,

A distinct river plume from the Manati River existed throughout the current measurements, A detached plume was Seen offshore north of Punta Manati while the river discharge was spreading to the northwest as shown in Figure 2.1-f5,

Eight drops were made for each of the periods with four nearshore and four parallel offshore. The drops furthest offshore moved slowly to the northeast then to the southwest and disappeared in a convergence. The offshore dye spots west of the river moved to the west at about 0.2 knots (10 cm/sec). The nearshore dye spots moved slowly to the west and wore dic persed in the surf except for the drop in the river plume.

Drop three, in the plume, moved at about 0.3 knots (18 cm/sec) to the west initially, then increased to about 0-8 knots (40 gp/sec) to the west-northwest. The outer drop just north of the river plume was seen to partially disappear under the river plume.

During the afternoon, the turbid water was confined to the nearshore regions. The river plume flowed to the west along the shore. The offshore dye? spots moved westward and

Hiely?shoreward at 0,6 t0'0-9 Eases (30 fo dhe Sele) The drop just west of Punta Manati moved into an eddy toward? the river mouth. The drop nearshore just east of Punta Nanati disappeared in the surf after moving west at about 0-6 keats (30 cm/sec). ?The drop in the innedfate plume was disperced rather quickly to the west. The outer plume moved west ner Palmas Aitas at about | knot (50 cm/sec).

The surface currents measured at Punta Manati were weak to the west nearshore and weak to the east offshore near the top of the flood. ?When measured near the bottom of the ebb, they were to the west at 30 to 40 cm/sec similar to those Measured at Tortuguero Bay (Wood et al., 1975b) and at Tslote (PRWRA, 1975) as would be expected.

2.1.4 BATHYMETRY

Contour lines for 10, 20, and 100 meters are shown in

Figure 2.1-F! and offset depth profiles of the five Punta

Manati site transects are shown in Figure 2.1-FS. The depths

were taken from Chart No. C§GS 903 (NOS. 1972). The shelf

---Page Break---

---Page Break---

pate ?81a

---Page Break---

Pte, Manati

Manati

1 Palmas Altes

Vertical exaggeration

Fig. 2.1-FS Offset bottom profiles along the sampling transects of Punta Manati. Vertical lines indicate relative positions of hydrographic casts.

---Page Break---

width is fairly uniform at Punta Manati at about 25 kilometers to the 100 meter contour. The shelf is a little narrower to the northwest of the Manati River mouth suggesting a sub-marine canyon associated with the river. A broad shallow region exists just west of Palmas Altas with the broadest portion of the shelf about 2 kilometers west. There exist a few outcrops near the mouth of the Manati River and off Palmas Altas, but no extensive reefs are found here, The vertical lines descending from the surface (transect lines) in Figure 2.1-FS indicate the relative positions and depths of the A, By and C hydrographic stations. Most of the soun ings indicated on the chart were found to be accurate, However, the nearshore regions (<10 m) are not well charted.

2.1.5 TEMPERATURE, SALINITY AND DENSITY

The physical parameters of temperature and salinity Were measured at the Punta Manati site on seven cruises covering four seasons in two years (Table 2.1-T1).

TABLE 2.1-T1 Schedule of hydrographic cruises to Punta Manat

wrwTER SPRING sues PALL

i973 at s/t12 9/7 7

1974 4/28 8/22 2/1518 uA

The hydrographic sampling grid is shown in Figure 2.1-F1. A maximum of five north-south transects were made on each cruise. Each transect had three stations. The "A" stations were near-shore (ca 18 m) with two sampling depths at 0 and 10 meters. The "BY stations were seaward in about 125 meters of water with four depths at 0, 25, 50 and 100 meters. The most seaward sampling was at the *c? stations in excess of 325 meter depths at about 18°31.8'N latitude with eight depths: 0, 25, 50, 100, 150, 200, 250, and 300 meters. The sampling, analytical and data processing procedures are described in?"A Manual for Hydrographic Cruises" (Wood, 1975a).

Temperature

Temperatures were measured using deep sea reversing thermometers accurate to better than #.0,05°C, The thermometers were used in pairs, or in triplicate when possible.

---Page Break---

Although only one temperature is shown on the computer printout of the data (see Appendix 2.1A) for each depth, these values are often the average of two or three thermometers. Most temperatures below $0 meters were measured using both ?protected? and ?unprotected? reversing thermometers. A thermoneter depth, 12, was then calculeted for the sampling depths and correlated quite well with the calculated depthy CZ, obtained from the amount of hydrowire paid out, NZ, and the cosine of the wire angle, 0. An example of this corre lation is shown in Wood et ai., (1975b)-

?The data were averaged by a computer program which first interpolated between the depths sampled to provide temperatures (and other hydrographic paraneters) at "standard depths." The averaged standard depth temperatures and salinities are plotted By season in igure 2.1-Fe.. The diagonal lines sndicate! density as sigma-t. Depth is not shown on the plot, but generally in-Greases to the lower right corner of the plot, i.e., density increases with depth. Very little change is een seasonally where signa-t is greater than 25.2, however, a definite change can be seen in the tower densities (surface waters), The temperature increases between winter and summer, while salinity increases between fall and spring.

The averaging for the depth profiles was done first for all stations by season (Figures 2.1-F7, 9, 11 and 13) then by type of station by season (Figures 2.1°F8, 10, 12 and 14).

A comparison of the averaged "C" station standard depth temperature data by season is shown in Figure 2.1-FI5.. A Sequence of events can be seen from this comparison, Surface temperatures were lowest in the winter (25.6°C) with the deepest thermocline (100 m) caused by cooling and deep mixing by winter storms. This mixing process tends to carry heat to the depths

50 that the highest temperatures between 100 and 250 meters

occur during the winter. (This condition is also part of a Phenomenon one might call "seasonal lag.) Little seasonal Shange is seen below 250 meters. There was a steady temperature decrease in the 100 to 250 meter depth interval between winter and fall. No sharp thermocline existed during the spring season as relatively calm warm weather conditions allowed surface warm-ing to occur. Surface temperatures were at a maximum in the late summer months (28.2°C) with a thermocline at about S0 meters. There was a temperature range of about 2.6°between summer and winter in the nearshore surface waters at Punta Nanati.

A temperature inversion occurs in the fall as surface cooling begins. The thermocline was at about 25 meters with generally cooler temperatures between 75 and 100 meters than during other seasons. Very little difference was seen in the temperatures with distance from shore for any of the seasons. Bathythermograph traces from the "C" stations are in Appendix 2.14 and surface temperatures were mapped seasonally by serial infrared scanning (Wood, 1975¢).

u

---Page Break---

°

2

3

=

z

2

5

4

6

2

8

3 3

2

A

@ © w

s 8 a s & 2

FwSewed-seu o

Fig. 2.1-F6 Tenperature-salinity of averaged seasonal date at

Punta anati for the years 1973 and 1976,

2

---Page Break---

So 34 35 36 37

TC 16 1% 20 2 824 6B

100

3 xr4umo

2

2

t

200

300

[nan anaes Sena aenees eee

min 0 1 2

ee PO} po-at P/I X10.

PMA-1

Fig. 2.1-f7 Averaged hydrographic parageters (temperatures, TC:

. salinity, '3*/oo; density, 4; dissolved oxygen, 025

and reactive phosphates PO) ?vs. standard aeerh 4

eters for the winter Season oF 1993 and 1998 ae

Pinte Manat?

13

---Page Break---

50

100

I4aumo6

100

200

300

5 mult

ce

o.t 2 3 4 5 6

PCY po-at Pn x10, PMA-t

Fig. 2.1-F8 Depth profiles of hydrographic parameters averaged

by type of station for the winter season oY T39S

and 1355,

?

---Page Break---

Sloe 34 35 36 37

TC 16 1B 20-22 24 26 28 &

100

°

E

Pp

T

H

m

200

300

[a eee Ses ae

Qmno 1 1 2 4 5 6

PO} po-at P/Ix10 Pye

Fig. 2.1-F9 Averaged hydrographic parameter depth profiles for

the spring season of 1973 and 1974 at Punta Manati.

6

---Page Break---

507 (Pp o\\s o A

100 |

db oO c

E

P

T

H

100

m

P L of\e |s

200

300

Oymino 1 2 3 4 5 6

POA pg-at Pr x10 PMa-2

Fig. 2.1-F10 Depth profiles of hydrographic parameters aver:

by type of station for the spring season of 19

ang 18740 ON

---Page Break---

Tc

∘

100

.

E

P

T

H

m

200

300

oy

Qmno 1 4 2 6

PQ§ pg-at.P/Ix10 PMA-3.

Fig. 2.1-F11 Averaged hydrographic parameter depth profiles for

the sunmer season of 1973 and 1974"

?

---Page Break---

50

100

I4umo)

100

200

300

mill Oo 1 2 6

p9-atPIxi0 PMA-3

Fig. 2.1-F12 Depth profiles of hydrographic parameters averaged

by typeof station for the sunmer season of 1975

and 1874, 18

---Page Break---

TC 16 18 20, 22 24 26 2B

100

D

E

P

T

H

m

200

300

nen aA Gene

min oO 1 2 3 4 5 6

POS pa-at P/1X10 PMA-4

Fig. 2.1-F13_ Averaged hydrographic parameter depth profiles for

the fall season of 1974.

---Page Break---

S%o0 34 35 36 37

Tee 16 18 20 22 24 26 28

° TB

504 |p a

100 <I\

DO re

E

P

T

H

100

m

P ° io Js

200 L

300

[nc ee

Op mill 0 1 2 3 4 5 6

PG po-at P/1xi0. PMA-4

Fig. 2.1-F14 Depth profiles of hydrographic parameters averaged

by type of station for the fall season of 1974,

20

---Page Break---

TEMPERATURE °C

16 18 20, 22 24 26 28

3

5

3 rawmo

200

Fig. 2.1-F1S Averaged seasonal depth profiles of "C" station

temperatures at Punta Manati for 1973 and 1974.

a

---Page Break---

Salinity

Salinity, S*/oo, is the total salt content of water expressed in patts per? thousand. It is used along with temperature to typify ocean water masses. Low salinity usually occurs at the surface and indicates dilution by Precipitation, runoff, or fresh water intrusions. High Salinities are found in sub-tropical regions and are the result of high rates of evaporation, The salinities at

Punta Manati were determined using an induction salinoneter with the readings good to better than + 0.05/00. The average seasonal salinity data are shown plotted against depth with the other hydrographic parameters in Figures 2.1-F7 through Fi4. It is immediately obvious that there is a pattern throughout the year for salinity to increase with depth (as tonperature decreases) toa depth of about 150 meters where salinity begins to decrease slightly becoming fairly uniform with depth at about 36°/o0. This layer of high sa- Linity water with a maxinun of about 37°/oo was forned by evaporation in the sub-tropical North Atlantic Ocean.

A comparison of the averaged "C" station salinity data is shown in Figure 2.1-F16. The winter salinity profile shows

@ generally low salinity in the upper 150 meters and the deepest maximum at about 190 meters. The shallowest maximum occurs during the fall season at about 125 meters. The fal] maxinum is lower than during the remainder of the year and the Lowest Surface salinities (34°/oo) occur during this season. Surface salinities generally increase from fall to spring (34 to 36°/o0) then decrease through the summer into fall during the intensification of the tropical rainy season, A general increase in salinity was observed in the 25 to 125 meters layer between winter and fall with almost the reverse true between 150 and 250 meters.

The salinity of the Manati River is near zero, however, the lowest salinity at the closest "A" stations was about 32°/oo indicating how fast the river water is mixed with the Sea water. The depression of the nearshore surface salinity rarely extends beyond the "B" stations. Isohaline lines have been drawn from surface salinities for the fall of 1974 in Figure 2.1-F17. The sampling was done during the night and early morning when wind conditions were light from the east. The tide during the time of sampling went from a level of 30 cm toa low of 0 then a high rising tide of about 60 cm. The combi-nation of Weak easterly winds and weak ebb current followed by a strong flood current during the rainy season explains the . extent of the Manati River plune.

---Page Break---

SALINITY "oo

35 36 37

° NYE

? ?

100

D

?

Pp

T 4

H

m

200 4

PMA

winter

Spring 2

Simmer 3

Far 4

300 3

Fig. 2.1-F16 Averaged seasonal depth profiles of "C" station

salinity at Punta Manati for 1973 and 1974.

23

---Page Break---

---Page Break---

DENSITY of

20 22 2426

100

3 r40mo

300

t) profiles of "cv

season for Punta Manati,

Fig. 2.1-F18 Averaged water density (si

Station data plotted by

1973 and 1974,

25

---Page Break---

Density

The stability of the water column is a function of

the density gradient. Density,#, is @ function of temperature

and salinity, and always increases with depth in a stable

water colunn, Density is usually converted for convenience

to an expression signa-t, ©

ome - 1) x 103. Qn)

Small changes in sigma-t with depth indicate a well-mixed or unstable zone, whereas a high gradient is indicative of a very stable region of the water column.

A comparison of the averaged seasonal sigma-t profiles is shown in Figure 2.1-F18. Sigma-t varies from 22 to 24 in the surface waters and is highest in the winter months. The pyconcline occurs at about 100 meters in winter because of deep storm mixing and generally cooler surface temperatures. The most stable water column occurs in the fall when surface water density decreases because of dilution. A general decrease in signa-t occurred from winter to fall at the surface, while the opposite was seen at about 100 meters, Very little seasonal change in sigma-t was seen below about 200 meters,

The tendency for slightly higher sigma-t values in the " station over the "B" and "C" stations noticed at the Tortuguero Bay site (Wood et al., 1975b) was not seen at Punta Manati probably because of contributions from the Manati River. Sigma-t profiles are shown in Figures 2.1-F7 through F14.

2.2 CHEMISTRY

2.2.1 DISSOLVED OXYGEN

The amounts of dissolved oxygen, D.0., in the water off Punta Manati were determined by the Winkler titration method with the analyses usually performed on shipboard within a few hours of sample collection. Sone of the values were checked with a YS1 polarographic probe with results similar to those Teported for Punta Higuero (Wood, 1974). The titration values were more consistent and generally higher than the probe readings. The titration values are generally good to better than * Tt; However, sone analytical problens were experienced on the 1973 winter cruise. Dissolved oxygen data are included with phe byatographic daca in the Appendix 2.14 in mi/t, mg/t and

?sate

Oxygen saturation is a function of both temperature and salinity. Since neither shift drastically in the tropics little change in near surface D,O, is expected nor was it seen.

---Page Break---

Averaged D.O. values in milliliters per liter are plotted

with other hydrographic parameters in Figures 2.1-F7 through

F14 by season and type of station, The highest values, except

for the winter season, were found at about 100 meters.? Sur=

face values were near? saturation with some super-saturation

at depths of 25 to 75 meters because of photosynthesis. A

comparison of seasonal averaged values is shown in Figure 2.2-F1.

?The oxygen mininun occurred at about 225 meters for all seasons

except fall where a very pronounced minimun was seen at about

150 meters. Slightly higher D.O, in the surface waters during

fall and winter seasons is consistent with higher D.0, satura

tion with lower temperature and salinity, Generally, very

little seasonal change was noticed in D.0.

2.2.2 NUTRIENTS

Nutrients are important from two aspects. First,

nutrients are generally low in the tropical Atlantic Océan

surface waters and linit primary productivity. Second, the

discharge of wastes from agricultural, municipal or industrial

sources may contain such high nutrient levels that they cause

eutrophication and local ecological degradation.

Reactive phosphate can be determined quickly and accurately with the Murphy and Riley molybdate blue complex Rethod (Strickland and Parsons, 1968) and is a good indicator of pollution. Only a limited number of nitrate analyses were performed on the waters off Punta Manati. The tropical and Sub-tropical North Atlantic is generally deficient in nutrients, especially nitrate. Reactive silica is usually not regarded as a pollution probien.

\ctive Phosphate

The concentration of reactive phosphate is generally low in the surface waters (0.05 ug-at. P/i), slightly lower in the summer and slightly higher in the winter as seen in Figure 2.2-F2. The levels of phosphate were uniformly to about 200 meters where they began to increase being 0.3 to 0.5 ug-at. P/t at 300 meters, The increase in phosphate generally coincides with the decreased salinity below the Salinity maximum. This is because the high salinity water was formed in the sub-tropical North Atlantic which is deficient in nutrients. Slightly higher phosphate values were seen in the nearshore surface waters, especially near the mouth of the Manati River, probably fron agricultural runoff,

a

---Page Break---

DISSOLVED OXYGEN mi/l

3 4 5 6

100

3 r40mo

200

winter 4

Spring 2

?Summer 3

4

300 Fall

Fig. 2.

?FI Averaged dissolved oxygen depth profiles by season,

1973 and 1974,

28

---Page Break---

REACTIVE PHOSPHATE _ g-at. Pil

Oo | o1 02 03 04 05 06

100

wi Favmo

300

Fig. 2.2-F2 Averaged reactive phosphate depth profiles by season,

1973 and 1974,

---Page Break---

Nitrate

Nitrate was determined by the cadnium-copper reduction method (Wood et al., 1967). Samples were analysed for nitroce at Punta Manati oniy for the fall 1974 season. (Nitrates have been done routinely at the Islote site about 3 kilometers to the west and the data is available in Kendall et al., 1975).

Nitrate profiles for the PMA-3A, B, and C stations are shown in Figure 2.2-F3. They are similar?in shape to the phosphate profiles for the sane season except that the higher Surface values for the "A" and "B" stations are much more pronounced. There is obviously a large source of nitrate in the Manati River region, possibly from agricultural sources or from industry.

---Page Break---

Nitrate g-at.N/I

2.4 6 8 10 12 14 16 18

° ???

B

100 PMA-3

© Oct. 31,1974

E

P

T a

H

m

200

300

Fig. 2.2-F3_ Plot of nitrate vs. standard depth for the fall season

of 1974,

---Page Break---

3.1 GEOPHYSICAL PARAMETERS AT PUNTA MANATI

by

E.D. Wood

The beach outcrops are Pleistocene cemented dunes as gre the high grounds on either side of the Manati Riser (Briggs 1965). Much of the shoreline is composed of way consolidated sand (Figure 3.1-F1). Some of the sand aoe posits landward from the beach contain fine-grained quartz sand and clay, especially near the Manati River,

The cross-hatched area is alluvium deposited by eriodic river flooding (Hickenlooper 1967). Sediments in the shaded areas along the shore were deposited by storm and wave swash and wind (Fields and Jordan 1972),

Sediment deposits largely from the Manati River exist Seaward and to the west of the river. There is a region just east of the river mouth that is usuaily hard bottom? this nat just north of Punta Nanati covered by Station PUA-4h (Figure 2,12F1). It had been reported that sand moves on and off oF sone of the hard bottom, however, attempts to retrieve sede) ments from PMA-4A have been fruitless. The ocean bottom areas shaded in Figure 3.1-F1 were drawn from aerial photo-

graphs taken in August 1973, Sand was visible near Panes

Boquilla and north and west of the Manati River with a tongue

gf sand running west just offshore north of Palmas Altas.

The sand deposits west of Palmas Altas were confined to

several patches. Sediments collected at PMACTA, 2A, Sk, and

SA Were Sieved and the results are shown in Figures?3 12F2

and F3. (All of the samples are uni-modal with the highest

percent of sediment collected on the 38 (125 um) sersens

The statistics for the sediments are in Table 34-1"

TABLE 8.1-T1 Statistics for the Funta Manati sedimente

STATION PMA-14 PHA-24, PMA-3A PUARSA

Median dé 28 28 29 27

Mean Ms 29 2.8 2.9 27

sta. dev. 6 Os 0.6 O68 os

---Page Break---

?YaeueH waung ae saysodep o>ezans so sadds tedrouysa ta-4'¢ *8ta

---Page Break---

99.

98}

101 2 3 4 PAN 10 1 2 3 4 pan

B=-109,S um

Fig. 3.1-F2 Histograms and cumulative weight percent plots of

sediments from Stations PMA-1A and 2A.

---Page Break---

99.5)

96]

95

Fig. 3.1-F3 Histograms and cumulative wei,

Sediments from Stations PMA-3A

ght percent plots of

SA.

---Page Break---

The shape of the histogram of PMA-SA differs somewhat from those sediments west of the Manati River with over seventy percent of the sediment collected on the 3 f screen and only 0.48 less than 1 p.

The plume of the Manati River has been observed on numerous occasions. The dominant pattern is to the west along the shore as shown in Figure 3.1-F4, With periods

of light winds and a flood current, the pattern changes to the east with more spreading. On rare occasions (high river discharge and a near calm sea) the plume may be seen to spread in an arc several kilometers from the river mouth as a thin layer of muddy, low salinity water overlying the sea water.

?The river produces very little discharge during the dry season. The usually turbulent north coast sea conditions rapidly mix the river water with the sea water so that the effects (e.g., low salinity) are rarely seen beyond the "A"

stations even? during the rainy season.

---Page Break---

+(sez001q 10ys330 pur) 3uozand y>ets

Pue (pura nor) quosin> poor} *(puyM AtsoIsee pur)

quoaan> qa Buranp ountd xoary yivuny 943 Jo 1U93x9

ea93eT pur advys areurxoadde yi Suyzesyput wes8erg pa-i-¢ ?8ta

---Page Break---

4a ZOOPLANKTON STUDIES 1973

by

Marsh J. Youngbluth

4.1.1 INTRODUCTION

The foltoving report provides estimates of the abun

dance and density of zooplankton in the surface waters along

a portion of the north coast of Puerto Rico. These data form

one part of an environmental survey conducted by the Puerts

Rico Nuclear Center, Ail collections were gathered in an area

adjacent to the region proposed for the siting of a future power plant. Samples were gathered on 3 days during 1975,

29 January, 11 May, and 7 August

4.1.2. MATERIALS AND METHODS

Field Procedures

Zooplankton were collected with a 1/2 meter diameter cylinder-cone shaped nylon net. This net was designed to Teduce clogging error (Smith et al., 1968). Mesh size was 233 microns. The net was towed from a 1? foot skiff in a circular path through the upper 2 meters. The speed of the vessel ranged from 2 and 8 knots (determined with a Sims yacht speedometer). The duration of a tow was 10 minutes. After each tow, before the cod end was removed, the net was washed with seawater with the aid of a battery driven pump (12 volt, Jabsco water-puppy). The catch was preserved in 4. sea water formalin buffered to pil 7.6. All samples were gathered during the daylight hours. The volume of water filtered through « het was estimated with a flowmeter (TSK or General Oceanics Model 2030) suspended off-center in the mouth of the net.

The volumes usually ranged from 100 to 150m. The meters Were calibrated every 2 months. Calibration factors fell within 8% of the mean, At each site three tows were made in the area adjacent

to the region where a power station may be located. Single

tows were taken at the other stations. The regions sampled

Were chosen in such a way as to collect within and around the

area where thermal alteration is likely to occur (Figure 4:1-F1).

oratory Procedures

Within 24 hours after samples were collected the pit

was checked and adjusted, if necessary, to 7.6. If a saxple

contained a noticeable conglomerate of phytoplankton or detritus,

the zooplankton were separated from such material by gentic

---Page Break---

ssuoraeas woayuetdooz f2eueK wrung E761 JO UOTI"D0T

---Page Break---

filtration through 202 micron mesh netting. Before estimates of biomass or numbers were made all organisms larger than 1 cm, usually hydrozoan medusae, were removed.

Biomass was calculated as wet volume (Ahlstrom and Thraikill, 1962). This estinate is subject to considerable error and? should be viewed only as a rough measure of standing stock. The measurements were reproducible but are undoubtedly biased toward higher than actual values by variable proportions of interstitial water and detritus,

The total number of organisms was estimated by yolu-wetric subsanpling with replacenent (Brinton, 1962).? Three aliquots from each sample were counted, The abundance of major taxonomic groups of holoplankton and meroplankton were determined fron dilutions of 300 to S00 organisms. Copepods usually the most numerous of the zooplankters, were identified to species.

All biomass and enumeration data were standardized to a per cubic meter basis or multiple thereof. Data were initially reduced with hand calculators (Hewlett Packard Model 45) and more recently with a computer (PDP-10). See Appendix 4.1A for a listing of the prograr

4.1.3 RESULTS

A total of 21 samples was collected from 5 stations

(Figure 4. 1°F1). The densities of several taxonomic groups

of fooplankton at each station have been deterained (Tables

4.1-1°5 through 17). These data are arranged to facilitate

comparisons between sets of consecutive tows, nearshore tors,

ands offshore tows.? The densities of total zooplankton usually

afcered more between catches from aiffictent areas than? be-

tween consecutive samples fron one areas, The degree of

Variation between samples is expressed ds a ratio, forned by

Uividing the Largest total aumber of sooplankton by the. smaa-

est within each set (Table teIeTi)s. The ratios are similar

fo those observed In other coastal regions around Puerto Rico.

Another way of Judging differences between samples was deters

inined by" careulating the variance. between consecutive. samples

tnd estinating the husber of tovs needed to detect various

levels of difference (Table 4<1212)-

---Page Break---

TABLE 4.1-T1, Summary of ratios betveen the highest and lowest density

values of total zooplankton during each period

DATE 29 January 1 May 7 August

Consecutive Tows 1.2 18

Nearshore Tows

Offshore Toxs 2.9 2.3 1.3

ALL Tows 3.8 2.8 3a

TABLE W.1-T2. Total zooplankton (logy transformed) from 9 sets of

replicate tows. The number of replicate tows (n) needed

to detect a 5 to 50% difference in density is indicated.®

DATE 28 January a1 May 7 August

STATION 1 1 2

2.69197 2.56110 2.33648

2.78675 2.70759 2,18N69

2.73798, 2.71517 2.19988

ast ? se 7

208 1

Were (+) fg Student's © for the 95% confidence level

G2 (dufs2), 62 is the sample variance based on replicate

tous, and ¢ ie the half-width of the confidence interval

desired.

These data indicace that a large number of replicate

tows would be necessary to detect density differences at the

5% level. However, on the average, differences of 201 can

be noted with only?3 tows. Differences of 50% may be revealed

with a single tow. Density estimates larger than 50% were

found within and between nearshore and offshore catches. The

range of density values during a sampling period was usually

two to four-fold.

---Page Break---

Seasonal changes in the abundance of total zooplankton at any station or among all samples fell within the sane range (Table 4.1-T7). The highest concentrations occurred in January. The larger densities, however, probably represent the range of variation among tropical zooplankton communities in the coastal waters around Puerto Rico father than recurrent Seasonal pulses since the 95% confidence intervals from each Station overlap (Table 4.1-T3).

TABLE 4.1-T3, Average density of ali zooplankton collected

Total Zooplankton/ad

	29 January	11 May	7 Avgust
Range	seu-742	166-464	159-476
Median	550	373	299
Mean	80	340	202

958 Cae #12 aus #365

?These fluctuations in density refer primarily to holo-
planktonic organisms since they composed, in most cases, 60
to 90% of the total zooplankton. Meroplankton formed 3? to
25% and were equally numerous during each sampling period.
Copepods dominated the holoplankton and the larvae of gas-
tropods and carideans formed the bulk of the meroplankton.

Fish eggs were abundant in this area, constituting 2
to 25% of the total zooplankton (Table 4.1-T4). The largest
density, 87/m?, was observed at Station 4 on 29 January 1975.
Fish eggs were? somewhat more numerous in January and August
when they averaged 39 and 33/n?,respectively. Most of the
eggs were round and 0.5 to 2 mm?in diameter, Oblong eggs
Were common. It is not known which groups of fish are re-
Presented by most of the eggs.

TABLE 4.1-TH. Summary of densities of fish eggs from all stations
sampled at the Punta Manati Site

STATION

Range 17-98 16-35 3-47.87 21-38 387

Median 2% 8a 2 ot 28

Mean 7 et 3 ot 23

a2

---Page Break---

Copepods formed 50 to 85% of the zooplankton community.

A total of 39 species were identified. Time did not allow

a detailed study of species abundance at all stations, con-

sequently, one sample at Station 1 from each period was

Selected for study. The entire sample was scanned to form a

species list and subsampled for quantitative analysis. Using

these data, the species most numerous, those connmonly ob-

served, and others occasionally found, are listed in Table 4.1-TS.

TABLE ?.2-T5. Copepod populations observed at the Punta Nanati Site

Species usually sost nunerous (5 individuals/n?)

Clausocatanus fureatus

Faracalanus spp. (F- aculeatu

p,

Farranuia graciiie

Ofehona spp-(O- flunifera, 0. spp.)

Keartla spinaca 7

Tenora turbinate

Species cononly present (observed on 2 or more sampling periods)

Conyeacus spp. (C. giesbrechti, C. pacificus, C. epeciosue, C. subulatus)

Coryeacus, E: embawehes, ©- paciticus, C. spesicous, C- aubutatus)

Onewea spp. (0. Bedi terra jenusta, 0. ?Pi

ai

valgaris

Salocalanis pavo

Rocynocera clausi

Species occasionally present

Eucalanus epp. (E- mucronatus, 2. app.)

Tasleutfa flavicomls

ieee

copii

Tabidecers spp.

icfa pachydactyla

?Herocatants longicornts Pontella piuats

Eis gracinis

Macrosetelia

3

---Page Break---

4.1.4 DISCUSSION

The variety and abundance of zooplankton observed at the Punta Manati site were similar at each station and throughout the year. Holoplanktonic forms dominated the yooplankton community. Meroplanktonic organisms, particularly the larvae of gastropods and decapods, and? fish eggs were equally numerous. No obvious patterns of distribution vere apparent anong the zooplankton sampled along the coast or offshore.

Limitations of the Da

The sampling progran was designed to provide quanti-

tative estinates of" 1) the standing stock Of zooplankton,

2) the Variety of major taxonomic groups, and 3) the dic

Yersity and abundance of the more numerous copepod species

The manner of field sampling determined the variety and bic-

mass" of organisms encountered. The data in this report are

based on collections made in the surface waters during the

daylight hours. The sampling gear and methods were Kept

uniform, ive., ?net type, net mesh, towing speed, and depth

range sampled, "A snail nusber of replicate. tows were gathered

at each site to obtain sone measure of the variability? be-

teen samples.? To obtain a better understanding of the 200-

Plankton community More sampling with replication should be

done at frequent intervals, at @ greater? nunber of stations,

at different depths, during the day and night, and during

ditferont. seasons for several years. Information gathered

in these ways will be necessary to interpret fluctuations. in

Standing stock and diversity in relation to environmental

changes in biotic interactions»

---Page Break---

?parnsvou 304 y

est eer we eeu eer est te ex800

ae eee ete een ers ors ge eusort

we ate wet 60L oss a ecro6z

s * e 2 ¢ oF 7 7 sae

SuOTTESS TOES TS

sxoy ex0ussz0

nox exoysavon

nog axeoptdag exouszeext

TeuPERAMT UOSRCPTEOOE Go TequME TCL Tier Sieve

- - : - - - yec80L

- - - : - : - ?yeLsorT

sor ser veo" woes ae 440" 60" ta ectosz

5 * e 2 4 2 a r sea

ses woes BORIS

exon 82009550 smo] esoysivey soy areorrday sacyszroy

ays Tieuey Hluha (jy ta) Werqueydoos Go SPEEORq THIOL ors save

---Page Break---

a er % 6 6 4 6 a eva0u

5 ez eos ost st st or cusorr

8 4 zo tom on ? se extosz,

s * e og Ff oF ow er aed

ToS aS SoS

smog, 21095330 ?snoy, sxoyeaeey, Sho e2t0F doy axoysseey

(gw /soqunu) uorxuetdozou jo zequau Teioz, ist" STEVE

cor ate coc ut eet sor ear ur exeoe

ser ne nue 092 62h Len 99m eee exsorr

coz sts Sut 929 6am orn nes erm ectosz

5 * e t or at area

woes oS wre

smoy, e0uss30 snog o40yss00N ?snog aaRopTdey suoysizeox.

?ays FaruEy esung (<u/soqunu) uosyuetdoToy Jo Gequnu Teop su-t' g1eys

---Page Break---

et on not or or er eu804

oz wz zor cor 9 or eee exsort

nor zor wr ut ae one extosz

s * ? 2 4 eaeg

Woes TOES

snot a1048350 sno} esoysae0K, sno, s2eoFTday ssoysseen,

?(qWor/sequnuy syseuBoyoey> so aqua Te30], Tei-E'y STavL

wn coc eet ue on z er eus0u

sore 16 uat ame ese ue eesorr

Sst oes. str een uae Ste sense sur08e

$ * ? eof ox

Beas ROTTS

so, 8048330 sno s2oys.voy,

*ed¥s Faeueq Brung (,5/saqunU) spodedo> jo zequnu TwIOL

onL-tn Sava

4a

---Page Break---

eh oer son rez use ser are non evo

os cer sun the tHe ao 62 coz exsorr

etm oer 9ze as ose 26s coe extosz

s . e 2 t Es 7 * oaeg

SSPE ROPE ?BuoyaeaS

?smog, ax048350 sroy azoyss09K enon eyeoFTdey suoyexeoN

(_Wor/aequra) eaaey aeByTon Jo aoquna Teron etiets Sava

wots ee se 6m uw z x90

erst 6s one ore ner one fez eusorr

sr ase, woo oget ver 6 ser extosz

s * coz oaeg

Boas Ropes

?sno, 22098530 toy axoysseoy exoysaeey

S3FS TAPUEH EDUNg (,UOT/ZeqnU) SuveDeAIeT Jo aogew THIOL chi-t'n aTeVE

---Page Break---

2 str sor see zw s on eso

s we e+ 6 ze u * exsorr

oz + ok ek m om zz ectosz

s . ec oe or « & sea

BOTS OTS SRA

smog 94048550 smog s0yssoN smog axvortdoy axousseey

(guoT/aeqana) oeasey ueaniysesy Jo voqune TeI02 Sti-t*h SIEVE

6 8 mg or * eea0e

+ az ere ee ah a mr exsort

ese sor ze gee our Re ete ectosz

$ * eo 2 oF oF * oad

os OPTS

nog, 82048330 soy axoysueoy nog savoytday suoyeuvon,

?anys Faeuey erung (,wOT/AoquNE) sPaLeT Woop] Jo aequU THIOL bint'h STGVE

---Page Break---

eee ee & % te ex80e

we mort st se 1 exsorr

ec © ene a * zt extose

$ * e o@ ¢ or a er wea

SOTTS ToS Boyes

sno 22048330 soy axoyssE6y sno oxeoFtdoy. asoysseon

(c2/soqmna) Bo ers Jo aequnu TwieL chiss TRVE

se ? oF ? eo oe exo

z e © 9 us wr eusorr

+ + tk + a + extosz

$ + © 2 ¢ or a ea

Tas TOTS Tas

mou 2048550

nop ox0yeseoy,

smog arvo;tdoy auoysseoy,

Toa7s FAEGUN BLung (,upT/TOquNE) SUBABDOPETD Jo ToquNT TOL Stir STEVE

---Page Break---

42 ZOOPLANKTON STUDIES 1974

by

Mary E. Nutt and Marian N, Yeaman

4.2.1. INTRODUCTION

?The following report provides quantitative estimates of the biomass, abundance, and composition of the zooplankton at Punta Manati on 14 May, 1S August, and 31 October 1974. Comparisons are made with'1973 samples from the same 1o- cation, and with 1974 samples fron two other north coast

Sites, Islote and Manati.

4.2.2. MATERIALS AND METHODS

Field Procedures

Four stations were sampled on each occasion. Station 2 is located in 20 meters of water directly north of the proposed power plant site, and was sampled with three repli Cate tows. Stations 1 and 3 lie on either side of Station 2; Station 4 is offshore at a depth of 100 meters (Figure 4.2-Fi).

Oblique tows from the bottom to the surface were made with 1/3 meter cylinder-cone shaped nets (202 u mesh) towed at 2 knots" Oblique tovs ensure that alt zooplankton species are sampled regardless of their position in the water column at the time of sampling. This is important since many plank-tonic organisms migrate diurnatly and will be found at Oiffer-ent depths during different hours of the day. A 202 u mesh net does not readily clog with phytoplankton and captures @ wide size Tange of zooplankton. The net wag equipped with

a digital flowmeter and approximately 100 m? of water were filtered. Samples were preserved in 4% buffered formalin.

Laboratory Procedures

Samples were washed to remove phytoplankton and detritus, and all animals larger than 1 cc were removed. Approximately 24 hours after collection, ?the biomass was measured by volume displacement (Ahlstrom and Thrailkill, 1962). Zooplankton abundances Were estimated by subsampling. The sample was poured back and forth between two large beakers until thor- Oughly mixed, at which time a subsample was poured out. Repeated subsampling of a single sample shoved all groups

of organisms to be randomly distributed by this method.

---Page Break---

?suoraeas uoryuetdoor yreuey wrung jo UOHIB201 La-2"b ?Sta

---Page Break---

In all cases, subsamples contained more than 450 animals. Each animal was identified to major group and counted. The dominant copepods were identified to species, When replicate tows were taken, confidence intervals

Were calculated from the equation,

r+

where is the estimated mean, t is Student's t-value, s? is

the estimated variance, and n?is the number of samples.

4.2.3 RESULTS

Zooplankton found in the Punta Manati samples are listed in Table 4.2-T1. Copepods are invariably the most abundant organisms, followed by fish eggs, chaetognaths, and larvaceans. Other animals such as ostracods, pteropods, and gastopod veligers are occasionally numerous, but are not always present in the plankton.

Copepods were represented by 48 species, but 80 to 90 percent of these consisted of four species (Temora turbi-hata, Clausocalanus furcatus, Paracalanus sp., and Olthona unifera). Seven other species vere consisiently present femora stylifera, Nannocalanus minor, Calanopia americana, Acareta pinata, ?farranute gracilis, Coryeaeus Spoeand Sieawa spo). the ronaining? copepod? spores appeared spo-radically and in numbers less than 5 per cubic meter.

Fish eggs ranged in abundance from 40 to 117 per cubic meter. Most were clear, round, pelagic eggs. No attempts were made at identification. Fish larvae ranged from 0 to 8 per cubic meter. No identifications were made.

No spiny lobster larvae appeared in the samples.

Table 4.2-T2 shows individual values, means, variances, and confidence intervals for one set of replicate tows made on 31 October 1974 at Station 2. Most of the variances are significantly higher than their means (x° distribution for the variance-to-mean ratio) which indicates a non-randon or "patchy" distribution. The confidence intervals are wide

but realistic for marine zooplankton distributions (Wiebe

and Holland, 1968) and must be considered whenever @ mean

---Page Break---

TABLE 4.2-T1.

HOLOPLANKTON

?COPEPODS

calanosde:

Nannocalanue ainor

Undtnula vulgaris

Fucalanus attenuatus

Rerocatanus Tongteorats

ierocalanus anderson =

Paracalanus aculeatus

Clausccalanus Furcatus

?Euchaeta marina

Beolectthnie danse

Tesora septs

Tenerepages furcatis

eet Aaeicorie eutla Plavicornte

Candacta p

pachyaactya

penal ee

Taptiseara ap

Halopetifs Tongicomie.

Harpacticoids:

Mivacia efferata

Wacrosetella graciiic

Ueuloustella gractTis.

Enterpine acutterons=

cyclopoid:

Ofthona plunifere

?Ofthona setigera

?Oithona oculata

Saphivel Ts topica

Son stasis

Sepia quadrara

SSevensus (eomeamns) easee =

epee ?igetaad Face

Corycaeus (Agetus) Iimbatus

Zooplankton from Punta Manat

a2 a

us coryeaeus) Latus

Zoryeasus (jeaeus) agiite

Oneaee ?mediterranea

Saphieine

Farranala

---Page Break---

Table 4,2-T1 (continued)

?CHAETOGNATHS ?TUNTCATES

sagitta hispida

Eeptite eafacs Talia denocnati

Sees

Feta serrarodentata Pourourres

fronts Sut

PRerosagitta draco Tonopteris spy

ARVACEANS ETOPROCT LARVAE

Ofkepieura sp. Menbranipora nesbranacea

Peteiiianis peazuciaa

GASTROPOD VELIGERS

PrEROPODS

Linseing leseurii ?ONECED LARVAE

?isscins retroverea CHRRIPEDE LARVAE

seeseie acieats

Sqifeta subule RINODERM LARVAE

ostracons ophteptuteus Larvae

Echinopluteus larv.

Euconchoscia chierchiae

FISH LARVAE

?MEROPLANATO FISH B63

[STOMATOPOD LARVAE,

ANpHTPODS

DECAPOD LARVAE

caridea

?Apheus sp.

feknthtyra op.

Penaetde

Seyliaridea

PaLicurus sp.

calatheides

Poreellana sp.

brachyara

sencrsrins

Lucifer sp.

cuapoceRans

Bvadne ep.

Fenftfa sp.

MEDUSAE

SIPHONOPHORES

CTEWOPHORES

55

---Page Break---

Se

TABLE 4.2-T2, Vartabitity among zooplankton replicate tove at

Punta Manati, Station 2, 31 October 1974 (Abundances

in numbers per cubic meter)

as

Total Chaetoz- Larva- Malacos-? Fish

Zooplankton Copepods naths ceans © tracane = eggs

Tow A aui2 1132 82 ve 3 7

tow 8 1878 ao12 48 as 6 83

Tow ¢ 1702 1968 25 68 18 108

Mean 1568 am 42 eo 8 82

Variance 21008 15276219, aa eo 519

BE C.T. 1208 to EK to «S$ to 78 $3 t0 107 0 to 29 26 to
1920 1878 139

a

Figures 4.2-F2 and 4,2-F3 show the 951 confidence intervals for the more abundant zooplankton, groups at Station 2: copepods, malacostracans, chaetognaths, Larvaceaas, fish larvae, and? fish eggs, as well as total numbers, and biomass. Appendix 4.24 shows abundances of zooplankton groups for ail stations and sampling data. Appendix 4.28 shows abundances of the conson copepods species for ail stations and saapiing data.? With the exception of fish eggs, the zooplankton is Somewhat sparser at the offshore station.

4.2.4 DISCUSSION

Im both species composition and abundance, the z00-

plankton at Punta Manati is similar to that at Islote and Tortuguero Bay (Figure 4.2-F4). No important differences between sites can be seen; when a zooplankton group dominates the plankton at Punta Manati it can usually be found in samples from the other two sites.

Youngbluth's data from the previous year (see Section fala foERE ReROTE) show substanclally? fewer" tooplankton

than were found in 1974. This discrepancy is probably due

to differences in sampling methods; Youngbluth used surface tows, Nutt used oblique tows. (See Table 4.2-T3 for a comparison Of surface and oblique tows at Islote.) In general, the Same zooplankton groups and species were Seen both in 1973

and in 1974,

---Page Break---

Copepods

2800

2000 y 7

120 q d

Y

A ry

so» J 4 E

Ta May 18 Aug ST Oct Ta Way 18 Ag 3T Oct

Larvaceans Chaetoonaths

100 -| Y 100 -|

Y q

20 -| Y 80 Y y

wo, 4 «4 H 4

wo 10 4 Y

7 4 4

?go ?ly a ¢

1a May 15 Aug 31 Oct 14 May 15 Aug 31 Oct

Fig. 4.2-F2 Zooplankton abundances at Station 2: 95%

confidence intervals for total zooplankton,

copepods, larvaceans, and chaetognaths.

---Page Break---

Biomass

20

60 -|

20 -

Matacostracans

14 May 15 Aug 31 Oct

Fish Larvae

a

120 -|

40 -|

T4May 15 Aug 31 Oct

Fish Eggs

ESSSSSSSS

a

SSSSSSSSSSSSI

15 Aug 31 Oct

14 May 15 Aug 31 Oct

Fig. 4.2-F3. Zooplankton abundances at Station 2: 95%

confidence intervals for biomass, malacostracans,

fish larvae, and fish eggs.

---Page Break---

ISLOTE MANATI TORTUGUERO

proms 8 |

i

common 0 | ail !

|

J

|

Chaetognaths

Larvaceans

Malacostracans

Fish age

I

rome | |

15 May

20 Aus

5 Nov

1 May

15 Aug

ato Le

4 May

15 Aug

31 Oct

Fig. 4.2054 4 comarison of ssoplankton abundances at Tstote,

Panta?Manaet, and Tortuguero. Bay"

---Page Break---

ue 6e +8 18

car L020 ns or 0 oer crm | on ne on est +10 486

eo eee eet ?a 8 se sure | sete | eoursaey

z se se aw 99 6e ose ceo roy

? ze 5 ze 1 st ne 9 ste0

z zs a of us ee vom 280 080

z ze ¥ 2 su on 908 808 sno

?mos anbTT90

aworol wos 06 03 0 = 60 sae 2 o| exe oro | «3-0 a6

toe o 80m * ezso_ | szeoz_| sourssey

t se or on . est ere wesK

t ee 9 8 ° * att 652 oneo

+ oe % az ° z sor a s260

t an z es ° ° nse *0" st60

seasey usta | sy ysra | oearet avo | spodosasey [spooesasy | _ suseu | epodedoy | trou

2s s00eT eH ~Soi9e4

nox sovzins

(20x0m o¢qno aed soquny) sugt Trady LT

Z uoraess ?mors Ie sMca uoaxuetdooe soesuns pue snbyTqo Jo SoEpaEsaCO Y ?eL-z*y SIEVE

---Page Break---

With quarterly sampling it is difficult to assess

seasonality in the plankton at Punta Manati, but the data

seem to indicate changes which repeat themselves. For ex-

ample, the copepod Temora turbinata dominates the plankton

on 14?May 1974, is sparse 0: lugust, and appears again

on 31 October in numbers greater than before, This pattern

is seen also at Islote and Tortuguero Bay, At this time it

is not known whether this repetition is seasonal or random,

and there has been no attempt to correlate these fluctuations with physical, chemical, or other biological parameters.

As both fish eggs and fish larvae are abundant along the north coast of Puerto Rico, we recommend that any further work at Punta Manati involve a? full-scale study of ichthyoplankton. Many of the reef fishes produce clear round pelagic

S, but so do the commercially important snapper, grouper, and Other food and game fishes, It is not known whether the eggs found in the Manati region are produced locally or by fish living in other areas of the north coast.

The existing data provide little information on the vertical distribution of the zooplankton. Since oblique tows capture more animals than surface tows, evidence exists that the majority of the zooplankton are not at the surface during the daytime hours. We recomend that oblique tows, or a combination of surface and bottom tows, be used in the future. Studies at Islote revealed a significant diurnal

nigration of Brachyuran and Caridean larvae (Youngbluth, 1974). Future work at Punta Manati should include a study of vertical distribution and migration.

---Page Break---

43 BENTHIC INVERTEBRATES AND FISH STUDIES

by

Paul Yoshioka

4.3.1, INTRODUCTION

This report covers benthic studies made at Punta Manati from May, 1973 to August, 1974. The Punta Manati site was visited, but not on a predetermined schedule during this interval. Study stations ranged in depth from $ to 33 meters.

The scope of studies ranged from preliminary descriptive surveys to the establishment of a permanent station. Organisms examined in this study ranged in size from the microscopic in-faunal populations to the macroalgae and fish.

During the latter part of this study a major portion of the investigative effort was spent on the macroalgae, Various aspects of the ecology of the macroalgae were examined as to distributional and temporal patterns of presence and absence, abundance, and species diversity,

4.3.2. MATERIALS AND METHODS

Field Procedures

Field stations at Punta Manati are given in Figure 4.3-F1 and Appendix 4.3. Field collections are divided into three categories: fish collections, transect dives, and station dives.

Fish collections. All fish collections were done in the nearshore (+ 5m) area. Fish were poisoned with roterone (PRONOX-FISH) and collected with dip nets. Fish were collected on four occasions. Sampling sites included both sand beach and rock areas.

Transect dives. Transects were traversed on a predetermined compass direction by two divers, either swinming or

propelled by a diver propulsion vehicle (DPV). Notes were '

taken on depth, bottom type, topography, and dominant oF un-

sual organisms.

Most of the transects were run in a direction perpen-

dicular to the shoreline, thereby transversing a depth gradient.

Several transects were run parallel to the shoreline to observe

changes in benthic communities relative to factors other than depth.

---Page Break---

FAtuEY kang 3 SUOTIeRS PTOFS soFpNas ysTs puE OFUIUOT TH-e'h ?BL

---Page Break---

Stations dives. Dives were made at several stations

to collect quantitative samples. Algac and bottom substrate

were collected in 1/4 m2 samples. Replicates were taken when-

ever possible. Algae were sampled by hand, and bottom sub-

Strate with the aid of a hammer and chisel, Both were placed

immediately in plastic bags held adjacent to the collecting site. Algae and/or bottom substrate were collected at stations.

Photographs were taken when conditions permitted to aid in the general description at the area, The presence and absence and relative abundance of the iarger invertebrates and fish were noted during the latter stages of the investigation.

Laboratory Procedures

Aigal, and substrate samples were brought te. the Laboratory sorted in phylogenetic groups, and preserved in 70% ethyl alcoho or 10% formalin for later identification. References used in identifications are listed in the bibliography, The samples Were often frozen prior to sorting. When sufficiently abundant, both the dry and wet weight of the algal species were recorded.

4.3.3 RESULTS

Description of the study site. A fine-grained blackish sand, probably of terrigenous origin, was found to be the predominant substrate in the immediate vicinity of the mouth of the Manati River. The same substrate was observed at depths over 25 meters, about 1/2 mile offshore of the river. No dermersal fishes were observed in the sandy areas, The only noticeable benthic organisms were occasionat patches of the plant Halophila, observed at 25 meters. Other organisms ob-

Scrved on the sand habieat at the Punta Menai sige were. the

sand dollar Nellita sexies perforata, the sea pansy Renilla sp.,

the starfish Astropecten sp., and the crab Callinectes sp

Beachrock is the predominant substrate offshore from

the rocky headlands to the east and at depths less than 15

meters to the west of the Manati River. The substrate is

usually flat, although at places a depth gradient is noticeable.

Occasional rocky outcrops or depressions up to 1.5 meters high,

or deep, and several meters across are encountered.

lard coral fauna exists (<1$ surface cover). Occasional gor-

gonian colonies are found, principally Pseudopterogorgia fol-

ot

---Page Break---

Most of the fish life observed (~90% of the individuals,

2708 of the species) occurred in the vicinity of rocky out:

c£ops or depressions: Also, the urchin Diadema and the delicately colored hydroid Stylaster were found only in such areas. Shelter appears to be a najor factor deternining the presence of these animals. Stylaster grows under ledges and Diadena was found only in crevices.

Fish and large invertebrate species observed and identified at the Punta Manati site are listed in Appendix 4.3B. Fish species collected at the nearshore poison stations are listed

in Appendix 4.3C.

Quantitative Sample:

Infaunal and epifaunal species identified in the 1/4 m? substrate samples are listed in Appendix 4,3D. Excluding algae and colonial forms, a total of 48 species were found in the three substrate samples. The numbers of individuals Were quite equally distributed among the species. Most species were represented by only one or two individuals which sug: gests that they are "rare" or relative to the quadrat size. ?or instance, the 14 species found in replicate A (Station 3) were represented by only 22 individuals and the 11 species in replicate B by 17 individuals. The "rareness" of the species probably accounts for the lack of similarity between the samples;

only one species was found in common between replicate B (Station 3 and Station 1), and 4 species between Station | and replicate A (Station 3). ?the lack of similarity between the samples cannot be attributed to large-scale habitat differences. Replicates A and B (Station 3) had only three species in common although the samples were taken a few meters apart. It would appear that due to infaunal distribution patterns, the 1/4 me quadrat is inadequate to representively sample the infaunal community.

A total of 28 algal species were recorded from three quadrat samples at Station 2 in June 1974 (see Appendix Only 11 species occurred in all three samples, but these species accounted for 88% of the algal biomass.? These Species also showed significant concordance in their relative abundance in bionass {Kendall Concordance Test, p<0.01), in~ dicating that a 1/4 né sample gives an adequate portrayal of the algal community structure. The dominant algal species in decreasing order of abundance ?were Dictyopteris plagiogranna, Bryothannion triquetrun, coralline algacy Pacocktelia eariegata, ant Anansia aiTtt fda.? these species accounted ter over BOF of the total algal biomass, Algal biomass ranged from 182 to 219 g. (wet weight).

Samples taken at Station 2 in August showed several differences. Algal species diversity was lower; each re-Plicate contained 13 species. In June the nunber of species per

---Page Break---

replicate ranged from 16 to 20. The difference is significant at the 0,1 level (Fisher Randomization Test). No correlation was found between the relative abundances of species in the two replicates, consequently, algal community structures de-rived from these replicates may be artifacts of sampling variability. However, the more abundant algal species appear

to be coralline red algae, Dictyopteris plagiogramma, Bryothamnion triguetrum, and Halimeda Giscoigen

The two replicate samples taken at Station 4 in August displayed an even greater amount of variability. Algal biomass ranged from 3.6 to 119 g per 1/4-m and the number of algal species from? 6 to 15 per quadrat. No correlation was found between the relative abundances of species in the two replicates. However, the most abundant algae was Sargassum polyceratian

A significant correlation between the relative abun-dances of algal species was found for the two replicates taken at Station 3 in June (Kendall-Tau, pc.0S), Algal biomass ranged from 304 to 588 per quadrat which was greater than the algal biomass at Station 4 in June. The dominant algal species in decreasing order of abundance were the coralline red algae, Dictyopteria plagiogramma, Anansia multifida, Bryothamnion

triquetrun and Botryocladia occidentalis, These species ac-count for over SOF OF the algal biomass,

In summary, no trend was found for algal biomass through tine or depth. ?Algal species diversity increased with depth (Stations 2 and 3 in June, and Stations 2 and # in August)

and decreased from June to August (Station 2). However, these trends were not significant at the 0.05 level.

4.1.4 DISCUSSION

The most noticeable difference of the benthic biota between the Punta Manati site and the Tortuguero Bay site, a few miles to the east, is the dominance of the algal comminity which is probably associated with the exposed condition of the Punta Manati site. Most of the Tortuguero Bay site is sheltered by Punta Chivato from the predominantly northeasterly swell.

Visual estimates of the cover of the hard bottomed

substrate by algae ranged between S0 to 80% depending upon station or season, The relatively high abundance of algae Suggests that competition for substrate space may play an

important role in the algal community. Competition usually tends to reduce species diversity. However, algal species diversity was at least moderately high; the number of algal

---Page Break---

species found in any single 1/4 m? sample ranged between 6

and 20. Grazing by urchins has been found to maintain high algal species diversity in other algal communities (Paine and Valas 1569, Ogden et al., 1973). flowever, only a few indi= viduals of? the urchin Diadema were observed, all of which occurred in crevices oF other sheltered positions, No other Racroinvertebrate grazers have been observed in the area. The only other algal grazers observed were schools of surgeon fish, Acanthurus spss

Consequently, if competition is a major feature of the algal community and'if the effect of grazers is minimal, then other ecological processes may be responsible for maintaining algal species diversity at Punta Manati, One possibility is the role of physical disturbance. If environmental changes on a time scale are roughly equivalent to the generation

fine of the competing species, competitive exclusion Will

not occur (Hutchinson 1961). ?Several factors suggest harsh, possibly seasonal, changes in the benthic environnent at Punta Manati. The Punta Manati site is exposed to the pre-dominant northeasterly swell and its accompanying surge and scouring action. When visited, the rocky substrate at Punta Manati was always found to be covered by a thin layer (~4 cm) of sand which suggests considerable sand movement across the bottom. In addition, Diadema were always observed in crevices or other protected situations whereas in other less exposed areas along the south coast they are often found in open water. The greatest abundance of gorgonians and hard corals was often found on rock outcrops where they would be less exposed to scouring action.

With sufficient physical disturbance in the forn of surge and scour, the domination of the bottom substrates by one or more algal species could be prevented. Further long term studies would be required to test this hypothesis.

Limi

ions of the Data

From May 1973 to the present, benthic studies at the Manati site have been headed by a number of different in-vestigators. As a consequence, the research enphasis has changed in the course of this study.

There are little data relevant to seasonal or other temporal changes in the benthic communities at Punta Manati.

?The preliminary portions of this study were necessarily concerned with general descriptive surveys of the Tortuguero Bay site. Only gross temporal changes in the benthic communities would have been noted in such circumstances. Studies at permanent stations did not begin until the terminal portions

of this study, and with site visits only occurring on a quarterly basis it was impossible to distinguish between seasonal and other temporal changes in the biota.

---Page Break---

If the ultimate goal of any environmental study is the prediction of the effects of a pollutant on a natural community, many of the parameters which have been examined (species lists, distributions, biomass, diversity indices)

in this or other investigations, though often necessary as preliminary studies, are inadequate in this regard. Distributional studies?or species lists no matter how complete provide little insight into the interactions of their component species. Diversity indices are highly speculative in their origin and their ecological implications remain a source of controversy (Fager 1972, lledgpeth 1973). These parancters provide only a static outlook on a community.

What is required is an awareness of the dynamic processes responsible for the control and regulation of natural communities. In order to predict the effect of a disturbance Such as thermal pollution, first it is necessary to understand the mechanisms which maintain the organization of @ community, and then how these organizing mechanisms will be affected by this pollutant (Dayton 1972). Several studies have shown that ecological processes such as predation and competition are responsible for the observed structure of many natural communities (Janzen 1970, Harper 1969, Huffaker and Kenneth 1959, Brooks and Dodson 1963, Hall et al., 1970, Paine 1969, Conell 1961, Dayton 1971, Paine and Vadas'{969, Kitching and? Ebling 1961, and Ogden et al., 1973),

---Page Break---

44 PLANT ASSOCIATIONS

by

Michael J. Canoy

4.4.1. INTRODUCTION

The north central coast of Puerto Rico is bounded by a narrow beach/dune community. The mean height of the forest is 2-4 meters with coconut paims rising higher

The prime site at Punta Manati occupies a low hill just east of the mouth of the Manati River. The area is predominantly sand, consolidated beach rock and limestone.

Piant communities in and around the plant site are typical of the area from Palmas Altas to Tortuguero. There are four distinct major conmunity types. Two of these, moist asslands and successional "fence row? communities, are junan artifacts. The other systems, the beach conminity and Secondary growth mesophytic communities on the two hills are disturbed but more diverse. Mango, Mamey and Cupey del rio trees occasionally occur up to 30 feet tall.

The exposed beach and oceanward face of the dune repre- sent a continuous attempt by plants to maintain themselves in a high energy environment. Cne of the worst things that can happen to this association is disruption of the dune integrity. This allows erosion to begin and the association to be washed away.

4.4.2 MATERIALS AND METHODS

For the adjacent north coast sites (Tortuguero Bay, Punta Manati and Punta Chivato) a simple survey method wa:

used. Beginning 1/2 kilometer west of the Manati site and continuing 1/2 kilometer east of Punta Chivato, a transect following the coastal highway was covered. (See Figure 4.4-F1). Within every kilometer a 10 meter transect was walked on both Eides of the road. The major vegetation along this transect was noted and unknown species were taken to the Mayaguez laboratory for identification.

At the end of each sample transect a one meter square was sampled for grasses, vines, and forbs. A common plant species list for the Punta Manati area is given in Appendix 4.4A.

je area was surveyed for animal species, also. Appendix 4.43

---Page Break---

?suoyaeyoosse queqd 105 Aoains woxe yaeuey eaund ?La-py"y ?Sta

nva20

DHNYAY

07314 TWwnoiss30ns_JS

AS34804 DHAHdOSaW SW

mou 30Nas Yd

ALINMWHOD 34OHS/HOVIE SQ

Tawny.

?om

70

---Page Break---

lists vertebrate and invertebrate species observed during the study period. None of the species observed is known to be on any list of threatened or endangered species. The species lists derived were smaller but very Similar to the extensive lists derived from the study made at Barrio Islote (see Environmental Report for NORCO-NP-1), therefore it was Assumed this method was qualitatively accurate.

4.4.3 RESULTS

Generally the vegetation can be divided into four distinct community types: beach community, secondary growth mesophytic conmunities, moist grasslands and successional "fence row" communities.

The beach community is largely composed of Iponea spp., Sporobolus, Kyllinga, and Remirea. This community is a very wagit entity and Cepands of contfacts monthiy. Ta storm periods it may disappear entirely and return a season later.

Beach thickets more or less extend from the mean storm wave level into the edge of ?the pasture and fields. The seaward edge of the thicket is about one meter in height. This increases inland to about $-6 meters. A few coconuts, almonds, and Tabebuia reach 8-10 meters.

Mesophytic growth here is typified by Chrysobalanus, Byrosonima, Naney, Cupey del rio, with undergrowth of Smitax, Nepsera, Portulaca and-Crototaria? ?The beach xevarch is typically dominated by Iponea, Remirea, Coccoloba and Lantana.

Chrysobalanus and Tebebula are developing 50 to 60 meters from the-shores

Secondary growth is typically composed of human satellite plants such as Tabebuia, coconut, almond, and black olive. Fiamboyan and Cassia trees appear occasionally and Maney apples have been planted. Around "fence row" communities

\d human habitation are bananas, plantains, oranges, and avocados. These plants should be surveyed for resident back-ground radiation (total beta and gamma spectrum and total) prior to operating any nuclear facilities.

n

---Page Break---

REFERENCES.

Ablstrom, D. H. and J. R. Thraikill, 1962. Plankton volune loss with time of preservation. CALCOFI Rept. 9:57-75,

Almy, C. C., Jr. and C. Carrion-Torres, 1963. Shallow-water stony corals of Puerto Rico. Carib. J. Sci. 3(2§3}:133-162.

Anikouchine, W. A. and R. W. Sternberg, 1973. ?The World Ocean: An Introduction to Oceanography, ?Prentice-fiail, Inc..,"Englewood Cliffs, N.J-

Bailey, R. M. (Chaiman), 1970. A List of Comon and Scientific Names of Fishes from the United Statés and Canada (Third Edition. Aner. Fish. Soc. Publ. No. 6:1-149.

Bayer, F. M., 1961. The Shallow-water Octocorallia of the West Indian Region. Martinus ?Nijhoff, The Hague, Netherlands.

Bigelow, i. B. and W. C. Schroeder, 1953. Fishes of the Gulf of Maine. Fish and'Wildl. Serv. Fish. Bull. 74, Vol. $3, U. S. Dept. of the Interior, GP, Washington, D.C.

Bohike, J. E. and C.C.G. Chaplin, 1968, Fishes of the Bahamas and Adjacent ?Tropical Waters. ?Acad. of Nat. Sci, of Nat. Sci. of Phila., Livingston Publ. Co., Wynnewood, Pa.

Breder, C. M., Jr., 1948. Field Book of Marine Fishes of the Atlantic Coast.

G.'N. Puthamn'S Sons, ?New York,

Briggs, R. P., 1965. Geologic Map of the Barceloneta Quadrangle, Puerto Rico:

1-142. Ul S. Geological Survey.

Brinton, E., 1962. Variable factors affecting the range and estimated concentra-

?tion of euphausiids in the North Pacific. Pac. Sci. 16:374-408.

Brock, V. E., 1954. A preliminary report on a method of estimating reef fish pop-

ulations: J, of Wildl. Mgmt.? 18(3):297-308.,

Brooks, J. L. and $. L. Dodson, 1965. Predation, body size, and competition of

Plankton: ?Science? 150:28- 35.

Carpenter, E. J.) S.J. Anderson, and B. B. Peck, 1974. Copepod and chlorophy11

Concentrations in receiving waters of a nucléar power Station and problens associated with their measurement. Estuar. and Coast. Mar. Sci. 2:1-25.

Casey, J. G., 1964. Anglers guide to sharks of the northeastern United States ?Mine to? Chesapeake Bay. bur. of Sport Fisheries and Wildlife, Circular 179, Washington, D. C.

Corvigon, F., 1964. Los Corycaeidae dol Caribe suroriental (Copepoda, Cyclopoida). Mem. Soc. Science Nat. La Salle. 24:163-201,

n

---Page Break---

Cervigon, F., 1966. Los Peces Marinos de Venezuela, Tomos I y II, Monografias Nos.'11y 12, Fundacion La Salle de Ciencias Naturales, Caracas.

Grace, F. A., 1972. The shrimps of the Smithsonian-Bredin Caribbean Expeditions with a summary of the Nest Indian shallow-water species (Crustacea: Decapoda: Natantia), Smith Contr. Zool., No. 98.

Chaplin, C.C.G. and P. Scott, 1972. Fishwatcher's Guide to West Atlantic Coral Reefs.? Livingston Publ. "Co., liynnewood, Pa.

Clark, H. L., 1935. Scientific survey of Porto Rico and the Virgin Islands. A?handbook of the littoral echinoderms of Porto Rico and the other West

Indian islands. N.Y. Acad, of Sci. 16(1).

Connel1, J. H., 1961. The influence of interspecific competition and other factors on? the distribution of the barnacle Chthanalus stellatus. Ecology 42:710-723.

Darwin, C., 1854. A monograph on the subclass Cirripedia. Ray Society, London: ?Repr. by Johnson Reprint Corp. (1968), New York.

Dawson, E. Y., 1956. How to Know the Seaweeds, William C, Brown Co. , Dubuque, ?fowa.

Day. J. H., 1967. A monograph on the polychacta of southern Africa, Parts I and Ii. British Museum (Natural History), London.

Dayton, P. K., 1971. Competition, disturbance, and comunity organization: ?thé provision and subsequent utilization of space ina rocky interitdal community. Ecol. Mon. 41:351-389.

» 1972. Toward an understanding of community resilience of the potential effects of enrichments to the benthos at Meshundo Sound Antarctica. Proc. Coll. Conserv. Prob. in Antarctica, Ed. B. C. Parker, Allen Press,

p. 81-85.

Dukin, W. J. and A. N. Colefax, 1940. The plankton of the Australian coastal waters of New South Wales.? Univ. Sydney Dept. Zool., Monogr. 1.

Elton, C., 1966. Animal Ecology. Sedgwick and Johnson, London.

Fager, E. W., 1972. Diversity: A sampling study. Am, Nat. 106:295-310.

Fields, F. I. and D. G. Jordan, 1972. Storm-wave swash along the north coast of Puerto Rico; HA-430." U. 8. Geological Survey.

Fraser, J. Hl. and V. K. Hansen (Eds.), Fiches d' identification du Zooplankton. Conseil Permanent International Pour 1'Exploration de la Mer. Andr. Fred. Host § Fils, Copenhague.

Frost, B. and A. Fleminger, 1968. A revision of the genus Clausocalanus (Copepoda: Calanoida) with renarks on distributional patterns in diagnostic characters. Bull, Scripps Inst. Oceanogr.

Glynn, P. W., 1964. Conon Marine Invertebrate Animals of the Shallow Waters of Puerto Rico. Inst. Mar. Sci., Univ. Puerto Rico, Mayaguez,

3

---Page Break---

Goldberg, W. M., 1973, The ecology of the coral-octocoral comunities off the Southeast Coast of Florida: geonorphology, species composition, and Zonation. Bull. Mar. Sci, 25:465-488,

Gonzalez, J. G. and 7. E. Bowmn, 1965. Planktonic copepods from Bahia Fosforescente, Puorto Rico, and adjacent waters. Proc, U, S. Nat. Ms. 117(3813):241°304,

Grice, G. D., 1960. Copepods of the genus Oithona from the Gulf of Mexico. TRAIL. Mar, Set. 10:488-490.

1961. calanoid copepods fron equatorial waters of the Pacific Ocean. ish. Bull. 61:1-246.

1963. A revision of the genus Candacia. Zool. Medelingen.

eT.

Grigg, R. W., 1972. Orientation and growth forms of sea fans, Limmol. and ?Oeeaoge 17:185-192.

Hal, D. J., W. E, Cooper, and E. E. Werner, 1970. An experimental approach {to the production dynamics and Structure of fresh water animal communities.

imnol. and Oceanogr. 15:839-929,

Harper, J. L., 1969. the role of predation in vegetational diversity. Brookhaven

?Symp. Biol. No, 22:48-62.

artman, W. D., 1988. A collection of sponges from the west coast of the

Yuedtan Pehinsula with descriptions of two new species. Bull. Mar. Sci.

Gulf Carib. 5(5):161-189, and A color key £0 the sponges of ia Parguera,

Puerto Rico. ?Inst. Mar. Biol., Univ. Puerto Rico, Mayaguez, No. 1789.

Hedgpeth, J. W., 1973. The inpact of impact studies. Helgol. wiss. Mures.

4: 436-445,

Hickenlooper, 1. J., 1967. Floods at Barceloneta and Manati, Puerto Rico; HA-262.

U.S. Geological Survey.

Huffaker, C. B. and C. E, Kenneth, 1959. A ten year study of vegetation changes

?associated with biological control of Klamath weed. J. Range Manag. 12:60"82.

Husclnan, K., 1966. revision of the genus Lucicutia. Bull. Mar. Sei, 16:702-747, Hutchinson, G. E., 1961. The paradox of the plankton. Am, Nat. 95:157-145.

Hyman, L. H., 1955. The invertebrates: Echinodermata. The coclomate Bilateria.

VoL. 4

Janzen, D. H., 1970. Herbivores and the number of tree species in tropical

forests. ?An. Nat. 104:50-528.

ass,» 1972. Polypacophora of the Carithean region. Stuies on the fauna

?Of Glracao?and other Caribbean islands. 41(13)):1-162,

Kendall, T. R., E. D. Wood, and T. Smith, 1975. Hydrographic data report,

north coast of Puerto Rico, 1975-1974, PRNC Report=177.

---Page Break---

Kinzie, R.A

UII, 1973. The zonation of West Indian gorgonians. Bull. Mar.

sel. 2s)

138!

Kitching, J. A., and P. J. Ebling

1961. |The ecology of Lough Ine XI. The control
of algae by?Paracentrotus Livi

(Echinoidea). J. Animal Ecol. ?30:373-383.

Laubengels, M. de, 1956. A discussion of the sponge fauna of the Dry Tortugas
in particular? and the West Indios in general, with material for a revision
of the fanilies and orders of the Porifera. "Publ. Carmeg. Inst. 467
(Paps. Tortugas Lab. 30):1-228,

1949. Sponges of the western Bahamas. An.Mks. Novit.
Woes.

Manning, R. B., 1959. Key to the genera and species of Western Atlantic Stomatopoda. After Schmitt, W. L., The stomatopods of the west coast of Anerica, ?based on the collections made by the Allan Hancock Expeditions, 1933-38. Allan Hancock Pac. Exped., (4) :129-255.

Mclean, R. A., 1951. Scientific survey of Porto Rico and the Virgin Islands. The Pelecypoda of Porto Rico and the Virgin Islands. N.Y. Aead. Sci. 17(2).

Menzies, R. J., and P. W. Glynn, 1968. The comon marine isopod crustacea of Puerto Rico. Studies on the Fauna of Curacao and other Caribbean islands. 27(008) 1-133.

Monroe, W. il, 1971. Geologic map of the Manati Quadrangle, Puerto Rico-Map T-ie7, U's.6.81, Dept. of the Interior-

National Ocean Survey, 1971. Tide Tables 1972, NOMA, U. S. Dept. of Comerce.

National Oceanic Survey, 1972a. Tide Tables, 1973, East Coast of North and South Anerica, NOAA, U. S. Dept. of Comerce.

?_____., 1972, North Coast of Puerto Rico, Chart No. CUGS 903. NOM, Dept. of Comeree, Nov. 4, 1972.

National Weather Service, 1973. Raw weather data taken hourly at San Juan Intemational Airport. NOiA, Dept. of Camerce, San Juan.

Nutt, M. E., 1975. Islote Environmental report, 1975. Puerto Rico Nuclear Center.

Ogden, J. C., R.A. Brown, and N. Salesky, 1973. Grazing by the echinoid Disdena antillarum Philippi.? Formation of halos around West Indian patch reefs. Science 182:715-717,

Opresko, D. M., 1973. Abundance and distribution of shallow-water gorgonians in the ?area of Miami, Florida. Bull. Mar. Sci. 28:535-538,

Ovre, J. Bs and M, Fayo, 1967. Copepods of the Florida current. Fauna Caribaea 1:1-137. ps

Paine, R. T., 1966. Food web conplexity and species diversity. An, Nat. 98:97-108.

---Page Break---

Paine, R. T. and R. L. Vadas. 1969. The effect of grazing of the sea urchin, Strongylocentrotus, on benthic algal populations. Lim, and Ocean." 14:710-791.

Park, T. S., 1970. Calanoid copepods from the Caribbean Sea and Gulf of Hexico,?2. New species and new records from plankton samples. Bull. Mar. Sci, 20:872-546.

Provenzano, A. J., 1959. The shallow-water hermit crabs of Florida. Bull. Mar. Sci. Gulf and Carib. 9(4):349-420.

1961. Pagurid crabs (Decapoda, Anomura) from St. John, Virgin Islands, with descriptions of three new speices. Crustaceana, 3(2):151-166.

Puerto Rico Nuclear Center, 1972. Preliminary report on the survey of, Tortuguero Bay site for the installation of nuclear power plants. Report to Puerto Rico Kater Resources Authority, Aug. 23, 1972.

1974. PRNC-174. Punta Higuero power plant

?cavironmental studies 1973-1974. Report to P.R. Water Resources Authority.

Puerto Rico Water Resources Authority, 1975. North Coast Nuclear Plant No. 1 Environmental Report.

Rathbun, M. J., 1933. Scientific survey of Porto Rico and the Virgin Islands. Brachyuran?crabs of Porto Rico and the Virgin Islands. N. Y. Acad. Sci. 15(1)

Roos, P. J., 1971. The shallow-water stony corals of the Netherlands Antilles. ?Studies on the fauna of Curacao and other Caribbean islands. 37(130) 1-108,

Rose, M., 1933. Copepods pelagiques. Faume Fr. 26:1-374.

Schmitt, W. L., 1935. Scientific survey of Porto Rico and the Virgin Islands. Crustacea Wacrura and Anomura of Porto Rico and the Virgin Islands. N. Y. Read. Sci. 15(2):125-277.

Schultz, G. A. 1969. How to Know the Marine Isopod Crustaceans. Willian C. Brom Co.; Dubuque, Towa,

Shoemaker, C. R., 1935. Scientific survey of Porto Rico and the Virgin Islands. ?The amphipods of Porto Rico and the Virgin Islands. N. Y. Acad. Sci. 15(2):229-262.

Smith, F. G.W., 1971, Atlantic Reef Corals. Univ. Miami Press, Coral Gables, Florida.

Smith, P. E., RC. Counts, and R. 1, Clutter, 1968. Changes in filtering efficiency of plankton?nets due to clogging under tow. J. Cons. perm. int. Explor. Mer. 32:252-248,

Smith, S.V., 1973. Factor-analysis of presence-absence data in Atlas Kanesha Bay: A Reef Ecosystem under Stres

Strickland, J. D. H. and 7. R. Parsons, 1968. A Practical Handbook of Seawater ?Analysis, Bulletin 167. Fish. Res? Bd. Canada, Ottawa.

---Page Break---

Suarez-Caabro, J. A., 1955. Quetognatos de los mares Cubanos, Mem. de la Sociedad Cubana de Historia Natural. 22:125-180.

Taylor, W. M., 1960. Marine algae of the eastem tropical and subtropical coasts of? the Americas. Univ. Michigan Studies Sci. Ser., 21.

?Thomas, L. P., 1962. The shallow water anphiurid brittle stars (Echinodermata, Ophiuroidea) of Florida. Bull. Mar. Sci. Gulf Carib. ?12(4):623-604.

?Treadwell, A. L., 1939. Scientific survey of Porto Rico and the Virgin Islands. Polychaetous ?annelids of Porto Rico and vicinity. N.Y. Acad, Sel. 16(2): 151-319,

Van Name, W. G., 1930. Scientific survey of Porto Rico and the Virgin Islands, The ascidians of Porto Rico and the Virgin Islands. N. Y. Acad. Sci. 10(4) 405-535.

?_____, 1945. the North and South Averican ascidians. Bull. Aner. Ths. Nat Hist., 84,

Vicente, V. P. A key to the sponges of the West Indies. Unpubl.

Wamke, G. L. and R. T. Abbott, 1962. Caribbean Seashells. Livingston Publ. ?Co, liynnewood, "Pa

Wiebe, P. H, and W. R. Holland, 1968. Plankton patchines repeated net tows. Linnol! and Oceanogr. 13:515-321.

Williams, A. B., 1965. Marine decapod crustaceans of the Carolinas. U. S. Fish?Wildl.?Serv. Fishery Bull. 65(1).

Wood, E. D., 1974. Punta Higuero power plant environmental studies 1973-1974. PRNC-174,

» 1975a. A Manual for Hydrographic Cruises. In preparation (as a PRNC Report, 1975).

Wood, E. D., M. J. Youngbluth, M. E. Nutt, P. Yoshioka and M. J. Canoy, 1975b. ?Tortuguero Bay Site Selection Survey, Puerto Rico Nuclear Center, Mayaguez.

Wood, E. D., 1975c. Aerial infrared scanning of discharge regions of present and alternate power plant sites. Puerto Rico Nuclear Center, Mayaguez.

Yamaji, I., 1973. Illustrations of the Marine Plankton of Japan. Hoikuska Pub. Go. Led.

Youngbluth, M. J., 1973, Results of the plankton survey at Bahia de Tortuguero Punta Manati and Quebrada de Toro. 1 yanuasy and March 1973. Unpubl.

report, FNC.

??________., 19748. Die1 changes in the composition of a tropical,

?coastal zooplankton comity.

n

---Page Break---

Youngbiuth, M. J., 1974. Diel changes in the composition of tropical 200-

Plankton assenblages from coastal waters around Puerto Rico." Unpubl.

report, PRNC.

,1974c. Survey of zooplankton populations in Jobos Bay.

?Unpubl. report, PRNC.

8

---Page Break---

euoqazpuc> uyer

snoyaea ayeoypuy sequmt soulyH

sPupdoreasp zo Ow/tro mwserdysate>

Baya103 Krrexoue2 ?spmot eo o-keseya-ute>

ssmoy 36° Suzanp

Foghat? saea9N uoy3dzs9seq ope

aya 30 e8uey> *potaeyoun So oreo cams

Dyas;aa3o8s TOUR oy UO Aye 50 9383 i

Teerissoerrag stow ot uo AX 50 9838 20 saava GNIA-¥aS 30 auVIS

*pedotessp set Buywooaq so

Aupatossrp Atres0Ues spnOId TO

?spnoto adeoxe ?_-arqeauseqo 304 so ponies

?sxos2ss0uphy on =o 30U JuamoTeAeP PROT 00

+60 x03 adoaxe ?anoy Suspeooad

943 Bupanp to uoyreaiseqo jo outs 943

ae dyys oy3 ae nous Surazyap uo ?wsoxe

pues ?usoasienp +80; ?uoyaeaydyooad ON ?6T-00

swozeatesgo 50

?wo0u ontq so) used3-KeFn

Tq Ueoud 20) ontg-YoyUDeA

Te

fous 04a 3° deus ou av uoraeazdzoozd ON *Eh-00 vent doeg--?-?-----00

oyadza9e0q ?p09

009 avis waEEvaM ?3000 1V0S WOTOD ALVA "EOI

"8000 STZ ?O° - INMOAV QXV gaxL aNOTD ?ALTTEEISIA *waHIVaN

?QNOOTS Id SUSE NI - GTIAS OXIA

*SaNoO8S NI - GOTHId AVA

"000 SAVK GNIN SIZ ?OH = LHOTaH GAVA

?Hdd 9810 IHo0aS ~ AONTAVESNVAL

*t0°O X HAIG ONTTAVS MAMIXVR = HLdzO "daVS-XVH

SU *WV-00/NT SINSTALON ?SESLER NE SAV SHLEGO TV

wi'e xaonaday

---Page Break---

equa up passsoo Aye 50 aunoey

"2009 43409 an0T9

?aco ALTarerstA ?Moo NoTuogara ssvaKoD

---Page Break---

seve

or-Wna

27930 B¥MLUYICHI1 =» S3DUBL Hat DCNUBHLAMIUS

---Page Break---

sete gyi9e er

Boy eae'e ar+92 °

SHid30 CuvONYIS ez 2ze

ger9z ot 8 et ot

ety ee" geese sy-92 OD

9:7 08°2 a0"2 Orr9z BE-92 Myr92 2T Bk

SOM@ Ayse V/9K /7H 1-915 NITWS GAYE ML LONE 2k 29 Bet

N3oaxo da ca) Lea)

666" wOLDVS T33HH_BBLGH 266" _Y3LTL N3DAx0

2 Mowy 3uIM et 41430 KYW 9¥907 GGTT ?1nd GGT BHI, SSIH T 1S¥D

a ¥O102» LHOT3N 3AYR LAY ONDTD 940 OTWNH 138 Bt eEe99e 9NOT

tae ¢30 TINS @ D3KIC 3am 8 3eA1 ONO7D B"@ LIK gwSL ON 2ta-BTLYT

#eyaSivua gg D9KTC ONIM «C ALITIBISIA @rez keO gud erst enon

9 Goluad 3AYA gt 2073A GNIM 20 M3HLV3M O'BTOT ?ORYE E¥/TA/ 29 GVO

£62220 32N¥343y ONHa YFewd NoTivAS 228 381069 ORKNTY. A

e2

---Page Break---

vere

6606

Sc:%6

scte6

stre6

32'96

ary

68'56

S2te6

ie ASK

9)

a

29'y

sory

aw

Na9AxO

42 3ony 3uIM

et wo102 4HO13H

d30 DINOS aa O34T0

© UdSNNEL 60 O3uI0

@ GOluad 3AVK et 90738

t66"

Dy

3am

3AM

ont

NIM

?Vezez@ 30N3¥3s3u INMe

Mia!

°

e

a

za

sagroe

cre"98

ssurse

aster

oosrce

aes'se

2erron

Teerse

vostas

a

zor eet

1962 6

wer92 as

962 og

Lotse ee

orez at

apr e

Sh4g30 GuyaNYLS 162 2ze

U6'v2 gate Loe? ST 9 68 oT

e192 Baro eer92 21 8 eas

dgs2 gore devez Gt oo 6 £2 2

Oy'92 ayroz es92 TE @ ag

AVL WU NS BL 20 Sun

ow cay 41430

MOLOVS 733KM 8913 66" U34IL N3DAKO

30 xVA O01 LTT

AWY 0n072 $48 GIKNH 738

34A1 00079

@ 13H aw3L

AATUBISIA $22 480 aW3L

waHLVIN geezet?OUVE

@t-vid NOLLVAS

?1nd TST JWI, SSIK T usvD

* £tpg+99@ 9NOT

Ngttf-or YT

Ter uno

se/ter 28 L¥0

228 3SINY2 oBHNTYd Ay

a

---Page Break---

gesro8 aerct

So9-9R aerat

ByLt99 L615T

928-99 9Et2z

195798 9989

attr 99 Oc+sz

4s'a0t oe'> 60L'6e aye

186 vetp 269'sR et9z

66546 2Ltb Terr ocr9z

rs 2uty eesise 6or9z

Carrs ety Besice Braz

SHid30 GuVONTIS ?a6z zee

S2iy Lv'92 sis'os Ottet Bere et-et ot tee eoz oes

Gry Ter92 Gs9'9e Borat Bore GeraT Zt chz Te ace

6979 90°92 vEci9e O2'0Z Ba'e Bz"oz Gt Bez Er ade

TSty Gyece peer9s e922 ectzz Terzz TE 8 Set OST

WWL9IS NIWS 3AYL ML TL NS BL 8D Sutn

NZDAXC dw tay H1d30

43

SOM AYSx

466° MOLOVS T33HK BBLS 66" YILTL N3OAXC

ST FNONY 3UIM Gat HLe30 XYW 9¥907 966 ?LN GET GHIL SS3K 2 LS¥D

see v2 966°9¢ @9'NZ BOD By'HZ St BE 65 Bet

6:9 yOry G¥is2 GEL'Ge Or'9Z Gore ey9z Zt by as aS

v9 Zety vers? SuI'Ge BE'SZ GO" BE9z GT 12 G2 Sz

0:9 2c Ge's2 apgice Bx°92 Tr'oz Se'92 TS ook 8

Won WW LOIS NITS 3AYL WL TL ON BL 29 Sut

N394x0 awh «ay Hia30)

466" YOLDV4 T3ZHN Y3L3W 166" USLTL_N3DAXO

Ot 31OW 3YIN GBT HLd30 KYH 1V9O1 Szet ?LHD pT GNIL SSIH TF LsvD

40703 AHQIIM BAYH ¢ _uWW GNO72 228 OIWNW TZU MH Bt ye-998 9NOT

@zeg 430 31N0s ?93810 3avm «8 3dA1 GnO7D aR 3M gwIL ON OT TE-AT YT

se avdGNvHA «TT -D5uI0 GNM §?@ ALITIBISIA G°Z2 AUC gW3L ret non

§ Golvad 3AYH G8 90738 GNIM Ze waHLVIK EGRET ONY «Eu /Tas Za LYE

Gezzze 30NIU3494 ONKS OT-¥W NOLLYLS 228 381nND oBHNIs Aw

---Page Break---

8G'96 6919 o9ty cetez zegtce Orr9z er

9296 LLY ¥L'y GESZ ROG'SE THt9Z @

SHid30 GuvONvLs 262 228

So 66196 699 99"y GEre2 zoErse Ovr9Z BB'a By'9z Gt Tr AT BT

dat 92496 Lc'9 pty GEEZ ogrse Tyt92 Tht9z Byioz Tr Be

SOKe AVSx VOW T/1W LOIS NITS GAL KL LON FL dg SUT

Na94x0 du3L (ay M630)

466" WOLOYS 733HH B313N 66" YILTL N3DAXO

@ 37ONY BUI BS -HLg3C KYW 1¥907 wHTT ?LHD ¢7GT BNI SS3H T LSVO

ry 40102» AHOI3H 3AYH -< _Ldy GNO72 $28 GIHNH TZ C*Ee=998 9N07

6200 d30 DINOS 8a 93410 3AYH «8 da GNOTD «ATE 13M GHA NB*6z-8T YT

fe eyaBNNAL = 6893410 ONIN ALITIGISIA 9°22 AMO aWaL CST non

G Goluad 3AVK GT D0T3A ONIN Zo MSHLVIH BtATOT = OWS «L/Ta7 28 10

262220 30N3U3434 ONue Va-vkd NOLLYLS 220 38Iny2 ogHntyd Aw

a5

---Page Break---

22490 9

atics ects

9yr69 Lute

99'ae 95'S

gras 22°9

6¢a0T a6'9

orteot 2ere

?29s

Beree

S6*oat 96°89 cay

YELIN SOM ?LYSK 9K 177M 1 91

NBDAXO

468"

Ot TONY IWIN get Hig

at xon09 AMI3H 3aNH 2

eta 30 JINOS Ga O3uI0 JAY 8

eydSNVuL gg -D3NI0 GNIK 8

@ Goldad 3AYH «gt 073A anim ze

30N3U3434 ONNa

yore?

$1982

9°92

a 792

tg?

yr92

T5192

SI

atte aoe

52 00°2

re'se ago

192 as*9;

S NTS 3A, AL

dn

wOLd¥s 73348 ¥3LIH

30 XvW W907 acct *

any anova)

4anon3

ALIgigiA avez

WIMLy3m 9°ctoT

@2-YWe NOTLYAS

eer

SL

a6

a

22

er

e

Hid30 GavONYiS ?gez 220

?i162 9T 40% g6 got

@yr92 2T 6h by Bs

pers? ct 12 92 s7

2te2 tt 8 8 eb

TL Ne FL 20 3atn

3a (a) 1430)

s3ery BILTL N39Axo

AnD @°6T 3HIL SS3K Tt LS¥D

THK 738m LiEe-998 9NOT

Aa dWL ON 6tag-eT LT

AWD @W3L 6*6T non

uve = ee/tey te iva

228 3SInND guns Au

88

---Page Break---

azte

gata

acre

az'e sot

YELIN SOHe

at yor09

@4e@ 430 DINOS

2 eyaSNVEL

9 Goru3e 3n¥H

sezeze

Tete arto acheo8

stty ass"9¢

grct9s

g9ct9¢

209798

eterog

aclse

T2968

629'50

et9"68

8629'S

ety Le'92 terton

Sty Gc'92 esscor

Sty att92 escc9e

#2" 26's2 c9L"9e

Win 1 als Niivs

?grat ees

orrat aez

te-22 zez

grize act

Terre eat

apse &e

292 re

?a ee

a az

oer er

oee e

SHid30 GavaNris |

eoret Goret et Tee 662

ore 8t Syt8t 2 yz ace

teraz Terez <t 902 vez

Ote2z st+z2 ut+22 TT @ est

GAYL MLNS BLD

ant Hy a

466" wOLOVS T33HM_¥3L3W (86° W3LTL_N3DKKO

TONY 3UIN G?E HLd30 KYW VDOT T28 ?LHD w'ZT WIL SSIN agree Toy cerb2 26998

vies ws'e2 accrss

?Laat gerez sr

vt"66 zrrse zy-se

AYSK 191s Nrvs

serve Tetez gy wet oat

aeive zer9z 23 8s ag

?e"92 ?gr92 gt 12 gz

ger9e oeroz tt ae

3AvL TL NB BL a9

cy HL

£66" MOLOWS 133M _43LIH £66" _Y3LTL NIOAK

BIONY BEIM @OT Mid3O KYA W907 fre ?KD C*eT 3KIL SS3H

£ ADIZH BAYH _LwY Ono? 988 OTKNH T3H& Ct EeH99%

a 93NI0 3AVN G 3dAy ONOTD «A 13H HHL TRAST

9T D3u10 ONIN B ALITIBISIA Z*¢2 AUC GHIL tet s@ 2073 ONIN 28 wIMLVIR «GOT ORV EL/Tey 20

3ON3W3434 ONNE D2-Yad NOTLYLS 22@ 381n¥9 oBhaTI

92 220

gor

ese

gee

ast

Burm

430

2 aso

eer

as

sz

a

Burm

230

T iso

2 9N07

ca)

snow

iva

We ne

a

---Page Break---

2 s0t2

290"

2 Sota

2 908

aore

20

este 20'2

enre

aore

aera

aare

WuLIN SoMa

2

at 009

4620 430 31N0S

eo dydshyaL

& o1w3d 3AVH

cezzee

esac sets vere

US'T6 9249 aety

zztaet go's To's

16166 1889 TA"y

TOT 669 en's

TEQOT vere 32°C

IGroTT 98'L US's

uote 49's este tree

US'B0T £649 GO"y 6F'S7

£966 989 GL'e He 'EZ

FerorT 99°4 este ex'sz

AYSK VOR VW 1 SIS

NBgAxO

iset x

2 TONY BIN eet HLa3}

y AKOIaM aaye 2

a2 93uI0 Zaye 8

a2 23810 ONIy 8

2% 30734 ONIN Ze

39N3U3 434 ONHE

ptytoe 2u'82

642799 90''52,

acerse co*92

paerse T9'92

fa9'cp cbr9z

299768 ap*92

2y9rge 25°92

s2aroe T9's2 a2

2ye59 av'92 ao:

T6959 20°92 a

2y96n 25°92 Te:

NETS)? 3avL

OL2¥s 733KM B3L3H

O KYH WOO) 9zET

Any on079 aaa

Bea 0no79 88

ALtUeisin avez

waMLyaM 0°07

at-wie NOTLWS

ear

?

a

a

#2

ar

e

sHie30 GuvONVIS eee cee

*@ te'c2 et 20T 96 act

ta ep9z 25 ae uy as

ta 292 et a2 42 ge

?oz asto2 tT oe

Wi Uk BL 2D BT

anu cy 4430

ee°t ¥SL1L N39Ax0

?inD p65 JWIL SS3H T 1sva

OtknH 734 ctzg-99@ 9NOT

Le gW3L oN tOR-aT LVT

ABO GKIL pt6t now

et Oud Sv/Tey te 3i¥0

220 381N¥D OBKNIYE Aw

88

---Page Break---

uetes

Smig30 GuvONVIS 98 220

geo t9:4t ot 662 Lez gor

B 2G:8t 21 92 gre ace

@ 96:82 Gt get tst ave

22 62:22 TY 8 bes aGT

We LNB BL

awa (a) Hi30

gets gure

49ty gate

e265 uc's

v2¢ 20'9

9K 7K

N39Ax0

466" HOLOV4 T33HM 93L3H BTO'T HaLTL N3DAKO

G3 FIONY FHIM Gos HLg30 XYH 9Y907 Bret ?LKD C°BT SWIL SS3k 2 LSWO a top versz eersz eT <6 oat oat

a ger9e 21 cy ac ag

@ 292 et 92 gz ge

?a 8 yy°92 Shr92 Syeo2 Tr a 8

WeLIN: SOHe WN 29 3¥In

N394x0) 41830

66" MOLDV4 T33HN_¥3L3A wFerT WALT

@ 37ONY HIM eet HLg30 KYW T¥D0T @ ET ?umd BrOT 3)

at wor909 By zaye £ awy anor gue clMnH 138» gtze-99@ 9n07

a2r0 430 31NOs 13M gwd @tageer LWT

dSNVUL ?@@ 93810 ONIN 82 Aud aW3L crT now

jd NV Zt -3073A GNIM zretet = ouve«eu/tey te diva

9ezzz@ 30N3¥3438 ONNE Of-ved NOLLWLS 228 9SI0Nd caKniYs Ay

N394x0

1 883K T Lsvo

3 oot

---Page Break---

Qe'y cetez ezy9n 22762 er

99:82 peerse oor 9z si

| wE182 wAoiSE HL 92 as

6006 Tuty Gyts2 g2g'ge Sbr92 es

ares fete ayts2 gcse 2v-92 ez

65'66. Ber BErE2 aserse Srrve er

£8" Loter BERTSE Let9e e

SHLd30 CuVONTIS vez zee

$2196 f8'9 BLT» LE'y2 O2¥'96 zz+Gz

! pet 92768 bete2 vagics oc 92

ve gars Sy182 699'Ge Te'9z Bere Trr92 et (2 62 G2

82° 6etant a6: 9782 gag'ss ce'92 Op'92 Bergz Tro 8G

YULIN SOME LYSK 179K V/TH LOTS NITS SAYL WL LNG FL 20 SEM

N30Axo aha Lead

@ 2262 9t yet oar get

2 ger92 27 6 ag es

66" wOLDVS T93HN_Y3LIK BEATTY waLTL NIDKKO

y STONY BUI eT Hid3d xYH DOT 2TEy ?UWO 2"?T JKIL SSI T isyO

Og 40102 LHDI3H 3AYH 2 Lu GOT 24a GINNH 138» gt TE-990 ONOT

v8Za 430 DINOS G9 D3KIG 3aYM @ Seal Qno1] ate 13K andi ay)

e bydSNVEL «gg 93410 GNIM @ ALITIGISIA 2"92 AHO anal wow

9 GoIw3d 3AYH Zt D0T3A GNIM 29 W3HLVIM GreTOT = OMY Ez/TEy te BLvO

} 922z@ 4N3N3434 ONue Qy-vad NOTLWLS 228 3SINwD oaNnIYd A &

90

---Page Break---

at

sz

v2!

ot

art

YELIN SOME

,

20"

pe

to

eo"

YeLIN SoMa

?

wor09

avta 430 91N05

?

uvasnves

oordad Ave

sezzze

seies 26r-9n goret eer

sto peston 26185 oaz

yte9 ezL'9e Bree age

s2tce B94"9p £2422 est

92426 Bayron 29"62 eat

*86 TRB 9 2r+92 se

2926 BtLr6p cer92 as

ae a6 Baden Let9e ee

errs 2996" 6o°92 2

Te'96 Peo 2092 ar

staat T29'e6 G19 e

Shie30 GavONvis ez zza

zeteo Byi9z vastos sere au'a eret ot 62 t6z oor

eer es TE'92 goGr9e BL'8T ae'd PLteT 2t Tez zee B52

bad 26752 Teds9e L94G2 gerd Lyre2 ET BET pes Bae

sttoc 4yrs2 Sea'98 Tyee Ty2e Pyr22 TE a Get BST

ASK LOIS NDWS GAY Wi UL Ne zy BD Gute

x3 cay 1638

£66" yOLDV4 133KM BIL3K BTO'T YALTL NIDAKO

TRIN FUIN BEE H143O KYW TVIE7 vrET ?1Wd CLT 3WIL SSIN 2 4SWD

g2t26 tet9 asrioe 29°62 o'o 29°c2 at 16 eat got

25:26 98"9 StL769 Le'92 Bare Le'92 2F Be ee aS

2279 Gory Seis? BL9'Se GE'9Z QO'D BETS2 CT Ge G2 Ge

SEtIOT A679 LO"y BEEZ T29°Ge Gor9Z GH'92 Geroz TT oc

AYSK VOW 7H LOIS NIWS ?3AYL KL 1. NE BL 20 uTy

N39ax0 aH3L cay 11430

466" MOLDV4 TI3HM UIL3N BEET UILTL NIDAXO

B79NY BHI BT H4d30 KYM WWDO7 S yF ?LWO Tver 3KLL SSI T ISO

y AWOIaM 3AvR ¢ Lay GnO12 Tea GIWNH 734 ot Te=9em ONO

@9 93NIC 3AYH 8 34k1 O07] ate L3H gH3L td OTTR=BT LWT

@@ 23y10 ONIN @ ALITIGISIA Erez kuC awl Lect whom

2% 90734 GNIM 2a waMLVIN GTeTAT OME «au /Tey ta Suv

3ON3U3434 ONME Oevad NOILYLS 228 3S1N¥9 OaKNTNS § wy

9

---Page Break---

sare

yore

yore

sore

6a

sare

zee

cor

ve

at

20

wait S0Ke

®

at ot0a

ete 430 INOS

© byasuvaL

QolW3s 3AtH

eezeze

Serve e249 9e'% Bein? etOtoR TeHZ

6O'k $4"9 BEty GEE? eB OR Te+sz

TEI96 T9'9 OO'F GP'Se averse ey i9z

GEtas LL"9 octy avie2 seoree LEt92

QgtAs Lc"9 bc'y Te'sz T29°Ge LEte

Gh'Ls 1219 69'y Ov'cz HTO"Ge ET9z

69°96 G9°9 $9" BEtEZ LAP'GR EE'92

S6tya 8279 oety Betyz ETOTOR TErHZ

TE'96 19'9 S9'w BOTT? Zecise ay r92

9°86 BL'9 Scythia? S29'Ge LET92

69°96 G9'9 99"% BEtEz Lagtee BEr92

aYSx 9H 71K 1 91S NTS) ANE

N39Ax0

664 wOL9v4 133K LIK

B0ONy 3uIy get M183!

y AHOIaN 3AYN funy ano7D

a 93ufc 3qvR @ 3uAs GnO7D

Qa O3uIG ONIN GALI TIAISIA

27 073A ONIN 28 uaKLV3e

39N3N3438 ONNG

suig30 GuyoNvis

ero tetye or

2° Ay" 92 ZF

Qere sg'92 Gt

av'9z BE:92 TT

Pree veant)

wah

YH WOOT 2vzt ?AND ¢r9T FI

8g-¥ad NOTLWLS

yea Oth T2e

3

a

p

@ iat gH

42 80 awd

eta One

?ss

ay

6t

2

a

65e°T BLL N39AXO

eat

se

es

es

ez

et

e

sez 220

ear at

es as

2 $2

o 8

29 Juin

mid 30

ssvo

9x07

ca

nos

teste te 3Lv0

220 3SinwD ogHntyd Aw

2

---Page Break---

ezt

ze"

a

ar

VELIN SOHe

sot

fo"

20"

ga"

YULIN SoKG

e

at xot09

¢48e 430 SIN0S

uyasnvas

@ colw3d anvH

zerzze

aztec apt 6r'oz

Tetye Tet geroz

ete 0"» a0'97

setay

acraet

ctaet

2ttec

ootee

sere

R64ey Zork itz Ostcz

ASK 9K VW LOTS

66"

JNoNy 3uIN Bae HLa3)

98166 n6'9 CBT y Atty?

46" 20t 46"9 CB'y oste2

66'e0t 66°9 9R'y cree

ab'B0r @6'9 ce"y z¥re2

ayse VW 77H 1 OTS

N394x0

466" a

FIONN SHIR eT 183

2 AMOIaH GAYN &

60 93810 Say 8

2t O3u10 ONIN @

92 9073 ONIN

30N3U3438 ONMe

gcr98 v9tet

seston ester

56998 B6t6T

etree

c's?

pared

592

se:92

verge

28:52

agree

got

Soret

20°22 oe

eactos £T'22 2t

NITWS3AYL

O19¥4 193HH 83434

0 xv W907 156

tty 99 6Lt62 B2

pecise sor9z

LE9°58 SE192 Bi

219° G6 as-92 62

NEWS) 3a¥L

JO19¥4 133M 831K

any 0079 get

adku ano19 ae

ALTUAISIA 6°92

MaMLyaM 9 ez

26-¥ae NOTLWLS

one

acz

ea

ast

eat

se

86

a

2

er

:

SHLd30 OuyONYIS a

99:e8 ot

ss'at zt

@ 2e'a2 ¢t

*22 St: 22 1h

Hi Na

na

662 662

?v2 62.

66T 66T

@ ect

zap

Oo ML

6TO°T B341L N39Ax0

?IHD 6°87 BWiL SSIW

10 6cr62 et

ta stroz at

ta egtoz et

92 T8192 1h

WL NS

na

et oot

rad

we a

ee

21 a0

oD my

s50°T 3LTL N39Ax0

9 xv WOT Tat ?1KO wept 3WIL SS3W

OtnoH 138

43M awa

Auo ahaL

et Gave

ee 220

ws

sz.

aoz

ast

3uIn

430

2 uswo

et

as

<2

a

Berm

630

1 asvo

h 9tae-998 9n07

\ @'Teeer

grat

eu/tey to

av

now

3uva

220 3S19w9 CaNnlvd Ay

93

---Page Break---

cust ?tr how

azo-va ?ON os pnzy

37930 FUNLBNIeW3i = S FOB HasBOOUSIHLAMIE

---Page Break---

fez george teee

"82 2p6rge 82°42

---Page Break---

£062 ot

3Ty $9°92 er

very ees 2t

70"y oF" Perla e012 vo012 TE

TELIN Sota T/7K 1 OTS NITYS) SANE UW one

N394x0 ae

SHie30 GuvONYIs

(ay 1e30

66" BOLOVS 733Hm 233K ys@'T B3LTL N394xO

2 STONY FEIN BOT M1430 XVK 1907.9 az ?IKD T°? SKI Soa T As¥O

BONO ANDI3M BAYH © Luv gno19 98 atanH Tau

Sore o30 Simos Sa 1332 BAYH 8 dks anon] Ota Lam ana

BvASNYEL 62 D34I0 ONIK Z AITBISiA~ Bez Aud anal

S GOlWId NTR 9g D0T3N GNIN 2 USMiVIR S*9TeT Gord

cv822 32N34343¥ ONud Stee NOLLYLS.

98 9NGT

Tuy

17 now

eerety 6a diva

@ 381M oBKNTYE Ay

---Page Break---

sere

zere

oe

Tree

ete

ore

vere

sore

sere

82

ou't

uae

aa

SoMa

e

a

aera

aet2 <a

ae"? sot

YeLIN SOKe

?

at xo709

6982 30 21N0s

ydSNveL

9 oolmaa any

ceveze

vera eet9 rst92

229 unt92

ere 70'8 2hr97

#599 132

gern tre 85" 92

ena 16°6 aed

erro 469 zoree

es0 68"9 a

2e'3 a8'9 9

aera 18°9 ad

eore 189 op'82,

strc iets pty tot92

6Br9/ 22°89 sty uet92

?6°S 18'9 G2" BT"92

StreG 95'9 aa» ogrc2

AYSe VOW VK 1 Ors

N394x0

68"

79Nv 3utH ese MLa3

E196 TTL aby gote2

SG itor ae'9 Soy B9'e?

98" Tot 88°9 zo"» ayrcz

GOTT ca°9 Ry Lbtez

Lysk 479K 77H I ors

N39Ax0

166" ow

Bony WIN get HLa3

4% ANOISH SAYH oz

62 93810 SAyH 8

#2 9N10 ONIM «8 ALINIBISIA a-G2 AHO dw3L

£2 30734 ONIN 20

30N3u3438 ONMe

eae

ese

paz

ast

eat

se

8s

2 es

carne e

Ba6"Gp 90rL2 er

966°SS SurLe a

SH1g30 GuvONNIS eee 82a

Gry SS4CT gare EovcT OT R62 OME

S199 Tyrer Teret et coz ace

99°96 2c'6t 2er63 21 Tez as

sean 92°22 o2tz2 2-22 Tr 9 est

NIWS 3A¥L WL LNB BL BD

awa cy 830

OLOVs 733HM WIL3H GOT BIULL NIDAKO

OO KYH 9¥907 222z ?ind y'2 BWI, SS3K 2 ASYO

vtS:98 264y2 goro 26r¥2 oT 4s eat BLT

?8°99 89192 go's 09192 eT 26 ue BS

Gee: Lo+c2 go'a cars? 2 92 S22

966s Se°42 co'ez orc2 TE 9 8g

NIWS BAN, UWL TL we BL go Sum

3h (wy) Hida)

OLD¥4 T33HM BILZH HSO'T YILLL NI04x0

0 X¥H 1¥907 Sst und BT GHIL SS3K_T ASV

AKY 0079 9a GIKNH T3y 2 9x07

Beal on072 "8 1aK awd Wn

non

wanLyan Teter ova eu/ety se LV

DTeWhd NOLLYAS

ze 3SIN¥o OBNNTWE Aw

---Page Break---

gate gat

203 g2t

WHLIN SOHa

ae x0109

eae 430 DINOS

wrasuya

> aolwad anew

zeveze

aera t6r9 pare 9)

ans 1659 GOry HErEz

pei2at :6°9 vate gvtez

SP'20T 46°9 SB"% pEtEZ

AYSK T/9K 77K LOIS

N39AKG

rrr

B09Ny Gate Or Le

§ LKOIaN AvH e

Ta 33810 3ayn 8

67 23st0 ONIN @

2 30134 Onin ze

3ON3H3438 ON4e

seerge 33702 er

eLese acrez 8

Shid30 GuvONNIS ?_zzy Gee

666'Ge TT+u2 ape Tr-cz 2t et er et

6a'ge azt42 aztce aerc2 tT a 88

NTWS Sak ?RL UL NB BL 20 Sut

onan ow Hia30

OLOVS 133MM 33H ¥S9°T HILT. NFDAXO

I xYH WOOT Pzay ?1nd HrEe BWIL SSIW T is¥D

AW¥ GNO72 49a GI4NH 738m 9" EE=998 9NOT

dk, 00079 O° 3k en3L ON Ltez-BT Lv

ALT atStA a-gz Ae ewdL prs now

NaMLvaM @-9teT NYE cu/TIY Ge YG

Yee¥ne NOLLVAS

828 3SInwa OUNTYE Ay

98

---Page Break---

&e

e

es

ee

pore anise zt

fe'> ovter e

sHig3¢ GuyaN Slr 2a

gee 66°52 ot eer gor

- as as

62 2

ea

CHIN Sona ML Ne 20 31m

k3L uy Hi30

£66" MOLOV4 T33HH 99434 N39Ax0

© 310 IN gut H1a3G x¥R 1907 eeaz 1 8S3q T is¥o

Ho102 ¢ JHOT3H 3avm yy gno12 age W738 om ct Epe99e 9NOT

Stro aa0 3tn0s ta ?38u0 Baym ft gn873 @ 3M dw3k ON TERSAT L¥T

UYaSNvdi yd D4¥10 ONIN £ ALIMEISIA are2 40 ghd G8 now

S$ QoIH3d JAVA ya 073A ONIM 29 MBKLYIH S*gTaT UVa Ev/ety ge 31¥0

Sers2e 19N3N3 43H INNS @2-vus NOLLWAS

920 3SiNu3 OBKNIWE Aw

---Page Break---

griy Berg teyr9e zocer ear

168"98 g9r6T ese

ra9798 eae

zeu 96 ect

Tos98 eat

ree-9e 4

gee-ge as

TPe' 99 ?_ aE

eter9s e

pau-9e et

966"Se @

SHid30 CovONVLS oe e2e

Teb-9e 26°LT Go'e Ze'eT eT 1462 ene gue

?65°99 B9°3T Bore goreT el coz age es

ve9'98 Terue gore Toc2 Zt eT2 22 202

Go's 20-y gcge Specgs carte Gertz Go-c2 GIB eee Bey

vow VW LOTS NIWS FAL ML UNG LB) SHIH

N394xo we oy H1e30

166" HOLOVs 733KM ¥3L3K

HIM ave H.g30 xvm W907 aete

7 M3LEL N39Ax0

g°t Skt SS3H 2 AsvO

TwS'99 de'¥2 Bere Be's2 oT Tet oat eet

Gperse 22°92 awa Bet9z eT 9S BS OS

ctwr9e co°e2 Oa" Le'ce 21 82 2 ge

Brae 966'se ¥BrL2 Her L2 vee tr eg 8g

9K WK LOTS NITYS BAN, | Kd N@o 21 20 elm

N3OAx0 dnb cy Hie30

66" NOLOVS 133HN W313H 968°T Y3LTL N3DAXO

2 Fwy wim ast Wig3C xm W207 saz ?LHD OT SKIL SSW tT is¥d

o 4OI09 of IHDT3M an¥Y LY GNOT2 ?ee OTKNH 13H mH 9*Ee-908 9NOT

e489 @80 JINOs pp 93817 3nve @ 3gai ONO] «BTA Lae add LIERSBT YT

BydSNvHL 62 D3HIC GNM L ALTTEBISIA 2-gz AHO gh3L oho non

© ontwsd 3n¥N 72 00734 ONIN Ze MBkLYIN ?TeT © GHYa «Su /ety Ge AYO

90992% JONINTAIM ONHE D@-vae NOLLWLS 828 3S1nyD cgHNIVd A a

100

---Page Break---

---Page Break---

---Page Break---

Sauron ereze e

SHid30 GavONviS _ 99y 920

sagas go-et

easton 20¢8T 62 uvz ase

Faeroe Cotee ?et eet oz

6a8"99 38°22 ?etext ?est

605"99 sorsz 6866 Bet

a SoT+9¢ 62192 eS ae as

Seur9e c. 92 sz sz

snd-on o5rc2 ae

NEWS) SARL

N39AX0. cw) M1630

£66" OLD¥4 T33HH B3LIW HSE H2LTL N3DAXO

@ 340Ny SUIM aoe HLg30 XH TV907 etas ?ind Frys SKIL SIN T Is¥O

ar wo709 nH 738 =998 N07

pera 430 SINOS, im eka At Ly

~ BvaSNYEL

© O91N3d 3AYH 9g 90734 ONT owve = cesty ga BuvO voyeze 30049249" ONNe De-vad NolaWss 820 381049 OBKNIS Ay

103

---Page Break---

rete gure

m8 REZ

2's oe

nasa ere

YeLIN SoHo

6

a2. voteg

9209 03u 31N0s

~?evasNYeL

© antesg 3am

covazw

aera

vera

6219 o8'e eprez

8°9 BU"b bere?

verter <o"9 gate artez

Sy'TOT pe'9 GL» verge

LYSK Von WW LOTS

NB9Ax0.

466" MOLDVs T33HN BILSH

Flow WIN at nla

5

a

a

a

iMgi24 aarH

D3u10 Gaye 8

D3e10 auiy g

2073A auim ze

30N3H343H ONme

geese curee

680'99 Bt-2z,

Beorse fe+02 gare

susan O5e42 eTh22 Brtc2 TT

NITe

er

e

SW4e30 GavONris a

eerce at st at

a @

GAL aE oe BL 20

nad On AL

pS0°h USL1L N394KO

OO x¥y 7¥O07 GeTT ?Ko grgT SKIL SS3n

Any ang39

34ai on973

ALDinargin

HSHL YH

Veevnd NOLLVAS

92a oLWnh 138

ae Lae awa

8°62 AUC GWIL

Suter CHve

9¢t¢-994

N gtez-er

Beer

Se/Tty 6a

oy 920

or

2

Buln

430

Taso

Ye 9NO7

an

unk

310

822 3S10¥9 oBKATNd Ay

108

---Page Break---

Teyeze 30N3¥3134 ONwe

---Page Break---

---Page Break---

---Page Break---

yeiin SOMe

2

ar yo709

este 430 I1N0S

_ ~ ayasNvaL

© goly3e 3nvs

?yz epston vise eer

?itp 22782 Se

9euroe 99'92 e6

PIB9¢ 66°92 es

Lo2'98 GB°2z _ a

Souroe cutee ar

sao"9s 60°42 e

SHid30 GuVONVIS ez ze

gpraut 46° e° so'cz ot 96 et Bet

TeTaT a6 Wr Be 8s

GL: 20t ve" az se 2

sor2nt 96 g eo 8 @

LYSK V/9K WK LOTS NTT FL 29 Balm

N39Axo. Oy H1a30

66" MOL2¥4 T33HM 33H pSO"T Y3LIL N3OAXO

FUONY BBIN Dt Hig30 KWH TOOT eZRT ?1A C22 3HIL SIH T LS¥D

© NoraM GAYH c_4H¥ ano79 orane 73e ?N07

ze 93810 3AvN 8 3e41 ano1D 136 g83L an

6) 3ST OWI TO AITTIBISIA Ore ABT dw9L nok

89 073A ONIN W3MivIn G'esor ONY fu/Tty Ga 31¥0

2uye20 3ON3H743E ONME @6-vid NOLAWAS ze 381049 oBknayd Aw

---Page Break---

SHLd30 GuvONvIS 29% eze

© ezct» 962 e6z eae

@ screT $ cr2 oez esz

@ srraz 2 he ost goz

@ 6trs2 tT get eet act

2 29+¢2 9t aT got cot

_ ? @ Byis2 cr 4s ae as

Te'92 ga'e te92 2t ye 2 ge

area var : atece atede tr2 tt a 8B

YELIN SOHe Lyx 479K 1/9K NIWS BAY ?RL 51 NS 2120 Sut

N394x0 awa (4) Higa

66" wOLDV4 T33HM_¥IL3N ySErT YILLL NI9KKO

S Bow 38IN gue HLg3C KYW WOOT Lea ?Lhd 9°2T 3HIL SS3M TF LSVD

a ¥O10] ¢ IHOI3H 3AY¥ Tt LAY GNOT2 ZB GTKNH 7344 S*ee-998 ONOT

270 430 DINOS ia 93470 3AYH 3dal anor] ee Lak gwSL ot. StTE-BT LT

? - ?BVaSRVEL ~ 93-?T3ATO ONT ALITIBISTA AUD gaat ret nO

% Gotead 3n¥* 22 20738 ONIN Ze M3MLVIN BTOTeT ? CUYE ?Su/TT Ge GLY.

2ove2e 3ON3E343u NKE DG-vHe NOLLWLS 920 3S1n¥D OBKNIVE Aw

108

---Page Break---

os-vaa

On-vna

st oz

?930 3unLyYadHaL

a st az

$3084. HdBBOONNIHLAHLUA

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

Toe voty votez gusrst zorsz et

20'e 067% G82 Gor'ce T5'Se e

- ? SHLgIO-DUVONYIS? ~ Tes ene

TOL T6"y p9tez GeStce Zs'Gz Gere zorczz 6 Bt OT

28°c a6'y OG G2 garrse T5162 e

YULIN SOME AYSK VOW T/T LOTS NEWS SAV. KL ONG BL 2D uN

N3DAxO awa cy 1430

466" MOLOVE T33HM WILK GOT YILTL N3DKX0

@ Bony 3YIM OF HLg3C XYR 9¥907 OTE ?LKD C°OT KIL BSI T Is¥O

ANOT3M 3AYH -& HY Ong)

wor0a

Yee aia DTNOS

vasnvu.

4 GoTwad 3AVK 073A GNIM

Teoees 3ONINIIIN ONUE VFevWe NOLLYAS

719

12 arce 13K awaL

uve = va/bey ta 3LVC

fee 3StnuD osNnTvE Ay

197

---Page Break---

ates were 96e

ote:

298"

ar9"

908

286

su6

SHid30 GavONYIs ?_ze9 ena

ee es

Bese Sh ce 8s

zersz2 2 be se &

aug" se greet 2 28 8

NTS 3AM KL TL NEBL 2 BIN

dnb w1a30

£66" OLOV4 T33KM BIL3N 99O'T WILTL N3DAKO

@2 FTONY BUIM GOT HLg30 KYM WDD OyGt ?und B°GT ZKIL SSI T LS¥D

- wo] LHOIZH 3AM of LaY GnO1D @z@_GtANH Tay N07

bere dd0 DINOS ?ge O3uTO-3AVK G 344L GNOTD «g'zz 13K HIl a7

wrasnvas D3u1d GNIM ALITGISIA AMO awl get nox

4 Gol¥ad SAY 68 9073A ONIN

zs

UBHLvaM Grater Ouva aevoz7 te Suva

@ FONIN343N INue @t-vkd NOTLVAS 888 3SINYD oBNNTVE Ay

---Page Break---

eeree vite g9'92

atty go'92

vty a8'92

vety BL'G2

6e6 oc's2

gory Letc2 sz

26y o9'cz es

B6'y ot'y2 ee

26" y 60'sz ez

26 Lo"s7 et

Soy cose 2

SHid30 OMVONYIS e890 Geo

a etty g9'9z cev'oe LO'LT Bato CoLT » gaz <2 aE

a Shee 26'S Etty Z6'92 SENT 9E Stet & eee 9¥2 OGz

a 26'S yt'y S3'92 206+98 asez 2 9 Let BAe

a 22:9 serv aL'sz eco'ee 2:22 tT tet Get ast

a G22 Trt6 siz zeetse Barsz oT 888 BUT

a $2 26'y ae's2 Bsarcs ?c'92 at oy as BS

a 22°C B6"y Lo"92 Bczt9F gprs? 2 G2 62 G2

WO" 6%» L9"S2 GcEtGe fyc2 tt ao 9B

veLtn vWF LOIS NTS. ub N@ 24 20 Bele

N394x0 3k Oy Hie30

66° woLovs 133HN B3L3K Oye°T YILTL N3DAXO

Ot STONY TWIN ave HLa30 KYK TV2OT Eees ?LHD Gr8z SAIL SS3H T LSvD wOI102 sy AHOI3H 3AYH 2 AY GnoT2 zz GINNH 13H BT ¥e=998 9NOT

Gye 430 DINOS gg 93uIC BAYH 8 Gadi GNOID "7k 13M GH3L oN BTZE-eT YT

wydSNYEL ? g@ D3uLO ONIN < ALTTBGISIA ABC awl 902 enon

& Goldad 3AVH Tt DOTHAN GNIM 2@ ?H3MLVIH G*BTOT ORV «bu /e/ Te 3L¥O

fe9ece 30N9Y3I3u ONes

Ot-vad NOLLWAS

82 3S1MD OAAIE Aw

129

---Page Break---

byerse t5's2 or

ag0'se To+cz e

SH1d30 GuvONNIS ots ate

kv'gs 26" Grerse TS'G2 8's Totg2 2 at et aT

a'L6 g8'9 92" zeerse To'S2 ge'D Te-c2 tt @ oe

AYSK VOW VW L918 NIWWS GAY KL LONE BL 89 GUTH

N394xo dn3h cy ued)

12 252 ce

Oe abe wares

466" HOLDVS T33HM UILIW CPO" YILTL NIDAXO

@ 379NY FEIN OF HLd3C KYW WOOT hE LWO CeET SHA SS3H T Ls¥D

vor0a AHOT3M 3AYH 9 Lav on079

eae 430 DINOS 79

UyaSNVuL

? GolWae aAvH

© OINMH 138 eteee99e 9NOT

213M gw. NL62-BT YT

@ Aw gW3L areT non

90734 ONIN f20T OWYE pu/O2/ te SuVO

veoece 3ONTHI43y ONYE YeeVHd NOTLVLS £8 3SInYD CBHNTYd Ay

130

---Page Break---

TGr9ox thie ets zetez eeLise gar

29'Z0T 2T'C 86'y BB'C2 ERE Ge se

96'9 es

69 er

969 ee

16:9 at

669 a

SH1d30 ONVONNIS 9 Bee

tore orte 99'S BO'2 9y'Gz gt 25 eat Bot

96:9 cote 9:62 gare a9'cz at be eg as

s6'9 sere Gr's2 ov'e sy'cz zt Gz sz gz

65°9 Gath S668 cy's2 00 Lerce TY ook

VOW VW NIWyS GAL Wi ML NG BL 2 dat

N494x0 dna ny a3

466" wOL2V4 133MM H9L3N pyO*T HILTL NIDAKO

@ B1owv Sun @at M1430 KYW 9V907 BzET ?LHD EBT BHIL SIH T isvO

4O102 of LHDIIN SAH © AY GNO19 889 GTKNH 73H HK Bt EE-998 9NOT

zete 30 DINOS 92 234IG 3nVR 8 dai an079 2 2M aW3L ON StTEAOT LyT

uydSNvuL ?g@ D3NI0 ONIN ¢ALTTIaIStA EO aw3L rer nox

9 Golwad 3AYH TT 2073A ONIN 28 MBKLV3H G*@zeT OMY tLVBzv Te Gu¥O

yy9ese 30N5U3234 ONne 82-vag NOLLYAS @e2 38InYo OBNIE Aw

---Page Break---

stiee

aprec

gore

2606

vers

2e°9

anes

m9

s2teot 2:

scot ts'e

TEeT vate

a2'eot 96'9

zt ettee

arse

a9r28

seveeeetc'9

49566 49"9

g9tcot Te'e

65165 £6°9

ezect eo+9

AYSK 9K

sere

20°9

ag

gy

some

sty

aety

zety

sory

ao'y

arg

g2t6

a6»

92"6

a

very

WK

NB9AxG

@ ony gure

wooo ¢ iHoray

yete 30 DINOS c9 O3¥TC

wydSNvaL Dautd

9 cotMae 3avH 20734

a

Sy9eee 30N3¥343u ONNE

arioz

22192

te'sz

etree

vetez

sere

tetee

oute2

pctee

sete?

te'e2

ayoz

L292

rad

sare

yeree

terez

scree

ated

iors

tot wi

aan

3aTN

Nim

Nim

aa

z

a

?

20

gystoe o6ter

ac'9¢ oer6t

266°98 £2452

gectog Tot8z

5"se 02452

99°66 verge

Bacge 22782

204" 66 vy?

B69'6e errs

oy's2

6r's2

SH1d30 OBVONYIS goo ota

9yS'98 96°LT BO'D 96'LT » 2 Bae Bue

acc'9p 6E'6T Gate BETES eB Bee Use

66°95 $2112 Be'g F212 2 @ Bde Boz

ed'9¢ Od" g's Gee tT @ act ast

Gls'G8 O2'62 0°D Oz"<z Ot 46 GaT BET

GaL'6¢ L2"62 fod L2"G2 OT @ as as

LeLsp ays2 Gree av 2 sz?

69°60 6y'G2 Ooo Byrcz Tr @ of

NEWS 3AYL HL TL NB 2k 20 Bed

3a ony 130

OLOV4 33HH B3L3H CharT UILTL N39AXO

JO XYH W007 S gt ?LWO T:az WIL SSI T Ls¥D

4WY GnO79 gaz GIWNH 734 © -m 9teR=998 DNOT

dhl ONO19 8°82 19K wWIL ON COTR-eT L¥T

ALTMUBISIA O° 4eO awaL Tree now

WaKLV3M G*eTBT ORY pu/8z/ ta 3.¥O

22d NOTLYLS. Be 381NYD OBHNIYS Ay

---Page Break---

£ 26t%

9 90"

BLeish ooisz

Zye'se vytsz

eri tet &%

62566

sHig30 GUyONYIS te ete

gate 35" gtrtot sore ze'y were acdgp bytez Syisz oF ot et at

8°2 60" 61466 s6°9 9Rty BL*C2 ZwL ¥yTEz veraz at 2 8 8

YULIN SOMd ASK /9H V/TH 1 OLS NIWS Sava RL ON BL do Qu

Na9Ax0 wa cy Hue30

66" MOLQv4 T33HM_BBLIN pPOrT BIULL NIDAKO

@ 31ONY FEIN OF HLgIO KYM 1¥907 BGK ?Lhd O'HT BHI SSaR T AS¥D

WOI10] ¢ AHOIZH AAR 9 AY GN012 Ee GINNH 73Y MH L*ze=998 9NOT

zea 430 21N0s ?Q3N10 SAY 8 3441 CNOTD a*ez 13K gk3L oN -G*E2NAT 17

wy dSNVUL. D3u10 ONIN 9 ALIVIGISIA @'A Aud aw3L ET ngs

© Golwad 3AYM 98 073A ONIN 28 M3MLVIN EzaT ?OMYE ?ru/Bzy Te GiVO

?298e9 | 30N3N3430 ONwG Yeevag NOLLYLS 8 3S1N¥9 OBHNTVE Aw

133

---Page Break---

996"5¢ 99%G2

erg

ar

2 vse

SHid30 CuyONrAs

c9'9 38'y gorse gorez oF

?e9 bete asrsz 89:62 at zy

96°9 co'y 2562 ze'ce zt 62

eat Sere gery cree ceesas paces

SOMe AvSX T/9H S/W LOTS NTIS SANE

NBoAxo

ayo ese

eer gat

as as

2

a

29 un

Wy 4830)

466" wOLOVs T33H4 BFL3H fyasT USLTL N39KKO

@ STONY BBIN Bet HLa3d KYW VDOT Ores ?AMD BrLT BAIL SS3W T AsvD

woI09 f AH9I3K 3nYM 2 any ano

wete 30 DINOS ?Be O34TC 3AYH @ 34A1 ONOTD

UyaSNveL gg -D9NIC ONIK ¢ ALITNeISIA

O1AMH 134 9tze=998 ONO

LK dW3L NW ORERT LWT

AeO an3L arct

ynow

a

9 Gotdid 3AVH Ft D073A GNIM 29 © MSHLVIN g-TzeTUVE «buvezy te JuvO

Zv9ecg 30N3W343¥ ONwe @e-vad NotLWLS Bee ASIN oBWNIYE Ay

134

---Page Break---

aytoz

stt92

sercz

es'9z ot¥ 98

ey'sz 929'98

g3'92 98898

ge'62 T2099

f6'h2 BTR

ei82 ase'se

cie2 eal se

fete co ?e722 a9d'se

YULIN SoMa 2918 NTs

466* yolov4 133K" ¥313H

@ Fon aWIM gee H1430 XW

O10], AHDI3M 3AYH oF _Aky GnOTd

zara 430 DINOS $8 93¥EG 3AYM @ ual GNOTD

vaSNvaL gg -D9NT0 ONIN Z ALI TIEISIA

9 Qolu3d 3AYH TT 073A ONIM Ze uamLVaM

Syoeee 30N3N3434 ONNE

Dgevad NOLLWLS

otter

SHid30 OBVONYIS

ae'e sttet 96

gee vores ve

were 2ttaz 2 6t

eeve at

a0°8 Tet

as

62

@

SAV a

a

s*2zer

OlWnH T3u

Castlarrs ry

ANC awl g+8t

ouva

wy

syert 3111 N3DAKO

W907 Bayt ?4nd cret 3WIL SSH

M Cizes99@ OK

N ctte-eT

veseey ta

Be 3S1nD CBHNIVE Aw

s99 sto

ees

2sz

202

act

ent

as

sz

@

3atm

kig3a

Tasva

non

3uvo

135

---Page Break---

set

ot"

YeLIN Soka

woroa

eae 430 DINOS

Urasnves

© Colusa 3ave

egteot

otter

agtaat

attat

ASK

a6'8

0's

26'9

sere

9K

sory

2'6

oer

zty

WK

NJOAx0

stony 3u1m

©

ee

62

ve

AMOI H

93810

Daata

073A

pers

veer

vere:

oan:

11

466°

ar

anvn

3am

ants

ant

oegeeo 30NIN3434 ONMd

Mia!

,

6

9

ze

2 z28'se anise ar

2 OLe'9e fH e

SHid30 GuvONNIS 989 ete

2 eee'se er's2 ao'a Gyrgz 2 tt oT Bt

2 Oce'9e SerSZ aoa yg2 TE © 8 B

S NIWS SAL ML UL NB BL 29 3eIn

dna cay 1638

MOLOVE T33HM U3L3H Geet Y3LIL N39AX0

30 XYH WOOT 9TBT LHD EtwT BL SEEK T LS¥O

AWy Qn012 gee GInNH T3Y MH 9" TE=998 9NOT

Beal On079 avez 13K gHIL oN Stez-BT AT

ALIMeISih 9°8 4HO gw3L tot 0H

MSHiVaM G*ezeT ONY su/ézy te 1¥C

VoevWd NOILYLS

@e0 3SIN¥o OaKNTVE Ay

136

---Page Break---

B19 sety corer

re:9 96:82

oer9 tersz

26'9 futez

£69 tevez

96°9

969

are geree

9a: tere2

269

9679

zeree

» Tarcz

WoW VW L ots

N394x0

we?

VaLIN OMG

zee9e

soa'90

sta-98

suerse

peers

ToB'se

ease

reo98

st0-98

O98" oe

?e860

NEWS

corse

e9ee

69752

29'62

ard

9°82

39'62

ugsz

6982

a9"s2

T9662

BAY

eer

<<

Bs

es

ez

at

@

SHid30 GuyONv1S aes oF

Gero Lstsz gt tL 66

@e'o 49'62 BT es as

gore agrcz 2t cz 52

geo t9:c2 tr ee

3

Who UNG BL 20 Sutn

Waa (oy) 830)

466" OLDYS TY3HM U3L3H SPOT WILTL N3DAXO

@ FMoNy 3BIN Bot H1e30 xVH

wo10]-¢ AHDIaM GAYM £ _Aky gnolg.

z0Te 230 DINOS ge D3UIG 3AM @ ead Ono?

BvdGNveL ga -93uIG GNIM 9 ALITUBISIA

9 colwad 3AVK Tt 20730 GNIM 26 w3KLVaK

veges 32N3u343¥ ONME

@pevad NOTLYLS

207 2tzt ?ind 2°9y BWIL SSH T ISVO

892 OLWNH 134 Ztte=998 ONO

e aK gW3L N-¥toReeT LY?

AEC ge3L 2c 9 now

zat OUVE bu /8z/ te Biv

@e0 3SIn¥o oaKnTE Ay

197

---Page Break---

ar'92 cest9e aareT Th

£8192 Lad?oe @2'6T ez

98's2 2z6'9R s5't2 eae

iT'62 99ctog corte est

6erez easese cctG2 eot

2ere2 e9e'se ¥9'52 se

64182 pae'se 5°62 es

Terese zaerse Sorce es

terez zae'se 25'<2 22

tere2 zaerse Se"c2 et

ee's2 2e0'se a5+se e

Shid30 OuyONYs

fy'9z 296'98 caret gute catet y 112 462

ge192 cactor gzt6t Beret ¢ $82 oce

98:52 2c6ron S5tt2 s'32 20 8 ane

LT'G2 gecton e952 fyez t @ ast

6182 aesrce Scie? eis 9 @ das

2:02 vae-se 15162 isre2 at 9 ag

Te'e2 2aarce 26°<2 2erez 25 ae st

GretoT co"4 £6" BUr2z zaR'se 5°62 6:52 tr a8

nyse WoW VW 191s NTS AML at NB 2L 20

N394x0 ay

66" wOLDVS T33HM BILH PyATT YSLTL N3DAx0

2 SNONV 3BIN @OE HLg30 KYH T¥DO7 cat ?ind 6°9T 3KIL SS3H

yoI02 «> AHDI3H 3nvR THY Gn019 ged GIKNH 13H BF te-99%

96f@ 430 DINOS D3uIO BAVA 8 3dAl GHOTD G"92 13N GHA ON Et 2E-aT

ydSNVEL 9@-99BI0 ONIN L ALITIGISIA 8°@ AMO GH3L St9T

9 Gold3d Save TT D073N GNIM 28 u3hLVIK GrzzaT OMY BLvBRy te

T9982 3ONINI43Y ONNE

Ovavad NOLL

99 o80

ous

asz

eee

est

get

as

<2

@

Buln

30

T asvo

2 2N07

an

nn

uve

28 3SINND OBKNTWE Ae

138

---Page Break---

rete vi vocige terse

SB'y perc? p2eSe Gyraz

gate et ceraet 20°C Téy ve'cz vaLiGe Tetsz

aa'e 60" 2/'66 £6'9 GBiy vErE? HZu'Ge Br-cz

VBLIN SOME L¥Sk 79K T/7K LOTS NITYS BAN

N39Ax0

er

e

SHLe30 DeVONYIS Bo eee

aero twis2 ot gt et

aero aerc2 at tO

Wi NE BL 29

nah ee

(66° YOLI¥S 193HH 343K pert H3LIL N3OAXC

6 FTONY TWIN BS HLG30 KVR 1¥O07 EFOT ?AND ovwT BALL SS3K Tt 1S¥D

wor02¢ INOI3M BAYH 2 wy ono7D

e200 430 DINOS eg 38TG SAH 8 3d OnO79

avaSNVL G2 93410 ONIN «9 ALI Tiers

esvece 30N3¥343¥ ONMe Ye-vhid NOLLWLS

.

9 Oola¢ SAY © 9@ 3OT3A GNIM 28 M3MLWaH OS"

6 OIHNH 138 Stae=998 9NOT

52 Lae dw3L oN StezeeT 1vT

8 AuC an3k oT now

ezetoMve tu /82/ to 31¥0

820 381nud OAKNTVE Aw

139

---Page Break---

to 66°9 gee'9e Lotez eer

?6 98'9 eso'on 99'ez

to aa'9 deuron 19762

te 2699 tp9az

te sero agree

to S619 a9+s2

?a sero re Ed

SHid30 GuvONYIS geo eee

26180T 66'9 Gay Lorez Eee OR LstS2 BetD Lerse oT 1S 66 But

arr yo'82 cserse 19"S2 Bo'o L9"G2 at or 0s as

42) stiaot co'9 98"» zerez Gperce O9-s2 aoe eorc2 2t a G2 G2

Bar eTegat G69 gAty Te"c2 Tee-ge as'S2 aoe eorce Tr a be

NSOHG AYSK T/9W VW LOIS NEWS GANL HL LNG SL BD Sure

N394x0 awa Oy HLe36)

466" HOLDVS T33HM HIL3W PHOT BILTL NIDAKC

@ STONY BUI BBT HLg30 xVM TV90T BGBT ?4n9 B'S BHI, SS3K Tt ISvO

yor09 AHOI3M 3AWN Tiny Gno1d Bec? OtKnH 134 9taea998 ONT

28T@ 430 DINOS 23810 3AVK 8 341 GNOTD B"9z 13H GHIL «ON OTAESAY LY?

UydSNvHL a4 D3BIG ONIN 9 ALTUBISIA @2 Aud gndL Ot oT now

§ Gotuad 3AVK c@ 2073 GNIN 22 H3HLV3HGtzezet uve «eu /eey ta SLO

Be9eee 39N3N3I3u ONNE

86-Yad NoTLVLS

ee 381N¥9 oAKnIVS

140

---Page Break---

982

6552

asrz

vetaot 45162

?9 gate settot soarse acre

?3 6a'2 9o'tat Toast 65°62

SHid30 OUVONYIS ~ oto eee

get zetye sevt9e covey tote § $82 eaz gee

set vetee aag'9n 96495 Bere © Bee Ore 362

a: sotae 2a6'9e Lotte UeTz 2 26% 263 Boz

ot tras zecton R618 2 pst ast

ut act6s. QT3+99 autsz Bcre2 9s BR ROT

at: getter 26°68 65'62 sere2 oF ty Gy Os

6a" yttgot Bu8'Se 65'S? ieis2 2b 2 ve Se

a¢ 9a'tat

2 roe'ch és'52

VULIN SOKe LYSK,

NTs 3AVL

serc2 1} 9 8 8

NG 22 20 Gutn

(ny i430

Na9Ax0

£66" wOLdV4 T33HN _U3L3K ovOrT U3LIL N3DAXO

GT ITONY IWIN COE ?HLd30 KYK TVDOT ZeTt tLWD GrsT 3WIL SSIW T AS¥D

wor) AHOI3N anvH AWY 0NO79 G92 GINNH 138 9taR=998 9NOT

e680 430 DINOS 9 DFUIO FAVH @ 3eAL GNOTD "92 13M awIL NP TEMOT IVT

WyaSNVEL 83 -O9BIT ONIN ALIMIGISIA 8°@ AWG @H3L 9ST unk

9 Goldad 3AVK 9 DOT3A GNIH 28 USHLVIK G'220T ONY = /BZ/ te GAVE

6s90ee 30NZU343u ONME DGe¥hid NOTLVAS ge 3SIND OBKNTE Aw

---Page Break---

Deva

nWka

3e-Wka 3e-via

fuse ?ez Ken

eno-va ?on s8ynay

oT Va

{

3 7930 aunivaTaWaL

az se az

3088. Hav¥SCHUSHA AMLYE

sz

az

142

---Page Break---

+ gt

1 ee

WaLiN SoMa

?

49709

eau 430 91n95

evasnvas

> dolysd 3avn

vouep

T6146 6919 goty eg'e2 zevige Gstvz 96'92 9stoz zB Bt AF

166 5219 Sut GstE2 Scg'sr f4'92 es'g2 Cgtgz T oT oT 8

AVS WOH W/1K LOTS ATS AVL KLUB 2D BTN

N3EAx0. an CES

466'' woLDVs 193MM w3u3K 949'' HALIL N3DAKO

Stow FeIN as mLa3C AVH WUT Bee TLKD Off SHIL SS3K TF 4syo.

YanS13H gave «2 wy GnO12 eB Oth 73am LtyRHog 9NOT

at 4sf0 Gav dal Gn019 OM 3k dada ON BhAEWRT YT

at 33u10 Uuiw ¢ ALTTialgin atez Aed awd C'S. wow

9 D079N GNI 24 MSMLYIM DYRBDT Duy wL/2z/¢?BLYG

3ON3M3474 Od votyag NOLAYAS asiNwo oBKntvs Aw

143

---Page Break---

YuLIN Some

?

49109

22a 430 DtNos

avdSNVML,

» Gotu3d aay

sour

9 ety ontce ceatge

y SFie2 dees Gorez gorez setcz & tet 6s aot

2 92e'se 25192 2b

2 098.

2 2592 ¢ as as Bs

zavioz 2 Gt G2 ge

?92 ay'oz oy'92 tT og ft

a

AYSE WOH VAN L918 NEWS dard WL at? Ne B. Tay Sut

N39

dna (ay Hue30

466" yOlovs T33HM w349H aco" ¥aLtL NaDAXO

379NV 3uIH aot

TLH9taH aay

69 93u1G 3Avm

@t 93utG Onin

£8 90734 GNIM

3ON3UI43¥ ONE

Mid3G xv WOOT 2 @ '4Wo ate FWLL S$3k ft asva

2 tay ono79

OtwnH 78 Zteeeg? 9NOT

y Bask On019 © 8°g Lam awk oN SttEeas ayy

4 AMT, Otte Aud ah3, tg unde

zo lw ? Ouve = pe /eere Gav

arene NotAvas 3siMwo oBHNIVE Ay

144

---Page Break---

tet

ost

ve!

vt

93

vst

sat

4a)

VuLIN SOKd

?

40709

ete 430 21Nos

dydSNved,

> Golu3d 3nvn

99esh

estye yater 682

?vite genet oe

zetee 29%6t eat

94 6

bye @

44tez 26

greg @

ast9z a

Vow VW A STS NETS AYE a

N39Axo ?

£66 wOLavs 735KH 343K cet YaLIL N39.

BIONY BUIM Gof M4g30 xVM 1907 42a ?LHD wT SKIL S:

© ANOI3K 3AVH 2 _dnV on072 26a OLWOM T3u

6@ 93410 3AVH > BdAL GOT «tg L3H an3L

Bt D3uf0 ONIN < ALITIGISIA tye AYO aH3L

a D013 ONIM 20 W3KAVN ThaTeE | OuvewL/ei

30N3¥3438 Onue OFeVRa NOLLYLS asinea

29

Wy #1230

Axo

S3k Tt ASvD

N07

a7

now

2/6 vO

oennive Aw

145

---Page Break---

---Page Break---

---Page Break---

asz

?a82

ast

- 2at

7

? $6. _._

ae

2

er

e

SHie30 CuVONYIS 4s ove

Beret » 162 662 gue

grat © GHz bbz BGz

?erst 2 6b gaz Bez

6ort2 Test get ast

be'y2 oT @ oat aot

W6"Sz Bt es es as

yg oe

Err £066 yo'9 acy certe cebres Bete Soe sear go

YELIN SOM@ avsx Vow T/tW 1 91S NIWS aAWL RL a) we Sy Suu

N39Ax0 da (ay Heese

466" MOL2VS T33KM U3L3H QL" Y3LTL N3BAXO

(BURTON 3UIN gee HLd30 xYA 4VO07 seo ?Ke g*2t SKIL Seam T isd

yO09 2 LHOISW anYM Tay gno79.

S7@ 430 Din0S g¢ 93uTG 3AM @ Sen) Gno7?

~ SVASNYEL~@t~ DUTT ONIN ~¢?AITTEBTRTA

% Oo1¥3s BAYH ge 073A GNIM 20 uSHLY3M

49g OWN 73u

ous

vereey 6a 310

OScf0d 30N3H343H ONES 8-vhe NOLLYLS. fe@ 3SIN¥O oBKNE Ay

148

---Page Break---

---Page Break---

---Page Break---

---Page Break---

Dawa

SA98U1 HobMOCWESHAAHLbE

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

---Page Break---

ust ?te 2990300

os0-va ?on osfnay

Deva oe-vaa orWad

1d

se

a

st az

2 "930 3uniuaagH3L

Se ae st we se az

$3088 HebUSOHUIHLAHIBO

---Page Break---

---Page Break---

Gort cat

e6ie a!

To arteiat

TO'vs 2649 Gate tetyz

96196 12:9 ot» tote2

?I9tast Tete wL*y Tetee

QS! Gbrtet 69 ya'y 2at2e

170

aw

~ VeLIN SoHE "uYSN TvowAZTH OTS 22 3utn

N39axo 4K) 41830

?_?? ea tomy sare ppGOO BOLOVE 334K UIE3K? BIZ wITTE-WaEAKe?? ~?

_- © STONY SUM AEE H4g3d xVA 199079 9 ?nD TeaT SKIL Seon Asya

Sonos fq {MQU3M AYR 8 aw cn079 agg OtWOH 134m Bt¥t-99 onOT

9eta-a30 Jtwos ?Ze a3utG 3Aym 8°8 1am dnd, wot TEaT ?u¥t

uvesnved, 33ula GNin 8°62 Abo gu3L?T+at non

SOT wae ane ??? TOTFA-OT S9ver ONVE ?Fu7tevar ?s1¥e ?

a zeees

Bonswsale onag

BreyKe NOtAVES

?¥81Nwo OBHMIVE Ay

---Page Break---

#20798 Setst ¥6t gee gue

ese ecz

Bez Doz

est act

e

20 3am

wy Hie30

N3DAXO

~ £86" BOLDVS 133M BIW ?RTE UIE -WIOAKO

MIO BUIN aut muedu KYA HOOT Eta stad got KIL 8834 T 1svo

40109 ¢ANo1aN 3AYR 9 any on079

ze@va 430 2IN0S 99 93H m8 agit ano7a

uvasnveL 6a D3) ALTMersia

-oord3e 3Ave $3. 30T3N ONIN 2B uSatyam

OLWNH 73y* etye=99 9NOT

A3hoda3L oN BttRORT LyT

AYO dn3i ty now

at ONY WL/TE/ET GLYCO

fees 39NgHI438 oNUe ore¥d NotuvAS 38towo o@Nnrve Aw

---Page Break---

26;T0T 2679 cary ooze cezrce gerez er

986 SOO GL*y S222 BONER 2c Ce

e

SHid30 GBVONVIS 92% ace

arg gee EE.3T £6:9 S879 y9°z2 cease gerzz gore oeezz > tt ot er

Feit Sma ?P18, $852 $e59 G2222 wosree 2eece aoe seceg TF 8

YULIN SOME ? A¥SK 779K WK 1 Ofs NTIS) ?SARS ON® BL an ew

NBDAxO 0H) Hie30

666" BOLOVS T33HM B343H BTL! UaLTL NZDAXO

2 Nowy autN et M4g30 xvA TyD0T GG And BET MIN eeee asvo

KONOD 4 :HOIaK 3AYH Z _Lay onoaa OtHOh 738 a*ee-998 onor

QINOS a ?9340 GAYN «8 34,1 gnowd Lie awl oy.

sonra $2 28ulO Guim Alrtueisin arge Ako Suan NAS.

430mm 26 9073 GNM eo waHASM G*ZteT Oe SSTey ay ava

®26260 30NIu343u oNuG Ye-vid NOLLWAS 8 38InyD oaNnave Ay

---Page Break---

SHid30 CUYONYIS 6s eg

ra ger22 wer eoy aay

9892 & 9S as

se 8 a

eo tt @ 6 8

Tb NG 21 a SutH

1430

173

verte

1x Son 473k Toke

Nagaxo Wah

466" wOLOVd T33HM U313K BTL! -HILTL NOAXO

@ F70N 3UIN gat MLg30 XWH TVD gyzz ?iM OZ BHI SSIN T As¥D

0109 AHOIIH SAYM 9 _LWY QNOT2 gg OINNH 738m T*ye=998 9NOT

e9te 430 DINOS ?23410 SANK 1079 13M gw3L | N-S*BRSeT ?LY

avaaNvaL 3u10 ONIN $14 2 ABO GHIL az non

© aoluad 3AvK 20734 GNIM VIM L'2TaT ONY ge/Tos Tr Suv

686060 30N3N3434 NuE @z-vid NOLLWAS @c8 3SInyD oeNnte Ay

---Page Break---

treet

T9892

e292

29°02

aerce

$ar0z

cared

orr6r

porte

go'82

sere

20°02

Te0c2

3a

289" re

Nts:

eer

ase

eae

est

eet

$e

as

es

az

at

@

SHid30 OUVORVIS ?ag6 age

ae: 8 862 e62 oop

ee'o < ez

eeo 9 ust

ea Sot

% oT

£ ts

z 06

toe

N@oz

OH) Hiead

foe" BOLE T33HM BILZH BTL! wOLTL N30AK0

S 3TOWY BUIN nk HLa3O xvH WOT EIZe «ima 2-2 LAMM SAD 3 aso

50098, 427K ave 9 wy conor sca tare Tay B'2e-998 9n07

obra se QINOS ge ?23ui0 3avn gaan Gaeta gfe OND gWaL ON Steet iT

ev dSNTeL 23u10 ONIm ¢ ALT THBIgiA 2 AW BW3L 202 on

S coiuad 30H ye 2073 ONIN 22 uamivan goSSar Owe beter tr 3i¥a

@6ese 32NI¥343u oNMe Deevad NOLLYLS.

250 3SIN¥D oaKnrWe Ay

178

---Page Break---

T6t96 39'9 ety gotzz

96°66 20°C 26" Ga't2

+ T6'96 t9'9 coy Bstz2

PT T5* 96°66 20'L 26" 90'T2

YHLIN SONS L¥Sx Vow T/W 1 OTS

NB9Axo

66"

© 30Ny auIN Bt HLaRt

0709 ?

9509 430 DINOS ¢@ 93NT0 JAYM og

avdSNveL ga D310 ONT

» Golwad 3AYH 29 20730 GNIn 20

626069 39N3u3434 ONuE

AHOIIH 3avH

vatise core er

£6620 voece e

SHid30 CAVONYIS 626 aga

verse 0642 Bare esrez 2 8 oat at

46°28 r9'42 @a'2 yercz tT 9 ogg

NIWS GATL WL UL NEBL zo Sut

dk3L On Hiead

OLd¥4 193HN W3L3H ATL SLL NIDAXO

OKYH AWOUT 2t6 'LKO Z-ET BWiL SS3N Tt is¥O

KY CNOTD 988 OIKNH 13x Btze=998 ONO?

das ON079 9° 13M GW9L ON Stez-Br L¥T

MIMBISIA gr¢z 4¥0 an3l geet enon

waKAWaN C'USaT Owe bu/tey at Gu¥O.

Ye-YHd NOTLWLS es@ aSinys oawnre Ae

175

---Page Break---

ear

Se

26

as

22

ar

e

SHid30 GBvENVIS 986 age

re9 96 Bere sree» tet oor eat

at 96 Ooo 9662s By as Be

gore seruzz 2 gz ge

iee-20 ere t2uzt @ 9 3

NEWS GAM kat ne Bn ag Sate

nae On 41830)

466" HOLDS 133HM BIL9W BTL! BaLIL NZDAKO

% ONY FutM get mLg3d xVH 49209 Laz ?umd G°@ JWLL Soon T sye

Siuoe $5 (RSI 34Ye any gn0r2 298 atninn 738°» e*zeeage 9n07

sete 430 21N0S 99 O3uIG Saye 8 aah Onoia ere ?Tan ease toe-et iva

Bye 82 93K1O Wim ¢ ALtTuBistA avez wo gual Sefe non

% goltad 3avk 98 90734 Ohm 29 uHuvaH Geter OuYa ave, tr TOT

986e6o 39N3¥I43y ONMe AR-vie NOTLVIS 858 3SIn¥9 oBWnrVE Ay

---Page Break---

Iee 22t9

zaree g2'9

Lee 22"9

?to agty

baS6 F6t9

To'r6 86's

SHid30 GayONLS

ae ta

ee pert

os 25°6t

ae asrt2

s cer82

£8 bore

bute are

vey rstc2

94: sez

» yore

26% S2°22 Lg we SutLe

oety arrer

arte

ote 296

2228 Gc'62 Lec+9p 26°52

Vik L918 NITYS) aaNL

N394x0

468" wOLD¥s 19344 ¥313H

e BUI 90s Hig:

sgt att 6'9 say aztcz

otto eat 8's oc'y 9etez

gee ga" GL'9 22's 2t¢82

sete set SO°C 26'» Getz

YeLIN Soxe 9K HL OTS

N39Axo

2 sony gen

¥0100 ¢ LHoIaH

aeee 230 DINOS §@ 3uI0

uyaSNveL ga O3uTG

Goluaa 3AY# a 2073h

OXY VDOT LEtE ?Lhd O°T

st

ve s)

Nis

262

ave

vst

oot

2

zoe

eee

eae

agt

rat

se

96

or

22

er

8

use ose

eee oor

esz ase

edz 202

eat act

29 Jat

uy 1630

@Te+ ¥3L1L N3DKx0

BHIL SS3N 2 ASYD

2182 go" L282 » got gat oat

192 ao'2 aer92 eas as as

e142 BO LUZ 2B Gz G2

oe scat 9 8 8

BAY, kL LN BL 29 du

en3h (4) Hid30

ABC U3iTL N3D4K0

466" wO.dv4 73344 9313K

eet mig30 xYH ¥9

BAYH § _Lwy ong72

BAYH 3441 0no79

ONIN 4 ALTTEBIgiA

ONIN 290 w3KAyan

2e-vae NOT

486060 39N3N3434 ONNe

ur gete +

tee a

saz

ercter

as

AnD pT 3Wi1 883M Tt is¥D

THM 128M 6*Ze-990 9NOT

ABM dW3L ON B*TE=OT 1¥T

ROO awd CT

now

owve pastor tr 3uv0

60 3SIn¥d oBKnTWs Ay

7

---Page Break---

sere

269

BL ¥ estze

v8'y U9'Te

£89 oc'y est2z

26°9 v8'y 19" tz

S/W 7H 1 91S

NJ94x0

VELIN SOMs

66"

@ 359Ny gure mas

40100 iMOIaN SAYN &

tee 430 DINOS Ge O3utG SAY 8

BVaSNVHL 6 -D38I0 ONIN

% corwad 3avH 28 20738 GNiN 20

26269 39N3¥343u ONMe

a

actise 69rcz et

20888 69°42 a

SHid30 GUVONYIS aes age

Bet'ch Gercz goo Betz» 6 ot at

zigree 69°42 ao'e egrcz ee oT Bg

NEWS GAT WL ONL NS ok 2a Sate

dna w) H4d30

OL0vS 733HM YBN ATC? LIL NIDAKO

0 xWH WOOT 286 ?1nd ¢'ET BWI SS3W T usva

AkY gNO72 98¢ GIHNH 13Y M ette+99@ ONO?

3da1 0n079 8s 13K gw3L oN Brezser u¥T

ALIMBISIA 8°92 AHO KIL 5*ET unow

WIHLV3M L*?TBT ONY pe/TEY eT Si¥O

Voevkd NOTLWLS 68 3SInuo oBKNTVG Aw

78

---Page Break---

ahicz cterog s2tez

Qetrz assr9n 99162

9uts2 ape on 15192

80'22 eedise 69912

28°22 popes 6ct42

$9122 eze'se aatce

Grr2z aces 20°42

SKid30 OuYONYIS te o¢e

3162 eter9e Gzrkz ee'e Gztez » eet Bat gET

26'9 28'r 94182 eeEt9R Lery2 Bo'a Letoz fF fs eG BS

e919 L9"y $6122 GagrSh GL'L2 Bato GL-L2 2 8 Gz gz

26°9 vO"y Ov'zz arene 2e'L2 BB zeU2 tT @ 8 3B

Von VW LOIS NIWS SAVE HL LON ZL zo UTM

NB9Ax0 ana (ay 430

466" wOl¥4 733HM B3L3K @TL+ H3LTL NBDAXO

9 STONY IWIN aay M130 KYW ?WOOT Szaz ?1KD pre HLL SS3H T LSvO

4O100 § AHOL3H JAYR ANY ONOT72 Sea GINNH T3Y om Lt TEe99@ ONO

e43e 430 INOS «Ge ONTO ZAVM «8 dks GnO1D «Bt LIN GKIL «ON OteESeT VT

WYdSNVEL 48 D310 ONIN -¢ ALIMIGISIA @¢2 AMC GRIL tre, nH

y Qoiead BAVA 98 D0T3A ONIN 20 MEMAVIM «C*CTET © OUYE = bu/Tas tr 3LYG

S86060 3ONINI43¥ One

avevie NOLLNS

so asinu> ceHnive Aw

179

---Page Break---

SHig30 GUYONYIS? £6 a¢e

seet9e ered @ 62 662 gee

ots 98 Eros ¢ eek bez sz

669'98 Soret 9 96T 64r Bar

96c'98 t't2 ¢ tet ost est

456198 8trez y 68 BAT Bet

vit9e oraz s 89 as as

reese sce 28 ge ge

S6"7 97°22 ors-ng seuzt a 2 8

YUAIN SOMA LYSE W/9K 37TH 1 -9IS NITWS, ATL ONG FL zo Bere

Na94xo oy Higad

66° woLovs 133HM B3L3H BTL* wILTL N3DAKO

y ROMY FEIN ue HiLg3C XYH VD0 get ?1nd O'S? 3HIL SS3m Tt is¥D

O10) 1NOI2M GAY 9 uy ONOTD 648 OLKNK TgY mH *Te-998 9N0T

zara @30 DtN0$ ze 33u10 Saye ©«@ 3441 Ond7D A3M awl oN O*TeeeT ?LyT

BVASNYEL Ga O3¥IG ONIN 4 ALITIBISIA B'gz2 Add andl otse non

% GoIdad 3AvH G8 90738 ONIM «20 M3HL¥3M G'7TeT Suva be/¥Ey Br Suva

86262 30N3¥3434 ONue Oy-vnd NOLLWLS @60 3SInuo oBKNIVE Ay

180

---Page Break---

S8's6 Bey 9L"y aGt22 ostist 99rLz ar

40'o s2'eat co's So'y agtez Ece've 94'L2 e

SHig30 CuVONVIS: ~?tks-oge

Bat ee'66 Bory 9c'h BEtZ2 getrch 9orLz BOT GerLZZ 8 BY BT so° yt 26'9 By OL'Z2 Cee ye 94°42 Bete GZ T BB

SoHd ?AVS VK T/7W 1 DIS NITWS GAYL KL UON@ BL) 80M

N39Ax0 ana M430

466" wOLDVs T9RKH BSL3H OTL) UBLTL N3DAXD

@ STONY BYIM GT Mid3C XY 1YD07 ¥GG ?UND GET BWIL SEH T LSVO

wO109«@ LHOTaM AVM 9 _LkY nO OINMH T3¥ A Ctae990 9NOT

NOS. Jam § 3d4L on079 AON gW3L ON EtBzeT YT

V8 D3ul0 ONIM =< ALT L@IgIA z AwC aw3s get xnow

% aolddd 3AVK © f@ D073A ONIN Ze WIMAVIM «C*ZTET OWE «pu /Te/ Bt uO

Te6eeo 3ON3¥34IU DNuE Yeavne NOLLWAS 68 3SInyD oBWNTWE Aw

ate8 430

---Page Break---

gota gtrze

:

a

8

si

?

8

a

ze

62"66

ots

ero ec'y

{9'@0t 96°9 LO"y

tee"

£66 2219 acy

62°66 £8"9 Gc'y

a¥Sx 779K 177K

NJoaxo

9 37ony 3eIN gat

40109 AHOI3M 3ayM

zete 30 D1nos Ga a3ut0 3Azm

wydSNaL (a 93410 ONIN

% Goldad 3AVK GB D073A NTH

eg60ca 30N3¥3434 ONNE

Secon sorez ear

2eL'9p L2"62 5

Toeto g6t9z es

aE

ee

a

e

286 as

Bet gat

Bs as

62 se

eo @

20 Juin

nat On) Hida

youovs

HLg30 x¥H 207 Zzet

Ta3HM B3L3W OTL" ¥3LTL NIDAXO

?19 6°22 3W1L 33K Ls¥o

£ any onor9 OLKNH 12¥ _m $*ae=998 9NOT

@ 3441 an079 LM aw3L ?N-StaEaT ?1v7

& AT iergin @ AWC BHI, 922 union

Ze waHLvaN Tet NYE FL/TEY at Bu¥O

Us-vne NOTLVS O50 3SINND oaKNTWe Ay

182

---Page Break---

zener

685

9276

e802

cortor 2622

eo: tor sere

zertet pa

grog aad

tee sztes

ata 92'6t

gore artz

2266 L282

aertor Tyee

strzet vere

zertor pare

YULIN SOKM LYSx 30h

NBOAXG

si

26

es

ez

ar

@

ans Ue

SHLd30 GuyaNvis

veret

sez 662 ae

ss2 sez sz

set 62 G02

ast oct ost

Ber edt Bat

3s 9g as

@ 62 ge

tT a 28 @

TENG BL 0 atm

cw Hie30

£66* MOLOVS 733HM W3L3K OTL U3LTL N3DAKO

2 YoNy 3eIN aoe HLg30 xYN W907 &

wO102 AHOI3N BATH -<_LnY ano1d ai

s688 430 DINOS Ge O3TO 3AM «8 ear cnoTD ?B

yasNvaL O3u10 ONIN ALTT)

¥ Gol¥ad 3AYK go D073A GNIN 28 WSHLV3K

8260¢e 30N5N3434 ONHE DGevAd NOLLWES

4b ?ano t°82 3WIL SS3W Tt LSvD

8 O1KNH 734M S*@e-998 NOT

GLa awaL wv TEET IVT

$2 AO gNaL T+82 sn0H

gtet Wve ee/Tey Ot GuvO

a5e 381nyd BNNs Ay

183

---Page Break---

---Page Break---

NJO0uLIN 8

saovuaAY TIVE ~WRd

185

---Page Break---

orety

SGhte

AB0AxG

2 Wsunra-vie

rats 6pat vty

Sages Peace ewan d

@ WSUNIM-vRa

aeate oper

arate stots

N390NLIN GONE N3DAKO

¥ MSANTM-vita

2enicz ee

aesiee ?i

$98te2

zectee 4

996 %ce 5

myBts2 ok

poates we

Tete Cyatee

oes ates |

WS Genuvesans ia30

4

Gunuvesesa, 41a30

aevaey HONOMML sezzze wud Vivo aOveaKY

Tie teres gpatgz t

e9'ez ?gsa'se geetee,

TERNS OATTAITWS 3unIWe3e31 G1a30

PE9us NO PyML eeerET NOE VaNS aneNaAY

---Page Break---

9 onTuas-vaa

pscuee Hennes

SIE Fe

2 8

ets BUN Yedda H4g3o

SMHS AMIN Ts

GSixre HONOMHL pc¥ez? YO VAVG 30YR3A¥

---Page Break---

sya'e

fse'ae snovge foes

SE Zoma Waa ? Twas ? AEN vs ?sunivasansy- Waa

2 waHNOS=VHE

ay

?aHNNS -VHE

ate bysty

se tet,

Sons Na9aKU

¥ usWNnS=VRE

a20Sb0 HONOWH EEsZeB-YON VivO JOYUaAY

ALiniis~ 3untvedanay A4aa0

~ R2OSp mOMOUHE peSzED NOS EVO JOVUTKY

STAGES WOCHMT (2628% wos VIVO -SOVEZAY

---Page Break---

© Tavi-vad ? 2eSaso-noTOMNIseoESe

---Page Break---

190

---Page Break---

APPENDIX 4.14

Data Reduction Program - 12 Mar. '75

TAB

191

---Page Break---

REALes ST, STE

DUVENSEOM TACLE (954 40°530) 4 1T(25) 6ST C150) /DATAOIIS) smATAS(LAY

Le TETLE CA, ty, TTT C49)

188 FUMAT CUBS OR ARE GEN GED, SO SEEM cod Oke ASS TDD

AOL FOMATCL5 xy an, t55

362 Foamarcieas)

MOS FORMATO'TN 7K, TaRLE HI

18x," ate "arated

404 ?FoRNATC##", 123, 42612.3)

105 FOUMATCI>N I>3,3 "FLoray

486 FORMATO 12a, Les er4)

37 FOMATC*2", 16,$x,46,>%65F48,3, 118)

AOR FORMATO HAE, 15F Hy 0D

189 FORMATC!1", L645)

DATA DATAN, TASLE/9¢tae2,/

DATA COTITLECL J) sT84,8) ,J84447) 7

ANTOTAL lowass? OF pOORLANKTON (ML/$@aH3)

2ITOTAL NUMRER OF Z00PLANKTON PER inane

SITOTAL NUMBER OF SoPEPOS BED qaaMs

ENTOTAL Munck? OF CHAETOGNATHS ER 4BaH3

STTOTAL NWuewER OF LeRvaceaus Pea segms

SITOTAL NUMGEP OF CLACOCERANS PER 1sgms

7ITOTAL NUMER OF PTEEQPODS PER dade.

HITOTAL NUMWER OF OTHER PER Louns

SYTOTAL # OF VELICER LARVAE PFA i4ens

PITOTAL # OF CIRRIPFOE NAUPLIT PER ivoMs

ANTOTAL # OF CIPRIFEDE CYPRIS PER 1vams

BITOTAL # OF PEAEID LARVAE PER isem3

GHTOTAL # OF PRACHYURAN LaaVAE PER 1DOn3

DITOTAL MuMaen OF OTHER BER anos.

EVTOTAL NUNAES OF FISH EGGS PeR 199g

FATOTAL NUMRER OF FISH LARVAE PER icons

GPTOTAL NUHSER OF HOLOPLANKTON PER 3B0K3

OATA CCTITLECT J) 124)8),J942)349/

ANTOTAL NUMBER OF MEROPLANKTON PER LO0H3

2tPrAcevTage oe CopEPnOS

SIPERCENTAGE OF CHAETCGNATHS.

4IPERCENTAGE oF LARVACEANS

B'PERCENTAGE OF CLapocesans

G'PERCENTAGE OF PTEROPODS

HW SPERCENTAGE OF OTHER.

ZIPERCENTAGE OF VELIGFR LARVAE

TPERCENTAGE oF CIRRIPEDE NAUPLIT

SIPERCENTAGE OF CIARIPEDE CyPAIS

AIPERCENTAGE OF PENAEID LARVAE

BYPERCENTAGE OF BRACHYURAN LARVAE

G'PERCENTAGE OF OTHER

PERCENTAGE nF FISw EGGS

PERCENTAGE OF FISW LAaVAE

FSPERCENTAGE OF HOLOPLaNKTON

G'PERCENTAGE OF MEROPLANKTON,

c READ TITLF,

2 READ (2ese2erho=98) THTe

849//20%, 1885/7/52K,

STATIOSS*////

---Page Break---

2

32

33

34

0

PRINT 449, TITL

Trinees

than

IstAT ve,

TAVLE ?Chae deaedy

READ FLAS? cash,

ReaO 2295 11(12 ST CL) DILUTsPIR2, REVSPH REVS, MET, AS) IREP

09 92 184, 42720

PRINT 4274 1TCITINE) »STCISTATH) :DILUT, PIR2, REVSPM, REVS, uET,

```
BEPIRZOHEVS/REVSPH/AID,

Dieurantvyry ay ike

TABLE CITINF) 1STATN 4A) STABLE (ITIMEs ISTATN, 4) ¢¥ET/2

09 $2 Jet, 1keP

READ 491, To, DATAG

PRINT 168, TOW,DATAD

00 28 K=2446

OATANGK)=O4 TANCK) #DATAD( Kod)

comTInuE .

CONTINUE

SUM HOLMPL ANATON,

D9 22 K22,7

DAYAN(L7) SNA TANCK) sDATANCL7)

CONTINUE

SUM MEROPL ALKTON,

D9 25 Kea,49)

DATAN(18) SDATAN GK) ¢OATANGLED

CONTINUE .

TATCECITINE s ISTATN, 6) STABLE CITIME ISTATN) $6) #4TA(2}

Do $2 Ke19,$4

TALE CITIMEs ISTATNAKDETABLE CI TIMES ISTATN,K) *DATAN(K=26),

CONTINUE

Do st K=2,18

TASLE CITING ISTATNG KD ETABLE CITIME» ISTATN,K) SOATAN(K)@DILOZ

DATANGKISE,

CONTINUE
```

CHECK FOR END OF & DATA SET,

IF (AS.£0,1He) Go 70 99.

REAO 408, 1TCITIME*S) sSTNEW,OILUT

Ree

TR2)REVSPM REVS, WET, AS, IREP

TECLTCHTIME*S) NEGITCITIMED) ETIMESITIMESd

Do 33 IstaTNea,1s -

IF (STNEM.EQ.STCISTATNY? GO TO 34

CONTI UE

NEW STATION,

Iselser

ISTATNAIS|

ST(IS)#STNEW

TABLE CITIMEs ISTATN, SE)eTABLECITIME, ISTATN) 38) 04,

continue

PRINT TITLES.

09 82 171,48

PRINT 383) Lo (TITLEC Os Ey eJedeR) oTIIbs (ST CK) SK EL) ES)

0 82 Jet, tTIME

00 95 kas

193

---Page Break---

55

an

cr

98

82

ae

9

DIVIDE aY auntER AF TORR,

TE CTABLE (JK, $5) 429474) GO Th 5D

Take (SMe E) STATLE CURT) /TARLEC SK 399

ConTINUE

IF UL.cT.a9 co To at

PRINT 404) 1T(00 (TABLE (Je Ku 1) 0K:

Go 10 a2

PRINT 495,)T(J) 0 (TABLE JoKs Dy

conti yue

Do 84 119,34

PRINT A235 fo (TITLECIe 1) oo8d 08D TIT Ls (STOK) 9 KELVIS)

00 84 Jaa, ITIME

Do 67 Kety18

CONVERT To PERCENTAGES,

TP UTABLEC I,K, 34) £5404) GO TA 68

```
+18)

118)

TABLE (Jiky 1) 2TAGLEC Ks 12/TABLE( J) Ks 360 0400,
CONTINUE

PRINT 106, 1T( J) CTABLECJ/Ky1) /K2L0 1S)
CONTINUE

O92 181,36
09 9a Jetsitime
09 99 katy 18
TAGLECJoKsT) 20.
CONTINUE

ao tat

CALL EXIT
```

End

194

---Page Break---

APPENDIX 4.24

Major zooplankton groups at each station

and for each sampling date.

Explanatory notes for computer printouts.

PTEROPODS: non-coiled species (e.

STPHONOPHORES:

THALTACEA:

8-5 Creseis acicula)

Siphonophore bracts, not whole animals

includes salps and doliolids

195

---Page Break---

ZOOPLANKTON MAvATI

BIOMASS 1 ?1/108 CUBIC METERS

ABLNDANCE IN #/CUBIC METER

station 1 statioy 2 station 3

C2 tows 3 ToWS) ce TOUS)

Browtass 16 18 °

toTAL 96a 1635 1206

coPerons 575 1209 785

cHaETOGvaTHS 34 51 36

LARVACERYS 7 24 26

erenovons 36 20 °

ostaacops 30 46 138

cLapocenays =o 1 2

MEDUSAE 23 1 3

SIPHONOPHORES 7 1 6

crevopHonEs 9 ° °

THALIACEA 2 2 2

AUWELID LARVAE 11 ae 1

CIARIPEDE LAR @ a 5

ECHINODERE LAR 10 3 ?

ECTOPROCT LAR 1 a a

BIVALVE LARVAE 1 ° °

SASTROPOD VEL 5S a1 a3

FORAMINIFERA 1 2 3

MALACOSTRAGANS 22 23 2s

SISH LARVAE @ ° 3

FISH EGGS ae aa aa

10.

May 1ar7a

OFFSHORE

©2 Tows>

10

487

2ae

16

39

---Page Break---

aroma ol Mates er

BIAS BE uri pees iste

ABUIDAICE 1 #vcusic TETER

stating 1 statiay 2 remnat 3

Ort cams: C1 tt

Browacs 6 19 ? 13

roTAL asin 198 688 18¢

oPsroas rere an 19s 463

ainetociaTHs se 0 te

manmacsias 2 2 7

Prenopons 3 1 © 2

ostnacans 3 a 2 °

Gapcsnais e ? e

?epusaE s 1 1 2

StPHONO>NORES 8 an v 5

crewruonze e © e

THaLtacea 2 1 1 7

AINELID LARVAE 8 6 4 e

erasrsoe Lar 9 3 1 e

BOHIVODETI LAR Ie 1 3 3

EoTOPmcT Lan @ 1 2 2

SIUALIE LARIAE 15 2 4 2

castors ve. ee ae %

FORAITHIFSRA 15 2 7 7

?ALAGOSTRAGAIS 29 ey 1s 3

FISH Lamar 8 2 2 e

Fis Ecos ts 86 1e 165

---Page Break---

200PLANKTDE PuITa 4araTL a1 9c

bloMAss 14 aLviee cute

ABINDAVCE 1 4#/CuBIC METER

statias 3

ere er Be :

siowass 2 2 1 13

ror er 364 asve 861

corerace 1008 ren asie st

a ae 93 2a

Lanvac > sc 2 43

Prenopons 7 ? ° 2

vemaciss 7 2 s ?

GaDoceeals 1 5 2

teousas 2 ° s. 6

?rpvo~o7Es 2 1 ° 2

stevens @ e ° e

maracta ° e °

ANVELID LamAE 15 a 20 4

crnREpese Lan 2 ? . 6

SoMIVO: Tt Lat s e «

ScTDPROCT Lar 4 2 15 2

?SIVALVE LAQAE @ 4 s 2

sasrao=5 7S. 18 ta aa a

PoRAMVEFSRA @ 2 5 e

aLacostoacats 18 ° 2a .

SISK Latuar 2 ° ° °

FISH Ecos 64 a2 a7 18

---Page Break---

ZOOPLAYKTON

Mavart

BIOWASS IN ML/ 189 CUBIC ETERS

ABUNDAUCE IV NUNSERS/CUBIC METER

Browass

qoTAL

corerons

ouazToGvaTHS

LaRvacEANs

-FTEROPODS-?

ostracons

LADOCERAYS

wepusae

SEPHONOPHORES

crEvoPHoRES

?TMALLACEA

AIVELID LARVAE

CURRIPEDE LAR

ECHINODER! LAR

ECTOPROCT LAR

BIVALVE LARVAE

GASTROPOD VEL

FORAMINIFERA

MIALACOSTRACANS

FISH LARVAE

FIsH Ecos

MEAL

18

1695

1209

st

24

20

48

23

aa

VARIAYCE

5

194650

12701

388

set

a

258

10

?

197

15

358

14

aan

MAY 1/74

station 2

3 REPLICATES

195 Cele

12 To 24

ae To 2731

272 To 2187

270

e710

470

8

e

a

870

e70

er

e%

100

6s

36

86

?

?

mn

an

16

12

70

18

9a

---Page Break---

zo0PLAITD1

Browacs Eh sie? ov

ABINDAICE IY 1UEBERS/CHr

Browass

rota.

copepons

crastocraTa=

LanvACEAYS

PTEROPODS

ostracons

Lavocenais

MEDUSAE

stPHoVoPHonES

CTEVOPHORES

THALIACEA

AUWELID LaRV,

CURRIPEDE Lan

ECHINODER! Lan

SCTOPROCT LaR

BIVALVE LARVAE

GastroPop ve.

FORAMIVIFERA

1ALACOSTRACASS

15H LARVAE,

aa

3s

ene

ems

ens

am 3

ens

e 10 88

116

29 10 56

ina

1 69

---Page Break---

DOPLALTOS PUITA iAnaTt 24 act

Boiacs 1) wurise cvste aetens

ABUIDRICE TY VUISENs/cUSIC ?METER

Had

stones 3 en.

ora. 1564 2ieas

coPerons ten ise76

ae 29 sr

86 tat sam

4 3 ens

osteacops 2 3 ems

avocenass 1 3 ans

MEDUSAE ° ° an

stpnovoprones 1 x ems

cTEvoPHORES ° e on

THaLtacca ° ° ate

AUVELID LARVAE 4 22 e710 16

CIRRIPEDE Lan a 22 eto 15

EOMINODER! Lan 5 12 #10 14

SCTOPROCT Lan 2 12 aru

BIVALVE LARVAE 4 2 ems

sastnoPoD ve. 14 38 eo 70 a2

FORAtINIFERA 2 19 etn

MALACD STRacAWS ° 67 @ 70 29

FISH LARVAE e e a0

FISH Ecos se sis 26 10 135

---Page Break---

---Page Break---

APPENDIX 4,28

Copepod species at each station

and for each sampling date.

Explanatory notes for computer printouts-

T. TURBINATA: ra turbinate

T. STYLIFERA: stylifera

SM CALANOIDS: Includes Paracalanus acuteatus

Crausoeataul Faveacus

Mecynocera cls pnocera eTaust

Kerocalaniz sp.

and other juvenile

?calanoids

---Page Break---

4.28

coperons sanery

ABUIDRICE IN «/CUBIC METER

STATION 1 statioN 2

C2 > © 3 ToUs

TeTURBIVATA 137 675

TSTLIFERA 3 8

St caLavorns 197 208

caLavorra ' 5

ACARTIA ° 6

nuercutra 1 s

FARRAULA, 1s n

conycneus 38 46.

cETHOWA 104 8

owcaza 18 19

204

station a

©2 TVs)

ais

°

279

n

1

15

or

136

MAY 14/74

OFFSHORE

© 2 TONS)

198

---Page Break---

coPerops

ABUNDAICE IN

?Te TURBIIATA

TeSTWLIFERA

St caLavorDs

ewvoca.avys

cALAVORtA

ACARTIA

wiprswa

UCHAETA

EUCAL ANUS

FARRAUULA

convcaeus

ortHowa

oucaca

eycuate 4ETER

station 1

C1 tow

20

13

692

5

2

45

19

16

6

130

ae

sectart

station 2

© 3 Tous)

a

2

260

2

10

58

16

statioy 3

C1 tw

s7

18

18 ausust 774

OFFSHORE

©1Toy>

323

13

3e

13

33

---Page Break---

oPEPops savatt 31 ocTOBER /74

ABUIDAYCE IN #/CUBIC METER

STATION 1 STATION 2 STATION 9.??OFFsHORE

Citow> 3 tows) Ctr © Ca TOW

TeTunsiwata 173 225 sia st

TesTLirenA 2 ae 5 e

St CALAVOIDS 589 766 290 32a

NawocALauUs 2 3 ° 6

camorta 6 e 20 2

acantta ° 13 2 a

Lucrcurta 13 3 e °

BuCALAUS 9 2 e ?

FARRATULA 1s 24 a9 2s

conrcatus 29 38 a 37

ormiowa 17 169 186 te

oucaca ee 16 29 26

---Page Break---

?operons Mavart May taza

sowrDAIcE 1 wUNSERS/cUBIC 4ETER ?Shepuicares

next vantaice 498 cate

Trussivata ors serees © 70 1562

nermirena . ? or 13

st catavoros 208 130 137 70 an

caLavorta s 2 ime

scantta 6s 7287 210 278

uereurta 5 2 ime

Fansatua " 18 Lm a

conveatus as 198 8 t0 198

onriowa ee 787 14 1 ise

eveara 182 om se

207

---Page Break---

coperons mavatt

ABLIDAICE IY MIMBERS/CUBIC METER

seav

?Te TURBIVATA a7

TeSTYLIFERA 2

9 cALAVOIDS 260

NawOCALAIUS 3

caLnnorta 2

ACARTIA ae

worwua 2

puciaeta °

Buca aus °

FARRAVLA ey

convcazus te

ormiowa 36

Oncaea 16

VARIANCE

12

2

1573

23

34

18

135

ta

15 august 774

statio? 2

?2 REPLICATES

198 cote

28 10 as

ems

161 10 358

em?

ems

14 70 43

em 20

29 70 86

6 10 25

---Page Break---

coPePons MavaTE 31 ocTaSE7 774

statioy 2

ABUIDAICE IN NUVBERS/CUBIC METER 3 REPLICATES

aeay VARIANCE +95 Gere

T.TuRBL¥ata 225 2907 92 70 959

T.STYLIFERA 12 36 8 10 27

St caLAvorDs 766 sea9 532 1 999

NawocaLavus 3 9 emu

CaLAvoPrA . ° ene

ACARTIA 13 133 © 10 a2

Lucrcuria 3 ° et

BUCALAVUS 2 3 em.

FARRAYULA 2a 38 9 10 40

conycasus 38 3 29 7 46

ortHowa 169 1299 19 10 296

oucaza 18 108 @ 10 4a

---Page Break---

APPENDIX 4.94%

Benthic Stations at Punta Manati

STATION 4 east of Manati River (Pt, Manati)

2 January 1973

Depth: 7-208

Investigator: S. Martin

STATION 2 Location: Pe. Manati (East of Manat! River)

Date: 6 June 197%, 1% August 197%

Depth: ae

Investigator: P.M, Yoshioka

STATION 3 Location: Pt, Manati (East of Manati River)

Date: 6 June 197%

Depth: ae

Investigator: P.M. Yoshioka

?TRANSECT A east of Manati River, parallel to

shore

24 May 1975

15-209

P.M, Yoshioka

?TRANSECT 8 Location: Pe, Manati (Bast of Manat River)

31" May. 1973

jo- 179

Investigator: V. Vicente

TRANSECT C Location: offshore of Manati River moxth

Date: 29 Mar, 1378

Deptt 20m

Investigator: P.M, Yoshioka

TRANSECT D Location: wost of Manati River (Palmas Altas)

Date: 11 May 1973

Deptt 0-179

Investigator: V, Vicente

?Refer to Figure ¥.3-Fi.

210

---Page Break---

APPENDIX. 4.34 (continued)

STATION & Location:

Date:

Dep:

Investigator:

STATION 5 Location:

Date:

Depth:

Investigator:

a Tecation

Date

Investigator:

an

Inshore of Seation 2

AW August 197

ae

P.M, Yoshioka,

west of Manati River (1/2 mile W)

31 January. 1973

7 = 20. (15 m)

8. vartin

Rocky area east of the Manati River

mouth

30 January 1973, 14 June 1973,

21 February 197%, 9 Apria 1978

D, Martin

---Page Break---

APPENDIX 4.38 Macro invertebrates and fish observed

?at Punta Manat!.

STATION STATION

2 3

?ANIMAL, KINGDOM

Phylum Porifera

Anthosigmelia varians

?Caiigepengla vaginas

?Sinashine caverns

Trefna strobitina

jularfa magca

?Sphaeclospongia vesparia

ae:

Phylum Chidarta

(Class Hydrozoa

ites so * x

Subclass Zoantharia

saricia 9p

ifocetala stoke

Biploria sp.

Phylum Chordata

?Subphylum Vertebrata

?clase Pisce

Fanily Holocentridae

Holocentrus, sp. x x

Family Serranidae

Cophatopholia fulva x x

Family Carangidae

Caranx erysos x

212

---Page Break---

APPENDIX 4.38 (continued)

statton starrox

2 2

Prylun Chordata (continued)

Fanity botjenidae

coyunus chrysunas x

amity Sotaentéae

Eyuetue sp. x

Fanihy wuitidae

Paudupeneus maculatus x

Fantly Chastodontidne

Setseantias Snlestar X

Fantly Ponacontridae

Fonacentrus partitus x x

Family tabridae

Sotianss ruts x

asses biFosctatum x x

Fantly Acanthuridae

scanthurss op. x x

Fanily Sconbridae

Sconberonorus sp. x

---Page Break---

sepyuoteg

?seprep Tudo

seppo059 7409

seprmawerado

?seproosouseuny

TaeUOTeS BOPRIOG

epsuseang

?suoyawis uostod esoysavou 3e paroet {os seszede ueTA 96H KIGNIGEY

---Page Break---

adyae BRAOUOTT IST

saroas

epyBunaey

upqtolody

ouprunsaes

oepraaeututs

sepraauscoro

seprupaosy

---Page Break---

aepave woporset

Ss

oeprrTeH

?sepruseyos: g

sep Keepruog

orppaseo

---Page Break---

---Page Break---

sepranqauroy

---Page Break---

APPENDIX 43D Infaunal and epifaunal speci

in 1/4 n? eanpl

STATION

4

Phylum Annelida

CLASS Polychaeta

Family Aphroiditidae

Eunice rubra

Sabeliidae (family) 2

sytlidae (Faniiy)

Unid, polychaet © 1

Sylile? prolifera

Phylum Sipunculida

Sipuncuria ep. #2 2

StBnSuLIa op. #7 5

Tae stpmneniota

Phylum Mollusca

CLASS Gastropoda

Vermicutaria knorné

STS ct

?Syaathan poser

?Hissstie maT Ticostata

Trivia ate

CLASS Pelecypoda

Anadare notabiLis

rea imbricata ?

?Diplodonta qucteifornis

Faeete ease

teeta ,

219

3

8

StattON

1

---Page Break---

APPENDIX 4.30 (continued)

STATION

Phylum Arthopoda

CLASS Crustacea

SUBCLASS Malacostraca,

Order Tsopoda

Alfctrona hineuta

?Cirelana obtrunest

order Amphipoda

Unid. gamaria 2

order Decapoda

Suborder Natantia

Section Caridea

Unid. caridea 1

Synaipheus minvs

Suborder Reptanita

Section Srachyura

Zplattus ditavatus 1

?Fortune sp- 1

Section Anomura

Pachycheles ackleianus

Phylum Bryozoa

Unia. Bryozoa ath at

Phylum Echinodermata

CLASS Echinoidea

Bucidaris tribuloides 2 4

Welifta sextesperforata

CLASS Asteroidea

Asterina folius 1

CLASS Ophiurosa

?Amphturidae (famity) 2

ophiactie milter

Ophfocoma echinata

Slots eary 1

Ophfonerefe aquasulocs

220

STATION

1

---Page Break---

APPENDIX 4.90 (continued)

statron sTartow

3 1

A 8

Phylum Chordata

Subphylum Urochordat

CLASS Ascidea

Unia. ascidian x

* 2 species

** 3 unid. bryozoan:

3 different epecies

---Page Break---

APPENDIX 4.4A Common plant species Let for the Punta Manat area, Grasses, Vines, Herbs:

?Bidens pilosa

Burgerea siarab

Chrysobatanus ep.

Coceone

weitere

Cocos nucifera

crotatanin retusa

Doda narteina

Eeichelis fructtcosa

Ipanen pea-caproe,

Jones sp

Yyltega peruviana

Eantana favolucrata

Plumtera alba

Poychotria undata

Rand

=p.

Rawoleia totraphylie

Renirea naritina

Scaevola plunien!

Sideroxyion foetidise nun

Snttax ep.

Sporobolus vinginfous

Tabebuta pattica

Hania latiforiolara

---Page Break---

APPENDIX 4.4B Terwestrial species List at Punta Manati, SPECIES

Leptodactylus sp.

Anolis crystatelis

Aves:

Cobunbiganiina passerina

Minus polygottus

Togus nexteanus

---Page Break---

Notics

Government. Neither the United Stats nor the United States Atomic Energy Comm

rmusion, nor any ofthc employers ner any of thet contracton, subcontractor OF

?her employees, makes any warenty, expres or implied, ot saimrs any lege

aby oF responsibilty for the accuracy. completeness or usefulness of any

Information, appara, product of proces dione oF represents tht ts ust

Stould not infringe pratly owned nights

---Page Break---