MORPHOMETRIC EVALUATION OF THE AMERICAN HIPPURITIDS (RUDISTS, CRETACEOUS)

Reinaldo Rojas Consuegra

Museo Nacional de Historia Natural. Obispo No. 61. Palza de Armas. C. Habana. Cuba. E-mail: vdinest@mnhnc.inf.cu

ABSTRACT

The rudist Family Hippuritidae is represented by elevators, with morphological and functional adaptations that allowed them to flourish in certain Cretaceous environments. The relationship between height (H) and diameter (D) of the shell is defined here as the Coefficient of Elevation (R), on the basis of which shells can be classified in the following categories (submorphotypes): High Elevator, HE (R>2), Middle-High Elevator, MHE (1.9>R>1), Middle-Low Elevator, MLE (0.9>R>0.5) and Low Elevator LE (R<0.4). The graphic expression of the R-values, for a set of specimens of a known taxon, clearly reflects its general morphological trend. Therefore, this type of morphometric analysis should provide a new clue for the interpretation of palaeoenvironmental variations, comparison of sedimentation rates, estimation of the morphological evolution of the taxa through the time, and it may be useful for correlation between different area or regions.

Introduction

The rudist Family Hippuritidae (Mollusk: Bivalve) is represented by elevators (Skelton and Gili, 1991), with morphological and functional adaptations that allowed them to flourish in certain Cretaceous environments within the Tethys. The lower valve was adapted for upward growth above the sea floor. Its upper valve had a particular system of canals and pores, which, together with the oscules, and the pillars of the lower valve, promoted successful feeding and development of the organism (Skelton, 1978; 1979; 1991).

The present work contain a general evaluation of the morphometric characteristics of the American hippuritids species, and define forth submorphotypes for the elevators.

Materials and Methods

The database used in the present evaluation was obtained in part from the literature (Alencáster, 1971; Van Dommelen, 1971), and complemented with measurements (height - H and diameter - D of the shells) of the specimens deposited in the rudist collection at the National Museum of Natural History of Cuba.

Classification

The American hippuritids are represented by some taxa (Praebarrettia, Barrettia, Parastroma, Torreites, Vaccinites, Hippurites) that show remarkable morphological variations on the elevator mode (MacGillavry, 1937; Chubb, 1971).

The relationship between height (H) and diameter (D) of the shell is defined here as the Coefficient of Elevation (R), on the basis of which shells can be classified in the following categories (submorphotypes): High Elevator, HE (R>2), Middle-High Elevator, MHE (1.9>R<1), Middle-Low Elevator, MLE (0.9>R<0.5) and Low Elevator LE (R<0.4). The graphic expression of
the R-values, for a set of specimens of a known taxon, clearly reflects its general morphological trend.
The Coefficient of Elevation depends directly on the height and width reached by the shell, which were influenced by other factors such as the rate of lower valve growth, sedimentation rate, sea-bottom quality, hydrodynamical characteristics of the environment, etc.

For example, the Campanian Barrettia monilifera (HE=17.4%, MHE=58.7%, MLE=23.9%, LE=0%) is very similar to the Santonian Barrettia coatesi (HE=12.8%, MHE=64.1%, MLE=23.1%, LE=0%). So although the former species has a much bigger shell size, both species fall within the Middle-High to High Elevator range. Barrettia gigas (HE=0%, MHE=18.2%, MLE=72.7%, LE=9.1%) is very different from the previous two species, because it falls in the Middle-Low to Low Elevator range.

Discussion

Genera Parastroma

According to the Coefficient of Elevation (R) Parastroma sanchezi Duovillé, 1926, is a typical sub-morphotyp of Meddle-Low Elevator (83.3%).

The general height of its shells doesn't overcome its diameter, and in some cases it is inferior halfway its diameter. This sub-morphotyp is characterized by its aspect of very wide low cone. Parastroma cf. sanchezi belongs to the sub-morphotyp Meddle-Low Elevator (88.9%) also, very similar to the P. sanchezi, but with dimensions in general much smaller (50-200 mm). In general, this species possesses near form to a "flying plate", it presents qualitative features (ornamentation) something different from P. sanchezi, and it even resembles each other more to P. trechmanni.

Parastroma trechmanni Chubb, 1971, shows two clusters, the main grouping classifies this species like a Middle – Low Elevator (57.1%) to Low Elevator (16.7%). The height spreads to be near half of the diameter of the shell, presenting an aspect of wide and low, flat cone. According to this sub-morphotype he resembles each other to P. sanchezi.

The second tendency classifies as a sub-morphotyp Middle - High Elevator (26.2%), which differs clearly of the previous of P. sanchezi or P. cf. sanchezi, and looks like P. guitarti.

Parastroma guitarti (Palmer), 1933 is revealed mainly as belonging to the sub-morphotyp Middle - High Elevator (65.4%). It also presents a group of individuals of the sub-morphotype Middle - Low Elevator (23.1%), that could respond to the morphology characteristic of the juvenile stadium.

This species differs clearly of the previous ones, to present a height (up to 500 mm) which have a tendency to be generally bigger (76.9%) that its diameter (250mm). Its form varies from a low cone until columnar - cylindrical very high.
In Parastroma genera they are the species that reach the biggest sizes inside or of the American Hippuritids.

To *P. guitarti* (of Cuba) they could correspond the individuals that form the cluster 2 of the *P. trechmanni* (of Jamaica), because plotted coincidentally in the same morphometric field.

*P. cf. sanchezii* of Guayos (Cuba) behaves in a very similar way to *P. trechmanni*, and both coincide with the inferior half of the field that *P. sanchezii* occupies. Of here the following possibilities arise:

1. *P. cf. sanchezii* is synonymous of *P. trechmanni*, and then this last species is present in Cuba.
2. *P. trechmanni* is a similar species to *P. sanchezii* (cluster 1), with which was not compared for the foundation of that taxon (Chubb, 1971), or it is considered a valid species, following Dommelen (1971).
3. The cluster 2 of *P. trechmanni* coincident partially with *P. guitarti*, that which could indicate the presence of that species in Cuba also.

The most parsimonious position seems to be, the possibility of the presence shared in both islands (Jamaica and Cuba) of the three species: *P. guitarti, P. sanchezii* and *P. trechmanni*.

**Genera Barrettia**

The species belonging to the genera Barrettia generally behaves as Middle - High Elevator (43,8%) and Middle - Low Elevator (42,5%). As MLE classifies only one specie: *B. gigas* (72.7%). While other two species are classified as the sub-morphotype MHE: *B. monilifera* (58.7%) and *B. coatesi* (64.1%), but *B. multilirata* also presents partially this tendency (35.8%).

According to their aspect the species of the genera they are conical (cluster 1) to cylindrical one, high or columnar. While, according to their size they could be reaching gigantic sizes: *B. gigas* (+300 mm of diameter) and *B. monilifera* (+400 mm of high).

**Genera Praebarrettia**

The species of this genera are classified inside the sub-morphotype High Elevator (64.7%) to Meddle - High Elevator (55%), until Middle - Low Elevator (35%). The species *P. corrali* is of small size. Their height rarely
overcomes the 150 mm, although commonly it overcomes until more than twice its diameter, which doesn't reach the 50 mm. While *P. sparcilirata* presents a general height that reaches up to 300mm, and its width overcomes the 150 mm, evidencing their biggest size.

**Genera Torreites**

This genera contain one of the smallest species of the American Hippuritids (*T. schoppi*, Santonian age).

The species of this genera are manifested inside the sub-morphotype High Elevator (60%) to Middle - High Elevator (75%); and in smaller degree, they appear as Middle - Low Elevator (18.8%). Their height and width vary thoroughly from less than 50 mm until a maximum 200 mm. For their general aspect they are cylindrical fine, relatively small, until conical medium and lightly conical wide.

**Genera Vaccinites**

The data on the genera are scarce. This genera is integrated by the smallest species inside the American Hippuritids. In general they belong to the sub-morphotype High Elevator, although their measures are very small ones (*H = 50 -150 mm; D = < 25 mm*).
Family Hippuritidae

Among the American Hippuritids, according to the Coefficient of Elevation of the main species that contains, they can be distinguished four submorphotypes (HE, MHE, MLE, LE).

In general, no one genera classifies as a High Elevator, although some species by separate could be classified: *P. guitarti*, *T. schoppi* and *P. corrali*.

As Meddle - High Elevator classifies three genera: Barrettia, Praebarrettia and Torreites, while as Middle - Low Elevator appears the other three genera: Parastroma, Barrettia and Vaccinites. Finally, as Low Elevator doesn't classify any genera, needier any specie.

Concluding, the whole family of Hippuritids classifies as Middle - High Elevator in little more than 40%, Middle - Low Elevator among 30 - 40, High Elevator in less than 15%, and Low Elevator in around 10%.

<table>
<thead>
<tr>
<th>Specie</th>
<th>Diameter</th>
<th>Height</th>
<th>R</th>
<th>Submorphotype</th>
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<tbody>
<tr>
<td>1. P.corrali</td>
<td>38.9</td>
<td>85.1</td>
<td>2.19</td>
<td>HE</td>
</tr>
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<td>2. T.sanchezi</td>
<td>29.8</td>
<td>55.4</td>
<td>1.88</td>
<td>MHE</td>
</tr>
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<td>3. B.coatesi</td>
<td>55.6</td>
<td>85.2</td>
<td>1.53</td>
<td>MHE</td>
</tr>
<tr>
<td>4. B.monilifera</td>
<td>106.4</td>
<td>153.9</td>
<td>1.45</td>
<td>MHE</td>
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<tr>
<td>5. V.i.macgillavryi</td>
<td>58.8</td>
<td>81.7</td>
<td>1.39</td>
<td>MHE</td>
</tr>
<tr>
<td>6. P.guitarti</td>
<td>151.8</td>
<td>209.7</td>
<td>1.38</td>
<td>MHE</td>
</tr>
<tr>
<td>7. T.schoppi</td>
<td>118.9</td>
<td>151.6</td>
<td>1.28</td>
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</tr>
<tr>
<td>8. B.multilirata</td>
<td>169.1</td>
<td>208.8</td>
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<td>9. P.sparcilirata</td>
<td>105</td>
<td>125</td>
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<td>10. V.i.verbunti</td>
<td>82.3</td>
<td>83.4</td>
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<td>11. B.gigas</td>
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<td>12. V.martini</td>
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<td>13. P.trechmanni</td>
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<td>14. P.sanchezi</td>
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<td>15. P.cf.sanchezi</td>
<td>145</td>
<td>102.2</td>
<td>0.70</td>
<td>MLE</td>
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</table>

Interpretation

*P. sanchezi* specie was adapted to a habitat not very energy one, with relatively high deposition rate but of continuous character, seated in a relatively soft substrate of grainstone-packstone. *P. cf. sanchezi* occupied a habitat not very energy one, of drop deposition rate, of probably grainstone-packstone substrate.

Apparently, *P. trechmanni* contain a mixture of two species, or he manifests two ways of adaptation to different habitats. The individuals belonging to the cluster 1, they seem to have been adapted to a habitat of low energy, it goes down deposition rate and probable relatively soft substrate, formed of fine sands to loams (packstone - wackestone).

The individuals that integrate the cluster 2, were possibly inhabitants of a bottom with a rate of possibly more deposition, with a moderate to high energy. *P. guitarti* was inhabited a bottom with discharge deposition rate, with moderate energy to high, because it possesses a very thick and heavy shell that was implanted in a relatively consolidated substrate of burden-sandy (rudstone – grainstone).
The species belong to the genera Barrettia occupied an habitat with variable parameters, from relatively low energy until moderate to high, with low deposition rate (B. coates, B. gigas), until high (B. monilifera and B. multilirata).

Praebarrettia inhabited an habitat very variable one, so much for their energy as the deposition rate.

The species of the genera Torreites inhabited in the grainstone – packstone substrate, with high energy condition, and a low deposition rate.

The species of the Vaccinites genera inhabited an habitat of high energy (they formed small clusters), but with low deposition rate, in probable the rudstone – grainstone substrate.

Conclusions

Therefore, this type of morphometric analysis should provide a new clue for the interpretation of palaeoenvironmental variations, comparison of sedimentation rates, estimation of the morphological evolution of the taxa through the time, and it may be useful for correlation between different area or regions.

Reference