

THE AGE OF THE BAITOA FORMATION, DOMINICAN REPUBLIC,
USING MOLLUSCA FOR CORRELATIONEMILY H. VOKES
TULANE UNIVERSITY

ABSTRACT

In an attempt to prove that mollusks may be used for inter-formational correlation, a study was undertaken to ascertain the age of the shallow-water Baitoa Formation, which has proved barren of micro-guide-fossils (planktic foraminifera or calcareous nannofossils). Only a limited number of gastropod species from the genera *Orthaulax*, *Murex*, *Chicoreus*, *Typhis*, *Vasum*, and *Fasciolaria* were examined but by utilizing their "concurrent ranges" the age was determined to be late lower Miocene (Burdigalian) just as the formation was originally thought to be by Cooke.

The classic method of studying fossils, both mega- and micro-, has been for a worker to examine a fauna and prepare a monograph on the entire group. In the last century we had a number of these works, often attaining epic proportions, such as Dall's "Tertiary Faunas of Florida" (1890-1903), as well as numerous European efforts of equal magnitude. In more modern times we have seen this trend continue with the primary change being photographs instead of engravings (a change not always for the better) and even the most recent monographs, such as Woodring's impressive study of the Gatun fauna (1957-1973), are basically no different from those of a century ago.

This approach has one serious flaw in that no person can possibly know all about every species from every locality, and so errors in identification are inevitable. When I began to work in the field of Paleontology I decided a different approach might be more useful in the long run — and that was to take a particular genus and look at it through time. Thus subtle changes due to the continuing evolutionary shifts would be more conspicuous. With more precise identifications inter-formational correlation would be refined. And more importantly, incorrect correlations based upon *incorrect* identifications would be eliminated.

For most of the Tertiary formations of the western Atlantic we now have good

inter-basinal correlation by means of planktic foraminifera or calcareous nannofossils. But the extremely shallow water Baitoa Formation of the Dominican Republic (text fig. 1) has proved to be barren of such invaluable aids and we must, of necessity, turn to the mollusks, as they are all we have. This paper, in a sense, is a test of my theory that mollusks can be utilized for inter-basinal correlation — if, and only if, the identifications are based upon a detailed knowledge of a particular genus of Mollusca. Being essentially non-pelagic, mollusks tend to develop into highly regional species and in the modern fauna there are more species limited to a narrow geographic (or ecologic) range than otherwise. In the western Atlantic the number of species in common between the Gulf of Mexico, for example, and the Greater Antilles is minimal and we would not expect the ancient faunas to be greatly different. But if we can find a few species in common between two disjunct fossil faunas, particularly species restricted to a short time span (*i.e.*, index fossils) then we should be able to use these *almost* as well as microfossils for geologic correlation.

Because of the problems that could be introduced by my doing the very thing I mentioned above, I shall employ only those genera as I personally, or one of my students, have studied in some depth. Thus, the Typhinae were studied by Richard Gertman (1969), the Fascioliariidae by Amanda Hunt (unpubl. Tulane dissertation, 1975), and the Muricidae and Vasidae by me (Vokes, 1963, 1965, 1966). Of particular concern, the extinct strombid genus *Orthaulax* was treated by Vokes and Vokes (1968). Although far from a representative portion of the fauna I will limit myself to these few groups because I feel confident of my identifications; in other genera I do not.

The geological setting of the Baitoa is of no particular value in establishing its age. It lies unconformably upon the upturned beds of the Tabera Formation (text fig. 2), which has long been considered as Oligo-

cene because of the presence of *Lepidocyclina* (Vaughan *et al.*, 1921, p. 61). This age is confirmed by W. H. Akers (personal communication), who dates the Tabera outcrop at Baitoa as Neogene Zone 3 (late Oligocene). The Baitoa is thought to be overlain conformably, or at least paraconformably, by the Cercado Formation but this contact has not been seen. As the Baitoa is identifiable only in the immediate vicinity of the type locality, the stratigraphic relationship with the overlying beds is totally conjectural. There is no reason, from the physical standpoint, that the Baitoa could not be basal Cercado as originally suggested by Cooke (1920).

Gabb (1873), who made the first detailed study of the geology of the Dominican Republic, considered that there was but a single formation of late Miocene age overlying the Tabera (although he did not use that name). Maury (1917, 1919) separated the Cercado and the Gurabo "formations" on a faunal basis, as the Cercado is shallow and the Gurabo is deep-water, but her party did not get to Baitoa due to political difficulties and she did not treat the Baitoa except to put the "*Orthaulax* beds" below the Cercado. The formation was named by Cooke (1920, p. 220), who did not discuss the stratigraphy but only gave a chart with the Baitoa indicated as the basal member of the Cercado, with a Burdigalian age indicated for the Baitoa, which he correlated with the Chipola Formation of northwest Florida. Although the type localities and lithologies were covered in the subsequent study by Vaughan *et al.* (1921) there still was no basis given for the assignment to a Burdigalian age. Only in a third paper (Cooke, 1921) on the occurrence of *Orthaulax* at Baitoa did Cooke state that the fauna of "corals and mollusks with which the *Orthaulax* is associated have been studied by Vaughan and Woodring, who correlate them with the Burdigalian fauna of Europe and with the fauna of the Chipola marl member of the Alum Bluff formation of Florida" (1921, p. 24). But examination of the faunal lists of the material "studied" (Vaughan *et al.*, 1921, pp. 113, 114) sheds little light on this statement as all of the species listed are either "cf." or "n. sp." or are species described by Gabb or Maury.

Recent work in planktic foraminifera and calcareous nannofossils has caused a revision in the ages of many of our Caribbean formations. Much of this is because the principal work that has been used as a standard of reference is the Bowden, Jamaica, molluscan fauna monographed by Woodring 50 years ago (1925, 1928). At that time he called this formation "middle Miocene" and all subsequent Caribbean correlation has been based upon comparisons with it. But we now know (Lamb and Beard, 1972, p. 32) that the Bowden shell bed is basal Pleistocene and thus almost all of the later Neogene formations are being moved upward — the Gurabo Formation should be dated as uppermost Miocene or early Pliocene — N.17 to 19 (Dr. Akers, pers. comm.) instead of middle Miocene. The shallow-water Cercado Formation is as "undatable" as the Baitoa but on molluscan affinities it seems to be much closer to the age of the Gurabo than to the Baitoa, which it resembles more nearly on an ecologic basis. In spite of the similarity of facies between the Baitoa and the Cercado there are very few species in common between the two; but there are a large number of species in common between the Cercado and the Gurabo, including the so-called "guide fossil" *Aphera islacolonis* (we have rare specimens in the Gurabo Formation from TU 1211 and 1250), in spite of the differences in facies. As a guess, they will work out to be the same age — either late upper Miocene or lowermost Pliocene, instead of early and late middle Miocene. Where does this leave the Baitoa? Is it still Burdigalian or should it be moved into the now vacant middle Miocene slot? Is it the basal conglomerate of the Cercado Formation? This study is an attempt to find out.

Most of the species of mollusks from Santo Domingo were originally described by Gabb (1873), who gave no locality data whatsoever. Since Gabb's time there have been three principal collections made in the beds of the Yaque Group. The first was by the Maury party (1917) but they were prevented from even reaching Baitoa by a revolution. So, although they have good stratigraphic control for the Cercado and Gurabo, they did nothing with the Baitoa. The second party was that of the



Text figure 1. Boulder showing large pebbles and coral fragments, Baitoa Formation at TU 1226, type locality of the formation.



Text figure 2. Baitoa Formation at the type locality, seen resting on the upturned beds of the Oligocene Tabera Formation. (Line indicates the contact.)

U.S. Geological Survey, under the direction of Vaughan (Vaughan *et al.*, 1921), who made extensive collections in all three units. And finally we (my husband and I) collected there in 1976, 1977, and 1978, again in all three units. In spite of these fairly intensive surveys, some of Gabb's species have yet to be rediscovered. With these we must use deductive means for determining the stratigraphic position. But fortunately most of his species have been pinned down and it appears that many are from the Baitoa Formation. From the condition of his material it has been suggested that he had some as-yet undiscovered locality, for at the type Baitoa the preservation is not very good. But this is conjecture and he may have simply spent a lot of time at Baitoa for almost all of his species have been taken there by us or the U.S.G.S. party.

The single most "important" species, that which caused the original correlation of the Baitoa with the Chipola, is *Orthaulax inornatus*. Gabb described this strange strombid from Santo Domingo and in his collection he had several specimens. The matrix of the type lot is typical of Baitoa in that certain of the specimens are filled with a concrete-like siltstone, whereas other examples are completely clean. The U.S. Geological Survey obtained a broken

specimen at Baitoa, which prompted Cooke's study of the genus. Ramirez (1956, pl. 1, fig. 7) also reported the species and we have collected three specimens (Plate 1, fig. 1) at Baitoa, none any better than the broken U.S.G.S. specimen figured by Cooke (1921, pl. 2, fig. 6). However, on the road into Baitoa (TU 1253 = USGS 8559) we also collected a somewhat more complete, although poorly preserved, example (Plate 1, fig. 2).

Our studies on the variability of *Orthaulax* (Vokes and Vokes, 1968) cast doubt on the specific distinctness of the Chipola *O. gabbi* Dall vs. the Dominican *O. inornatus*. With this additional material now at hand there is even less doubt that the two forms are synonymous. Examination of the five specimens in the type lot of *O. inornatus* shows certain minor differences between these and the Chipola examples of *O. gabbi*. The protoconch is slightly larger in diameter in *O. inornatus* and the spire is not quite as elongated. However, even in these five specimens there is such variability that Pilsbry (1922, p. 369) named three of the lower spired ones as subspecies *altilis*. In our study the opinion was expressed, which is still held today, that the Aquitanian Tampa Limestone *O. pug-nax* (Heilprin) is also a synonym of *O. gabbi* and hence *O. inornatus*. Unfortunately, I

PLATE 1

Figures

- 1, 2. *Orthaulax inornatus* Gabb ($\times 1$)
 1. USNM 263951; height (incomplete) 31.0 mm, diameter 29.5 mm.
Locality: TU 1226, Baitoa Formation.
 2. USNM 263952; height 64.0 mm, diameter 40.0 mm.
Locality: TU 1253, Baitoa Formation.
- 3, 4. *Orthaulax gabbi* (Dall ($\times 1\frac{1}{4}$))
 3. USNM 645902; height 52.0 mm, diameter 23.0 mm.
Locality: TU 457, Chipola Formation.
 4. USNM 645901, height 55.0 mm, diameter 30.0 mm.
Locality: TU 458, Chipola Formation.
- 5, 6. *Fasciolaria kempfi* Maury
 5. ($\times 1$) USNM 263953; height 106.8 mm, diameter 37.8 mm.
Locality: TU 711, Chipola Formation.
 6. ($\times 1\frac{1}{4}$) USNM 263954; height (incomplete) 38.7 mm, diameter 23.9 mm.
Locality: TU 1226, Baitoa Formation.
- 7, 8. *Chicoreus dujardinoides* (Vokes)
 7. ($\times 1\frac{1}{2}$) USNM 263955; height 34.5 mm, diameter 19.0 mm.
Locality: TU 820, Chipola Formation.
 8. ($\times 1\frac{1}{4}$) ANSP 4003; height 46.5 mm, diameter 30.0 mm.
Locality: "Santo Domingo," ? Baitoa Formation.

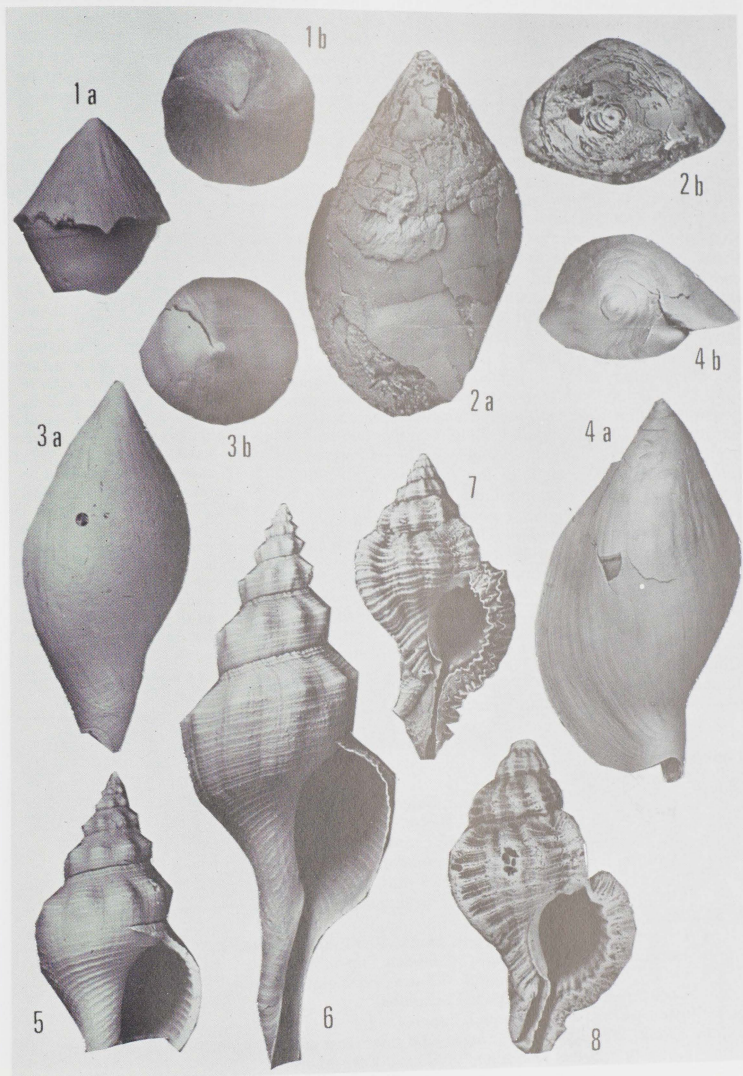


PLATE 1

know of no examples of *O. pugnax* with the protoconchs preserved but the general shape of the specimens extant shows no discernable differences between the Tampa and the Chipola specimens. As noted in the previous *Orthaulax* paper (Vokes and Vokes, 1968, p. 74), there is one specimen from the Tampa that is identical to the type of *O. inornatus*, as it was identified by Dall (1915, p. 86). Likewise, the type of *O. inornatus atilis* (Pilsbry, 1922, pl. 30, fig. 18) shows an outline more like that of *O. pugnax* or *O. gabbi*. From the variability seen in the Chipola specimens of "*O. gabbi*," of which we have hundreds, all of the specimens presently known of both *O. inornatus* and *O. pugnax* may be matched exactly. The cross-sectional outline may be circular (Plate 1, fig. 3) or triangular, (Plate 1, fig. 4) the spire may be high or low. The only conclusion possible is that there is such infraspecific variation in *Orthaulax* spire height and outline are essentially meaningless. The matter of the protoconch to me is more bothersome but at this time I can see no reason not to accept it as a geographical variation within the species. The alternative is to accept them as different species, which really does not change the situation greatly as there is no other formation where this exact variant is known to occur.

The same species also occurs in the Oligocene Browns Town Formation of Jamaica (TU 1015), and in the Pirabas Lime-

stone of Brazil, which is probably equivalent to either the Tampa or Chipola in age. So it seems likely that the various occurrences of *Orthaulax inornatus* are no younger than Burdigalian, but this is by no means certain.* In fact, on the basis of

*In the U.S. National Museum there is a collection made from 3 km northeast of Comendador (now Elias Piña), very near the Haitian border, that contains four examples of unquestionable *O. aguadillensis* and one of unquestionable *O. inornatus*. They are not the same species, small examples of *O. aguadillensis* are readily separable from comparably sized examples of *O. inornatus*. The fossils occur in what has been called the "lower Las Cahobas Formation." At Elias Piña the beds have been dated by Dr. Akers (personal communication) as N. 13, middle Miocene. Perhaps this locality represents the time of transition between *O. inornatus* and *O. aguadillensis*. The rest of the associated fauna fits in with an intermediate position. There is a *Turbinella* like *T. valida* Sowerby but with a less sloping shoulder, a big *Terebra* most like *T. sulcifera* Sowerby but becoming smooth at an earlier stage than the latter species, a totally flat-topped *Conus* that is unlike any species in the area, and *Pachycrommium guppyi* (Gabb), which occurs in the Baitoa, Cercado and Gurabo formations. The only other identifiable species is *Strombus proximus* Sowerby, which occurs in the Cercado and the shallow-water portions of the Gurabo Formation. According to Dr. Akers (personal communication) the foraminifera are all extremely shallow water and give no definite age indications beyond "middle Miocene to Recent."

PLATE 2

Figures

1-3. *Vasum tuberculatum* Gabb

1. ($\times \frac{3}{4}$) ANSP 2624 (holotype); height 111.0 mm, diameter 86.0 mm.

Locality: "Santo Domingo," Baitoa Formation.

2. ($\times 2$) USNM 263956; height 40.7 mm, diameter 29.3 mm.

Locality: TU 1196, Chipola Formation.

3. ($\times 1\frac{1}{2}$) UCMP 14670; height 55.8 mm, diameter 39.0 mm.

Locality: TU 1269, Cantaure Formation.

4, 5. *Vasum dominicense* Gabb

4. ($\times 1$) ANSP 2623 (lectotype); height 60.0 mm, diameter 37.0 mm.

Locality: "Santo Domingo," ? Baitoa Formation.

5. ($\times 2$) USNM 263957; height 33.5 mm, diameter 17.4 mm.

Locality: TU 1196, Chipola Formation.

6, 7. *Vasum pugnax* Pilsbry and Johnson ($\times 1$)

6. ANSP 2626 (holotype); height 80.0 mm, diameter 50.0 mm.

Locality: "Santo Domingo," ? Baitoa Formation.

7. USNM 263958; height (incomplete) 71.6 mm, diameter (incomplete) 35.5 mm.

Locality: TU 547, Chipola Formation.



PLATE 2

the material we have seen, it is probable that there are but two valid species of *Orthaulax* (if one excludes the bizarre ancestral Oligocene *O. hermandoensis* that does not cover the spire). One of these is the smaller, less massive, usually (but not always) high spired *O. inornatus* and the only other is the very massive, much larger (specimens may weigh several pounds), low spired *O. aguadillensis* Maury.

It would appear that *O. inornatus* was replaced by the more massive *O. aguadillensis*, for although originally described as coming from beds of "Oligocene" and "lower Miocene" age in almost every limestone formation of the Caribbean (by one or another name) most of these formations are now known to be younger, usually upper Miocene in age. In the southern Rio Yaque Group, in Santo Domingo, the species is common in beds just below those dated by Dr. Akers (personal communication) as about N.18 or Mio-Pliocene. The Quebradillas Limestone of Puerto Rico is now dated as uppermost Miocene by Seiglie and Moussa (1975, p. 2315) and the "Aguadilla Limestone" (type locality for *O. aguadillensis*), is the same as the Los Puertos Limestone that immediately underlies the Quebradillas (the two have been combined in an Aymamon Limestone but that name has been rejected by recent workers in Puerto Rico).

In the Muricidae, the group where I have concentrated most of my attention, we see very few species from the Baitoa. One we collected there is *Murex messorius* Sowerby, which is a good guide to the Neogene (ranging from the lower Miocene to the Recent), but which does not occur in the Chipola. *Murex messorius* has been reported from the Pirabas Limestone of Brazil (as *Murex sutilis* White), so it is not too surprising that it be found at Baitoa.

The only other muricid we have found at Baitoa is *Typhis obesus* Gabb. This presumably is the type locality as it has not been taken elsewhere in the Dominican beds. The species is common in the Chipola Formation but also is common in the Gatun Formation of Panamá, probably late Miocene in age, so one might consider it as a "false prophet." It is curious that the species has not been taken in either the Cercado or the Gurabo formations, which more nearly match the Gatun in age. One

can only assume the Cercado is too shallow water and the Gurabo is too deep. Several other species of *Typhis* are found in these beds but not *T. obesus*.

So far we are not doing too well in our efforts at correlation. But in the Gabb collection at the Academy of Natural Sciences of Philadelphia there is a beach-worn specimen (ANSP 4003) that was not identified by Gabb (Plate 1, fig. 8). Neither, needless to say, was the locality given. But this specimen is almost certainly the same as *Chicoreus dujardinioides* (Vokes) from the Chipola (Plate 1, fig. 7). This species is not uncommon in the shallow water calcarenite beds of Farley Creek and the upper beds along the Chipola River. But so far as is known it occurs nowhere else and so maybe it is the unequivocal guide fossil we seek. If we make the assumption (based upon its appearance) that Gabb's specimen did indeed come from Baitoa then here is the first unquestionable species that is correlatable with, and only with, the Chipola Formation.

There are a total of six species of *Vasum* described from the beds of Santo Domingo. Of these we now know *V. aedificatum* (Guppy) is found in the Cercado Formation (TU 1230) and the Gurabo (TU 1225); *V. gurabicum* Maury is found in the Gurabo (TU 1211, 1215-common, 1225, 1246, 1277, 1282) and the Mao Adentro Limestone (TU 1252). The most widespread species is *V. haitense* (Sowerby), which is found in the Baitoa, the Chipola, and the Pirabas, but also in the Gurabo (although not yet in the Cercado) — another of our "false prophets."

This leaves three species, two described by Gabb, and the third described by Pilsbry and Johnson from Gabb's material. Of these, *V. tuberculatum* Gabb (Plate 2, fig. 1) was reported from Baitoa (USGS 8668) by Vaughan *et al.* (1921, p. 113), although we have not collected it there. This species is characterized by bifid shoulder spines and is similar to the Recent *V. rhinoceros* (Gmelin) from the east coast of Africa, although the latter has only three columellar plications in contrast to the four or five (three strong, with one or two weaker between them) of *V. tuberculatum*.

From the Cantaure Formation of Venezuela (TU 1269) we have a single specimen of *V. tuberculatum* (Plate 2, fig. 3, from the collections of the University of California,

Berkeley) and another is in the collection of Mr. John Gibson-Smith, of Caracas, Venezuela. The Cantaure Formation is the same Burdigalian age as the Chipola (see Hunter and Bartok, 1974, p. 147), thus, it was with great pleasure that a specimen, collected in the upper beds of the Chipola (TU 1196) was recognized as *V. tuberculatum* (Plate 2, fig. 2). As the species has been identified from no other western Atlantic formations we seem to be in possession of a second infallible guide fossil. But such is not the case, for in the Aquitanian of France is another species named by Peyrot (1928, p. 29) as *V. aquitanicum* that is indistinguishable from our small Chipola specimen. But it may have taken that length of time to cross the Atlantic.

Vasum dominicense Gabb is still a question mark. Vaughan *et al.* (1921, p. 140) reported that they had a specimen from the Gurabo Formation at Bluff 2 on the Rio Mao (USGS 8528) but this specimen cannot be located in the USNM today. Neither we nor Maury collected any specimens of *V. dominicense* but we do have a large example of *V. gurabicum* from a locality not far from that of the U.S.G.S. (TU 1225) that looks not unlike *V. dominicense* and might be the basis for a mistaken identification. Gabb had two specimens, the larger of which (Plate 2, fig. 4) is worn but looks very much like it might have come from Baitoa and which yielded a friable sand matrix identical to that recovered from one of the well-preserved paratypes of *Orthaulax inornatus*. The smaller (see Pilsbry, 1922, pl. 27, fig. 4) is better preserved but the specimen is now lost (E. Scott, 1978, *in litt.*). From the uppermost beds along Farley Creek (TU 1196) in the Chipola Formation we have two specimens (Plate 2, fig. 5) of an undescribed *Vasum* that are very close to Gabb's species, but which show small spines at the shoulder that Gabb's specimens do not appear to have. It has the appearance of being intermediate between *V. dominicense* and *V. gurabicum*. Or it may be within the range of variability of *V. dominicense*, but we cannot say at this time. Certainly it is the closest form yet found to *V. dominicense*.

The last species of *Vasum* is *V. pugnus**

described by Pilsbry and Johnson (1917, p. 167) from a specimen in Gabb's collection (Plate 2, fig. 6). From the hardened matrix in the specimen it is assumed that the specimen came from Baitoa, but this assumption has not been proved or disproved by additional collecting. The miserable holotype remains unique. I believe the reason Gabb did not name it was because of the poor nature of the specimen. It is impossible to say even how many columellar plications the species has due to the infilling with a matrix akin to concrete (which is typical of Baitoa).

As poor as the specimen of *V. pugnus* is, it is possible to say that it is unlike any other species of *Vasum* described from the New World. There is an Aquitanian species, *V. stephanense* Peyrot, from France, that is the nearest kin but differs in having a higher spire and, consequently, more elongate shell. Interestingly, Peyrot (1928, p. 32) comments that his unique specimen is rolled, the spire is broken and the outer lip is mutilated. Obviously this type of *Vasum* lived in very shallow water, which also suggests Baitoa.

Once again there is a single specimen (Plate 2, fig. 7), even worse than the type of *V. pugnus*, which has been taken from the environs of a coral reef in the Chipola Formation (TU 547). The most conspicuous feature visible on this wretched creature is the subsutural constriction, which is most like that seen in *V. pugnus*. The shoulder nodes are somewhat stronger in the Chipola specimen but this might well be in the range of variability. In any case it is the nearest relative we have found in the New World.

One final family, in which there is a single species of interest to us, is the Fasciolaridae. One species of *Fasciolaria* s.s. (type: *F. tulipa*) unfortunately was described as two species — *semistriata* and *intermedia*, both on the same page by Sowerby (1850, p. 49), with neither figured. Gabb collected two species in Santo Domingo and decided they must be the two species of Sowerby and so assigned one name to each. The true *F. semistriata* occurs in both the Cercado and Gurabo formations and is the more common of the two forms. The second species, *F. kempi*, which is referred to the subgenus *Triplofusus* (type: *F. gigantea*), was named sub-

*Inexplicably spelled *V. pugnans* in Vokes, 1966.

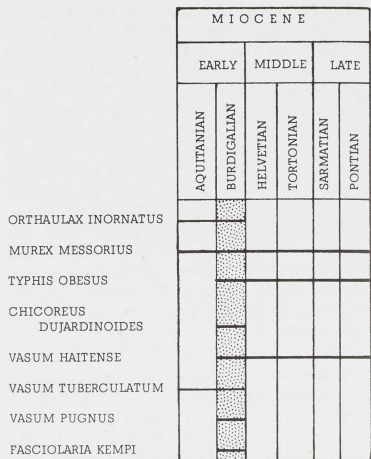
sequently by Maury (1910) from one of Gabb's specimens. There is no doubt that this species comes from the Baitoa Formation. The U.S. Geological Survey collected specimens, as did Ramirez (1956, pl. 1, fig. 2), and we have also collected several examples at Baitoa (Plate 1, fig. 6). Among Baitoa species (excluding those of the genus *Phos*) it would be considered one of the more common. However, all are tailless — our specimen is no better (or worse) than the holotype.

This species has a curious history — it was named by Maury (1910, p. 138) as being from the Chipola Formation. Later (1917, p. 245) she admitted that one of Gabb's specimens had been mixed in with the collections from the Chipola. Undoubtedly someone was comparing it with the Chipola material for, as it develops, the species does occur rarely in the Chipola beds (Plate 1, fig. 5). Thus, in spite of its rather questionable pedigree it becomes our only single species that unequivocally occurs in the Chipola and the Baitoa formations alone. The only other related species is *F. gorgasiana* Brown and Pilsbry, which is found in the Gatun Formation, but which may readily be distinguished by its bigger protoconch and smoother shell.

In summary we can see that with *Fasciolaria kempfi* we have the only absolutely unquestionable correlation in the small group we have examined, plus the slightly questionable *Chicoreus dujardinioides*. But if we look at the ranges (text fig. 3) of all the species so far discussed, and consider them from the point of "concurrent ranges" as is done for foraminifera or nannofossils, then we note that the *only* possible age for the Baitoa Formation is late lower Miocene, the same as the Chipola, with which it was originally correlated nearly 70 years ago. Furthermore, in my opinion, we have proved that molluscan species may be utilized for correlation just as micro-fossils are, providing the specific determinations are sufficiently precise.

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Text figure 3. Geologic ranges of certain molluscan species found in the Chipola and Baitoa formations.

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LOCALITY DATA

457. Chipola Fm., west bank of Chipola River, about ½ mile below Tenmile Creek (SW ¼ Sec. 17, T1N, R9W), Calhoun Co., Florida.

458. Chipola Fm., east bank of Chipola River, above Farley Creek (SW $\frac{1}{4}$ Sec. 20, T1N, R9W), Calhoun Co., Florida.
547. Chipola Fm., west bank of Chipola River, about 2000 feet above Fourmile Creek (SW $\frac{1}{4}$ Sec. 29, T1N, R9W), Calhoun Co., Florida.
711. Chipola Fm., west bank of Chipola River, about $\frac{1}{4}$ mile up from Farley Creek (SW $\frac{1}{4}$ Sec. 20, T1N, R9W), Calhoun Co., Florida.
820. Chipola Fm., Farley Creek, at bridge of Florida Highway 275 (SW $\frac{1}{4}$ Sec. 21, T1N, R9W), Calhoun Co., Florida.
1015. Browns Town Fm., Orange Park, east of Claremont, Parish of St. Ann, Jamaica.
1196. Chipola Fm., Farley Creek, north bank about 0.8 mile east of bridge on Florida Highway 275 (NE $\frac{1}{4}$ Sec. 21, T1N, R9W), Calhoun Co., Florida.
1211. Gurabo Fm., Rio Gurabo, west bank, second bluff below the bridge on Los Quemados-Sabaneta road, Dominican Republic (= USGS 8546).
1215. Gurabo Fm., Rio Gurabo, bluffs on both sides, from the bridge on Los Quemados-Sabaneta road, upstream to approximately 1 km above the bridge, Dominican Republic (= USGS 8539-8543; Maury's Zone D).
1225. Gurabo Fm., banks of large arroyo on west side of the Rio Mao, upstream from Mao Adentro and downstream from Cercado de Mao, about 11 kms (by winding road) south of Mao, Dominican Republic.
1226. Baitoa Fm., type locality, east bank of the Rio Yaque del Norte, below the village of Baitoa, and above the confluence of the Rio Yaque and the Rio Bao, Dominican Republic (= USGS 8558).
1230. Cercado Fm., Rio Caña, east bank, just above the bridge at Caimeto on Los Quemados-Sabaneta road, Dominican Republic (= USGS 8534; Maury's Zone H).
1246. Gurabo Fm., Rio Gurabo, from 1 km to 2 km (airline) upstream from bridge on Los Quemados-Sabaneta road, Dominican Republic (= USGS 8538; Maury's Zone E).
1250. Gurabo Fm., Rio Verde, south bank, just above the ford at the crossing of a side road that connects the Duarte Highway and the La Vega-Moca Highway, about 10 km north of La Vega, Dominican Republic. (One of the few localities mentioned specifically by Gabb, 1873.)
1252. Mao Adentro Limestone, Arroyo Las Lavas, at crossing of Duarte Highway K 18.5 west of Santiago de los Caballeros on road to Navarette, Dominican Republic (= USGS 8663).
1253. Baitoa Fm., road cut on west side of road from Santiago de los Caballeros to Baitoa, 2

- km north of the village of Baitoa, Dominican Republic (= USGS 8559).
1269. Cantaure Fm., series of arroyos about 500 yds. south of "Casa Cantaure" [which is literally one house and which is about 400 yds. south of older, now abandoned, house that was the "Casa Cantaure" of Jung, 1965, and others], 14 km (by road) west of Pueblo Nuevo, Paraguaná Peninsula, Venezuela.
1277. Gurabo Fm., Rio Gurabo, both sides, upstream from the horsetrail to 0.5 km above the trail, or approximately 2 km (airline) to 2.5 km above the bridge on Los Quemados-Sabaneta road, Dominican Republic (see Vaughan *et al.*, 1921, pl. 11; = Maury's Zone F).
1282. Cercado Fm., tributary of the Rio Caña to the east, about 1 km above the bridge at Caimeto on Los Quemados-Sabaneta road, Dominican Republic (Maury's Zone I).

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REVIEW

A STRUCTURAL, STRATIGRAPHIC AND PETROLOGIC STUDY OF ANORTHOSITES, ECLOGITES, AND ULTRAMAFIC ROCKS AND THEIR COUNTRY ROCKS, TAFJORD AREA, WESTERN SOUTH NORWAY, by H. K. Brueckner. Published by the Geological Survey of Norway, 1977, *Bulletin* 41, 53 pp., 21 figs., 2 tbls., folding map, \$10.00 (distributed in the United States by the Columbia University Press, New York).

The Tafjord area contains Caledonized metamorphic rocks divided into two groups, the 1000 m.y. old Fetvatn Gneiss, a granodioritic gneiss intruded as part of a large plutonic complex during the Sveconorwegian Cycle; and, the Vikvatn Sequence of metasedimentary and metavolcanic rocks of later Pre-Cambrian age, containing anorthosite, eclogite, and anhydrous peridotite. The structure, petrology, and facies metamorphism of the sequences are described and illustrated. A folding map of the area is included.

—H.C.S.