A new cladistic insight on comparative anatomy and phylogeny of rudists (Bivalvia, Hippuritida)

Valentin Rineau[a]*, Jean-Pierre Masse[b] and Loïc Villier[a]

[a] Sorbonne Université, Muséum national d'Histoire naturelle, CNRS, UMR 7207, CR2P, Centre de Recherche en Paléontologie – Paris, 8 rue Buffon, 75005 Paris, France ; [b] CEREGE, Aix-Marseille Université, Centre Saint-Charles, 13331 Marseille Cedex 03, France

*Corresponding author. Email: valentin.rineau@gmail.com

Table of Contents

Appendix 1: Glossary and acronyms 1

Appendix 2: Character list 6

Appendix 3: Character matrix 117

Appendix 4: 3ia file and corresponding nexus file 119

Appendix 5: Table of results of the character test procedure 158

Appendix 6: Proposal of classification of all Hippuritidina genera 160

Appendix bibliography 162

Appendix 1: Glossary and acronyms

Anterior accessory cavity (AAC) – The AAC-LV is a cavity of the LV generally inset between the AM-LV and the anterior side of the shell which can be filled with radial blades. The AAC-RV is a cavity of the RV generally in contact with the ATS, inset between D and the anterior side of the shell. As AAC-LV and AAC-RV are not homologous, they can develop independently on each vale, and are always cited with the abbreviation of the concerned valve. The cavities are designated by the general term "accessory cavities" because they can be endomyophoral or ectomyophoral, depending on the taxa.

Accessory cavity – Term applying to any shell cavity in the aragonitic layer, excepted sockets and ligamentary cavities. The different cavities are separated by aragonitic walls. Accessory cavities include ectomyophoral cavities (cavities lying on the outer side of a myophore) and endomyophoral cavities (cavities lying on the inner side of a myophore).

Anterior ectomyophoral cavity (AECC) – Cavity of the RV developed between the anterior tooth socket and the anterior side of the shell. It can be filled with radial blades. The AECC is always adjacent to the AM-RV.

Anterior myophore (AM) – Attachment structure for the animal muscle that can be horizontal (shelf), tilted, or vertical (protruding or not into the opposite valve). Recognizable by its anterior position and sometimes by muscle scars. There is an anterior myophore in each valve. In Hippuritidae, the anterior myophore is stretched and divided into two myophoral blades.

Anterior tooth (AT) – Protrusion of shell wall inserted into a cavity of the opposite valve. Located in the anterior side of the shell, it is generally as large as or larger than the posterior tooth.

Anterior tooth socket (ATS) – Cavity where the anterior tooth inserts. The socket lies anteriorly to the central tooth. It can be filled with radial blades. Connection with the posterior tooth socket is possible in case of elongation on the ventral side of the shell.

Blade – Aragonitic shell thickening protruding out of the commissural plane and lying along a cavity wall of the other valve. Blades generally carry a myophore. When thick, the blade can have a tooth-like morphology.

Calcitic canals – Radial canals in the outer shell layer of the left valve, communicating with the outside by pores and communicating with the inside by openings in the shell margin.

Central tooth (CT) – Protrusion of shell wall between anterior tooth socket and posterior tooth socket. It can be highly regressed, as in Radiolitidae to well-developed and surrounding the anterior tooth socket, as in Diceratidae.

Central tooth socket (CTS) – Cavity in which the central tooth inset. The cavity lies between anterior tooth, posterior tooth and general cavity. It can be filled with radial blades, and be in connection with the posterior accessory cavity on the ventral side of the shell.

Commissural plane – Plane between the left valve and the right valve, passing through the margins of both shells. A protrusion is a term applied to any structure passing through the commissural plane, such as teeth or myophoral blades.

Costulations – Overgrowths of the outer calcitic shell layer, forming ornament of the shell surface.

Dentition – Group of all teeth and sockets of a shell. In most rudists, dentition includes anterior and posterior teeth on the left valve, a central tooth on the right valve, and their associated sockets. In *Diceras*, a tooth in the left valve is missing and a tooth in the right valve is supernumerary. Other supernumerary teeth are found in *Monopleura aliena* and in some Antillocaprinidae.

Diceratid tooth (DT) – Protrusion of shell wall between anterior tooth socket and D. It can be seen only in Requieniidina and *Diceras*.

Ectomyophoral cavity – Accessory cavity next to a myophore.

Endomyophoral cavity – Accessory cavity in which lies a myophore.

Flange(s) – Longitudinal outgrowths of the inner shell layer. Flanges can reach important sizes and are highly variable in number and development.

General cavity (GC) – General cavity initially occupied by most soft internal organs of the organism. It is usually the largest cavity of the shell.

Inner layer – Aragonitic internal layer of the shell.

Left valve (LV) – Left valve, free valve or superior valve. The left valve can be coiled or not, and can be reduced to an operculum.

Ligamentary cavity – Longitudinal cavity where the ligament is inserted.

Ligamentary groove – Small inflexion of the shell allowing insertion of the ligament, and oriented toward the exterior of the shell.

Longitudinal section – Section of a rudist fossil perpendicular to the commissural plane.

Margin – Flat zone all around the shell where the left valve and the right valve are in contact.

Myophores – The myophores are attachment structures for the muscle, with a specific microstructure. There are usually an anterior and a posterior, on each valve, but more in Hippuritidae.

Myocardinal apparatus – Ensemble of dentition and myophores of a shell.

Outer layer – Calcitic external layer of the shell.

Pallial cavities – Cavities resulting in canals when filled with blades. The LV pallial cavities are AAC-LV and PAC, and the RV pallial cavities are PENC and PECC.

Pallial canals – Canals originating from the pallial cavities filled by radial walls. The pallial canals can vary greatly in size, number and shape (e.g. square, round, triangular).

Pores – Numerous small holes opening on the outside of the left valve and allowing the calcitic canals of the left valve to communicate with the outside of the shell.

Posterior accessory cavity (PAC) – Cavity developed between the posterior myophore of the left valve and the posterior side of the shell. It can be filled with radial blades.

Posterior ectomyophoral cavity (PECC) – Cavity of the RV inset between the PTS (plus the PENC when present) and the posterior side of the shell. It can be filled with radial blades. The PECC is always adjacent to the PM-RV.

Posterior endomyophoral cavity (PENC) – Cavity of the RV is connected to the PTS on its posteroventral side. The cavity is hardly ever filled with radial blades. The PENC always includes the PM-RV. The position of the myophore in the cavity is, however, variable.

Posterior myophore (PM) – Attachment structure for the muscle of the animal, that can be horizontal (shelf), tilted, or vertical (protruding or not). Recognizable by its posterior position and sometimes by its muscle scar. There is a posterior myophore in each valve.

Posterior tooth (PT) – Protrusion of shell wall on the posterior side present in all rudists attached with their left valve except *Diceras*.

Posterior tooth socket (PTS) – Cavity where the posterior tooth is inserted. The cavity lies posteriorly to the central tooth in the so-called inverse rudists. It can be filled with radial blades, and it can be in contact with the anterior tooth socket on the ventral side of the shell.

Pillar – Two posterior radial folds of the outer shell layer that correspond to infoldings of the radial bands. In Hippuritidae, the dorsal fold is the P1, and the ventral fold is the P2.

Radial bands – Two zones with a differentiated pattern on the outer calcitic shell layer. Radial bands extend from the umbo to the commissure of either valves or only the RV. They are easily recognizable by a distortion of growth increments that differ from the rest of the shell.

Right valve (RV) – Right valve, attaching valve or inferior valve. It is generally the most developed valve. It can be coiled or not.

Tabulae – Skeletal wall partitioning the animal cavities parallel to the commissural plane. The designation of tabulae is followed by the indication of the implied cavity.

Transverse section – Section of a rudist fossil parallel to the commissural plane.

Tubes – Tubular cavities running along with the shell and probably produced by anastomosis of flanges. Tubes are independent structures from the pallial canals.

Umbo – Apex and oldest part of the shell valves. It is usually coiled.

Wall – The term wall is used to refer to the skeletal walls that delineate cavities, as an example, the CTS/G wall, separating G from CTS. All rudist cavities can be partitioned with walls. When a cavity is filled with numerous walls, the resulting cavities are generally described as pallial canals (with the reference of the cavity of origin).

Appendix 2: Character list

Name: Name of the character

Position: left or right valve

Kind: which morphological structure the character is based on

Coding: newick tree format of the character hierarchy. Several issues can arise in the 3ta framework, which require different solutions that in parsimony, namely missing data (Zaragüeta & Bourdon, 2007), inapplicable data (Zaragüeta & Bourdon, 2007), and polymorphism (Rineau 2017). The method to treat missing and inapplicable data in 3ta is explained in Zaragüeta & Bourdon (2007). The procedure to remove polymorphism is explained in Rineau (2017) and in Lisbeth's 1.0 manual (Zaragüeta et al. 2012). Imagine a hierarchical character (0(1)), and a taxa *X* which has both the states 0 and 1. Because the state 1 is included in the state 0, any taxa placed in (1) is also placed in (0). Thus, issues of polymorphism in the specific case of fully pectinate hierarchical trees is resolved by deleting the least derived state for a given taxa. Polymorphism in the case of non-fully pectinate character hierarchies is explained in Lisbeth's 1.0 manual (Zaragüeta et al. 2012). However, there is no such case in our characters.

States definitions: definitions by character state

States tests

1 passed – clade 1

1: Character state number.

Passed: result of the cladistic test (passed means secondary homology, rejected means homoplasy).

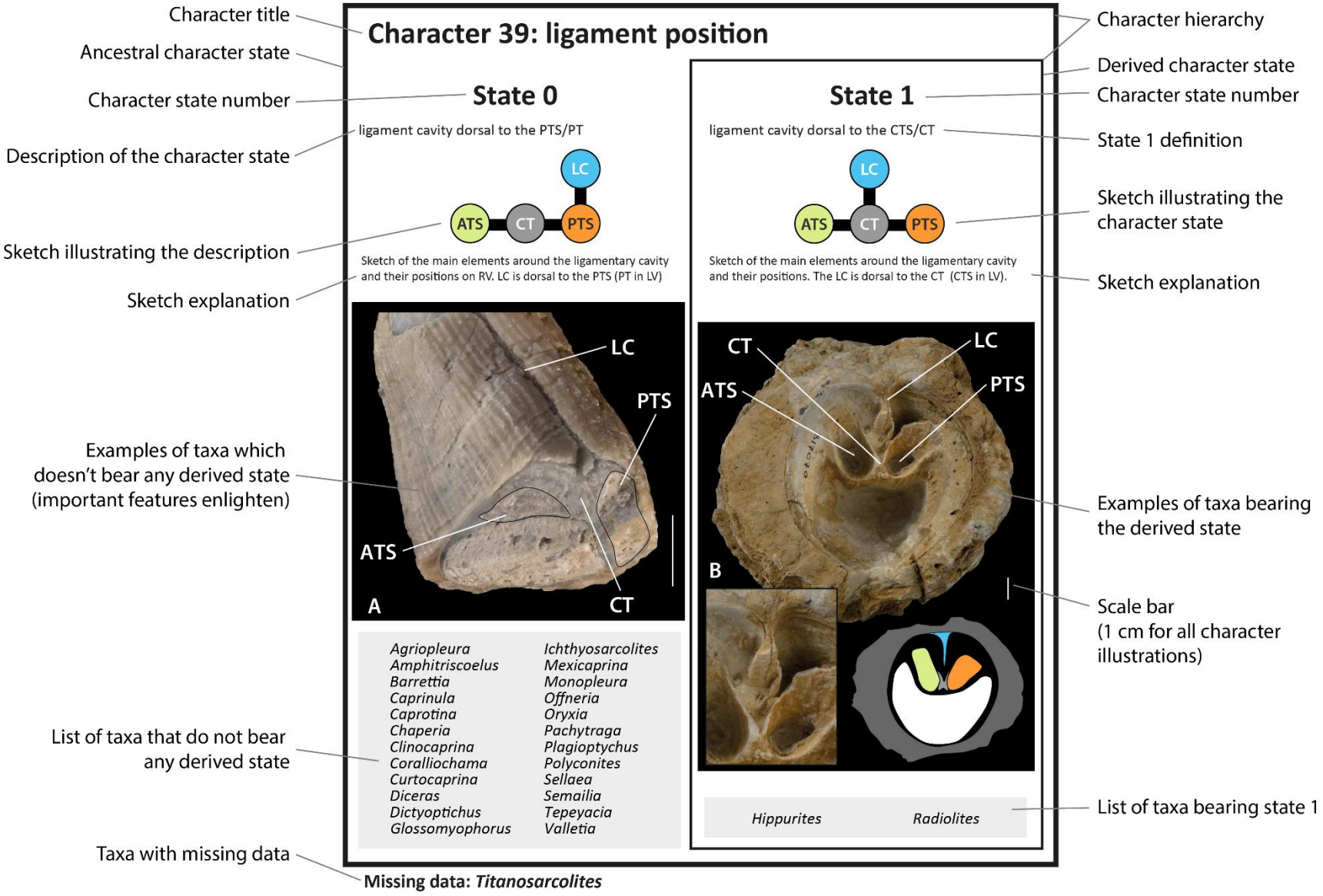
clade 1: position of synapomorphy on phylogeny (several positions if rejected).

According to Cao (2007), the acceptance of a character state implies in 3ta that the state becomes a synapomorphy that characterizes a specific clade. The rejection of a character state implies that the state cannot be associated with a clade (polyphyly of the character state). The procedure is described in Cao (2007) and implemented in Lisbeth 1.0. We use here a modified algorithm presented in Rineau (pp. 91-99, 2017).

Retention index: retention index calculated in 3ta and presented as percentage

Remarks: remarks concerning the coding, other phylogenetic analyses or other genera

EXAMPLE OF HIERARCHICAL CHARACTER



HIERARCHICAL CHARACTER 1

Name: posterior tooth morphology

Position: left valve

Kind: teeth

Coding: (0(1(2(3))))

States definitions

0 Dorsal margin of the shell flat (no PT)

1 presence of a PT dorsally to the PM

2 large and elongated PT

3 PT squeezed by the ligament and elongated anteroposteriorly

States tests

1 passed – clade 1

2 rejected – clades 7, 9, 12, 18, 22, *Sellaea*

3 passed – clade 22

Retention index

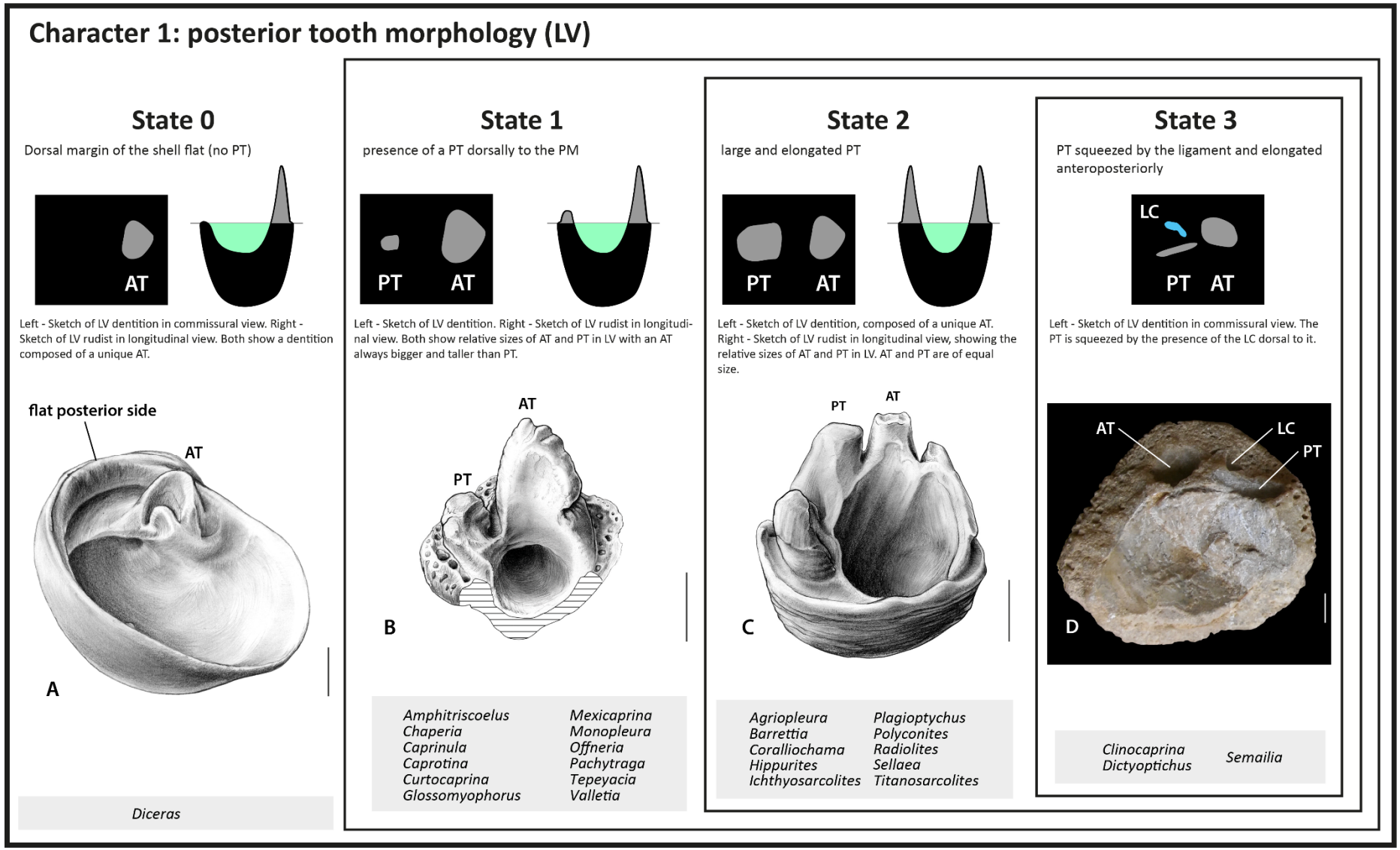
77.68 %

Remarks

Related to character 3b of Skelton & Masse (1998; #1.1, #1.2). Related to characters 10 (#1.3), 11 (#1.2) and 12 (#1.1) of Mitchell (2013). Related to character 3 of Sano *et al.* (2014).

The state 2 is reached when the height of the PT is at least half that of the AT. The PT can also reach the same dimensions as AT in state 2. The state 3 is for taxa with a PT sub-

quadrangular in section; the height of the PT is rarely described and is not involved in the definition of state 3.



Missing data: *Oryxia*

Hierarchical character #1. A – *Diceras arietinum* (MNHN.F.A70651). B – *Mexicaprina minuta* (JPMA.14097-5). C – *Radiolites radiosus* (MNHN.F.J09021). D – *Clinocaprina lowentsami* (USNM.245242). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 2

Name: anterior tooth morphology

Position: left valve

Kind: teeth

Coding: (0(1))

States definitions

0 two apexes AT

1 simple AT

States tests

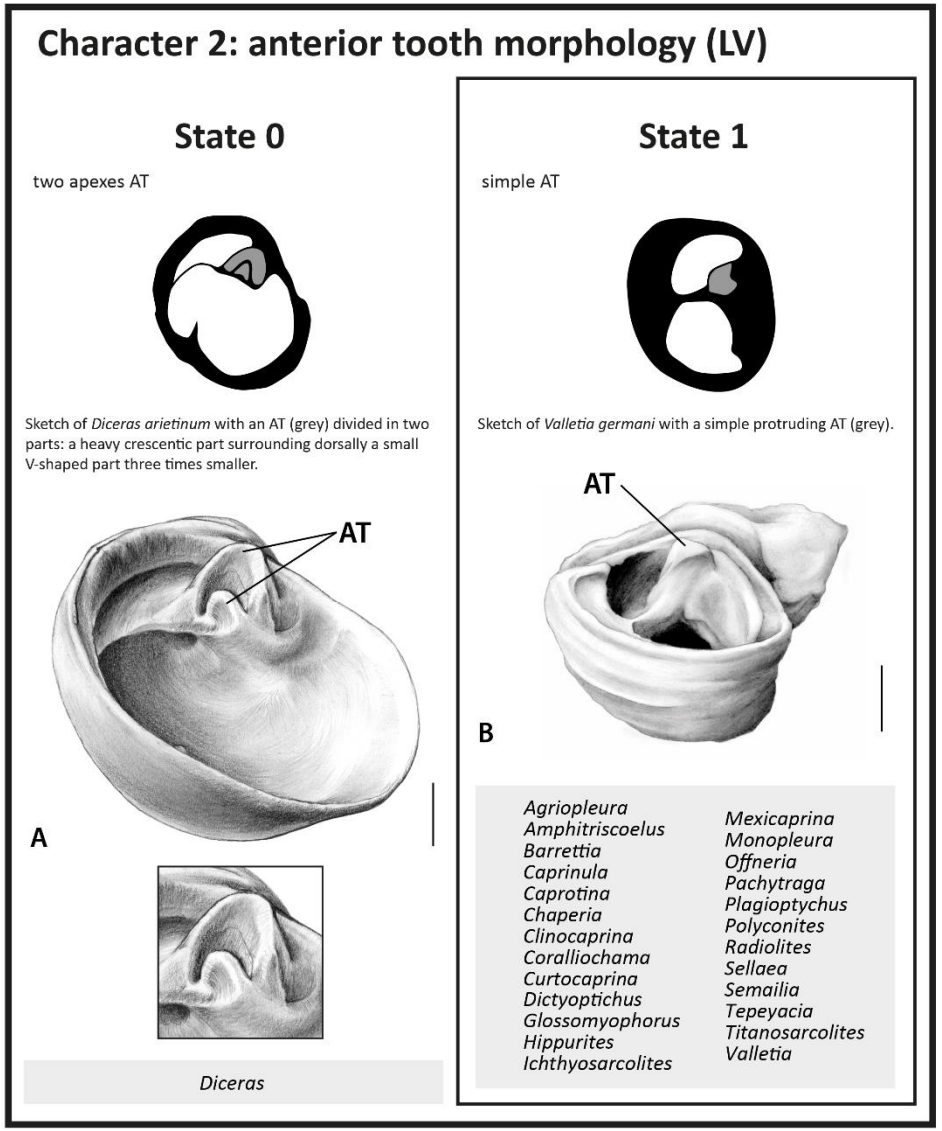
1 passed – clade 1

Retention index

100.0 %

Remarks

This character is informative in 3ta which requires only one taxon in the plesiomorphic state and two taxa in the apomorphic state in order to make a hypothesis of phylogenetic relationship: *a* and *b* are closer related to each of them than to *c* : (*a*, *b*), *c*).



Hierarchical character #2. A – *Diceras arietinum* (MNHN.F.A70651). B – *Valletia germani* (MNHN.F.J05798). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 3

Name: teeth ornamentation

Position: left valve

Kind: teeth

Coding: (0(1))

States definitions

0 smooth teeth

1 dorsally costate teeth (ridges and furrows)

States tests

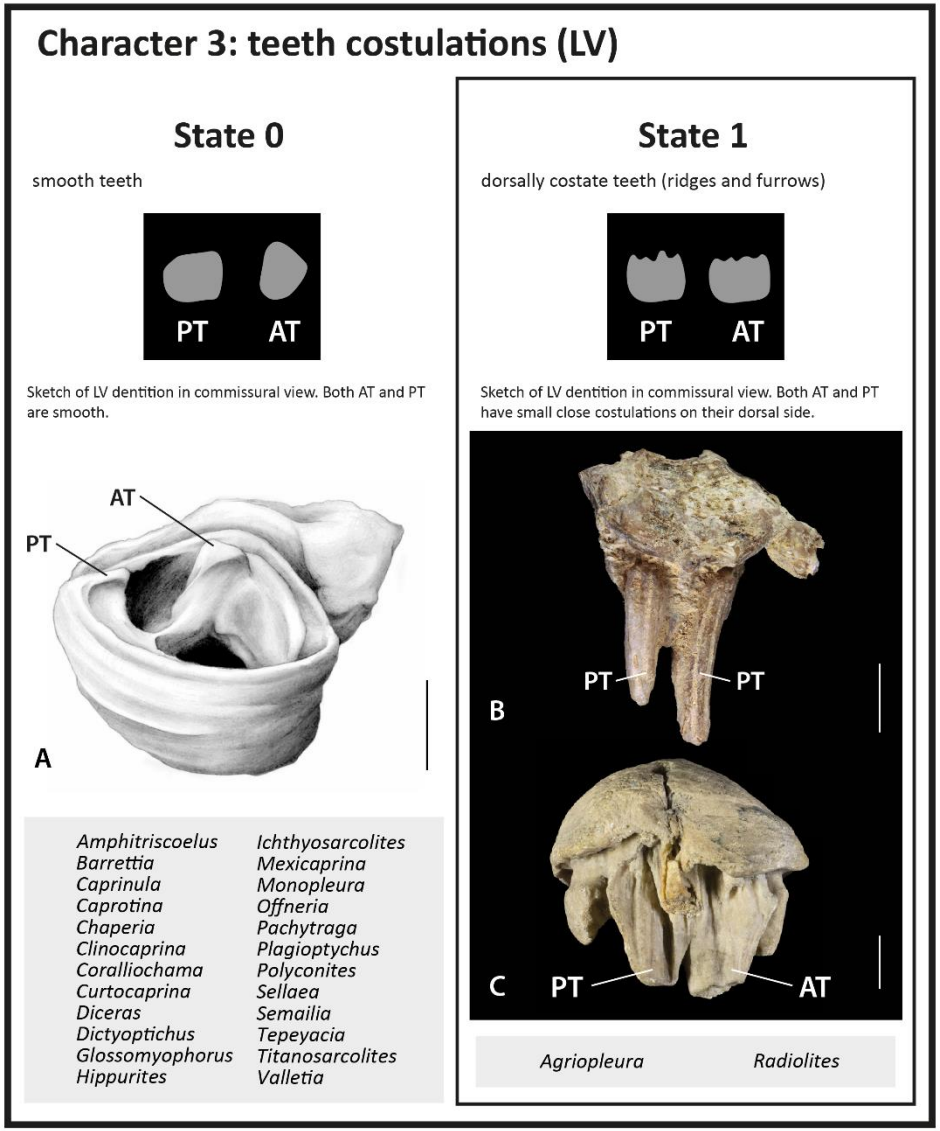
1 passed – clade 13

Retention index

100.0 %

Remarks

Associated to folds on the RV for the opening of the shell.



Hierarchical character #3. A – *Valletia germani* (MNHN.F.J05798). B – *Eoradiolites davidsoni* (UT.NPL4087). C – *Radiolites radiosus* (MNHN.F.J09021). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 4

Name: posterior myophore morphology

Position: left valve

Kind: myophores

Coding: (0(1(2(3(4)(5(6))))))

States definitions

0 PM on a blade alongside G, on its posterior side

1 PM forming a horizontal shelf alongside the shell commissure

2 PM shelf tilted towards the CTS. Vertical or oblique and inwardly directed

3 vertical PM blade projecting straight into the RV, and the PM is beyond the commissure

4 projecting PM blade twisted, parallel to the commissure

5 vertical and projecting PM blade becoming outwardly directed (‘backflips’)

6 vertical and projecting PM blade stranded perpendicular to the shell wall, facing the PT

States tests

1 passed – clade 1

2 passed – clade 3

3 rejected – clades 4, 7, 12, 19, *Amphitriscoelus*, *Pachytraga*, *Sellaea*

4 passed – clade 7

5 rejected – clades 12, 19, *Amphitriscoelus*

6 rejected – clades 14, 24

Retention index

74.78 %

Remarks

Related partially to characters 1 and 6 of Chartrousse (1998a; #4.2, 4.3, 4.5). Related to character 7 of Skelton & Masse (1998; #4.1, #4.5). Related partially to character 5 of Sano *et al.* (2014).

This character implies paralogous nodes and is decomposed in three independent parts.

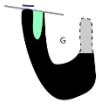
We describe the PM-LV as a complex hierarchical character with recognition of seven states. The ancestral condition to the character, as present in *Diceras* and *Epidiceras* (Epidiceratidae, Requieniidina), is the presence of a blade where inserts the PM-LV. A myophoral shelf parallel to the commissure develops by thickening of the supporting the PM blade. The onset of a blade thickening is visible in *Plesiodiceras* (Epidiceratidae, Requieniidina) and *Epidiceras*. The state 2 is understood as a modification of the state 1, where the myophore supported by a shelf becomes tilted inwardly. The tilting is related to a spill of the PM-LV towards the CTS. The evidence for the inclusion of the state 2 in the state 1 is that in adumbonal view, the PM occupies the same shell surface in state 2 than in state 1, with titling being the only variation. The state 3 is differentiated from the state 2 by the development of the dorsal shell wall supporting the tilted PM. This state has been retained as synapomorphic for the subfamily Coalcomaninae by Chartrousse (1998b; family Caprinuloideidae in Skelton 2013a). The PM extends beyond the commissure, inserted in a cavity of the RV. Several taxa have a small PM-LV blade, as *Coralliochama* and are assigned to state 2 but not state 3. The criterion for state 3 being a PM blade that protrudes largely from the commissural plane. The PM in states 2 and 3 is inwardly oriented (toward G). The PM-LV blade can be tilted outwardly in some taxa, marking a right angle and the myophore returning to a position parallel to the commissure. Another explanatory hypothesis for the genesis of state 3 would be

the rise of the myophoral shelf and a cavity excavating the posterior side of the shell (Skelton 2013). However, the myophore has clearly a blade-like aspect in most Polyconitids rather than an altered protruding shelf. The state 5 is difficult to root in the character, as it presents a conformation where there is still a blade, the myophore being at the contrary outwardly directed. Two evolutionary pathways can be hypothesized: (i) the blade is convergent with the other blades, and the outward-facing myophoral blade developed itself from the myophoral shelf in state 1, and (ii) the myophoral blade is the same as in states 2 and 3, the myophore undergoing what could be called a 'myophoral backflip' with the myophore moving from a side to another of the blade (state 5 rooted in state 3). This latter hypothesis is supported by two pieces of evidence: a single explanation for the development of the myophoral blade, and the observation on *Mexicaprina minuta* shells that the PM-LV on its protruding blade is on the apex of the blade (#4, illustration 3-C and fig. 5-C). On this shell, a muscle scar can be observed at a transitional stage between the inward and the outward orientation. For these reasons, we choose to include the state 5 in the state 3, the state 3 gathering all taxa with a posterior myophoral blade, wherever the PM is. The state 6 is explained by the torsion of the myophoral blade at 90 degrees, facing the ventral side of the shell.

Character 4: posterior myophore morphology (LV)

State 0

PM on a blade alongside G, on its posterior side

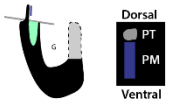


State 1

PM forming a horizontal shelf onto the shell commissure alongside the CTS

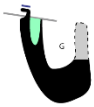
State 2

PM shelf tilted towards the CTS. Vertical or oblique and inwardly directed.



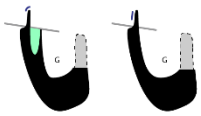
State 3

vertical PM blade projecting straight into the RV



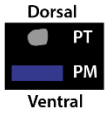
State 4

projecting PM blade twisted, parallel to the commissure



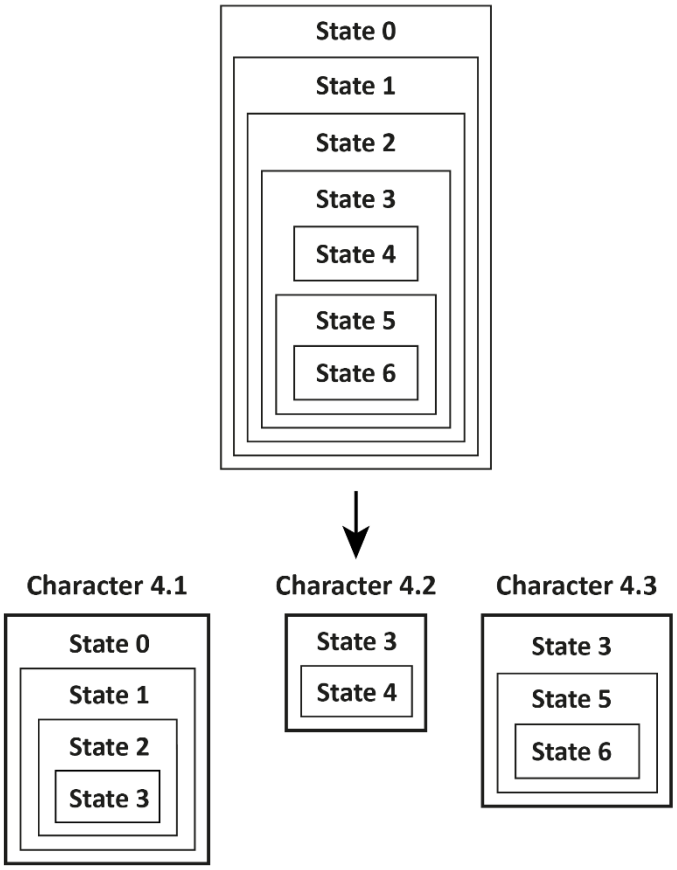
State 5

vertical and projecting PM blade becoming outwardly directed ("backflips")

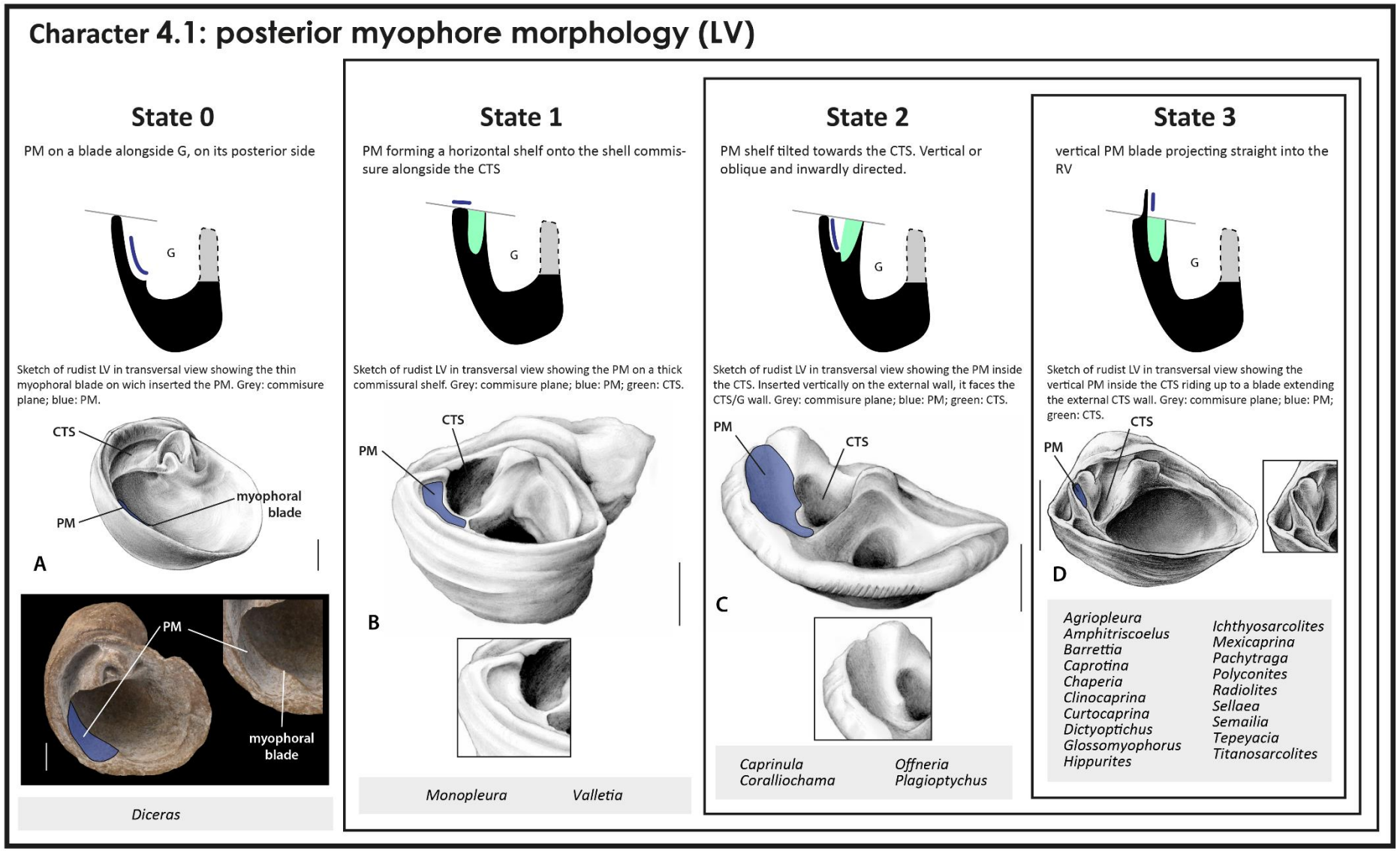


State 6

vertical and projecting PM blade stranded perpendicular to the shell wall, facing the PT

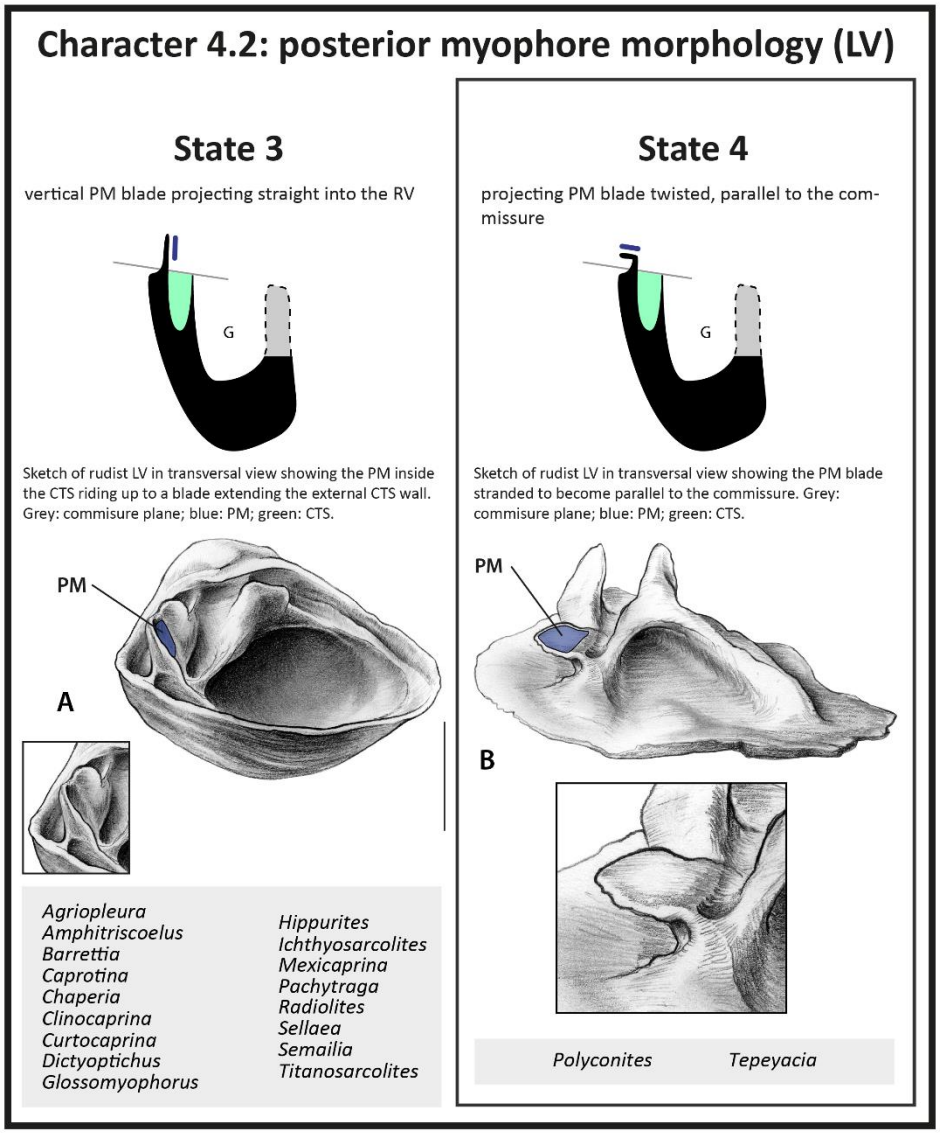


Hierarchical character #4, its character state intensions, and its decomposition in three sub-characters.

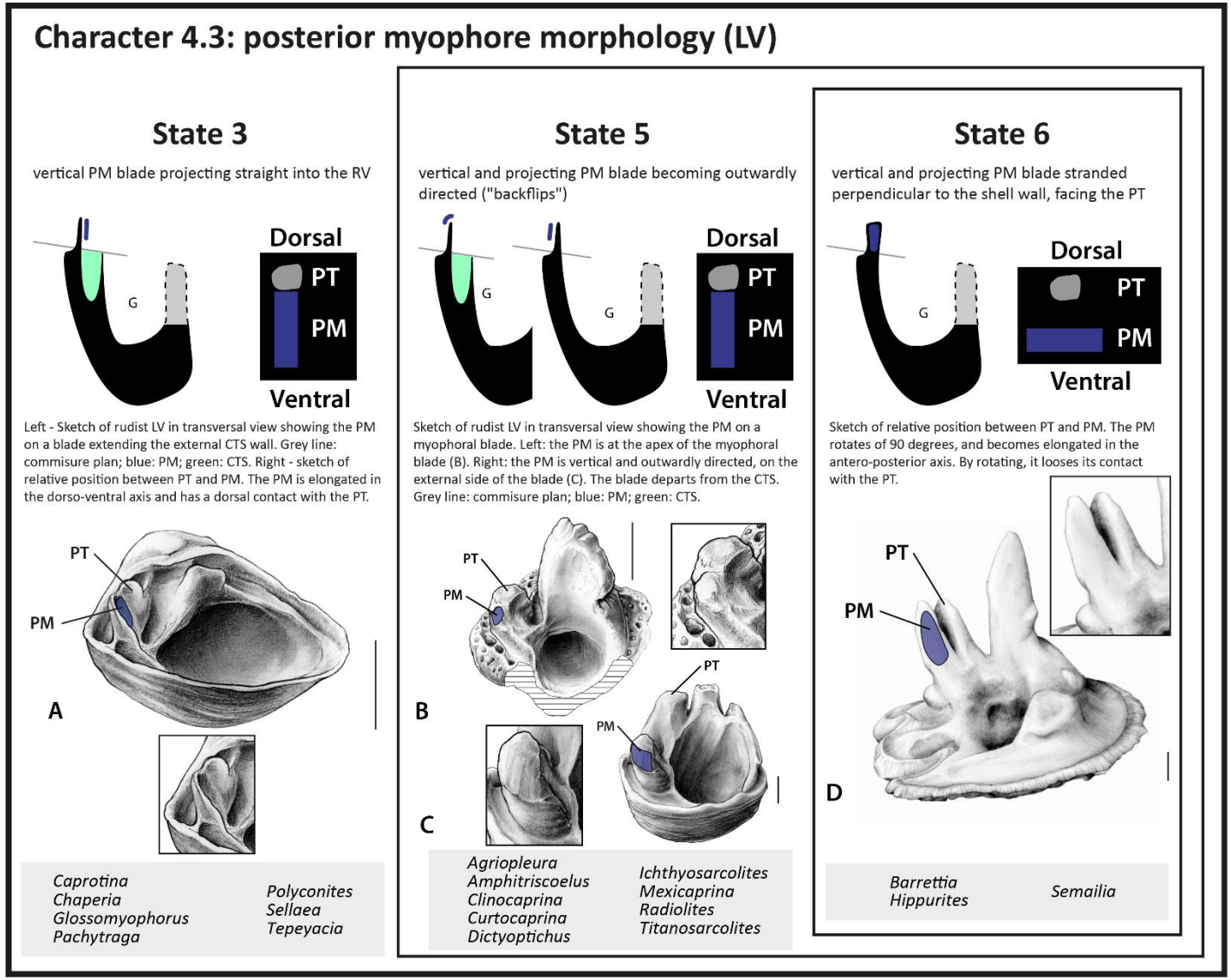


Missing data: *Oryxia*

Hierarchical character #4.1. A – *Diceras arietinum* (MNHN.F.A70651). B – *Valletia germani* (MNHN.F.J05798). C – *Plagioptychus arnaudi* (UPMC.1273). D – *Caprotina striata* (MV 2003.2.5147). Scale bars, 10 mm.



Hierarchical character #4.2. A – *Caprotina striata* (MV 2003.2.5147). B – *Polyconites verneuili* (Ch02 in Pascual-Cebrian et al. 2013). Scale bars, 10 mm.



Hierarchical character #4.3. A – *Caprotina striata* (MV 2003.2.5147). B – *Mexicaprina minuta* (JPMA.14097-5). C – *Radiolites radiosus* (MNHN.F.J09021). D – *Hippurites radiosus* (MNHN.F.A58757). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 5

Name: relative position of the posterior myophore and posterior tooth

Position: left valve

Kind: myophores

Coding: (0(1))

States definitions

0 contact between PM and PT

1 PM and PT separated by a gap

States tests

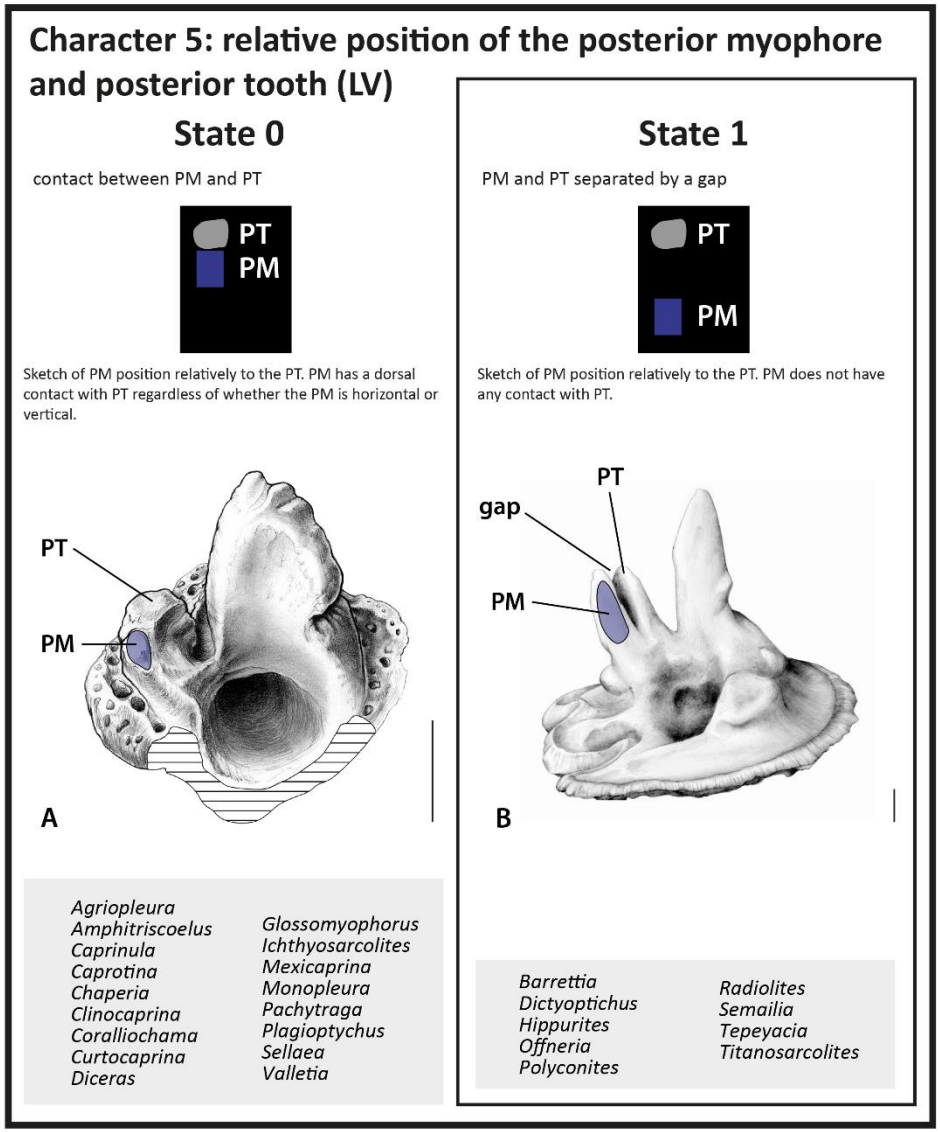
1 rejected – clades 7, 12, 18, 22

Retention index

55.56 %

Remarks

A ‘gap’ implies an absence of contact between the PM and the PT, and a complete dissociation and individualization of the PM. If PM protrudes sharply in a thick blade, the PM-LV can lead to a ‘tooth-like myophore’ but remains distinct from the close PT (see character 7 of Mitchell 2013).



Hierarchical character #5. A – *Mexicaprina minuta* (JPMA.14097-5). B – *Hippurites radiosus* (MNHN.F.A58757). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 6

Name: anterior myophore morphology

Position: left valve

Kind: myophores

Coding: (0(1(2)(3(4(5)))))

States definitions

0 AM vertical, attached directly on the inner shell surface

1 AM forming a horizontal shelf on the shell commissural plane

2 AM shelf large, flat and quadrangular.

3 AM tilted towards the anterior side of the shell, forming an AAC. AM vertical alongside the AAC/G wall and outwardly directed.

4 AM outwardly directed projecting itself in the RV by the development of the AAC/G wall

5 AM shelf stretched and divided into two contiguous parts

States tests

1 passed – clade 1

2 passed – clade 9

3 rejected – clade 5, 7, 10

4 rejected – clades 5, 7, 12, 19

5 passed – clade 14

Retention index

87.99 %

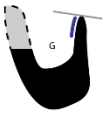
Remarks

This character includes a paralogous clade and is presented in three independent parts.

The AM-LV can be found in varied forms. The ancestral state is a direct insertion of the myophore on the anterior wall of G, as observed in other bivalves. There is no differentiated macrostructure to carry the myophore. On state 1, the myophoral zone is thickened. The myophoral shelf has a different morphology than the PM-LV (#4.1) probably due to the absence of an ancestral myophoral blade. The comparison between the two myophoral shelves on the same valves offers the best conditions to understand the differences, as with *Monopleura* or *Valletia* (see also Schneider & Skupien 2015). While the PM is well delineated in its contact with G, marking an acute angle because of the ancestral presence of a myophoral blade, the AM looks like less clear-cut on the anterior side of G. The AM-LV is generally not as well delineated as PM-LV. The state 1 is a paralog clade from which two independent states arise: state 2 and state 3. In state 2, the AM shelf becomes slightly better delineated. It has a globally quadrangular outline, increasing in surface compared to state 1. In state 2, the AM becomes completely parallel to the commissural plane. Plagioptychid taxa exhibit AM-LV of state 2 that can heavily protrude beyond the commissural plane while staying horizontal (e.g. in *Plagioptychus coquandi*). In state 3, the myophoral shelf is tilted and pushed posteriorly by the anterior development of the AAC-LV. It results in a vertical, outwardly directed myophore. This hypothesis explains the 180° rotation of myophores from vertical and inwardly oriented (state 0) to vertical and outwardly oriented (state 3). A tilted AM-LV and the presence of AAC-LV are thought to represent a single evolutionary event. No character is coded for AAC-LV in order to avoid redundancy in the matrix that would derive from the mechanical dependency between these cavities and myophores. The vertical and outwardly directed myophore can develop itself like a blade to protrude out of the commissural plane (state 4). Hippuritids show such a blade, even if it is thick and modified by

the capuloid LV. In this family, the myophore extends in the dorsoventral axis and is divided into two parts (state 5).

Character 6: anterior myophore morphology (LV)



State 0

AM vertical attached directly on the inner shell surface

State 1

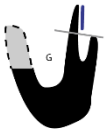
AM forming a horizontal shelf on the shell commissural plane

State 2

AM shelf large and quadrangular

State 3

AM tilted towards the anterior side of the shell forming an AAC. Vertical alongside the AAC/G wall and outwardly directed.

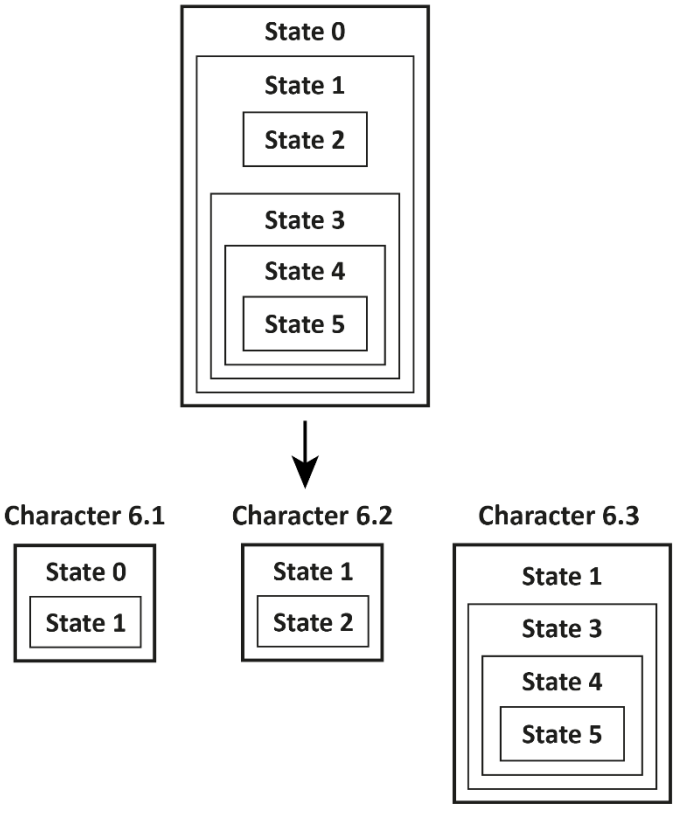


State 4

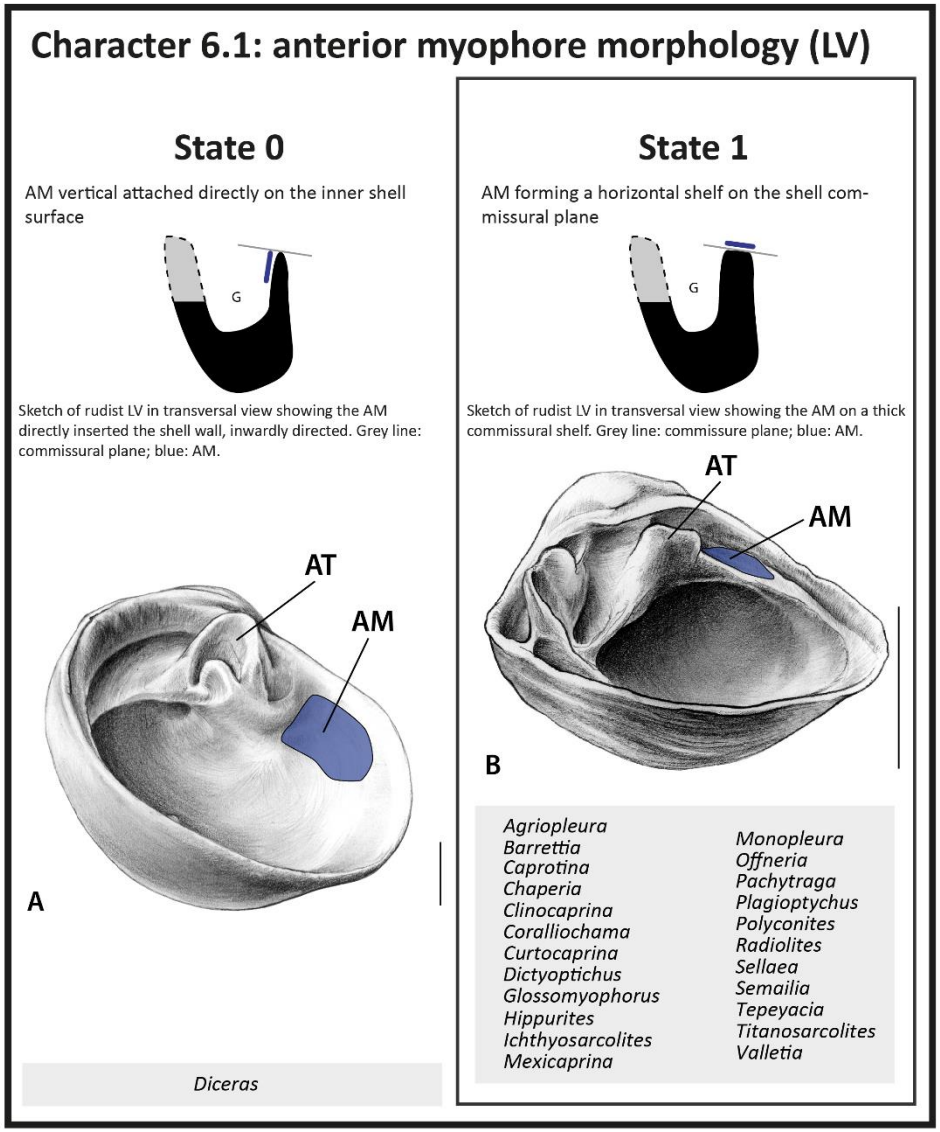
AM outwardly directed projecting itself in the RV by the development of the AAC/G wall

State 5

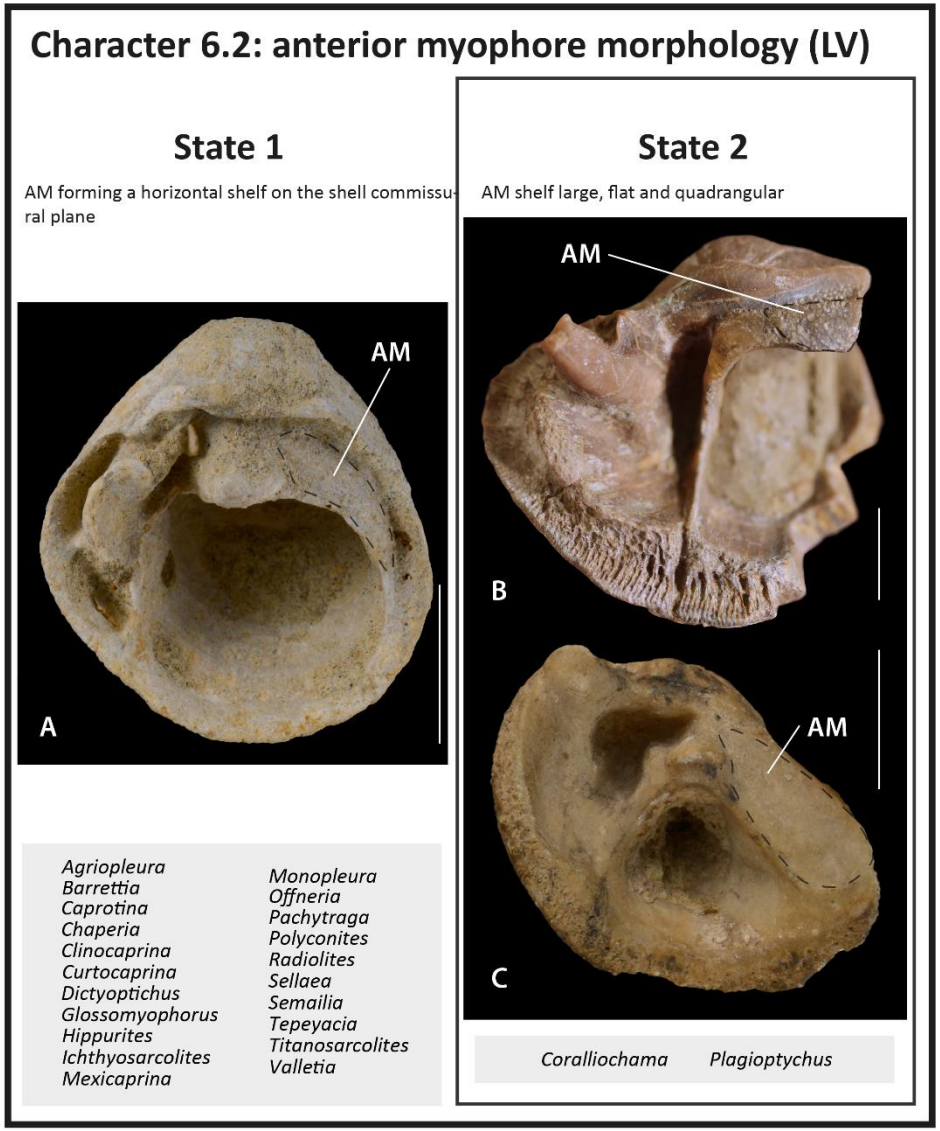
AM shelf stretched and divided into two contiguous parts



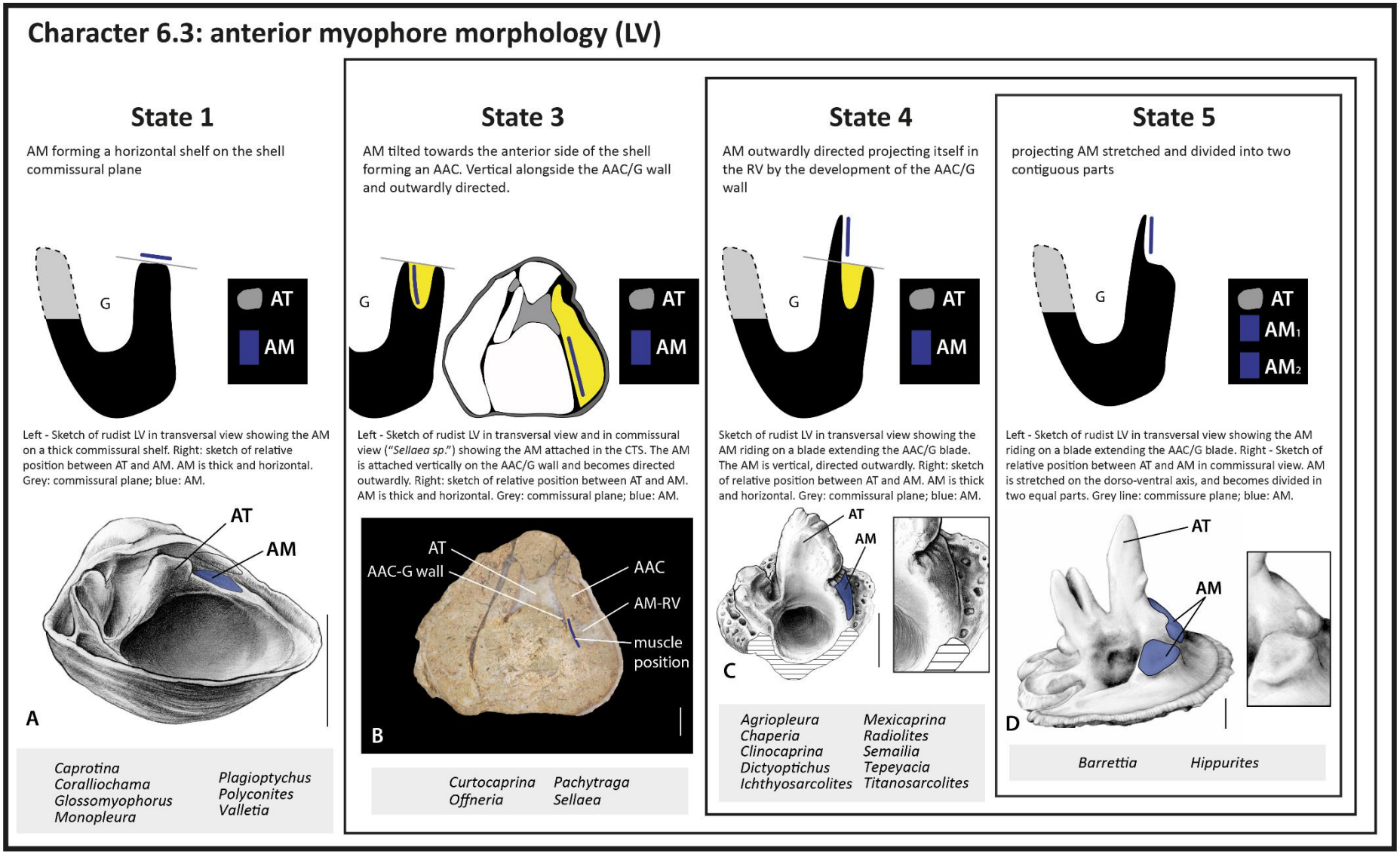
Hierarchical character #6, its character state intensions, and its decomposition in three sub-characters.



Hierarchical character #6.1. A – *Diceras arietinum* (MNHN.F.A70651). B – *Caprotina striata* (MV 2003.2.5147). Scale bars, 10 mm.



Hierarchical character #6.2. A – Caprotina striata (MV 2003.2.5147). B – Coralliochama orcutti (USNM.186662). C – Plagioptychus arnaudi (UPMC.1273) Scale bars, 10 mm.



Hierarchical character #6.3. A – *Caprotina striata* (MV 2003.2.5147). B – *Sellaea cespitosa* (WSA3058). C – *Mexicaprina minuta* (JPMA.14097-5). D – *Hippurites radiosus* (MNHN.F.A58757). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 7

Name: anterior myophore and anterior tooth relative position

Position: left valve

Kind: myophores

Coding: (0(1))

States definitions

0 contact between AM and AT

1 AM and AT separated by a gap

States tests

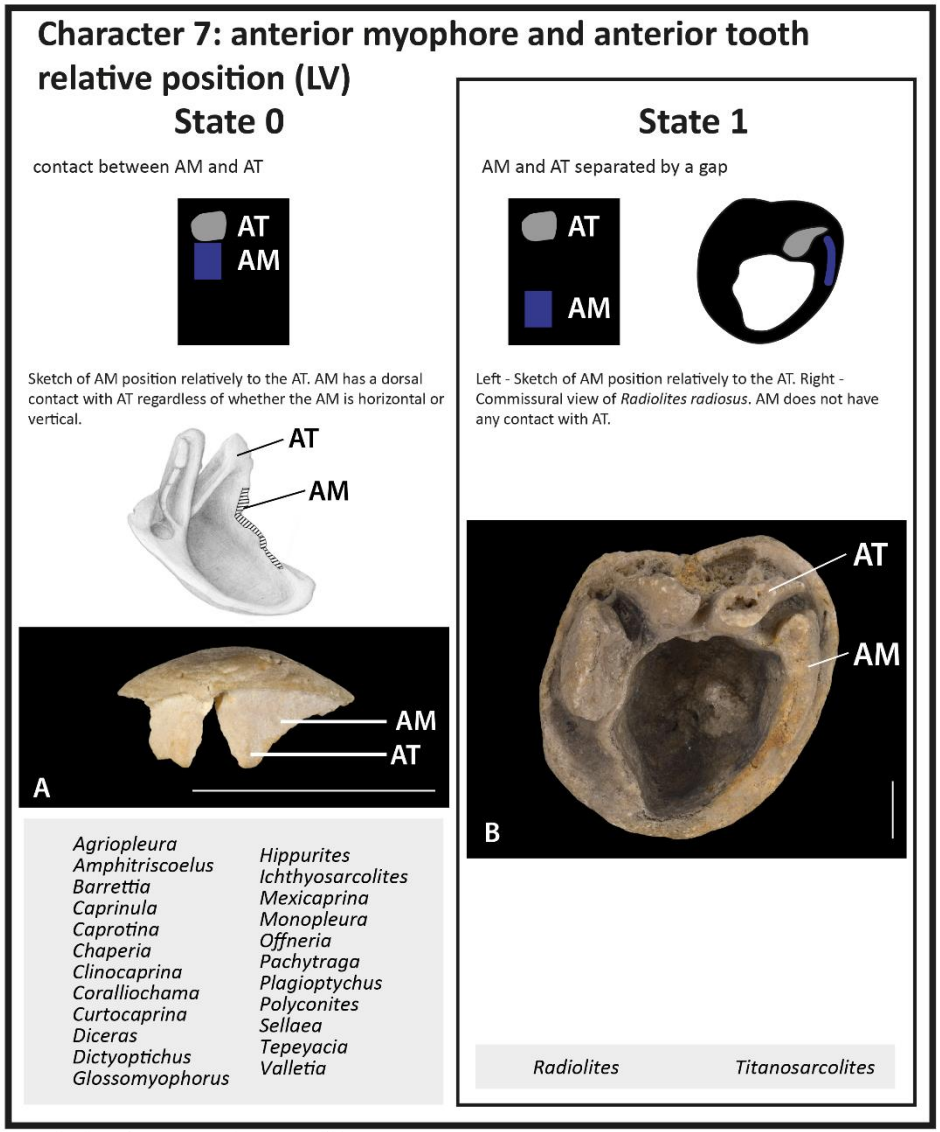
1 rejected – clades 13, 25

Retention index

47.83 %

Remarks

If protruding sharply as a thick blade, the AM-LV can lead to a ‘tooth-like myophore’. See character 7 of Mitchell (2013), which however only applies to the PM. Its taxonomic sampling does not allow the description of an equivalent character state on the other valve (see character 8 of Mitchell 2013).



Hierarchical character #7. A – *Chaperia costata* (MNHN.F.R07950). B – *Radiolites radiosus* (MNHN.F.J09021). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 8

Name: orientation of the central tooth socket/general cavity wall

Position: left valve

Kind: vertical blades

Coding: (0(1(2)))

States definitions

0 wall separating CTS from the G horizontal

1 tilting of the wall to the dorsal side of the shell

2 verticalization of the wall to the dorsal side of the shell

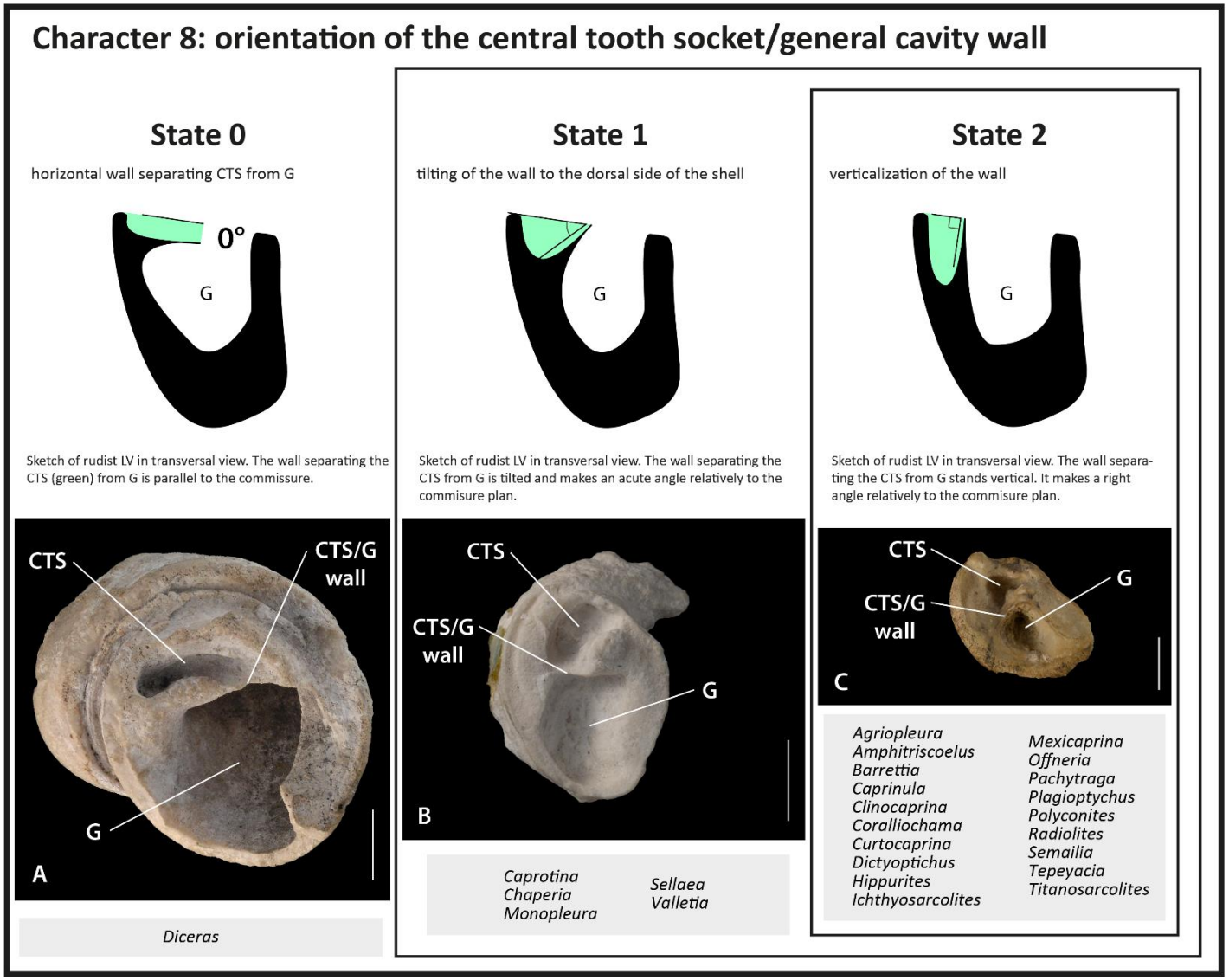
States tests

1 passed – clade 1

2 rejected – clades 7, 9, 11

Retention index

96.29 %



Hierarchical character #8. A – *Diceras arietinum* (MNHN.F.A70651). B – *Monopleura michaillensis* (UPMC.1272). C – *Plagioptychus arnaudi* (UPMC.1273). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 9

Name: central tooth socket morphology (LV)

Position: left valve

Kind: vertical blades

Coding: (0(1))

States definitions

0 CTS located between ligament and G

1 CTS located dorsally to the PT and the AT

States tests

1 rejected – clade 12, 20

Retention index

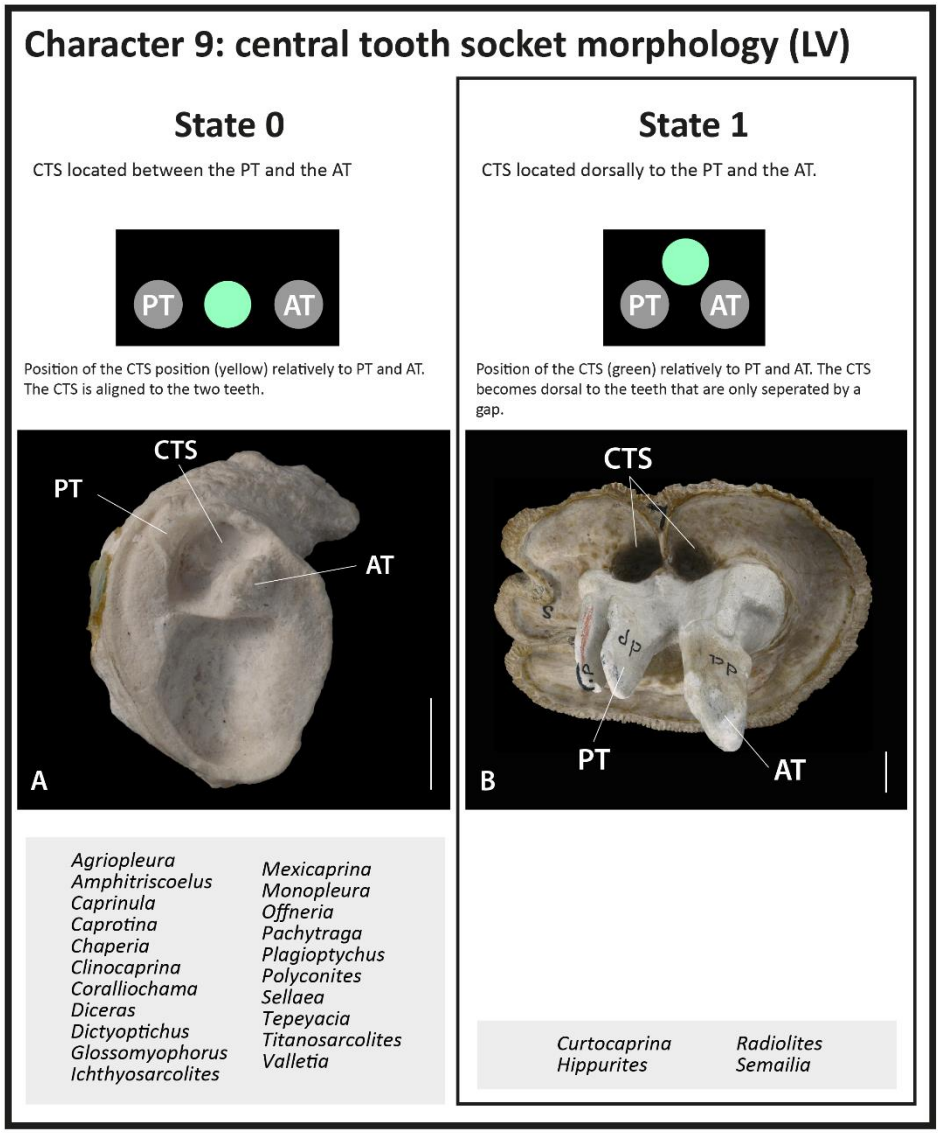
64.29 %

Remarks

The CTS is generally not recognized in Hippuritids and Radiolitids, in which it is assumed to be lost, the space is too small between the teeth. We hypothesize here that in shells where the AT and the PT are close to each other, the CTS can be retrieved in a more dorsal position. An example of a dorsal CTS can be found in *Rotacaprina*. The dorsal shift of the CTS can be difficult to recognize, as it can be associated to a shift of the ligament (#38.1) to a dorsal position in the derived state #38.1 (#38.0: ligament in posterodorsal position).

In *Hippurites*, *Agriopleura* and *Radiolites*, for example, the CTS is assumed to disappear and newly formed accessory cavity appears (table 2). It is more parsimonious to postulate that conjunction of #9.1 and #38.1 lead to a CTS divided into two parts, representing the accessory cavities of the usual nomenclature. This cavity is also unlikely to be a mere deformation of the

shell resulting from the modification of the LV into a capuloid valve, as in *Hippurites radiosus* for example.



Hierarchical character #9. A – *Monopleura michaillensis* (UPMC.1272). B – *Hippurites radiosus* (MNHN.F.A58757). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 10

Name: Position of the wall that separates the central tooth socket from the general cavity

Position: left valve

Kind: vertical blades

Coding: (0(1))

States definitions

0 posterior insertion of the wall separating CTS from G located ventral to the PM

1 posterior insertion of the wall separating CTS from G located between PT and PM

States tests

1 rejected – clade 5, 12, 20

Retention index

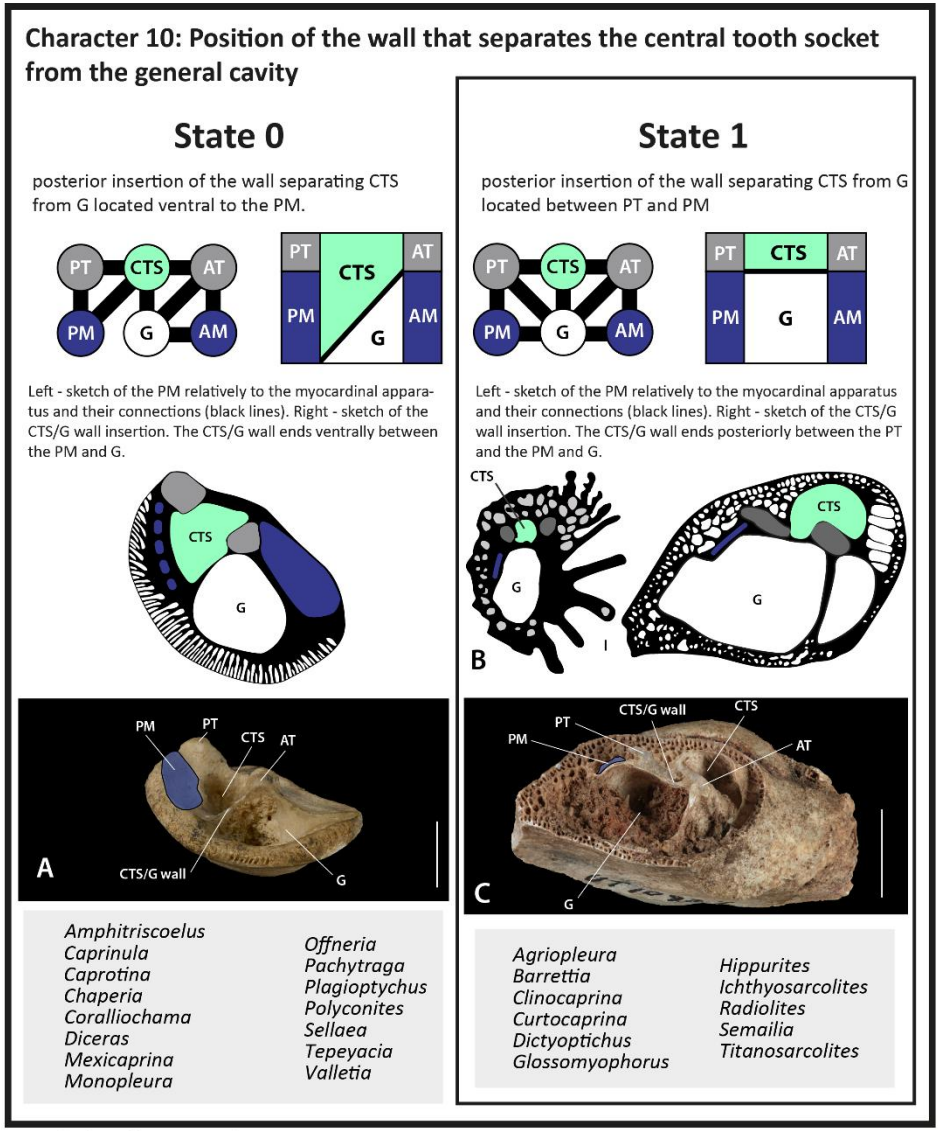
70.91 %

Remarks

Related to character 30 of Skelton & Smith (2000), but described in a distinct manner (see fig. 19).

Related to what Mac Gillavry (1937) called 'symmetrization', the state #10.1 leading in most cases to a symmetric myocardinal apparatus.

A discussion of this character linked to the ichthyosarcolitid toothlet hypothesis can be found in Figure 19. The state 0 includes taxa having their blade inserted on the ventral side of G, and without contact with the PM-LV.



Hierarchical character #10. A – *Plagioptychus arnaudi* (UPMC.1273). B – *Titanosarcolites giganteus* (UT.47533). C – *Curtocaprina clabaughikinsorum* (UT.10937). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 11

Name: posterior accessory cavity

Position: left valve

Kind: canals

Coding: (0(1))

States definitions

0 root

1 presence of a posterior accessory cavity

States tests

1 rejected – clades 4, 7, 9, 15, *Sellaea*

Retention index

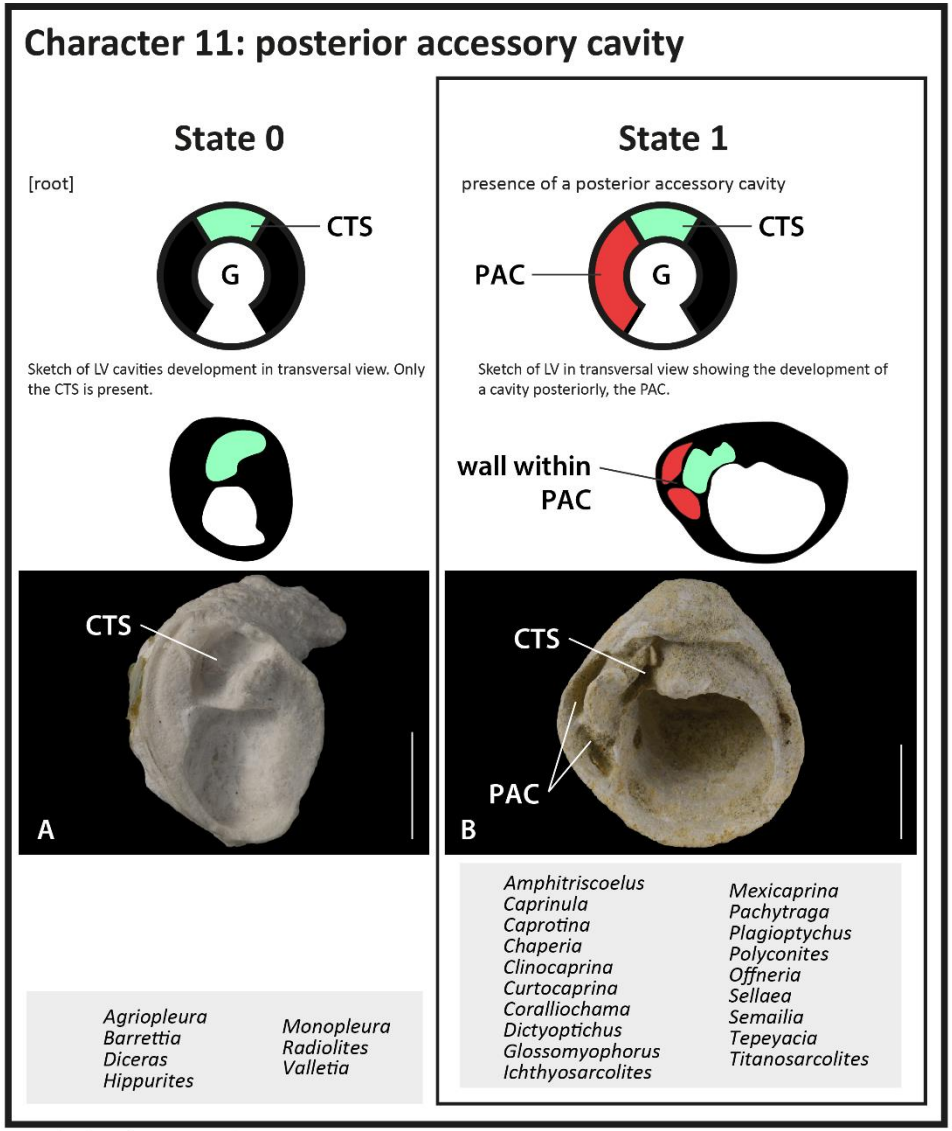
62.91 %

Remarks

Related partially to character 31 of Skelton & Smith (2000).

The posterior accessory cavity can be found as a small ovoid cavity between the posterior side of the shell and the PM-LV in Polyconitidae. In Caprotinidae, a blade develops to form ventral and dorsal cavities. The PAC can be highly modified, with a wide ventral development and/or the multiplication of radial walls giving to it an aspect of pallial canals as in *Offneria* or *Plagioptychus*. We, however, reserve the term 'Complete pallial canals' (Figs. 14-17) on the LV for radial blades (#13.1) filling the cavity resulting from the fusion between the PAC and the AAC-LV (#6.3). We call Plagioptychid-like canals the canals deriving from the PAC only. Plagioptychid-like canals are here considered to be a conjunction of

independent character states (#11.1 and #13.1) rather than an autonomous character state itself.



Hierarchical character #11. A – *Monopleura michaillensis* (UPMC.1272). B – *Caprotina striata* (MV 2003.2.5147). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 12

Name: position of the pallial cavities

Position: left valve

Kind: canals

Coding: (0(1))

States definitions

0 LV ventral side thick, devoid of canals

1 ventral contact between the AAC and the PAC

States tests

1 passed – clade 17

Retention index

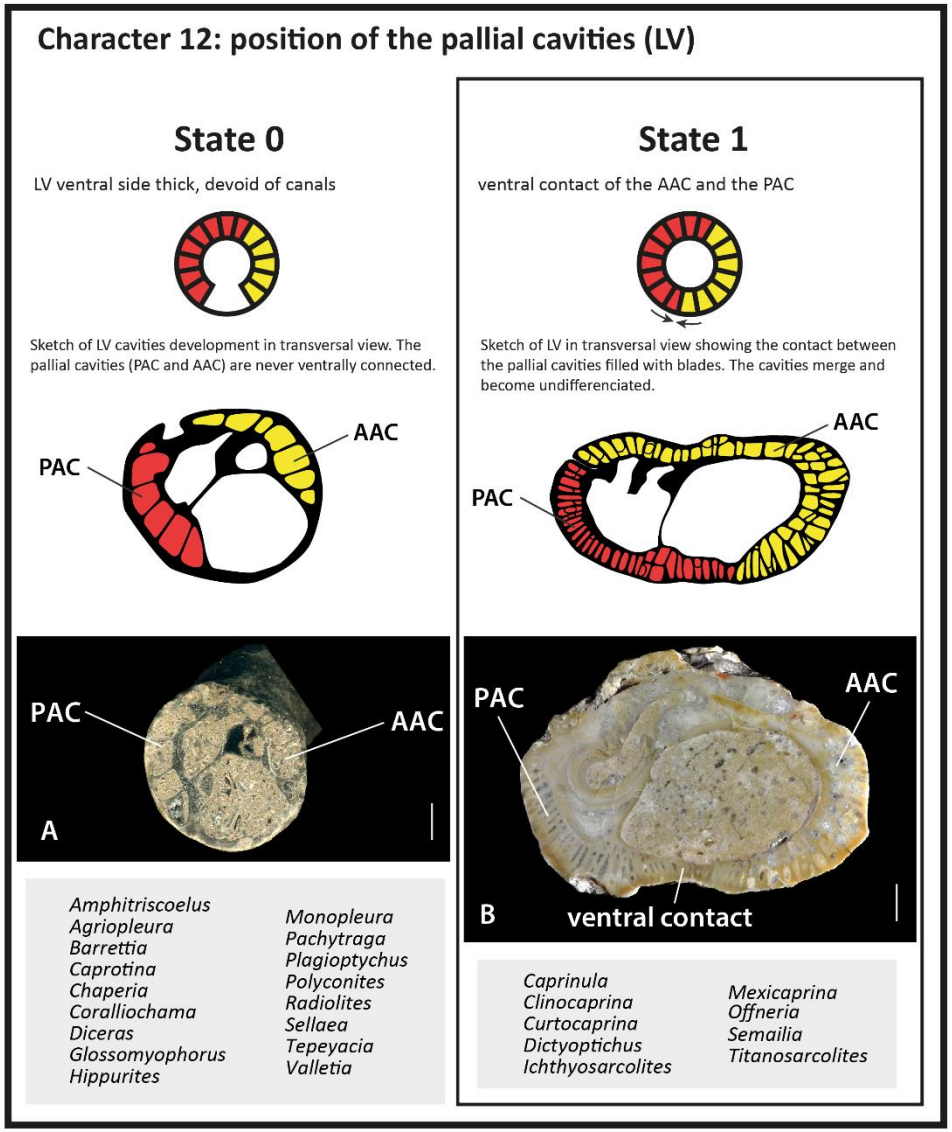
100.0 %

Remarks

Related to character 10 of Chartrousse (1998a). Related partially to character 19 of Mitchell (2013) (with #30). Related partially to character 11 of Sano *et al.* (2014).

In former analyses, the lack of pallial canals on the ventral side of some taxa is considered a ventral interruption of a continuous series. We here understand this as an incomplete development of independent structures (PAC and AAC) that form a continuous row of pallial canals only after merging on the ventral side. The derived state is reached when both PAC and AAC-LV extend towards the ventral side and they come into contact. When the cavities are in contact, they are filled with radial blades and it could become virtually impossible to differentiate the two cavities. This contact seems however to exists only on canaliculated forms. This state can be recognized in highly modified states by the presence of canals

posteriorly from the PM-LV (an indicator of the presence of a modified PAC-LV) and anteriorly from the AM-LV (an indicator of the presence of a modified AAC-LV). This is the case in *Caprinula* or *Titanosarcolites*. In *Plagioptychus*, no canals are present anteriorly from AM-LV. It leads us to believe that there is no AAC in *Plagioptychus* and that the canals only come from the development of the PAC in this genus. When comparing to *Plagioptychus*, we consider that *Coralliochama* is in the same situation, since AM-LV forms a plagioptychid-like horizontal shelf (#6.2). This morphology suggests that no AAC-LV has deformed the myophore, which could have resulted in a modification in the orientation of the myophore, the latter becoming vertical, perpendicular to the commissural plane, by the development of a cavity (#6.3).



Hierarchical character #12. A – *Amphitriscoelus waringi*. B – *Offneria rhodanica* (UCBL.R275). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 13

Name: morphology of the pallial canals

Position: left valve

Kind: canals

Coding: (0(1(2((3)(4)))))

States definitions

0 root

1 numerous radial walls, forming pallial canals

2 several rows of pallial canals

3 walls specialized in two morphologies leading to two canal morphologies: a row of rectangular canals along the external side of the shell wall, and capillary canals everywhere else

4 bifurcating walls

States tests

1 rejected – clades 9, 15

2 rejected – clades 9, 17

3 passed – clade 17

4 rejected – clades 9, 18, 22

Retention index

82.99 %

Remarks

Related to characters 12 and 16 of Chartrousse (1998a). Related partially to character 10 of Smith (1994) (#13.1). Related to character 9 of Stone & Telford (1999; #13.1).

This character includes a paralogous clade and is presented in three independent parts.

Character 13: morphology of the pallial canals (LV)

State 0

[root]

State 1

numerous radial walls forming pallial canals

State 2

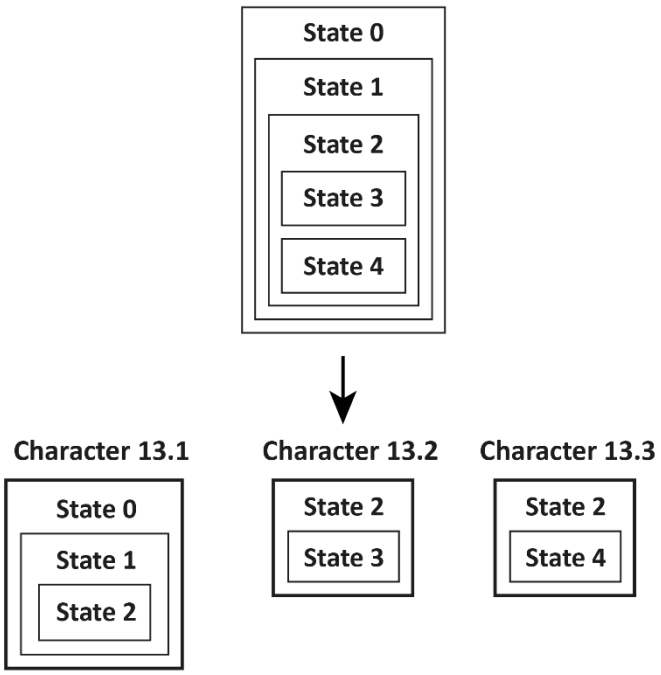
walls polyfurcated leading to several rows of pallial canals

State 3

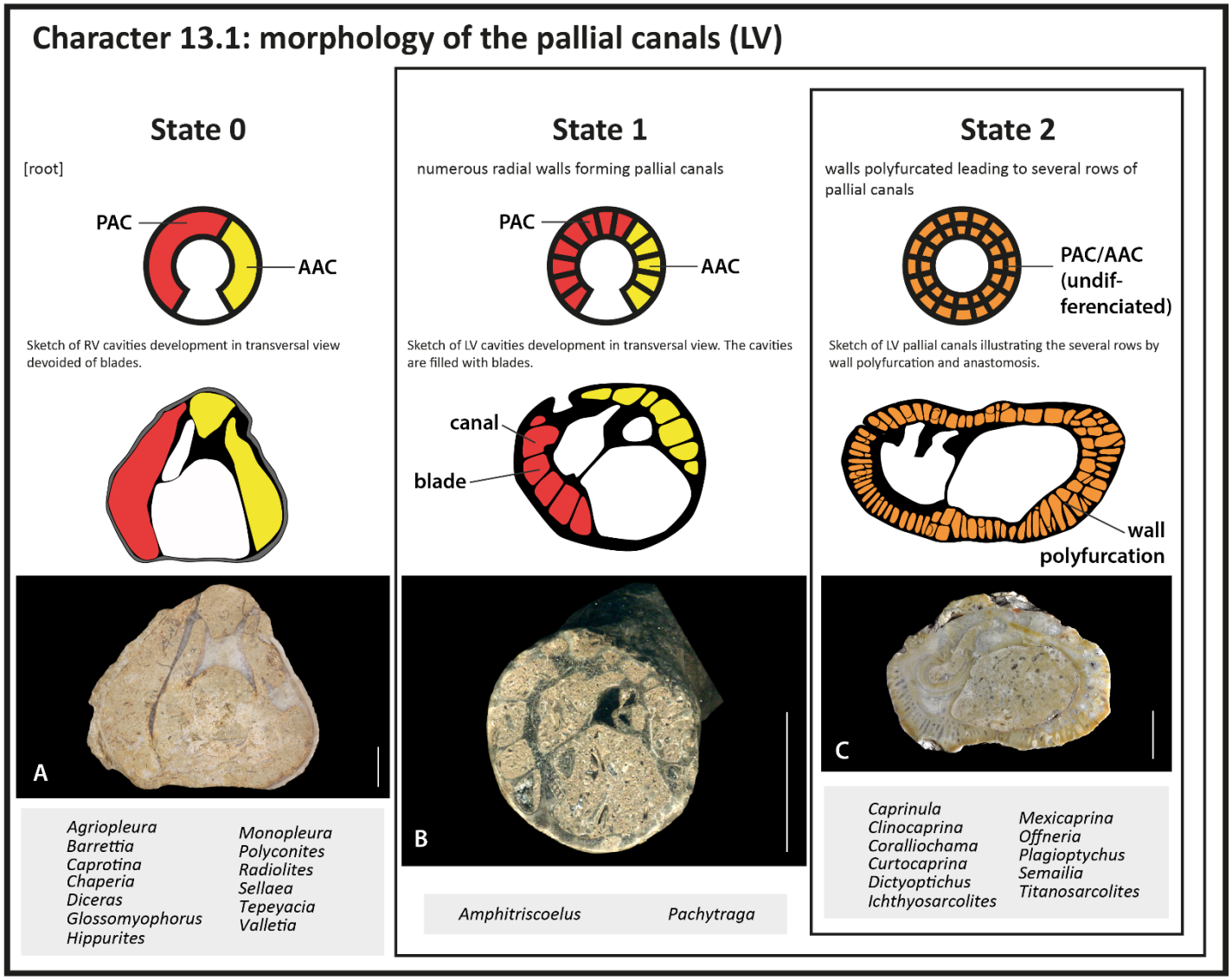
walls differentiated in two morphologies leading to two morphologies of canals: a row of rectangular canals along the external side of the shell wall, and capillary canals everywhere else

State 4

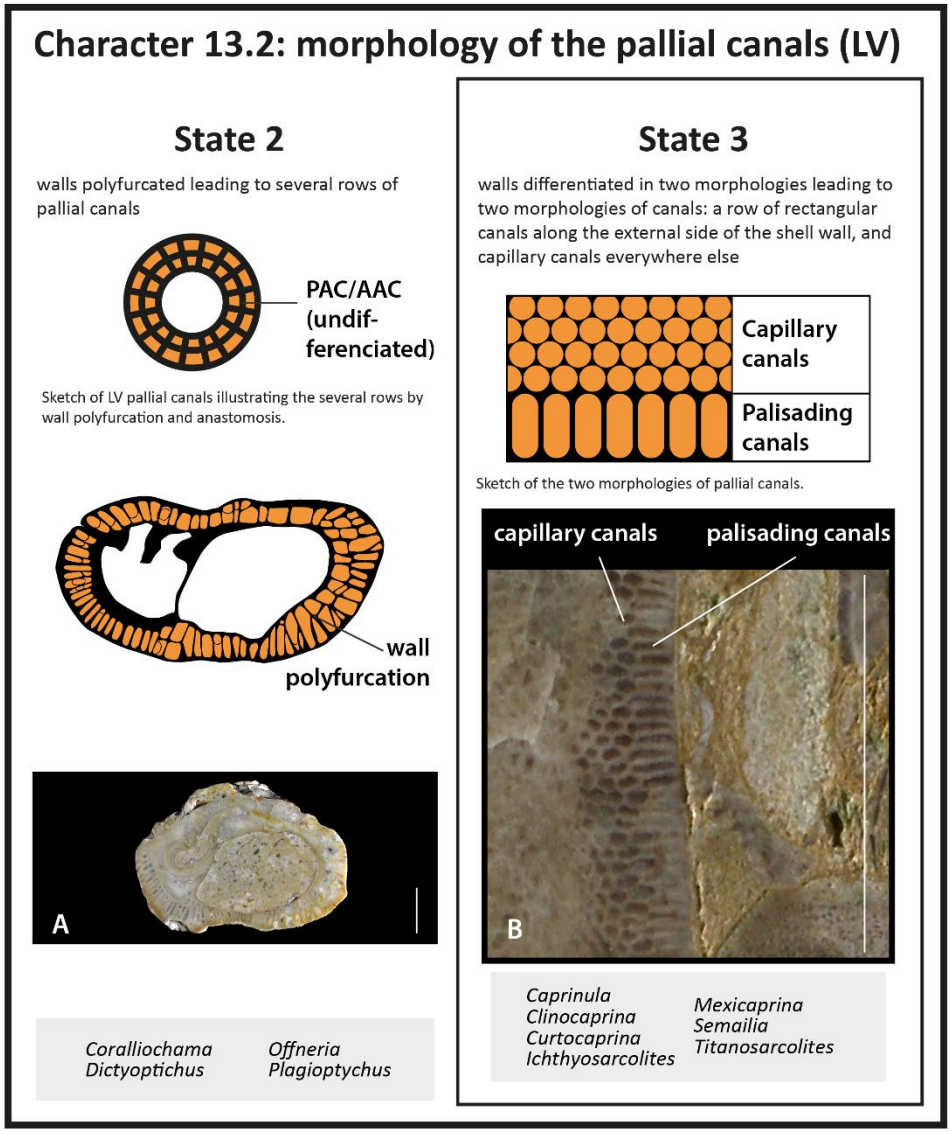
walls bifurcated towards the outside of the shell



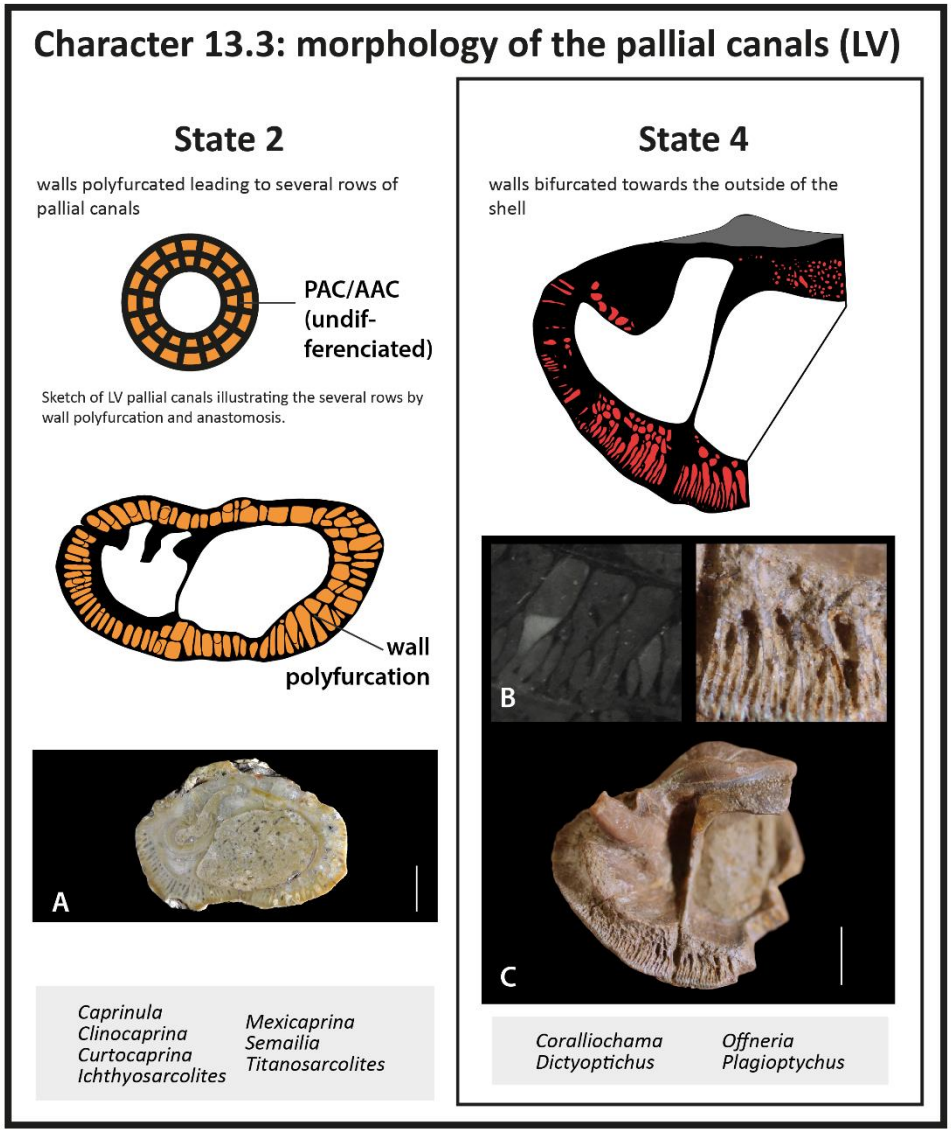
Hierarchical character #13, its character state intensions, and its decomposition in three sub-characters.



Hierarchical character #13.1. A – *Sellaea cespitosa* (WSA3058). B – *Amphitriscoelus waringi*. C – *Offneria rhodanica* (UCBL.R275). Scale bars, 10 mm.



Hierarchical character #13.2. A – *Offneria rhodanica* (UCBL.R275). B – *Titanosarcolites giganteus* (UT.47533). Scale bars, 10 mm.



Hierarchical character #13.3. A – *Offneria rhodanica* (UCBL.R275). B – *Schiosa ramosa* (R485, Université Claude Bernard Lyon 1; Coalcoman, Mexico). C – *Coralliochama orcutti* (USNM.186662). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 14

Name: differentiation of an internal row of large pallial canals

Position: left valve

Kind: canals

Coding: (0(1(2)))

States definitions

0 root

1 one internal row of large polygonal canals bordering G

2 the large polygonal canals increase in size between the two myophores and the shell/exterior wall

States tests

1 rejected – clade 17

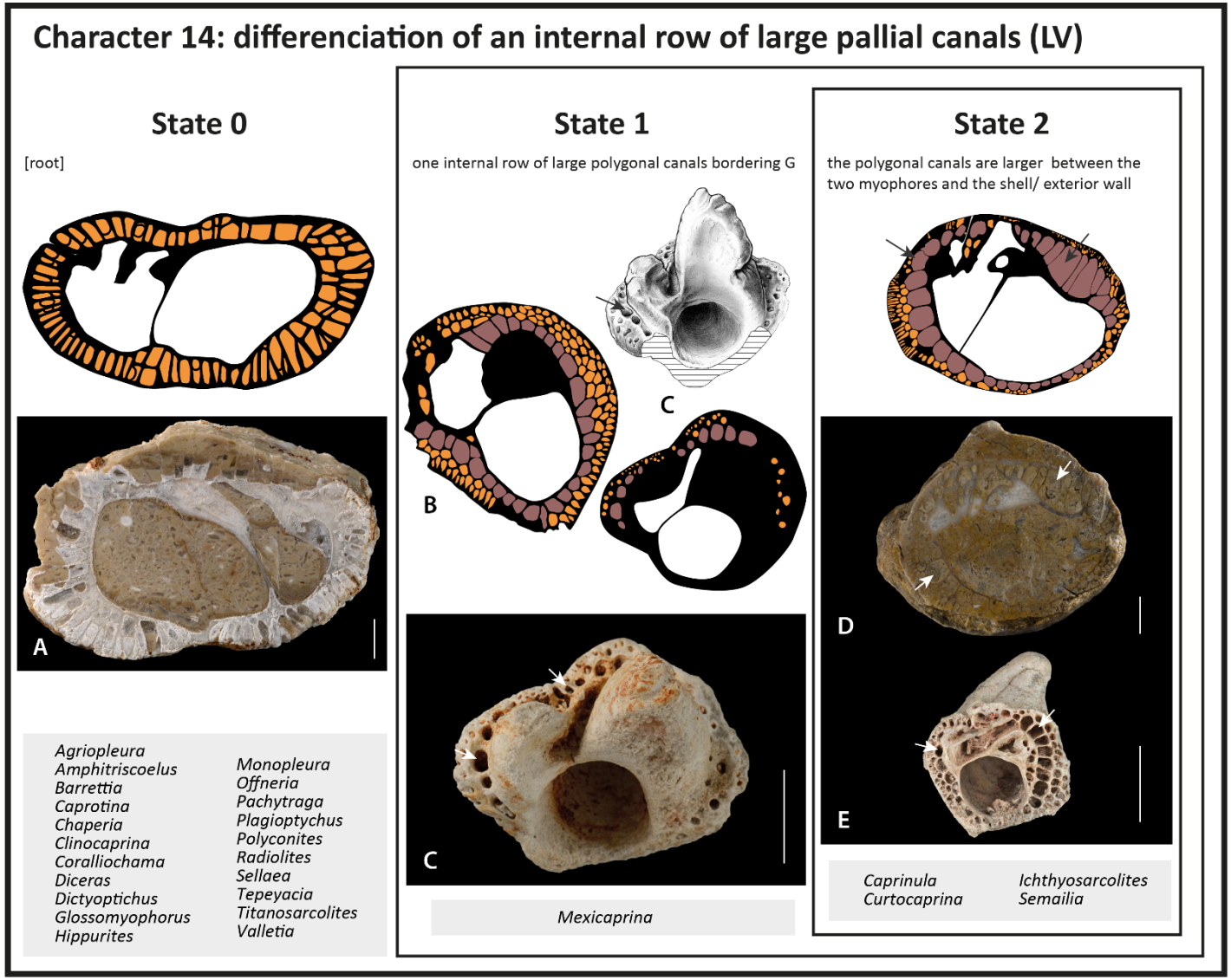
2 rejected – clades 18, 20

Retention index

84.0 %

Remarks

This character follows at a larger taxonomic scale the models of Chartrousse (1998b, 206-233) who produced the most advanced work about the evolution of pallial canals. The postulated row of large polygonal canals may be originated from the CTS partitioning, following the observations made on *Kimbleia capacis* (Aguilar-Perez 2008), and bordering G (see *Caprinuloidea romeri* as another example of state 2).



Hierarchical character #14. A – *Offneria rhodanica* (JPMA.16494). B – *Kimbleia capacis* (PUAB-81521). C – *Mexicaprina minuta* (JPMA.14097-5). D – *Caprinula boissyi* (MNHN.6924). E – *Caprinuloidea* sp. (UT.10922-2). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 15

Name: anterior tooth canal

Position: left valve

Kind: canals

Coding: (0(1))

States definitions

0 thick AT

1 circular canal in the AT

States tests

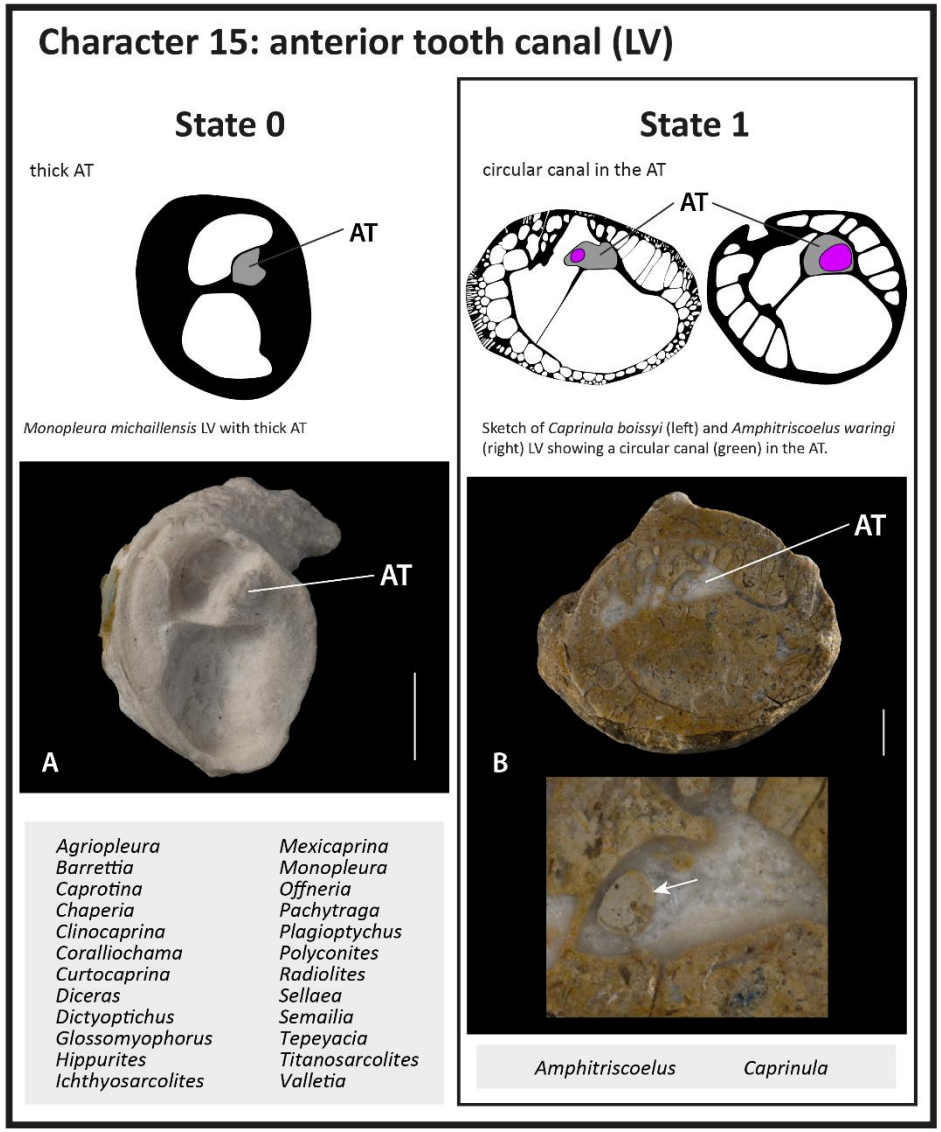
1 rejected – clade 18, *Amphitriscoelus*

Retention index

66.67 %

Remarks

The anterior tooth canal is probably unrelated to pallial canals of the LV, and most likely to be a neoformation. Other large canals inside rudist teeth can be seen in *Alencasteria* and *Stellacaprina* (see Mitchell 2013b).



Hierarchical character #15. A – *Monopleura michaillensis* (UPMC.1272). B – *Caprinula boissyi* (MNHN.6924). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 16

Name: capillary canals in the myophores

Position: left valve

Kind: canals

Coding: (0(1))

States definitions

0 thick anterior and posterior myophores

1 capillary canals in AM and PM

States tests

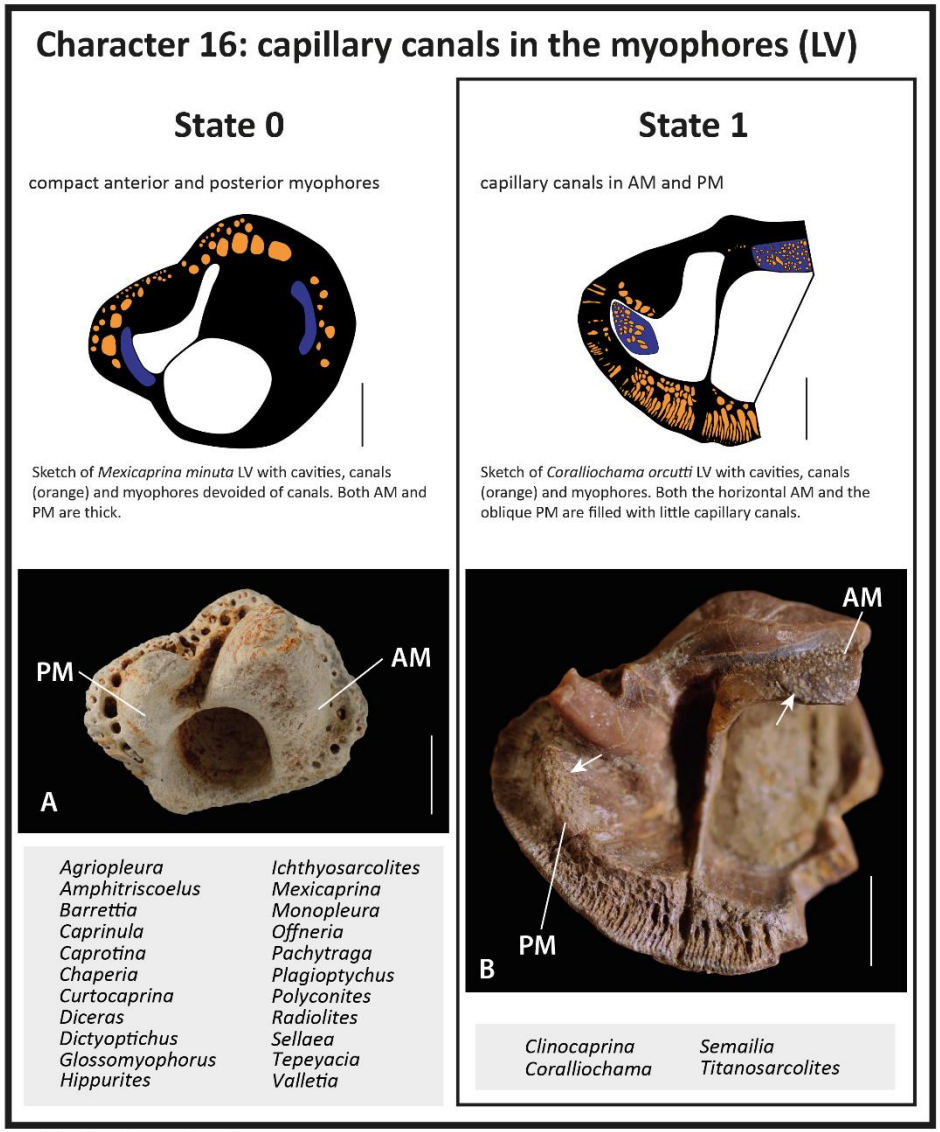
1 rejected – clades 9, 23

Retention index

65.91 %

Remarks

These canals are likely to be derived pallial canals, the morphology of myophoral canals being always similar to the other pallial canals of the shell.



Hierarchical character #16. A – *Mexicaprina minuta* (JPMA.14097-5). B – *Coralliochama orcutti* (USNM.186662). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 17

Name: tabulae in the general cavity G

Position: left valve

Kind: horizontal blades

Coding: (0(1))

States definitions

0 filled G bottom

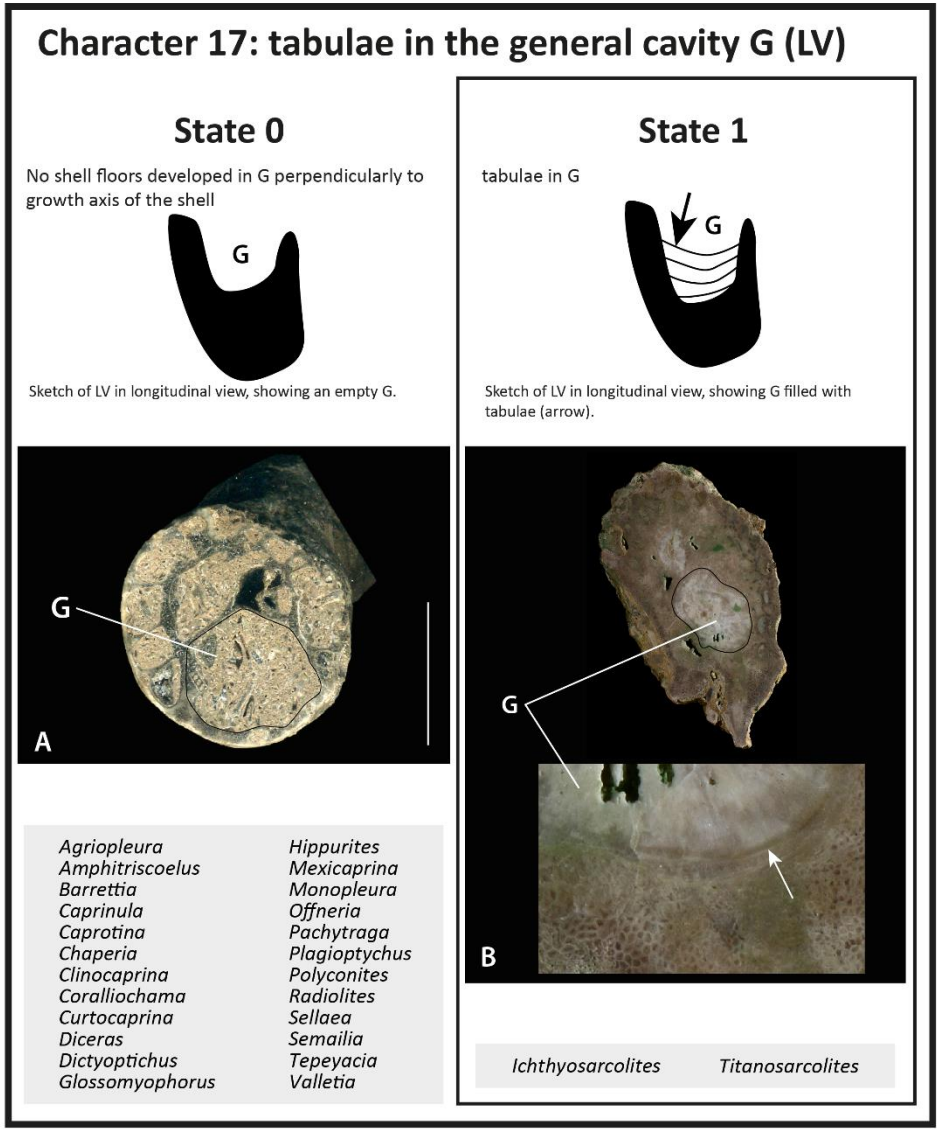
1 tabulae in G

States tests

1 passed – clade 25

Retention index

100.0 %



Hierarchical character #17. A – *Amphitriscoelus waringi*. B – *Titanosarcolites giganteus* (UT.47533). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 18

Name: tabulae in pallial canals

Position: left valve

Kind: horizontal blades

Coding: (0(1))

States definitions

0 root

1 tabulae in pallial canals

States tests

1 rejected – clade 18, 23

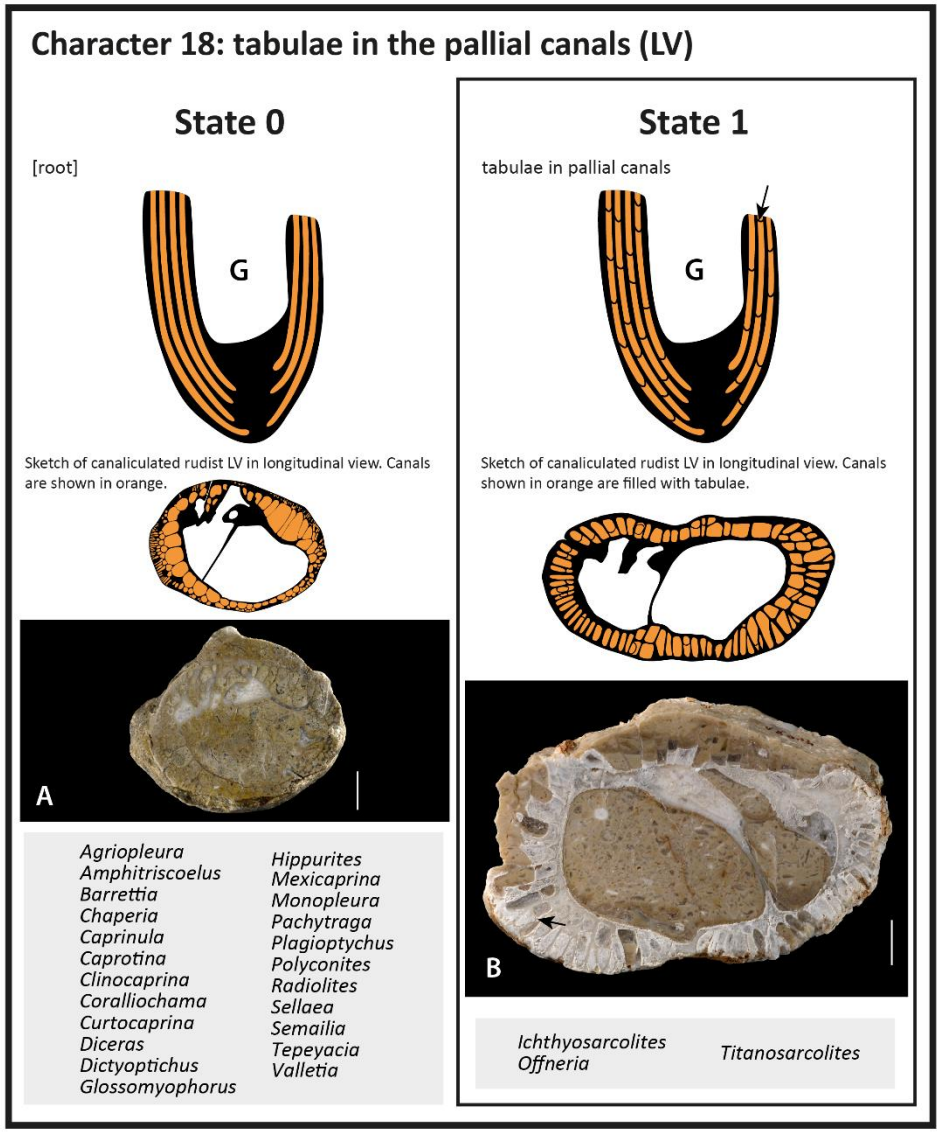
Retention index

87.12 %

Remarks

Related to character 8 of Chartrousse (1998a; with #34). Related partially to character 21 of Mitchell (2013) (with #34).

Generation of tabulae in pallial canals is not rhythmic in rudists, the generation of tabulae being asynchronous among canals, and other structures.



Hierarchical character #18. A – *Caprinula boissyi* (MNHN.6924). B – *Offneria rhodanica* (JPMA.16494). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 19

Name: tabulae in the central tooth socket

Position: left valve

Kind: horizontal blades

Coding: (0(1))

States definitions

0 root

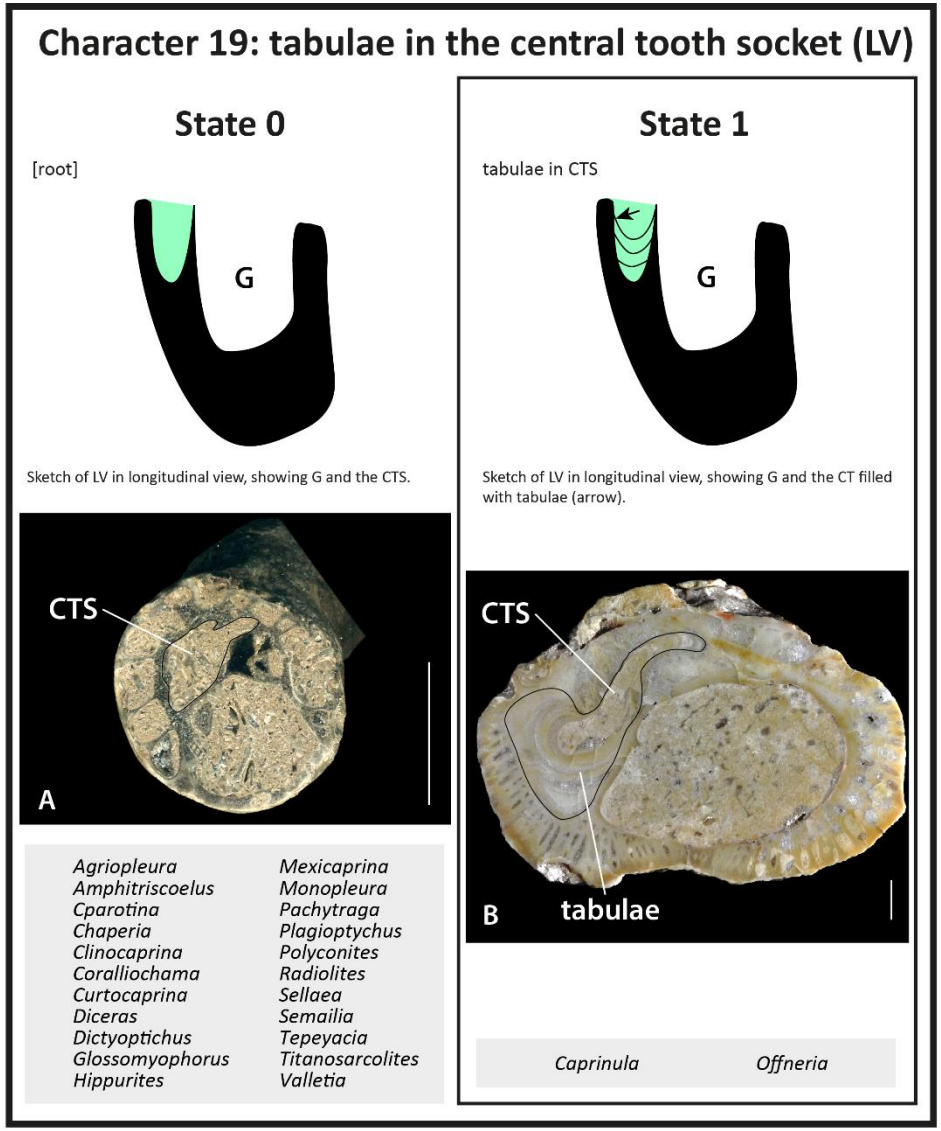
1 tabulae in CTS

States tests

1 accepted – clade 18

Retention index

100.0 %



Hierarchical character #19. A – *Amphitriscoelus waringi*. B – *Offneria rhodanica* (UCBL.R275). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 20

Name: calcitic canals

Position: left valve

Kind: canal/pore system

Coding: (0(1))

States definitions

0 compact calcitic outer shell layer

1 radial canals in the outer calcitic shell layer

States tests

1 passed – clade 14

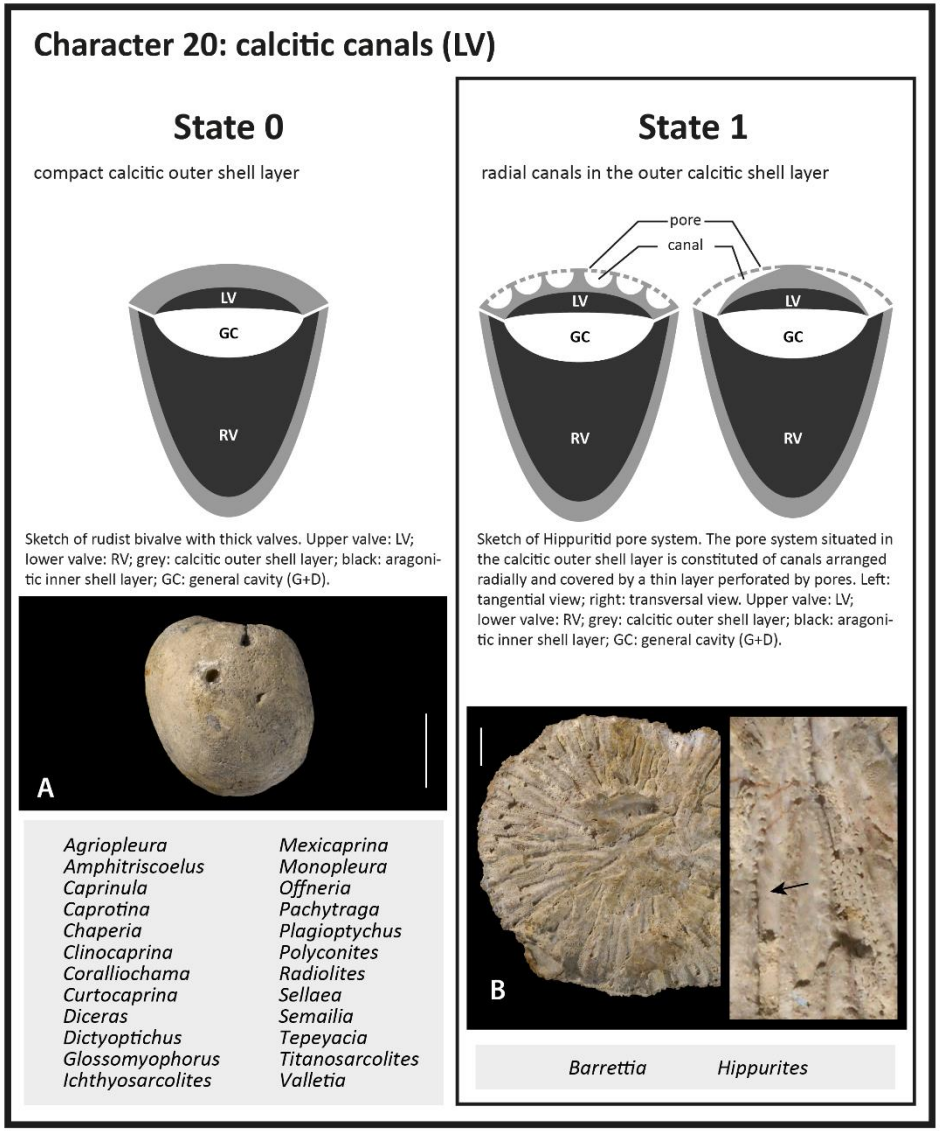
Retention index

100.0 %

Remarks

Related to character 13 of Steuber (1999; with #21). Related to character 4 of Skelton & Smith (2000; with #21).

Pores and canals are coded as separated homologs herein. These structures are considered independent, their morphologies being dissociated in Hippuritids with different evolutionary rates. As an example, *Radiolitella pulchellus* shows radial calcitic canals in the same fashion as Hippuritids, but without pores (Rineau & Viller 2019).



Hierarchical character #20. A – *Radiolites radiosus* (MNHN.F.J09021; umbonal view). B – *Hippurites radiosus* (MNHN.F.A58757; umbonal view). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 21

Name: calcitic pores

Position: left valve

Kind: canal/pore system

Coding: (0(1))

States definitions

0 compact outer shell layer

1 pores in the outer calcitic shell layer

States tests

1 passed – clade 14

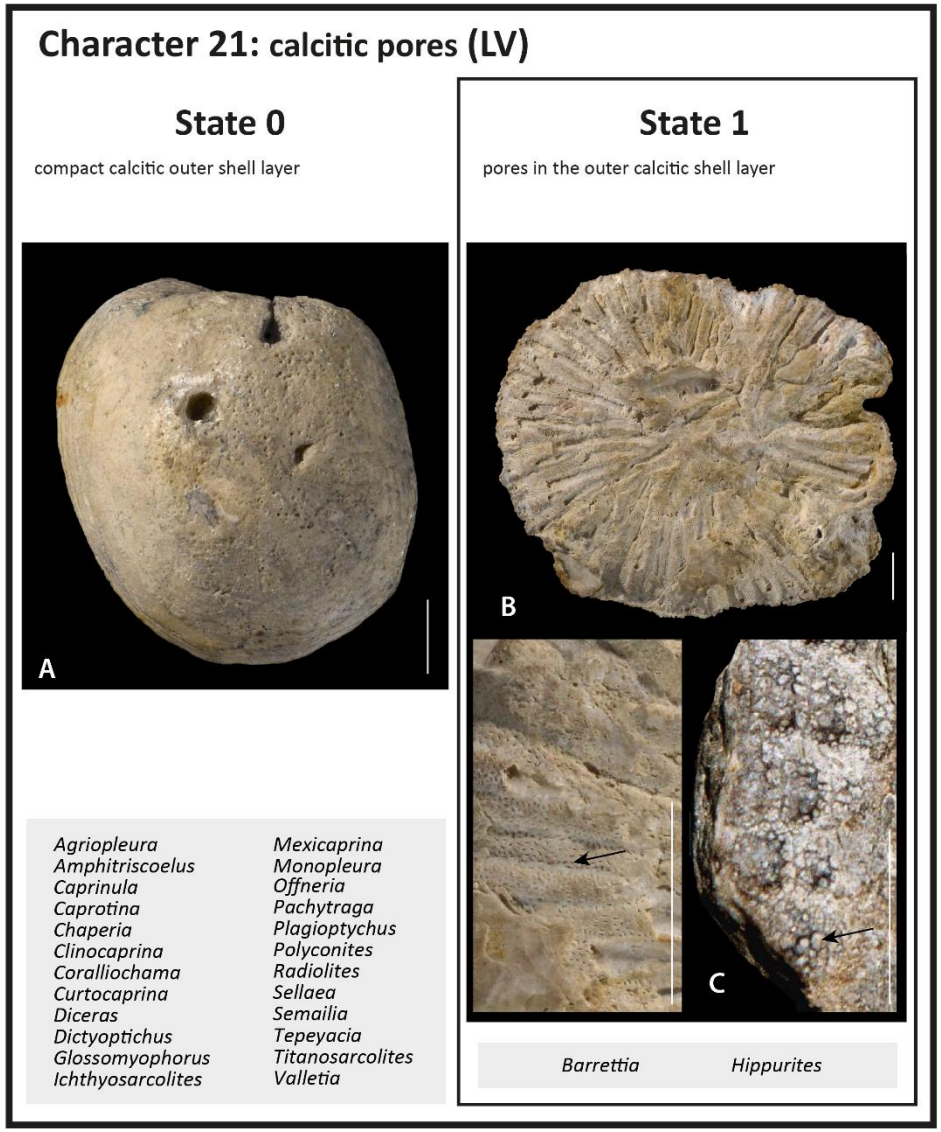
Retention index

100.0 %

Remarks

Related to character 13 of Steuber (1999) (with #20). Related to character 4 of Skelton & Smith (2000) (with #20).

See character #20 for discussion about dependency between calcitic canals and calcitic pores.



Hierarchical character #21. A – *Radiolites radiosus* (MNHN.F.J09021; umbonal view). B – *Hippurites radiosus* (MNHN.F.A58757; umbonal view). C – *Barrettia monilifera* (fig. 3D in Mitchell 2010; UWIGM.2010.01.0003). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 22

Name: left valve coiling

Position: left valve

Kind: coiling

Coding: (0(1))

States definitions

0 coiled left valve

1 uncoiled left valve

States tests

1 passed – clade 12

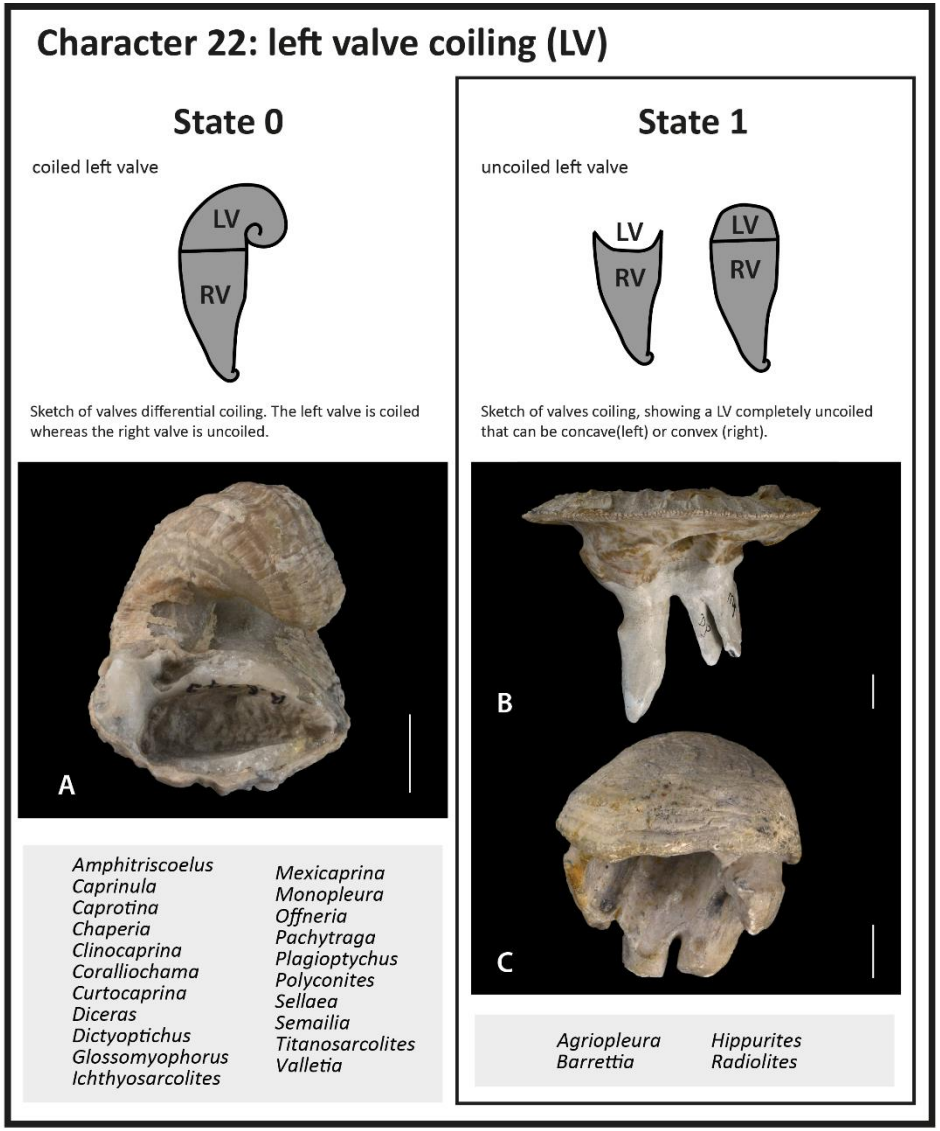
Retention index

100.0 %

Remarks

Related partially to character 2 of Smith (1994). Related to character 15 of Skelton & Smith (2000). Related to character 2 of Sano *et al.* (2014).

Only shells with the umbo at the centre of the shell in umbonal view are considered as fully uncoiled.



Hierarchical character #22. A – *Glossomyophorus costatus* (MNHN.F.R06779). B – *Hippurites radiosus* (MNHN.F.A58757). C – *Radiolites radiosus* (MNHN.F.J09021). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 23

Name: diceratid tooth

Position: right valve

Kind: teeth

Coding: (0(1))

States definitions

0 presence of an anterior crescentic diceratid tooth (DT) between D and the ATS

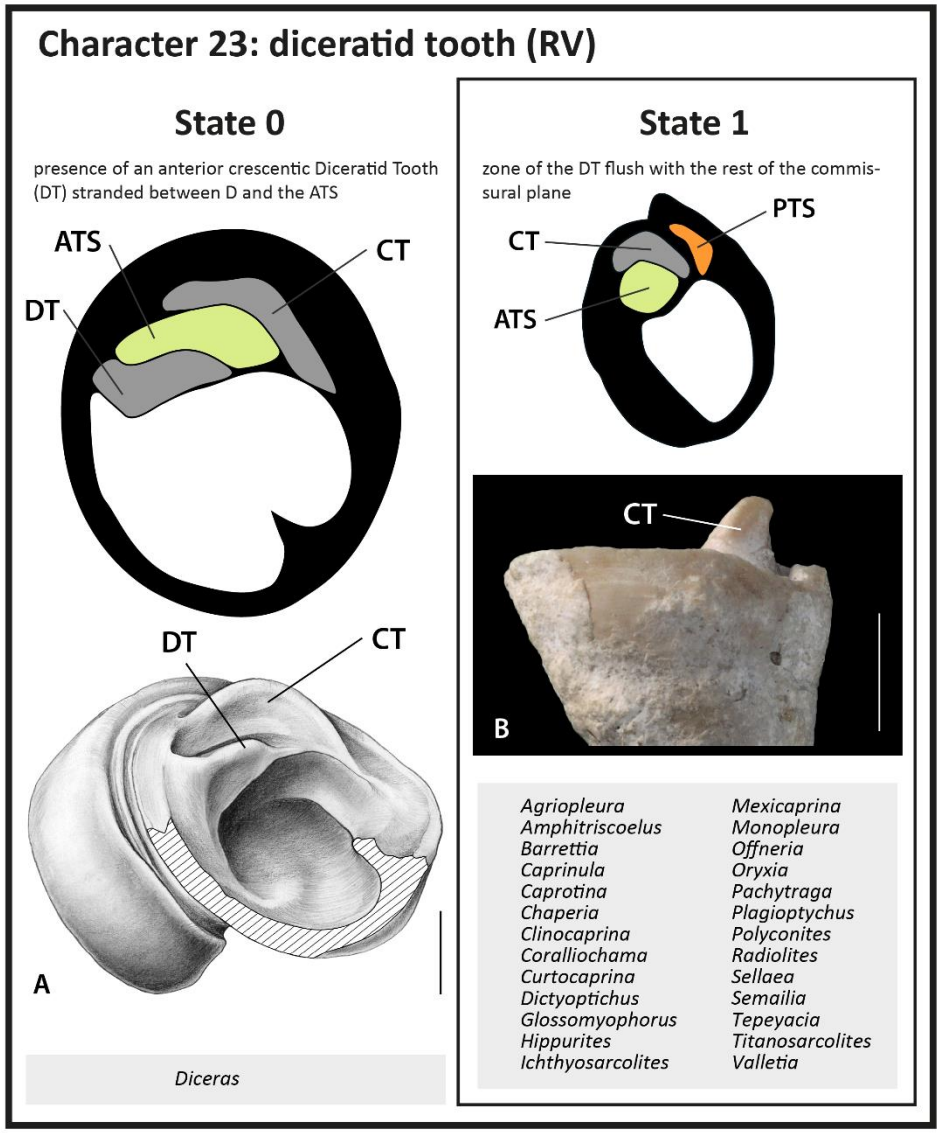
1 zone of the DT flat and thin

States tests

1 passed – clade 1

Retention index

100.0 %



Hierarchical character #23. A – *Diceras arietinum* (MNHN.F.A52439). B – *Monopleura michaillensis* (UPMC.1272). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 24

Name: central tooth morphology

Position: right valve

Kind: teeth

Coding: (0(1))

States definitions

0 crescent-shaped CT surrounding the ATS

1 conical-shaped CT between ATS and PTS

States tests

1 passed – clade 6

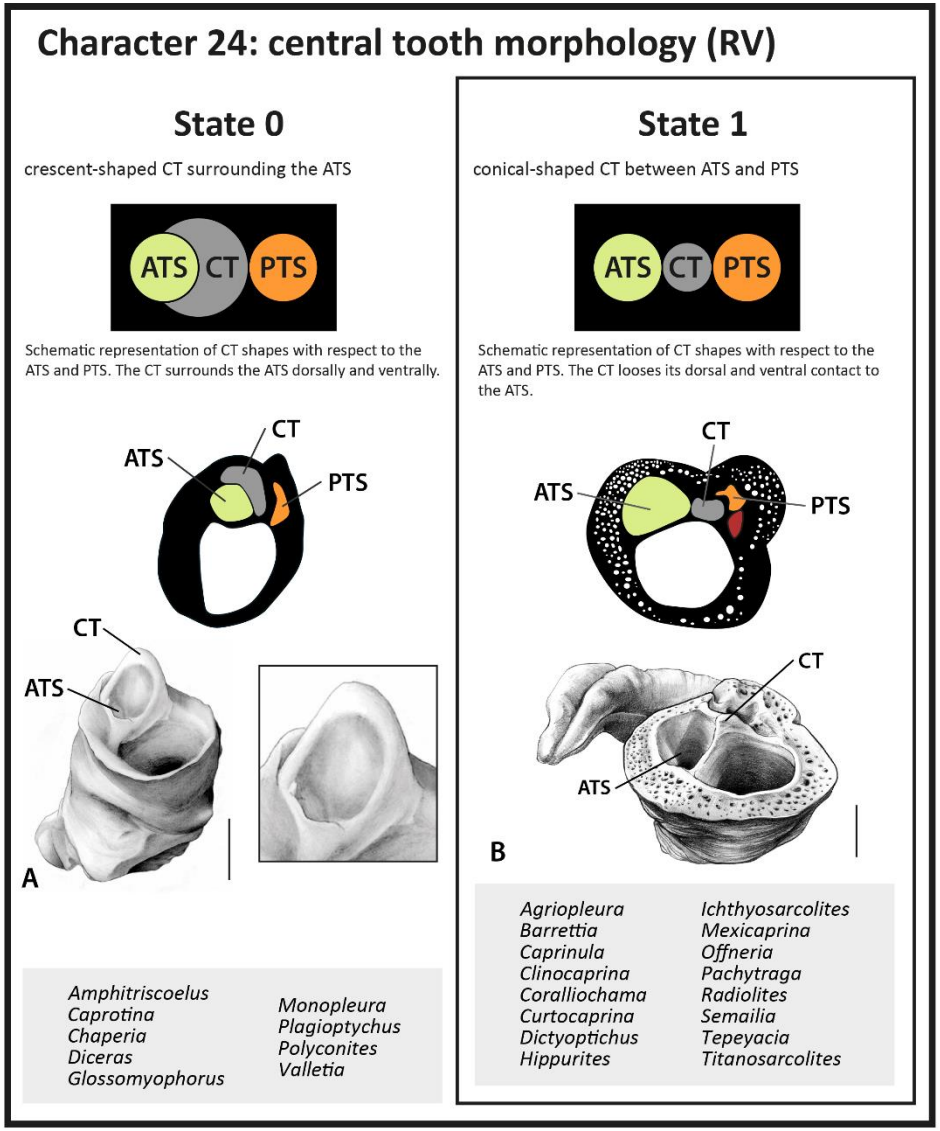
Retention index

81.9 %

Remarks

Related to character 18 of Skelton & Smith (2000). Related to character 4 of Sano *et al.* (2014; with #25).

Pachytraga paradoxa is polymorphic for this state. However, the character being hierarchical, *Pachytraga* is coded 1.



Hierarchical character #24. A – *Monopleura michaillensis* (UPMC.1272). B – *Mexicaprina minuta* (JPMA.14097-1). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 25

Name: central tooth orientation

Position: right valve

Kind: teeth

Coding: (0(1))

States definitions

0 CT curved towards the posterior side

1 CT straight

States tests

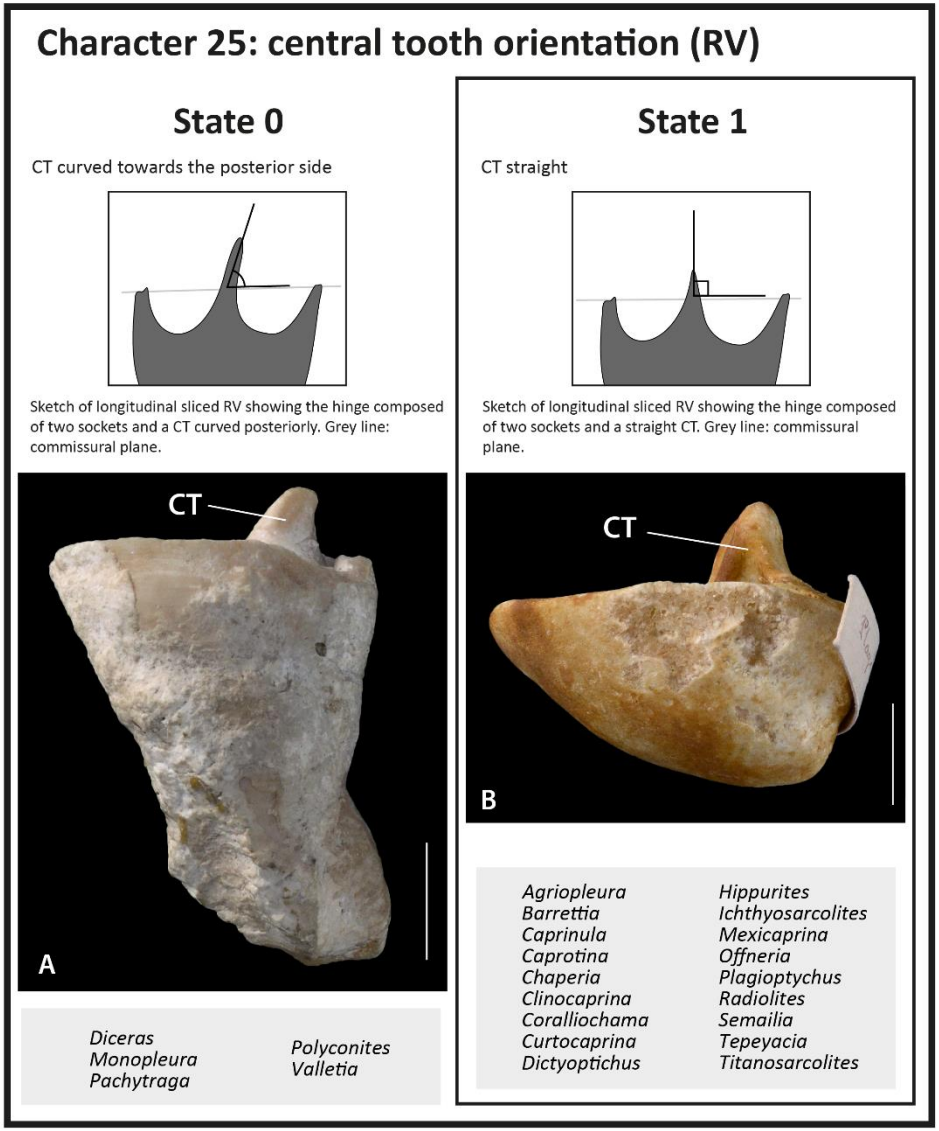
1 rejected – clades 4, 7, 9, 12, 17

Retention index

79.61 %

Remarks

Related to character 4 of Sano *et al.* (2014; with #24).



Hierarchical character #25. A – *Monopleura michaillensis* (UPMC.1272). B – *Plagioptychus arnaudi* (UPMC). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 26

Name: posterior myophore morphology

Position: right valve

Kind: myophores

Coding: (0(1)(2(3(4))(5(6))))

States definitions

0 PM inserted on a posteroventral blade

1 PM alongside D

2 PM on the commissural plane and forming a horizontal shelf ventral to the PTS

3 formation of a PENC by PM tilting

4 PM adjoining the PENC, vertical and outwardly oriented

5 outwardly verticalized PM projecting into the LV by development of the PENC/D wall

6 PM adjoining the PENC, vertical and inwardly oriented

7 loss of the contact between PTS and PENC (thickening of the PTS/PENC blade)

States tests

1 rejected – clades 7, 13, 21

2 rejected – clades 4, 9, 14, 18, 22, *Amphitriscoelus*, *Mexicaprina*, *Monopleura*, *Pachytraga*, *Sellaea*, *Valletia*

3 rejected – clades 4, 14, 18, 22, *Amphitriscoelus*, *Mexicaprina*, *Pachytraga*, *Sellaea*

4 rejected – clades 4, 18, *Pachytraga*, *Sellaea*

5 rejected – clade 18, *Pachytraga*

6 rejected – 14, 22, *Amphitriscoelus*, *Mexicaprina*

7 passed – clade 22

Retention index

50.32 %

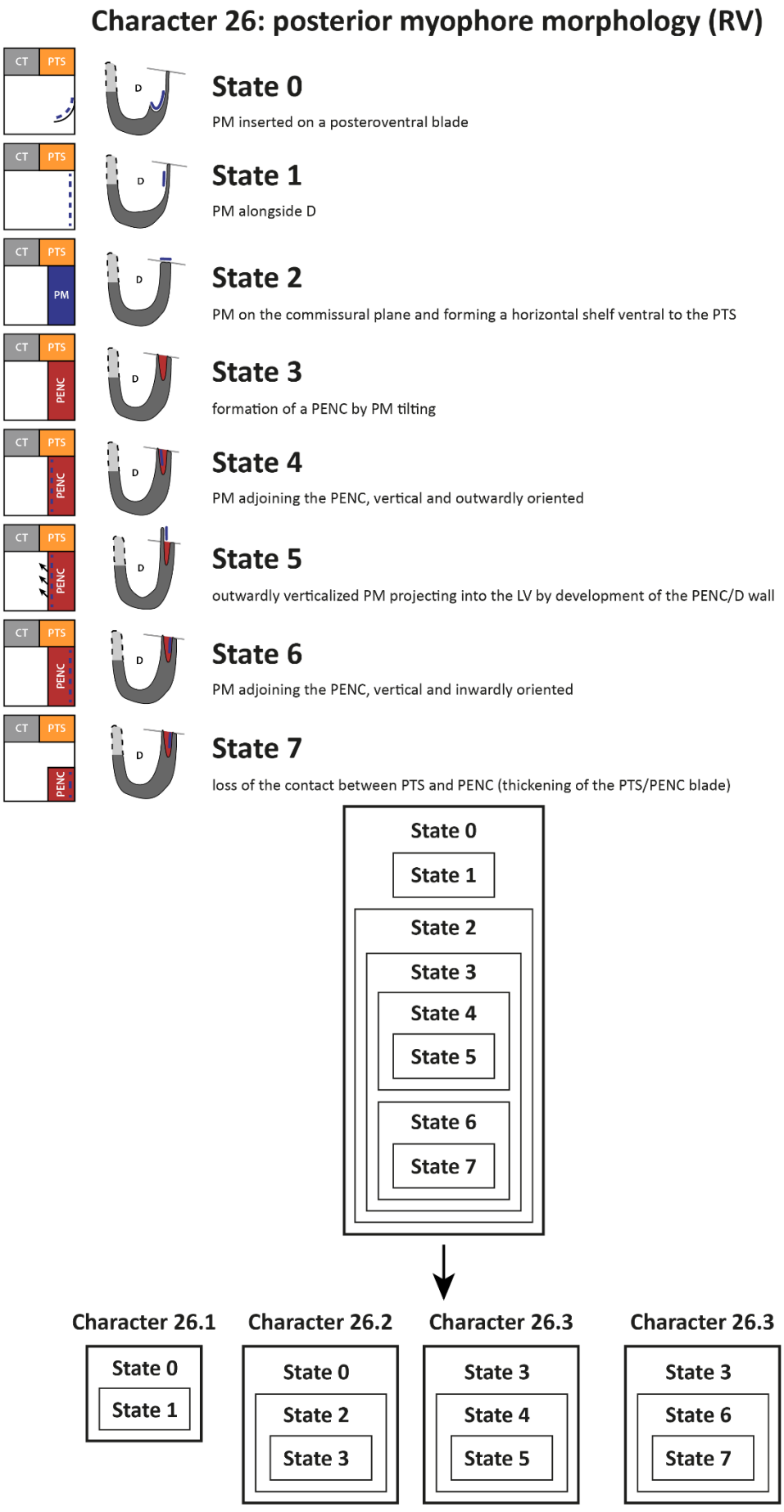
Remarks

Related partially to character 1 of Chartrousse (1998a; #26.2, #26.3, #26.4). Related to character 5 of Skelton & Masse (1998; #26.2, #26.5). Related partially to character 10 of Steuber (1999; #26.1, #26.2).

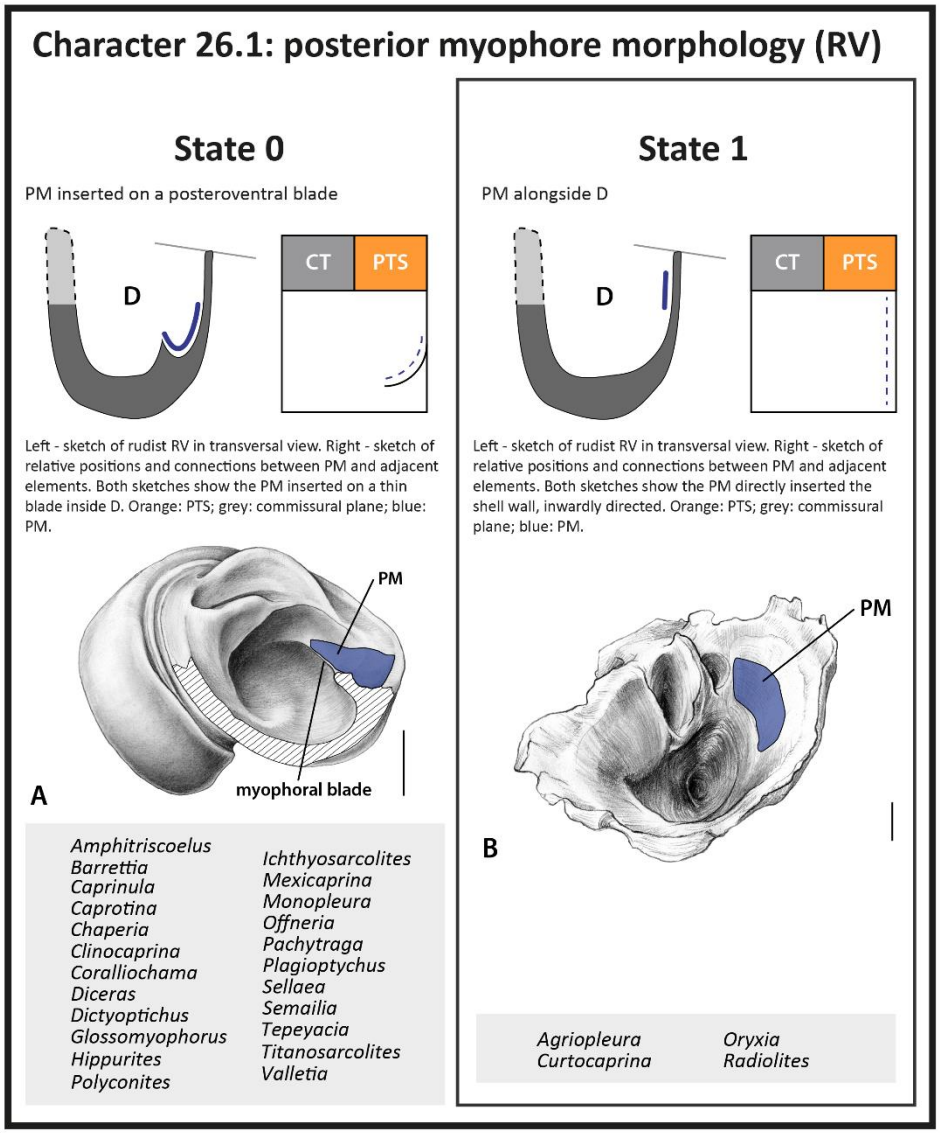
This character includes a paralogous clade and is presented in three independent parts.

The posterior myophore morphology is complex and shows seven different states, as in LV myophore. The ancestral state is a thin myophoral blade visible in Diceratidae. Two states are quite similar: one with the PM is simply inserted in the posterior wall of D without any particular structure (state 1), and a second one with the PM-RV horizontal on a thick and well-delineated myophoral shelf (state 2). No evidence of relation can be found between state 1 and 2. We choose to include both states 1 and 2 in the state 0 that becomes a paralogous clade. The state 1 is understood as resulting from resorption of the myophoral blade, and the state 2 is seen oppositely as a strong development of the myophoral blade up to form a myophoral shelf. Then, the myophoral shelf can hollow in a PENC (state 3). *Plagioptychus arnaudi* as many other Plagioptychids show the very beginning of myophoral shelf tilting and PENC formation, which prefigures state 3. All other states, from 4 to 7, are variations of the myophore position in relation to the PENC. The hollowing of the PENC can result in an outwardly oriented (state 4) or an inwardly oriented (state 6) vertical myophore, making the state 3 paralogous. When outwardly orientated, the myophore can rise as a blade out of the commissural plane (state 5). This state is considered by Chartrousse (1998b) as the synapomorphy of the family Caprinidae. The state 7 is included in the state 6, where the

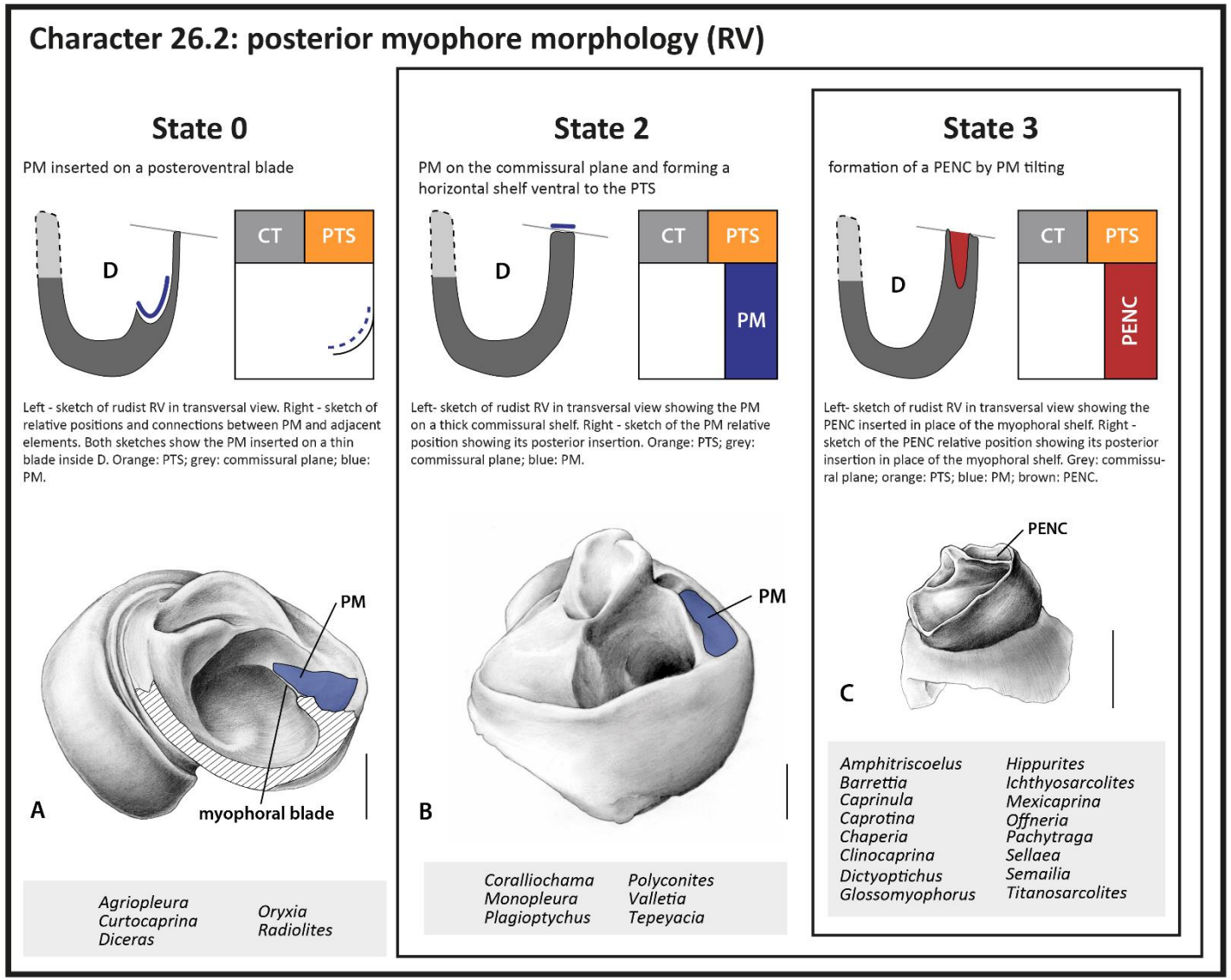
PENC containing the PM-RV inwardly oriented loses contact with the PTS. *Hippurites* and *Barrettia* have clearly the state 6, as shown in their ontogenesis (Götz 2003).



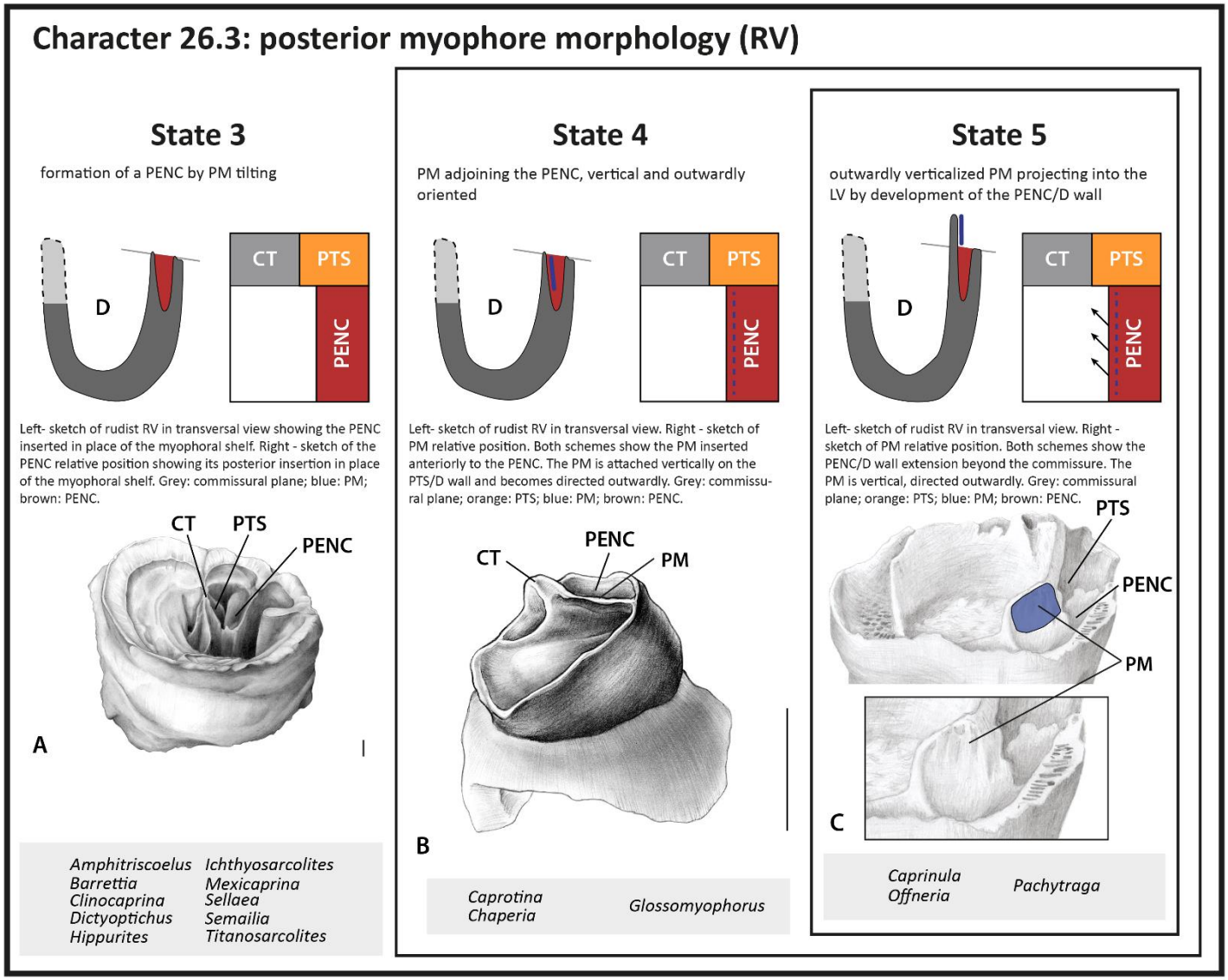
Hierarchical character #26, its character state intension and its decomposition in three sub-characters.



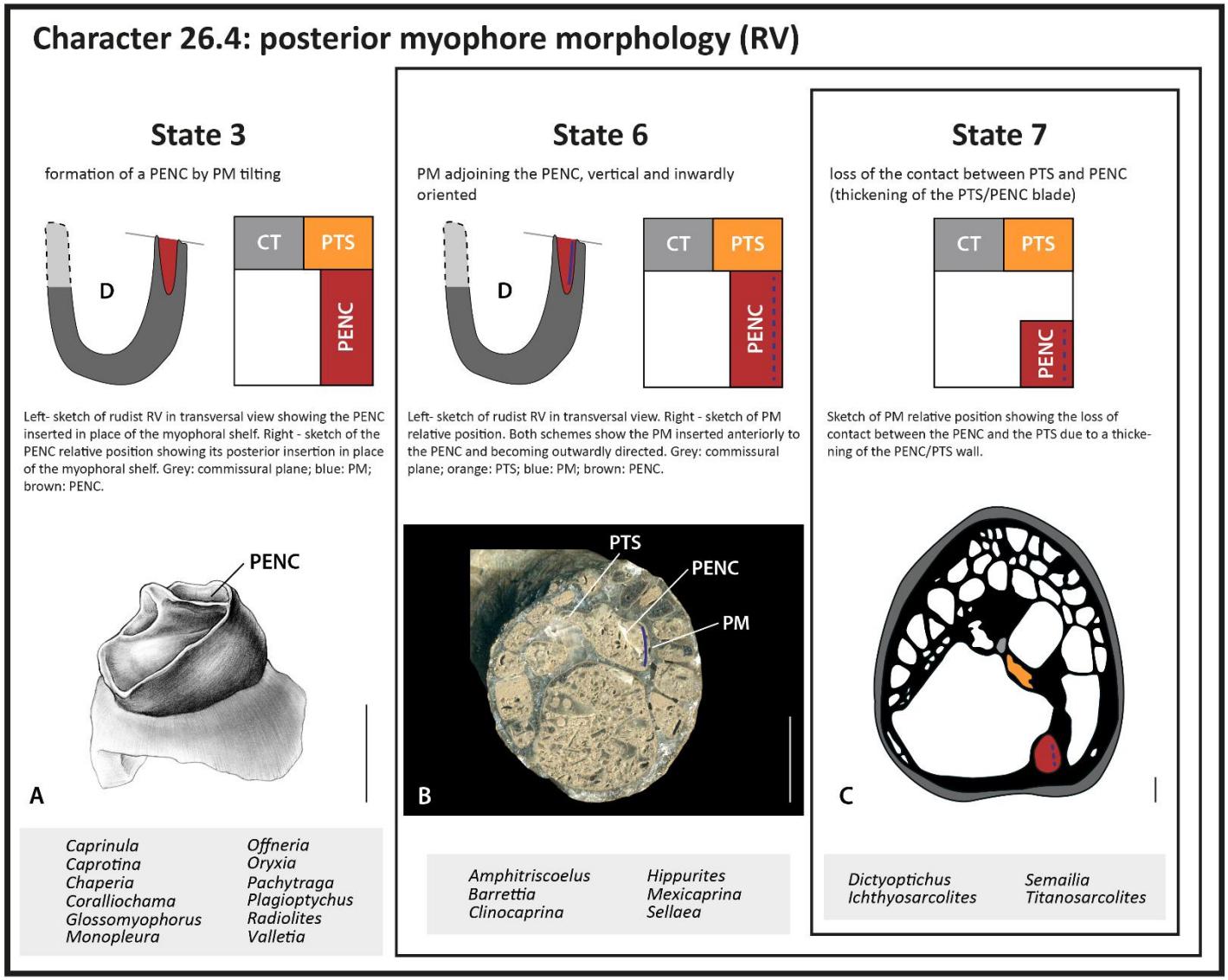
Hierarchical character #26.1. A – *Diceras arietinum* (MNHN.F.A52439). B – *Polyconites verneuili* (Ch02 in Pascual-Cebrian et al. 2013). Scale bars, 10 mm.



Hierarchical character #26.2. A – *Diceras arietinum* (MNHN.F.A52439). B – *Plagioptychus arnaudi* (UPMC.1273). B – *Caprotina striata* (MV 2003.2.5147). Scale bars, 10 mm.



Hierarchical character #26.3. A – *Hippurites radiosus* (MNHN.F.A58757). B – *Caprotina striata* (MV 2003.2.5147). C – *Offneria rhodanica* (UCBL.R781). Scale bars, 10 mm.



Hierarchical character #26.4. A – *Caprotina striata* (MV 2003.2.5147). B – *Amphitriscoelus waringi*. C – *Dictyoptychus morgani* (NHMUK PI.L-58427; original picture provided by Peter W. Skelton). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 27

Name: anterior myophore morphology

Position: right valve

Kind: myophores

Coding: (0(1(2(3)))

States definitions

0 AM in D along the inner side of the shell

1 AM forming a horizontal shelf onto the shell commissure alongside D.

2 AM shelf tilted towards the ATS and forming an AAC. Vertical or oblique and inwardly directed.

3 Loss of contact between individualized ATS and AAC. AAC located posteroventrally.

States tests

1 rejected – clades 5, 7, 9, 18, 21, 25, *Mexicaprina*, *Monopleura*, *Sellaea*, *Valletia*

2 rejected – clades 21, 25, *Mexicaprina*

3 rejected – clades 21, 25

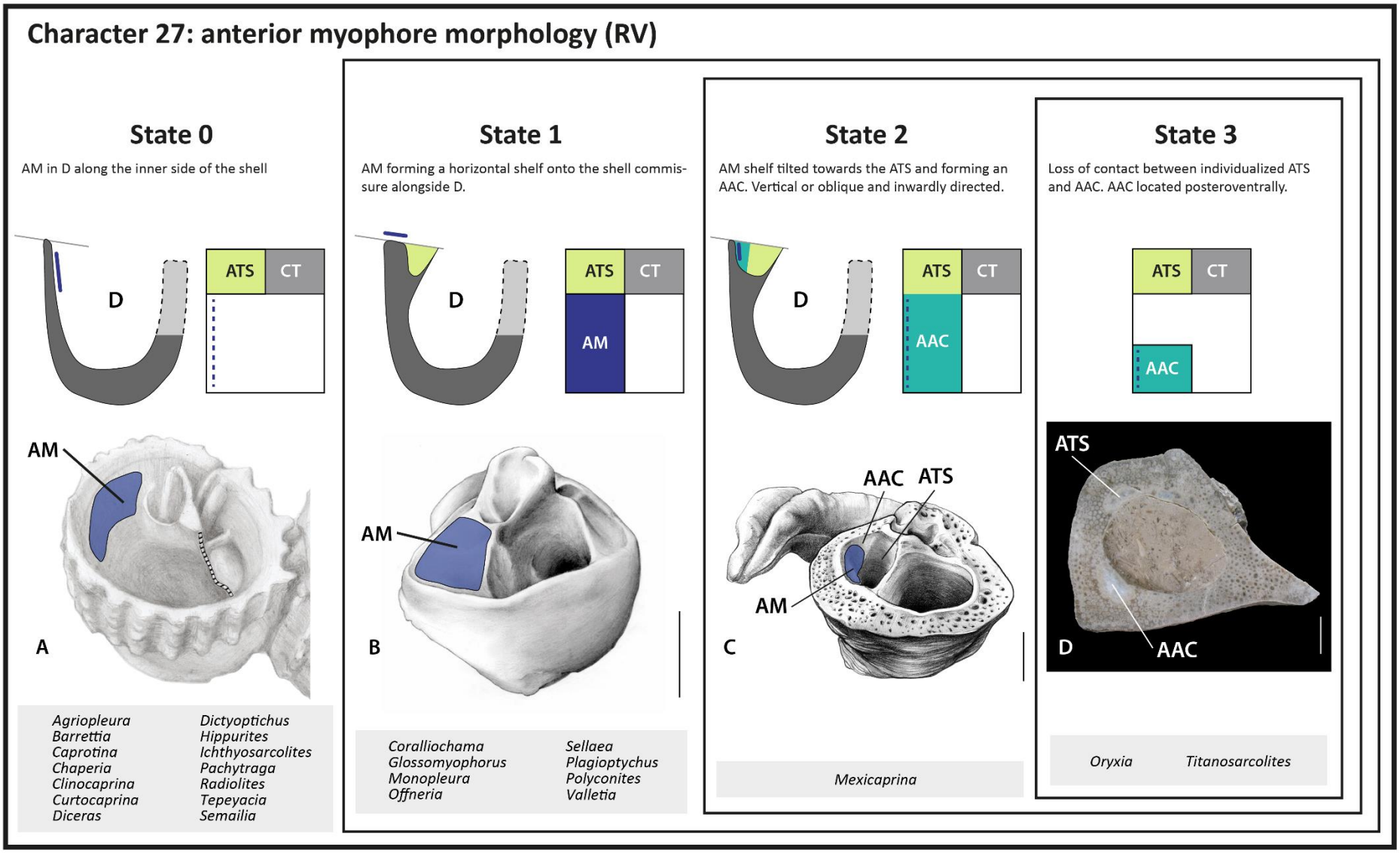
Retention index

43.21 %

Remarks

All of the states of this character are rejected, which means that the states cannot characterize any clade. However, the retention index indicates that half the 3is content is used to construct and support the cladogram.

The ancestral state of the AM-RV is an insertion of the inner shell as in other bivalves (state 0). It can become inserted on a myophoral shelf that may not be delineated as well as PM-RV (see remarks of character #6) (state 1). By inward tilting, the myophoral cavity can merge with the ATS or the AAC. We propose a grouping for all taxa with a vertical myophore inwardly directed. The hypothesis is that the myophore tilting allows the development of an AAC in direct contact with ATS (state 2). The state 3 varies from state 2 only by the loss of contact between AAC and ATS.



Hierarchical character #27. A – *Chaperia costata* (MNHN.F.R07942). B – *Plagioptychus arnaudi* (UPMC.1273). C – *Mexicaprina minuta* (JPMA.14097-1). C – *Oryxia sulcata* (BJ.1901-HR2). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 28

Name: the position of the anterior ectomyophoral cavity

Position: right valve

Kind: vertical blades

Coding: (0(1))

States definitions

0 [root]

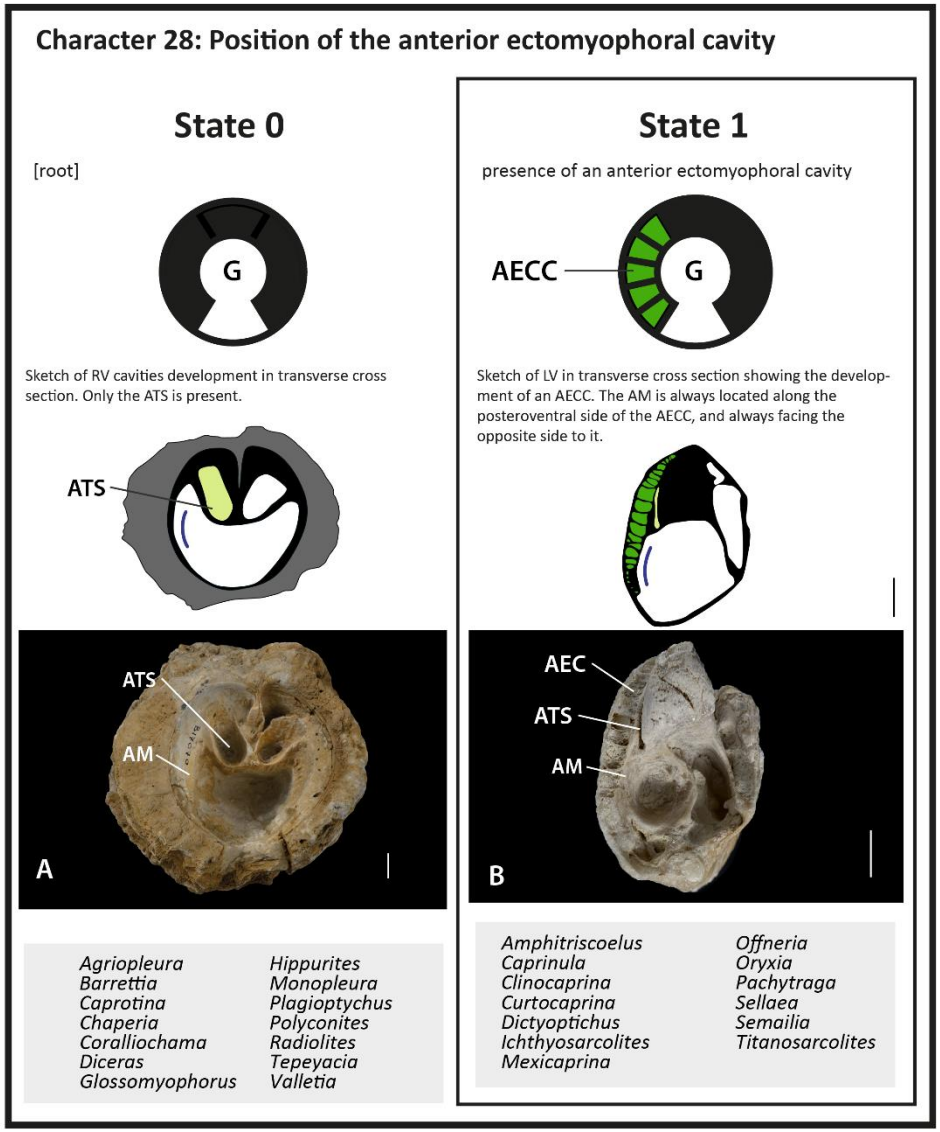
1 presence of an anterior ectomyophoral cavity

States tests

1 rejected – clade 15, *Sellaea*

Retention index

82.51 %



Hierarchical character #28. A – *Radiolites radiosus* (MNHN.F.J09021). B – *Pachytraga paradoxa* (JPMA.17738-1). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 29

Name: position of the posterior ectomyophoral cavity

Position: right valve

Kind: vertical blades

Coding: (0(1))

States definitions

0 [root]

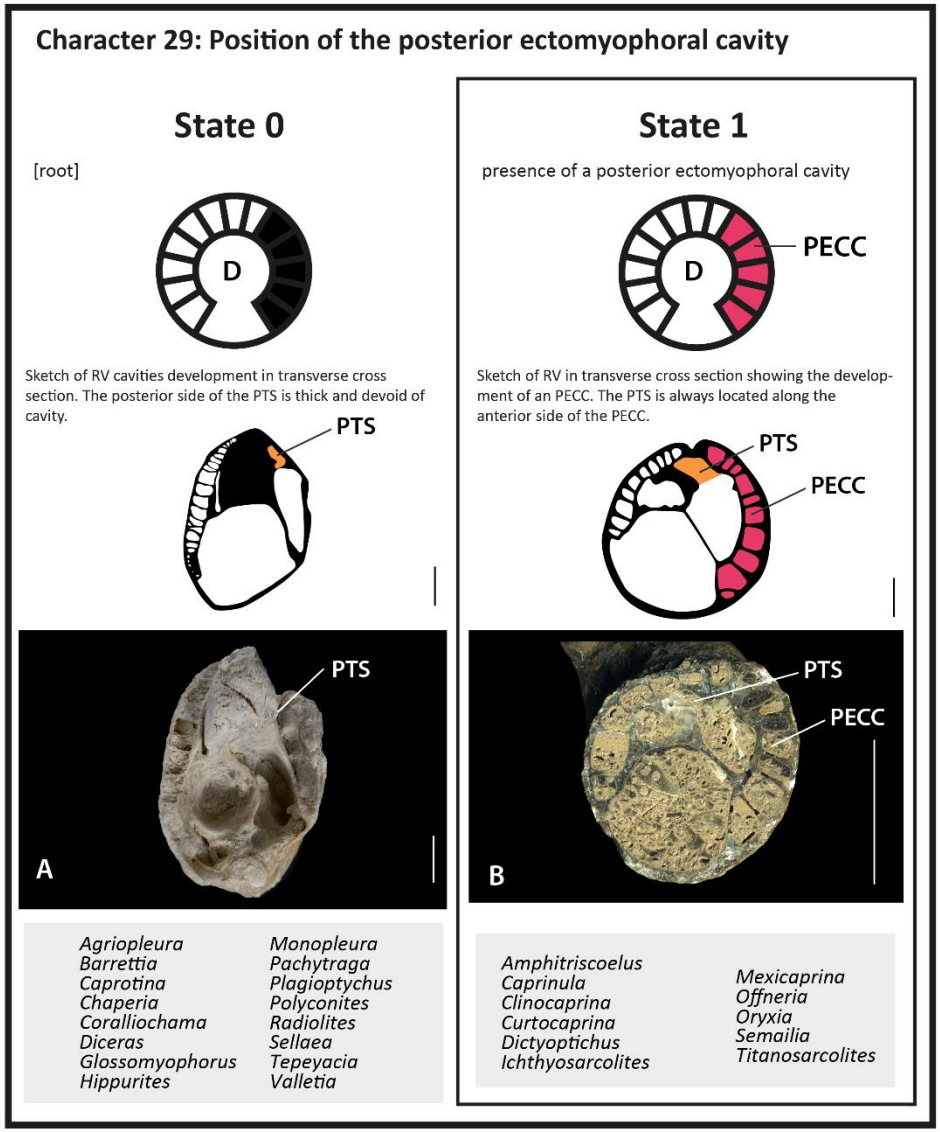
1 presence of a posterior ectomyophoral cavity

States tests

1 accepted – clade 16

Retention index

100.00 %



Hierarchical character #29. A – *Pachytraga paradoxa* (JPMA.17738-1). B – *Amphitriscoelus waringi*. Scale bars, 10 mm.

HIERARCHICAL CHARACTER 30

Name: position of the posterior tooth socket

Position: right valve

Kind: vertical blades

Coding: (0(1(2)))

States definitions

0 root

1 posterior tooth socket between the CT and the PM

2 loss of the contact between PTS and D by dorsal development of the PM

States tests

1 passed – clade 1

2 rejected – clades 7, 9, 18

Retention index

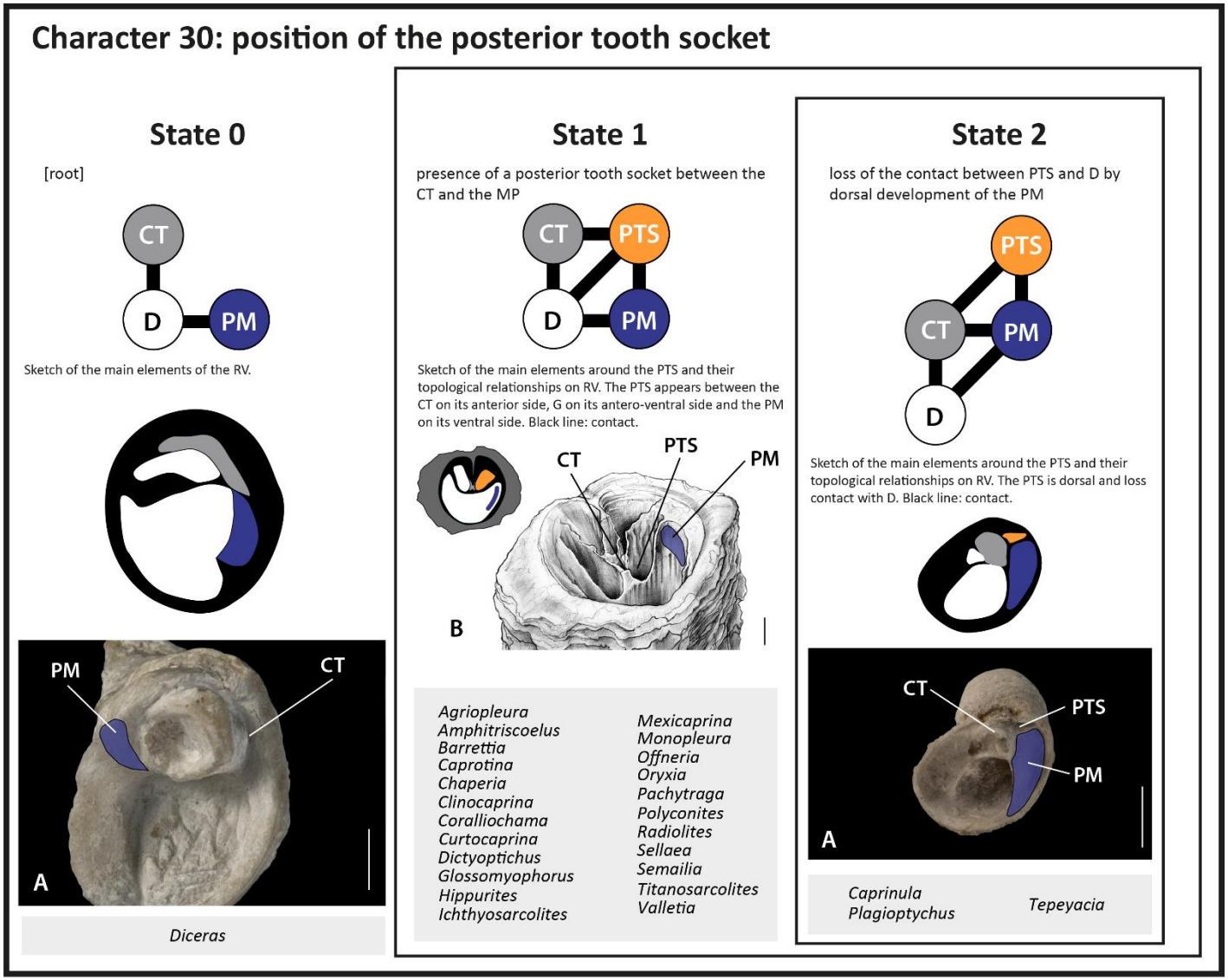
53.35 %

Remarks

Related partially to character 12 of Steuber (1999; #29.2).

See remarks of character #28.

In *Curtocaprina*, the PTS cavity becomes a notch because of the loss of the PTS/D wall.



Hierarchical character #30. A – *Diceras arietinum* (MNHN.F.A52439). B – *Radiolites radiosus* (MNHN.F.J09021). C – *Plagioptychus arnaudi* (UPMC.1273). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 31

Name: development of the pallial cavities

Position: right valve

Kind: canals

Coding: (0(1))

States definitions

0 RV ventral side thick, devoid of cavities

1 ventral contact of the AECC and PECC

States tests

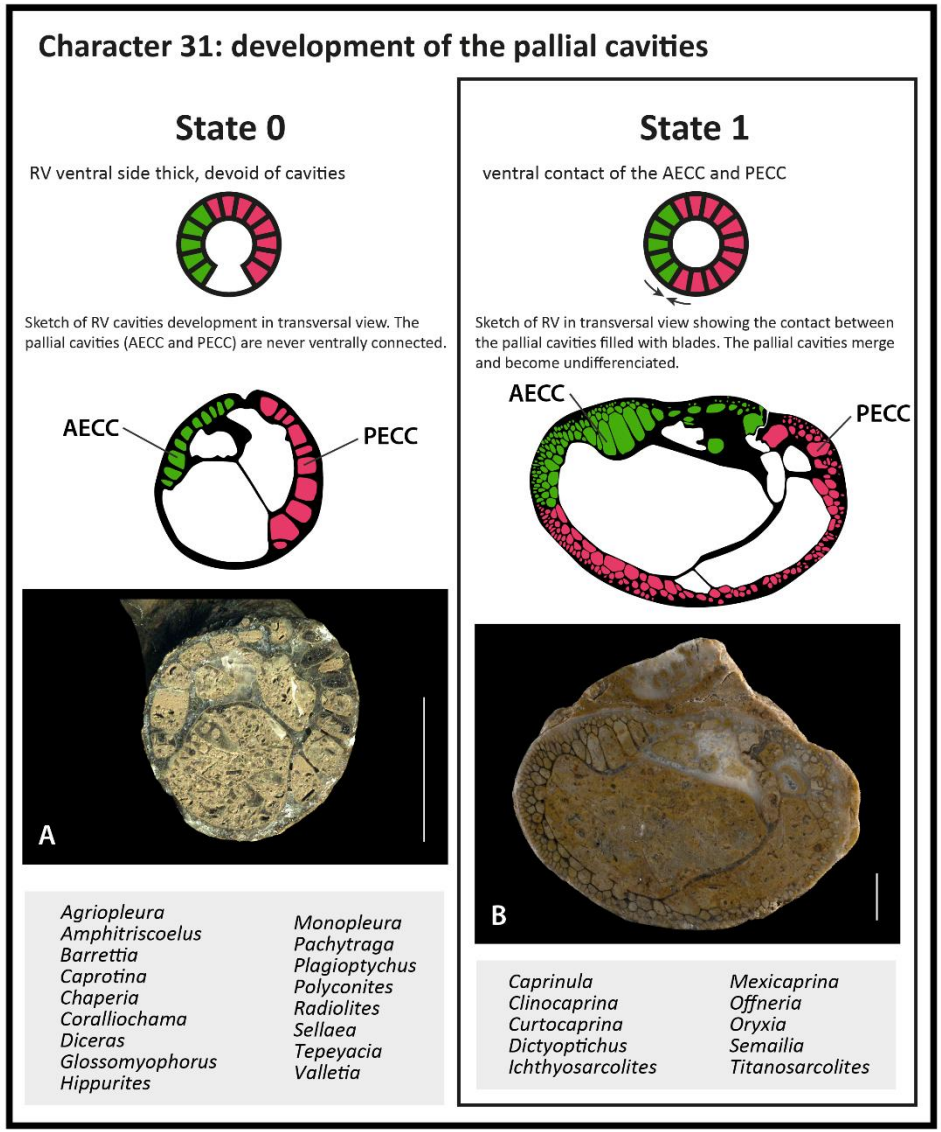
1 passed – clade 17

Retention index

100.0 %

Remarks

Related to character 9 of Chartrousse (1998a). Related partially to character 19 of Mitchell (2013; with #12).



Hierarchical character #31. A – *Amphitriscoelus waringi*. B – *Caprinula boissyi* (MNHN.6924). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 32

Name: morphology of the pallial canals

Position: right valve

Kind: canals

Coding: (0(1(2(3))))

States definitions

0 root

1 numerous radial walls forming pallial canals

2 walls polyfurcated leading to several rows of pallial canals

3 differentiated walls leading to two morphologies of canals: a row of palisading canals along the external side of the shell wall, and capillary canals everywhere else

States tests

1 rejected – clade 13, 15, *Sellaea*

2 passed – clade 17

3 rejected – clade 18, 21, 23, *Mexicaprina*

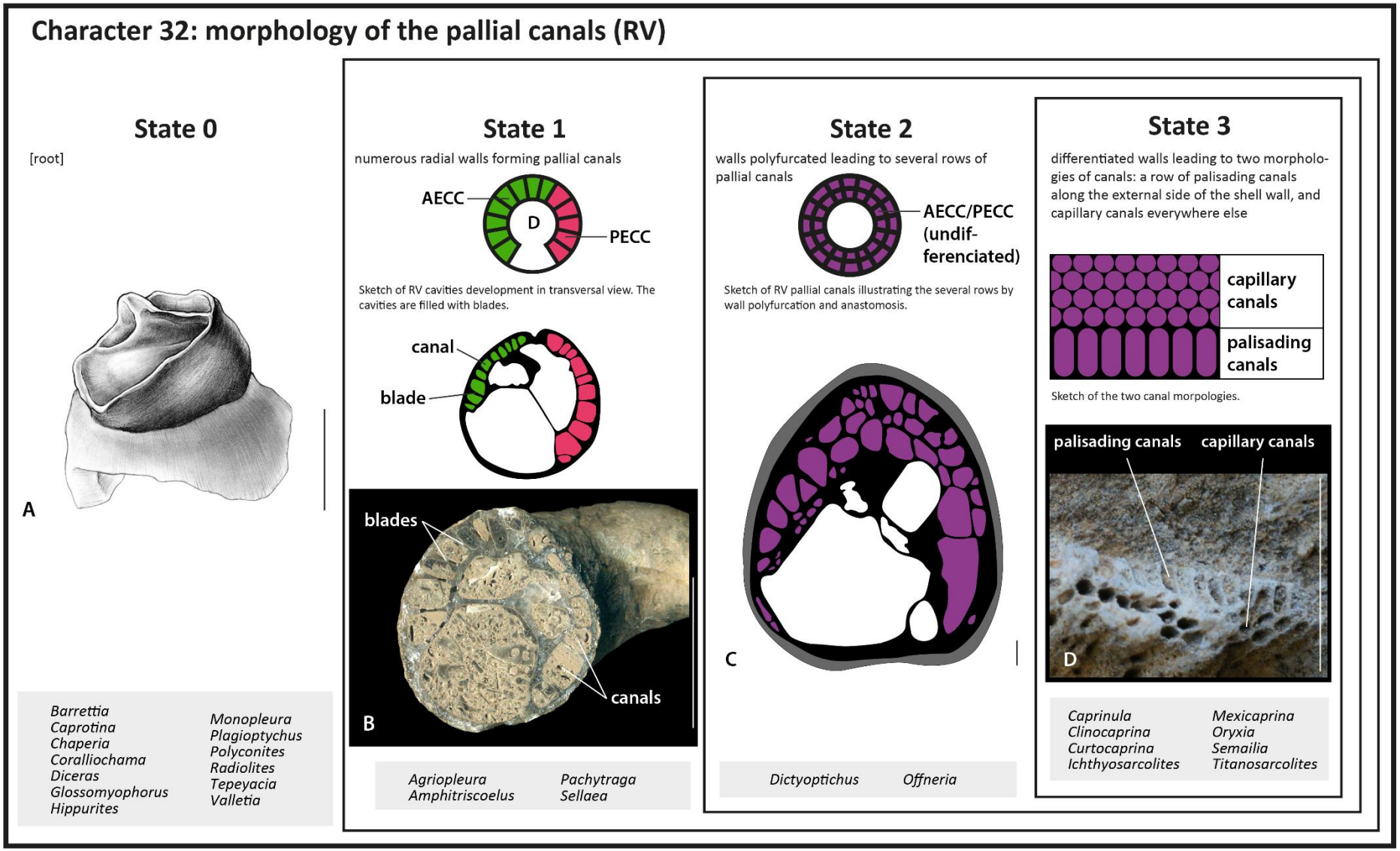
Retention index

92.71 %

Remarks

Related to character 11 of Chartrousse (1998a). Related partially to character 11 in Smith (1994; #31.1). Related to character 10 of Stone & Telford (1999; #31.1).

See remarks of character #12.



Hierarchical character #32. A – *Caprotina striata* (MV 2003.2.5147). B – *Amphitriscoelus waringi*. C – *Dictyoptychus morgani* (NHMUK PI.L-58427; original picture provided by Peter W. Skelton). D – *Ichthyosarcolites bicarinatus* (Upper Cenomanian, D559a road, south exit of La Bédoule, Var, France; picture provided by Marc Floquet). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 33

Name: capillary canals in the central tooth

Position: right valve

Kind: canals

Coding: (0(1))

States definitions

0 compact shell in the CT

1 capillary canals in the CT

States tests

1 rejected – clade 21, 25

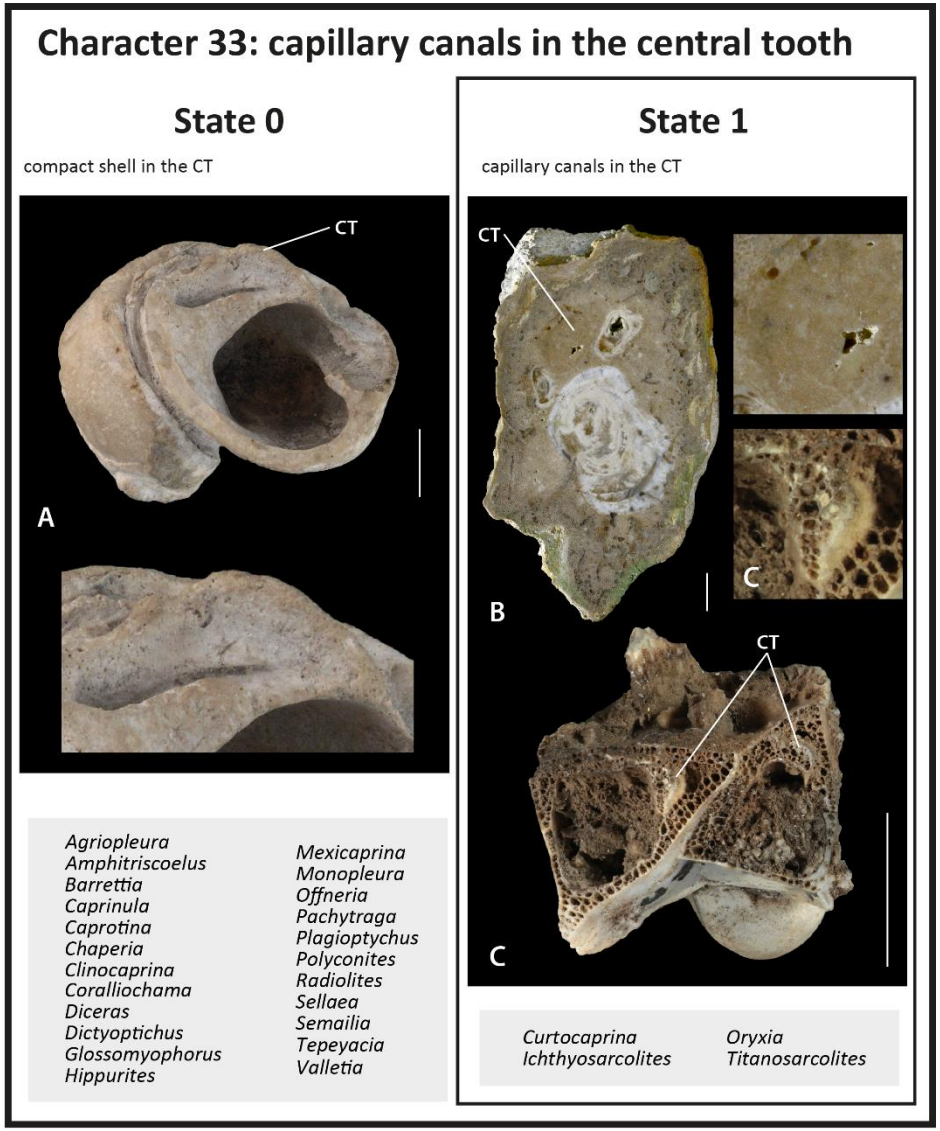
Retention index

61.59 %

Remarks

Related to character 21 of Mitchell (2013).

Because canals of the central tooth have always the same morphology as other pallial canals, they are hypothesized homologous.



Hierarchical character #33. A – *Diceras arietinum* (MNHN.F.A52439). B – *Titanosarcolites giganteus* (UT.47533). C – *Curtocaprina clabaughikinsorum* (UT.10922). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 34

Name: tabulae in the general cavity

Position: right valve

Kind: horizontal blades

Coding: (0(1))

States definitions

0 no shell floors developed in D perpendicularly to growth axis of the shell

1 tabulae in D

States tests

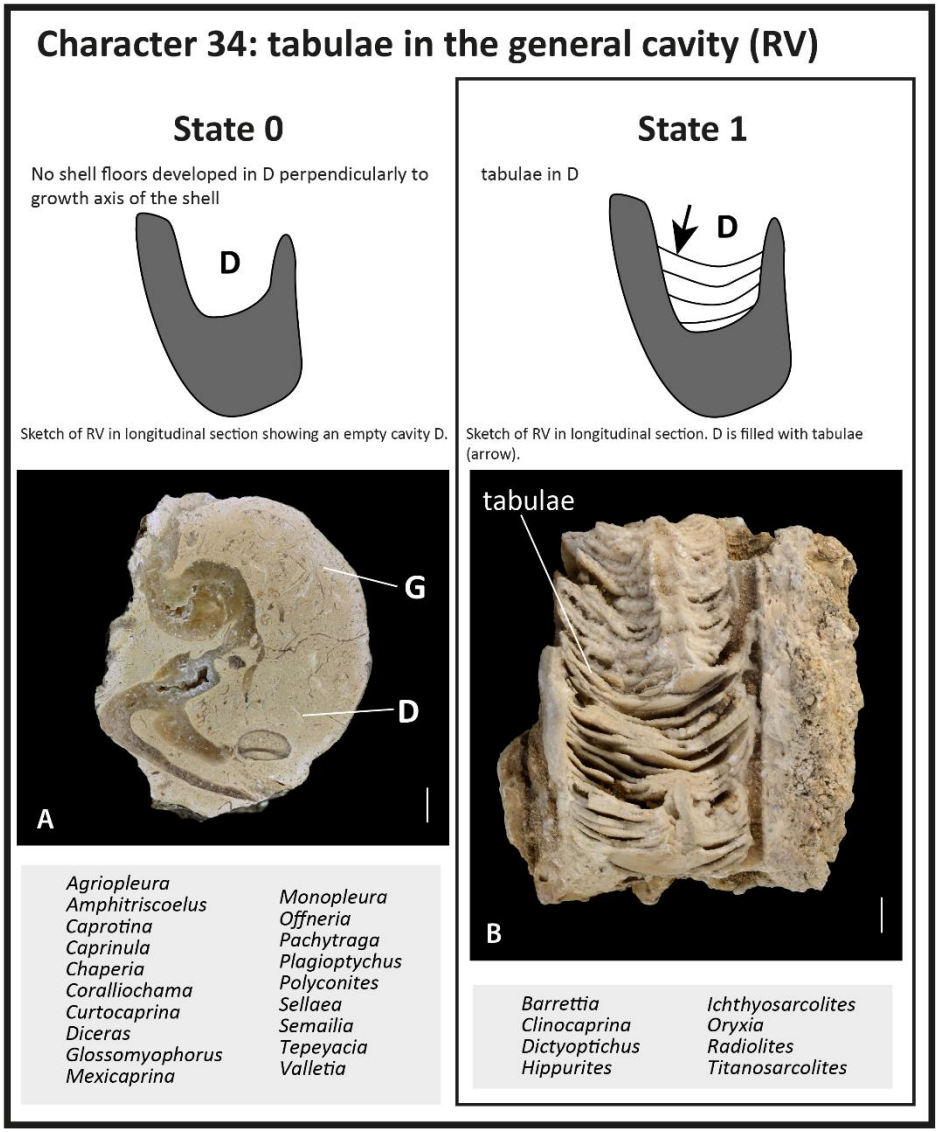
1 rejected – clades 12, 20

Retention index

74.62 %

Remarks

See character #17.



Hierarchical character #34. A – *Sellaea* sp. (UT.48167). B – *Hippurites* sp. (SU.PAL.2018.0.113). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 35

Name: tabulae in pallial canals

Position: right valve

Kind: horizontal blades

Coding: (0(1))

States definitions

0 root

1 tabulae in pallial canals

States tests

1 rejected – clades 18, 22

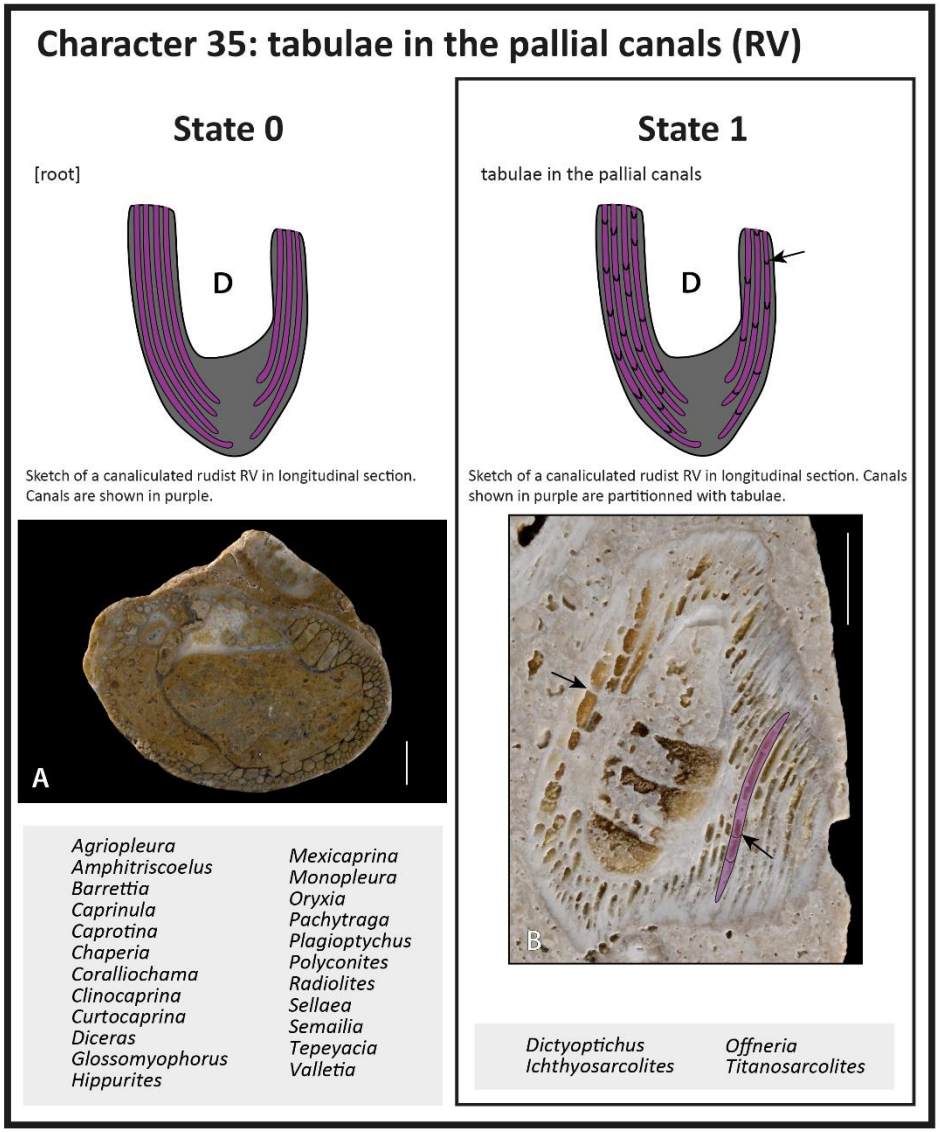
Retention index

88.64 %

Remarks

Related to character 8 of Chartrousse (1998a; with #18). Related partially to character 21 of Mitchell (2013; with #18).

See remarks on character #18.



Hierarchical character #35. A – *Caprinula boissyi* (MNHN.6924). B – *Caprinuloidea* sp. (JPMA). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 36

Name: pillars

Position: both valves

Kind: pillars

Coding: (0(1))

States definitions

0 flat siphonal bands

1 infolding of the siphonal bands to form internal pillars

States tests

1 rejected – clades 7, 14

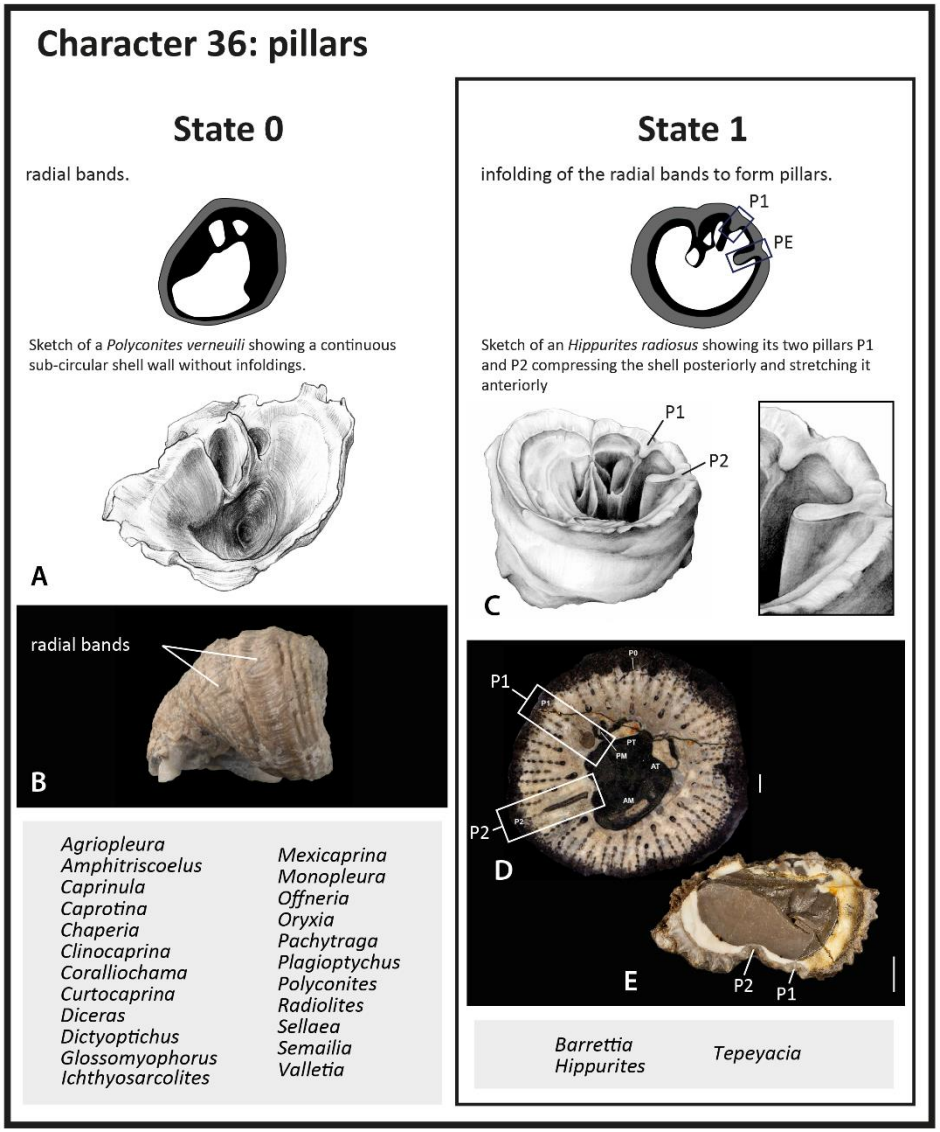
Retention index

50.72 %

Remarks

Related to character 8 of Skelton & Smith (2000).

Pillars P1 and P2 are postulated homologous to radial bands because they are both paired and situated in the same posterior side of the shell. Pillars P1 and P2 are understood as strong infoldings of the radial bands. The ligamentary ridge, which is not homologous to the pillars, may adopt a similar morphology in some Hippuritid species, as in *Barrettia*. Multiple pillars can also develop from infoldings linked to costae. The character state coded here considers only the two pillars P1 and P2 derived from the radial bands. Other pillars may be present, for example in *Barrettia*. However, the multiplication of pillars is non-informative in our taxonomic sampling, because only *Barrettia* has it.



Hierarchical character #36. A – *Polyconites verneuili* (Ch02 in Pascual-Cebrian et al. 2013). B – *Glossomyophorus costatus* (MNHN.F.R06779). C – *Hippurites radiosus* (MNHN.F.A58757). D – *Barrettia monilifera* (UWIGM.RUD.2006.223). E – *Tepeyacia corrugata* (CAS.66657.01). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 37

Name: outer calcitic shell layer

Position: both valves

Kind: outer layer

Coding: (0(1))

States definitions

0 thin calcitic outer shell layer, thinner than a tenth of the shell thickness

1 thick calcitic outer shell layer

States tests

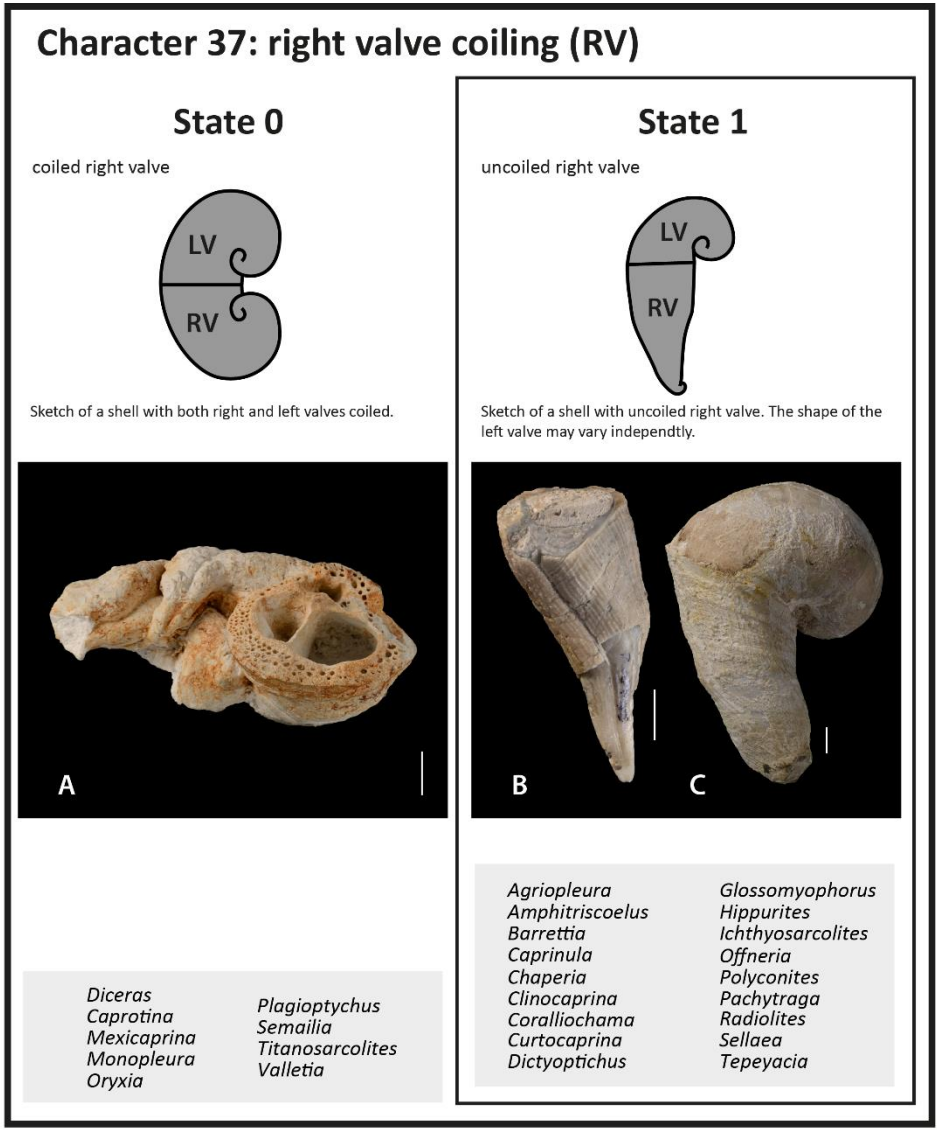
1 rejected – clades 5, 7, 9, 12, 18, 20, *Amphitriscoelus*, *Pachytraga*, *Sellaea*

Retention index

51.2 %

Remarks

Related to characters 5 of Chartrousse (1998a). Related to character 3c in Skelton & Masse (1998). Related partially to characters 2 and 9 in Steuber (1999). Related to character 1 in Sano *et al.*, (2014), but redefined to reduce size effect.



Hierarchical character #37. A – *Mexicaprina minuta* (JPMA.14097-1). B – *Glossomyophorus costatus* (MNHN.F.R06779). C – *Sellaea* sp. (WSA3058). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 38

Name: ligamentary structures

Position: both valves

Kind: ligament

Coding: (0(1(2(3))))

States definitions

0 external ligamentary groove parallel to the commissure

1 invagination of the ligament, forming a ligamentary cavity perpendicular to the commissure and connected to the exterior by a groove

2 ligamentary groove loss and complete internalization of the ligamentary cavity

3 complete loss of the groove and of the ligamentary cavity

States tests

1 passed – clade 2

2 passed – clade 20

3 rejected – clades 21, 25

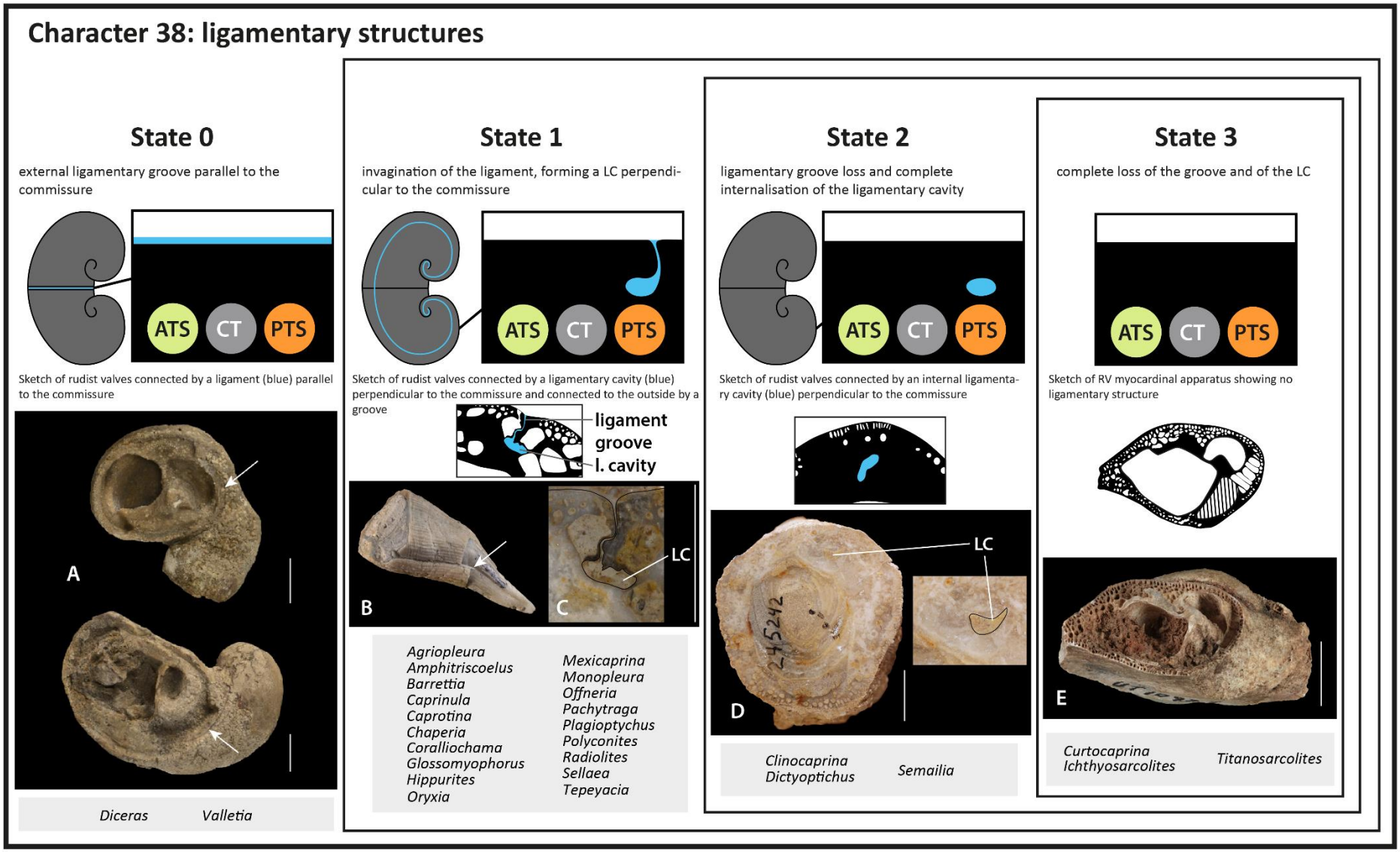
Retention index

97.3 %

Remarks

Related partially to character 5 of Smith (1994; #37.0, #37.1). Related partially to character 1 in Chartrousse (1998a; #37.0, #37.1). Related to character 2 of Skelton & Masse (1998; #37.0, #37.1). Related partially to character 5 of Steuber (1999; #37.0, #37.1). Related to characters 11 and 12 of Skelton & Smith (2000). Related partially to character 6 of Mitchell (2013;

#37.1, #37.2). See Yonge (1967) for a complete discussion on ligament rotation. *Titanosarcolites giganteus* has a remnant ligamentary cavity in one valve (pers. com. anonymous reviewer). Thus *T. giganteus* is polymorphic for this character state.



Hierarchical character #38. A – *Valletia germani* (MNHN.F.J05798). B – *Glossomyophorus costatus* (MNHN.F.A27280). C – *Caprinula boissyi* (MNHN.6924). D – *Clinocaprina lowentsami* (USNM.245241). E – *Curtocaprina clabaughikinsorum* (UT.10937). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 39

Name: ligament position

Position: both valves

Kind: ligament

Coding: (0(1))

States definitions

0 ligament cavity dorsal to the PTS/PT

1 ligament cavity dorsal to the CTS/CT

States tests

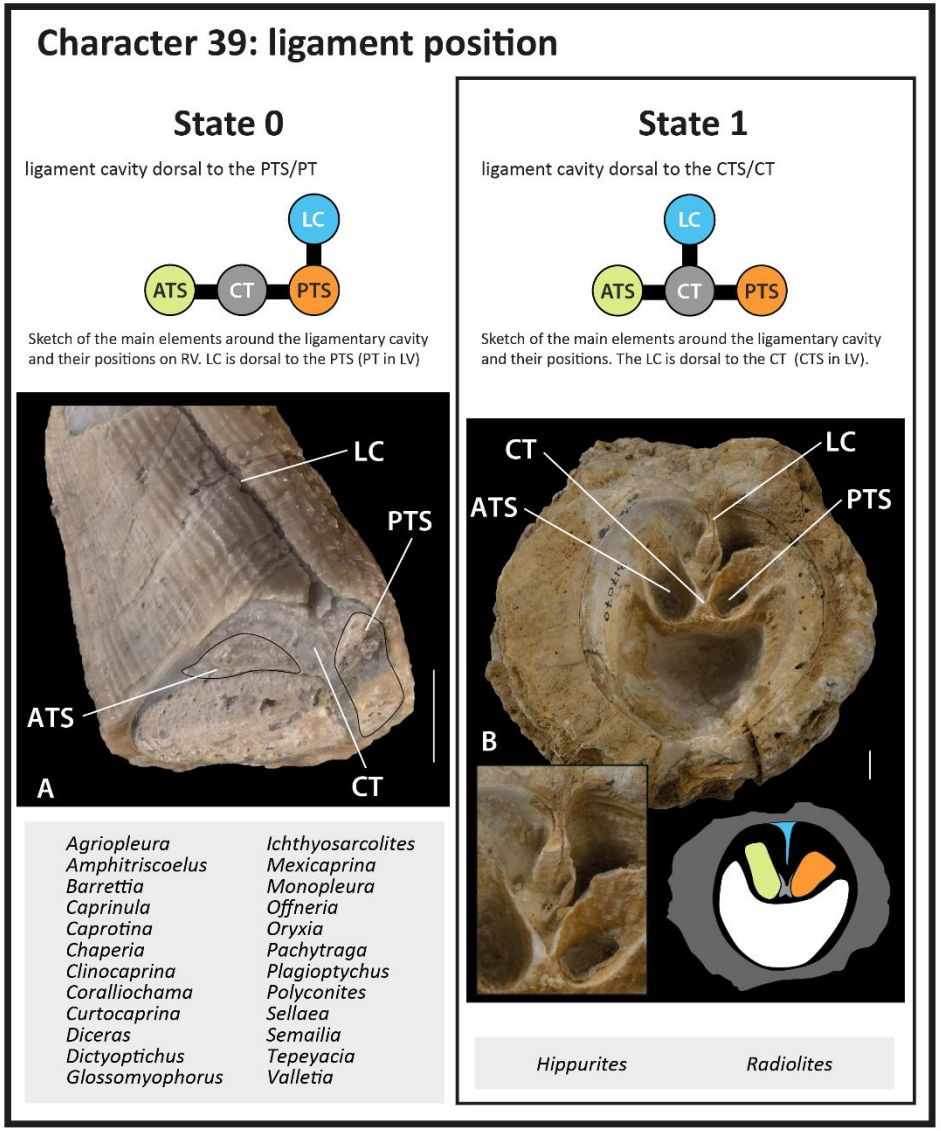
1 passed – clade 12

Retention index

91.67 %

Remarks

See #9.



Hierarchical character #39. A – *Glossomyophorus costatus* (MNHN.F.A27280). B – *Radiolites radiosus* (MNHN.F.J09021). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 40

Name: shell costulations

Position: both valves

Kind: ornament

Coding: (0(1))

States definitions

0 smooth shell

1 more or less developed ribs on the outer layer of the shell

States tests

1 rejected – 4, 7, 9, 12, 18, 22, *Amphitriscoelus*, *Mexicaprina*, *Monopleura*, *Pachytraga*, *Sellaea*

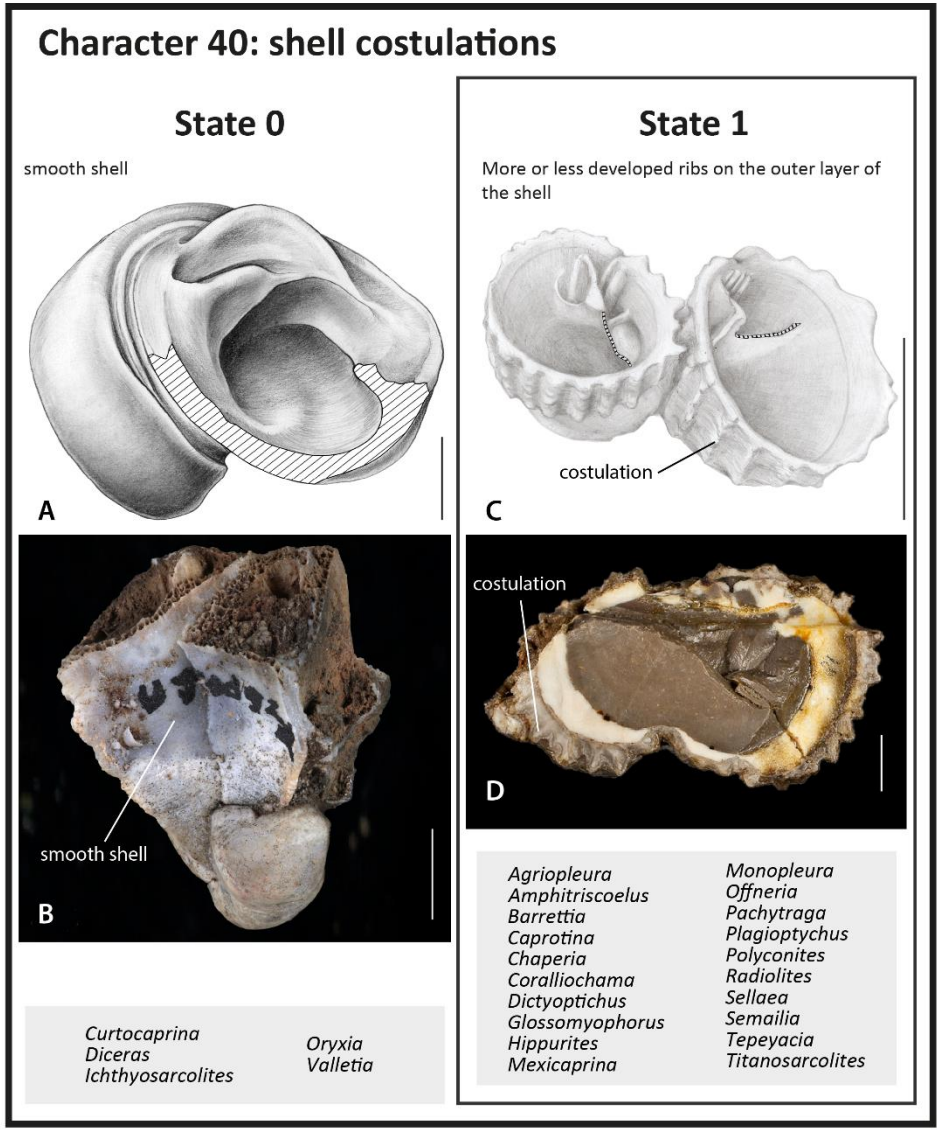
Retention index

44.11 %

Remarks

Related to character 3 in Skelton & Smith (2000).

Ribs are defined as ornamental costae of the outer calcitic shell layer that do not impact the course of the inner aragonitic shell layer.



Hierarchical character #40. A – *Diceras arietinum* (MNHN.F.A52439). B – *Curtocaprina clabaughikinsorum* (UT.10922). C – *Chaperia costata* (MNHN.F.R07942). D – *Tepeyacia corrugata* (CAS.66657.01). Scale bars, 10 mm.

HIERARCHICAL CHARACTER 41

Name: flanges

Position: both valves

Kind: ornament

Coding: (0(1))

States definitions

0 shell cross-section circular to sub-circular in shape

1 presence of elongated narrow flanges

States tests

1 rejected – clades 21, 24

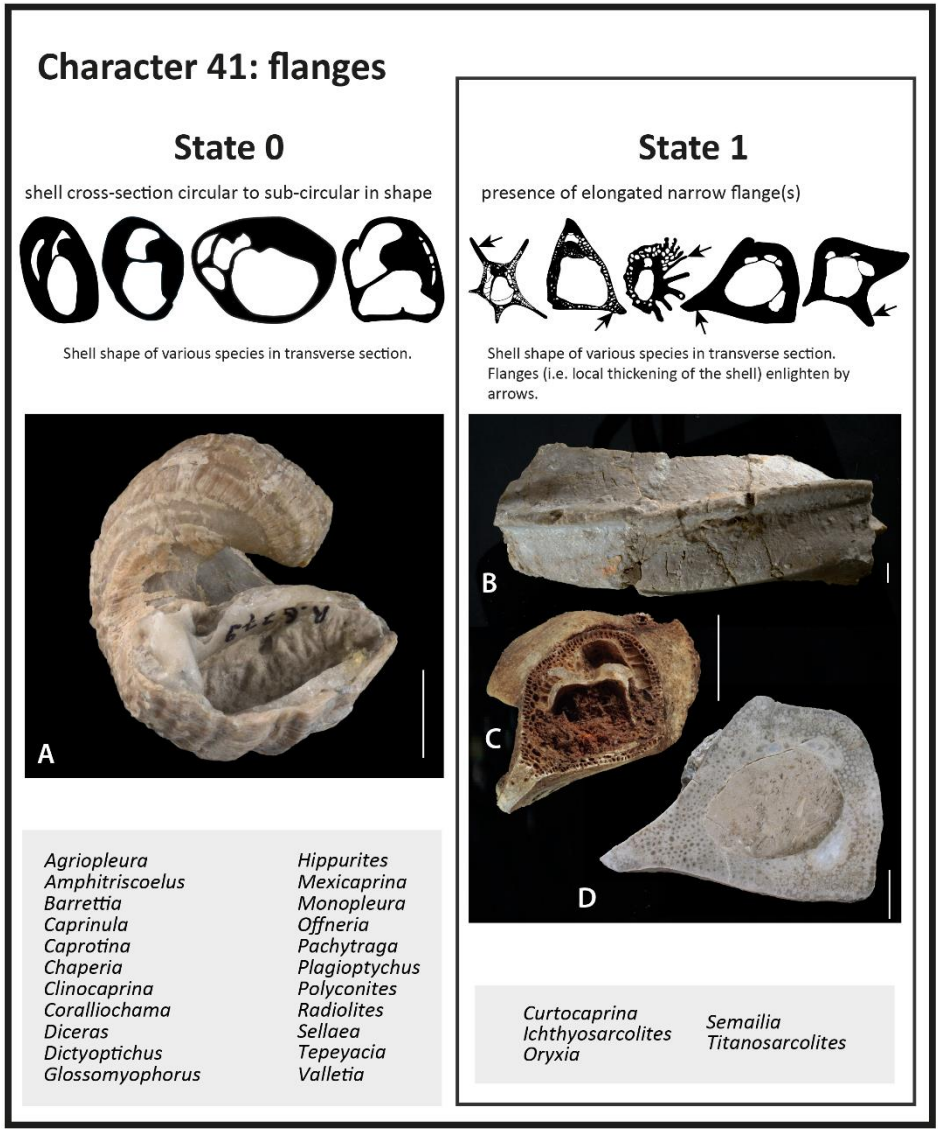
Retention index

94.55 %

Remarks

Related to character 4 of Mitchell (2013).

Contrary to costae, flanges involve the inner aragonitic shell layer. Flanges can involve the aragonitic inner layer and the calcitic outer layer, depending of their thickness. We code the wide variety of flange morphologies and number as a single derived state. Antillocaprinids especially can reach an important number of flanges. When the outer layer is thin, flanges can involve the aragonitic and the calcitic outer layer.



Hierarchical character #41. A – *Glossomyophorus costatus* (MNHN.F.R06779). B – *Ichthyosarcolites bicarinatus* (MGUP.021.2-110; picture provided by Carolina d'Arpa and Tony Costaglia). C – *Curtocaprina clabaughikinsorum* (UT.10937). D – *Oryxia sulcata* (BJ.1901-HR2). Scale bars, 10 mm.

Appendix 3: Character matrix

Matrix of the 41 3ta characters with their hierarchical coding and their assignation to taxa.

Character number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Character hierarchy	(0(1(2(3))))	(0(1))	(0(1))	(0(1(2(3(4)(5(6)))))))	(0(1))	(0(1)(2)(3(4(5)))))	(0(1))	(0(1(2)))	(0(1))	(0(1))	(0(1))	(0(1))	(0(1(2((3)(4)))))	(0(1(2)))	(0(1))	(0(1))	(0(1))	(0(1))	(0(1))	(0(1))	(0(1))	(0(1))	(0(1))	(0(1))	(0(1))	(0(1)(2(3(4(5))(6(7)))))))	(0(1(2(3))))	(0(1))	(0(1))	(0(1(2)))	(0(1))	(0(1(2(3))))	(0(1))	(0(1))	(0(1))	(0(1))	(0(1))	(0(1))	(0(1(2(3))))	(0(1))	(0(1))	(0(1))
Agriopleura marticensis	2	1	1	5	0	4	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	1	0	1	0	0	0	0	1	1	0	1	0
Amphitriscoelus waringi	1	1	0	5	0	?	0	2	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	?	6	?	1	1	1	0	1	0	0	0	0	1	1	0	1	0
Barrettia monilifera	2	1	0	6	1	5	0	2	?	1	0	0	0	0	0	0	0	0	?	1	1	1	1	1	1	6	0	0	0	1	0	0	0	1	0	1	1	1	0	1	0
Caprinula boissyi	2	1	0	2	0	?	0	2	0	0	1	1	3	2	1	0	0	0	1	0	0	0	1	1	1	5	?	1	1	2	1	3	0	0	0	0	1	1	0	?	0
Caprotina striata	1	1	0	3	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	4	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0
Chaperia costata	1	1	0	3	0	4	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	4	0	0	0	1	0	0	0	0	0	0	1	1	0	1	0
Clinocaprina lowentsami	3	1	0	5	0	4	0	2	0	1	1	1	3	0	0	1	0	1	0	0	0	0	1	1	1	6	0	1	1	1	1	3	0	1	1	0	1	2	0	?	0
Coralliochama orcutti	2	1	0	2	0	2	0	2	0	0	1	0	4	0	0	1	0	0	0	0	0	0	1	1	1	2	1	0	0	1	0	0	1	0	0	0	1	1	0	1	0
Curtocaprina clabaughikinsorum	1	1	0	5	0	3	0	2	1	1	1	1	3	2	0	0	0	0	0	0	0	0	1	1	1	1	0	1	1	1	1	3	1	0	0	0	1	3	0	0	1
Diceras arietinum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dictyoptichus morgani	3	1	0	5	1	4	0	2	0	1	1	1	4	0	0	0	0	0	0	0	0	0	1	1	1	7	0	1	1	1	1	2	0	1	1	0	1	2	0	1	0
Glossomyophorus costatus	1	1	0	3	0	1	0	?	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	?	4	1	0	0	1	0	0	0	0	0	0	1	1	0	1	0
Hippurites radiosus	2	1	0	6	1	5	0	2	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	6	0	0	0	1	0	0	0	1	0	1	1	1	1	1	0
Ichthyosarcolites bicarinatus	2	1	0	5	0	4	0	2	0	1	1	1	3	2	0	0	1	1	?	0	0	0	1	1	1	7	0	1	1	1	1	3	0	1	1	0	1	3	0	0	1
Mexicaprina minuta	1	1	0	5	0	4	0	2	0	0	1	1	3	1	0	0	0	0	0	0	0	0	1	1	1	6	2	1	1	1	1	3	0	0	0	0	0	1	0	1	0
Monopleura michaillensis	1	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	1	0	0	1	0	0	0	0	0	0	0	1	0	1	0
Offneria rhodanica	1	1	0	2	1	3	0	2	0	0	1	1	4	0	0	0	0	1	1	0	0	0	1	0	1	5	1	1	1	1	1	2	0	0	1	0	1	1	0	1	0
Oryxia sulcata	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	1	3	1	1	1	1	3	1	1	0	0	0	1	0	0	1

| | | |

Appendix 4: 3ia file and corresponding nexus file

```
File generated by matx;
;
;
Taxa
 AA = Diceras
 AB = Valletia
 AC = Monopleura
 AD = Glossomyophorus
 AE = Radiolites
 AF = Agriopleura
 AG = Hippurites
 AH = Barrettia
 AI = Mexicaprina
 AJ = Amphitriscoelus
 AK = Pachytraga
 AL = Offneria
 AM = Dictyoptichus
 AN = Semailia
 AO = Titanosarcolites
 AP = Clinocaprina
 AQ = Ichthyosarcolites
 AR = Curtocaprina
 AS = Plagioptychus
 AT = Coralliochama
 AU = Polyconites
 AV = Tepeyacia
 AW = Caprotina
 AX = Chaperia
 AY = Caprinula
 AZ = Sellaea
 BA = Oryxia
;
Characters
[1 ] (AA (AB AC AD AI AJ AK AL AR AV AW AX (AE AF AG AH AO AQ AS AT AU AY AZ (AM AN AP))))
[2 ] (AA (AB AC AD AE AF AG AH AI AJ AK AL AM AN AO AP AQ AR AS AT AU AV AW AX AY AZ))
[3 ] (AA AB AC AD AG AH AI AJ AK AL AM AN AO AP AQ AR AS AT AU AV AW AX AY AZ (AE AF))
[4 ] (AA (AB AC (AL AS AT AY (AD AK AW AX AZ (AU AV) (AE AF AI AJ AM AO AP AQ AR (AG AH AN))))))
[5 ] (AA AB AC AD AF AI AJ AK AP AQ AR AS AT AW AX AY AZ (AE AG AH AL AM AN AO AU AV))
[6 ] (AA (AB AC AD AU AW (AS AT) (AK AL AR AZ (AE AF AI AM AN AO AP AQ AV AX (AG AH)))))
[7 ] (AA AB AC AD AF AG AH AI AJ AK AL AM AP AQ AR AS AT AU AV AW AX AY AZ (AE AO))
[8 ] (AA (AB AC AW AX AZ (AE AF AG AH AI AJ AK AL AM AN AO AP AQ AR AS AT AU AV AY)))
[9 ] (AA AB AC AD AF AI AJ AK AL AM AO AP AQ AS AT AU AV AW AX AY AZ (AE AG AN AR))
[10] (AA AB AC AI AJ AK AL AS AT AU AV AW AX AY AZ (AD AE AF AG AH AM AN AO AP AQ AR))
[11] (AA AB AC AE AF AG AH (AD AI AJ AK AL AM AN AO AP AQ AR AS AT AU AV AW AX AY AZ))
[12] (AA AB AC AD AE AF AG AH AJ AK AS AT AU AV AW AX AZ (AI AL AM AN AO AP AQ AR AY))
[13] (AA AB AC AD AE AF AG AH AU AV AW AX AZ (AJ AK ((AI AN AO AP AQ AR AY) (AL AM AS AT))))
[14] (AA AB AC AD AE AF AG AH AJ AK AL AM AO AP AS AT AU AV AW AX AZ (AI (AN AQ AR AY)))
[15] (AA AB AC AD AE AF AG AH AI AK AL AM AN AO AP AQ AR AS AT AU AV AW AX AZ (AJ AY))
[16] (AA AB AC AD AE AF AG AH AI AJ AK AL AM AQ AR AS AU AV AW AX AY AZ (AN AO AP AT))
[17] (AA AB AC AD AE AF AG AH AI AJ AK AL AM AN AP AR AS AT AU AV AW AX AY AZ (AO AQ))
[18] (AA AB AC AD AE AF AG AH AI AJ AK AM AN AR AS AT AU AV AW AX AY AZ (AL AO AP AQ))
[19] (AA AB AC AD AE AF AG AI AJ AK AM AN AO AP AR AS AT AU AV AW AX AZ (AL AY))
[20] (AA AB AC AD AE AF AI AJ AK AL AM AN AO AP AQ AR AS AT AU AV AW AX AY AZ (AG AH))
[21] (AA AB AC AD AE AF AI AJ AK AL AM AN AO AP AQ AR AS AT AU AV AW AX AY AZ (AG AH))
[22] (AA AB AC AD AI AJ AK AL AM AN AO AP AQ AR AS AT AU AW AX AY AZ (AE AF AG AH))
[23] (AA (AB AC AD AE AF AG AH AI AJ AK AL AM AN AO AP AQ AR AS AT AU AV AW AX AY AZ BA))
[24] (AA AB AC AD AJ AL AS AU AW AX (AE AF AG AH AI AK AM AN AO AP AQ AR AT AV AY))
[25] (AA AB AC AK AU (AE AF AG AH AI AL AM AN AO AP AQ AR AS AT AV AW AX AY))
[26] (AA (AE AF AR BA) (AB AC AS AT AU AV ((AD AW AX AZ (AK AL AY)) (AG AH AI AJ AP (AM AN AO AQ)))))
[27] (AA AE AF AG AH AK AM AP AQ AR AV AW AX (AB AC AD AL AS AT AU AZ (AI (AO BA))))
[28] (AA AB AC AD AE AF AG AH AS AT AU AV AW AX (AI AJ AK AL AM AN AO AP AQ AR AY AZ BA))
[29] (AA AB AC AD AE AF AG AH AK AS AT AU AV AW AX AZ (AI AJ AL AM AN AO AP AQ AR AY BA))
[30] (AA (AB AC AD AE AF AG AH AI AJ AK AL AM AN AO AP AQ AR AT AU AW AX AZ BA (AS AV AY)))
[31] (AA AB AC AD AE AF AG AH AJ AK AS AT AU AV AW AX AZ (AI AL AM AN AO AP AQ AR AY BA))
[32] (AA AB AC AD AE AG AH AS AT AU AV AW AX (AF AJ AK AZ (AL AM (AI AN AO AP AQ AR AY BA))))
[33] (AA AB AC AD AE AF AG AH AI AJ AK AL AM AN AP AQ AS AU AV AW AX AY AZ (AO AR AT BA))
[34] (AA AB AC AD AF AI AJ AK AL AN AR AS AT AU AV AW AX AY AZ (AE AG AH AM AO AP AQ BA))
[35] (AA AB AC AD AE AF AG AH AI AJ AK AN AR AS AT AU AV AW AX AY AZ BA (AL AM AO AP AQ))
[36] (AA AB AC AD AE AF AI AJ AK AL AM AN AP AQ AR AS AT AU AW AX AY AZ BA (AG AH AV))
[37] (AA AB AC AI AN AO AS AW BA (AD AE AF AG AH AJ AK AL AM AP AQ AR AT AU AV AX AY AZ))
[38] (AA AB (AC AD AE AF AG AH AI AJ AK AL AS AT AU AV AW AX AY AZ BA (AM AN AP (AO AQ AR))))
[39] (AA AB AC AD AF AH AI AJ AK AL AM AN AP AQ AR AS AT AU AV AW AX AY AZ BA (AE AG))
[40] (AA AB AQ AR BA (AC AD AE AF AG AH AI AJ AK AL AM AN AO AS AT AU AV AW AX AZ))
[41] (AA AB AC AD AE AF AG AH AI AJ AK AL AM AP AS AT AU AV AW AX AY AZ (AN AO AQ AR BA))
;
```

Instructions for using the 3ia file:

1. Copy and paste the text below into a text file, then save with the '.3ia' extension.

2. Download and install the Lisbeth software at:

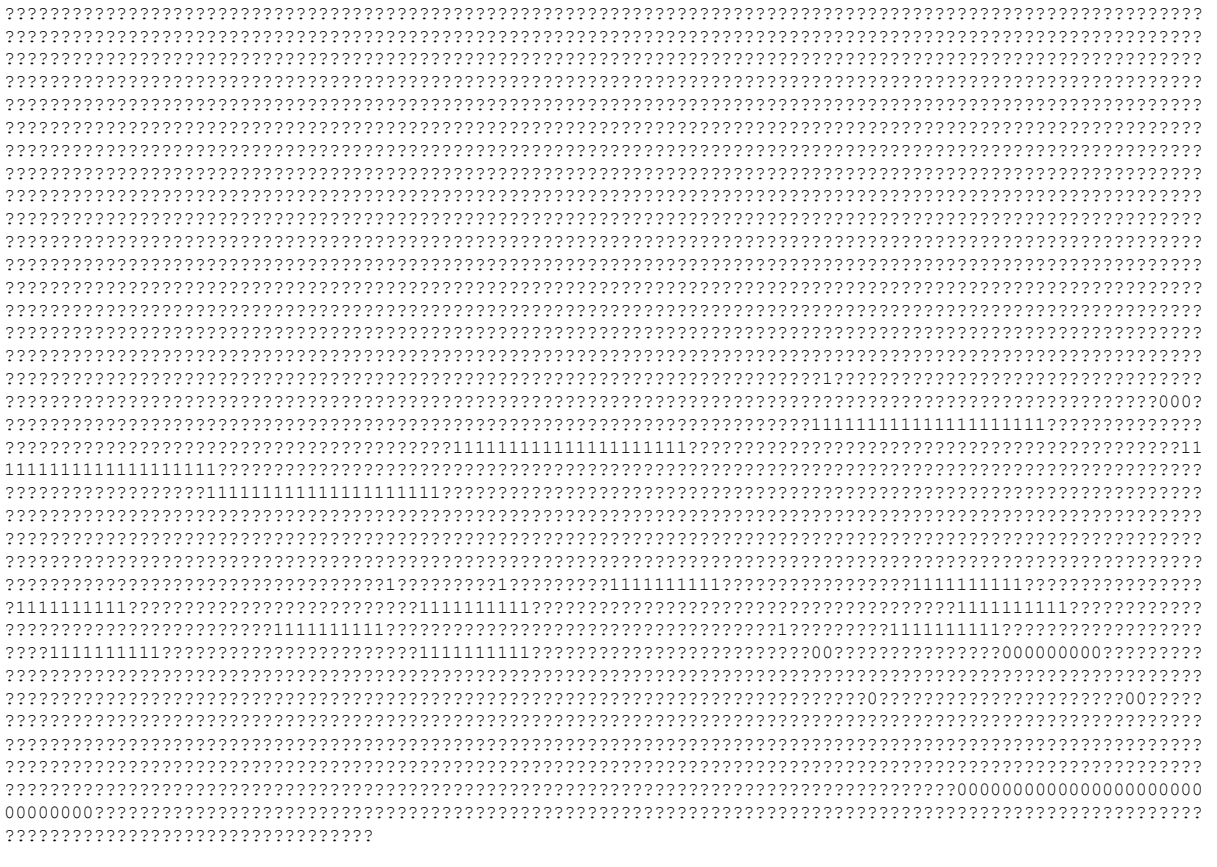
https://www.infosyslab.fr/?q=en/resources/software/lisbeth=en/resources/software/lisbeth

after installing Python 3.3.

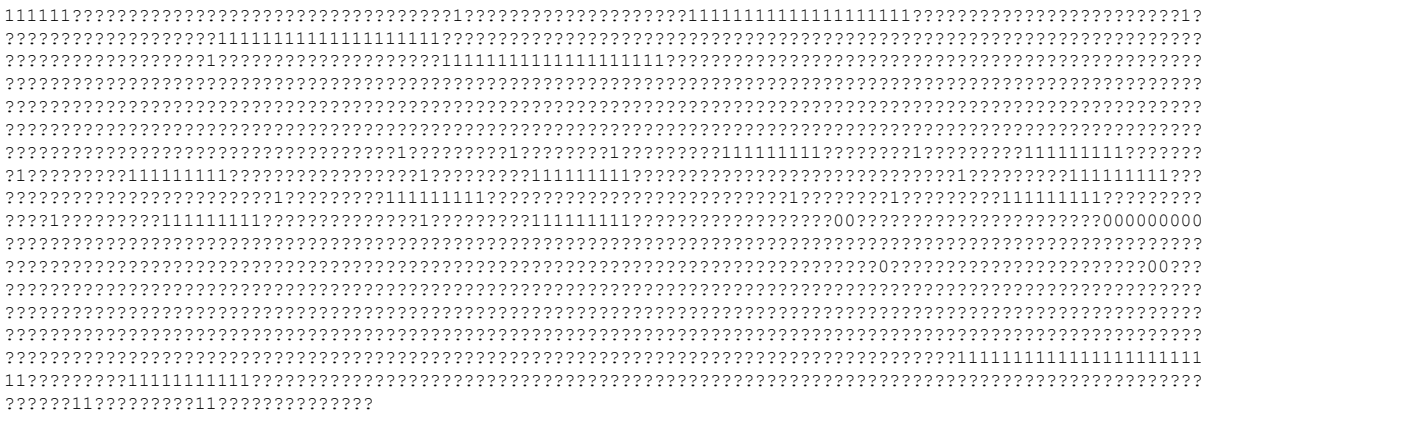
3. Follow the procedure to switch from the .3ia file to the.3iz file and then convert to .nex readable by PAUP or TNT. The procedure is available in: https://lis-upmc.snv.jussieu.fr/lis/ressources/lisbeth/doc/en/LisBeth%20functionalities.pdf%20functionalities.pdf (Part 3: heuristic search).

```
#nexus

begin data;

Dimensions ntax=28 nchar=6346;

Format symbols="0 1" missing=?;


Matrix


Profil
00000000000
```

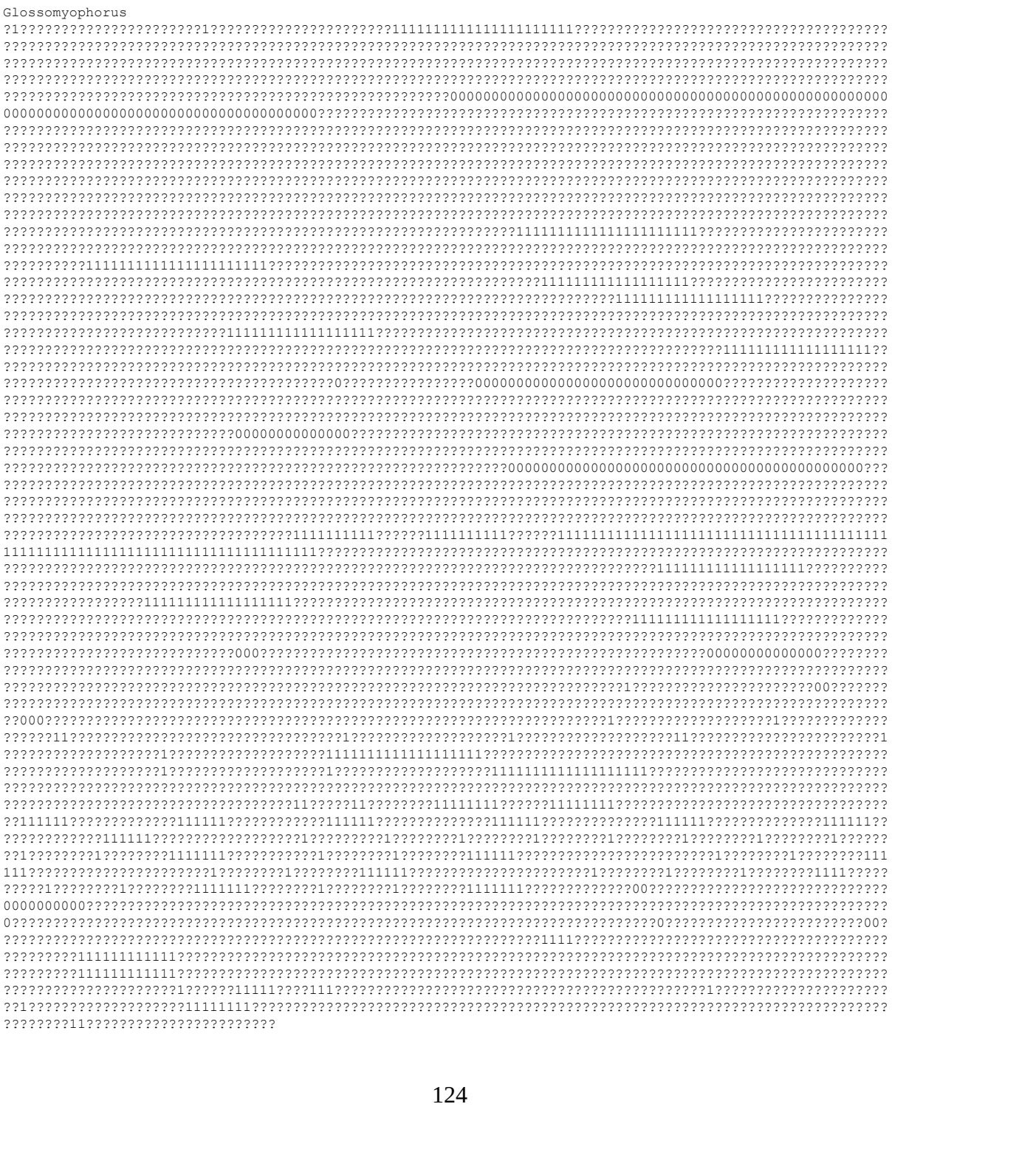
Valletia



Monopleura

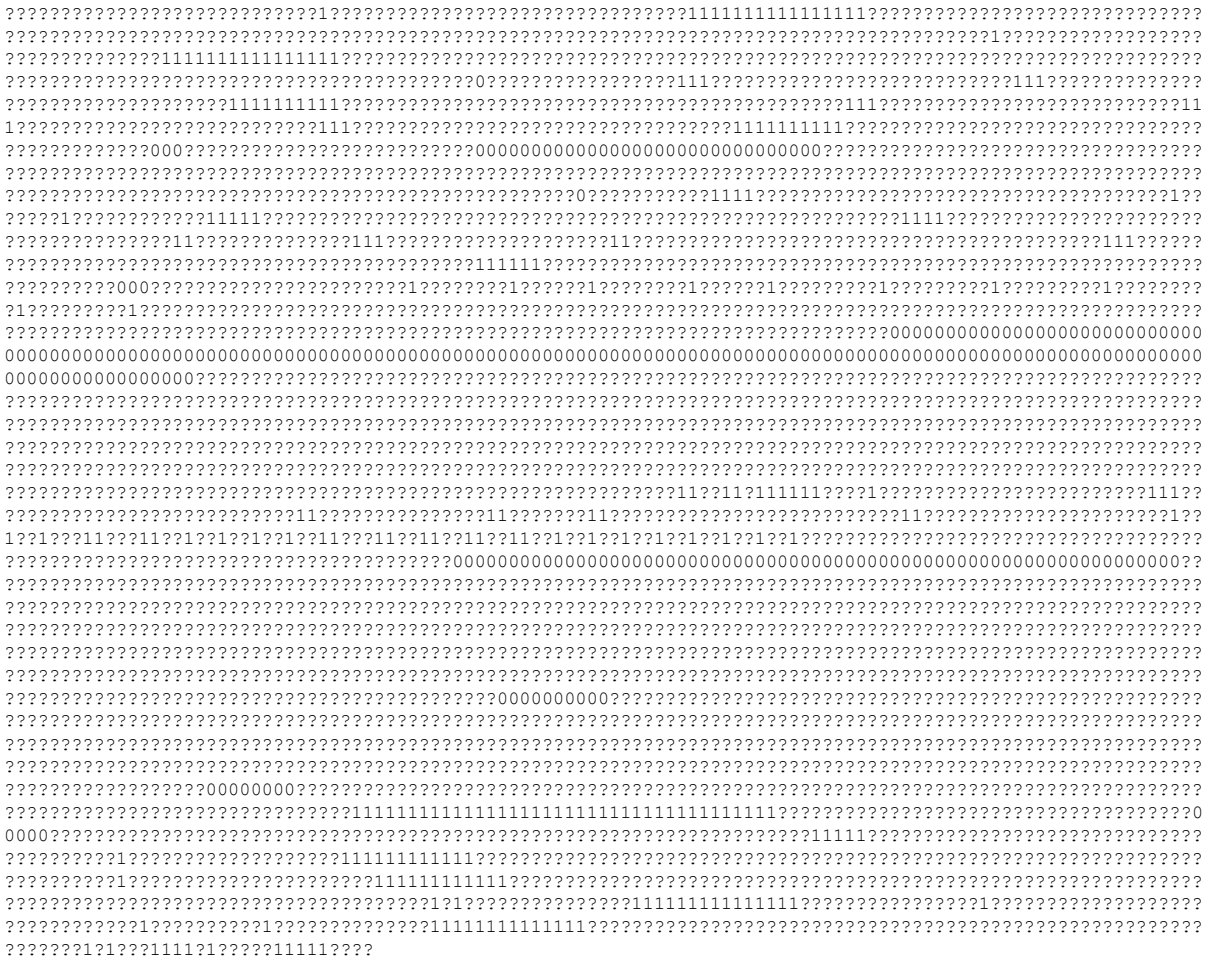


Glossomyophorus

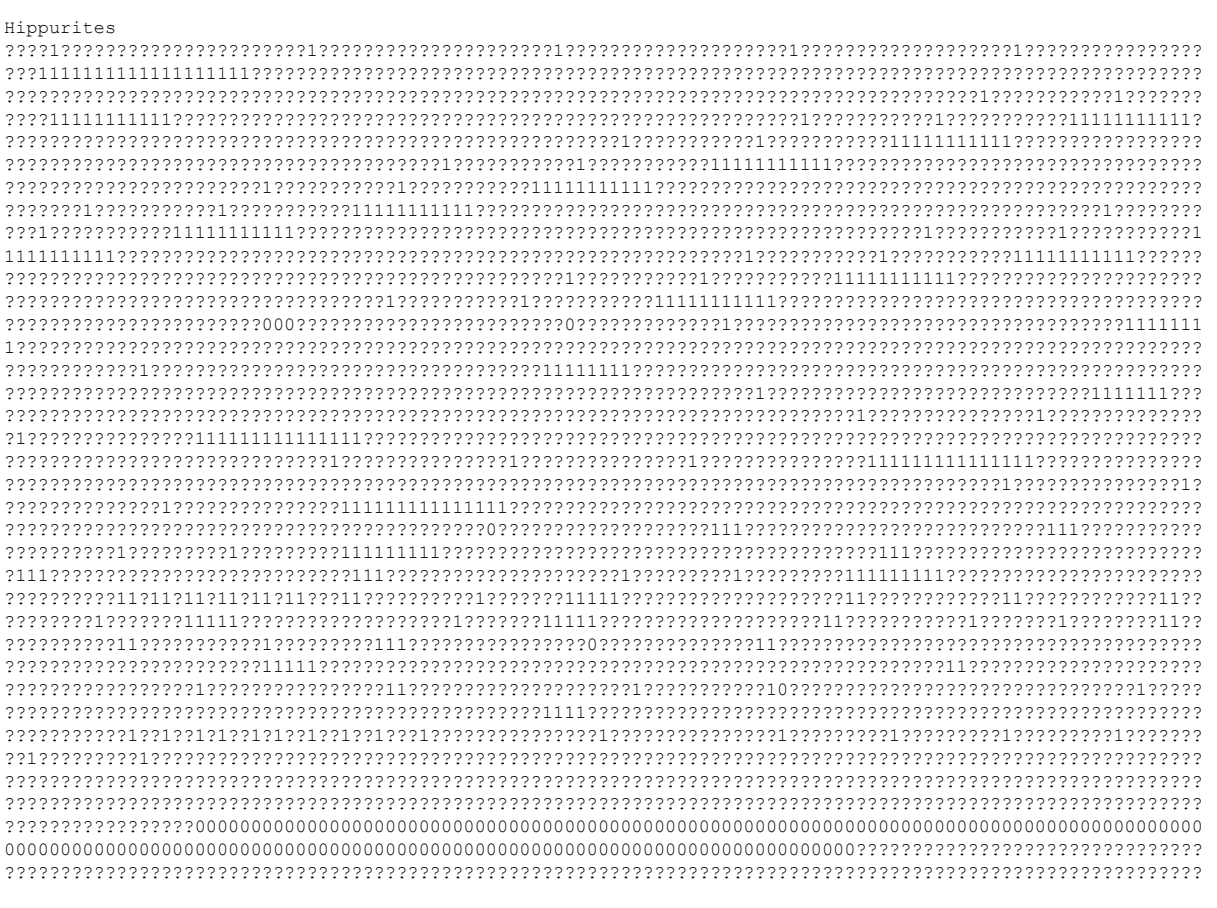


Radiolites

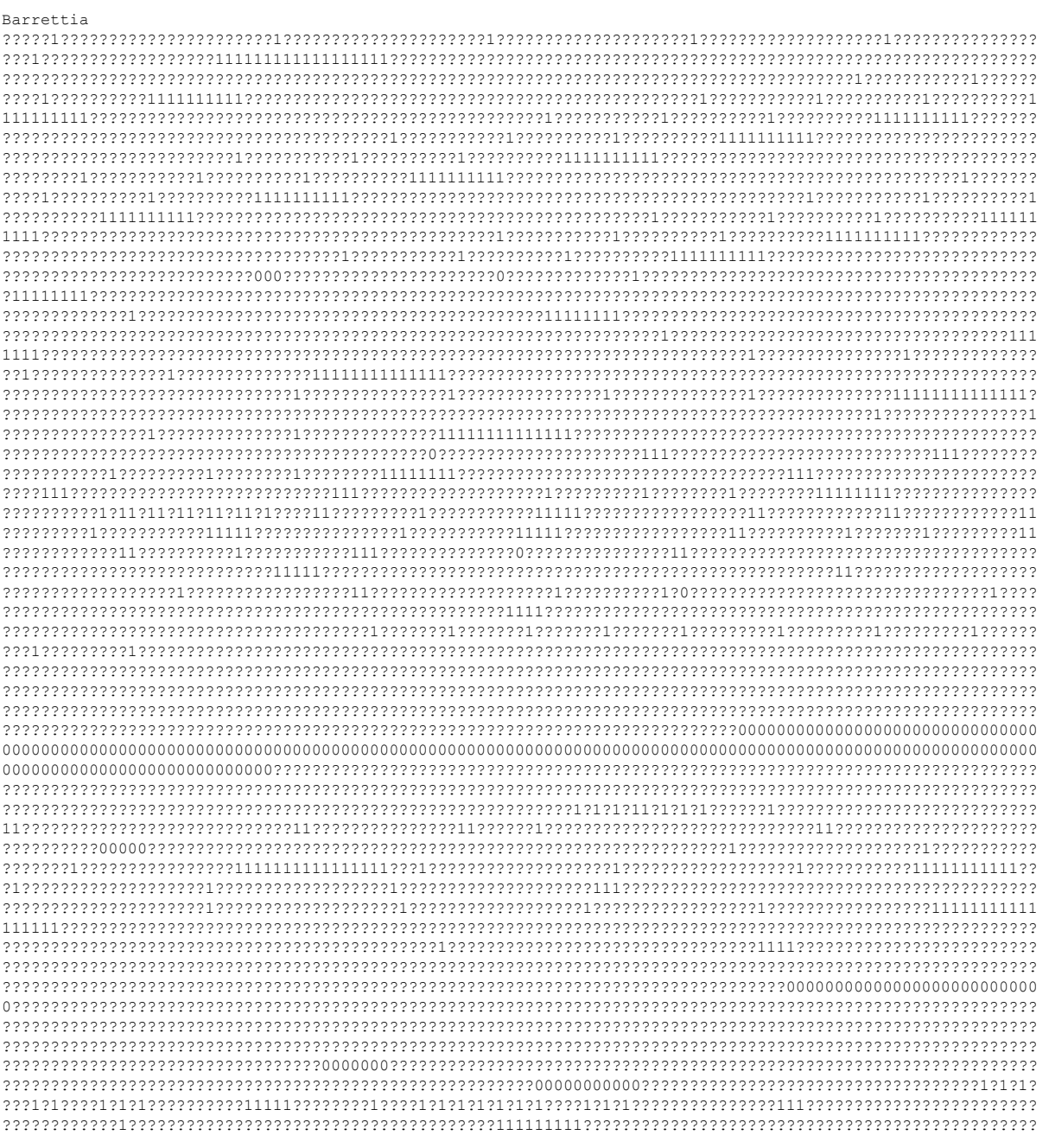
Agriopleura



Hippurites



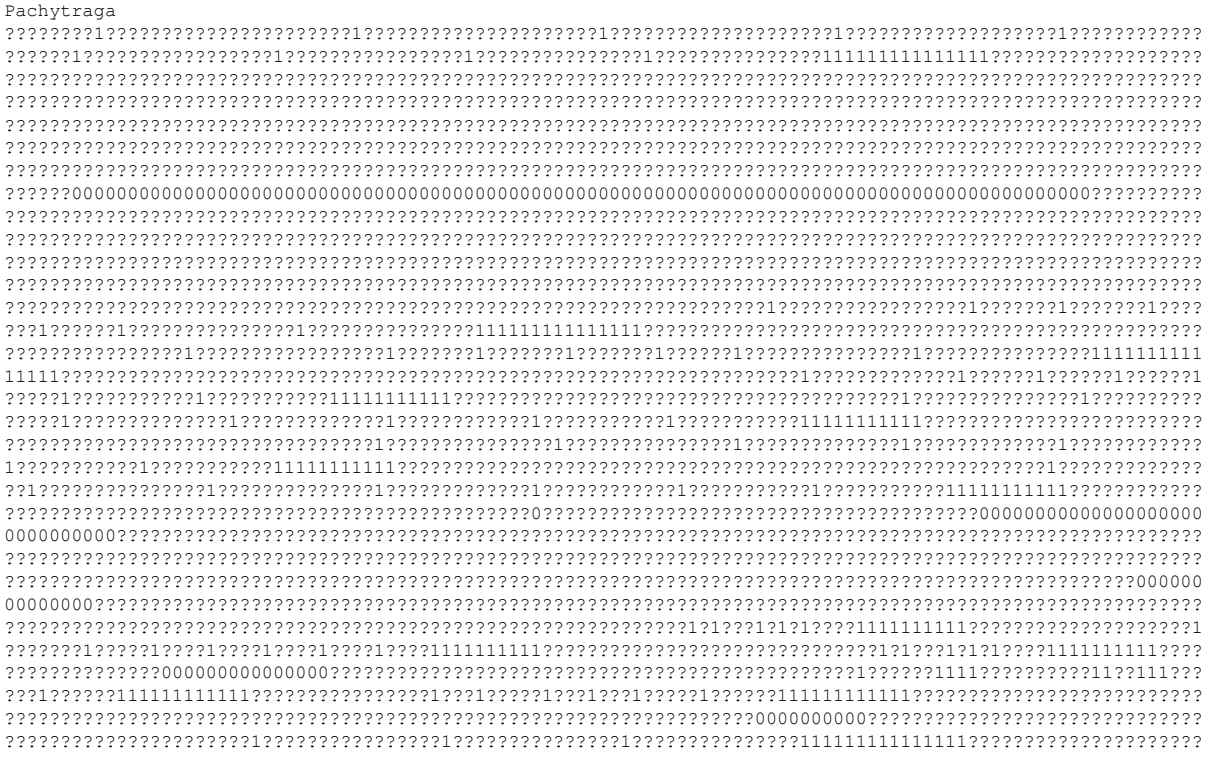
Barrettia



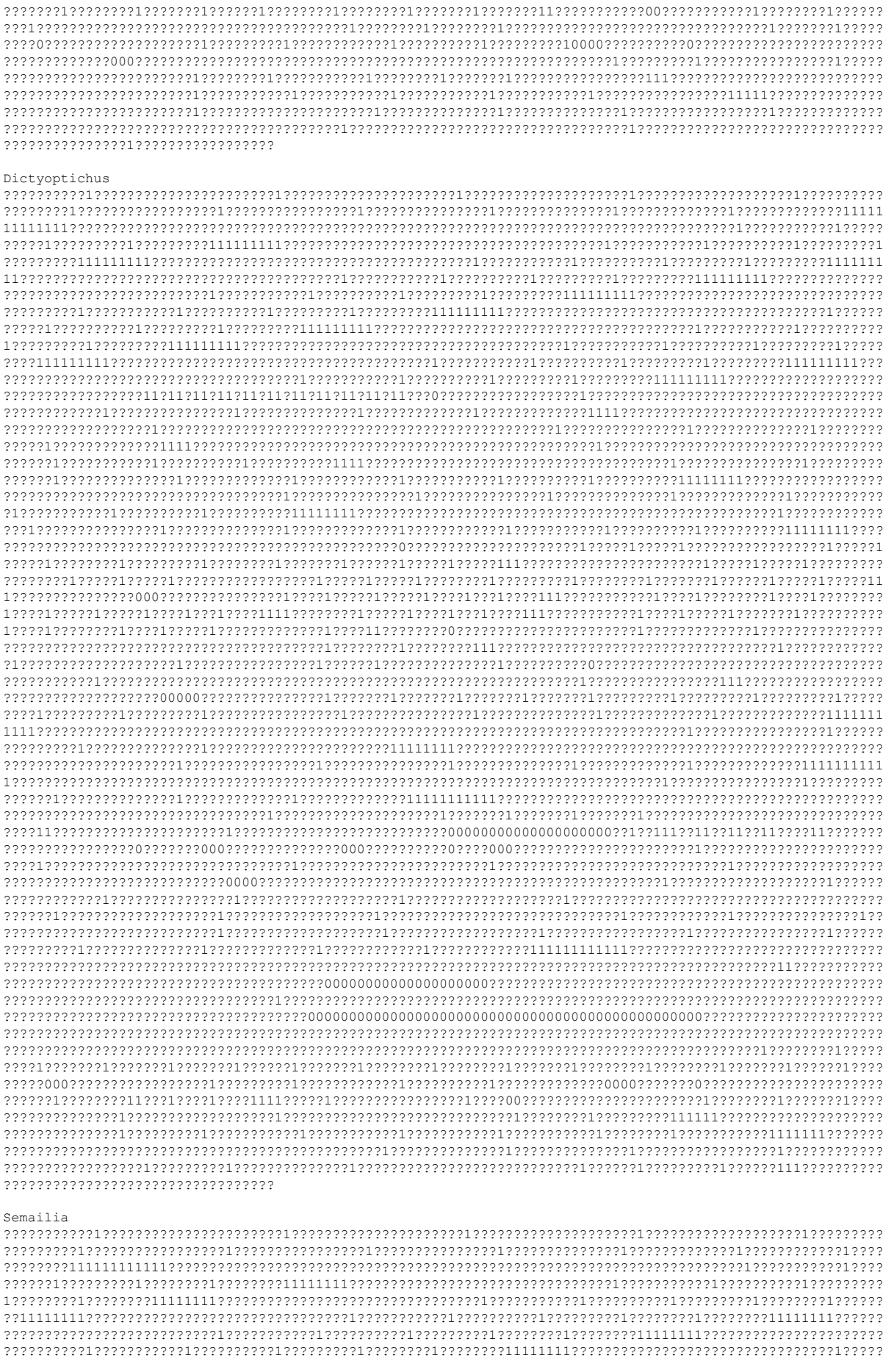
Mexicaprina

Amphitriscoelus

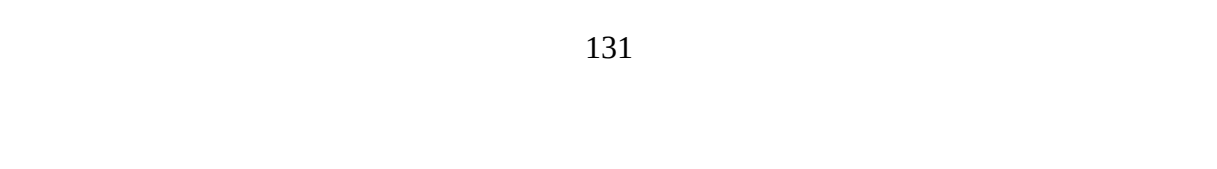
Pachytraga



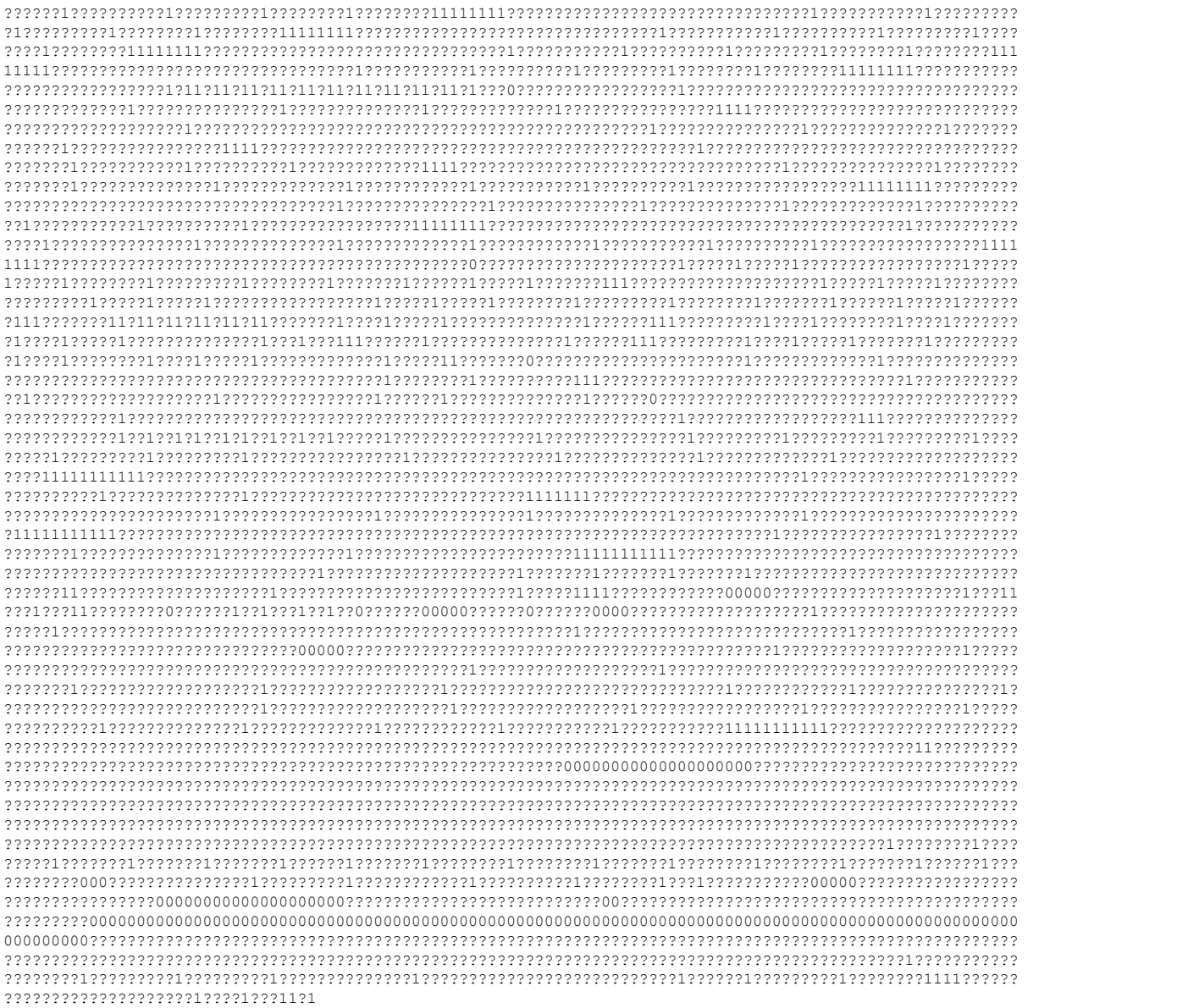
Offneria



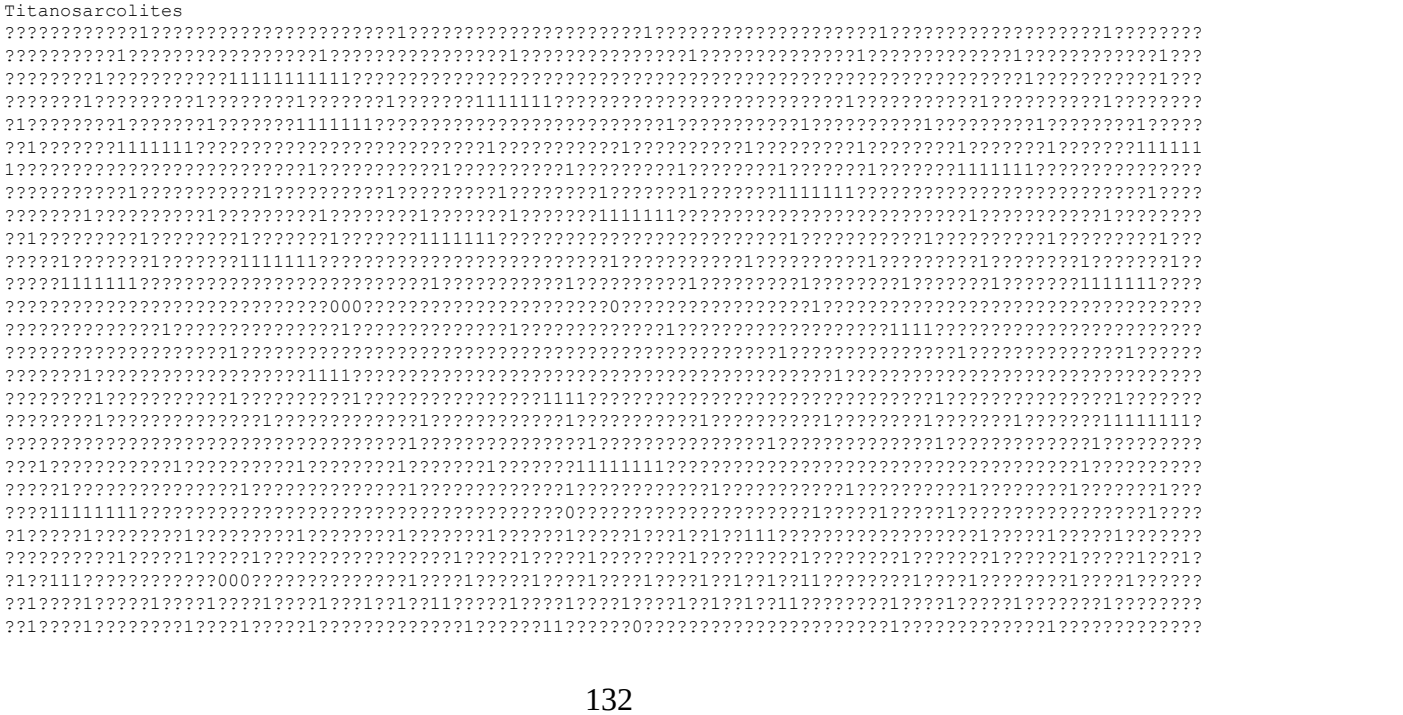
Dictyoptichus

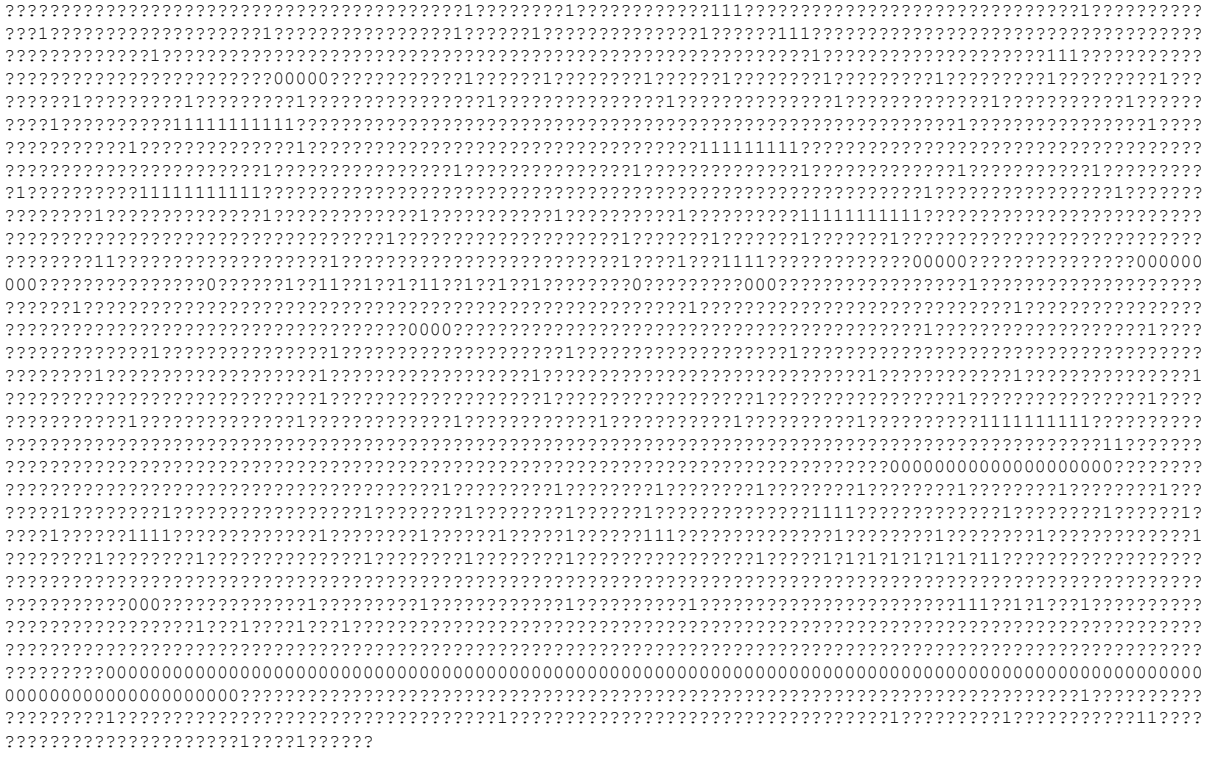


Semailia

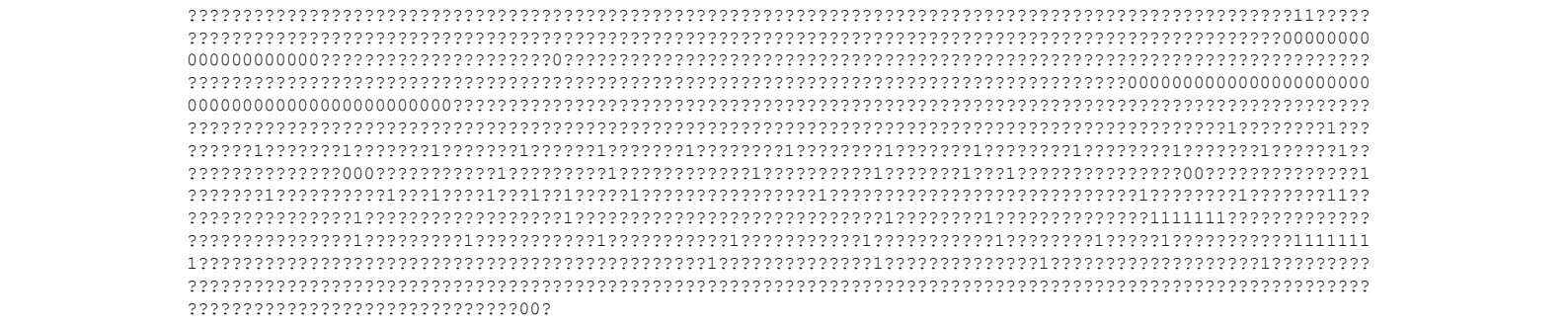


Titanosarcolites

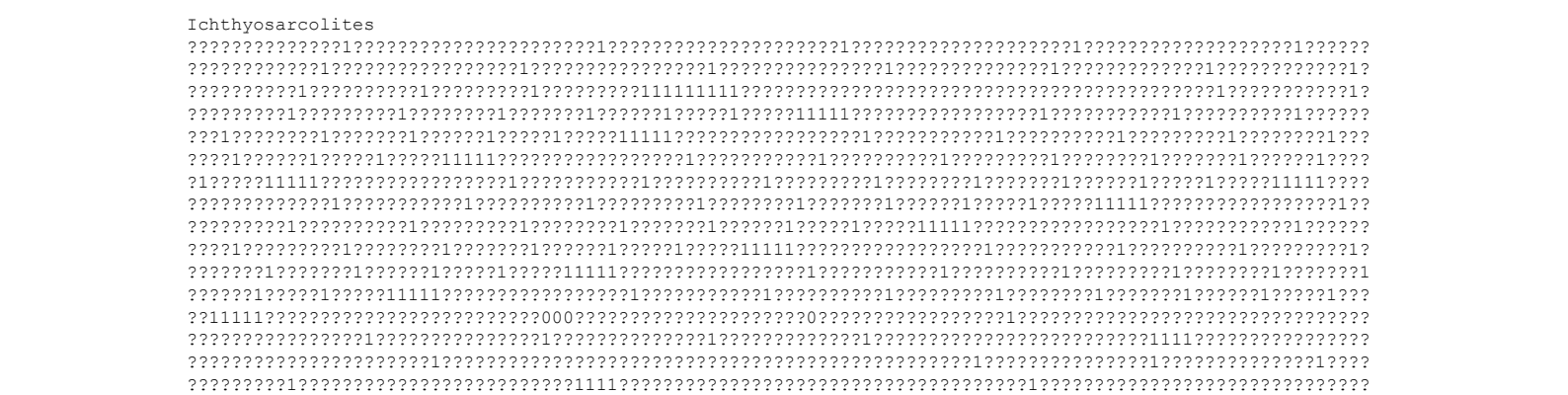




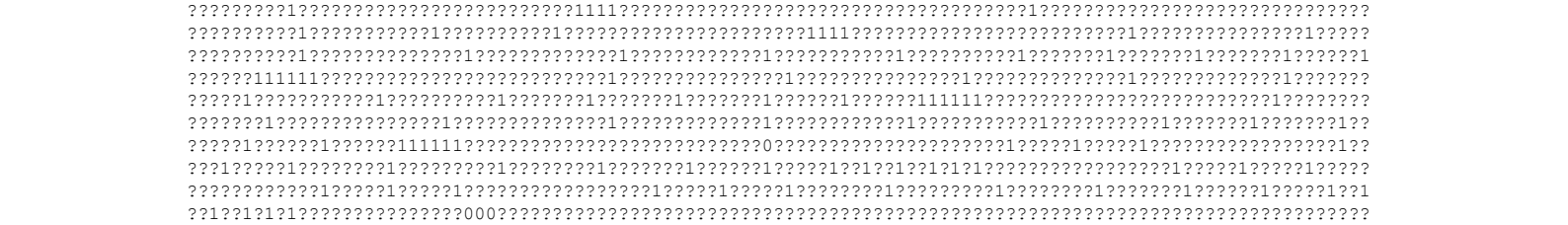
Clinocaprina

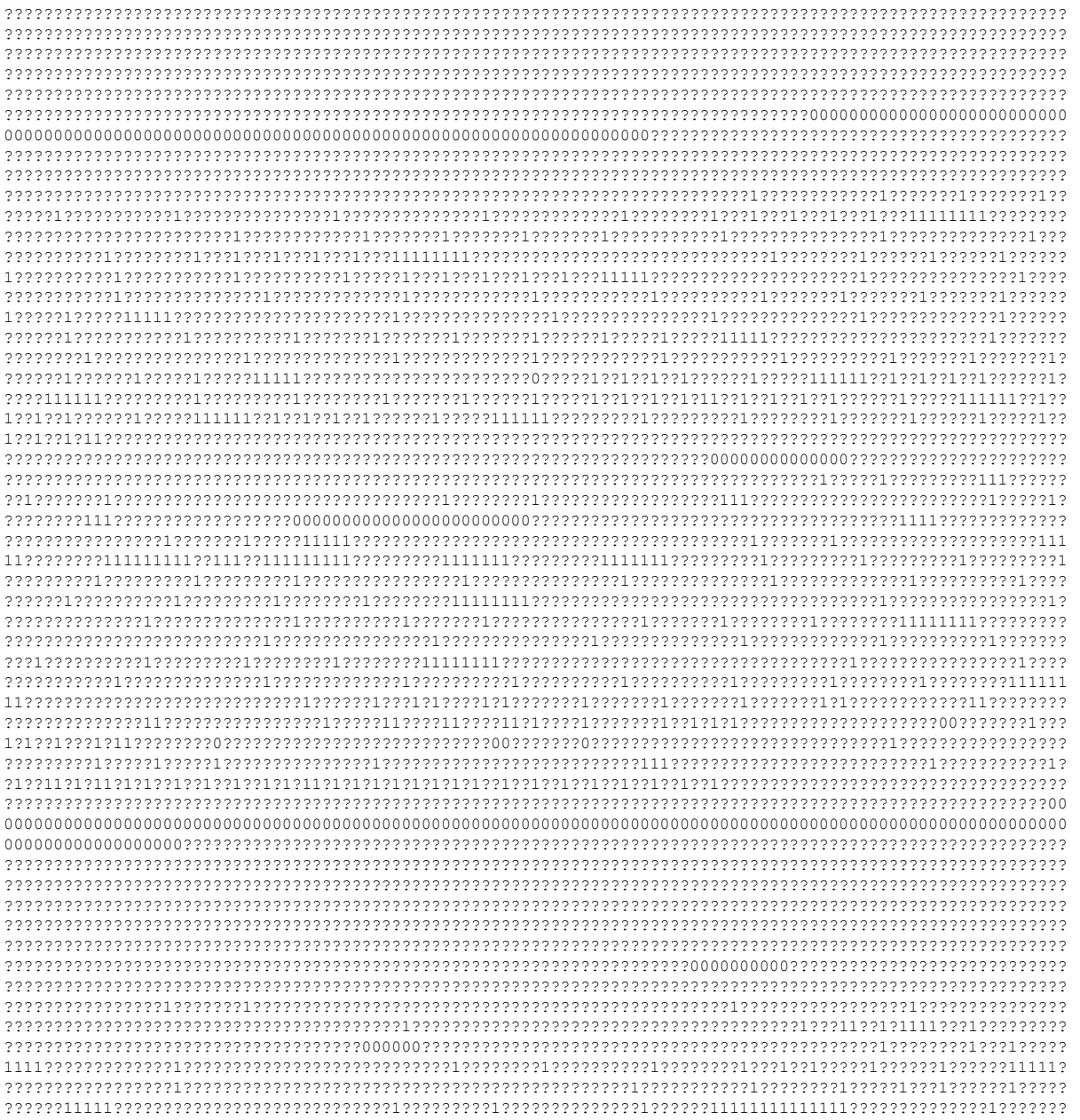


Ichthyosarcolites

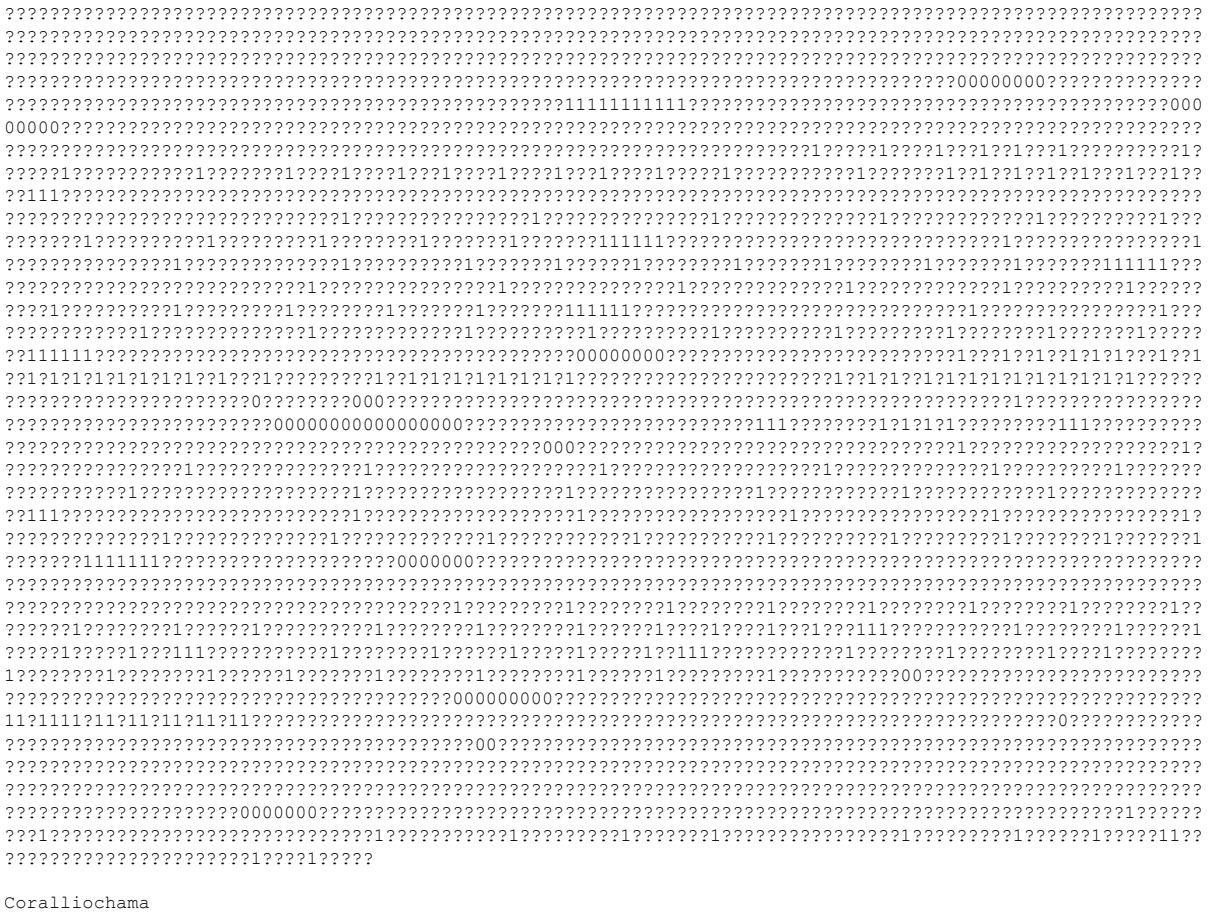


Curtocaprina

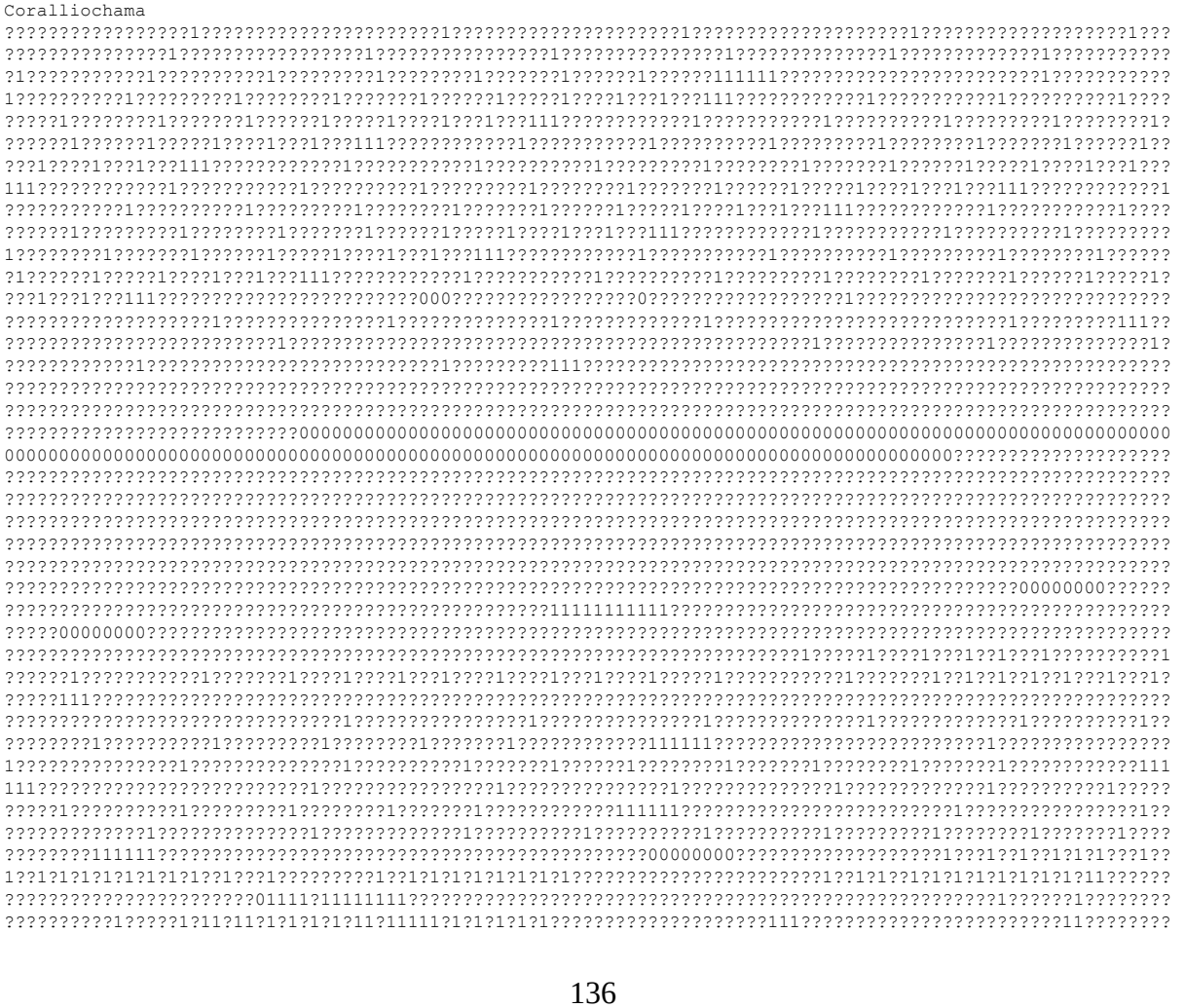


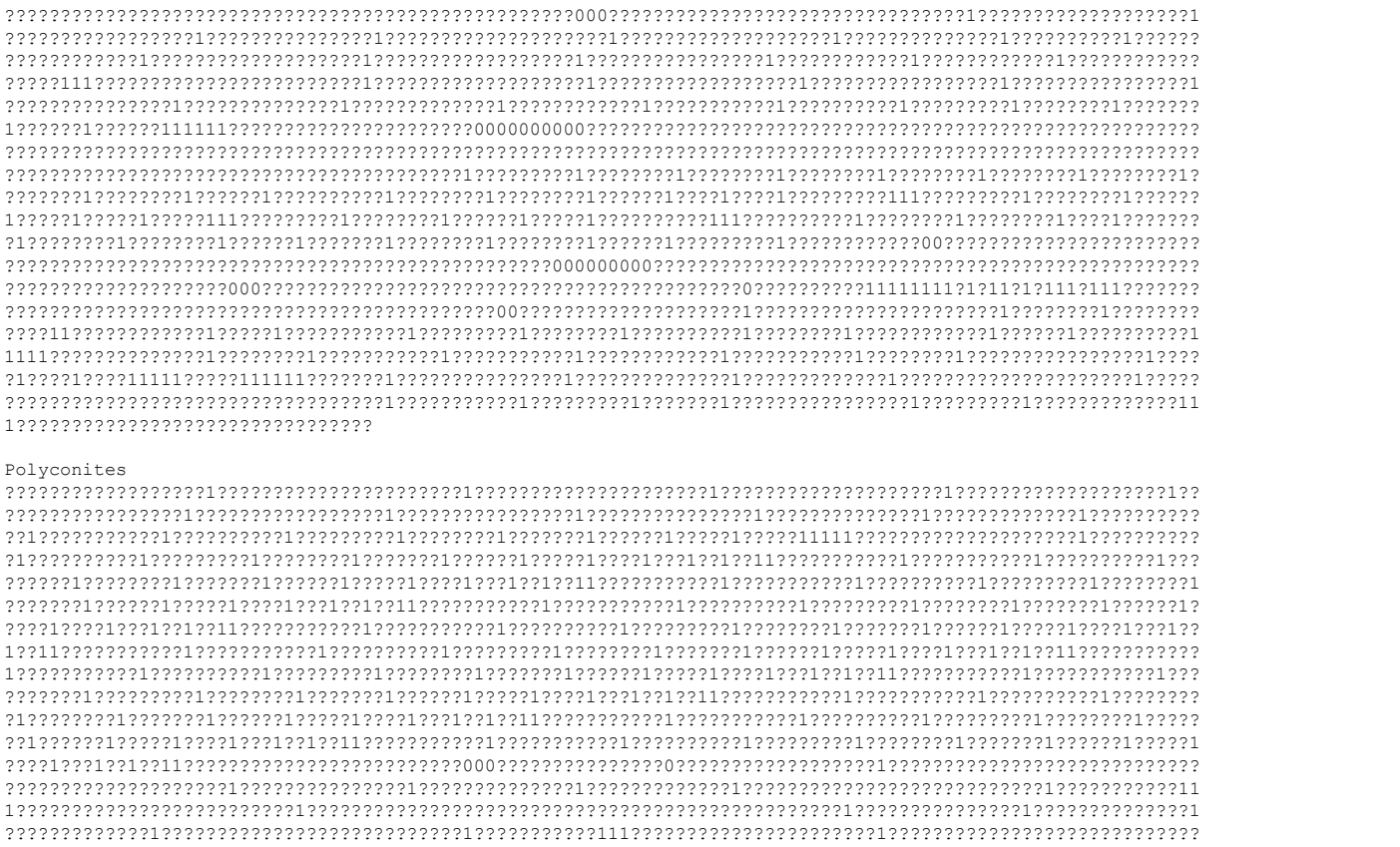


Plagioptychus

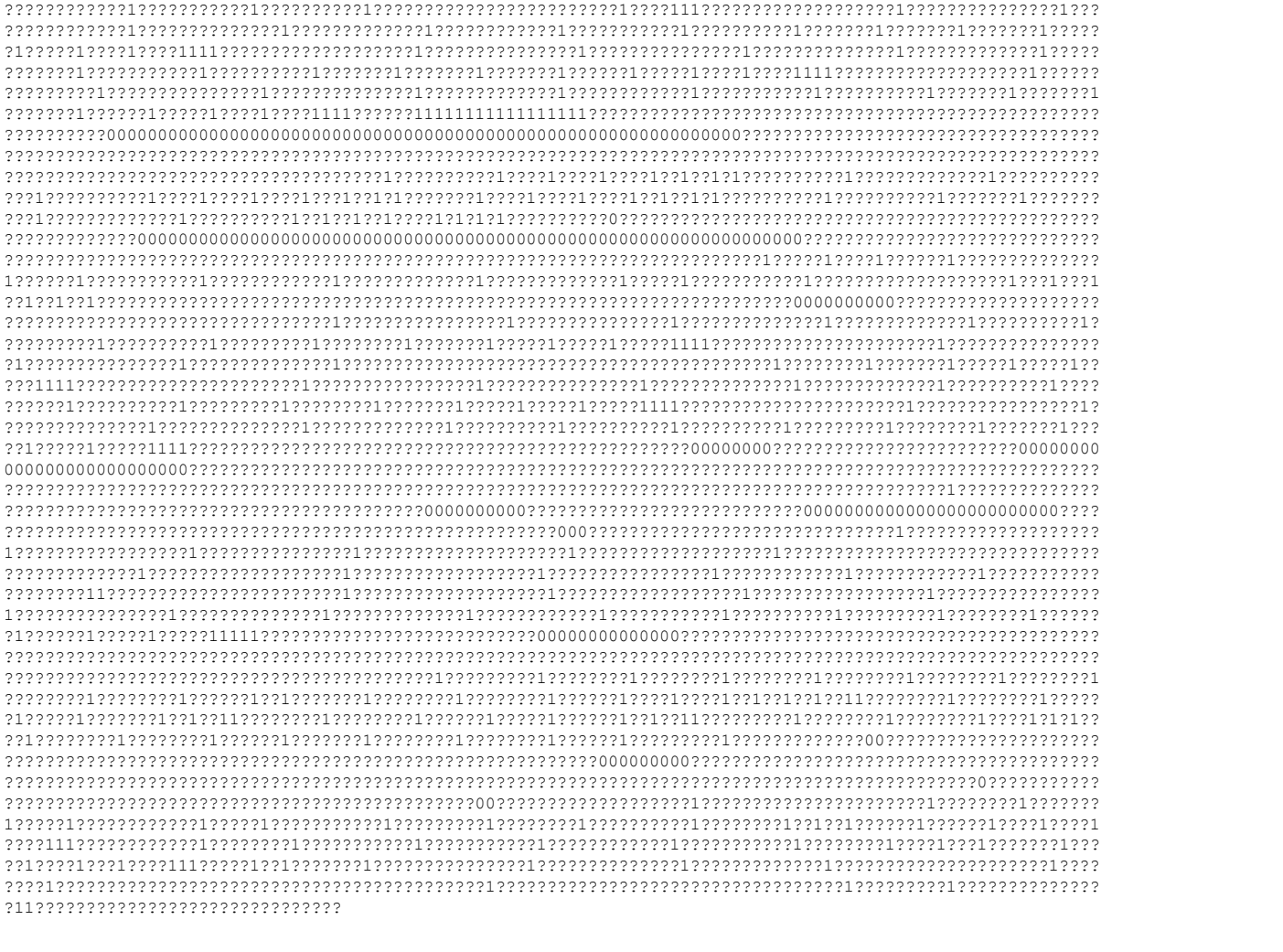


Coralliochama

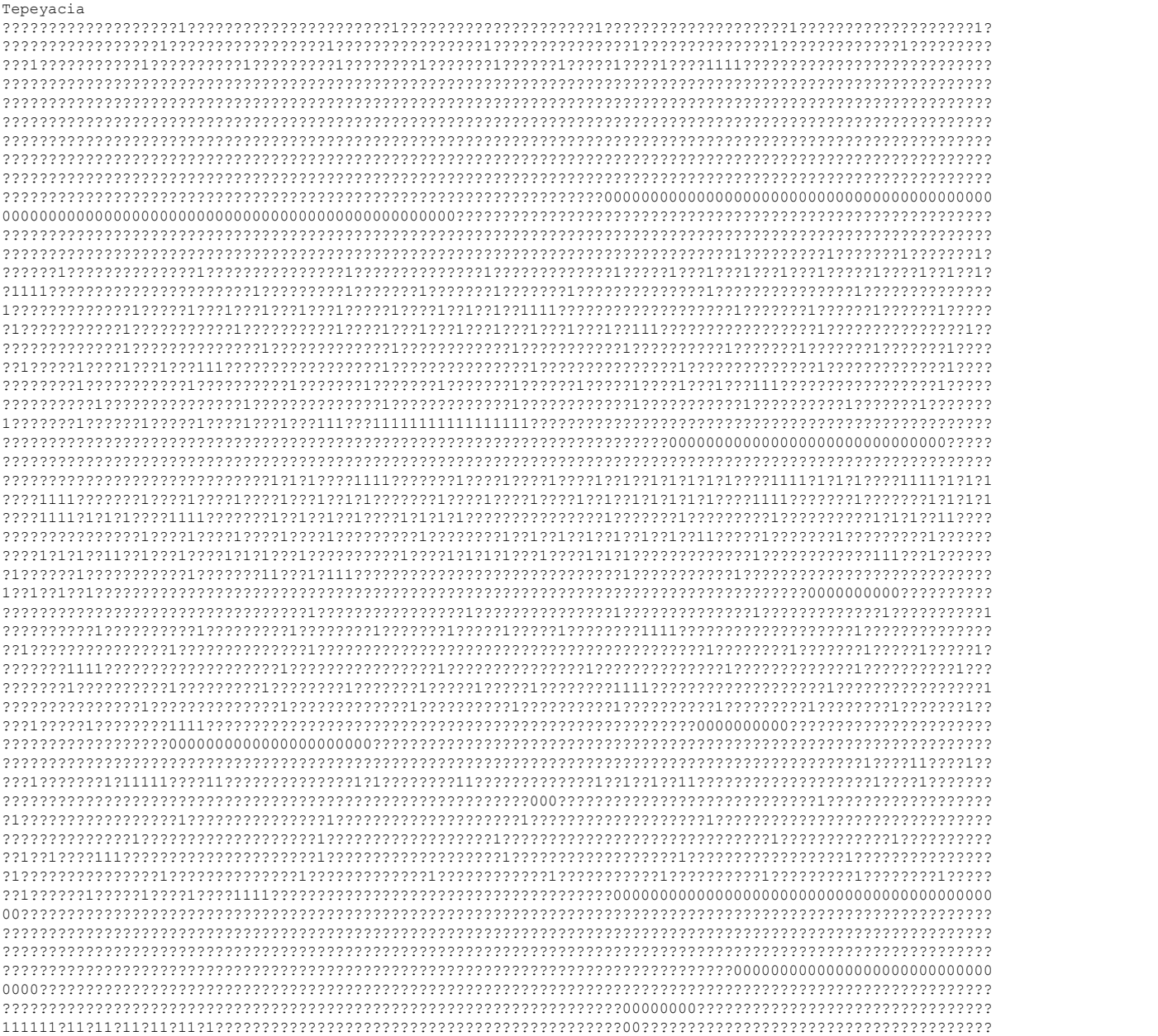




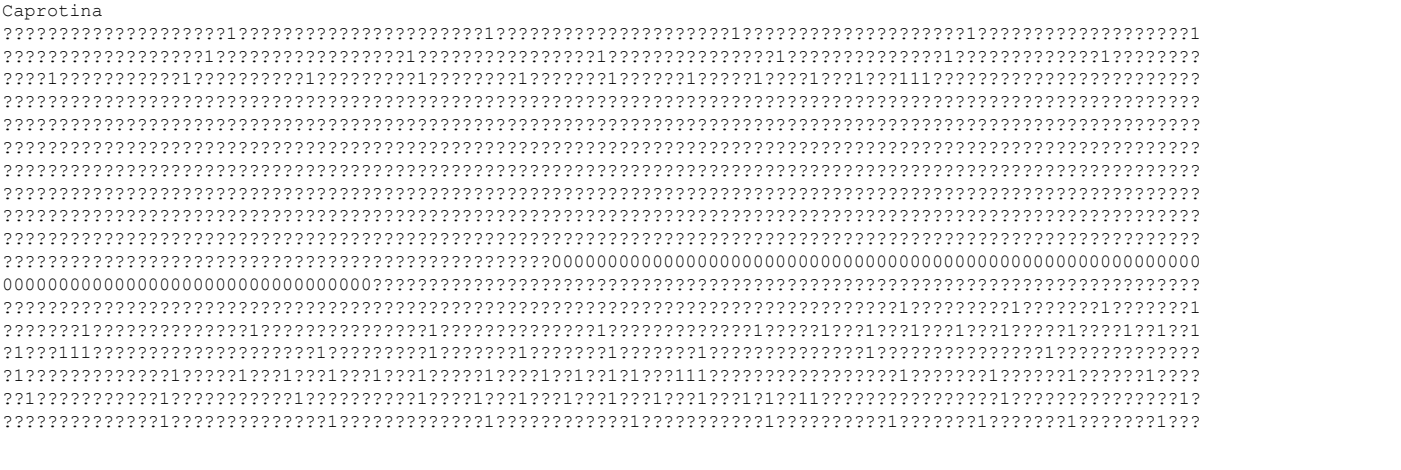
Polyconites

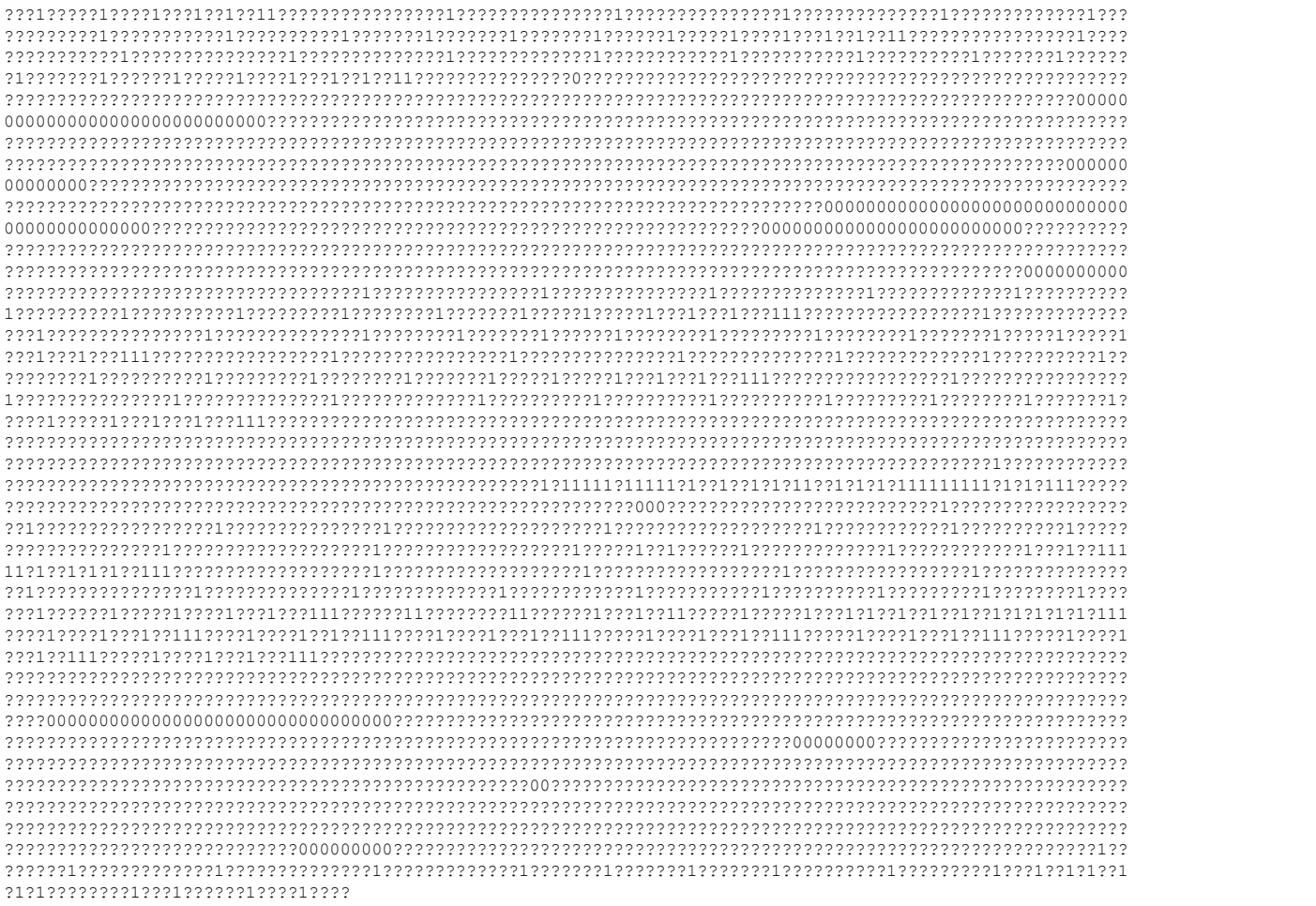


Tepeyacia

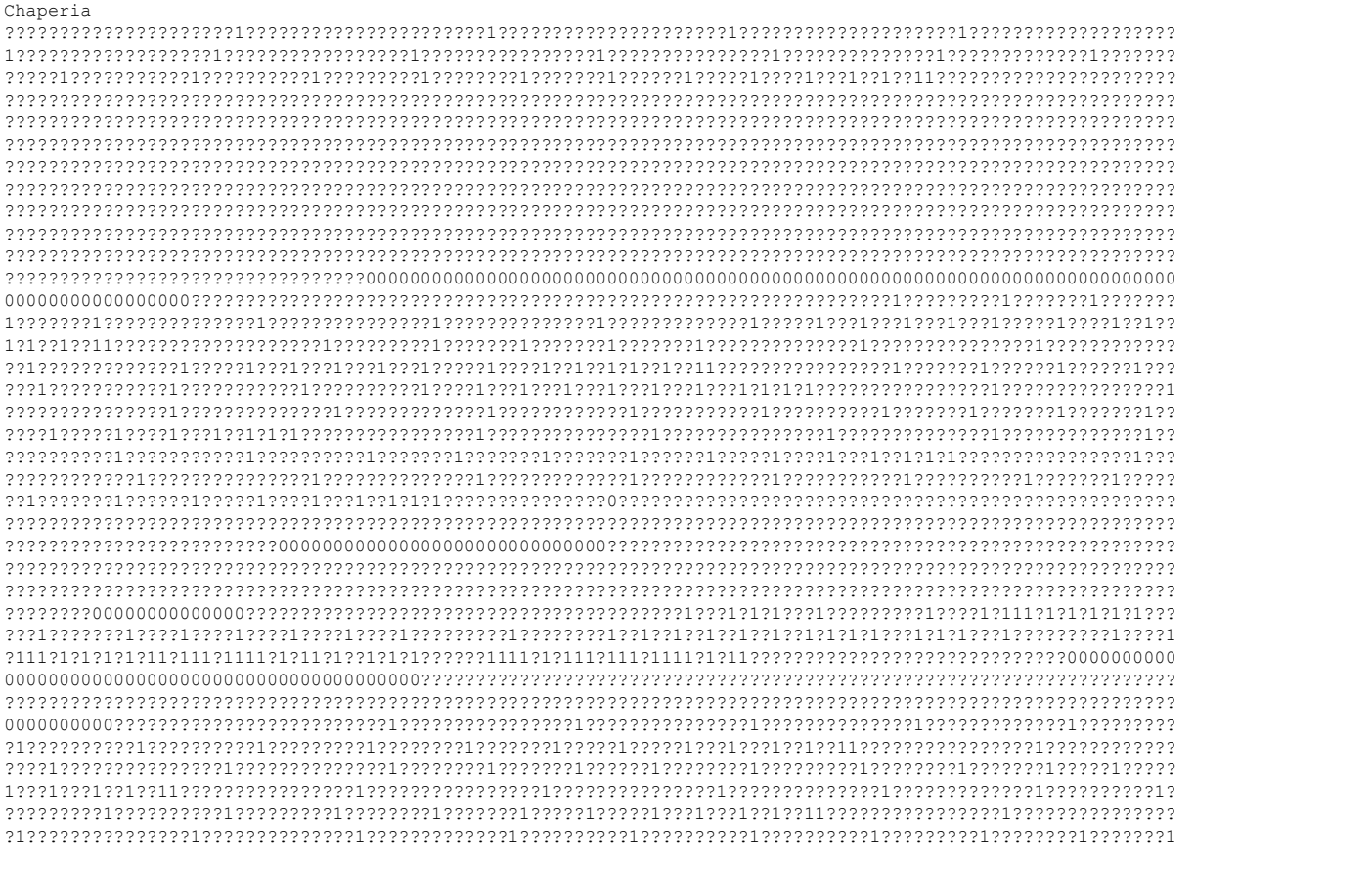


Caprotina





Chaperia



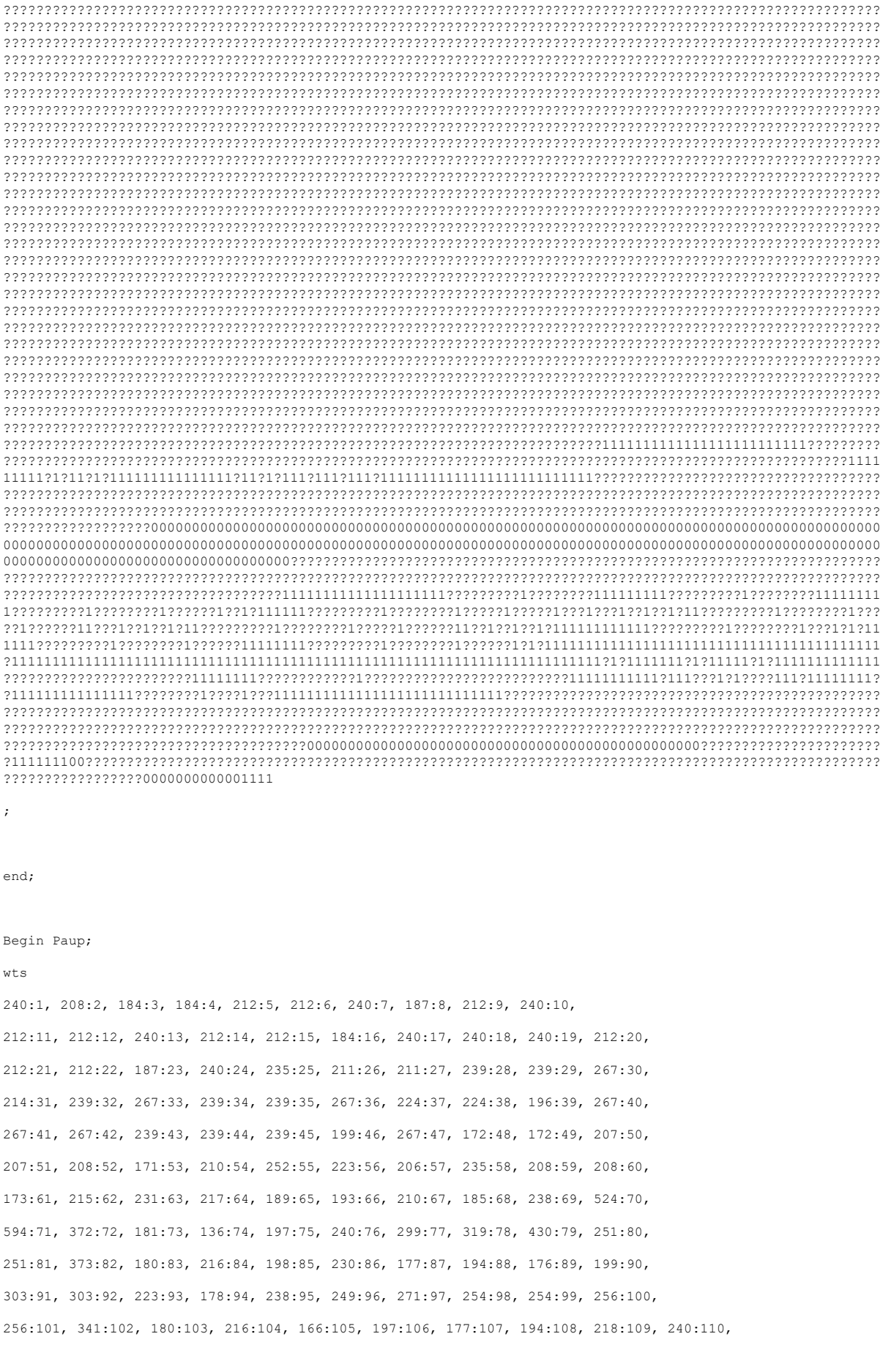
?????1?????1???1???1??1??11???
??
??1????????????
??1???????1??1??1??1?1?????????????????1?1?1?1?1????
??000?????????????????????????1?????????????????
???1?????????????????1?????????????????1?????????????????????1?????????????????????1?????????????????1???????????1????
??????????????????1?????????????????????1?????????????????????1?????????????????????????1????????????1???1?1???
????1??1?1?1???1??11?????????????????????1?????????????????????1?????????????????????1?????????????????1?????????????
???1?????????????????1?????????????????1?????????????????1?????????????????1?????????????????1?????????1????????1???
????1?????1?????1?????1????1???1??1??11???
??
??
??
??00000000000000000000000000000000000000?????????????????????????????????????
??00000000000?????????????
??
??00?????????????????1????1??1??1??1?????????1?????????1?1?1
??1??111?????????????????????1?????????????1?????????1????????1?????????????1?????????????1??????1??????1????1???
?1??1??1?????????????????????????1???????????1???????????1???????????1???????????1???????????1???????????????1???????1?
????1????1???1??1??1?????1?????1?1111?????????????????1?????????????????1?????????????1?????????????????????????1?
???????1?????????????1?????????????1?????????????1????????1???????1???????1???????1??????????1?????????1???1??1?1??
1?1?1?????????????????????????????

Caprinula
????????????????????????1?????????????????????????1?????????????????????1?????????????????????1?????????????????????
?1?????????????????1?????????????????1?????????????????1?????????????????1?????????????????1?????????????????1???????
??????1???????????1??????????1?????????1?????????1???????1???????1?????1????1???1??1?1?1???????????1?????????
??1???????????1?????????1????????1???????1???????1?????1????1???1??1?1?1???????????1???????????1?????????1??
???????1????????1???????1??????1?????1????1???1?1?1???????????1???????????1???????????1?????????1????????1???????
1???????1??????1?????1????1???1??1?1?1???????????1???????????1???????????1?????????1????????1????????1??????1
?????1????1???1??1?1?1???????????1???????????1???????????1??????????1????????1????????1??????1?????1????1???1?
?1?1?1?????????????????1?????????????????1?????????????????1?????????????????1?????????????????1?????????????????
???1??1?1?????????????????????1???1?????????????1????????
???1?????????????1?????????????????????????????1?????????????1??1?1???
??

??1??1?????????????????????????????1???????????????1???????????????1???????????????1?????????????????????????????????1???????1
??????????????1??1?????????1????1???1?????????????????1?????????????????1?????????????????1?????????????????????????????1
??
??????????????????????????????0

Sellaea
????????????????????????1????????????????????????1????????????????????????1????????????????????1?????????????????????
??1????????????????????1????????????????????1????????????????????1????????????????1????????????????1?????????????1?????
???????1???????????1??????????1?????????1?????????1???????1??????1?????1????1???1??1?11?????????????1????????
???1???????????1??????????1????????1???????1??????1?????1????1???1??1?11?????????????1????????????1??????????1?
????????1????????1????????1???????1??????1?????1????1???1??1?11?????????????1????????????1????????????1???????1??????
?1???????1??????1?????1????1???1??1?11?????????????1???????????1???????????1????????1????????1???????1??????
1?????1????1???1??1?11?????????????1???????????1???????????1????????1????????1???????1??????1?????1????1???1
??1?11?????????????1????????????1???????????1?????????1????????1???????1??????1?????1????1???1??1?11??????????
??1???????????1??????????1?????????1????????1???????1??????1?????1????1???1??1?11?????????????1????????????1?
????????1?????????1????????1???????1??????1?????1????1???1??1?11?????????????1???????????1???????????1???????1??????
???1????????1????????1???????1?????1????1???1??1?11?????????????1???????????1???????????1????????1????????1???
????1??????1?????1????1???1??1?11?????????????1???????????1???????????1????????1????????1???????1??????1????
?1????1???1??1?11??????????????????????????????000??????????0?????????????????????1?????????????????????
???????????????????????1?????????????????1?????????????????1?????????????????1?????????????????????????1????????
????1??1?1?????????????????????1???1?????????????1?????????
????1??????????1???1?????1?11?????????????????1?????????????
1?????????????????1?????????????1?????????????1????????????1????????????1?????????1???????1???????1???????1?
?????1?????1????1???1??1?11?????????????????1?????????????????1?????????????????1?????????????????1?????????????1?
???????????1???????????1???????????1???????1???????1???????1???????1??????1?????1????1???1??1?11?????????????????1??
????????????1?????????????????????1????????????????1????????????????1????????????1????????????1???????1????????1????
???1???????1??????1?????1????1???1??1?11?????????????????0???
??
??
??000000000000000000000000000000000000000000000000000000000000
0000000000???
??
??????????????????????????????????0000000000000000000000?????????0?????????????????1?????????1????1?????????1?11???
????1???????1????1????1????1????1????1?????????1????????1??1??1??1??1??1?11?????????????1?????????1????
1?????????1?11???000000000000000???
????????????????????????????????????0000000000000000000000000000000000000000000000000000000000000000000000000000
0000000000???
??????????00000000000??????????????????1????????????????1????????????????1????????????????1????????????????1????????
???1??????????1??????????1?????????1????????1???????1?????1?????1???1???1??1?11?????????????????1?????????
??????1????????????????1????????????????1????????1???????1??????1????????1????????1????????1?????1???
??1???1???1??1?11?????????????????1????????????????1????????????????1????????????????1????????????1???????????
1??????????1??????????1?????????1????????1???????1?????1?????1???1???1??1?11?????????????????1????????????
???1???
?1?????1?????1???1???1??1?11???
??
??1?????????
??
?????1??000?????????????????????1?????????????
?????1?????????????????1????????????????1????????????????????1?????????????????????1??????????????????1??
????????????????????1????????????????????1????????????????????1?????????????1?????????????1???1???1??1???
????????????1??1?1?????????????????????1?????????????????????1????????????????1????????????????1???????????
??????1??????1?????1????1???1??1?11??????1?????????1????????1???1??1?11????????1???????????1????????????1?
??????1??????1?????1????1???1??1?11??????1?????????1????????1???1??1?11????????1???????????1????????????1?
1????????1????????1??????1??1?1?????1????????1????????1???????????1???????1??1??1?1?1????????1????????1????
????????1?????1??1??1?1?1????????1????????1????????????1???1??1??1?1?1??????????1????????1????????1??????????
???1????????1????????1??????1????????1????????1????????1??????1?1?1?????1?????????????00??????????1????????11
1????????1??1????????1????????1???????1?1????????1?1?????1???????0000000
??1????????????1????????????????????????????????????0????????
??00????????????????????????????1?????????????
???1????1?????????????????????1???????????1????????1????????1???????????1?????????????????1??????1??????1????1?
???1??1?1?????????????????????????1???????????1???????????1???????????1???????????1??????????????????1???????
1????1????1????1??1?1?????1????????????????????????????1?????????????1?????????????1?????????????????????????
1???1????????????????1????????1????????1?????????????????????1???????
?????1?????????????????????????

Oryxia
??



;

end;

Begin Paup;

wts

240:1, 208:2, 184:3, 184:4, 212:5, 212:6, 240:7, 187:8, 212:9, 240:10,

212:11, 212:12, 240:13, 212:14, 212:15, 184:16, 240:17, 240:18, 240:19, 212:20,

212:21, 212:22, 187:23, 240:24, 235:25, 211:26, 211:27, 239:28, 239:29, 267:30,

214:31, 239:32, 267:33, 239:34, 239:35, 267:36, 224:37, 224:38, 196:39, 267:40,

267:41, 267:42, 239:43, 239:44, 239:45, 199:46, 267:47, 172:48, 172:49, 207:50,

207:51, 208:52, 171:53, 210:54, 252:55, 223:56, 206:57, 235:58, 208:59, 208:60,

173:61, 215:62, 231:63, 217:64, 189:65, 193:66, 210:67, 185:68, 238:69, 524:70,

594:71, 372:72, 181:73, 136:74, 197:75, 240:76, 299:77, 319:78, 430:79, 251:80,

251:81, 373:82, 180:83, 216:84, 198:85, 230:86, 177:87, 194:88, 176:89, 199:90,

303:91, 303:92, 223:93, 178:94, 238:95, 249:96, 271:97, 254:98, 254:99, 256:100,

256:101, 341:102, 180:103, 216:104, 166:105, 197:106, 177:107, 194:108, 218:109, 240:110,

1000:111, 220:112, 176:113, 232:114, 275:115, 338:116, 431:117, 322:118, 290:119, 290:120,
299:121, 207:122, 244:123, 226:124, 356:125, 213:126, 229:127, 211:128, 234:129, 220:130,
176:131, 232:132, 275:133, 338:134, 357:135, 322:136, 290:137, 290:138, 225:139, 207:140,
244:141, 226:142, 356:143, 213:144, 229:145, 211:146, 234:147, 343:148, 372:149, 513:150,
478:151, 574:152, 574:153, 412:154, 559:155, 536:156, 299:157, 319:158, 216:159, 224:160,
228:161, 228:162, 544:163, 321:164, 328:165, 369:166, 359:167, 343:168, 343:169, 345:170,
345:171, 305:172, 254:173, 271:174, 180:175, 180:176, 187:177, 204:178, 502:179, 268:180,
446:181, 389:182, 372:183, 372:184, 374:185, 374:186, 339:187, 279:188, 315:189, 204:190,
240:191, 226:192, 259:193, 410:194, 323:195, 613:196, 517:197, 678:198, 619:199, 619:200,
451:201, 320:202, 337:203, 279:204, 284:205, 256:206, 289:207, 656:208, 365:209, 703:210,
722:211, 733:212, 691:213, 532:214, 297:215, 333:216, 242:217, 273:218, 228:219, 245:220,
469:221, 314:222, 707:223, 643:224, 660:225, 671:226, 276:227, 369:228, 225:229, 257:230,
228:231, 228:232, 475:233, 297:234, 736:235, 940:236, 634:237, 304:238, 471:239, 254:240,
257:241, 228:242, 228:243, 401:244, 326:245, 678:246, 481:247, 261:248, 371:249, 194:250,
226:251, 213:252, 230:253, 418:254, 299:255, 650:256, 261:257, 297:258, 194:259, 226:260,
213:261, 230:262, 491:263, 299:264, 228:265, 338:266, 161:267, 214:268, 178:269, 211:270,
451:271, 259:272, 448:273, 235:274, 305:275, 235:276, 235:277, 323:278, 252:279, 251:280,
254:281, 235:282, 251:283, 272:284, 268:285, 359:286, 205:287, 221:288, 184:289, 254:290,
221:291, 238:292, 302:293, 237:294, 242:295, 217:296, 226:297, 233:298, 259:299, 286:300,
489:301, 559:302, 338:303, 264:304, 285:305, 395:306, 217:307, 217:308, 120:309, 156:310,
139:311, 142:312, 132:313, 268:314, 268:315, 236:316, 220:317, 220:318, 221:319, 221:320,
120:321, 156:322, 106:323, 183:324, 173:325, 965:326, 303:327, 396:328, 287:329, 256:330,
256:331, 120:332, 156:333, 139:334, 177:335, 167:336, 303:337, 323:338, 287:339, 256:340,
256:341, 120:342, 156:343, 139:344, 177:345, 167:346, 668:347, 687:348, 698:349, 656:350,
210:351, 246:352, 155:353, 435:354, 247:355, 673:356, 608:357, 625:358, 189:359, 282:360,
138:361, 440:362, 230:363, 701:364, 905:365, 189:366, 356:367, 138:368, 367:369, 230:370,
644:371, 174:372, 284:373, 107:374, 383:375, 232:376, 174:377, 210:378, 107:379, 457:380,
232:381, 357:382, 120:383, 272:384, 104:385, 136:386, 210:387, 120:388, 121:389, 106:390,
219:391, 462:392, 532:393, 311:394, 237:395, 257:396, 368:397, 204:398, 204:399, 93:400,
129:401, 112:402, 129:403, 105:404, 241:405, 241:406, 209:407, 193:408, 193:409, 209:410,
209:411, 93:412, 129:413, 79:414, 171:415, 146:416, 938:417, 276:418, 369:419, 260:420,
243:421, 243:422, 93:423, 129:424, 112:425, 164:426, 140:427, 276:428, 296:429, 260:430,
243:431, 243:432, 93:433, 129:434, 112:435, 164:436, 140:437, 653:438, 673:439, 698:440,
656:441, 183:442, 219:443, 128:444, 422:445, 220:446, 658:447, 608:448, 625:449, 161:450,
255:451, 111:452, 428:453, 203:454, 701:455, 905:456, 161:457, 329:458, 111:459, 354:460,
203:461, 644:462, 161:463, 271:464, 95:465, 371:466, 220:467, 161:468, 197:469, 95:470,
444:471, 220:472, 330:473, 92:474, 260:475, 77:476, 109:477, 197:478, 93:479, 109:480,
79:481, 207:482, 387:483, 457:484, 236:485, 162:486, 199:487, 309:488, 129:489, 129:490,
22:491, 41:492, 55:493, 41:494, 63:495, 166:496, 166:497, 134:498, 134:499, 134:500,
134:501, 134:502, 22:503, 41:504, 22:505, 83:506, 104:507, 863:508, 201:509, 311:510,
201:511, 168:512, 168:513, 22:514, 41:515, 55:516, 41:517, 63:518, 201:519, 237:520,
201:521, 168:522, 168:523, 22:524, 41:525, 55:526, 41:527, 63:528, 579:529, 598:530,

608:531, 566:532, 96:533, 115:534, 55:535, 284:536, 127:537, 584:538, 534:539, 551:540,
74:541, 168:542, 55:543, 306:544, 127:545, 627:546, 831:547, 74:548, 242:549, 55:550,
232:551, 127:552, 553:553, 74:554, 168:555, 22:556, 232:557, 127:558, 74:559, 94:560,
22:561, 306:562, 127:563, 243:564, 22:565, 173:566, 22:567, 22:568, 94:569, 22:570,
22:571, 22:572, 86:573, 360:574, 430:575, 208:576, 135:577, 155:578, 266:579, 102:580,
102:581, 22:582, 38:583, 71:584, 38:585, 38:586, 139:587, 139:588, 65:589, 49:590,
49:591, 65:592, 65:593, 22:594, 38:595, 38:596, 38:597, 38:598, 847:599, 135:600,
253:601, 118:602, 102:603, 102:604, 22:605, 38:606, 71:607, 38:608, 38:609, 135:610,
180:611, 118:612, 102:613, 102:614, 22:615, 38:616, 71:617, 38:618, 38:619, 293:620,
312:621, 299:622, 296:623, 96:624, 112:625, 71:626, 38:627, 38:628, 349:629, 260:630,
316:631, 22:632, 96:633, 55:634, 96:635, 22:636, 353:637, 597:638, 22:639, 169:640,
55:641, 22:642, 22:643, 296:644, 22:645, 112:646, 38:647, 38:648, 38:649, 22:650,
38:651, 38:652, 112:653, 38:654, 243:655, 22:656, 120:657, 22:658, 38:659, 38:660,
38:661, 38:662, 38:663, 87:664, 363:665, 433:666, 212:667, 138:668, 175:669, 285:670,
105:671, 105:672, 22:673, 41:674, 55:675, 41:676, 22:677, 142:678, 142:679, 68:680,
68:681, 68:682, 68:683, 68:684, 22:685, 41:686, 22:687, 41:688, 22:689, 703:690,
138:691, 273:692, 138:693, 105:694, 105:695, 22:696, 41:697, 55:698, 41:699, 22:700,
138:701, 199:702, 138:703, 105:704, 105:705, 22:706, 41:707, 55:708, 41:709, 22:710,
506:711, 525:712, 495:713, 492:714, 96:715, 115:716, 55:717, 234:718, 22:719, 510:720,
421:721, 477:722, 74:723, 168:724, 55:725, 256:726, 22:727, 514:728, 758:729, 74:730,
242:731, 55:732, 183:733, 22:734, 441:735, 74:736, 168:737, 22:738, 183:739, 22:740,
74:741, 94:742, 22:743, 256:744, 22:745, 96:746, 22:747, 173:748, 22:749, 22:750,
94:751, 22:752, 22:753, 22:754, 71:755, 411:756, 480:757, 259:758, 185:759, 222:760,
333:761, 153:762, 153:763, 38:764, 38:765, 55:766, 38:767, 22:768, 189:769, 189:770,
116:771, 116:772, 116:773, 116:774, 116:775, 38:776, 38:777, 22:778, 38:779, 22:780,
887:781, 225:782, 334:783, 225:784, 192:785, 192:786, 38:787, 38:788, 55:789, 38:790,
22:791, 225:792, 260:793, 225:794, 192:795, 192:796, 38:797, 38:798, 55:799, 38:800,
22:801, 580:802, 599:803, 609:804, 567:805, 112:806, 112:807, 55:808, 258:809, 22:810,
584:811, 535:812, 552:813, 91:814, 165:815, 55:816, 280:817, 22:818, 628:819, 832:820,
119:821, 267:822, 83:823, 206:824, 50:825, 554:826, 91:827, 165:828, 22:829, 206:830,
22:831, 91:832, 91:833, 22:834, 280:835, 22:836, 288:837, 50:838, 189:839, 50:840,
50:841, 91:842, 50:843, 22:844, 50:845, 22:846, 414:847, 451:848, 230:849, 156:850,
193:851, 303:852, 156:853, 156:854, 22:855, 41:856, 47:857, 41:858, 47:859, 193:860,
193:861, 119:862, 119:863, 119:864, 119:865, 119:866, 22:867, 41:868, 47:869, 41:870,
47:871, 857:872, 195:873, 305:874, 195:875, 195:876, 195:877, 22:878, 41:879, 47:880,
41:881, 47:882, 195:883, 231:884, 195:885, 195:886, 195:887, 22:888, 41:889, 47:890,
41:891, 47:892, 331:893, 291:894, 333:895, 291:896, 22:897, 41:898, 47:899, 41:900,
47:901, 466:902, 449:903, 466:904, 22:905, 115:906, 47:907, 194:908, 47:909, 409:910,
613:911, 22:912, 189:913, 47:914, 120:915, 47:916, 336:917, 22:918, 115:919, 47:920,
120:921, 47:922, 22:923, 41:924, 47:925, 194:926, 47:927, 169:928, 22:929, 120:930,
22:931, 22:932, 41:933, 22:934, 22:935, 47:936, 22:937, 283:938, 352:939, 205:940,
131:941, 94:942, 279:943, 84:944, 84:945, 37:946, 37:947, 69:948, 22:949, 37:950,

135:951, 135:952, 61:953, 61:954, 61:955, 47:956, 47:957, 37:958, 37:959, 37:960,
22:961, 37:962, 858:963, 170:964, 232:965, 170:966, 123:967, 123:968, 64:969, 64:970,
97:971, 57:972, 72:973, 170:974, 232:975, 170:976, 123:977, 123:978, 64:979, 64:980,
97:981, 57:982, 72:983, 245:984, 264:985, 258:986, 216:987, 138:988, 138:989, 97:990,
57:991, 72:992, 242:993, 236:994, 120:995, 64:996, 138:997, 97:998, 57:999, 72:1000,
329:1001, 438:1002, 93:1003, 167:1004, 126:1005, 57:1006, 100:1007, 256:1008, 50:1009, 123:1010,
50:1011, 57:1012, 57:1013, 50:1014, 50:1015, 50:1016, 57:1017, 57:1018, 314:1019, 93:1020,
148:1021, 93:1022, 93:1023, 50:1024, 93:1025, 50:1026, 93:1027, 71:1028, 296:1029, 332:1030,
111:1031, 111:1032, 148:1033, 259:1034, 111:1035, 111:1036, 22:1037, 22:1038, 22:1039, 22:1040,
22:1041, 74:1042, 74:1043, 116:1044, 116:1045, 116:1046, 116:1047, 116:1048, 22:1049, 22:1050,
22:1051, 63:1052, 63:1053, 665:1054, 151:1055, 260:1056, 151:1057, 151:1058, 151:1059, 22:1060,
22:1061, 22:1062, 57:1063, 57:1064, 151:1065, 186:1066, 151:1067, 151:1068, 151:1069, 22:1070,
22:1071, 22:1072, 57:1073, 57:1074, 529:1075, 548:1076, 590:1077, 548:1078, 96:1079, 96:1080,
22:1081, 299:1082, 121:1083, 533:1084, 516:1085, 533:1086, 74:1087, 148:1088, 22:1089, 321:1090,
121:1091, 609:1092, 813:1093, 103:1094, 250:1095, 50:1096, 248:1097, 150:1098, 535:1099, 74:1100,
148:1101, 22:1102, 248:1103, 121:1104, 74:1105, 74:1106, 22:1107, 321:1108, 121:1109, 271:1110,
50:1111, 74:1112, 50:1113, 50:1114, 74:1115, 50:1116, 22:1117, 50:1118, 135:1119, 446:1120,
515:1121, 294:1122, 221:1123, 241:1124, 352:1125, 188:1126, 188:1127, 37:1128, 73:1129, 86:1130,
73:1131, 79:1132, 225:1133, 225:1134, 193:1135, 176:1136, 176:1137, 193:1138, 193:1139, 37:1140,
73:1141, 54:1142, 115:1143, 121:1144, 922:1145, 260:1146, 353:1147, 243:1148, 227:1149, 227:1150,
37:1151, 73:1152, 86:1153, 73:1154, 79:1155, 260:1156, 279:1157, 243:1158, 227:1159, 227:1160,
37:1161, 73:1162, 86:1163, 73:1164, 79:1165, 621:1166, 641:1167, 667:1168, 624:1169, 111:1170,
147:1171, 86:1172, 316:1173, 143:1174, 626:1175, 576:1176, 593:1177, 90:1178, 183:1179, 70:1180,
321:1181, 127:1182, 669:1183, 873:1184, 118:1185, 285:1186, 98:1187, 248:1188, 155:1189, 612:1190,
90:1191, 200:1192, 54:1193, 264:1194, 143:1195, 90:1196, 126:1197, 54:1198, 338:1199, 143:1200,
287:1201, 66:1202, 188:1203, 50:1204, 82:1205, 126:1206, 67:1207, 54:1208, 67:1209, 103:1210,
404:1211, 474:1212, 253:1213, 179:1214, 216:1215, 327:1216, 146:1217, 146:1218, 37:1219, 57:1220,
70:1221, 57:1222, 22:1223, 183:1224, 183:1225, 151:1226, 151:1227, 151:1228, 151:1229, 151:1230,
37:1231, 57:1232, 37:1233, 99:1234, 63:1235, 905:1236, 218:1237, 328:1238, 218:1239, 186:1240,
186:1241, 37:1242, 57:1243, 70:1244, 57:1245, 22:1246, 218:1247, 254:1248, 218:1249, 186:1250,
186:1251, 37:1252, 57:1253, 70:1254, 57:1255, 22:1256, 596:1257, 616:1258, 625:1259, 583:1260,
111:1261, 131:1262, 70:1263, 299:1264, 86:1265, 601:1266, 551:1267, 568:1268, 90:1269, 183:1270,
70:1271, 321:1272, 86:1273, 644:1274, 848:1275, 118:1276, 285:1277, 98:1278, 248:1279, 115:1280,
571:1281, 90:1282, 183:1283, 37:1284, 248:1285, 86:1286, 90:1287, 110:1288, 37:1289, 321:1290,
86:1291, 287:1292, 66:1293, 188:1294, 50:1295, 66:1296, 110:1297, 50:1298, 37:1299, 50:1300,
86:1301, 491:1302, 516:1303, 479:1304, 524:1305, 553:1306, 479:1307, 491:1308, 477:1309, 440:1310,
491:1311, 477:1312, 440:1313, 98:1314, 115:1315, 98:1316, 146:1317, 98:1318, 172:1319, 553:1320,
598:1321, 561:1322, 534:1323, 562:1324, 467:1325, 590:1326, 651:1327, 577:1328, 319:1329, 347:1330,
325:1331, 579:1332, 608:1333, 534:1334, 221:1335, 221:1336, 295:1337, 311:1338, 311:1339, 295:1340,
310:1341, 408:1342, 372:1343, 408:1344, 347:1345, 388:1346, 96:1347, 96:1348, 131:1349, 131:1350,
103:1351, 120:1352, 134:1353, 148:1354, 147:1355, 130:1356, 130:1357, 132:1358, 132:1359, 97:1360,
82:1361, 99:1362, 85:1363, 85:1364, 117:1365, 134:1366, 133:1367, 134:1368, 129:1369, 85:1370,

145:1371, 189:1372, 321:1373, 178:1374, 69:1375, 110:1376, 171:1377, 126:1378, 187:1379, 198:1380,
289:1381, 146:1382, 69:1383, 110:1384, 169:1385, 124:1386, 180:1387, 224:1388, 248:1389, 277:1390,
104:1391, 146:1392, 169:1393, 124:1394, 180:1395, 224:1396, 174:1397, 277:1398, 104:1399, 146:1400,
291:1401, 321:1402, 433:1403, 427:1404, 523:1405, 523:1406, 360:1407, 508:1408, 484:1409, 167:1410,
186:1411, 84:1412, 145:1413, 120:1414, 145:1415, 492:1416, 209:1417, 277:1418, 317:1419, 308:1420,
291:1421, 291:1422, 293:1423, 293:1424, 254:1425, 175:1426, 191:1427, 100:1428, 100:1429, 103:1430,
120:1431, 450:1432, 184:1433, 395:1434, 337:1435, 321:1436, 321:1437, 322:1438, 322:1439, 287:1440,
175:1441, 211:1442, 100:1443, 161:1444, 117:1445, 175:1446, 359:1447, 239:1448, 562:1449, 465:1450,
598:1451, 567:1452, 567:1453, 399:1454, 188:1455, 204:1456, 147:1457, 204:1458, 148:1459, 205:1460,
604:1461, 253:1462, 481:1463, 194:1464, 120:1465, 161:1466, 619:1467, 178:1468, 120:1469, 145:1470,
582:1471, 178:1472, 120:1473, 145:1474, 429:1475, 146:1476, 105:1477, 146:1478, 599:1479, 146:1480,
105:1481, 146:1482, 152:1483, 262:1484, 85:1485, 162:1486, 70:1487, 127:1488, 400:1489, 175:1490,
212:1491, 99:1492, 99:1493, 150:1494, 99:1495, 115:1496, 255:1497, 68:1498, 85:1499, 85:1500,
126:1501, 234:1502, 126:1503, 134:1504, 133:1505, 117:1506, 149:1507, 175:1508, 69:1509, 69:1510,
104:1511, 104:1512, 76:1513, 93:1514, 107:1515, 121:1516, 119:1517, 103:1518, 103:1519, 119:1520,
119:1521, 84:1522, 55:1523, 71:1524, 57:1525, 57:1526, 90:1527, 107:1528, 121:1529, 107:1530,
102:1531, 58:1532, 118:1533, 162:1534, 309:1535, 151:1536, 42:1537, 83:1538, 144:1539, 99:1540,
160:1541, 170:1542, 277:1543, 118:1544, 42:1545, 83:1546, 142:1547, 97:1548, 153:1549, 197:1550,
235:1551, 250:1552, 77:1553, 118:1554, 142:1555, 97:1556, 153:1557, 197:1558, 161:1559, 250:1560,
77:1561, 118:1562, 264:1563, 294:1564, 406:1565, 400:1566, 495:1567, 495:1568, 348:1569, 495:1570,
472:1571, 140:1572, 159:1573, 57:1574, 118:1575, 93:1576, 117:1577, 480:1578, 181:1579, 249:1580,
290:1581, 281:1582, 264:1583, 264:1584, 281:1585, 281:1586, 241:1587, 148:1588, 164:1589, 73:1590,
73:1591, 76:1592, 93:1593, 438:1594, 157:1595, 368:1596, 310:1597, 294:1598, 294:1599, 310:1600,
310:1601, 275:1602, 148:1603, 184:1604, 73:1605, 134:1606, 90:1607, 148:1608, 346:1609, 212:1610,
535:1611, 438:1612, 571:1613, 555:1614, 555:1615, 387:1616, 161:1617, 177:1618, 120:1619, 177:1620,
121:1621, 178:1622, 592:1623, 226:1624, 481:1625, 167:1626, 93:1627, 134:1628, 619:1629, 150:1630,
93:1631, 117:1632, 582:1633, 150:1634, 93:1635, 117:1636, 429:1637, 134:1638, 93:1639, 134:1640,
599:1641, 134:1642, 93:1643, 134:1644, 140:1645, 249:1646, 73:1647, 150:1648, 57:1649, 115:1650,
388:1651, 163:1652, 185:1653, 71:1654, 71:1655, 123:1656, 71:1657, 88:1658, 228:1659, 41:1660,
57:1661, 57:1662, 99:1663, 221:1664, 98:1665, 107:1666, 121:1667, 90:1668, 137:1669, 148:1670,
52:1671, 52:1672, 52:1673, 52:1674, 26:1675, 26:1676, 26:1677, 52:1678, 52:1679, 52:1680,
52:1681, 52:1682, 52:1683, 26:1684, 26:1685, 26:1686, 26:1687, 26:1688, 70:1689, 26:1690,
45:1691, 220:1692, 70:1693, 26:1694, 50:1695, 70:1696, 26:1697, 45:1698, 146:1699, 70:1700,
26:1701, 50:1702, 110:1703, 65:1704, 45:1705, 146:1706, 168:1707, 26:1708, 50:1709, 110:1710,
65:1711, 45:1712, 72:1713, 168:1714, 26:1715, 50:1716, 65:1717, 45:1718, 110:1719, 336:1720,
336:1721, 189:1722, 336:1723, 272:1724, 26:1725, 70:1726, 26:1727, 50:1728, 26:1729, 26:1730,
65:1731, 65:1732, 65:1733, 65:1734, 65:1735, 26:1736, 26:1737, 26:1738, 26:1739, 26:1740,
26:1741, 45:1742, 45:1743, 45:1744, 45:1745, 45:1746, 45:1747, 26:1748, 45:1749, 26:1750,
26:1751, 26:1752, 134:1753, 70:1754, 26:1755, 50:1756, 419:1757, 70:1758, 26:1759, 50:1760,
382:1761, 70:1762, 26:1763, 50:1764, 213:1765, 70:1766, 26:1767, 50:1768, 382:1769, 70:1770,
26:1771, 50:1772, 26:1773, 45:1774, 26:1775, 26:1776, 26:1777, 147:1778, 26:1779, 26:1780,
26:1781, 50:1782, 26:1783, 26:1784, 26:1785, 26:1786, 69:1787, 69:1788, 104:1789, 104:1790,

61:1791, 77:1792, 91:1793, 104:1794, 87:1795, 87:1796, 104:1797, 104:1798, 69:1799, 42:1800,
42:1801, 75:1802, 91:1803, 91:1804, 478:1805, 257:1806, 70:1807, 42:1808, 103:1809, 183:1810,
204:1811, 314:1812, 150:1813, 150:1814, 277:1815, 75:1816, 119:1817, 26:1818, 67:1819, 83:1820,
187:1821, 187:1822, 112:1823, 84:1824, 144:1825, 155:1826, 139:1827, 139:1828, 155:1829, 155:1830,
245:1831, 42:1832, 87:1833, 26:1834, 67:1835, 125:1836, 885:1837, 110:1838, 81:1839, 138:1840,
223:1841, 316:1842, 206:1843, 190:1844, 190:1845, 203:1846, 75:1847, 218:1848, 61:1849, 102:1850,
118:1851, 110:1852, 81:1853, 138:1854, 223:1855, 242:1856, 206:1857, 190:1858, 190:1859, 130:1860,
75:1861, 218:1862, 61:1863, 102:1864, 118:1865, 156:1866, 186:1867, 300:1868, 448:1869, 448:1870,
300:1871, 448:1872, 425:1873, 26:1874, 70:1875, 61:1876, 86:1877, 166:1878, 141:1879, 173:1880,
156:1881, 156:1882, 173:1883, 173:1884, 133:1885, 42:1886, 42:1887, 61:1888, 77:1889, 141:1890,
202:1891, 186:1892, 186:1893, 202:1894, 202:1895, 167:1896, 42:1897, 103:1898, 75:1899, 132:1900,
196:1901, 551:1902, 534:1903, 381:1904, 75:1905, 119:1906, 61:1907, 102:1908, 182:1909, 589:1910,
556:1911, 572:1912, 58:1913, 103:1914, 61:1915, 86:1916, 166:1917, 632:1918, 836:1919, 535:1920,
58:1921, 103:1922, 61:1923, 86:1924, 166:1925, 575:1926, 382:1927, 42:1928, 87:1929, 61:1930,
102:1931, 182:1932, 551:1933, 42:1934, 87:1935, 61:1936, 102:1937, 182:1938, 42:1939, 103:1940,
26:1941, 83:1942, 147:1943, 197:1944, 26:1945, 42:1946, 42:1947, 26:1948, 67:1949, 83:1950,
75:1951, 75:1952, 132:1953, 52:1954, 52:1955, 87:1956, 87:1957, 61:1958, 61:1959, 75:1960,
87:1961, 87:1962, 87:1963, 87:1964, 87:1965, 52:1966, 26:1967, 26:1968, 75:1969, 75:1970,
75:1971, 442:1972, 221:1973, 51:1974, 26:1975, 66:1976, 147:1977, 184:1978, 295:1979, 114:1980,
114:1981, 241:1982, 58:1983, 83:1984, 26:1985, 50:1986, 66:1987, 151:1988, 151:1989, 92:1990,
67:1991, 108:1992, 119:1993, 119:1994, 119:1995, 119:1996, 119:1997, 209:1998, 26:1999, 50:2000,
26:2001, 50:2002, 108:2003, 849:2004, 90:2005, 65:2006, 102:2007, 186:2008, 296:2009, 186:2010,
154:2011, 154:2012, 167:2013, 58:2014, 182:2015, 61:2016, 86:2017, 102:2018, 90:2019, 65:2020,
102:2021, 186:2022, 222:2023, 186:2024, 154:2025, 154:2026, 94:2027, 58:2028, 182:2029, 61:2030,
86:2031, 102:2032, 156:2033, 166:2034, 280:2035, 428:2036, 428:2037, 281:2038, 428:2039, 405:2040,
26:2041, 50:2042, 61:2043, 86:2044, 166:2045, 125:2046, 156:2047, 156:2048, 156:2049, 156:2050,
156:2051, 117:2052, 26:2053, 26:2054, 61:2055, 61:2056, 125:2057, 166:2058, 166:2059, 166:2060,
166:2061, 166:2062, 131:2063, 26:2064, 66:2065, 75:2066, 116:2067, 180:2068, 531:2069, 498:2070,
345:2071, 58:2072, 83:2073, 61:2074, 86:2075, 166:2076, 495:2077, 536:2078, 552:2079, 58:2080,
83:2081, 61:2082, 86:2083, 166:2084, 539:2085, 816:2086, 442:2087, 58:2088, 83:2089, 61:2090,
86:2091, 166:2092, 539:2093, 346:2094, 26:2095, 50:2096, 61:2097, 86:2098, 166:2099, 515:2100,
26:2101, 50:2102, 61:2103, 86:2104, 166:2105, 26:2106, 66:2107, 26:2108, 66:2109, 131:2110,
180:2111, 26:2112, 26:2113, 26:2114, 26:2115, 50:2116, 66:2117, 75:2118, 75:2119, 116:2120,
52:2121, 52:2122, 52:2123, 52:2124, 26:2125, 26:2126, 26:2127, 52:2128, 52:2129, 52:2130,
52:2131, 52:2132, 52:2133, 26:2134, 26:2135, 26:2136, 26:2137, 26:2138, 417:2139, 196:2140,
26:2141, 26:2142, 26:2143, 122:2144, 159:2145, 270:2146, 89:2147, 89:2148, 200:2149, 58:2150,
58:2151, 26:2152, 26:2153, 26:2154, 126:2155, 126:2156, 26:2157, 26:2158, 26:2159, 53:2160,
53:2161, 53:2162, 53:2163, 53:2164, 126:2165, 26:2166, 26:2167, 26:2168, 26:2169, 26:2170,
701:2171, 65:2172, 65:2173, 26:2174, 162:2175, 271:2176, 162:2177, 129:2178, 129:2179, 126:2180,
58:2181, 157:2182, 26:2183, 26:2184, 26:2185, 65:2186, 65:2187, 26:2188, 162:2189, 197:2190,
162:2191, 129:2192, 129:2193, 53:2194, 58:2195, 157:2196, 26:2197, 26:2198, 26:2199, 65:2200,
26:2201, 65:2202, 65:2203, 65:2204, 65:2205, 65:2206, 26:2207, 26:2208, 26:2209, 26:2210,

26:2211, 26:2212, 26:2213, 65:2214, 65:2215, 65:2216, 65:2217, 65:2218, 26:2219, 26:2220,
26:2221, 26:2222, 26:2223, 26:2224, 26:2225, 26:2226, 26:2227, 26:2228, 26:2229, 26:2230,
26:2231, 26:2232, 26:2233, 26:2234, 26:2235, 316:2236, 284:2237, 114:2238, 58:2239, 58:2240,
26:2241, 26:2242, 26:2243, 353:2244, 247:2245, 247:2246, 58:2247, 58:2248, 26:2249, 26:2250,
26:2251, 397:2252, 601:2253, 284:2254, 58:2255, 58:2256, 26:2257, 26:2258, 26:2259, 323:2260,
114:2261, 26:2262, 26:2263, 26:2264, 26:2265, 26:2266, 210:2267, 26:2268, 26:2269, 26:2270,
26:2271, 26:2272, 26:2273, 26:2274, 26:2275, 26:2276, 26:2277, 180:2278, 26:2279, 26:2280,
26:2281, 26:2282, 26:2283, 26:2284, 26:2285, 26:2286, 26:2287, 180:2288, 191:2289, 224:2290,
163:2291, 163:2292, 197:2293, 180:2294, 180:2295, 147:2296, 164:2297, 164:2298, 180:2299, 195:2300,
223:2301, 212:2302, 196:2303, 196:2304, 70:2305, 26:2306, 234:2307, 112:2308, 67:2309, 202:2310,
110:2311, 65:2312, 160:2313, 110:2314, 65:2315, 86:2316, 233:2317, 352:2318, 448:2319, 448:2320,
300:2321, 448:2322, 425:2323, 233:2324, 233:2325, 233:2326, 233:2327, 233:2328, 194:2329, 390:2330,
545:2331, 508:2332, 339:2333, 508:2334, 67:2335, 26:2336, 216:2337, 67:2338, 26:2339, 143:2340,
106:2341, 65:2342, 143:2343, 106:2344, 65:2345, 69:2346, 92:2347, 326:2348, 422:2349, 422:2350,
274:2351, 422:2352, 358:2353, 92:2354, 92:2355, 92:2356, 92:2357, 92:2358, 53:2359, 350:2360,
505:2361, 468:2362, 298:2363, 468:2364, 445:2365, 224:2366, 87:2367, 26:2368, 150:2369, 187:2370,
298:2371, 150:2372, 150:2373, 277:2374, 187:2375, 187:2376, 128:2377, 67:2378, 155:2379, 155:2380,
155:2381, 155:2382, 155:2383, 245:2384, 852:2385, 126:2386, 65:2387, 190:2388, 299:2389, 190:2390,
190:2391, 190:2392, 203:2393, 126:2394, 65:2395, 190:2396, 225:2397, 190:2398, 190:2399, 190:2400,
130:2401, 233:2402, 369:2403, 464:2404, 464:2405, 317:2406, 464:2407, 441:2408, 233:2409, 233:2410,
233:2411, 233:2412, 233:2413, 194:2414, 587:2415, 587:2416, 434:2417, 572:2418, 572:2419, 588:2420,
648:2421, 852:2422, 551:2423, 575:2424, 382:2425, 551:2426, 26:2427, 26:2428, 200:2429, 67:2430,
67:2431, 168:2432, 65:2433, 65:2434, 126:2435, 65:2436, 65:2437, 53:2438, 233:2439, 308:2440,
403:2441, 403:2442, 256:2443, 403:2444, 364:2445, 233:2446, 233:2447, 233:2448, 233:2449, 233:2450,
194:2451, 356:2452, 511:2453, 474:2454, 305:2455, 474:2456, 86:2457, 58:2458, 293:2459, 128:2460,
99:2461, 260:2462, 125:2463, 97:2464, 219:2465, 125:2466, 97:2467, 145:2468, 249:2469, 368:2470,
463:2471, 463:2472, 316:2473, 463:2474, 440:2475, 265:2476, 249:2477, 249:2478, 265:2479, 265:2480,
226:2481, 449:2482, 587:2483, 550:2484, 397:2485, 567:2486, 61:2487, 41:2488, 235:2489, 103:2490,
83:2491, 203:2492, 100:2493, 81:2494, 161:2495, 100:2496, 81:2497, 88:2498, 249:2499, 343:2500,
438:2501, 438:2502, 291:2503, 438:2504, 399:2505, 249:2506, 249:2507, 249:2508, 249:2509, 249:2510,
209:2511, 392:2512, 546:2513, 510:2514, 340:2515, 510:2516, 458:2517, 236:2518, 66:2519, 41:2520,
163:2521, 200:2522, 310:2523, 130:2524, 130:2525, 216:2526, 167:2527, 167:2528, 66:2529, 41:2530,
93:2531, 93:2532, 93:2533, 93:2534, 93:2535, 142:2536, 864:2537, 106:2538, 81:2539, 202:2540,
311:2541, 202:2542, 169:2543, 169:2544, 142:2545, 106:2546, 81:2547, 202:2548, 238:2549, 202:2550,
169:2551, 169:2552, 68:2553, 184:2554, 325:2555, 421:2556, 421:2557, 274:2558, 421:2559, 357:2560,
184:2561, 184:2562, 184:2563, 184:2564, 184:2565, 145:2566, 577:2567, 544:2568, 349:2569, 562:2570,
529:2571, 504:2572, 605:2573, 809:2574, 467:2575, 531:2576, 298:2577, 467:2578, 678:2579, 138:2580,
138:2581, 748:2582, 244:2583, 170:2584, 713:2585, 172:2586, 98:2587, 631:2588, 172:2589, 98:2590,
746:2591, 205:2592, 131:2593, 760:2594, 220:2595, 146:2596, 74:2597, 77:2598, 74:2599, 176:2600,
74:2601, 176:2602, 396:2603, 316:2604, 449:2605, 33:2606, 74:2607, 77:2608, 77:2609, 77:2610,
291:2611, 70:2612, 33:2613, 70:2614, 107:2615, 217:2616, 33:2617, 33:2618, 68:2619, 109:2620,
109:2621, 61:2622, 159:2623, 68:2624, 109:2625, 109:2626, 61:2627, 159:2628, 406:2629, 326:2630,

487:2631, 105:2632, 76:2633, 522:2634, 76:2635, 76:2636, 507:2637, 76:2638, 76:2639, 105:2640,
76:2641, 49:2642, 49:2643, 49:2644, 147:2645, 49:2646, 147:2647, 182:2648, 33:2649, 165:2650,
49:2651, 49:2652, 49:2653, 33:2654, 33:2655, 33:2656, 52:2657, 33:2658, 151:2659, 33:2660,
151:2661, 306:2662, 226:2663, 358:2664, 33:2665, 33:2666, 52:2667, 52:2668, 52:2669, 49:2670,
74:2671, 49:2672, 172:2673, 49:2674, 172:2675, 349:2676, 269:2677, 430:2678, 61:2679, 49:2680,
74:2681, 74:2682, 74:2683, 328:2684, 107:2685, 33:2686, 33:2687, 107:2688, 180:2689, 33:2690,
33:2691, 33:2692, 33:2693, 33:2694, 33:2695, 131:2696, 33:2697, 33:2698, 33:2699, 33:2700,
131:2701, 107:2702, 33:2703, 61:2704, 61:2705, 33:2706, 107:2707, 107:2708, 33:2709, 33:2710,
165:2711, 33:2712, 33:2713, 61:2714, 33:2715, 342:2716, 121:2717, 48:2718, 48:2719, 121:2720,
195:2721, 48:2722, 48:2723, 48:2724, 48:2725, 48:2726, 48:2727, 146:2728, 48:2729, 48:2730,
48:2731, 48:2732, 146:2733, 121:2734, 48:2735, 76:2736, 76:2737, 48:2738, 48:2739, 48:2740,
48:2741, 121:2742, 48:2743, 48:2744, 76:2745, 48:2746, 48:2747, 72:2748, 83:2749, 199:2750,
83:2751, 199:2752, 215:2753, 83:2754, 244:2755, 104:2756, 75:2757, 100:2758, 100:2759, 100:2760,
90:2761, 125:2762, 125:2763, 374:2764, 299:2765, 431:2766, 49:2767, 90:2768, 74:2769, 109:2770,
109:2771, 358:2772, 299:2773, 431:2774, 33:2775, 74:2776, 106:2777, 109:2778, 106:2779, 208:2780,
106:2781, 208:2782, 428:2783, 332:2784, 493:2785, 93:2786, 106:2787, 109:2788, 93:2789, 93:2790,
48:2791, 68:2792, 48:2793, 166:2794, 48:2795, 166:2796, 371:2797, 291:2798, 452:2799, 77:2800,
48:2801, 68:2802, 68:2803, 68:2804, 33:2805, 33:2806, 33:2807, 165:2808, 33:2809, 165:2810,
33:2811, 33:2812, 48:2813, 48:2814, 73:2815, 48:2816, 48:2817, 172:2818, 48:2819, 48:2820,
172:2821, 348:2822, 268:2823, 401:2824, 48:2825, 48:2826, 48:2827, 73:2828, 48:2829, 73:2830,
48:2831, 73:2832, 293:2833, 293:2834, 265:2835, 265:2836, 176:2837, 221:2838, 221:2839, 250:2840,
264:2841, 238:2842, 237:2843, 61:2844, 25:2845, 102:2846, 83:2847, 45:2848, 25:2849, 61:2850,
25:2851, 61:2852, 25:2853, 202:2854, 283:2855, 45:2856, 25:2857, 105:2858, 281:2859, 202:2860,
202:2861, 202:2862, 202:2863, 202:2864, 202:2865, 61:2866, 41:2867, 105:2868, 416:2869, 416:2870,
283:2871, 41:2872, 105:2873, 25:2874, 25:2875, 25:2876, 45:2877, 25:2878, 45:2879, 25:2880,
61:2881, 41:2882, 105:2883, 25:2884, 41:2885, 41:2886, 99:2887, 266:2888, 220:2889, 415:2890,
415:2891, 247:2892, 107:2893, 171:2894, 83:2895, 266:2896, 204:2897, 399:2898, 399:2899, 231:2900,
90:2901, 154:2902, 61:2903, 57:2904, 61:2905, 41:2906, 41:2907, 102:2908, 99:2909, 61:2910,
41:2911, 83:2912, 96:2913, 92:2914, 159:2915, 76:2916, 76:2917, 96:2918, 92:2919, 159:2920,
76:2921, 76:2922, 237:2923, 335:2924, 61:2925, 76:2926, 140:2927, 281:2928, 237:2929, 237:2930,
237:2931, 237:2932, 237:2933, 202:2934, 61:2935, 90:2936, 154:2937, 415:2938, 335:2939, 468:2940,
468:2941, 468:2942, 300:2943, 57:2944, 107:2945, 154:2946, 61:2947, 76:2948, 140:2949, 61:2950,
76:2951, 140:2952, 61:2953, 76:2954, 140:2955, 61:2956, 76:2957, 140:2958, 61:2959, 76:2960,
140:2961, 77:2962, 57:2963, 105:2964, 41:2965, 41:2966, 90:2967, 93:2968, 41:2969, 134:2970,
115:2971, 77:2972, 41:2973, 93:2974, 41:2975, 93:2976, 41:2977, 217:2978, 327:2979, 60:2980,
25:2981, 134:2982, 312:2983, 234:2984, 217:2985, 217:2986, 234:2987, 234:2988, 234:2989, 93:2990,
57:2991, 122:2992, 448:2993, 448:2994, 315:2995, 57:2996, 150:2997, 41:2998, 25:2999, 25:3000,
77:3001, 41:3002, 77:3003, 41:3004, 93:3005, 57:3006, 122:3007, 41:3008, 57:3009, 57:3010,
41:3011, 41:3012, 41:3013, 41:3014, 41:3015, 41:3016, 41:3017, 41:3018, 41:3019, 41:3020,
41:3021, 41:3022, 41:3023, 41:3024, 41:3025, 40:3026, 40:3027, 40:3028, 40:3029, 40:3030,
79:3031, 75:3032, 79:3033, 75:3034, 79:3035, 79:3036, 226:3037, 64:3038, 64:3039, 68:3040,
75:3041, 75:3042, 75:3043, 75:3044, 53:3045, 60:3046, 53:3047, 60:3048, 68:3049, 25:3050,

40:3051, 25:3052, 25:3053, 25:3054, 40:3055, 25:3056, 25:3057, 25:3058, 25:3059, 40:3060,
25:3061, 40:3062, 25:3063, 25:3064, 668:3065, 147:3066, 147:3067, 147:3068, 97:3069, 116:3070,
44:3071, 373:3072, 173:3073, 200:3074, 92:3075, 109:3076, 32:3077, 32:3078, 347:3079, 92:3080,
129:3081, 32:3082, 291:3083, 118:3084, 134:3085, 520:3086, 68:3087, 178:3088, 32:3089, 316:3090,
114:3091, 52:3092, 150:3093, 35:3094, 77:3095, 57:3096, 35:3097, 35:3098, 35:3099, 176:3100,
286:3101, 97:3102, 116:3103, 44:3104, 35:3105, 373:3106, 157:3107, 184:3108, 92:3109, 92:3110,
16:3111, 16:3112, 331:3113, 255:3114, 176:3115, 176:3116, 176:3117, 176:3118, 176:3119, 176:3120,
92:3121, 112:3122, 16:3123, 35:3124, 275:3125, 391:3126, 391:3127, 258:3128, 118:3129, 118:3130,
504:3131, 35:3132, 35:3133, 68:3134, 162:3135, 16:3136, 35:3137, 300:3138, 114:3139, 35:3140,
133:3141, 16:3142, 16:3143, 16:3144, 16:3145, 16:3146, 16:3147, 16:3148, 16:3149, 16:3150,
16:3151, 16:3152, 16:3153, 16:3154, 16:3155, 16:3156, 16:3157, 16:3158, 16:3159, 92:3160,
235:3161, 68:3162, 68:3163, 16:3164, 331:3165, 92:3166, 119:3167, 92:3168, 92:3169, 16:3170,
16:3171, 267:3172, 191:3173, 92:3174, 92:3175, 92:3176, 92:3177, 92:3178, 92:3179, 92:3180,
92:3181, 16:3182, 16:3183, 191:3184, 368:3185, 368:3186, 235:3187, 89:3188, 89:3189, 481:3190,
89:3191, 89:3192, 235:3193, 68:3194, 142:3195, 257:3196, 68:3197, 216:3198, 184:3199, 68:3200,
142:3201, 16:3202, 184:3203, 68:3204, 68:3205, 16:3206, 257:3207, 68:3208, 142:3209, 16:3210,
16:3211, 257:3212, 16:3213, 114:3214, 166:3215, 16:3216, 16:3217, 68:3218, 16:3219, 114:3220,
74:3221, 74:3222, 474:3223, 191:3224, 117:3225, 295:3226, 194:3227, 120:3228, 456:3229, 295:3230,
74:3231, 147:3232, 74:3233, 285:3234, 164:3235, 74:3236, 164:3237, 90:3238, 147:3239, 147:3240,
74:3241, 206:3242, 147:3243, 74:3244, 74:3245, 43:3246, 43:3247, 43:3248, 43:3249, 43:3250,
27:3251, 27:3252, 43:3253, 43:3254, 43:3255, 117:3256, 43:3257, 105:3258, 258:3259, 105:3260,
274:3261, 27:3262, 27:3263, 27:3264, 27:3265, 27:3266, 27:3267, 27:3268, 27:3269, 27:3270,
27:3271, 120:3272, 46:3273, 301:3274, 419:3275, 249:3276, 419:3277, 27:3278, 27:3279, 27:3280,
27:3281, 27:3282, 27:3283, 55:3284, 27:3285, 27:3286, 27:3287, 27:3288, 27:3289, 62:3290,
62:3291, 62:3292, 62:3293, 62:3294, 62:3295, 62:3296, 27:3297, 27:3298, 27:3299, 62:3300,
62:3301, 62:3302, 62:3303, 90:3304, 62:3305, 62:3306, 27:3307, 43:3308, 43:3309, 43:3310,
43:3311, 43:3312, 27:3313, 55:3314, 43:3315, 43:3316, 43:3317, 27:3318, 27:3319, 27:3320,
27:3321, 27:3322, 27:3323, 55:3324, 27:3325, 27:3326, 27:3327, 27:3328, 27:3329, 27:3330,
27:3331, 27:3332, 27:3333, 27:3334, 27:3335, 27:3336, 27:3337, 79:3338, 51:3339, 65:3340,
93:3341, 51:3342, 51:3343, 79:3344, 51:3345, 51:3346, 16:3347, 72:3348, 72:3349, 72:3350,
43:3351, 65:3352, 65:3353, 65:3354, 93:3355, 223:3356, 192:3357, 321:3358, 297:3359, 393:3360,
393:3361, 246:3362, 393:3363, 354:3364, 124:3365, 124:3366, 72:3367, 43:3368, 51:3369, 51:3370,
389:3371, 143:3372, 192:3373, 219:3374, 223:3375, 223:3376, 223:3377, 223:3378, 223:3379, 184:3380,
120:3381, 120:3382, 43:3383, 43:3384, 51:3385, 51:3386, 366:3387, 115:3388, 255:3389, 192:3390,
192:3391, 192:3392, 192:3393, 192:3394, 157:3395, 120:3396, 120:3397, 43:3398, 43:3399, 65:3400,
65:3401, 255:3402, 129:3403, 373:3404, 293:3405, 454:3406, 426:3407, 426:3408, 258:3409, 146:3410,
146:3411, 72:3412, 43:3413, 65:3414, 65:3415, 504:3416, 157:3417, 452:3418, 452:3419, 319:3420,
117:3421, 117:3422, 43:3423, 43:3424, 51:3425, 51:3426, 293:3427, 115:3428, 474:3429, 474:3430,
400:3431, 96:3432, 170:3433, 43:3434, 43:3435, 51:3436, 51:3437, 315:3438, 115:3439, 513:3440,
717:3441, 437:3442, 124:3443, 272:3444, 72:3445, 43:3446, 51:3447, 51:3448, 241:3449, 143:3450,
440:3451, 268:3452, 96:3453, 170:3454, 43:3455, 43:3456, 51:3457, 51:3458, 241:3459, 115:3460,
437:3461, 96:3462, 96:3463, 43:3464, 43:3465, 51:3466, 51:3467, 315:3468, 115:3469, 68:3470,

142:3471, 16:3472, 16:3473, 16:3474, 16:3475, 280:3476, 80:3477, 72:3478, 142:3479, 43:3480,
43:3481, 194:3482, 72:3483, 72:3484, 43:3485, 43:3486, 43:3487, 96:3488, 72:3489, 43:3490,
43:3491, 43:3492, 72:3493, 43:3494, 43:3495, 142:3496, 43:3497, 65:3498, 65:3499, 65:3500,
65:3501, 65:3502, 129:3503, 79:3504, 51:3505, 65:3506, 93:3507, 51:3508, 51:3509, 79:3510,
51:3511, 51:3512, 16:3513, 72:3514, 72:3515, 72:3516, 43:3517, 65:3518, 65:3519, 65:3520,
93:3521, 181:3522, 150:3523, 321:3524, 297:3525, 393:3526, 393:3527, 246:3528, 393:3529, 354:3530,
124:3531, 124:3532, 72:3533, 43:3534, 51:3535, 51:3536, 389:3537, 102:3538, 150:3539, 177:3540,
181:3541, 181:3542, 181:3543, 181:3544, 181:3545, 142:3546, 120:3547, 120:3548, 43:3549, 43:3550,
51:3551, 51:3552, 325:3553, 73:3554, 213:3555, 150:3556, 150:3557, 150:3558, 150:3559, 150:3560,
115:3561, 120:3562, 120:3563, 43:3564, 43:3565, 65:3566, 65:3567, 213:3568, 87:3569, 426:3570,
426:3571, 258:3572, 146:3573, 146:3574, 65:3575, 65:3576, 504:3577, 116:3578, 489:3579, 319:3580,
117:3581, 117:3582, 51:3583, 51:3584, 293:3585, 73:3586, 474:3587, 96:3588, 170:3589, 51:3590,
51:3591, 315:3592, 73:3593, 550:3594, 754:3595, 437:3596, 124:3597, 272:3598, 51:3599, 51:3600,
241:3601, 102:3602, 477:3603, 268:3604, 96:3605, 170:3606, 43:3607, 43:3608, 51:3609, 51:3610,
241:3611, 73:3612, 437:3613, 96:3614, 96:3615, 43:3616, 43:3617, 51:3618, 51:3619, 315:3620,
73:3621, 68:3622, 142:3623, 16:3624, 16:3625, 16:3626, 16:3627, 280:3628, 38:3629, 72:3630,
142:3631, 43:3632, 43:3633, 194:3634, 72:3635, 72:3636, 43:3637, 43:3638, 43:3639, 96:3640,
72:3641, 43:3642, 43:3643, 43:3644, 72:3645, 43:3646, 43:3647, 142:3648, 43:3649, 65:3650,
65:3651, 65:3652, 65:3653, 65:3654, 87:3655, 44:3656, 16:3657, 65:3658, 93:3659, 16:3660,
16:3661, 44:3662, 16:3663, 16:3664, 16:3665, 44:3666, 44:3667, 44:3668, 16:3669, 65:3670,
65:3671, 65:3672, 93:3673, 184:3674, 157:3675, 286:3676, 258:3677, 354:3678, 354:3679, 206:3680,
354:3681, 354:3682, 97:3683, 97:3684, 44:3685, 16:3686, 16:3687, 16:3688, 354:3689, 108:3690,
157:3691, 184:3692, 184:3693, 184:3694, 184:3695, 184:3696, 184:3697, 184:3698, 92:3699, 92:3700,
16:3701, 16:3702, 16:3703, 16:3704, 331:3705, 80:3706, 255:3707, 157:3708, 157:3709, 157:3710,
157:3711, 157:3712, 157:3713, 92:3714, 92:3715, 16:3716, 16:3717, 65:3718, 65:3719, 255:3720,
129:3721, 338:3722, 258:3723, 419:3724, 391:3725, 391:3726, 258:3727, 118:3728, 118:3729, 44:3730,
16:3731, 65:3732, 65:3733, 504:3734, 157:3735, 452:3736, 452:3737, 319:3738, 89:3739, 89:3740,
16:3741, 16:3742, 16:3743, 16:3744, 258:3745, 80:3746, 474:3747, 474:3748, 400:3749, 68:3750,
142:3751, 16:3752, 16:3753, 16:3754, 16:3755, 280:3756, 80:3757, 474:3758, 717:3759, 437:3760,
97:3761, 244:3762, 44:3763, 16:3764, 16:3765, 16:3766, 206:3767, 108:3768, 400:3769, 268:3770,
68:3771, 142:3772, 16:3773, 16:3774, 16:3775, 16:3776, 206:3777, 80:3778, 437:3779, 68:3780,
68:3781, 16:3782, 16:3783, 16:3784, 16:3785, 280:3786, 80:3787, 68:3788, 142:3789, 16:3790,
16:3791, 16:3792, 16:3793, 280:3794, 80:3795, 44:3796, 114:3797, 16:3798, 16:3799, 166:3800,
44:3801, 44:3802, 16:3803, 16:3804, 16:3805, 68:3806, 44:3807, 16:3808, 16:3809, 16:3810,
44:3811, 16:3812, 16:3813, 114:3814, 16:3815, 65:3816, 65:3817, 65:3818, 65:3819, 65:3820,
129:3821, 44:3822, 16:3823, 65:3824, 93:3825, 16:3826, 16:3827, 44:3828, 16:3829, 16:3830,
16:3831, 44:3832, 44:3833, 44:3834, 16:3835, 65:3836, 65:3837, 65:3838, 93:3839, 184:3840,
157:3841, 286:3842, 258:3843, 354:3844, 354:3845, 206:3846, 354:3847, 354:3848, 97:3849, 97:3850,
44:3851, 16:3852, 16:3853, 16:3854, 354:3855, 108:3856, 157:3857, 184:3858, 184:3859, 184:3860,
184:3861, 184:3862, 184:3863, 184:3864, 92:3865, 92:3866, 16:3867, 16:3868, 16:3869, 16:3870,
331:3871, 80:3872, 255:3873, 157:3874, 157:3875, 157:3876, 157:3877, 157:3878, 157:3879, 92:3880,
92:3881, 16:3882, 16:3883, 65:3884, 65:3885, 255:3886, 129:3887, 338:3888, 258:3889, 419:3890,

391:3891, 391:3892, 258:3893, 118:3894, 118:3895, 44:3896, 16:3897, 65:3898, 65:3899, 356:3900,
157:3901, 452:3902, 452:3903, 319:3904, 89:3905, 89:3906, 16:3907, 16:3908, 16:3909, 16:3910,
258:3911, 80:3912, 474:3913, 474:3914, 400:3915, 68:3916, 142:3917, 16:3918, 16:3919, 16:3920,
16:3921, 280:3922, 80:3923, 474:3924, 717:3925, 437:3926, 97:3927, 244:3928, 44:3929, 16:3930,
16:3931, 16:3932, 206:3933, 108:3934, 400:3935, 268:3936, 68:3937, 142:3938, 16:3939, 16:3940,
16:3941, 16:3942, 206:3943, 80:3944, 437:3945, 68:3946, 68:3947, 16:3948, 16:3949, 16:3950,
16:3951, 280:3952, 80:3953, 68:3954, 142:3955, 16:3956, 16:3957, 16:3958, 16:3959, 280:3960,
80:3961, 44:3962, 114:3963, 16:3964, 16:3965, 166:3966, 44:3967, 44:3968, 16:3969, 16:3970,
16:3971, 68:3972, 44:3973, 16:3974, 16:3975, 16:3976, 44:3977, 16:3978, 16:3979, 114:3980,
16:3981, 65:3982, 65:3983, 65:3984, 65:3985, 65:3986, 129:3987, 358:3988, 488:3989, 284:3990,
193:3991, 213:3992, 308:3993, 161:3994, 161:3995, 308:3996, 308:3997, 308:3998, 326:3999, 326:4000,
193:4001, 439:4002, 235:4003, 265:4004, 332:4005, 369:4006, 369:4007, 236:4008, 384:4009, 258:4010,
393:4011, 452:4012, 261:4013, 319:4014, 246:4015, 262:4016, 336:4017, 301:4018, 373:4019, 436:4020,
225:4021, 300:4022, 226:4023, 226:4024, 300:4025, 264:4026, 409:4027, 505:4028, 314:4029, 336:4030,
262:4031, 262:4032, 336:4033, 301:4034, 306:4035, 373:4036, 358:4037, 278:4038, 439:4039, 410:4040,
410:4041, 242:4042, 488:4043, 264:4044, 53:4045, 72:4046, 141:4047, 168:4048, 77:4049, 77:4050,
316:4051, 77:4052, 97:4053, 259:4054, 74:4055, 74:4056, 53:4057, 146:4058, 69:4059, 89:4060,
176:4061, 203:4062, 77:4063, 77:4064, 351:4065, 77:4066, 97:4067, 259:4068, 90:4069, 90:4070,
90:4071, 110:4072, 69:4073, 162:4074, 69:4075, 236:4076, 69:4077, 162:4078, 69:4079, 89:4080,
69:4081, 162:4082, 167:4083, 89:4084, 176:4085, 81:4086, 81:4087, 176:4088, 203:4089, 77:4090,
77:4091, 351:4092, 240:4093, 176:4094, 176:4095, 176:4096, 176:4097, 176:4098, 141:4099, 77:4100,
77:4101, 240:4102, 102:4103, 102:4104, 53:4105, 126:4106, 53:4107, 72:4108, 74:4109, 74:4110,
53:4111, 146:4112, 97:4113, 97:4114, 118:4115, 118:4116, 69:4117, 143:4118, 246:4119, 172:4120,
226:4121, 226:4122, 79:4123, 226:4124, 226:4125, 226:4126, 212:4127, 153:4128, 212:4129, 153:4130,
226:4131, 457:4132, 310:4133, 79:4134, 153:4135, 79:4136, 79:4137, 310:4138, 153:4139, 153:4140,
74:4141, 90:4142, 149:4143, 74:4144, 90:4145, 74:4146, 90:4147, 90:4148, 74:4149, 90:4150,
74:4151, 90:4152, 102:4153, 102:4154, 74:4155, 74:4156, 117:4157, 117:4158, 88:4159, 88:4160,
145:4161, 145:4162, 74:4163, 74:4164, 74:4165, 74:4166, 74:4167, 147:4168, 147:4169, 147:4170,
147:4171, 74:4172, 74:4173, 90:4174, 90:4175, 90:4176, 147:4177, 147:4178, 147:4179, 147:4180,
206:4181, 74:4182, 231:4183, 74:4184, 74:4185, 90:4186, 164:4187, 174:4188, 147:4189, 147:4190,
164:4191, 164:4192, 147:4193, 147:4194, 183:4195, 290:4196, 274:4197, 74:4198, 176:4199, 74:4200,
88:4201, 74:4202, 191:4203, 74:4204, 93:4205, 167:4206, 110:4207, 74:4208, 147:4209, 74:4210,
415:4211, 378:4212, 149:4213, 149:4214, 102:4215, 74:4216, 74:4217, 133:4218, 149:4219, 149:4220,
170:4221, 186:4222, 168:4223, 168:4224, 133:4225, 133:4226, 262:4227, 246:4228, 262:4229, 262:4230,
246:4231, 246:4232, 74:4233, 74:4234, 74:4235, 274:4236, 127:4237, 90:4238, 90:4239, 90:4240,
90:4241, 90:4242, 74:4243, 74:4244, 88:4245, 88:4246, 51:4247, 64:4248, 64:4249, 146:4250,
151:4251, 72:4252, 72:4253, 299:4254, 126:4255, 100:4256, 221:4257, 229:4258, 210:4259, 468:4260,
188:4261, 247:4262, 358:4263, 64:4264, 137:4265, 64:4266, 35:4267, 35:4268, 35:4269, 151:4270,
128:4271, 20:4272, 118:4273, 20:4274, 20:4275, 20:4276, 20:4277, 20:4278, 20:4279, 20:4280,
20:4281, 20:4282, 20:4283, 20:4284, 20:4285, 20:4286, 20:4287, 20:4288, 20:4289, 20:4290,
20:4291, 20:4292, 118:4293, 20:4294, 20:4295, 20:4296, 20:4297, 118:4298, 20:4299, 20:4300,
20:4301, 93:4302, 20:4303, 118:4304, 36:4305, 36:4306, 36:4307, 78:4308, 36:4309, 71:4310,

36:4311, 71:4312, 20:4313, 36:4314, 199:4315, 36:4316, 36:4317, 110:4318, 36:4319, 36:4320,
36:4321, 36:4322, 36:4323, 36:4324, 78:4325, 36:4326, 71:4327, 36:4328, 71:4329, 36:4330,
134:4331, 16:4332, 16:4333, 16:4334, 16:4335, 16:4336, 16:4337, 16:4338, 16:4339, 16:4340,
16:4341, 16:4342, 16:4343, 16:4344, 16:4345, 16:4346, 16:4347, 115:4348, 16:4349, 16:4350,
16:4351, 16:4352, 16:4353, 16:4354, 115:4355, 16:4356, 16:4357, 16:4358, 16:4359, 16:4360,
16:4361, 16:4362, 16:4363, 51:4364, 16:4365, 51:4366, 51:4367, 66:4368, 51:4369, 51:4370,
51:4371, 51:4372, 51:4373, 16:4374, 115:4375, 16:4376, 16:4377, 16:4378, 16:4379, 16:4380,
66:4381, 66:4382, 66:4383, 123:4384, 128:4385, 335:4386, 111:4387, 115:4388, 322:4389, 111:4390,
115:4391, 322:4392, 74:4393, 74:4394, 115:4395, 115:4396, 322:4397, 74:4398, 74:4399, 115:4400,
115:4401, 322:4402, 111:4403, 74:4404, 206:4405, 111:4406, 74:4407, 273:4408, 111:4409, 74:4410,
300:4411, 111:4412, 74:4413, 243:4414, 74:4415, 74:4416, 74:4417, 243:4418, 90:4419, 111:4420,
90:4421, 74:4422, 147:4423, 74:4424, 90:4425, 74:4426, 74:4427, 74:4428, 74:4429, 74:4430,
206:4431, 74:4432, 74:4433, 74:4434, 147:4435, 111:4436, 115:4437, 322:4438, 111:4439, 115:4440,
249:4441, 111:4442, 115:4443, 322:4444, 111:4445, 115:4446, 322:4447, 111:4448, 115:4449, 322:4450,
111:4451, 115:4452, 322:4453, 111:4454, 74:4455, 206:4456, 111:4457, 74:4458, 300:4459, 56:4460,
56:4461, 28:4462, 28:4463, 56:4464, 28:4465, 28:4466, 56:4467, 28:4468, 28:4469, 56:4470,
28:4471, 28:4472, 56:4473, 56:4474, 56:4475, 28:4476, 28:4477, 28:4478, 28:4479, 56:4480,
56:4481, 28:4482, 28:4483, 56:4484, 28:4485, 28:4486, 56:4487, 28:4488, 28:4489, 56:4490,
28:4491, 28:4492, 56:4493, 56:4494, 56:4495, 28:4496, 28:4497, 28:4498, 28:4499, 56:4500,
35:4501, 35:4502, 39:4503, 39:4504, 35:4505, 35:4506, 39:4507, 39:4508, 39:4509, 39:4510,
28:4511, 28:4512, 28:4513, 126:4514, 35:4515, 35:4516, 35:4517, 35:4518, 39:4519, 39:4520,
35:4521, 35:4522, 39:4523, 39:4524, 39:4525, 39:4526, 28:4527, 28:4528, 28:4529, 126:4530,
35:4531, 35:4532, 35:4533, 35:4534, 56:4535, 56:4536, 28:4537, 28:4538, 56:4539, 28:4540,
28:4541, 56:4542, 28:4543, 28:4544, 56:4545, 28:4546, 28:4547, 56:4548, 56:4549, 56:4550,
28:4551, 28:4552, 28:4553, 28:4554, 56:4555, 56:4556, 28:4557, 28:4558, 56:4559, 28:4560,
28:4561, 56:4562, 28:4563, 28:4564, 56:4565, 28:4566, 28:4567, 56:4568, 56:4569, 56:4570,
28:4571, 28:4572, 28:4573, 28:4574, 56:4575, 35:4576, 35:4577, 39:4578, 39:4579, 35:4580,
76:4581, 76:4582, 28:4583, 28:4584, 35:4585, 35:4586, 35:4587, 35:4588, 39:4589, 39:4590,
35:4591, 76:4592, 76:4593, 28:4594, 28:4595, 35:4596, 35:4597, 35:4598, 35:4599, 56:4600,
56:4601, 28:4602, 28:4603, 56:4604, 28:4605, 28:4606, 56:4607, 28:4608, 28:4609, 56:4610,
28:4611, 28:4612, 56:4613, 56:4614, 56:4615, 28:4616, 28:4617, 28:4618, 28:4619, 56:4620,
71:4621, 43:4622, 43:4623, 71:4624, 43:4625, 43:4626, 71:4627, 43:4628, 43:4629, 71:4630,
28:4631, 28:4632, 71:4633, 71:4634, 71:4635, 43:4636, 43:4637, 43:4638, 28:4639, 71:4640,
50:4641, 50:4642, 78:4643, 50:4644, 64:4645, 92:4646, 50:4647, 50:4648, 78:4649, 35:4650,
35:4651, 71:4652, 71:4653, 71:4654, 43:4655, 64:4656, 64:4657, 49:4658, 92:4659, 54:4660,
50:4661, 50:4662, 54:4663, 50:4664, 50:4665, 54:4666, 50:4667, 78:4668, 71:4669, 71:4670,
71:4671, 50:4672, 35:4673, 78:4674, 50:4675, 50:4676, 54:4677, 54:4678, 54:4679, 39:4680,
39:4681, 43:4682, 43:4683, 43:4684, 43:4685, 50:4686, 50:4687, 50:4688, 113:4689, 50:4690,
50:4691, 50:4692, 35:4693, 35:4694, 43:4695, 43:4696, 43:4697, 43:4698, 64:4699, 64:4700,
98:4701, 64:4702, 64:4703, 64:4704, 92:4705, 50:4706, 50:4707, 50:4708, 35:4709, 35:4710,
141:4711, 43:4712, 43:4713, 43:4714, 43:4715, 43:4716, 43:4717, 43:4718, 43:4719, 126:4720,
43:4721, 64:4722, 49:4723, 64:4724, 49:4725, 64:4726, 28:4727, 28:4728, 28:4729, 28:4730,

28:4731, 28:4732, 28:4733, 28:4734, 28:4735, 28:4736, 28:4737, 28:4738, 28:4739, 28:4740,
28:4741, 28:4742, 28:4743, 28:4744, 28:4745, 28:4746, 28:4747, 43:4748, 43:4749, 43:4750,
43:4751, 43:4752, 43:4753, 43:4754, 43:4755, 43:4756, 43:4757, 28:4758, 28:4759, 43:4760,
43:4761, 43:4762, 43:4763, 43:4764, 43:4765, 28:4766, 43:4767, 66:4768, 66:4769, 50:4770,
66:4771, 80:4772, 80:4773, 66:4774, 50:4775, 50:4776, 51:4777, 51:4778, 43:4779, 59:4780,
59:4781, 59:4782, 64:4783, 80:4784, 66:4785, 80:4786, 169:4787, 54:4788, 70:4789, 66:4790,
66:4791, 70:4792, 54:4793, 54:4794, 56:4795, 56:4796, 43:4797, 59:4798, 59:4799, 157:4800,
50:4801, 66:4802, 51:4803, 66:4804, 54:4805, 70:4806, 66:4807, 66:4808, 70:4809, 54:4810,
54:4811, 56:4812, 56:4813, 43:4814, 59:4815, 59:4816, 157:4817, 50:4818, 66:4819, 51:4820,
66:4821, 54:4822, 50:4823, 50:4824, 54:4825, 54:4826, 54:4827, 39:4828, 39:4829, 43:4830,
43:4831, 43:4832, 43:4833, 50:4834, 50:4835, 35:4836, 50:4837, 66:4838, 66:4839, 70:4840,
54:4841, 54:4842, 56:4843, 56:4844, 43:4845, 59:4846, 59:4847, 59:4848, 50:4849, 66:4850,
51:4851, 66:4852, 129:4853, 66:4854, 50:4855, 50:4856, 51:4857, 51:4858, 43:4859, 59:4860,
59:4861, 59:4862, 64:4863, 80:4864, 115:4865, 80:4866, 125:4867, 50:4868, 109:4869, 110:4870,
110:4871, 43:4872, 59:4873, 59:4874, 59:4875, 64:4876, 80:4877, 115:4878, 80:4879, 150:4880,
209:4881, 176:4882, 211:4883, 43:4884, 59:4885, 59:4886, 59:4887, 50:4888, 66:4889, 51:4890,
66:4891, 150:4892, 101:4893, 135:4894, 43:4895, 43:4896, 43:4897, 43:4898, 50:4899, 50:4900,
35:4901, 50:4902, 160:4903, 231:4904, 43:4905, 43:4906, 43:4907, 43:4908, 50:4909, 50:4910,
35:4911, 50:4912, 176:4913, 28:4914, 44:4915, 44:4916, 44:4917, 35:4918, 51:4919, 51:4920,
51:4921, 28:4922, 44:4923, 44:4924, 44:4925, 35:4926, 51:4927, 51:4928, 51:4929, 43:4930,
43:4931, 141:4932, 43:4933, 43:4934, 126:4935, 43:4936, 59:4937, 59:4938, 43:4939, 59:4940,
44:4941, 59:4942, 59:4943, 43:4944, 59:4945, 44:4946, 59:4947, 43:4948, 59:4949, 143:4950,
59:4951, 64:4952, 49:4953, 64:4954, 66:4955, 80:4956, 66:4957, 66:4958, 66:4959, 143:4960,
49:4961, 49:4962, 66:4963, 130:4964, 49:4965, 49:4966, 35:4967, 35:4968, 126:4969, 163:4970,
49:4971, 49:4972, 49:4973, 114:4974, 35:4975, 35:4976, 49:4977, 49:4978, 49:4979, 49:4980,
49:4981, 49:4982, 35:4983, 35:4984, 99:4985, 49:4986, 49:4987, 114:4988, 63:4989, 35:4990,
49:4991, 78:4992, 49:4993, 49:4994, 49:4995, 78:4996, 35:4997, 35:4998, 35:4999, 35:5000,
35:5001, 35:5002, 35:5003, 35:5004, 35:5005, 35:5006, 128:5007, 35:5008, 35:5009, 99:5010,
49:5011, 49:5012, 114:5013, 49:5014, 49:5015, 142:5016, 35:5017, 35:5018, 35:5019, 35:5020,
35:5021, 35:5022, 35:5023, 35:5024, 35:5025, 35:5026, 49:5027, 49:5028, 49:5029, 49:5030,
49:5031, 66:5032, 66:5033, 49:5034, 66:5035, 66:5036, 66:5037, 115:5038, 49:5039, 66:5040,
115:5041, 66:5042, 49:5043, 66:5044, 66:5045, 49:5046, 49:5047, 49:5048, 66:5049, 66:5050,
49:5051, 49:5052, 49:5053, 49:5054, 49:5055, 49:5056, 98:5057, 49:5058, 49:5059, 49:5060,
49:5061, 49:5062, 49:5063, 49:5064, 49:5065, 49:5066, 49:5067, 49:5068, 49:5069, 78:5070,
49:5071, 49:5072, 49:5073, 78:5074, 98:5075, 49:5076, 49:5077, 98:5078, 49:5079, 49:5080,
49:5081, 78:5082, 49:5083, 49:5084, 49:5085, 49:5086, 49:5087, 49:5088, 66:5089, 66:5090,
49:5091, 66:5092, 66:5093, 66:5094, 115:5095, 49:5096, 66:5097, 115:5098, 66:5099, 49:5100,
66:5101, 66:5102, 49:5103, 49:5104, 49:5105, 66:5106, 66:5107, 66:5108, 66:5109, 66:5110,
49:5111, 66:5112, 66:5113, 66:5114, 115:5115, 49:5116, 66:5117, 115:5118, 66:5119, 49:5120,
66:5121, 66:5122, 49:5123, 49:5124, 49:5125, 66:5126, 66:5127, 66:5128, 49:5129, 78:5130,
49:5131, 49:5132, 49:5133, 78:5134, 98:5135, 49:5136, 49:5137, 98:5138, 49:5139, 49:5140,
49:5141, 78:5142, 49:5143, 49:5144, 49:5145, 49:5146, 49:5147, 49:5148, 64:5149, 92:5150,

64:5151, 64:5152, 49:5153, 92:5154, 113:5155, 64:5156, 64:5157, 98:5158, 64:5159, 64:5160,
64:5161, 98:5162, 92:5163, 64:5164, 49:5165, 64:5166, 49:5167, 64:5168, 49:5169, 74:5170,
28:5171, 28:5172, 28:5173, 263:5174, 185:5175, 396:5176, 28:5177, 102:5178, 28:5179, 93:5180,
28:5181, 28:5182, 28:5183, 263:5184, 185:5185, 433:5186, 28:5187, 102:5188, 28:5189, 51:5190,
28:5191, 28:5192, 28:5193, 28:5194, 28:5195, 28:5196, 28:5197, 28:5198, 28:5199, 28:5200,
28:5201, 28:5202, 28:5203, 28:5204, 28:5205, 28:5206, 28:5207, 28:5208, 28:5209, 28:5210,
263:5211, 185:5212, 396:5213, 28:5214, 102:5215, 28:5216, 93:5217, 28:5218, 28:5219, 28:5220,
28:5221, 28:5222, 28:5223, 28:5224, 28:5225, 28:5226, 28:5227, 28:5228, 28:5229, 28:5230,
28:5231, 28:5232, 28:5233, 28:5234, 28:5235, 28:5236, 28:5237, 263:5238, 185:5239, 396:5240,
28:5241, 102:5242, 28:5243, 93:5244, 28:5245, 28:5246, 28:5247, 28:5248, 28:5249, 28:5250,
28:5251, 28:5252, 28:5253, 28:5254, 28:5255, 28:5256, 28:5257, 28:5258, 28:5259, 28:5260,
28:5261, 28:5262, 28:5263, 28:5264, 28:5265, 28:5266, 28:5267, 28:5268, 28:5269, 28:5270,
28:5271, 28:5272, 241:5273, 28:5274, 163:5275, 410:5276, 28:5277, 102:5278, 28:5279, 28:5280,
28:5281, 28:5282, 28:5283, 28:5284, 28:5285, 28:5286, 28:5287, 28:5288, 28:5289, 28:5290,
28:5291, 28:5292, 28:5293, 28:5294, 28:5295, 28:5296, 28:5297, 28:5298, 28:5299, 28:5300,
28:5301, 28:5302, 28:5303, 28:5304, 28:5305, 28:5306, 28:5307, 28:5308, 28:5309, 28:5310,
184:5311, 28:5312, 28:5313, 28:5314, 28:5315, 28:5316, 28:5317, 28:5318, 317:5319, 28:5320,
28:5321, 28:5322, 28:5323, 28:5324, 102:5325, 28:5326, 28:5327, 28:5328, 28:5329, 28:5330,
28:5331, 28:5332, 28:5333, 28:5334, 28:5335, 28:5336, 28:5337, 28:5338, 28:5339, 28:5340,
28:5341, 28:5342, 28:5343, 28:5344, 28:5345, 28:5346, 28:5347, 28:5348, 28:5349, 28:5350,
28:5351, 28:5352, 28:5353, 28:5354, 147:5355, 28:5356, 28:5357, 28:5358, 28:5359, 147:5360,
28:5361, 28:5362, 102:5363, 28:5364, 280:5365, 28:5366, 28:5367, 28:5368, 28:5369, 28:5370,
102:5371, 28:5372, 28:5373, 28:5374, 28:5375, 28:5376, 28:5377, 28:5378, 28:5379, 28:5380,
28:5381, 28:5382, 28:5383, 28:5384, 43:5385, 43:5386, 43:5387, 43:5388, 43:5389, 43:5390,
43:5391, 43:5392, 28:5393, 43:5394, 43:5395, 43:5396, 43:5397, 43:5398, 28:5399, 43:5400,
162:5401, 43:5402, 43:5403, 43:5404, 43:5405, 147:5406, 28:5407, 43:5408, 43:5409, 221:5410,
43:5411, 43:5412, 28:5413, 43:5414, 43:5415, 102:5416, 43:5417, 28:5418, 28:5419, 28:5420,
28:5421, 28:5422, 147:5423, 28:5424, 184:5425, 28:5426, 28:5427, 28:5428, 28:5429, 28:5430,
28:5431, 28:5432, 28:5433, 28:5434, 28:5435, 28:5436, 28:5437, 28:5438, 28:5439, 28:5440,
28:5441, 28:5442, 28:5443, 28:5444, 28:5445, 28:5446, 28:5447, 28:5448, 28:5449, 28:5450,
28:5451, 28:5452, 28:5453, 263:5454, 28:5455, 185:5456, 433:5457, 28:5458, 102:5459, 28:5460,
93:5461, 28:5462, 28:5463, 28:5464, 28:5465, 28:5466, 28:5467, 28:5468, 28:5469, 28:5470,
28:5471, 28:5472, 28:5473, 28:5474, 28:5475, 28:5476, 28:5477, 28:5478, 28:5479, 28:5480,
28:5481, 45:5482, 28:5483, 45:5484, 45:5485, 45:5486, 28:5487, 263:5488, 185:5489, 433:5490,
28:5491, 102:5492, 28:5493, 93:5494, 28:5495, 28:5496, 28:5497, 28:5498, 28:5499, 28:5500,
28:5501, 28:5502, 28:5503, 28:5504, 28:5505, 28:5506, 28:5507, 28:5508, 28:5509, 28:5510,
28:5511, 28:5512, 28:5513, 28:5514, 28:5515, 28:5516, 28:5517, 28:5518, 28:5519, 28:5520,
93:5521, 263:5522, 93:5523, 185:5524, 433:5525, 28:5526, 102:5527, 28:5528, 93:5529, 276:5530,
445:5531, 263:5532, 433:5533, 263:5534, 433:5535, 184:5536, 354:5537, 263:5538, 433:5539, 263:5540,
359:5541, 263:5542, 433:5543, 241:5544, 410:5545, 317:5546, 104:5547, 77:5548, 169:5549, 206:5550,
187:5551, 165:5552, 224:5553, 128:5554, 77:5555, 91:5556, 64:5557, 157:5558, 194:5559, 175:5560,
153:5561, 212:5562, 116:5563, 64:5564, 64:5565, 91:5566, 64:5567, 157:5568, 194:5569, 175:5570,

153:5571, 212:5572, 116:5573, 64:5574, 91:5575, 64:5576, 157:5577, 175:5578, 116:5579, 175:5580,
249:5581, 116:5582, 49:5583, 23:5584, 194:5585, 175:5586, 153:5587, 212:5588, 249:5589, 116:5590,
91:5591, 64:5592, 157:5593, 175:5594, 116:5595, 175:5596, 116:5597, 91:5598, 64:5599, 157:5600,
175:5601, 116:5602, 175:5603, 116:5604, 91:5605, 64:5606, 157:5607, 194:5608, 175:5609, 153:5610,
212:5611, 116:5612, 64:5613, 91:5614, 64:5615, 157:5616, 194:5617, 175:5618, 153:5619, 212:5620,
116:5621, 64:5622, 91:5623, 64:5624, 157:5625, 194:5626, 175:5627, 153:5628, 212:5629, 116:5630,
64:5631, 91:5632, 64:5633, 194:5634, 175:5635, 153:5636, 212:5637, 64:5638, 116:5639, 81:5640,
91:5641, 64:5642, 194:5643, 175:5644, 153:5645, 212:5646, 116:5647, 64:5648, 91:5649, 64:5650,
64:5651, 194:5652, 175:5653, 153:5654, 212:5655, 64:5656, 116:5657, 27:5658, 27:5659, 171:5660,
152:5661, 130:5662, 189:5663, 93:5664, 27:5665, 134:5666, 171:5667, 152:5668, 130:5669, 189:5670,
93:5671, 98:5672, 98:5673, 115:5674, 98:5675, 98:5676, 98:5677, 98:5678, 98:5679, 98:5680,
98:5681, 115:5682, 98:5683, 98:5684, 115:5685, 98:5686, 98:5687, 98:5688, 113:5689, 98:5690,
98:5691, 98:5692, 98:5693, 98:5694, 66:5695, 108:5696, 144:5697, 125:5698, 236:5699, 103:5700,
162:5701, 66:5702, 42:5703, 42:5704, 42:5705, 42:5706, 42:5707, 42:5708, 42:5709, 42:5710,
42:5711, 42:5712, 42:5713, 42:5714, 42:5715, 42:5716, 42:5717, 42:5718, 42:5719, 42:5720,
42:5721, 42:5722, 42:5723, 42:5724, 42:5725, 42:5726, 42:5727, 42:5728, 42:5729, 42:5730,
42:5731, 42:5732, 42:5733, 42:5734, 42:5735, 42:5736, 42:5737, 42:5738, 42:5739, 42:5740,
96:5741, 74:5742, 133:5743, 37:5744, 96:5745, 37:5746, 96:5747, 37:5748, 86:5749, 74:5750,
74:5751, 90:5752, 74:5753, 74:5754, 74:5755, 74:5756, 172:5757, 74:5758, 111:5759, 90:5760,
74:5761, 231:5762, 74:5763, 74:5764, 74:5765, 74:5766, 74:5767, 170:5768, 74:5769, 74:5770,
74:5771, 49:5772, 49:5773, 37:5774, 37:5775, 37:5776, 37:5777, 37:5778, 37:5779, 37:5780,
37:5781, 37:5782, 37:5783, 37:5784, 37:5785, 37:5786, 96:5787, 37:5788, 37:5789, 37:5790,
37:5791, 37:5792, 37:5793, 37:5794, 53:5795, 37:5796, 53:5797, 53:5798, 53:5799, 37:5800,
53:5801, 53:5802, 37:5803, 53:5804, 37:5805, 53:5806, 53:5807, 37:5808, 96:5809, 112:5810,
112:5811, 37:5812, 37:5813, 37:5814, 37:5815, 37:5816, 37:5817, 37:5818, 37:5819, 37:5820,
37:5821, 37:5822, 37:5823, 37:5824, 37:5825, 37:5826, 37:5827, 37:5828, 37:5829, 37:5830,
37:5831, 37:5832, 37:5833, 37:5834, 37:5835, 37:5836, 96:5837, 37:5838, 37:5839, 98:5840,
98:5841, 115:5842, 115:5843, 16:5844, 16:5845, 16:5846, 16:5847, 16:5848, 16:5849, 16:5850,
16:5851, 16:5852, 16:5853, 16:5854, 16:5855, 16:5856, 16:5857, 16:5858, 16:5859, 16:5860,
16:5861, 16:5862, 16:5863, 16:5864, 16:5865, 16:5866, 16:5867, 16:5868, 16:5869, 16:5870,
16:5871, 16:5872, 16:5873, 16:5874, 16:5875, 16:5876, 16:5877, 16:5878, 16:5879, 16:5880,
16:5881, 16:5882, 16:5883, 16:5884, 16:5885, 16:5886, 16:5887, 16:5888, 16:5889, 16:5890,
16:5891, 16:5892, 16:5893, 16:5894, 16:5895, 16:5896, 16:5897, 16:5898, 16:5899, 16:5900,
16:5901, 16:5902, 16:5903, 16:5904, 16:5905, 16:5906, 16:5907, 16:5908, 16:5909, 16:5910,
16:5911, 16:5912, 16:5913, 16:5914, 16:5915, 16:5916, 16:5917, 16:5918, 16:5919, 16:5920,
16:5921, 16:5922, 16:5923, 16:5924, 16:5925, 16:5926, 16:5927, 16:5928, 16:5929, 16:5930,
16:5931, 16:5932, 16:5933, 16:5934, 16:5935, 16:5936, 16:5937, 16:5938, 16:5939, 16:5940,
16:5941, 16:5942, 16:5943, 16:5944, 16:5945, 16:5946, 16:5947, 16:5948, 16:5949, 16:5950,
16:5951, 16:5952, 16:5953, 16:5954, 16:5955, 16:5956, 16:5957, 16:5958, 16:5959, 16:5960,
16:5961, 16:5962, 16:5963, 16:5964, 16:5965, 16:5966, 16:5967, 16:5968, 16:5969, 16:5970,
16:5971, 16:5972, 16:5973, 16:5974, 16:5975, 16:5976, 16:5977, 16:5978, 16:5979, 115:5980,
16:5981, 16:5982, 16:5983, 16:5984, 16:5985, 16:5986, 16:5987, 16:5988, 16:5989, 16:5990,

16:5991, 16:5992, 16:5993, 16:5994, 16:5995, 16:5996, 16:5997, 16:5998, 16:5999, 16:6000,

16:6001, 16:6002, 16:6003, 16:6004, 16:6005, 16:6006, 16:6007, 16:6008, 16:6009, 16:6010,

16:6011, 16:6012, 16:6013, 16:6014, 16:6015, 16:6016, 16:6017, 16:6018, 16:6019, 16:6020,

16:6021, 16:6022, 16:6023, 16:6024, 16:6025, 16:6026, 16:6027, 16:6028, 16:6029, 16:6030,

16:6031, 16:6032, 16:6033, 16:6034, 16:6035, 16:6036, 16:6037, 16:6038, 16:6039, 16:6040,

16:6041, 16:6042, 16:6043, 16:6044, 16:6045, 16:6046, 16:6047, 16:6048, 16:6049, 16:6050,

16:6051, 16:6052, 16:6053, 16:6054, 16:6055, 16:6056, 16:6057, 16:6058, 16:6059, 16:6060,

16:6061, 16:6062, 16:6063, 16:6064, 16:6065, 16:6066, 16:6067, 16:6068, 16:6069, 16:6070,

16:6071, 16:6072, 16:6073, 16:6074, 16:6075, 16:6076, 16:6077, 16:6078, 16:6079, 16:6080,

16:6081, 16:6082, 16:6083, 16:6084, 16:6085, 16:6086, 16:6087, 16:6088, 16:6089, 16:6090,

16:6091, 16:6092, 16:6093, 16:6094, 16:6095, 16:6096, 16:6097, 16:6098, 16:6099, 16:6100,

16:6101, 16:6102, 16:6103, 16:6104, 16:6105, 16:6106, 16:6107, 16:6108, 16:6109, 16:6110,

16:6111, 16:6112, 16:6113, 16:6114, 16:6115, 16:6116, 16:6117, 16:6118, 16:6119, 16:6120,

16:6121, 16:6122, 16:6123, 16:6124, 16:6125, 16:6126, 16:6127, 16:6128, 16:6129, 16:6130,

16:6131, 16:6132, 16:6133, 16:6134, 16:6135, 16:6136, 31:6137, 31:6138, 16:6139, 31:6140,

179:6141, 31:6142, 31:6143, 31:6144, 31:6145, 31:6146, 16:6147, 16:6148, 16:6149, 31:6150,

31:6151, 31:6152, 31:6153, 16:6154, 31:6155, 31:6156, 31:6157, 31:6158, 31:6159, 31:6160,

31:6161, 16:6162, 16:6163, 16:6164, 31:6165, 31:6166, 31:6167, 31:6168, 16:6169, 31:6170,

16:6171, 16:6172, 16:6173, 16:6174, 16:6175, 78:6176, 78:6177, 115:6178, 16:6179, 16:6180,

16:6181, 16:6182, 16:6183, 16:6184, 27:6185, 27:6186, 27:6187, 27:6188, 27:6189, 27:6190,

27:6191, 27:6192, 27:6193, 27:6194, 27:6195, 27:6196, 12:6197, 12:6198, 12:6199, 27:6200,

27:6201, 27:6202, 27:6203, 27:6204, 27:6205, 12:6206, 27:6207, 12:6208, 12:6209, 12:6210,

12:6211, 12:6212, 12:6213, 12:6214, 61:6215, 98:6216, 147:6217, 15:6218, 15:6219, 15:6220,

15:6221, 15:6222, 15:6223, 15:6224, 15:6225, 15:6226, 15:6227, 15:6228, 15:6229, 15:6230,

15:6231, 15:6232, 15:6233, 15:6234, 15:6235, 15:6236, 15:6237, 15:6238, 15:6239, 15:6240,

15:6241, 15:6242, 15:6243, 15:6244, 15:6245, 15:6246, 15:6247, 15:6248, 15:6249, 15:6250,

15:6251, 15:6252, 15:6253, 15:6254, 15:6255, 15:6256, 15:6257, 15:6258, 15:6259, 15:6260,

15:6261, 15:6262, 15:6263, 15:6264, 15:6265, 15:6266, 15:6267, 15:6268, 15:6269, 15:6270,

15:6271, 15:6272, 15:6273, 15:6274, 15:6275, 15:6276, 15:6277, 15:6278, 15:6279, 15:6280,

15:6281, 15:6282, 15:6283, 15:6284, 15:6285, 15:6286, 15:6287, 15:6288, 15:6289, 15:6290,

15:6291, 15:6292, 15:6293, 15:6294, 15:6295, 15:6296, 15:6297, 15:6298, 15:6299, 15:6300,

15:6301, 15:6302, 15:6303, 15:6304, 15:6305, 15:6306, 15:6307, 15:6308, 15:6309, 15:6310,

15:6311, 15:6312, 15:6313, 15:6314, 15:6315, 15:6316, 15:6317, 15:6318, 15:6319, 15:6320,

15:6321, 15:6322, 15:6323, 15:6324, 15:6325, 15:6326, 15:6327, 15:6328, 15:6329, 15:6330,

15:6331, 15:6332, 15:6333, 15:6334, 15:6335, 15:6336, 15:6337, 15:6338, 15:6339, 15:6340,

15:6341, 15:6342, 59:6343, 59:6344, 59:6345, 59:6346;

outgroup Profil /only;

hsearch addseq=random nreps=1000;

roottrees;

savetrees /file=rineauetal2020_optimaltree.tre

;

end;

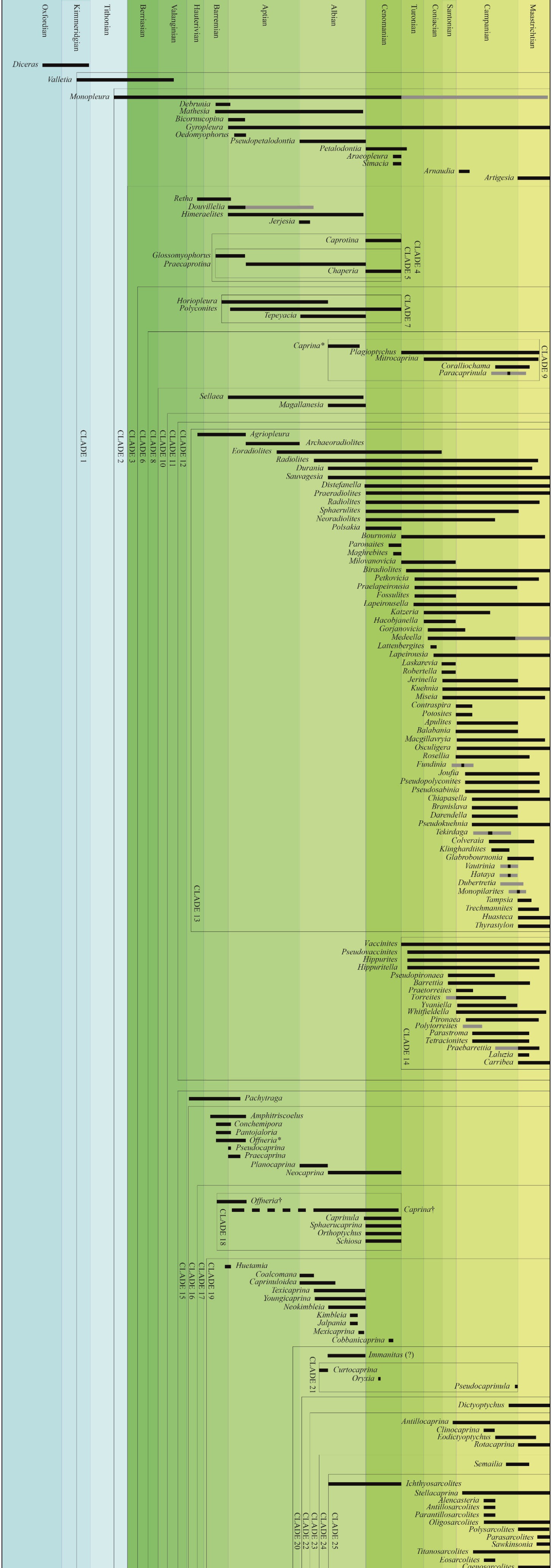
Appendix 5: Table of results of the character test procedure

Overview of the results of the character testing procedure using 3ta. List of hierarchical characters with their localization (LV, RV or both), their number in this paper, their kind, their number of informative states (i. e. excluding the root), their retention index, and the character states numbers that pass the congruence test and become synapomorphies on the cladogram.

Valve involved	Character number	Kind	Number of informative states	Retention index (%)	Synapomorphies (states numbers)
LV	1	Teeth	3	77.68	1, 3
	2		1	100.00	1
	3		1	100.00	1
	4	Myophores	6	74.78	1, 2, 4
	5		1	55.56	
	6		5	87.99	1, 2, 5
	7		1	47.83	
	8	Vertical blades	2	96.29	1
	9		1	64.29	
	10		1	70.91	
	11	Canals	1	62.91	
	12		1	100.00	1
	13		4	82.99	3
	14		2	84.00	1
	15		1	66.67	
	16		1	65.91	
	17	Horizontal blades	1	100.00	1
	18		1	87.12	
	19		1	100.00	1
	20	Canal/pore system	1	100.00	1
	21		1	100.00	1
	22	Coiling	1	100.00	1
RV	23	Teeth	1	100.00	1
	24		1	81.90	1
	25		1	79.61	
	26	Myophores	7	50.32	7
	27		3	38.45	
	28	Vertical blades	1	82.51	
	29		1	100.00	1
	30		2	53.35	1
	31	Canals	1	100.00	1
	32		3	92.71	2
	33		1	61.59	
	34	Horizontal blades	1	74.62	
	35		1	88.64	
Both valves	36	Pillars	1	50.72	
	37	Outer layer	1	51.20	
	38	Ligament	3	97.30	1, 2
	39		1	91.67	1
	40	Ornamentation	1	44.11	
	41		1	94.55	

Appendix 6: Proposal of classification of all Hippuritidina genera

Attempt of taxonomic assignment of all Hippuritidina genera (in Skelton 2013a) in our cladogram. As the assignments presented here remain hypothetical and untested by cladistic analysis, we do not give them a taxonomic value (see Appendix 4). Black line: stratigraphic range; grey line: uncertainty; dotted line: ghost range. *Caprina**: *C. mulleri* and *C. choffati* (?); *Caprina*†: all other *Caprina* species. *Offneria**: *O. interrupta*, and *O. simplex*; *Offneria*† all other *Offneria* species.


Oxfordian
Kimmeridgian
Tithonian
Berriasian
Valanginian
Hauterivian
Barremian
Aptian
Albian
Cenomanian
Turonian
Coniacian
Santonian
Campanian
Maastrichtian
Diceras
Valletia
Monopleura
Debrunia
Mathesia
Bicornucopina
Gyropleura
Oedomyophorus
Pseudopetalodontia
Petalodontia
Araeopleura
Simacia
Arnaudia
Artigesia
Retha
Douvillelia
Himeraelites
Jerjesia
Caprotina
Glossomyophorus
Praecaprotina
Chaperia
CLADE 4
CLADE 5
Horiopleura
Polyconites
Tepeyacia
CLADE 7
Caprina*
Plagioptychus
Mitrocaprina
Coralliochama
Paracaprinula
CLADE 9
Sellaea
Magallanesia
Agriopleura
Archaeoradiolites
Eoradiolites
Radiolites
Durania
Sauvagesia
Distefanella
Praeradiolites
Radiolites
Sphaerulites
Neoradiolites
Polsakia
Bournonia
Paronaites
Maghrebites
Milovanovicia
Biradiolites
Petkovicia
Praelapeirousia
Fossulites
Lapeirousella
Katzeria
Hacobjanella
Gorjanovicia
Medeella
Lattenbergites
Lapeirousia
Laskarevia
Robertella
Jerinella
Kuehnia
Miseia
Contraspira
Potosites
Apulites
Balabania
Macgillavryia
Osculigera
Rosellia
Fundinia
Joufia
Pseudopolyconites
Pseudosabinia
Chiapasella
Branislava
Darendella
Pseudokuehnia
Tekirdaga
Colveraia
Klinghardtites
Glabrobournonia
Vautrinia
Hataya
Dubertretia
Monopilarites
Tampsia
Trechmannites
Huasteca
Thyrastylon
CLADE 13
Vaccinites
Pseudovaccinites
Hippurites
Hippuritella
Pseudopironaea
Barrettia
Praetorreites
Torreites
Yvaniella
Whitfieldella
Pironaea
Polytorreites
Parastroma
Tetracionites
Praebarrettia
Laluzia
Carribea
CLADE 14
Pachytraga
Amphitriscoelus
Conchemipora
Pantojaloria
Offneria*
Pseudocaprina
Praecaprina
Planocaprina
Neocaprina
Offneria†
Caprina†
Caprinula
Sphaerucaprina
Orthoptychus
Schiosa
CLADE 18
Huetamia
Coalcomana
Caprinuloidea
Texicaprina
Youngicaprina
Neokimbleia
Kimbleia
Jalpania
Mexicaprina
Cobbanicaprina
CLADE 19
CLADE 15
CLADE 16
CLADE 17
Immanitas (?)
Curtocaprina
Oryxia
Pseudocaprinula
CLADE 21
Dictyoptychus
Antillocaprina
Clinocaprina
Eodictyoptychus
Rotacaprina
Semailia
Ichthyosarcolites
Stellacaprina
Alencasteria
Antillosarcolites
Parantillosarcolites
Oligosarcolites
Polysarcolites
Parasarcolites
Sawkinsonia
Titanosarcolites
Eosarcolites
Caenosarcolites
CLADE 20
CLADE 22
CLADE 23
CLADE 24
CLADE 25
CLADE 1
CLADE 2
CLADE 3
CLADE 6
CLADE 8
CLADE 10
CLADE 11
CLADE 12
CLADE 13

Appendix bibliography

Aguilar-Pérez, J. 2008. *Rudistas Del Cretacio Inferior y Medio, Barremiano-Cenomaniano, Noreste, Centro y Oeste de México.* Unpublished PhD thesis, Universitat Autònoma de Barcelona, Barcelona. 139 pp.

Chartrousse, A. 1998a. *Les Caprinidae (Rudistes) Du Crétacé Inférieur*. Unpublished PhD thesis, Université de Provence, Aix-Marseille, 281 pp.

Chartrousse, A. 1998b. The myocardinal organization of coalcomaninid rudists revisited. *Geobios*, **31**, 75–85.

Cao, N. 2008. Analyse à trois éléments et anatomie du bois des Fagales Engl. Unpublished Phd thesis, Muséum National d'Histoire Naturelle, Paris, 239 pp.

Carter, J. G., Altaba, C. R., *et al*. 2011. A synoptical classification of the Bivalvia (Mollusca). *Paleontological contributions*, 29, 29.

Dominguez, E. & Wheeler, Q. D. 1997. Forum - Taxonomic Stability is Ignorance. *Cladistics*, 13, 367–372, doi: 10.1111/j.1096-0031.1997.tb00325.x.

Götz, S. 2003. Larval settlement and ontogenetic development of *Hippuritella vasseuri* (Douvillé) (Hippuritoidea, Bivalvia). *Geologia Croatica*, **56**, 123–131.

Mac Gillavry, H. J. 1937. Geology of the province of Camarguey, Cuba with revisional studies in Rudist paleontology (mainly based upon collections from Cuba). *Geographische en Geologische Mededeelingen*, **14**, 168 pp.

Mitchell, S. F. 2013. Revision of the Antillocaprinidae Mac Gillavry (Hippuritida, Bivalvia) and their position within the Caprinoidea d'Orbigny. *Geobios*, **46**, 423–446. https://doi.org/10.1016/j.geobios.2013.07.003

Nelson, G. 1972. Phylogenetic relationship and classification. *Systematic Zoology*, 21, 227–231.

Nelson, G. 1973. Classification as an expression of phylogenetic relationships. *Systematic Zoology*, 22, 344–359.

Prin, S. 2016. The relational view of phylogenetic hypotheses and what it tells us on the phylogeny/classification relation problem. *In*: Williams, D., Schmitt, M. & Wheeler, Q. (eds) *The Futur of Phylogenetic Systematics: The Legacy of Willi Hennig*. The Systematics Association, Special Volume Series, 431–468.

Rineau, V. 2017. *Un Nouveau Regard Cladistique Sur l'anatomie Comparée, La Phylogénie, La Systématique et La Paléoécologie Des Rudistes (Bivalvia, Hippuritida).* Unpublished Phd thesis, Université Pierre et Marie Curie, Paris, 624 pp.

Rineau, V. & Villier, L. 2019. Description of a New Genus of Radiolitidae (Bivalvia, Hippuritida) with Canals in the Calcitic Shell Layer. Pp. 33–35 in Boughdiri, M., Bádenas, B., Selden, P., Jaillard, E., Bengtson, P. & Granier, B. (eds) *Paleobiodiversity and Tectono-Sedimentary Records in the Mediterranean Tethys and*

Related Eastern Areas. Advances in Science, Technology & Innovation (IEREK Interdisciplinary Series for Sustainable Development). *Springer, Cham*. https://doi.org/10.1007/978-3-030-01452-0_8

Quinn, A. 2017. When is a cladist not a cladist? *Biology & Philosophy*, 32, 581–598, doi: 10.1007/s10539-017-9577-z.

Sano, S.-I., Iba, Y., Skelton, P. W., Masse, J.-P., Aguilar, Y. M. & Kase, T. 2014. The evolution of canaliculate rudists in the light of a new canaliculate polyconitid rudist from the Albian of the Central Pacific. *Palaeontology*, **57**, 951–962. https://doi.org/10.1111/pala.12096

Schneider, S. & Skupien, P. 2015. Palaeoecology of *Valletia antiqua* Favre in Joukowsky & Favre, 1913 (Bivalvia, Hippuritida, Diceratidae); with comments on the taxonomy and distribution of the genus *Valletia*. *Bulletin of Geosciences*, **90**, 1–20. https://doi.org/10.3140/bull.geosci.154

Skelton, P. W. 2013. Rudist classification for the revised Bivalvia volumes of the 'Treatise on Invertebrate Paleontology'. *Caribbean Journal of Earth Science*, **45**, 9–33.

Sereno, P. C. 2005. The Logical Basis of Phylogenetic Taxonomy Lee, M. (ed.). *Systematic Biology*, 54, 595–619, doi: 10.1080/106351591007453.

Skelton, P. W. & Masse, J.-P. 1998. Revision of the Lower Cretaceous rudist genera *Pachytraga* Paquier and *Retha* Cox (Bivalvia: Hippuritacea), and the origins of the Caprinidae. *Geobios Mémoire Spécial*, **22**, 331–370.

Skelton, P. W. & Smith, A. B. 2000. A preliminary phylogeny for rudist bivalves: sifting clades from grades. *Geological Society, London, Special Publications*, **177**, 97–127.

Smith, A. 1994. *Systematics and the Fossil Record. Documenting Evolutionary Patterns*. Blackwell scientific publications, 232 pp.

Steuber, T. 1999. *Cretaceous Rudists of Boetia, Central Greece*. Special papers in paleontology, London, 61 pp.

Stone, J. R. & Telford, M. 1999. Using critical path method to analyse the radiation of rudist bivalves. *Palaeontology*, **42**, 231–242.

Yonge, C. M. 1967. Form, habit and evolution in the Chamidae (Bivalvia) with reference to conditions in the rudists (Hippuritacea). *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, **252**, 49–105.

Zaragüeta, R. 2002. *Test Morphologique et Moléculaire Des Hypothèses de Phylogénie Des Clupeomorpha (Actinopterygii, Teleostei).* Unpublished Phd thesis, Muséum national d'histoire naturelle, 534 pp.

Zaragüeta, R. & Bourdon, E. 2007. Three-item analysis: Hierarchical representation and treatment of missing and inapplicable data. *Comptes Rendus Palevol*, 6, 527–534, doi: 10.1016/j.crpv.2007.09.013.

Zaragüeta, R., Ung, V., Grand, A., Vignes-Lebbe, R., Cao, N. & Ducasse, J. 2012. LisBeth: New cladistics for phylogenetics and biogeography. *Comptes Rendus Palevol,* 11, 563–566, doi: 10.1016/j.crpv.2012.07.002.