VARIATION IN THE GENUS *ORTHAULAX* (MOLLUSCA: GASTROPODA)

HAROLD E. VOKES*
and
EMILY H. VOKES*
TULANE UNIVERSITY

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ILLUSTRATIONS

I. ABSTRACT

A study of approximately 750 specimens of *Orthaulax gabbi* Dall, from the Chipola Formation of northwestern Florida, reveals a high degree of variation in the spire height, spire angle, and nature of the cross-sectional outline of the shell. As these characteristics are the criteria upon which new species have been distinguished in the past it is probable that several of the existing taxa, if adequately known, would be found to be synonyms.

The eleven described species of *Orthaulax* are listed with their stratigraphic occurrence. In addition, *O. gabbi* is discussed in greater detail and the color pattern of the species is figured.

II. INTRODUCTION

In the almost 100 years since Gabb first described the bizarre strombid genus *Orthaulax* (1873, p. 272; type species: *O. inornatus*) a number of species and subspecies have been described. Almost all of these were based upon but one or two specimens and were differentiated by such characteristics as spire height, spire angle, or nature of the cross-sectional outline of the shell.

In the Tulane Geological Collections we are fortunate to have a large number of specimens of a single species, *O. gabbi* Dall, from the same stratigraphic level, the Chipola Formation of northwestern Florida (approximately 750 specimens from 27 localities). Although perfect specimens complete with outer lip are less common than broken specimens, nevertheless a good percentage are almost complete. Even superficial examination of this collection makes it immediately apparent that there is a high degree of variation within one "population" in the above-mentioned "specific" characteristics. It is possible to match a Chipola specimen with every described species to a greater or lesser degree of exactness. This is not to suggest that all of the described species are synonyms, but certainly many of them are suspect and one should be very hesitant to name any new species of *Orthaulax*.

The details of the various attributes and geologic position of the species of *Orthaulax* have been summarized by Cooke (1921) and Woodring (1923). The genus is widespread in the upper Oligocene and lower Miocene beds of the southern United States and especially in the Caribbean area. Its presence in the Chipola Formation has been taken as an indication of the lower Miocene age of that formation but this seems to be

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rather *ad hoc* reasoning. *Orthaulax* is a good example of a "facies fossil," in that it is almost always confined to limy beds. In the Chipola Formation, for example, the majority of the specimens occur along the Chipola River and Farley Creek, a tributary to the east. Here the Chipola is an unconsolidated calcarenite with local coral reef development. To the west, on Ten Mile Creek, the facies changes markedly to a fine arenaceous clay, and here *Orthaulax* is almost completely lacking. The single exception to this facies control in the Chipola Formation is at Alum Bluff (the lower part) where *Orthaulax* is common but the matrix is a coarse quartz sand. The paleoecology of the Chipola exposed at Alum Bluff appears to be different from any other Chipola locality as indicated by the abundant shells of *Mercenaria langdoni* (Dall) not seen anywhere in the Chipola River area. It is presumed to have been a very shallow water, nearshore environment. The presence of a nearby coral reef cannot be discounted, but no coral has been found at this locality. The sands of both the Oak Grove and the Shoal River formations are also non-calcareous with no coral and no *Orthaulax*. The absence of *Orthaulax* would appear to be far more indicative of ecologic than of age differences. The middle Miocene formations throughout the Caribbean area including the Cercado and the Gurabo in Santo Domingo, and the Gatun in Panamá, are also of the argillaceous facies. It is probable that the line did die out by the middle Miocene but we have no real way of determining the final appearance due to lack of strata of the proper facies.

O. gabbi is the only species of *Orthaulax* that occurs in any numbers in non-consolidated limestones. Almost all other specimens of *Orthaulax* known are from indurated formations and occur as internal and external molds, or casts. Usually these are imperfectly preserved and almost invariably the expanded outer lip is lost. It has been speculated by Davies (1935, p. 266) that the shell of *Orthaulax* was adapted to strongly surging water, as would be found in association with coral reefs. Certainly the appearance of *Orthaulax* is directly correlative with coral reefs, even in the Chipola Formation. This high energy environment is not conducive to the preservation of the thin outer lip of these otherwise massive shells. Apparently we have in the Chipola Formation a combination of coral environment where the *Orthaulax* would live plus a low energy back reef site for optimum preservation conditions.

Below is a chronological list of the described forms of *Orthaulax* with their stratigraphic occurrences. This is not meant to be a critical analysis for we do not have the comparative material necessary. It is simply a compilation with appropriate comments on possible relationships.

III. List of Described Species

Orthaulax inornatus Gabb

Orthaulax inornatus Gabb, 1873, Acad. Nat. Sci. Phila., Proc., v. 24 (for 1872), p. 272, pl. 9, figs. 3, 4.

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Plate 1

Orthaulax gabbi Dall

(All figures × 1)

1-4. Growth sequence showing progressive envelopment of the spire.
   1. USNM 645907; height 19 mm, diameter 10.5 mm; locality TU 458.
   2. USNM 645908; height 27 mm, diameter 14 mm; locality TU 547.
   3. USNM 645906; height 39.5 mm, diameter 19 mm; locality TU 547.
   4. USNM 645905; height 46 mm, diameter 23 mm; locality TU 548.

5. Specimen with shell broken away to show layered nature of the callus.
   5. USNM 645896; height 47 mm, diameter 22 mm; locality TU 547.

6-8. Variation in large specimens.
   6. USNM 645898; height (incomplete) 35.5 mm, diameter 46 mm; locality TU 821.
   7. USNM 645899; height 82.5 mm, diameter 46 mm; locality TU 548.
   8. USNM 645897; height 79 mm, diameter 39 mm; locality TU 458.

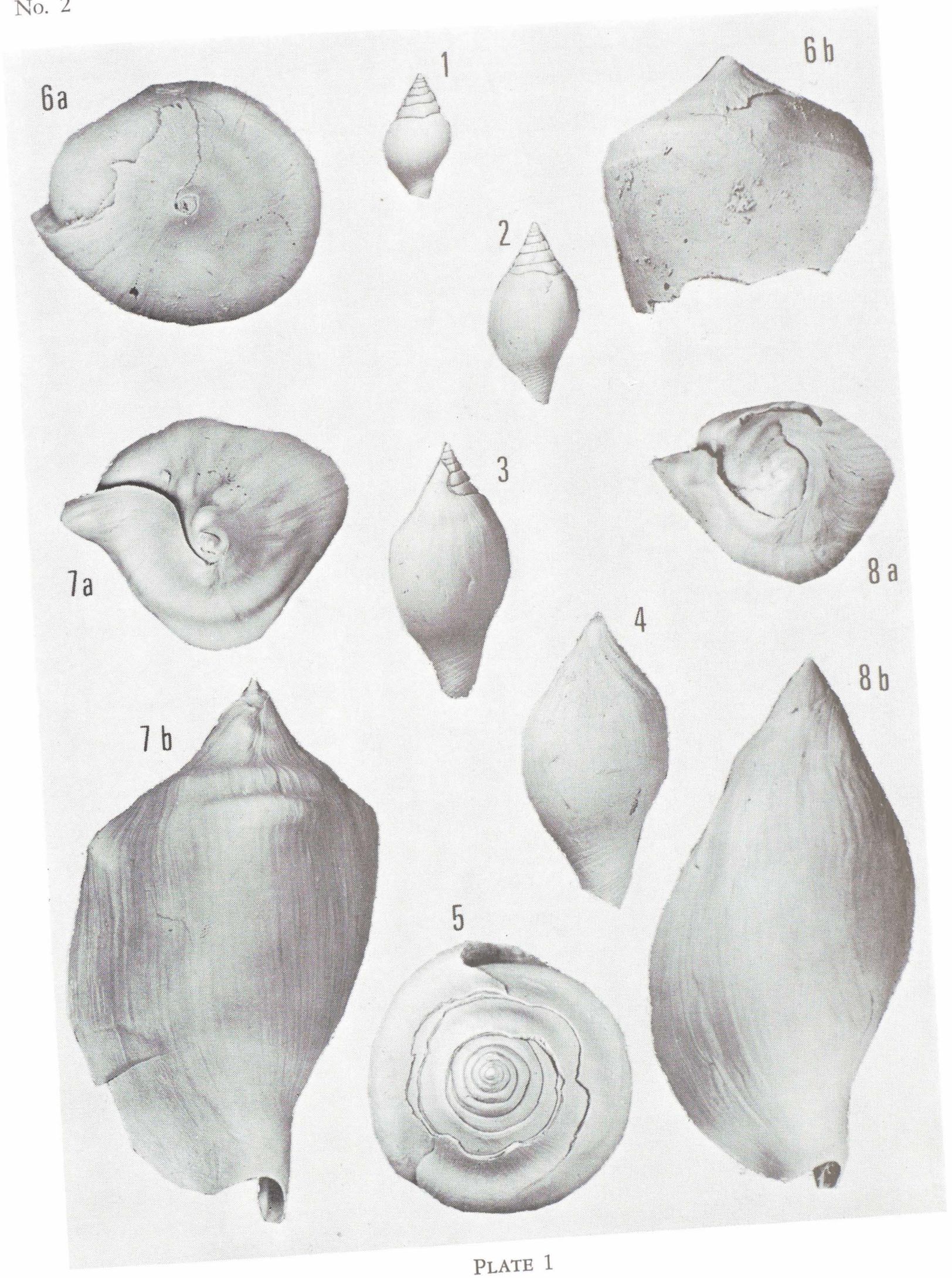

PLATE 1

Geologic occurrence: Baitoa Formation, Dominican Republic; lower Miocene.

Discussion: Although this genus and species usually have been cited as of Gabb, 1872, examination of the volume concerned shows that pages 265 to 280 were published February 11, 1873. Described without locality data, the species is now known to come from the Baitoa Formation of Santo Domingo. Pilsbry (1922, pl. 30, figs. 13-18) figured several specimens from Gabb's collection which demonstrate the variability of this form. *O. inornatus* has a series of spiral lines at the anterior end of the shell and a relatively high spired outline. (For the lower spired members, Pilsbry proposed a sub-species *altilis*.)

ORTHAULAX PUGNAX (Heilprin)

Wagneria pugnax HEILPRIN, 1887, Wagner Free Inst. Sci., Trans., v. 1, p. 106, pl. 15, fig. 36, 36a.

Geologic occurrence: (?) Flint River Formation, Georgia; upper Oligocene. Tampa Limestone, Florida; lower Miocene.

Discussion: Although the type of *O. pugnax* has a relatively low spire, an example figured by Dall (1916, pl. 88, fig. 9) from Ballast Point has a spire angle equal to *O. inornatus,* as it was identified by Dall.* *O. pugnax* also has spiral lines on the base of the body whorl and it is strongly suspected that *O. pugnax* is a synonym of *O. inornatus.* Unfortunately there is little good material available for *O. pugnax* so that a positive assignment is impossible. If the two should prove to be synonymous one might suggest that the Baitoa Formation correlates with the Tampa Limestone rather than with the Chipola, as shown by Cooke, *et al.* (1943).

Woodring (1923, p. 2) reported a number of occurrences of *O. pugnax* from the Glendon Limestone of southern Alabama and northern Florida. However, these specimens are referable to the form subsequently named *O. hernandoensis* by Mansfield. The specimens reported from the upper Oligocene Flint River Formation are probably also to be referred to *O. hernandoensis.*

ORTHAULAX GABBI Dall
Plates 1-3

Orthaulax gabbi DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 170, pl. 12, figs. 5, 5a, 5b.

Geologic occurrence: Chipola Formation, Florida; (?) lower Miocene.

Discussion: Although *O. gabbi* strongly resembles *O. pugnax,* as was observed by Cooke (1921, p. 29), the two forms do seem to differ in the presence of spiral ribbing on the base of *O. pugnax* which is lacking in adult specimens of *O. gabbi.* Some young specimens of *O. gabbi* display faint ribs but these do not persist to the adult stage. *O. gabbi* seems to be confined to the Chipola Formation. It was reported by Cooke (1921, p. 30) from Panamá but Woodring (1959, p. 191) is of the opinion that the specimens in question are closer to *O. aguadillensis* Maury and *O. pugnax* respectively.

* Druid Wilson, of the U. S. Geological Survey, has examined this specimen and he is of the opinion that the shell is a true *O. inornatus* from Ballast Point. The specimen in question is approximately 40 mm in diameter (Dall's illustration is natural size) and is completely circular in cross-section. It has no shoulder development and is much higher spired than any other known specimen of *O. pugnax.* For the present the question of whether we have a single individual of *O. inornatus* from Tampa, Florida, or whether *O. pugnax* and *O. inornatus* are the same species will remain a moot point. Far more material of both forms must be discovered before the problem can be resolved.

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PLATE 2
Orthaulax gabbi Dall
(All figures × 1)

1. Largest perfect specimen in TU collections.
   1. USNM 645904; height 99.5 mm, diameter 62 mm; locality TU 548.

2-5. Series demonstrating variation in shape in smaller specimens.
   2. USNM 645903; height 58 mm, diameter 31 mm; locality TU 830.
   3. USNM 645902; height 52 mm, diameter 23 mm; locality TU 457.
   4. USNM 645900; height 54 mm, diameter 30 mm; locality TU 458. (Note specimen broken and repaired in life.)
   5. USNM 645901; height 55 mm, diameter 30 mm; locality TU 458.

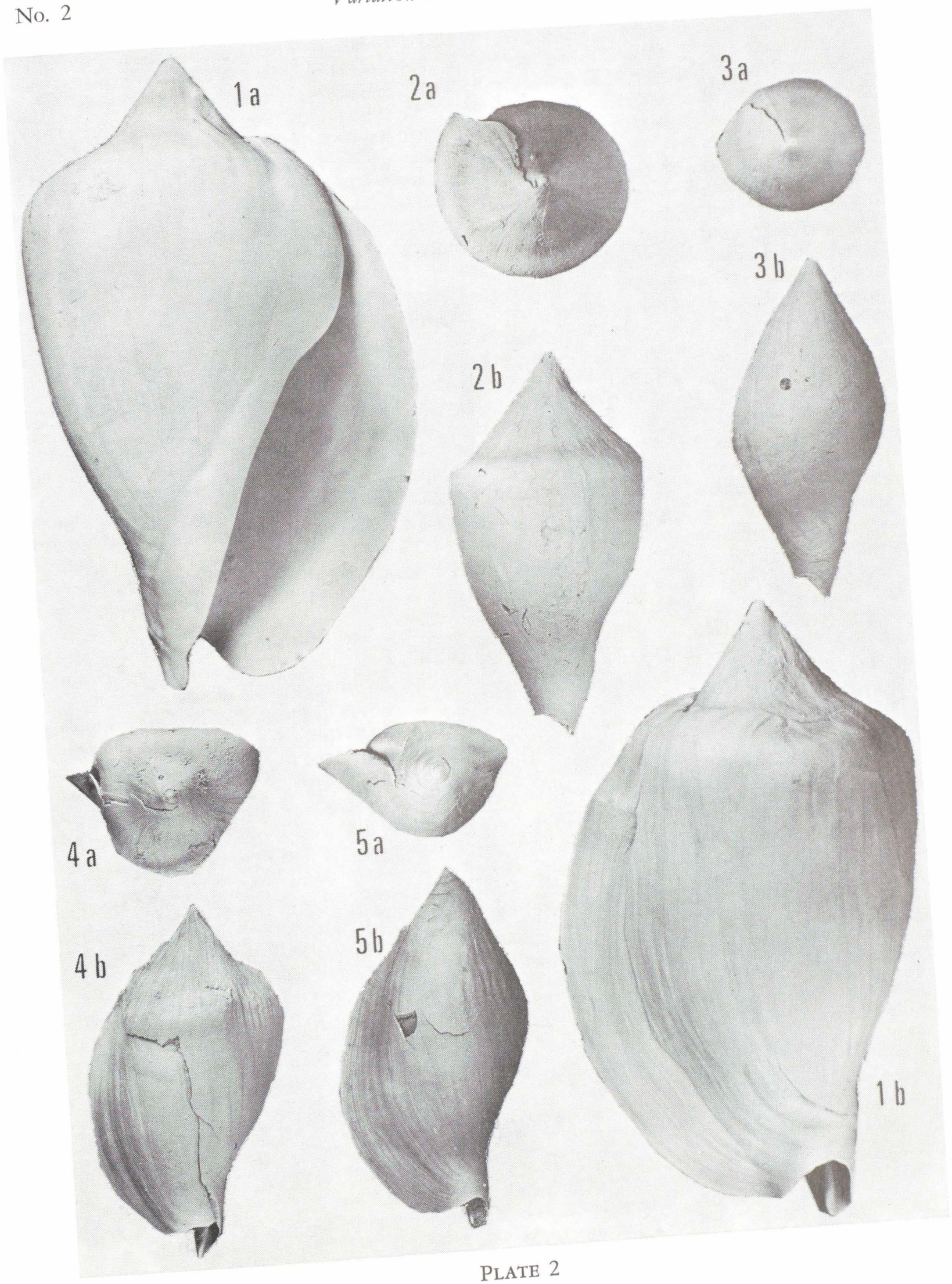

PLATE 2

Dall, in his original description of *O. gabbi,* stated (1890, p. 171) that "no indications of color-pattern have been observed." However, with the aid of ultraviolet light a very distinctive color pattern can be seen. Specimens in which the smoothly polished surface has not been etched by ground water or surface erosion display a color pattern, under long-wave (3660 Å) ultraviolet light, similar to that of the *Conus textile* group and *Oliva porphyria,* a multitude of small triangular patches with the apices directed toward the aperture of the shell. This pattern persists to the largest specimens seen, which measure approximately 110 mm in height, as noted by Dall. Plate 3 shows specimens under ultraviolet light, and it should be noted that these pictures are photographic *negatives* for the ultraviolet process reverses the color pattern. What was dark on the shell shows up as light and vice-versa. By making a double negative it is possible to restore the actual pattern. This process was developed by Axel A. Olsson, of Coral Gables, Florida, and we wish to acknowledge our gratitude for his sharing this idea with us. The fluorescent qualities of these specimens have been enhanced by a three-day immersion in commercial laundry bleach (sodium hypochlorite). Although they displayed some color pattern originally the intensity was greatly increased by this treatment.

Orthaulax aguadillensis Maury

Orthaulax aguadillensis Maury, 1920, Sci. Surv. Porto Rico and Virgin Islands, v. 3, pt. 1, p. 58, pl. 9, fig. 4.

Geologic occurrence: Cevicos Limestone, Dominican Republic; upper Oligocene–lower Miocene. "Aguadilla Limestone" and "Quebradillas Limestone," (= Aymamón Limestone) Puerto Rico; Baitoa Formation, Dominican Republic; Thomonde Formation, Haiti; Consolación Limestone (= lower Paso Real Formation), Cuba; lower Miocene.

Discussion: The largest species of *Orthaulax,* with specimens over 150 mm in height, *O. aguadillensis* was described from the "Aguadilla Limestone" of Puerto Rico but that name is no longer in use. Likewise, it was reported from the "Quebradillas Limestone" by Hubbard (1921, p. 146, as "*O. portoricoensis*") but that formational name also is no longer used. Apparently all lower Miocene limestones in Puerto Rico are now referred to the Aymamón Limestone.

O. aguadillensis is marked by strong spiral lines on the body whorl and seems also to represent a valid form. These lines may not always be present for Woodring (1959, p. 191) observed: "Strong spiral sculpture covering a larger part of the shell is present or absent on *O. aguadillensis* Maury."

Orthaulax portoricoensis Hubbard

Orthaulax portoricoensis Hubbard, 1921, Sci. Surv. Porto Rico and Virgin Islands, v. 3, pt. 2, p. 146, pl. 25, figs. 1-5.

Geologic occurrence: "Quebradillas Limestone" (= Aymamón Limestone), Puerto Rico; lower Miocene.

Discussion: As pointed out by Woodring (1923, p. 7) this species is clearly a synonym of *O. aguadillensis* Maury. The form is widespread in the "Quebradillas Limestone." Hubbard (1921, p. 145, pl. 23, fig. 3) also reported an "*O. gabbi?*" from the "Quebradillas" but in view of the poor condition of his specimen it is more reasonable to assume that it also is *O. aguadillensis.*

Orthaulax caepa Cooke

Orthaulax caepa Cooke, 1921, U. S. Geol. Surv. Prof. Paper 129-B, p. 31, pl. 5, figs. 2a-3b.

Geologic occurrence: Consolación Limestone (= lower Paso Real Formation), Cuba; lower Miocene.

Discussion: The type of *O. caepa* shows spiral threads which are similar to those present on *O. aguadillensis* but are more distantly

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Plate 3
Orthaulax gabbi Dall

1-3. Color pattern as revealed by ultraviolet light.
1. USNM 645909; height 104.5 mm, diameter 55 mm; locality TU 548.
   a. (X 2) Enlarged portion of shell.
   b. (X 1)
2. (X 3) USNM 645911; height 30 mm, diameter 12.5 mm; locality TU 458.
3. (X 3) USNM 645910; height 34.4 mm, diameter 16 mm; locality TU 555.

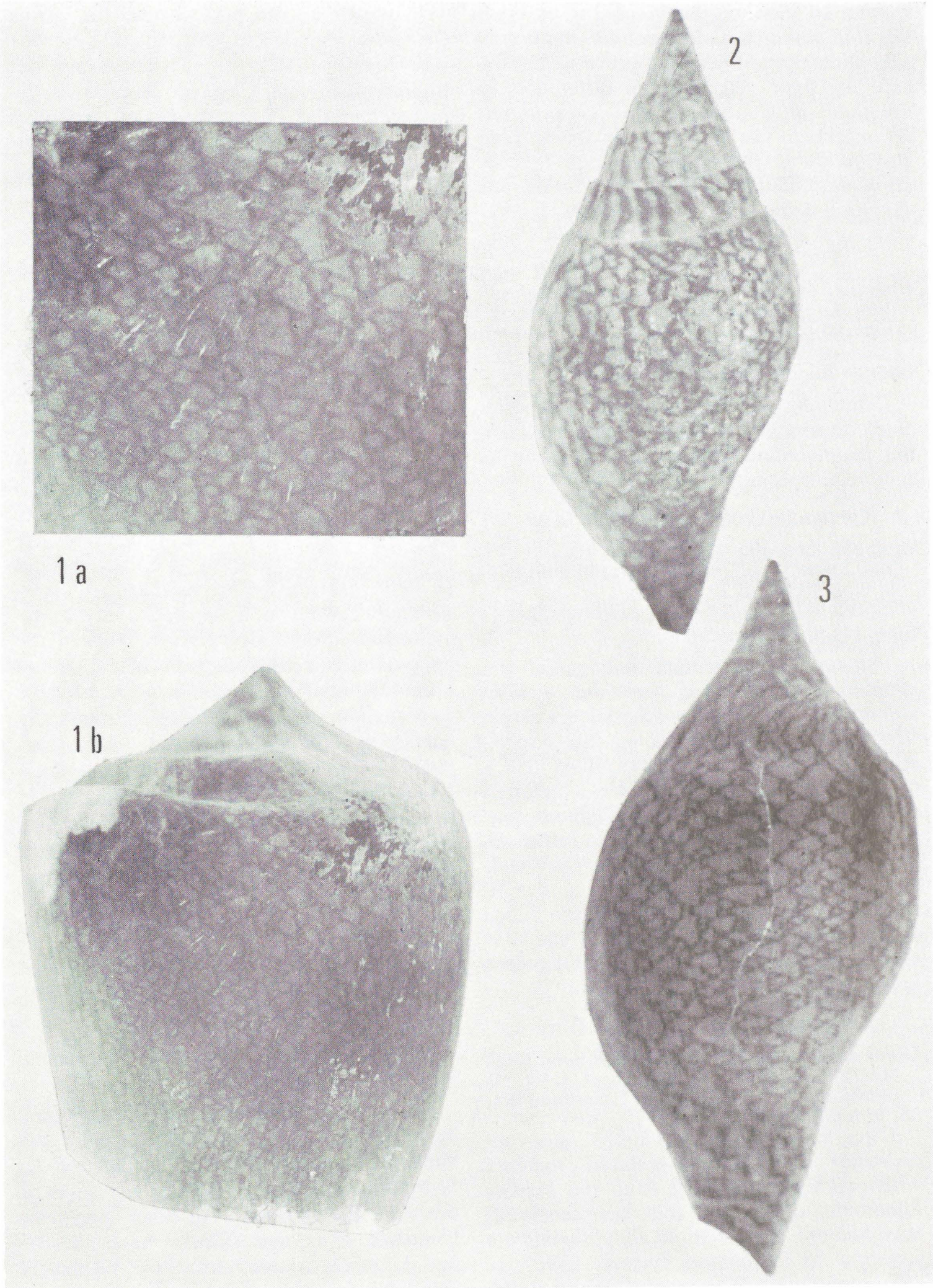

PLATE 3

spaced. In view of the variability of other traits in this genus, one wonders how variable these spiral lines may prove to be. Except for these markings the differences in the shells of *O. caepa* and *O. aguadillensis* are minimal. The fact that *O. aguadillensis* also occurs in the same formation (see *O. bermudezi* Clench and Aguayo) makes one skeptical of the validity of *O. caepa.*

Orthaulax altilis Pilsbry

Orthaulax inornatus altilis Pilsbry, 1922, Acad. Nat. Sci. Phila., Proc., v. 73, p. 369, pl. 30, figs. 16-18.

Geologic occurrence: Baitoa Formation, Dominican Republic; lower Miocene.

Discussion: Pilsbry named this subspecies of *O. inornatus* for the lower spired form but there seems little reason to accept it as a valid subspecies.

Orthaulax conoides Woodring

Orthaulax conoides Woodring, 1923, U. S. Natl. Mus., Proc., v. 64 (Art. no. 2491), p. 9, pl. 2, figs. 1, 2, 7.

Geologic occurrence: (?) Ciboa Marl, Puerto Rico; (?) upper Oligocene.

Discussion: The species *O. conoides* was proposed for a form of *Orthaulax* with an almost flat spire. In the original discussion Woodring (1923, p. 9) noted that a specimen of *O. gabbi* from Alum Bluff had a comparable outline. The reader is referred to pl. 1, fig. 6 for another similar example.

The name of the formation in which *O. conoides* was found was not given by Woodring, but from his description of the lithology it would seem to be in the Ciboa Marl which has been placed in the Rio Guatemala Group of (?) late Oligocene age.

Orthaulax brasiliensis Maury

Orthaulax brasiliensis Maury, 1925, Serv. Geol. Min. Brazil, Mon. 4, p. 110-111, pl. 4, fig. 10.

Geologic occurrence: Pirabas Limestone, Brazil; lower Miocene.

Discussion: Ferreira (1967) has reexamined Maury's type material, together with much new material from the Pirabas Limestone of Brazil, and has concluded that Maury's species is in all probability a synonym of *O. pugnax.* Ferreira (1967, p. 172) noted that *O. inornatus* is also found in the Pirabas, further strengthening our suspicion that *O. inornatus* and *O. pugnax* are the same.

Inasmuch as the presence of the genus *Orthaulax* was one of the principal reasons why Maury (1925, p. 45) correlated the Pirabas with the Chipola Formation the presence of the Tampa species of *Orthaulax* rather than the Chipola species would suggest that perhaps the Pirabas might better be correlated with the Tampa.

Orthaulax hernandoensis Mansfield

Orthaulax pugnax hernandoensis Mansfield, 1937, Florida Geol. Surv., Bull. 15, p. 144, pl. 6, figs. 5, 6.

Geologic occurrence: Glendon Limestone, Alabama and Florida; middle Oligocene. Flint River Formation, Alabama and Georgia; Suwannee Limestone, Florida; upper Oligocene.

Discussion: Mansfield (1937, p. 144) stated that this "subspecies" had a higher spire than strict *pugnax* and that there was no indication that the outer lip had ever enveloped the spire. If the first difference mentioned were the only one there would be little justification in separating *O. hernandoensis* even as a subspecies much less as a valid species. However, in none of the 26 specimens in the collections of the United States National Museum that seem referable to Mansfield's species is the spire completely enveloped (Druid Wilson, *in litt.*). Inasmuch as *O. hernandoensis* is the oldest known species of *Orthaulax,* occurring in the middle Oligocene Glendon Limestone, it is not unreasonable to find this important generic character in a developmental stage.

Orthaulax bermudezi Clench and Aguayo

Orthaulax bermudezi Clench and Aguayo, 1939, Soc. Cubana Hist. Nat. "Felipe Poey," Mem., v. 13 (5), p. 357, pls. 47, 48.

Geologic occurrence: Paso Real Formation, Cuba; lower Miocene.

Discussion: Woodring (1959, p. 191) noted that *O. bermudezi* seems to be the same as *O. aguadillensis.* The type of *O. bermudezi* is unique in having a portion of the outer lip preserved. All other specimens identified as *O. aguadillensis* have lost the lip. Like *O. aguadillensis, O. bermudezi* is a large form, the holotype is 152 mm in diameter, including the outer lip, and the maximum length of the form is about 170 mm.

IV. Locality Data

(for figured specimens only)

457. Chipola Fm., west bank of Chipola River, about ½ mile below Ten Mile Creek (SW ¼ Sec. 17, T1N, R9W), Calhoun Co., Florida. (Same as USGS 2213, 2564, and 3419, "One mile below Bailey's ferry.")
458. Chipola Fm., east bank of Chipola River, above Farley Creek (SW ¼ Sec. 20, T1N, R9W), Calhoun Co., Florida.
547. Chipola Fm., west bank of Chipola River, about 2000 ft. above the mouth of Four Mile Creek (SW ¼ Sec. 29, T1N, R9W), Calhoun Co., Florida.
548. Chipola Fm., west bank of Chipola River (NW ¼ Sec. 29, T1N, R9W), Calhoun Co., Florida.
555. Chipola Fm., east bank of Chipola River, about 1000 ft. above the mouth of Four Mile Creek (SW ¼ Sec. 29, T1N, R9W), Calhoun Co., Florida.
821. Chipola Fm., Farley Creek, 0.1 mile east of bridge of Florida Highway 275 (SW ¼ Sec. 21, T1N, R9W), Calhoun Co., Florida.
830. Chipola Fm., Ten Mile Creek, at power line crossing about one mile west of Chipola River (SE ¼ Sec. 12, T1N, R10W), Calhoun Co., Florida.

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November 22, 1968