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Pseudoshasticrioceras bersaci nov. sp. (Ammonoidea, Gassendiceratinae), and new ammonite biohorizon for the Upper Barremian of southeastern France

Didier Bert*  
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Abstract: Research in the Feraudianus Subzone of the Sartousiana Zone of the Barremian stage led to the discovery of a new species of Pseudoshasticrioceras: P. bersaci nov. sp. Its study provides evidence concerning the developments of the latest Gassendiceratinae Bert et alii, 2006, and the relationship between the genus Pseudoshasticrioceras Delany, 1998, and Gassendiceras Bert et alii, 2006. In particular, this new species is derived from Pseudoshasticrioceras magnini (Delany, 1992) by a minor revision in the processes of ontogenesis (retardation of ornamentation - neoteny). However, the evolution towards Pseudoshasticrioceras autrani Delany, 1998, implies a "failure" in this process that may possibly be related to parallel changes in environmental conditions. On the other hand, the very closely defined stratigraphic position of Pseudoshasticrioceras bersaci nov. sp., and its position in the anagenetic lineage of Pseudoshasticrioceras, demonstrates its interest as a biostratigraphic marker: a new Bersaci Biohorizon is proposed; it is located between the Magnini and the Autrani biohorizons.  

Key Words: Ammonitinae; Pseudoshasticrioceras; Gassendiceratinae; Upper Barremian; Sartousiana Zone; Feraudianus Subzone; biozonation; southeastern France.  

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I - Introduction

The Upper Barremian was intensively researched as part of the revision of the Hemihoplitidae conducted by one of us (DB). Many ammonites were collected from levels previously reported as being poor in fossils. Some of our results have been published (Bert & Delany, 2000; Bert et alii, 2006, 2009). The continuation of this research in the median levels of the Feraudianus Subzone (Sartousiana Zone) have resulted in a better understanding of the dynamics of the ammonite faunas. In particular the collection of a large homogeneous sample of specimens of the genus Pseudoshasticrioceras Delany, 1998, of which a palaeontological study is presented here, provides new elements concerning the evolution of the last Gassendiceratinae Bert et alii, 2006, and establishes a new biostratigraphic marker. The biochronological framework used for this work (Upper Barremian) is that proposed recently by Bert et alii (2008).
We had previously recognized (BERT & DELANOY, 2000; BERT et alii, 2006, p. 181) several stages of ornamentation that recur frequently in most Hemihoplitidae SPATH, 1924, at the different stages of ontogenic development. These stages are defined as follows:

1. Usually restricted to the younger whorls of the shell, the "heberti" type of stage features a sub-octagonal section of the whorls, and a more or less radial ornamentation consisting mostly of simple fine ribs, only slightly differentiated and regularly tri-tuberculated. This developmental stage is named for its occurrence in the taxon "Ezeiceras" heberti (FALLOT, 1884) [nomen dubium] of which the specimen-type is from a now inaccessible polyzonal bed. The specimen is only the nucleus, 27 mm in diameter, of an indeterminate individual of the Hemihoplitidae. Indeed, almost all the Hemihoplitidae less than 30 mm in diameter show this stage which is so similar in all specimens that speciation is then not possible (BERT & DELANOY, 2000; BERT et alii, 2006).

2. The "barremense" stage is generally distinguishable by an alternation of main tri-tuberculated ribs and of thinner intermediary ribs that are highly variable in appearance and in number. But this "standard" stage differs among the Pseudoshasticrioceras DELANOY, 1998, by the greater prominence of the interlayer ribs and their lesser number (see description). The name of this stage is derived from Barrassyloceras barremense (KILIAN, in KILIAN & LEEHARDT, 1895) of which the type specimen, from the Gardenazza area (Tyrol), was featured by UHLIG in 1887 (Pl. 4, fig. 3). This is a fragmentary specimen (almost 90 mm in diameter) on which the type-ornament is on the last half-whorl preserved.

3. The name of the "camereiceras" type ornament is based on the morphology and type of ornament known in adults, or pre-adult, of the genus Camereiceras DELANOY, 1990. The morphology features a very characteristic oval compressed section with a broad base and flanks converging to a narrow venter. The ribs are less differentiated and blunter than in the previous stage, so peri-umbilical and lateral tubercles are very weak or absent. In contrast, peri-ventral tubercles are very well marked, regular, claviform, and their arrangement flanks the venter in a very characteristic way.

II. Study of Pseudoshasticrioceras bersaci nov. sp.

Systematics:

Order: Ammonoidea ZITTEL, 1884
Sub-order: Ammonitina HYATT, 1889
Super-family: Ancyloceratoidea GILL, 1871
Family: Hemihoplitidae SPATH, 1924
Sub-family: Gassendiceratinaceae BERT et alii, 2006
Genus: Pseudoshasticrioceras DELANOY, 1998

Type-species: Pseudoshasticrioceras magnini (DELANOY, 1992), in DELANOY (1992, Pl. 24, fig. 1).

Pseudoshasticrioceras bersaci nov. sp.

(Pls. 1 - 6)

Synonymy:

? 1964. Crioceratites (Emericiceras) hoheneggeri (UHLIG, 1883) - THOMEL, Pl. 5, figs. 2-3.
V 1992. Emericiceras sp. gr. magnini sp. nov. - DELANOY, Pl. 25, fig. 1a-d.
V 1992. Emericiceras aff. magnini sp. nov. - DELANOY, Pl. 26, fig. 1; Pl. 27, fig. 1; Pl. 29, figs. 2-3.

Denomination: This species is dedicated to our colleague S. BERSAC of Vence (France).

Holotype: Specimen n° AR76, collection BERT (Pl. 1, figs. 1-2).

Type-locality: The LAC section, in the Méouille area, near Saint-André-les-Alpes (Alpes-de-Haute-Provence, France – Figs. 1 - 2) previously illustrated by BERT et alii, 2008, Fig. 4.

Bed-type: Bed n° 257 from LAC section (Fig. 2).

Geographic distribution: Pseudoshasticrioceras bersaci nov. sp. is known to date only in the southeastern France, in both basinal and distal platform areas.

Stratigraphic distribution: All the specimens from the Vocontian Basin come from a bed above the Magnini Biohorizon. This level is taken to be the base of the Bersaci Biohorizon (new, this work). It is located in the middle part of the Feraudianus Subzone (Sartoussiana Zone) of the Upper Barremian, between the Magnini and Autrani biohorizons (BERT et alii, 2008).
Figure 1: Barremian paleogeography of southeastern France and location of the area studied (from ARNAUD, 2005).

**Figure 1**: Cadre paléogéographique du Sud-Est de la France et localisation du secteur d’étude (d’après ARNAUD, 2005).

**Diagnosis:** Shell weakly uncoiled; with rapid growth in height, the section always higher than wide. Ornamentation always well marked. Three successive ontogenetic stages are known: (1) in the inner whorls, a sub-octagonal section ("heberti" stage); (2) after 25 mm in diameter, the whors increase in height and the section is compressed further. Ornamentation is trituberculated main ribs, with only a few broad intermediary ribs, which join the main ribs at the top of the flanks (an alternative to the "barremense" stage); (3) up to 100 mm in diameter, compressed oval section with broader base and sides converging towards the venter. Ornamentation blunt with lateral and periumbilical tubercles which tend to disappear ("camereiceras" stage).

**Material studied (N = 6):** Of all the specimens collected, four were from the pelagic domain in the Angles historical stratotype area (Vocontien Basin, area of Saint-André-les-Alpes, Alpes-de-Haute-Provence, southeastern France - Fig. 1): specimen n° AM30 and AR76 are from that section bed LAC/257 (BERT collection); n° 28416 (DELANOY collection) and n° MOR 079 (BERSAC collection) were collected from the interval between beds 194B and 196 of La Grau de Moriez site (see DELANOY, 1997b, p. 233). The other two specimens come from bed 4B4 of the Saint-Laurent de l’Escarène section, Alpes-Maritimes (see DELANOY, 1992), which is on a distal platform: n° EM 108 and EM 109 (MASCARELLI collection) are casts in the DELANOY’s collection.

**Figure 2:** Distribution of the ammonites in the LAC section pars (Méouille area, Saint-André-les-Alpes, Alpes-de-Haute-Provence). In grey are the specimens found in stratigraphically equivalent strata (outside the main section).

**Figure 2**: Répartition des faunes dans la coupe LAC pars (secteur de Méouille, Saint-André-les-Alpes, Alpes-de-Haute-Provence). En grisé, les espèces trouvées en place latéralement dans d’autres coupes, mais dans des niveaux corrélables banc par banc.
Nevertheless, the section remains much higher and the thickness ratio is only \(0.42\). In contrast, the growth in thickness remains low, with sub-joined whorls and a spiral gap generally weak. All are less than 3.5 mm in width (average relative umbilicus of \(O/D = 0.42\)). The growth in height is rapid (Table) with an average relative height of \(H/D = 0.36\). In contrast, the growth in thickness remains low, even if the difference in the kind of preservation in samples from the basin and from the platform are taken into account, for the average thickness ratio is only \(E/D = 0.23\). Nevertheless, the section remains much higher than wide (\(E/H = 0.61\) on average) and tends to become greater with growth. In Fig. 3, the average curves of the relations between the measured values of \(H\), \(E\) and \(O\) in relation to the diameter are in agreement with the allometric relationship \(Y = bx^a\). However, for \(H = f(D)\) \([R^2 = 0.99\) with \(p \approx 0.1]\) and \(E = f(D)\) \([R^2 = 0.86\) with \(p \approx 0.3]\), \(a\) values are close to 1, so we may consider the growth of these characters as almost isometric. Thus relative-height and relative-thickness are fairly constant in relation to the diameter. In contrast, for \(O = f(D)\) \([R^2 = 0.99\) and \(p < 0.001 - Fig. 3\)] and \(O = f(H)\) \([R^2 = 0.98\) and \(p < 0.001 - Fig. 4\)], there is a lower value of \(a\). This is linked to the

| n° Specimen | D | H | E | O | H/D | E/D | O/D | E/H | O/H | N/2 | N | spiral gap | α° |
|-------------|---|---|---|---|-----|-----|-----|-----|-----|-----|---|-------------|---|
| AR76 (holotype) Pl. 1, figs. 1-2 | 158 | 59.9 | - | - | 59.6 | 0.38 | - | 0.38 | 0.99 | - | - | - | - |
| | 121.5 | 43.3 | 27.9 | 52.7 | 0.36 | 0.18 | 0.43 | 0.47 | 1.22 | - | - | 0 | 120° |
| | 77.12 | 25.3 | 21 | 33 | 0.33 | 0.17 | 0.43 | 0.48 | 1.30 | 15 | 30 | 0 | 180° |
| MOR 079 Pl. 3, fig. 2 | 73.2 | 27 | 15.5 | 33.5 | 0.37 | 0.21 | 0.46 | 0.57 | 1.24 | - | - | 2.8 | - |
| | 45.9 | 15.74 | 7.8 | 21.8 | 0.34 | 0.17 | 0.47 | 0.50 | 1.39 | - | - | 1.15 | 190° |
| 28416 Pl. 6, fig. 2 | 80.4 | 28.7 | 18.1 | 34.5 | 0.36 | 0.23 | 0.43 | 0.63 | 1.20 | 17 | 36 | 2.8 | - |
| | 66.2 | 23.3 | 14.3 | 28.0 | 0.35 | 0.22 | 0.42 | 0.61 | 1.20 | 19 | 38 | 2.6 | 70° |
| | 47.8 | 18.2 | 13.1 | 23.4 | 0.38 | 0.27 | 0.49 | 0.72 | 1.29 | 18 | 38 | 1.4 | 90° |
| EM 108 Pl. 4, fig. 1 Pl. 5, fig. 1 | 189 | 70 | - | 75.4 | 0.37 | - | 0.40 | - | 1.08 | 23 | 43 | 4 | 90° |
| | 149.6 | 58.1 | 32 | 58.2 | 0.39 | 0.21 | 0.39 | 0.55 | 1.00 | 23 | 41 | 2.5 | 90° |
| | 115.2 | 43 | 27.7 | 47.2 | 0.37 | 0.24 | 0.41 | 0.64 | 1.10 | 20 | 38 | 2 | 90° |
| | 87 | 32.4 | 23 | 35 | 0.37 | 0.26 | 0.40 | 0.71 | 1.08 | 18 | 36 | 3.5 | 90° |
| | 68 | 24.1 | - | 30 | 0.35 | - | 0.44 | - | 1.24 | 18 | 36 | 2 | 90° |
| | 52.9 | 19.3 | - | 23.4 | 0.36 | - | 0.44 | - | 1.21 | 17 | - | - | - |
| EM 109 Pl. 2, fig. 1 Pl. 3, fig. 1 | 175 | 61.2 | - | 73.2 | 0.35 | - | 0.42 | - | 1.20 | 21 | 38 | 3 | - |
| | 138.4 | 50.5 | 34 | 55.9 | 0.36 | 0.25 | 0.40 | 0.67 | 1.11 | 20 | 36 | - | 90° |
| | 113.2 | 42.5 | 29 | 45.2 | 0.38 | 0.26 | 0.40 | 0.68 | 1.06 | 17 | - | - | 90° |
| | 88 | 31.54 | 23.5 | 35 | 0.36 | 0.27 | 0.40 | 0.75 | 1.11 | 16 | - | - | 90° |
| Average | 0.36 | 0.23 | 0.42 | 0.61 | 1.17 |
| Standard deviation | 0.01 | 0.04 | 0.03 | 0.09 | 0.11 |
| Coefficient of variation (%) | 4.09 | 16.09 | 7.07 | 15.23 | 9.16 |
Figure 3: Representation of $H$, $E$ and $O$ in function of the diameter ($D$) for *Pseudoshasticrioceras bersaci* nov. sp.

Figure 4: Representation of the umbilicus ($O$) in function of whorl height ($H$) for *Pseudoshasticrioceras bersaci* nov. sp.
Figure 5: Representation in the number of ribs per half-turn of whorl \((N/2)\) depending on the diameter \((D)\) for *Pseudoshasticrioceras bersaci* nov. sp.

Figure 5 : Représentation du nombre de côtes par demi-tour de spire \((N/2)\) en fonction du diamètre \((D)\) pour *Pseudoshasticrioceras bersaci* nov. sp.

decrease of \(O/H\) with respect to the diameter: The progression of this parameter is thus slightly allometric and the average width of the umbilicus increases in proportion with the diameter and the height of the whorl. The analysis of the dispersion parameters reveals that in all cases the clouds of points are weakly scattered around the average, homogeneous and without a breaking slope, thus indicating a harmonic growth. The coefficients of determination \(R^2\) are still very high. The standard deviations (Table) are very low and highly correlated with each other. We notice, however, that the coefficients of variation present certain disparities: around 5%, and in all are less than 10%, for reports of \(H\) and \(O\) calculations. But they are more than 15% for the relations involving \(E\), which is quite high in comparison to values given above. This result was anticipated due to the taphonomic differences: thinner by post mortem compression in the basin and uncompressed, thicker, on the distal platform. In any case there is no bimodality in the clouds of points of these diagrams, thus demonstrating the perfect uniformity of the sample with regard to growth parameters.

The ornamentation is always well marked and increases slightly quantitatively with greater diameter (Fig. 5). Two extremes of morphology with respect to robustness (covariance) can be recognized all connected by intermediaries, but that fact does not influence the ontogenic succession. Three successive stages can be recognized during growth.

- The first observations were made from specimens 15 mm in diameter. This stage is very similar to the "heberti" stage recognizable in most Hemihoplitidae and defined above (see Bert *et alii*, 2006). The section is very characteristic, sub-octagonal scarcely taller than wide; the ornamentation is already very close to that of the next stage, but more regular.

- Beginning at a diameter of 25 mm there is a variant of the "barremense" stage with strongly trituberculated ribs. The height of the whorls tends to increase and the section becomes increasingly higher and compressed: the umbilical wall is generally quite high, the peri-umbilical area is inclined and grades gradually to the rounded flanks, then to the venter which is quite narrow and pinched. The ornamentation is composed of main trituberculated ribs, slightly inclined backward and wider at the top of the flanks than at their base, with rare interlayer ribs. The first tubercle is at the base of the flanks, slightly above the peri-umbilical area. It is quite small and well marked in the inner whorls, and it may be slightly elongated in the direction of the rib that supports it. The lateral conical tubercle is
positioned in the upper third of the flanks. In the inner whorls the latter is equal in size and prominence to the peri-umbilical tubercle; however in the more robust specimens (n° AR76, Pl. 1, figs. 1-2; EM 109, Pl. 2, fig. 1; Pl. 3, fig. 1a-b; MOR 079, Pl. 3, fig. 2) it tends to become dominant, but conversely is less marked than the basal tubercle in the more slender specimens (n° EM 108, Pl. 4, fig. 1; Pl. 5, fig. 1a-b; 28416, Pl. 5, fig. 2; Pl. 6, fig. 2a-b). The external tubercle is the most important: its base is as wide as that of the rib which supports it; it is pinched in the direction of coiling, thus making it claviform, and it is topped by a very short flat triangular spine. On the venter, the main ribs are very wide and blunt. The intermediary ribs are scarce, quite broad, and more or less join the main ribs starting at the margino-ventral area. The presence of some peri-umbilical bifurcations determines a V-rib conformation.

- The last stage ("camereiceras" stage) known is attained at a diameter of 90-95 mm in the slender forms (n° EM108, Pl. 4, fig. 1; Pl. 5, fig. 1a-b), and at around 100-110 mm in the more robust forms (n° EM 109, Pl. 2, fig. 1; Pl. 3, fig. 1a-b; AR76; Pl. 1, figs. 1-2). The section becomes very characteristic: a compressed oval with a broader base and flanks that converge to the narrow venter. The ornamentation is blunter with the ribs less differentiated and more widely blunt than in the previous stage. The lateral and then the peri-umbilical tubercle gradually disappear. Instead, the peri-venter tubercles become more important, because of the widening of the ribs at the top of the flanks, and they are distributed on both sides of the venter in a very characteristic way, rather like that of some representative adults or sub-adults of Camereiceras Delany, 1990.

The suture line is very difficult to trace in most of our specimens, especially those from the basin (partial dissolution), but it is fairly denticulate and seems to show a trifide lateral lobe, asymmetric and broad-based (n° EM 109).

**Variability:** Westermann (1966), used Buckman’s work (1892) on the Sonninidae (Early Bajocian), that clarified in ammonites the "laws" of covariation based mainly on the relationship between the width of the section and the strength of the ornamentation. Since then, numerous studies have demonstrated that Buckman’s "First Law" can be extended to ammonoids ranging in age from Paleozoic to Cretaceous (see Morard & Guex, 2003, Tab. 1 for a summary). Overall, the sample studied here is very homogeneous, especially in the succession of its ontogenic stages, but using "Buckman’s Law" in a more detailed study shows it to be quite variable. Thus, two main morphologies are recognized, based on the relative robustness of the ornamentation. But, because of differences in both the mode of preservation and the degree of post mortem compression it is not possible here to demonstrate a correlation between habitat and development of ornamentation as is usually the case. Variability in the ornamentation density is quite small and very homogeneous (Fig. 5). At most, the forms with a more robust ornamentation tend to have fewer ribs.

In conclusion, the variability in shell and ornament, including all intermediaries, falls within the limits generally accepted for ammonites of the range of variability of a single species.

**Differential diagnosis:** The sample studied here has all the characters of the genus Pseudohastaticrioceras Delany, 1998. In particular it is very close to the type-species of the genus, Pseudohastaticrioceras magnini (Delany, 1992), of which one specimen is figured here for comparison (Pl. 6, fig. 1). This species differs essentially from ours in the duration of the successive stages of ontogeny. The tuberculated stage of the type "barremense" lasts longer and exists in specimens with an average diameter of up to 100 mm rather than 50 mm (discriminated character). The "heberti" type ontogenic stage is a little longer too.

Compared to Pseudohastaticrioceras quereilhaci Bert et alii, 2006, the differences from our species are more pronounced, for the tuberculated stage of P. quereilhaci is even smaller than in the type-species. In addition, the stage with a high section of the "camereiceras" type occurs later in the growth of our sample.

Pseudohastaticrioceras murphyi (Delany, 1992) is very different from the specimens studied here, for it has no trace of the tuberculated stage of the "barremense" type, at least to when the diameter is greater than 20-25 mm. The ribs are always thinner than those of our specimens.

The adult of Pseudohastaticrioceras autrani Delany, 1998, is smaller (around 100 mm in diameter) and the "barremense" stage, with trituberculated ribs, is smaller than in our specimens (up to 40-55 mm in diameter); also its coiling is narrower.

A comparison of the specimens studied here with other species of the genus shows that the succession of, and especially the duration of, ontogenic stages makes it original morphologically. So we propose the name Pseudohastaticrioceras bersaci nov. sp. to identify it.
More generally, when compared with species of the genus *Gassendiceras* BERT et alii, 2006, and especially with *Gassendiceras quelquejeui* BERT et alii, 2006, and *Gassendiceras enayi* BERT et alii, 2006, the representatives of the genus *Pseudoshasticrioceras* DELANOY, 1998, have a number of morphological and ornamental differences which, despite undeniable affinities, allow their distinction beyond dispute:

1. a narrower coiling which makes peri-venter spines shorter.
2. at equal diameters, the height of the whorls, and the rapidity of their growth during ontogeny, is always greater.
3. the ribs are less well differentiated, even at the "barremense" stage. In particular, the intermediate ribs (rarely totally inermous) are clearly less numerous and have the same aspect as the main ribs at the upper part of the flank, with the mark of a peri-ventral claviform tubercle.
4. the peri-umbilical bifurcations of the ribs are more numerous, especially with their very distinctive "V" shape.

| Biozones | Sub-zones | Biohorizons |
|----------|-----------|-------------|
| Giraudi  | Waagenoides |  |
|          | Sarasini   |  |
|          | Puzosianum |  |
| Giraudi  | Emerici    |  |
| Giraudi  | Giraudi    |  |
| Sartousiana | Feraudianus | Autran Biohorizon |
|          | Prosima    |  |
|          | Casanovai  |  |
|          | Provincialis |  |
|          | Limentinus |  |
| Vandenhekei | Barremense |  |
|          | Marchandi  |  |
|          | Breistrofferi |  |
| Vandenhekei |  |  |

**Phyletic position and evolution:** Stratigraphically (Fig. 2), *Pseudoshasticrioceras bersaci* nov. sp. immediately follows *Pseudoshasticrioceras magnini* (DELANOY, 1992) in the Magnini Biohorizon, and it precedes *Pseudoshasticrioceras autrani* DELANOY, 1998, in the Autrani Biohorizon.

As in many other groups of ammonites, the duration and the appearance of the different stages of ontogeny may be determinants in evolutionary trends (DOMMERGUES et alii, 1986). Thus, during time, there is a retardation (neoteny) of the stages of ornamentation between *Pseudoshasticrioceras quereilhaci* BERT et alii, 2006, *Pseudoshasticrioceras magnini* (DELANOY, 1992) and *Pseudoshasticrioceras bersaci* nov. sp., caused mainly by a lengthening of the trituberculated stage. It should be noted that the process appears to be reversed in the *Gassendiceras* where there is a reduction in the duration of the "barremense" stage over time (unpublished data).

Although data are still incomplete for these *Pseudoshasticrioceras* species and for *Pseudoshasticrioceras autrani* DELANOY, 1998, there is an abrupt reduction in duration of the "barremense" and "camereiceras" stages, and a sudden decrease in the adult size. This "failure" may parallel some extrinsic elements like the contemporary drop in sea level (sequence boundary SbB4 in ARNAUD, 2005) which preceded the marine transgression at the base of the Giraudi Biozone. These changes caused the morphological distinctions known among the representatives of the genus *Imerites* ROUCHADZÉ, 1933, now classified as *Gassendiceratinae* BERT et alii, 2006 (BERT et alii, 2008). New specimens (BERT et alii, 2009) clearly show a direct link between the latest *Pseudoshasticrioceras* and the first *Imerites*. 

**Figure 6:** Proposed biozonal scheme, after BERT et alii, 2008, and REBOULET et alii, 2009, amended. In red the Bersaci biohorizon (new).

**Figure 6 :** Biozonation proposée, d’après BERT et alii, 2008, et REBOULET et alii, 2009, modifié. En rouge le biohorizon à Bersaci (nouveau).
III. Biostratigraphy

**Bersaci Biohorizon (new):** Pseudoshasticrioceras bersaci nov. sp. has a very limited and precise stratigraphic position as the successor, by anagenetic processes, of the index-species Pseudoshasticrioceras magnini (DELANOY, 1992); so in the stratotype area (Vocontian Basin, southeastern France) its stratigraphic appearance is in conjunction with its biological appearance. This position and the necessity of establishing a complete high resolution biozone for the Barremian (REBOULLET et alii, 2006, 2007; BERT et alii, 2008) lead us to propose Pseudoshasticrioceras bersaci nov. sp. as a new biostratigraphic marker, a biohorizon, in the Vocontian Basin of southeastern France (Fig. 6). Pseudoshasticrioceras bersaci nov. sp. characterizes the strata immediately above those of the Magnini Biohorizon. It should be noted that these beds are not distinguishable as such in the historical section of the stratotype near Angles, where deposits of this portion of the Upper Barremian are abnormal (gaps, faunal concentration, etc.) - see BERT et alii, 2008). As already noted by DELANOY (1997b), the thickness of the deposits of the Feraudianus Subzone increases in the direction of Saint-André-les-Alpes, then toward Moriez and Barrême. In the sections near Saint-André-les-Alpes, the first appearance of Pseudoshasticrioceras bersaci nov. sp. closely precedes the major beds of the Autrani Biohorizon (BERT et alii, 2008), at the top of the Feraudianus Subzone (Sartousiana Biozone), where Pseudoshasticrioceras autrani DELANOY, 1998, and the first recognized Heteroceras couleti DELANOY, 1994, occur.

**Index species:** Pseudoshasticrioceras bersaci nov. sp.

**Status:** This biohorizon is defined by the first appearance of its index-species (bed n° 257 in the LAC section, Fig. 2), and its upper limit is currently set at the base of the Autrani Biohorizon (bed n° 263 in the LAC section). It is also present in the GRY section, near Angles.

**Faunal assemblages:** The index-species, characterized in this work, is generally fairly well represented in the sections. It is associated with the "classic" fauna of the Feraudianus Subzone (DELANOY, 1997a, 1997b; BERT et alii, 2008): Macroscaphites yvani (PUZOS) macro and microconch, Protetragonites crebisulcatus (UHLIG), Eulytoceras phestus (MATHERON), Silesites seranonis (d'ORBIGNY), Barremites difficilis (d'ORBIGNY), etc.

IV. Conclusion

The discovery of Pseudoshasticrioceras bersaci nov. sp. at a specific level of the Feraudianus Subzone provides a biostratigraphic marker which can serve as a new biohorizon for the Upper Barremian of southeastern France. This new biohorizon is between the Magnini and the Autrani biohorizons. It is the result of the need for the establishment of the finest possible biostratigraphic framework, to further the study of the different ammonites groups in the Upper Barremian, and especially the Hemihoplitidae (BERT, in progress).

The description of this new species also provided a better understanding of the genus Pseudoshasticrioceras DELANOY, 1998, and of its differences from the genus Gassendiceras BERT et alii, 2006, morphologically close, and from which it is very probably derived. The stages of ornamentation in these genera do indeed have the same ontogenic organization with the succession of "heberti", "barremense" and "camereiceras" stages. But there are a number of morphological differences (coiling, structure of the shell) and ornamentation (rarser and less differentiated interlayer ribs, and "V" shaped peri-umbilical bifurcations) in the successive stages, especially in the "barremense" type.

This contribution, and the recognition of certain ontogenetic heterochronies in its development, has furnished a better understanding of the evolution of Pseudoshasticrioceras. They are an intermediate between the Gassendiceras, with which they occur jointly in the Feraudianus Subzone (BERT et alii, 2006, 2008), and the Imerites that distinguish the more recent Giraudi Biozone. Further research is necessary to complete this evolutionary canvas, particularly to clarify certain points relationship between P. bersaci nov. sp. and P. autrani DELANOY, 1998, as well as the precise derivation of the Pseudoshasticrioceras among the Gassendiceras.

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Plate 1: *Pseudoshasticrioceras bersaci* nov. sp.

**Figs. 1-2:** Specimen no AR76 (holotype), BERT collection, from the bed LAC/257, Méouille near Saint-André-les-Alpes (Alpes-de-Haute-Provence, France).

**Planche 1 : Figs. 1-2 :** Spécimen no AR76 (holotype), collection BERT, banc LAC/257 de Méouille près de Saint-André-les-Alpes (Alpes-de-Haute-Provence, France).
Plate 2:  

*Pseudoshasticrioceras bersaci* nov. sp.

**Fig. 1:** Specimen n° EM 109, MASCARELLI collection, from the bed 4B4 of the deposit of Saint-Laurent de l’Escarène (Alpes-Maritimes, France).

**Planche 2 : Fig. 1 :** Spécimen n° EM 109, collection MASCARELLI, banc 4B4 de Saint-Laurent de l’Escarène (Alpes-Maritimes, France).
Plate 3: *Pseudoshasticrioceras bersaci* nov. sp.

**Fig. 1a-b:** Specimen n° EM 109, MASCARELLI collection, from the bed 4B4 of the deposit of Saint-Laurent de l’Escarène (Alpes-Maritimes, France).

**Fig. 2:** Specimen n° MOR 079, BERSAC collection, from the gap of beds 194B to 196 of the deposit of La Grau de Moriez (Alpes-de-Haute-Provence, France).

**Planche 3 : Fig. 1a-b :** Spécimen n° EM 109, collection MASCARELLI, banc 4B4 de Saint-Laurent de l’Escarène (Alpes-Maritimes, France).

**Fig. 2 :** Spécimen n° MOR 079, collection BERSAC, de l’intervalle de bancs 194B à 196 de La Grau de Moriez (Alpes-de-Haute-Provence, France).
Plate 4:

*Pseudosthasticrioceras bersaci* nov. sp.

**Fig. 1:** Specimen n° EM 108, MASCARELLI collection, from the bed 4B4 of the deposit of Saint-Laurent de l’Escarène (Alpes-Maritimes, France).

**Planche 4 : Fig. 1 :** Spécimen n° EM 108, collection MASCARELLI, banc 4B4 de Saint-Laurent de l’Escarène (Alpes-Maritimes, France).
Plate 5: *Pseudoshasticrioceras bersaci* nov. sp.

**Fig. 1a-b:** Specimen n° EM 108, MASCARELLI collection, from the bed 4B4 of the deposit of Saint-Laurent de l'Escarène (Alpes-Maritimes, France).

**Fig. 2:** Specimen n° 28416, DELANOY collection, from the gap of beds 194B to 196 of the deposit of La Grau de Moriez (Alpes-de-Haute-Provence, France).

**Planche 5 : Fig. 1a-b :** Spécimen n° EM 108, collection MASCARELLI, banc 4B4 de Saint-Laurent de l’Escarène (Alpes-Maritimes, France).

**Fig. 2 :** Spécimen n° 28416, collection DELANOY, de l'intervalle de bancs 194B à 196 de La Grau de Moriez (Alpes-de-Haute-Provence, France).
Plate 6:

Planche 6 :

Pseudoshasticrioceras magnini (DELANOY, 1992)

Fig. 1: Specimen n° LAC 032, BERSAC collection, from bed LAC/256, Méouille near Saint-André-les-Alpes (Alpes-de-Haute-Provence, France).

Fig. 1 : Spécimen n° LAC 032, collection BERSAC, banc LAC/256 de Méouille près de Saint-André-les-Alpes (Alpes-de-Haute-Provence, France).

Pseudoshasticrioceras bersaci nov. sp.

Fig. 2a-b: Specimen n° 28416, DELANOY collection, from the gap of beds 194B to 196 of the deposit of La Grau de Moriez (Alpes-de-Haute-Provence, France).

Fig. 2a-b : Spécimen n° 28416, collection DELANOY, de l’intervalle de bancs 194B à 196 de La Grau de Moriez (Alpes-de-Haute-Provence, France).
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