Three new species of *Buchotrigonia* Dietrich, 1938 (Bivalvia; Trigonioida), from the Lower Cretaceous of Colombia

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**ABSTRACT**

This paper describes three new Berriasian species of the genus *Buchotrigonia* Dietrich, 1938 from Colombia: *Buchotrigonia etayoi* sp. nov., *B. perezi* sp. nov., and *B. kauffmani* sp. nov. They are the oldest known species of the genus *Buchotrigonia* in the world.

Key words: Systematics, Bivalvia, Trigonioida, Buchotrigonia, Lower Cretaceous, Berniasian, Colombia.

**RESUMEN**

Tres nuevas especies de *Buchotrigonia* Dietrich, 1938 (Bivalvia; Trigonioida) del Cretácico Inferior de Colombia. En el presente artículo se describen tres nuevas especies del género *Buchotrigonia* Dietrich, 1938, del Berniasian de Colombia: *Buchotrigonia etayoi* sp. nov., *B. perezi* sp. nov. y *B. kauffmani* sp. nov. Las especies propuestas son las más antiguas conocidas de este género en el mundo.

Palabras claves: Sistemática, Bivalvia, Trigonioida, Buchotrigonia, Cretácico Inferior, Berniasian, Colombia.

**INTRODUCTION**

Leopold von Buch (1839) first described the bivalve *Trigonia abrupta* in his work on South American fossils collected by the naturalist Alexander von Humboldt in 1836. One hundred years later, Dietrich (1938) assigned this species to *Buchotrigonia*, a new subgenus. Subsequently, Cox (1952) elevated *Buchotrigonia* to generic status and divided it into the nominal subgenera *Buchotrigonia* and *Syrotigonia*. The record of *Buchotrigonia* s. str. in the Americas is extensive with several species that have been described from the United States, Venezuela, Colombia, Perú and Chile in strata ranging in age from Berniasian (new species described herein) to late Campanian (*Buchotrigonia topocalmensis* Pérez y Reyes, 1980, from Chile).

The three new species described herein are the oldest known members of *Buchotrigonia*. These fossils were collected by the author in 1987 in the area west of Departamento de Cundinamarca, Colombia, from coarse turbiditic sandstones and conglomerates of the middle Cáqueza Group (Villamil, 1990) (text-Figs. 1, 2).

The Cáqueza Group, originally defined by Hubach (1945), represents the first transgressive-regressive cycle of the Colombian Cretaceous (cycle 1 of Macellari, 1988). The lower unit of the Cáqueza
Three new species of Buchotrigonia Dietrich, 1938 (Bivalvia; Trigoniidae), from the Lower Cretaceous...

Text-FIG. 1. a- Index map showing the type localities of Buchotrigonia etayo sp. nov. and B. kauffmani sp. nov. (locality A), and B. perezi sp. nov. (locality B), located about 50 km northwest of Bogotá; b- the map on the right shows the Berriasian deposits in Colombia, modified from Etayo-Serna et al., 1976.

The type section of the Cäqueza Group is located near the village of the same name, 40 km east of Bogotá. The facies, however, are markedly different. They are composed of thinly bedded and fine-grained turbidite deposits interbedded with organic-rich shales. The upper Cäqueza Group contains trigoniids of the genus Mediterraneotrigonia Nakano, 1974, in life position; however, no Buchotrigonia were found in this upper unit.
The type Cáqueza Group is composed of more dista facies and does not contain abundant Buchotrigonia spp. probably because the energy of the turbidite flow was not enough to carry fragments that large. Only scattered Buchotrigonia and Pterotrigonia van Hoepen, 1929 have been collected by the author from the type Cáqueza Group; smaller fossils are more common.

Verification of the differences between the three new species here described, in comparison with B. abrupta (type species) and B. topocalmensis, was performed using two independent biometrical methods. One of them utilized two external ornamentation characteristics, each of which can be measured several times in one shell. These are the angle that the marginal carina forms with each subvertica flank costae, and the perpendicular distance from the subvertical flank costae to the carina (text-Fig. 4). After plotting all the data for αi

Text-FIG. 2. Sections of the Cáqueza Group, lower and intermediate unit. The section on the left was measured on the railroad Utica - Tobia. The section on the right was measured between Villeta and La Magdalena.

Text-FIG. 3. Simplified portion of a stratigraphic column of the Cáqueza Group, lower interval, measured in the railroad that leads to Tobia from Utica. This figure shows the coarse sandstones from where the fossils were collected, and a sketch of the arrangement of valves in the outcrop.

Text-FIG. 4. Schematic Buchotrigonia showing the two measured features; d= distance between any given point in the carina and the anterior flank; α= angle formed by the marginal carina and the costae that cross that same point. Comparison of the regression lines of d vs. α for the type species of the genus (bold line) and for the three new species.
Three-dimensional graphs using independent measured characters support the separation of morphologic clusters (species). The following characteristics were measured on the external surface of each shell or mold: \( a \) - the distance from the umbo to the point where the flank costae begin to break (\( dh \)); \( b \) - a distance perpendicular to \( dh \) from the point where the flank costae begin to break to the marginal carina (\( d! \)); \( c \) - the number of costae per centimeter on the anterior flank (text-Fig. 6). The graph in text-figure 6 shows morphologic clusters, each representing one species.

The main advantage of these two methods is that juvenile specimens, fossil fragments, and impressions can all be measured and analyzed.

**SYSTEMATIC DESCRIPTIONS**

Order Trigonioida Dall, 1889
Superfamily Trigoniacea Lamarck, 1819
Family Trigoniidae Lamarck, 1819

**Genus Buchotrigonia Dietrich, 1938**

**Type species:** *Buchotrigonia abrupta* (von Buch, 1839). Aptian of Colombia.

**Diagnosis** (emend.): Medium to large shells (5-8 cm long) with trigonal to elongate-elliptical outline. Wide area with oblique costae in early growth stages, which diverges in chevron-like manner from those of the flank, then smooth. Flank with three different types of costae: eccentric in early growth stages, and subsequently subvertical and transverse. Flank costae in late growth stages are not continuous.

**Distribution.** *Buchotrigonia* is distributed in America, Spain and France.

*Buchotrigonia etayoi* sp. nov.

Pl. 1, Figs. 1-4, 7

**Eymology:** Named in honor of Fernando Etayo-Serna, paleontologist of the Universidad Nacional de Colombia.

**Material:** 130 specimens were studied. Most of them are very well preserved external molds; the rest are replaced with black calcium carbonate. Latex and silicone casts of the molds were made for taxonomic and biometric studies.

**Holotype:** The holotype is a well preserved right valve of a medium size specimen (LM 071 - s9; Pl. 1, Fig. 4), found in locality A, text-Fig. 1.

**Paratypes:** LM 071 - s2, a right valve (Pl. 1, Fig. 1); LM 071 - s2', a left valve; LM 071 - s8, a left valve; LM 071 - 9, a left valve (Pl. 1, Fig. 7); LM 071 - 10, fragment of a well preserved anterior region of a shell (Pl. 1, Fig. 2), LM 071 - s19, a left valve internal mold, that shows the adductor and pedal retractor muscle scar (Pl. 1, Fig. 3).

**Repository:** Laboratorio de Estratigrafía, Departamento de Geociencias, Universidad Nacional de Colombia, Bogotá.

**Type locality:** The type locality is on the south side of the road between Villeta and La Magdalena (Cundinamarca, Colombia), 1 km east of La Magdalena (\( 4° 59' 11.25" \) N; 74° 32'18.75" W), text-Fig. 1, loc.A; text-Fig. 2.

**Other localities:** The specimens were collected about 4 km north of type locality, 1 km west of Tobia on the south side of the railroad near type locality (text-Fig. 1); close to the town of Tobia (QNOIO-15), and from Tobia (F0081-b).

**Stratigraphic occurrence:** *Buchotrigonia etayoi* sp. nov. was collected from the coarse sandstones of a turbiditic sequence in the Cauza Group, intermediate unit (not formally named; text-Fig. 2).

**Associate fauna:** *Buchotrigonia etayoi* sp. nov., *B. kauffmani* sp. nov. and fragmentary echinoids, indeterminate gastropods, and bivalves such as *Protocardia* sp., *Exogyra* sp., and *Mediterraneotrigonia* sp.

**Age:** Berriasian, based on *Sarasinella cf. S. hondaana* Haas (late Berriasian) studied by F. Etayo-Serna.
T. Villamil

Text-FIG. 6. Schematic Buchotrignia showing the point where the flank costae begin to divide (lower sketch) and the measured distances dh and dl (upper sketch). Plotted measurements differentiate B. abrupta (von Buch), B. etayoi sp. nov., B. perezi, and B. kauffmani sp. nov. (1991, written communication), collected from the same stratigraphic interval as Buchotrignia etayoi (sample number 21074, not illustrated).

Diagnosis: Species of Buchotrignia that is slightly higher than long, large, with trigonal outline, and no more than 6 transverse costae per centimeter on the anterior zone of the flank. Non-tuberculate costae occur on the adambonal region of the shell.

Description: Large shell with a maximum length of ca. 69 mm and rounded trigonal outline; slightly higher than long in most specimens (Pl. 1, Figs. 1-4; Fig. 7 shows a long rather than tall specimen). The anterior margin of the shell is broad, shows continuous flank ornamentation (Pl. 1, Fig. 2), and has a rounded outline. The posterior margin is slightly elongated, straight, and forms an angle of about 50° with the ventral margin. The umbones are wide, and slightly

Text-FIG. 5. a- Lateral view showing flank ornamentation. Buchotrignia etayoi sp. nov., B. perezi sp. nov., and B. kauffmani sp. nov.; b- ornamentation of the area and escutcheon of the species B. etayoi sp. nov., dorsal view.
opisthogyous. The marginal carina is sharp in early growth stages, than obtuse and relatively wide (3-5 mm). The area comprises approximately 15% of the shell, and is divided by a weak ridge into an upper and a lower area, both of which are ornamented with oblique costae only in the early growth stages (text-Fig. 5b). The surface of the area and the flank form an angle of 110° in the adumbonal region and subsequently increases to 120° towards the ventral margin. The escutcheon comprises 6-8% of the valve surface, and is characterized by oblique costae in the very early growth stages, and growth lines in the late adult stages (text-Fig. 5b).

The flank is divided into three regions: a- the adumbonal one-tenth of the valve is ornamented with continuous eccentric costae; b- the anterior flank contains transverse straight costae that are subhorizontal, 6 per centimeter, and comprises 30% of the valve surface; c- the central posterior flank (45% of the shell) contains subvertical costae, that are thinner than the intercostal spaces (Pl. 1, Fig. 4).

**Measurements, mm**

<table>
<thead>
<tr>
<th>Fossil number</th>
<th>L</th>
<th>H</th>
<th>W</th>
<th>H/L</th>
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<td></td>
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<tr>
<td>LM 071-s9 (rv)</td>
<td>54</td>
<td>57</td>
<td>20</td>
<td>1.05</td>
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<td>Paratypes</td>
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<td></td>
<td></td>
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<td></td>
</tr>
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<td>LM 071-s2 (rv)</td>
<td>50</td>
<td>51</td>
<td>20</td>
<td>1.02</td>
<td>0.80</td>
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<tr>
<td>LM 071-s2 (lv)</td>
<td>44</td>
<td>51</td>
<td>21</td>
<td>1.16</td>
<td>0.95</td>
</tr>
<tr>
<td>LM 071-s8 (lv)</td>
<td>48</td>
<td>52</td>
<td>21</td>
<td>1.08</td>
<td>0.87</td>
</tr>
<tr>
<td>LM 071-9 (lv)</td>
<td>69</td>
<td>65</td>
<td>24</td>
<td>0.94</td>
<td>0.70</td>
</tr>
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</table>

- L= length; H= height; W= width of one valve; rv= right valve; lv= left valve.

**Discussion.** Buchotrigonia etayoi sp. nov. differs from B. abrupta (von Buch, 1839), the type species of the genus, mainly in the following aspects: B. etayoi sp. nov. is larger and its average ratio H/L is greater than the type species (1.05 average in B. etayoi sp. nov. and 0.85 average for B. abrupta (von Buch)). B. etayoi sp. nov. has non-tuberculate costae in the adumbonal region (Table 1). The point where the flank costae separate is located closer to the umbo in the species B. etayoi sp. nov. than in the type species B. abrupta (von Buch) (text-Figs. 6, 7). Consequently, the percentage of the shell ornamented with eccentric costae is relatively less in B. etayoi sp. nov. (10%) than in B. abrupta (von Buch) (25%).

Buchotrigonia etayoi sp. nov. is wider and larger than B. reesidei (Stoyanow, 1949); the latter

commonly has zigzag costae (Stoyanow, 1949), a feature that never appears in the new species of Colombia. Buchotrigonia etayoi sp. nov. differs from B. ? fortii (Lisson, 1930) in that it is shorter, has thinner costae, and the flank ornamentation is not continuous. Buchotrigonia etayoi sp. nov. is smaller than B. topocalmensis Pérez and Reyes; the area is divided, and the escutcheon is ornamented; in addition, the point where the flank costae separate is closer to the umbo in B. etayoi sp. nov. The new species does not exhibit thick concentric costae like B. (Buchotrigonia?)

Text-Fig. 7. Graph of dh versus dl showing discrete species groupings. Each circle represents a measured specimen. The lower group comprises Barremian species; the middle group Barremian-Aptian species, and the upper group represents Campanian species. The lower diagram shows Cretaceous stages and dh versus dl. Flank ornamentation is shown in schematic drawings which represent the morphologic groups. The point where the costae divide moves away from the umbo through time, and the amount of surface area ornamented with eccentric costae becomes larger with time.
TABLE 1. COMPARISON BETWEEN THE THREE NEW SPECIES AND BUCHOTRIGONIA (B.) ABRUPTA (VON BUCH, 1939)

<table>
<thead>
<tr>
<th>Taxon species</th>
<th>Outline</th>
<th>H/L mean</th>
<th>W mean</th>
<th>Size</th>
<th>% Eccentric costae</th>
<th>Transverse costae density (middle region)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. abrupta</td>
<td>trigonal</td>
<td>0.85</td>
<td>17</td>
<td>medium</td>
<td>25 %</td>
<td>5</td>
</tr>
<tr>
<td>B. etayoi</td>
<td>trigonal</td>
<td>1.05</td>
<td>21</td>
<td>large</td>
<td>10 %</td>
<td>6</td>
</tr>
<tr>
<td>B. perezi</td>
<td>trigonal</td>
<td>0.87</td>
<td>16</td>
<td>medium</td>
<td>10 %</td>
<td>7-8</td>
</tr>
<tr>
<td>B. kauffmani</td>
<td>elongate-elliptical</td>
<td>0.65</td>
<td>19</td>
<td>large</td>
<td>5 %</td>
<td>4</td>
</tr>
</tbody>
</table>

H = height; L = length; W = width one valve

inca (Fritzsche, 1923); this characteristic and the vauognic ccestae toward the ventral margin suggests that the taxonomic position of B. (B.?) inca (Fritzsche) is doubtful. Perhaps it will fit better in the genus Syrotrigonia Cox, 1952.

Some dissimilarities between Buchotrigonia etayoi sp. nov., B. perezi sp. nov., and B. kauffmani sp. nov. are shown in text-figures 5a, 6-7. B. etayoi sp. nov. is generally higher than long, whereas the other new species are relatively long (text-Fig. 5a). Transverse costae density per centimeter is greater in B. etayoi sp. nov. than in B. kauffmani sp. nov. (6.0 in B. etayoi sp. nov.; 4.0 in B. kauffmani sp. nov.), and lesser than in B. perezi sp. nov. (8.0 costae/cm) (Table 1).

**Buchotrigonia perezi sp. nov.**

Plate 1, Figs. 6,8

*Etymology:* Named in honor of Ernesto Pérez, paleontologist of the Servicio Nacional de Geología y Minería, Chile (SERNAGEOMIN).

*Material:* Four well preserved external molds from which latex casts were made.

*Holotype:* The holotype is a well preserved external mold of the right valve catalogued as To. 004. This specimen was found at locality B (text-Figs. 1, 2; PI.1, Fig. 8).

*Paratype:* A well preserved but incomplete external mold of a right valve found in Quebradanegra (QN 010-18; Pl. 1, Fig. 6).

*Repository:* Laboratorio de Estratigrafía, Departamento de Geociencias, Universidad Nacional de Colombia, Bogotá.

*Type locality:* One km west of Tobia (Cundinamarca, Colombia), on the south side of the railroad that leads to Utica (5° 1' 39" N; 74° 31' W (text-Fig. 1, loc. B).

*Other locality:* Between Villata and La Magdalena (text-Fig. 1), 1 km east from La Magdalena. Two external molds come from this locality: LM 071-S13, right valve; LM 071-S32, left valve; this last specimen was not collected in situ.

*Stratigraphic occurrence:* The holotype of Buchotrigonia perezi sp. nov. was collected from the coarse sandstones of a turbiditic sequence in the Caqueza Group, intermediate unit (not formally named; text-Fig. 2).

*Associated fauna:* This species was found together with Buchotrigonia etayoi sp. nov. Nearby strata yielded Ptychomya sp. and Mediterraneotrigonia sp.

*Age:* Berriasian, based on Sarasinella cf. S. hordaana Haas (late Berriasian) studied by F. Etayo-Serna (1991, written communication). These ammonites were collected from a stratigraphic interval 100 m above Buchotrigonia perezi sp. nov. The sample number of the ammonites is 21074, not illustrated.

*Diagnosis:* Species of Buchotrigonia of medium size that are slightly longer than high, with trigonal outline, with no more than 8 transverse costae per linear centimeter on the anterior zone of the flank. Nontuberculate costae occur in the adumbonal region of the shell.
Description: Medium size Buchotrigonia (approximately 5 cm in length). Outline trigonal, slightly longer than high (Pl. 1, Figs. 6-8). The umbones are slightly opisthogyrous. The area comprises 10% of the valve surface, it is bisected by a ridge, and ornamented with oblique costae in early growth stages (Pl. 1, Fig. 8). The marginal carina is sharp in early growth stages, then wide and rounded. The surfaces of the area and the flank form an angle of 120° in early growth stages and subsequently about 130°. The escutcheon is wide, depressed, with oblique costae in the very early growth stages.

The outline of the anterior margin of the shell is wide and straight whereas the posterior margin ends in an elongated and rounded manner. The ventral margin is crenulated and has a rounded outline.

The flank is divided as in Buchotrigonia etayoi sp. nov. into three regions (text-Fig. 5a; Pl. 1, Figs. 6, 8): the adumbonal region is ornamented with continuous eccentric costae; the anterior one is ornamented with transverse straight costae, 7 per centimeter (text-Fig. 6, Z axis) increasing to 8 towards the ventral margin and comprises 30% of the valve surface; the central posterior flank (50% of the total surface) has subvertical, relatively fine costae that are inclined towards the posterior margin.

Measurements, mm

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<td>To. 004 (rv)</td>
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<td>0.92</td>
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<tr>
<td>Paratype</td>
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<td>29</td>
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<td>0.82</td>
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Discussion: Buchotrigonia perezi sp. nov. differs from B. abrupta (von Buch) in having non-tuberculate costae in the adumbonal region. The percentage of eccentric costae is relatively low (<10%) compared to B. abrupta (von Buch) (about 25%; Table 1). This difference is represented by the plots in text-figures 5 and 6. B. perezi sp. nov. does not have the zigzag pattern of ornamentation and is slightly larger than B. reesidei (Stoyanow). The new species is relatively shorter and has thinner costae than B. ? fortii (Lisson, 1930). Lisson’s species has continuous costae in the flank (Lisson, 1930, Pl. 1, Fig. 1) whereas B. perezi sp. nov. shows clear discontinuous costae. B. perezi sp. nov. is smaller than B. topocalmensis Pérez and Reyes, 1980, and has a bisected area and an ornamented escutcheon. B. perezi sp. nov. differs from B. etayoi sp. nov. in being smaller and having greater density of costae per centimeter in the anterior region of the shell (text-Fig. 6, Z axis). The point where the flank costae begin to divide is located closer to the umbo in B. perezi sp. nov. than in B. abrupta (von Buch) and in B. topocalmensis Pérez and Reyes (text-Figs. 6, 7). Buchotrigonia perezi sp. nov. is smaller, less elongated and has straighter costae ornamenting the anterior flank than does B. kauffmani sp. nov. (text-Fig. 5a).

Buchotrigonia kauffmani sp. nov.

Plate 1, Figs. 5-8-10

Etymology: Named in honor of Erle G. Kauffman, paleontologist of the University of Colorado at Boulder.

Material: Three specimens, two are well preserved external molds; the third is an internal mold.

Holotype: LM-071 s3, a well preserved specimen (Pl. 1, Figs. 9-10)

Paratypes: LM-071 s1, a well preserved internal mold of a left valve (Pl. 1, Fig. 5), and LM-071 s7, the posteroventral region of a large specimen.

Repository: Laboratorio de Estratigrafía, Departamento de Geociencias, Universidad Nacional de Colombia, Bogotá.

Type locality: The type locality is between Villeta and La Magdalena (Cundinamarca, Colombia), 1 km east of La Magdalena on the south side of the road (4°59′11.25″N; 74°32′18.75″W), Fig. 1, loc. A.

Stratigraphic occurrence: Buchotrigonia kauffmani sp. nov. was collected from the coarse turbiditic sandstones of the intermediate unit of the Caqueza Group (not formally named, text-Fig. 2).

Associated fauna: This species was found together with Buchotrigonia etayoi sp. nov., scale echinoid fragments and other undetermined bivalves.

Age: Berriasian, based on Sarasinella cf. S. hondanae Hass (late Berriasian; F. Etayo- Serva, 1991, written communication).

Diagnosis: A very elongated, large species of Buchotrigonia. Shell with no more than 4 transverse costae per linear centimeter on the anterior flank, which form an elongated reclining 'S' pattern (Pl. 1, Fig. 9). Non tuberculate costae occur on the adumbonal region of the shell.
Description: Large forms with elongate and elliptical outline; opisthogyrous umbones (Pl. 1, Figs. 9, 10). The area comprises 10% of the valve surface; it is bisected by a ridge and ornamented, only in the adumbonal region, with oblique costae concave towards the umbo. The escutcheon is wide, elongated and shows the same ornamentation as the area (Pl. 1, Fig. 9). The marginal carina is broad towards the ventral margin, rounded in cross section, it generates an angle of 135° between the flank and the area. The anterior margin has a rounded contour, whereas the posterior one terminates in an acute angle. The ventral margin is crenulated. The flank is divided into three regions: the adumbonal flank (<5% of the total surface) is ornamented with eccentric costae; the anterior one is ornamented with transverse costae that form an elongated reclining ß pattern (4 per centimeter); the posterior central region (60% of the valve surface) has subvertical costae.

Measurements, mm

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L = length; H = height; W = width of one valve. *=approximate values.

Discussion. Buchotrigonia kauffmanis sp. nov. is the most elongated and one of the the largest species of the genus Buchotrigonia. It differs from B. abrupta (von Buch) in being larger and having non-tuberculate costae in the adumbonal region (Table 1). The point where the flank costae begin to break is closer to the umbo in B. kauffmanis sp. nov. than in B. abrupta (von Buch) and B. topocalmensis Pérez and Reyes (text-Figs. 6, 7). This new species differs from all the other taxa of the genus mainly in its elongate-elliptical outline and in the curved costae on the anterior flank.

MORPHOLOGIC-STRATIGRAPHIC TRENDS IN THE SOUTHERN AMERICAN BUCHOTRIGONIA SPECIES

The strongly ornamented flank of Buchotrigonia shows a point where the eccentric costae divide (text-Figs. 6, 7); the distance from this point to the umbo (dh) parallel to the shell height (h) was measured in 44 specimens of the 5 Southamerican species. The distance is parallel to the valve length from the point where the costae divide to the marginal carina (dl in text-Fig. 6) was also measured. These two distances were chosen because they represent the amount of pre-adult shell, they vary between diachronous taxa and are constant within contemporary species. This is demonstrated herein by the similar values for the three Berriasian species (text-Fig. 7). The selected criterion is therefore not valid for biometrical separation of all species; its chronological value seems to be significant, however.

Three statistical groups are clearly separated when plotting all measurements (text-Fig. 7). The lower cluster represents the Lower Cretaceous (Berriasian) species Buchotrigonia etayo sp. nov., B. perezi sp. nov., and B. kauffmani sp. nov. The intermediate cluster belongs to the Aptian species B. abrupta (von Buch), and the upper group to the Campanian species B. topocalmensis Pérez and Reyes (text-Fig. 7).

CONCLUSIONS

The three new species of Buchotrigonia here described occur in the Berriasian stage of Colombia based on their association with Sarasineila cf. S. hondanae Haas. These are the oldest known species of this genus in the world.

The point where the eccentric costae divide is close to the umbo in the Berriasian species (B etayo, B. perezi and B. kauffmani) in opposition to the Aptian and Campanian species (B. abrupta and B. topocalmensis) where it happens in the central and lower zones respectively.
ACKNOWLEDGEMENTS

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REFERENCES


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THREE NEW SPECIES OF Buchotrigonia Dietrich, 1938 (Bivalvia; Trigoniida), FROM THE LOWER CRETACEOUS...

PLATE 1
(All photographs taken of latex casts, figures in natural size)

Figures

Figs. 1-4,7 Buchotrigonia etayoi sp. nov. p. 230
South side of the road between Villeta and La Magdalena (Cundinamarca, Colombia), 1 km east of La Magdalena (text-Fig. 1, location A). Cáqueza Group, intermediate unit. Berriasian.

1 Specimen LM 071-s2 (paratype). Right valve. Internal features view.
2 Specimen LM 071-10 (paratype). Both valves. Anterior view which shows transverse flank costae.
3 Specimen LM 071-s19 (paratype). Left valve. Internal mold. Note adductors and pedal retractor muscle insertion areas.
4 Specimen LM 071-s9 (holotype). Right valve. Lateral view. Note the different density between subvertical and transverse flank costae.
7 Specimen LM 071-9 (paratype). Left valve. Internal region view. It shows a long rather than tall specimen.

Figs. 6, 8 Buchotrigonia perezi sp. nov. p. 233
One km west of Tobia (Cundinamarca, Colombia) on the south side of the railroad that leads to Utica (text-Fig. 1, location B). Cáqueza Group, intermediate unit. Berriasian.

6 Specimen QN 010-18 (paratype). Right valve. Lateral view. Note that the point where the flank costae begin to divide is located close to the umbo.
8 Specimen To. 004 (holotype). Right valve. Lateral view. Note the great density of transverse flank (8 costae per centimeter)

Figs. 5,9-10 Buchotrigonia kauffmani sp. nov. p. 234
South side of the road between Villeta and La Magdalena (Cundinamarca, Colombia), 1 km east of La Magdalena (text-Fig. 1, location A). Cáqueza Group, intermediate unit. Berriasian.

5 Specimen LM 071-s1 (paratype). Left valve. Internal mold. Note muscle insertion area and the integripalliate line.
9 Specimen LM071-s3 (holotype). Both valves. Dorsal view. Note the area bisected by a ridge and ornamented with oblique costae concave towards the umbo.
10 Lateral view which shows transverse flank costae that form an elongated reclining 'S' pattern.