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Contents

Research Articles

Departments

Editorial

Emily Brontë is not generally known for her poetry, but I came across this poem and thought it worth sharing. It was written on 17 May 1839.—Ken Curry

I AM THE ONLY BEING

I am the only being whose doom
No tongue would ask, no eye would mourn;
I've never caused a thought of gloom,
A smile of joy, since I was born.

In secret pleasure, secret tears,
This changeful life has slipped away,
As friendless after eighteen years,
As lone as on my natal day.

There have been times, I cannot hide,
There have been times when this was drear,
When my sad soul forgot its pride
And longed for one to love me here.

But those were in the early glow
Of feelings long subdued by care,
And they have died so long ago,
I hardly now believe they were.

First melted off the hope of youth,
Then fancy's rainbow fast withdrew;
And then experience told me truth
In mortal bosoms never grew.

'Twas grief enough to think mankind
All hollow, servile, insincere;
But worse to turn to my own mind,
And find the same corruption there.

New Division! ECOLOGY AND EVOLUTIONARY BIOLOGY

The Mississippi Academy of Sciences is pleased to announce the formation of a new division, effective immediately, in Ecology and Evolutionary Biology. The Division of Ecology and Evolutionary Biology encourages submission of papers in these areas to the Journal of the Mississippi Academy of Sciences, and for presentation at next year's annual meeting of MAS in Hattiesburg. Papers appropriate to this division may come from researchers conducting studies in ecology and evolution in terrestrial, wetlands, or aquatic environments, involving organisms of any kind, or be strictly theoretical in content. Dr. Clifford Ochs of the University of Mississippi (byochs@olemiss.edu) and Dr. David Beckett of the University of Southern Mississippi (david.beckett@usm.edu) are the chair and vice-chair of the division for the coming year.—Cliff Ochs

[insert Ohaus advertisment here]

Life on Mars: Past, Present and Future

2003 Annual Meeting Dodgen Lecture

Christopher P. McKay, a Planetary Scientist with the Space Science Division of NASA Ames since 1982, researches the relationship between the chemical and physical evolution of the solar system and the origin of life. He is actively involved in planning for future Mars missions, including human settlements. Chris has been conducting polar research since 1980 in Mars-like environments such as the Antarctic dry valleys and, more recently, the Siberian Arctic. He has a strong interest in involving students in planning for the exploration of space, particularly Mars.

Christopher P. Mckay received his doctorate in astrophysics from the University of Colorado in 1982 and has been a research scientist with the space science division of the NASA Ames Research Center ever since. The year McKay entered graduate school, the Viking spacecraft landed on Mars, an event that aroused his continuing interest in planetary science and the origins of life. Today McKay helps to plan future Mars missions, and he regularly journeys to the dry valleys of Antarctica to study life in cold, dry conditions.

Dr. McKay is currently a planetary scientist with the Space Science Division of NASA Ames Research Center. He received his Ph.D. in AstroGeophysics from the University of Colorado in 1982 and has been a research scientist with the NASA Ames since that time. Dr. McKay is one of the world's leading researchers studying Titan, and has been involved in numerical modeling of planetary atmospheres for many years. He is currently working on models of Titan's thick atmosphere in support of the joint NASA/ESA mission to the Saturn system. Dr. McKay is co-Investigator on the Titan probe atmospheric structure experiment (HASI). His broader interests focus on understanding the relationship between the chemical and physical evolution of the solar system and the origin of life. He has been actively involved in planning for future Mars missions including human settlements. Dr. Mckay has also been involved with polar research since 1980, traveling to the Antarctic dry valleys and more recently to the Siberian Arctic to conduct research in these Mars-like environments.

A Comparison of Ten Serological Tumor Markers for the Detection of Gastric Cancer

Kevin L. Beason[1], Shawn R. Clinton[1], Sabrina Bryant[1], James T. Johnson[1], Margaret Jackson[1], Harold Schultze[1], Deborah Fortenberry[1], Cynthia Bright[1], Helen Hua[1], Jiarong Ying[1], Paul Sykes[1], Cynthia Wilson[2], Kay Holifield[3], Charlton Vincent[3], and Margot Hall[1, 4]

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Gastric cancer comprises only 2% of cancer cases in the United States but represents the most prevalent cancer in less developed countries and the fourth most prevalent cancer world wide. Early diagnosis and therapeutic intervention could radically reduce the number of deaths attributed to this disease. For this reason, minimally invasive cancer specific tests are urgently sought and recently have included the serological tumor markers. The objective of this study was to compare ten tumor antigens (carcinoembryonic antigen [CEA], CA 19-9, CA 195, CA 50, CA 72-4, CA 125, CA 15-3, CA 27.29, alpha-fetoprotein [AFP], and Cyfra 21-1) for their diagnostic efficacy in gastric cancer patients. The assays used in this study included CA 72-4, CA19-9, CA 15-3, CA 125, CA 27.29, and Cyfra 21-1 from Fujirebio Diagnostics/Centocor Inc., CA 195 and CEA from Hybritech, Inc., CA 50 from CIS bio international, and AFP from Abbott Inc. Sera from 200 healthy adults were used to determine the normal reference intervals. Diagnostic parameters were determined using sera from 554 patients including 184 with no disease, 11 with non-malignant disease, 12 with gastric cancer, and 347 with other types of cancer. The diagnostic sensitivities included: CA 50 (70%), CA 19-9 (64%), CA 195 (58%), CEA (50%), CA15-3 (45%), CA 125 (40%), CA 27.29 (30%), CA 72-4 (27%), AFP (22%), and Cyfra 21-1 (9%). With the exception of CA 195 and CA 15-3 (75% specificity), all the markers had diagnostic specificities equal to or greater than 80% (range 80–95%). Analytical parameters were evaluated for the assays and compared favorably. We concluded that CA 50 was the best tumor antigen for use in the diagnosis of gastric cancer.

Keywords: cancer, gastric cancer, stomach cancer, carcinoembryonic antigen, alpha-fetoprotein, CEA, AFP, CA 50, CA 19-9, CA 195, CA 72-4, CA 125, CA 15-3, CA 27.29, Cyfra 21-1, tumor marker.

With 558,458 estimated new cases and 405,215 estimated deaths world-wide in 2001, gastric cancer is the fourth most prevalent cancer globally. Similarly, in less developed countries gastric cancer ranks first in prevalence and second only to lung cancer for incidence of new cases (World Health Organization, 2001). Originally the number one cause of cancer deaths in the United States, today the incidence and prevalence of gastric cancer have declined drastically, possibly due to the widespread use of refrigeration and antibiotics in the processing of food. This has led to a decreased consumption of salt cured and smoke cured meat and fish which have long been associated with increased risk of gastric cancer (Hossfeld and Sherman, 1990; Key et al., 1998). Additionally, *Helicobacter pylori* infection is considered to be a predisposing factor for gastric cancer because it can cause chronic atrophic gastritis, resulting in increased gastric pH, bacterial colonization of the stomach, and the production of carcinogenic N-nitroso compounds from dietary proteins. The decreased incidence of *Helicobacter pylori* infection in the United States, due to improved sanitation and the use of antibiotics, has paralleled the observed decline in gastric cancer. No comparable decreases of infection rates or gastric cancer

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incidences have been observed in less developed countries. (Key et al., 1998).

Possible therapeutic methods and strategies include total gastrectomy, radical subtotal gastrectomy, resectioning of involved portions of liver, pancreas, and transverse colon, splenectomy and removal of involved lymph nodes, chemotherapy, and radiotherapy (Hossfeld and Sherman, 1990; National Cancer Institute Symptoms, 2000). The prognosis depends on the extent of tumor spread at the time of initial treatment and is generally better for gastric lymphomas than for carcinomas. The overall five-year survival rate for all patients is approximately 10%. This increases to about 40% for patients who were diagnosed and treated early (Hossfeld and Sherman, 1990; National Cancer Institute Symptoms, 2000).

Traditional methods of gastric cancer diagnosis have included biopsy, barium X-rays, gastroscopy, upper GI series with double contrast media, computer tomography (CAT scans), exfoliative cytology, and gastric cytology following brushing and washing of the stomach (National Cancer Institute Symptoms, 2000; Hossfeld and Sherman, 1990). There is evidence to support the use of serum tumor antigens as an aid in diagnosis, to measure tumor size, and to evaluate post surgical therapeutic methods and the presence of recurrent disease in gastric and other gastrointestinal cancers. (Wu and Nakamura, 1997). CA 72-4 is the principal tumor antigen in current use for the diagnosis and prognosis of gastric cancer. Other markers which have been assessed for gastric cancer include, among others, CA 19-9, CA 50 and CEA, (Wu and Nakamura, 1997). Similarly CA195 and CA125 have been reported to have some sensitivity for gastric cancer (Hall et al., 1999). CA 19-9, CA 50, and CA195 are markers for a variety of gastrointestinal cancers and CA125 is a marker of ovarian cancer. Elevated CA 15-3 has been reported in a variety of adenocarcinomas including breast, lung, ovary, colon, and pancreas. It is principally used in the assessment of breast cancer patients (Lauro et al., 1999). CA27.29 is used as a marker for therapeutic monitoring in breast cancer patients and has not been reported in gastric cancer patients (Gion and Minone, 2001; Frenette et al., 1994). It has been reported in some cases of ovarian, uterine, lung, prostate, colorectal, and pancreatic cancer (Fujirebio Diagnostics, 1998). Elevated alpha-fetoprotein has been extensively used as a marker for hepatic disease, including hepatoma, and for yolk sac derived germ cell tumors. It has also been reported in a few patients with other gastrointestinal cancers (Wu and Nakamura, 1997; Butch et al., 2000). Similarly, Cyfra 21-1 is used as a marker of lung cancer and has not been reported to be useful in diagnosis and monitoring of gastric cancer (Wu and Nakamura, 1997; Hubbard, 1990).

CA 72-4 is a 1 million kDa mucin-like glycoprotein complex (TAG 72) which is predominantly associated with human adenocarcinoma of the gastrointestinal tract (Johnson et al., 1986; Lan et al., 1987). Two monoclonal antibodies (cc49 and B72.3) have been developed against CA 72-4 (TAG 72) which detect distinct antigenic determinants expressed on the circulating antigen found in a variety of gastrointestinal cancers, and lung cancer (Patterson et al., 1986; Klug et al., 1986). The use of CA 72-4 is recommended in cases of gastric cancer and it has been used in tumor panels (ratio of CA19-9 to CA72.4) to exclude pancreatic disease (Wu and Nakamura, 1997).

CA 19-9 is a high molecular weight (200–1000 kDa) mucin like glycoprotein which exists as a ganglioside on tumor cells. The expression of this sialylated Le^a blood group antigen (sialylated lacto-N-fucopentoeose II ganglioside) is required for the expression of CA 19-9 and hence Le^{a-b-} patients do not express the antigen and can present as false negatives (Steinberg, 1990). A monoclonal antibody was developed against CA 19-9 derived from the SW-1116 human colon carcinoma cell line (Koprowski et al., 1979). CA 19-9 is clinically useful in the detection of pancreatic, colorectal, hepatic, and other gastrointestinal cancers. It has also been described in breast and lung cancer (Wu and Nakamura, 1997). CA 50 is related to CA 19-9 but lacks a fucose residue. Its epitope is the same as that found in Le^{a-b-} (Lewis negative) patients. It has been reported in patients with gastric, colon, and hepatic cancer (Wu, 1996). CA 195 is also related to CA 19-9. It is defined by the mouse monoclonal antibody CC3C-195 and it recognizes both Le^a and sialyl-Le^a epitopes. Binding with higher affinity to the sialylated Le^a blood group antigen, the antibody can bind to both the sialylated and unsialylated Le^a blood group. CA 195 has been reported in pancreatic, colon, and gastric cancers (Wu and Nakamura, 1997).

CA 125 is a 200 kDa glycoprotein expressed by tissue of mullerian duct origin as well as by ovarian tumors. It is defined by the mouse monoclonal antibody OC 125 derived from an ovarian cancer cell

line (OVCA 433). It is currently used for detecting epithelial tumors of the ovary. However, it has also been reported in breast, lung, endometrial, and gastrointestinal tumors. It can be elevated with pregnancy and with pelvic inflammatory disease. (Jacobs and Bast, 1989)

CEA is a 150–300 kDa cell surface heterogeneous glycoprotein which is structurally similar to IgG. Abnormally elevated serum levels have been reported in patients with colorectal cancer, breast cancer, and a variety of other carcinomas (Cooper et al., 1979; Reynoso et al., 1972). Additionally, CEA levels can be elevated in heavy smokers and patients with nonmalignant pathologies (Clarke et al., 1982). Consequently, CEA is currently used in therapeutic monitoring and as a diagnostic aid, but is not useful in screening for cancer.

CA 15-3 is a 300–450 kDa glycoprotein defined by two monoclonal antibodies. The 115D8 antibody recognizes human milk fat globule membranes and the DF3 antibody reacts with a breast cancer antigen extract (Kufe et al., 1984; Hilkens et al., 1984). It has been reported in cases of breast, ovarian, pancreatic, lung, and colorectal cancer (Wu and Nakamura, 1997).

CA 27.29 is a mucin antigen defined by the monoclonal antibody B27.29. This antibody recognizes an antigen extracted from ascites fluid derived from patients with breast cancer. CA 27.29 has an epitope that is shared with the DF3 antibody of CA15-3. (Burtis and Ashwood, 1996). It is currently being marketed as a specific test for breast cancer.

Alpha-fetoprotein (AFP) is a 70,000 kDa glycoprotein which has been isolated from patients with hepatocellular carcinomas and germ cell tumors (Chan et al., 1986). Maternal serum and amniotic fluid AFP levels are routinely used for the prenatal diagnosis of open neural tube disease and gastroschisis, and together with karyotyping have been used to diagnose cases of Down's syndrome (Milunsky, 1987; Knight et al., 1988). Alpha-fetoprotein has been reported to be useful in screening for hepatocellular carcinoma in high incidence areas such as Asia, and for classifying and staging germ cell tumors (Chan et al., 1986). Alpha-fetoprotein has been reported in cases of hepatocellular carcinoma, testicular and ovarian germ cell tumors, as well as pancreatic, colorectal, and gastric carcinomas (Butch et al., 2000).

Cyfra 21-1 is a 40 kDa fragment derived from cytokeratin 19. One subgroup of intermediate filament proteins, cytokeratins are found in epithelial cells. The monoclonal antibody recognizes an epitope on the Cyfra 21-1 fragment and is useful in the detection of non-small cell lung cancer, including squamous cell carcinoma of the lung (Pujol et al., 1993). It has also been reported in cases of cervical cancer and other malignancies (Bonfrer et al., 1994; Bodenmuller et al., 1992).

In a clinical laboratory, in order to compare different assay methods one must evaluate their specific performance characteristics (precision, linearity, analytical sensitivity, and analytical specificity) and their clinical performance (normal reference interval and predictive values). Precision is evaluated by assaying replicate samples and determining the mean, standard deviation, and coefficient of variation. Linearity is determined by assaying dilutions of an elevated serum sample and plotting the results and/or performing regression analysis. The minimum detectable concentration of analyte in the test (analytical sensitivity) is determined by assaying replicate samples lacking the analyte (e.g., diluent) and calculating the mean plus two standard deviations. Values falling below this cutoff are presumed to be analyte free. The analytical specificity represents the degree of assay interference from drugs or other chemicals (e.g., bilirubin) present in the specimen. This is not always reported but can be determined by spiking samples with varying concentrations of the suspected interfering drugs/chemicals.

In order to establish a healthy (normal) adult reference interval for the analyte using a particular assay, one calculates the mean plus or minus two standard deviations (95% confidence interval) on assay results from a population set of adults known to be in good health. Subsequently, any patient result which falls within this interval is considered to be "normal" or healthy; whereas, patient results which fall outside (above or below) the limits of this interval are considered to be abnormally elevated or decreased respectively. For tumor markers a low result would have no clinical significance. Therefore, one establishes the cutoff between normal (presumed negative for disease) and abnormal (presumed positive for disease) results by using the mean plus two standard deviations. Predictive validity compares the ability of a new test method to accurately diagnose/predict the presence or absence of disease with that of an established method. Predictive value results include diagnostic sensitivity and specificity, diagnostic efficiency, and positive and negative

predictive values. For the calculation of predictive values, one compares the test results with the "true results" as defined by an external test method considered to be the reference test method. For example one could compare the results of a tumor antigen assay (test results) with those obtained by the physician with histologic analysis of biopsy material (true results). Individual patient assay results are then assigned to one of four categories (true positives [TP], true negatives [TN], false positives [FP], or false negatives [FN]) from which the predictive values are derived. Predictive values include: (a) diagnostic sensitivity (% of individuals with the disease who test positive by the assay), i.e., [100 TP/(TP + FN)], (b) diagnostic specificity (% of individuals without the disease who test negative by the assay), i.e., [100 TN/(TN + FP)], (c) diagnostic efficiency (% of all test results that are either true positives or true negatives), i.e., [100 (TP + TN)/(TP + TN + FP + FN)], (d) positive predictive value (% of all positive test results that are true positives), i.e., [100 TP/(TP + FP)], and (e) negative predictive value (% of all negative test results that are true negatives), i.e., [100 TN/(TN + FN)].

The purpose of this study was to evaluate the analytical and clinical performances of ten serologic tumor marker tests (CEA, CA 19-9, CA 195, CA 50, CA 72-4, CA 125, CA15-3, CA 27.29, AFP, and Cyfra 21-1) for the detection of gastric cancer. Particular attention was paid to the comparison of their diagnostic sensitivities as this value reflects the tumor marker test's ability to detect the disease. A working hypothesis that CA 72-4 would prove to be superior to the other tumor markers was developed based on reports in the literature of its superiority (Wu and Nakamura, 1997; Spila et al., 1996).

MATERIALS AND METHODS

***Assays*—**All assays were performed according to the directions supplied by the manufacturers. The Tandem^{R}-E CEA assay (Hybritech, Inc) is a solid phase two-site immunoenzymometric assay (ELIZA) utilizing two monoclonal IgG antibodies directed against unique sites on the CEA antigen. This assay was quantitated spectrophotometrically using the Photon Immunoassay Analyzer^{TM} from Hybritech, Inc. The Tandem^{R}- CA 195/Hybri C Mark^{TM} assay (Hybritch Europe, Inc.) is a solid phase two-site immunoradiometric assay (CA 195) (RIA) utilizing monoclonal IgM antibodies developed against the Lewis A (blood group determinant) and sialyated Lewis A epitopes on the CA 195 antigen. This assay was measured using a Genesys^{TM} 5000 gamma counter (Laboratory Technologies, Inc.). The Centocor^{R} CA 19-9^{TM} assay (Fujirebio Diagnostics, Inc./Centocor, Inc.) is a solid phase radioimmunoassay (CA 19-9) (RIA) using the 1116-NS-19-9 antibody for both the capture and tracer antibodies. This antibody is directed against an epitope which is biochemically related to the Lewis A determinant; the assay was quantitated using a Genesys^{TM} 5000 gamma counter (Laboratory Technologies, Inc.). The RIA-gnost^{R} CA-50 assay (CIS bio international) is a solid phase two-site immunoradiometric assay (CA 50) (RIA) utilizing monoclonal mouse antibodies directed at two carbohydrate chains (sialylated Lewis A and sialylated lactotetraose) of the adenocarcinoma cell line Colo 205. The assay was measured using a Genesys^{TM} 5000 gamma counter (Laboratory Technologies, Inc.). The Centocor^{R} CA 72-4^{TM} assay (Fujirebio Diagnostics, Inc./Centocor, Inc.) is a solid phase radioimmunoassay (CA 72-4) (RIA) based on two monoclonal antibodies, cc49 and B72.3, which react with distinct antigenic determinants on a tumor associated glycoprotein TAG 72. The antigen was quantitated using the Genesys^{TM} 5000 gamma counter (Laboratory Technologies, Inc.). The Centocor^{R} CA 125^{TM} assay (Fujirebio Diagnostics, Inc./Centocor, Inc.) is a solid phase two-site immunoradiometric assay (CA 125) (RIA) using two mouse monoclonal antibodies, OC125 directed against the OVCA 433 ovarian cancer cell line and a second antibody directed against another CA 125 epitope. The assay was measured using a Genesys^{TM} 5000 gamma counter (Laboratory Technologies, Inc.). The Centocor^{R} Cyfra^{TM} 21-1 assay (Fujirebio Diagnostics, Inc./Centocor, Inc.) is a solid phase immunoradiometric assay (RIA) utilizing two mouse monoclonal antibodies, KS19.1 and BM19.21, to detect cytokeratin 19 fragments in serum. The assay was quantitated using a Genesys^{TM} 5000 gamma counter (Laboratory Technologies, Inc.). The Centocor^{R} CA 15-3^{R} assay (Fujirebio Diagnostics, Inc./Centocor, Inc.) is a solid phase radioimmunoassay (RIA) using the 115D8 murine monoclonal antibody as the capture antibody and the I^{125} labeled DF3 murine monoclonal antibody as the tracer. This assay was quantitated using an Iso Data^{R} gamma counter. The Truquant^{R} BR^{TM} assay (Fujirebio Diagnostics, Inc./Centocor, Inc.) is a solid phase competitive inhibition radioimmunoassay (competitive RIA) using polystyrene

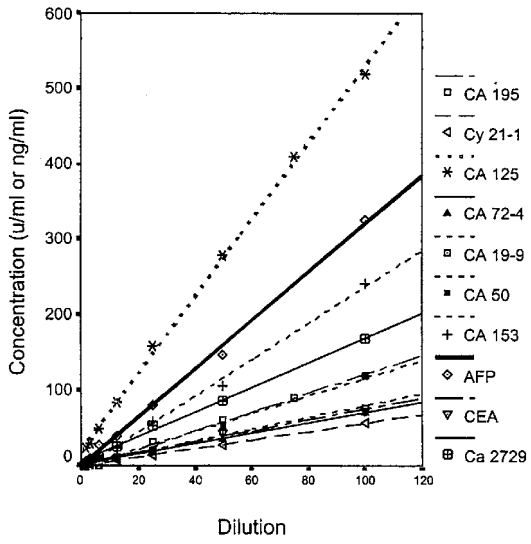

Figure 1. Comparison of the linearity of CEA, CA 19-9, CA 195, CA 50, CA72-4, CA 125, CA 15-3, CA 27.29, AFP, and Cyfra 21-1 tumor markers.

tubes coated with CA 27.29 antigen and I^{125} labeled murine monoclonal B27.29 antibody. This assay was quantitated using an Iso Data^{R} gamma counter. The IMx ^{R} AFP assay (Abbott Laboratories, Inc.) is a microparticle enzyme immunoassay (MEIA) utilizing two monoclonal antibodies directed against unique sites on the AFP antigen. This assay was quantitated using the IMx^{R} Automated Analyzer from Abbott Laboratories, Inc. All dilutions were performed using diluent supplied by the manufacturers in the assay kits. These diluents contain physiological concentrations of protein which maintains the sample protein concentration within limits which do not affect the assay. Regression analysis was used to determine the linearity of the assays and the independent t-test was used to compare male and female subjects when developing the reference intervals. Statistical analysis was performed using SPSS software.

Patients—Procedures used in this study were in accord with ethical standards established by the University of Southern Mississippi (USM). Permission for the study was granted by the USM Human Subjects Protection Review Committee (HSPRC/IRB).

All study participants were selected from patients seen in an area hospital. Five hundred and fifty four patients were randomly chosen and the assays were run in a blind fashion. Blood samples were collected using appropriate aseptic technique. Following serum separation aliquots were coded and frozen at -20EC. Subsequently, aliquots were thawed at 37EC and assayed in duplicate (sample permitting) for the tumor antigens. The diagnoses were obtained from the attending physicians and were based on pathological examination. Patient Classifications included (a) no known disease, (b) nonmalignant disease, (c) non gastric cancer, and (d) gastric cancer. Cancer patients were classified according to the primary site of the tumor, regardless of the presence or absence of metastases. Since available information on patient therapy was incomplete, statistical analyses were performed on the total patient pool without reference to this.

The normal control subjects were healthy males (100) and females (100) ranging from 18–65 years of age. Their blood samples were collected and processed in the same manner as the patient samples.

RESULTS

Precision and Linearity—Quality control samples analyzed over a 6 month period were used to determine intra- and inter-assay precision. The within-run coefficient of variation (%CV) was less than 10% for all but the CA 15-3 assay which was somewhat higher (20%) (Table 1). Similarly the between-run coefficient of variation was less than 17% for each of the assays (Table 2). Serial dilutions of abnormal pool samples exhibited good linearity (Fig. 1) with R^2 values equal to or greater than 0.989 for all the assays.

Reference Intervals—The minimum detectable concentration was determined by analyzing approximately 20 replicates of the zero calibrator/diluent and establishing the mean + 2SD as the cut-off value (Table 3a). The normal adult reference intervals were established by determining the 95% confidence intervals for healthy control male and female subjects. The intervals (Tables 3a, 3b) were broader than those reported by the manufacturer for all but the CA 125, CA 72-4, CA 27.29, and AFP assays which were somewhat narrower. There was no significant difference between healthy adult males and females for any of the assays except CA 19-9, where the males were significantly ($p < 0.05$) higher.

Diagnostic Parameters—In this study there were 184 patients without disease, 11 patients with nonmalignant disease, 12 patients with gastric cancer, and 347 patients with other types of cancer including:

Table 1. Within-run precision for CEA, CA 19-9, CA 195, CA 50, CA 72-4, CA 125, CA 15-3, CA 27.29, AFP, and Cyfra 21-1.

Sample	n	Mean	SD	%CV
CEA Low Control	43	4.28 ng/mL	0.29	6.78
CEA High Control	40	64.04 ng/mL	2.79	4.36
CA 19-9 Low Control	20	39.66 U/mL	2.18	5.51
CA 19-9 High Control	20	76.28 U/mL	4.79	6.28
CA 195 Low Control	30	11.60 U/mL	1.10	9.53
CA 195 Mid Control	30	52.30 U/mL	3.55	6.80
CA 195 High Control	30	79.40 U/mL	7.24	9.13
CA 50 Low Control	20	12.78 U/mL	0.58	4.54
CA 50 High Control	20	100.45 U/mL	4.18	4.16
CA 72-4 Low Control	20	9.24 U/mL	0.74	8.05
CA 72-4 High Control	20	69.66 U/mL	3.57	5.13
CA 125 Low Control	20	55.16 U/mL	3.48	6.31
CA 125 High Control	20	101.39 U/mL	6.38	6.29
CA 15-3 Control	50	46.83 U/mL	9.60	20.50
CA 27.29 Control I	42	75.36 U/mL	6.61	8.77
CA 27.29 Control II	37	106.51 U/mL	9.93	9.32
AFP Low Control	10	20.36 ng/mL	2.22	10.90
AFP Medium Control	10	77.87 ng/mL	3.16	4.06
AFP High Control	10	171.22 ng/mL	4.96	2.90
Cyfra 21-1 Low Control	20	4.41 ng/mL	0.28	6.27
Cyfra 21-1 High Control	20	14.17 ng/mL	0.77	5.41

Table 2. Between-run precision for CEA, CA 19-9, CA 195, CA 50, CA 72-4, CA 125, CA 15-3, CA 27.29, AFP, and Cyfra 21-1.

Sample	n	Mean	SD	%CV
CEA Low Control	76	4.44 ng/mL	0.37	8.33
CEA High Control	72	62.64 ng/mL	3.40	5.43
CA 19-9 Low Control	59	44.57 U/mL	4.33	9.72
CA 19-9 High Control	59	84.85 U/mL	8.65	10.19
CA 195 Low Control	62	11.67 U/mL	1.88	16.11
CA 195 Mid Control	58	52.03 U/mL	4.81	9.25
CA 195 High Control	62	80.68 U/mL	10.39	12.88
CA 50 Low Control	57	12.87 U/mL	0.86	6.68
CA 50 High Control	57	105.46 U/mL	7.73	7.33
CA 72-4 Low Control	65	9.57 U/mL	0.71	7.37
CA 72-4 High Control	66	71.17 U/mL	3.57	5.01
CA 125 Low Control	86	54.08 U/mL	5.50	10.17
CA 125 High Control	86	107.11 U/mL	8.14	7.56
CA 15-3 Control	67	45.21 U/mL	6.61	14.62
CA 27.29 Control I	73	74.99 U/mL	6.95	9.27
CA 27.29 Control II	68	117.76 U/mL	16.38	13.91
AFP Low Control	38	19.60 ng/mL	1.44	7.35
AFP Medium Control	38	78.15 ng/mL	3.88	4.96
AFP High Control	38	167.01 ng/mL	6.28	3.76
Cyfra 21-1 Low Control	78	4.45 ng/mL	0.50	11.23
Cyfra 21-1 High Control	76	13.97 ng/mL	0.86	6.16

pancreatic, small intestinal, esophageal, lung, breast, ovarian, prostatic, renal, colorectal, gallbladder, hepatic, cecal, uterine, testicular, head and neck, leukemia, lymphoma, and all other types. Patients' diagnoses were made by the attending physicians and were predicated on a variety of pathologic findings including the histologic analysis of biopsy or surgical tissue. For purposes of this study, patients with gastric cancer were considered to be positive for disease. Similarly, cutoffs between normal (negative) and abnormal (positive) test results used were those listed by the manufacturers and are cited in Table 4. In Table 4, the diagnostic sensitivity of CA 50 (70.0%) is superior to that of the other markers (CA 19-9, 63.6%; CA 195, 58.3%; CEA, 50.0%; CA 15-3, 45.5%; CA 125, 40.0%; CA 27.29, 30.0%; CA 72-4, 27.3%; AFP, 22.2%; and Cyfra 21-1, 9.1%). The diagnostic specificities of the ten assays range from 75–95% with Cyfra 21-1 having the highest value. The negative predictive and positive predictive values range from 97–99% and 3–9% respectively. The efficiency of the Cyfra 21-1 assay was the best (92.6%), presumably due to the fact that it had the highest % specificity.

DISCUSSION

The incidence and prevalence of gastric cancer make it an important medical problem world wide. For some time the medical community has sought a minimally invasive, inexpensive, and early diagnostic test for this and other types of cancer. With the exception of PSA in prostate cancer, tumor markers have generally not proven useful as screening tests either because their incidence is too low in the general public, or because the cutoff between benign and malignant disease is not sufficiently precise.

Table 3a. Reference intervals for CEA, CA 19-9, CA 195, CA 50, CA 72-4, CA 125, CA 15-3, CA 27.29, AFP, and Cyfra 21-1.

Sample	n	Mean	SD	Range
Zero/Diluent Controls				
CEA	20	0.00 ng/mL	0.35	0.00–00.70
CA 19-9	20	0.00 U/mL	0.70	0.00–01.40
CA 195	20	0.00 U/mL	1.50	0.00–03.00
CA 50	20	0.08 U/mL	0.12	0.00–00.32
CA 72-4	20	2.93 U/mL	0.36	2.21–03.64
CA 125	20	3.20 U/mL	1.44	0.40–06.00
CA 15-3	21	0.02 U/mL	0.08	0.00–00.18
CA 27.29	24	0.24 U/mL	1.16	0.00–02.56
AFP	13	0.00 ng/mL	0.01	0.00–00.02
Cyfra 21-1	20	0.01 ng/mL	0.03	0.00–00.07
Healthy Adults				
CEA	264	2.82 ng/mL	2.64	0.00–08.10
CA 19-9	199	16.01 U/mL	15.53	0.00–47.08
CA 195	230	4.96 U/mL	6.58	0.00–18.11
CA 50	200	14.93 U/mL	13.81	0.00–42.55
CA 72-4	200	1.32 U/mL	1.09	0.00–03.50
CA 125	200	10.60 U/mL	8.58	0.00–27.76

Table 3b. Reference intervals for CEA, CA 19-9, CA 195, CA 50, CA 72-4, CA 125, CA 15-3, CA 27.29, AFP, and Cyfra 21-1.

Sample	n	Mean	SD	Range
Healthy Adult Males				
CEA	133	3.08 ng/mL	2.36	0.00–07.80
CA 19-9	99	18.73 U/mL	18.67	0.00–56.07
CA 195	121	5.07 U/mL	6.50	0.00–18.07
CA 50	100	14.84 U/mL	15.30	0.00–45.44
CA 72-4	100	1.41 U/mL	0.91	0.00–03.23
CA 125	100	10.44 U/mL	8.26	0.00–26.95
CA 15-3	106	25.36 U/mL	13.92	0.00–53.20
CA 27.29	100	18.94 U/mL	8.28	2.38–35.50
AFP	107	3.47 ng/mL	1.79	0.00–07.05
Cyfra 21-1	100	1.02 ng/mL	2.06	0.00–05.13
Healthy Adult Females				
CEA	131	2.55 ng/mL	2.89	0.00–08.33
CA 19-9	100	13.33 U/mL	11.08	0.00–35.49
CA 195	109	4.83 U/mL	6.69	0.00–18.21
CA 50	100	15.02 U/mL	12.22	0.00–39.46

Thus increased concentrations have been reported in some cases of benign disease while not observed in cases of *in situ* cancer when the prognosis is best (Wu and Nakamura, 1997; Roulston and Leonard, 1993). Despite this, many tumor antigens have proven useful for diagnosis and for therapeutic monitoring and the detection of recurrent disease.

In this study we compared ten serologic assays (CEA, CA 19-9, CA 195, CA 50, CA 72-4, CA 125, CA 15-3, CA 27.29, AFP, and Cyfra 21-1) for their efficacy at detecting gastric cancer. The within-run and between-run precision was slightly higher for CA 15-3 and CA 195 than for the other assays, but all values were below 20%. The linearity was excellent for all the assays. The minimum detectable concentration of analyte (zero calibrator/diluent mean + 2SD) was slightly higher for CA 125 than for the other assays. This test was therefore repeated using a patient sample that had previously given a result of 0 U/mL (data not shown). The results did not differ from those of the zero calibrator/diluent, confirming its value. The normal reference intervals were broader than those cited by the manufacturers for all the assays except CA 125, CA 72-4, CA 27.29, and AFP. The CA 19-9 assay exhibited a significantly higher reference interval for males than for females; otherwise there were no significant differences between the sexes. The assays compared favorably for cost and availability of instrumentation. With the exception of CEA and AFP, all of the assays were radiolabeled (I^{125}) and therefore had shorter shelflives. The turnaround time varied from 1 hour for AFP (automated assay) to approximately 3–24 hours for the other assays (manual assays with varying incubations periods). The CEA (ELIZA assay) required only the use of a spectrophotometer

Table 4. Comparison of predictive values of CEA, CA 19-9, CA 195, CA 50, CA 72-4, CA 125, CA 15-3, CA 27.29, AFP, and Cyfra 21-1 for gastric cancer.

	Sensitivity %	Specificity %	Predictive Value (+) %	Predictive Value (-) %	Efficiency %	Cutoff Value
CEA (n = 554)	50.0	80.1	5.3	98.6	79.4	5.0 ng/mL
CA 19-9 (n = 541)	63.6	87.0	9.2	99.1	86.5	37.0 U/mL
CA 195 (n = 554)	58.3	75.1	4.9	98.8	74.7	10.5 U/mL
CA 50 (n = 515)	70.0	84.4	8.1	99.3	84.1	25.0 U/mL
CA 72-4 (n = 550)	27.3	90.4	5.5	98.4	89.1	5.6 U/mL
CA 125 (n = 527)	40.0	91.1	8.0	98.7	90.1	35.0 U/mL
CA 15-3 (n = 515)	45.5	75.0	3.8	98.4	74.4	35.0 U/mL
CA 27.29 (n = 494)	30.0	81.2	3.2	98.2	80.2	37.7 U/mL
AFP (n = 418)	22.2	86.9	3.4	98.2	85.7	8.9 ng/mL

and therefore might be more attractive than the other assays for use in a small lab.

Sera from 554 patients seen in a local hospital were assayed for ten tumor antigens and the diagnostic parameters were compared. The physicians' diagnoses and the manufacturers suggested cutoff values were utilized to assign the test results to the categories of true or false positives and negatives. Predictive values were calculated for gastric cancer. The most important finding of this study was the observation that CA 50 was clearly superior to CA 72-4 for the detection of gastric cancer, exhibiting a diagnostic sensitivity of 70% as compared to 27%. Similarly, CA 19-9, CA 195, CEA, CA 15-3, and CA 125 all excelled when compared to CA 72-4. The importance of this stems from the fact that CA 72-4 has been reported to be the best tumor marker for gastric cancer and is currently being marketed as a gastric/gastrointestinal cancer marker. Since CA 50, CA 195, and CA19-9 share very similar epitopes, it should not be surprising that all three react similarly with gastric as well as with other carcinomas. Similarly, CEA shares some antigenic determinants with CA 19-9 (Wu and Nakamura, 1997).

In a similar study, Pectasides et al. (1997), found CA 50 and CA 19-9 to be superior to CEA for the diagnosis of gastric cancer. Haglund et al. (1992) investigated CA 19-9 and CA 50 for their diagnostic capabilities and found them to have the same sensitivity for gastric cancer.

In two studies the authors reported a discrepancy between the markers depending on the stage of the cancer. In a study involving 100 cancer patients (44 with early cancer and 56 with advanced cancer), Kodama et al. (1995) reported that in advanced cancer CA 72-4 was superior to CEA and CA 19-9 for the diagnosis, prognosis, and detection of recurrent disease. By contrast they found CA 19-9 and CEA to be better for the detection of early stage (I and II) disease. Likewise, in a study by Van-Dalen and Kessler (1996) in which 4266 serum samples from 23 labs were analyzed for CEA, CA 15-3, CA 19-9, CA 72-4, CA 125, Cyfra 21-1, and AFP, the authors reported that CA 72-4 was the most sensitive for stage IV disease. However, the authors found CA 72-4, CA 19-9, and CEA to be equally sensitive for stage I–III disease.

By contrast, in a study of 242 patients, Spila et al.

(1996) found that CA 72-4 was superior to both CEA and CA 19-9 for the diagnosis and prognosis of both primary and recurrent gastric cancer. Likewise, Fernandez-Fernandez et al. (1996) have reported that in a study of 167 patients with gastric cancer and 92 patients with benign disease they found CA 72-4 to be superior to both CA 19-9 and CEA at all stages of disease. Discrepancies between their results and ours could be the result of genetic differences in the patient populations, the stage of the tumors, the presence of pathologic complications, the prevalence of disease (gastric cancer) in the population sample, and/or the use and type(s) of therapies. Since CA 19-9, CA 195, CA 50, and CA 72-4 are blood group antigen type carbohydrate markers and CEA contains incomplete blood group substances, it is not surprising that patients who do not express a particular blood group antigen will have serum which does not react in tumor marker assays that use monoclonal antibodies directed at epitopes found on these antigens (Wu and Nakamura, 1997). Thus the genetic background of a patient could cause false negative values with these tests. The greater the tumor burden and the more metastatic it has become, the greater the likelihood of increased levels of antigen and hence of positivity with a particular antigen assay. Both positive and negative predictive values are somewhat dependent on the disease prevalence in the sample population (Cembrowski et al., 2000). For this reason many studies are designed to include increased numbers of patients with the disease being studied (high prevalence), and to exclude any patients with other diseases. While this would lead to better (higher) predictive values, it doesn't reflect the local patient population. In this study, patients were randomly selected and included therefore only 12 gastric cancer patients and numerous patients with other types of cancer and with no cancer. This better represents what is actually seen in American hospitals but could introduce a bias if the disease cohort shares some unique feature(s). The gastric cancer patients' sera were collected prior to surgery and chemotherapy but there is limited data about any medications they may have been using which could have interfered with the assay. Regretfully that information is not available at this time.

In conclusion, ten assays (CEA, CA 19-9, CA 195, CA 50, CA 72-4, CA 125, CA 15-3, CA 27.29, AFP and Cyfra 21-1) were evaluated for their efficacy at diagnosing gastric cancer. CA 50 proved to be superior to the other assays with CA 19-9, CA 195, and CEA also proving effective. In contrast to previous studies, our results did not support the use of CA 72-4 for the diagnosis of gastric cancer and therefore our hypothesis was rejected.

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Bats (Mammalia: Chiroptera) Recorded from Mist-Net and Bridge Surveys in Southern Mississippi

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We surveyed communities of bats in southern Mississippi using mist nets and searches of bridges. We captured 41 individuals representing five species of bats over 28 nights of trapping. *Nycticeius humeralis* was the species most frequently captured in our nets, followed by *Lasiurus seminolus*, *Myotis austroriparius*, *Pipistrellus subflavus*, and *Lasiurus borealis*. These species are representative of communities of forest-roosting bats native to the southeastern United States. However, all *M. austroriparius* were captured exclusively at the entrances of caves. Seven of 99 bridges that we searched were occupied by *Corynorhinus rafinesquii* as day-roosts. These seven bridges were all made of concrete and had girders or channel beams along their undersides. Our data on *C. rafinesquii* are consistent with findings of other studies, which suggest that the construction style of bridges plays an important role in providing day-roosts for this species.

Kennedy et al. (1974) and Jones and Carter (1989) listed all species of bats (Order Chiroptera) known to inhabit Mississippi in their reviews of this state's mammals. Although a few studies (e.g., White, 1960; La Val, 1967; Jones and Suttkus, 1975; Middleton, 1976; Cliburn and Middleton, 1983; Miller, 2000; Welch et al., 2001) have documented observations or collections of bats from distinct locations in Mississippi, no investigators have as yet compared species inventoried among different habitats in this state. Furthermore, three species of bats, *Lasiurus cinereus* (hoary bat), *Lasiurus intermedius* (northern yellow bat), and *Corynorhinus rafinesquii* (Rafinesque's big-eared bat), are poorly represented in collections from Mississippi (see Kennedy et al., 1974). Whether the lack of records from Mississippi for these species reflect inadequate efforts of sampling or the bats' inherent rarity is not clear. Therefore, the objectives of this study were: 1. to conduct surveys of communities of bats in southern Mississippi; 2. to collect specimens of *Lasiurus cinereus*, *Lasiurus intermedius*, and *Corynorhinus rafinesquii*.

MATERIALS AND METHODS

We defined the study area as encompassing the portion of Mississippi south of Interstate 20, which crosses the entire state in an east-west direction. Frost et al. (1986) describe much of this region as having been historically dominated by longleaf pine (*Pinus palustris*) savanna, while more mesic habitats were characterized by beech (*Fagus grandifolia*), oaks (e.g., *Quercus nigra*), and magnolias (*Magnolia* spp.). Tupelo (*Nyssa* spp.) and baldcypress (*Taxodium distichum*) occurred along larger streams and rivers. In recent years suppression of natural fire regimes and widespread conversion of native forests to loblolly pine (*Pinus taeda*) plantations have dramatically altered the landscape of the region (Frost et al., 1986).

Inland habitats that we sampled included upland hardwood-pine (*Pinus* spp.) forest, lowland hardwood-pine forest, two limestone caves surrounded by upland, mesic hardwood forest, and cypress swamp (Table 1). The two caves, Pitts and Eucutta, are among the largest caves in Mississippi (Knight et al., 1974). At coastal sites (i.e., Davis Bayou and Mississippi Sandhill Crane National Wildlife Refuge), we typically found marshes bordered by swampy forests of wax myrtle (*Myrica cerifera*), sweetbay (*Magnolia virginiana*), and pines. We also sampled one night on Horn Island, a barrier island approximately 10 km off the coast of Mississippi. The interior of this island, managed by the National Park Service, was dominated by scrub forests of slash pine (*Pinus elliotti*). A few marshy ponds comprised the only sources of fresh water. Because we sought to add to the known distribution (in Mississippi) of each of our "target" bats, we chose some sampling sites based on the presence of suitable habitat (based on records in literature) for one or more of these three species, *L.*

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cinereus, *L. intermedius*, and *C. rafinesquii*.

From June 1999 through July 2000 we sampled at thirteen different sites in eight counties of southern Mississippi using standard mist net procedures for insectivorous bats (Kunz and Kurta, 1988). Although we visited most localities only once during the investigation, we trapped twice at two sites. We generally selected evenings when the temperature was not expected to fall below 18EC. We collected bats using nylon mist nets 2.6 m high, ranging from 2.6 m to 9 m long and attached at each end to a metal pole approximately 3 m tall. We placed one to four mist nets at each site; we standardized our efforts by defining a net-night as one mist net opened during one night of trapping. We usually trapped just above the surface of water sources to intercept bats as they foraged or came to drink. We also placed nets over dirt roads within forested habitat and across the entrances of the two limestone caves. We chose the latter as additional sampling sites for *C. rafinesquii*, based on records from caves (Jones, 1977; Best et al., 1992). We opened our nets approximately 15 minutes before civil sunset and trapped for a minimum of three hours unless capture rates declined to less than one bat per hour. We determined sex and species of captured bats. We determined relative age (juvenile or adult) by noting the degree of ossification of the epiphyseal caps on the phalanges of the fingers (Anthony, 1988). Our methods followed University of Southern Mississippi IACUC protocol # 204-004.

Because several investigators (e.g., Lance and Garrett, 1997, Hurst and Lacki, 1999) have reported very little success in capturing *C. rafinesquii* in mist nets, we incorporated surveys of potential roosting sites (i.e., bridges) into our study. Individuals of this species have been noted to congregate along the undersides of concrete bridges by day, particularly during warmer months (Lance and Garrett, 1997; Lance et al., 2001). From May 1999 through early September 1999 we surveyed the undersides of 84 bridges located within the study area. Most of these bridges were located in and nearby the DeSoto or Bienville National Forests (NF). We checked 15 additional bridges in the Homochitto NF in June 2000. Several bridges in the DeSoto NF found to be inhabited by *C. rafinesquii* during previous searches by other investigators (C. Potin, pers. comm.) were included in our survey. A survey consisted of one or both of the investigators walking beneath a bridge and looking for bats along the underside of the structure. When bats were encountered, we determined the species, counted number of individuals, and noted presence or absence of young. We maintained a minimum distance of about 10 feet from clusters of bats so as not to disturb females with pups. As a result, we may have counted fewer bats than were actually present on some occasions.

RESULTS

We captured 41 bats of five different species over 28 net-nights (Table 1). *Nycticeius humeralis*, the evening bat, was the species most frequently caught in our mist nets, accounting for 39% of all captures (n = 16). Other species that we captured were: *Lasiurus seminolus*, the seminole bat (n = 11, 27% of captures); *Myotis austroriparius*, the southeastern myotis, (n = 8, 20%); *Pipistrellus subflavus*, the eastern pipistrelle, (n = 3, 7%); *Lasiurus borealis*, the red bat, (n = 3, 7%). *Nycticeius humeralis* and *L. seminolus* occurred together at four localities. We captured two species, *P. subflavus* and *M. austroriparius*, at the entrances of both Pitts and Eucutta caves. All of the *M. austroriparius* that we captured in our survey were trapped at these caves. We captured two species, *N. humeralis* and *L. seminolus*, while sampling at Horn Island. We found *P. subflavus* at three different sites (including Pitts and Eucutta caves) and *L. borealis* at three sites. We did not capture any *L. cinereus* or *L. intermedius*. Sex ratios for all species captured during the present study were: *N. humeralis*, 1.3 males/female; *L. seminolus*, 0.6 male/female; *M. austroriparius*, 1 male/1.7 females; *L. borealis*, 0 males/3 females; *P. subflavus*, 0.5 male/female. We captured juveniles of two species, *L. seminolus* and *L. borealis*.

Six of 84 bridges that we surveyed in 1999 were inhabited by *C. rafinesquii* (Table 2). Three of these bridges were located in the Chickasawhay District of the DeSoto NF within a 6 km-span of a single road. The remaining three bridges were located in the DeSoto District of the DeSoto NF. The number of big-eared bats roosting beneath a bridge ranged from one to an estimated 25 individuals. We were able to identify young under two bridges on 27 May 1999, at one bridge on 10 June 1999, and under one bridge on 18 June 1999 (Table 2). One of the 15 bridges from Homochitto NF that we checked on 7 June 2000 was occupied by a solitary, male *C. rafinesquii* (Table 2). We found a female *P. subflavus* nursing a pup under another bridge in Homochitto NF.

Table 1. Locations in southern Mississippi visited by authors while conducting mist-net surveys for bats from July 1999 through July 2000.

Location (county)	Habitat[4]	Date(s) visited	Species (# individuals) collected
Van Hook Golf Course (Forrest)	A	July 1999	None
Rails-to-Trails (Lamar)	A	July 1999	None
Bluff Creek at Bluff Creek Rd (Stone)	B	3 August 1999	*Lasiurus borealis** (1), *L. seminolus** (7), *Nycticeius humeralis** (2), *Pipistrellus subflavus** (1)
Pitts' Cave (Wayne)	C	4 August 1999	*Myotis austroriparius* (5), *P. subflavus* (1)
Horn Island, GINS[1] (Jackson)	D	12 August 1999	*L. seminolus** (1), *N. humeralis** (7)
Davis Bayou, GINS[1] (Jackson)	B	14 August 1999, 13 October 1999	*L. seminolus** (2), *N. humeralis** (6)
Beaver pond adjacent Cabin Rd, SCCNWR[2] (Adams)	E	17 August 1999, 19 August 1999	*L. borealis* (1), *N. humeralis* (1)
Gillirad Lake, N edge, SCCNWR[2] (Wilkinson)	F	18 August 1999	*L. borealis* (1), *L. seminolus* (1)
Tiger Creek at Hwy 15 (Jones)	B	2 September 1999	None
Eucutta Cave (Wayne)	C	16 September 1999	*M. austroriparius* (3), *P. subflavus* (1)
MSSCNWR[3] (Jackson)	G	September 1999	None
Holliman Property (Lamar)	B	6 April 2000	None
Spector Farm (Pearl River)	B	1 July 2000	None

[1]Gulf Islands National Seashore; [2]St. Catherine's Creek National Wildlife Refuge; [3]Mississippi Sandhill Crane National Wildlife Refuge
[4]Key to categories of habitat: A = upland mixed hardwood–pine forest; B = lowland mesic hardwood–pine forest; C = upland mesic hardwood forest; D = coastal marsh; E = bottomland hardwood forest; F = cypress swamp; G = wet pine savanna
*New county record for a species

Table 2. List of counties in southern Mississippi in which the authors observed bridges occupied by *Corynorhinus rafinesquii*.[1]

Location	Date(s) Surveyed	# bridges used by C. RAF.[2]	# bats seen per bridge	Pups observed under bridge?
Jones	10 June 1999,	2	12	Yes
	2 September 1999		3	No
Perry	27 May 1999	2	11, 25	Yes, Yes
Stone	18 June 1999	1	9	Yes
Wayne	2 September 1999	1	1	No
Wilkinson	7 June 2000	1	1	No

[1]Exact locations of bridges may be obtained from the authors.
[2]*Corynorhinus rafinesquii*

DISCUSSION

Most of the species that we captured in our survey are representative of communities of forest-dwelling bats occurring throughout much of the southeastern United States. *Nycticeius humeralis* was the most common species that we captured, both in terms of number of individuals and number of sites where it was found. We collected *N. humeralis* in pine and bottomland-hardwood forests, and in both inland and coastal sites. Lance and Garrett (1997) captured *N. humeralis* more frequently than any other species in pine forests of central Louisiana, as did Krishon et al. (1997) in coastal Georgia. On Horn Island, a colony of this species apparently roosted within a boathouse at the end of a dock, utilizing the space between the tin roof and one of its concrete support columns. This structure was located approximately 300 m from the pond where we captured seven individuals of *N. humeralis*. Roosts for *N. humeralis* on Horn Island might include numerous pine snags (see Menzel et al., 2000). This species of bat had not been previously recorded from this locality.

Lasiurus seminolus was the second most-frequently captured species in our study. This species was also second to *N. humeralis* as the most common bat found in lowland, pine-dominated forest in Louisiana (Lance and Garrett, 1997). Menzel et al. (1998) determined that *L. seminolus* roosted predominantly in pine trees, while *L. borealis* preferred hardwoods. We captured a single *L. seminolus* on Horn Island, where the only trees available as roosts were pines. This species of bat had not previously been reported from Horn Island. Two of the three sites where we collected *L. borealis* were bottomland-hardwood forests. Miller (2000), however, captured more red bats than any other species in pine plantations of central Mississippi. Lowery (1974) described *L. borealis* as common and widespread in Louisiana.

Our records of *M. austroriparius* from Eucutta and Pitts Caves in Wayne County are especially noteworthy because this species was not recorded by Middleton (1976) in his survey of cave-dwelling vertebrates in Mississippi, although this bat had been previously captured in Pitts Cave (LaVal, 1967). Over much of its range, *M. austroriparius* roosts in caves (Whitaker and Hamilton, 1998), but concern exists over the decline and degradation of such habitats (Humphrey and Gore, 1992). We caught only adult males from Eucutta Cave and adult females from Pitts Cave. In this species, male and female bats tend to roost separately while pups are being born and nursed, but this segregation ends by late summer (Barbour and Davis, 1969). Lance and Garrett's (1997) survey supported Lowery's (1974) assertion that this species is widespread but uncommon in Louisiana where caves are apparently not present. However, *M. austroriparius* also roosts in hollow trees in bottomland forests (Hofmann et al., 1999). *Pipistrellus subflavus* was the only bat documented by Cliburn and Middleton (1983) from the caves that they visited. Best et al. (1992) recorded *P. subflavus* from limestone caves in southern Alabama, usually during cooler months. This species was the only bat that we found both at and away from caves. We obtained one specimen by netting over a stream in a pine forest interspersed with deciduous species (e.g., *Magnolia virginiana*, *Nyssa sylvatica*) and have observed this species roosting underneath concrete bridges. Findings of Menzel et al. (1999) suggest that during summer in the southern United States, *P.*

subflavus roosts among foliage of evergreen trees located within the understory of mixed oak-pine stands.

The lack of captures for *Lasiurus cinereus* and *L. intermedius* during our study may be further evidence of these species' rarity in Mississippi. Kennedy et al. (1974) listed only two records of *L. cinereus* from Mississippi (Madison and Oktibbeha Counties). Barbour and Davis (1969) categorized the species as widespread but rare in the eastern United States. Little is known of the species' preferences with regard to roosting habitat, though Lowery (1974) noted that most specimens in Louisiana came from areas dominated by pine forests. Compared to the frequency of its detection by ultrasonic equipment, *L. cinereus* was rarely captured by Hart et al. (1993) in Pennsylvania. Future surveys to determine presence of *L. cinereus* in Mississippi and elsewhere should utilize ultrasonic detectors along with mist-netting. Only two records of *L. intermedius* from Mississippi exist, these specimens coming from Hancock and Warren Counties (Kennedy et al., 1974). Specimens of *L. intermedius* are typically scarce in collections of bats from the southeastern United States (Whitaker and Hamilton, 1998). Barbour and Davis (1969) suggested that capturing *L. intermedius* via mist-netting is difficult, even in apparently suitable habitat. The distribution of *L. intermedius* closely follows that of Spanish moss (*Tillandsia usneoides*), a preferred roosting substrate (Barbour and Davis, 1969). At one of our coastal sites (Davis Bayou, Jackson County), we unsuccessfully attempted to locate resting individuals by probing clumps of Spanish moss using a handheld net. Other sites (e.g., wet pine savanna in Jackson County and a golf course in Forrest County) provided the open, pasture-like environments which *L. intermedius* favors (Barbour and Davis, 1969), but Spanish moss was scarce or not present. Efforts to identify areas in Mississippi containing both ideal foraging habitat and roosting sites for *L. intermedius* as described by Jennings (1958) and Krishon et al. (1997) should continue.

Another species of bat native to the study area that we did not capture was *Myotis lucifugus*. Richmond (1968) reported a specimen from Horn Island, but did not elaborate on the circumstances of its collection. *Myotis lucifugus* is largely absent from the Gulf Coast, and this record would represent a substantial extension of the species' range (see Whitaker and Hamilton, 1998). Given this bat's superficial resemblance to *N. humeralis* and the tendency of *N. humeralis* to roost in buildings (a situation where bats might come into contact with an untrained observer), we suspect that this record of *M. lucifugus* was actually a misidentified *N. humeralis*. LaVal (1967) collected a specimen of *M. lucifugus* from Pitts Cave, but this species was absent from Middleton's (1976) survey and has not been observed during subsequent visits to this and nearby caves (A. W. Trousdale, personal observations).

Corynorhinus rafinesquii historically ranged across Mississippi (Jones and Carter, 1989); however, local patterns of distribution for the species are poorly known throughout its range (Jones, 1977). Lance and Garrett (1997) captured only one specimen of *C. rafinesquii* during their extensive mist-netting efforts in Louisiana. Bridge surveys, which we adopted for our study, provided a much better method of finding big-eared bats. Of the four colonies that we located, the two observed on 27 May 1999 (in Perry County) contained the youngest pups based on their relative size, pelage, and inability to fly. Considering that *C. rafinesquii* are able to fly at three weeks of age (Jones, 1977), those pups would not likely have been born before early May, which is consistent with observations from Louisiana (Lowery, 1974).

All of the bridges occupied by *C. rafinesquii* were made of concrete and possessed some type of structure (i.e., rectangular compartments or girders) along their undersides. Similar preferences in bridge selection by this species were noted by McDonnell and Clark (1999) in North Carolina and by Lance et al. (2001) in Louisiana. We found *C. rafinesquii* under two bridges in Perry County that had been used by the species during previous years (C. Potin, pers. comm). In early August 1999 we returned to a bridge in Stone County under which we had observed a *C. rafinesquii* colony two months earlier and found a solitary individual. Lance (pers. comm.) located the species under this same bridge in 1997. If *C. rafinesquii* shows fidelity to certain bridges, this behavior may have important consequences for management of the species, considering that in many areas older bridges (which typically feature compartments or girders) are increasingly being replaced by slab bridges (Lance et al., 2001).

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Echinacea Cultivar Evaluation In Southwest Mississippi

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Echinacea species grown as medicinal plants are a potential economic crop for farmers in Mississippi. Field experiment was used to compare the survival, growth, and mineral composition of *E. angustifolia, E. pallida*, and *E. purpurea.* This evaluation was repeated during the following growing season with *Echinacea* plants that overwintered. The two-year study was conducted on a Memphis silt loam soil in southwest Mississippi. Plant survival during the 1999 growing season was highest for *E. purpurea* and lowest for *E. angustifolia*. During the 2000 growing season, percent of shoot regrowths from mature plants allowed to overwinter in 1999 was highest for *E. angustifolia* and lowest for *E. purpurea* early in the spring but was not different at the end of that growth period. Both root and shoot developments were generally highest for *E. purpurea* and *E. pallida* during both growth periods compared to *E. angustifolia*. Macronutrient levels were generally highest for *E. purpurea* and *E. pallida*, respectively. Research results indicate that these *Echinacea* species will grow to maturity and flower during the first year of growth in southwest Mississippi. However due to *E. angustifolia* low germination rate, poor seedling growth in the greenhouse, and very low survival rate in field plot after transplanting, it is the least desirable of the three species. Both *E. purpurea* and *E. pallida* are recommended for production in southwest Mississippi at this time.
Keywords: *Echinacea* species, medicinal plants, survival, growth, mineral composition.

The State of Mississippi is known for its agricultural products. Its mild climate, long growing season, and adequate rainfall are ideal for the production of agronomic crops such as cotton, soybean, corn, and rice. However, for some of these crops production has exceeded demand, thus depressing prices below the level of profitability. Therefore, compelling reasons exist for farmers to consider diversification of crops grown and to produce them in more sustainable cropping systems.

Echinacea is one of the alternative crops being evaluated for adaptation, yield potential, and quality at Alcorn State University. It belongs to the Asteraceae or daisy family, which has daisy-like flowers aggregated into tight heads and leaves that are either opposite or alternate, simple or compound (Stuart, 1982). Although there are up to nine *Echinacea* species, all native to North American prairies, the three main species used for medicinal purposes are *E. angustifolia*, *E. pallida*, and *E. purpurea* (Still, 1994). These species can be grown in USDA hardiness zones 3–10 which extend from upper Midwest to Florida (Adam, 2000), especially when annual precipitation is from 30 cm to 81 cm per year. *Echinacea* species is considered the most effective detoxicant in Western medicine for the circulatory, lymphatic, and respiratory systems. It is a bitter, slightly aromatic, alternative herb that stimulates the immune system, promotes healing and has antiviral and antibacterial effects. It is used internally for skin diseases, fungal infections, boils, abscesses, slow-healing wounds, upper respiratory tract infections, and venereal diseases (Bauer and Wagner, 1991; Brown, 1995; and Chevallier, 1996). In Europe, materials isolated from *E. purpurea* are believed to relieve prostatic problems and other urinary ailments (Weiss, 1998).

Echinacea production promises to be an increasingly profitable business. Prices per pound of dry root cross sections for *E. angustifolia, E. pallida*, and *E. purpurea* are $21.00, $14.50, and $14.00 respectively (San Francisco Herb and Natural Food Co., 2002). However, the growth of Echinacea farming has been rather slow due to time and labor involved in growing and marketing the crop. Cultivation of some herb species is difficult due to slow seed germination and lack of cultural information (Galambosi, 1992). In addition, as result of the increased utilization of medicinal plants for healthcare, destructive harvesting threatens their sustainability. Cultivation techniques for commercial production needs to be established to prevent the

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future loss of native *Echinacea* species. Smith-Jochum and Albrecht (1987) noted that raising seedlings indoors and transplanting them to field plots in spring resulted in better growth than direct-seeded plants.

Some agronomic studies have indicated that fertilization can increase production and accumulation of secondary metabolites in plants (Jain, 1990). Fields pretreated with organic and inorganic fertilizers significantly increased Espinheira Santa (*M. aquifolium* Mart) plant height, stem diameter, and the number of leaves and branches, but levels of triterpenes and total phenols were not affected (Pereira et al., 1995). However, monoterpenes which have the same initial steps of the biosynthetic route of triterpenes were influenced by fertilizer application (Bordoloi et al., 1985). Herb growth was enhanced by such organic fertilizers as compost, alfalfa meal, bone meal, cottonseed, and dehydrated manure (Felty, 1981).

Because most herbs are poor competitors, weeds cause significant yield reductions by directly competing with herbs for water, nutrients, and light (Rao and Singh, 1985). Many organic horticultural operations rely on manual labor and a combination of mulching/cultivation for adequate weed control. Bhella (1988) reported that black polyethylene mulch leads to rapid tomato plant growth and an earlier first harvest due to the soil warming effects of radiation absorbed by the mulch.

This study was undertaken to investigate three *Echinacea* species for their potential as an alternative crop for Mississippi farmers.

MATERIALS AND METHODS

A field study initiated in the summer of 1999 was used to determine *Echinacea* seedling survival, plant growth and mineral composition. This study was conducted on a Memphis silt loam (Fine silty, mixed thermic; Typic Hapludalfs) soil at Alcorn Experiment Station. A randomized complete block (RCB) experiment design with four replications of each of the three *Echinacea* species (treatments) was used.

Soil extractable nutrient levels, soil reaction, and soil organic matter were determined before the initiation of the study in 1999 and at the end of the study in 2000. Soil samples collected at 0–20 cm soil depth were analyzed for phosphorus, potassium, calcium, and magnesium, soil reaction, and soil organic matter content. Cations were analyzed by atomic absorption spectrometry, soil reaction by barium chloride-triethanolamine method, and organic matter by wet and dry combustion techniques.

Field preparation included plowing, disking, and bedding. Each bed (6.1 m long and 1.5 m wide) was planted with five rows of either *E. purpurea*, *E. pallida* or *E. angustifolia* species at a 0.3 m x 0.3 m plant spacing. Bone meal fertilizer applied at the rate of 2.3 kg per bed was incorporated into the soil at bed preparation. Seedlings at 3-leaf stage were raised in Pro Mix Bx® (Premier Horticulture, Inc. Red Hill, PA), a blend of Canadian sphagnum peat moss, perlite, vermiculite, and dolomitic and calcitic limestone, with a pH range of 5.0 to 7.0, in the greenhouse and transplanted into rows on July 14, 1999. Response 9-9-7® (Ag/Response, Inc. Naples, FL), a seaweed extract prepared by mixing 1 part of extract in 500 parts of water was applied at the rate of 0.24 liter per plant a week later to enhance bone meal fertilizer absorption. Natural rainfall was supplemented with overhead sprinkler irrigation as needed. Weed control was achieved with pine bark mulch and hand pulling. Plots were free from insect and disease problems hence, pesticide was not used.

On August 1, and November 11, 1999, *Echinacea* species were evaluated for survival, and the percent of the total transplanted per bed was reported for each species. Following the second evaluation for plant survival, three plants randomly selected from each bed were used for data collection on canopy height, canopy width, stem diameter, shoot dry weight, root length, root dry weight, and plant mineral composition. Plants used for data collection on growth parameters were limited due to low survival for all species, especially *E. angustifolia*.

Canopy height was a measure of the distance from the soil level to the highest point of the plant under its natural stand. Canopy width was the average of the values obtained for the largest width of the plant shoot measured in both north-south and east-west directions of the row within each block. Stem diameter was the caliper value for measurement taken at soil level. Roots lifted with digging fork were rinsed with tap water and fan dried before their fresh weight determination. Representative root and shoot samples taken after their fresh weight determination were oven dried at 70EC for 24 hours, reweighed, and used to determine their dry weights. After dry weight determination, root dry samples were ground in a Wiley mill® (20 mesh) (Arthur H.

Thomas Co. Philadelphia, PA) and used for root mineral composition determination.

After the November 11, 1999, data collection, the remaining plants for each *Echinacea* species were counted and allowed to overwinter. Additional pine bark mulch was applied to each bed to protect roots from cold damage. On April 28, 2000, counts were made to determine the number of plants that survived the mild winter in southwest Mississippi. On May 9, 2000 additional Response 9-9-7® was applied at the rate of 1 cup per plant. Other field management practices were as for 1999 growth period. On July 8, 2000, data collection on plant growth parameters were as for the first growth period. Data were subjected to analysis of variance, and means separated by the Least Significant Difference (LSD) test (Steele and Torrie, 1980).

RESULTS

In 1999 (first growth period), plant survival 18 and 120 days after transplanting was highest for *E. purpurea* and lowest for *E. angustifolia* (Table 1). In 2000 (second growth period), when plant survival was based on the number of plants allowed to over-winter, plant survival 289 days after transplanting was highest for *E. angustifolia* and lowest for *E. purpurea* which was not significantly different from *E. pallida*. Plant survival among the three species 360 days after transplanting was not different.

In 1999 root dry weight, canopy height, flowers per bed, and shoot dry weight were highest for *E. purpurea* (Table 2). The same plant species had the highest canopy width, but was not significantly different from that reported for *E. pallida*. Both root length and stem diameter among the three species were not different.

In 2000 root dry weight and root length were highest for *E. pallida* (Table 2). Stem diameter was highest for *E. purpurea*, but was not different from *E. pallida*. Canopy height and canopy width were highest for *E. pallida*, but were not different from *E. purpurea* which had the highest significant values for flowers per bed and shoot dry weight. Growth for all species were generally higher in the year 2000 compared to 1999.

In 1999 root macronutrient composition was significant for phosphorous, potassium, calcium and magnesium (Table 3). Phosphorus was highest for *E. angustifolia*, but was not significantly different from *E. purpurea*. Potassium and calcium were highest for *E. pallida* and *E. purpurea*, respectively. Magnesium was highest for *E. purpurea*., but was not significantly different from *E. pallida*. Both nitrogen and sulfur were not different among the three species.

In 2000 all the root macronutrients were influenced by production practices (Table 3). Nitrogen was highest for *E. angustifolia* and lowest for *E. purpurea*. Phosphorus was highest for both *E. purpurea* and *E. angustifolia* and lowest for *E. pallida*. Potassium was highest for *E. purpurea*, but was not significantly different from *E. pallida.* Both calcium and magnesium were highest for *E. purpurea*, whereas sulfur was highest for both *E. pallida* and *E. angustifolia*.

Table 1. Survival potential of *Echinacea* species.

Echinacea species	First growth period (1999)*		Second growth period (2000)**	
	Aug. 1	Nov. 11	April 28	July 8
	Percent survival of *Echinacea* species			
E. purpurea	79.3	76.0	59.5	49.8
E. pallida	62.2	54.8	63.9	54.2
E. angustifolia	8.8	6.2	70.0	58.3
Mean	50.1	45.6	64.5	54.1
$LSD_{0.05}$	16.0	16.0	4.5	NS

*Values are based on the initial seedlings transplanted on July 14, 1999.

**Values are based on number of plants allowed to overwinter after some plants were uprooted and used for data collection on Nov. 11, 1999.

DISCUSSION

The comparable soil fertility levels before and after the two growth periods indicate that soil fertility levels in southwest Mississippi may be adequate for *Echinacea* growth and development. However, transplanting seedlings after the middle of July could lead to a reduction in plant survival. Hot days following late season transplanting could therefore result in the loss of transplants even with the application of overhead sprinkler irrigation. Kemery and Dana (1995) reported that 57% of *E. pallida* seedlings planted in April survival compared to 9% of those planted in

Table 2. *Echinacea* growth potential.

Echinacea species	Plant growth components*						
	Root dry weight (gm/plant)	Root length	Stem diameter	Canopy height	Canopy width	Flowers per bed	Shoot dry weight (gm/plant)
				(cm)			
1999							
E. purpurea	14.2	29.8	1.4	43.7	44.0	128.5	91.8
E. pallida	10.7	21.8	1.0	14.6	39.3	8.3	30.1
E. angustifolia	4.8	24.3	0.9	11.0	16.2	0.3	5.7
Mean	9.9	25.3	1.1	23.1	33.2	45.7	42.5
$LSD_{0.05}$	3.3	NS	NS	18.3	13.4	53.6	30.8
2000							
E. purpurea	32.3	20.3	1.4	73.8	52.0	149.3	126.6
E. pallida	36.7	35.0	1.2	89.0	60.1	28.0	83.7
E. angustifolia	4.4	24.5	0.8	43.1	19.2	0.5	15.5
Mean	24.4	26.6	1.1	68.6	43.8	59.3	75.3
$LSD_{0.05}$	1.8	10.1	0.3	22.9	9.1	73.3	9.1

*Values are averages obtained from three mature plants pulled from each bed within each of the four blocks.

September. Transplanting *Echinacea* species between April 15 and May 15 or as soon as the danger of frost is over could lead to better root development, and concomitant absorption of adequate moisture needed to overcome high summer temperatures in southwest Mississippi. While *Echinacea* species are drought tolerant, they do better with additional soil moisture (Tchnida et al., 1999). It is therefore important that farmers planning to switch to *Echinacea* and other herb production realize the need for supplemental irrigation.

This study indicates that *E. purpurea, E. pallida*, and *E. angustifolia* will grow to maturity and flower during the first year of growth in southwest Mississippi. However reports from North Mississippi were not similar (Burandt, 1990, personal communication). *Echinacea purpurea* grown from seeds flowered and fruited in Egypt by the end of the first growth season (Shalaby et al., 1997). In Finland and Switzerland, where *E. purpurea* seedlings were transplanted to the field in June and April, plants attained the fruiting stage in August of the following year (Galambosi, 1992). These findings suggest the impact of climatic conditions on *Echinacea* growth and development.

Data also show that biomass productions were generally greater for the three *Echinacea* species during the second growth period as compared to the first growth period. Shalaby et al. (1997) also reported that *E. purpurea* cultivated as perennials produced higher yields compared to those cultivated as annuals. Although biomass productions were higher during the second growth period in southwest Mississippi, root nitrogen, potassium, calcium, and magnesium were higher during the first growth period. The reduction in nutrient levels in plants could indicate their utilization in the increased biomass development. Even then, the levels are still

comparable to those considered adequate in most vegetable (Splittstoesser, 1984). This means that in addition to their medicinal significance, *Echinacea* species could provide additional of dietary minerals in human nutrition.

Considering *E. angustifolia's* poor germination and seedling growth in the greenhouse (Igbokwe, unpublished data), and low survival rate in field plot after transplanting (Table 1), farmers switching to *Echinacea* production should consider *E. purpurea* and/or *E. pallida* for production in Mississippi. They should also consider sharing planting, harvesting, and drying equipment by forming cooperatives in order to reduce cost of production.

Table 3. Root mineral composition for *Echinacea* species.*

Echinacea species	Macronutrient composition					
	N	P	K	Ca	Mg	S
1999	(%)					
E. purpurea	4.0	0.30	2.3	2.5	1.1	0.14
E. pallida	4.3	0.26	3.3	2.2	0.9	0.17
E. angustifolia	3.8	0.33	1.1	0.3	0.2	0.16
Mean	4.0	0.30	2.2	1.7	0.7	0.16
$LSD_{0.05}$	NS	0.04	0.8	0.2	0.2	NS
2000						
E. purpurea	1.6	0.36	1.2	0.60	0.53	0.25
E. pallida	1.9	0.31	1.1	0.37	0.19	0.33
E. angustifolia	3.4	0.36	1.0	0.34	0.20	0.33
Mean	2.3	0.34	1.1	0.44	0.31	0.30
$LSD_{0.05}$	0.1	0.03	0.1	0.13	0.04	0.01

*Analysis was based on dry weights of plant samples.

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The Terrestrial Coleoptera of Point Clear Island and Surrounding Marshlands, Hancock County, Mississippi

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A general survey of the terrestrial beetles of Point Clear Island and surrounding marshlands was conducted using a wide variety of collection techniques. A list containing at least 279 species, representing 39 families, was compiled, with the Carabidae (57 species), Scarabaeidae (39 species) and Staphylinidae (33 species) best represented. The list compared favorably with results of similar studies done in North Carolina and Florida salt marshes, South Carolina salt marshes and beach habitats, and on Horn Island, Jackson Co., Mississippi, although the Point Clear area had considerably greater species diversity.

The extensive tidal marsh of southwestern Hancock County, Mississippi encloses several small, sandy islands, of which Point Clear Island is one of the largest and most accessible. These islands are part of a Late Holocene littoral ridge complex (Otvos, 1973) and are surrounded, more or less, by dense marsh vegetation. Because of the size of Point Clear Island, private ownership of the eastern half of the island, and its relative nearness to the mainland, there has been some interest over the years in potential development, much to the chagrin of some local residents as well as to those of us who have been studying the natural history of this area. However, we were pleased to learn recently that most of the privately owned land on the island and much of the surrounding salt marsh has been acquired for conservation by the state of Mississippi. While Point Clear Island appears to be safe from development for the foreseeable future, which is, in our way of thinking, a very pleasant development, indeed, one major change recently occurred on the island that significantly impacts species diversity. The flowing artesian well at the east end (Fig. 1. "A") has been capped, thus the only freshwater pond known on Point Clear Island no longer exists. Consequently, several freshwater insect species, as well as some plant species, occurring only at this site have likely disappeared from the island.

A general survey of the insect fauna of Point Clear Island and surrounding marshlands was conducted from September, 1985 through April, 1987. We have discussed portions of our survey in earlier papers [Ephemeroptera and Odonata (Lago and Testa, 1987); Embiidina, Dermaptera, Isoptera and Orthoptera (Lago et al., 1988); aquatic and semi-aquatic Hemiptera and Coleoptera (Lago and Testa, 1989); biting flies (Lago and Testa, 1990) and terrestrial Hemiptera and auchenorrhynchous Homoptera (Lago and Testa, 2000)]. In the current paper, we consider the terrestrial Coleoptera occurring in the study area. Based on difficulty we have had in finding individuals willing to work with other segments of our collections, this will probably be the last of our Point Clear Island contributions. Voucher specimens, and all as yet unidentified material, are housed in the insect collection at the University of Mississippi. Exceptions to this are the specimens of *Ataenius aequalis* (Scarabaeidae) and *Chlaenius maxillosus* (Carabidae), which are in the collection of the senior author.

MATERIALS AND METHODS

***Study Area*—**We have described various physical characteristics of our study area in each of the papers mentioned above, some including more detail than others. Point Clear Island, situated about two miles south of Lakeshore, is larger (4 km long X 230 m wide near mid-length) than many of our coastal marsh-bound islands. At the east end (Point Clear) it is exposed to the Gulf of Mexico (Fig. 1). Elevation peaks at 2.5 m above sea level within 50 m of Point Clear, but most of the island has an elevation of less than 1.5 m. At the extreme west end, the island grades into a series of narrow, isolated sandy ridges separated by shallow brackish marshes. The soil is

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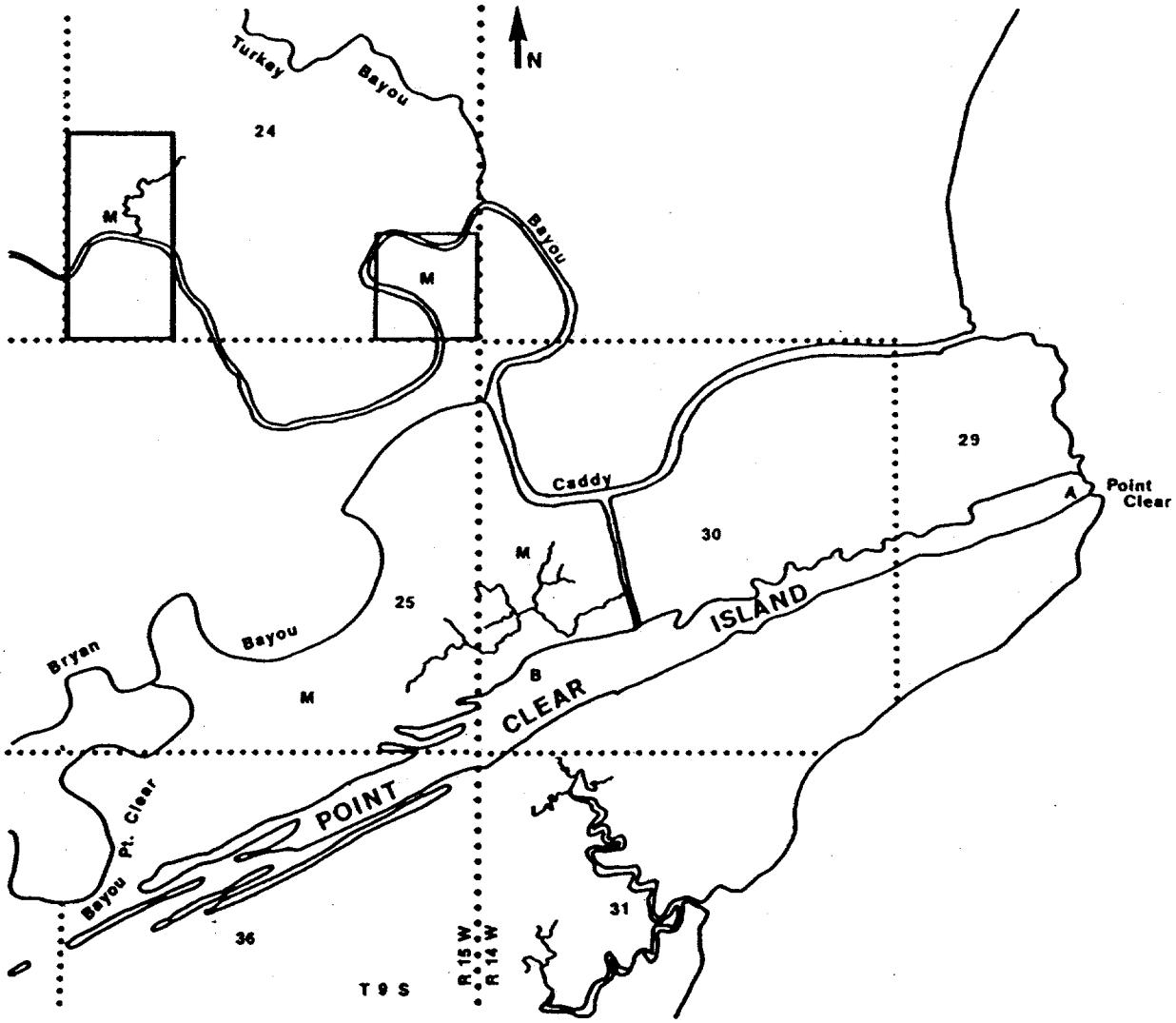

Figure 1. Map of Point Clear Island and vicinity. Numbers denote township, range and section. A–artesian pond; B–area of brackish ponds and marshes; M–tidal marsh collecting areas

Eustis loamy fine sand (Smith et al. 1981), with the lower elevations toward the west being somewhat less sandy than the higher elevations to the east.

Most of the island is forested. The dominant species present is slash pine (*Pinus elliottii* Engelmann), although some hardwoods are present [live oak (*Quercus virginiana* Miller) and southern magnolia (*Magnolia grandiflora* L.)] where elevations are greater than 1.5 m. Two species of palmetto [*Serenoa repens* (Bartram) Small and *Sabal minor* (Jacquin) Persoon] dominate the understory in forested areas. Common shrubs include French mulberry (*Callicarpa americana* L.), which can be found throughout the island, yaupon (*Ilex vomitoria* Aiton) and hawthorn (*Crataegus* sp.), which occur primarily on the eastern ("higher") half of the island, and marsh elder (*Iva frutescens* L.), which occurs in extensive stands on margins of the island above the high water line and along some swales. Open sandy habitats, densely to sparsely covered with mixed grasses and various forbs, are scattered on the island, with the two largest areas, totaling 1.5 to 2 hectares, located near the island mid-point. An area of open sandy beach, beginning at Point Clear and extended intermittently about 350 m to the southwest in a narrow arching band, encloses the southeastern corner of the marsh.

Because of the capping of the artesian well near Point Clear, and the subsequent loss of the freshwater pond, only brackish aquatic habitats remain on the

island. The freshwater pond was a focal point of much collecting activity during our visits to the island, but its disappearance will undoubtedly affect diversity of aquatic insects more than the terrestrial species considered in the current paper. Most permanent or semi-permanent brackish ponds were located near the middle of the island (Fig. 1 "B"). None of these seemed to be connected in any way to the waters of the Gulf, i.e. water levels did not fluctuate with the tides. Most of these ponds were choked with stands of *Juncus* spp. and *Spartina patens* (Ait.) Mull. Water levels in the brackish ponds were seriously affected by periods of drought conditions, and during the summer of 1986, all but one (inhabited by a large alligator and family) dried completely.

The vegetation of Mississippi tidal marshes was described by Eleutarius (1972, 1980). The marshes surrounding Point Clear Island appear to be typical for the region and are dominated by two species of plants: black rush (*Juncus roemerianus* Scheele) and smooth cord grass (*Spartina alterniflora* Loisel). The most abundant of these is black rush, and large, monotypic stands are present both north and south of the island. Scattered along the edges of black rush stands, particularly along bayous, are similarly uniform, but much smaller, "islands" of smooth cord grass. Small areas of higher ground, not affected by daily tides, are found scattered throughout the marshes, and these proved to contain a surprising diversity of terrestrial insects. A variety of plant species, which vary considerably based on site stability (= height above high tide) may be found in these areas. The highest banks are often covered with halophytic shrubby species, such as *Baccharis halimifolia* L. and *Iva frutescens*. Somewhat lower areas along bayous, or between these shrubby ridges and the salt marsh, are generally covered with low herbaceous vegetation. The dominant species here is salt grass [*Distichlis spicata* (L.) Greene] and the term "*Distichlis* meadow" will be used in subsequent references to this habitat. The largest *Distichlis* meadow within the study area occurred along the access canal between Bayou Caddy and the north side of the island, while others were found in isolated patches along all bayous. Most meadows were less than 40 m long and varied from one to 3 m in width.

***Methods*—**Sampling of the insect fauna of Point Clear Island and surrounding marshlands (Fig. 1) was conducted from September, 1985, through April, 1987. Ten collecting trips, comprising 56 man-days (27 days), were made to the study area during this time period. Most collecting was done during the spring, summer and autumn of 1986, with cool season collections made in late October and early February.

Over this 20 month period, collections were made throughout the length of Point Clear Island. Collecting activities were concentrated, however, on the eastern end surrounding the artesian pond and in an extensive area near the middle of the island. The artesian area extended about 1 km westward from the Point and the mid-island area began about 300 m east of the access canal (Fig. 1) and extended southwestward nearly 1.5 km. The latter area contained most of the brackish marshes located on the island.

In all areas of true coastal marsh, collecting activity generally was limited by accessibility and, by necessity, occurred primarily along waterways. Collecting in marsh habitats was concentrated in three areas (Fig. 1 "M"). The first, and largest, was the extensive marsh adjacent to the northwest boundary of the island and delimited by the access canal, Bayou Caddy, Bryan Bayou and Bayou Pt. Clear. The two smaller areas were located in the southeastern (40 acres) and southwestern (80 acres) corners of T9S-R15W-Sec. 24. In the following list of species, and on specimen data labels, these two localities are designated 1 mi SSW Lakeshore and 1.5 mi SW Lakeshore, respectively.

A wide variety of collecting techniques was employed during this study. Many specimens were captured using either aerial or light-duty sweeping insect nets. Hand-picking from flowers, the surface of the soil, under bark of dead trees, etc. was predictively productive. Large numbers of specimens were taken at black lights, which were employed in both island and marsh habitats (as many as three per evening) at least once per trip when air temperatures and weather conditions were favorable. Some of the marsh habitats sampled were less than 1 km from the mainland, so in an attempt to attract as few beetles as possible from the mainland, light trapping in these areas involved setting an enamel pan filled with 50% ethanol on the soil surface and laying a blacklight bulb directly on the pan. These lights, surrounded by marsh vegetation, were not easily seen from any distance, but were, nevertheless, very effective in attracting specimens, including some species that most certainly flew from the mainland. Additionally, Malaise traps and both baited and unbaited pitfall

traps yielded specimens on the island. Baits included goat and human feces and mammal carrion. Both cattle and hogs occurred sporadically on the island during the collecting period and fecal material from these yielded numerous dung beetles.

As was indicated earlier, a set of voucher specimens has been placed in the insect collection at the University of Mississippi.

RESULTS

During this survey, specimens of at least 279 species (not all could be identified to species), representing 39 families, were collected. The number of beetle families recognized has fluctuated considerably over the past several years because of both splitting and lumping. In the following list of species, however, a fairly conservative family classification is used, e.g. Scarabaeidae is used in the classical sense, as is Curculionidae. The primary exception to this is the inclusion of the alleculids and lagriids in the Tenebrionidae because of the general acceptance of this classification.

Some families include both aquatic, semiaquatic and terrestrial species. The reader is directed to Lago and Testa (1989) for a discussion of the aquatic and semiaquatic beetles, except for the Dryopidae which was inadvertently omitted from that paper (but is listed below).

Annotations in the following list include collection dates, collection sites and numbers of specimens examined. In those instances where three or more collection dates were available for a particular species, the dates are presented as a range without regard to year of collection as long as they appeared to represent continuous seasonal occurrence. If only two dates were available, they are listed separately, as are dates that were widely disjunct. The abbreviation PCI refers to the island proper, as well as marsh habitats directly bordering the island. Although a few references are made to host plants, these are hand-picking records as sweeping generally does not lend itself well to associating insects with food plants.

ANNOTATED LIST OF SPECIES

Anobiidae

Ernobius parvus White. 1.5 mi SW Lakeshore, 25 April, 1 specimen.

Tricorynus sp. PCI, 23 June, 1 specimen.

Anthicidae

Anthicus ephippium LaFerté-Sénectère. PCI, 23 June, 4 specimens.

Tomoderus sp. PCI, swept from vegetation near artesian pond, 23 June, 1 specimen.

Vacusus vicinus (LaFerté-Sénectère). PCI, 24 June, 2 specimens.

Anthribidae

Trigonorhinus sticticus (Boheman). PCI, 25 April–20 May, 8 specimens.

Bruchidae

Acanthoscelides floridae (Horn). PCI, 20 May–23 October, 3 specimens.

Caryobruchus gleditsiae (L.). PCI, 15 August, 1 specimen.

Megacerus coryphae (Olivier). PCI, 24 June–17 August, 7 specimens, 1 ex. *Baccharis halimifolia*. 1.5 mi SW Lakeshore, 25 June–14 August, 6 specimens, 1 ex. *Baccharis halimifolia*. 1 mi SSW Lakeshore, 12 August, 1 specimen.

Buprestidae

Anthaxia quercata (F.). 1.5 mi SW Lakeshore, 12 May, 1 specimen.

Taphrocerus agriloides Crotch. PCI, 25 June–23 October, 8 specimens. 1.5 mi SW Lakeshore, 27 September, 1 specimen.

Taphrocerus gracilis (Say). 1.5 mi SW Lakeshore, 14 August–25 October, 9 specimens, 3 from *Baccharis halimifolia*. 1 mi SSW Lakeshore, 25 April–14 August, 10 specimens.

Taphrocerus laevicollis LeConte. PCI, 12 May, 4 specimens.

Taphrocerus schaefferi Nicolay & Weiss. PCI, 13 August, 2 specimens.

Cantharidae

Chauliognathus marginatus (F.). 1.5 mi SW Lakeshore, 14 August, 1 specimen.

Cantharis sp-1. PCI, 24 April, 8 specimens.

Cantharis sp-2. PCI, 24 April, 9 specimens.

Carabidae

Acupalpus pauperculus Dejean. 1 mi SSW Lakeshore, 12 August, 1 specimen, at black light.

Acupalpus testaceus Dejean. PCI, 24 April, 12 August, 2 specimens. 1 mi SSW Lakeshore, 23 June, 1 specimen.

Amblygnathus subtinctus (LeConte). PCI, 15 August, 1 specimen.

Agonum decorum (Say). PCI, 24 April, 1 specimen.

Agonum punctiforme (Say). PCI, 10 May, 23 June, 2 specimens.

Anisodactylus dulcicollis (LaFerté-Sénectère). PCI, 29 June, 1 specimen.

Anisodactylus merula (Germar). PCI, 17 August, 3 specimens, in pit traps.

Bembidion impotens Casey. PCI, 27 September, 2 specimens.

Bembidion rapidum (LeConte). PCI, 27 September, 1 specimen.

Bembidion viridicolle (LaFerté-Sénectère). PCI, 10 May–12 August, 47 specimens. 1.5 mi SW Lakeshore, 23 June–12 August, 6 specimens. 1 mi SSW Lakeshore, 23 June, 12 August, 2 specimens.

Brachinus quadripennis Dejean. PCI, 24 April–23 June, 3 specimens.

Bradycellus rupestris (Say). PCI, 23 June, 15 August, 2 specimens.

Calosoma sayi Dejean. PCI, 12 August, 1 specimen, at black light.. 1 mi SSW Lakeshore, 12 August, 5 specimens, at black light.

Calosoma scrutator (F.) PCI, 24 April, 1 specimen, at black light. 1 mi SSW Lakeshore, 23 June, 1 specimen, at black light.

Chlaenius erythropus Germar. PCI, 15 August, 17 August, 2 specimens, unbaited pitfall traps.

Chlaenius maxillosus Horn. PCI, 12 August, 2 specimens. 1 mi SSW Lakeshore, 12 August, 4 specimens. The four "marsh" specimens of this very uncommon species were captured at a black light placed in a *Distichlis* meadow. They were not actually captured in the pan of alcohol, but were found running on the wet surface of the soil near and under the pan.

Cicindela dorsalis venusta LaFerté-Sénectère. PCI, 26 June, 1 specimen, on sand beach southwest of Point Clear.

Cicindela hamata Audouin & Brullé. PCI, 20 May–26 June, 57 specimens, on beach southwest of Point Clear.

Cicindela punctulata Olivier. PCI, 24 June–17 August, 13 specimens.

Cicindela severa LaFerté-Sénectère. PCI, 24 June–17 August, 39 specimens. Occasionally specimens were collected as they ran on paths through tall grass at dusk, but most were taken at a black light run near the largest brackish pond near the middle of the island. Graves and Pearson (1973) list one Mississippi record for this species, stating "the Mississippi coast does not appear to be very suitable for this species." In our experience, however, Point Clear Island and surrounding marshlands should be considered a reasonably good habitat for them.

Cicindela togata LaFerté-Sénectère. PCI, 26 June–12 August, 7 specimens, on sand beach southwest of Point Clear.

Cicindela trifasciata ascendens LeConte. PCI, 26 June, 29 specimens, on beach southwest of Point Clear.

Clivina americana Dejean. PCI, 23 June–15 August, 12 specimens. 1.5 mi SW Lakeshore, 12 August, 1 specimen. 1 mi SSW Lakeshore, 23 June, 1 specimen. All specimens taken at black light.

Elaphropus sp. PCI, 12 May–12 August, 2 specimens.

Galerita lecontei Dejean. PCI, 23 June–15 August, 7 specimens. Most were taken at black light near Point Clear.

Harpalus compar LeConte. PCI, near artesian pond, 23 June, 1 specimen.

Harpalus texanus Casey. PCI, near artesian pond, 23 June, 2 specimens.

Lebia analis Dejean. PCI, 12 August, 1 specimen.

Lebia fuscata Dejean. PCI, 24 April, 1 specimen.

Lebia viridipennis Dejean. PCI, 12 August–15 August, 4 specimens. 1.5 mi SW Lakeshore, 12 August, 3 specimens.

Lebia viridis Say. PCI, 11 May–15 August, 4 specimens. 1.5 mi SW Lakeshore, 12 August, 1 specimen.

Loxandrus celeris Dejean. PCI, 23 June, 3 specimens.

Loxandrus floridanus LeConte. PCI, 12 & 15 August, 4 males, plus 2 females that probably represent this species (23 June). 1 mi SSW Lakeshore, 28 June, 1 male.

Loxandrus sp-1. PCI, 23 June, 1 female.

Megacephala carolina (L.). PCI, 23 June–17 August, 45 specimens. Commonly taken in pitfall traps and at black light.

Notiobia terminata (Say). PCI, 24 April–24 June, 6 specimens.

Panagaeus crucigerus Say. PCI, 23 June–15 August, 3 specimens, at black light.

Paratachys sp. PCI, 24 April–15 August, 61 specimens. 1.5 mi SW Lakeshore, 12 August, 9 specimens. 1 mi SSW Lakeshore, 13 August, 21 specimens.

Pasimachus sublaevis (Palisot de Beauvois). PCI, 24 June–17 August, 9 specimens. Of the 9 specimens, 7 were taken in pitfall traps.

Pentagonica flavipes flavipes (LeConte). PCI, 23 June, 1 specimen.
Platynus cincticollis (Say). PCI, 24 April, 8 specimens.
Pseudaptinus lecontei (Dejean). PCI, 23 June, 1 specimen.
Pterostichus ebeninus (Dejean). PCI, 20 May, 1 specimen.
Scarites subterraneus F. PCI, 23 June, 2 specimens. 1 mi SSW Lakeshore, 12 August, 1 specimen.
Selenophorus granarius Dejean. PCI, 29 June–17 August, 5 specimens.
Selenophorus fatuus (LeConte). PCI, 23 June–17 August, 9 specimens.
Selenophorus maritimus Casey. PCI, 15 August, 1 specimen.
Selenophorus opalinus (LeConte). PCI, 24 April–15 August, 6 specimens.
Selenophorus palliatus (F.). PCI, 23 June–17 August, 18 specimens. 1 mi SSW Lakeshore, 12 August, 1 specimen.
Stenocrepis duodecimstriata (Chevrolat). PCI, 10 May–17 August, 41 specimens.
Stenolophus infuscatus (Dejean). PCI, 23 June, 1 specimen, at black light.
Stenolophus lecontei (Chaudoir). PCI, 24 April–12 August, 3 specimens. 1.5 mi SW Lakeshore, 12 August, 1 specimen. All specimens taken at black light.
Stenolophus ochropezus (Say). PCI, 24 April, 13 specimens. 1.5 mi SW Lakeshore, 12 August, 2 specimens. All specimens taken at black light.
Tachys sp. PCI, 12 August–15 August, 4 specimens.
Tachyta nana inornata (Say). PCI, 24 April, 1 specimen.
Tetragonoderus intersectus (Germar). PCI, 12 May–17 August, 31 specimens. One specimen was taken during a sweep of *Baccharis halimifolia*. This seemed an unusual place to find a typically nocturnal, ground-inhabiting species.
Zuphium sp. PCI, 12 August, 3 specimens. 1.5 mi SW Lakeshore, 12 August, 8 specimens. All specimens taken at black light.

Cerambycidae

Anelaphus pumilus (Newman). PCI, 24 April, 10 May, 2 specimens, at black light.
Archodontes melanopus (L.). PCI, 24 June, 1 specimen, at black light.
Elaphidion mucronatum (Say). PCI, 23 June, 1 specimen, at black light.
Enaphalodes atomarius (Drury). PCI, 24 June, 1 specimen, at black light.
Goes tigrinus (DeGeer). PCI, 24 June, 1 specimen.
Hippopsis lemniscata (F.). PCI, 10 May, 1 specimen.
Leptostylus albescens (Haldeman). PCI, 12 May, 1 specimen, at black light.
Liopinus alpha (Say). PCI, 24 April, 1 specimen, at black light.
Methia sp., prob. *pusilla* Newman. 1.5 mi SW Lakeshore, 12 August, 1 specimen.
Prionus pocularis Dalman. PCI, 24 June, 2 specimens, at black light.

Chelonariidae

Chelonarium lecontei Thomson. PCI, 24 June, 1 specimen, at black light.

Chrysomelidae

Acalymma vittata (F.). PCI, 24 April, 2 specimens.
Alticia litigata Fall. PCI, 24 April–27 September, 7 specimens.
Alticia sp. PCI, 24 April, 1 specimen.
Chaetocnema pulicaria Melsheimer, or near. PCI, 15 August, 1 specimen.
Chaetocnema sp. 1.5 mi SW Lakeshore, 12 May, 1 specimen.
Colaspis favosa Say. PCI, 15 August, 2 specimens.
Colaspis recurva Blake. PCI, 24 June, 3 specimens.
Crepidodera bella Parry. PCI, 25 April, 1 specimen, swept from *Distichlis* meadow.
Derospidea brevicollis (LeConte). 1.5 mi SW Lakeshore, 14 May, 1 specimen, ex. *Opuntia* sp.
Diabrotica undecimpunctata howardi Barber. PCI, 15 August–23 October, 13 specimens. 1.5 mi SW Lakeshore, 14 August–25 October, 8 specimens. Specimens were occasionally taken from flowers of *Baccharis halimifolia*.
Donacia cincticornis Newman. 1 mi SSW Lakeshore, 12 May, 1 specimen.
Erynephala maritima (LeConte). PCI, 12 May, 1 specimen.
Exema canadensis Pierce. 1.5 mi SW Lakeshore, 25 May, 27 September, 2 specimens.
Exema gibber (F.). 1.5 mi SW Lakeshore, 14 May, 1 specimen, ex. *Opuntia* sp.
Floridocassis repudiata (Suffrian). 1.5 mi SW Lakeshore, 2 specimens (1 female, 1 male).
Lysathia ludoviciana (Fall). 1.5 mi SW Lakeshore, 12 May, 2 specimens.
Metachroma lurida (Olivier). PCI, 29 June, 2 specimens.
Metachroma orientale Blake. PCI, 10 May, 1 specimen.

Ophraella notulata (F.). PCI, 25 April–23 October, 16 specimens. 1.5 mi SW Lakeshore, 25 April–25 October, 131 specimens, several series swept from *Iva frutescens* and *Baccharis halimifolia*.

Pachybrachis vestigialis Fall. 12 May–13 August, 5 specimens.

Paria sp. 1.5 mi SW Lakeshore, 25 April, 1 specimen, swept from *Juncus roemerianus*.

Rhabdopterus sp. PCI, 12 August, 1 specimen (female).

Systena frontalis (F.). 1.5 mi SW Lakeshore, 12 May, 3 specimens.

Trirhabda bacharidis (Weber). 1.5 mi SW Lakeshore, 12 May, 4 specimens.

Cleridae

Cregya oculata (Say). PCI, 29 June, 1 specimen.

Isohydnocera aegra (Newman). PCI, 24 April–20 May, 4 specimens, 1 from *Shrankia* sp. and 1 swept from *Distichlis* meadow. 0.5 mi SW Lakeshore, 25 April, 1 specimen.

Coccinellidae

Chilocorus stigma (Say). PCI, 25 April, 1 specimen.

Coccinella septempunctata L. PCI, 25 April, 1 specimen.

Cycloneda sanguinea sanguinea (L.). PCI, 14 February–23 October, 56 specimens. 1.5 mi SW Lakeshore, 25 April–25 October, 8 specimens. 1 mi SSW Lakeshore, 12 August, 3 specimens. Two specimens were swept from *Baccharis halimifolia*.

Hippodamia convergens Guérin-Méneville. PCI, 23 June, 26 June, 2 specimens.

Naemia seriata (Melsheimer). PCI, 14 February–19 October, 121 specimens. 1.5 mi SW Lakeshore, 12 May–25 October, 6 specimens. 1 mi SSW Lakeshore, 23 June–14 August, 9 specimens. Three specimens of this common species were swept from *Baccharis halimifolia*.

Olla v-nigrum (Mulsant). PCI, 29 June–15 August, 5 specimens. 1.5 mi SW Lakeshore, 25 October, 1 specimen. 1 mi SSW Lakeshore, 12 August, 3 specimens.

Psyllobora parvinotata Casey. PCI, 25 June, 1 specimen.

Scymnus (*Pullus*) sp. PCI, 12 May–23 June, 4 specimens.

Scymnus (*Pullus*) *securus* J. Chapin. PCI, 17 August, 3 specimens.

Scymnus (*Scymnus*) *indianensis* Weise. PCI, 24 April, 1 specimen.

Colydiidae

Aulonium parallelopipedum (Say). PCI, 24 June, 1 specimen, at black light.

Cryptophagidae

Cryptophilus integer (Heer). PCI, 15 August, 1 specimen.

Curculionidae

(not including aquatic species, see Lago and Testa, 1989)

Agraphus bellicus (Say). PCI, 28 February–23 October, 6 specimens.

Apion sp. PCI, 13 August, 1 specimen.

Baris sp. PCI, 23 June, 1 specimen. 1.5 mi SW Lakeshore, 25 April, 1 specimen, swept from *Distichlis* meadow.

Conotrachelus posticatus Boheman. PCI, 29 June, 1 specimen.

Cylas formicarius elegantulus (Summers). PCI, 12 August–15 August, 4 specimens.

Eudiagogus maryae Warner. PCI, 26 June, 2 specimens.

Eudiagogus pulcher Fahraeus. PCI, 13 August–27 September, 6 specimens.

Eudiagogus rosenschoeldi Fåhraeus. PCI, 12 May–27 September, 4 specimens.

Graphognathus peregrinus (Buchanan). PCI, 23 October, 3 specimens.

Nicentrus sp. PCI, 12 May, 14 May, 2 specimens.

Notiodes sp. PCI, 12 May, 6 specimens.

Onychylis sp. PCI, 20 May, 1 specimen.

Sibariops sp., or near. PCI, 12 May, 1 specimen. 1.5 mi SW Lakeshore, 12 May, 1 specimen.

Sphenophorus coesifrons Gyllenhal. PCI, 20 May, 1 specimen.

Tanymecus sp. PCI, 13 August, 1 specimen.

Dryopidae

(not included in Lago and Testa, 1989)

Helichus lithophilus (Germar). 1.5 mi SW Lakeshore, 12 August, 1 specimen, at black light.

Elateridae

Nearly all of the adult click beetles collected during this study were taken at black lights.

Alaus myops (F.). PCI, 24 June, 1 specimen.

Aeolus scutellatus (Schaeffer). PCI, 23 June, 3 specimens.

Conoderus amplicollis (Gyllenhal). PCI, 17 August, 1 specimen.

Conoderus auritus (Herbst). PCI, 12 August, 1 specimen.

Conoderus aversus (LeConte). PCI, 23 June–24 June, 9 specimens.

Conoderus bellus (Say). PCI, May 11–23 June, 2 specimens.
Conoderus falli Lane. PCI, May 10–15 August, 10 specimens.
Conoderus lividus (DeGeer). PCI, 23 June, 1 specimen.
Conoderus scissus (Schaeffer). PCI, 23 June–15 August, 65 specimens.
Conoderus vespertinus (F.). PCI, 23 June, 1 specimen.
Dipropus (*Ischiodontus*) *soleatus* (Say). PCI, 24 June, 12 August, 3 specimens.
Glyphonyx nanus Smith & Balsbaugh. PCI, 11 May–23 June, 20 specimens. 1 mi SSW Lakeshore, 12 August, 1 specimen.
Lanelater sallei (LeConte). PCI, May 12–24 June, 5 specimens.
Megapenthes insignis LeConte. PCI, 24 June, 12 August, 2 specimens.
Megapenthes rufilabris (Germar). PCI, 23 June–15 August, 12 specimens.
Melanotus piceatus Blatchley. PCI, May 11, 2 specimens.
Agrypnus rectangularis (Say). PCI, 17 August, 2 specimens.
Neotrichophorus carolinensis (Schaeffer). PCI, 23 June–15 August, 10 specimens.
Orthostethus infuscatus (Germar). PCI, 10 May, 12 August, 2 specimens.

Erotylidae

Ischyrus quadripunctatus quadripunctatus (Olivier). PCI, 10 May, 1 specimen, at black light.

Heteroceridae

All of the heterocerid specimens collected during this study were taken at black light.
Neoheterocerus fatuus (Kiesenwetter). PCI, 9 May–15 August, 288 specimens. 1.5 mi SW Lakeshore, 12 August, 3 specimens.
Neoheterocerus glicki (Pacheco). 1 mi SSW Lakeshore, 23 June, 1 specimen.
Tropicus pusillus (Say). PCI, 10 May–15 August, 26 specimens. 1.5 mi SW Lakeshore, 24 April–12 August, 10 specimens. 1 mi SSW Lakeshore, 12 August, 8 specimens.

Histeridae

Hypocaccus fraternus (Say). PCI, 24 April–23 June, 11 specimens, 6 were taken from a rotting fish carcass and 2 were found under dung of something that had been eating crabs (probably raccoon).

Hydrophilidae

Although the terrestrial members of this family are often associated with fecal material, all of the specimens collected during this study were taken at black lights.
Cercyon praetextatus (Say). PCI, 10 May, 12 August, 15 August, 8 specimens.
Cercyon mendax Smetana. PCI, 12 August, 1 specimen. 1 mi SSW Lakeshore, 12 August, 1 specimen.

Languriidae

Languria erythrocephalus Blatchley. PCI, 23 June, 2 specimens.

Leiodidae

Ptomaphagus consobrinus (LeConte). PCI, 28 February, 13 specimens, pitfall traps baited with human feces.

Limnichidae

Eulimnichus ater (LeConte). PCI, 15 August, 92 specimens. 1 mi SSW Lakshore, 12 August, 1 specimen. All specimens collected at black light

Lycidae

Celetes basalis LeConte. PCI, 24 April, 1 specimen.

Melyridae

Collops balteatus LeConte. PCI, 24 April–15 August, 164 specimens. Very common on a variety of plants along the beach just southwest of Point Clear.
Collops nigriceps (Say). PCI, 25 April–14 August, 21 specimens, 3 swept from *Distichlis* meadow, 1 was taken from *Baccharis halimifolia*. 1.5 mi SW Lakeshore, 25 April, 1 specimen. 1 mi SSW Lakeshore, 25 April, 14 August, 3 specimens. 0.5 mi SW Lakeshore, 25 April, 1 specimen.
Temnopsophus bimaculatus Horn. 1 mi SSW Lakeshore, 14 May, 2 specimens.

Mordellidae

Mordella atrata Melsheimer. PCI, 12 May–23 October, 33 specimens, 5 of which were collected from flowers of *Helenium amarum*. 1.5 mi SW Lakeshore, 12 May, 1 specimen.
Mordella marginata Melsheimer. 1.5 mi SW Lakeshore, 27 September, 1 specimen.
Mordellistena nigricans (Melsheimer) PCI, 23 June–15 August, 70 specimens. 1 mi SSW Lakeshore, 23 June, 2 specimens. *Baccharis halimifolia* flowers yielded most specimens of this species.
Mordellistena splendens Smith PCI, 23 June–15 August, 4 specimens. 1 mi SSW Lakeshore, 23 June, 3 specimens.

Mordellistena sp., near *ambusta* LeConte. PCI, 12 May, 1 specimen.

Mycetophagidae

Typhaea stercorea (L.). PCI, 15 August, 1 specimen.

Nitidulidae

Lobiopa insularis (LaPorte). PCI, 23 June, 1 specimen, at black light.

Carpophilus sp. PCI, 28 September, 1 specimen.

Omosita colon (L.). PCI, 15 August, 1 specimen, pitfall trap baited with human feces.

Stelidota strigosa (Gyllenhal). PCI, 12 May, 1 specimen.

Phalacridae

Genus and species undetermined–PCI, 25 April–15 August, 21 specimens, 14 of which were swept from *Distichlis* meadow. 1.5 mi SW Lakeshore, 25 April, 12 August, 2 specimens.

Platypodidae

Platypus compositus Say. PCI, 23 June–24 June, 4 specimens, at black light.

Rhipiphoridae

Macrosiagon pectinata (F.). PCI, 12 May, 1 specimen.

Scarabaeidae

Anomala flavipennis Burmeister. PCI, 15 August, 5 specimens, black light.

Anomala innuba (F.). PCI, 15 August, 1 specimen, black light.

Anomala undulata Melsheimer. PCI, 24 April–23 June, 39 specimens, black light.

Ataenius aequalis Harold. PCI, 12 August, 1 specimen collected at black light. This is apparently only the second record for this species in the U.S., the first being from "Louisiana" (Cartwright, 1974).

Ataenius cylindrus Horn. PCI, 17 August, 2 specimens, in pitfall traps baited with human feces.

Ataenius imbricatus (Melsheimer). PCI, 23 June–15 August, 4 specimens. 1.5 mi SW Lakeshore, 12 August, 1 specimen. 1 mi SSW Lakeshore, 23 June, 3 specimens. All specimens were collected at black light.

Ataenius picinus Harold. PCI, 10 May–15 August, 13 specimens. 1 mi SSW Lakeshore, 12 August, 2 specimens. All specimens were collected at black light.

Ataenius platensis (Blanchard). PCI, 23 June–17 August, 16 specimens. 1.5 mi SW Lakeshore, 12 August, 1 specimen. Seven specimens were captured in pitfall traps baited with human feces, the remainder were collected at black light.

Ataenius spretulus (Haldeman). PCI, 15 August, 5 specimens. 1.5 mi SW Lakeshore, 12 August, 5 specimens. 1 mi SSW Lakeshore, 12 August, 2 specimens. All specimens were collected at black light.

Ataenius strigatus (Say). PCI, 11 May–15 August, 11 specimens, 3 from pitfall traps baited with human feces, the remainder were collected at black light.

Ateuchus lecontei (Harold). PCI, 29 June–19 October, 25 specimens, 3 from pitfall traps baited with goat dung, 21 from traps baited with human feces.

Cyclocephala lurida Bland. PCI, 23 June–12 August, 11 specimens. 1 mi SSW Lakeshore, 23 June, 3 specimens. All specimens were collected at black light.

Cyclocephala nigricollis Burmeister. PCI, 23 June–12 August, 8 specimens. 1 mi SSW Lakeshore, 24 June, 1 specimen. All specimens were collected at black light.

Dichotomius carolinus (L.). 1.5 mi SW Lakeshore, 12 May, 1 specimen in pitfall trap baited with human feces.

Diplotaxis subcostata Blanchard. PCI, 24 April, 20 May, 129 specimens. Most specimens were taken at black light, but two were collected as they fed on leaves of *Quercus virginiana*.

Dyscinetus morator (F.). PCI, 24 April–15 August, 90 specimens. 1.5 mi SW Lakeshore, 24 April, 2 specimens. 1 mi SSW Lakeshore, 24 April–12 August, 12 specimens. All specimens were collected at black light.

Euetheola humilis rugiceps (LeConte). PCI, 23 June–15 August, 17 specimens. 1 mi SSW Lakeshore, 12 August, 4 specimens. All specimens were collected at black light.

Geotrupes blackburnii excrementi Say. PCI, 28 February–19 October, 4 specimens, 1 ex. cow dung, 3 from pitfall traps baited with human feces.

Ligyrus gibbosus (DeGeer). PCI, 15 August, 2 specimens, collected at black light.

Martineziella dutertrei (Chalumeau). PCI, 23 June–15 August, 63 specimens. 1.5 mi SW Lakeshore, 12 August, 2 specimens. All specimens were collected at black light.

Omorgus monachus (Herbst). 1 mi SSW Lakeshore, 23 June, 1 specimen at black light.

Onthophagus gazella (F.). PCI, 12 May–23 October, 131 specimens. 1 mi SSW Lakeshore, 12 August,

34 specimens. Although most specimens of this species were taken at black light both on the island and in the marsh, 34 were collected in pitfall traps baited with human feces and a small series was collected from fresh pig dung on the island.

Onthophagus hectate (Panzer). PCI, 12 May–19 October, 68 specimens, most of which were captured in pitfall traps baited with human feces, but a few specimens were collected in cattle dung. 1.5 mi SW Lakeshore, 12 May, 12 specimens, ex. pitfall traps baited with human feces.

Onthophagus taurus Schreber. PCI, 17 August, 28 September, 2 specimens, pitfall traps baited with human feces.

Onthophagus tuberculifrons Harold. PCI, 19 October, 1 specimen, ex. cattle dung.

Parataenius simulator (Harold). PCI, 23 June–15 August, 6 specimens, at black light.

Phyllophaga cupuliformis Langston. PCI, 24 April–11 May, 13 specimens, at black light.

Phyllophaga dispar (Burmeister). PCI, 24 June, 4 specimens, at black light.

Phyllophaga prununculina (Burmeister). PCI, 23 June–24 June, 14 specimens, at black light.

Phyllophaga (*Phytalus*) *obsoleta vanalleri* (Schaeffer). 1 mi SSW Lakeshore, 23 June, 1 specimen.

Platytomus longulus (Cartwright). PCI, 12 August, 2 specimens. 1 mi SSW Lakeshore, 23 June–12 August, 3 specimens. All specimens taken at black light.

Polyphylla occidentalis (L.). PCI, 10 May–24 June, 3 specimens, at black light.

Pseudocanthon perplexus (LeConte). PCI, 12 May, 5 specimens, pitfall traps baited with human feces.

Serica parallela Casey. PCI, 24 April–20 May, 135 specimens, at black light.

Strategus aloeus (L.). PCI, 23 June–24 June, 5 specimens. 1 mi SSW Lakeshore, 23 June, 1 specimen. All specimens taken at black light

Strategus antaeus (Drury). PCI, 23 June–17 August, 9 specimens, 3 of which were captured on separate occasions as they were walking along sandy paths on the island during mid-afternoon.

Trigonopeltastes delta (Forster). PCI, 12 May, 1 specimen, in Malaise trap near center of island.

Trox terrestris Say. PCI, 28 February, 13 specimens,1 from a pitfall trap baited with goat dung, the remainder from traps baited with human feces. Of these specimens, two were taken near the artesian pond on the eastern end of the island, the remainder were collected near mid island.

Trox variolatus Melsheimer. PCI, 28 February, 23 specimens, all taken in pitfall traps baited with human feces.

Scolytidae

Ips grandicollis (Eichhoff). PCI, 29 June, 1 specimen, at black light.

Xyleborus ferrugineus (F.). PCI, 12 August, 1 specimen, at black light.

Silphidae

Necrodes surinamensis (F.). PCI, 24 April, 23 June, 2 specimens, at black light.

Silvanidae

Ahasverus advena (Waltl). PCI, 15 August, 1 specimen.

Staphylinidae

Aleochara lustrica Say. PCI, 17 August, 1 specimen, pit trap baited with human feces.

Aleochara notula Erichson. PCI, 29 June 1 specimen, pit trap baited with human feces.

Aleocharinae.

Sp 1. Undetermined genus and species (2 specimens), April, PCI.

Sp. 2. Undetermined genus and species (1 specimen), May, PCI.

Anotylus sp. PCI, 28 February–29 June, 7 specimens from pit trap baited with human feces.

Belonuchus sp. PCI 29 June, 1 specimen from pit trap baited with human feces.

Bledius sp-1. PCI, 12 & 15 August, 2 specimens.

Bledius sp-2. PCI, 23 June, 5 specimens.

Bryoporus sp. PCI, 28 February, 1 specimen, from pit trap baited with goat dung.

Carpelimus (or related genus). 31 specimens, not separated to species groups.

Eupsenius rufus LeConte. PCI, 23 June, 2 specimens.

Homaeotarsus sp-1. PCI, 11 May–15 August, 16 specimens. 1 mi SSW Lakeshore, 23 June, 1 specimen. 1.5 mi SW Lakeshore, 12 August, 1 specimen.

Homaeotarsus sp-2. PCI, 23 June, 15 August, 3 specimens. 1 mi SSW Lakeshore, 12 August, 1 specimen. 1.5 mi SW Lakeshore, 12 August, 2 specimen.

Homaeotarsus sp-3. PCI, 23 June, 1 specimen. 1.5 mi SW Lakeshore, 12 August, 1 specimen.

Homaeotarsus sp-4. PCI, 23 June, 1 specimen.

Lobrathium sp-1. PCI, 29 April–15 August, 37 specimens.

Lobrathium sp-2. PCI, 23 June–15 August, 31 specimens.
Lobrathium sp-3. PCI, 12 August, 1 specimen.
Lobrathium sp-4. PCI, 12 August, 1 specimen.
Myrmecosaurus ferrugineus Bruch. PCI, 28 February, 1 specimen taken under bark of *Magnolia grandiflora* in association with ants.
Neobisnius sp. PCI, 11 May, 15 August, 2 specimens.
Nisaxis maritima Casey. PCI, 15 August, 1 specimen.
Nisaxis tomentosa (Aubé). PCI, 24 April, 23 June, 2 specimens.
Philonthus alumnus Erichson. PCI, 11 May–15 August, 10 specimens. 1 mi SSW Lakeshore, 23 June, 12 August, 4 specimens.
Philonthus inquietus Erichson. PCI, 28 February, 12 May, 10 specimens, 1 from pit trap baited with human feces.
Philonthus sp. PCI, 9 May–15 August, 55 specimens. 1 mi SSW Lakeshore, 23 June, 12 August, 7 specimens. 1.5 mi SW Lakeshore, 12 August, 8 specimens.
Pinophilus sp-1. PCI, 23 June, 12 & 15 August, 20 specimens. 1 mi SSW Lakeshore, 23 June, 12 August, 10 specimens. 1.5 mi SW Lakeshore, 12 August, 6 specimens.
Pinophilus sp-2. PCI, 10 May, 23 June, 2 specimens. 1 mi SSW Lakeshore, 23 June, 12 August, 6 specimens. 1.5 mi SW Lakeshore, 12 August, 3 specimens.
Osorius sp. PCI, 17 May, 1 specimen, pit trap baited with human feces.
Oxytelus sp. PCI, 28 February, 2 specimens from pit trap baited with human feces.
Reichenbachia puncticollis (LeConte). PCI, 23 June, 1 specimen.
Rugilus sp. 29 June, 15 August, 2 specimens, 1 from a pit trap baited with human feces.
Scopaeus sp. PCI, 15 August, 1 specimen. 1 mi SSW Lakeshore, 12 August, 1 specimen. 1.5 mi SW Lakeshore, 12 August, 1 specimen.

Tenebrionidae

Alobates barbata Knoch. PCI, 10 May, 24 June, 2 specimens.
Diaperis maculata Oliver. PCI, 19 October, 3 specimens.
Gonwanocrypticus obsoletus (Say). PCI, 14 February–17 August, 10 specimens. A few of these ground inhabitants were collected in pitfall traps.
Haplandrus atra (LeConte). PCI, 10 May, 1 specimen.
Hymenorus curticollis Casey. PCI, 10 May, 1 specimen, at black light.
Hymenorus dubius Fall. PCI, 23 June, 1 specimen, at black light.
Hymenorus heteropygus Fall. PCI, 23 June, 3 specimens, at black light.
Hymenorus niger Melsheimer. PCI, 23 June, 1 specimen, at black light.
Hymenorus pilosa (Melsheimer). PCI, 24 June, 1 specimen, at black light.
Isomira pulla (Melsheimer). 1.5 mi SW Lakeshore, 25 April, 1 specimen, ex. *Iva frutscens*.
Platydema erythrocera LaPorte & Brullé. PCI, 19 October, 1 specimen.
Schoenicus puberulus LeConte. PCI, 12 August, 1 specimen.
Statira basalis Horn. PCI, 24 April, 7 specimens, at black light.
Strongylium tenuicolle (Say). PCI, 24 June, 1 specimen, at black light.
Uloma mentalis Horn. PCI, 19 October, 2 specimens.
Ulus maritimus Casey. PCI, 12 May, 1 specimen.

DISCUSSION

Results of this survey are difficult to compare to those of other coastal areas primarily because sampled habitats often differ greatly. In a study conducted in northeastern Florida, McCoy and Rey (1981) examined the terrestrial species of beetles associated with salt marshes. They listed 51 species (including several identified only to the generic level) in 23 families, numbers considerably smaller than we recorded in our study; however, their sampling was restricted to salt marsh habitat only, while our list includes the island fauna. We made no special effort to separate marsh samples from island samples, particularly because we collected extensively within the ecotone between these two main habitats. Differences between the two lists appear to be due mostly to the extensive terrestrial habitat collecting conducted on Point Clear Island. Also, the Florida survey was done during daylight hours and with sweep nets only, while we employed a much wider array of techniques, including night collecting. Nevertheless, and not unexpectedly, the lists share many similarities. Of the 22 terrestrial families present in the Florida marshes (the 23rd family was Dytiscidae, an aquatic group), only

Dermestidae, Latridiidae and Oedemeridae were absent from our list. These three families were represented by four species, but only one of these (*Melanophthalma* sp., Latridiidae) was particularly common. While future collecting on and around Point Clear Island will probably reveal the presence of these normally common families, and it is possible that any one of them may be common there from time to time, none fell prey to us during our sampling period. Eight of the 51 Florida species were found in the Point Clear area during the current study and 16 others were represented in our list by congeners. Major differences between families well represented in both areas were most apparent within the lists of weevils (Curculionidae), with only one congener, and rove beetles (Staphylinidae), with no overlap. These diverse families are probably under-represented in both lists and we suspect the apparent discrepancies are attributable more to chance in collecting than to actual faunal differences.

In a somewhat more inclusive study, Davis (1978) presented a list of insects associated with the coastal zone of South Carolina. This survey encompassed marshes as well as beach habitats, and resulted in a list of 62 species of terrestrial beetles belonging to 20 families. The inclusion of beach habitats increased the general similarity between the South Carolina and Point Clear Island lists. As might be expected from localities this far distant from one another, species differences do occur, but basic familial and generic diversity between the two areas is quite similar. Four families [Eucinetidae, Lampyridae, Oedemeridae, Corylophidae (as Orthoperidae)], each represented by single species, included in the South Carolina list were not present in our samples, but only one of these was represented by a common species (*Eucinetus strigosus* LeConte). Perhaps the greatest discrepancy between the lists is the presence of at least 50 species of Carabidae in the Point Clear area while none is listed from South Carolina. This must be the result of an inadvertent omission from the South Carolina paper. Davis and Gray (1966) studied salt marshes in North Carolina and found about nine species of beetles (three of which were listed as "sp."), representing six families, in their samples. Of the six specific species they listed, three occurred in our study area, and representatives of all of the other genera, except *Cryptocephalus* (Chrysomelidae), also occurred on or around Point Clear Island.

Unlike the above mentioned studies, Richmond (1962, 1968) collected extensively in terrestrial habitats during his survey of the Horn Island (Jackson County, MS) fauna and flora. He included 187 species of terrestrial beetles representing 37 families in his lists, which is fairly comparable to our list (279 species, 39 families). The larger number of species on the Point Clear list is, in our opinion, primarily due to the relative closeness of Point Clear to the mainland and to differences in collecting methods. Richmond relied on mosquito light traps, lights on buildings and sweeping (Rings and Richmond,1953, Richmond, 1962) while we used a much wider array of techniques (black lights, hand picking, baited and unbaited pitfall traps, etc.). The Horn Island list contained six families that we did not find: Bostrichidae (3 sp.), Byrridae (1 sp.), Lampyridae (1 sp.), Monommidae (1 sp.), Oedemeridae (3 sp.) and Ostomidae (=Trogositidae) (1 sp.). Since most of the species listed in these families do not require specialized techniques for collection (most come to light), and representatives of these families are rather widely distributed in Mississippi, their absence from our samples is difficult to explain. The most reasonable explanation is that if they occurred on Point Clear Island, they were present in very low numbers during the sampling period and were simply missed.

However, very distinct species differences do exist between the two islands. Richmond's study, as well as recent collections made on Horn Island, indicated numerous species occur there that do not occur on Point Clear. For example, *Ataenius miamii* (Cartwright), *Cyclocephala setidiosa* (LeConte), *Ligyrus cunuculus* (F.) and *Odontopsammodius bidens* (Horn) (Scarabaeidae) and *Leichenum canaliculatus variegatum* (Klug) (Tenebrionidae) are species occurring on Horn Island that have not been, or are rarely, collected anywhere else in Mississippi, and were not found on Point Clear Island during our sampling period. We believe that some of these differences are attributable to the presence of extensive, open, sandy habitats, including dunes, (see Richmond, 1962: figs 5–9) on Horn Island. By comparison, Point Clear Island is mostly vegetated. Outside of these habitat related differences, and those attributable to nearness to the mainland (greater species diversity in several families on Point Clear Island), the faunal lists from the two islands are fairly similar, sharing 51 species. If the identity of all of the specimens collected by Richmond were known (47 were left as "sp."), that number would almost

certainly be greater.

The beetle fauna of Point Clear Island and surrounding marshlands is quite diverse, and is undoubtedly more so than is indicated in the above list. In a general survey, such as the one conducted here, it is nearly impossible for a group of collectors to accumulate representatives of every species of a group exhibiting the incredible diversity of habits and habitat use that beetles do, in a time as short as two years. However, we do believe that the variety of techniques we employed and the wide coverage of seasons and conditions in which we collected have yielded a strong representation of the beetle fauna of the study area. And with the recent news that most of the area is now under state control, this very interesting section of the Mississippi coastal marsh zone will be available to future investigators who wish to expand on our work or to examine any of the other myriad ecological facets associated with this unique environment.

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President's Column

I am looking forward to a large and exciting meeting in Hattiesburg in February and hope you and your students are making plans to join us. The annual meeting is always a good place for students to present their work and look at the possibilities of graduate programs within the state. This also means that graduate departments should consider recruiting exhibits at the meeting. I know my department will be there!

I want to use my column this time to make a couple of appeals. First I want to appeal for a volunteer to serve as MAS corporate chair. The corporate chair is responsible for contacting businesses, industry, foundations, i.e. anyone that can provide support to the Academy. Margot Hall has served faithfully in this role for the past two years, but she would like to be replaced by someone with more interest and experience in working with the corporate sector. Please contact me at robert.bateman@usm.edu if you are willing to help the Academy in this way. This position is important to the long term financial health of the Academy.

My second appeal has to do with the state of science education at the precollege level in Mississippi Although there are certainly some excellent science and mathematics teachers in the junior high and high schools, we are all aware that there are many teachers teaching outside of their content area because of the lack of properly certified teachers. I am appealing to college students, undergraduate or graduate, majoring in an area of science to consider a career as a junior high or high school science teacher. The pay is getting better, you will always have a job, and you can make a major difference in the scientific literacy of the Mississippi population. Encourage someone you know, whether they are a college student or a retired scientist, to consider teaching science to these young people. They are, after all, our scientists of the future.—Bob Bateman

Executive Officer's Column

Money is the root of all evil; money makes the world go around; money can't buy true happiness. Whatever. The essential point is that money always has our attention. This has never been more true these days in Mississippi and the country. If we're not in a recession, it is a pretty good imitation of one. Things seem particularly bleak here because we never had enough money to start with. The Mississippi economy has been living off the casino float for some time and now those barges have sprung a leak. The Nissan benefits, while potentially substantial, are still in our future. We live off sales taxes in this state and, if people don't have enough confidence in their own financial affairs to spend money, the state doesn't have enough money to spend. However, we are not alone in our budgetary doldrums. Tennessee has been in the news lately and it's clear speaking with colleagues from other states that most are as bad off, if not worse, than us.

And yet perceptions play a large role in our predicament. Consider the state of science funding. Over the last few years, the budget of the NIH has been doubled; there are clear plans to do the same with the National Science Foundation. The US Department of Agriculture has greatly expanded its funding for research. EPA is getting a funding increase. In terms of national funding for science, we may actually be entering a golden age. Don't worry; Polly Anna is not inhabiting the Executive Officer position. I also recognize that much of the new funding is not generally available and does not help us in Mississippi. Nevertheless, there is science money out there and it will help our broad discipline of science. Our problem is to bring some money to focus on our science infrastructure in this state.

There is no question that attendance at our meetings has been hurt a little by economic problems. However, we have not experienced a particularly large decrease and we would like to attribute that to the vision of our scientists - you guys. We all see the need to keep communicating with our peers and educating our students. While money has been tight, the clever scientists in Mississippi have been developing clever ways to keep doing their good science. Let's all keep being clever and who knows what will happen when good times appear again. Just think about all that federal money just for the asking! (They may require a little detail like a good grant proposal, but, remember, you guys are CLEVER!)—John Boyle

Divisional Report
Zoology and Entomology

The Zoology and Entomological Division met on the morning of Friday, Feb. 22, 2002. During this sixty-sixth annual meeting of MAS, five oral

presentations were made. This was a decreased from the previous years. In the year 2000, ten oral papers and one poster were presented. In 2001, five oral papers and three posters were presented. Faculty participation interest appears to have declined. Efforts will be made to resuscitate the interest in the future and involve more graduate students as well as undergraduate students. About 25 individuals attended the presentations. The papers presented were interesting and thought-provoking. The comments and questions from the captivated audience were relevant and beneficial.

At the business meeting of 1998, a suggestion was made to create an annual award for the best student paper presentation. To date, this has not materialized. An effort will be made to get this started.

At the end of the divisional session, Dr. Alex D. W. Acholonu of Alcorn State University was elected as chair of the division and Dr. Elgenaid Hamadain of Jackson State University, was elected as the vice-chair. Dr. Timothy C. Lockley of the U. S. D. A. was the immediate past chair.

It has been a pleasure to serve as the vice-chair and an honor to be elected as chair of the division.—Alex D.W. Acholonu

The Mississippi Junior Academy of Sciences

Call for Papers

Students in grades 9–12 are invited to submit research papers detailing their research projects to the Mississippi Junior Academy of Sciences Annual Research Paper Competition.

Deadline for Entry: December 13, 2002 (entries must be postmarked by this date)

Send entries to:
Betsy Sullivan
Mississippi Museum of Natural Science
2148 Riverside Drive
Jackson, MS 39202

Competition Date and Location: February 13, 2003
University of Southern Mississippi and Hattiesburg Convention Center
Hattiesburg, Mississippi

Call for Judges

The MJAS is meeting as a part of Mississippi Academy of Sciences for the first time. We look forward to sharing the student's achievements with all MAS members. Judges are needed for the Mississippi Junior Academy of Sciences Annual Research Paper Competition.

Three sets of judges are needed for the following areas:
Written Paper Judging (December 18, 2002)
Divisional Judging (February 13, 2002)
Overall Competition Judging (February 13, 2002)

All MAS members interested in becoming a judge should contact:
Betsy Sullivan
Mississippi Museum of Natural Science
2148 Riverside Drive
Jackson, MS 39202

MAS

Telephone: (601) 354-7303 ext 124
E-mail: betsy.sullivan@mmns.state.ms.us

*The **Awards and Resolutions Committee** seeks nominations from the membership at large for awards to be presented at the Annual Meeting of the Mississippi Academy of Sciences:*

- **Outstanding Contributions to Science**
  Recognizes a member of the MAS whose research, teaching, or service to the community has significantly furthered the cause of science
- **Dudley F. Peeler Outstanding Contributions to the Mississippi Academy of Sciences Award (Peeler Award)**
  Recognizes a member of the MAS for long-term service to the Academy itself.
- **Community/Junior College Science Teacher**
  Recognizes a member of the MAS with outstanding accomplishment in the teaching of science at the community or junior college level
- **Secondary Science Teacher**
  Recognizes a member of the MAS with outstanding accomplishment in the teaching of high school science

These awards recognize the exceptional contributions of fellow MAS colleagues. To nominate **a current MAS member** for any of these awards, please specify the award category and submit the following:

a. **two supporting letters** from members of the Academy having firsthand knowledge of the nominee's accomplishments
   - Nominees for the **Outstanding Contributions to Science** should exhibit a commitment to the acquisition, dissemination, and application of scientific knowledge. An extensive research publication record by itself is not the only criterion on which nominations are considered.
   - Nominees for the **Peeler Award** should exhibit long-term, fundamental contributions toward the advancement of the Mississippi Academy of Sciences.
   - Nominations for either of the **Science Teacher Awards** must include a summary of the nominee's science teaching achievements as well as a summary of outstanding achievements of the nominee's students.

b. **curriculum vitae of the nominee**
   - Include educational background, professional experience, current position and work address, and both daytime and evening phone numbers as well as any other information considered to be pertinent for a specific award.

c. **additional letters of support** (optional)
   - Letters of recommendation from persons who are not MAS members will be accepted but are not required.

Send nominations to:
Dr. Sarah Lea McGuire, Chair
MAS Awards and Resolutions Committee
Department of Biology, Post Office Box 150305
Millsaps College, Jackson, MS 39210

If you have questions or comments, please do not hesitate to contact the Chair at 601-974-1414 (phone), 601-974-1401 (FAX), or mcguisl@millsaps.edu (email).

DEADLINE FOR ALL NOMINATIONS IS DECEMBER 2, 2002

MISSISSIPPI ACADEMY OF SCIENCES ABSTRACT FORM/MEMBERSHIP FORM

ABSTRACT INFORMATION

Abstract title _____

Name of presenting author(s) _____
(Presenter must be a current (i.e., 2003 membership dues must be paid) student member, regular member, or life member of the MAS)

Telephone _____ Email _____

Check the division in which you are presenting

__ Agriculture and Plant Science
__ Cellular, Molecular and Dev. Biol.
__ Chemistry and Chem. Engineering
__ Ecology and Evolutionary Biology
__ Geology and Geography
__ Health Sciences
__ History and Philosophy of Science
__ Math., Computer Sci. and Statistics
__ Marine and Atmospheric Sciences
__ Physics and Engineering
__ Psychology and Social Sciences
__ Science Education
__ Zoology and Entomology

Type of presentation

__ Poster presentation __ Workshop
__ Lecture presentation __ Invited symposium

If the presenting author for this paper is also presenting in another division, please list the other division: _____

Audio-visual equipment needs

__ 2" x 2" slide projector
__ Overhead projector

Other audio-visual equipment including computers and computer projection equipment must be provided by the speaker.

MEMBERSHIP INFORMATION

New __ Renewal __
Mr. Ms Dr. _____
Address _____
City, State, Zip _____
School or Firm _____
Telephone _____ Email address _____
PLEASE INDICATE DIVISION WITH WHICH YOU WISH TO BE AFFILIATED _____
Regular member $25 Student member $5 Life member $ 250
Educational $150 Corporate Patron $1000 Corporate Donor $500

CHECKLIST

The following MUST be DONE:

__ 1. Enclose copy of abstract (even if abstract has been submitted electronically)
__ 2. Complete and enclose abstract form /membership form(this form)
__ 3. Enclose the following payments (make check payable to Mississippi Academy of Sciences):
  __ $25 per abstract
  __ $25 regular membership fee OR $5 student membership fee (2003 membership must be paid for abstract to be accepted)
__ 4. You must supply a check # _____ or P.O. # _____(credit cards are not accepted)

In addition you MAY preregister at this time:

__ Enclose the following payments:
  __ $20 regular member (after 15 Jan.) ___ $12 regular member (Preregistration before Jan. 15, 2003)
  __ $10 student member (after 15 Jan.) ___ $ 5 student member (Preregistration before Jan. 15, 2003)
  __ $50 nonmember (after 15 Jan.) ___ $40 nonmember (Preregistration before Jan. 15, 2003)

NOTE: **Abstracts that are resubmitted for changes will incur a $10 resubmission fee. Late abstracts will be accepted with a $10 late fee during November increased to $25 after that. Late abstracts will be accepted only if there is room in the appropriate division.** They will be published in the April issue of the MAS JOURNAL.

MISSISSIPPI ACADEMY OF SCIENCES—ABSTRACT INSTRUCTIONS
PLEASE READ ALL INSTRUCTIONS BEFORE YOU SUBMIT YOUR ABSTRACT

- Your paper may be presented orally or as a poster. Oral presentations are generally 15 minutes although some divisions allow more time. The speaker should limit a 15 minute presentation to 10–12 minutes to allow time for discussion; longer presentations should be limited accordingly. Instructions for poster presentations are given on the reverse side of this sheet.
- Enclose a personal check, money order, institutional check, or purchase order for $25 publication charge for each abstract to be published, payable to the Mississippi Academy of Sciences. The publication charge will be refunded if the abstract is not accepted.
- The presenting author must be a member of the Academy at the time the paper/poster is presented. Payment for membership of the presenting author must accompany the abstract.
- Attendance and participation at all sessions requires payment of registration.
- Note that three separate fees are associated with submitting and presenting a paper at the annual meeting of the Mississippi Academy of Sciences. (1) An abstract fee is assessed to defray the cost of publishing abstracts and (2) a membership fee is assessed to defray the costs of running the Academy. (3) Preregistration payment ($12 regular; $5 student) may accompany the abstract, or you may elect to pay this fee before January 15th, or pay full registration fees at the meeting.
- Abstracts may be submitted by e-mail or entered directly through the MAS website. The URL is http://www.msacad.org. This abstract submission form and the appropriate fees should be sent by US mail even if the abstract has been submitted electronically.
- Abstracts may be submitted as a WordPerfect, Word, ASCII, ANSI, or .RTF file on a PC readable diskette. *Formatting should be minimal*. This abstract submission form and the appropriate fees should be sent by US mail even if a diskette is used for the abstract.
- Abstracts may be submitted typed or printed on clean white paper. Abstracts received in this form will be scanned into a computer. Leave ample margins and use a sanserif type font to help minimize errors in scanning.
- **Abstracts that are resubmitted for changes will incur a $10 resubmission fee.**
- **Late abstracts will be accepted with a $10 late fee during November increased to $25 after that. Late abstracts will be accepted only if there is room in the appropriate division.** They will be published in the April issue of the MAS JOURNAL.
- Submit your abstract and appropriate fees to the Abstracts' Editor, John Boyle, **TO BE RECEIVED NO LATER THAN NOVEMBER 1, 2002**.
- Late abstracts will be accepted with a $10 late fee and only if there is room in the appropriate division. They will be published in the April issue of the MAS journal.

Dr. John Boyle
Mississippi State University
Dept. of Biochemistry
P.O. Drawer 9650
Mississippi State, MS 39762

FORMAT FOR ABSTRACT

- Your abstract should be informative, containing: (a) a sentence statement of the study's specific objectives, unless this is given in the title; (b) brief statement of methods, if pertinent; (c) summary of the results obtained; (d) statement of the conclusions. It is not satisfactory to state, "The results will be discussed."
- Your abstract, including a concise, descriptive title, author(s), location where work was done, text and acknowledgment, may not exceed 250 words. **Excessively long abstracts will be truncated**.
- The title should be all capital letters. Use significant words descriptive of subject content.

- < Authors' names start a new line.
- < The institution where your research was done should include city, state, and zip code. Do not include institutional subdivisions such as department.
- < The abstract should be one paragraph, single spaced, starting with a 3-space indentation.
- < Use standard abbreviations for common units of measure. Other words to be abbreviated, such as chemical names, should be spelled out in full for the first use, followed by the abbreviation in parenthesis. Do not abbreviate in the abstract title.
- < Special symbols not on your printer or typewriter must be in black ink.
- < Use italics for scientific names of organisms.
- < Begin authors' names on a new line. Place an asterisk (*) after the presenter(s), if there are multiple authors.
- < Use superscripts for institutional affiliations where necessary to avoid ambiguity.
- < Refer to these examples as guides.

EXAMPLES OF TITLES AND AUTHORS:

[single author, no ambiguity about designated speaker or affiliation]
AN EXPERIMENTAL MODEL FOR CHEMOTHERAPY ON DORMANT TUBERCULOUS INFECTION WITH PARTICULAR REFERENCE TO RIFAMPICIN
Joe E. Jones, Mississippi State University, Mississippi State, MS 39762
Abstract body starts here . . .

[two authors, both designated as speakers, different affiliations, but no ambiguity]
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Joe E. Jones[1], Ralph A. Smith[1]*, and Alice D. Doe[2], [1]Mississippi State University, Mississippi State, MS 39762 and [2]University of Mississippi Medical Center, Jackson, MS 39216
Abstract body starts here . . .

GUIDELINES FOR POSTER PRESENTATIONS

- < The Academy provides poster backboards. Each backboard is 34" high by 5' wide. Mount the poster on the board assigned to you by your Division Chairperson. Please do not draw, write, or use adhesive material on the boards. You must provide your own thumb tacks.
- < Lettering for your poster title should be at least 1" high and follow the format for your abstract. Lettering for your poster text should be at least 3/8" high.
- < Posters should be on display during the entire day during which their divisional poster session is scheduled. They must be removed at the end of that day.

< Authors must be present with their poster to discuss their work at the time indicated in the program.