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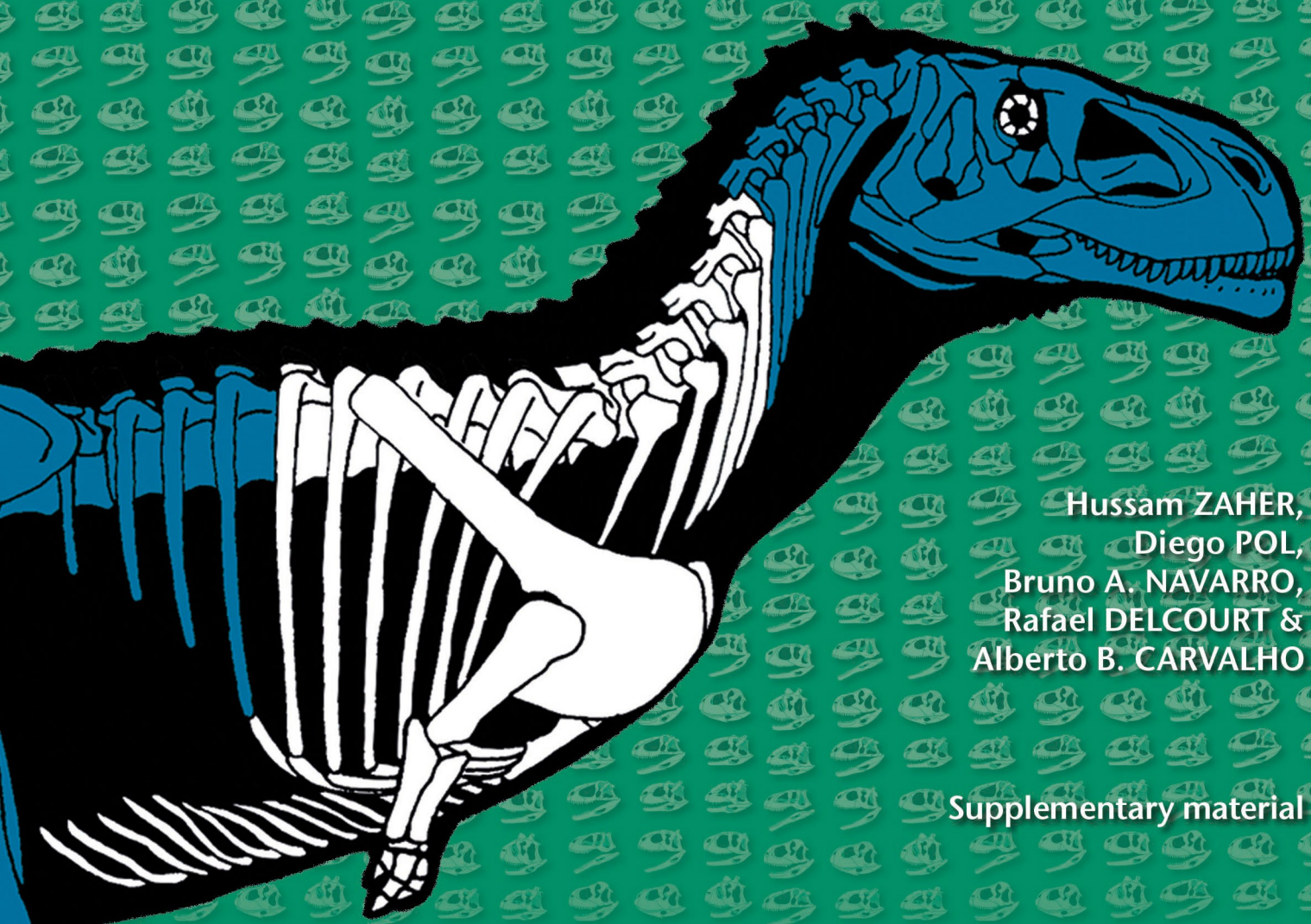
An Early Cretaceous theropod dinosaur from Brazil sheds light on the cranial evolution of the Abelisauridae



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Supplementary material

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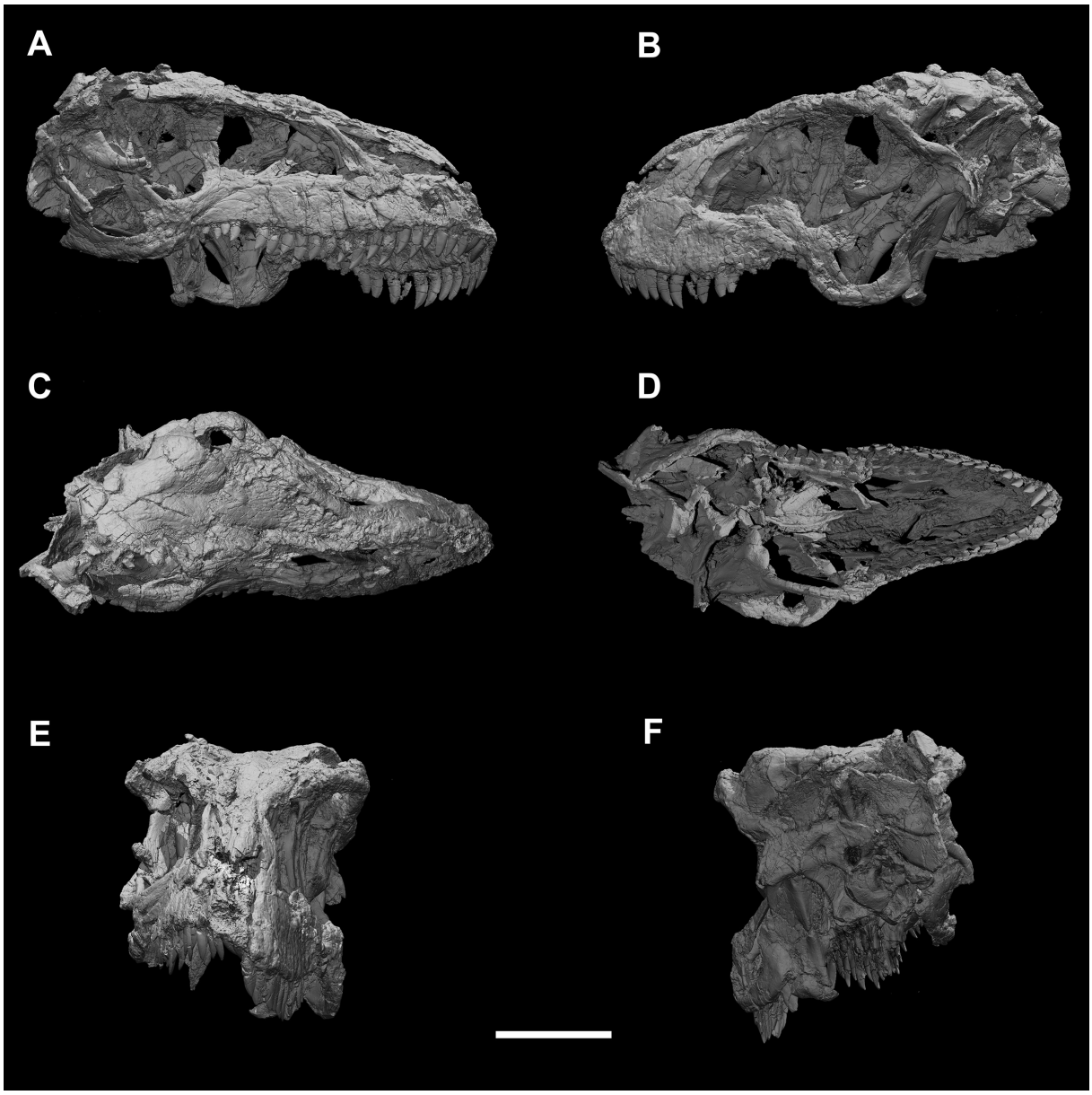
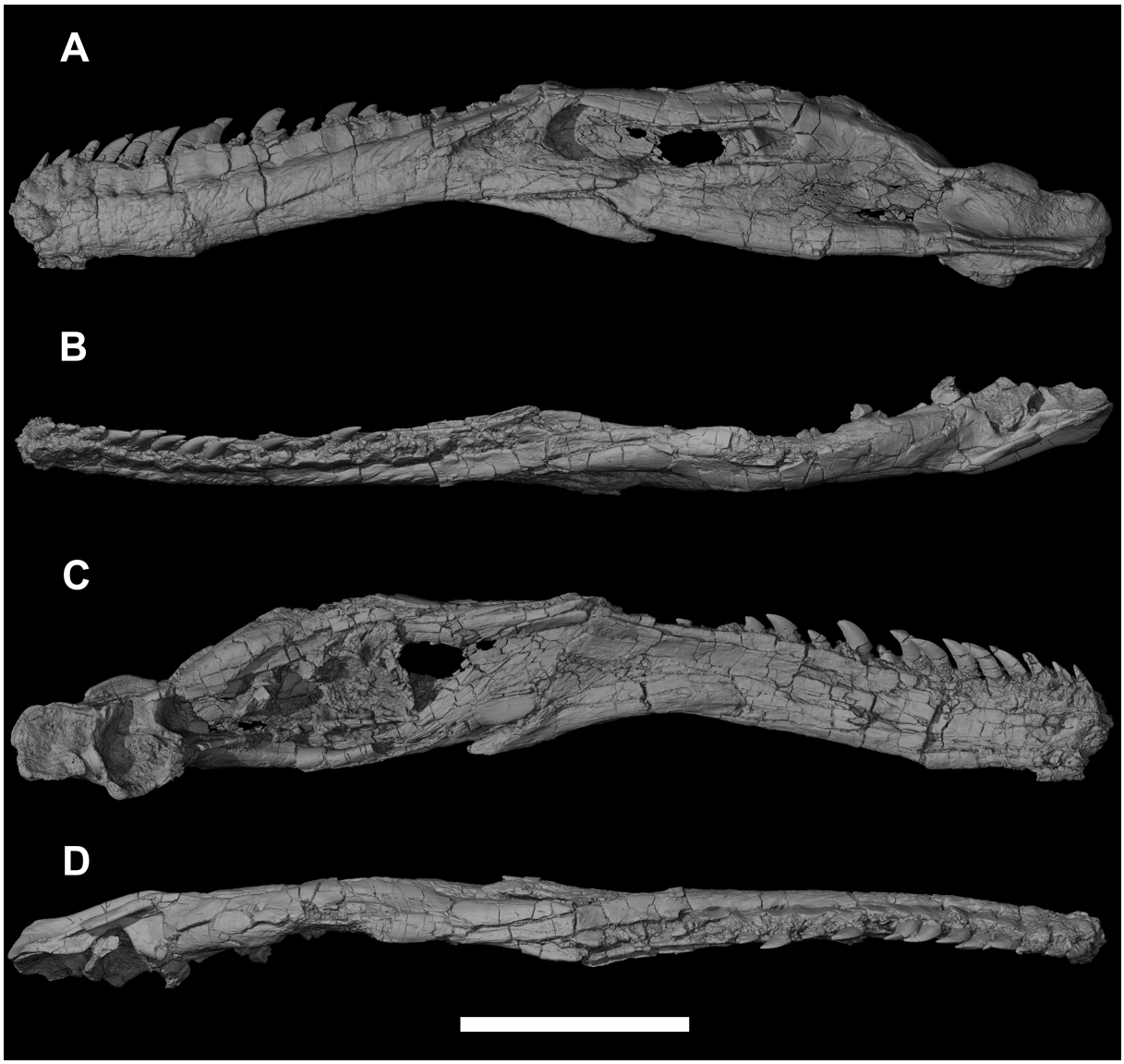
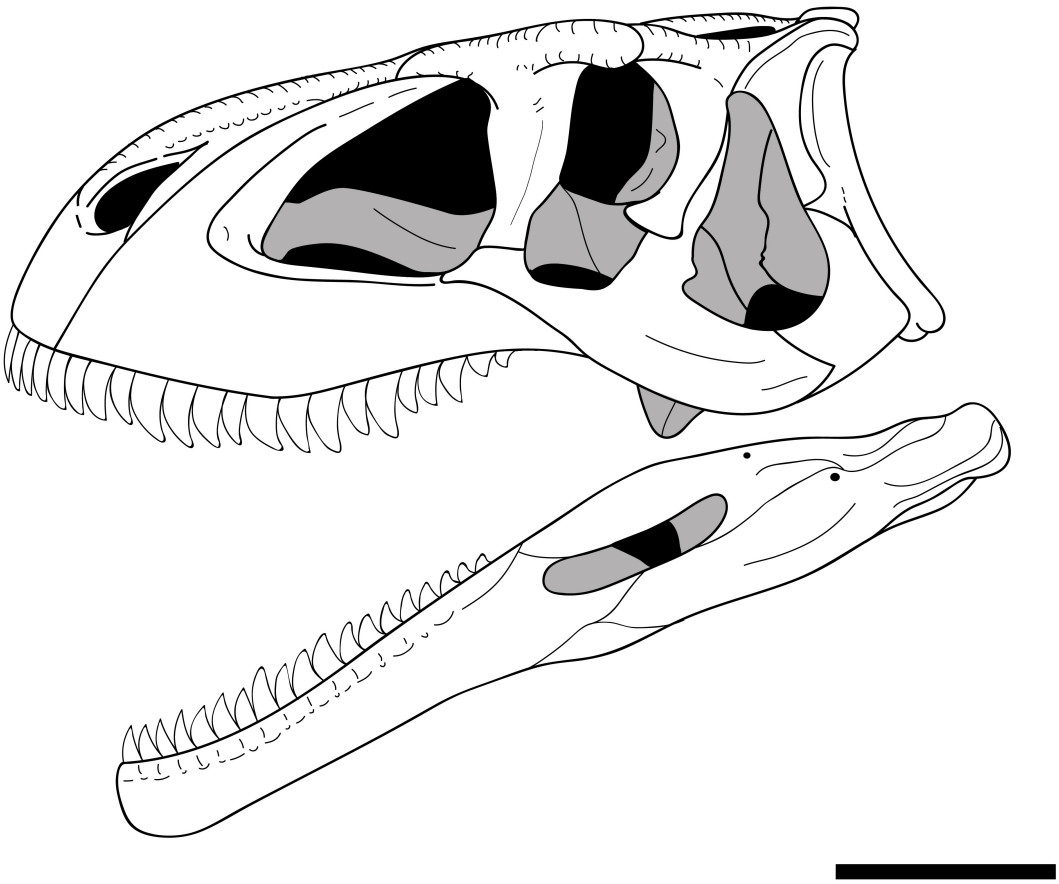
1. Supplementary figures



Supplementary Figure 1.1 | Micro CT scan of *Spectrovenator ragei* n. gen., n. sp. (MZSP-PV 833) skull in right lateral (A), left lateral (B), dorsal/parietal (C), ventral/palatal (D), anterior/rostral (E) and posterior/occipital (F) views. Scale = 5 cm.



Supplementary Figure 1.2 | Micro CT scan of *Spectrovenator ragei* n. gen., n. sp. (MZSP-PV 833) left mandible in labial/lateral (A) and dorsal (B), lingual/medial (C) and dorsal (D) views. Scale = 5 cm.



Supplementary Figure 1.3 | Reconstruction of *Spectrovenator ragei* n. gen., n. sp. (MZSP-PV 833) skull and mandibles based on non-distorted portions of cranial bones. Scale = 5 cm.

2. Phylogenetic analysis

2.1. Annotated character list

The following appendix details the character list used in the phylogenetic analysis taken from Rauhut and Carrano (2016). Some comments are included regarding the condition present in *Spectrovenator*.

*1) External surface of maxilla and nasal: smooth (0), sculptured (**1**) (Carrano and Sampson, 2008).*

The maxilla and nasal of *Spectrovenator* are sculptured as in others abelisaurids. The maxillae have vertically oriented grooves however the process that contacts the jugal is smoother. The nasals have a broad ornamented ridge bounding the pits and invaginations as in *Rugops*.

*2) External surface of postorbital, lacrimal, and jugal: smooth (0), sculptured (**1**) (Carrano and Sampson 2008).*

As in others abelisaurids these tree bones are sculptured. The postorbital and lacrimal are sculptured mainly on their dorsal surface. The ventral portions of these bones are smoother. The jugal is only slightly ornamented.

3) Maxillary process of premaxilla: well–developed (0), reduced to a short triangle (1) (Carrano and Sampson 2008).

4) Subnarial foramen: enclosed (0), reduced/open dorsally (1) (Carrano and Sampson 2008).

5) Height/length ratio of premaxilla ventral to external naris: 0.5–2.0 (0), > 2.0 (1) (Carrano and Sampson 2008).

*6) Proportions/presence of the anterior ramus of the maxilla: absent without extending beneath the naris (0), anteroposteriorly long (1), or tall and blunt (**2**) (Carrano and Sampson 2008).*

The character scorings of *Rugops*, *Masiakasaurus*, and *Noasaurus* have been changed to character state 2. These taxa share with the *Spectrovenator* and other ceratosaurs the presence of an anterior extension that is short and dorsoventrally high. Among these taxa there is a rather continuous variation on the shape of the anterior margin so that some abelisaurids have a markedly short and high anterior process whereas others have a high-angled by oblique anterior margin (*e.g. Rugops*, *Abelisaurus*). Therefore, the current scoring reflects the major difference on the anterior process of the maxilla noted between the short and high condition of ceratosaurs ("typically reaching only to the posterior edge of the naris") and the long and low process of tetanurans and *Syntarsus* ("extending far beneath the naris"). The condition described by character state 0 (absent) was slightly modified noting that in *Herrerasaurus* (the only taxon scored with this character state) the anterior region of the maxilla has a limited projection and fails to reach the level of the external naris.

*7) Ascending process of the maxilla: posterodorsally directed, with strongly convex anterior and concave posterior margin (**0**), or subvertical, with almost straight anterior and posterior margins (1) (modified from Bonaparte and Novas 1985).*

The ascending process of *Spectrovenator* has a convex anterior margin of the ascending process of the maxilla, as in *Ceratosaurus*, *Noasaurus*, and some abelisaurids (e.g., *Majungasaurus*, *Abelisaurus*).

*8) Extension of ascending process of maxilla: large, reaching posteriorly to more than half the length of the maxilla (**0**), reduced, posterodorsal tip ends well before the half length of the maxilla (1) (modified from Canale et al. 2009, C 16).*

In *Spectrovenator* the ascending process of the maxilla projects posteriorly much more than the anteroposterior midpoint of the maxilla as in others abelisaurids, such as *Carnotaurus* and *Majungasaurus*.

*9) Facet for nasal articulation on maxilla: shallow, anterolateral (0), socket, lateral (**1**) (Carrano and Sampson 2008).*

10) Palatal process of maxilla: long and ridged (0), reduced, small, and blunt (1) (modified from Carrano and Sampson 2008).

*11) Anteroventral border of antorbital fenestra: graded or stepped (**0**), demarcated by raised ridge (1) (Carrano and Sampson 2008).*

The ventral margin of the antorbital fenestra has a slightly stepped limit lacking the prominent ridge of some non-abelisaurid taxa. This character is shared by others abelisaurids as *Rugops*, *Kryptops* and *Abelisaurus.*

*12) Antorbital fossa: extends to the anterior margin of the ascending process of the maxilla, at least in its dorsal part (0), separated from the anterior margin of the ascending process (**1**) (modified from Canale et al. 2009, C 15).*

The antorbital fossa along the ascending process of the maxilla in *Spectrovenator* is more extensive than in derived abelisaurids (e.g. *Carnotaurus*), resembling the relatively broad extension of the antorbital fossa of *Ekrixinatosaurus*, *Rugops*, and *Noasaurus*. The condition of these taxa, nonetheless, does not reach the much more developed condition present in *Ceratosaurus* and *Allosaurus* (in which the fossa occupies the almost the entire anteroposterior width of the dorsal part of the ascending process of the maxilla).

*13) Ventral portion of antorbital fossa: present on maxilla (0), strongly reduced or absent (**1**) (modified from Carrano and Sampson 2008).*

The posterior extension of the antorbital fossa in *Spectrovenator* is slightly more developed than in *Rugops* (resembling the condition of *Ekrixinatosaurus*). However, the antobital fossa along the posterior process of the maxilla is reduced in comparison with non-abelisaurid theropods (*Noasaurus*, *Ceratosaurus*).

*14) Anteroposterior length of maxillary-jugal contact relative to total maxilla length: less than 40% (**0**), more than 40% (1) (Carrano and Sampson 2008).*

The anteroposterior length of the maxilla-jugal contact is approximately 25% in *Spectrovenator*, being similar to *Rugops* and shorter than in more derived abelisaurids. The isolated maxilla of the Bajo Barreal abelisaurid (Lamanna *et al.* 2002, UNPSJB PV 247) has a maxillary-jugal suture slightly longer than that of *Rugops* and *Spectrovenator*.

*15) Inclination of maxilla-jugal contact: low, less than 45° from the horizontal (**0**), steep, more than 45° from the horizontal (1) (Canale et al. 2009, C 20).*

Although the suture of *Spectrovenator* is not as steep as in *Carnotaurus* and *Skorpiovenator*, it is slightly more oblique than tetanurans (e.g. *Allosaurus*) and resembles the condition of *Rugops*.

*16) Nasal-nasal contact in adults: separate (0), partly or fully fused (**1**) (Carrano and Sampson 2008).*

The anterior regions of the nasals in *Spectrovenator* are fused to each other whereas in the posterior part they seem to be unfused, as in *Rugops* and *Carnotaurus*.

*17) Row of foramina on dorsal nasal surface: absent (0), present (**1**) (Carrano and Sampson 2008).*

The foramina are present and closely resemble the condition of *Rugops*, including the presence of unusual pits on the dorsal surface of the nasal that was previously considered an autapomorphic of *Rugops*. As noted by Carrano and Sampson (2008) the foramina are also present on the nasal of *Carnotaurus*.

*18) Posterior narial margin: fossa (0), laterally splayed hood (**1**) (Carrano and Sampson 2008).*

The posterior narial margin in *Spectrovenator* is laterally covered as in other ceratosaurs. In this region the nasals are forked and sculptured covering the narial margin.

*19) Location of nasal-frontal contact relative to highest point of orbit: anterior (**0**), directly above (1) (Carrano and Sampson 2008).*

The nasal-frontal contact is located close to the level of the midpoint of the lacrimal in *Spectrovenator*. This condition is also present in *Eoabelisaurus* and *Carnotaurus*, but not in *Abelisaurus* (Novas *et al.*, 2013).

20) Condition of prefrontal in adults: separate (0), partly or completely fused (1) (Carrano and Sampson 2008).

The prefrontals are partly fused to the lacrimal in *Spectrovenator*, and their suture is only visible along their ventral descending process on the anteromedial region of the orbit.

*21) Frontals unfused (**0**), or fused (1) (Canale et al. 2009, C. 37).*

The frontals are unfused as can be observed in the dorsal surface and the CT-scans of the skull of *Spectrovenator*. This resembles the condition of *Rugops* but differ from the derived condition of other abelisaurids such as *Abelisaurus*, *Carnotaurus* and *Majungasaurus*.

*22) Frontal-parietal contact in adults: separate (**0**), fused at least on the dorsal surface (1) (modified from Carrano and Sampson 2008).*

The frontal-parietal suture is visible within the supratemporal fossa and along parts of the skull roof too. This condition is shared with *Ceratosaurus*, *Masiakasaurus* and *Rugops*, whereas *Eoabelisaurus* and other abelisaurids have the frontal-parietal fused.

*23) Skull roof dorsoventral thickness: thin, relatively flat (**0**), thickened (1) (Carrano and Sampson 2008).*

The frontals and parietals are moderately thick in *Spectrovenator* but not as much as in derived abelisaurids. The skull roof is relatively flat as in *Rugops* and *Eoabelisaurus*.

*24) Skull roof ornamentation: none (**0**), midline (1), lateral (2) (Carrano and Sampson 2008).*

There are none ornamentation on the skull roof, although the postorbital is thickened and slightly ornamented but not in the same degree as in *Ekrixinatosaurus* and *Skorpiovenator*. The ornamentation of the posterolateral region of the frontals resembles the condition of *Rugops* (i.e. slight rugosities).

*25) Arrangement of bones along dorsal margin of orbit: postorbital and lacrimal separated by frontal, which forms part of orbital rim (0), contact between postorbital and lacrimal that excludes frontal from orbital rim (**1**) (Carrano and Sampson 2008).*

The lacrimal and postorbital of *Spectrovenator* have an extensive overlapping contact along the dorsal margin of orbit as in more derived abelisaurids.

*26) Small fenestra in the skull roof placed between prefrontal, frontal, postorbital and lacrimal absent (0), or present (**1**) (Sereno et al. 2004; Canale et al. 2009, C 40).*

The fenestra is fully preserved on the left side of *Spectrovenator*. This character is shared between *Ekrixinatosaurus*, *Rugops*, and *Arcovenator*.

*27) Knob-like dorsal projection of parietals and supraoccipital: absent (**0**), present (1) (Carrano and Sampson 2008).*

This region is slightly damaged in *Spectrovenator* but the parietal does not seem to project dorsally above the level of the skull roof, as in *Eoabelisaurus* but differing from the condition of *Rugops* and more derived abelisaurids.

*28) Development of median parietal skull table: flat, broad (**0**), narrow, with sagittal crest (1) (Carrano and Sampson 2008).*

Despite the compression of this region, it can be observed that the parietal lacks a crest between the supratemporal fossa (present in *Rugops* and more derived abelisaurids) but has a

flat surface that is nonetheless narrow and resembles the condition of *Eoabelisaurus* and *Ceratosaurus*.

*29) Size and elevation of nuchal wedge and parietal alae: moderate (**0**), tall and expanded (1) (Carrano and Sampson 2008).*

The nuchal wedge is moderate as in *Eoabelisaurus* and *Rugops.* It is not as high and wide as derived abelisaurids (e.g., *Carnotaurus*, *Majungasaurus*).

*30) Size of infratemporal fenestra: subequal to size of orbit or smaller (0), considerably enlarged, larger than orbit and especially expanded ventrally (**1**) (modified from Rauhut 2003).*

The ventral region of the infratemporal fenestra is larger than the orbit, as in Ceratosauria. The left side of *Spectrovenator* is less distorted than the right side and correcting the distortion the infratemporal fenestra is proportionately smaller than in *Carnotaurus* and *Majungasaurus*, but it is subtriangular as in *Majungasaurus*.

*31) Postorbital suborbital flange: absent (0), present (**1**) (Carrano and Sampson 2008).*

The suborbital flange is small and subrectangular, and almost contact the lacrimal, being slightly more developed than in *Abelisaurus* but is not as broad as in *Carnotaurus* or *Majungasaurus*.

*32) Anteroposterior length of postorbital relative to height: markedly less (0), equal to or greater (**1**) (Carrano and Sampson 2008).*

The left postorbital of *Spectrovenator* is longer than its dorsoventral height, as in other abelisaurids. *Eoabelisaurus* and more basal ceratosaurians have a higher than long postorbital whereas *Abelisaurus* has the postorbital subequal in length and height.

*33) Length of the posterior process of the postorbital: less than half the length of the anterior process (**0**); more than half, but less than the length of the anterior process (**1**); longer than the anterior process (2) (modified from Canale et al. 2009, C 47) (ordered).*

The posterior process of the postorbital is about 50% the length of the anterior process in *Spectrovenator* and was therefore scored as uncertain 0/1.

*34) Orientation of posterior edge of postorbital: vertical (0), strongly sloped anteroventrally at an angle of 25 ° or more (**1**) (modified from Carrano and Sampson 2008).*

The posterior edge curved is and anteriorly deflected along its length, resembling the condition of most abelisaurids (*Majungasaurus*, *Carnotaurus*, and *Abelisaurus*), with the exception of *Ilokelesia* and *Arcovenator*.

*35) Jugal process of the postorbital: with distinct kink in posterior margin at the beginning of the jugal facet (0), jugal facet continuous with posterior margin of the dorsal part of the postorbital (**1**) (Pol and Rauhut, 2012, C35).*

As noted by Pol and Rauhut (2012), most theropods have the articular facet for the jugal offset from the posterior margin of the ventral process of the postorbital. In *Spectrovenator*, as in other ceratosaurs, the posterior margin of this facet is continuous with the posterior margin of the ventral process of the postorbital.

*36) Anterior margin of ventral process of the postorbital: straight or slightly concave (**0**), strongly concave (1) (modified from Canale et al., 2009, C46).*

The distal end of the jugal process of the postorbital of *Spectrovenator* is slightly expanded, as in *Arcovenator*, *Majungasaurus*, and *Abelisaurus*

*37) Posterior margin of the ventral process of the postorbital: convex in at least its dorsal part (**0**); straight or slightly concave over its entire length (1) (modified from Canale et al. 2009, C. 50).*

The posterior margin of the ventral process is convex in *Spectrovenator* as in *Masiakasaurus*, *Skorpiovenator*, and *Majungasaurus*. However this character varies among abelisaurids. In *Ilokelesia* and *Arcovenator* the ventral process is concave and in *Eoabelisaurus* is straight.

38) Dorsal margin of postorbital strongly inflated and bulked: absent (**0**), or present (1). (Canale *et al.* 2009, C 51).

The postorbital of *Spectrovenator* is slightly inflated manly anteriorly, however not to the same degree as in *Skorpiovenator* and *Ekrixinatosaurus*.

*39) Lateral depression on the posterodorsal part of the junction of the postorbital processes: present (**0**), absent (1) (Pol and Rauhut, 2012, C39).*

Spectrovenator has a depression at the origin of the anterior, posterior, and ventral processes, so that the lateral surface of the anterior process is offset laterally respect to the lateral surface of the base of the ventral process. The same condition is present in *Eoabelisaurus*, *Arcovenator*, and *Ilokelesia*.

*40) Morphology of anteroventral portion of ventral process of the postorbital: confluent with remainder of process (**0**), step and fossa present (1) (Carrano and Sampson 2008).*

The postorbital of *Spectrovenator* does not have any step or fossa on the ventral end of the lateral surface, so that anteroventral region of the ventral process is confluent with the remainder of the postorbital as *Masiakasaurus*, *Abelisaurus*, and *Majungasaurus*.

*41) Morphology of dorsalmost postorbital-squamosal contact: smooth (**0**), knob (1) (Carrano and Sampson 2008).*

There are no knobs at the postorbital-squamosal contact in *Spectrovenator*, a feature only noted in some abelisaurids (*Abelisaurus*, *Carnotaurus*) by Carrano and Sampson (2008).

*42) Angle between dorsal margin of upper temporal arc (formed posterior process of postorbital and anterior process of squamosal) and dorsal skull roof: less (**0**) or more (1) than 45° (modified from Canale et al. 2009, C. 52).*

The left side of *Spectrovenator* is slightly crushed so that the angle has been artificially accentuated. However, the right side has preserved enough of the posterior process of the postorbital and anterior process of the squamosal so that character state 0 can be determined for this specimen.

*43) Appearance of postorbital-squamosal contact in lateral view: contact edges visible (**0**), edges covered by dermal expansions (1) (Carrano and Sampson 2008).*

The contact of the postorbital-squamosal of *Spectrovenator* is visible in lateral view and has the typical tongue-in-groove articulation of non-abelisaurid theropods.

*44) Anterior process of lacrimal: includes antorbital fossa and rim (**0**), antorbital fossa only (1) (Carrano and Sampson 2008).*

The anterior process of lacrimal includes a superficial surface that tapers anteriorly, in addition to the antorbital fossa, resembling the condition of non-abelisaurid theropods. Other abelisaurid, such as *Rugops*, *Carnotaurus* and *Majungasaurus*, lack this superficial anterior process of the lacrimal. *Skorpiovenator* also has a well-developed anterior process but is dorsoventrally deeper than in *Spectrovenator*.

*45) Lacrimal fossa: exposed laterally (0), covered by dermal ossifications (**1**) (Carrano and Sampson 2008).*

The lacrimal fossa is laterally covered by a dermal ossification, as in *Eoabelisaurus*, *Rugops*, and more derived abelisaurids.

*46) Suborbital process of lacrimal: absent (0), present (**1**) (Carrano and Sampson 2008).*

The suborbital process is developed in *Spectrovenator* as in most abelisaurids. This process is more ventrally located along the posterior edge of lacrimal than in *Majungasaurus*, but more dorsally than in *Skorpiovenator*, resembling the placement of this process in *Rugops*.

*47) Morphology of lacrimal along dorsal orbit rim: flat (0), raised brow or shelf (**1**) (Carrano and Sampson 2008).*

The posterior process of lacrimal in *Spectrovenator* is robust and laterally projected forming an ornamented brow, as in most abelisaurids.

*48) Constriction of ventral ramus of lacrimal: present (**0**); absent (1) (modified from Canale et al. 2009, C. 43).*

The ventral ramus of lacrimal resembles the condition of *Rugops* and basal ceratosaurs, differing from the condition of more derived abelisaurids.

*49) Posterior expansion of ventral part of lacrimal: present, ventral part of posterior margin of lacrimal concave (**0**); strongly reduced or absent, ventral part of posterior margin straight or slightly convex (1) (modified from Canale et al. 2009, C. 43).*

The posterior margin of the ventral region of the lacrimal is mostly straight, with a minor posteroventral expansion. This contrast with the more developed posterior expansion present in *Ceratosaurus*. The ventral expansion of the ventral end of the lacrimal is moderate so that *Spectrovenator* was scored as uncertain with character states 0 and 1.

*50) Morphology of jugal-maxilla contact: slot or groove (0), lateral shelf (**1**) (Carrano and Sampson 2008).*

The jugal forms a laterally facing shelf on maxilla and the contact among these bones are broad as in other abelisaurids.

*51) Morphology of jugal-lacrimal articulation: simple butt joint (0), overlapping and pocketed (**1**) (Carrano and Sampson 2008).*

The jugal is dorsally expanded and overlaps the lateral surface of the lacrimal in *Spectrovenator*, as in others abelisaurids.

*52) Minimal height of jugal below the orbit: one third or less of the height of the orbit (**0**); half the height of the orbit or more (1) (modified from Canale et al. 2009, C 32).*

The jugal is dorsoventrally low below the orbit in *Spectrovenator*, as in *Majungasaurus*, *Abelisaurus* and *Eoabelisaurus*. Although the left side is more distorted than the right side, in the latter the dorsoventral depth is less than half the height of the orbit.

*53) Ventral margin of the posterior half of the jugal: straight or only slightly convex (0); strongly convex (**1**) (modified from Canale et al. 2009, C 33).*

The posterior half of the jugal is crushed on both sides. However, in the right side the jugal is less distorted and is clearly convex along its posterior half.

*54) Relative lengths of posterior jugal prongs: upper prong much shorter than lower (0); both prongs subequal in length (**1**) (Carrano and Sampson 2008).*

The dorsal prong is subequal in length to the ventral prong, as preserved on the left side in the skull *Spectrovenator*, resembling the condition of *Majungasaurus* and *Carnotaurus*.

*55) Squamosal contribution to nuchal crest: absent or minimal (0), present and broad (**1**) (Carrano and Sampson 2008).*

The squamosal contacts the parietal in *Spectrovenator* and contributes to the vertically oriented nuchal crest, as in more derived abelisaurids.

*56) Quadrate flange of squamosal: wraps around quadrate head (0), ends posterior to quadrate head (**1**) (Carrano and Sampson 2008).*

The postquadratic process of the squamosal extends posteriorly to the quadrate head, as in others abelisaurids.

*57) Dorsoventral proportions of quadratojugal prongs for jugal: narrow (0), deep (**1**) (Carrano and Sampson 2008).*

The quadratojugal of *Spectrovenator* is dorsoventrally deeper than the jugal prongs, as seen in others abelisaurids.

*58) Overlap of quadratojugal onto quadrate posteriorly: absent (0), present (**1**) (Carrano and Sampson 2008).*

*59) Quadrate foramen: present (0), absent (**1**) (Carrano and Sampson, 2008).*

The quadrate foramen is absent in *Spectrovenator*, as in *Ceratosaurus*, *Eoabelisaurus*, and abelisaurids. However, medial to the quadratojugal-quadrate suture a small fossa is present dorsal to the lateral condyle. A similar fossa is present in *Majugasaurus*, but more medially located than in *Spectrovenator*.

60) Ossification of interorbital region: weak or absent (0), extensive (1) (Carrano and Sampson, 2008).

Part of the interorbital ossification has been preserved on the right side but is crushed and it cannot be determined how extensive it was.

61) Morphology of trigeminal foramen: single (0), partly or fully split (1) (Carrano and Sampson 2008).

*62) Vagal canal opening: through otoccipital (0), onto occiput (**1**) (Carrano and Sampson 2008).*

The vagal canal opens posteriorly onto the occiput in *Spectrovenator*, along with the exit of the hypoglossal canal.

*63) Depth of basisphenoid recess: shallow (0), deep (**1**) (Carrano and Sampson 2008).*

The basisphenoid recess is deep in *Spectrovenator*, as in other ceratosaurs.

64) *Shape of opening for basisphenoid recess: ovoid (**0**), teardrop-shaped (1) (Carrano and Sampson 2008).*

In contrast to the posteriorly pointed tear-drop shaped basisphenoid recess of *Ceratosaurus* and *Majungasaurus*, the basisphenoid recess is ovoid in *Spectrovenator*, resembling the condition of non-ceratosaurian theropods.

65) *Depth of indentation between basal tubera and basisphenoid processes: deep notch (0), shallow embayment (**1**) (Carrano and Sampson 2008).*

A very shallow embayment is present between the basal tubera in *Spectrovenator*, as in *Masiakasaurus* and more derived abelisaurids, but contrasting with the notch present in *Ceratosaurus* and *Eoabelisaurus*.

66) *Medial fossa ventral to occipital condyle: absent (**0**), present (1) (Carrano and Sampson 2008).*

As in other ceratosaurians, there is no median fossal ventral to the occipital condyle in *Spectrovenator*.

67) *Size of dorsal groove on occipital condyle: wide (0), narrow (1) (Carrano and Sampson 2008).*

68) *Orientation of basioccipital-basisphenoid suture: oblique (0), horizontal (**1**) (Carrano and Sampson 2008)*.

This basioccipital-basisphenoid suture is horizontally oriented in *Spectrovenator*, as in other abelisauroids.

69) *Depth of median ridge on supraoccipital: less than width (0), greater than width (**1**). (Carrano and Sampson 2008)*.

The median ridge of the supraoccipital of taxnoname is not as posteriorly prominent as that of other ceratosaurs, but is nonetheless prominent in anteroposterior extension with respect to its lateromedial width.

70) *Morphology of jugal process of palatine: tapered process, triradiate palatine (0), expanded process, tetraradiate palatine (**1**) (Carrano and Sampson 2008)*.

The palatine of *Spectrovenator* has a flange posteroventral with triangular-shaped ("lacrimal flange" in Carrano and Sampson, 2008) giving it a tetraradiate appearance as in tetanurans and ceratosaurians.

71) *Pocket on ectopterygoid flange of the pterygoid: absent (0), present (**1**). (Carrano and Sampson 2008)*.

The pocket is present in the left ectopterygoid of *Spectrovenator*. The right ectopterygoid lost the distal tip on the part that it is possible see the referred pocket.

72) *Shape of pterygoid articulation with basipterygoid process: tab-like (0), acuminate (**1**). (Carrrano and Sampson 2008).*

This articulation in taxnoname is acuminateand the distal tip is rounded as in *Majungasaurus* and *Carnotaurus*.

73) *Arrangement of jugal and pterygoid processes of ectopterygoid: oblique (0), parallel (**1**). (Carrrano and Sampson 2008).*

The jugal and pterygoid processes of *Spectrovenator* are parallel to each other as in ceratosaurians.

74) *Proportions of ectopterygoid: gracile (0), robust (**1**). (Carrrano and Sampson 2008).*

This ectopterygoid of *Spectrovenator* is robust and is expanded anteroposteriorly at its distal end.

75) *Ventral excavation into ectopterygoid: absent (0), fossa (1), groove (2). (Carrrano and Sampson 2008).*

76) *Size of external mandibular fenestra: small to moderate (0), large (**1**). (Carrrano and Sampson 2008).*

This external mandibular fenestra of *Spectrovenator* is large as in other abelisauroids and expanded anteroposteriorly as in *Majungasaurus*.

77) *Position of anterior end of external mandibular fenestra relative to last dentary tooth: posterior (0), nearly ventral or ventral (**1**). (modified from Carrano and Sampson 2008).*

The external mandibular fenestra of *Spectrovenator* ends only slightly more posteriorly than the posteriormost dentary tooth, as in *Masiakasaurus* (both taxa scored as 1

based on the modified character definition). This position of the anterior end of the fenestra is only slightly more anterior in *Carnotaurus* and *Majungasaurus*.

78) Horizontal ridge on lateral surface of surangular below mandibular joint: weak or moderate (0), strong (**1**) (Carrano and Sampson 2008).

A prominent ridge extends anterior to the craniomandibular joint.

79) *Contour of posterior edge of splenial: straight (0), curved or notched (**1**). (Carrano and Sampson 2008).*

The posterior edge of splenial is curved as in others ceratosaurs and the dorsal edge is slight concave.

80) *Prongs at anterior end of splenial: one (0), two (1). (Carrano and Sampson 2008).*

81) *Morphology of dentary-surangular articulation just above external mandibular fenestra: small notch (0), large socket (**1**) (Carrano and Sampson 2008).*

A large acute v-shaped process of the surangular fits on a long facet on the lateral surface of the posterodorsal branch of the dentrary, as in other ceratosaurs. This differs however from the condition of other abelisaurids that have a rounded anterior process of the surangular (e.g., *Carnotaurus*).

82) Shape of articulated dentary rami in dorsal view: V-shaped (0), U-shaped (1) (Carrano and Sampson 2008).

*83) Ventral margin of dentary: straight or only slightly convex (**0**), strongly convex anteroposteriorly (1) (Canale et al. 2009, C. 22).*

The ventral margin of dentary is straight as in *Majungasaurus* rather than convex as in *Ceratosaurus*, *Carnotaurus* and *Ekrixinatosaurus*. There is a slight convexity in the first third of the bone, however it is slightly crushed in this region.

84) Position of lateral dentary groove: at or above mid-depth (**0**), in ventral half (1) (Carrano and Sampson 2008).

The lateral dentary groove is above mid-depth as in *Majungasaurus*, *Rajasaurus*, *Masiakasaurus*, *Genyodectes* and *Ceratosaurus*. The apomorphic condition is found in brachyrostrans. In *Spectrovenator* this groove reaches the alveolar margin at the posterior end of the dentary.

85) Position of posterior end of posteroventral process of dentary relative to posterior end of posterodorsal process: far posterior (0), directly ventral (1) (Carrano and Sampson 2008).

The posteroventral process of dentary is longer than in derived abelisaurids (e.g., *Majungasaurus*) and extends along the anterior third of the mandibular fenestra.

86) Arrangement of premaxillary tooth carinae: nearly symmetrical, on opposite sides (0), more asymmetrical, both on lingual side (1) (Carrano and Sampson 2008).

*87) Number of maxillary teeth: more than 12 (**0**), 12 or fewer (1) (Carrano and Sampson 2008).*

Spectrovenator has 18 maxillary alveoli.

*88) Tooth curvature: substantially-curved mesial and distal profiles with apex positioned distal to distal profile (0), or apex centrally positioned; mesial profile exhibits strong curvature; distal profile is straight or very slightly curved (**1**) (modified from Smith 2007; Canale et al. 2009, C 5).*

The tooth curvature of *Spectrovenator* is strong and the distal profile is slightly curved as in other abelisaurids.

*89) Surface texture of paradental plates: smooth (**0**), vertically striated or ridged (1) (Carrano and Sampson 2008).*

The paradental plates in *Spectrovenator* are smooth as in noasaurid and basal ceratosaurs. *Rugops*, instead, has rugose has the apomorphic rugose surface present in derived abelisaurids.

*90) Visibility of paradental plates in medial view: widely exposed (**0**), obscured (1) (Carrano and Sampson 2008).*

The paradental plates are well exposed in medial view.

91) Medial groove in paradental plates exposing replacement teeth: present (0), absent (1) (Carrano and Sampson 2008).

The deformation of the skull precludes determining with certainty if teeth were visible

*92) Pronounced size difference between premaxillary and maxillary teeth: absent (**0**) present (1) (Rauhut 2004).*

The preserved premaxillary teeth are subequal in size to most maxillary teeth in *Spectrovenator*.

93) Transverse flattening of lateral maxillary teeth: moderate (0), extreme (1) (Rauhut 2004).

*94) Size of largest maxillary tooth: less (**0**) or more (1) than height of the dentary (Rauhut, 2004).*

The largest maxillary teeth are 70% the height of the dentary.

95) Neural arch pneumaticity: moderate (0), extreme (1) (Carrano and Sampson 2008).

96) Internal structure of presacral vertebrae: solid (0), camerate (1), camellate (2) (Carrano and Sampson 2008).

*97) Atlantal epipophysis: short and triangular in lateral outline (0); strongly elongate and rod-like (**1**) (modified from Canale et al. 2009, C 58).*

The atlantal epipophysis is well developed and robust as in others ceratosaurs.

98) *Length of axial epipophyses: moderate, overhanging the postzygapophysis for a distance that is less than half of the length of the articular surface of the latter (0), long, overhanging the postzygapophysis for a distance that is more than half of the length of the articular surface (1) (modified from Carrano and Sampson 2008).*

99) *Morphology of axial spinopostzygapophyseal lamina: weakly concave (0), deeply invaginated (1) (Carrano and Sampson 2008).*

100) *Development of axial diapophyses: weak, nubbin (0), prominent, pendant (1) (Carrano and Sampson 2008).*

101) *Axial pleurocoels: absent (0), present (1) (Carrano and Sampson 2008).*

102) *Postzygodiapophyseal lamina in axis: absent (0), present (1) (Canale et al. 2009, C.60).*

103) *Anterior pleurocoel in postaxial presacral vertebrae: absent (0), fossa (1), foramen (2) (modified from Gauthier, 1986).*

There is an anterior pneumatic foramen preserved in a posterior cervical vertebra.

104) *Posterior pleurocoel in postaxial presacral vertebrae: absent (0), fossa only (1), fossa with pneumatic foramen (2) (Carrano and Sampson 2008).*

105) *Anterior articular surface of postaxial cervical vertebrae: concave (0), flat (1), convex (2) (modified from Rauhut 2003).*

107) *Demarcation of dorsal surface of neural arch from diapophyseal surface in anterior cervical vertebrae: gently sloping (0), ridge (1) (Carrano and Sampson 2008).*

108) *Ratio between anterior width and height of middle and posterior cervical centra: less (0) or more (1) than 1.3 (modified from Rauhut 2003).*

109) *Anteroposterior position of cervical neural spines: posterior half of centrum (0), anterior half of centrum (1) (Carrano and Sampson 2008).*

110) *Ventral keel on anterior cervicals: present (0), faint or absent (1) (Carrano and Sampson 2008).*

The ventral surface of cervicals lacks a well-developed keel.

111) *Anterior prongs on postaxial cervical epipophyses: absent (0), present (1) (Carrano and Sampson 2008).*

The preserved cervical epipophyses lack the anterior prongs present in *Carnotaurus* and *Dahalokely*.

112) *Development of pre- and postspinal fossae in postaxial cervical vertebrae: narrow (0), broad (1) (Carrano and Sampson 2008).*

113) *Postzygapophysis in mid-cervical vertebrae: placed at least partially over the posterior end of the neural arch pedicle and does not overhang the centrum posteriorly (0); posterior to the neural arch pedicle and overhangs the centrum posteriorly (1) (modified from Carrano et al. 2002; Canale et al. 2009, C. 54).*

114) *Position of cervical zygapophyses: close to midline (0), placed far laterally (1) (Carrano and Sampson 2008).*

115) *Morphology of anterior cervical epipophyses: low, blunt (0), long, thin (1), long, robust (2) (Carrano and Sampson 2008).*

116) *Height of mid-cervical epipophyses: low, less than one-third of the height of the neural arch (as measured from the dorsal margin of the centrum to the lateral edge of the postzygapophysis) (0), high, more than half the height of the neural arch (1) (Rauhut and Carrano 2016, C.116)*

117) *Length/height ratio of mid-cervical centra: less than 2 (0), 2-3 (1), more than 3 (2) (modified from Carrano and Sampson 2008) (ordered).*

118) *Height of postaxial cervical neural spines: moderate or tall (0), short (1) (Carrano and Sampson 2008).*

119) *Postzygodiapophyseal lamina in mid-cervical vertebrae: present, and connects the diapophysis with the postzygapophysis (0); reduced, indicated by a low ridge in parts (1) (modified from Canale et al. 2009, C. 57).*

120) *Accessory fossa on dorsal surface of postaxial cervical transverse processes: present (0), absent (1) (Carrano and Sampson 2008).*

121) *Constriction of posterior cervical vertebrae: moderate, centrum width at mid-length half the width at posterior end or more (0), extreme, mid-centrum width one-third or less (1) (Rauhut and Carrano 2016, C.121).*

The posterior cervical vertebrae are moderately constricted at their midpoint.

122) *Anterior pneumatic recess in anterior dorsals: absent (0), present (1) (modified from Rauhut, 2003).*

123) *Shape of anterior articular surface of centrum in vertebrae D1 and D2: subcircular (0), dorsoventrally compressed, width/height ratio 1.15 or more (1) (modified from Farke and Sertich 2013).*

124) *Shape of dorsal transverse processes in dorsal view: rectangular (0), triangular (1) (Carrano and Sampson 2008).*

125) *Height of dorsal parapophyses: slightly elevated from centrum (0), project far laterally (1) (Carrano and Sampson 2008).*

As in most ceratosaurs the parapophyses are markedly projected laterally in the dorsal vertebrae.

126) *Paradiapophyseal lamina: absent, weak (0), pronounced (1) (Carrano and Sampson 2008).*

127) *Dorsal vertebral centrum length relative to height: more than 2 (0), less than 2 (1) (modified from Rauhut 2003).*

The dorsal vertebral centra are relatively shorter rather than elongated as in noasaurids.

128) *Infradiapophyseal fossa of middle and posterior dorsal vertebrae: undivided (0), divided by paradiapophyseal lamina (1) (Farke and Sertich 2013).*

129) *Orientation of prezygapophyses in posterior half of dorsal vertebral series in anterior view: dorsal or dorsomedial (0), dorsolateral (1) (Farke and Sertich 2013).*

130) *Number of sacral vertebrae: five or less (0), six or more (1) (modified from Carrano and Sampson 2008).*

131) *Transverse dimensions of mid-sacral centra relative to other sacrals: equivalent (0), constricted (1) (Carrano and Sampson 2008).*

132) *Orientation of ventral margin of mid-sacral centra: horizontal (0), arched (1) (Carrano and Sampson 2008).*

133) *Dorsal edge of sacral neural spines: as thin as remainder of spine (0), thickened (**1**) (Carrano and Sampson 2008).*

The dorsal edge of the sacral neural spines is broad and rugose as in other ceratosaurs.

134) *Condition of sacral neural spines in adults: separate (0), fused (1) (Carrano and Sampson 2008).*

135) *Pneumaticity of sacral neural spines: weak or absent (0), well developed (1) (Carrano and Sampson 2008).*

136) *Neural spines of anterior caudal vertebrae in comparison to last dorsal vertebrae: approximately of equal anteroposterior length (0), two thirds or less the length of last dorsal neural spines (1) (modified from Carrano and Sampson 2008).*

137) *Longitudinal ventral groove in anterior caudal vertebrae: present (0), absent (1) (modified from Rauhut 2003).*

138) *Centrodiapophyseal laminae in anterior mid-caudal vertebrae: absent (0), present as low, rounded ridges (1) (Rauhut et al. 2003).*

139) *Proportions of anterior caudal neural arch base relative to mid-centrum proportions: smaller (0), equal or greater (1) (modified from Carrano and Sampson 2008).*

140) *Hyposphene-hypantrum articulations in anterior to mid-caudal vertebrae: absent (0), present (1) (Canale et al. 2009, C. 80).*

141) *Distal morphology of anterior to mid-caudal transverse processes: tapering (0), expanded posteriorly (**1**) (modified from Carrano and Sampson 2008).*

The transverse process is expanded posteriorly in *Spectrovenator*.

142) *Anterior process at distal end of anterior to mid-caudal transverse processes: absent (0), present (**1**) (modified from Carrano & Sampson 2008).*

The transverse process of anterior caudals of *Spectrovenator* bears an anaterior process.

143) *Neural spines of mid-caudals: inclined posteriorly (0), rectangular and sheet-like (1); anteroposteriorly short and vertical (2) (Rauhut 2003).*

144) *Proximodistal length of anterior caudal transverse processes: less (0), or more (1) than 1.4 times the length of caudal centra (Rauhut et al. 2003).*

145) *Contact between cervical vertebrae and cervical ribs in adults: separate (0), fused (1) (Carrano and Sampson 2008).*

146) *Wing-like process at the base of the anterior cervical rib shafts: absent (0), present (**1**) (Carrano and Sampson 2008).*

147) *Bifurcate cervical rib shafts: absent (0), present (**1**) (Carrano and Sampson 2008).*

The anterior cervical ribs are bifurcated and have a distal styliform process.

148) *Large vertical depression on lateral side of scapula above the glenoid: absent (0); present (1) (Pol and Rauhut, 2012).*

149) *Distal expansion of scapula: present (0), absent (1) (Gauthier 1986).*

150) *Relative width of scapular blade: broad, more than twice glenoid depth (0), narrow, less than twice glenoid depth (1) (Carrano and Sampson 2008).*

151) Development of posteroventral process on coracoid: moderate (0), pronounced (1) (Carrano and Sampson 2008).

152) Spacing between glenoid and posteroventral process of coracoid: moderate (0), close (1) (Carrano and Sampson 2008).

153) Ratio of coracoid height (as measured over the glenoid) and coracoid length: less than 1.8 (0), more than 1.8 (1) (modified from Carrano and Sampson 2008).

154) Shape of humeral head: elongate (0), globular (1) (Carrano and Sampson 2008).

155) Shape of distal humeral condyles: rounded (0), flattened (1) (Carrano and Sampson 2008).

156) Placement of humeral greater tubercle relative to internal tuberosity: proximal (0), distal (1) (Carrano and Sampson 2008).

157) Posterolateral tubercle on proximal part of the humerus: absent or poorly developed as a low mound (0), well-developed, sharply defined tubercle (1) (Novas et al. 2006).

158) Humerus S-shaped in lateral view (0), or straight (1) (Rauhut 2003).

159) Humerus in anterior view: with a concave or straight lateral margin and a mildly concave medial margin (0), with a convex lateral and strongly concave medial margin (1) (Rauhut and Carrano 2016, C.159).

160) Longitudinal torsion of humeral shaft: absent (0), present (1) (Carrano and Sampson 2008).

161) Size of deltopectoral crest: prominent flange (0), reduced (1) (Carrano and Sampson 2008).

162) Length of humerus relative to femur length: more than one-third (0), less than one third (1) (Carrano and Sampson 2008).

163) Length of radius: more (0), or equal to or less than half the length of the humerus (1) (Rauhut 2003).

164) Distal articular surface of radius: flat or slightly concave (0), strongly convex (1) (modified from Canale et al. 2009, C. 90).

165) Ratio between length of metacarpal two and length of humerus: more than 20 % (0), between 20 % and 15 % (1); less than 15 % (2) (ordered) (Pol and Rauhut 2012, C.156).

166) Distal end of metacarpal I: strongly asymmetrical, lateral condyle considerably higher dorsoventrally and more distally expanded than medial condlye (0), asymmetry reduced, lateral and medial condyles of subequal size or indistinct (1) (Rauhut and Carrano 2016, C.166).

167) Ventromedial expansion of medial distal condyle of Mc II: present (0), absent (1) (Pol and Rauhut, 2012, C.157).

168) Pronounced rim on proximal border of extensor fossa on metacarpal II and metacarpal III: absent (0), present (1) (Rauhut and Carrano 2016, C.168)

169) Distal articular end of metacarpal III in dorsal view: broad, with two condyles that are more or less symmetrical (0), broad, lateral condyle extends further distally than medial condyle (1), reduced in width, single convex articular surface (2) (Rauhut and Carrano 2016, C.169).

170) Metacarpal IV: slender, width of mid-shaft less than half of the width of mid-shaft of McII (0), robust, width more than half of that of Mc II (1) (Pol and Rauhut, 2012, C.158).

171) Relative length of manual phalanx II-1: more than twice width (0), less than twice width (1) (modified from Carrano and Sampson 2008).

172) Constricted neck between articular ends of manual phalanges: present (0), absent (1) (new character).

173) Gynglimoidal distal articular surface of proximal manual phalanges: well developed, condyles separated by deep notch (0); reduced, notch weak or absent (1) (modified from Canale et al. 2009, C. 93).

173) Development and curvature of manual unguals: well developed and highly recurved with distal end ventrally deflected forming an angle of at least 90 degrees with respect to the proximal articular surface (0), or absent or reduced in size and straight or poorly curved (1) (Pol and Rauhut 2012, C.162).

*174) Contacts between pelvic elements in adults: separate (0), at least partially fused (**1**) (Carrano and Sampson 2008).*

At least part of the ilium-pubis suture is fused in *Spectrovenator*.

*175) Ratio of length of femur to length of ilium: more than 1.3 (0), less than 1.1 (**1**) (modified from Canale et al. 2009, C. 82).*

176) Posterior width of iliac brevis fossa: subequal to anterior width (0), twice anterior width (1) (Carrano and Sampson 2008).

*177) Lateral brevis shelf in ilium: directed mainly ventrally, postacetabular blade of the ilium faces mainly laterally (**0**), flares laterally, postacetabular blade of the ilium faces dorso-laterally (1) (Rauhut and Carrano 2016, C.177).*

*178) Morphology of lateral ilium between supraacetabular crest and brevis shelf: gap (0), continuous (**1**) (Carrano and Sampson 2008).*

*179) Anterior margin of ilium: faces anteriorly or anterodorsally (0), faces anteroventrally (**1**) (Pol and Rauhut, 2012, C.167).*

*180) Shape of posterior margin of iliac postacetabular process: convex (0), undulating (**1**) (Carrano and Sampson 2008).*

*181) Shape of dorsal margin of central iliac blade: convex (0), straight (**1**) (modified from Carrano and Sampson 2008).*

*182) Relative sizes of iliac-pubic and iliac-ischial articulations: subequal (0), iliac-pubic articulation anteroposteriorly larger (**1**) (Carrano and Sampson 2008).*

*183) Relative proximodistal length of pubic and ischial peduncle: pubic peduncle considerably longer than ischial peduncle (**0**), peduncle of subequal length, or ischial peduncle longer (1) (Pol and Rauhut, 2012).*

*184) Orientation of ischial peduncle of ilium: posteroventrally inclined (**0**), vertical (1) (Pol and Rauhut, 2012).*

*185) Shape of anterior margin of iliac preacetabular process: rounded (0), undulating (**1**) (Carrano and Sampson 2008).*

*186) Anteroventral lobe of iliac preacetabular process: absent (0), present (**1**) (Carrano and Sampson 2008).*

187) Contact between pubic apices: separate (0), contacting (1) (Carrano and Sampson 2008).

188) Morphology of contact between pubis and ilium: planar (0), peg-and-socket (1) (Carrano and Sampson 2008).

189) Morphology of dorsal surface of pubic boot on midline: convex (0), concave (1) (Carrano and Sampson 2008).

*190) Notch ventral to obturator process on ischium: absent (0), present (**1**) (Carrano and Sampson 2008).*

191) Morphology of distal ischium: rounded, separate (0), expanded, with triangular boot (1) (modified from Carrano and Sampson 2008).

*192) Morphology of contact between ischium and ilium: planar (0), peg-and-socket (**1**) (Carrano and Sampson 2008).*

*193) Proportions of limb bones: moderate to gracile (**0**), robust (1) (Carrano and Sampson 2008).*

194) Dimorphism in hind limb morphology: absent (0), present (1) (Carrano and Sampson 2008).

*195) Fourth trochanter of femur: developed as a high flange or crest (**0**), reduced to a low ridge (1) (Bonaparte 1991; Canale et al. 2009, C. 96).*

*196) Morphology of anterolateral muscle attachments on proximal femur: continuous trochanteric shelf (0), distinct lesser trochanter and attachment bulge (**1**) (Carrano and Sampson 2008).*

197) Development of medial epicondyle of femur: rounded (0), ridge (1), long flange (2) (Carrano and Sampson 2008).

198) Morphology and orientation of femoral tibiofibularis crest: narrow, longitudinal (0), broad, oblique (1) (Carrano and Sampson 2008).

*199) Cnemial crest: distal end subequal or smaller in proximodistal width to shaft of crest (0), distal end expanded proximodistally (**1**) (modified from Carrano and Sampson 2008, C.135).*

The cnemial crest of *Spectrovenator* is proximodistally expanded at its end, and has a prominent hook-like distal process resembling the condition of *Quilmesaurus* (Coria 2001; Juarez Valieri *et al.* 2007), *Genusaurus* (Accarie et al 1995), and unnamed material from the Campanian of France (Allain and Pereda Suberbiola 2003).

*200) Expansion of cnemial crest (as measured from the level of the tibial shaft): ratio tibial length / cnemial crest > 6.5 (0), less than 6.5 (**1**) (modified from Canale et al. 2009, C. 99).*

*201) Shape of distal tibia in distal view: rounded (0), mediolaterally elongate (**1**) (Carrano and Sampson 2008).*

*202) Anterior side of distal end of tibia: with marked step, demarcating the border of the ascending process of the astragalus (**0**), flat (1) (Rauhut 2003).*

The thin ascending process of the astragalus accommodates on the anterior surface of the distal tibia within a concavity that is bounded by a medial oblique margin. This condition is similar to other abelisaurids but differs from the very shallow concavity present in *Elaphrosaurus* or *Velocisaurus*.

203) Development of fibular fossa on medial aspect of proximal fibula: posterior groove (0), posteriorly open fossa (1), medially open fossa (2) (Carrano and Sampson 2008).

*204) Size of iliofibularis tubercle on fibula: moderate (0), large (**1**) (Carrano and Sampson 2008).*

*205) Contact between fibula and ascending process of astragalus in adults: separate (**0**), fused (1) (Carrano and Sampson 2008).*

*206) Morphology of astragalar ascending process: blocky (0), laminar (**1**) (Carrano and Sampson 2008).*

The ascending process in *Spectrovenator* is laminar and sub-rectangular shaped.

*207) Orientation of astragalar distal condyles: ventral (0), anteroventral (**1**) (modified from Carrano and Sampson 2008, C.141).*

The astragalus is articulated with the distal tibia in *Spectrovenator* and the distal condyles are anteroventrally directed at about 30º.

*208) Horizontal groove across the anterior face of the astragalar condyles: absent or weak (0), pronounced (**1**) (Carrano and Sampson 2008).*

*209) Contact between astragalus and calcaneum in adults: separate (0), fused (**1**) (Carrano and Sampson 2008).*

*210) Development of astragalar articular surface for distal end of fibula: large, dorsal (0), reduced, lateral (**1**) (Carrano and Sampson 2008).*

The astragalar facet for the tibia is small reduced as in *Majungasaurus*.

*211) Height of the ascending process of the astragalus relative to depth of astragalar body: less or equal (0), greater (**1**) (Carrano and Sampson 2008).*

The height of the ascending process in *Spectrovenator* is approximately twice of the size of the astragalar body.

*212) Width of shaft of metatarsal II relative to widths of metatarsals III and IV: subequal (**0**), reduced (1) (Carrano and Sampson 2008).*

The shaft of the metatarsals II, III and IV are subequal in non-noasaurid abelisauroids. In *Spectrovenator* the shaft of metatarsal II is slightly over half the width of metatarsals IV and approximately half the width of metatarsal III. *Spectrovenator* is scored as intermediate given this condition is intermediate between that of noasaurids (e.g. *Masiakasaurus, Elaphrosaurus*) and *Eoabelisaurus* and derived abelisaurids (e.g. *Aucasaurus*, *Rahiolisaurus*, *Majungasaurus*).

*213) Proximal articular surface of metatarsal II: Subequal in width to that of Mt III and IV and (**0**), two thirds or less the width of Mt III or IV (1) (modified from Carrano and Sampson 2008, C.148).*

The metatarsal II has the articular surface subequal to of metatarsal IV and but narrower than the proximal articular surface of III.

214) Distal end of metatarsal IV: strongly asymmetrical, medial condyle much broader and more distally expanded than lateral condyle (0); more symmetrical, condyles subequal (1) (modified from Canale et al. 2009, C. 112).

*215) Morphology of lateral and medial grooves on pedal unguals: single (0), double (**1**) (Carrano and Sampson 2008).*

The grooves of pedal unguals are similar to other abelisauroids in having a Y-shaped system of lateral grooves, being the ventral groove deeper than the dorsal.

*216) Mediolateral symmetry of pedal digit II ungual: symmetrical (0), asymmetrical (**1**) (Carrano and Sampson 2008).*

The pedal digit II ungual of *Spectrovenator* is asymmetrical; the lateral surface is more convex than the medial.

*217) Ventral surface of pedal unguals with a well developed flexor tubercle, and usually flat (0), or without flexor tubercle and with a ventral depression in its proximal end (**1**) (Novas et al. 2005; Canale et al. 2009, C. 113).*

The flexor tubercle is absent and the proximal end is almost straight. The ventral depression is well developed and proximally deep.

218) Length of pedal digit phalanges I-1 + I-2 relative to III-1: greater (0), less than or equal (1) (Carrano and Sampson 2008).

2.2. Data matrix

An executable data matrix in TNT format has been uploaded also as supplementary material.

Herrerasaurus

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000000000000000000010000000000000000010000000000000000000[01]000100000000001?00000000?
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Syntarsus

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Dilophosaurus

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00010???0?1000?000000001000000010000?00
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Allosaurus

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020000[01]000000100011001000001000010200111011000000 1
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Berberosaurus

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11?????????????????????010[01]1???10110????????????
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Spinostropheus

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Genyodectes

```
0???0?????????????????????????????????????????????????????????????????????????????????000?[01]?
0001111?????????????????????????????????????????????????????????????????????????????????????????????
????????????????????????????????????????
```

Ceratosaurus

```
000012001000000001000000000101002010000000000000000000000000111?
110000111011100111101001000011111210111122100000000[01]121000001011110011 0?1?
010010020000010000011010100000100111[01]011101??00000?111111010[01]110110110111110001 0???
```

Deltadromeus

```
????????????????????????????????????????????????????????????????????????????????????????????????????????
????????????????????????????????????????????0??????1????1??111111?10?
0?????????????????????????????????1?0?01100?1121?111?1100?0???
```

Limusaurus

001?0?0???0?00000?00?000000??000?01[01]???00?0?0?0000??????00?????????????????1-?????0?0-
1???????1??0?000??0????1??????21??0??11?????????????10?00?010011011111??100101?11?
[01]001110011100[01]10000?00?0????1[12]?00???1??1????1??1???

Elaphrosaurus

??
1[01]??????110001110011002110101111000111 11?00101??1?1??1?01111111111010??10?01????
101101100001 1?0?0100?110100112101001001 0?????

Laevisuchus

??
1??????????01?1?0011?011?00?????[01]????????????????
0??

Velocisaurus

??
??
????0???????11?1?11111111?1?1?

Noasaurus

0??1?20111110?0???0?????????????????????????????10011??
01[12]?????????01?1?101110??00?????????????????????????000?????????????????????????
0?????????????????0?????????????????????1?????

Masiakasaurus

00?1?20?111?0?????00000000????00001000100?0?0010?????????????11?1001???????11?111000011001 1?0?
12?01111221011110011102100011111 01[01]101111011110 01?0111?01111111111010????????110111111?
11010??111011011121 0?111111111111111111

Eoabelisaurus

?0?????????????????0001000000[01]100201010010 00?10?0[01]??0??01?011????000?1?????????????????
00???0?1[12]??????221?110?0101?101000101111101111 1?1021110200??110?0000??
101[01]0101101111111111011?0[01]00?11?-11???0[01][01]101101101111??000111?

Rahiolisaurus

??-??
001??????1111100[01]01?0111?12?0?00?????????111?????????????????????11?????????????????????1??
01111110?1?1??0?0?1?11111111?1?11?0010????

Spectrovenator

11???200??011001110100001100 0111[01]110000000001110[01]1101111111??11010?1111111?1111?1?000?
0100?0?0??1?????2??????10?????????01??1?1?????1????????11???11?????????????????????????11?
0111110011???1?10?01??1110?10111111[01]0?111?

Rugops

111112??1?011001110100001111 0?????????????1111001 1?????????????????????????????????????101101?
0???
0???

Kryptops

```
1????20111011?????????????????????????????????????????????????????????????????????????????????????????
01100?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????
????????????????????????????????????????????
```

Abelisaurus

```
1111120?1?011??101111112101111101110?000101?11111?1001?111?10???10011??1???1??1?????????
101?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????
????????????????????????????????????????????
```

Ilokelesia

```
?1?????????????????????????????????11101111010?1?????????????????????1?????????????????????????????????????????
1??????22211001010121011 0????1111?????????2??112?
011?????????????????????????????????????????????????????????????????????????????????????????111?
```

Ekrixinatosaurus

```
1??1?011??01110?????1110?11?1?1?0????1???11??????????????1????1?????????????????????????11??01?0????
1???????222?11?001?1???11???????1??[01]???0?0???111??0?????????????????????????????????1?????1????
111?????0?011?1110??01??1?00????1?
```

Skorpiovenator

```
11?112111?01111????????01????111111101110110111111??11???1?????????????????????1??????111?01???0?
0??????????[01]?1???010?21?11?????????????????????2?111?1?11?????????????????????????????????1?
011001101 1?????????11?????????????????0?1???1?
```

Aucasaurus

```
11?112??1?0?11???1??11?2???????0?????????????110???1?????????????????????????????????????????????
0?????????????????????1?????????????1??????????????[01]?????1?21111?1?????010?211111111111211 1001?1??
101?11???111???1?0??1?1111??1?1111??0??1111
```

Carnotaurus

```
111112111?011110110111121011111101111011101110111111111110111???100111?111?111111111110?
10100012?111112211110111012101000111111111111111110211?1?
101111010021111011111211100111111011111111111?11110?1111????11????1?????????
```

Genusaurus

```
????????????????????????????????????????????????????????????????????????????????????????????????????????????
?1????????2??????0??????????????0???1???1?????????????????????????????????????????????????????????11?01??
1111????????0?0[01]201???11?????????????????
```

Indosaurus

```
?????????????????????11?1111?111?????????????????????????????????????11?????
1?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????
????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????
```

Majungasaurus

```
111112011101110101111111101111110110001000111101111011111111111111011111111121111111001101101000
121111112211110101012101000101111 11[01]1111111210002101101010021111111?112111001????
101111[01]1011?11??11?11??1?1011?1111110011111
```

Zaher H., Pol D., Navarro B. A., Delcourt R. & Carvalho A. B. 2020. — An Early Cretaceous theropod dinosaur from Brazil sheds light on the cranial evolution of the Abelisauridae. *Comptes Rendus Palevol* 19 (6): 101-115. https://doi.org/10.5852/palevol2020v19a6

Rajasaurus

11????????????????1??1111?111????????????????????1?????????1111??01???????211????1?0110?101???
12????????????????????????011?111??110?11?0???????0????????????????????????????0???0???110???
1???11??111??1?11?1?????0?0????

Arcovenator

11????????????????0?111111111?1110?0100??0????????????11???11??11?111??????????????????
1??
1110??0????????001??????????????

Dahalokely

??
1???????
[01]2111101110121110001111111[01]???
????????????????????????????

Camarillasaurus

??
?0?????????????????00??0????????????211????1??0??0???1???
101??1?????????????????

Pycnonemosaurus

??
??111111?0??
1???1?????1?10????????????????

CCG_20011

??
????????110?0111?0?1??211010?0?0000???????1?0???
[01]???

MNN_tig6

??
11??????2200101[01]0010112011010111100???111?????????
000???

USNM_8415

??
???
10001001???

2.3. Strict Consensus

The tree search resulted in 30336 most parsimonious trees of 446 steps that produce the following strict consensus:

```
    ,-- Herrerasaurus
    |  ,-- USNM_8415
    |  |-- MNN_tig6
    |  |-- CCG_20011
    |  |-- Camarillasaurus
    |  |-- Masiakasaurus
 |--|  |-- Noasaurus
    |  |-- Velocisaurus
    |  |-- Laevisuchus
    |  |-- Elaphrosaurus
    |  |-- Limusaurus
    |  |-- Deltadromeus
    `--+-- Spinostropheus
       |-- Allosaurus
       |-- Dilophosaurus
       |-- Syntarsus
       |  ,-- Ceratosaurus
       |--+-- Genyodectes
       |  `-- Berberosaurus
       |  ,-- Eoabelisaurus
       |  |  ,-- Pycnonemosaurus
       |  |  |-- Arcovenator
       |  |  |-- Rajasaurus
       `--|  |-- Majungasaurus
          |  |-- Indosaurus
          |  |-- Genusaurus
          |  |-- Abelisaurus
          `--+-- Kryptops
             |-- Rugops
             |-- Spectrovenator
             |     ,-- Skorpiovenator
             |  ,--|  ,-- Ekrixinatosaurus
             |  |  `----- Ilokelesia
             `--|  ,-- Dahalokely
                |  |-- Carnotaurus
                `--+-- Aucasaurus
                   `-- Rahiolisaurus
```

2.4. Reduced Consensus

Using the IterPCR method (Pol and Escapa, 2009) for identifying unstable taxa results in the identification of five unstable taxa. The IterPCR method was used with the implementation in TNT (Goloboff and Szumik, 2015) with the following commands: *pcr . > 0; nelsen// {0};*

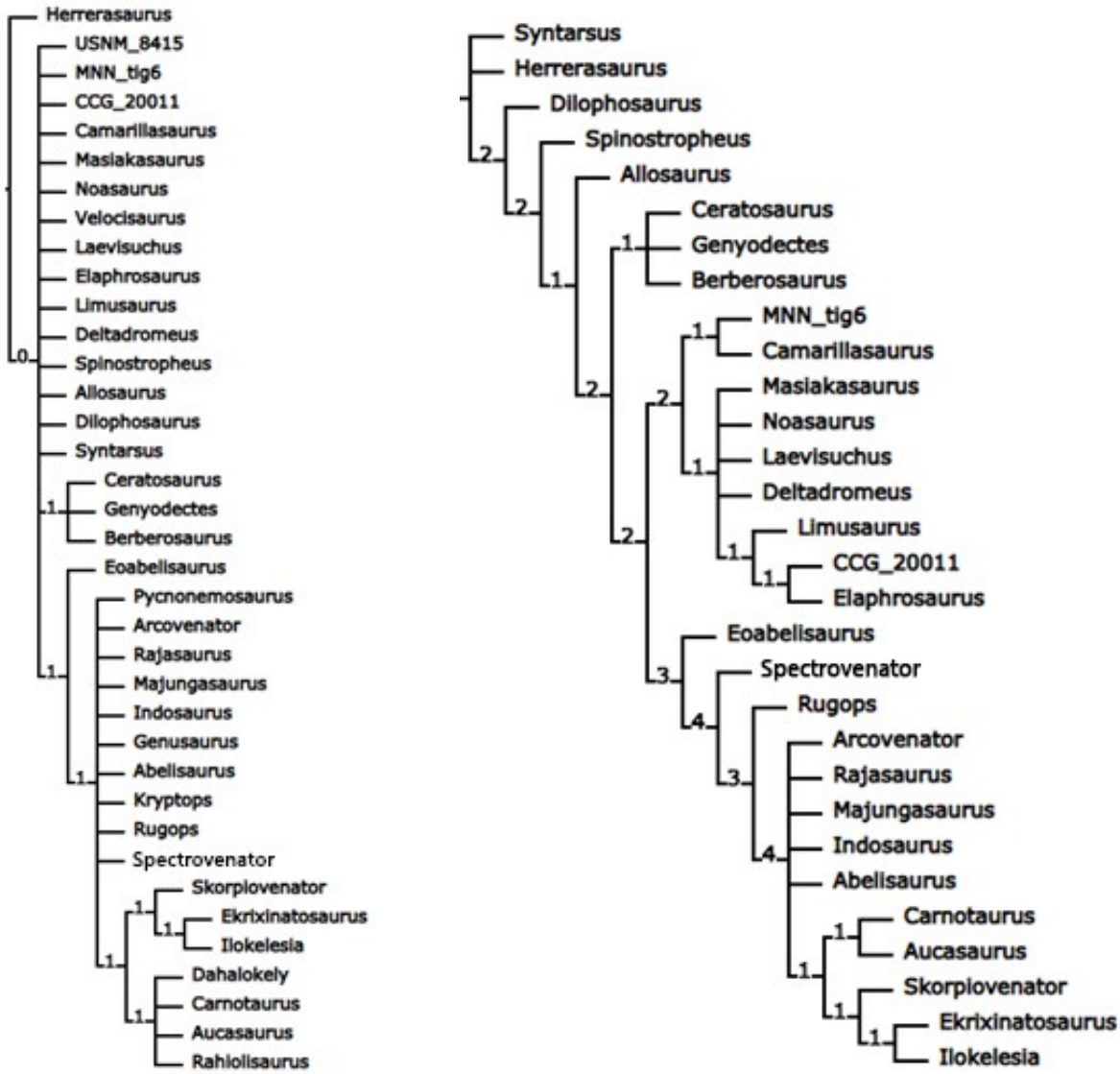
When these five taxa are pruned from the 30336 most parsimonious trees the following reduced strict consensus is obtained:

```
    ,-- Herrerasaurus
    |   ,--e Syntarsus
|--|   |   ,-- Dilophosaurus
    `--e|   |  ,-- Spinostropheus
        `--e|  |  ,-- Allosaurus
            |  |  |      ,-- Ceratosaurus
            `--|  |   ,--+-- Genyodectes
               |  |   |  `-- Berberosaurus
               `--|   |          ,--e MNN_tig6
                  |   |      ,--e---e Camarillasaurus
                  |   |      |    ,--ae Deltadromeus
                  `--e|  ,--e|    |         ,--e Limusaurus
                      |  |   `--ae|    ,--ae|   ,--e CCG_20011
                      |  |        |    |    `--e---e Elaphrosaurus
                      |  |        `--ae|       ,--ae Masiakasaurus
                      `--|             `--ae>ae+--ae Noasaurus
                         |                       `--ae Velocisaurus
                         |  ,-- Eoabelisaurus
                         |  |   ,--d Spectrovenator
                         `--|   |     ,--bcd Rugops
                            `--d|     |         ,--bc Arcovenator
                                |     |         |--b Rajasaurus
                                `--bcd|         |--b Majungasaurus
                                      |         |--bcd Indosaurus
                                      `--bcd>bcd+--b Abelisaurus
                                                |      ,-- Skorpiovenator
                                                |   ,--|  ,-- Ekrixinatosaurus
                                                |   |  `----- Ilokelesia
                                                `--b|  ,-- Dahalokely
                                                    |  |-- Carnotaurus
                                                    `--+-- Aucasaurus
                                                       `-- Rahiolisaurus

Legends:
a: Laevisuchus (11)
b: Kryptops (19)
c: Genusaurus (26)
d: Pycnonemosaurus (33)
e: USNM_8415 (36)
```

2.5. Support analyses

The following trees show the ***Bremer*** support values obtained when all taxa are included and when seven unstable taxa are pruned after the tree searches, as they were identified to be highly unstable among suboptimal trees and mask support for certain abelisaurid clades. The seven unstable taxa are *Rahiolisaurus*, *Kryptops*, *Dahalokely*, *Genusaurus*, *Velocisaurus*, *Pycnonemosaurus*, and USNM 8415.



The following trees show the ***jackknife*** support values obtained when all taxa are included and when the seven unstable taxa identified above are pruned after the pseudoreplicates are finished. Top trees are majority rule trees based on absolute frequencies and bottom trees are based on GC frequencies.

```
Group freqs., 1000 replicates, cut=50 (tree 0) - Jacknifing (P=36)
   ,-- Herrerasaurus
   |     ,-- USNM_8415
   |     |-- MNN_tig6
   |     |-- CCG_20011
   |     |-- Pycnonemosaurus
   |     |-- Camarillasaurus
   |     |-- Dahalokely
   |     |-- Arcovenator
   |     |-- Rajasaurus
   |     |-- Majungasaurus
|--|     |-- Indosaurus
   |     |-- Genusaurus
   |     |-- Carnotaurus
   |     |-- Aucasaurus
   |     |-- Skorpiovenator
   |     |-- Ekrixinatosaurus
   |     |-- Ilokelesia
   |     |-- Abelisaurus
   |     |-- Kryptops
   `--100+-- Rugops
         |-- Spectrovenator
         |-- Rahiolisaurus
         |-- Eoabelisaurus
         |-- Masiakasaurus
         |-- Noasaurus
         |-- Velocisaurus
         |-- Laevisuchus
         |-- Elaphrosaurus
         |-- Limusaurus
         |-- Deltadromeus
         |-- Ceratosaurus
         |-- Genyodectes
         |-- Spinostropheus
         |-- Berberosaurus
         |-- Allosaurus
         |-- Dilophosaurus
         `-- Syntarsus
Average group support: 2.9

GC values, 1000 replicates, cut=0 (tree 1) - Jacknifing (P=36)
   ,-- Herrerasaurus
   |     ,-- Syntarsus
|--|     |    ,-- Dilophosaurus
   `--100|    |    ,-- Spinostropheus
         `--16|    |   ,-- Allosaurus
              `--31|    |    ,-- USNM_8415
                   |    |    |        ,-- Berberosaurus
                   `--1|    |   ,--13|    ,-- Ceratosaurus
                       |    |    |    `--36--- Genyodectes
                       `--14|    |            ,-- MNN_tig6
                            |    |       ,--18--- Camarillasaurus
                            |    |       |   ,-- Laevisuchus
                            `--3|   ,--1|   |-- Deltadromeus
                                |    |   |   |    ,-- Limusaurus
                                |    |   `--1+--11|    ,-- CCG_20011
                                |    |       |    `--29--- Elaphrosaurus
                                |    |       |    ,-- Velocisaurus
                                `--3|       `--13|   ,-- Masiakasaurus
                                    |           `--4--- Noasaurus
                                    |    ,-- Eoabelisaurus
                                    |    |    ,-- Spectrovenator
                                    `--39|    |    ,-- Pycnonemosaurus
                                         `--39|    |   ,-- Genusaurus
                                              |    |   |-- Kryptops
                                              `--10|   |-- Rugops
                                                   |   |       ,-- Arcovenator
                                                   `--1|   ,--1|   ,-- Abelisaurus
                                                       |   |   `--1|   ,-- Indosaurus
                                                       |   |       `--1|   ,-- Rajasaurus
                                                       |   |           `--0--- Majungasaurus
                                                       `--0|        ,-- Skorpiovenator
                                                           |   ,--35|    ,-- Ekrixinatosaurus
                                                           |   |    `--32--- Ilokelesia
                                                           `--2|        ,-- Dahalokely
                                                               |   ,--22--- Rahiolisaurus
                                                               `--6|   ,-- Carnotaurus
                                                                   `--3--- Aucasaurus
Average group support: 14.4
```

```
Group freqs., 1000 replicates, cut=50 (tree 0) - Jacknifing (P=36)
   ,-- Herrerasaurus
   |    ,-- Dilophosaurus
   |    |-- Syntarsus
|--|    |    ,-- MNN_tig6
   |    |    |-- CCG_20011
   |    |    |-- Camarillasaurus
   `--80|    |-- Masiakasaurus
        |    |-- Noasaurus
        |    |-- Laevisuchus
        |    |-- Elaphrosaurus
        |    |-- Limusaurus
        `--58+-- Deltadromeus
             |-- Ceratosaurus
             |-- Genyodectes
             |-- Spinostropheus
             |-- Berberosaurus
             |-- Allosaurus
             |    ,-- Eoabelisaurus
             |    |    ,-- Spectrovenator
             `--73|    |    ,-- Rugops
                  `--95|    |    ,-- Arcovenator
                       |    |    |-- Rajasaurus
                       `--86|    |-- Majungasaurus
                            |    |-- Indosaurus
                            |    |-- Carnotaurus
                            `--91+-- Aucasaurus
                                 |-- Skorpiovenator
                                 |-- Ekrixinatosaurus
                                 |-- Ilokelesia
                                 `-- Abelisaurus
Average group support: 13.9

GC values, 1000 replicates, cut=0 (tree 1) - Jacknifing (P=36)
   ,-- Herrerasaurus
   |    ,-- Syntarsus
|--|    |    ,-- Dilophosaurus
   `--80|    |    ,-- Spinostropheus
        `--28|    |   ,-- Allosaurus
             |    |   |         ,-- Berberosaurus
             `--52|   |    ,--12|    ,-- Ceratosaurus
                  |   |    |    `--37--- Genyodectes
                  `--9|    |              ,-- MNN_tig6
                      |    |         ,--18--- Camarillasaurus
                      |    |         |   ,-- Laevisuchus
                      `--38|    ,--15|   |-- Deltadromeus
                           |    |    |   |    ,-- Masiakasaurus
                           |    |    `--8+--28--- Noasaurus
                           |    |        |    ,-- Limusaurus
                           `--20|        `--18|    ,-- CCG_20011
                                |             `--34--- Elaphrosaurus
                                |    ,-- Eoabelisaurus
                                |    |    ,-- Spectrovenator
                                `--70|    |    ,-- Rugops
                                     `--95|    |        ,-- Arcovenator
                                          |    |    ,--7|   ,-- Abelisaurus
                                          `--84|    |   `--4|   ,-- Indosaurus
                                               |    |       `--7|   ,-- Rajasaurus
                                               `--90|           `--0--- Majungasaurus
                                                    |         ,-- Carnotaurus
                                                    |    ,--29--- Aucasaurus
                                                    `--21|    ,-- Skorpiovenator
                                                         `--41|    ,-- Ekrixinatosaurus
                                                              `--37--- Ilokelesia
Average group support: 31.9
```

The following trees show the ***bootstrap*** support values obtained when all taxa are included and when the seven unstable taxa identified above are pruned after the pseudoreplicates are finished. Top trees are majority rule trees based on absolute frequencies and bottom trees are based on GC frequencies.

```
Group freqs., 1000 replicates, cut=50 (tree 0) - Standard Bootstrap
   ,-- Herrerasaurus
   |     ,-- USNM_8415
   |     |-- MNN_tig6
   |     |-- CCG_20011
   |     |-- Pycnonemosaurus
   |     |-- Camarillasaurus
   |     |-- Dahalokely
   |     |-- Arcovenator
   |     |-- Rajasaurus
   |     |-- Majungasaurus
|--|     |-- Indosaurus
   |     |-- Genusaurus
   |     |-- Carnotaurus
   |     |-- Aucasaurus
   |     |-- Skorpiovenator
   |     |-- Ekrixinatosaurus
   |     |-- Ilokelesia
   |     |-- Abelisaurus
   |     |-- Kryptops
   `--100+-- Rugops
         |-- Spectrovenator
         |-- Rahiolisaurus
         |-- Eoabelisaurus
         |-- Masiakasaurus
         |-- Noasaurus
         |-- Velocisaurus
         |-- Laevisuchus
         |-- Elaphrosaurus
         |-- Limusaurus
         |-- Deltadromeus
         |-- Ceratosaurus
         |-- Genyodectes
         |-- Spinostropheus
         |-- Berberosaurus
         |-- Allosaurus
         |-- Dilophosaurus
         `-- Syntarsus
Average group support: 2.9

GC values, 1000 replicates, cut=0 (tree 1) - Standard Bootstrap
   ,-- Herrerasaurus
   |     ,-- Syntarsus
|--|     |   ,-- Dilophosaurus
   `--100|   |        ,-- Spinostropheus
         |   |    ,--3--- Allosaurus
         `--5|    |    ,-- USNM_8415
             |    |    |   ,-- Laevisuchus
             `--26|    |   |-- Deltadromeus
                  |    |   |    ,-- MNN_tig6
                  |    |   |--13--- Camarillasaurus
                  `--10|   |   ,-- Limusaurus
                       |   |--5|    ,-- CCG_20011
                       |   |   `--25--- Elaphrosaurus
                       |   |    ,-- Velocisaurus
                       `--2+--16|   ,-- Masiakasaurus
                           |    `--5--- Noasaurus
                           |    ,-- Berberosaurus
                           |--11|    ,-- Ceratosaurus
                           |    `--41--- Genyodectes
                           |    ,-- Eoabelisaurus
                           |    |    ,-- Spectrovenator
                           `--29|    |   ,-- Genusaurus
                                |    |   |   ,-- Kryptops
                                `--28|   |   |-- Rugops
                                     |   |   |   ,-- Pycnonemosaurus
                                     `--4|   |--2--- Arcovenator
                                         |   |    ,-- Skorpiovenator
                                         |   |--29|    ,-- Ekrixinatosaurus
                                         `--1|    `--30--- Ilokelesia
                                             |        ,-- Dahalokely
                                             |   ,--18--- Rahiolisaurus
                                             |--2|   ,-- Carnotaurus
                                             |   `--2--- Aucasaurus
                                             |   ,-- Abelisaurus
                                             `--1|   ,-- Rajasaurus
                                                 `--2+-- Majungasaurus
                                                       `-- Indosaurus
Average group support: 12.0
```

```
Group freqs., 1000 replicates, cut=50 (tree 0) - Standard Bootstrap
   ,-- Herrerasaurus
   |    ,-- Dilophosaurus
   |    |-- Syntarsus
|--|    |    ,-- MNN_tig6
   |    |    |-- CCG_20011
   |    |    |-- Camarillasaurus
   `--84|    |-- Masiakasaurus
        |    |-- Noasaurus
        |    |-- Laevisuchus
        |    |-- Elaphrosaurus
        |    |-- Limusaurus
        `--50+-- Deltadromeus
             |-- Ceratosaurus
             |-- Genyodectes
             |-- Spinostropheus
             |-- Berberosaurus
             |-- Allosaurus
             |    ,-- Eoabelisaurus
             |    |    ,-- Spectrovenator
             `--69|    |    ,-- Rugops
                  `--95|    |    ,-- Arcovenator
                       |    |    |-- Rajasaurus
                       `--83|    |-- Majungasaurus
                            |    |-- Indosaurus
                            |    |-- Carnotaurus
                            `--89+-- Aucasaurus
                                 |-- Skorpiovenator
                                 |-- Ekrixinatosaurus
                                 |-- Ilokelesia
                                 `-- Abelisaurus
Average group support: 13.5

GC values, 1000 replicates, cut=0 (tree 1) - Standard Bootstrap
   ,-- Herrerasaurus
   |    ,-- Syntarsus
|--|    |    ,-- Dilophosaurus
   `--84|    |    ,-- Spinostropheus
        `--15|    |   ,-- Allosaurus
             |    |   |         ,-- Berberosaurus
             `--40|   |    ,--10|    ,-- Ceratosaurus
                  |   |    |    `--41--- Genyodectes
                  `--0|    |        ,-- Laevisuchus
                      |    |        |-- Deltadromeus
                      |    |        |    ,-- MNN_tig6
                      `--23|        |--16--- Camarillasaurus
                           |    ,--6|    ,-- Masiakasaurus
                           |    |   |--31--- Noasaurus
                           |    |   |    ,-- Limusaurus
                           |    |   `--10|    ,-- CCG_20011
                           `--12|        `--30--- Elaphrosaurus
                                |    ,-- Eoabelisaurus
                                |    |    ,-- Spectrovenator
                                `--64|    |    ,-- Rugops
                                     `--95|    |        ,-- Abelisaurus
                                          |    |    ,--4|   ,-- Arcovenator
                                          `--75|    |   `--1|    ,-- Indosaurus
                                               |    |       `--10|   ,-- Rajasaurus
                                               `--87|            `--1--- Majungasaurus
                                                    |         ,-- Carnotaurus
                                                    |    ,--23--- Aucasaurus
                                                    `--13|    ,-- Skorpiovenator
                                                         `--33|    ,-- Ekrixinatosaurus
                                                              `--33--- Ilokelesia
Average group support: 27.4
```

2.6. List of synapomorphies

The following list of unambiguous synapomorphies is based on the optimization of all most parsimonious trees after pruning the five unstable taxa identified with the IterPCR method that collapse most internal nodes within Abelisauridae (see section 1.3 and 1.4).

```
     ,--0 Herrerasaurus
     |    ,--1 Syntarsus
|--37|    |    ,--2 Dilophosaurus
     `--38|    |    ,--5 Spinostropheus
          `--39|    |    ,--3 Allosaurus
               |    |    |         ,--7 Ceratosaurus
               `--41|    |    ,--42+--6 Genyodectes
                    |    |    |    `--4 Berberosaurus
                    `--40|    |              ,--35 MNN_tig6
                         |    |         ,--59---32 Camarillasaurus
                         |    |         |    ,--8 Deltadromeus
                         `--43|    ,--45|    |         ,--9 Limusaurus
                              |    |    `--44|    ,--47|    ,--34 CCG_20011
                              |    |         |    |    `--49---10 Elaphrosaurus
                              |    |         `--48|    ,--14 Masiakasaurus
                              `--46|              `--50+--13 Noasaurus
                                   |                   `--12 Velocisaurus
                                   |    ,--15 Eoabelisaurus
                                   |    |    ,--17 Spectrovenator
                                   `--51|    |    ,--18 Rugops
                                        `--56|    |    ,--30 Arcovenator
                                             |    |    |--29 Rajasaurus
                                             `--55|    |--28 Majungasaurus
                                                  |    |--27 Indosaurus
                                                  `--54+--20 Abelisaurus
                                                       |         ,--23 Skorpiovenator
                                                       |    ,--58|    ,--22 Ekrixinatosaurus
                                                       |    |    `--57---21 Ilokelesia
                                                       `--53|    ,--31 Dahalokely
                                                            |    |--25 Carnotaurus
                                                            `--52+--24 Aucasaurus
                                                                 `--16 Rahiolisaurus
```

Node 39 :
All trees:
Char. 32: 1 ➔ 2
Char. 77: 0 ➔ 1
Char. 104: 0 ➔ 1
Char. 159: 0 ➔ 1
Char. 202: 0 ➔ 1
Char. 210: 0 ➔ 1

Node 40 :
All trees:
Char. 116: 1 ➔ 0

Node 41 :
All trees:
Char. 112: 1 ➔ 0
Char. 113: 0 ➔ 1
Char. 200: 0 ➔ 1

Node 42 :
Some trees:
Char. 91: 0 ➔ 1
Char. 92: 0 ➔ 1
Char. 93: 0 ➔ 1
Char. 107: 1 ➔ 0
Char. 169: 0 ➔ 1

Node 43 : Ceratosauria
All trees:
Char. 8: 0 ➔ 1
Char. 17: 0 ➔ 1
Char. 34: 0 ➔ 1
Char. 59: 0 ➔ 1
Char. 65: 1 ➔ 0
Char. 68: 0 ➔ 1
Char. 73: 0 ➔ 1
Char. 79: 0 ➔ 1
Char. 80: 0 ➔ 1
Char. 90: 0 ➔ 1
Char. 94: 0 ➔ 1
Char. 96: 0 ➔ 1
Char. 101: 0 ➔ 1
Char. 103: 0 ➔ 2
Char. 123: 0 ➔ 1
Char. 129: 0 ➔ 1
Char. 130: 0 ➔ 1
Char. 133: 0 ➔ 1
Char. 142: 0 ➔ 2
Char. 148: 0 ➔ 1
Char. 154: 0 ➔ 1
Char. 155: 0 ➔ 1
Char. 157: 0 ➔ 1
Char. 170: 0 ➔ 1
Char. 173: 0 ➔ 1
Char. 175: 0 ➔ 1
Char. 177: 0 ➔ 1
Char. 187: 0 ➔ 1
Char. 188: 0 ➔ 1
Char. 190: 0 ➔ 1
Char. 191: 0 ➔ 1

Char. 196: 0 ➔ 1
Char. 197: 0 ➔ 1
Char. 203: 0 ➔ 1
Char. 208: 0 ➔ 1

Node 44 :
All trees:
Char. 152: 0 ➔ 1

Node 45 : Noasauridae
All trees:
Char. 108: 0 ➔ 1
Char. 112: 0 ➔ 1
Char. 114: 2 ➔ 01
Char. 116: 0 ➔ 2
Char. 151: 0 ➔ 1
Char. 153: 0 ➔ 1

Node 46 : Abelisauroidea
All trees:
Char. 2: 0 ➔ 1
Char. 3: 0 ➔ 1
Char. 9: 0 ➔ 1
Char. 11: 0 ➔ 1
Char. 67: 0 ➔ 1
Char. 75: 0 ➔ 1
Char. 76: 0 ➔ 1
Char. 106: 0 ➔ 1
Char. 109: 0 ➔ 1
Char. 131: 0 ➔ 1
Char. 147: 0 ➔ 1
Char. 150: 0 ➔ 1
Char. 156: 0 ➔ 1
Char. 162: 0 ➔ 1
Char. 164: 0 ➔ 1

Node 47 :
All trees:
Char. 144: 0 ➔ 1
Char. 174: 1 ➔ 0
Char. 187: 1 ➔ 0

Node 48 :
All trees:
Char. 194: 0 ➔ 1
Char. 211: 0 ➔ 1

Node 49 :
All trees:
Char. 120: 0 ➔ 1

Node 50 :
All trees:
Char. 212: 0 ➔ 1
Some trees:
Char. 10: 0 ➔ 1

Node 51 : Abelisauridae
All trees:
Char. 44: 0 ➔ 1

Char. 111: 0 ➔ 1
Char. 127: 0 ➔ 1
Char. 135: 0 ➔ 1
Char. 140: 0 ➔ 1
Char. 167: 0 ➔ 1

Node 52 :
Some trees:
Char. 23: 0 ➔ 2
Char. 45: 1 ➔ 0
Char. 110: 0 ➔ 1

Node 53 :
All trees:
Char. 6: 0 ➔ 1
Char. 35: 0 ➔ 1
Char. 39: 0 ➔ 1
Char. 51: 0 ➔ 1
Some trees:
Char. 82: 0 ➔ 1
Char. 83: 0 ➔ 1
Char. 210: 1 ➔ 0

Node 54 :
All trees:
Char. 20: 0 ➔ 1
Char. 21: 0 ➔ 1
Char. 22: 0 ➔ 1
Char. 28: 0 ➔ 1
Some trees:
Char. 13: 0 ➔ 1
Char. 23: 0 ➔ 1
Char. 47: 0 ➔ 1
Char. 48: 0 ➔ 1

Node 55 : *Rugops* + more derived abelisaurids
All trees:
Char. 26: 0 ➔ 1
Char. 27: 0 ➔ 1
Char. 43: 0 ➔ 1
Char. 88: 0 ➔ 1

Node 56 : Abelisauridae excluding *Eoabelisaurus*
All trees:
Char. 1: 0 ➔ 1
Char. 19: 0 ➔ 1
Char. 24: 0 ➔ 1
Char. 25: 0 ➔ 1
Char. 30: 0 ➔ 1
Char. 31: 0 ➔ 1
Char. 45: 0 ➔ 1
Char. 54: 0 ➔ 1
Char. 87: 0 ➔ 1
Char. 180: 0 ➔ 1
Char. 198: 0 ➔ 1
Some trees:
Char. 33: 0 ➔ 1
Char. 57: 0 ➔ 1

Node 57 :
All trees:
Char. 104: 1 ➔ 2

Node 58 :
All trees:
Char. 37: 0 ➔ 1
Char. 41: 0 ➔ 1
Char. 118: 0 ➔ 1
Some trees:
Char. 23: 2 ➔ 0

Node 59 :
All trees:
Char. 113: 1 ➔ 0

3. Selected measurements from the skull and mandible of *Spectrovenator ragei* n. gen., n. sp. (MZSP-PV 833).

SKULL	mm
Width between infratemporal fenestrae	108,29
Width between top of orbits	99,24
Width of rostrum anterior to antorbital fenestra	61,25
Width of nasals over antorbital fenestra	38,21
Width of premaxillary anterior ascending process	33,33
Tip of premaxilla to frontoparietal suture	205,14
Frontoparietal suture to occipital condyle	32,79
Length, tip of rostrum to back of left quadratojulgal	216,41
Length, tip of rostrum to back of rigth quadratojulgal	195,37
Dorsoventral depth, postorbital to ventralmost extent of jugal	89,86
Dorsoventral depth, top of supraoccipital to bottom of basioccipital	77,72
Dorsoventral depth, rostrum at break in front of orbits	68,41
MANDIBLE	
Length, left ramus	260,98

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