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THE CROWN CONCH (*MELONGENA* : MELONGENIDAE) IN FLORIDA AND ALABAMA WITH THE DESCRIPTION OF *Melongena sprucecreekensis*, n. sp.

John K. Tucker[1]

ABSTRACT

The *Melongena corona* species-group in the United States is reviewed. Three species, one of which is polytypic, are recognized. These include *M. corona* from the Gulf Coast, *M. bicolor* from the Keys and Atlantic Coast, and a new species from the Spruce Creek Estuary of the Atlantic Coast. *M. c. corona* ranges from Cedar Key south to Cape Sable, Florida, and *M. c. johnstonei* ranges from Little Lagoon, Alabama, to Deckle-Keaton Beach, Florida. These two subspecies differ in shoulder and anterior end spine counts. An intergrade zone was found in the area between Deckle-Keaton Beach and Cedar Key, Florida. The second species, *M. bicolor*, ranges from Matanzas Inlet to the Dry Tortugas, Florida. This species is shown to differ in food habits and morphological details from its congeners. Morphometric data are presented to differentiate a new species of *Melongena* from the Spruce Creek Estuary of Florida.

RESUMEN

Se revisa el grupo de especies de *Melongena corona* de los Estados Unidos. Se reconocen tres especies, una de las cuales es politípica. Estas incluyen *M. corona* de la costa del Golfo de México, *M. bicolor* de los Cayos y la Costa Atlántica de Florida y una nueva especie del Estuario del Arroyo Spruce en la Costa Atlántica de Florida. En Florida, *M. c. corona* se distribuye desde el Cayo Cedar al norte hasta Cabo Sable al sur. *M. c. johnstonei* se distribuye desde Little Lagoon, Alabama hasta la Playa de Deckleton-Keaton, Florida. Estas dos especies se diferencian en el número de espinas anteriores y del hombro. Se encontró una zona de intergradación en el area entre la Playa de Deckle-Keaton y el Cayo Cedar, Florida. La segunda especie, *M. bicolor*, se distribuye desde el Islote Matanzas hasta Dry Tortugas, Florida. Esta especie difiere de otras especies congenéricas en hábitos alimenticios y detalles morfológicos. Se presentan datos morfométricos con el objeto de diferenciar una nueva especie de *Melongena* del Estuario del Arroyo Spruce en Florida.

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INTRODUCTION

The *Melongena corona* species group contains predatory gastropods that inhabit shallow subtidal and intertidal marine and brackish water habitats along the coasts of Florida and Alabama. They were first reviewed by Clench and Turner (1956) who recognized three species including *M. bispinosa* (Philippi, 1844), *M. bicolor* (Say, 1827), and the polytypic *M. corona* (Gmelin, 1791) (Table 1). Of these, *M. bicolor* and *M. corona* occur in the United States and are the subject of this investigation. Subsequently, Abbott (1974), considered these taxa subspecies of a single polytypic species.

The purpose of the present paper is to characterize variation in shell morphology from collections made within the range of the species group in the United States. The data gathered support a different set of taxa as compared to those recognized by Clench and Turner (1956) and Abbott (1974) who based their taxonomic decisions on visual cues alone. In particular, I present evidence that three species, rather than one or two, make up the species group in the United States.

Table 1. Comparison of the classification of the *Melongena corona* species group of Clench and Turner (1956) and the one adopted in the present paper.

Taxon	Range
Clench & Turner	
M. bispinosa (Philippii, 1844)	Yucatan
M. c. corona (Gmelin, 1791)	Keaton Beach to Cape Sable, Florida
M. c. johnstonei Clench & Turner, 1956	Gulf Shores, Alabama to Panacea, Florida
M. c. altispira Pilsbry & Vanatta, 1934	Cape Sable to Matanzas Inlet, Florida
M. bicolor (Say, 1827)	Biscayne Bay to Key West and the Dry Tortugas
Present paper	
M. bispinosa (Philippi, 1844)	Yucatan
M. c. corona (Gmelin, 1791)	Cape Sable to Cedar Key, Florida
M. c. johnstonei Clench & Turner, 1956	Panacea, Florida to Gulf Shores, Alabama
M. bicolor (Say, 1827)	Dry Tortugas to Matanzas Inlet, Florida
M. sprucecreekensis, n. sp.	Spruce Creek Estuary, Volusia County, Florida

ACKNOWLEDGEMENTS

Doug and Louise Compton, and Sue Hutchins provided information on a number of localities visited during the current study. Neil Avery, Neil Miller, Neil Rushton, Myra J. Tucker, and Moynell M. Tucker helped with the collection and preparation of specimens for the study. Jeannie L. Tucker assisted with the photography. Russell Jensen and Fred Thompson read a very early version of this manuscript, and their comments were most helpful and appreciated. Lauren E. Brown and Angelo Capperella read later versions.

MATERIALS AND METHODS

Statistical methods.– Except for maximum shell width to maximum shell length relationships, I used the SAS ANOVA and MANOVA statistical programs for the analysis of variance with the Waller-Duncan K-ratio *t*-test (Waller grouping) and Ryan-Einot-Gabriel-Welsch multiple range test (REGWQ grouping) selected for separation of means (SAS Institute 1988). I restrict presentation of means separations to the REGWQ results because they seem to be the most conservative. The general linear model was used for each, because sample sizes were unbalanced. For comparisons of maximum shell width to maximum shell length relationships among samples, I used analysis of covariance (ANCOVA) with the width as the dependent variable and maximum shell length as the covariate. Models were considered significant where $p < 0.05$. I also subjected means from Gulf Coast samples to cluster analysis.

Specimens examined.– I used specimens collected specifically for the study in order to standardize collecting methods. Specimens from museum collections were not used, because they were collected by methods unknown to me. Since these gastropods are usually numerous where they occur, the possibility that some criteria, such as size, appearance of the shell, coloration, or extent of spine development, used to select the specimens collected by others cannot be eliminated. Any criteria could bias samples. Consequently, all specimens used were collected by the author or by the author with the assistance of other collectors using one of two methods. In all cases, the potential collecting site was first surveyed to estimate the abundance of specimens. Transects were used at the Courtney Campbell and Port St. Joe localities, where specimens were exceedingly numerous. At each collecting point along a particular transect all specimens were collected. Collecting points were spaced at five meter intervals along the transects all of which were at least 100 meters long. The number and length of transects and collecting points varied. Transects were used only to avoid a priori selection of the collecting points and cannot be considered to produce random collections as the transect locations were not randomly selected. At the other localities every specimen encountered was collected.

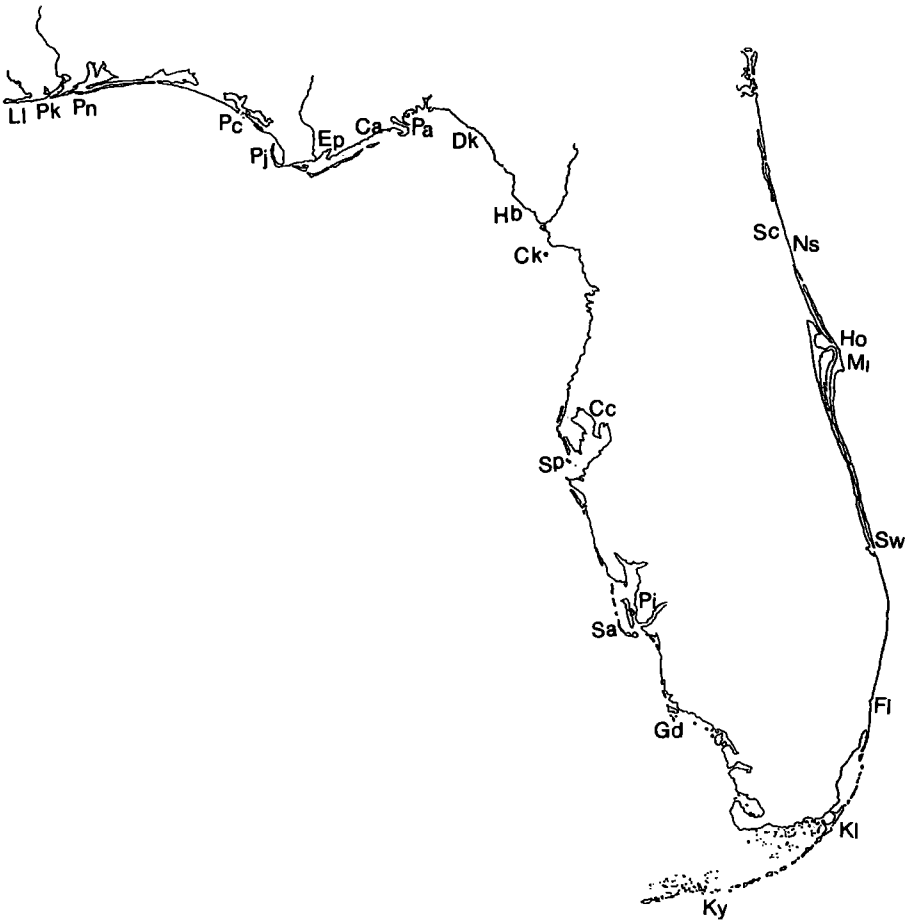


Figure 1. Coastal Florida and eastern Alabama showing approximate location of samples listed in Appendix 1.

Besides the type specimens of the new species from Spruce Creek, voucher specimens from the other localities are deposited in the Florida Museum of Natural History.

Samples.– The term sample refers to the groupings used in statistical treatment and has no biological reality. A total of 24 samples were constructed (Fig. 1). Each was assigned a two letter code and a number (Appendix 1). The numbers were assigned to allow graphical presentation of the data from each sample. Gulf Coast samples were numbered 1-16. East Coast samples were numbered 17, 19, 21, 23, 25, 27, 29, and 32. The numbers were assigned so that each graphical representation (Figs. 2A-D) devotes about equal space to Gulf and East coast samples. The numbers do not represent the distance between adjacent samples.

Biological populations are represented by 19 samples (Li, Pj, Ep, Ca, Pa, Hb, Ck, Cc, Sp, Sa, Pi, Gd, Kl, Fl, Sw, Mi, Ho, Ns, and Sc). Five samples were composites of from two to six populations. Populations of four of these (Pk, Pn, Pc, and Dk) were from the same immediate geographic area but, from my examination of the sites, likely contain individuals from more than one population. Spine counts and ratios and maximum shell width to maximum shell length relationships for these subsamples were first compared by MANOVA and ANCOVA, respectively. Since no significant ($p > 0.05$) differences were found, data from subsamples were combined. A fifth sample (Ky) was constructed with data from six more widely spaced populations due to the small sample sizes from each individual population. No statistically significant differences were found with MANOVA or ANCOVA among these subsamples.

Characters.– The following data were recorded where possible for each specimen. The abbreviation in parentheses is used hereafter. Maximum shell width (W) and maximum shell length (L) was measured to the nearest 0.1 mm with vernier calipers. Spine counts included both broken and entire spines. These counts included number of spines on the shoulder (S) and anterior end (AE) when complete. Occasional specimens have spine rows on the whorl tops and shoulder slope. Because they were only present in a few specimens, they were excluded from further consideration. One ratio, shoulder spine count divided by anterior end spine count (S/A), was derived for each specimen with a completed AE.

Unlike S, which appears in early shell growth stages, AE begins at a late or intermediate growth stage. Because L at completion and start of AE was thought to vary geographically, the pattern of development of AE was quantified by defining three criteria. First, L of the smallest specimen in the sample with AE completed was determined (= Min spine). Second, L of the largest specimen in the sample without any trace of AE was determined (= Max 0). Third, the mean L of specimens in the sample with incomplete AE (= Mean B) was determined.

Sex was determined by presence or absence of a penis. Individuals without a visible penis were considered females.

RESULTS AND DISCUSSION

Sexual dimorphism.– Collections from four samples (Sc, Mi, Cc, Sp), all collected within one week of each other, were analyzed for possible sexual dimorphism in W to L relationships, S, and AE. Models for all MANOVAs and ANCOVAs were not significant at the 0.05 level.

Size-dependent variation.– Six samples (Pj, Hb, Ck, Cc, Sc, and Mi) contained sufficient specimens to look for evidence of size dependent variation in W to L relationships and S. Specimens from each sample were divided into five size classes. The size class boundaries were arbitrarily set at 30 mm increments of L. The localities chosen were selected using two criteria. First, specimens must have been collected in the same immediate area so that the data represent variation in biological populations. Second, at least fifteen individuals must be present in each of two or more size classes. Results from ANOVAs for S and ANCOVA for W to L relationships were not significant at the 0.05 level in any of the samples.

Variation in food habits.– During the course of this study, I made observations of prey selection. Along the Gulf Coast and at Spruce Creek, I found prey items included pelecypods, primarily oysters. Gunter and Menzel (1957) made similar observations in Apalachicola Bay. On the other hand, in East Coast specimens that I observed, all prey items were gastropods, in concurrence with the observations of Clench and Turner (1956).

I also observed variation in prey preference within the East Coast group. I found those from the coastal Floridian samples (observations made for Mi, Ho, and Ns) selecting the sessile vermetid gastropod, *Petaloconchus varians* (Orbigny 1841), a species not previously reported in the diet of *Melongena*. Specimens from the Keys and Biscayne Bay (samples Ky and Kl) were observed feeding on small species of *Cerithium*, confirming the observations of Butler reported by Clench and Turner (1956). I did not observe any predation on pelecypods, though they were present.

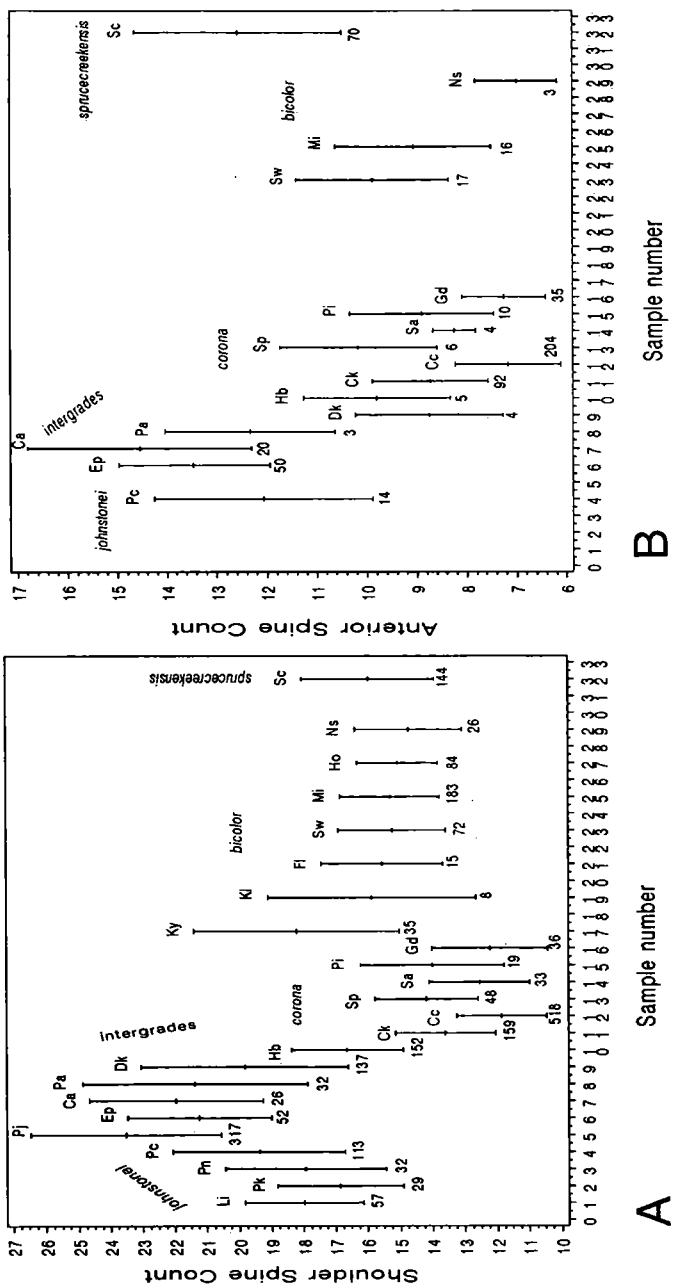
Geographic variation.– For W to L relationships, results of ANCOVA were highly significant. Table 2 contains a listing of samples and those samples that do not differ significantly from them. Results of MANOVA for S, AE, and S/A, which included all samples, were also significant ($p < 0.05$). Details from these analyses are presented separately for Gulf Coast and East Coast samples.

Table 2. Results of ANCOVA for dependent variable width with covariate length by the effect of locality. Sample abbreviations are explained in Appendix 1.

Species/subspecies	locality	w/l	n	Results of ANCOVA not different from:
Melongena corona johnstonei	Li	0.57	57	[none]
	Pk	0.56	29	Pn, Pc, Ep
	Pn	0.56	32	Pk, Ep
	Pc	0.56	113	Pk
	Pj	0.59	317	Ca, Pa, Dk, Hb
	Ep		0.57	52 Pk, Pn
	Ca	0.60	137	Pj, Pa, Dk, Hb
	Pa	0.58	32	Pj, Ca, Hb
	Dk	0.59	137	Pj, Ca, Pa, Hb
	Hb	0.60	152	Pj, Ca, Pa, Dk, Sp
	Ck	0.61	159	Cc, Sp, Sa, Pi
	Cc	0.61	518	Ck, Sa, Pi
	Sp	0.60	48	Hb, Ck, Sa
	Sa	0.59	33	Ck, Cc, Sp, Pi
	Pi	0.62	19	Ck, Cc, Sa
M. c. corona	Gd	0.65	36	[none]
M. bicolor	Ky	0.55	35	Kl
	Kl	0.53	8	Ky
	Fl	0.57	15	Sw, Mi, Ho, Ns
	Sw	0.59	72	Fl, Mi, Ho, Ns
	Mi	0.60	183	Fl, Sw, Ho, Ns
	Ho	0.59	84	Fl, Sw, Mi, Ns
	Ns	0.61	26	Fl, Sw, Mi, Ho
M. sprucecreekensis	Sc	0.54	144	[none]

Gulf Coast Samples (Figs. 4A-J).– Of the three subspecies of *M. corona* (Table 1) that Clench and Turner (1956) recognized, two of them, namely the nominate race and *M. c. johnstonei* were said to occur along the Gulf Coast from Little Lagoon, Alabama, to Cape Sable, Florida. Clench and Turner (1956) suggested that specimens from between Keaton Beach and Panacea, Florida, were intergrades between *M. c. corona* and *M. c. johnstonei*. Clench and Turner based their concepts on the widely used nonnumeric method of simply looking at specimens from many locations and reporting the differences they observed without statistical analysis. My conclusions about the Gulf Coast specimens, which are supported by statistical treatment of numeric data in general, mirrors their conclusions.

Statistical analysis supported recognition of two Gulf Coast subspecies of *M. corona*. Visually, specimens from Li and Gd look very different. The latter are broad bodied with a few large shoulder spines, whereas the former are narrower


Shoulder Spine Count
Anterior Spine Count
Sample number
Sample number
A
B
johnstonei
intergrades
corona
bicolor
spruceecreekensis
Pj
Ca
Pa
Ep
Pc
Pn
Li
Pk
Dk
Hb
Ck
Cc
Sa
Sp
Pi
Gd
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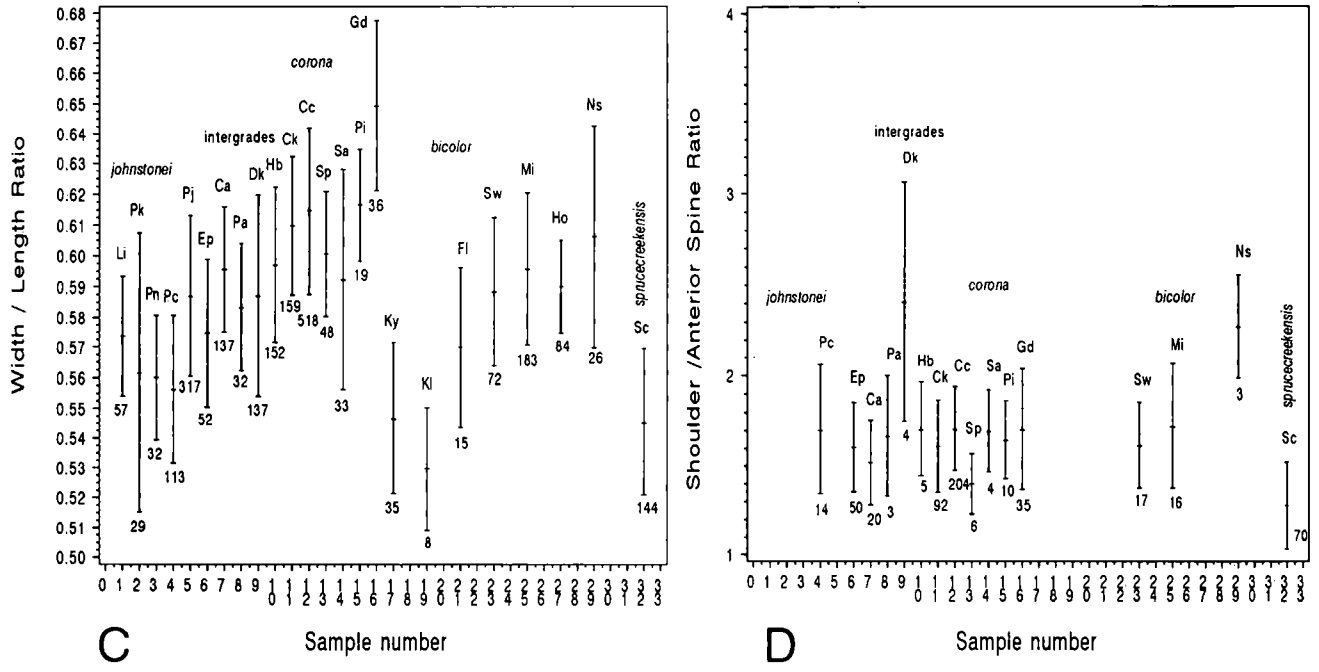

Figure 2. (A) comparison of S (y-axis); (B) comparison of AE (y-axis); (C) comparison of W/L (y-axis); and (D) comparison of S/A (y-axis) of the *Melongena corona* species group. Gulf Coast samples are arranged so that the western most sample is on the left side of each figure and the southeastern most sample is in the right middle of each figure. East Coast samples are arranged so that the southern most sample is in the right middle of each figure and the northern most sample is at the right side of each figure. Separation of adjacent samples does not correspond in any way to geographic distances between samples. The horizontal line represents the mean while the vertical line represents the mean plus one standard deviation. Letter codes above the vertical lines are sample abbreviations (Appendix 1 contains localities included in each sample). Numbers at the bottom of the vertical lines are sample sizes.

bodied and have many relatively small shoulder spines. However, these two extremes result from more or less clinal variation in S (Fig. 2A), AE (Fig. 2B), and W/L (Fig. 2C).

However, the clines producing the end members isolated as subspecies by Clench and Turner and myself are not simple and considerable interpopulational variation exists complicating them. If the clines were gradual, then geographically adjacent samples should not differ significantly in the ANCOVA for W to L relationships and the REGWQ groupings should align samples from west to southeast for the spine counts. Deviations from this pattern are discussed separately for each character.

The cline in S (Fig. 2A) at first rises from Ll to Pj and then falls from Pa to Cc. Means for S from Ll, Pk, and Pn do not differ (Table 3A) from each other but are lower than those from Pj, Ep, Ca, Pa, and Dk (Table 3A). Because mean S declines from Pa to Cc, they pass through the level of the means of S for the western four samples. As a consequence, means of S for Ll, Pk, Pn, and Pc do not differ from those of Hb (Table 3A). The area included in the decline in mean S from Pa to Ck closely corresponds to the intergrade zone reported by Clench and Turner (1956). Samples from Cc, Sp, Sa, Pi, and Gd have S means that are lower than any determined for the other Gulf Coast samples (Table 3A). These samples are all contained in the area Clench and Turner (1956) suggested was occupied by *M. c. corona.*

The cline in AE more or less parallels the cline in S. However, the far western samples contained no (for Pk and Pj) or only one (for Ll and Pn) specimen that have completed AE which makes interpretation uncertain. However, the pattern for AE (Fig. 2B) resembles that for S (Fig. 2A). Mean AE rises to a high at Ca (Table 3C) then falls to a low at Cc. If the REGWQ groupings for S and AE are compared, the rankings for each sample are roughly similar. However, sample sizes for AE are small for some samples as compared to S.

If the changes in S and AE number parallel each other, then the ratio between S and AE (S/A) should not show evidence of much variation that can be related to geography. With one notable exception, this is true (Table 3B). Dk has a relatively high S/A and is significantly different from all other samples (Fig. 2D). This may indicate that the clines for S and AE are not closely aligned. However, the sample size (n = 4) is small for the Dk sample.

The cline in W/L (Fig. 2C) appears more regular with W/L increasing from Ll towards Gd and does not seem to follow the pattern of rise and then fall found for S and AE. However, the ANCOVA results mirror the pattern in S and AE. Pk, Pn, and Pc are more similar (ANCOVA not statistically different) to each other than they are to those of Pj, Ca, and Pa (Table 2). Samples Ck, Cc, Sp, Sa, and Pi are more similar (ANCOVA not statistically different) to each other than they are to Hb, Dk, Pa, Ca, Ep, and Pj which in turn are more similar (ANCOVA not statistically different) to each other than they are to Pk, Pn, and Pc. These three sample groupings (Li-Pk-Pn-Pc, Pj-Ep-Ca-Pa-Dk-Hb, and Ck-Cc-Sp-Sa-Pi-Gd) are

Table 3. REGWQ Groupings for samples from the Gulf Coast sites possessing the character Manova included characters S, S/A, and AE. Samples with the same letter have means that are not significantly different.

A for S sample			B for S/A sample			C for AE sample			D for mean B sample				E for mean B sample (n>20)	
Site	Mean	Group	Site	Mean	Group	Site	Mean	Group	Site	Mean	n	Group	Site	Group
Pj	23.5	A	Dk	2.59	A	Ll	17.0	A	Ca	108.4	4	A	Pc	A B
Ca	22.0	B	Pn	2.13	A B	Ca	14.6	A B	Sc	97.1	69	A B	Ck	C B
Pa	21.4	B	Hb	2.03	C B	Ep	13.5	B	Pc	95.2	35	A B	Dk	C
Ep	21.2	B	Cc	1.71	D C B	Pa	12.3	C B	Ck	84.8	52	C B	Sp	C
Dk	19.8	C	Gd	1.70	D C B	Pc	12.1	C	Pi	82.0	8	C B	Hb	C
Pc	19.4	C	Pc	1.70	D C B	Sp	10.2	C D	Pn	79.1	11	C B	Cc	D
Ll	18.0	D	Sa	1.69	D C B	Hb	9.8	E C D	Ep	77.6	2	C B		
Pn	17.9	D	Pa	1.67	D C B	Pi	8.9	E D	Pk	77.4	7	C B		
Pk	16.9	D	Pi	1.65	D C B	Dk	8.8	E D	Ll	75.4	3	C B		
Hb	16.6	D	Ck	1.61	D C B	Ck	8.7	E D	Pa	72.7	7	C B		
Sp	14.2	E	Ep	1.61	D C B	Sa	8.3	E D	Dk	69.4	41	C		
Pi	14.0	E	Ca	1.52	D C B	Pn	8.0	E D	Gd	69.0	1	C		
Ck	13.6	E F	Sp	1.40	D C	Gd	7.3	E D	Pj	66.2	9	C D		
Sa	12.5	G F	Ll	1.18	D	Cc	7.2	E	Sp	61.1	21	C D		
Gd	12.2	G							Hb	61.0	61	C D		
Cc	11.9	G							Sa	45.4	9	E D		
									Cc	38.8	208	E		

close to the geographic distributions of *M. c. johnstonei, johnstonei-corona* intergrades, and *M. c. corona*, respectively, of Clench and Turner (1956).

The presence or absence of AE can also be used as a taxonomic character so long as it is related to shell length, because AE appears at some stage of growth and is not present at all growth stages. Table 5 contains data from samples where at least 30 specimens had begun but not completed AE. It is interpreted by me to show that specimens from western samples, such as Pk, Dk, and Hb, begin development of the AE spine row at a larger size (bigger Mean B) than do those from sample Cc. ANOVA for L among specimens with AE started for Gulf Coast samples with more than 30 specimens support differences between western and southern samples in the size at appearance of AE in samples with more than 30 specimens (Table 3E), because samples align geographically by Mean B. If all Gulf Coast samples are included (Table 3D), then the relationship is less obvious.

The results discussed above suggest much the same conclusions about Gulf Coast *Melongena* that were reached by Clench and Turner (1954). These are that the Gulf Coast *Melongena* are conspecific with each other and that two subspecies can be recognized. The nominate race, *M. c. corona*, ranges from Cedar Key south to Goodland. I also found dead specimens of M. c. *corona* at Everglades City and Flamingo. The second subspecies, *M. c. johnstonei*, ranges from Little Lagoon, Alabama, to Panacea, Florida. Intergrades between these two subspecies occur from Panacea to Cedar Key.

Cluster analysis (Fig. 3) strongly supports recognition of two subspecies, because all of the samples from areas containing shells identified as *M. c. corona* by Clench and Turner (1956) separate out from those that they and I identified as *M. c. johnstonei* or as intergrades. Cluster analysis is not as successful in isolating *M. c. johnstonei* from intergrades. This is due to the rise and fall in S and AE counts in the region occupied by *M. c. johnstonei* and the intergrades previously noted.

This pattern of variation may be attributable to the two major rivers that enter the Gulf of Mexico within the range of *M. corona*. Variation in S demonstrates a possible effect on clinal variation by the rivers. Two changes in S can be seen in Figure 2A. The most westerly of these occurs between Pc and Pj which straddle Apalachie Bay where the Apalachicola River enters the Gulf. At this point S is higher than for those samples to the west (Table 3A) but begins a decline to a low at the second more dramatic change between Dk and Ck which straddle the mouth of the Suwannee River. The three groupings suggested to exist by the results of the ANCOVA for W and L relationships also break at these points. Specimens from Ck south also cluster together (Fig. 3).

These rivers may act as barriers to gene flow in the species. The postulated effect of these rivers on *Melongena* is speculative, but it is known that *M. c. johnstonei* becomes inactive when exposed to lowered salt concentrations (Gunter and Menzel, 1957). This snail has no planktatrophic stage and hatches at a crawling stage rather than as a floating veliger or larval shell (Clench and

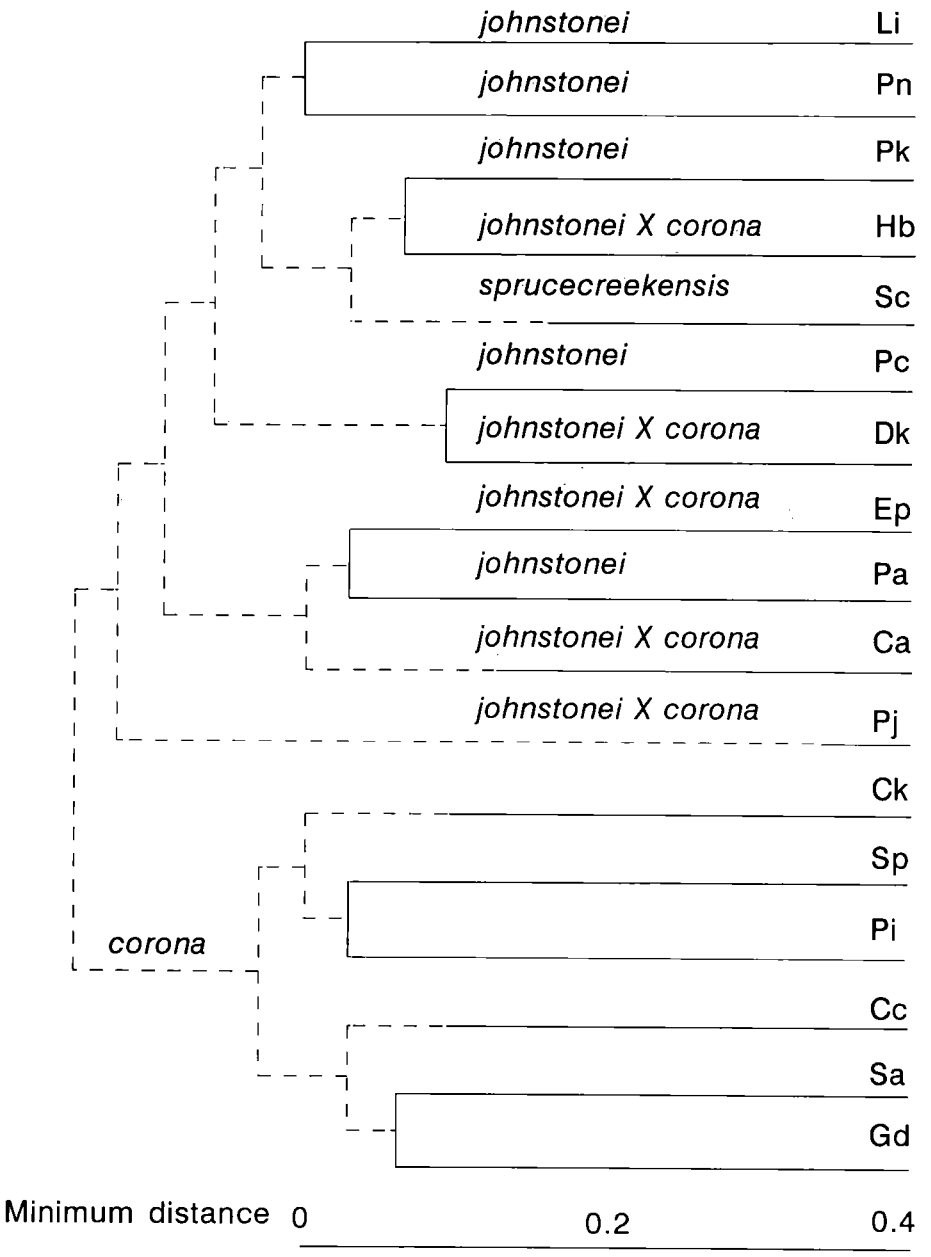

Figure 3. Linkages and minimum distances for cluster analysis of all Gulf Coast samples and *M. sprucecreekensis* (Sc) for characters S, W/L. AE, and S/A. Sample abbreviations are explained in Appendix one. Solid lines represent minimum distances while dashed lines represent linkages between clusters.

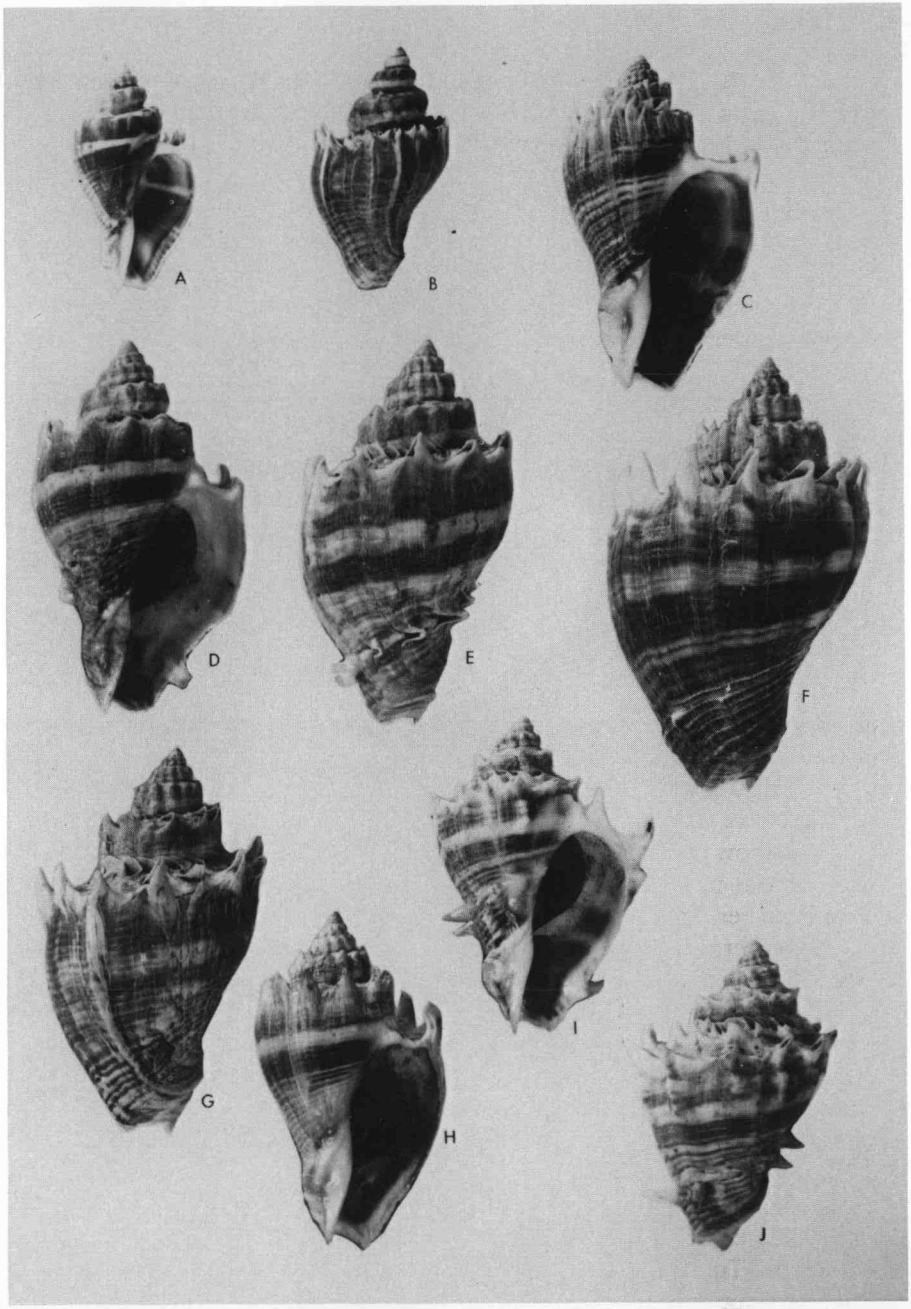

Figure 4. *Melongena corona*. *M. c. corona* from Ck (Figs. A, G), shell lengths 88.5 (A), and 76.8 mm (G); *M. c. corona* from Cc (Figs. H-I), shell length 73.1 mm (H-I); B, C, *M. c. johnstonei* topotypes from Ll, shell lengths 73.2 mm (B) and 69 (C); *M. c. corona* X *M. c. johnstonei* from Dk (Figs. D, E), shell length 89.4 mm (D, E); from Pj (Fig. F), shell length 96.2 mm; from Hb (Fig. J), shell length 99.0 mm

Turner, 1956). These two observations suggest that it is not unreasonable to associate areas of possible reduced gene flow as elucidated from changes in shell characters with influxes of fresh water.

East Coast Samples (Figs. 5A-E, 6A-C).– Clench and Turner (1956) recognized two entities, *M. c. altispira* and *M. bicolor* from the East Coast of Florida. Clench and Turner (1956) thought the latter differed from the former "by being smaller, much lighter in color and having more and better developed shoulder spines." Clench and Turner (1956) did not quantify these suggested differences.

I believe that the data presented herein suggest that these two East Coast taxa are slightly differentiated forms of a single species. Variation in W/L and S show more or less gradual clinal changes (Figs. 2A, C). Variation in S/A also may be clinal (Fig. 2D), a reflection of AE counts that decrease faster than S counts do (Figs. 2A, B). However, this purported cline is generated by data collected from just three specimens at Ns that had completed AE.

Of the samples compared for S only the Ky sample differs significantly from the others (Table 4A). ANCOVA for W to L relationships mirrors the MANOVA for S. The Ky and Kl samples, while not significantly different from each other (Table 2), differ from the other samples, which in turn do not differ from each other. Such a result would be expected if a cline existed due to the considerable distance between the Fl and Kl samples.

My data do support Clench and Turner's contention that the specimens from the Keys have more spines than those from other East Coast areas. However, my data also show that this difference is rather minute and the result of a cline. This suggests that the East Coast *Melongena* are not sufficiently differentiated by the shell characters I studied to recognize subspecies.

However, I made no effort to quantify coloration, which Clench and Turner (1956) also used to differentiate the two taxa they recognized. Coloration of Ky and Kl specimens is very pale. Few specimens were found that had dark banding on the anterior end, which is usually present in specimens from more northern East coastal localities. Many but not all of the Ky and Kl specimens also have the shoulder spines greatly reduced in size, and a number had no spines at all. This is rare among specimens from other East Coast samples. However, at least some specimens from every other sample were as pale as the Ky and Kl specimens. Consequently, the East Coast *Melongena* should be identified as *M. bicolor*.

Whether *M. bicolor* and *M. corona* are conspecific or not remains a problem. Clench and Turner (1956) reported specimens that they identified as *M. c. altispira* from the Cape Sable region and in the same area that they recorded *M. c. corona*. They made no mention of an intergrade zone. During the current study none of the Florida Bay coastal areas investigated produced living specimens. Some dead shells were encountered, all of which were *M. c. corona* similar to those from Gd.

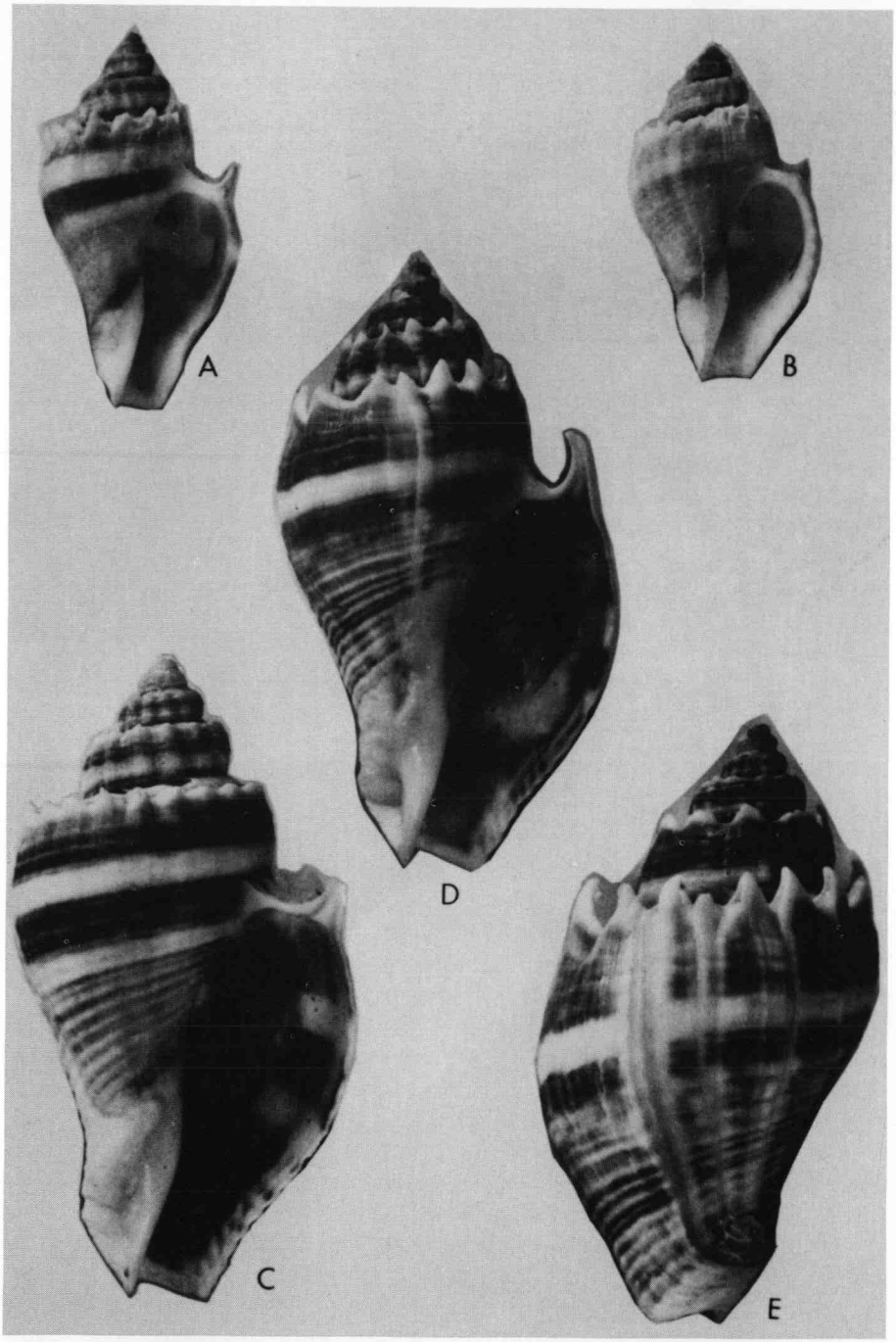

Figure 5. *Melongena bicolor*. A, from Kl shell length 40.0 mm; B, from Ky shell length 36.2 mm; C, from Ns shell length 66.4 mm; D, E from Mi shell length 63.1 mm. Sample abbreviations are explained in Appendix 1.

Comparison of the my data for the Gd sample and the geographically closest samples of *M. bicolor* (Kl and Ky) demonstrate that significant morphological differences exist. The relationship for W to L is significantly different, as are spine counts (Figs. 2A, C). The Gd sample includes shells with higher W/L and lower S than any sample from the East Coast or Keys. In fact, all of the samples I identify as *M. c. corona* (Cc, Sp, Sa, Pi, and Gd) differ significantly from the Ky and Kl samples of *M. bicolor*. Besides these statistical differences, clinal variation in W/L of the two are exactly opposite. In *M. corona* the cline shows an increase in W/L from north to south, whereas in *M. bicolor* the cline is one of increasing W/L from south to north.

Since these two differ morphologically as well as in food habits, the present paper recognizes two closely related, allopatric or parapatric species, namely *M. bicolor* and *M. corona*.

Finally, a population was discovered in the Spruce Creek Estuary (Spruce Creek, Strickland Bay, and Turnbull Bay) in Volusia County, Florida, that are markedly different morphologically from surrounding populations of *M. bicolor* and are distinguishable from Gulf Coast populations of *M. corona* as well.

Melongena sprucecreekensis, new species
Figure 6A-C

Description.-- The shell reaches at least 185 mm in length and is solid and strongly sculptured. Mean W/L is 0.55. The shell is white in color but that is overlain by two, or less commonly, three brown to grey bands of varying width. The color bands are located on the body whorl with one anterior and one posterior to the midbody region. Occasionally the posterior band is subdivided into two bands by an intervening light colored area. Since the spire is scalariform, the posterior color band is also exposed on the spire whorls. There are 7-10 convex whorls. The aperture is subovate in shape. The widest portion of the body is located well anterior of the shoulder. The outer lip may be thin or thick and crenulate at least in specimens that are longer than 90 mm. The columella is broad and twisted. The sculpture consists of a row of strong, erect to recurved spines along the whorl shoulder. A row of spines may be present near the anterior end. Shoulder spines average 16.03 (range 12-22). Anterior end spines number between 9 and 17 with a mean of 12.43. The S/A ratio is 1.26. At the suture there are numerous imbrications or frills representing previous growth stages of the anal canal. In specimens more than 120 mm long, these imbrications may be raised into spines. The operculum is horny, approximates the shape of the aperture, and has a terminal nucleus. The periostracum is smooth, dull, and greenish in color. The radula is identical to that of *M. c. johnstonei* (see Clench and Turner 1956, plate 96). Egg capsules are also similar to those of *M. c. johnstonei*.

Types.– The holotype (UF 40336) and ten paratypes (UF 40337) are deposited in the Florida Museum of Natural History, University of Florida, Gainesville, Florida. Fifty other paratypes were also designated with ten each being deposited in the National Museum of Natural History (USNM 792416), American Museum of Natural History (AMNH 206086), Delaware Museum of Natural History (DMNH 155535), Los Angeles County Museum of Natural History (LACM 2033) and San Diego Natural History Museum (TS 81658).

Type locality.– The type locality is designated as 7.26 km (4.5 miles) north of New Smyrna Beach, Volusia County, Florida, where U. S. Route 1 crosses Strickland Bay of the Spruce Creek Estuary.

Remarks.– This species is known only from the Spruce Creek Estuary along the northeastern coast of Florida. An intensive search for further populations of the species was made in the Halifax River to the north of Spruce Creek and in the Indian River Lagoon to the south. Although *M. bicolor* was found both to the north (Daytona Beach-dead specimens only) and to the south (New Smyrna Beach) of the Spruce Creek system none was found in the system itself.

Comparison.– The new species differs from surrounding populations of *M. bicolor* in shell morphology and food habits.

Among the data collected during the current study, S/A and AE for the Sc sample are statistically different for those determined for specimens of *M. bicolor* (Table 4B, C). Even though W/L ratios of *M. sprucecreekensis* are numerically similar to those of the Ky and Kl samples, ANCOVA separates the Sc sample from all *M. bicolor* samples as well as from all *M. corona* samples.

Although it has not been tested experimentally, Figures 2B-D suggest that little or no gene flow exists between the Sc sample and neighboring samples of *M. bicolor*. Besides differences in means for spine counts, the developmental pattern of anterior end spine row also differ. *M. sprucecreekensis* has a distinctly higher value of Mean B when compared to *M. bicolor*. Min Spine is also higher in *M. sprucecreekensis* than it is in any population of *M. bicolor*. Thus specimens of *M. sprucecreekensis* smaller than 58 mm are unlikely to have any sign of the anterior end spine row, while most specimens of *M. bicolor* of this size (and smaller) will have the spine row started.

These two species also differ in food habits. *M. sprucecreekensis* feeds primarily on oysters (Fig. 6C), with some other bivalves also being taken, whereas *M. bicolor* feeds primarily on gastropods.

Finally, *M. sprucecreekensis* reaches a size unknown in *M. bicolor*. Clench and Turner (1956) reported a maximum shell length of 72 mm for *M.*

Table 4. REGWQ Groupings for samples from the East Coast sites possessing the character. Manova included characters S, W/L, S/A, and AE. Samples with the same letter have means that are not significantly different. Sample abbreviations are explained in Appendix 1.

A For S Sample			B For S/A Sample			C For AE Sample			
Sites	Mean	Group	Sites	Mean	Group	Sites	Mean	Group	
Ky	18.2	A	Ns	2.27	A	Sc	12.6	A	
Sc	16.0	B	Mi	1.72	B	Sw	9.9	B	
Kl	15.9	B	Sw	1.62	B	Mi	9.1	B	C
Fl	15.6	B	Sc	1.28	C	Ns	7.0		C
Mi	15.3	B							
Sw	15.2	B							
Ho	15.1	B							
Ns	14.7	B							

bicolor. The largest specimen observed in my study was 89 mm in maximum shell length. *M. sprucecreekensis* reaches at least 185 mm in maximum shell length. Absolute size is of course a difficult character to use in determining conspecificity. It is always possible that utilization of oysters as prey items in some way enhances growth, and the observed differences are ecological and not genetic. This seems unlikely to me, because smaller specimens from Sc do not differ from larger ones in morphological parameters.

M. sprucecreekensis more closely resembles certain populations of *M. corona* from the Gulf Coast, even though it is located geographically closest to populations of *M. bicolor*. While it is statistically different in W to L relationships, in AE it is statistically identical to Pa, Pc, Sp, and Hb samples from the Gulf Coast.

M. sprucecreekensis also resembles the subspecies of *M. corona* in food habits. Both primarily predate on pelecypods.

It may seem anomalous that the morphological parameters and food habits of *M. sprucecreekensis* more closely resemble those of cross-state *M. corona* than it does the surrounding populations of *M. bicolor*. There are at least three possible explanations.

First, the Spruce Creek population could represent a relatively recent introduction of Gulf Coast specimens to the Spruce Creek area by human or natural means. This possibility is considered remote as morphometric parameters of *M. sprucecreekensis* should approximate those of one of the Gulf Coast samples if this were an introduction. In S, Sc is statistically identical to Hb and Pk of the Gulf Coast. In AE, Sc is statistically identical to Ep, Ca, Pa, Pc, Sp, and Dk. In Mean

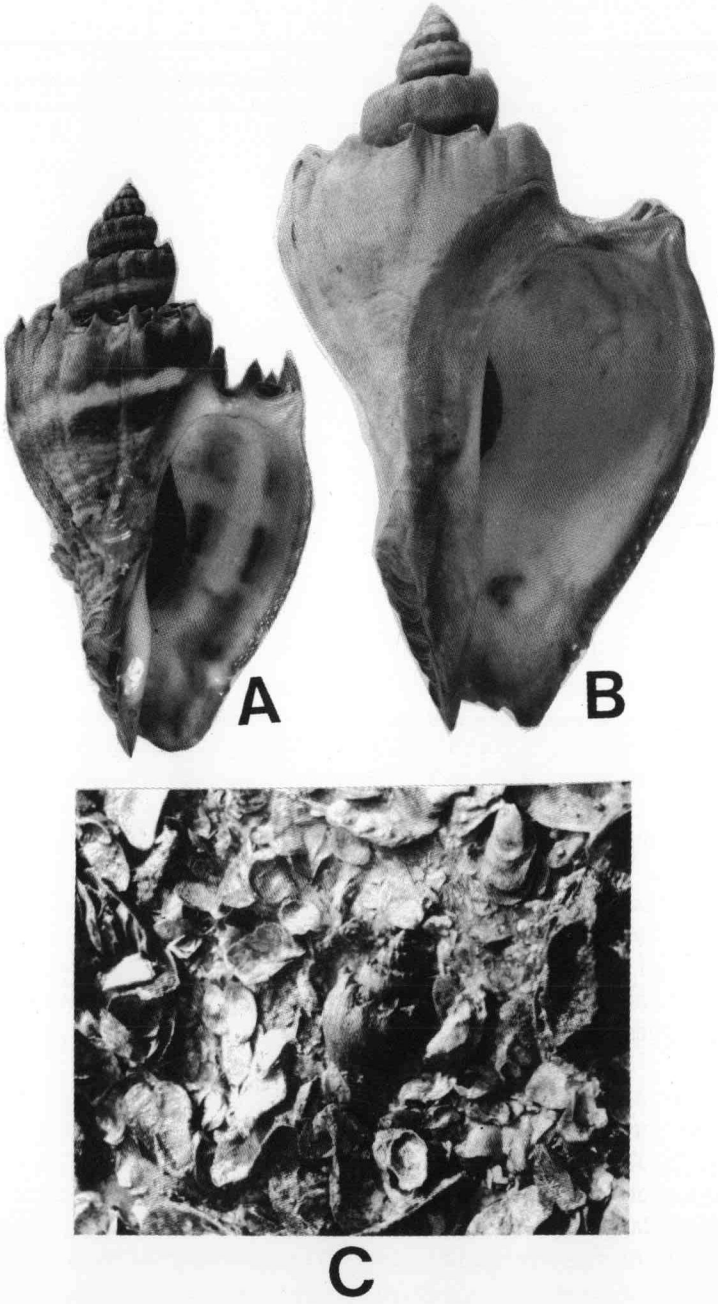

Figure 6. A-C, *Melongena sprucecreekensis*, n. sp. A, paratype, shell length 151 mm; B, holotype, shell length 185 mm; C, a specimen *in situ* on an oyster bar at the type locality. Sample abbreviations are explained in Appendix 1.

Table 5. Developmental pattern of anterior end spine row in several populations of the *Melongena corona* species group. Sample abbreviations are explained in Appendix 1. All measurements are in mm.

Taxon/ sample	Max. 0	Min. spine	Mean B	n
corona johnstonei				
Pc	122.1	78.8	97.1	35
corona X johnstonei				
Dk	103.2	69.3	69.4	41
Hb	93.6	52.7	61.0	61
Ck	104.6	74.3	84.8	52
corona corona				
Cc	58.2	29.9	38.8	208
sprucecreekensis				
Sc	74.7	61.2	98.5	69

B, Sc is statistically identical to Ca and Pc. Sc clusters with Pk and Hb (Fig. 3). Although it resembles Gulf Coast specimens in a general way, it does not match up with any sample from the Gulf Coast.

Second, *M. sprucecreekensis* could represent a phenotypical response to the particular conditions found in the Spruce Creek area by specimens that are genotypically similar to the surrounding populations of *M. bicolor*. *M. bicolor* does occasionally prey on bivalves and may be associated with oysters in some areas of the Indian River (J. Johnson, pers. comm.). A large East Coast *Melongena* that feeds on oysters may simply reflect faster growth rates under those conditions. However, *M. sprucecreekensis* differs from equal sized *M. bicolor* in all counts and ratios. *M. sprucecreekensis* is significantly narrower bodied at all growth stages than is *M. bicolor*. Such consistency in morphological differences strongly suggests to me that *M. sprucecreekensis* is not an ecotypic variant of *M. bicolor*.

Finally, *M. sprucecreekensis* may be a Pleistocene relict that reached the East Coast from the stock now restricted to the Gulf Coast during a period of elevated sea level (Cooke, 1939). Left behind by falling sea levels, it was isolated by the colonization of the East Coast by *M. bicolor*. This hypothesis cannot be tested from the available data. However, it should prove amenable to allozyme testing, as was done for the Seaside sparrow (*Ammodramus maritimus*) by Avise and Nelson (1989).

The molluscan fauna of Florida has been extensively studied, and thus it is unexpected that such a large species has remained undiscovered for so long. However, the validity of *M. sprucecreekensis* is supported by morphometric

differences and by differences in food habits as compared to the parapatric *M. bicolor*. One could argue that what I identify as a full species should be considered a subspecies of *M. corona* because no one trait studied by me will separate every individual of *M. sprucecreekensis* from every individual of *M. corona*. Whatever the taxonomic status, it is important to recognize that, within a reasonable degree of certainty from the shell traits reported herein, an entity genetically distinct from *M. bicolor* exists along the East Coast.

Unlike most molluscan species along Florida's rapidly developing and already heavily developed East Coast, *M. sprucecreekensis* inhabits a limited range. It also appears to be dependent on oysters for food. Consequently, any development in the Spruce Creek Estuary that adversely impacts the oyster populations will adversely impact *M. sprucecreekensis*. Development has not left this area untouched. Much of the eastern part of the system is developed, and other projects are planned for both the upstream and downstream portions of the estuary. Although quantitative studies of relative abundance have not been completed, preliminary data indicates that oyster bars, a focus of activity for *M. sprucecreekensis*, support far fewer individuals in developed parts of the system than is the case in relatively undeveloped Strickland Bay area.

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APPENDIX 1

The abbreviations and locality numbers used in the tables and figures are listed with each followed by the locality or localities from which specimens making up that particular sample were collected. The number in parenthesis is the number of specimens collected at each locality.

Gulf Coast. 1-Li, Little Lagoon, 7 miles west of Gulf Shores, Alabama on Alabama route 180 (57); 2-Pk, Alabama end of Perdido Key (4), Cotton Bayou, Orange Beach, Alabama (11), Big Bayou, Orange Beach, Alabama (14); 3-Pn, U. S. route 98, north of Gulf Breese, Pensacola, Florida (13), U. S. route 98, north of Pensacola Beach, Santa Rosa Sound (15), Florida route 292, 3 miles east of Pensacola, Santa Rosa Sound (4); 4-Pc, Florida route 77 bridge across bayou George (49), U. S. route 98 bridge to Tyndall Air Force Base, along bridge abutment on the base (64); 5-Pj, Port St. Joe, along U. S. route 98, St. Joseph Bay (315); 6-Ep, U. S. route 98, 1 mile east of East Point, Florida (52); 7-Ca, halfway between Carabelle and Lanark Village on U. S. route 98 (26); 8-Pa, end of Florida route 372A near Panacea (29); 9-Dk, outside Deckle Beach on Florida route 361 (86), outside Keaton Beach on Florida route 361 (32), Jug Island off Florida route 361 (19); 10-Hb, outside Horseshoe Beach on Florida route 351 (149); 11-Ck, both sides of Cedar Key along Florida route 24 (164); 12-Cc, along both sides of Courtney Campbell Causeway (Florida route 60) in Tampa Bay (518); 13-Sp, rest area on south end of the Sunshine Skyway bridge, St. Petersburg (48); 14-Sa, causeway between Sanibel and Captiva Island, on the inland side (33); 15-Pi, Pine Island Sound off Pineland (19); 16-Gd, east side of Marco Island, Goodland (36).

East Coast and the Keys. 32-Sc, junction of Spruce Creek and U. S. route 1 (144); 29-Ns, along the Indian River Lagoon where U. S. route A1A crosses, west side of bridge (26); 27-Ho, Indian River, 1/4 mile north of Haul-Over canal, Merritt Island, on the east side of river (84); 25-Mi, Florida route 520 bridge between Merritt Island and Cocoa Beach, in the Banana River (183); 23-Sw, causeway between Port Sewall and Sewall's Point on U. S. route A1A (72); 21-Fl, at the end of Florida route 84 (15); 19-Kl, east end of Key Largo on both Florida Bay and Atlantic sides (18); 17-Ky, along U. S. route 1 on the Gulf of Mexico side of the road at the following keys: Ramrod Key (13), Bahia Honda Key (16), Little Duck Key (1), Marathon Key (4) and Lower Matecumbe Key (2).

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