

ADDITIONS TO THE TYPHINAE (GASTROPODA: MURICIDAE)  
OF THE GATUN FORMATION, PANAMA

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The molluscan fauna of the Gatun Formation of Panamá is one of the most completely studied fossil assemblages in the Western Hemisphere (see Woodring, 1957-1982). A total of 396 shelled mollusks have been described from the unit (Woodring, 1982, p. 542) and yet, as a recent collecting trip to Panamá revealed, the treasure trove is far from exhausted.

In 1969 Gertman monographed the muricid subfamily Typhinae in the western Atlantic and he included four species from the Gatun Formation. But new land clearing for rural housing projects in the vicinity of Cativá (ca. 8 km west of Colón) has opened several new, very rich sites and added two new typhine species to the Gatun fauna.

The most exciting, and unexpected, find was a very large (ca. 35 mm in height) *Rugotyphis*, unlike any species known to the writer. That such a large, and moderately common (a dozen specimens in the type lot) species, should have escaped discovery for so long is amazing. The initial discovery was made by Robert H. Stewart, formerly Geologist for the Panama Canal Company (now retired), who remains the leading expert on Panamanian geology and who most graciously not only parted with his specimen but took us to the locality to obtain more.

The second exciting "find" was a species previously not known to occur in the Gatun — *Typhis (Talityphis) alatus* Sowerby, described from the Gurabo Formation of the Dominican Republic. When Gertman did his study he had no material other than the type lot available. But since that time we have collected extensively in the Dominican Republic and now have a number of examples of *T. alatus*. The species is always confined to the deeper facies (Gurabo and an unnamed middle Miocene formation) and has yet to be found in the more shallow facies (Cercado or Baitoa formations). Presumably it is this preference for deeper water that has precluded its appearance in the shallow facies of the Gatun. This would appear to be corroborated by the discovery of a single large specimen of *T. alatus* at

Telfers Island, near Colón, in what must be the uppermost Gatun beds yet known, and by extrapolation also the deepest. Unfortunately, this nice theory is upset by the additional discovery of a second incomplete example at TU 1431, near Sabanita, which is not only the earliest Gatun, but also the shallowest water — nearly shoreline, with much fossil wood, oysters, sand-dollars, and other shallow-water indicators.

Another typhine species that occurs in the Dominican Republic, as well as in the Gatun Formation, is *Typhis (Talityphis) obesus*, described by Gabb without precise locality data but now known to be confined (in the Dominican Republic) to the early Miocene Baitoa Formation. Again, this is a good example of facies control, for the Baitoa is extremely shallow-water and the presence of *T. obesus* in both formations is a result of ecology rather than precise time correlation. However, it is curious that the form has not yet been found in the Dominican Cercado Formation, which more nearly correlates with the Gatun in age than does the Baitoa.

One of the localities (TU 1429) did not produce any new typhine species but rather an incredible number (more than 100 in about two hours) of the small *Siphonochelus (Pilsbrytyphis) woodringi* Gertman. This species is known only from the upper beds of the Gatun Formation, near Mount Hope. The type lot contained 18 specimens, all from one locality (USGS 8410 = Woodring 175), which is approximately four kms to the west of TU 1429. Whatever the ecologic conditions were in this small area, they were optimum for *S. woodringi*.

On the basis of the other fauna present at the same locality, it would seem to be deeper water than the usual Gatun Formation, for it is here we have found our only examples of *Gemmula vaningeni* (Brown and Pilsbry). This species is most closely related to the Recent eastern Pacific *G. hindsiana* Berry, which Keen (1971, p. 707) notes is found in depths of 40 to 70 meters. According to Woodring (1970, p. 364) *G. vaningeni* is common only in the Mount

Hope area; he records 27 examples from his locality 175, which as noted above is the type locality of *Siphonochelus woodringi*.

Here we have also collected our only examples of *Scosia sublaevigata* (Guppy), which Woodring (1959, p. 201) reported as principally occurring near the French Canal, west of Mount Hope. The closely related *S. laevigata* (Sowerby) is abundant in the Gurabo Formation of the Dominican Republic; *S. sublaevigata* was described from the deep-water beds of the Bowden Formation of Jamaica; and the living member of the line, *S. striata* (Lamarck), is particularly common at TU 977, in material from Mudlump 90, off the mouth of the Mississippi River, which is judged to have been deposited at about 70 meters depth (Odé, 1973, p. 89).

The age of the Gatun Formation has yet to be satisfactorily determined. Woodring maintained that the age was middle Miocene noting, however, "it should be understood that the age assignments are Lyellian ages not planktonic foraminiferal ages. For the Neogene of America, planktonic foraminiferal ages are almost invariably too young in terms of Lyellian ages" (1973, p. 454). Only in the last volume of his study did he concede that planktonic foraminiferal dates obtained by workers at the British Museum (Natural History) indicated the Gatun was probably latest Miocene or even possibly early Pliocene (1982, p. 576). He concluded that regardless of the exact age the Gatun is correlative with the Cercado and Gurabo formations of the Dominican Republic, as well as with the shall bed of Bowden, Jamaica.

In this writer's opinion, Brown and Pilsbry were more nearly correct in their early assessment wherein they stated: "On the whole we conclude that the Gatun fauna is slightly later than the Santo Domingo and earlier than the Bowden" (1911, p. 337). The beds of the Gurabo formation have been dated as in foraminiferal zone N. 18 (W. H. Akers, personal communication) and the Bowden shell bed is N. 22 (Lamb and Beard, 1972, p. 32). The Rio Banano Formation of Costa Rica (TU 589), which is probably most nearly correlative with the Gatun has been dated by Dr. Akers (personal communication) as N. 20. Thus, it seems likely that the Gatun is about mid-Pliocene in age.

For the sake of completeness, the entire typhine fauna of the Gatun Formation is reviewed below, even though in some cases there is no new information to add. Complete synonymies are not included, instead the reader is referred to Gertman's monograph.

#### SYSTEMATIC PALEONTOLOGY

Family MURICIDAE da Costa, 1776

Subfamily TYPHINAE Cossmann, 1903

Genus TYPHIS Montfort, 1810

*Typhis* MONFORT, 1810, Conchyl. Syst., v. 2, p. 614-615.

Type species: *Typhis tubifer* (Bruguière, 1792), by orig. desig.

Subgenus TALITYPHIS Jousseume, 1882

*Talityphis* JOUSSEUME, 1882, Rev. Mag. Zool., (Ser. 3) v. 7, p. 338.

Type species: *Typhis expansus* Sowerby, 1874, by orig. desig.

*Discussion:* In their study of worldwide Recent Muricidae Radwin and D'Attilio (1976, p. 201) stated that they believed *T. expansus* Sowerby to be the same species later described as *T. puertoricensis* Warmke, 1964. This would mean that the form usually cited as "*T. expansus*" would have no valid name, which they remedied by proposing the new name *T. perchardei* (*ibid.*, p. 236). This change would have a deleterious effect on the concept of the subgenus *Talityphis*, for *T. puertoricensis* is better assigned to *Rugotyphis* (see Gertman, 1969, p. 153), a very different morphotype, leaving the large group of alate typhines without a name. However, the problem was easily solved by a photograph of the type specimen of *T. expansus* from the National Museum of Wales at Cardiff, which proved the species to be that form so identified by most workers. Photographs of this specimen and a more extended discussion will be given by the writer in another work on the fauna of the Dominican Republic (Vokes, in press).

TYPHIS (TALITYPHIS) ALATUS Sowerby

Plate 1, figs. 1-3

*Typhis alatus* G. B. SOWERBY I, 1850, Geol. Soc. London, Quart. Jour., v. 6, p. 48, pl. 10, fig. 4.

*Typhis (Talityphis) alatus* Sowerby. GERTMAN, 1969, Tulane Stud. Geol. Paleont., v. 7, no. 4, p. 159, text fig. 3 (holotype).

**Discussion:** The usual species of *Talityphis* found in the Gatun Formation is *T. obesus* Gabb. Although many writers have confused it with *T. alatus* the two forms are readily distinguishable and only similar at the subgeneric level. The most immediate apparent difference between the two species is the more extended spire of *T. alatus*, but this is not the most diagnostic feature by which to differentiate the two. In *T. alatus* there is always a large swelling immediately anterior to the tube. Only two other species of *Typhis* have this feature. One is *T. eucteanus*, discussed below, and the second is the early Miocene *T. precursor* Keen and Campbell, 1964, from Colombia. This bulge can be seen in the pictures of the holotype of that species (refigured in Gertman, 1969, pl. 3, fig. 1). The latter species is probably ancestral to *T. alatus*, but differs in having a much shorter siphonal canal.

The specimen figured here (pl. 1, fig. 1) from Telfers Island is a giant, measuring over 40 mm in height, nearly as large as the holotype of *T. precursor* (height 47.5 mm). But it is not unique. An equally large specimen (height 40.3 mm) has been collected in the middle Miocene (N.11) of the Dominican Republic (TU 1249) but the more usual size for the numerous Dominican examples we now have is about 30 mm.

The Telfers specimen was collected by Mr. John Gunter of Panamá City, Panamá, who generously donated his prize to science. The discovery of *T. alatus* in the Gatun is an addition to the Gatun fauna but it is not a range or time extension, for Olsson (1964, p. 141) reported the species from the Picaderos Formation of northwestern Ecuador. Examination of his specimen (USNM 23485) confirmed his identification. The Picaderos is thought to be of approximately the same age as the Gatun.

**Occurrence in Panamá:** Telfers Island and TU 1431. These represent the highest and lowest Gatun Formation respectively; therefore, Brown and Pilsbry's (1911, p. 354) reference to *T. alatus* may be valid. We have not seen this specimen.

**Figured specimens:** Fig. 1, USNM 365139; height 40.3 mm, diameter 27.5 mm; locality: Telfers Island, Province of Colón, Panamá. Fig. 2, USNM 365140; height (incomplete) 22.0 mm; diameter 17.7 mm; locality TU 1431. Fig. 3, USNM 323913; height 23.5 mm,

diameter 14.6 mm; locality TU 1250 (Dominican Republic).

#### TYPHIS (TALITYPHIS) OBESEUS Gabb

Plate 1, fig. 4

*Typhis obesus* GABB, 1873, Amer. Phil. Soc., Trans., (N. S.) v. 15, pt. 1, p. 203.

*Typhis obesus* Gabb. PILSBRY, 1922, Acad. Nat. Sci. Phila., Proc., v. 73, p. 354, pl. 28, figs. 5, 6 (holotype).

*Typhis (Talityphis) alatus obesus* Gabb. WOODRING, 1959, U.S. Geol. Surv., Prof. Paper 306-B, p. 221, pl. 31, figs. 3, 4.

*Typhis (Talityphis) obesus* Gabb. GERTMAN, 1969, Tulane Stud. Geol. Paleont., v. 7, no. 4, p. 160, pl. 4, figs. 1-4.

*Typhis obesus* Gabb. VOKES, 1979, Tulane Stud. Geol. Paleont., v. 15, no. 4, p. 112.

**Discussion:** Although this species has been reported from many localities and many different geological levels throughout the Western Hemisphere (see Gertman, 1969, p. 162), most of these identifications prove to be in error and the species has actually only been taken in the Baitoa Formation of the Dominican Republic (the type locality) and the Chipola Formation of Florida (both late lower Miocene in age) and in the Gatun Formation of Panamá. A more complete discussion and reassignment of the various misidentifications will be given in the aforementioned paper on the Dominican fauna (Vokes, in press).

**Occurrence in Panamá:** TU localities 757, 958, 962, 1431; Woodring locality 136. All in the lower Gatun, near Sabanita and Cativa. Brown and Pilsbry's (1911, p. 354) reference to *T. obesus* from the Gatun locks excavation has not been verified.

**Figured specimen:** USNM 646220; height 27.5 mm, diameter 23.0 mm; locality TU 757.

#### TYPHIS (TALITYPHIS) EUCTEANUS Woodring

Plate 1, fig. 5

*Typhis (Talityphis)* sp. GERTMAN, 1969, Tulane Stud. Geol. Paleont., v. 7, no. 4, p. 160, pl. 5, fig. 1.

*Typhis (Talityphis) eucteanus* WOODRING, 1970, U.S. Geol. Surv., Prof. Paper 306-D, p. 434, pl. 63, figs. 9, 10.

**Discussion:** As the specific name implies (*eukteanos* — Greek, tall or slender), this is the most slender of the *Talityphis* species. It shares with *T. alatus* the swelling beneath the tube, but may be distinguished from

that species by its extremely elongated siphonal canal.

All known specimens of *T. eucteanus* have been taken in the lower part of the Gatun. When Woodring described the form he had three specimens and there were three in the Tulane Collection. No new material has been found since that time.

*Occurrence in Panamá:* TU locality 958; Woodring locality 138f (= TU 757).

*Figured specimen:* USNM 646221; height 17.7 mm, diameter 9.2 mm; locality TU 958.

#### Subgenus RUGOTYPHIS Vella, 1961

*Rugotyphis* VELLA, 1961. *Palaeontology*, v. 4, p. 376.

Type species: *Typhis francescae* Finlay, 1924, by orig. desig.

#### TYPHIS (RUGOTYPHIS) STEWARTI

E. H. Vokes, n. sp.

Plate 1, figs. 8, 9

*Description:* Shell large, stout; early whorls unknown, but presumably a protoconch of one and one-half bulbous whorls; seven post-nuclear whorls. Four varices per whorl, each with a short, sharp spine at the apical end, directed

nearly at right angles to the axis of the shell; each varix crossed by about four faint spiral ribs; varical face of two parts: a thickened portion nearer the body, and a thin free-standing flange, crenulated by the spiral ribs and slightly reflected abaperturally; this flange developed only on the body portion of the shell, abruptly truncated at the constriction into the anterior canal. Varical flange with the appearance of having been wrapped over the original varix from behind, especially at the shoulder, with a small fold directed toward the suture, forming a strange gutter-like structure enveloping the shoulder spine and connecting it to the preceding tube. Terminal varix with a small partition, but none visible on previous varices, perhaps having been decorticated; tubes closer to the preceding than to the succeeding varix, directed abaxially and abapically. Shell smooth, except for the crenulations of the varices. Aperture ovate-rounded, surrounded by an entire raised rim; anterior canal closed, narrow, almost straight, distal end only slightly reflected.

*Dimensions of holotype:* height 35.0 mm, diameter 25.2 mm.

*Holotype:* USNM 365136.

*Type locality:* TU 1432, Gatun Formation, north side Boyd-Roosevelt Highway, behind Residential Martin Luther King (formerly Palo Quemado), approximately 1.5 km east of junction

### PLATE 1

#### Figures

- 1-3. *Typhis (Talityphis) alatus* Sowerby
  1. ( $\times 1\frac{1}{2}$ ) USNM 365139; height 40.3 mm, diameter 27.5 mm  
Locality: Telfers Island, Prov. of Colón, Panamá. Gatun Formation.
  2. ( $\times 2$ ) USNM 365140; height (incomplete) 22.0 mm, diameter 17.7 mm  
Locality: TU 1431. Gatun Formation.
  3. ( $\times 2\frac{1}{2}$ ) USNM 323913; height 23.5 mm, diameter 14.6 mm  
Locality: TU 1250. Gurabo Formation
4. *Typhis (Talityphis) obesus* Gabb  
( $\times 1\frac{1}{2}$ ) USNM 646220; height 27.5 mm, diameter 23.0 mm  
Locality: TU 757, Gatun Formation
5. *Typhis (Talityphis) eucteanus* Woodring  
( $\times 3$ ) USNM 646221; height 17.7 mm; diameter 9.2 mm  
Locality: TU 958. Gatun Formation
6. *Siphonochelus (Pilsbrytyphis) woodringi* Gertman  
( $\times 2$ ) USNM 365138; height 23.0 mm; diameter 11.2 mm  
Locality: TU 1429. Gatun Formation
7. *Siphonochelus (Pilsbrytyphis) gabbi* (Brown and Pilsbry)  
( $\times 3\frac{1}{2}$ ) ANSP 1722 (holotype); height 13.3 mm, diameter 7.6 mm  
Locality: Gatun Lock. Gatun Formation
- 8, 9. *Typhis (Rugotyphis) stewarti* E. H. Vokes, n. sp.
  8. ( $\times 1\frac{1}{2}$ ) USNM 365136 (holotype); height 35.0 mm, diameter 25.2 mm  
Locality: TU 1432. Gatun Formation
  9. ( $\times 1\frac{1}{2}$ ) USNM 365137 (paratype); height (incomplete) 28.1 mm, diameter 27.4 mm  
Locality: TU 1433. Gatun Formation

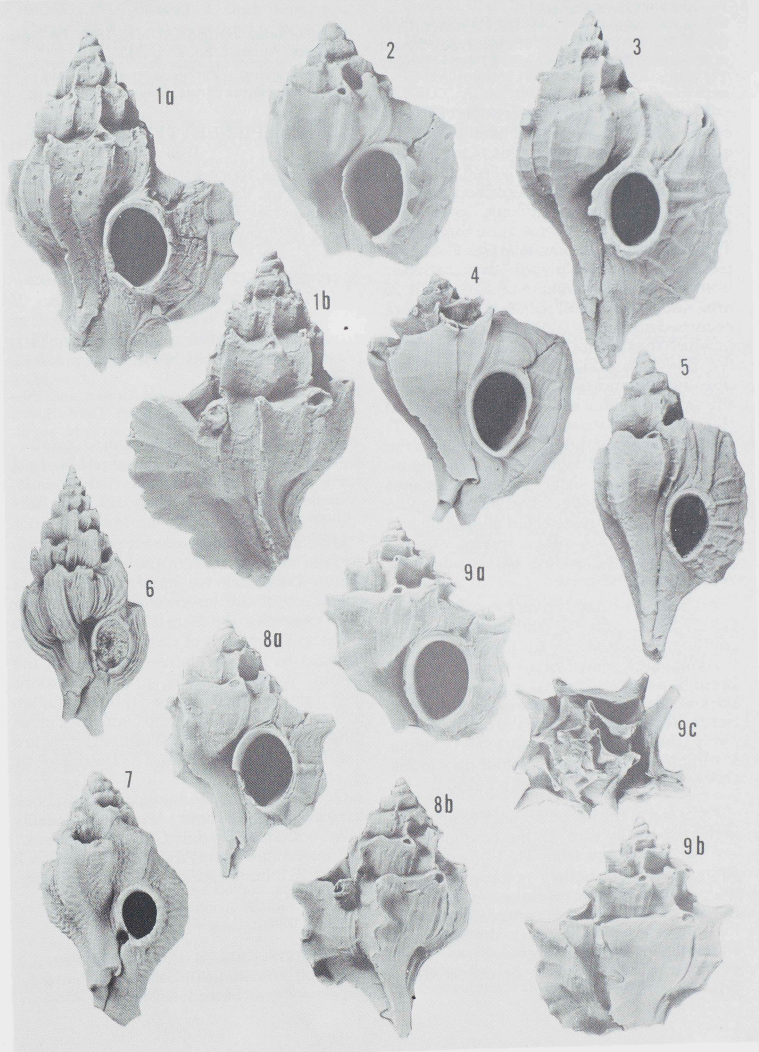


PLATE 1

of road to Refinería Panamá, S.A., at Cativá, Province of Colón, Panamá.

*Figured specimens:* Fig. 8, USNM 365136 (holotype). Fig. 9, USNM 365137 (paratype); height (incomplete) 28.1 mm, diameter 27.4 mm; locality TU 1433.

*Discussion:* With the exception of *T. precursor* and the two giant examples of *T. alatus* mentioned above, this is the largest species of *Typhis* yet discovered. It is also totally unlike any other described form, so that comparisons are difficult. In general, its nearest relative seems to be the Recent *T. cleryi* Petit de la Saussaye (see Gertman, p. 154, text fig. 2-holotype) but that species is much smaller (maximum size about 25 mm) and the shoulder spines of *T. cleryi* are recurved adapically, unlike the new species in which they jut out almost at right angles to the body. In addition, the varical flange does not extend past the body whorl onto the siphonal canal as it does in *T. cleryi*. In this respect it more nearly resembles *T. keenae* Gertman, but that species lacks the crenulated free-standing flange, having instead about four distinct recurved spines along the varical edge. The shoulder spine of *T. keenae* is also directed adapically and neither it nor any other species has the peculiar gutter-like fold at the shoulder seen in the new species.

All examples have come from the lowest Gatun beds, and the rather beach-worn condition of the specimens tends to suggest that this species must have lived in extremely shallow water. This is unusual for members of the Typhinae, although the members of *Rugotyphis* do seem to occur in relatively shallow water — e.g., the Chipola Formation of northwestern Florida and the Caloosahatchee beds of south Florida.

As noted in the introduction, this new find is not especially rare. In the type lot there are two specimens from TU 1433 and eight from TU 1432. Another two examples remain in the collection of Robert H. Stewart, for whom the species is named, in honor of his long years of dedication to the geology of Panamá, his many kindnesses over those years to us, and because he collected the type specimen!

Genus SIPHONOCHELUS Jousseau, 1880

*Siphonochelus* JOUSSEAU, 1880, Le Naturaliste, Année 2, no. 42, p. 335.

Type species: "*Typhis arenatus* Hinds" (= *Typhis arcuatus* Hinds, 1843), by orig. desig.

Subgenus PILSBRYTYPHIS Woodring, 1959

*Pilsbrytyphis* WOODRING, 1959, U. S. Geol. Surv., Prof. Paper 306-B, p. 220.

Type species: *Typhis gabbi* Brown and Pilsbry, 1911, by orig. desig.

SIPHONOCHELUS (PILSBRYTYPHIS) GABBI  
(Brown and Pilsbry)  
Pl. 1, fig. 7

*Typhis gabbi* BROWN and PILSBRY, 1911, Acad. Nat. Sci., Phila., Proc., v. 63, p. 354, pl. 26, fig. 6.

*Typhis (Pilsbrytyphis) gabbi* Brown and Pilsbry, WOODRING, 1959, U. S. Geol. Surv., Prof. Paper 306-B, p. 220 (in part only, not pl. 32, figs. 2, 3, 5, 7 = *S. woodringi* Gertman).

*Siphonochelus (Pilsbrytyphis) gabbi* (Brown and Pilsbry), GERTMAN, 1969, Tulane Stud. Geol. Paleont., v. 7, no. 4, p. 179, pl. 7, fig. 4 (holotype).

*Discussion:* *Siphonochelus gabbi* was described as coming from the excavations at Gatun Lock, but we have never taken a specimen of the species in Panamá. Our only examples are from TU 967, in the Rio Banano Formation of Costa Rica, which is thought to be correlative in age with the Gatun. Woodring (1959, p. 220) mentions only a single immature specimen in addition to the type from the middle Gatun. All of his other specimens, from the upper Gatun, are a different species, named *S. woodringi* by Gertman.

*Occurrence in Panamá:* Gatun Lock (Brown and Pilsbry); Woodring locality 147g; both in the middle Gatun Formation.

*Figured specimen:* ANSP 1722 (holotype); height 13.3 mm, diameter 7.6 mm; locality: Gatun Lock.

SIPHONOCHELUS (PILSBRYTYPHIS)  
WOODRINGI Gertman  
Plate 1, fig. 6

*Typhis (Pilsbrytyphis) gabbi* Brown and Pilsbry. WOODRING, 1959, U. S. Geol. Surv., Prof. Paper 306-B, p. 220 (in part not of Brown and Pilsbry), pl. 32, figs. 2, 3, 5, 7.

*Siphonochelus (Pilsbrytyphis) woodringi* GERTMAN, 1969, Tulane Stud. Geol. Paleont., v. 7, no. 4, p. 180, pl. 7, fig. 6.

**Discussion:** This species also has the peculiar "peanut-shell" sculpture of *Pilsbrytyphis*, but in *S. woodringi* it is oriented axially rather than spirally as in *S. gabbi*.

As noted above, this species is confined to the upper Gatun in the vicinity of Mount Hope, but it is extremely abundant in this small area.

**Occurrence in Panamá:** TU locality 1429; Woodring localities 175, 176, 176a, 177b. All in the upper Gatun Formation.

**Figured specimen:** USNM 365138; height 23.0 mm, diameter 11.2 mm; locality TU 1429.

#### ACKNOWLEDGMENTS

John Gunter and Robert H. Stewart, both of Panamá City, Panamá, generously donated two of the specimens upon which this work is based. In addition, both provided numerous other material to the Tulane Collections, of fossil and Recent mollusks, and we wish to express our extreme gratitude to these gentlemen. Dr. Myra Keen, Stanford University (Emeritus), did her usual good job of reviewing the manuscript.

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#### LOCALITY DATA

589. Rio Banano Fm., Rio Banano, north bank, about 0.6 to 0.8 km above the railroad bridge at La Bomba, Limón Province, Costa Rica.
757. Gatun Fm., roadcut on south side of Boyd-Roosevelt Highway at junction of road to Refinería Panamá, S. A., just east of Cativá, Prov. of Colón, Panamá.
958. Gatun Fm., hillslope on east side of road from Boyd-Roosevelt Highway to Refinería Panamá, S. A., about ½ km north of junction, just east of Cativá, Prov. of Colón, Panamá.
962. Gatun Fm., on road to Refinería Panamá, S. A., about one-half km south of the gate, hillcut and fill for new power plant construction (1968), Prov. of Colón, Panamá.
967. Rio Banano Fm., Rio Banano, south bank, just above railroad bridge at La Bomba, Limón Province, Costa Rica.
977. Unnamed post-Pleistocene formation, mudlump no. 90, mouth of South Pass, Mississippi River delta, Plaquemines Parish, Louisiana.
1249. Unnamed formation, roadcut 8.6 km west of the plaza at San Cristóbal, on road to Baní, Dominican Republic (= loc. H-20001, Bermudez, 1949).
1250. Gurabo Fm., Rio Verde, south bank, just above the ford at the crossing of a side road that connects Duarte Highway and La Vega-

- Moca Highway, about 10 km north of La Vega, Dominican Republic.
1429. Gatun Fm., construction site, one km southeast of Boyd-Roosevelt Highway, just south of Coco Solo Hospital, Prov. of Colón, Panamá.
1431. Gatun Fm., hilltop construction site, 0.5 km northwest of intersection of Boyd-Roosevelt Highway and road to Puerto Pilon, at Sabanita, Prov. of Colón, Panamá.
1432. Gatun Fm., north side Boyd-Roosevelt Highway, clearing behind Residential Martin Luther King (formerly Palo Quemado), approximately 1.5 km east of junction of road to Refinería Panamá, S.A., at Cativá, Prov. of Colón, Panamá.
1433. Gatun Fm., north side Boyd-Roosevelt Highway, clearing behind Urbanization San Martin, approximately 0.5 km east of junction of road to Refinería Panamá, S.A., at Cativá, Prov. of Colón, Panamá.

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## REVIEWS

LANGUAGE OF THE EARTH, edited by Frank H. T. Rhodes and Richard O. Stone. Published by Pergamon Press, New York, Oxford, Toronto, Sydney, Paris, Frankfurt, 1981, xiii + 417 pp., cloth \$35.00, paper \$17.50

*Language of the Earth* is an anthology designed to provide supplementary readings for elementary earth science students. As Professor Rhodes states, with conventional styles of teaching the subject matter all too often emerges as "given, frozen, complete, canned." This book is designed to make earth science more real, meaningful, useful and intelligible by offering selected readings from original authors "to illustrate the scope and range of the science and to convey its flavor and style, rather than catalog its contents; to display all our knowledge as provisional rather than infallible, as refinable rather than complete and finished; to show the inspiration and sweeping implications of earth science, rather than representing it as an isolated area of study."

The readings are well chosen; they illustrate that geologists are human, that geological science is exciting and dynamic, subject to controversy and changing as new discoveries emerge, that there is beauty, humor, poetry, art, intrigue, world history and politics in geology as well as economic benefits. Thus, an overview of earth science is presented which is delightfully readable as much as it is useful. It is highly recommended for students of earth science and for those who wish to browse in a volume which will reveal to them the scope and significance of the geosciences.

FOSSILS: The Key to the Past, by Richard Fortey. Published by Van Nostrand Reinhold Company, New York, Cincinnati, Toronto, London, Melbourne, 1982, 172 pp., illustrated, \$24.95

This book is intended to illustrate how fossils can be and have been used to reconstruct the past history of the Earth. It presents paleontology as a living science with changing perspectives on interpretation of the past as new discoveries emerge and are considered. Many of the illustrations in this handsome volume are in color and these are numerous, well selected, and serve more than adequately to depict the panorama of paleontology for the non-technical reader and student.

Beginning with the historical background of paleontology, the author discusses fossilization, utilization of fossils to subdivide and define geological time, concepts of drifting plates, sedimentary processes and features, facies and climatic distributions, reefs, submarine canyons, turbidites, and many other features. Succeeding chapters deal with recognition of fossils, identification, reconstructions of living images from fossil remains, origin and evolution of life, fossils in the service of man (economic importance and usefulness), and how to make a collection of fossils. This work constitutes a short course in the geology of fossils and their role in elucidating geology for the non-technical reader. It is highly recommended for those who wish to gain an overview of fossils and historical geology.

—H.C.S.