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THE POTENTIAL BIOLOGICAL EFFECTS OF DEPLETED URANIUM ON RANGE C-74 UPON THE ALGAL FLORA OF ROCKY CREEK ON EGLIN AIR FORCE BASE

DEPARTMENT OF BIOLOGY
COLLEGE OF ARTS AND SCIENCES
UNIVERSITY OF ALABAMA
UNIVERSITY, ALABAMA 35486

AUGUST 1976

FINAL REPORT: NOVEMBER 1974 - JULY 1976

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AIR FORCE ARMAMENT LABORATORY
AIR FORCE SYSTEMS COMMAND • UNITED STATES AIR FORCE

EGLIN AIR FORCE BASE, FLORIDA

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Stream samples were collected at five time periods: November 23 and 24, 1974, February 21 and 22 and April 25, 1975, and February 6 and April 30, 1976, from selected sites on Rocky and Turkey Creeks, Eglin Air Force Base, Florida. Rocky Creek is in a drainage area for some depleted uranium while Turkey Creek is not. The physical parameters pH, temperature and dissolved oxygen were measured as the water samples were taken. The algae present in the samples were identified to genus, and the algal populations in Rocky Creek were compared to

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20. those in Turkey Creek. Three species of green algae were isolated from water samples taken from Rocky Creek and obtained in axenic culture. The sensitivity of these three isolates to U_3O_8, UO_2 and uranyl nitrate was determined in laboratory tests.

PREFACE

The Air Force contract directly related to this report is contract number F08635-75-C0039. This report covers the study period November 1974 to July 1976; and the report was submitted August 1976. Air Force program monitor for this project was Ms. Sandra Lefstad of the Environics and Human Factors Office (DLV), Air Force Armament Laboratory, Eglin Air Force Base, Florida 32542.

Both laboratory and field data were generated in part by Mr. Gary L. Blume, Mr. Gary T. Thacker and Mr. Richard S. Semmes, students in the Biology Department of the University of Alabama. Their assistance in the project is gratefully acknowledged. Collection of field data was made possible by the assistance of Ms. Lefstad and Sergeant Gary G. Wyman of the Environics and Human Factors Office, Air Force Armament Laboratory, Eglin Air Force Base, Florida 32542. This assistance and valuable suggestions obtained through consultation with these individuals is also gratefully acknowledged.

This report has been reviewed by the Information Officer (IO) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

J. A. Farmer
Chief, Environics and Human Factors Office

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SECTION I

INTRODUCTION

Depleted uranium (uranium with the fissionable material removed), predominantly U^{238}, is abundant and of limited usefulness. Because of its high density it can be and has been used to a limited extent in the manufacture of armor-penetrating shells.

Uranium, including U^{238}, is naturally radioactive. It is also chemically toxic to some organisms. This study is a combined field and laboratory study of possible environmental effects of depleted uranium upon the flora of a stream, Rocky Creek, on Eglin Air Force Base Reservation.

1. DESCRIPTION OF GEOGRAPHICAL AND ENVIRONMENTAL FACTORS

a. General Area

The Eglin AFB Reservation is located in Northwest Florida where it occupies a portion of Santa Rosa Island, Okaloosa Island, the southeastern part of Santa Rosa County, the southern half of Okaloosa County, and the southwestern quarter of Walton County. It covers an area of approximately 750 square miles. To the south the Reservation is adjacent to Choctawhatchee Bay and the Gulf of Mexico, while to the north and east it is bordered roughly by the Yellow River and Alaqua Creek.

The Reservation lies on generally level or gently rolling terrain, all under 300 feet elevation and sloping to sea level on the west and south. It is drained by small tributaries of the Yellow River and Alaqua Creek and by smaller streams that flow directly into Pensacola Bay and Choctawhatchee Bay. The valleys of these streams often are steep sided and terminate abruptly. The soil of most of the Reservation consists of somewhat excessively drained, deep, acid sands of the Lakeland series. In the stream bottoms, the soils are much more heavily organic (Reference 1).

b. Rocky and Turkey Creeks

These two streams of the area originate on the Reservation and drain into Choctawhatchee Bay. Of the two, Rocky Creek is the longer and has somewhat larger water flow near its discharge point. Rocky Creek is in an area that drains some land which has had an exposure to depleted uranium. Turkey Creek is free of any non-native uranium and was selected as a control stream to compare with Rocky Creek. The water of both creeks is clear except for immediately after a rain. Several collection sites were selected on each creek, (see Figure 1) but there are more collection sites on Rocky than on Turkey Creek. One collection site on Rocky Creek (site number 4) is an artificial pond produced by road construction in the past, and site number 3 is a bog that is near Rocky Creek on a short tributary. The following sites are judged to be most nearly comparable: site numbers 2 and 8; site numbers 5 and 9; site numbers 6 and 10; site numbers 7 and 11.

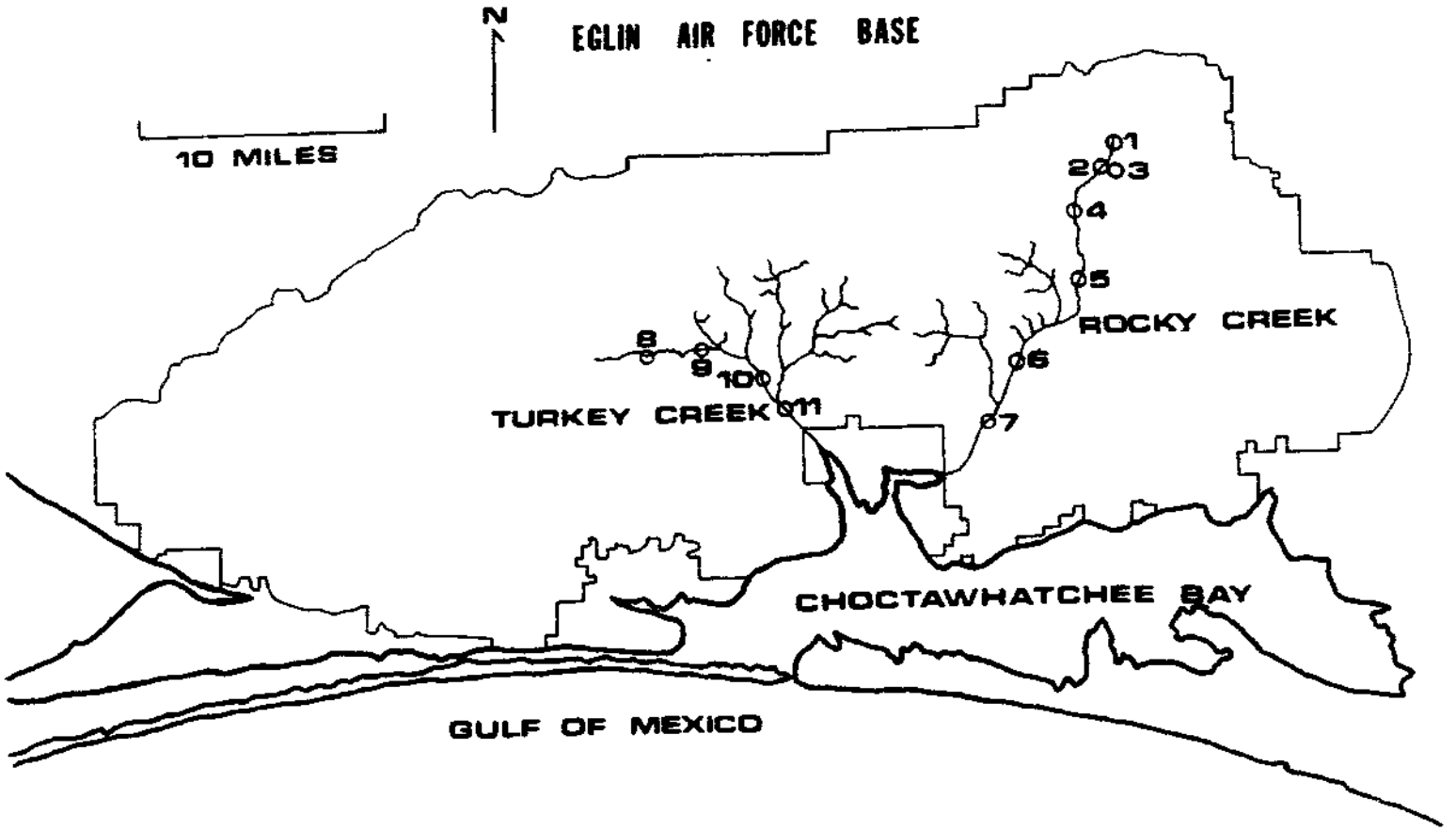

Figure 1. Map of Eglin AFB Reservation showing sampling sites

SECTION II

FIELD STUDIES

1. INTRODUCTION

Site visits for the purposes of measuring physical properties of water in the two streams and of collecting algae at the designated collecting points were made on the following dates: 1) November 22 and 23, 1974, 2) February 21 and 22, 1975, 3) April 25, 1975, 4) February 6, 1976 and 5) April 30, 1976.

2. PHYSICAL MEASUREMENTS OF STREAM WATER

These measurements included pH, temperature and dissolved oxygen. The visiting dates, except for April 30, 1976, were during clear weather not following extensive rainy periods, and there was no measurable turbidity. Conditions on April 29, 1976 were similar, but on April 30 rain started in the morning and continued throughout the collection period. Measurements were taken at each site on Turkey and Rocky Creeks on these collection dates and are reported in tables 1 through 5.

Water temperature ranged from a surface low of 16°C at some sites, to a high of 19.0°C at the bog (surface) and pond sites, November 23 and 24, 1975; on February 21 and 22, 1975, it ranged from 16.0° to 19.0°C; on April 25 it was 20.0° to 21.0°C, except for the bog and pond sites where it was, respectively, 25.0° and 23.0°C. On February 6, 1976 water temperature at Rocky Creek was similar to temperatures measured the year before, but at Turkey Creek water temperatures were measurably higher than in February, 1975. On April 30, 1976 water temperatures ranged from 19.0° to 21.0°C at all sites.

Except for the bog site and for site 1 during rain, pH values ranged from 5.0 to 5.7 and there was no detectable seasonal variation; at site 1 during rain the pH was only 4.6 and at the bog site pH was generally lower than at other sites, ranging from 4.9 to 5.1.

Dissolved oxygen was highest in February, 1975, ranging from 8.1 to 9.4 ppm (except for the bog site where it was only 3.4 ppm); it was lower in February, 1976. In November, 1975, the range in flowing water was from 8.1 to 9.2 ppm (the bog site value was 6.0 ppm at the surface and 4.5 ppm, subsurface). In April, 1975, the values were slightly lower than earlier for flowing water, ranging from 7.6 to 9.0 ppm, and slightly higher at the bog site, 7.3 ppm. However, during the rain in April, 1976, dissolved oxygen values were lower than those for April, 1975.

3. COLLECTION OF ALGAE AT STREAM SITES AND ISOLATION OF SELECTED SPECIES INTO AXENIC CULTURES

a. Methods

Two one-half gallon collections were made at each site. These were returned to the laboratory at the University of Alabama on the second

collection day (or one day after collection) and refrigerated until the time of examination. Each collection was examined microscopically and the fresh water algae were identified to genus. In some instances more than one species of a genus was collected and these are differentiated in the list of organisms collected by an assigned species number.

In addition, at the first collection dates, November 24 and 25, two water samples of approximately 1 ml volume were taken axenically at each site and added to 10 ml of one of each of the following sterile types of media in a test tube: Bristol's Inorganic Salt Medium (Reference 2), FW-1 Medium (Reference 3) and BG-11 Medium (Reference 4). These tubes were placed on illuminated culture racks in the laboratory at the University of Alabama for approximately 4 weeks. At this time many of the tubes contained significant quantities of mixed algae as well as bacteria. By dilution and sub-culturing techniques several organisms were obtained in unialgal cultures. The unialgal cultures were then sub-cultured and treated successively with selected antibiotics. Ultimately three organisms were obtained in axenic culture.

These organisms, isolated from Rocky Creek, were utilized in laboratory studies testing the effects of uranium upon their growth.

b. Results

Forty-four algal species were collected from Rocky Creek November 22 and 23, 1974, and identified to genus; the collections at Turkey Creek yielded 21 species on these dates. Table 6 gives species found at each site; Table 7 is a list of all species at all Rocky Creek sites and Table 8 is a similar list for Turkey Creek.

On February 21 and 22, 1975, the algal biomass was conspicuously greater than it had been the preceding November. Also, the number of species collected was greater (see Tables 9, 10 and 11). Fifty-six species were collected at all sites on Rocky Creek and 26 were collected at the sites on Turkey Creek.

On April 25, 1975, the algal biomass was similar to that observed February 21 and 22. Sixty-four species were collected from Rocky Creek which was higher than in February, 1975 (see Tables 12 and 13). From Turkey Creek, 29 species were collected, also a few more species than were found in February at these sites (Tables 12 and 14).

On February 6, 1976, 52 species were collected from Rocky Creek (Tables 15 and 16); on this same date 26 species were collected from Turkey Creek (Tables 15 and 17). A comparison of these flora with those seen in February of 1975 shows some variation in the lists of organisms found in both Rocky and Turkey Creeks. One notable difference was the presence of Euglena in both streams in 1976, an organism that usually thrives where organic materials containing B vitamins are present. This is believed to be a result of the earlier hurricane activity. Another difference was a greatly decreased quantity of Batrachospermum in both

streams and an absence of the smaller species in the collection of Rocky Creek.

A comparison of the algal flora of April, 1976 (Tables 18, 19 and 20) with that present in April, 1975, also reveals differences in species present. Some of the differences are the result of the 1975 hurricane but some are the result of weather conditions prevailing on April 30; rain began early in the morning and continued to be heavy throughout the collecting period. This was accompanied by stream swelling and washing away of planktonic forms that otherwise would be expected to be present and collected.

SECTION III

LABORATORY TESTS

1. MATERIALS AND METHODS

The forms of uranium used in the investigation included U_3O_8 (green uranium oxide) in powder form, UO_2 in powder form and uranyl nitrate.

The organisms used in the experiments were:

1. A Chlorococcum sp. isolated from site 3 on Rocky Creek (designated Eglin 3A),

2. A Chlamydomonas sp. isolated from site 6 on Rocky Creek (designated Eglin 6A),

3. An organism tentatively identified as a Chlorococcum sp. isolated from site 4 on Rocky Creek (designated Eglin 4A).

The culture medium used was Bristol's Inorganic Mineral Solution (Reference 2). Culture vessels were 300 ml capacity nepheloculture flasks and they contained 100 ml of medium. Inoculation was by sterile pipet from an axenic liquid culture. Illumination of the cultures was by cool-white fluorescent tubes (Westinghouse); intensity at the culture surface was 300 f-ca. Temperature was maintained at 20±1°C.

Growth was determined by turbidimetric measurements made at regular intervals, using a Klett-Summerson Colorimeter and a red filter. The final, recorded, readings on the cultures were made approximately 14 days after flask inoculation while the control cultures (no uranium) were in the logarithmic phase of growth.

The uranium oxides, described as insoluble in water (Reference 5), were added to the culture medium in the concentration of 1 g/100 ml, an excess, in order to obtain a solution saturated with uranium oxide. To determine algal cell density (by turbidity readings) the cultures were stirred approximately 1 minute before reading. The heavy uranium oxides settle immediately after stirring leaving the algal cells in suspension. Careful manipulation of the nepheloculture flasks allows pouring the medium with suspended algal cells into the side-arm without any undissolved uranium oxide. Uranium nitrate is soluble in water in the concentrations used in these experiments. However, some precipitate developed in the nepheloculture flasks containing medium and growing algae in the higher concentrations of uranyl nitrate. Acidification of these cultures to about pH 2.0 at the end of the culture period brought this precipitate into solution, and the algal cells were not bleached or otherwise visibly damaged in the time required to make the turbidimetric readings.

A comparison was made of growth in control cultures (with no uranium) with growth in each level of uranium utilized, and statistical significance of differences was determined by the t values obtained for each comparison (Reference 6).

2. RESULTS

Each organism isolated into axenic culture was grown first in medium containing powdered green uranium oxide (U_3O_8) and then in medium containing uranium dioxide (UO_2). Growth of one isolate, Eglin 6A, was unaffected by either uranium oxide (Tables 21, 22 and 25), and this organism was not cultured in medium containing soluble uranium nitrate.

In contrast, the other two algal isolates had growth significantly inhibited by powdered green uranium oxide (U_3O_8) and by powdered UO_2. These were Eglin 3A and Eglin 4A (Tables 23, 24, 26 and 27).

Growth tests were conducted on Eglin 3A and Eglin 4A in medium containing soluble uranium nitrate in varying concentrations up to 2×10^{-4} M, in order to determine the level at which uranium nitrate could be shown to inhibit growth. For Eglin 3A the following concentrations were inhibitory: 2×10^{-4} M and 10^{-4} M (Table 28); for Eglin 4A these concentrations of uranium nitrate inhibited growth: 2×10^{-4} M, 10^{-4} M and 5×10^{-5} M (Table 29).

SECTION IV

DISCUSSION AND CONCLUSIONS

The biological effects of uranium have been studied principally in relation to its toxicological effects upon man (References 7 and 8). Most of the experimental toxicological work has involved small mammals. Maynard and Hodge (Reference 9) report histological renal damage to small mammals fed uranium. Other effects include a drop in urinary coproporphyrin excretion (Reference 10) and liver dysfunction in addition to kidney damage (Reference 11).

At the cellular, or biochemical, level, it is generally conceded that uranium damage is primarily chemical and not radiological. Dounce and Lan (Reference 12) studied the activity of a number of enzymes isolated from uranium poisoned animals and found that the action of thrombin upon fibrinogen had been impaired. They also found that both phosphorylase and phosphoglucomutase activities were inhibited by uranium. Other enzymes were not inhibited and they concluded uranium interferes with specific active groups rather than simply complexing with SH groups. Singer et al. (Reference 13) found that some uranium enzyme inhibition could be reversed by the addition of hydroxydicarboxylic acids to the reaction mixtures. Glucose utilization by both bacteria and yeast is inhibited by uranium; yeast in particular, are extremely sensitive to uranium and 2.5×10^{-5} M $UO_2(NO_3)_2$ inhibits glucose oxidation in yeast 99 percent (Reference 14).

Terrestrial plants are inhibited by high levels of natural uranium in the growth medium (Reference 15). Earlier experimental studies on higher plants showed that uranium at 50 ppm caused damage, particularly to the root system (Reference 16). Soil bacteria are inhibited by uranium at 100 ppm (Reference 17). To the best of our knowledge there have been no previous studies of uranium effects upon soil algae. A few studies of the biological fate of uranium have considered ecological effects. Concentration of uranium in food chains has been the object of several studies (References 18 and 19). Recently, Hanson (Reference 20) reviewed the literature dealing with environmental effects of uranium in a consideration of the possible ecological effects of depleted uranium munitions.

The present study is concerned primarily with possible ecological effects of depleted uranium munitions upon the algal flora of Rocky Creek on Eglin Air Force Base. Between the time that collections were made in 1975 and again in 1976 a hurricane of significant force went through the area which includes the two streams. Considerable physical alteration of several of the sites resulted from activity of this hurricane. As a result, there was some change in the algal flora of the two streams between February and May of 1975 and February and May of 1976; as a consequence, establishing a baseline of species native to the sites has been made somewhat more difficult. In spite of this, comparisons may be made of the algal flora at comparable sites of Rocky Creek to the flora at the collection sites of Turkey Creek. Rocky Creek, to all appearances, is presently a healthy stream. It contains a great diversity of algal species, even more than were found in Turkey Creek, the nearby stream selected because it has not been contaminated with depleted uranium.

Of the three species of algae isolated from Rocky Creek, two were found to be sensitive in culture to powdered U_3O_8 (green uranium oxide) and to powdered UO_2, each added at a concentration of 0.1 percent. Enough uranium was taken up by the algal cells in culture, at a pH buffered at 6.5, to inhibit growth significantly. The third species was not demonstrated to be affected by U_3O_8 or UO_2. The two species that were inhibited by U_3O_8 and UO_2 were also tested using uranyl nitrate. One species was demonstrated to be inhibited by a uranyl nitrate molarity of 10^{-4}, the other by a molarity of 5×10^{-5}.

As a conclusion, it may be stated that there is no evidence from this study that there has been any ecological damage done as yet to Rocky Creek by depleted uranium. However, species isolated from this stream have been shown to be sensitive to uranium as U_3O_8 and as UO_2, and also to uranyl nitrate; these species and presumably others from the stream can be expected to show damage from depleted uranium on the range should its level become sufficiently high to give a concentration in the water of the stream approaching 5×10^{-5} M.

TABLE 1. PHYSICAL PROPERTIES OF WATER FROM TURKEY AND ROCKY CREEKS

NOVEMBER 23 AND 24, 1974

Site Number	pH	Temperature (°C)	Dissolved Oxygen (ppm)
ROCKY CREEK:			
1	5.3	16.5	8.1
2	5.5	16.5	9.1
3 (surface)	4.9	19.0	6.0
(sub-surface)	4.9	15.5	4.5
4	5.8	19.0	9.1
5	5.7	16.0	9.1
6	5.6	16.0	9.2
7	5.5	16.0	9.0
TURKEY CREEK:			
8	5.4	18.0	8.4
9	5.6	17.0	8.6
10	5.6	18.0	9.0
11	5.6	17.0	9.2

TABLE 2. PHYSICAL PROPERTIES OF WATER FROM TURKEY AND ROCKY CREEKS

FEBRUARY 21 AND 22, 1975

Site Number	pH	Temperature (°C)	Dissolved Oxygen (ppm)
ROCKY CREEK:			
1	5.2	17.5	8.1
2	5.4	18.0	8.8
3	4.9	17.0	3.4
4	5.6	18.5	9.4
5	5.6	17.0	9.4
6	5.4	16.5	9.2
7	5.5	16.0	9.4
TURKEY CREEK:			
8	5.4	19.0	8.2
9	5.5	18.0	8.6
10	5.5	16.5	9.3
11	5.4	16.5	9.2

TABLE 3. PHYSICAL PROPERTIES OF WATER FROM TURKEY AND ROCKY CREEKS

APRIL 25, 1975

Site Number	pH	Temperature (^{o}C)	Dissolved Oxygen (ppm)
ROCKY CREEK:			
1	5.2	20.0	7.6
2	5.4	20.4	8.5
3	5.1	25.0	7.3
4	5.6	23.0	9.0
5	5.7	21.0	8.7
6	5.6	21.0	9.0
7	5.6	20.5	8.6
TURKEY CREEK:			
8	5.4	20.5	8.2
9	5.5	20.0	8.4
10	5.4	20.0	8.6
11	5.4	21.0	8.6

TABLE 4. PHYSICAL PROPERTIES OF WATER FROM TURKEY AND ROCKY CREEKS

FEBRUARY 6, 1976

Site Number	pH	Temperature (°C)	Dissolved Oxygen (ppm)
ROCKY CREEK:			
1	5.2	17.0	7.8
2	5.6	18.0	9.0
3	5.0	17.0	5.9
4	5.5	17.0	8.8
5	5.8	16.2	8.4
6	5.7	17.0	7.4
7	5.8	17.0	8.4
TURKEY CREEK:			
8	5.4	20.0	8.4
9	5.6	20.0	8.8
10	5.5	18.5	7.7
11	5.6	18.0	8.2

TABLE 5. PHYSICAL PROPERTIES OF WATER FROM TURKEY AND ROCKY CREEKS

APRIL 30, 1976

Site Number	pH	Temperature (°C)	Dissolved Oxygen (ppm)
ROCKY CREEK:			
1	4.6	19.0	7.0
2	5.4	20.0	8.0
3	5.0	21.0	6.2
4	5.6	21.0	8.6
5	5.8	21.0	8.6
6	5.9	21.0	6.9
7	5.8	20.5	7.4
TURKEY CREEK:			
8	5.4	19.0	8.2
9	5.0	20.0	7.0
10	5.5	20.5	8.6
11	5.7	21.0	8.2

TABLE 6. LISTS OF ALGAL SPECIES COLLECTED NOVEMBER 22 AND 23, 1974

ROCKY CREEK AND TURKEY CREEK, EGLIN AIR FORCE BASE, FLORIDA

ROCKY CREEK:

SITE 1 (5 species)

Oscillatoria sp. 1	Oscillatoria sp. 3	Mougeotia sp.
Oscillatoria sp. 2	Pandorina sp.	

SITE 2 (19 species)

Batrachospermum sp.	Micrasterias sp.	Zygnema sp.	Fragilaria sp.
Chaetonema sp.	Oscillatoria sp.	Cosmarium sp. 2	Surirella sp.
Mougeotia sp.	Synechocystis sp.	Frustulia sp.	Pleurotaenium sp.
Tabellaria sp. 1	Coleochaete sp.	Closterium sp. 1	Oscillatoria sp. 1
Netrium sp.	Tabellaria sp. 2	Gyrosigma sp.	

SITE 3 (23 species)

Micrasterias sp.	Volvox sp.	Cosmerium sp.	Docidium sp.
Stigonema sp.	Gyrosigma sp.	Closterium sp.	Pleurotaenium sp.
Mougeotia sp.	Netrium sp.	Frustulia sp. 2	Oscillatoria sp.
Coleochaete sp.	Spirogyra sp. 1	Debarya sp.	Anabaena sp.
Frustulia sp. 1	Euastrum sp.	Xanthidium sp.	Spirogyra sp. 1
Zygnema sp.	Bulbochaete sp.	Chroococcus sp.	

SITE 4 (22 species)

Pleurotaenium sp.	Oscillatoria sp. 2	Tabellaria sp. 1	Cosmarium sp. 1
Closterium sp.	Ceratium sp.	Tabellaria sp. 2	Zygnema sp.
Bulbochaete sp.	Fragilaria sp.	Closterium sp. 2	Cosmarium sp. 2
Micrasterias apiculata	Desmidium grevilli	Synechocystis sp.	Mesotaenium sp.
Scenedesmus sp.	Mougeotia sp.	Oscillatoria sp. 1	
Netrium sp.	Frustulia sp.		

SITE 5 (9 species)

Tabellaria sp. 1	Oscillatoria sp.
Tabellaria sp. 2	Closterium sp. 2
Mougeotia sp.	Frustulia sp.
Coleochate sp.	Mesotaenium sp.
Surirella sp.	

TABLE 6. LISTS OF ALGAL SPECIES COLLECTED NOVEMBER 22 AND 23, 1974

ROCKY CREEK AND TURKEY CREEK, EGLIN AIR FORCE BASE, FLORIDA (concluded)

SITE 6 (15 species)

Pithophora sp.	Mougeotia sp.	Closterium sp.
Spirogyra sp. 2	Fragilaria sp.	Oscillatoria sp. 2
Tabellaria sp. 1	Netrium sp.	Oscillatoria sp. 3
Tabellaria sp. 2	Batrachospermum sp.	Frustulia sp.
Johannesbaptistia pellucida	Chaetonema sp.	

SITE 7 (8 species)

Batrachospermum sp.	Chaetonema sp.
Coleochaete sp.	Plectonema sp.
Mougeotia sp.	Oscillatoria sp. 3
Tabellaria sp. 1	Frustulia sp.

TURKEY CREEK:

SITE 8 (8 species)

Oscillatoria sp. 1	Synechocystis sp.
Coleochaete sp.	Fragilaria sp.
Frustulia sp.	Closterium sp.
Desmidium sp.	Surirella sp. 1

SITE 9 (5 species)

Fragilaria sp. 2	Gyrosigma sp.	Surirella sp. 2
Frustulia sp.	Oscillatoria sp. 3	

SITE 10 (13 species)

Chaetonema sp.	Tabellaria sp. 2	Hammatoidea sp.	Oscillatoria sp. 1
Batrachospermum sp.	Pleurotaenium sp.	Tabellaria sp. 1	Mougeotia sp.
Frustulia sp.	Hapalosiphon sp.	Synechocystis sp.	Closterium sp.
Spirogyra sp. 3			

SITE 11 (14 species)

Batrachospermum sp.	Frustulia sp.	Hapalosiphon sp.
Coleochaete sp.	Tabellaria sp. 1	Synechocystis sp.
Fragilaria sp.	Tabellaria sp. 2	Oscillatoria sp. 3
Closterium sp.	Chaetonema sp.	Oscillatoria sp. 1
Mougeotia sp.	Spirogyra sp. 2	

TABLE 7. LIST OF ALGAL SPECIES COLLECTED, ROCKY CREEK

NOVEMBER 22 AND 23, 1974

44 species identified from sites 1 through 7

Anabaena sp.
Batrachospermum sp.
Bulbochaete sp.
Ceratium sp.
Chaetonema sp.
Chroococcus sp.
Closterium sp. 1
Closterium sp. 2
Coleochaete sp.
Cosmarium sp. 1
Cosmarium sp. 2
Debarya sp.
Desmidium grevillii
Docidium sp.
Euastrum sp.
Fragilaria sp.
Frustulia sp. 1
Frustulia sp. 2
Gyrosigma sp.
Johannesbaptistia pellucida
Mesotaenium sp.
Micrasterius apiculata
Micrasterius sp.
Mougeotia sp.
Netrium sp.
Oscillatoria sp. 1
Oscillatoria sp. 2
Oscillatoria sp. 3
Pandorina sp.
Pithophora sp.
Plectonema sp.
Pleurotaenium sp.
Scenedesmus sp.
Spirogyra sp. 1
Spirogyra sp. 2
Spirogyra sp. 3
Stigonema sp.
Surirella sp.
Synechocystis sp.
Tabellaria sp. 1
Tabellaria sp. 2
Volvox sp.
Xanthidium sp.
Zygnema sp.

TABLE 8. LIST OF ALGAL SPECIES COLLECTED, TURKEY CREEK

NOVEMBER 22 AND 23, 1974

21 species identified from sites 8 through 11

Batrachospermum sp.
Chaetonema sp.
Closterium sp.
Coleochaete sp.
Desmidium sp.
Fragilaria sp.
Frustulia sp.
Gyrosigma sp.
Hammatoidea sp.
Hapalosiphon sp.
Mougeotia sp.
Oscillatoria sp. 1
Oscillatoria sp. 3
Pleurotaenium sp.
Spirogyra sp. 2
Spirogyra sp. 3
Surirella sp. 1
Surirella sp. 2
Synechocystis sp.
Tabellaria sp. 1
Tabellaria sp. 2

TABLE 9. LISTS OF ALGAL SPECIES COLLECTED FEBRUARY 21 AND 22, 1975

ROCKY CREEK AND TURKEY CREEK, EGLIN AIR FORCE BASE, FLORIDA

ROCKY CREEK:

SITE 1 (10 species)

Chlorella sp.	Oscillatoria sp. 2	Surirella sp.
Frustulia sp.	Oscillatoria sp. 3	Tabellaria sp. 2
Netrium sp. 1	Roya sp.	Tabellaria sp. 3
Oscillatoria sp. 1		

SITE 2 (25 species)

Amphiprora sp.	Gyrosigma sp.	Schizogonium sp.
Batrachospermum sp. 1	Mougeotia sp.	Spirogyra sp. 1
Chaetonema sp.	Nannochloris sp.	Spirogyra sp. 2
Closterium sp.	Netrium sp. 1	Spondylosium sp.
Coleochaete sp.	Netrium sp. 2	Surirella sp.
Debarya sp.	Oscillatoria sp. 1	Tabellaria sp. 1
Eudorina sp.	Oscillatoria sp. 2	Tabellaria sp. 2
Fragilaria sp. 1	Roya sp.	Tabellaria sp. 3
Frustulia sp.		

SITE 3 (37 species)

Anabaena sp.	Fragilaria sp. 1	Roya sp.
Bulbochaete sp.	Frustulia sp.	Schizogonium sp.
Ceratium sp.	Gloeocystis sp.	Spirogyra sp. 2
Chaetonema sp.	Gyrosigma sp.	Spondylosium sp.
Chlamydomonas sp.	Micrasterias sp.	Staurastrum sp.
Chlorella sp.	Mougeotia sp.	Surirella sp.
Chlorococcum sp.	Netrium sp. 1	Tabellaria sp. 1
Chroococcus sp.	Oscillatoria sp. 1	Tabellaria sp. 2
Closterium sp.	Oscillatoria sp. 2	Tetmemorus sp.
Cosmarium sp.	Pandorina sp.	Volvox sp.
Debarya sp.	Pleurotaenium sp.	Xanthidium sp.
Docidium sp.	Rhizoclonium sp.	Zygogonium sp.
Euastrum sp.		

TABLE 9. LISTS OF ALGAL SPECIES COLLECTED FEBRUARY 21 AND 22, 1975

ROCKY CREEK AND TURKEY CREEK, EGLIN AIR FORCE BASE, FLORIDA (concluded)

TURKEY CREEK:

SITE 8 (8 species)

Amphiprora sp.	Frustulia sp.	Oscillatoria sp. 1
Chlamydomonas sp.	Microspora sp.	Tabellaria sp. 2
Fragilaria sp. 1	Mougeotia sp.	

SITE 9 (15 species)

Amphiprora sp.	Fragilaria sp. 1	Surirella sp.
Batrachospermum sp. 1	Frustulia sp.	Tabellaria sp. 1
Chaetonema sp.	Gyrosigma sp.	Tabellaria sp. 2
Chlamydomonas sp.	Mougeotia sp.	Tabellaria sp. 3
Coleochaete sp.	Oscillatoria sp. 3	Zygogonium sp.

SITE 10 (15 species)

Amphiprora sp.	Gyrosigma sp.	Spirogyra sp. 3
Chlamydomonas sp.	Hammatoidea sp.	Surirella sp.
Chlorella sp.	Mougeotia sp.	Tabellaria sp. 1
Fragilaria sp. 1	Oscillatoria sp. 1	Tabellaria sp. 2
Frustulia sp.	Oscillatoria sp. 2	Tabellaria sp. 3

SITE 11 (17 species)

Batrachospermum sp. 1	Frustulia sp.	Spirogyra sp. 2
Batrachospermum sp. 2	Gyrosigma sp.	Tabellaria sp. 1
Chaetonema sp.	Mougeotia sp.	Tabellaria sp. 2
Closterium sp.	Oscillatoria sp. 1	Tabellaria sp. 3
Coleochaete sp.	Oscillatoria sp. 2	Ulothrix sp.
Fragilaria sp. 1	Oscillatoria sp. 3	

TABLE 10. LIST OF ALGAL SPECIES COLLECTED, ROCKY CREEK

FEBRUARY 21 AND 22, 1975

56 species identified from sites 1 through 7

Amphiprora sp.	Mougeotia sp.
Anabaena sp.	Mougeotiopsis sp.
Batrachospermum sp. 1	Nannochloris sp.
Batrachospermum sp. 2	Netrium sp. 1
Bulbochaete sp.	Netrium sp. 2
Ceratium sp.	Oscillatoria sp. 1
Chaetonema sp.	Oscillatoria sp. 2
Chamaesiphon sp.	Oscillatoria sp. 3
Chlamydomonas sp.	Pandorina sp.
Chlorella sp.	Pleurotaenium sp.
Chlorococcum sp.	Rhizoclonium sp.
Chroococcus sp.	Roya sp.
Closterium sp.	Schizogonium sp.
Coleochaete sp.	Spirogyra sp. 1
Cosmarium sp.	Spirogyra sp. 2
Cylindrocystis sp.	Spirogyra sp. 3
Debarya sp.	Spondylosium sp.
Docidium sp.	Staurastrum sp.
Euastrum sp.	Stigeoclonium sp.
Eudorina sp.	Surirella sp.
Fragilaria sp. 1	Tabellaria sp. 1
Fragilaria sp. 2	Tabellaria sp. 2
Frustulia sp.	Tabellaria sp. 3
Gloeocystis sp.	Tetmemorus sp.
Gyrosigma sp.	Ulothrix sp.
Hormidium sp.	Volvox sp.
Hyalotheca sp.	Xanthidium sp.
Micrasterius sp.	Zygogonium sp.

TABLE 11. LIST OF ALGAL SPECIES COLLECTED, TURKEY CREEK

FEBRUARY 21 AND 22, 1975

25 species identified from sites 8 through 11

Amphiprora sp.
Batrachospermum sp. 1
Batrachospermum sp. 2
Chaetonema sp.
Chlamydomonas sp.
Chlorella sp.
Closterium sp.
Coleochaete sp.
Fragilaria sp. 1
Frustulia sp.
Gyrosigma sp.
Hammatoidea sp.
Microspora sp.
Mougeotia sp.
Oscillatoria sp. 1
Oscillatoria sp. 2 (large)
Oscillatoria sp. 3 (tiny)
Spirogyra sp. 2
Spirogyra sp. 3
Surirella sp.
Tabellaria sp. 1
Tabellaria sp. 2
Tabellaria sp. 3
Ulothrix sp.
Zygogonium sp.

TABLE 12. LISTS OF ALGAL SPECIES COLLECTED APRIL 25, 1975

ROCKY CREEK AND TURKEY CREEK, EGLIN AIR FORCE BASE, FLORIDA

ROCKY CREEK:

SITE 1 (19 species)

Anabaena sp.	Debarya sp.	Mougeotiopsis sp.	Spirogyra sp.2
Bulbochaete sp.	Fragilaria sp.	Netrium sp.	Tabellaria sp. 1
Chlorococcum sp.	Frustulia sp.	Nostoc sp.	Tabellaria sp. 2
Coleochaete sp.	Gyrosigma sp.	Oscillatoria sp. 2	Tabellaria sp. 3
Cylindrocystis sp.	Mougeotia sp.	Roya sp.	

SITE 2 (32 species)

Amphiprora sp.	Gyrosigma sp.	Roya sp.
Batrachospermum sp. 1	Hammatoidea sp.	Schizogonium sp.
Batrachospermum sp. 2	Micrasterias sp. 1	Spirogyra sp. 1
Chaetonema sp.	Microspora sp.	Spirogyra sp. 2
Chlamydomonas sp.	Mougeotia sp.	Spondylosium sp.
Closterium sp.	Netrium sp. 1	Surirella sp.
Coleochaete sp.	Oscillatoria sp. 1	Tabellaria sp. 1
Cylindrocystis sp.	Oscillatoria sp. 2	Tabellaria sp. 2
Debarya sp.	Oscillatoria sp. 3	Tabellaria sp. 3
Fragilaria sp.	Raphidiopsis sp.	Zygnema sp.
Frustulia sp.	Rhizoclonium sp.	

SITE 3 (45 species)

Asterionella sp.	Docidium sp.	Mougeotia sp.	Spondylosium sp.
Binuclearia sp.	Euastrum sp.	Mougeotiopsis sp.	Staurastrum sp. 1
Bulbochaete sp.	Fragilaria sp.	Netrium sp. 1	Staurastrum sp. 2
Chlamydomonas sp.	Frustulia sp.	Netrium sp. 2	Surirella sp.
Chlorella sp.	Gymnozyga sp.	Oscillatoria sp. 1	Tabellaria sp. 1
Chlorococcum sp.	Gyrosigma sp.	Oscillatoria sp. 2	Tabellaria sp. 2
Chroococcus sp.	Hapalosiphon sp.	Oscillatoria sp. 3	Tabellaria sp. 3
Closterium sp.	Mesotanenium sp.	Pandorina sp.	Ulothrix sp.
Cosmarium sp.	Micrasterias sp. 1	Plectonema sp.	Volvox sp.
Crucigenia sp.	Micrasterias sp. 2	Roya sp.	Xanthidium sp.
Cylindrocystis sp.	Microspora sp.	Spirogyra sp. 2	Zygnema sp.
Debarya sp.			

TABLE 12. LISTS OF ALGAL SPECIES COLLECTED APRIL 25, 1975

ROCKY CREEK AND TURKEY CREEK, EGLIN AIR FORCE BASE, FLORIDA

SITE 4 (32 species)

Amphiprora sp.	Coleochaete sp.	Mougeotia sp.	Roya sp.
Binuclearia sp.	Cylindrocystis sp.	Mougeotiopsis sp.	Spirogyra sp. 2
Bulbochaete sp.	Debarya sp.	Netrium sp. 1	Spondylosium sp.
Ceratium sp.	Docidium sp.	Oscillatoria sp. 1	Tabellaria sp. 1
Chaetonema sp.	Fragilaria sp.	Oscillatoria sp. 2	Tabellaria sp. 2
Chlamydomonas sp.	Frustulia sp.	Oscillatoria sp. 3	Tabellaria sp. 3
Chlorella sp.	Gyrosigma sp.	Pleurotaenium sp.	Volvox sp.
Chlorococcum sp.	Meridion sp.	Rhizoclonium sp.	Zygnema sp.

SITE 5 (29 species)

Batrachospermum sp. 1	Frustulia sp.	Pleurotaenium sp.	Spirogyra sp. 4
Bulbochaete sp.	Hammatoidea sp.	Raphidiopsis sp.	Surirella sp.
Chaetonema sp.	Mapalosiphon sp.	Rhizoclonium sp.	Tabellaria sp. 1
Chlamydomonas sp.	Microspora sp.	Roya sp.	Tabellaria sp. 2
Chlorella sp.	Mougeotia sp.	Spirogyra sp. 1	Tabellaria sp. 3
Coleochaete sp.	Mougeotiopsis sp.	Spirogyra sp. 2	Ulothrix sp.
Debarya sp.	Oscillatoria sp. 3	Spirogyra sp. 3	Zygnema sp.
Fragilaria sp.			

SITE 6 (19 species)

Batrachospermum sp. 1	Closterium sp.	Mesotaenium sp.	Spirogyra sp. 2
Batrachospermum sp. 2	Coleochaete sp.	Mougeotia sp.	Tabellaria sp. 1
Chaetonema sp.	Fragilaria sp.	Oscillatoria sp. 3	Tabellaria sp. 2
Chlamydomonas sp.	Frustulia sp.	Raphidiopsis sp.	Tabellaria sp. 3
Chlorococcum sp.	Gyrosigma sp.	Roya sp.	

SITE 7 (26 species)

Amphiprora sp.	Closterium sp.	Oscillatoria sp. 3	Spirogyra sp. 3
Asterionella sp.	Debarya sp.	Pleurotaenium sp.	Tabellaria sp. 1
Batrachospermum sp. 1	Fragilaria sp.	Raphidiopsis sp.	Tabellaria sp. 2
Batrachospermum sp. 2	Frustulia sp.	Rhizoclonium sp.	Tabellaria sp. 3
Chaetonema sp.	Hormidium sp.	Roya sp.	Tetraspora sp.
Chlamydomonas sp.	Micrasterias sp.	Spirogyra sp. 2	Ulothrix sp.
Chlorococcum sp.	Mougeotia sp.		

SITE 8 (13 species)

Amphiprora sp.	Chlamydomonas sp.	Frustulia sp.	Tabellaria sp. 2
Asterionella sp.	Coleochaete sp.	Mougeotia sp.	Tabellaria sp. 3
Batrachospermum sp. 2	Fragilaria sp.	Tabellaria sp. 1	Ulothrix sp.
Chaetonema sp.			

TABLE 12. LISTS OF ALGAL SPECIES COLLECTED APRIL 25, 1975

ROCKY CREEK AND TURKEY CREEK, EGLIN AIR FORCE BASE, FLORIDA (concluded)

SITE 9 (20 species)

Amphiprora sp.	Coleochaete sp.	Hammatoidea sp.	Roya sp.
Batrachospermum sp. 1	Debarya sp.	Mougeotia sp.	Surirella sp.
Chaetonema sp.	Fragilaria sp.	Oscillatoria sp. 1	Tabellaria sp. 1
Chlamydomonas sp.	Frustulia sp.	Oscillatoria sp. 3	Tabellaria sp. 2
Chlorella sp.	Gyrosigma sp.	Raphidiopsis sp.	Tabellaria sp. 3

SITE 10 (17 species)

Amphiprora sp.	Coleochaete sp.	Oscillatoria sp. 1	Tabellaria sp. 1
Batrachospermum sp. 1	Fragilaria sp.	Oscillatoria sp. 2	Tabellaria sp. 2
Chaetonema sp.	Frustulia sp.	Pandorina sp.	Tabellaria sp. 3
Chlamydomonas sp.	Mougeotia sp.	Raphidiopsis sp.	Ulothrix sp.
Closteriopsis sp.			

SITE 11 (22 species)

Asterionella sp.	Fragilaria sp.	Netrium sp. 1	Spirogyra sp. 3
Batrachospermum sp. 1	Frustulia sp.	Oscillatoria sp. 2	Tabellaria sp. 1
Batrachospermum sp. 2	Gymnozyga sp.	Oscillatoria sp. 3	Tabellaria sp. 2
Chaetonema sp.	Gyrosigma sp.	Raphidiopsis sp.	Tabellaria sp. 3
Chlamydomonas sp.	Hammatoidea sp.	Roya sp.	Zygnema sp.
Chlorella sp.	Mougeotia sp.		

TABLE 13. LIST OF ALGAL SPECIES COLLECTED, ROCKY CREEK

APRIL 25, 1975

64 species identified from sites 1 through 7

Amphiprora sp.	Microspora sp.
Anabaena sp.	Mougeotia sp.
Asterionella sp.	Mougeotiopsis sp.
Batrachospermum sp. 1	Netrium sp. 1
Batrachospermum sp. 2	Netrium sp. 2
Binuclearia sp.	Nostoc sp.
Bulbochaete sp.	Oscillatoria sp. 1
Ceratium sp.	Oscillatoria sp. 2 (large)
Chaetonema sp.	Oscillatoria sp. 3 (tiny)
Chlamydomonas sp.	Pandorina sp.
Chlorella sp.	Plectonema sp.
Chlorococcum sp.	Pleurotaenium sp.
Chroococcus sp.	Raphidiopsis sp.
Closterium sp.	Rhizoclonium sp.
Coleochaete sp.	Roya sp.
Cosmarium sp.	Schizogonium sp.
Crucigenia sp.	Spirogyra sp. 1 (2 chloroplasts)
Cylindrocystis sp.	Spirogyra sp. 2 (1 chloroplast)
Debarya sp.	Spirogyra sp. 3 (4 chloroplasts)
Docidium sp.	Spirogyra sp. 4 (3 chloroplasts)
Euastrum sp.	Spondylosium sp.
Fragilaria sp.	Staurastrum sp. 1
Frustulia sp.	Staurastrum sp. 2
Gymnozyga sp.	Surirella sp.
Gyrosigma sp.	Tabellaria sp. 1
Hammatoidea sp.	Tabellaria sp. 2
Hapalosiphon sp.	Tabellaria sp. 3
Hormidium sp.	Tetraspora sp.
Meridion sp.	Ulothrix sp.
Mesotaenium sp.	Volvox sp.
Micrasterias sp. 1	Xanthidium sp.
Micrasterias sp. 2	Zygnema sp.

TABLE 14. LIST OF ALGAL SPECIES COLLECTED, TURKEY CREEK

APRIL 25, 1975

29 Species identified from sites 8 through 11

Amphiprora sp.
Asterionella sp.
Batrachospermum sp. 1
Batrachospermum sp. 2
Chaetonema sp.
Chlamydomonas sp.
Chlorella sp.
Closteriopsis sp.
Coleochaete sp.
Debarya sp.
Fragilaria sp.
Frustulia sp.
Gymnozyga sp.
Gyrosigma sp.
Hammatoidea sp.
Mougeotia sp.
Netrium sp. 1
Oscillatoria sp. 1
Oscillatoria sp. 2
Oscillatoria sp. 3
Pandorina sp.
Raphidiopsis sp.
Roya sp.
Surirella sp.
Tabellaria sp. 1
Tabellaria sp. 2
Tabellaria sp. 3
Ulothrix sp.
Zygnema sp.

TABLE 15. LISTS OF ALGAL SPECIES COLLECTED FEBRUARY 6, 1976

ROCKY CREEK AND TURKEY CREEK, EGLIN AIR FORCE BASE, FLORIDA

ROCKY CREEK:

SITE 1 (18 species)

Amphiprora sp.	Cosmarium sp.	Netrium sp. 1	Spirogyra sp. 1
Asterionella sp.	Euglena sp.	Oscillatoria sp. 1	Surirella sp.
Closterium sp. 1	Gymnozyga sp.	Oscillatoria sp. 2	Tabellaria sp. 1
Closterium sp. 2	Mougeotia sp. 1	Oscillatoria sp. 3	Tabellaria sp. 2
Coleochaete sp.	Mougeotia sp. 2		

SITE 2 (16 species)

Chaetonema sp.	Gyrosigma sp. 1	Netrium sp. 1	Surirella sp.
Closterium sp.	Mougeotia sp. 1	Netrium sp. 2	Tabellaria sp. 1
Cosmarium sp.	Mougeotia sp. 2	Schizogonium sp.	Tetraedron sp.
Gomphonema sp.	Mougeotia sp. 3	Spirogyra sp. 3	Ulothrix sp.

SITE 3 (20 species)

Anabaena sp.	Frustulia sp.	Navicula sp.	Spondylosium sp.
Arthrodesmus sp.	Gyrosigma sp.	Netrium sp. 1	Staurastrum sp.
Closterium sp. 1	Mougeotia sp. 1	Oscillatoria sp. 1	Tabellaria sp. 1
Eudorina sp.	Mougeotia sp. 2	Rhizoclonium sp.	Xanthidium sp.
Euastrum sp.	Mougeotia sp. 3	Spirogyra sp. 3	Zygnema sp.

SITE 4 (26 species)

Actinastrum sp.	Gyrosigma sp. 1	Oscillatoria sp. 2	Spondylosium sp.
Amphiprora sp.	Micrasterias sp.	Oscillatoria sp. 4	Staurastrum sp.
Closteriopsis sp.	Mougeotia sp. 1	Pandorina sp.	Tabellaria sp. 1
Closterium sp. 1	Mougeotia sp. 2	Pleurotaenium sp.	Tabellaria sp. 2
Closterium sp. 3	Netrium sp. 1	Rhizoclonium sp.	Ulothrix sp.
Fragilaria sp. 1	Netrium sp. 2	Spirogyra sp. 3	Zanthidium sp.
Frustulia sp.	Oscillatoria sp. 1		

SITE 5 (16 species)

Amphiprora sp.	Cosmarium sp.	Frustulia sp.	Navicula sp.
Asterionella sp.	Euglena sp.	Gyrosigma sp. 1	Oscillatoria sp. 1
Chlamydomonas sp.	Fragilaria sp. 1	Microspora sp.	Oscillatoria sp. 3
(Palmella stage)	Fragilaria sp. 2	Mougeotia sp. 2	Tabellaria sp. 1
Closterium sp.			

TABLE 15. LISTS OF ALGAL SPECIES COLLECTED FEBRUARY 6, 1976

ROCKY CREEK AND TURKEY CREEK, EGLIN AIR FORCE BASE, FLORIDA (concluded)

SITE 6 (11 species)

Asterionella sp.	Closterium sp. 2	Gyrosigma sp. 1	Netrium sp. 2
Closterium sp. 1	Closteriopsis sp.	Mougeotia sp. 2	Tabellaria sp. 1
Closterium sp. 3	Fragilaria sp. 1	Netrium sp. 1	

SITE 7 (21 species)

Amphiprora sp.	Fragilaria sp. 2	Mougeotia sp. 3	Oscillatoria sp. 2
Asterionella sp.	Gomphonema	Navicula sp.	Pandorina sp.
Batrachospermum sp. 1	Meridian sp.	Netrium sp. 1	Spondylosium sp.
Closterium sp. 1	Mougeotia sp. 1	Nostoc sp.	Tabellaria sp. 1
Closteriopsis sp.	Mougeotia sp. 2	Oscillatoria sp. 1	Tetraspora sp.
Fragilaria sp. 1			

TURKEY CREEK:

SITE 8 (8 species)

Amphiprora sp.	Cosmarium sp.	Navicula sp.	Rhizoclonium sp.
Coleochaete sp.	Fragilaria sp. 1	Oscillatoria sp. 1	Tabellaria sp. 1

SITE 9 (9 species)

Amphiprora sp.	Gyrosigma sp. 1	Navicula sp.	Netrium sp. 2
Asterionella sp.	Gyrosigma sp. 2	Netrium sp. 1	Oscillatoria sp. 1
Euglena sp.			

SITE 10 (9 species)

Amphiprora sp.	Mougeotia sp. 1	Oscillatoria sp. 1	Surirella sp.
Asterionella sp.	Navicula sp.	Oscillatoria sp. 2	Ulothrix sp.
Closterium sp. 1			

SITE 11 (17 species)

Amphiprora sp.	Coleochaete sp.	Meridian sp.	Netrium sp. 2
Asterionella sp.	Fragilaria sp. 1	Mougeotia sp. 2	Oscillatoria sp. 1
Batrachospermum sp. 1	Fragilaria sp. 2	Mougeotia sp. 3	Spondylosium sp.
Batrachospermum sp. 2	Gomphonema sp.	Netrium sp. 1	Tabellaria sp. 1
Closterium sp. 1			

TABLE 16. LIST OF ALGAL SPECIES COLLECTED, ROCKY CREEK

FEBRUARY 6, 1976

52 species identified from sites 1 through 7

Actinastrum sp.	Mougeotia sp. 1
Amphiprora sp.	Mougeotia sp. 2
Anabaena sp.	Mougeotia sp. 3
Arthrodesmus sp.	Navicula sp.
Asterionella	Netrium sp. 1
Batrachospermum sp. 1	Netrium sp. 2
Chaetonema sp.	Nostoc sp.
Chlamydomonas sp. (Palmella stage)	Oscillatoria sp. 1
Closteriopsis sp. 1	Oscillatoria sp. 2
Closterium sp. 1	Oscillatoria sp. 3
Closterium sp. 2	Oscillatoria sp. 4
Closterium sp. 3	Pandorina sp.
Coleochaete sp.	Pleurotaenium sp.
Cosmarium sp.	Rhizoclonium sp.
Euastrum sp. 1	Schizogonium sp.
Eudorina sp.	Spirogyra sp. 3
Euglena sp.	Spondylosium sp.
Fragillaria sp. 1	Staurastrum sp.
Fragillaria sp. 2	Surirella sp.
Frustulia sp.	Tabellaria sp. 1
Gomphonema sp.	Tabellaria sp. 2
Gymnozyga sp.	Tetraedron sp.
Gyrosigma sp.	Tetraspora sp.
Meridion sp.	Ulothrix sp.
Micrasterias sp.	Xanthidium sp.
Microspora sp.	Zygnema sp.

TABLE 17. LIST OF ALGAL SPECIES COLLECTED, TURKEY CREEK

FEBRUARY 6, 1976

26 species identified from sites 8 through 11

Amphiprora sp.
Asterionella sp.
Batrachospermum sp. 1
Batrachospermum sp. 2
Closterium sp. 1
Coleochaete sp.
Cosmarium sp.
Euglena sp.
Fragillaria sp. 1
Fragillaria sp. 2
Gomphonema sp.
Gyrosigma sp. 1
Gyrosigma sp. 2
Meridion sp.
Mougeotia sp. 2
Mougeotia sp. 3
Navicula sp.
Netrium sp. 1
Netrium sp. 2
Oscillatoria sp. 1
Oscillatoria sp. 2
Rhizoclonium sp.
Spondylosum sp.
Surirella sp.
Tabellaria sp. 1
Ulothrix sp.

TABLE 18. LISTS OF ALGAL SPECIES COLLECTED APRIL 30, 1976

ROCKY CREEK AND TURKEY CREEK, EGLIN AIR FORCE BASE, FLORIDA

ROCKY CREEK:

SITE 1 (7 species)

Amphiprora sp.	Frustulia sp.	Navicula sp.
Asterionella sp.	Mougeotia sp. 2	Tabellaria sp. 1
Cosmarium sp.		

SITE 2 (18 species)

Amphiprora sp.	Micrasterias sp.	Oscillatoria sp. 2
Batrachospermum sp. 1	Mougeotia sp. 1	Oscillatoria sp. 3
Closterium sp. 1	Mougeotia sp. 2	Spirogyra sp. 1
Frustulia sp.	Navicula	Surirella sp.
Gomphonema sp.	Netrium sp. 1	Tabellaria sp. 1
Gyrosigma sp. 1	Oscillatoria sp. 1	Ulothrix sp.

SITE 3 (32 species)

Amphiprora sp.	Eremosphaera sp.	Oscillatoria sp. 4
Anabaena sp.	Euastrum sp.	Plectonema sp.
Chroococcus sp.	Euglena sp.	Rhizoclonium sp.
Closterium sp. 1	Frustulia sp.	Roya sp.
Closterium sp. 2	Gymnozyga sp.	Staurastrum sp.
Closterium sp. 3	Gyrosigma sp.	Synura sp.
Closterium sp. 4	Hyalotheca sp.	Tabellaria sp. 2
Closteriopsis sp.	Mougeotia sp. 1	Triploceras sp.
Coleochaete sp.	Mougeotia sp. 2	Ulothrix sp.
Cosmarium sp.	Oscillatoria sp. 1	Xanthidium sp.
Docidium sp.	Oscillatoria sp. 2	

SITE 4 (19 species)

Amphiprora sp.	Frustulia sp.	Oscillatoria sp. 2
Asterionella sp.	Mougeotia sp. 1	Peridinium sp.
Closterium sp. 1	Mougeotia sp. 2	Pleurotaenium sp.
Closterium sp. 2	Navicula sp.	Rhizoclonium sp.
Coleochaete sp.	Netrium sp. 1	Spirogyra sp. 1
Cosmarium sp.	Oscillatoria sp. 1	Tabellaria sp. 1
Fragilaria sp.		

TABLE 18. LISTS OF ALGAL SPECIES COLLECTED APRIL 30, 1976

ROCKY CREEK AND TURKEY CREEK, EGLIN AIR FORCE BASE, FLORIDA (continued)

SITE 5 (19 species)

Amphiprora sp.	Fragilaria sp.	Oscillatoria sp. 4
Batrachospermum sp. 1	Frustulia sp.	Pleurotaenium sp.
Closteriopsis sp.	Gomphonema sp.	Spirogyra sp. 1
Closterium sp. 1	Mougeotia sp. 2	Surirella sp.
Coleochaete sp.	Mougeotia sp. 3	Tabellaria sp. 1
Cosmarium sp.	Navicula sp.	Tabellaria sp. 2
Euglena sp.		

SITE 6 (17 species)

Amphiprora sp.	Euglena sp.	Oscillatoria sp. 4
Batrachospermum sp. 1	Fragilaria sp.	Spirogyra sp. 1
Closterium sp. 1	Frustulia sp.	Tabellaria sp. 1
Closterium sp. 2	Gomphonema sp.	Tabellaria sp. 2
Closterium sp. 3	Mougeotia sp. 2	Ulothrix sp.
Closteriopsis sp.	Navicula sp.	

SITE 7 (27 species)

Amphiprora sp.	Coleochaete sp.	Mougeotia sp. 1
Anabaena sp.	Cosmarium sp.	Mougeotia sp. 2
Batrachospermum sp. 1	Euglena sp.	Netrium sp.
Batrachospermum sp. 2	Fragilaria sp.	Oedogonium sp
Binuclearia sp.	Frustulia sp.	Oscillatoria sp. 1
Calothrix sp.	Gomphonema sp.	Oscillatoria sp. 4
Closterium sp. 1	Gryosigma sp. 1	Surirella sp.
Closterium sp. 2	Gyrosigma sp. 2	Tabellaria sp. 1
Closteriopsis sp.	Micrasterias sp.	Tabellaria sp. 2

TURKEY CREEK

SITE 8 (14 species)

Amphiprora sp.	Fragilaria sp.	Surirella sp.
Coleochaete sp.	Frustulia sp.	Synura sp.
Cosmarium sp.	Mougeotia sp. 3	Tabellaria sp. 1
Closterium sp. 3	Netrium sp.	Tabellaria sp. 2
Euastrum sp.	Oscillatoria sp. 1	

TABLE 18. LISTS OF ALGAL SPECIES COLLECTED APRIL 30, 1976

ROCKY CREEK AND TURKEY CREEK, EGLIN AIR FORCE BASE, FLORIDA (concluded)

SITE 9 (11 species)

Amphiprora sp.	Gomphonema sp.	Tabellaria sp. 1
Binuclearia sp.	Mougeotia sp. 2	Tabellaria sp. 2
Fragilaria sp.	Navicula sp.	Zygnema sp.
Frustulia sp.	Surirella sp.	

SITE 10 (15 species)

Amphiprora sp.	Frustulia sp.	Oscillatoria sp. 1
Closterium sp. 2	Mougeotia sp. 1	Oscillatoria sp. 4
Coleochaete sp.	Mougeotia sp. 2	Spriogyra sp. 1
Euglena sp.	Navicula sp.	Spriogyra sp. 2
Fragilaria sp.	Netrium sp. 1	Tabellaria sp. 2

SITE 11 (22 species)

Amphiprora sp.	Fragilaria sp.	Oscillatoria sp. 1
Anabaena sp.	Frustulia sp.	Oscillatoria sp. 3
Asterionella sp.	Gomphonema sp.	Oscillatoria sp. 4
Closterium sp. 1	Gyrosigma sp.	Spondylosum sp.
Closterium sp. 2	Micrasterias sp.	Surirella sp.
Closterium sp. 3	Mougeotia sp. 2	Tabellaria sp. 1
Closteriopsis sp.	Netrium sp. 1	Tabellaria sp. 2
Euglena sp.		

TABLE 19. LIST OF ALGAL SPECIES COLLECTED, ROCKY CREEK

APRIL 30, 1976

51 species identified from sites 1 through 7

Amphiprora sp.	Micrasterias sp.
Anabaena sp.	Mougeotia sp. 1
Asterionella sp.	Mougeotia sp. 2
Batrachospermum sp. 1	Mougeotia sp. 3
Batrachospermum sp. 2	Navicula sp.
Binuclearia sp.	Netrium sp. 1
Calothrix sp.	Oedogonium sp.
Chroococcus sp.	Oscillatoria sp. 1
Closteriopsis sp.	Oscillatoria sp. 2
Closterium sp. 1	Oscillatoria sp. 3
Closterium sp. 2	Oscillatoria sp. 4
Closterium sp. 3	Peridinium sp.
Closterium sp. 4	Plectonema sp.
Coleochaete sp.	Pleurotaenium sp.
Cosmarium sp.	Rhizoclonium sp.
Docidium sp.	Roya sp.
Eremosphaera sp.	Spirogyra sp. 1
Euastrum sp	Staurastrum sp.
Euglena sp.	Surirella sp.
Fragilaria sp.	Synura sp.
Frustulia sp.	Tabellaria sp. 1
Gomphonema sp.	Tabellaria sp. 2
Gymnozyga sp.	Triploceras sp.
Gyrosigma sp. 1	Ulothrix sp.
Gyrosigma sp. 2	Xanthidium sp.
Hyalotheca sp.	

TABLE 20. LIST OF ALGAL SPECIES COLLECTED, TURKEY CREEK

APRIL 30, 1976

33 species identified from sites 8 through 11

Amphiprora sp.
Anabaena sp.
Asterionella sp.
Binuclearia sp.
Coleochaete sp.
Cosmarium sp.
Closterium sp. 1
Closterium sp. 2
Closterium sp. 3
Closteriopsis sp.
Euastrum sp.
Euglena sp.
Fragilaria sp.
Frustulia sp.
Gomphonema sp.
Gyrosigma sp.
Micrasterias sp.
Mougeotia sp. 1
Mougeotia sp. 2
Mougeotia sp. 3
Navicula sp.
Netrium sp. 1
Oscillatoria sp. 1
Oscillatoria sp. 3
Oscillatoria sp. 4
Spirogyra sp. 1
Spirogyra sp. 2
Spondylosum sp.
Surirella sp.
Synura sp.
Tabellaria sp. 1
Tabellaria sp. 2
Zygnema sp.

TABLE 21. ALGAL GROWTH (TURBIDIMETRIC KLETT UNITS) WITH AND WITHOUT U_3O_8 (0.1 g/100 ml CULTURE MEDIUM); ORGANISM IS ISOLATE 6A FROM SITE 6.

Flask No.	X Control Flasks	Y Flasks containing U_3O_8
1	87	59
2	67	95
3	80	74
4	67	--
5	58	105
6	65	78
7	54	104
8	87	71
9	58	73
10	39	78

$\bar{X} = 69.2$

$\bar{Y} = 81.8$

"t" = 1.88, not significant at the 5 percent level.

TABLE 22. ALGAL GROWTH (TURBIDIMETRIC KLETT UNITS) WITH AND WITHOUT U_3O_8 (0.1 g/100 ml CULTURE MEDIUM); ORGANISM IS ISOLATE 6A from SITE 6; SECOND EXPERIMENT.

Flask No.	X Control Flasks	Y Flasks containing U_3O_8
1	71	71
2	68	86
3	88	89
4	77	78
5	80	68
6	54	89
7	72	48
8	51	71
9	85	81
10	72	67

$\bar{X} = 71.8$

$\bar{Y} = 74.9$

"t" = 0.56, not significant at the 5 percent level.

TABLE 23. ALGAL GROWTH (TURBIDIMETRIC KLETT UNITS) WITH AND WITHOUT U_3O_8 (0.1 g/100 ml CULTURE MEDIUM); ORGANISM IS ISOLATE 3A FROM SITE 3.

Flask No.	X Control Flasks	Y Flasks Containing U_3O_8
1	74	11
2	58	17
3	61	16
4	35	43
5	59	7
6	83	12
7	79	9
8	25	9
9	68	3
10	59	10

$\bar{X}$ = 59.8

$\bar{Y}$ = 13.9

"t" = 6.84, significant at the 1 percent level.

TABLE 24. ALGAL GROWTH (TURBIDIMETRIC KLETT UNITS) WITH AND WITHOUT U_3O_8 (0.1 g/100 ml CULTURE MEDIUM), ORGANISM IS ISOLATE 4A FROM SITE 4.

Flask No.	X Control Flasks	Y Flasks Containing U_3O_8
1	92	49
2	85	12
3	77	0
4	89	0
5	70	6
6	63	0
7	99	15
8	77	0
9	74	7
10	70	22

$\bar{X} = 79.6$

$\bar{Y} = 11.1$

"t" = 11.3, significant at the 1 percent level.

TABLE 25. ALGAL GROWTH (TURBIDIMETRIC KLETT UNITS) WITH AND WITHOUT UO_2 (0.1 g/100 ml CULTURE MEDIUM); ORGANISM IS ISOLATE 6A FROM SITE 6.

Flask No.	X Control Flasks	Y Flasks Containing UO_2
1	35.0	41.0
2	38.0	41.0
3	39.0	37.0
4	39.0	38.0
5	41.5	43.0
6	42.0	52.0
7	42.0	48.0
8	43.0	41.0
9	41.0	42.0
10	42.0	35.0

$\bar{X}$ = 40.25

$\bar{Y}$ = 41.80

"t" = 0.97, not significant at the 5 percent level.

TABLE 26. ALGAL GROWTH (TURBIDIMETRIC KLETT UNITS) WITH AND WITHOUT UO_2 (0.1 g/100 ml CULTURE MEDIUM; ORGANISM IS ISOLATE 3A FROM SITE 3.

Flask No.	X Control Flasks	Y Flasks Containing UO_2
1	27	4
2	36	4
3	25	22
4	33	20
5	31	11
6	47	20
7	35	18
8	41	23
9	47	12
10	26	19

$\bar{X} = 34.8$

$\bar{Y} = 13.3$

"t" = 8.8, significant at the 1 percent level.

TABLE 27. ALGAL GROWTH (TURBIDIMETRIC KLETT UNITS) WITH AND WITHOUT UO_2 (0.1 g/100 ml CULTURE MEDIUM); ORGANISM IS ISOLATE 4A FROM SITE 4.

Flask No.	X Control Flasks	Y Flasks Containing UO_2
1	62	17
2	61	7
3	71	6
4	74	4
5	73	14
6	80	6
7	71	13
8	86	9
9	80	7
10	90	6

$\bar{X}$ = 74.8

$\bar{Y}$ = 8.9

"t" = 20.21, significant at the 1 percent level.

TABLE 28. ALGAL GROWTH (TURBIDIMETRIC KLETT UNITS) WITH VARYING CONCENTRATIONS OF URANYL NITRATE ADDED TO THE CULTURE MEDIUM; ORGANISM IS ISOLATE 3A FROM SITE 3.

Replicate No.	Uranyl Nitrate Molarity				
	0	2×10^{-5}	5×10^{-5}	10^{-4}	2×10^{-4}
1	58	28	52	56	37
2	74	44	33	39	12
3	55	49	46	43	46
4	54	63	53	22	26
5	55	51	49	53	37
6	49	55	56	49	35
7	44	57	62	56	40
8	58	41	58	41	29
Mean	55.9	48.6	51.1	44.9	32.7
"t"		1.48	1.09	*2.20	**4.81

*"t" = significant at the 5 percent level.

**"t" = significant at the 1 percent level.

TABLE 29. ALGAL GROWTH (TURBIDIMETRIC KLETT UNITS) WITH VARIOUS CONCENTRATIONS OF URANYL NITRATE ADDED TO THE CULTURE MEDIUM; ORGANISM IS ISOLATE 4A FROM SITE 4.

Replicate No.	Uranyl Nitrate Molarity				
	0	2×10^{-5}	5×10^{-5}	10^{-4}	2×10^{-4}
1	58	62	48	61	48
2	65	64	27	47	29
3	43	24	31	42	38
4	53	30	49	33	32
5	69	77	51	54	48
6	86	76	59	45	55
7	81	67	63	56	46
8	58	47	43	47	47
Mean	64.1	59.8	47.6	49.4	42.8
"t"		0.54	*2.62	*2.63	**3.56

*"t" = significant at the 2 percent level.

**"t" = significant at the 1 percent level.

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