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Ammonites and stratigraphy of the Bathonian in the Digne-Barrême area

(South-Eastern France, dept. Basses-Alpes)

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RIASSUNTO — La serie giurese delle Catene Subalpine, tra Digne e Barrême, è stata oggetto dei lavori ormai classici di Garnier (1872) e di Haug (1891), che ne fecero conoscere la stratigrafia e le ricchissime faune. Queste ultime, tuttavia, non erano ancora state illustrate in modo adeguato.

W. J. Arkell, d'altro canto, aveva giustamente sottolineato l'importanza delle serie giuresi di questa regione, in particolare nell'intervallo Bajociano - Batoniano inferiore, per stabilire una suddivisione zonale di grande dettaglio (1956, p. 149). Una loro revisione si imponeva dunque da tempo.

A questo scopo ho eseguito nuove raccolte di ammoniti nelle località fossilifere più note (Bas Auran, Chaudon), rilevandone la successione strato per strato.

Le faune del Batoniano così raccolte sono risultate di una ricchezza straordinaria; il loro studio, esposto nel presente lavoro, ha permesso di raggiungere notevoli risultati, sia in campo stratigrafico che in campo più strettamente paleontologico.

Il Bajociano (serie del Beaumont, del Ravin du Feston, di Chaudon) è stato ripreso contemporaneamente in esame da G. Pavia, sotto la guida dell'autore; i risultati di questa revisione verranno anch'essi pubblicati quanto prima.

Per quanto riguarda l'inquadramento geologico regionale, è sufficiente ricordare che le serie studiate appartengono alla zona di facies delfinese e si trovano presso il margine frontale delle Catene Subalpine. Dal momento che le caratteristiche del Giurese in facies delfinese e le sue variazioni sono ben note, appare superfluo descriverle in questa sede. Vale tuttavia la pena di sottolineare la scoperta di una lacuna locale, al limite tra le facies calcareo-marnose del Bajociano - Batoniano inferiore e le « terre nere », lacuna che interessa soprattutto il Batoniano medio.

La sezione del Bas Auran, dove la facies calcareo-marnosa del Bajociano continua per un buon tratto anche nel Batoniano, ha fornito una successione faunistica particolarmente completa al passaggio tra questi due piani e nel Batoniano inferiore. Il Batoniano medio vi è invece assai ridotto e lacunoso, essendo limitato allo strato calcareo più alto, subito sotto la base delle « terre nere ».

A Chaudon, solo gli ultimi tre strati della serie calcareo-marnosa appartengono al Batoniano (parte basale della zona a Zigzag). La loro superficie mostra evidenti tracce di erosione sottomarina, già notate da Garnier un secolo fa; una importante lacuna separa infatti questi strati calcarei dalla base delle « terre nere », in cui era nota da tempo una faunetta ferruginosa del Batoniano superiore, con Epistrenoceras *e* Prohecticoceras retrocostatum.

Un po' più a Nord, presso il Col de Pierre Basse, la parte basale delle « terre nere » ha viceversa fornito una fauna ferruginosa del Batoniano inferiore, contenente, tra l'altro, Berbericeras sekikense.

Ne segue che soltanto il Batoniano inferiore del Bas Auran si prestava ad un tentativo di suddivisione dettagliata, così come ad una discussione del limite inferiore, col Bajociano. Si sa infatti dai lavori di Guillaume, Rioult e Mouterde che i due indici di zona, Parkinsonia parkinsoni *e* Zigzagiceras zigzag, *si incontrano a livelli separati da un'intervallo abbastanza importante, occupato da almeno due livelli faunistici successivi con valore di sottozone.*

Di conseguenza, sono stato innanzitutto condotto a distinguere una nuova sottozona a Parkinsonia bomfordi, *al tetto della zona a Parkinsoni; essa è assai ben rappresentata tanto a Chaudon che al Bas Auran;* P. parkinsoni *scompare a questo livello, venendo sostituita da* P. subplanulata *e da* P. bomfordi; *quest'ultima, pur essendo assai rara nella regione in esame, doveva essere scelta come indice di sottozona per ragioni di priorità. Tre Perisfinctidi, interessanti per motivi diversi, sembrano ugualmente confinati a questo livello; si tratta di* Procerites costulatosus, Planisphinctes planilobus *e* P. tenuissimus (*il cui tipo viene da Chaudon*). *Accanto ad essi, numerosi* Leptosphinctinae, Oppelia *e* Cadomites *sottolineano le affinità ancora bajociane piuttosto che batoniane di questa sottozona.*

Il limite Bajociano - Batoniano è stato tracciato, al Bas Auran, subito prima della comparsa di Morphoceras *s.s. Per il Batoniano inferiore è stato possibile confermare l'interpretazione recente di Torrens, riconoscendovi un'unica zona, a* Zigzagiceras zigzag, *suddivisa in tre sottozone. La prima è ben rappresentata sia a Chaudon che al Bas Auran (strati 23-12; cf. Tav. 1); essa è caratterizzata dall'abbondanza di* Parkinsonia *del sottogenere* Gonolkites; P. (G.) convergens *è stata scelta come indice di sottozona.* Prohecticoceras *aff.* primaevum, Parkinsonia schloenbachi, P. (G.) convergens, P. (G.) subgaleata, Morphoceras parvum, M. densicostatum, Ebrayiceras sulcatum, Bigotites diniensis *n. sp.,* Procerites tmetolobus, P. subprocerus, P. (Lobosphinctes) intersertus, P. (Phaulozigzag) phaulomorphus, Zigzagiceras (Franchia *n. subg.*) arkelli *n. sp. ed altri ancora, sembrano confinati in questa prima sottozona.* Lissoceras psilodiscus, Oxycerites yeovilensis, O. nivernensis, Parkinsonia pachypleura, P. (Oraniceras) württembergica, Morphoceras multiforme, M. patescens, *comparsi a questo livello (o prima), salgono anche nella sottozona successiva. Questa abbraccia l'estensione verticale di* Zigzagiceras *s.s. e di* Procerozigzag; *entrambi sono rappresentati da numerose specie (alcune nuove) e mostrano una rapida evoluzione (Tav. 2, 23).* Morphoceras macrescens *ed* Ebrayiceras pseudoanceps *sono ugualmente limitati a questa sottozona intermedia; il primo è stato scelto come specie-guida. L'ultima sottozona (strati 6-2 al Bas Auran) corrisponde alla zona a Fallax di Arkell; essa è caratterizzata da* Procerites fowleri *e* P. fullonicus *alla base,* Morphoceras perinflatum *nella parte di mezzo,* Asphinctites recinctus *al tetto;* Siemiradzkia aurigera *e* Procerites imitator *sono presenti attraverso tutto il suo spessore, mentre accanto ad essi persistono* Lissoceras psilodiscus, Oxycerites yeovilensis (= O. fallax *auctt.*) *ed* O. nivernensis. O. yeovilensis *è stato provvisoriamente conservato come indice di sottozona, in attesa di trovarne uno più soddisfacente.*

Segue la zona a Progracilis del Batoniano medio, ridotta all'ultimo strato calcareo nella serie del Bas Auran, subito sotto la base delle « terre nere »; tra le specie più indicative, rinvenute a questo livello, sono da ricordare: Oxycerites oxus, Paroecotraustes formosus *e* Wagnericeras fortecostatum.

Oltre settanta specie (di cui almeno cinque nuove) e tre sottospecie (tutte nuove) sono descritte nella parte sistematica del lavoro. La scoperta di queste forme nuove e lo studio dello sviluppo ontogenetico dell'ornamentazione in numersi Procerites, Siemiradzkia, *ecc., hanno permesso di interpretare sotto un angolo nuovo i rapporti filetici tra i principali generi batoniani della famiglia* Perisphinctidae, *ponendone in discussione l'attuale assetto sistematico. Appare infatti evidente che un buon numero di essi sono derivati, più o meno direttamente, dal genere* Bigotites. Procerites (Lobosphinctes) *e* Zigzagiceras (Franchia *n. subg.*) *sono particolarmente interessanti a questo riguardo, unendo caratteri ancestrali propri di* Bigotites *(costrizioni periodiche, accrescimento per « segmenti evolutivi », interruzione ventrale delle coste nella parte giovanile) e caratteri nuovi (come i nodi parabolici nel nucleo di* Franchia *n. subg.*), *che ne fanno veri e propri anelli di transizione verso i generi* Procerites *e* Zigzagiceras, *rispettivamente. Nell'ambito di* Zigzagiceras *s.s. si assiste poi a successive modificazioni dell'ornamentazione, che portano gradualmente al genere* Siemiradzkia *(Tav. 2), precedentemente posto in una sottofamiglia diversa.*

Lo studio del nuovo materiale ha inoltre permesso di stabilire che i generi Asphinctites *e* Berbericeras *non appartengono alla famiglia* Perisphinctidae *ma alla famiglia* Morphoceratidae, *contrariamente all'opinione di autori precedenti.*

Al termine della parte introduttiva si è infine data una breve discussione del dimorfismo nelle ammoniti, quale risulta dalle faune batoniane prese in esame.

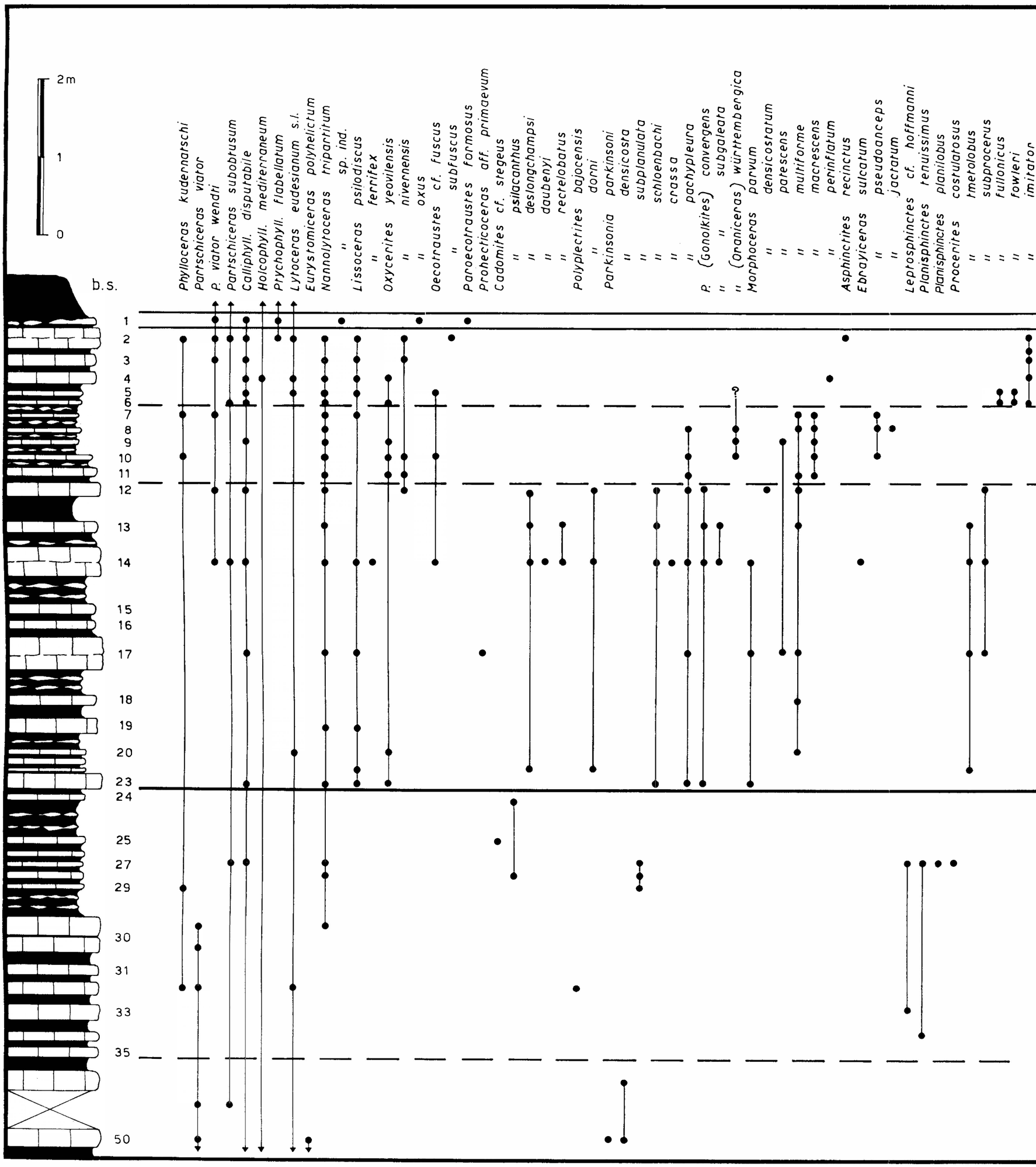
RÉSUMÉ — La série jurassique des Chaines Subalpines, aux environs de Digne et de Barrême, a fait l'objet des travaux désormais classiques de Garnier (1872) et de Haug (1891), qui en ont fait connaitre la stratigraphie et la richesse des faunes. Ces dernières, d'autre part, n'avaient pas encore été illustrées de façon convenable. W. J. Arkell, de son côté, avait justement souligné l'importance des séries jurassiques de cette région, notamment au Bajocien -

EXPLANATION OF PLATE 1

The Bathonian section at Bas Auran. It summarizes data from both the Ravin du Bès and the Ravin d'Auran outcrops. For more details see the text (pp. 8-13).

The exact horizon of *Morphoceras pingue* De Grossouvre being unknown, this species has not been mentioned on the present table.

Oecotraustes (*Paroecotraustes*) *maubeugei* Stephanov should be added to the species found in bed 1.


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Phylloceras kudernatschi
Partschiceras viator
P. viator wendti
Partschiceras subobtusum
Caliphyll. dispulabile
Holcophyll. mediterraneum
Prychophyll. flabellatum
Lytoceras eudesianum s.l.
Eurystomiceras polyhelictum
Nannolytoceras tripartitum
" sp. ind.
Lissoceras psiloceras
" ferrifex
Oxycerites yeovilensis
" nivernensis
" oxus
Oecotraustes cf. fuscus
" subfuscus
Paroecotraustes formosus
Prohecticoceras aff. primaevum
Cadomites cf. stegeus
" psilacanthus
" deslongchampsi
" daubenyi
" rectelobatus
Polyplectites bajocensis
" dorni
Parkinsonia parkinsoni
" densicosta
" subplanulata
" schloenbachi
" crassa
" pachypleura
P. (Gonolkites) convergens
" " subgaleata
" (Oraniceras) württembergica
Morphoceras parvum
" densicostatum
" patrescens
" multiforme
" macrescens
" perinflatum
Asphinctites recinctus
Ebrayiceras sulcatum
" pseudoanceps
" jactatum
Leptosphinctes cf. hoffmanni
Planisphinctes tenuissimus
Planisphinctes planilobus
Procerites costulatosus
" tmetolobus
" subprocerus
" fullonicus
" fowleri
" imitator

THE BATHONIAN SECTION AT BAS AURAN

(S-E France, Dept. Basses-Alpes)

densicostatum
" *parescens*
" *multiforme*
" *macrescens*
" *perinflatum*
Asphinctites reclinctus
Ebrayiceras sulcatum
" *pseudoanceps*
" *jactatum*
Leptosphinctes cf. hoffmanni
Planisphinctes tenuissimus
Planisphinctes planilobus
Procerites costulatosus
" *tmetolobus*
" *subprocerus*
" *fullonicus*
" *fowleri*
" *imitator*
P. (Lobosphinctes) intersertus
P. (Gracilisphinctes ?) spp. plur. ind.
Wagnericeras fortecostatum
Wagnericeras (?) n. sp. ind.
Zigzagiceras zigzag
" *euryodos*
" *plenum*
" *torrensi*
Z. torrensi variecostatum
" *lenthayense*
" *aff. lenthayense*
" *(Franchia) arkelli*
" *(Procerozigzag) crassizigzag*
" " *pseudoprocerum*
" *(P.) postpollubrum garnieri*
" " *postpollubrum*
Siemiradzkia aurigera
" *spp. plur. ind.*
Pseudoperisphinctes cf. rotundatus

Progracilis z

Yeovilensis sbz.

Macrescens sbz.

Convergens sbz.

Bomfordi sbz.

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Zigzag zone

Parkinsoni zone

BATHONIAN

BAJOCIAN

b.s. *black shales (probably Upper Bathonian)*

limestone beds

marls

Bathonien inférieur, pour établir une subdivision zonale poussée dans les moindres détails (1956, p. 149). Leur révision s'imposait donc depuis longtemps.

Dans ce but j'ai entrepris de nouvelles recoltes d'ammonites, faites couche par couche avec le plus grand soin, dans les localités fossilifères les mieux connues (Chaudon, Bas Auran, etc.). Les faunes du Bathonien ainsi recueillies sont d'une richesse extraordinarie; leur étude, exposée dans ce travail, a permis d'atteindre des résultats remarquables, soit au point de vue stratigraphique qu'au point de vue strictement paléontologique.

Le Bajocien (séries du Beaumont, du Ravin du Feston, de Chaudon) a été revu en mème temps par M. G. Pavia, sous le guide de l'auteur; les résultats de cette révision seront également publiés sous peu.

Au point de vue de l'encadrement géologique régional, il est à peine nécessaire de rappeller que les séries étudiées appartiennent à la zone des faciès dauphinois et qu'elles se trouvent tout près du chevauchement frontal des Chaines Subalpines. Les caractères des séries jurassiques de type dauphinois et leurs variations étant fort bien connus, il n'en sera pas faite mention ici. Il convient toutefois de souligner la découverte d'une lacune locale à la limite entre le faciès marno-calcaire du Bajocien - Bathonien inférieur et les terres noires, lacune intéressant surtout le Bathonien moyen.

La coupe du Bas Auran (Planche 1), où le faciès marno-calcaire monte assez haut dans le Bathonien, a livré une succesion de faunes très riche et fort complète au passage Bajocien-Bathonien et au Bathonien inférieur; le Bathonien moyen y est par contre reduit et lacuneux, seule la zone à Progracilis étant représentée (banc sommital de la série marno-calcaire).

A Chaudon, seuls les trois derniers bancs de la série marno-calcaire appartiennent au Bathonien (partie tout à fait inférieure de la zone à Zigzag); leur surface montre de nombreuses traces d'érosion soumarine, déjà remarquées il y a un siècle par Garnier. Une lacune importante les sépare en fait des terres noires, qui ont livré tout près de leur base une faunule ferrugineuse du Bathonien supérieur (avec Prohecticoceras retrocostatum *et* Epistrenoceras), *qu'on trouve déjà mentionnée dans le thèse de Haug.*

Un peu plus au Nord, près du Col de Pierre Basse, la base des terres noires contient par contre une faune ferrugineuse du Bathonien inférieur (avec Berbericeras sekikense).

Il apparait donc que seul le Bathonien inférieur du Bas Auran se prêtait à une subdivision détaillée, ainsi qu'à une discussion de la limite avec le Bajocien. L'on sait, en fait, depuis les travaux de Guillaume, de Rioult et de Mouterde, que les deux marqueurs de zone — Parkinsonia parkinsoni *et* Zigzagiceras zigzag *— se rencontrent à des niveaux séparés par un hyatus assez important, que couvrent au moins deux niveaux faunistiques de valeur sous-zonale. J'ai été d'abord amené à distinguer une nouvelle sous-zone à* Parkinsonia bomfordi, *au toit de la zone à Parkinsoni; elle est fort bien représentée tant à Chaudon qu'au Bas Auran;* P. parkinsoni *ne s'y rencontre plus, sa place étant prise par* P. subplanulata *et* P. bomfordi *(très rare ici, mais qu'il fallait choisir comme marqueur pour des raisons de priorité). Trois Périsphinctidés, intéressants à des égards différents, semblent également cantonnés à ce niveau; ce sont* Procerites costulatosus *(qui est bien un'éspèce bajocienne, comme le soutenait S. Buckman),* Planisphinctes planilobus *et* P. tenuissimus *(dont le type vient de Chaudon). A côté de ceux-ci, de nombreux* Leptosphinctinae, Oppelia *s.s. et* Cadomites, *soulignent les affinités encore bajociennes plutôt que bathoniennes de cette sous-zone.*

La limite Bajocien - Bathonien a été tracée, au Bas Auran, juste au dessous de l'apparition des premiers Morphoceras *s.s. Pour le Bathonien inférieur on a pu confirmer l'interprétation récente de H. S. Torrens, qu'y voit une seule zone —* à Zigzagiceras zigzag *— subdivisée en trois sous-zones. La première est bien représentée tant à Chaudon qu'au Bas Auran (couches 23-12, voir Planche 1). Elle est caractérisée par l'abondance de* Parkinsonia *du sousgenre* Gonolkites; P. (G.) convergens *a été choisi comme marqueur. Parmi les autres éspèces qui semblent cantonnées à ce niveau (du moins dans les Basses-Alpes) on peut mentionner:* Prohecticoceras *aff.* primaevum, Parkinsonia schloenbachi, P. (Gonolkites) subgaleata, Morphoceras parvum, M. densicostatum, Ebrayiceras sulcatum, Bigotites diniensis *n. sp.,* Procerites tmetolobus, P. subprocerus, P. (Lobosphinctes) intersertus, Zigzagiceras (Franchia *n. subg.*) arkelli *n. sp. D'autres* (Lissoceras psilodiscus, Oxycerites yeovilensis, O. nivernensis, Parkinsonia pachypleura, P. (Oraniceras) württembergica, Morphoceras multiforme, M. patescens), *apparaissant ici, ou même avant, se rencontrent également dans la sous-zone successive. L'extension verticale de celle-ci couvre à son tour celle de* Zigzagiceras *s.s. et de* Z. (Procerozigzag); *tous les deux y sont représentés par plusieures éspèces, en partie nouvelles, et montrent un'évotution très rapide (Planche 2).* Morphoceras macrescens *et* Ebrayiceras pseudoanceps *sont également cantonnés dans cette sous-zone; le premier a été choisi comme marqueur.*

La dernière sous-zone (couches 6-2 au Bas Auran) correspond grosso modo *à la zone à Fallax d'Arkell. Elle est caractérisée par* Procerites fowleri *et* P. fullonicus *à la base,* Morphoceras perinflatum *au milieu,* Asphinctites recinctus *au sommet;* Siemiradzkia aurigera *et* Procerites imitator *se rencontrent à travers tout son épaisseur, ainsi que* Lissoceras psilodiscus, Oxycerites nivernensis *et* O. yeovilensis, *survivant des niveaux inférieur.* Oxycerites yeovilensis (= O. fallax *auctt.*) *a été provisoirement gardé comme marqueur, bien qu'il ne soit pas jugé très satisfaisant. Suit au dessus la zone à Progracilis du Bathonien moyen (banc sommital de la série marno-calcaire) ayant fourni, entre autres*: Oxycerites oxus, Paroecotraustes formosus *et* Wagnericeras fortecostatum.

De nombreux Phyllocératidés et Lytocératidés, sans grande valeur stratigraphique, se rencontrent à travers tous les niveaux de la coupe.

Soixantedis éspèces (dont cinq nouvelles) et trois souséspèces (toutes nouvelles) sont décrites dans la partie systématique du travail. La découverte de ces formes nouvelles, ainsi que l'étude du developpement ontogénique de l'ornementation chez de nombreux Procerites, Siemiradzkia, *etc., a permis d'envisager sous un angle nouveau les rapports phylétiques entre les principaux genres de Périsphinctidés bathoniens, dont la position taxinomique serait entièrement à revoir.*

Il apparait, en fait, que bon nombre de Périsphinctidés bathoniens sont issus de Bigotites. *Les deux sousgenres* Lobosphinctes *et* Franchia *n. subg. sont particulièrement intéressants à cet égard, puisqu'ils réunissent à la fois des caractères ancestraux de* Bigotites, *dans les tours jeunes (constrictions périodiques, accroissement par « segments évolutifs», interruption ventrale des côtes), et des caractères nouveaux (comme les noeuds paraboliques, chez* Franchia *n. subg.), qui en font de véritables anneaux de transition vers* Procerites *et* Zigzagiceras *s.l., respectivement. Au sein de* Zigzagiceras *s.s. l'on assiste également à des modifications successives de l'ornementation, qui conduisent à* Siemiradzkia, *dont plusieures éspèces possèdent encore un très court stade du type « zigzag » (Pl. 18, fig. 3).*

Les genres Asphinctites *et* Berbericeras, *d'après l'étude du nouveau matériel, sont enfin à ranger avec les Morphocératidés, contrairement aux avis précédents.*

La nature du dimorphisme chez les ammonites est également discutée, sur la base des éxemples rencontrés au Bathonien inférieur.

INTRODUCTION

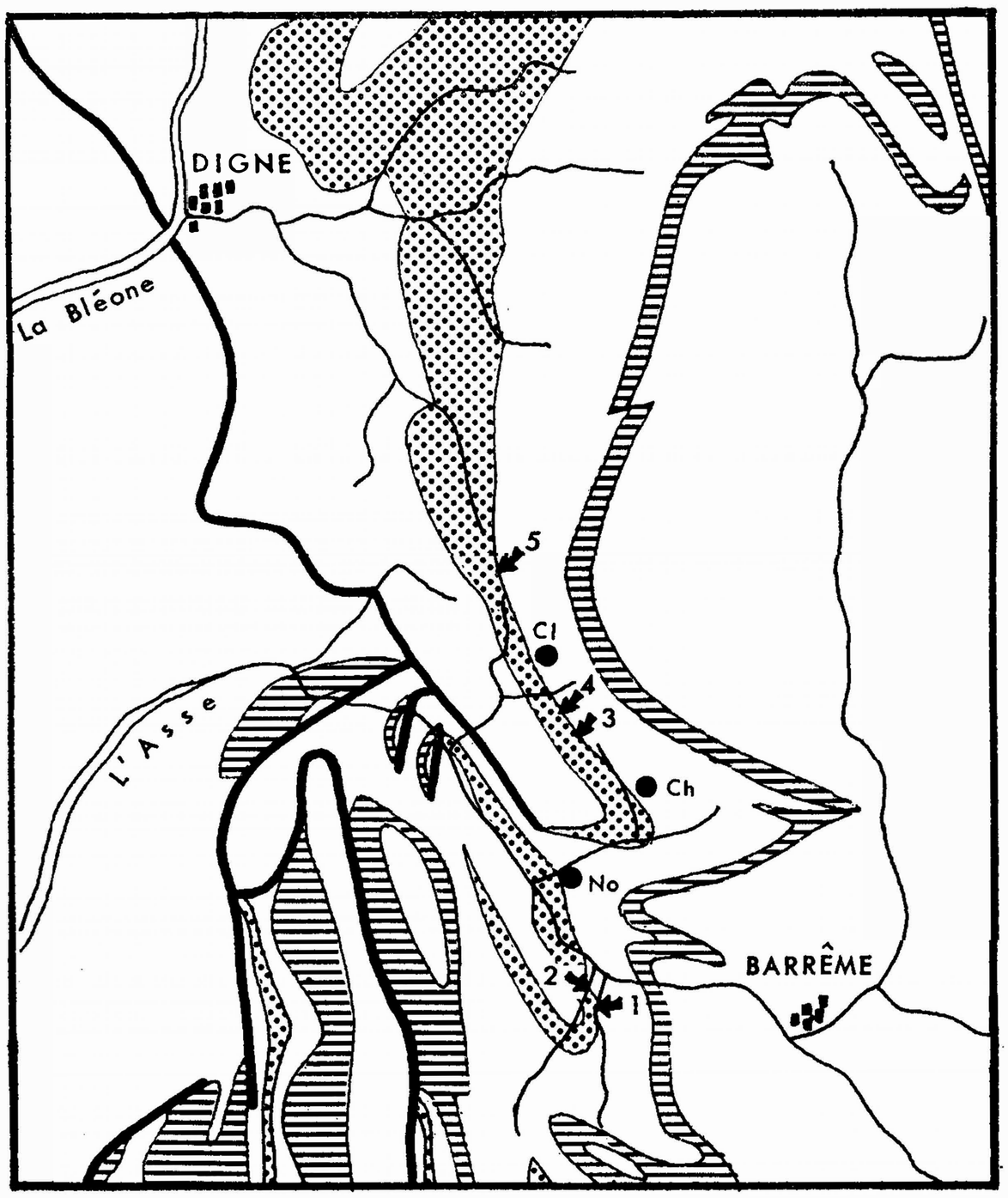
The country between Digne and Barrême (Southeastern France, Dépt. Basses-Alpes) is of unique interest for Lower Bathonian stratigraphy. In his classic work on the Subalpine Ranges E. Haug wrote (1891, p. 80): « La faune de la zone à *Oppelia fusca* des Basses-Alpes est une des plus riches que l'on connaisse; la plupart des espèces du Bathonien inférieur d'autres régions s'y retrouvent. Je ne connais pas d'autre localité dans le bassin méditerranéen, où elle soit aussi bien caractérisée et où elle puisse être aussi facilement séparée des faunes qui l'ont précédée et qui l'ont suivie . . . ». Arkell's opinion on the same subject is similar (1956, p. 149): « . . . this may be one of the most important areas in the world for establishing the zonal succession . . . The Lower Bathonian is strongly represented with a long list of characteristic ammonites of the Zig-zag zone perhaps unequalled anywhere in the world . . . ».

Stratigraphical details and long lists of ammonites may be found in the classic works of Garnier (1872), Haug (1891), Zurcher (1895) and Guillaume (1938). Yet, these faunas have never received monographic treatment; a single *Parkinsonia convergens* (S. Buckman) from Chaudon has been figured — under a wrong name — by Nicolesco, and the lectotype of *Planisphinctes tenuissimus* (Seimiradzki) also comes from Chaudon, but it is from the Upper Bajocian. Moreover, most if not all Parkinsoniids and Perisphinctids are listed under wrong names, while on the other hand typically Upper Bajocian forms, such as *Parkinsonia parkinsoni* (Sowerby), *Strigoceras truellei* (d'Orbigny) and « *Perisphinctes* » *martinsi* (d'Orbigny) are listed by Haug in his « Oppelia fusca » assemblage: we shall see that this was mainly due to collection failure.

A revision of the best known sections (Bas Auran and Chaudon) is thus long overdue. Both localities are known to paleontologists since a long time: large numbers of ammonites from Chaudon or Bas Auran may in fact be found in several classic collections, such as those of d'Orbigny in the Muséum d'Histoire Naturelle in Paris, of Roman at Lyon, of Haug at the Sorbonne, of Maurel in Barrême. But these are practically useless for a stratigraphic revision because their exact horizons are unknown. I had therefore to rely entirely on new specimens collected *in situ*. Notwithstanding the intensive collections made in the past, these localities were by no means exhausted, so that I have been able to collect quite a large number of species, including most, if not all, of those listed by Haug, and many new for this area.

The Bas Auran section, especially, appears to be an outstanding point of reference for the european Lower Bathonian, because it combines mediterranean Phylloceratids and Lytoceratids (of little stratigraphic value, however) with NW european *Zigzagiceras* spp., *Procerozigzag* spp., *Parkinsonia pachypleura, Procerites fullonicus, Procerites fowleri,* and central european *Lissoceras psilodiscus, Ebrayiceras sulcatum, Parkinsonia schloenbachi, P.* (*Oraniceras*) *württembergica,* allowing useful correlations to be made as well as the founding of a detailed subdivision within the Lower Bathonian.

The revised sections belong in the « Zone dauphinoise » and lie near the border thrust of the Subalpine ranges. They fall within the « Castellane » sheet of the « Carte Géologique détaillée de la France au 80.000^{e} » and within the « Digne N.os 7-8 » topographic sheets of the « Carte de France au 25.000^{e} » (text-fig. 1).



Text-fig. 1 - Geologic sketch map of the region between Digne and Barrême (South-Eastern France; Dépt. Basses-Alpes); adapted from Goguel (1936, pl. 1).
Dotted area: Middle Jurassic marl and limestone sequence (Murchisoni to Parkinsoni or Zigzag zones). Hatchured area: Kimmeridgian to Berriasian pelagic limestones (« Barre Tithonique »). Heavy black lines: main thrusts and faults.

Revised sections:

1) Bas Auran;
2) Ravin du Bès;
3) Le Touert;
4) Les Reichasses;
5) Col de Pierre Basse.

No: Norante;
Ch: Chaudon;
Cl : La Clappe (Bédéjun).

STRATIGRAPHY

THE BAS AURAN SECTION

The Bas Auran locality, first mentioned by Haug in his thesis (1891, p. 78), and also visited by the French Geological Society on its 1895 extraordinary meeting (Zurcher 1895), lies on the left side of the Asse valley, near the border thrust of the Subalpine Ranges, two and a half kilometres South of Norante and four West of Barrême. Upper Bajocian and Lower Bathonian here grade imperceptibly into each other, and are represented by black limestones in regular layers, 5 to 50 cm thick, rhythmically alternating with grey marls. The Lower Bathonian is the most fossiliferous and includes, along with a strongly reduced Middle Bathonian representative, the topmost six metres of this formation, that is, about 23 limestone beds. They are in turn overlain by a thick sequence of black *Posidonia alpina* shales - the basal « terres noires » of French Geologists. The uppermost limestone bed (Progracilis zone) ends with an eroded surface and may be locally reduced to a mere seam of worn nodules. This suggests the existence of a non-depositional gap at the lower boundary of the « terres noires ».

The Bathonian and the uppermost Bajocian limestones outcrop in the form of large slabs, covered with ammonites and steeply dipping to the East, on the left bank of the Ravin d'Auran, some two hundred metres SW of the Ferme du Bas Auran; at mid-height, these slabs are cut by some small vertical strike faults (N-S), that must be taken into account when measuring the section, since some layers are repeated and might be counted twice.

A more complete section, extending downwards into the whole Upper Bajocian, lies some 300 metres to the NW, along the gorge cut by the Ravin du Bès, and it is easier to measure. Since the faunal succession and stratigraphy agree in the smallest details, the figured section (Plate 1) summarizes data from both the Ravin du Bès and the Ravin d'Auran outcrops, which will be referred to as the « Bas Auran section » only, in the following pages.

Lithology and faunal succession are tabulated in Plate 1; the limestone beds are numbered from top to bottom, since the abrupt change in lithology at the upper boundary with the black *Posidonia* shales is the only *terminus a quo* to start numbering from; marly partings are not numbered, as well as some thin and impersistent beds, difficult to trace over a long distance (especially in the Macrescens subzone). Beds 30 (double), 23, 17 (double), 14 (double), 12, 11, 4, 3 and 2 (double), thicker and more resistant, form steps in the morphology and provide useful points of reference; on the other hand, the following groups of beds: 29-24, 22-18, 10-5, thinner and more easily eroded, form low cliffs between the «steps». It may also be noticed that the thicker and more resistant beds are often the more fossiliferous and have a yellowish colour when weathered, while the others weather grey; a slower rate of deposition, with penecontemporaneous oxidation of iron sulphide and carbonaceous matter, in the case of the thicker beds, may account for these differences.

Ammonites are usually preserved as internal casts of the same nature as the embedding rock; they are more or less crushed parallel to the bedding plane when the clay fraction becomes important. The test is seldom preserved; in this case it may be partly or wholly transformed into pyrite, limonite or gypsum. These same minerals may also form the infilling of some chambers, especially the inner whorls. In some beds (22, 12, 6) the ammonites have a markedly darker colour than the embedding limestone and are then more or less completely phosphatized. The upper halves of ammonites lying on the tops of beds (seldom those with thin beds) are often absent because of submarine erosion; the eroded surface bears Serpulid worms in some instances. This is particularly evident in beds 4 to 1, that is, in

the more condensed part of the section (topmost Lower and basal Middle Bathonian).

In a few beds the mode of preservation of the ammonites and their matrix are highly characteristic, and this may sometimes help locating unhorizonted specimens. Thus, for instance, the ammonites from the Bomfordi subzone (especially from beds 29-27) are usually slightly crushed, their test is partly lacking and partly haematitized, while the body chamber contains small empty tubules, originally filled with pyrite. On the other hand, those from the Progracilis zone (bed 1) are often in a much harder and darker matrix and are covered by an argillaceous film of glossy appearance.

Fossils other than ammonites are rare throughout the sequence: only a few nautiloids, belemnites, gastropods (*Pleurotomaria*), brachiopods (especially in bed 1, where a peculiar species of *Homoeorhynchia* occurs), sponges, echinoids and problematic tracks usually referred to as « *Cancellophycus* » in the litterature, being found.

REMARKS ON THE AGE OF THE FAUNAL ASSEMBLAGES AND ON THE PROPOSED SUBDIVISIONS

Uppermost Bajocian, Parkinsoni zone — The assemblage from bed 50 (visible in the Ravin du Bès section only) obviously falls here: *P. parkinsoni* is very abundant, accompanied by *P. densicosta* (Quenstedt), *Partschiceras viator* (d'Orbigny) and *Eurystomiceras polyhelictum* (Böck.).

The following beds (49 to 35) are almost devoid of ammonites (only a single *Parkinsonia* of the *densicosta* - *pseudoferruginea* group has been found), but they can still be placed in the same zone.

The assemblage from beds 34-24 is richer and rather peculiar: besides the usual Phylloceratids of no stratigraphic value and *Nannolytoceras tripartitum* (Raspail), which appears at this level, it contains: *Cadomites* cf. *stegeus* (S. Buckman), *C. psilacanthus* (Wermbter), *Polyplectites bajocensis* (De Grossouvre), *Parkinsonia subplanulata* Wetzel, *Leptosphinctes* cf. *hoffmanni* (Gemmellaro) (rather common and reaching gigantic size), *Planisphinctes planilobus* S. Buckman, *Planisphinctes tenuissimus* (Siemiradzki) and *Procerites costulatosus* (S. Buckman).

Cadomites psilacanthus and *C. stegeus* are known to occur in the Parkinsoni zone of other regions and have never been reported from higher levels; the type of *Polyplectites bajocensis* is stated to come from the top of the ironshot oolite of Bajeux, just below the « oolithe blanche », that is from the upper part of the Parkinsoni zone (De Grossouvre 1930, p. 373). *Parkinsonia subplanulata* has been reported to occur in the upper part of the Parkinsoni zone of Germany and adjacent regions (see p. 33). *Leptosphinctes* s.s. is one of the commonest genera in the Upper Bajocian; records from higher levels seem rather suspect (Wetzel 1924, in the Lower Bathonian at Vandenesse, not confirmed by Mouterde, 1953); in the Digne area *Leptosphinctes* s.s. does not range higher. The type of *Procerites costulatosus* must come from the Parkinsoni zone, as stated by Buckman, if his locality is correct (*teste* Torrens). The type of *Planisphinctes planilobus* is stated to come from the Zigzag bed, but this could be one of the species of the topmost Bajocian recorded in error from the Zigzag zone by Arkell (this, however, needs confirmation). There remains *Planisphinctes tenuissimus,* the type of which comes from Chaudon, where this species is found at the same level as at Bas Auran and with a very similar assemblage, including several forms typical of the topmost Bajocian, such as *Parkinsonia bomfordi* Arkell, *P.* (*Durotrigensia*) *dorsetensis* (Wright) and *P. (D.?) pseudoferruginea* Nicolesco.

It is therefore logical to leave this assemblage in the Upper Bajocian, Parkinsoni zone. On account of its rather peculiar character and of the absence of the index form (*P. parkinsoni*) it seems however desirable to introduce for it a new subzone at the top

of the Parkinsoni zone. On grounds of priority it may be named after *Parkinsonia bomfordi* Arkell, the index form of Buckman's « Schloenbachi » zone (see Arkell 1951-59, p. 9, footnote 3). Other supporting ammonites for this subzone, at least judging from their range in the Basses-Alpes, are *Parkinsonia subplanulata, Procerites costulatosus, Planisphinctes planilobus* and *P. tenuissimus.*

Remarks on the Bajocian Bathonian boundary — It has been recommended by the Colloque du Jurassique that the Bajocian — Bathonian boundary should fall between the Parkinsoni and Zigzag zones (for a lengthy discussion of the Bajocian stage as originally interpreted by d'Orbigny and its stratotype, see Rioult in *Coll. Jur. Luxembourg,* pp. 239-258). Thus conceived, the Bajocian - Bathonian boundary is crossed in strength by a large number of genera which had already appeared during the Upper Bajocian (or even earlier) and in full evolution, namely: *Strigoceras, Lissoceras, Oppelia* s.s., *Oxycerites, Trimarginia* (see Wendt 1964), *Oecotraustes, Cadomites, Polyplectites, Parkinsonia, Spiroceras, Bigotites* (see page 40), *Lobosphinctes, Procerites, Planisphinctes, Dimorphinites* (at least after Wendt, 1964). Of the new genera and subgenera appearing in the Lower Bathonian, on the other hand, the more numerous disappear or become excedingly rare just above its upper limit: *Morphoceras* s.s., *Ebrayiceras* (a single species being found in the Middle Bathonian), *Berbericeras* (see page 39), *Polysphinctites, Zigzagiceras* (s.l.), *Phaulozigzag, Oraniceras, Gonolkites.* Only *Prohecticoceras, Wagnericeras, Siemiradzkia* and *Pseudoperisphinctes* continue higher up, to the Upper Bathonian.

On faunal evidence such a boundary is therefore less sharp, for instance, than that between the Humphriesianum and Subfurcatum zones, which is marked by: 1) the appearance of the entirely new superfamily *Perisphinctaceae,* with *Parkinsoniidae, Spiroceratidae, Morphoceratidae* and *Perisphinctidae* (concerning the latter, a few ancestral *Leptosphinctinae* may have in fact appeared earlier, at least in the Humphriesianum zone, but such early records still need confirmation and, however, these forms do not become really common and widespread until the base of the Subfurcatum zone); 2) the appearance of the family *Thamboceratidae* in the Middle East (including *Ermoceras* - see Westermann 1965); 3) the almost complete extinction of *Hildocerataceae,* the only exception being *Vastites,* from the Lower Bathonian; 4) the complete extinction of *Otoitidae;* 5) the strong decline of *Stephanoceratidae,* among which *Cadomites, Polyplectites, Teloceras* (? in the basal Subfurcatum zone) and *Epalxites* (or n. gen.) *gibbum* (Parona) (from the Subfurcatum zone of the Venetian Alps) are the only survivors.

A sharper boundary (not as sharp as the preceding one, however) is also marked by the appearance of very rare *Clydoniceratidae* in the Progracilis zone (the placing of *Micromphalites bousqueti* in the Lower Bathonian by De Grossouvre needs confirmation), accompanied by the almost complete extinction of *Parkinsoniidae* and *Morphoceratidae.* This last arrangement would agree better with d'Orbigny's inclusion of *Zigzagiceras zigzag* and *Morphoceras multiforme* in the Bajocian.

If we assume that such faunal breaks, as those just discussed, should have the greatest importance for the delimitation of stages, then the following succession might be suggested: Aalenian, from the Opalinum to the Concavum zone; unnamed stage (it may be equivalent to the Ledonian of Marcou, 1848, emend. Gardet, 1942), from the Sowerbyi to the Humphriesianum zone (the latter inclusive of the Bladgeni zone of some authors); Bajocian, from the Subfurcatum to the Zigzag zone (inclusive of the « Fusca » or « Fallax » or Yeovilensis zone *auctt.*); Bathonian, from the Progracilis to the Discus zone. It may be noticed that, thus conceived, the Bajocian stage would agree with d'Orbigny's original interpreta-

EXPLANATION OF PLATE 2

Evolution of some Lower Bathonian representatives of the family *Perisphinctidae*. All schematic drawings often restaured, based on specimens from the Digne area (X 1).

Fig. 1 - *Bigotites diniensis* n. sp. Convergens subzone. Pag. 40.

2 - *Zigzagiceras* (*Franchia* n. subg.) *arkelli* n. sp. Topmost part of the Convergens subzone (bed 12). Pag. 52.

3 - *Zigzagiceras plenum* Arkell. Basal Macrescens subzone (bed 11). Pag. 47.

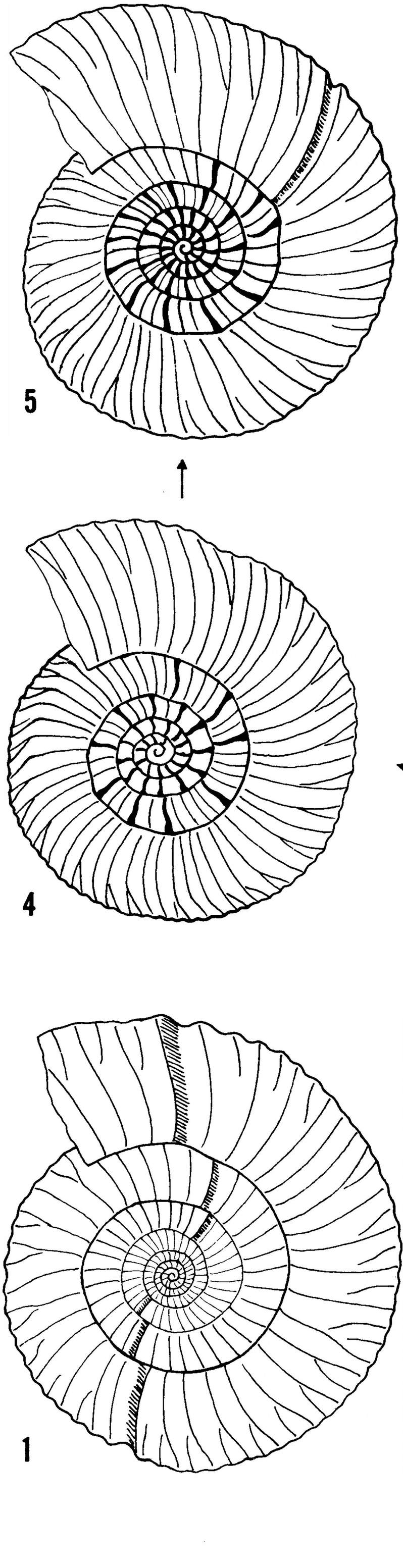
4 - *Zigzagiceras torrensi* n. sp. Macrescens subzone (bed 9). Pag. 47.

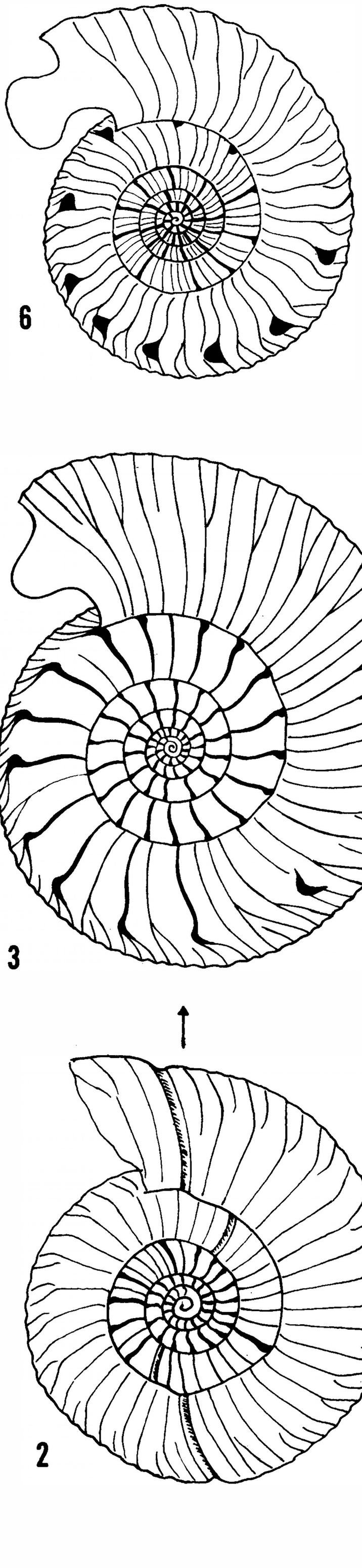
5 - *Zigzagiceras torrensi* n. sp. *variecostatum* n. ssp. Macrescens subzone (beds 8-7). Pag. 48.

6 - *Siemiradzkia aurigera* (Oppel). Yeovilensis subzone (beds 6-2). Pag. 53.

The first two are macroconch species, the others are microconchs.

C. STURANI, BATHONIAN AMMONITES DIGNE AREA

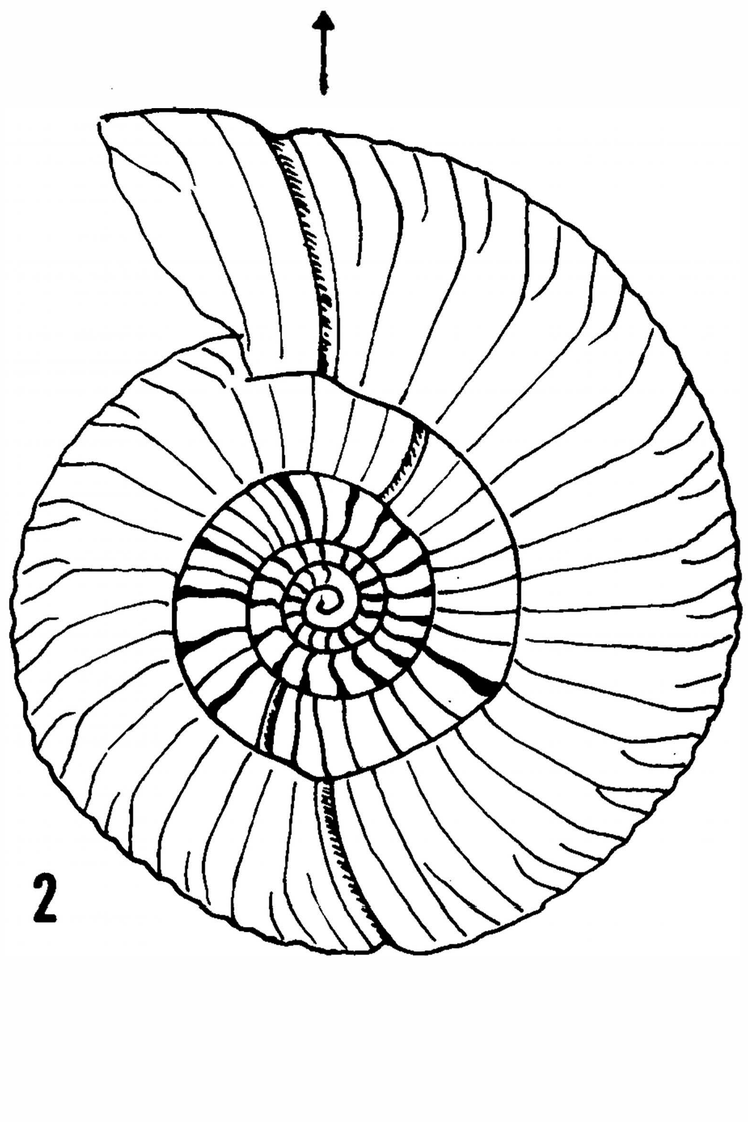

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tion, but for the amputation of the Humphriesianum zone (« conglomérat de Bajeux ») at the base of its statotype; it would also be equivalent to the newly introduced Koujavian stage (see Maubeuge 1965), rendering this new name superfluous.

But until a more satisfactory scheme has been discussed and accepted by a large majority of stratigraphers, and in order not to upset a very well established tradition, the recommendations of the Colloque du Jurassique will be followed in the present paper.

However, another difficulty must be pointed out. As supported by evidence from the Bas Auran section, confirming Guillaume's and Rioult's work on the Normandy coast, and Mouterde's work in the Nièvre, it appears that the ranges of *Parkinsonia parkinsoni* and *Zigzagiceras zigzag* are separated by a rather important, gap, bridged by two faunal assemblages of at least subzonal value.

The earlier one has already been dealt with in the preceding paragraph, as belonging to the uppermost Bajocian, Parkinsoni zone, Bomfordi subzone. The second one is that from beds 23-12 of the Bas Auran section, and this contains several forms usually regarded as typically Lower Bathonian, such as *Lissoceras psilodiscus, Parkinsonia pachypleura, P.* (*Gonolkites*) *convergens, P.* (*G.*) *subgaleata, Morphoceras multiforme* (and allied species), *Ebrayiceras sulcatum, Procerites tmetolobus, P. subprocerus,* and others. We shall therefore take bed 23, where a good number of the species listed above appear first, as the base of the Lower Bathonian.

Lower Bathonian: *the upper boundary* — In order to establish the upper boundary of the Lower Bathonian in the Bas Auran section, we shall now discuss the assemblages from the topmost beds downwards.

The base of the « terres noires » has yielded only a few crushed *Siemiradzkia* sp. ind. and Phylloceratids, but it is presumably still Bathonian as at Chaudon.

The assemblage from bed 1 includes *Oxycerites oxus* (S. Buckman), *Paroecotraustes formosus* Arkell, *P. maubeugei* Stephanov, *Wagnericeras fortecostatum* (De Grossouvre), *Siemiradzkia* sp., and could belong in the Middle Bathonian (Progracilis z.?). The bed next below (n. 2) is characterized by abundant *Siemiradzkia aurigera* (Oppel), accompanied by *Asphinctites recinctus* S. Buckman, the youngest Morphoceratid found in the Bas Auran section; both these species are considered topmost Lower Bathonian by Arkell (1951-59, p. 242). It seems therefore logical to draw the upper boundary of the Lower Bathonian between beds 2 and 1.

If we assume that the black *Posidonia* shales are Upper Bathonian at their base, as at Chaudon (and this is at least possible, if not probable), the whole Middle Bathonian above the Progracilis zone is missing. The eroded surface and the hard ground on top of bed 1 support evidence of non deposition during that period. Further evidence of non deposition is given by the Chaudon sections (Le Touert and Les Reichasses outcrops), where the gap is even more important.

Possible subdivisions within the Lower Bathonian — A threfold subdivision of Lower Bathonian, like that recently proposed by H. S. Torrens (1965, n. 53), is strongly supported by evidence from the Bas Auran section. Three distinct assemblages, or « horizons », can in fact be recognized here.

The lowermost (beds 23-12) is characterized by: 1) a first group of species, which seem confined to this horizon, at least in the Bas Auran section; these are: *Prohecticoceras* aff. *primaevum* (De Grossouvre), *Cadomites deslongchampsi* (Defrance in d'Orbigny), *C. daubenyi* (Gemmellaro), *C. rectelobatus* (Hauer), *Polyplectites dorni* (Roché), *Parkinsonia schloenbachi* Schlippe, *P. crassa* Nicolesco, *P. (Gonolkites) convergens* (S. Buckman), *P. (G.) subgaleata* (S. Buckman), *Morphoceras parvum* Wetzel, *M. densicostatum* Thalmann, *Ebrayiceras sulcatum* (Hehl in Zieten), *Procerites tmetolobus* S. Buckman, *P. subprocerus* (S.

Buckman), *P. (Lobosphinctes) intersertus* (S. Buckman), *Zigzagiceras* (*Franchia* n. subg.) *arkelli* n. sp.

2) A second group, including *Lissoceras psilodiscus* (Schloenbach), *Oxycerites yeovilensis* Rollier, *O. nivernensis* De Grossouvre, *Oecotraustes fuscus* (Quenstedt), *Parkinsonia pachypleura* S. Buckman, *Morphoceras multiforme* Arkell, *M. patescens* (S. Buckman), which range higher.

The next horizon (beds 11-7) covers exactly the range of *Zigzagiceras* s.s. and *Z. (Procerozigzag),* both represented by a high number of species and subspecies, several of which new, displaying rapid evolution (Plates 2 and 23): *Zigzagiceras zigzag* (d'Orbigny), *Z. euryodos* (Schmidt), *Z. plenum* Arkell, *Z. lenthayense* (Arkell), *Z.* aff. *lenthayense, Z. torrensi* n. sp., *Z. torrensi* n. sp. *variecostatum* n. ssp., *Z (Procerozigzag) crassizigzag* (S. Buckman), *Z. (P.) pseudoprocerum* (S. Buckman), *Z. (P.) postpollubrum* Wetzel, *Z. (P.) postpollubrum* Wetzel *garnieri* n. ssp.

Morphoceras macrescens S. Buckman, *Ebrayiceras pseudoanceps* (Ebray) and *E. jactatum* S. Buckman are also confined here, while *Lissoceras psilodiscus, Oxycerites yeovilensis, O. nivernensis, Oecotraustes* cf. *fuscus, Parkinsonia pachypleura, Morphoceras multiforme* and *M. patescens* survive from the preceding assemblage. The well known species *Parkinsonia (Oraniceras) württembergica* (Oppel) has also been found at this level, but seems to range higher. The earliest known *Wagnericeras* also comes from this horizon (bed 8).

It should be noted that the wealth of *Zigzagiceras* and *Procerozigzag* at this level is counterbalanced by the complete absence of *Procerites,* which reappears in the assemblage next above, just after the extinction of the former two. Such antagonism does not seem to depend on changes of the environment, since the lithology is not affected and remains the same (see also p. 18).

The third and highest horizon (beds 6-2) is characterized by *Procerites fullonicus* (S. Buckman) and *P. fowleri* Arkell at the base (beds 6-5), *Morphoceras perinflatum* Wetzel in its middle part (bed 4) and *Asphinctites recinctus* S. Buckman at the top (bed 2). *Siemiradzkia aurigera* (Oppel) and *Procerites imitator* (S. Buckman) occur throughout, as well as the long ranging *Lissoceras psilodiscus, Oxycerites yeovilensis* and *O. nivernensis. Parkinsonia (Oraniceras) württembergica* seems to be still present at the base of this horizon, while the following species: *Oecotraustes subfuscus* Waagen, *Gracilisphinctes* (?) sp., *Pseudoperisphinctes* cf. *rotundatus* (Roemer) and the coarsely ribbed *Siemiradzkia* n. sp. ind., are found in its upper part.

In addition, all three assemblages include several widespread and long ranging Phylloceratids and Lytoceratids, including *Nannolytoceras tripartitum,* the commonest ammonite in the Lower Bathonian of the Subalpine Ranges.

The last assemblage seems roughly equivalent to the Fallax (or Yeovilensis) zone auctt. In his recent paper (1965, p. 52) H. S. Torrens has shown reasons why the Fallax zone has to be merged with the Zigzag zone, so this needs no further discussion here.

In this way the Lower Bathonian is represented by a single zone, that of *Zigzagiceras zigzag.* The three subdivisions recognized within it and discussed in the previous lines, should thus deserve subzonal status. In my opinion this fits best the use of zones and subzones, as recently recommended by Dean, Donovan & Howarth (1961), and has the great advantage of not introducing a new separate zone at the base of the Bathonian stage, below the Zigzag zone.

Thus conceived, the Zigzag zone covers exactly the range of *Morphoceras* s.s. *plus* that of *Asphinctites,* if present evidence is not modified in future by further discoveries.

The first subzone covers the range of *Parkinsonia (Gonolkites) convergens,* which has a rather widespread occurrence and may therefore be chosen as the index form. Ar-

EXPLANATION OF PLATE 3

Fig. 1-2 - *Partschiceras viator* (d'Orbigny) *wendti* n. ssp.
Fig. 1. Holotype. Chaudon, Lower Bathonian, Convergens sbz. X 0,66.
Fig. 2. Paratype. Col de Pierre Basse, Lower Bathonian. Pag. 20.

3 - *Partschiceras viator* (d'Orbigny), juv. Dourbes, Upper Bajocian, Subfurcatum z. Pag. 21.

4 - *Ptychophylloceras flabellatum* (Neumayr), juv. Chaudon, Upper Bathonian X 1,3. Pag. 21.

5-6 - *Holcophylloceras mediterraneum* (Neumayr).
Fig. 5. Young specimen. Chaudon, Upper Bathonian.
Fig. 6. Nucleus. Col de Pierre Basse, Lower Bathonian. X 2. Pag. 22.

7 - *Holcophylloceras marioni* (Munier-Chalmas in Lanquine). Chaudon, Upper Bathonian. X 2. Pag. 22.

8 - *Nannolytoceras* n. sp. ind. Bas Auran, Middle Bathonian, Progracilis z. (bed 1). Pag. 23.

9a-b - *Nannolytoceras tripartitum* (Raspail); fragment showing the auriculate peristome at the end of the body chamber. Bas Auran, Lower Bathonian, Macrescens sbz. (bed. 8). Pag. 23.

10 *Oppelia (Oxycerites) nivernensis* De Grossouvre. Bas Auran, Lower Bathonian, Convergens sbz. (bed 12). Pag. 25.

11 - *Oecotraustes (Alcidellus) tenuistriatus* (De Grossouvre). Chaudon, Upper Bathonian. Pag. 24.

12a-b - *Lissoceras* cf. *haugi* n. sp. Chaudon, Upper Bathonian. X 1,5. Pag. 24.

13a-b - *Lissoceras* cf. *psilodiscus* (Schloenbach). Chaudon, Upper Bathonian. X 1,5. Pag. 23.

14 - *Oecotraustes* (subg.?) *fuscus* (Quenstedt). Bas Auran, Lower Bathonian, Yeovilensis sbz. (bed 5). X 1,5. Pag. 25.

15 - *Oecotraustes subfuscus* Waagen. Bas Auran, Lower Bathonian, Yeovilensis sbz. (bed 2). X 1,5. Pag. 26.

16a-b - *Lissoceras haugi* n. sp. Holotype. Chaudon (Les Reichasses), Lower Bathonian, Convergens sbz. Pag. 24.

17a-b - *Lissoceras psilodiscus* (Schloenbach). Bas Auran, Lower Bathonian, basal Convergens sbz. (bed 23). Pag. 23.

All photos. natural size except Figs. 1, 4, 6, 7, 12-15.

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kell's record of *P. convergens* from a higher level (1951-59, p. 156) is known to be based on a misidentification (*fide* Torrens).

The middle subzone covers exactly the range of *Zigzagiceras* s.s. and *Procerozigzag*; since the use of the same species (*Z. zigzag*) for both zonal and subzonal indexes is to be avoided, *Morphoceras macrescens* or *Ebrayiceras pseudoanceps,* both confined to this subzone at Bas Auran and both widely distributed in several regions, could be alternative indexes; the former is provisionally adopted here. The well known species *Morphoceras multiforme* and *P.* (*Oraniceras*) *wiirttembergica* do not seem suitable for the same purpose; the former because it seems to be more abundant in the underlying Convergens subzone at both Chaudon and Bas Auran; the latter because it is already present (though very rare) in the topmost Convergens subzone at Chaudon (as well as in Lorraine and in Germany, see Maubeuge 1950 and Westermann 1958), and also because it seems to pass up into the subzone next above.

On grounds of priority *Oxycerites yeovilensis* should be the index form of the third and highest subzone, and I am provisionally adopting this solution until a general agreement has been reached on the choice of a more suitable index. I do not think, in fact, that *O. yeovilensis* is satisfactory for this purpose, mainly because of its wide vertical range (from the topmost Bajocian to the topmost Lower Bathonian) and the difficulty of distinguishing it from other congeneric forms with a different vertical distribution (see Arkell 1951-59, p. 58-59). An alternative solution, supported by evidence from the Bas Auran section, could also be suggested, that is, to split the highest assemblage within the Zigzag zone into a Fowleri subzone below and a Recinctus subzone above (for the stratigraphic value of these species, see under their systematic descriptions). This, however, needs to be controlled by means of a comparative revision of other Lower Bathonian sections throughout Europe, and is therefore beyond the scope of the present paper.

THE CHAUDON SECTIONS

The celebrated locality of Chaudon lies 5 kilometres North of Bas Auran. The original distance between these sections must however have been slightly greater, owing to their mutual position, relative to the Dourbes thrust (see Goguel 1936, text-fig. 40). Ammonites from Chaudon were already known to d'Orbigny and some were figured by later Authors (*Garantiana baculata* (Quenstedt) by R. Douvillé, *Gonolkites convergens* by Nicolesco, *Planisphinctes tenuissimus* by Siemiradzki).

The uppermost Bajocian and the Lower Bathonian may be studied along the upper course of the Ravin de la Coueste (= Ravin des Izoards of ancient Authors), at the place called « le Touert », midway between the village of Chaudon and the Col de Corobin (Col de la Clappe of Ancient Authors).

Stratigraphical details for the whole Middle Jurassic of this section are given by Garnier (1872, pp. 650-656; pl. 8, fig. 2), while the ammonites are listed in Haug's classic work (1891, pp. 79-80). Both Authors placed the Bajocian - Bathonian boundary much lower than it is in reality, including in the Bathonian most of the Parkinsoni zone, which is evident from Haug's faunal list. Additional remarks are given by Guillaume (1938), who correctly correlated the topmost limestone beds of Chaudon with the « banc inférieur des couches de passage » of Port en Bessin (Convergens subzone), and pointed out that they were therefore somewhat earlier than the topmost limestone beds at Bas Auran. He failed, however, to recognize that this difference was mainly due to non deposition rather than to facies change.

The lithological sequence is roughly si-

milar to that at Bas Auran: the uppermost Bajocian is represented by black, marly limestones, regularly alternating with marls, the highest three limestone beds alone belonging to the Lower Bathonian (Convergens subzone). A thick sequence of black shales (« terres noires ») follows unconformably above.

The Parkinsoni zone is much more fossiliferous than at Bas Auran, especially in the highest five metres of the limestone - marl sequence (from bed 10 downwards; the limestone beds alone being numbered, from top to bottom, as at Bas Auran) and has yielded: *Phylloceras kudernatschi, Partschiceras viator, P. subobtusum, Holcophylloceras disputabile, Eurystomiceras polyhelictum, Strigoceras truellei, Oppelia* ssp. plur. of the *subradiata* group, *Polyplectites bajocensis, Cadomites* sp., *Parkinsonia parkinsoni* (extremely abundant), *P. rarecostata* (rare and disappearing before the preceding species), *P.* (*Durotrigensia*?) *densicosta, P. (D.?) pseudoferruginea* Nicolesco (appears later than *P. parkinsoni* and ranges higher up; it may be a junior synonym of *P. neuffensis* (Oppel)), and several *Leptosphinctinae.*

The Bomfordi subzone is well represented in the highest metre of the sequence (beds 4 to 9), with the same Phylloceratids, the first *Nannolytoceras tripartitum, Oppelia* spp. of the *subradiata* group, *Oppelia* cf. *pleurifer* (S. Buckman), *Oxycerites* cf. *yeovilensis, Cadomites psilacanthus, Polyplectites* sp. ind., *Parkinsonia* (*Durotrigensia*?) *pseudoferruginea* (but it does not reach the top of the subzone), *P.* (*Durotrigensia*) *dorsetensis, P. bomfordi* (a single specimen), *Parkinsonia* sp. of the « *depressa* » group (like *P. schloenbachi,* but less stoutly whorled), *Planisphinctes tenuissimus* (topotypes!), *Leptosphinctes* s.s. spp. plur., *L.* (*Prorsisphinctes*) cf. *glyphus* (S. Buckman), *Procerites costulatosus.*

The Lower Bathonian begins with the antepenultimate limestone bed (n. 3), which has yielded only a few ammonites: *P. (Gonolkites) convergens, Parkinsonia schloenbachi, Procerites* cf. *tmetolobus, P.* (*Lobosphinctes*) *intersertus* (morphotype with a tumid whorl section, probably transitional to *Bigotites*), besides the usual Phylloceratids (among which *P. viator wendti* n. ssp. appears at this level) and Lytoceratids.

The penultimate limestone bed (locally composed of two distinct beds separated by a thin shaly vein) outcrops widely on the right bank of the Ravin, at the place called Le Touert, some five hundred metres West of the Col du Corobin, and it is packed with fossils (ammonites and sponges). Its assemblage clearly belongs in the convergens subzone: *Partschiceras viator wendti* n. ssp., *P. subotusum, Calliphylloceras disputabile, Lytoceras eudesianum* s.l. (not common but reaching gigantic size), *Nannolytoceras tripartitum, Lissoceras haugi* n. sp., *Oppelia seebachi, Oxycerites yeovilensis, O. nivernensis, Oecotraustes* sp. ind., *Cadomites deslongchampsi, Polyplectites dorni, Parkinsonia schloenbachi, P. pachypleura, P.* (*Gonolkites*) *convergens, P.* (*G.*) *subgaleata, Morphoceras multiforme, M. patescens, Ebrayiceras sulcatum, E. rursum, Procerites tmetolobus, P. subprocerus, Procerites* aff. *schloenbachi, P. (Phaulozigzag) phaulomorphus, P.* (*Lobosphinctes*) *intersertus, Bigotites dinniensis* n. sp.

The highest limestone bed, thinner than the preceding ones and often reduced to a mere seam of worn nodules, contains the same assemblage, including *Parkinsonia* (*Gonolkites*) *convergens* and *subgaleata,* and a few additional species: *Parkinsonia* (*Oraniceras*) *wiirttembergica* (a single specimen), *Morphoceras densicostatum, Zigzagiceras* (*Franchia*) *arkelli* n. subg. n. sp. Notwithstanding the presence of *Oraniceras,* it seems logical to leave this bed within the Convergens subzone, correlating it with bed 12 of he Bas Auran section. Its upper surface is deeply eroded, suggesting the existence of a non - depositional gap between the limestone - marl sequence and the overlying black shales. This had already been

EXPLANATION OF PLATE 4

Fig. 1 - *Paroecotraustes formosus* Arkell. Bas Auran, Middle Bathonian, Progracilis z. (bed 1). Pag. 26.

2 - *Paroecotraustes maubeugei* Stephanov. Bas Auran, Middle Bathonian, Progracilis z. (bed 1). pag. 26.

3 - *Oecotraustes* (subg.?) *fuscus* (Quenstedt). Bas Auran, Lower Bathonian, Convergens sbz. (bed 14). X 2. Pag. 25.

4a-b - *Prohecticoceras retrocostatum* (De Grossouvre), morphotype with compressed whorls. Chaudon, Upper Bathonian. X 1,5. Pag. 27.

5 - *Prohecticoceras* aff. *primaevum* (De Grossouvre). Bas Auran, Lower Batonian, Convergens sbz. (bed 17). Pag. 27.

6 - *Oppelia (Oxycerites) nivernensis* De Grossouvre. Chaudon, Lower Bathonian, Convergens sbz. Pag. 25.

7a-b - *Oppelia seebachi* Wetzel. Chaudon, Lower Bathonian, Convergens sbz. Pag. 24.

8-10a-b - *Oppelia (Oxycerites) yeovilensis* Rollier.
Fig. 8. Chaudon, Lower Bathonian, Convergens sbz.
Figs. 10a-b, immature specimen. Bas Auran, Lower Bathonian, Macrescens sbz. (bed 11). Pag. 25.

9 - *Oppelia (Oxycerites) oxus* (S. Buckman). Bas Auran, Middle Bathonian, Progracilis z. (bed 1). Pag. 25.

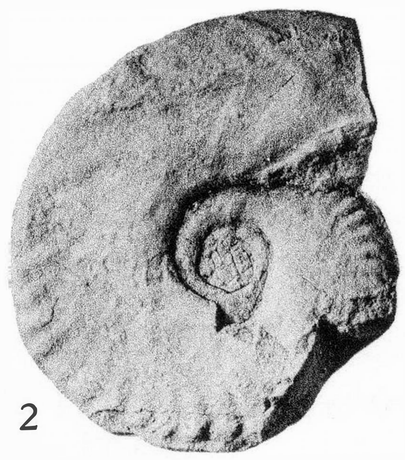
11 - *Lissoceras psilodicus* (Schloenbach). Bas Auran, Lower Bathonian, Macrescens sbz. (bed 7). Pag. 23.

All photos. natural size except Figs. 3-4a-b

C. STURANI, BATHONIAN AMMONITES DIGNE AREA



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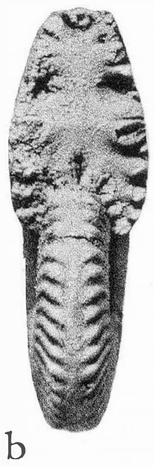
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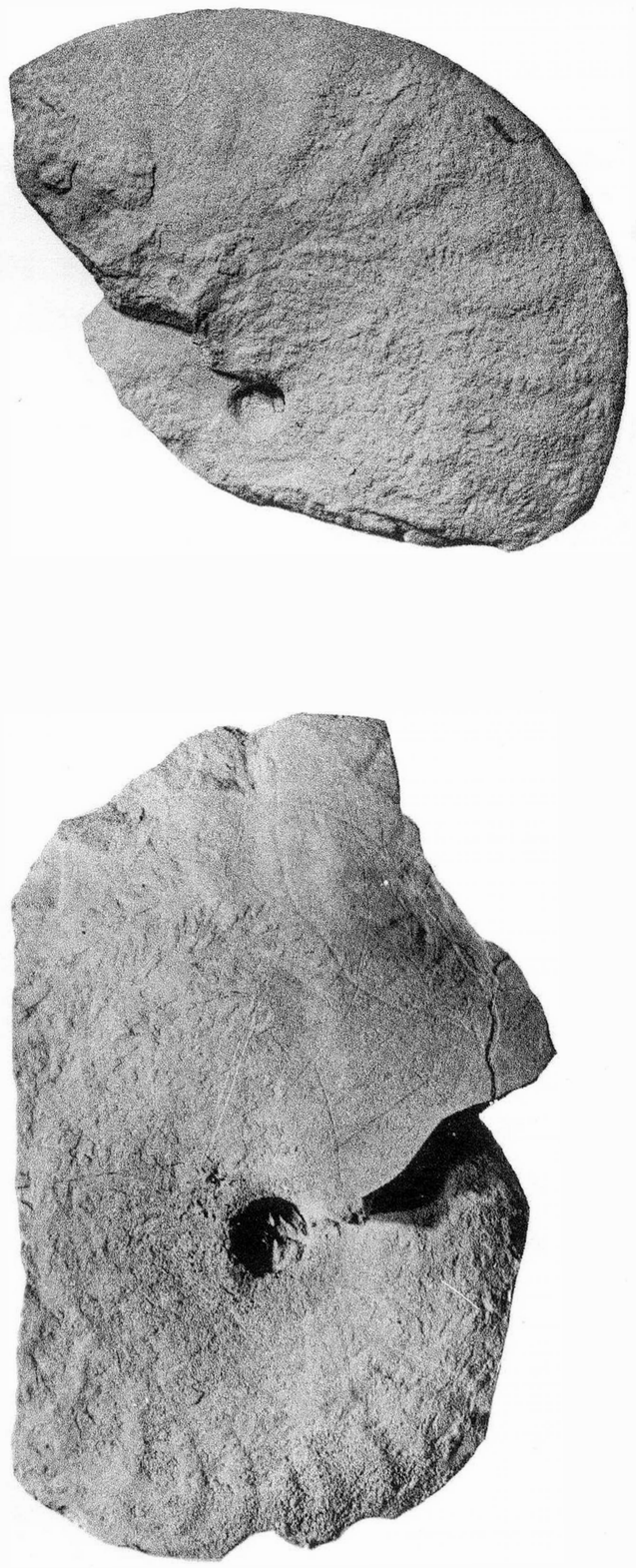
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4 a



4 b



9

6



7 a



7 b



8



11



10 a



10 b

clearly pointed out by Garnier (1872, p. 656), almost a century ago: « À Dourbes, les schistes paraissent se relier aux calcaires à *A. tripartitus,* mais il n'en est pas de même à Chaudon, où les derniers bancs de ces calcaires sont irréguliers, noduleux, souvent couverts de stries, et présentent tous les caractères de couches ayant subi une érosion; il semblerait qu'il y a eu une interruption entre leur dépôt et celui des schistes ».

This assumption is confirmed by the finding of a rich Upper Bathonian assemblage, already mentioned by Haug (1891, p. 82), near the base of the « terres noires » (basal three metres). These are crowded with millions of *Posidonia alpina* auctt. (= *Bositra buchi* (Römer)) and also contain completely crushed *Siemiradzkia* and *Choffatia* (?).

Besides these, there are abundant ferruginous, undeformed nuclei, mainly of Phylloceratids (*Partschiceras viator wendti* n. ssp., *P. subobtusum, Holcophylloceras mediterraneum, H. marioni* (Munier-Chalmas in Lanquine), *Ptychophylloceras flabellatum*), but also of *Lytoceras eudesianum adeloides, Lissoceras* spp., *Oecotraustes tenuistriatus* (De Grossouvre), *Prohecticoceras retrocostatum* (De Grossouvre), *Epistrenoceras subcontrarium* (Behrendsen) and at least four different species of *Siemiradzkia.*

P. retrocostatum, O. tenuistriatum and *E. subcontrarium* show that this assemblage is clearly Upper Bathonian. In other regions (Ardèche; see Elmi in *Coll. Jur. Luxembourg,* p. 537) a separate horizon with *Prohecticoceras retrocostatum* can be recognized, just below that yielding *Epistrenoceras*; even though most specimens lay loose on the ground and some mixing probably occurred while collecting them, *O. tenuistriatus* and *E. subcontrarium* seemed to occurr above *P. retrocostatum* also here.

Lower Bathonian above the Convergens subzone and the whole Middle Bathonian are therefore completely absent at Chaudon.

Not far from Le Touert, on the North slope of the Col du Corobin, there is another large outcrop of the Convergens subzone at the place called « Les Reichasses » (probably the same exposure known as « La Clappe » by ancient authors). The sequence is similar to that just described, though even more condensed in the topmost part of the limestone — marl sequence. The Bomfordi subzone seems to be missing, since the highest limestone bed, with the rich assemblage of the Convergens subzone, directly overlies beds containing abundant *Parkinsonia parkinsoni.* Here too traces of a non-depositional gap at the base of the terres noires are very evident. The first three metres of the black shales have yielded the same Upper Bathonian assemblage as at Le Touert.

COL DE PIERRE BASSE

Two kilometres North of Chaudon, at the Col de Pierre Basse, along the road from Digne to La Clappe (= Bédéjun), Chaudon and Norante, Prof. M. Lemoine of Paris has discovered an interesting assemblage of Lower Bathonian age, at the base of the Terres noires. I am much indebted to him for showing me this locality.

The topmost beds of the limestone — marl sequence are still Upper Bajocian, Parkinsoni zone (with *P. parkinsoni,* various *Leptosphinctes* s.s. and *Cadomites, Partschiceras viator* and other Phylloceratids). A few more beds of marly limestones, packed with *Posidonia alpina,* are scattered in the basal ten metres of the black shales. About seven metres above their base, these contain a rich ferruginous fauna, very different from that found at Chaudon at the base of the black shales in composition and age, but almost identical in the type of preservation and the small size of the ammonites (all nuclei): *Partschiceras viator wendti, P. subobtusum, Calliphylloceras disputabile, Holcophylloceras mediterraneum, Ptychophylloceras flabellatum, Lytoceras* sp., *Nannolytoceras tripartitum, Lissoceras psilodiscus, Oxycerites yeovilensis, Oecotraustes* spp. ind., *Cadomites* or *Polyplectites* sp., *Parkinsonia* (subg.?) sp.

ind., *Morphoceras perinflatum, Ebrayiceras pseudoanceps, Berbericeras sekikense* Roman, *Siemiradzkia* spp. plur. ind.

This assemblage is clearly Lower Bathonian, above Convergens subzone; it may belong in the Yeovilensis subzone (the *Morphoceras* and *Siemiradzkia*) or, more likely, be an admixture of both Macrescens and Yeovilensis subzones. It is also strikingly similar, even in the type of preservation, to that from Djebel-es-Sekika, the type locality of *Berbericeras sekikense*, illustrated by Roman (1930).

A few metres higher up, the discovery of *Sowerbyceras chantrei* (Munier-Chalmas in Collot) (= *S. transiens* (Pompekj)), may already indicate the Callovian.

It is thus confirmed that the lower boundary of the « terres noires » progressively engulfs earlier zones, from the border to the centre of the Fosse Dauphinoise (Guillaume 1938); but this downward progression is locally disturbed by unconformities because of non-deposition and submarine erosion. The Middle Bathonian is the part most affected by such pauses in sedimentation, at least in the region between Barrême and Digne.

Similar breaks in the sequence, marked by eroded surfaces and-or hard-grounds had been described by Garnier since 1872, especially in the Middle Jurassic section at La Blache, near Castellane.

ACKNOWLEDGEMENTS

H. S. Torrens, of the Geological Department, the University of Leicester, read the first draft of this paper and made a number of helpful suggestions, also allowing to quote unpublished data from his thesis. A joint final control on the field was held on April 1966, and this brought out several important additions and emendations. A critical discussion of the whole text followed in Turin. The writer would therefore like to express his warmest thanks to H. S. Torrens, for the great help he gave so friendly on this occasion.

The author's thanks are also due to the Editors of the Bollettino della Società Paleontologica Italiana, for accepting this paper in its integral form and for helpful criticism of the manuscript, as well as to Prof. R. Malaroda for reading the first draft of the paper.

Particular thanks are also expressed to Madame and Monsieur Louis Maurel, of Barrême, for the loan or gift of several interesting specimens from their collection.

The collecting and stratigraphic measuring at Chaudon (Le Touert and Les Reichasses outcrops) have been carried out jointly by the present writer and Mr. G. Pavia, who has undertaken the revision of the Bajocian in the Digne area, under the author's guidance. Some of the specimens figured have been collected by Mr. Pavia, as specified in the explanations of the plates.

PALAEONTOLOGICAL SECTION

GENERAL REMARKS

Bathonian faunas have been the object of several important monographs, from Arkell's outstanding « The English Bathonian Ammonites », to Westermann's revision of the Bathonian of NW Germany, Wendt's work in Sicily, Pugin's revision of Middle Jurassic *Lytoceratidae* and Torrens' general paper (1965), just to mention a few of the more recent ones.

Since most of the species found in the Bathonian of the Basses-Alpes have been thoroughly described — and their entangled synonymy discussed — in the papers mentioned above, reference will be made in each case to the most complete and satisfactory description available from the previous literature (usually Arkell's), unless additional remarks arise from the evidence of the material figured herein.

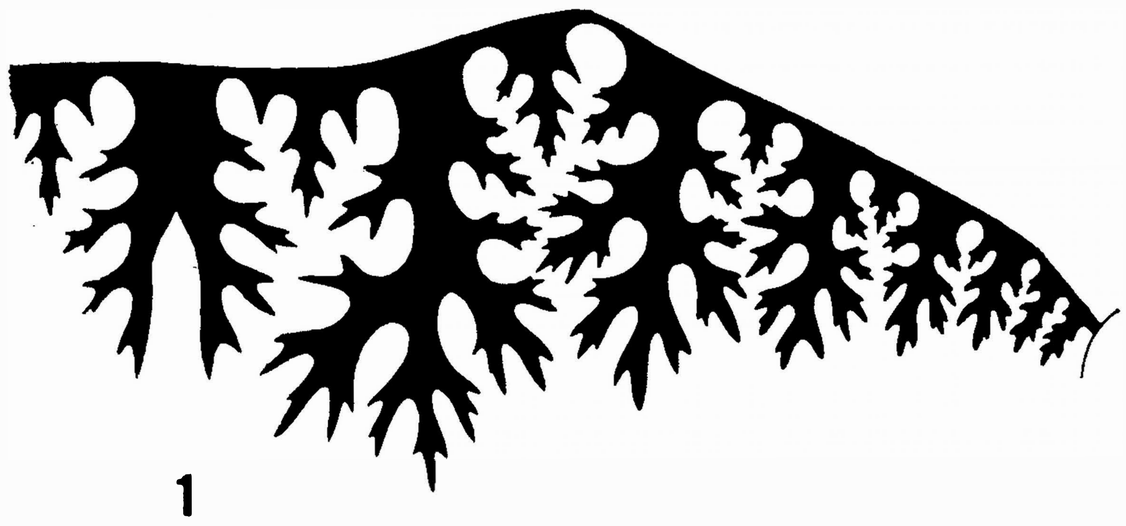
On the other hand I have thought it necessary to figure the largest possible number of species, owing to the importance of these

EXPLANATION OF PLATE 5

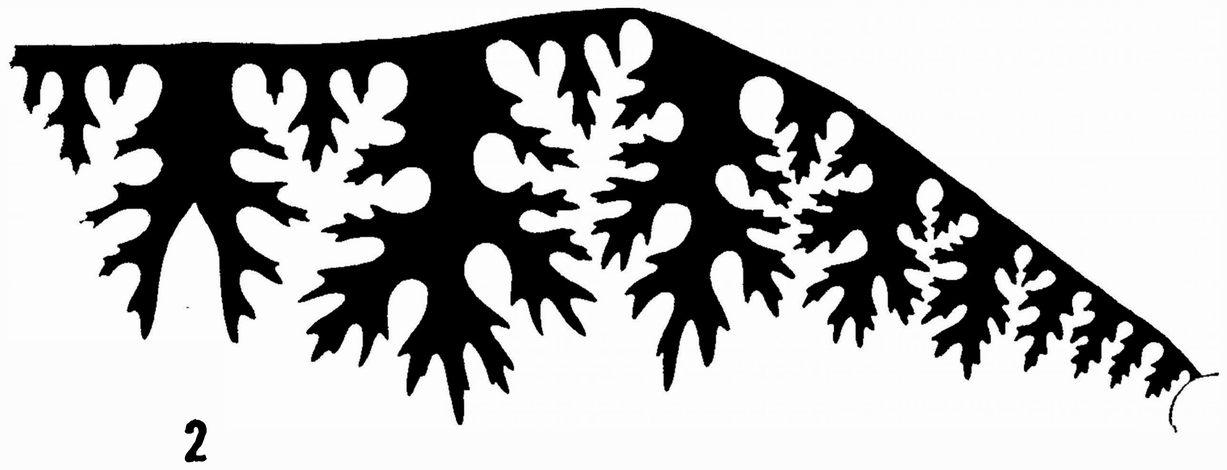
Fig. 1 - *Partschiceras viator* (d'Orbigny). Dourbes, Upper Bajocian, Subfurcatum z. Pag. 21.
2 - *Partschiceras viator* (d'Orbigny) *wendti* n. ssp. Col de Pierre Basse, Lower Bathonian. Pag. 20.
3 - *Partschiceras subobtusum* (Kudernatsch). Bas Auran, Lower Bathonian, Convergens sbz. Pag. 20.
4 - *Ptychophylloceras flabellatum* (Neumayr). Chaudon, Upper Bathonian. Pag. 21.
5 - *Holcophylloceras mediterraneum* (Neumayr) juv. Chaudon, Upper Bathonian. Pag. 22.
6 - *Holcophylloceras marioni* (Munier-Chalmas in Lanquine). Chaudon, Upper Bathonian. Pag. 22.
7 - *Epistrenoceras subcontrarium* (Behrendsen). Chaudon, Upper Bathonian. Pag. 29.
8 - *Berbericeras sekikense* Roman. Col de Pierre Basse, Lower Bathonian. Pag. 39.
9 - *Prohecticoceras retrocostatum* (De Grossouvre). Chaudon, Upper Bathonian. Pag. 27.
10 - *Prohecticoceras* aff. *primaevum* (De Grossouvre). Bas Auran, Lower Bathonian, Convergens sbz. (bed 17). Pag. 27.

All figures X 4.

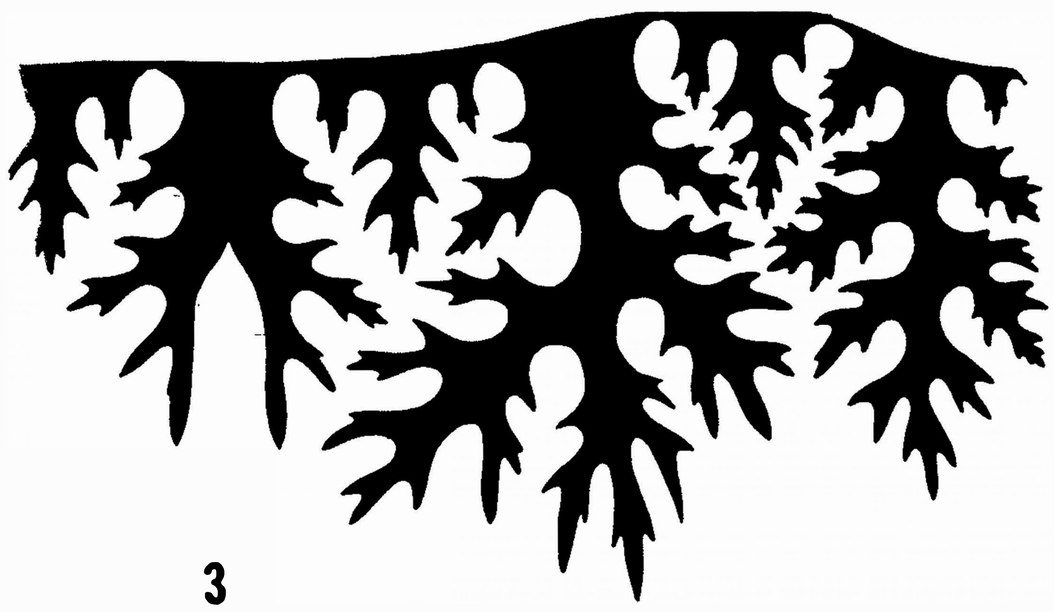
C. STURANI, BATHONIAN AMMONITES DIGNE AREA



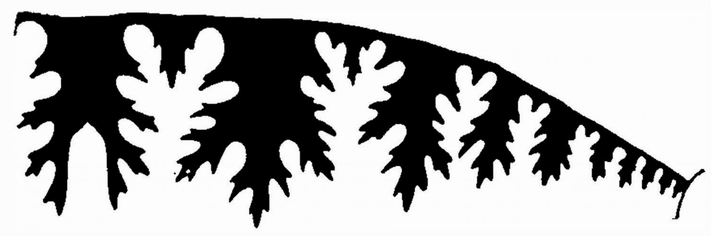
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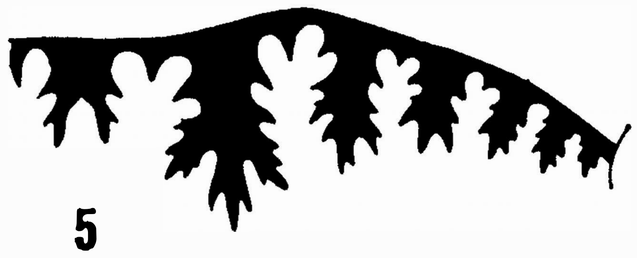
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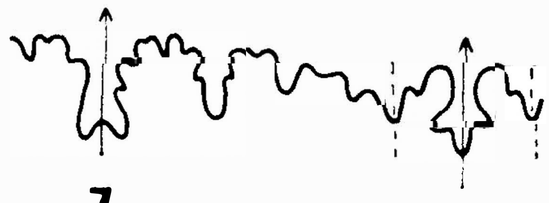
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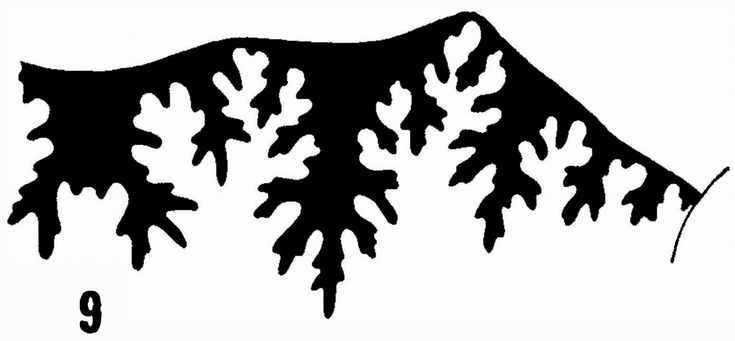
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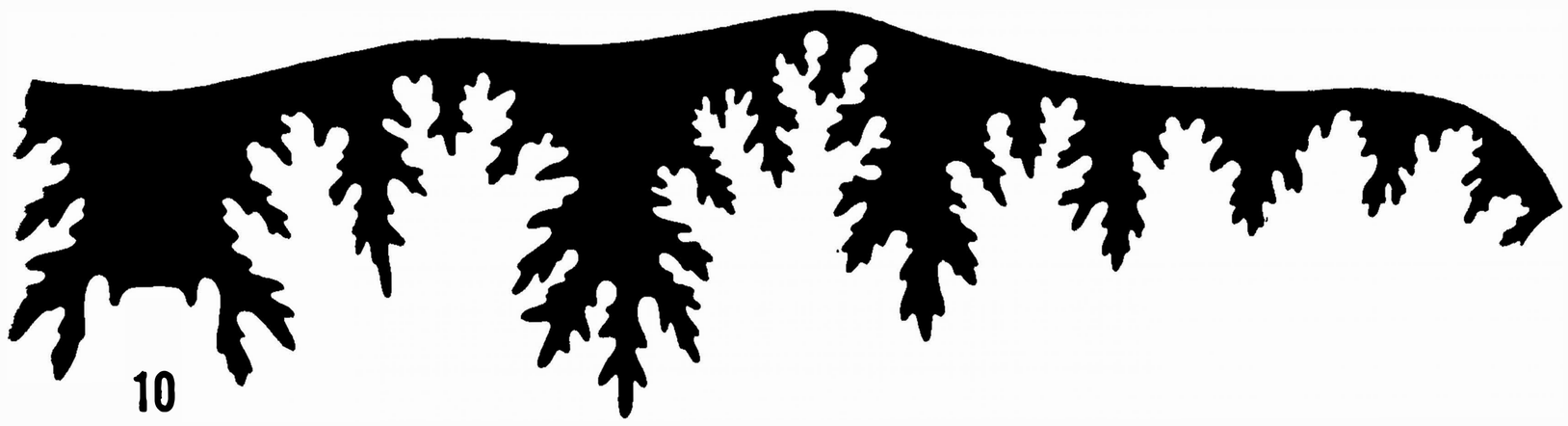
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faunas from the Basses-Alpes as an outstanding point of reference for both the detailed subzonal divisions within the Lower Bathonian and the possibility of correlation between different faunal provinces (Mediterranean, Northwest European, Central European).

Measurements are given according to Arkell's suggestions (1951-59; text-fig. 1).

The bulk of the fauna has been deposited in the palaeontological collections of the Istituto di Geologia dell'Università, Turin, while some specimens are in the H. S. Torrens collection at the Department of Geology, the University of Leicester.

In connection with the discussion of the Bajocian — Bathonian boundary, a few of the more interesting species from the topmost Bajocian, Parkinsoni zone, Bomfordi subzone, have also been described and and figured; these are: *Cadomites psilacanthus* (Wermbter), *Parkinsonia (Gonolkites?) subplanulata* Wetzel, *Procerites costulatosus* (S. Buckman), *Planisphinctes planilobus* S. Buckman and *Planisphinctes tenuissimus* (Siemiradzki).

As for the criteria I used when attributing each specimen to one taxon rather than to another, there is little to add to Arkell's statements on the same subject (1951-59; pp. 25-26, 166). Whenever possible, I also tried to follow the suggestions contained in Tintant's recent monograph (1963), when considering the degree of variability and its significance (whether simple morphotypes within a variable population, or good species, or successive subspecies within a wider chronospecies). I must confess, however, that in the present instance this was mainly based on subjective judgement rather than on statistical grounds: in the case of highly variable populations the number of available specimens never seemed to be large enough, because too many of them were incomplete, fragmentary, distorted or otherwise unsuitable for measurements, and the statistical plotting of the data obtained in such conditions would probably have been more misleading than the subjective evaluation of all characters and their mutual relations. This does not mean that I am disregarding statistic methods, as a rule; they were simply unapplicable in the present case. I think, however, that a palaeontologist must always describe his material as best he may, even if he has not got the chance of studying large assemblages in the most beautiful state of preservation.

In this way, I was led to confirm Arkell's interpretation of taxa, as the most natural, in almost all instances. The main departure from his classification concerns the subfamily groups within the family *Perisphinctidae.*

The Bathonian *Perisphinctidae* have previously been distributed between two subfamily groups: *Zigzagiceratinae* S. Buckman, 1920, and *Pseudoperisphinctinae* Schindewolf, 1925. The latter name has been replaced by *Siemiradzkiinae* Westermann, 1958, but should nevertheless be retained on the grounds of ICZN article 40 (a). According to the « Treatise » and to Arkell's monograph, *Zigzagiceratinae* include: *Zigzagiceras* (type genus), *Procerozigzag* (macroconch counterpart of *Zigzagiceras* s.s.), *Procerites, Phaulozigzag* (microconch subg. of *Procerites*), *Lobosphinctes, Gracilisphinctes, Wagnericeras* and *Suspensites* (either subg. or junior syn. of *Wagnericeras*).

Pseudoperisphinctinae include the following Bathonian genera, apart from the younger ones: *Pseudoperisphinctes* (subg. of *Siemiradzkia,* according to Westermann, 1958), *Siemiradzkia* (the type genus of *Siemiradzkiinae* Westermann), *Planisphinctes, Choffatia, Homoeoplanulites* (micr. subg. of *Choffatia*), *Subgrossouvria* (a senior synonym of *Loboplanulites* and a subg. of *Choffatia*) and *Berbericeras.*

The discovery of new species, which represent the connecting links between some of these well known genera, previously thought totally unrelated, as well as the study of the early ontogeny of the latter, which was often insufficiently known, have

thrown new light on the phyletic affinities of the Bathonian *Perisphinctidae,* showing at the same time that the subfamily groups discussed above are very unnatural. It appears in fact that quite a large number of the Bathonian *Perisphinctidae,* previously placed in different subfamilies, have got *Bigotites* as their common ancestor. This genus, which ranges as high as the Convergens subzone in the Digne area, shows peculiar, sinthetic features (constrictions, ventral smooth band), and seems to have been a particularly plastic stock. Near the Bajocian - Bathonian boundary, and short before its own extinction, *Bigotites* seems to have been at the origin of at least two main lineages, evolving in different directions.

The first one shows a trend towards an early loss of the constrictions and the ventral smooth band, while a more involute coiling — but no new characters in the style of ribbing — develops. Here belong *Procerites* and its allies, first appeared in the topmost Bajocian, Bomfordi subzone (*P. costulatosus*). The nuclei of the earliest known *Procerites* s.s. are in fact still constricted and possess a ventral smooth band. These features are even more evident in *Procerites (Lobosphinctes) intersertus*, from the topmost Bajocian and the basal Lower Bathonian, which retains constrictions up to the end of the phragmocone.

It should however be noted that there is an important gap in the vertical range of *Procerites,* corresponding to the Macrescens subzone, at least judging from the Bas Auran section. The nuclei of the younger species (*P. fullonicus, P. imitator*) being unknown, it is very difficult to say whether these are really congeneric with the earlier species (*P. subprocerus, P. tmetolobus*), or should be considered later homoeomorphs, phyletically unrelated and possibly arisen from a different ancestor (but which?).

The second lineage is characterized by the loss of constrictions and ventral smooth band, while the peculiar zigzag style of ribbing — with distant parabolic nodes — appears on the inner whorls. This group appears in the topmost part of the Convergens subzone, with *Zigzagiceras* (*Franchia* n. subg) *arkelli* n. sp., which still combines the constrictions and the ventral smooth band of typical *Bigotites* with the zigzag nucleus of typical *Zigzagiceras* s.l., representing thus a fine example of proterogenesis. (Plate 2).

Zigzagiceras s.s. and *Z.* (*Procerozigzag*), its macroconch dimorph, appear at the base of the Macrescens subzone, in the bed next above that yielding *Z.* (*Franchia*) *arkelli*; both show a rapid evolution (Plates 2 and 23). That of *Zigzagiceras* s.s. is particularly interesting, because it leads to typical *Siemiradzkia* through the progressive contraction of the zigzag nucleus and the appearance of an intermediate stage of ribbing, in which stronger primaries ending in parabolic nodes recur at increasing intervals among the normal ribs.

Pseudoperisphinctes, at least judging from the newly collected specimens, which pass through a very short zigzag stage in the nucleus, seems to have originated in the same way.

There remain a few more genera. *Choffatia* s.l., appearing in the Middle Bathonian, may have arisen from the similarly ribbed, evolute and well constricted *Wagnericeras,* such as *W. banaticum* (Kudernatsch) and *W. bathonicum* Arkell. These, in turn, may have arisen from *Bigotites,* of which they retain the constrictions and simple sutures; but the evidence for such a link is highly conjectural, since a fuller set of intermediate forms has still to be discovered. Besides, *Wagnericeras* as interpreted by Arkell, seems to be a morphological genus and it may prove to include genetically unrelated forms. The early ontogeny of several species of *Wagnericeras* and *Choffatia* should be reexamined, in this connection.

As for the microconch genus *Planisphinctes,* whose presence in the Lower Bathonian should be confirmed, its affinities are difficult to interpret. In any case it is not considered here to be closely related to *Sie-*

EXPLANATION OF PLATE 6

Fig. 1 - *Cadomites deslongchampsi* (Defrance in d'Orbigny). Chaudon, Lower Bathonian, Convergens sbz. Pag. 28.

2 - *Cadomites daubenyi* (Gemmellaro). Bas Auran, Lower Bathonian, Convergens sbz. (bed 14). Pag. 29.

3a-b - *Cadomites rectelobatus* (Hauer), inner whorls. Bas Auran, Lower Bathonian, Convergens sbz. (bed 14). X 2. Pag. 29.

4a-b - *Polyplectites dorni* (Roché). Bas Auran, Lower Bathonian, Convergens sbz. (bed 14). X 2. Pag. 29.

5 - *Parkinsonia (Gonolkites) convergens* (S. Buckman), immature specimen. Chaudon, Lower Bathonian, Convergens sbz. Pag. 33.

6 - *Parkinsonia (Gonolkites) subgaleata* (S. Buckman), immature specimen. Chaudon, Lover Bathonian, Convergens sbz. Specimen collected by G. Pavia. Pag. 34.

7 - *Parkinsonia (Oraniceras) württembergica* (Oppel). Bas Auran, Lower Bathonian, Macrescens sbz. (bed 10). Pag. 34.

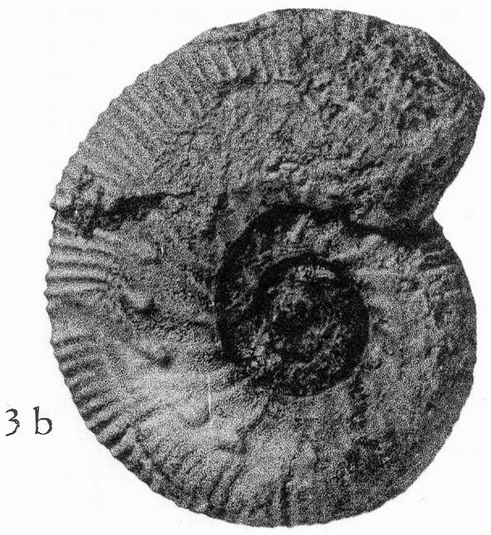
All photos. natural size except Figs 3a-b, 4a-b.



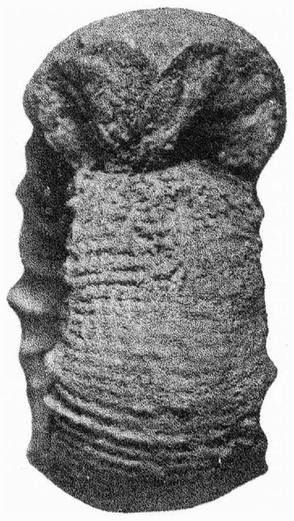
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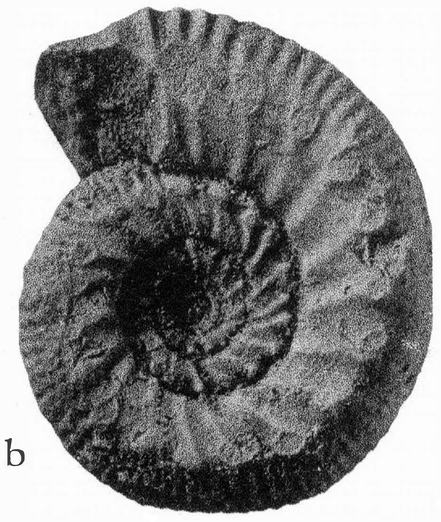
3 a



3 b



4 a



4 b

2



5



6



7

miradzkia, which appears later and has certainly arisen from *Zigzagiceras.*

Finally, *Berbericeras* has to be transferred to the Morphoceratids, being only doubtfully distinct from *Ebrayiceras.*

Also *Asphinctites,* placed in the *Perisphinctidae* by Westermann (1958), is here left within the family *Morphoceratidae.*

To conclude, it seems to me more advisable, for the time being, not to use subfamily groups within the Bathonian *Perisphinctidae,* since further researches are needed before a better scheme of classification can be suggested. The study of the early ontogeny seems to be particularly promising for such a purpose, notwithstanding Arkell's different opinion (1957, p. 110).

Turning back to the probable ancestor of *Procerites* s.l. and *Zigzagiceras* s.l., it should be noted that *Bigotites* includes small sized species with an auriculate peristome as well as large macroconchs (Nicolesco 1931, p. 12; also G. Pavia and the author, unpublished data). The simultaneous origin of dimorphs within both genera does not therefore represent a problem, if the sexual nature of dimorphism is accepted. This deserves a few more comments.

The theory concerning the sexual nature of dimorphism in ammonites has been recently revived by several authors (Callomon, Makowski, Tintant, Westermann), but the taxonomic implications are so important that much caution is needed before accepting it. A few cases will therefore be discussed here.

Within *Parkinsonia* s.l. the few auriculate microconchs, such as *P. acris* Wetzel, are really outnumbered by large species with simple peristomes and no dimorph pairs have yet been recognized. The same remark applies to *Procerites* versus *Phaulozigzag. Zigzagiceras* s.s. and *Procerozigzag* provide, on the contrary, one of the most striking examples of dimorphism, on both stratigraphical and morphological grounds. Within this same group it is on the other hand very difficult to state which could be the macroconch dimorphs of the numerous Lower, Middle and Upper Bathonian species of *Siemiradzkia.* The reverse condition, that is the macroconch species outnumbering their possible microconch dimorphs, is usually more common. Another well known case of dimorphism is that between *Morphoceras* and *Ebrayiceras;* some pairs can in fact be recognized, at least on stratigraphical grounds, among the species found in the Digne area.

In a more general way, the recognition of dimorphs is based on morphological as well as on stratigraphical grounds.

As for the first point, beyond certain reasonable boundaries, it becomes mainly a matter of an « eye of faith », because the degree of similarity that should be displayed by any pair of possible dimorphs cannot be fixed statistically and once for all. It may be noticed, for instance, that the microconch genus *Otoites* has been paired with *Stemmatoceras* and *Stephanoceras* by Callomon (1963, text-fig. 4), while for Westermann (1964) it is the male dimorph of *Emileia.* Likewise, the microconch genus *Glochiceras* has been paired in turn with *Ochetoceras* (Rollier 1913), *Lissoceratoides* (Makowski 1963, p. 71) and *Taramelliceras* (Callomon 1963, p. 43).

As for the second point, it is rather obvious that the members of each possible pair must have exactly the same vertical range, no matter how different their ecology and their *post-mortem* distribution could have been. But it is not enough that they are found within the same zone or even subzone, especially in the case of condensed sequences, which is the commonest condition throughout the epicontinental deposits of the Middle Jurassic over NW and central Europe.

These remarks apply particularly to those more striking examples of dimorphism usually referred to by most authors: *Oppelia* s.l. (M) - *Oecotraustes* s.l. (m); *Cadomites* (M) - *Polyplectites* (m); *Garantiana* s.l. (M) - *Strenoceras* (m) and *Pseudogarantiana* (m) (as for the latter two, in my opinion these could

be paired as well — or even better — with *Apsorroceras* (M) and *Spiroceras* (M), respectively, on both morphological and stratigraphical grounds).

Whatever the nature of dimorphism in ammonites may be, a lot more of work has still to be carried on, without overlooking the difficulties discussed above and checking the evidence case by case.

It is not fortuitous that the more convincing examples of dimorphism are to be found in those families, as the Kosmoceratids, which have been the object of exhaustive monographic treatment, so that their taxonomy is based on a sound interpretation of their phylogeny. But it should not be forgotten that there are other important groups (*Parkinsoniidae* and *Leptosphinctinae,* for instance), the taxonomy of which is still inspired by morphological rather than by phyletic criteria and is by no means satisfactory. On the other hand, the present study has shown that many a surprise can still await us, as to the existence of close links between genera previously thought totally unrelated, and this even dealing with appearently well known faunas, such as those of the European Lower Bathonian. The origin of entirely new groups through proterogenesis and the great rarity of such short lived intermediate links, as *Franchia* n. subg., may explain why so many genera are still considered cryptogenic.

As stated by Callomon (1963, p. 51), the recognition of sexual dimorphism in ammonites may lead to simplification and greater order in classification, on condition that it is applied with much caution and common sense.

SYSTEMATIC DESCRIPTIONS

PHYLLOCERAS KUDERNATSCHI (Hauer)

1905 *Phylloceras kudernatschi* Hauer - Popovici-Hatzeg 1905; p. 10; pl. 1, figs. 1-4. (*Cum syn.*).

1964 *Phylloceras kudernatschi* (Hauer) - Sturani 1964b; text-fig. 2 (suture line).

For description see Popovici-Hatzeg.

Bas Auran, from the topmost Bajocian, Bomfordi subzone (bed 29), up to the Macrescens subzone. Chaudon, from the Parkinsoni zone up to the Convergens subzone.

P. kudernatschi is a widespread mediterranean Phylloceratid, ranging from the Humphriesianum zone (Venetian Alps) up to the Callovian.

PHYLLOCERAS (PARTSCHICERAS) SUBOBTUSUM (Kudernatsch)

Plate 4, fig. 3 (suture line)

1905 *Phylloceras subobtusum* Kudernatsch - Popovici-Hatzeg 1905; pp. 11-12; pl. 1, figs. 8-9. (*Cum syn.*).

For description see Popovici-Hatzeg. The nucleus, up to 15 mm is smooth, but for the weak spiral edge marking the boundary between the flattened sides and the venter.

Bas Auran, from the topmost Bajocian, Bomfordi subzone (bed 27), up to the Yeovilensis subzone (bed 2). Chaudon, from the Bomfordi subzone up to the basal Upper Bathonian (nuclei). Col de Pierre basse, in the Lower Bathonian (nuclei).

P. subobtusum is another widespread mediterranean Phylloceratid, known to occur from the Humphriesianum zone up to the Upper Oxfordian (ssp. *chantrei* (Munier-Chalmas)).

PHYLLOCERAS (PARTSCHICERAS) VIATOR (d'Orbigny) WENDTI n. ssp.

Plate 3, figs. 1-2;
Plate 5, fig. 2 (suture line).

1964 *Phylloceras* (*Partschiceras*) n. sp. aff. *viator* - Wendt 1964; pp. 112-113; pl. 17, figs. 1a-b; pl. 23, fig. 1.

EXPLANATION OF PLATE 7

Fig. 1a-b - *Parkinsonia schloenbachi* Schlippe. Chaudon, Lower Bathonian, Convergens sbz. Pag. 30.

2a-b - *Parkinsonia pachypleura* S. Buckman. Bas Auran, Lower Bathonian, Macrescens sbz. (bed 10). Pag. 30.

3 - *Planisphinctes planilobus* S. Buckman. Bas Auran, topmost Bajocian, Bomfordi sbz. (bed 28). X 1,5. Pag. 39.

4 - *Parkinsonia (Gonolkites) convergens* (S. Buckman). Chaudon, Lower Bathonian, Convergens sbz. X 0,66. Pag. 33.

5 - *Parkinsonia (Gonolkites) subgaleata* (S. Buckman). Chaudon, Lower Bathonian, Convergens sbz. X 0,66. Pag. 34.

All photos. natural size except Figs. 3-5.

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1 a

1 b

2 a

3

4

5

2 b

The type of *P. viator* comes from Kobsel, Crimea, but « les environs de Chaudon » were already mentioned by d'Orbigny in the « *Paléontologie Française* » as a french locality for this species. In fact, *P. viator* is one of the commonest ammonites throughout the Upper Bajocian of the Digne Area (see Garnier, 1872, and Haug, 1891). In the specimens from the Bajocian, the characteristic blunt ribs on the venter and on the outer half of the whorl sides set in early, well before septation ceases, at a diameter of 20-30 mm (Plate 3, fig. 3). The whorl section may be rather inflated, as in the specimen of the *Pal. Fr.,* or slightly narrower, according to individuals.

On the other hand, the otherwise very similar specimens from the Bathonian are completely smooth — besides fine *lyrae* on the outer surface of the test only — up to a diameter of 50 mm, and the flared ribs do not appear until the end of the phragmocone in the fully grown specimens. The suture line, however, is almost identical to that of the Bajocian specimens (Plate 5, figs. 1-2).

This same form had already been described as new, but not named, by Wendt (1964), on specimens from the condensed faunas of Western Sicily (Bathonian - Lower Callovian).

In my opinion, this should be best regarded as a simple subspecies of *P. viator,* younger than the nominate one, the differences not being so important as to justify specific distinction. The specimen figured on Plate 3, fig. 1 has retained the whole body chamber and seems to have reached the adult size; it comes from the Convergens subzone of Chaudon and is here designated holotype. The agreement with the sicilian specimen figured by Wendt is very close.

P. viator wendti n. ssp. is rather common, both at Chaudon and at Bas Auran, and ranges from the base of the Convergens subzone up to the Upper Bathonian (nuclei).

PTYCHOPHYLLOCERAS FLABELLATUM (Neumayr)

Plate 3, fig. 4; Plate 5, fig. 4 (suture line).

1905 *Phylloceras flabellatum* Neumayr - Popovici-Hatzeg 1905; p. 12; pl. 1, figs. 5-7, 10-11; pl. 4, fig. 9; text-figs. 1-2. (*Cum syn.*).

1929 *Phylloceras biarcuatum* Munier-Chalmas in Collot - Lanquine 1929; pp. 315-316; pl. 12, fig. 5.

1964 *Calliphylloceras* (*Ptychophylloceras*) *flabellatum* (Neumayr) - Wendt 1964; pp. 115-116.

For description see Popovici-Hatzeg and Wendt.

P. biarcuatum Munier-Chalmas (*in schedis*), first described but not figured by Collot (1888, p. 66) and mentioned by Haug (1891, p. 82) for the Upper Bathonian of Chaudon, seems to be based on nuclei of *P. flabellatum,* at least judging from Lanquine (1929), who first figured it.

At Bas Auran the present species does not appear until the topmost part of the Yeovilensis subzone (bed 2, a single specimen), and becomes more common in the Progracilis zone (bed 1, over 10 specimens). Also found in the Lower Bathonian assemblage at the Col de Pierre Basse and in the Upper Bathonian of Chaudon (nuclei).

CALLIPHYLLOCERAS DISPUTABILE (Zittel)

1964 *Calliphylloceras disputabile* (Zittel) - Sturani 1964 b; pp. 10-11; pl. 1, figs. 2, 5a-b; text-fig. 5. (*Cum syn.*).

This is the commonest Phylloceratid in the Lower Bathonian of the Digne area, and is also found in the Middle Bathonian of the Bas Auran section (bed 1). For description see Sturani 1964b. Compressed morphotypes are rather common in this population from the Basses-Alpes.

HOLCOPHYLLOCERAS MEDITERRANEUM (Neumayr)

Plate 3, figs. 5-6; Plate 5, fig. 5 (suture line).

1964 *Holcophylloceras mediterraneum* (Neumayr) - Sturani 1964b; pp. 11-12; pl. 1, figs. 4, 6; text-fig. 6. (*Cum syn.*).

Very rare in the limestone facies (a single specimen from the Yeovilensis subzone of the Bas Auran section) *H. mediterraneum* is on the contrary more common, as ferruginous nuclei, in the shale facies (Lower Bathonian at the Col de Pierre basse and Upper Bathonian at Chaudon). Also found in the Bajocian of this same region, where it is not very common.

The nuclei, up to about 8 mm, are completely smooth and much more widely umbilicated than the adults (Plate 3, fig. 6).

For discussion of the synonymy, see Sturani (1964b).

H. mediterraneum is a species of very widespread occurrence, also outside the mediterranean region, and of long vertical range, reaching the Upper Jurassic.

HOLCOPHYLLOCERAS MARIONI (Munier-Chalmas in Lanquine)

Plate 3, fig. 7; Plate 5, fig. 6 (suture line).

1929 *Phylloceras marioni* Munier-Chalmas (*in schedis*) - Lanquine 1929; p. 316; pl. 12, fig. 6.

There are over 25 ferruginous nuclei from the Upper Bathonian of Chaudon, the largest one being 19 mm in diameter.

The present species looks like *H. mediterraneum,* but its constrictions are more numerous (6-8 against 4-6 per whorl) and less sharpely bent; fine, radial ribs, confined to the outer half of he whorl sides and the venter, are also visible on some specimens, including that figured by Lanquine. The suture line is rather different from that of *H. mediterraneum,* all the elements being much less stout and more complex, at a comparable diameter. *H. marioni* is also known from the Upper Bathonian of Saint-Marc near Aix-en-Provence.

LYTOCERAS EUDESIANUM (d'Orbigny) s.l.

1964 *Lytoceras eudesianum* (d'Orbigny) s.l. - Sturani 1964b; pp. 12-13; text-fig. 7 (suture line).

1964 *Lytoceras adeloides* (Kudernatsch) - Pugin 1964; pp. 20-28; text-fig. 4. (*Cum syn.*) .

1964 *Lytoceras eudesianum* (d'Orbigny) - Pugin 1964; pp. 28-33; pl. 2, fig. 1; text-fig. 5. (*Cum syn.*).

Bas Auran, from the topmost Bajocian, Bomfordi subzone, to the topmost Lower Bathonian, Yeovilensis subzone; Chaudon, in the Convergens subzone and in the Upper Bathonian (nuclei). This is the largest ammonite in the Bathonian of the Digne area, some specimens attaining nearly 500 mm, but it is not common.

None of the specimens from the Bomfordi subzone and the Lower Bathonian have retained the test, so it is difficult to state whether they belong to *L. eudesianum* or to *L. adeloides* (see Sturani 1964b, p. 12), the distinction between these two forms, which I do not regard as specifically distinct, consisting only in the number and position of the flares on the flared collars (Pugin 1964, p. 30). Specimens certainly belonging to *L. eudesianum* s.s. do exist in the Humphriesianum and Subfurcatum zone of this same region, while on the other hand the nuclei from the Upper Bathonian of Chaudon show the same type of flared collars as in typical *L. adeloides*. It seems therefore probable that these are simple subspecies with a different vertical range, *L. eudesianum adeloides* being the younger.

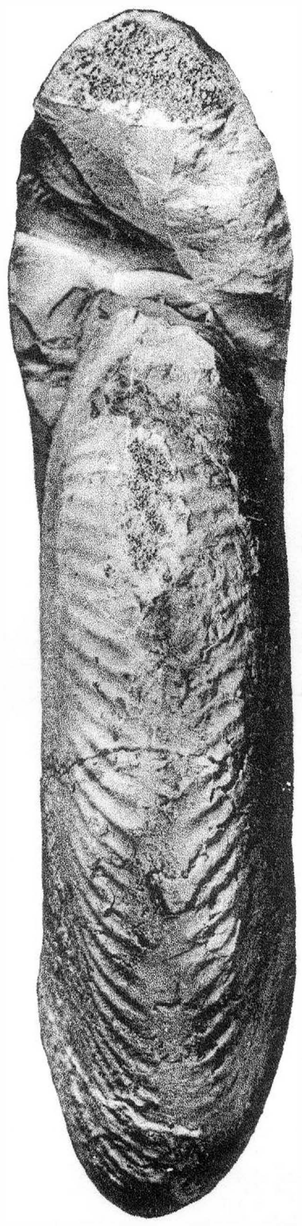
EXPLANATION OF PLATE 8

Fig. 1a-b, 4 - *Parkinsonia (Gonolkites) subgaleata* (S. Buckman). Figs. 1a-b. Fully grown specimen; Chaudon, Lower Bathonian, Convergens sbz. X 0,4. Specimen collected by G. Pavia.
Fig. 4. Bas Auran, Lower Bathonian, Convergens sbz. (bed 13). X 0,66. Pag. 34.

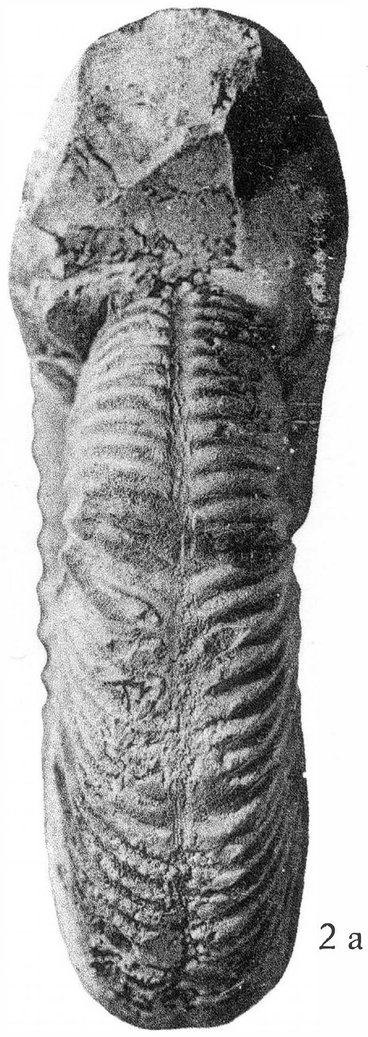
2a-b - *Parkinsonia (Gonolkites?) subplanulata* Wetzel. Bas Auran, topmost Bajocian, Parkinsoni z., Bomfordi sbz. (bed 28). X 0,66. Pag. 31.

3 - *Parkinsonia (Gonolkites) convergens* (S. Buckman). Chaudon, Lower Bathonian, Convergens sbz. X 0,66. Pag. 33.

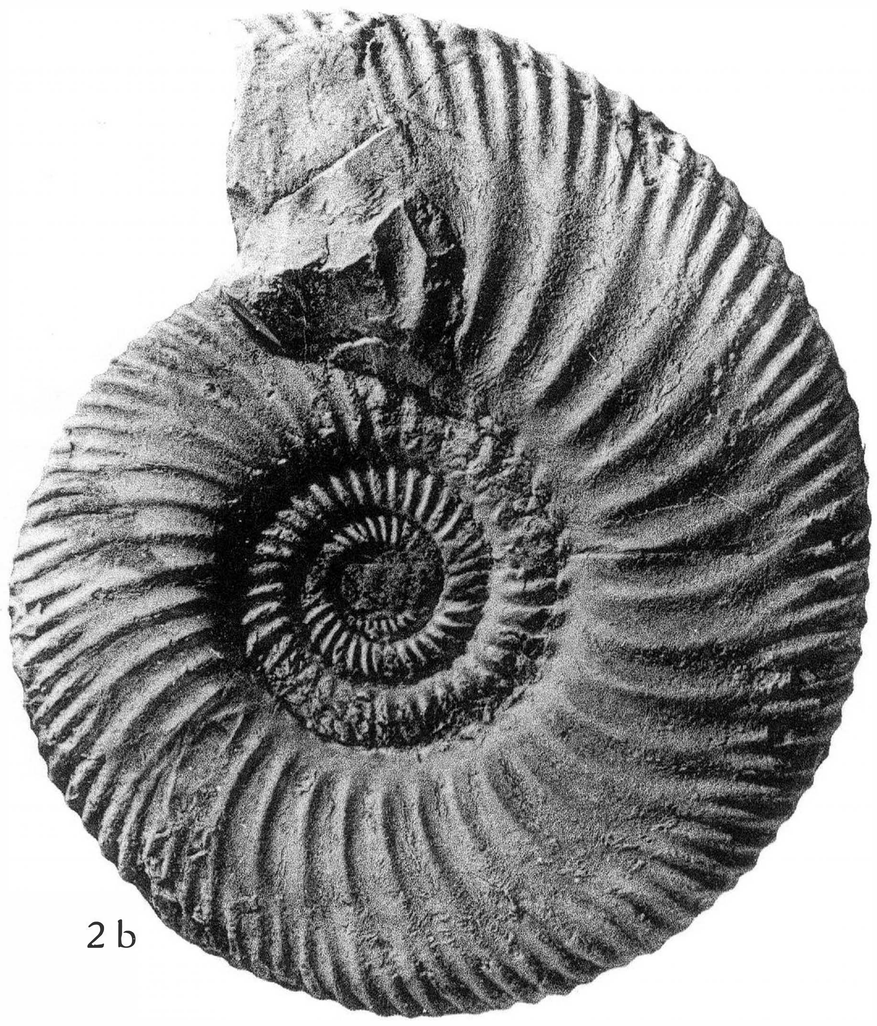
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1 a



2 a



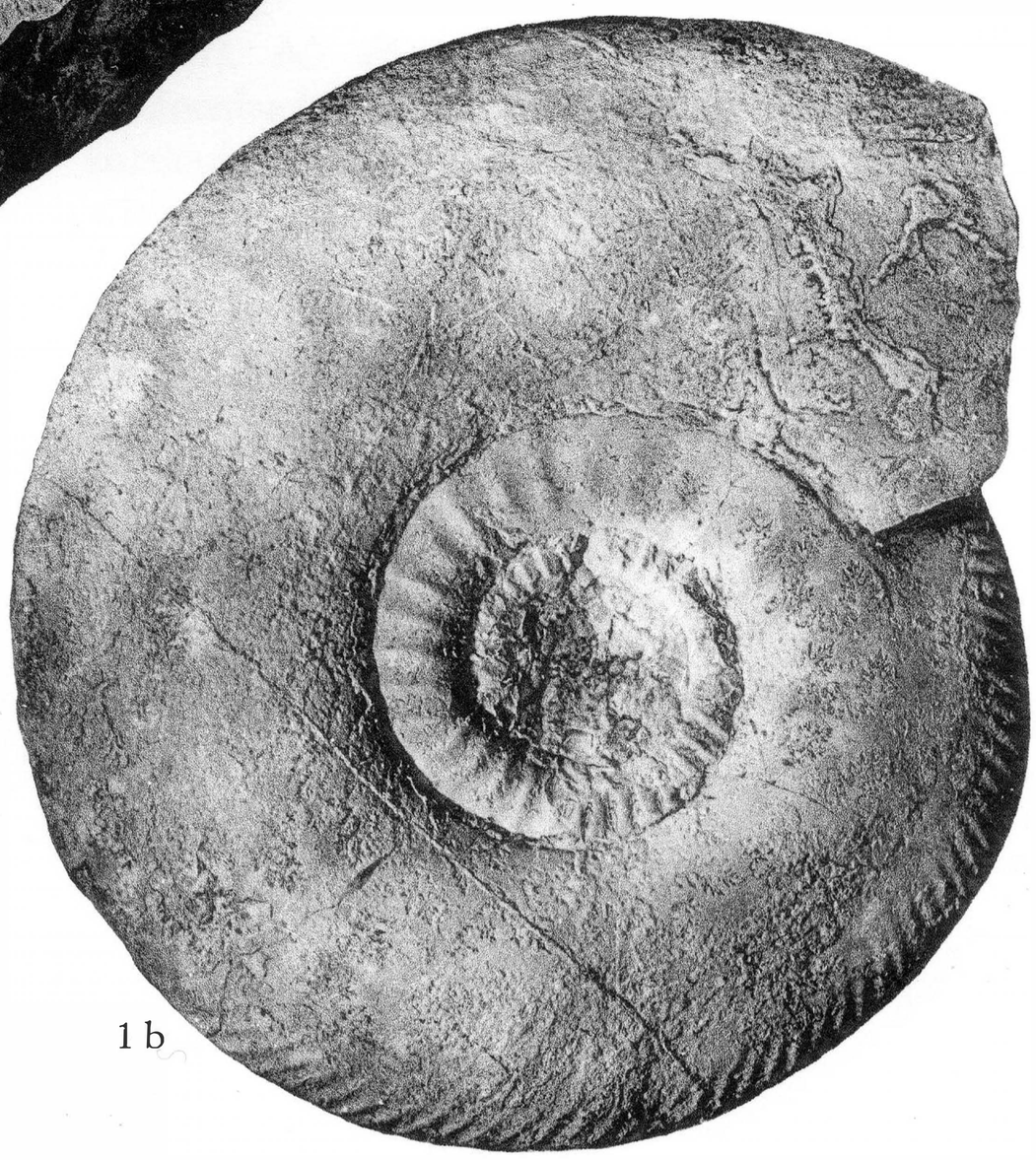
2 b



3



4



1 b

NANNOLYTOCERAS TRIPARTITUM (Raspail)
Plate 3, figs. 9 a-b

1964 *Nannolytoceras tripartitum* (Raspail) - Pugin 1964; pp. 48-58; pl. 3, figs. 1-6; text-figs. 9-10. (*Cum syn.*).

This is by far the commonest ammonite in the Lower Bathonian of the Basses-Alpes (type region); its designation by ancient authors as an index form in the local stratigraphy (« couches à *tripartitus* ») was therefore fully justified.

At Bas Auran *N. tripartitum* appears in the topmost Bajocian, Bomfordi subzone, and reaches the top of the Yeovilensis subzone (bed 2). Pugin (1964, p. 56) states that this species is already present, though rare, in the Subfurcatum zone; but this is not the case in the Digne area, where *N. tripartitum* is not found below the Bomfordi subzone. In this region its place is taken by *Eurystomiceras polyhelictum* (Böckh), which ranges from the Sowerbyi zone up to the middle part of the Parkinsoni zone.

Several specimens show the peristome (Plate 3, figs. 9a-b), which is preceded by a constriction and is provided with two long, narrow lappets delimiting a ventral sinus; the traces of such lappets are also visible on the internal cast near the last two or three constrictions (earlier peristomes). Under this regard, they do not seem to be homologous with the lappets found in several microconch genera of the suborder Ammonitina, which are confined to the adult peristome and are not related with previous constrictions.

The body chamber occupies about half a whorl. For the other characters, see Pugin's description.

NANNOLYTOCERAS n. (?) sp. ind.
Plate 3, fig. 8

Three specimens from the Progracilis zone of the Bas Auran section (bed 1) differ markedly from *N. tripartitum* in the following characters: A) the whorl section is subrectangular instead of elliptical, and its diameters increase at a faster rate; as a consequence, the coiling is tighter and the umbilicus narrower; B) the constrictions (3 per whorl) are convex forward and radially directed, instead of being concave and prorsiradiate on the whorl sides; moreover, they occur by pairs, separated by a blunt ridge, the anterior one in each pair being homologous with those of *N. tripartitum*. These specimens do not seem to fall within any previously known species (Pugin 1964, p. 45), but more material is needed before naming this taxon as new.

LISSOCERAS PSILODISCUS (Schloenbach)
Plate 3, figs. 17a-b; Plate 4, fig. 11

1951 *Lissoceras psilodiscus* (Schloenbach) - Arkell 1951-59; pp. 49-50; text-fig. 10; pl. 8, figs. 1a-b. (*Cum syn.*).
1964 *Lissoceras psilodiscus* (Schloenbach) - Sturani 1964b; text-fig. 11.

There are over ten specimens from the Bas Auran section, where *L. psilodiscus* ranges from the basal Convergens subzone (bed 23) up to the topmost Yeovilensis subzone (bed 2); also in the Lower Bathonian assemblage from the Col de Pierre basse (nuclei). All show perfect agreement with Schloenbach's type. The whorl section is particularly high and narrow, lanceolate, with the maximum thickness in the inner third and a narrow venter, neither keeled nor flattened. The umbilicus is proportionally small; the whorls smooth (on the internal cast, at least) except for a few broad sigmoidal undulations toward the end of the body chamber in some mature specimens.

The measurements of the specimen figured on Plate 3, fig. 17 are: max 58,5 mm (end of the phragmocone); at 58,5 : .49; .24,5;. 21.

Nuclei of an involute *Lissoceras,* with extremely compressed whorls, are also found

in the Upper Bathonian assemblage from Chaudon (Plate 3, figs. 13a-b); they could belong to *L. psilodiscus,* or rather to a closely allied (new?) species, but are too small for definite identification. It is however important to note that *Lissoceras* ranges higher up than previously known, reaching the Upper Bathonian.

L. psilodiscus has a wide geographical distribution and most records of it are from the Zigzag zone.

Lissoceras ferrifex (Zittel)

1852 *Ammonites erato* (non d'Orbigny) - Kudernatsch 1852; pl. 2, figs. 4-6 (*non cet.*).
1868 *Ammonites ferrifex* - Zittel 1868; p. 604 .
1964 *Lissoceras ferrifex* (Zittel) - Wend 1964; p. 120.
1964 *Lissoceras ferrifex* (Zittel) - Sturani 1964b; text-fig. 10.

Like *L. psilodiscus,* but the coiling is more evolute and the whorl height increases at a slower rate.

There is an adult specimen, showing part of the body chamber, from the Convergens subzone of the Bas Auran section; its measurements are: max 84 mm; at 68 mm (end of the phragmocone): . 45; . 24; . 25.

L. ferrifex is also known from the Bathonian of Swinitza (type loc.), of the Venetian Alps, of Sicily and of Sardinia; in the last region it occurs with an Upper Bathonian assemblage (Dieni, Massari & Sturani 1966).

Lissoceras haugi n. sp.
Plate 3, figs. 16a-b.

1891 *Haploceras* n. sp. aff. *oolithicum* - Haug 1891; p. 74.

The holotype (Plate 3, figs. 16a-b) comes from the Convergens bed of Les Reichasses (Chaudon) and has part of the body chamber preserved.

Its measurements, at the end of the phragmocone are: D 46 mm, .46,7; .43,4; .28. The whorl section is ovally shaped and stouter than that of any congeneric form, except *L. meletense* (Parona) from the Subfurcatum zone of the Venetian Alps. The whorl sides are regularly convex (not flattened as in the otherwise similar *L. monachum* (Gemmellaro), for which see Sturani 1964b), and the external side rounded.

This species had already been noted by Haug as probably new (see above), at the same locality (« La Clappe »).

A smaller specimen from the Upper Bathonian of Chaudon (Plate 3, figs. 12a-b) is rather similar, though slightly more compressed, its measurements being: D 16,3 mm; .46; .37; .26,3. It is difficult to say whether it is conspecific or not, owing to its small size; it confirms, however, that the genus *Lissoceras* reaches the Upper Bathonian.

Oppelia (oppelia) seebachi Wetzel
Plate 4, figs. 7a-b.

1950 *Oppelia* (*Oxycerites*) *fusca* (Quensted) *seebachi* - Wetzel 1950; p. 90; pl. 9, figs.9a-b.
1958 *Oxycerites* (*Pleuroxytes*) *seebachi* (Wetzel) - Westermann 1958; p. 49; pl. 10, figs. 5a-b (holotype refigd.).

Two specimens, both wholly septate, come from the Convergens subzone of Chaudon and show close affinities with the holotype. The main difference between this form and the Bajocian *O. flexa* (S. Buckman) consist in the more compressed whorl section and sharper venter of the former. As for its taxonomic position, it should be noted that *Pleuroxytes* has been placed by Arkell in the synonymy of *Oppelia* s.s.

The holotype comes from the Lower Bathonian of Eimen, Hils (Germany).

EXPLANATION OF PLATE 9

Fig. 1a-b - *Morphoceras densicostatum* Thalmann. Chaudon, Lower Bathonian, Convergens sbz. Specimen collected by G. Pavia. Pag. 36.

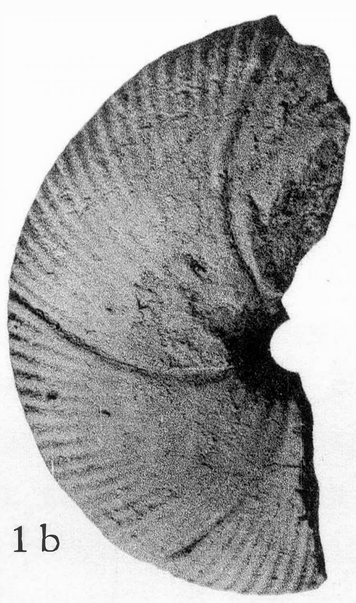
2, 5a-b, 6a-b, 7 - *Morphoceras multiforme* Arkell. All specimens from Chaudon, Lower Bathonian, Convergens sbz. Figs. 6a-b X 1,5. Pag. 31.

3 - *Morphoceras patescens* (S. Buckman). Bas Auran, Lower Bathonian, Macrescens sbz. (bed 8). Pag. 36.

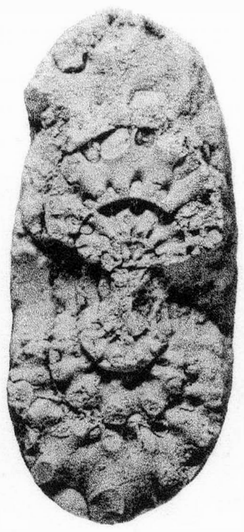
4a-b, 8 - *Morphoceras macrescens* (S. Buckman). Both specimens from Bas Auran, Lower Bathonian, Macrescens sbz. (beds 8 and 7, respectively). Figs. 4a-b. X 1,5. Pag. 35.

All photos. natural size except Figs. 4a-b, 6a-b.

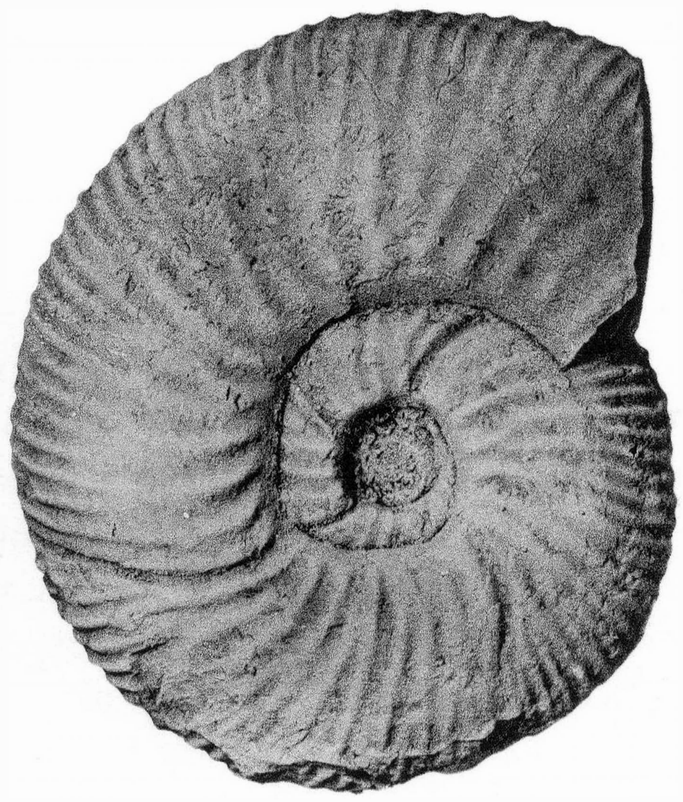
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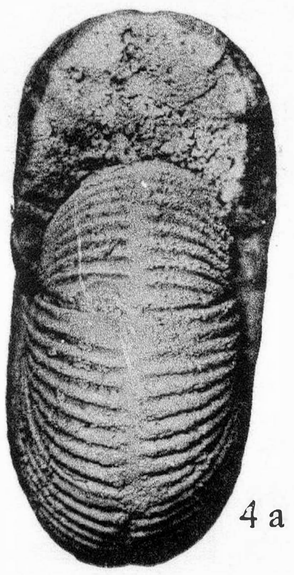
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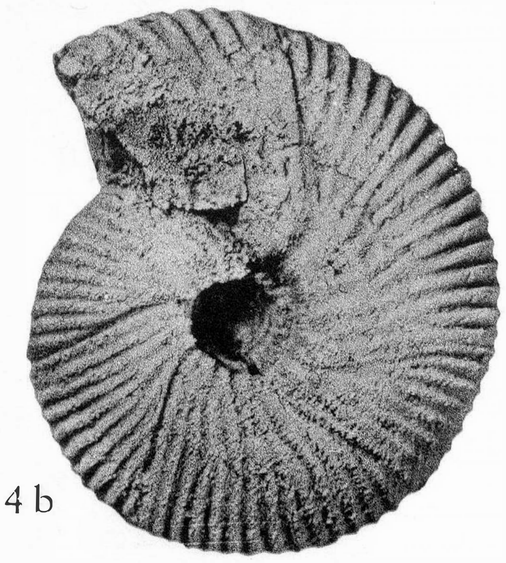
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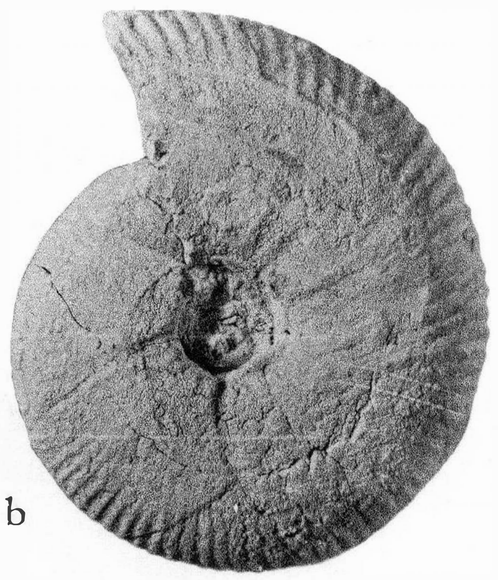
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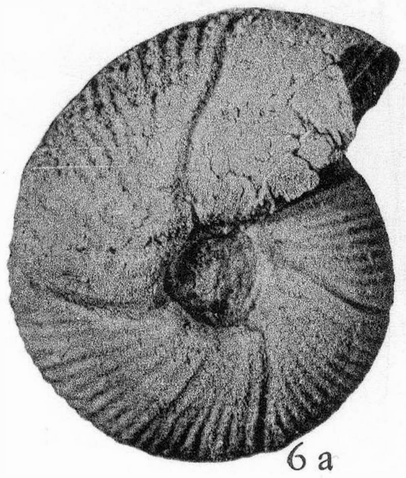
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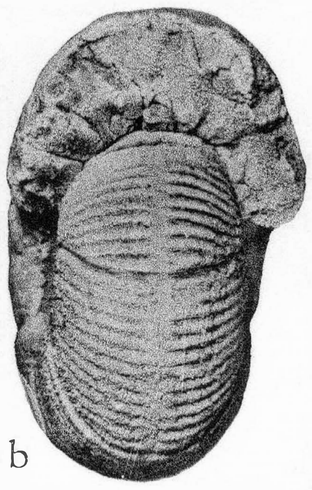
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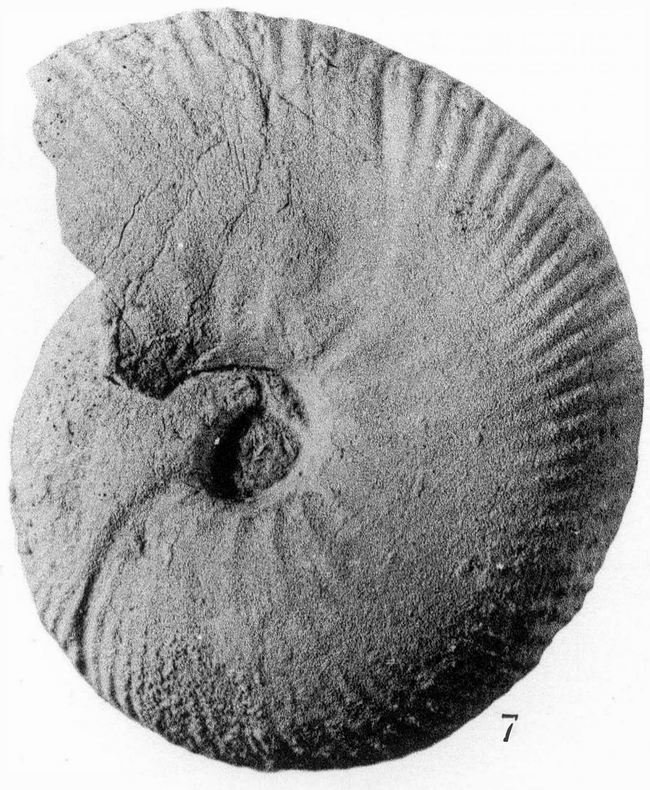
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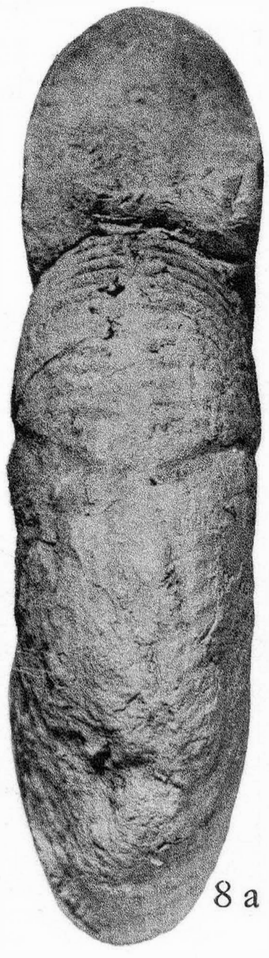
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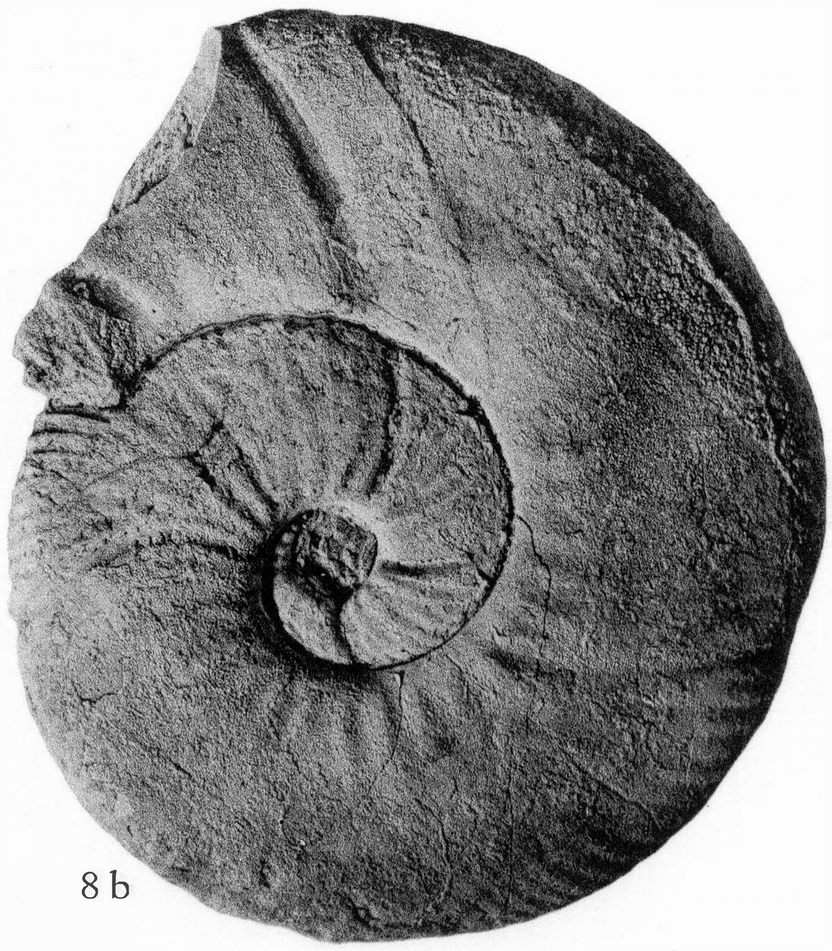
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7



8 a



8 b

OPPELIA (OXYCERITES) YEOVILENSIS Rollier
Plate 4, figs. 8, 10a-b

1951 *Oppelia* (*Oxycerites*) *fallax* (Guéranger) - Arkell 1951-59; pp. 56-60; text-figs. 15, 16/1; pl. 5, figs. 1-3; pl. 8, figs. 11a-b. (*Cum syn.*).
1958 *Oxycerites* (*Limoxytes*) *fallax* (Guéranger) - Westermann 1958; pp. 46-47; pl. 8, figs. 2a-b; pl. 9, figs. 1a-b.

Bas Auran, from the Convergens up to the Yeovilensis subzones (beds 23, 20, 11, 10, 9, 5); Chaudon, in the topmost Bajocian, Bomfordi subzone (a single specimen), and in the Convergens subzone (five specimens). It should be noted that one of the syntypes of *O. fallax* (Guéranger), still in the d'Orbigny's collection, comes from Chaudon.

For the entangled synonymy of *O. yeovilensis* see Rioult's recent paper (1961). It is possible that the specimen figured in the *Paléontologie Française* (the type of *O. fallax* (Guéranger)) is conspecific with that from Yeovil, Somerset, figured by Waagen (type of *O. yeovilensis* Rollier); in such a case the latter name would be a junior subjective synonym of the former. Since the interpretation and stratigraphic horizon of d'Orbigny's figured specimen is controversial, it seems best provisionally to follow Rioult in using Rollier's name.

Also in England (the type region) *O. yeovilensis* is known to occur from the topmost Bajocian, Bomfordi subzone, to the « Fallax » zone, both inclusive.

OPPELIA (OXICERITES) NIVERNENSIS
De Grossouvre
Plate 3, fig. 10; Plate 4, fig. 6

1951 *Oppelia* (*Oxycerites*) *limosa* (S. Buckman) - Arkell 1951-59; pp. 60-61; pl., 5, figs. 7, 8; pl. 6, figs. 5,6. (*Cum syn*).
1951 *Oppelia* (*Oxycerites*) *nivernensis* De Grossouvre - Arkell 1951-59; pp. 61-62; pl. 5, fig. 9. (*Cum syn.*).
1958 *Oxycerites* (*Limoxytes*) *nivernensis* (De Grossouvre) - Westermann 1958; p. 46; pl. 9, figs. 2-4; pl. 10, figs. 1-2. (*Cum syn.*).

There are five specimens from Bas Auran (beds 12, 11, 10, 6 and 2) and two others from the Convergens subzone of Chaudon.

Westermann's interpretation of *O. nivernensis,* including *O. limosa* as a synonym, is followed here.

The present species shows the style of ribbing of adult *O. fallax* at a smaller diameter; it is also distinguished from the latter by its smaller umbilicus and the smaller size of adult specimens.

O. nivernensis has been reported from several regions; in England it occurs from the topmost Bajocian up to the basal Middle Bathonian (Stonesfield slates).

OPPELIA (OXYCERITES) OXUS (S. Buckman)
Plate 4, fig. 9

1951 *Oppelia* (*Oxycerites*) *oxus* (S. Buckman) - Arkell 1951-59; pp. 66-67; pl. 6, figs. 8, 9; text-fig. 16/2. (*Cum syn.*).

There are two specimens, one from the Progracilis zone (bed 1), the other not *in situ,* but presumably from the same bed judging after the matrix. Both show the same style of ribbing as the holotype and the other english specimen figured by Arkell, whom see for their discription. The type level in England is also Progracilis zone.

OECOTRAUSTES (subg. ?) FUSCUS
(Quenstedt)
Plate 3, fig. 14; Plate 4, fig. 3

1958 *Oxycerites* (*Otoxytes*) *fuscus* (Quenstedt) - Westermann 1958; p. 52; pl. 10, figs. 8a-e. (*Cum syn.*).

There are two small and wholly septate specimens from Bas Auran, one from bed

14, the other from bed 5, showing very close agreement with the lectotype, for description of which see Westermann (1958).

The taxonomic position of this species is controversial, since no complete adult specimens are known.

Oecotraustes subfuscus Waagen
Plate 3, fig. 15

1919 *Oecotraustes subfuscus* Waagen - De Grossouvre 1919; pp. 409-410; pl. 14, fig. 4. (*Cum syn.*).

A single, small and fragmentary, but otherwise well preserved specimen, from the top of the Yeovilensis subzone (bed 2) of the Bas Auran section, shows very close agreement with that figured by De Grossouvre from the Lower Bathonian of the Nièvre. The main differences between this specimen and those referred to *O. fuscus* consist in its slightly stouter whorl section, with a less sharply keeled venter, and in its stronger ribbing (especially the primaries).

Oecotraustes (Paroecotraustes) formosus Arkell
Plate 4, fig. 1

1966 *Oecotraustes* (*Paroecotraustes*) *formosus* Arkell - Stephanov 1966; pp. 46-47; pl. 3, figs. 1-8. (*Cum syn.*).

A fine specimen from the Progracilis (?) zone of the Bas Auran section (bed 1), wholly septate at a diameter of 35 mm (Plate 4, fig. 1), is slightly distorted, but otherwise well preserved, and agrees perfectly with the type series, recently refigured by Stephanov, whom see for a complete description. Both spiral grooves described by Arkell as a typical feature of this species are visible.

O. (*P.*) *formosus* is known to occur from the Progracilis up to the Subcontractus zones (Stephanov, *loc. cit.*).

Oecotraustes (Paroecotraustes) maubeugei Stephanov
Plate 4, fig. 2

1966 *Oecotraustes* (*Paroecotraustes*) *maubeugei* - Stephanov 1966; pp. 51-52; pl. 5, figs. 1-7; pl. 6, figs. 1-8. (*Cum syn.*).

A single specimen from the Progracilis (?) zone of the Bas Auran section (bed 1), 36 mm in diameter and retaining the whole body chamber, seems to fall within the range of variation of *O. (P.) maubeugei* which is said by Stephanov to be the « most widely distributed and commonest *Oecotraustes* (*Paroecotraustes*) known from the whole of Europe ».

According to the Bulgarian Author, the vertical range of *O.* (*P.*) *maubeugei* is from Subcontractus to Aspidoides zones, although most records of this species are from condensed, generically Upper Bathonian assemblages.

Oecotraustes (Alcidellus) tenuistriatus (De Grossouvre)
Plate 3, fig. 11

1958 *Paroecotraustes* (*Alcidellus*) *tenuistriatus* (De Grossouvre) - Westermann 1958; pp. 40-42 (incl. spp.); pl. 3, figs. 3-5; pl. 4, figs. 1-4; pl. 5, figs. 3-5. (*Cum syn.*).

1959 *Eohecticoceras tenuistriatus* (De Grossouvre) - Zeiss 1959; pp. 108, 142.

Five small specimens from the Upper Bathonian of Chaudon are known, the largest one being 21 mm in diameter and wholly septate. They show perfect agreement with the NW German population figured by Westermann, also in the range of variation (width of the umbilicus, strength of the ribbing), which lent the German author to describe several distinct subspecies (more correctly morphotypes).

EXPLANATION OF PLATE 10

Fig. 1 - *Parkinsonia (Oraniceras) württembergica* (Oppel). Bas Auran, Lower Bathonian, probably basal Yeovilensis sbz. (not *in situ*). X 0,66. Pag. 34.

2a-b, 5 - *Asphinctites recinctus* S. Buckman. Both specimens from Bas Auran, Lower Bathonian, topmost Yeovilensis sbz. (bed 2). Pag. 37.

3a-b - *Procerites*? (*Gracilisphinctes*?) sp. ind. juv. Bas Auran, Lower Bathonian, Yeovilensis sbz. (bed 2). Specimen collected by H. S. Torrens. Pag. 45.

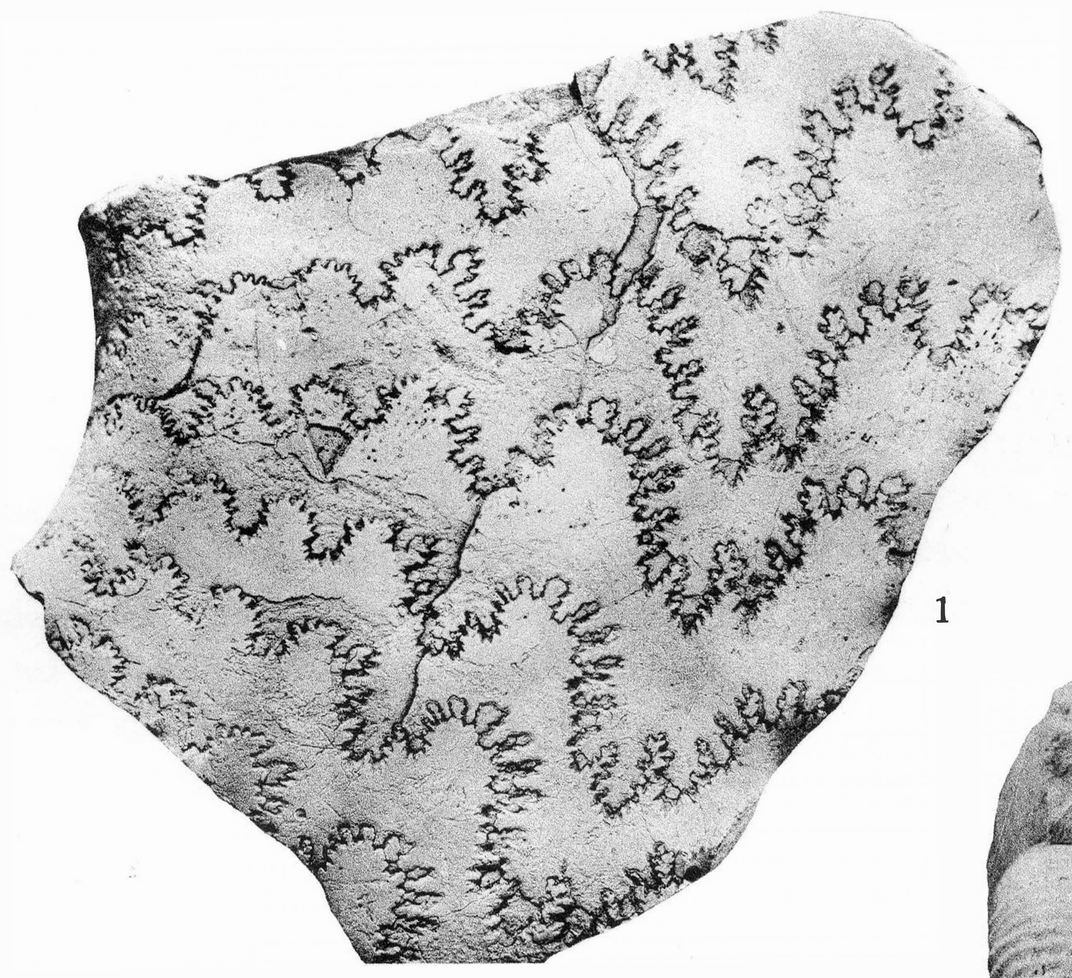
4a-b - *Morphoceras densicostatum* Thalmann. Chaudon, Lower Bathonian, Convergens sbz. Pag. 36.

6a-b - *Ebrayiceras sulcatum* (Hehl in Zieten), involute morphotype. Chaudon, Lower Bathonian, Convergens sbz. Specimen collected by H. S. Torrens. X 1,5. Pag. 38.

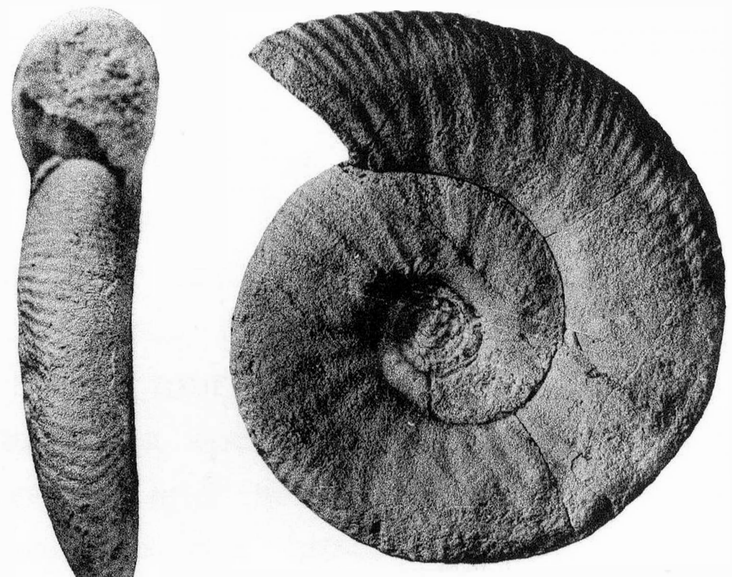
7 - *Morphoceras patescens* (S. Buckman), morphotype with blunt ribbing. Chaudon, Lower Batonian, Convergens sbz. Specimen collected by G. Pavia. Pag. 36.

All photos. natural size except Figs. 1, 6a-b.

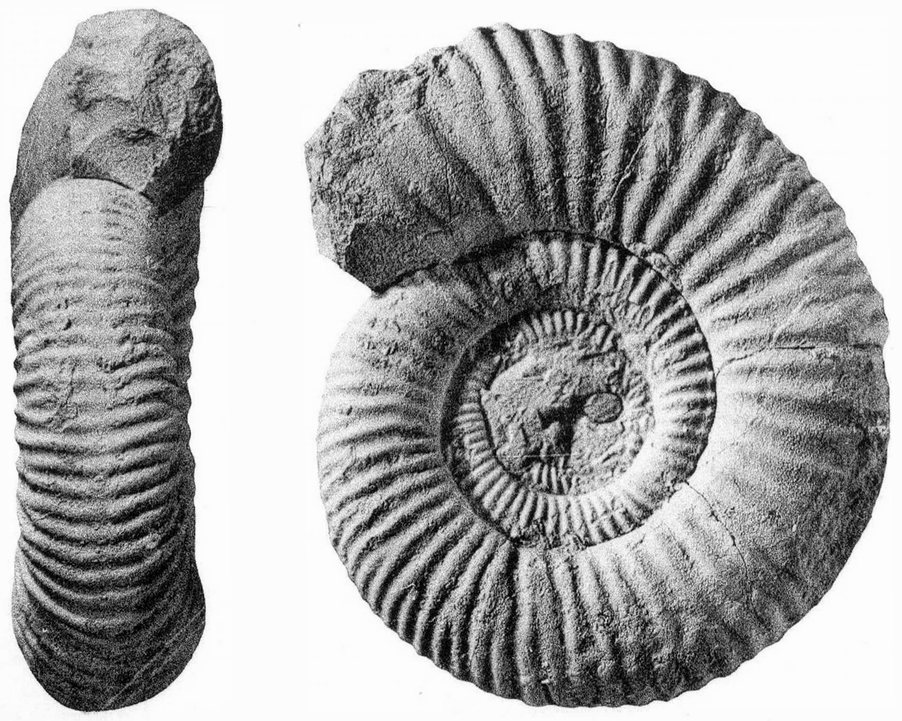
C. STURANI, BATHONIAN AMMONITES DIGNE AREA



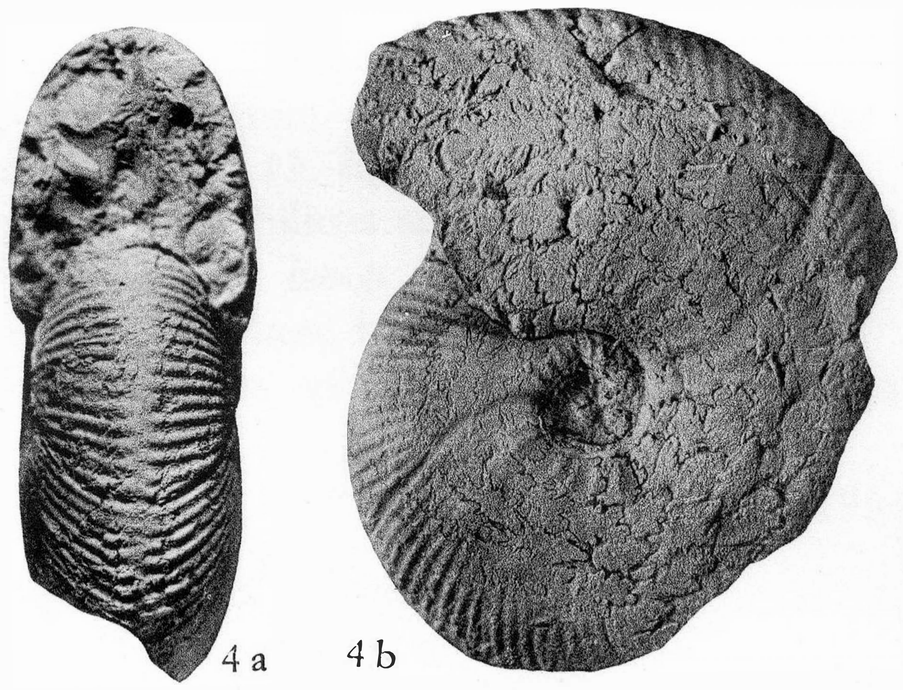
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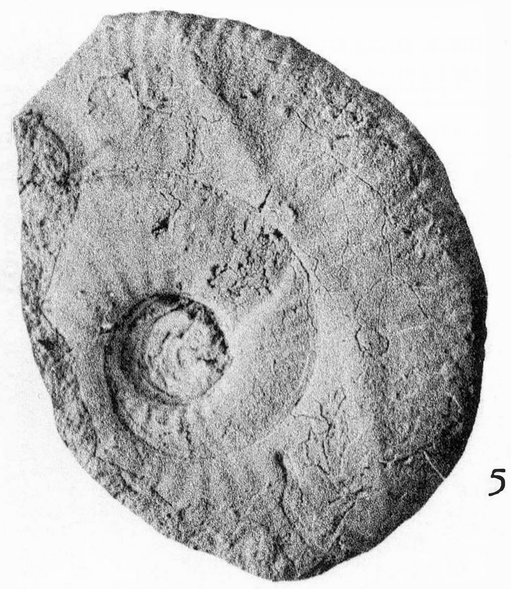
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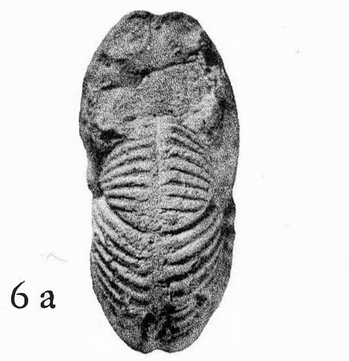
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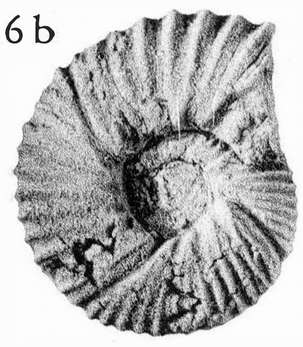
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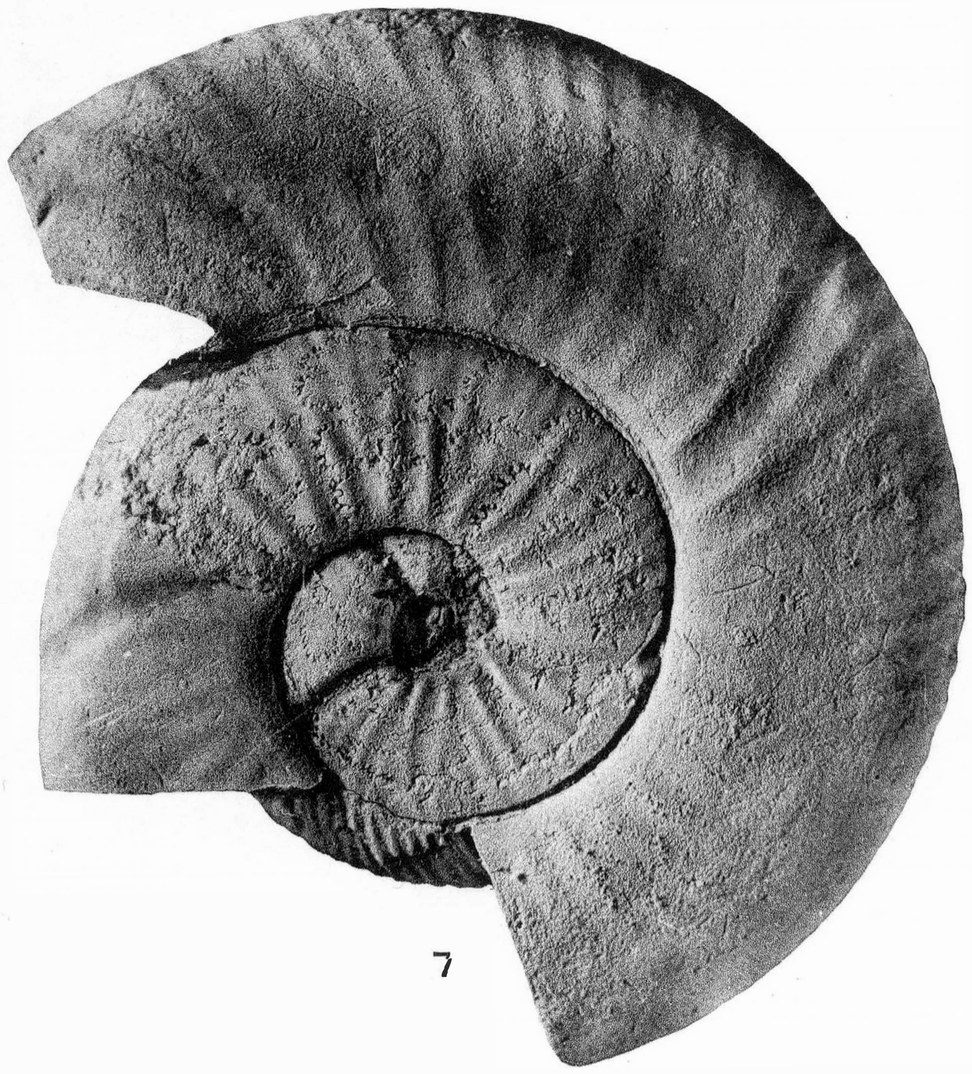
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6 a



6 b



7

O. tenuistriatus is characteristic of the Upper Bathonian (see Westermann, *loc. cit.*).

Prohecticoceras *aff.* primaevum (De Grossouvre)
Plate 4, fig. 5; Plate 5, fig. 10 (suture line)

There is a single, wholly septate and probably full grown specimen from the Convergens subzone of the Bas Auran section (bed 17), with the following features: compressed, discoidal, with fastigate venter; umbilicus small; whorl sides with a well marked median raised spiral band; primaries almost obsolete and strongly projected, disappearing at a diameter of 35 mm; secondaries very strong, straight, rursiradiate; the interspaces progressively increasing in width; at the periphery there are short, free tertiary riblets (one for every secondary), disappearing at a diameter of 50 mm.

The present specimen seems to fall within the range of variability of *P. primaevum* (De Grossouvre), of which it has the strong, straight and rursiradiate secondaries. It differs, however, from the holotype (De Grossouvre 1919; pl. 13, figs, 10a-b) by its larger size, smaller umbilicus and the presence of tertiary ribs. *P. haugi* (Popovici-Hatzeg), from a higer horizon, has more regularly concave secondaries and no tertiaries at all.

Prohecticoceras retrocostatum (De Grossouvre)
Plate 4, figs. 4a-b; Plate 5, fig. 9 (suture line)

1959 *Prohecticoceras retrocostatum* (De Grossouvre) - Zeiss 1959; pp. 102-103. (*Cum syn.*).

1964 *Prohecticoceras retrocostatum* (De Grossouvre) - Wendt 1964; pp. 126-128; pl. 19, figs. 2a-c.

A small, fragmentary specimen from the basal Upper Bathonian of Chaudon, closely agrees with the holotype as well as with several other figured specimens (Roman & Lemoine 1924, pl. 3, fig. 1; Wendt 1964, pl. 19, fig. 2). Its specific attribution has also been confirmed by H. S. Torrens.

Another specimen (Plate 4, figs. 4a-b), from the same locality and horizon, combines the dense ribbing typical of *P. retrocostatum,* with a much more compressed whorl section. Until more material is found, I consider this to be a simple morphotype.

P. retrocostatum is a species of rather widespread occurrence and seems to be everywhere confined to the basal Upper Bathonian (unnamed zone of Torren's scheme).

Cadomites psilacanthus (Wermbter)
Text-fig. 2

1845 *Ammonites humphriesianus* (non Sowerby) - d'Orbigny 1842-49; pl. 134, figs. 1-2 (*non cet.*).

1891 *Stephanoceras psilacanthus* (Behrendsen mscr.) - Wermbter 1891; p. 270.

1895 *Coeloceras cosmopoliticum* - Moericke 1895; p. 20.

1923 *Cadomites cosmopoliticum* (Moericke) - Fallot & Blanchet 1923; p. 151; pl. 11, fig. 10.

1964 *Cadomites* n. sp. - Sturani 1964a; pl. 6, fig. 1.

1964 *Cadomites arkelli* - Sturani 1964b; pp. 20-21; pl. 2, fig. 5; pl. 3, fig. 6; text-fig. 20.

non 1937 *Cadomites cosmopoliticus* - Gillet 1937; p. 82; pl. 5, fig. 8.

Remarks — When describing *C. psilacanthus,* Wermbter applied this name to specimens from the Humphriesianum zone of Germany, presumably belonging to *Stephanoceras* s.s., that he did not figure; on the other hand, as he placed *A. humphriesianus* (non Sowerby) d'Orbigny in synonymy with his

new species, on the grounds of ICZN article 72/d, d'Orbigny's figure must be considered the type of *C. psilacanthus*. *C. arkelli* Sturani, being based in the same figure, is therefore a junior objective synonym; I was informed about the existence of Wermbter's paper by H. S. Torrens after the publication of my work on the Upper Bajocian faunas of the Venetian Alps (Sturani 1964b), which see for fuller description of this species.



Text-fig. 2

Cadomites psilacanthus (Wermbter).
Bas Auran, presumably from the topmost Bajocian, Bomfordi sbz. Maurel Collection. X 1.

Material — There are two specimens from the topmost Bajocian, Bomfordi subzone, of Chaudon and two others from Bas Auran, at the same level (beds 28 and 26); all these are more or less fragmentary. A fifth specimen, also from Bas Auran and presumably from the same level, at least judging from the matrix, is in the Maurel collection at Barrême. This is complete and particularly well preserved, reaching a diameter of 80 mm, and it shows perfect agreement with both the type figures and the specimens from the Parkinsoni zone of the Venetian Alps.

Cadomites psilacanthus has never been reported to occur above the Parkinsoni zone.

CADOMITES DESLONGCHAMPSI
(Defrance in d'Orbigny)
Plate 6, fig. 1

1963 *Cadomites deslongchampsi* (d'Orbigny) - Stephanov 1963; pp. 175-176; pl. 1, figs 1a-c.
1964 *Cadomites deslongchampsi* (Defr. in d'Orb.) - Sturani 1964b; pp. 19-20; pl. 2, figs. 7a-b; text-fig. 18. (*Cum syn.*).

There are eight specimens from the Convergens subzone of Chaudon and almost as many from Bas Auran, at the same level (beds 23, 14, 13, 12).

Most specimens, including the one figured, show very good agreement with the holotype and the topotypes, lavishly refigured by Roché. Their maximum adult size varies between 50 and about 74 mm (including the body chamber). The whorl shape is coronate, trapezoidal; the venter is broad and less convex than in other congeneric forms; the primaries are sharp, each ending in a strong tubercle; the secondaries are dense, up to four per primary, with additional free intercalatories; they are sharp and lamellar on test, but rounded and much more feeble on the internal mould.

On a few specimens, most of which from the lowermost beds of the Convergens subzone, the secondaries are less numerous and sharper; these are probably transitional to *C. psilacanthus* (Wermbter), which occurs just below.

C. deslongchampsi is a species of widespread occurrence; the type level, in Normandy, is Upper Bajocian (ironshot oolite of Bajeux), but there are several records from the Lower Bathonian of other regions (England, Bulgaria, Persia).

EXPLANATION OF PLATE 11

Fig. 1a-c - *Morphoceras parvum* Wetzel. Bas Auran, Lower Bathonian, Convergens sbz. (bed 23). X 1. Pag. 37.

2a-b - *Morphoceras perinflatum* Wetzel. Bas Auran, Lower Bathonian, Yeovilensis sbz. (bed 4). X 1,5. Pag. 36.

3a-b - *Berbericeras sekikense* Roman. Col de Piere Basse, Lower Bathonian. X 3,5. Pag. 39.

4-5 - *Ebrayiceras sulcatum* (Hehl in Zieten). Both specimens form Bas Auran, Lower Bathonian, Convergens sbz. (bed 14). X 1,5. Pag. 38.

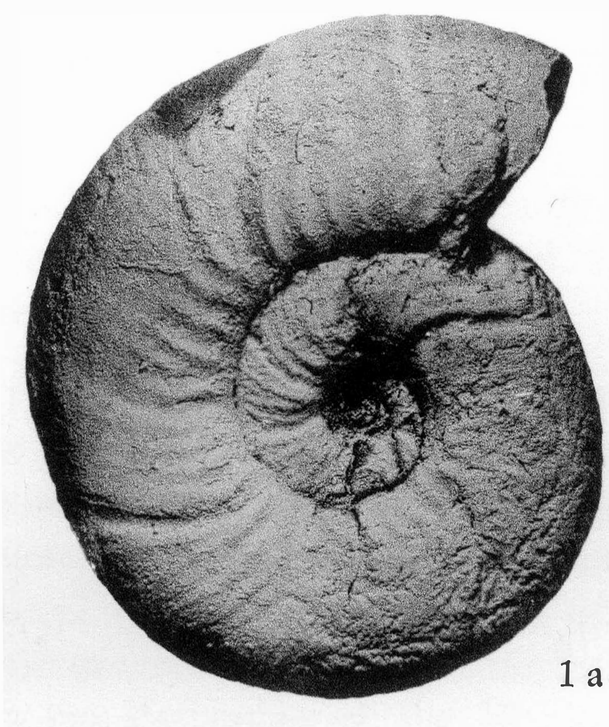
6-7 - *Ebrayiceras pseudoanceps* (Ebray). Both specimens from Bas Auran, Lower Bathonian, Macrescens sbz. (bed 8). X 1,5.

Fig. 6 represents a rather involute and finely ribbed morphotype. Pag. 38.

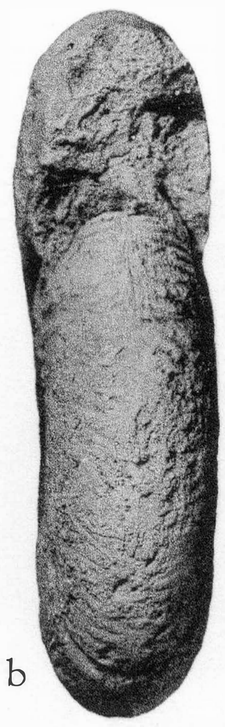
8 - *Ebrayiceras rursum* S. Buckman. Chaudon, Lower Bathonian, Convergens sbz. X 1,5. Pag. 39.

9 - *Asphinctites recinctus* S. Buckman. Bas Auran, Lower Bathonian; Yeovilensis sbz. (bed 2). X 1,5. Pag. 37.

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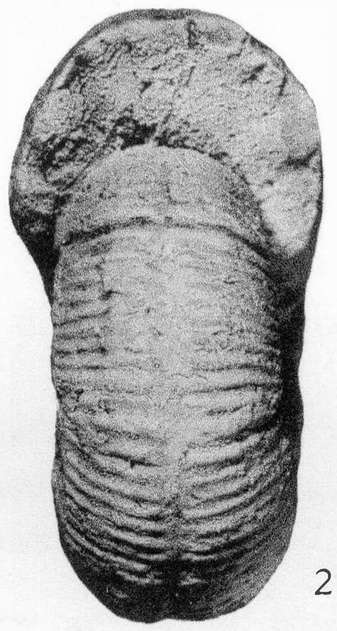
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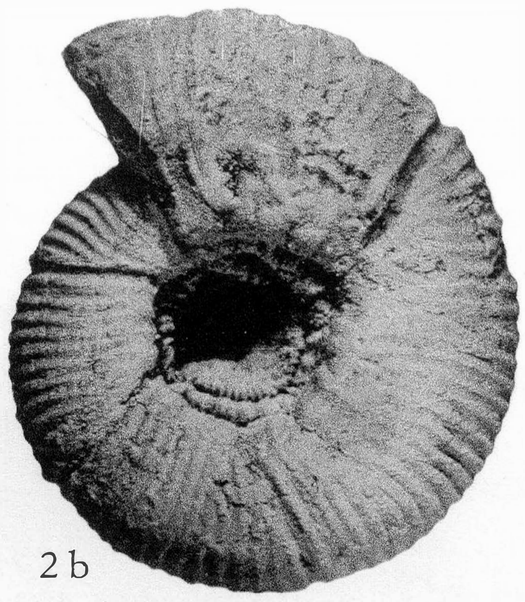
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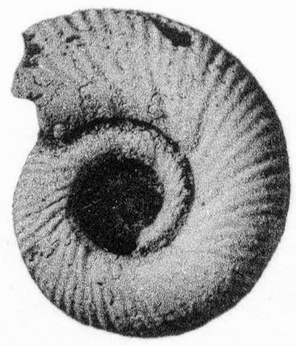
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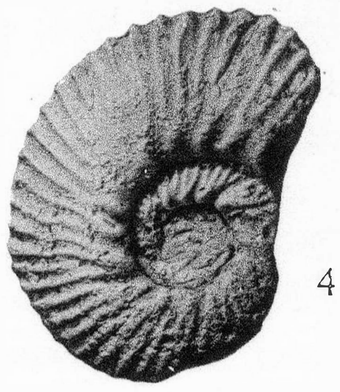
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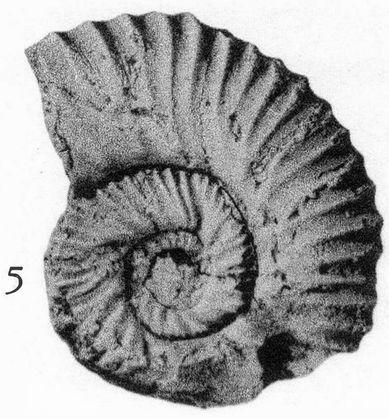
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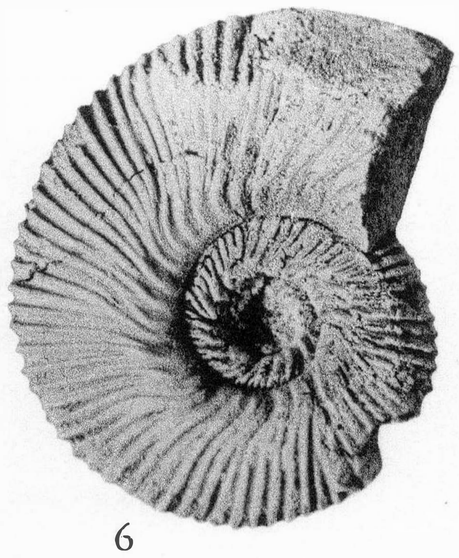
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8

9

CADOMITES DAUBENYI (Gemmellaro)
Plate 6, fig. 2

1963 *Cadomites orbignyi* De Grossouvre - Stephanov 1963; pl. 2, fig. 3.
1964 *Cadomites daubenyi* (Gemmellaro) - Wendt 1964; pp. 130-132; pl. 21, figs., 1a-b. (*Cum syn.*).
1964 *Cadomites daubenyi* (Gemmellaro) - Sturani 1964b; pp. 23-24; pl. 3, fig. 5; text-fig. 17. (*Cum syn.*).

A single specimen from the Convergens subzone of the Bas Auran section (bed 14) is known. For a detailed description and discussion of this species see Wendt and Sturani. *C. daubenyi* is a species of widespread occurrence and it is particularly common in the Bathonian of the Mediterranean region. *C. orbignyi* De Grossouvre is a junior subjective synonym.

CADOMITES RECTELOBATUS
(Hauer) *sensu* Sturani
Plate 6, figs. 3a-b; Plate 13, figs. 1a-b.

1964 *Cadomites rectelobatus* (Hauer) - Sturani 1964b; p. 22; pl. 2, figs. 6,8; text figs. 19a-b. (*Cum syn.*).

There are three small specimens (inner whorls), all from the Convergens subzone of the Bas Auran section (bed 14). The largest one (Plate 13, figs. 1a-b) is identical with specimens of comparable size from the Venetian Alps (see Sturani 1964b).

The distinguishing features of *C. rectelobatus,* in the present writer's interpretation, are: deep, narrow and crater-like umblicus; rapidly increasing whorl width; strongly convex external side; ribbing dense; primaries sinuous, ending in spiny tubercles.

C. rectelobatus is already found in the topmost Bajocian (Sturani 1964b), but becomes rather common only in the Lower Bathonian, especially in the Mediterranean region (I have recently seen some fine specimens from the Bathonian of Western Sicily).

POLYPLECTITES DORNI (Roché)
Plate 6, figs. 4a-b

1954 *Polyplectites dorni* (Roché) - Westermann 1954; pp. 342-344; pl. 32, fig. 4; text-figs. 143, 147. (*Cum syn.*).

Chaudon, in the topmost Bajocian, Bomfordi subzone (a single specimen, doubtful), and in the Convergens subzone (3 specimens); Bas Auran, in the Convergens subzone (beds 22, 14 and 12, four specimens).

The figured specimen, though much smaller than the lectotype, agrees closely with it in every other detail; the others are larger and also agree with the type, but are less well preserved.

The primaries are strong and less numerous than in other *Polyplectites,* ending in spiny tubercles; the whorl section is trapezoidal; the external side less convex than in congeneric forms. There are about 3/4 of a whorl of body chamber. The figured specimen showed two short lappets, which went broken while getting it free from the matrix.

The lectotype (Dorn 1928, pl. 5, fig. 6) has been found in the Franconian Alb, with a mixed assemblage of both the Bomfordi and the Convergens subzones.

EPISTRENOCERAS SUBCONTRARIUM
(Behrendsen)
Plate 5, fig. 7 (suture line); Plate 21, figs. 4-6

1915 *Strenoceras subcontrarium* Behr. - R. Douvillé 1915; pp. 25-27; pl. 7, figs. 10-25. (Incl. var.; *cum syn.*).

One of the commonest species in the Upper Bathonian of Chaudon. For description see R. Douvillé. The rich population

from this locality agrees perfectly with that from Saint Marc, near Aix-en-Provence, described and figured by R. Douvillé, also in the great range of variability, and includes several different morphotypes, « var. » *termieri* R. Douvillé and « var. tuberculée » of the same author being the commonest.

As for the type level, H. S. Torrens kindly informs me that « Behrendsen's *Epistrenoceras* is from the Makrocephalen-Schichten of Lechstedt and it was obviously for this reason that Westermann did not mention it. Kumm (1952, p. 436) accepts Behrendsen's details of its horizon. However Behrendsen (1884) records *Delecticeras, Ammonites psilodiscus, Ebrayiceras* (latter teste Wetzel 1924, p. 224) from the Makrocephalen-Schichten. As Arkell (1956, p. 140) correctly noted, old collections from the Makrocephalen-Scht. here include some from the Bathonian and, to judge from the *Ebrayiceras,* as far down as the Lower Bathonian; it is in my opinion almost certain that the *Epistrenoceras* figured by Behrendsen is one of these Upper Bathonoan ammonites recorded in error from the Callovian. In this context it is interesting to note that Menzel (1902, p. 44) records *Parkinsonia? subcontraria* Behr. from the same region of Germany in the Upper Bathonian ».

E. subcontrarium has also been reported by S. Elmi (Coll. Jur. Luxembourg, p. 537) from the Ardèche, where it is found just above the horizon yielding *Prohecticoceras retrocostatum.*

PARKINSONIA PACHYPLEURA S. Buckman
Plate 7, figs. 2a-b

1928 *Parkinsonia schloenbachi* (non Schlippe) - Dorn 1928; pl. 6, fig. 8.

1956 *Parkinsonia* (*Parkinsonia*) *pachypleura* S. Buckman - Arkell 1951-59; pp. 146-150; text-figs. 54, 57/5; pl. 18, figs. 1, 4, 9; pl. 19, figs. 8, 9. (*Cum syn.*).

This is the commonest *Parkinsonia* in the Lower Bathonian of the Digne area: Chaudon in the Convergens subzone (over 10 specimens); Bas Auran, from both the Convergens and the Macrescens subzones (beds 22, 17, 14, 12, 11, 10, 8; nine specimens).

For full description see Arkell. The population from the Basses-Alpes shows a certain degree of variation in the strength of the tubercles and in the L/H ratio, but the whorl section in never as stout nor the sides so convergent as in *P. schloenbachi,* which is otherwise similar. The figured specimen, from Bas Auran, measures: max 92 mm (est.); at 75 mm: .32; .29,3; .48. It has retained the whole of the body chamber, which occupies one whorl, and shows a simple peristome; the tubercles are well marked and sharp also on the internal cast and persist to the last rib. But on other specimens they disappear much earlier. The agreement with the English polulation figured by Arkell, including the holotype, is perfect.

PARKINSONIA SCHLOENBACHI Schlippe
Plate 7, figs. 1a-b

1865 *Ammonites ferrugineus* - Schloenbach 1865; pl. 4, figs. 1a-b only (non *A. ferrugineus* Oppel, 1856, nec *A. ferrugineus* Simpson, 1855).

1888 *Parkinsonia schloenbachi* - Schlippe 1888; p. 210; pl. 4, figs. 4, 4a (lectotype).

1891 *Parkinsonia eimensis* - Wermbter 1891, p. 271.

1931 *Parkinsonia schloenbachi* Schlippe - Schmidtill & Krumbeck 1931; pl. 90, figs. 1a-b;? pl. 89, figs. 4a-b.

1955 *Parkinsonia schloenbachi* Schlippe - Maubeuge 1955; p. 44; pl. 9, figs. 3a-c.

1956 *Parkinsonia schloenbachi* Schlippe - Arkell 1951-59; text-fig. 55/2 (reprod. of the type fig.); ? text-fig. 55/1.

EXPLANATION OF PLATE 12

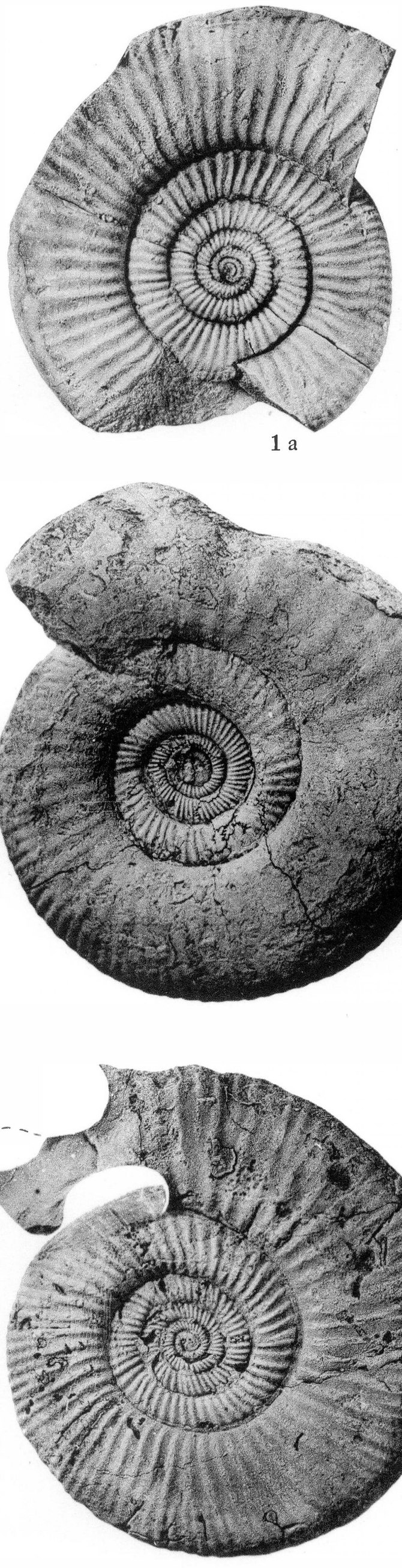
Fig. 1a-b, 4 - *Planisphinctes tenuissimus* (Siemiradzki). Figs. 1a-b. Topotype. Chaudon, topmost Bajocian, Parkinsoni z., Bomfordi sbz.
Fig. 4. Bas Auran, topmost Bajocian, Parkinsoni z., Bomfordi sbz. (bed 35). Note large lappets. Pag. 40.

2a-c - *Zigzagiceras* aff. *lenthayense* (Arkell). Bas Auran, Lower Bathonian, Macrescens sbz. (marly interbed 8-7). Fig. 2a X 0,66; Figs 2b-c (nucleus) X 1. Pag. 49.

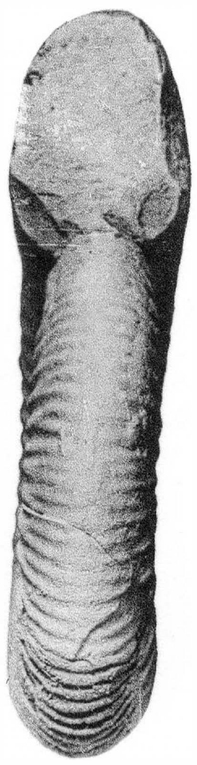
3 - *Procerites fullonicus* (S. Buckman). Bas Auran, Lower Bathonian, basal Yeovilensis sbz. (bed 6). X 0,66. Pag. 43.

5 - *Procerites costulatosus* (S. Buckman). Bas Auran, topmost Bajocian, Parkinsoni z., Bomfordi sbz. (bed 28). Pag. 41.

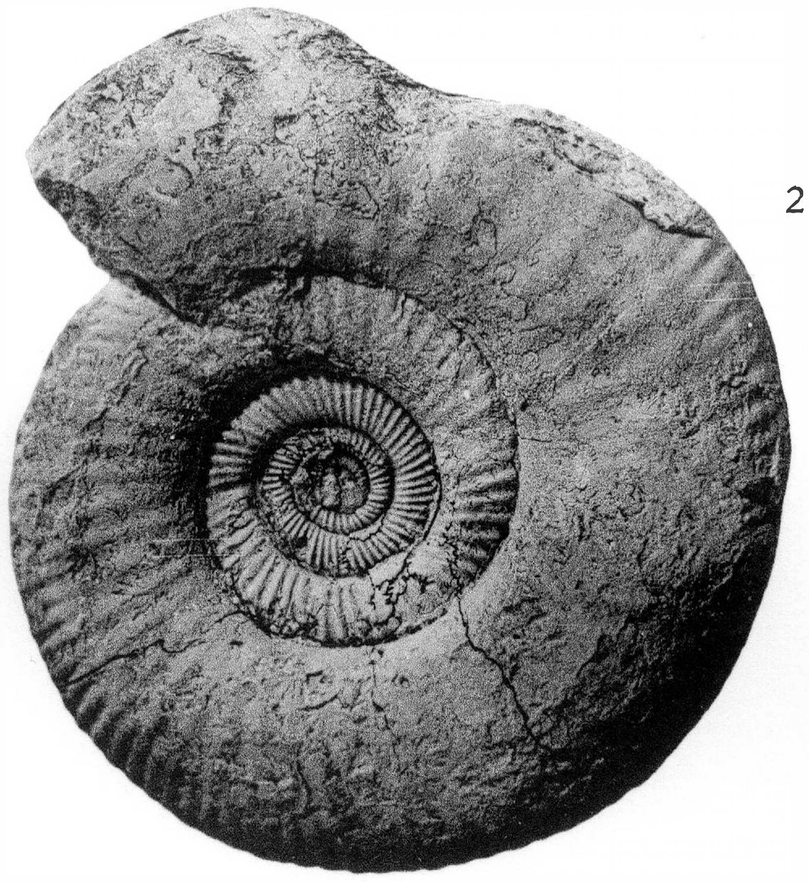
All photos. natural size except Figs. 2a-c, 3.



1 a



1 b



2 a



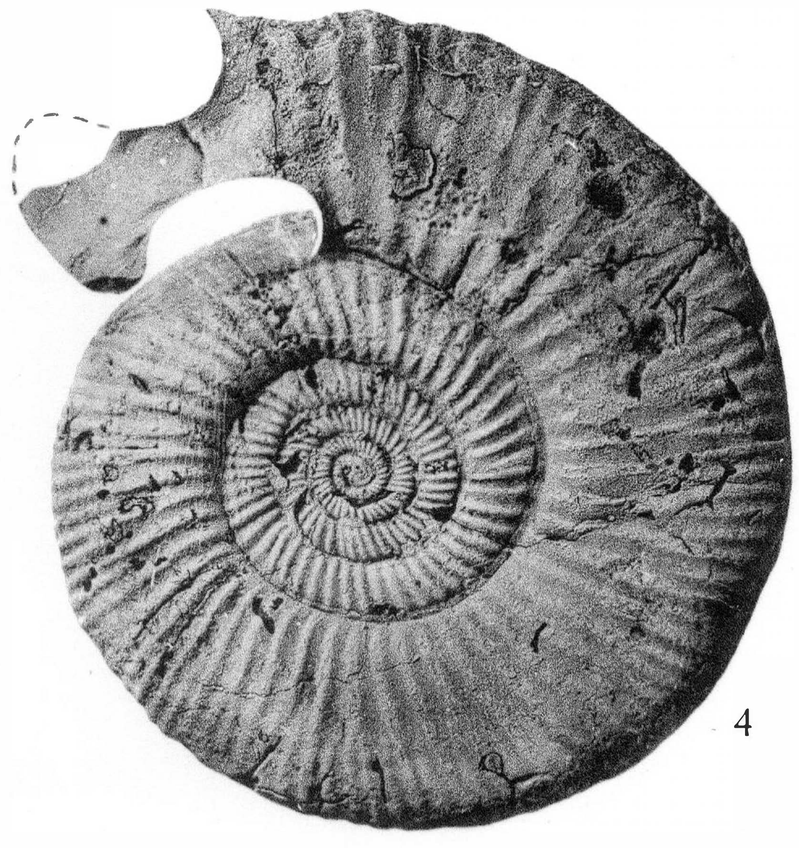
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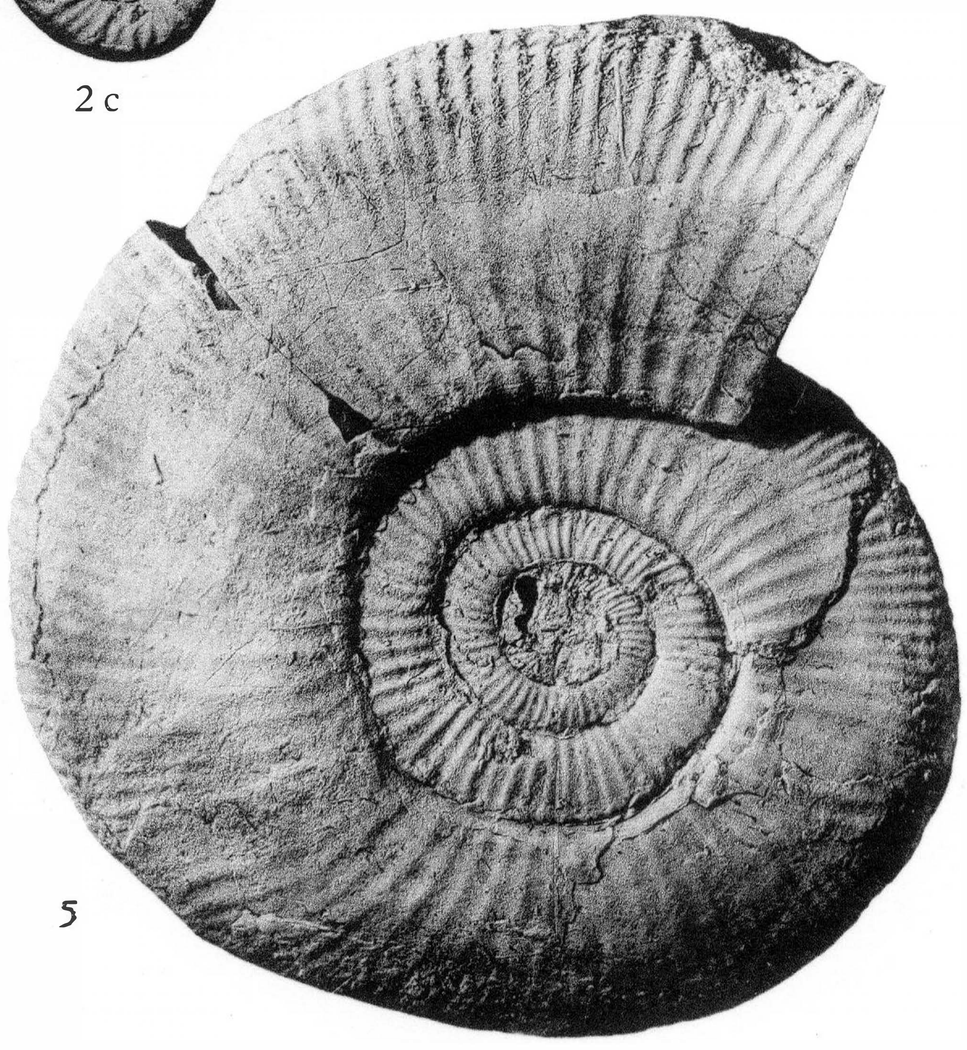
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1958 *Parkinsonia schloenbachi* Schlippe - Westermann 1958; p. 68; pl. 23, figs. 1-2; pl. 24, fig. 1.

non 1911 *Parkinsonia eimensis* - Wetzel 1911; p. 208.

non 1924 *Haselburgites schloenbachi* - S. Buckman, T.A., 5, pl. 493 (= *Parkinsonia bomfordi* Arkell).

non 1928 *Parkinsonia schloenbachi* - Dorn 1928; pl. 6, fig. 8 (= *P. pachypleura*).

There are over 15 specimens from the Convergens subzone of Chaudon and four others from Bas Auran, in the same subzone (beds 23, 13 and 12).

P. schloenbachi differs from *P. pachypleura* in being slightly more involute and in having a whorl section more trapezoidal and much stouter at any comparable diameter; the size of the full grown specimens is also larger. *P. crassa* Nicolesco and *P. postera* (Seebach) are both more involute.

There is good agreement between the figured specimen from Chaudon (Plate 7, figs. 1a-b) on one hand, Schlippe's type and the NW german specimens figured by Westermann on the other. When complete (it has been figured without the last whorl) this same specimen reaches about the size of Schloenbach's pl. 4, fig. 1 (type of *P. eimensis* Wermbter, non Wetzel), confirming that Wermbter's name is a junior synonym of *P. schloenbachi* Schlippe, as already supposed by Westermann (1958, p. 68). Its measurements are: max 120 mm (est.); at 70 mm: .33,5; .36,4; .45,7.

P. schloenbachi has usually been reported from the Lower Bathonian (which is the type level). Maubeuge's record from the Upper Bajocian of Switzerland (1955, p. 44) is based on a museum specimen and the horizon may therefore be suspect. Arkell's record from the Bomfordi subzone of England (1951-59, text-fig. 55/1), at least to judge from his figure, could apply to a different species of the « *depressa* » group, less tightly coiled, less stoutly whorled and more widely umbilicated.

PARKINSONIA CRASSA Nicolesco
Plate 13, fig. 3

1928 *Parkinsonia depressa* var. *crassa* - Nicolesco 1928; pp. 41-43; pl. 11, fig. 6 (*non cet.*).

non 1956 *Parkinsonia* (*Durotrigensia*?) *crassa* - Arkell 1951-59; p. 162; text-fig. 58 (right).

A single specimen from the Convergens subzone of the Bas Auran section (bed 14) is slightly smaller than, but otherwise very similar to the holotype, which comes from this same region and probably from the same horizon (Les Blaches de Castellane). This specimen is probably not fully grown and has got nearly a whole whorl of body chamber; the measurements are: max 80 mm; at 68 mm: .36; ?; .39.

P. crassa is somewhat intermediate in morphology between *P. schloenbachi* and *P.* (*Gonolkites*) *subgaleata*. The former, however, is more evolute, with more prorsiradiate primaries and a slightly stouter whorl section; the latter has blunter ribs and no tubercles, while these persist up to a diameter of 70 mm in *P. crassa*. The present species is also very close to, and perhaps a junior synonym of *P. postera* (Seebach) (holotype refigured by Westermann, 1958, pl. 27). From Westermann's description and figures it is not clear, however, whether the inner whorls of *P. postera* are tuberculate or not.

Parkinsonia (*Durotrigensia*?) cf. *crassa* Arkell (non Nicolesco), from the Bomfordi subzone of Fawler, Oxfordshire, and Chipping Norton, does not seem to belong here, but may be a junior synonym of *P. bomfordi*.

PARKINSONIA (GONOLKITES?) SUBPLANULATA Wetzel
Plate 8, figs. 2a-b; Plate 13, figs. 2a-b.

1849 *Ammonites parkinsoni planulatus* - Quenstedt, Cephalopoden; p. 143;

pl. 11, fig. 2 (non fig. 3) (non *A. planulatus* Schlotheim, 1820, nec *A. planulatus* Zieten, 1830).

1888 *Parkinsonia parkinsoni* (non Sowerby) - Schlippe 1888; pl. 4, fig. 1 (only).

1911 *Parkinsonia subplanulata* - Wetzel 1911; pp. 207-208; pl. 17, figs. 3-4.

1911 *Parkinsonia* cf. *eimensis* - Wetzel 1911; pl. 17, figs. 5-6 (non *P. eimensis* Wermbter, 1891, nec *P. eimensis* Wetzel, 1911).

1931 *Parkinsonia planulata* (Quenstedt, 1849) - Schmidtill & Krumbeck 1931; pp. 873-874; pl. 88, fig. 2a-c and pl. 91, fig. 1 (*non cet.*).

non 1858 *Ammonites parkinsoni planulatus* - Quenstedt, Der Jura; pl. 63, fig. 8.

non 1887 *Ammonites parkinsoni planulatus* - Quenstedt, Ammoniten; pl. 71, figs. 16, 19-21.

non 1911 *Parkinsonia planulata* - Wetzel 1911; pl. 17, figs. 1-2.

non 1928 *Parkinsonia planulata* - Dorn 1928; pl. 6, fig. 1.

non 1928 *Parkinsonia planulata* - Nicolesco 1927-28; pl. 12, figs. 4-8.

Discussion of the synonymy — Six out of the seven specimens figured by Quenstedt as « *Ammonites parkinsoni planulatus* » in his different works have been transferred to other species by later authors. One of those figured in the « *Cephalopoden* » (pl. 11, fig. 3) has become the type of *Ammonites ferrugineus* Oppel, 1856 (non Simpson, 1855) (= *Parkinsonia* (*Oraniceras*) *valida* Wetzel, 1950). The specimen figured in « *Der Jura* » (pl. 63, fig. 8) has become the type of *P. friederici augus*ti Wetzel, 1911, which is a junior subjective synonym of *P. densicosta* (Quenstedt, 1887) (see Nicolesco 1927-28, pp. 34-36). Those figured in the « *Ammoniten . . .* » (pl. 71, figs. 16, 19, 20, 21) belong to at least three different species: fig. 19 is a *P. radiata* Renz, fig. 20 is a *P. arietis* Wetzel, fig. 21 is a *P. rarecostata* (Buckman), while fig. 16, having lappets, is difficult to interpret.

The first figured specimen (Quenstedt, « Cephalopoden »; pl. 11, fig. 2) is therefore, by exclusion, the holotype of *Parkinsonia planulata* (Quenstedt, 1849). This is a small sized and wholly septate specimen, either incomplete or not fully grown, characterized by an oval whorl section, higher than wide, with moderately involute coiling, gently prorsiradiate and projected ribs and no tubercles. Since there are several earlier uses of *Ammonites planulatus,* the valid name for Quenstedt's species should be searched for among its junior subjective synonyms, if any.

P. parkinsoni (non Sowerby) var. « mit engerem Nabel » Schlippe (1888; p. 209; pl. 4, fig. 1, *non cet.*) is probably conspecific; it may be noticed that Schlippe placed *P. planulata* in synonymy with *P. parkinsoni.*

P. planulata, as interpreted by Wetzel (1911; pl. 17, figs. 1-2), differs from the type in its more evolute coiling and in having longer and more rectiradiate primaries; Wetzel's specimen has been placed by Nicolesco in the synonymy of his *P. planulata* var. *mutabilis,* itself a possible junior subjective synonym of *P. rarecostata* (S. Buckman). On the contrary, two other specimens placed by Wetzel in different, new taxa appear to be conspecific with Quenstedt's type, as already pointed out by Nicolesco (1927-28; p. 44). These are *P. subplanulata* Wetzel, 1911 (pl. 17, figs. 3-4) and *P.* cf. *eimensis* Wetzel (pl. 17, figs. 5-6) (non *P. eimensis* Wetzel, 1911, nom. nov. for *Ammonites neuffensis* Schloenbach, 1865 (non Oppel, 1857), which is a senior subjective synonym of *P. convergens* (S. Buckman), not available being also a junior homonym of *P. eimensis* Wermbter, 1891, itself a junior subjective synonym of *P. schloenbachi* Schlippe, 1888).

Parkinsonia subplanulata Wetzel. 1911, should therefore be the replacement name for *Ammonites parkinsoni planulatus* Quenstedt, 1849.

EXPLANATION OF PLATE 13

Fig. 1a-b - *Cadomites rectelobatus* (Hauer). Bas Auran, Lower Bathonian, Convergens sbz. (bed 14). Pag. 29.

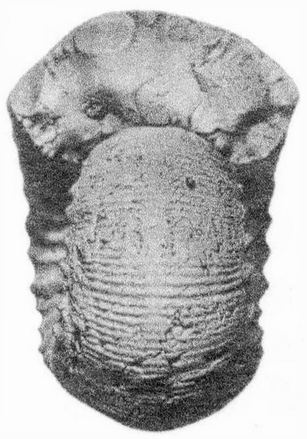
2a-b - *Parkinsonia* (*Gonolkites* ?) *subplanulata* Wetzel, immature specimen. Bas Auran, topmost Bajocian, Parkinsoni z., Bomfordi sbz. (bed 29). Pag. 31.

3 - *Parkinsonia crassa* Nicolesco. Bas Auran, Lower Bathonian, Convergens sbz. (bed 14). Pag. 31.

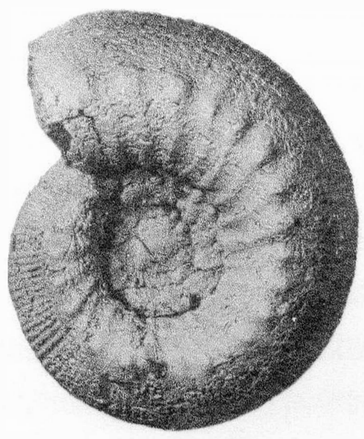
4a-c - *Zigzagiceras torrensi* n. sp. *variecostatum* n. ssp., paratype. Bas Auran, Lower Bathonian, Macrescens sbz. (bed 8). See also Plate 19, fig. 5. Pag. 48.

5 - *Procerites fowleri* Arkell. Bas Auran, Lower Bathonian, basal Yeovilensis sbz. (bed 6). X 0,5. Pag. 44.

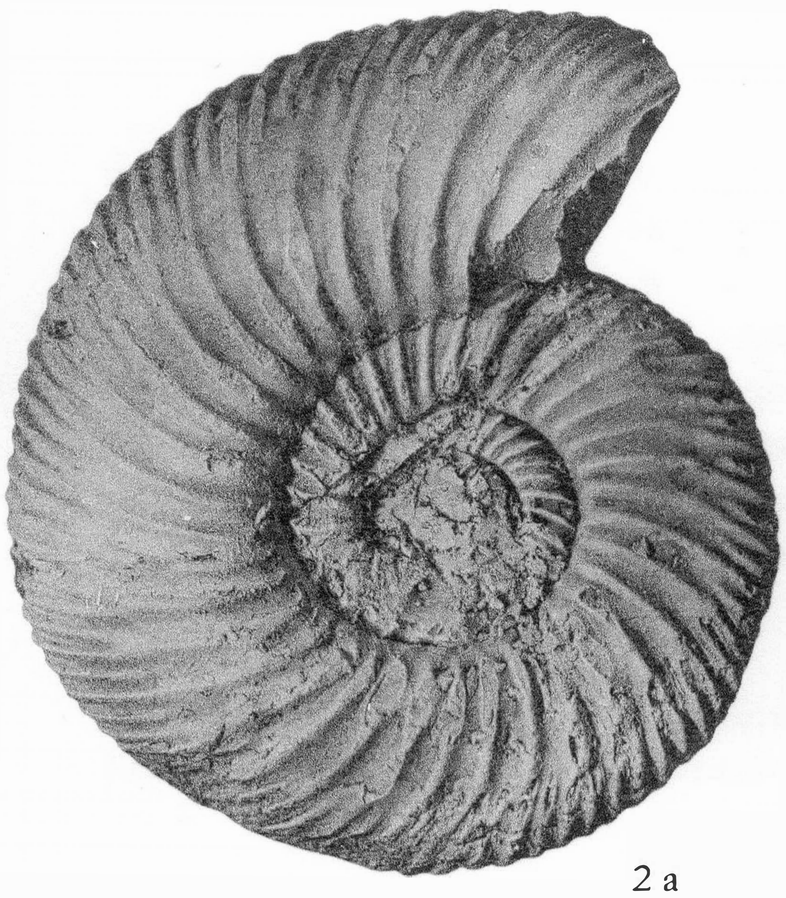
All photos. natural size except Fig. 5.



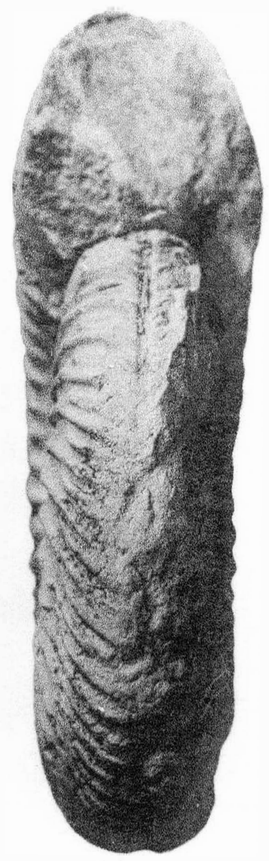
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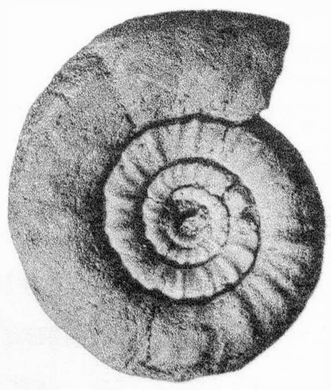
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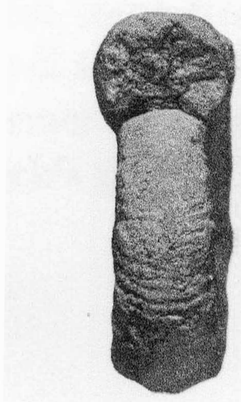


3



4 a

4 b



4 c





5

The specimen figured by Dorn (1928; pl. 6, fig. 1) as *P. planulata* is much more evolute than Quenstedt's type and certainly not conspecific.

None of the specimens figured by Nicolesco (1927-28; pl. 12, figs. 4-8) as *P. planulata* seem to belong here; those of figs. 4 and 5 are nuclei too small for identification, while those of figs. 6-8, from the Lower Bathonian of Sainte-Pézenne (Deux-Sèvres), have blunt ribs, fading with growth, and almost certainly belong to *P. subgaleata* (S. Buckman), as interpreted by the present writer. Nicolesco's *P. planulata* var. *mutabilis* and var. *complanata* are also completely different and certainly not conspecific with Quenstedt's type.

Among the several specimens figured by Schmidtill & Krumbeck (1931), either as *P. planulata* (Quenstedt, 1849) or as *P. subplanulata* Wetzel, only those of pl. 88, figs. 2a-c and pl. 91, fig. 1, seem to belong here without any doubt.

Description — Whorl shape oval, higher than wide, with a rather broadly rounded external side. Coiling moderately involute. Ribbing sharp on the inner and middle whorls, up to a diameter of about 75 mm; then becoming blunter but still very strong. Ribs gently prorsiradiate and regulary concave forward; mainly biplicate, but there are many free secondaries (the specimen of Plate 8, figs. 2a-b has 37 primaries and 85 secondaries on the last whorl). There are no tubercles and the point of furcation lies just above the middle of the whorls. Each whorl is 3/5 covered by the next one. The ventral groove is well marked and persistent, up to a diameter of at least 120 mm. The largest figured specimen has nearly a whorl of body chamber preserved and measures: max 125 mm; at 100 mm: .37; .33; .38,4. The smaller one (Plate 13, figs. 2a-b) measures: max 75 mm; at 75 mm: .37; .32; .38,3. Both come from the topmost Bajocian, Bomfordi subzone, of the Bas Auran section. The former is very close to Schmidtill & Krumbeck's pl. 91, fig. 1; the latter closely resembles Wetzel's *P.* cf. *eimensis* as well as Quenstedt's type.

Remarks — *P. subplanulata,* as here interpreted, seems to be transitional between *Parkinsonia* (*Gonolkites*) *subgaleata* (S. Buckman) and *Parkinsonia* (*Durotrigensia*?) *pseudoferruginea* Nicolesco (1928; pl. 9, fig. 3, holotype; also Schlippe 1888; pl. 5, fig. 1). It differs from the latter in being less densely ribbed, in having a slightly narrower umbilicus and a stouter whorl section; from the former, *P. subplanulata* is distinguished by being more sharply ribbed at any comparable diameter and in retaining the ventral groove up to the end of the body chamber, even in full grown specimens. *Parkinsonia bomfordi* Arkell is more evolute.

As for the subgeneric position, *P. subplanulata* seems to be an ancestral *Gonolkites.*

Distribution — *P. subplanulata* is confined to the upper half of the Bomfordi subzone, in the Bas Auran section, and has not yet been found at Chaudon. The previous records are from the uppermost Parkinsoni zone of Germany and Eastern France (Wetzel 1911; Schlippe 1888).

PARKINSONIA (GONOLKITES) CONVERGENS (S. Buckman)

Plate 6, fig. 5; Plate 7, fig. 4; Plate 8, fig. 3

1956 *Parkinsonia (Gonolkites) convergens* (S. Buckman) - Arkell 1951-59; pp. 153-156; pl. 18, figs. 2, 8; pl. 19, figs. 1, 2; text-fig. 57/2. (*Cum syn.*).

1958 *Parkinsonia (Gonolkites) convergens* (S. Buckman) - Westermann 1958; pp. 69-70; pl. 26, figs. a-c; ? pl. 25, figs. 1, 2.

There are over 12 specimens, at different stages of growth, from the Convergens subzone of Chaudon, and 5 others from Bas Auran, in the same subzone (beds 23, 14, 13 and 12).

For a detailed description and discussion of the synonymy see Arkell. The population from the Basses-Alpes is rather uniform and very similar to the english material (compare Plate 6, fig. 5 with Arkell's pl. 18, fig. 2; and Plate 7, fig. 4 with the front view of the holotype - Arkell's pl. 18, fig. 8). The largest specimen, from Chaudon (Plate 7, fig. 4) is about 150 mm in diameter and wholly septate; with the body chamber added it would probably excede 200 mm; the other measurements, at 136 mm, are: .41; .30; .33.

For comparisons with *P. (Gonolkites) subgaleata,* see under that species.

P. convergens is a species of widespread occurrence (England, Germany, France, Poland) and seems to be everywhere confined to the basal part of the Zigzag zone (Convergens subzone). The records of *Parkinsonia,* including *P.* cf. *convergens,* at higher horizons in the Bathonian of England (*Rugitela* beds of Whatley, Somerset) (see Arkell 1951-59; pp. 156, 239) have been re-examined by H.S. Torrens and M.K. Howarth, and « are known to be completely misidentified, since neither of them are *Parkinsonia* » (H. S. Torrens, personal communication).

PARKINSONIA (GONOLKITES) SUBGALEATA (S. Buckman)
Plate 6, fig. 6; Plate 7, fig. 5; Plate 8, figs. 1a-b, 4

1928 *Parkinsonia planulata* (non Quenstedt) - Nicolesco 1927-28; pl. 12, figs. 6-8 (*non cet.*).
1956 *Parkinsonia (Gonolkites) subgaleata* (S. Buckman) - Arkell 1951-59; pp. 156-160; pl. 18, fig. 7; pl. 19, figs. 3, 4; text-figs. 57/1 and 58 (left). (*Cum syn.*).

There are seven specimens from the Convergens subzone of Chaudon and three others from the Convergens subzone of Bas Auran (beds 14 and 13).

Several stages of growth are represented within this population, from immature specimens or nuclei to the very large and appearently full grown one of Plate 8, figs. 1a-b, which attains 250 mm with half of the body chamber preserved. All features vary with growth, so that, for instance, the middle whorls are stouter and more involute than both the inner and the outermost ones. These specimens from the Digne area are slightly more evolute than, but otherwise closely similar to the holotype.

*Comparisons - P. subgaleat*a is a species closely allied to *P. convergens*, the main differences being that in the former: A) the whorl section is slightly more inflated and less high, with less convergent sides and a more broadly rounded venter; B) the coilling is slightly more evolute; C) the ribs are stronger and less numerous, the primaries persisting up to a diameter of 160 mm, while in *P. convergens* they have already disappeared at 100 mm. The body chamber is completely smooth in both species, when fully grown. The suture lines do not show any appreciable differences.

As for the measurements, those of the specimen figured on Plate 7, fig. 5 are: max 130 mm (wholly septate); at 130 mm; .36; .31; .39.

P. (Gonolkites ?) postera (Seebach) (holotype refigured by Westermann, 1958; pl. 27) has an even stouter whorl section and much coarser secondaries, as already pointed out by Arkell (1951-59, p. 159); the inclusion of *P. subgaleata* in the synonymy of *P. postera* (Westermann 1958, p. 70) does not therefore seem to be justified, at least until more specimens of the latter species have been described.

PARKINSONIA (ORANICERAS) WÜRTTEMBERGICA (Oppel)
Plate 6, fig. 7; Plate 10, fig. 1

1928 *Parkinsonia compressa* Quenstedt var. *württembergica* Oppel - Nicolesco

EXPLANATION OF PLATE 14

Fig. 1a-b - *Procerites tmetolobus* S. Buckman. Chaudon (Les Reichasses), Lower Bathonian, Convergens sbz. X 0,56. Pag. 42.

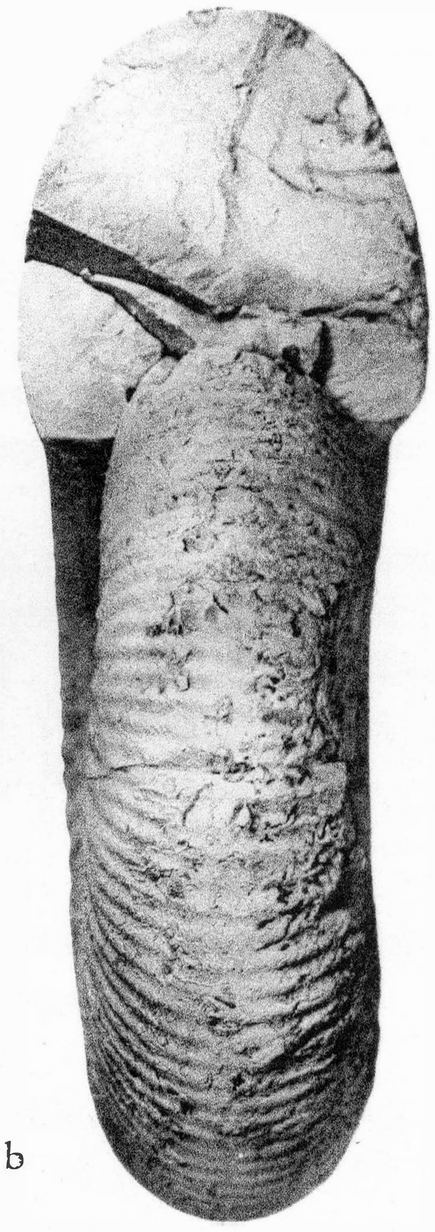
2a-b - *Procerites schloenbachi* De Grossouvre. Chaudon (Les Reichasses), Lower Bathonian, Convergens sbz. X 0,45. Pag. 43.

Both specimens collected by G. Pavia.

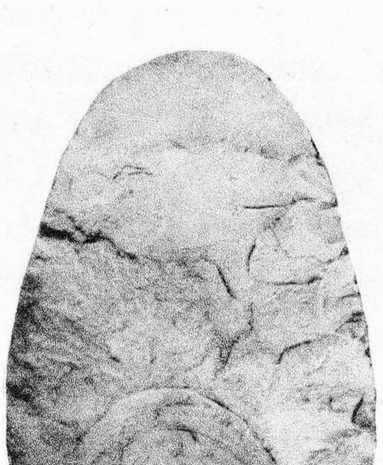
C. STURANI, BATHONIAN AMMONITES DIGNE AREA



1 a



1 b



2 a



2 b

1927-28; pl. 16, figs. 18a-b, 20a-b (*non cet.*).

1958 *Parkinsonia (Oraniceras) württembergica* (Oppel) - Westermann 1958; pp. 70-71; pl. 28, figs. 2a-b; pl. 29; pl. 30, figs. 1a-b. (*Cum syn.*; incl. ssp.).

P. (O.) württembergica has been found at Chaudon, in the highest limestone bed (topmost Convergens subzone, a single specimen), and at Bas Auran: two specimens from the Macrescens subzone (beds 10 and 9) and two others not in situ, but presumably from the base of the Yeovilensis subzone, at least judging from their position on the ground and the matrix.

The largest one (not in situ) is wholly septate at a presumable diameter of 270 mm; it has short, peripheral secondaries on the penultimate whorl, but becomes completely smooth in the last septate one, developing a lanceolate section, just like *Ammonites parkinsoni laevissimus* Quenstedt (« *Ammoniten* »; pl. 73, fig. 2). The other specimens are smaller and show perfect agreement with those figured by Westermann as *P. württembergica württembergica.*

It is rather doubtful whether *P. (O.) württembergica gyrumbilica* has any validity as a distinct subspecies, notwithstanding Westermann's interpretation.

P. (O.) württembergica is a species of widespread occurrence (Germany, E and SE France, Sicily, Poland, Caucasus) and is the index form of the « Württembergica — schichten s. str. » of German authors (*i. e.* the middle part of the Zigzag zone, as here interpreted), but it is already, though rarely, found in the basal Lower Bathonian (« Ferrugineus — Schichten »), with *P. (G.) convergens* (see Maubeuge, 1950, and Westermann, 1958).

MORPHOCERAS MULTIFORME Arkell
Plate 9, figs. 2, 5-7

1955 *Morphoceras multiforme* - Arkell 1951-59; pp. 132-133; text-figs. 47, 50; pl. 16, figs. 1, 2. (*Cum syn.*).

Morphoceras multiforme is quite common in the Convergens subzone of the Digne area, both at Chaudon (14 specimens) and at Bas Auran (6 specimens); in the latter locality it is also found higher up, in the Macrescens subzone (beds 11, 8 and 7), but it becomes rarer.

For a more detailed discussion of this species, see Thalmann (1925) and Arkell (*loc. cit.*).

The small nucleus from Chaudon (Plate 9, fig. 5) is almost identical to the lectotype.

M. multiforme is one of the commonest ammonites in the Lower Bathonian and has a very widespread occurrence: England, France, Switzerland, Swabia, Morocco, Algeria, Sicily, Persia, Bulgaria, Poland.

MORPHOCERAS MACRESCENS (S. Buckman)
Plate 9, figs. 4a-b, 8

1886 *Ammonites parkinsoni inflatus* - Quenstedt, Ammoniten; pl. 73, figs 18 and 19 (*non cet.*).

1955 *Morphoceras macrescens* (S. Buckman) - Arkell 1951-59; pp. 133-134; pl. 16, fig. 4; pl. 17, fig. 3. (*Cum syn.*).

This is the commonest ammonite in the middle part of the Zigzag zone at Bas Auran (over 25 specimens, most of which are from bed 8); it has thus been chosen as index for the Macrescens subzone.

M. macrescens has the same style of ribbing as *M. multiforme* (or just slightly coarser, on some specimens), but is much more compressed at any comparable diameter. The ribbing tends to fade on the second half of the body chamber; the peristome is simple, and is preceded by a constriction.

Quenstedt's « *Ammoniten* », pl. 73, figs. 18 and 19 (the latter type of var. *compressa* Wetzel, 1937), placed by Arkell in the synonymy of *M. patescens* with a query, are here considered to be representatives of *M. macrescens*.

M. macrescens is a species as widely distributed as *M. multiforme,* but seems to have a shorter vertical range (see above).

MORPHOCERAS DENSICOSTATUM Thalmann
Plate 9, figs. 1a-b; Plate 10, figs. 4a-b

1955 *Morphoceras densicostatum* Thalmann - Arkell 1951-59; pp. 134-135; pl. 17, fig. 4; text-fig. 48. (*Cum syn.*).

Like *M. macrescens,* but much more densely and finely ribbed, and also slightly more evolute.

Both at Chaudon and at Bas Auran *M. densicostatum* seems to be confined to the topmost part of the Convergens subzone: there are five specimens from the highest limestone bed of the former locality and one from bed 12, at the latter locality. All show good agreement with the english specimen figured by Arkell (Thalmann did not give type figures).

When more specimens will be available, also from other regions, *M. densicostatum* might prove to be a simple subspecies of *M. macrescens,* earlier than the nominate one.

MORPHOCERAS PERINFLATUM Wetzel
Plate 11, figs. 2a-b

1886 *Ammonites parkinsoni inflatus* - Quenstedt, Ammoniten; pl. 73, figs. 21 (?), 23 (lectotype) and 27 (*non cet.*).
1933 *Morphoceras polymorphum* «var. à large ombilic » - Roman 1933; pp. 69-70; text-fig. 4; pl. 2, figs. 17a-b.
1937 *Morphoceras inflatum* Quenstedt var. *perinflata* - Wetzel 1937; pp. 132-133.

Quenstedt's « *Ammoniten* », pl. 73, fig. 23 is here designated lectotype. It is a small specimen, 19 mm in diameter, differing from *M. multiforme,* at a comparable diameter, in its wider umbilicus and stouter whorl section; it comes from the Brauner Jura epsilon of the Swabian Alb.

The nucleus from Djebel-es-Sekika figured by Roman as a variety of *M. multiforme* and placed with a query in the synonymy of *M. patescens* by Arkell, shows much closer affinities with the lectotype of *M. perinflatum.*

At Bas Auran the present species is confined to the middle part of the Yeovilensis subzone (bed 4, two specimens); at the Col de Pierre basse small ferruginous nuclei are found with *Berbericeras sekikense,* in an assemblage of Lower Bathonian age, *post* Convergens subzone.

M. pingue De Grossouvre (see Arkell 1951-59; text-fig. 49) is rather similar in the general proportions, but has a different style of ribbing, lacking the ventral groove.

The ribbing style of *M. perinflatum,* as shown by the lectotype and the specimen figured herein (Plate 11, figs. 2a-b), is closer to that of *M. multiforme.*

This same species has also been reported from the condensed Bathonian of Sicily.

MORPHOCERAS PATESCENS (S. Buckman)
Plate 9, fig. 3; Plate 10, fig. 7

1922 *Patemorphoceras patescens* - S. Buckman, T. A., 4; pl. 351.
1955 *Morphoceras patescens* (S. Buckman) - Arkell 1951-59; p. 133; pl. 17, fig. 5.

Arkell has given an excellent description of this species, which differs markedly from both *M. multiforme* and *M. macrescens* by its coarser and more irregular ribbing. which persists to the end of the body chamber; in *M. patescens* the umbilicus is also proportionally larger and the septation persists for a short distance after its abrupt widening, while in the other two species the septation ceases just before that point is reached. The peristome is simple, somewhat contracted and preceded by a constriction.

EXPLANATION OF PLATE 15

Fig. 1a-c - *Zigzagiceras* (*Procerozigzag*) *postpollubrum* Wetzel *garnieri* n. spp., morphotype with an elliptical whorl section. Bas Auran, Lower Bathonian, Macrescens sbz. (bed 9). Fig. 1a X 0,66; Figs. 1b-c (nucleus) X 1. Pag. 52.

2a-c - *Procerites subprocerus* (S. Buckman). Bas Auran, Lower Bathonian, Convergens sbz. (bed 14). Figs. 2a-c (nucleus) X 1,5. Note constrictions on nucleus. Pag. 41.

3a-b - *Procerites* (*Phaulozigzag*) *phaulomorphus* S. Buckman. Chaudon, Lower Bathonian, Convergens sbz. Pag. 45.

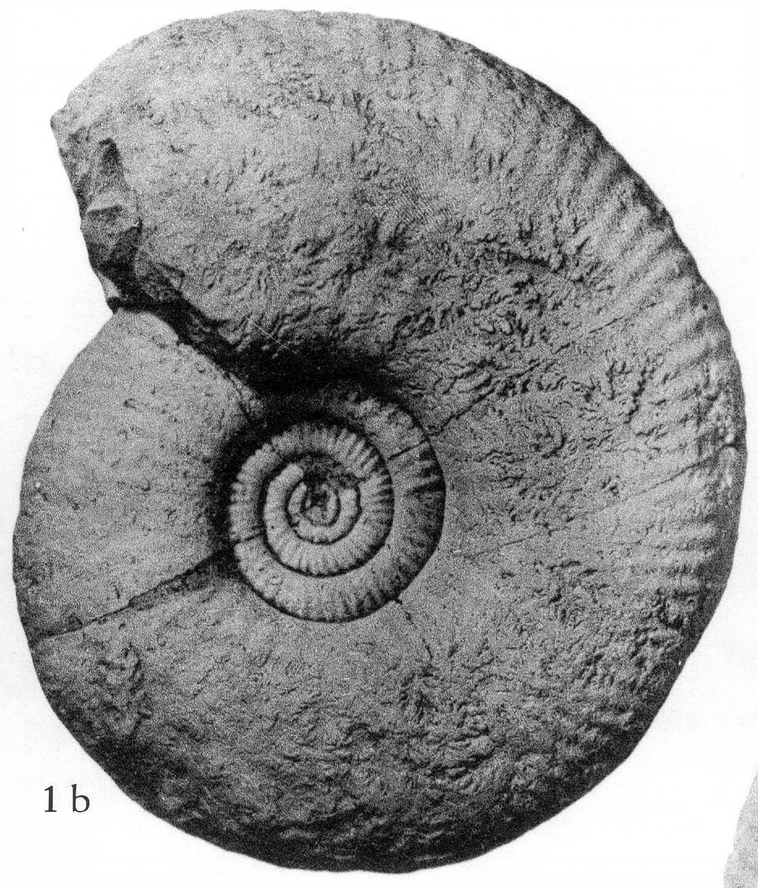
4 - *Procerites fowleri* Arkell, immature specimen. Bas Auran, Lower Bathonian, basal Yeovilensis sbz. (bed 6). Pag. 44.

5 - *Procerites imitator* (S. Buckman). Bas Auran, Lower Bathonian, Yeovilensis sbz. (interbed 3-2). X 0,66. Pag. 43.

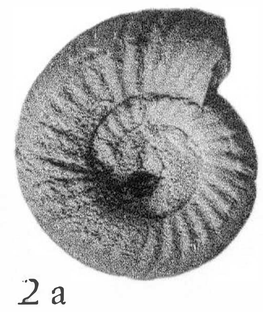
All photos. natural size except Figs. 1a-c, 2b-c, 5.



1 a



1 b



2 a



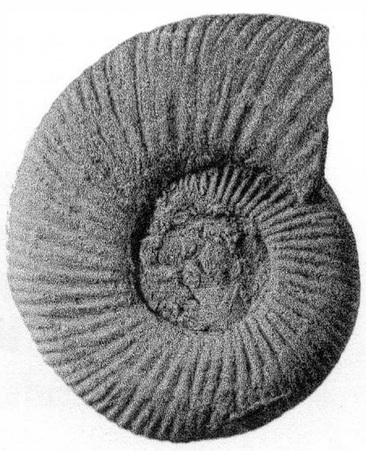
2 b

2 c



1 c







3 a

3 b



4



5

Material and horizon — Bas Auran, in the Convergens subzone (bed 17 of the Ravin du Bès section, a fine external mould left *in situ*) and in the Macrescens subzone (bed 8, a single specimen, figured on Plate 9, fig. 3); Chaudon, in the Convergens subzone (two specimens).

The specimens from Chaudon are slightly less coarsely ribbed (Plate 10, fig. 7), but otherwise very similar.

The holotype comes from the Zigzag zone of Broad Windsor, Dorset.

Morphoceras parvum Wetzel
Plate 11, figs. 1a-c

1937 *Morphoceras inflatum* Quenstedt var. *parva* - Wetzel 1937; pp. 131-132; pl. 14, figs. 6a-b (lectotype).

This is the earliest *Morphoceras* found in the Bas Auran section, where it is confined to the Convergens subzone (beds 23, 17 and 14; three specimens). It differs from both *M. multiforme* and *M. macrescens* in being more compressed and discoidal in shape and in reaching a much smaller adult size; the umbilicus is also proportionally wider. *M. patescens* is larger and has a different style of ribbing. *M. replictum* (S. Buckman), vaguely similar when adult, has a much more evolute nucleus.

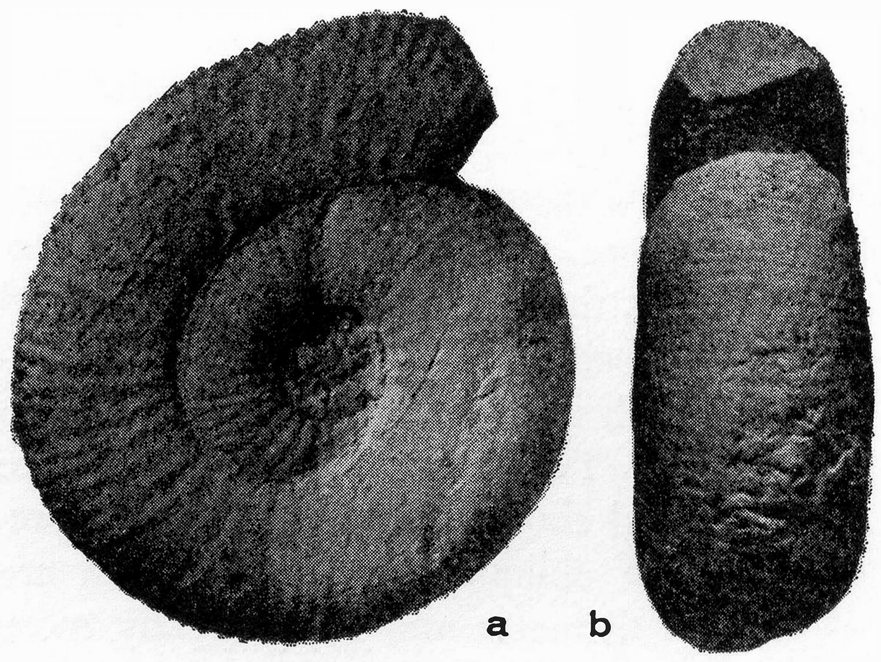
Quenstedt's « Ammoniten », pl. 73, fig. 26, placed by Wetzel in the synonymy of *M. parvum,* is more evolute and may rather belong to *Ebrayiceras.*

The lectotype (designated here) comes from the Zigzag zone of Vandenesse (Nièvre).

Morphoceras (or Asphinctites) pingue
De Grossouvre
Tex-figs. 3a-b

1955 *Morphoceras pingue* De Grossouvre - Arkell 1951-59; p. 135; text-fig. 49. (*Cum syn.*).

A single, complete specimen from Bas Auran is 49 mm in diameter and shows near perfect agreement with the holotype.



Text-figs. 3a-b

Morphoceras (or *Asphinctites ?*) *pingue* De Grossuvre.

Bas Auran, Lower Bathonian, exact horizon unknown. ***Ex*** **Maurel Collection. X 1.**

I am much indebted to Monsieur L. Maurel of Barrême, who collected it, for the gift of this interesting ammonite. The exact horizon within the Lower Bathonian is unfortunately unknown.

Owing to the complete absence of the ventral interruption of ribs and to the low number of constrictions (one every half a whorl), this species seems to make transition between *Morphoceras* s.s. and *Asphinctites.*

M. pingue is known to occur in the Lower Bathonian of England and France (Nièvre, type region).

Asphinctites recinctus S. Buckman
Plate 10, figs. 2a-b, 5; Plate 11, fig. 9

1955 *Morphoceras recinctum* (S. Buckman) - Arkell 1951-59; pp. 137-138; text-fig. 51 (reprod. of the type fig.). (*Cum syn.*).

Three specimens from the topmost bed (n. 2) of the Yeovilensis subzone of the Bas Auran section show very close agree-

ment with the holotype as well as with the french specimens figured by De Grossouvre as *Morphoceras transylvanicum* (? non Simionescu) (1919; pl. 15, figs. 1-2).

They have short primaries, branching more than twice; their base, near the umbilical margin, is raised, as in *Morphoceras pingue* De Grossouvre; the secondaries are fine and dense, not interrupted on the median line. At the beginning of the last whorl (body chamber) the coiling becomes excentric and much more evolute, as in most Morphoceratids. Two of these specimens are complete and show a simple peristome, preceded by an oblique constriction; both are 45 mm in diameter and have slightly more than a whole whorl of body chamber; one shows a second constriction just before the end of the phragmocone (Plate 10, fig. 5).

The absence of the ventral smooth band could justify the maintenance of *Asphinctites* as a separate genus (or, at least, as a subgenus of *Morphoceras*), and I agree with Arkell in leaving it within the family *Morphoceratidae*. Westermann (1958), on the contrary, places *Asphinctites* in the *Perisphinctidae* (either as *Siemiradzkiinae* or as *Leptosphinctinae*).

The type level, in England, is also Yeovilensis subzone (= Arkell's Fallax zone).

Ebrayiceras sulcatum (Hehl in Zieten)

Plate 10, figs. 6a-b; Plate 11, figs. 4, 5

1937 *Ebrayiceras sulcatum* (Hehl) - Wetzel 1937; pp. 123-135; (*cum syn.*).

Three specimens from the Convergens subzone of the Bas Auran section (bed 14) closely match Schloenbach's figure (1865; pl. 28, fig. 5). Another one, from the Convergens subzone of Chaudon, is more involute and more radially ribbed than the preceding specimens, but seems best to fall within this same species.

As pointed out by both Wetzel and Arkell, *E. sulcatum* is much more coarsely ribbed than any congeneric form, apart from *E. gauthieri* Roman, which is however much more evolute.

The type comes from the Lower Bathonian of Germany.

Ebrayiceras pseudoanceps (Ebray)

Plate 11, figs. 6, 7

1955 *Ebrayiceras pseudoanceps* (Ebray) - Arkell 1951-59; pp. 139-140; pl. 17, figs. 7-11. (*Cum syn.*).

The present species is not rare in the Macrescens subzone of the Bas Auran section (beds 10, 8, 7) and it is also found in the Lower Bathonian assemblage from the Col de Pierre Basse, with *Berbericeras sekikense*.

As pointed out by several authors, *E. pseudoanceps* seems to be polymorphic. This is confirmed by the small population from the Digne area, in which different morphotypes can be observed, some being densely ribbed and rather involute, while others closely agree with Roman's « variété à tours épais » from Djebel-es-Sekika (the nuclei from the Col de Pierre basse).

For a more detailed description and the general distribution, see Arkell.

Ebrayiceras jactatum (S. Buckman)

1956 *Ebrayiceras jactatum* (S. Buckman) - Arkell 1951-59; p. 141; pl. 17, figs. 1, 2, 12, 13. (*Cum syn.*).

There are three small and poorely preserved specimens, not worthwile figuring but otherwise closely similar to the holotype. All come from the Macrescens subzone of the Bas Auran section (beds 9 and 8). For fuller description, see Arkell.

E. jactatum has been reported to occur in the Lower Bathonian of England, Swabia, Persia and Sicily (Wendt, 1964).

EXPLANATION OF PLATE 16

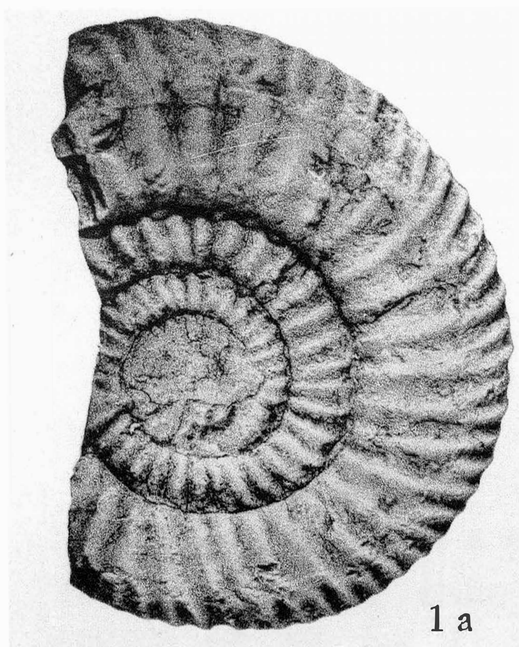
Fig. 1a-b, 2a-b, 3a-b, 6 - *Procerites* (*Lobosphinctes*) *intersertus* (S. Buckman).
Figs. 1a-b. Inner whorls of an evolute morphotype, Bas Auran, Lower Bathonian, Convergens subzone (bed 14).
Figs. 2a-b. A more involute morphotype. Chaudon, Lower Bathonian, Convergens sbz. (the outer whorls have been removed on Fig. 2b).
Figs. 3a-b. The same morphotype. Bas Auran, Lower Bathonian, Convergens sbz. (bed 14) (part of the last visible whorl removed on Fig. 3a).
Fig. 6 The same morphotype. Chaudon, Lower Bathonian, Convergens sbz. X 0,66. Pag. 44.

4a-b - *Bigotites diniensis* n. sp., paratype. Chaudon (Les Reichasses), Lower Bathonian, Convergens sbz. Pag. 40.

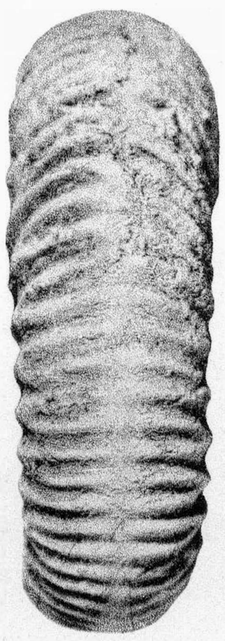
5 - *Zigzagiceras* (*Franchia* n. subg.) *arkelli* n. sp., paratype. Chaudon, Lower Bathonian, Convergens sbz. X 0,66. Pag. 52.

All photos. natural size except Figs. 5, 6.

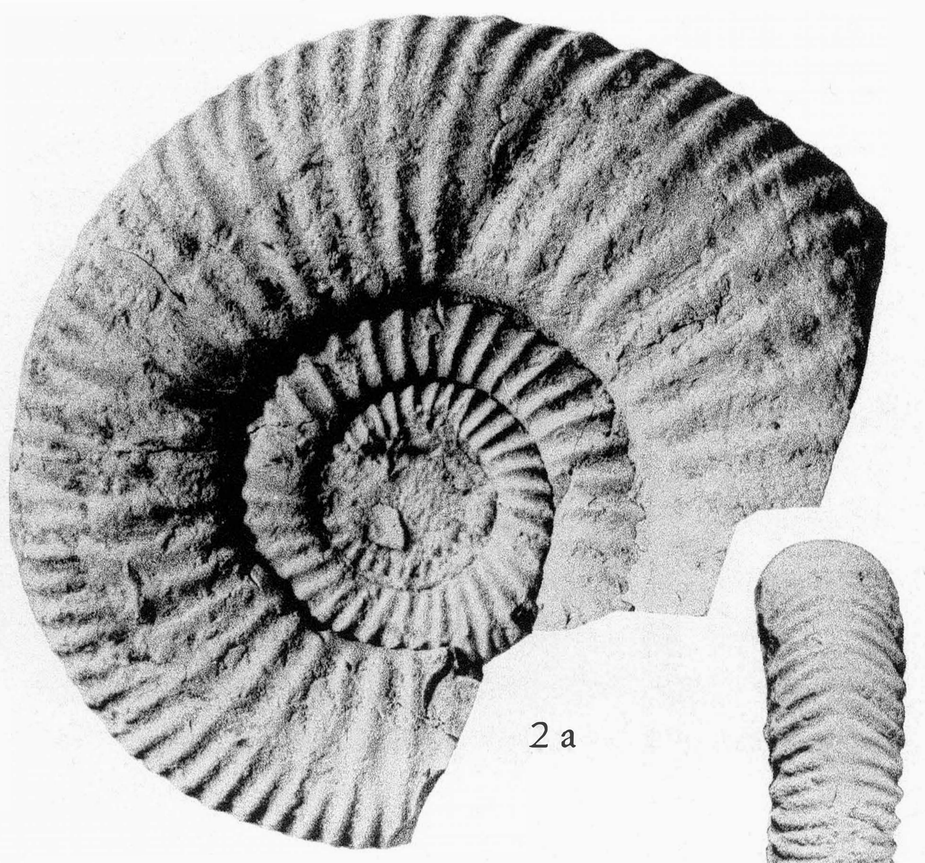
C. STURANI, BATHONIAN AMMONITES DIGNE AREA



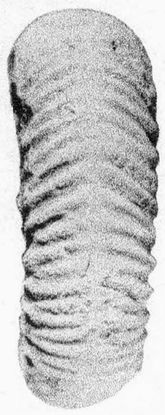
1 a



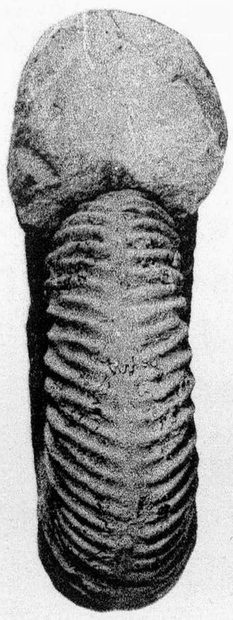
1 b



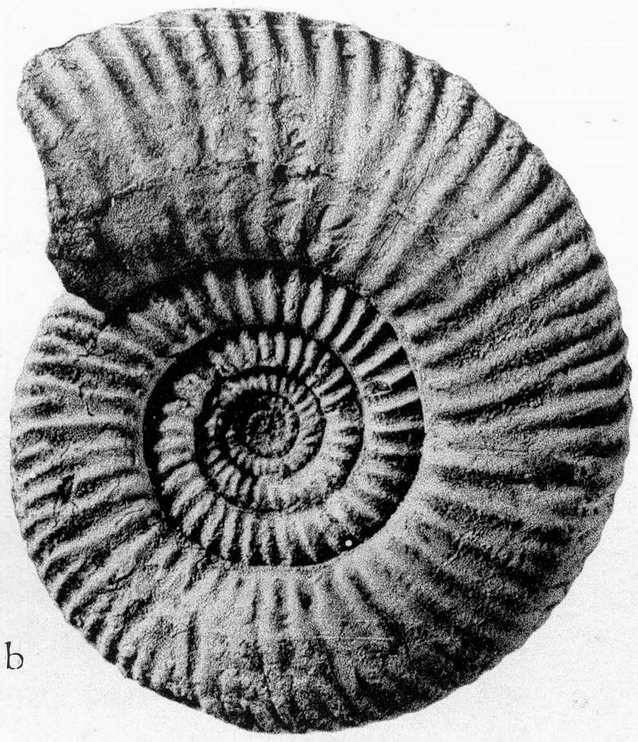
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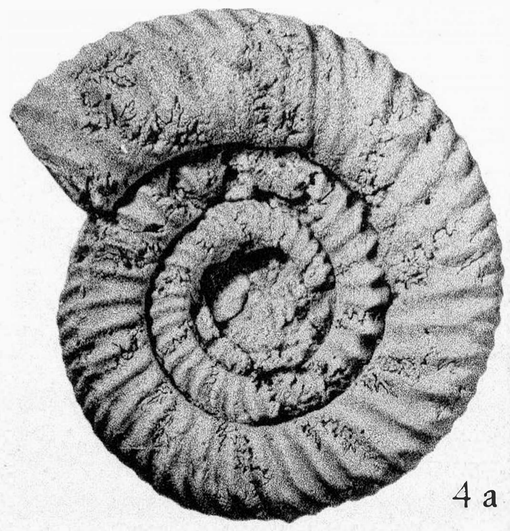
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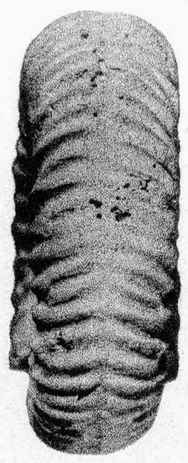
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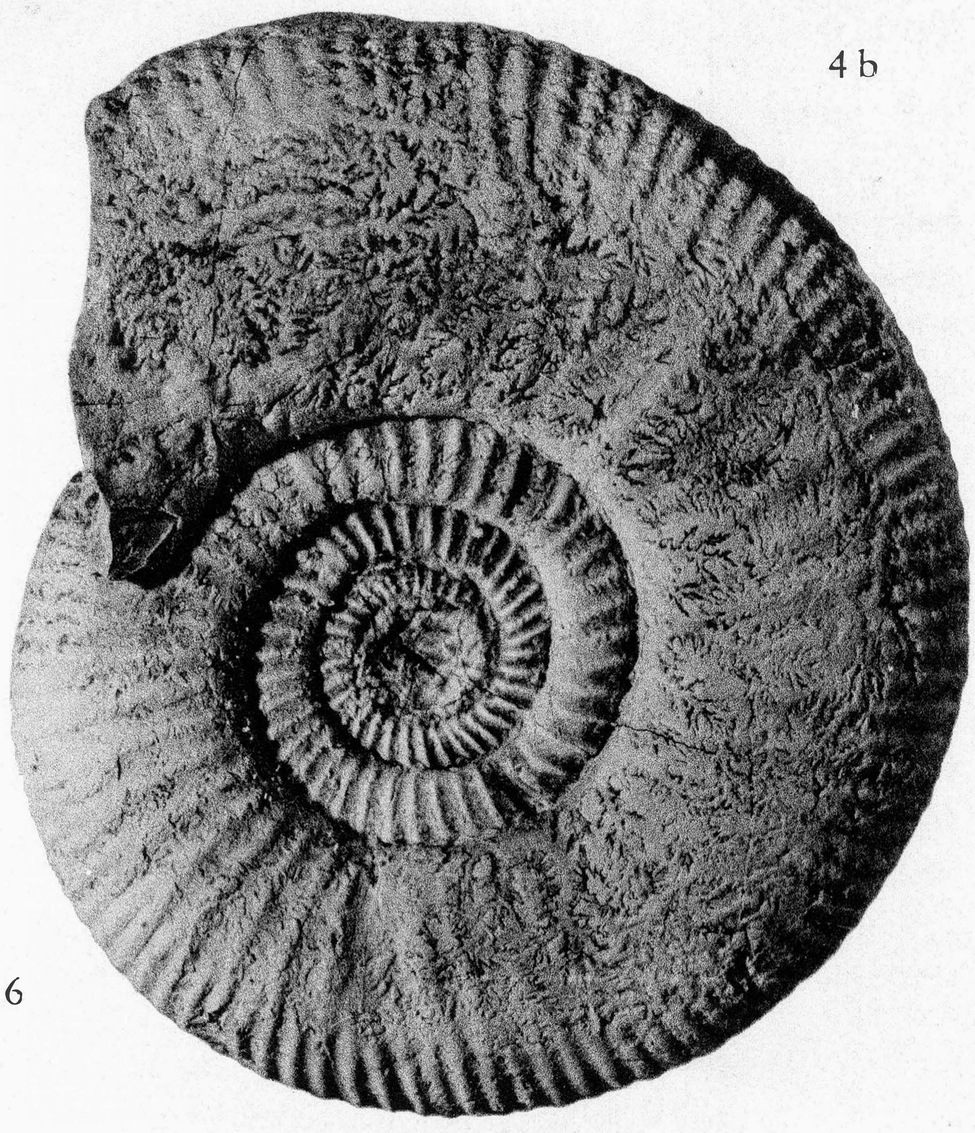
4 a



4 b



5



6

EBRAYICERAS RURSUM S. Buckman
Plate 11, fig. 8

1955-56 *Ebrayiceras rursum* S. Buckman - Arkell 1951-59; pp. 140-141; pl. 17, figs. 14, 15 (*Cum syn.*).

A single specimen from the Convergens subzone of Chaudon is known. It is more evolute, more compressed, more discoidal in shape and slightly more coarsely ribbed than *E. pseudoanceps,* thus closely matching the holotype of *E. rursum.*

E. problematicum (Gemmellaro) is similarly ribbed, but has a stouter whorl section, at least judging from the original figure (1877; pl. 19, fig. 1).

BERBERICERAS SEKIKENSE Roman
Plate 5, fig. 8 (suture line); Plate 11, figs. 3a-b

1933 *Berbericeras sekikense* - Roman 1933; pp. 67-69; text-fig. 3; pl. 2, figs. 15a-b (holotype).
1959 *Berbericeras sekikense* Roman - Arkell 1951-59; text-fig. 88/5a-b only (repr. of the type fig.) (non pl. 33, figs. 4-6).

There are seven ferruginous nuclei from the Lower Bathonian assemblage (*post* Convergens subzone) of the Col de Pierre basse. The better preserved one (Plate 11, figs. 3a-b) is almost identical to the holotype and is wholly septate at a diameter of 11 mm. It shows some faint constrictions at irregular intervals and a feeble but persistent ventral groove (just as feeble as in the nuclei of *Morphoceras,* at a comparable diameter). The ribbing style, with the primaries swept strongly forward on the umblical margin and furcating in the inner half of the whorl sides, is just like that of *Ebrayiceras pseudoanceps.* The suture line is also of an identical type, at a comparable diameter (see Roman 1933, text-figs. 2 and 3).

In the writer's opinion, also accepted by H. S. Torrens, there is hardly any doubt that *B. sekikense* has to be placed in the family *Morphoceratidae.* When more material is found, including adult specimens, distinction from *Ebrayiceras* may prove worthless.

The english Middle Bathonian ammonites of the Morrisi zone figured by Arkell under this name, and placed by him in the subfamily *Pseudoperisphinctinae,* near *Siemiradzkia,* are probably neither conspecific nor congeneric with *B. sekikense*, but could be later homoeomorphs. Similar forms are known from Poland, probably in the same zone (*fide* H. S. Torrens).

The assemblage from Djebel-es-Sekika, the type locality, is strikingly similar, even in the type of preservation, to that from the Col de Pierre Basse; the age, in both cases, is Lower Bathonian, *post* Convergens subzone.

PLANISPHINCTES PLANILOBUS S. Buckman
Plate 7, fig. 3

1956 *Parkinsonia* cf. *dorni* - Arkell 1951-59; pp. 151-152; pl. 18, fig. 5; pl. 19, figs. 5-7, 10-11 (non text-fig. 56, nec *Parkinsonia dorni* Arkell, 1951, nom. nov. for *P. ferruginea* (non Oppel) Dorn, 1928).
1959 *Siemiradzkia (Planisphinctes) planilobus* (S. Buckman) - Arkell 1951-59; p. 230; pl. 33, figs. 7a-c. (*Cum syn*).

There are four specimens from Bas Auran; one has been collected *in situ* by the author in the Bomfordi subzone (bed 28): the other three were in the Maurel collection; to judge from their identical type of preservation and matrix, they should come from the same horizon.

The largest specimen attains a diameter of 59 mm, with three quarters of a whorl of body chamber, and has got long lappets; it shows near perfect agreement with the holotype. As stated by Arkell « ribs are sharp and rod-like, with a high proportion of simple ribs up to the beginnig of the body chamber ». On the holotype the secon-

daries are said by Arkell to be « interrupted and distorted » on the middle of the venter; since this feature is also shown by all four specimens from Bas Auran, I do not think it to depend on an « injury or malformation », as stated by Arkell, but to be a peculiar character of this species. In this context, it is important to note that the specimens figured by Arkell as *Parkinsonia* cf. *dorni* (i.e., he could not identify them beyond any doubt with typical *P. dorni,* in which the secondaries are interrupted by a true, narrow and deep groove) are strikingly similar to both the holotype of *P. planilobus* and the specimens from Bas Auran described here. Besides, they come from the same localities and horizon: Zigzag bed of Burton Bradstock and Loders Cross.

The sutures, well exposed on the largest specimen from Bas Auran, are clearly perisphinctoid, with a slender first lateral and a strongly retracted suspensive lobe.

The ventral interruption of the ribs in *P. planilobus* does not represent a unique case within the family *Perisphinctidae,* because it is also found in *Bigotites* as well as in some younger genera.

It is difficult to state whether the types of *Parkinsonia dorni* Arkell (Dorn 1928, pl. 4, figs. 5-6) are also conspecific with *Planisphinctes planilobus* or really belong to *Parkinsonia* and are therefore different. In any case, Buckman's name has priority.

As for the type level of *P. planilobus,* to judge from its range in the Basses-Alpes, one may suspect that this is one of the species of the Bomfordi subzone recorded in error from the Lower Bathonian by Arkell, like *Oecotraustes costiger* S. Buckman and *O. nodifer* S. Buckman (the latter two *fide* H. S. Torrens).

Planisphinctes tenuissimus (Siemiradzki)
Plate 12, figs. 1a-b, 4

1898 *Perisphinctes tenuissimus* - Siemiradzki 1898-99; p. 85; pl. 21, fig. 19 (lectotype, designated here).

1928 *Perisphinctes perspicuus* (non Parona) - Dorn 1928; p. 244; pl. 7, fig. 2.

The lectotype comes from the Bajocian of Chaudon and is an evolute Perisphinctid characterized by fine, dense, rod-like ribs, mainly biplicate and not interrupted on the middle of the venter. Its measurements, at 40 mm, are: .30; .23; .50.

Among the newly collected material there are eight specimens agreeing in every detail with the lectotype; four of them come from the topmost Bajocian, Bomfordi subzone, of the Bas Auran section (beds 34 and 28), while the other four are topotypes from Chaudon and also come from the Bomfordi subzone. Some of them are complete and possess large, spatulate lappets (Plate 12, fig. 4).

P. tenuissimus differs from *P. planilobus,* the type species, in being more densely and finely ribbed, in lacking the ventral smooth band and in having a slightly more compressed whorl section, elliptical in shape.

The specimen figured by Dorn as *Perisphinctes perspicuus* (non Parona) (Parona's species belongs to the group of « *Perisphinctes* » *martinsi* and is earlier in age), is identical with the topotypes of *P. tenuissimus* and certainly belongs here; it comes from a condensed assemblage, including species of both the Bomfordi and the Convergens subzones.

P. tenuissimus is also reported from the Northern Caucasus (*Coll. Jur. Luxembourg,* p. 838) with two different assemblages, the earlier one yielding *Parkinsonia rarecostata,* the younger one yielding an obviously mixed fauna (Parkinsoni and Zigzag zones).

Bigotites diniensis n. sp.
Plate 2, fig. 1; Plate 16, figs. 4a-b; Plate 18, figs. 1a-b (holotype)

There are four specimens from the Convergens subzone of Chaudon; the largest one, wholly septate, is 77 mm in diameter (Plate 18, figs. 1a-b); the other three are smaller.

EXPLANATION OF PLATE 17

Fig. 1 - *Procerites (Lobosphinctes) intersertus* (S. Buckman). Chaudon, Lower Bathonian, Convergens sbz. (same as Plate 16, fig. 6). X 1,5. Pag. 44.

2 - *Procerites tmetolobus* S. Buckman. Chaudon, Lower Bathonian, Convergens sbz. (same as Plate 14, figs. 1a-b). Pag. 42.

3 - *Procerites subprocerus* (S. Buckman). Chaudon, Lower Bathonian, Convergens sbz. X 1,5. Pag. 41.

4 - *Procerites schloenbachi* De Grossouvre. Chaudon, Lower Bathonian, Convergens sbz. (same as Plate 14, figs. 2a-b). Pag. 43.

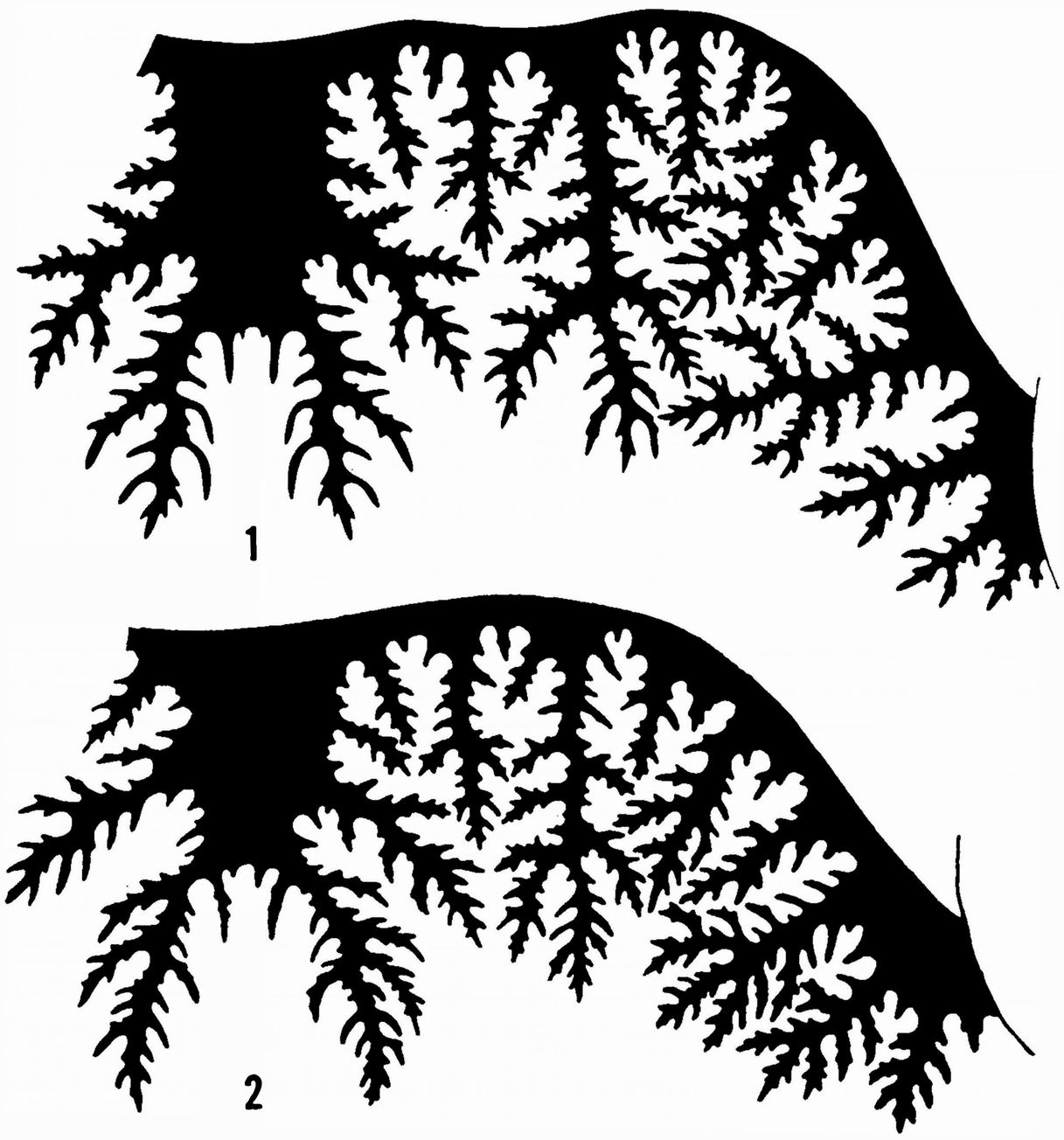
5 - *Procerites fullonicus* (S. Buckman). Bas Auran, Lower Bathonian, basal Yeovilensis sbz. (bed 6). Pag. 43.

6 - *Procerites fowleri* Arkell. Bas Auran, Lower Bathonian, basal Yeovilensis sbz. (bed 6) (same as Plate 13, fig. 5). Pag. 44.

7 - *Z. (Procerozigzag) postpollubrum garnieri* n. ssp. Bas Auran, Lower Bathonian, Macrescens sbz. (bed 8). Pag. 51.

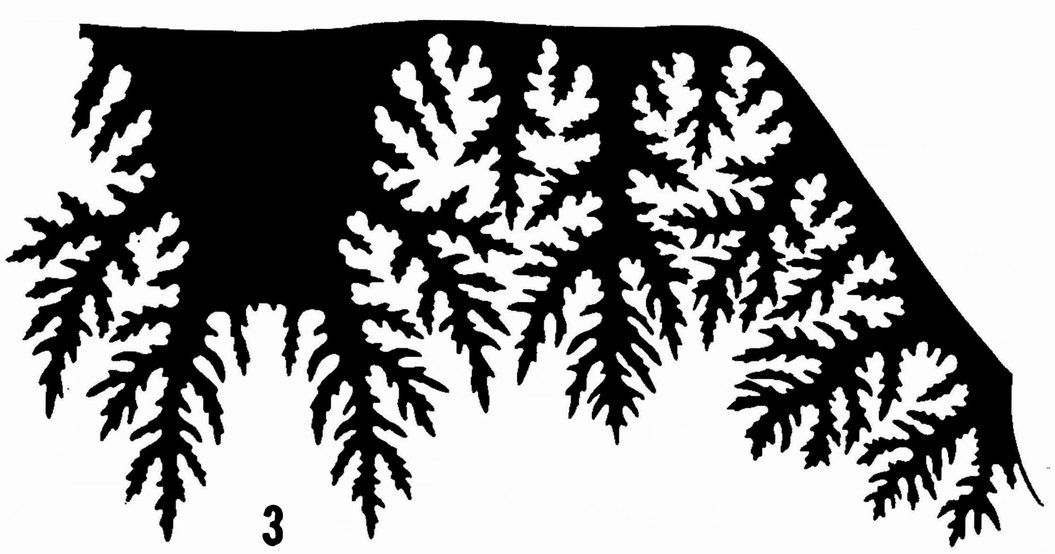
8 - *Z. (Procerozigzag) pseudoprocerum* (S. Buckman). Bas Auran, Lower Bathonian, Macrescens sbz. (bed 10). Pag. 50.

All figures natural size, except 1 and 3.

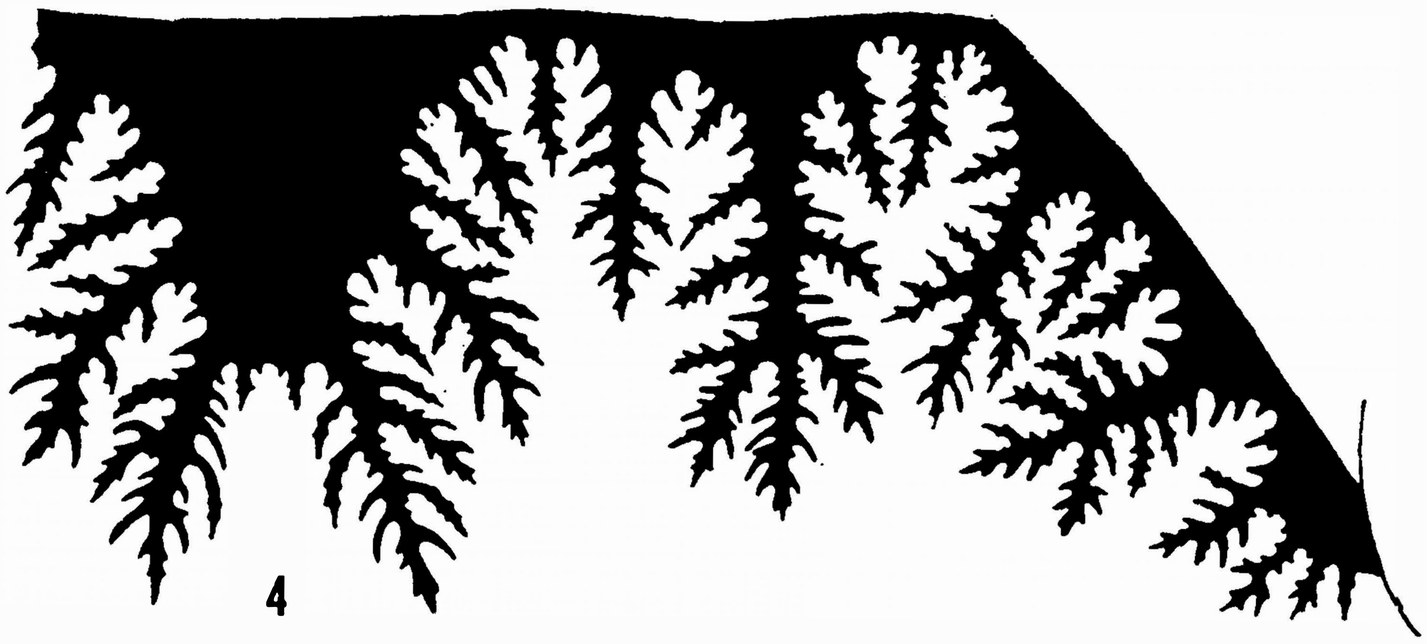


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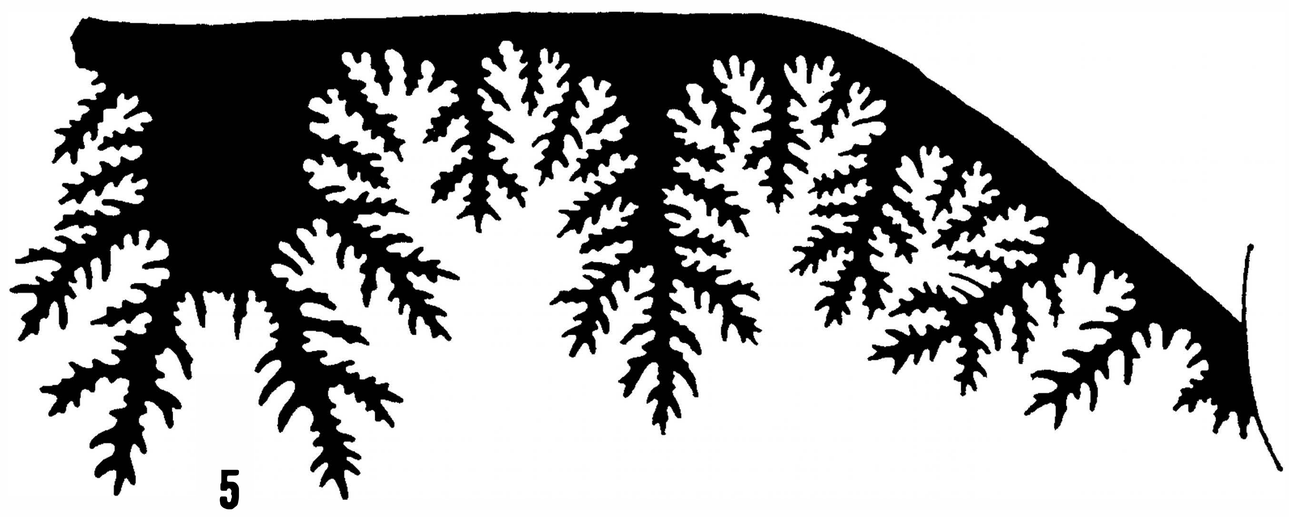
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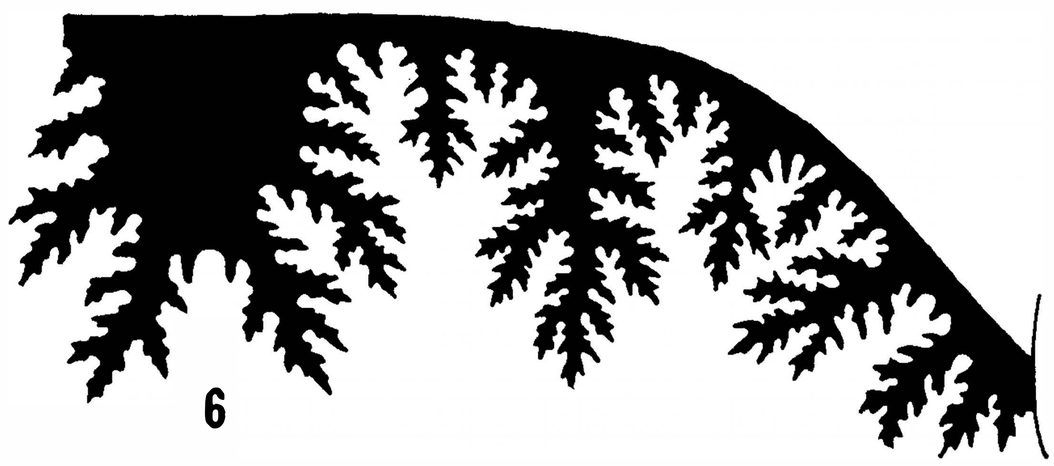
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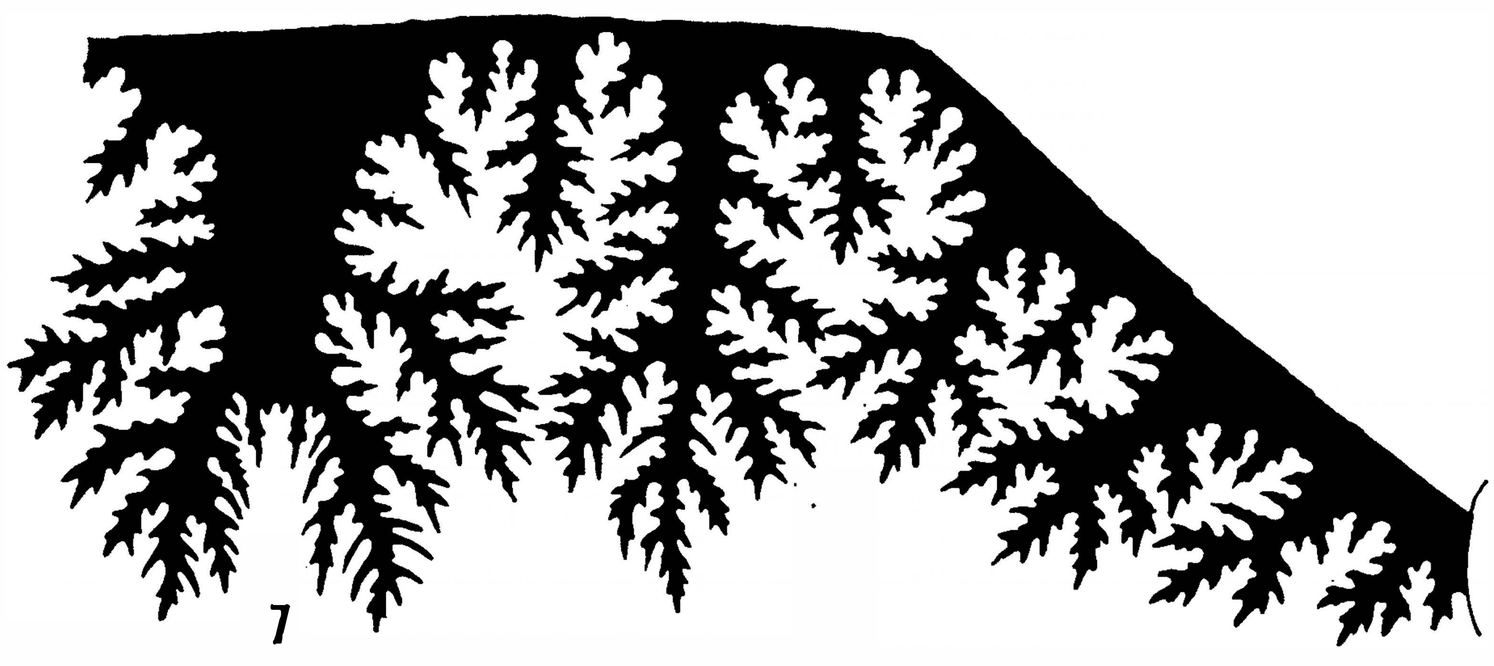
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This is an evolute, many-whorled species, with a rounded-quadrangular whorl section, slightly wider than high. The ribbing is sharp and strong; there are about 33 primaries per whorl, most of which biplicate, a few simple. They are usually raised at the well marked ventrolateral edge. The secondaries are less sharp; up to at least 50 mm diameter they are interrupted and displaced on both sides of a median smooth line. The whorls increase by segments between more or less well marked constrictions, one every half a whorl. Near the beginning of each «segment» the ventral smooth band and the displacement of the secondaries on both sides of it are more conspicuous. Near the end of the « segment », on the contrary, the secondaries become increasingly stronger and the ventral smooth band almost disappears. Such a feature is absolutely typical of *Bigotites*.

The suture lines, very well spaced, are of the same type as in the Upper Bajocian congeneric species figured by Nicolesco, at a comparable diameter.

The largest specimen (Plate 18, figs. 1a-b) has been designated holotype; it measures: max 77 mm (wholly septate); at 70 mm: .32; .35,7; .48,5. One of the paratypes (Plate 16, figs. 4a-b) measures: max 50 mm (wholly septate; part of the last visible whorl, however, has been removed for the photograph); at 50 mm: .29; .32; .54.

No specimens are known possessing the body chamber; none the less, considering that the largest one is still septate at 77 mm, this is presumably a macroconch species.

B. diniensis n. sp. is the first undoubted representative of this genus ever found in the Lower Bathonian and it is of the highest interest when compared with *Zigzagiceras* (*Franchia*) *arkelli* n. subg. n. sp. on one hand, and *Procerites (Lobosphinctes) intersertus* (S. Buckman) on the other, since both are here believed to be direct derivatives of *Bigotites*.

B. diniensis n. sp. is named from *Dinium*, the latin name of Digne.

Bigotites petri (Nicolesco) - the type species - is the nearest looking Bajocian form. *B. diniensis* n. sp., however, has a more quadrangular and depressed whorl section and it is also more evolute.

PROCERITES COSTULATOSUS (S. Buckman)
Plate 12, fig. 5

1958 *Procerites costulatosus* (S. Buckman) - Arkell 1951-59; pp. 185-189; pl. 21, fig. 8; text-fig. 69/1 (*cum syn.*).

There are three specimens from the the topmost Bajocian, Bomfordi subzone, of the Bas Auran section (bed 28), and another one from Chaudon, also found in the Bomfordi subzone.

The main distinguishing features are given by fine and dense ribbing, joined with a rather stout whorl section and a broadly rounded venter. The figured specimen, from Bas Auran, though flattened and somewhat distorted, is very similar to the holotype and shows the same dense ribbing. The suture line looks like that of the other congeneric forms. The nucleus, exposed on another specimen, has some constrictions, round about 5 mm, and it is very similar to that of *P. subprocerus* described below.

The type level, in England, must also be Parkinsoni zone, as stated by Buckman, if his locality is correct (*fide* H. S. Torrens).

PROCERITES SUBPROCERUS (S. Buckman)
Plate 15, figs, 2a-c; Plate 17, fig. 3
(suture line)

1958 *Procerites subprocerus* (S. Buckman) - Arkell 1951-59; pp. 183-185; pl. 22, figs. 1-5 (*cum syn.*).

non 1958 *Procerites subprocerus* (S. Buckman) - Westermann 1958; p. 76; pl. 32; pl. 33, fig. 1.

P. subprocerus is not rare in the Convergens subzone of Chaudon (over 10 spec-

imens) and has also been found at the same level in the Bas Auran section (beds 17, 14 and 12). This population shows a certain degree of variability, some specimens being slightly more densely ribbed than the holotype, while others are slightly more evolute; but, as a whole, it shows quite good agreement with the english material figured by Arkell, whom see for description.

It has been possible to isolate the nucleus of the specimen figured on plate 15, figs. 2a-c, for a close study of the early ontogeny. Round about a diameter of 12 mm the whorl section is almost circular in outline; the primary ribs are well marked, bi- or triplicate; the secondaries much weaker and interrupted by a narrow ventral smooth band; there are four constrictions per whorl, preceded by a stronger secondary (the strength of the secondaries increases by segments from each constriction to the next one, just as in *Bigotites*). Such primitive features have already disappeared by the time a diameter of 25 mm is reached; their discovery is of the highest interest, since they prove a close link with *Bigotites,* previously unsuspected.

Neither of the two specimens from the NW german Lower Bathonian figured by Westermann as *P. subprocerus* seem to belong here; that of pl. 33, fig. 1 is too evolute and could rather belong to *P. tmetolobus*; the other one (pl. 32) is much stouter and looks like the holotype of *Zigzagiceras (Procerozigzag) postpollubrum garnieri* n. ssp., at least judging from the outer whorls.

In the type region *P. subprocerus* is one of the commonest species in the lower part of the Zigzag zone, as understood here.

PROCERITES TMETOLOBUS S. Buckman

Plate 14, figs. 1a-b; Plate 17, fig. 2 (suture line)

1958 *Procerites tmetolobus* S. Buckman - Arkell 1951-59; pp. 191-192; pl. 23, figs. 1-4; pl. 15, fig. 3 (? non fig. 2); text-fig. 69/5. (*Cum syn.*).

This is one of the commonest species in the Convergens subzone, both at Chaudon (over 13 specimens) and at Bas Auran (7 specimens from beds 22, 17, 14 and 13).

P. tmetolobus looks like *P. subprocerus* but is more evolute. The whorl section is elliptical, higher than wide, with almost parallel sides and a rather broadly rounded venter. The ribs are mainly biplicate, especially in the young stages, but many remain simple; free secondaries and triplicate ribs appear later, by the time a diameter of 100 mm is reached. The suture line (Plate 17, fig. 2) has a particularly slender first lateral lobe, also in the last septa.

The nucleus, at 10 mm, has a depressed whorl section, with a broad, gently convex external side; the primary ribs, sharp and rather strong, end abruptly at the well marked ventrolateral shoulder, each giving rise to two weak secondaries, which are entirely confined to the external side and are interrupted by a median smooth band. Both the primaries and the secondaries of each side alternate with those of the opposite one, as in *Bigotites.* Some weak constrictions, preceded by a stronger secondary, are also present. Such features persist, though attenuated, up to a diameter of 50 to 70 mm in several of the specimens studied, showing close affinities with *P. (Lobosphinctes) intersertus* and with *Bigotites.*

The agreement between the population from the Basses-Alpes, at the adult stage, and the English specimens illustrated by Arkell, including the holotype, is perfect, also in the proportions. The specimen figured on Plate 14, figs. 1a-b measures: max 175 mm (wholly septate); at 150 mm: .37; .32; .38, 6.

In the Digne area *P. tmetolobus* is confined to the Convergens subzone; in England, which is the type region, it is most common in the Zigzag zone, but it is also reported from higher levels (Fuller's Earth rock of Whatley, Somerset).

EXPLANATION OF PLATE 18

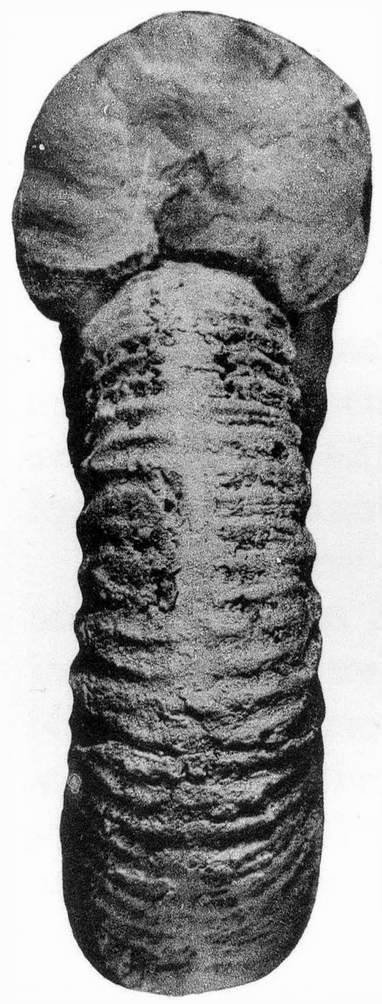
Fig. 1a-b - *Bigotites dimensis* n. sp., holotype. Chaudon, Lower Bathonian, Convergens sbz. Pag. 40.

2a-b, 4a-b - *Zigzagiceras* (*Franchia* n. subg.) *arkelli* n. sp. (type species of the subg. *Franchia* n. subg.).
Figs. 2a-b. Paratype, inner and middle whorls. Chaudon, Lower Bathonian, topmost Convergens sbz.
Figs. 4a-b. Holotype. Bas Auran, Lower Bathonian, topmost Convergens sbz. (bed 12). X 0,54. Pag. 52.

3 - *Siemiradzkia aurigera* (Oppel), inner whorls of the same specimen figured on Plate 24, figs. 4a-b, to show the peculiar development of the ornamentation, which passes through a very short zigzag stage. Bas Auran, Lower Bathonian, Yeovilensis sbz. (bed 2). X 2. Pag. 53.

All photos natural size, except Figs. 3, 4a-b.

C. STURANI, BATHONIAN AMMONITES DIGNE AREA



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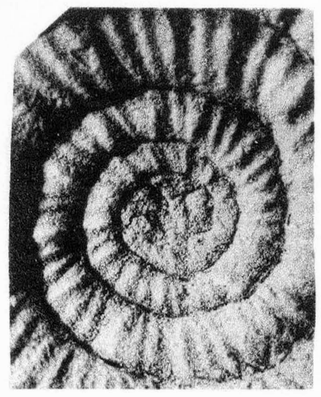


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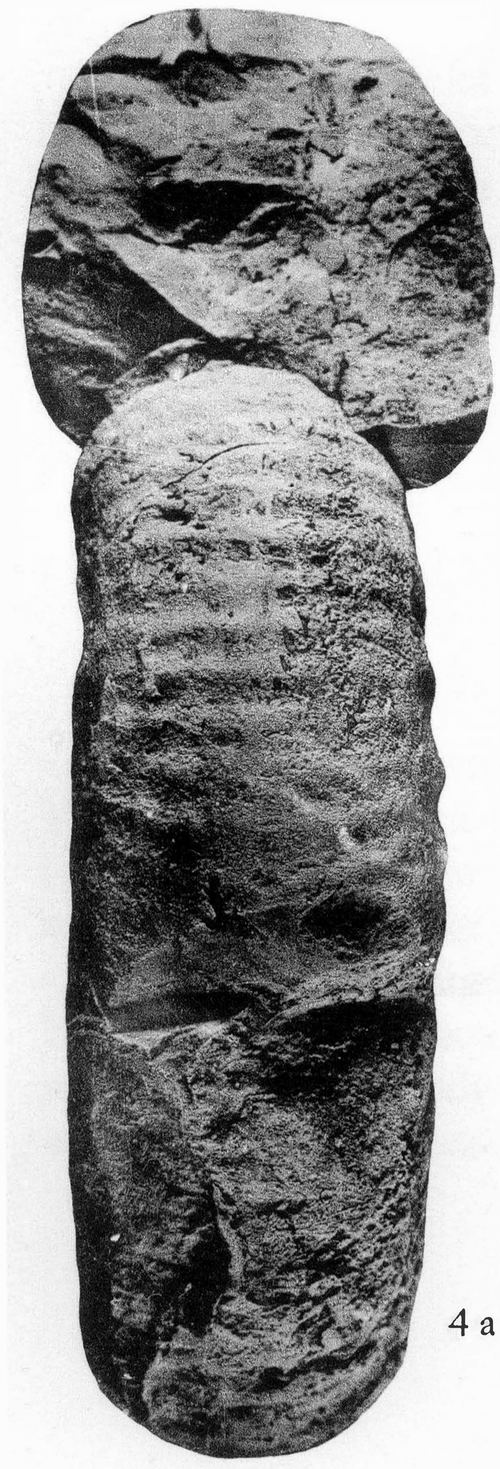
2 a

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3





4 a



4 b

PROCERITES SCHLOENBACHI De Grossouvre
Plate 14, figs. 2a-b; Plate 17, fig. 4 (suture line)

1958 *Procerites schloenbachi* De Grossouvre - Arkell 1951-59; pp. 181-183; text-figs. 62, 66 (? pl. 21, fig. 9). (*Cum syn.*).

For description see Arkell. A large and wholly septate specimen from the Lower Batonian of Bas Auran, in the Maurel collection at Barrême, shows near perfect agreement with Schloenbach's original figures (Arkell's text-fig. 62); its exact horizon is unfortunalely unknown.

Another very large and beautifully preserved specimen collected by Mr. G. Pavia in the Convergens subzone at Les Reichasses (Chaudon) is more evolute (the umbilicus is 7% wider than in the type) but shows the same style of ribbing, characterized by the strength and persistence of the ornamentation, with coarse secondaries, by reason of which I place this too (Plate 14, figs. 2a-b) in *P. schloenbachi,* comparing it with the large french specimen figured by Arkell (1951-59, text-fig. 66).

The type level of *P. schloenbachi* is Lower Bathonian; records from the Upper Bathonian given by De Grossouvre (see Arkell 1951-59; p. 183) may be misidentified.

PROCERITES FULLONICUS (S. Buckman)
Plate 12, fig. 3; Plate 17, fig. 5 (suture line)

1958 *Procerites fullonicus* (S. Buckman) - Arkell 1951-59; pp. 189-190; pl. 24, figs. 1-4; text-fig. 69/6. (*Cum sym.*).

There are 8 specimens from the basal Yeovilensis subzone of the Bas Auran section (two from bed 6, two from bed 5 and four others not in situ, but presumably from the same beds). The largest one, now in the H. S. Torrens' collection at Leicester, has nearly a whorl of body chamber and reaches a diameter of 300 mm.

The whorl section is highly oval, with a rather narrowly rounded venter, just as shown by Arkell's tex-fig. 69/6. The ribs are coarse and strong, especially the secondaries, which in some specimens are swept strongly forward after the point of furcation. The suspensive lobe (see Plate 17, fig. 5) is less strongly retracted than in the earlier congeneric forms and the saddles more open at their base.

There is perfect agreement between these specimens and the holotype, also in their proportions.

The type level is the uppermost Inferior Oolite and basal Lower Fuller's Earth of Somerset, England.

PROCERITES IMITATOR (S. Buckman)
Plate 15, fig. 5

1958 *Procerites imitator* (S. Buckman) - Arkell 1951-59; pp. 192-193; pl. 26, figs. 2-4; text-fig. 69/2. (*Cum syn.*).
non 1958 *Zigzagiceras (Procerozigzag) imitator* - Westermann 1958; p. 90; pl. 35, figs. a-b.

There are five specimens from the Yeovilensis subzone of the Bas Auran section (one from bed 6, two from the marly interbed 3-2; the others not *is situ,* but presumably from the same level). They resemble *P. fullonicus*, but have a much stouter whorl section, a broader venter and stronger ribs. For more details see Arkell's description. The small population from this locality is rather uniform and agrees with the holotype in every detail, but one: the ribbing is denser (42 against 32 primaries per whorl). Under this respect, it seems to make transition between *P. fullonicus* and the younger populations of *P. imitator,* such as those from England, where the present species ranges throughout the Middle and Upper Bathonian, up to the Aspidoides zone (*fide* H. S. Torrens).

The NW german specimen from the Lower Bathonian figured by Westermann is

obviously not conspecific, but it may belong to *Zigzagiceras (Procerozigzag)* or to *Wagnericeras.*

PROCERITES FOWLERI Arkell
Plate 13, fig. 5; Plate 15, fig. 4;
Plate 17, fig. 6

1958 *Procerites fowleri* - Arkell 1951-59; p. 191; pl. 24, fig. 5; text-fig. 69/4.

This is a large, evolute, smooth whorled *Procerites*. The whorl section is isodiametric and almost circular in outline up to about 30 mm; then it begins to increase in height and becomes elliptical, higher than wide, with a broadly rounded venter. The coiling is rather evolute, only 1/3 of each whorl being covered by the next one. The ribbing is dense and fine on the nucleus, up to a diameter of 40-50 mm; the ribs then become coarser and weaker; by a diameter of about 130 mm they have completely disappeared, only a few vague undulations persisting on the body chamber. The suture line (Plate 17, fig. 6) is close to that of *P. fullonicus,* with proportionally shorter elements. The maximum size is of about 250 mm, with just under or just over a whorl of body chamber, according to individuals. Some specimens show weak constrictions at irregular intervals, up to a diameter of about 50 mm.

At the Bas Auran section *P. fowleri* is confined to the base of the Yeovilensis subzone (9 specimens from beds 6 and 5). The type level (Lenthay beds) seems to occupy about the same position, since it overlies the Crackment Limestones, which have yielded both *Parkinsonia convergens, Morphoceras macrescens* and *Zigzagiceras* spp. (see Torrens (1964). *P. fowleri* has also been found in Bulgaria, at the same horizon, associated with *Oxycerites yeovilensis, Procerites fullonicus,* etc. (Boncev & Dimitrov 1965, p. 79).

PROCERITES (LOBOSPHINCTES) INTERSERTUS
(S. Buckman)
Plate 16, figs. 1-3, 6; Plate 17, fig. 1
(suture line)

1923 *Lobosphinctes intersertus* - S. Buckman, T. A., 5; pl. 447.
1964 *Procerites (Lobosphinctes) intersertus* (S. Buckman) - Sturani 1964b; pp. 34-35; pl. 4, fig. 5; text-fig. 30.

Buckman's type is an evolute and densely ribbed *Procerites,* with highly complex sutures, retaining quite strong constrictions at irregular intervals up to the end of the phragmocone (confirmed by H. S. Torrens). Its type level, according to Buckman, is Parkinsoni zone. Conspecific specimens, more finely ribbed than the holotype but possessing the same complex sutures and constrictions, are also known from the Parkinsoni zone of the Venetian Alps; their exact horizon, however, might be Lower Bathonian as well, because they occur in a strongly condensed sequence (Sturani 1964b, p. 5).

P. (Lobosphinctes) intersertus is very well represented in the Convergens subzone of the Digne area: there are over 15 specimens from Chaudon and two others from Bas Auran (beds 14 and 12). All show perfect agreement with the holotype, as for the most characteristic features: the suture line is of the very same type (Plate 17, fig. 1), with the stem of the external lobe narrower and longer than in *Procerites* s.s.; the first lateral lobe very slender as in *P. tmetolobus*; the suspensive lobe strongly retracted, its highest branch (first auxiliary) almost at right angles to the first lateral and almost touching its point; the accessory elements of the first lateral, second lateral and the auxiliaries are intelocked together (whence the specific name). The ribbing, on the outer whorls, is strong, mainly biplicate, with coarse secondaries, of typical *Procerites* - like style; it persists without weakening up to the end of the phragmocone, which

EXPLANATION OF PLATE 19

Fig. 1, 4a-b - *Zigzagiceras (Procerozigzag) pseudoprocerum* (S. Buckman).
Fig. 1. A rather coarsely ribbed morphotype, transitional to *Z. (P.) crassizigzag*. Bas Auran, Lower Bathonian, Macrescens sbz. (bed 11).
Figs. 4a-b. Inner whorls of another morphotype, closer to the holotype. Bas Auran, same bed. Pag. 50.

2a-b, 6a-b - *Zigzagiceras plenum* Arkell; wholly septate specimens. Both from Bas Auran, Lower Bathonian, Macrescens sbz. (bed 11). Pag. 47.

3a-b - *Zigzagiceras euryodos* (Schmidt); an incomplete specimen, wholly septate. Bas Auran, Lower Bathonian, Macrescens sbz. (bed 10 or 11). Pag. 47.

5 - *Zigzagiceras torrensi* n. sp. *variecostatum* n. ssp.; paratype, incomplete and wholly septate. Bas Auran, Lower Bathonian, Macrescens sbz. (bed 8). Also figured on Plate 13, figs. 4a-c. Pag. 48.

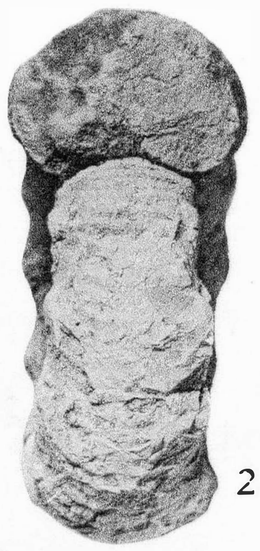
7 - *Zigzagiceras (Procerozigzag) postpollubrum* Wetzel. Medium-sized specimen, showing the beginning of the body chamber and probably not fully grown. Bas Auran, Lower Bathonian, topmost Macrescens sbz. (bed 7). Note the zigzag nucleus. Pag. 50.

All photos. natural size.

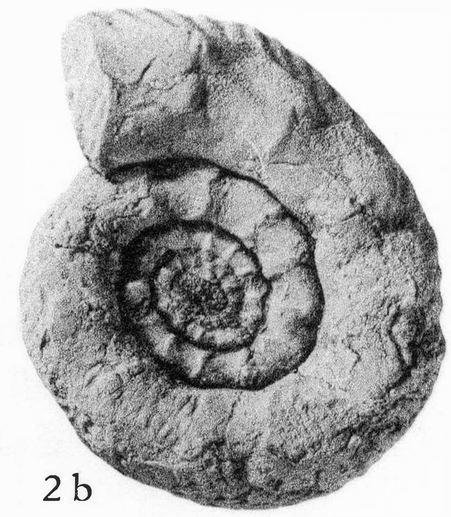
C. STURANI, BATHONIAN AMMONITES DIGNE AREA



1



2 a



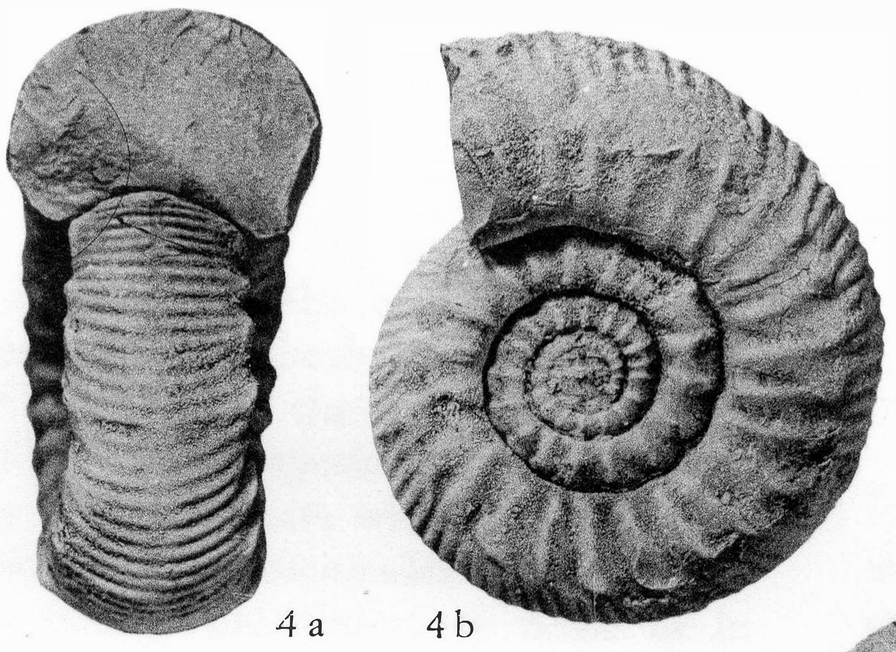
2 b



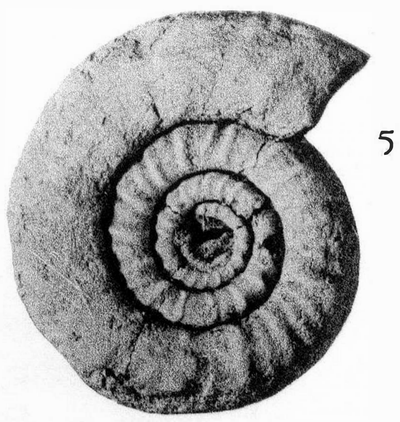
3 a



3 b



4 a 4 b



5



6 a



6 b



7

attains about 250 mm in the largest specimens (none have the body chamber preserved). All specimens show constrictions, of variable strength and at irregular intervals, up to the end of the phragmocone. In most of them the adult whorl section is highly oval, with a regularly rounded venter and the maximum thickness in the inner half. Slightly more to slightly less than half a whorl is covered by the next one, according to individuals.

The rich assemblage from the Digne area shows a certain variability, concerning the degree of involution, the density of ribbing and the shape of the whorl section.

Only a few specimens, as that of Plate 16, figs. 1a-b, which has been figured without the outer whorls for comparison with *Bigotites diniensis* n. sp., are as densely ribbed and evolute as the holotype, which measures: max 156 mm; at 142 mm: .32,5; .31; .41.

The commonest morphotype within the population from the Basses-Alpes is exemplified by the fine, wholly septate specimen figured on Plate 16, fig. 6; this is slightly more involute than the holotype, with proportionally higher whorls; its measurements, at 137 mm (end of the phragmocone), are: .37; .30; .37. This specimens has 44 primaries on the last septate whorl (ten less than the holotype, at a comparable diameter), but the secondaries are almost as dense as in the latter, because there are no simple ribs, while free intercalatories are frequent.

Another morphotype, represented by a single specimen from Chaudon, is characterized by a tumid whorl section, almost circular in outline and reminiscent of some Upper Bajocian *Bigotites*. Its measurements, at 86 mm, are: .35; .35; .43.

Several specimens allow the study of the inner and middle whorls; these are more evolute, with a more depressed section, at first wider than high, then isodiametric up to about 50-60 mm. The ribbing is dense, sharper than on the outer whorls. Constrictions of variable strength are always present, and the whorls enlarge by segments between them. The secondaries are always weakened and often quite interrupted on the median line; they are usually more or less displaced on both sides of this smooth band, as in *Bigotites*. Such primitive features are more or less conspicuous, according to individuals, but usually persist up to a higher diameter than in *Procerites* s.s.

PROCERITES (PHAULOZIGZAG) PHAULOMORPHUS (S. Buckman)

Plate 15, figs. 3a-b

1958 *Procerites (Phaulozigzag) phaulomorphus* (S. Buckman) - Arkell 1951-59; pp. 203-204; text-figs. 64/1-2. (*Cum syn.*).

? 1958 *Procerites (Phaulozigzag) phaulomorphus* (Buckman) - Westermann 1958; p. 77; pl. 33, figs. 2a-c.

A single, wholly septate specimen from the Convergens subzone of Le Touert (Chaudon) is 36 mm in diameter and is almost identical to the holotype and the topotype figured by Arkell, whom see for fuller description.

The general aspect is that of a miniature *Procerites subprocerus* at the adult stage. It may be noticed that both in the holotype and in the present specimen the secondaries are weakened and almost imperceptibly displaced on the median line, just as in some *Procerites* (especially *P. tmetolobus*).

PROCERITES? (GRACILISPHINCTES?) spp. plur. ind.

Plate 10, figs. 3a-b; Plate 24, fig. 6

There are several specimens, most of which fragmentary or nuclei, from the highest part of the Yeovilensis subzone at Bas Auran (bed 2), which could belong to *Gracilisphinctes*. The most complete one is 55 mm in diameter and has part of the body chamber preserved (Plate 10, figs. 3a-b); it

is rather evolute, with a rounded whorl section, and it has got three constrictions. This specimen shows some resemblance with the nuclei figured by Arkell (1951-59; pl. 28, figs. 3-6), which are however already more involute, at a comparable diameter.

The specimen figured on Plate 24, fig. 6 is more involute and more densely ribbed; it recalls *P. (G.) verciacensis* (Lissajous) (1923; pl. 7, fig. 1).

More and better preserved material is however needed before we can confirm the presence of *Gracilisphinctes* in the Bathonian of this region, beyond any reasonable doubt.

Wagnericeras fortecostatum (De Grossouvre)
Plate 24, figs. 8-9

1958 *Wagnericeras fortecostatum* (De Grossouvre) - Arkell 1951-59; pp. 204-205; pl. 29; figs. 2-3; text-fig. 76/4. (*Cum syn.*).

Five specimens from the Progracilis zone of the Bas Auran section (bed 1) closely agree with the holotype. The one figured on Plate 24, fig. 9, has 25 primaries on the last septate whorl and measures: max 115 mm (est.); at 100 mm: .41; .36; .34. Another specimen shows a single, shallow constriction and is slightly more evolute, its measurements being: max 130 mm; at 100 mm: .38; .35,6; .38. None of these specimens shows the nucleus.

The type level of *W. fortecostatum,* in the Dépt. Nièvre, is Middle Bathonian; in England this species ranges from the Progracilis zone (*fide* H. S. Torrens) up to the basal Upper Bathonian.

Wagnericeras (?) n. sp. ind.
Plate 20, fig. 1

A single specimen collected by H. S. Torrens in the Macrescens subzone of the Bas Auran section (bed 8), is 87 mm in diameter and shows the beginning of the body chamber. The whorl section, higher than wide, is rounded - triangular, with a short but well marked umblical wall, convergent sides, a narrowly rounded venter and the maximum thickness near the umbilical margin. The primary ribs are strong, but rounded and blunt; they are also proportionally short, being entirely confined to the inner third of the whorl sides, and are usually triplicate; additional free intercalatories are also present. The secondaries are blunt; near the end of the phragmocone they tend to fade, starting from the furcation points. Shallow, broad and prorsiradiate constrictions are also present, one every half a whorl. The nucleus is broken, up to about 6 mm; at this diameter it is densely and finely ribbed. The coiling is moderately involute, slightly more than one half of each whorl being covered by the next one.

The suture lines are proportionally simple, with short elements, as in typical *Wagnericeras.*

The measurements, at 81 mm (end of the phragmocone) are: .34,5; ?; .40.

The style of ribbing, apart from its smoothness, and the simple sutures seem to justify the attribution of the present specimen to *Wagnericeras;* if such assumption is correct, this would probably be the earliest known representative of that genus. Additional material is however needed before naming this species, which is probably new, and confirming its taxonomic position.

Zigzagiceras zigzag (d'Orbigny)
Plate 20, figs. 3a-b

1958 *Zigzagiceras zigzag* (d'Orbigny) - Arkell 1951-59; pp. 177-178; text-fig. 60/1-3. (*Cum syn.*).

A single, wholly septate specimen belonging to this well known species has been collected in the basal Macrescens subzone of the Bas Auran section (bed 11). It has

EXPLANATION OF PLATE 20

Fig. 1 - *Wagnericeras* (?) n. sp. ind. Bas Auran, Lower Bathonian, Macrescens sbz. (bed 8). Specimen collected by H. S. Torrens. Pag. 46.

2a-b - *Zigzagiceras torrensi* n. sp. *variecostatum* n. ssp. Holotype. Bas Auran, Lower Bathonian, Macrescens sbz. (bed 8). Specimen collected by H. S. Torrens. Pag. 48.

3a-b - *Zigzagiceras zigzag* (d'Orbigny). Bas Auran, Lower Bathonian, basal Macrescens sbz. (bed 11). Specimen collected by H. S. Torrens. Pag. 46.

4a-b - *Zigzagiceras lenthayense* (Arkell). Bas Auran, Lower Bathonian, Macrescens sbz. (bed 8). H. S. Torrens coll. Note lappets. Pag. 49.

All photos. natural size.

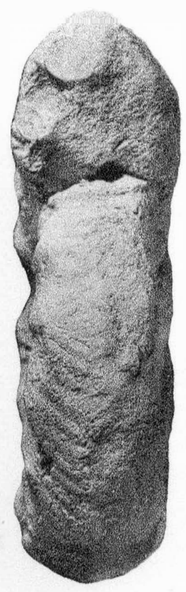
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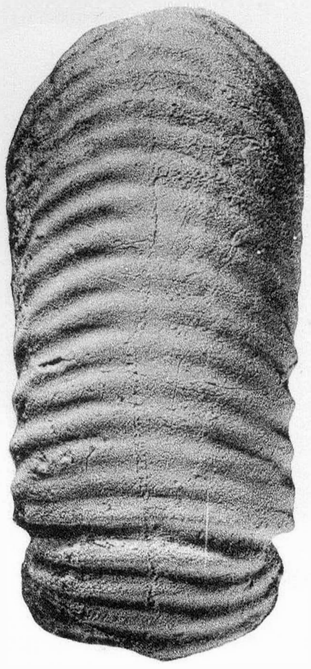
1



2a



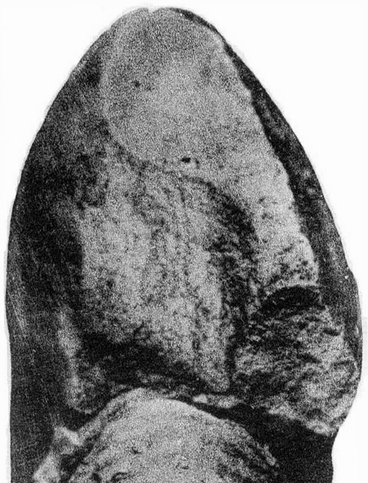
3a

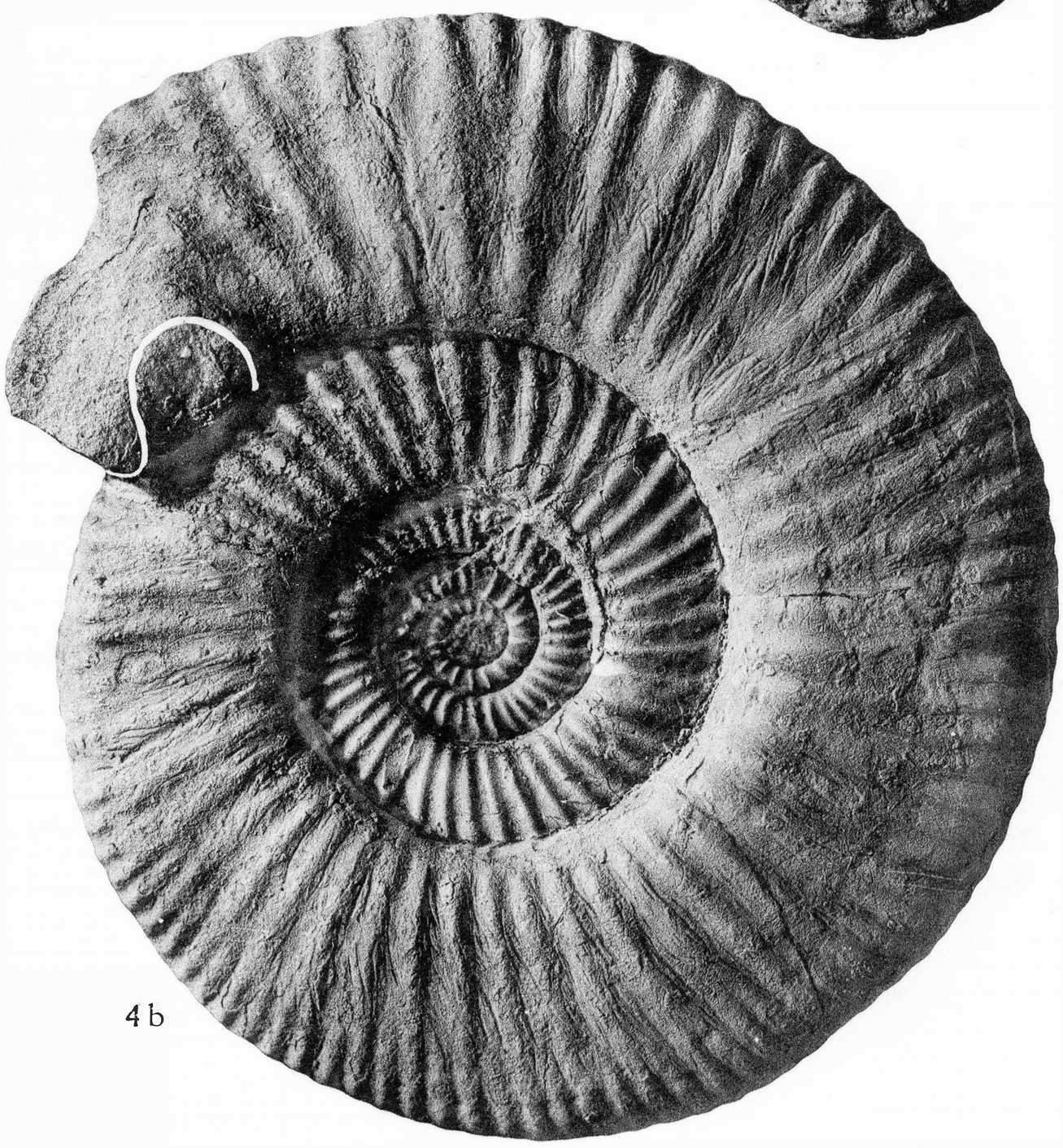


2b

3b







4a

4b

14 ribs on the last septate whorl (three more than the holotype) and shows a compressed section. As pointed out by Arkell, *Z. zigzag* is distinguished from the other congeneric forms mainly because of its more compressed section and the distant spacing of the ribs. Until more material becomes available for statistical measurements (it should be noted that the present species is by no means common), it is difficult to to state whether *Z. zigazag, Z. euryodos* and *Z. plenum,* which occur at the same level, are really good species or, rather, simple morphotypes, as the study of their macroconch dimorphs would suggest (see below).

Zigzagiceras plenum Arkell
Plate 2, fig. 3; Plate 19, figs. 2a-b, 6a-b; text-fig. 4.

1958 *Zigzagiceras plenum* - Arkell 1951-59; p. 179; pl. 20, fig. 5; pl. 21, figs. 2, 4, 5; pl. 22, fig. 7.

Four specimens from the basal part of the Macrescens subzone (bed 11) at Bas Auran show perfect agreement with the type series from the Zigzag zone of England, figured by Arkell, whom see for description.

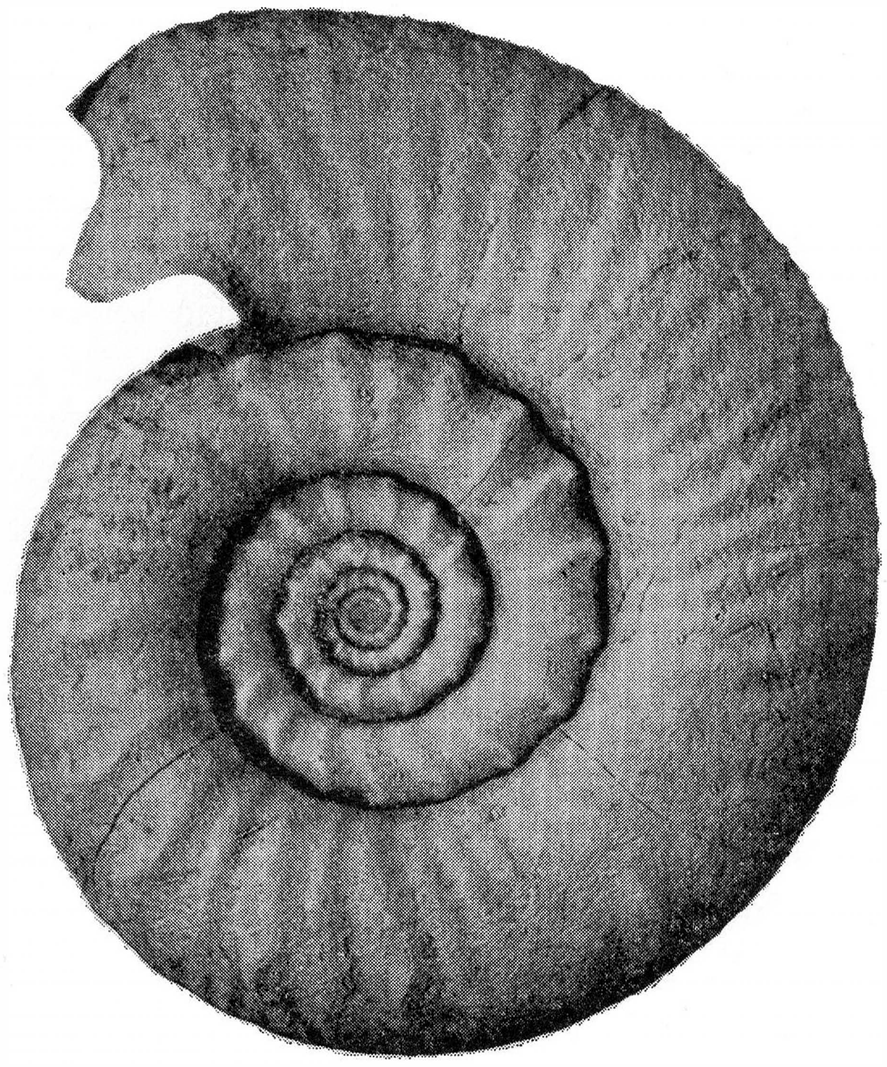
The beautiful specimen figured on Plate 2, fig. 3 and on text-fig. 4, reaches a diameter of 72 mm, with three quarters of a whorl of body chamber, and has got two short lappets. It also shows the recurrence of some parabolic nodes among the perisphinctoid ribbing, on the beginning of the body chamber, just as described by Arkell.

Zigzagiceras euryodos (Schmidt)
Plate 19, figs. 3a-b

1958 *Zigzagiceras euryodos* (Schmidt) - Arkell 1951-59; pp. 178-179; pl. 21, figs. 1, 3, 6; text-fig. 60/4. (*Cum syn.*).

There are four specimens from Bas Auran (beds 11 and 10, Macrescens subzone). For description see Arkell.

The largest one has got most of the body chamber, while the others, including the one figured, are septate throughout.



Text-fig. 4

Zigzagiceras plenum Arkell

Bas Auran, Lower Bathonian, presumably from the basal Macrescens subzone. Maurel Collection. X 1.

The whorl section is intermediate in shape between those of *Z. zigzag* and *Z. plenum*; the parabolic ribs, on the other hand, are slightly denser than in both those species.

Zigzagiceras torrensi n. sp.
Plate 2, fig. 4; Plate 21, figs. 3a-b

This is the microconch counterpart of *Procerozigzag postpollubrum garnieri* n. ssp., of which it has the same type of development in the style of ribbing.

Two specimens are known from the Macrescens subzone of the Bas Auran section, both from bed 9. The largest one is 56 mm in diameter and has part of the body

chamber preserved; its measurements are: at 54 mm: .35; .41,6; .42,5. The other one is smaller and wholly septate, but it is better preserved and has therefore been chosen as holotype (Plate 21, figs. 3a-b); its measurements are: max. 47 mm; at 43 mm: .34,8; .40,7; .45.

The nucleus has distant zigzag nodes up to about 15 mm; then, for half a whorl and up to about 20 mm, a normal rib appears between every parabolic one; from 20 to 27 mm there are two normal ribs between each stronger one; beyond this the parabolic nodes disappear and the ribs, biplicate or simple, are all of the same strength. At this stage the whorl section is stout, almost circular in outline and slightly wider than high, with strongly convex sides. The larger paratype shows a weak, irregular constriction at the beginning of the body chamber.

This species, that I am glad to dedicate to H. S. Torrens, differs from all the congeneric ones in the peculiar development of the style of ribbing, which passes through a stage transitional to *Siemiradzkia* before the parabolic nodes fade out (see Plate 2).

The nuclei of *Z. (Procerozigzag) postpollubrum garnieri* n. ssp., at a comparable diameter, are more involute but otherwise similar.

ZIGZAGICERAS TORRENSI n. sp.
VARIECOSTATUM n. ssp.
Plate 2, fig. 5; Plate 13, figs. 4a-c;
Plate 19, fig. 5; Plate 20, figs. 2a-b

Four specimens from the beds next above that yielding the type of *Z. torrensi* n. sp. (8 and 7) show the same style of ribbing, but differ in several other important features. The zigzag stage is more densely ribbed and proportionally shorter, ending at 10 mm; the following stage, transitional to *Siemiradzkia,* is on the other hand longer and lasts for about two whorls (a stronger rib ending in a parabolic node between every two - three normal primaries). The whorl section is slightly wider than high at all stages and subquadrate in shape, instead of rounded; the venter is much broader and more flattened than in typical *Z. torrensi* n. sp.; the proportions are also different. The specimen figured on Plate 13, figs. 4a-c measures: max 29 mm (wholly septate and certainly incomplete); at 29 mm: .31; .36; .50. The largest known specimen attains a diameter of at least 60 mm (est.) and has retained nearly half a worl of body chamber; on this, a quite strong constriction is visible (Plate 20, figs. 2a-b).

On account of their occurrence in younger beds and of the above mentioned differences, the present specimens seem to be worthy of recognition as representatives of a separate subspecies. The one figured on Plate 20, figs. 2a-b has been chosen as holotype, mainly because it shows all the stages of ribbing (the paratypes lack the outer whorls).

The great interest of this subspecies is that it shows a clear transition between typical *Zigzagiceras* and typical *Siemiradzkia,* previously thought totally unrelated. We shall in fact see that the style of ribbing of *S. aurigera,* which appears in the next highest beds, at the base of the Yeovilensis subzone, follows the same evolutive pattern, with the difference that the zigzag stage is even shorter, the stage with stronger and normal ribs alternating is longer (up to three whorls) and the parabolic nodes persist almost to the end of the body chamber (Plate 2, fig. 6; see also Plate 18, fig. 3).

ZIGZAGICERAS LENTHAYENSE (Arkell)
Plate 20, figs. 4a-b

1958 *Procerites? (Phaulozigzag?) lenthayensis* - Arkell 1951-59; p. 204; pl. 23, figs. 6a-b.

A beautiful specimen collected by H. S. Torrens in the Macrescens subzone of the

EXPLANATION OF PLATE 21

Fig. 1, 7a-b - *Zigzagiceras (Procerozigzag) postpollubrum* Wetzel *garnieri* n. ssp.
Figs. 7a-b. Holotype. Bas Auran, Lower Bathonian, Macrescens sbz. (bed 8). Pag. 51.

2a-b - *Zigzagiceras (Procerozigzag) crassizigzag* (S. Buckman); a morphotype with extremely depressed whorls. Bas Auran, Lower Bathonian, Macrescens sbz. (interbed 10-9). Pag. 49.

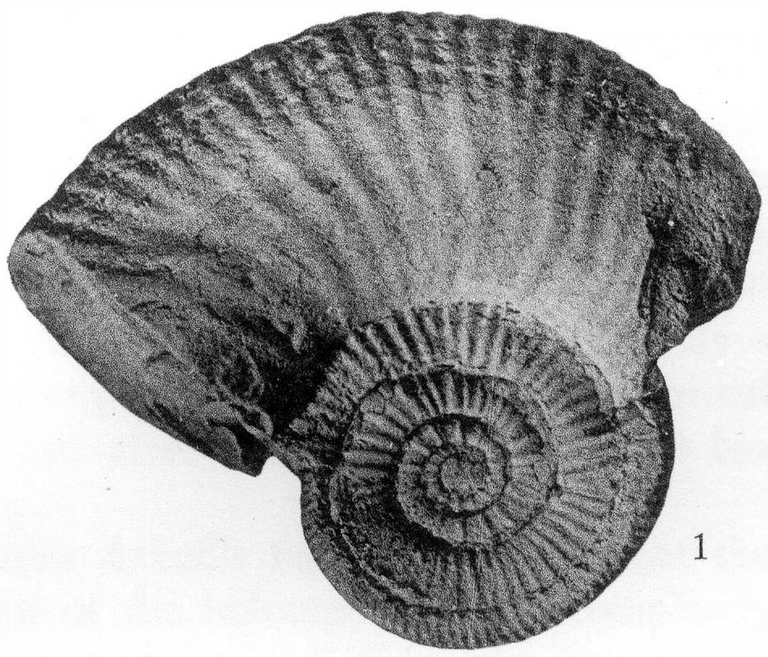
3a-b - *Zigzagiceras torrensi* n. sp. Holotype. Bas Auran, Lower Bathonian, Macrescens sbz. (bed 9). Pag. 47.

4-5 - *Epistrenoceras subcontrarium* (Behrendsen), morphotype *termieri* (R. Douvillé). Chaudon, Upper Bathonian. Both X 1,8. Pag. 29.

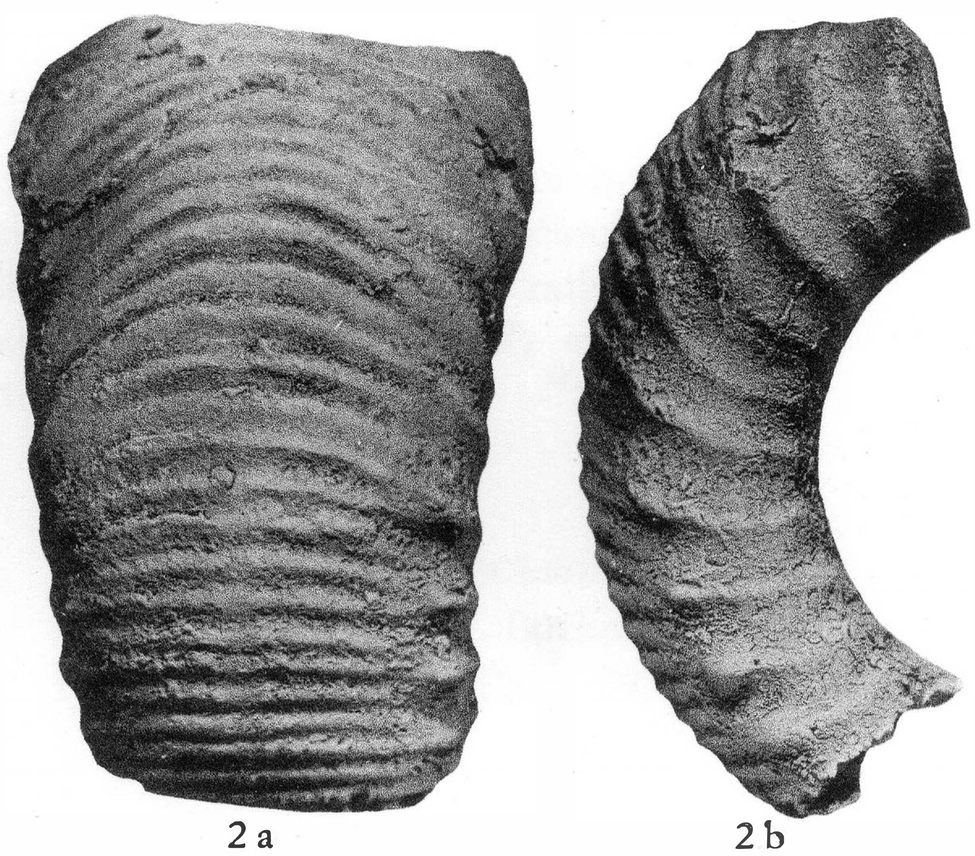
6 - *Epistrenoceras subcontrarium* (Behrendsen); another variant, closer to the holotype. Chaudon, Upper Bathonian, X 1,8. Pag. 29.

All photos. natural size except Figs. 4-6.

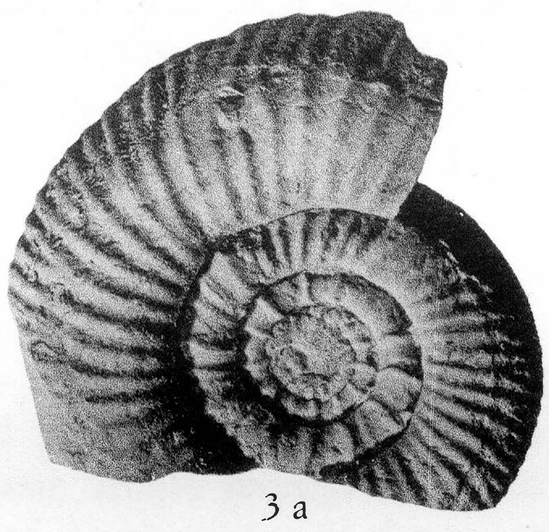
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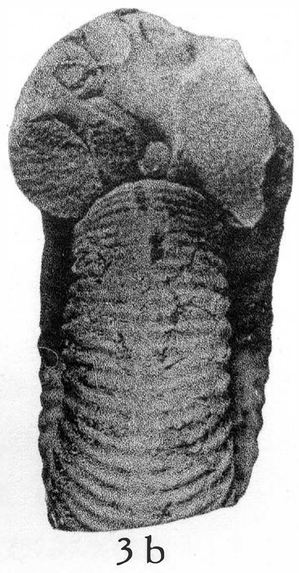
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2 a 2 b



3 a



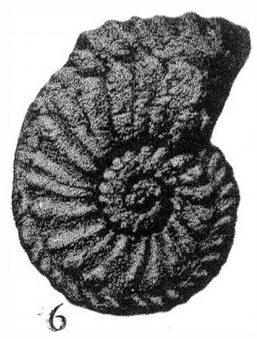
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4



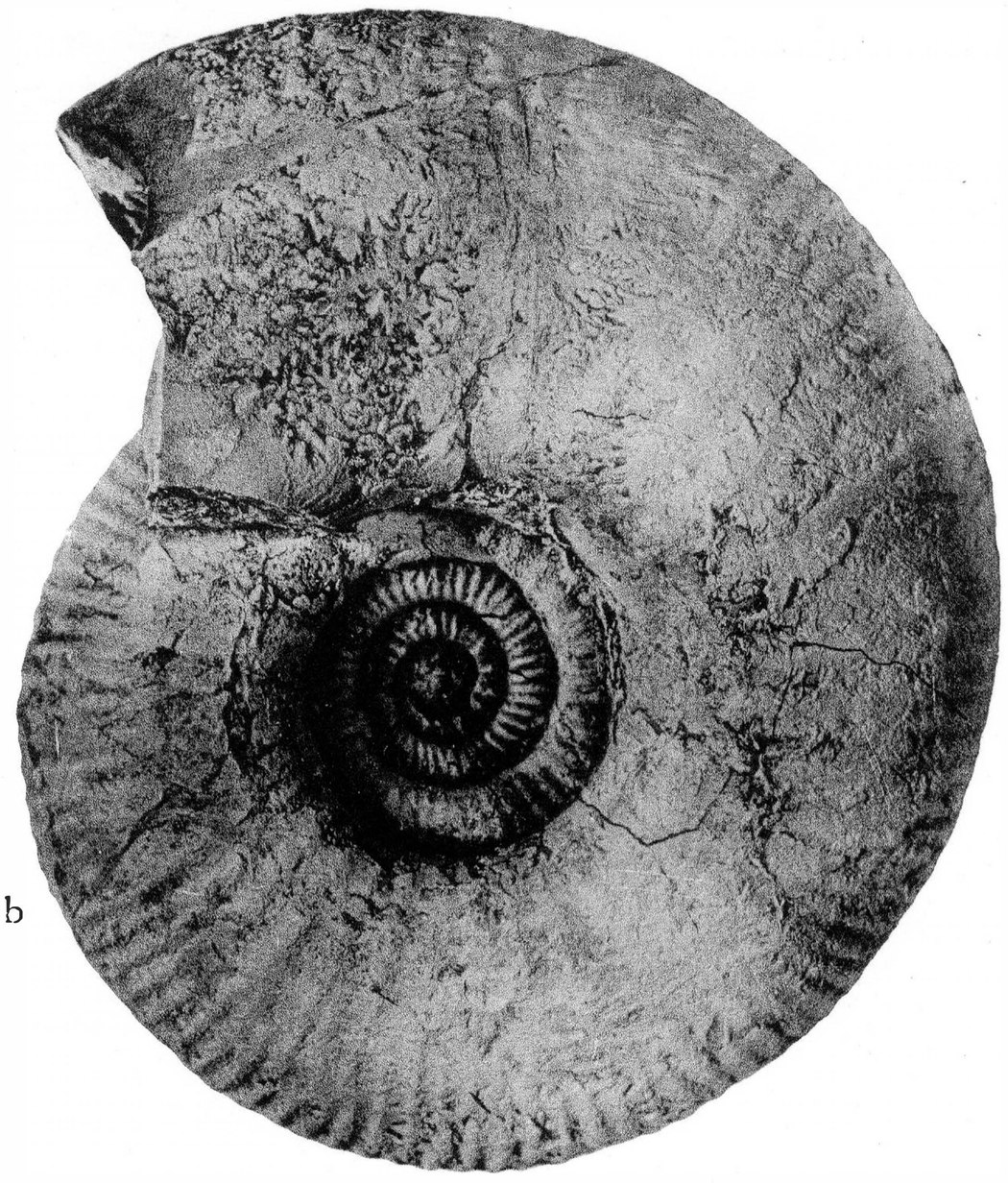
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6



7 a



7 b

Bas Auran section (bed 8) is almost identical to the holotype, showing the same style of ribbing and the characteristic compressed, trapezoidal whorl section. It has just under a whorl of body chamber and measures: max 110 mm; at 100 mm: .31,5; .26; .44.

The peristome has large, undoubted lappets. The nucleus, well exposed on both sides, is of the zigzag type and has well spaced primaries ending in parabolic nodes, up to about 12 mm diameter; in the following half a whorl the primaries get closer and closer while the nodes begin to fade; only a few stronger ribs recur among the normal ones, just after the perisphinctoid stage has set in.

From Arkell's figure it appears that the nucleus of the holotype is either completely worn or not exposed. Since the features of the middle and outer whorls do not suggest, by themselves, any possible link with typical *Zigzagiceras,* Arkell's doubts concerning the taxonomic position of this species were comprehensible. It should also be noted that this is one of the largest known species within *Zigzagiceras* s.s.

Z. torrensi n. sp. *variecostatum* n. ssp., found at the same level, has a completely different whorl section and also a different type of development in the ornamentation.

ZIGZAGICERAS aff. LENTHAYENSE (Arkell)
Plate 12, figs. 2a-c

A single, full grown specimen from the marly interbed 8-7 of the Bas Auran section is rather similar to that of *Z. lenthayense* just described, in the proportions and in the general aspect. It differs, however, in the following features: the whorl section, higher than wide, is perfectly elliptical instead of high trapezoidal; the ribbing (49 primaries per whorl) is denser and finer; the zigzag stage is even shorter, ending before a diameter of 8 mm is reached, and it is more irregularly and more densely ribbed; a stage transitional to *Siemiradzkia* follows for nearly a whorl more, up to 15 mm; from that diameter onward the ribbing is normal, of the perisphinctoid type.

When complete, this specimen should have attained a diameter of 120 mm, with three quarters of a whorl of body chamber; the actual maximum diameter is 105 mm; the other measurements, at 90 mm, are: .35,5; .31; .41.

Until more specimens are not found, it is uncertain whether this should be considered a good species or, rather, a simple morphotype within a highly variable population.

ZIGZAGICERAS (PROCEROZIGZAG) CRASSIZIGZAG (S. Buckman)
Plate 21, figs. 2a-b; Plate 23, fig. 1

1958 *Procerozizag crassizigzag* (S. Buckman) - Arkell 1951-59; pp. 179-180; pl. 20, figs. 6-9; pl. 22, fig. 6; text-fig. 61. (*Cum syn.*).

Nine specimens from the basal part of the Macrescens subzone of the Bas Auran section (beds 11, 10 and the marly interbed 10-9) are known. For description see Arkell.

Only few show near perfect agreement with the lectotype; these are much more coarsely ribbed than any congeneric form, at any stage of growth; their zigzag stage ends at about 70 mm; by this diameter the well spaced primaries get closer and closer, while the parabolic nodes tend to fade; then the ventrolateral shoulder becomes rounded and eventually the final, coarsely ribbed *Procerites*-like stage sets in. The adult whorl section is particularly stout, wider than high and reniform in shape. The largest specimen, wholly septate, reaches 200 mm; with the body chamber added it would probably exceed 300 mm.

A few other specimens are slightly more densely ribbed and probably transitional to *Z. (P.) pseudoprocerum,* morphotype *rhabdouchus,* while that of Plate 21, figs. 2a-b is

believed to represent another extreme morphotype, with particularly depressed whorls, twice as wide as high.

When more material becomes available for statistical measurements it is quite probable that the specific distinction between *Z. (P.) crassizigzag* and *Z. (P.) pseudoprocerum* will prove superfluous, these being only morphotypes within a single, highly variable species.

There is one more detail concerning this species: I do not agree with Arkell's statement (1951-59, p. 180) that *Stephanoceras* aff. *brodiaei* (Sow.) Burckhardt and *S. floresi* Burckhardt, from the Middle Jurassic of Mexico, are close to *P. crassizigzag* and Lower Bathonian in date; from Burckhardt's original figures (1927; pl. 12, figs. 10-11 and 14-16, 18-20 respectively) they seem to belong in the Middle Bajocian genus *Stemmatoceras,* as already stated by Burckhardt, who compared them with *S. frechi* Renz.

ZIGZAGICERAS (PROCEROZIGZAG)
PSEUDOPROCERUM (S. Buckman)

Plate 19, figs. 1, 4a-b; Plate 22, figs. 2a-b; Plate 23, figs. 2-3

1958 *Procerozigzag pseudoprocerus* (S. Buckman) - Arkell 1951-59; pp. 180-181; pl. 20, figs. 1-4, 10; pl. 21, fig. 7. (*Cum syn.*).

Over 20 specimens have been collected in the basal part of the Macrescens subzone of the Bas Auran section (beds 11, 10 and the marly interbed 10-9). For description see Arkell.

A few show good agreement with the holotype. The largest one attains 180 mm in diameter and shows the beginning of the body chamber; in the last whorl its section is isodiametric, stoutly oval in shape, with the maximum thickness near the umbilical margin. Two smaller specimens (incomplete) are particularly close to Arkell's pl. 20, fig. 4 and pl. 21, fig. 7; one of these has been figured on Plate 19, figs. 4a-b. The passage from the zigzag stage to the perisphinctoid middle and outer whorls is accomplished in an identical way as in *P. crassizigzag* (see above), but occurs earlier, between 40 and 50 mm, according to individuals.

On both sides of this median morphotype there are other variants. A first group of specimens, including the one figured on Plate 19, fig. 1, is more coarsely ribbed and has a slightly stouter whorl section, being particularly similar to the holotype of *Z. (P.) rabdouchus* (S. Buckman), which has been placed by Arkell in synonymy with *Z (P.) pseudoprocerum*; these are clearly transitional to *Z. (P.) crassizigzag* (see above).

A second group, including six specimens mainly from bed 10 and the marly interbed 10-9, is more densely ribbed, has a shorter zigzag stage ending at about 25 mm, and a different adult whorl section, slightly narrower, more flattened laterally and with a more abrupt umbilical wall (see Plate 22, figs. 2a-b, and Plate 23, fig. 3). These are believed to represent an extreme morphotype, from which *Z. (P.) postpollubrum garnieri* n. ssp. evolved, in the next highest beds.

ZIGZAGICERAS (PROCEROZIGZAG)
POSTPOLLUBRUM Wetzel

Plate 19, fig. 7; Plate 22, figs. 1a-b; Plate 23, fig. 6

1937 *Zigzagiceras postpollubrum* - Wetzel 1937; p. 107; pl. 11, figs. 3a-b (holotype).

The holotype comes from the Lower Bathonian of Vandenesse, Dept. Nièvre, and is a large, smooth, involute, deeply umbilicated ammonite, whose general aspect is more reminiscent of *Suspensites* or *Lycetticeras* than of any previously known *Pro-*

EXPLANATION OF PLATE 22

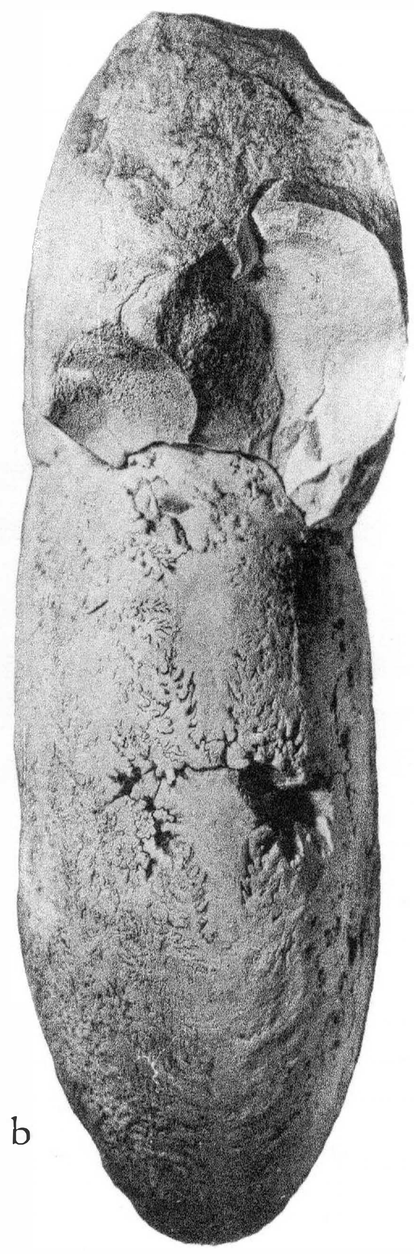
Fig. 1a-b - *Zigzagiceras (Procerozigzag) postpollubrum* Wetzel; fully grown specimen, retaining the whole body chamber. Bas Auran, Lower Bathonian, Macrescens sbz. (bed 7). X 0,4. Pag. 50.

2a-b - *Zigzagiceras (procerozigzag) pseudoprocerum* (S. Buckman); densely ribbed morphotype, with a more abrupt umbilical wall and a shorter zigzag stage. Bas Auran, Lower Bathonian, Macrescens sbz. (bed 10). X 0,5. Pag. 50.

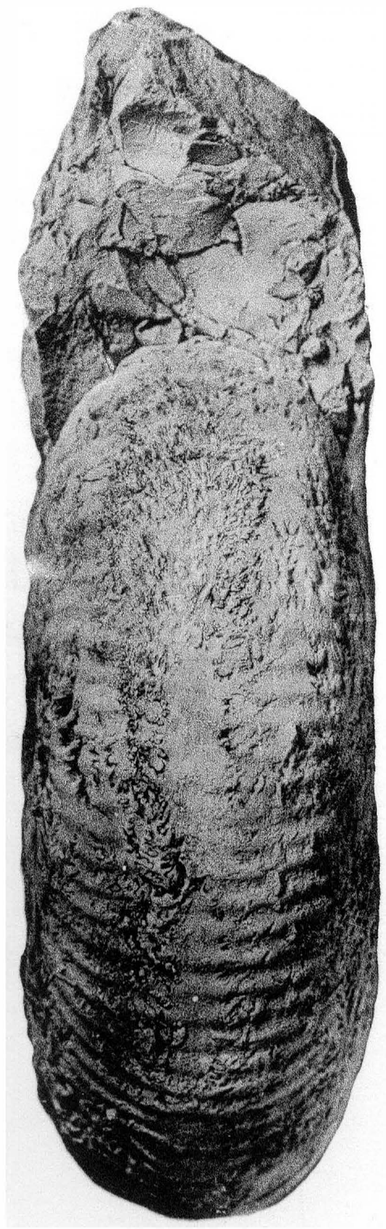
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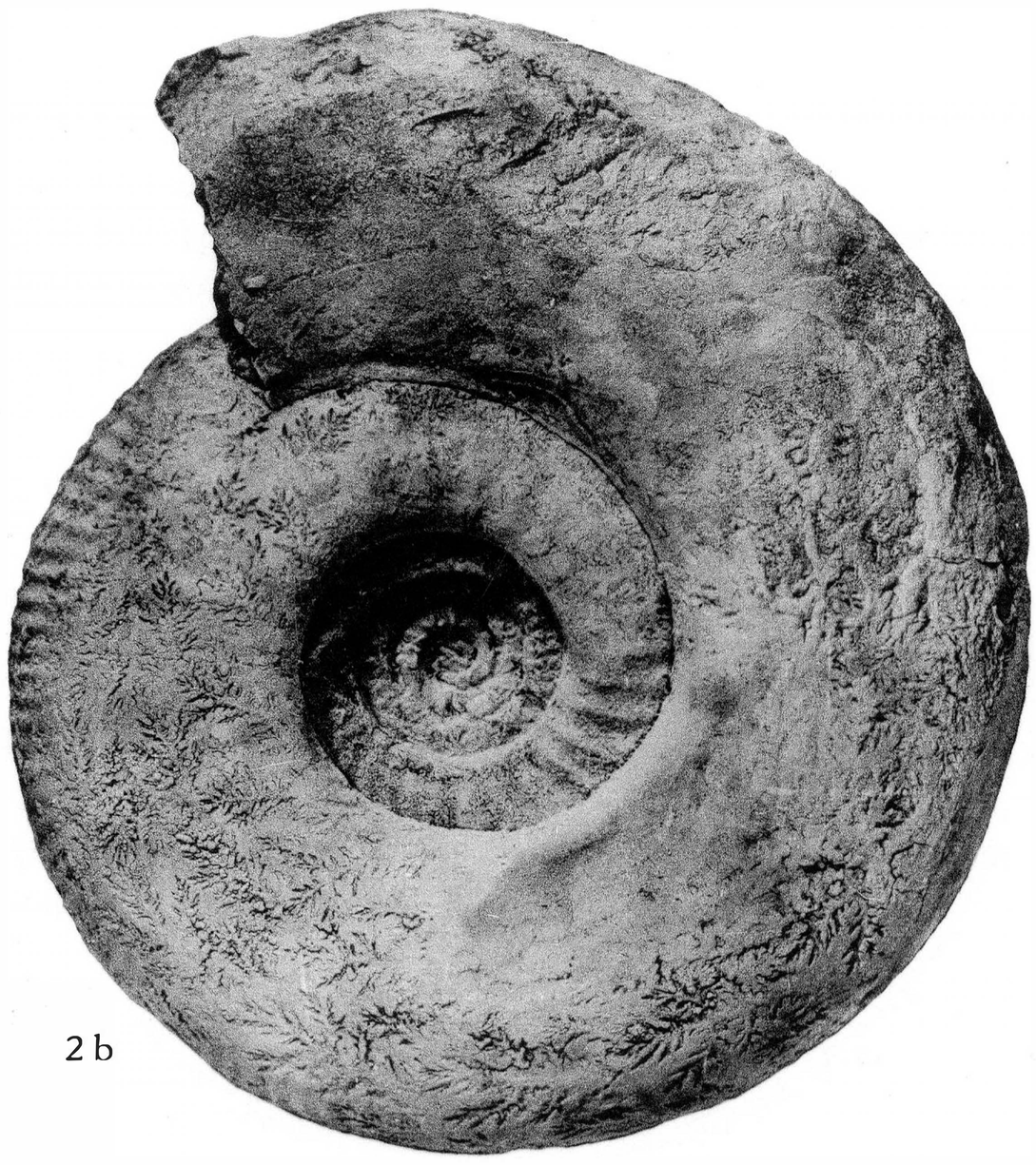
1 a



1 b



2 a



2 b

cerozigzag. The presence of a zigzag nucleus and the subsequent development of the ornamentation, excellently described by Wetzel, are nevertheless typical of the latter genus.

Specimens almost identical to the holotype (see Plate 22, figs. 1a-b) are well represented at Bas Auran and are confined to the topmost part of the Macrescens subzone (bed 7 and the marly interbed 7-6). These appear to be the end members of a wider chronospecies, beginning two beds earlier with more evolute and less stoutly whorled forms (*P. postpollubrum garnieri* n. ssp.; see below).

The nominate subspecies is represented by 5 specimens, at different stages of growth (three others are in the Maurel collection). The zigzag nucleus is clearly shown by two of the better preserved ones and it is much shorter than in *Z. (P.) crassizigzag* and *Z. (P.) pseudoprocerum,* ending at about 10-12 mm. Next seems to follow directly the normal perispinctoid ribbing, without the intercalation of a stage transitional to *Siemiradzkia,* as that shown by most specimens of *P. postpollubrum garnieri* n. ssp.

The umbilicus is crater-like and very narrow, while the whorl section, stouter than that of the other subspecies, is isodiametric and rounded-triangular in shape (plate 23, fig. 6). The primary ribs fade at about 80 mm diameter, the secondaries at 120 mm, well before septation ceases and proportionally earlier than in *P. postpollubrum garnieri* n. ssp.

The specimen figured on Plate 19, fig. 7 measures: max. 108 mm; at 100 mm; .48; .48; .24. The maximum size of other full grown specimens reaches 250 mm, with the body chamber.

Records of « *Suspensites arbustigerus* » from the Lower Bathonian, by several authors, may in some cases refer to misidentified specimens of *P. postpollubrum* (see Westermann 1958; pl. 34, figs. 4a-b, for instance). The same remark applies to the record of « *Pachyceras* » sp. from the Lower Bathonian of Castellane, in this same region (Haug 1891; p. 80).

Zigzagiceras (Procerozigzag) postpollubrum Wetzel garnieri n. ssp.

Plate 15, figs. 1a-c; Plate 21, figs. 1, 7a-b; Plate 23, figs. 4-5

1937 *Zigzagiceras* cf. *subprocerus* (non S. Buckman) - Wetzel 1937; p. 107; pl. 11, figs. 2a-b.

? 1958 *Procerites subprocerus* (non S. Buckman) - Westermann 1958; p. 76; pl. 32, figs. a-c.

Over twenty specimens are known, from the middle part of the Macrescens subzone of the Bas Auran section (from just below bed 9 to just above bed 8). They differ from the nominate subspecies mainly in being more evolute and less deeply umbilicated.

Several morphotypes can be distinguished; the commonest one is exemplified by the specimen figured on Plate 21, figs. 7a-b, which comes from bed 8 and has been chosen as holotype. It is wholly septate, but probably not fully grown, and measures: max. 106 mm (end of the phragmocone); at 100 mm: .45; .45; .30.

Its zigzag stage ends at about 14 mm and is followed, for half a whorl more, by another stage in which feeble normal ribs appear between each stronger one ending in parabolic nodes; the latter disappear by 20 mm, and the ribbing becomes regularly perisphinctoid, recalling that of *Procerites subprocerus*. On other specimens the intermediate stage is missing and the zigzag nucleus is directly followed by the perisphinctoid style of ribbing. The whorl section, near the end of the phragmocone, is rounded-triangular in shape and slightly less stout than in the nominate subspecies; the coiling is also proportionally more evolute, at all stages of growth, and the umbilicus is 6% wider.

The ribbing fades out at variable diameters, according to individuals, but usually later than in the nominate subspecies. The maximum diameter attained by the fully grown specimens excedes 300 mm (est.).

A second morphotype is represented by the specimen figured on Plate 15, figs. 1a-c. This is more compressed, more densely ribbed, and has an elliptical whorl section, with a more broadly rounded venter. The measurements are: max. 100 (wholly septate); at 100 mm: .44; .40; .29. Were it not for the presence of a zigzag nucleus, this specimen could very well be mistaken for a stoutly whorled *Procerites subprocerus*.

The earliest known specimen, from the marly interbed 10-9 (just above the last representatives of *Z. (P.) pseudoprocerum*), represents still another variant. This is even more evolute and clearly transitional to the most densely ribbed morphotype within *Z. (P.) pseudoprocerum* (see Plate 22, figs. 2a-b), which occurs just below. Its whorl section is reproduced on Plate 23, fig. 4; the measurements are: max. 190 mm, with part of the body chamber preserved; at 150 mm: .42; .42; .32.

Subgenus FRANCHIA n. subg.

Diagnosis — Large, evolute, coarsely ribbed Perisphinctids, combining the constrictions and ventral smooth band of *Bigotites,* which they have arisen from, with the zigzag nucleus of *Zigzagiceras* (*Procerozigzag*), which they gave rise to.

Type species (by monotypy) - Zigzagiceras (Franchia) arkelli n. sp.

Type level - Lower Bathonian, Zigzag zone, topmost part of the Convergens subzone.

Type region - South-Eastern France, Basses-Alpes (Bas Auran - type locality - and Chaudon).

Origin of name - In the honour of the distinguished Italian geologist, the late Secondo Franchi.

ZIGZAGICERAS (FRANCHIA) ARKELLI n. subg. n. sp.

Plate 2, fig. 2; Plate 16, fig. 5; Plate 18, figs. 2a-b, 4a-b

Holotype — A large and complete specimen from the topmost bed of the Convergens subzone (bed 12) of the Bas Auran section, collected by the author (Plate 18, figs. 4a-b). The nucleus, partly broken, shows strong ribs ending in parabolic nodes up to at least 18 mm; these are irregularly spaced and slightly denser than in typical *Zigzagiceras*. Up to about 22-25 mm a few stronger ribs, still ending in parabolic nodes, recur among the normal primaries; from this diameter onward the ribbing is normal and becomes progressively coarser, from the middle to the outer whorls without fading. There are two well marked constrictions per whorl, up to the end of the phragmocone. The primaries are 37 on the penultimate and 30 on the last whorl; they are mainly biplicate, with some additional free intercalatories on the last whorl. The secondaries, almost entirely confined to the venter, are very strong up to the end of the phragmocone, but become blunter on the body chamber. The style of ribbing, on the middle whorls, is almost identical to that of *Bigotites diniensis* n. sp.; there is also a striking resemblance to the coarsely ribbed Choffatias of the *cerealis* group.

The whorl section is rounded-quadrangular and depressed on the inner and middle whorls, with a very well marked ventrolateral edge; it becomes rounded-elliptical and more compressed laterally on the outer whorls. A short, but well marked umbilical wall is present throughout; the venter is broadly rounded. The body chamber (partly missing) occupies the whole last whorl.

The measurements are: max. 210 mm (with the complete body chamber it would attain about 260 mm); at 200 mm: .33,5; .31; .48; at 168 mm (end of the phragmocone): .33; .32; .46.

EXPLANATION OF PLATE 23

Evolution of *Zigzagiceras (Procerozigzag)*. All specimens from the Macrescens subzone of the **Bas Auran** section. Note the wide range of variation of the earliest forms, followed by a general trend towards contraction of the zigzag stage (dotted) and progressive deepening of the umbilicus, in *Z. (Procerozigzag) postpollubrum* Wetzel s.l.

Fig. 1 - *Z. (Procerozigzag) crassizigzag* (S. Buckman). Bed. 10.

2 - *Z. (Procerozigzag) pseudoprocerum* (S. Buckman); a variant close to the holotype. Bed 10.

3 - *Z. (Procerozigzag) pseudoprocerum* (S. Buckman); morphotype with shorter zigzag stage, more compressed whorls and more abrupt umbilical walls. Bed 10.

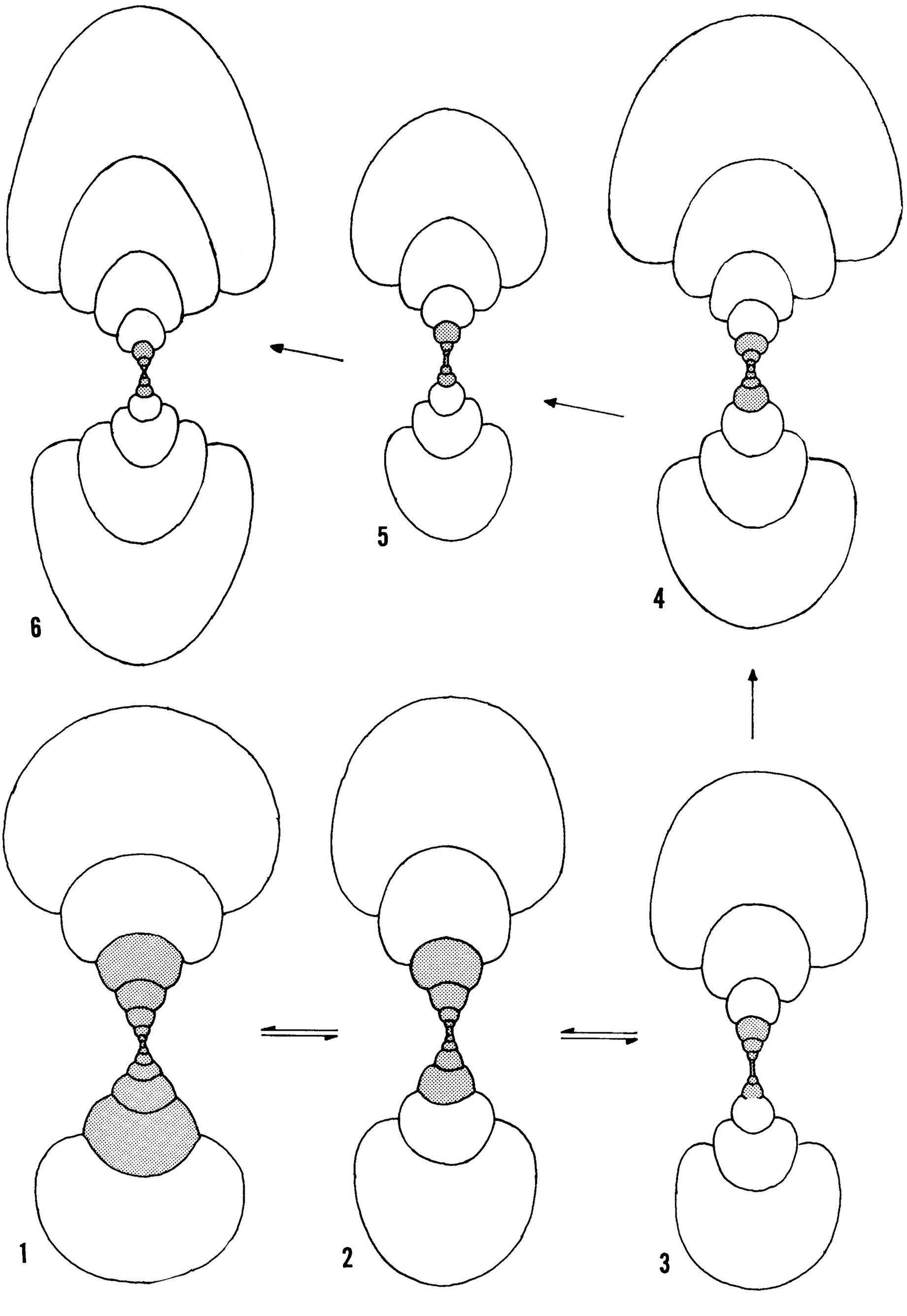
4 - *Z. (Procerozigzag) postpollubrum* Wetzel *garnieri* n.ssp.; the earliest specimen. From just below bed 9.

5 - *Z. (Procerozigzag) postpollubrum* Wetzel *garnieri* n. ssp.; holotype. Bed 8.

6 - *Z. (Procerozigzag) postpollubrum* Wetzel. Bed 7.

All figures X 0,66.

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Paratypes — The inner whorls can be best studied on a smaller paratype from the highest limestone bed of Chaudon (topmost part of the Convergens subzone). It is wholly septate and reaches a diameter of 75 mm (est.), but there are also fragments of the outer whorls, showing that this specimen attained as large a size as the holotype. The nucleus (Plate 18, figs. 2a-b) has a depressed whorl section, with a broad, slightly arched venter and a well marked ventrolateral edge, just as in *Bigotites diniensis* n. sp., at a comparable diameter. The ribbing is of the zigzag type, but denser than in typical *Zigzagiceras,* up to 16 mm. Between such a diameter and 22 mm, where the first true constriction appears, it becomes very irregular: first come 8 ribs close together, some ending in true parabolic nodes, some just raised at the ventrolateral edge, others simple and not even raised; then come three strong ribs ending in parabolic nodes and a simple one, just raised and closer to the next one. After the first constriction a single, strong parabolic rib recurs among the normal primaries, which are still raised at the ventrolateral shoulder, up to about 30 mm diameter, that is, up to the next constriction. Afterward, the ventrolateral shoulder becomes progressively more rounded.

At the zigzag stage the secondaries, entirely confined to the venter, are irregularly bunched at the parabolic nodes, some of them assuming a horse-shoe shape as in typical *Zigzagiceras.* Moreover, on the middle of the venter they are interrupted and slightly displaced on both sides of a narrow smooth band, exactly as in *Bigotites.* The ventral smooth band persists on the middle, normally ribbed whorls, up to at least 45-50 mm; these, if found isolately, would be very difficult to distinguish from *Bigotites diniensis* n. sp., *Procerites (Lobosphinctes) intersertus* and even *Procerites tmetolobus.*

A third paratype (Plate 16, fig. 5), also from the highest limestone bed of Chaudon (Le Touert), is intermediate in size between the preceding two, but it is more fragmentary, lacking most of the nucleus. A small portion of one of the inner whorls, showing the zigzag style of ribbing on the side opposite to the one figured, is however preserved, so that specific identity is out of doubt. The suture lines are well exposed on this specimen and are of the very same type as in some Upper Bajocian *Bigotites* figured by Nicolesco (1932, text-fig. 5, for instance). The measurements are: max 150 mm (wholly septate); at 150 mm: .31; .28; .47,6; at 114 mm: .31; .30; .48.

A few other fragmentary specimens from Chaudon are also known.

SIEMIRADZKIA AURIGERA (Oppel)

Plate 2, fig. 6; Plate 18, fig. 3; Plate 24, figs. 1, 4a-b, 5a-b

1958 *Siemiradzkia aurigera* (Oppel) - Westermann 1958; pp. 78-79; pl. 36, figs. 1-4.

1959 *Siemiradzkia aurigera* (Oppel) - Arkell 1951-59; pp. 227-228; pl. 33, figs. 8, 10; text-fig 83/3. (*Cum syn.*).

There are eleven specimens from almost all the beds within the Yeovilensis subzone of the Bas Auran section. As they show a certain degree of variability, I prefer to interpret this species in a rather broad sense, following De Grossouvre.

The commonest morphotype (six specimens, most of which from bed 2) shows particularly close agreement with d'Orbigny's original figure (*Pal. Fr.,* pl. 149, fig. 1), as well as with the neotype (De Grossouvre 1919; pl. 15, fig. 6). These are characterized by a coarsening of the ribs on the last half a whorl and by regularly spaced parabolic nodes (one every three to five ribs), which persist almost to the end of the body chamber. The most complete one attains 48 mm, with three quarters of a whorl of body chamber, and shows the base of two large lappets.

A second morphotype (three specimens) differs from the preceding one in being more finely and densely ribbed and in having a slightly more compressed section. These show near perfect agreement with De Grossouvre's pl. 15, figs. 3 and 5. The latter have been put in synonymy with *S. matisconensis* (Lissajous) by Arkell, but I do not agree with him on this point.

A third variant (Plate 24, figs. 5a-b) is characterized by much denser parabolic nodes (one every other rib) and looks like De Grossouvre's pl. 15, fig. 8; a single specimen is known, from bed 6.

Several specimens, as the one figured on Plate 18, fig. 3 (also on Plate 24, figs. 4a-b), allow the study of the nucleus and the early development of the style of ribbing, which were previously unknown (on all the specimens figured by De Grossouvre, including the neotype, the nucleus is concealed by the matrix). Up to 5 mm the nucleus is of the zigzag type, having only distant parabolic ribs; thereafter normal ribs appear between the stronger ones still ending in parabolic nodes (one every 2-4 normal primaries); by 20-25 mm the ribs are all of the same strength, but the parabolic nodes still recur, at increasingly wide intervals. The development of the ornamentation follows, at proportionally earlier diameters, the same path as in *Zigzagiceras torrensi* n. sp. *variecostatum* n. ssp.

It should be noted, at this point, that the nuclei of the younger *Siemiradzkia* spp. plur. ind. from the Upper Bathonian of Chaudon are coronate and completely smooth up to 2-4 mm; a short zigzag stage follows in some specimens, while in others the style of ribbing of adult *S. aurigera* sets in directly after the smooth nucleus.

As shown by the preceding description of the early development of the ribbing style, there is hardly any doubt that *S. aurigera* is a direct derivative of *Zigzagiceras*. The problem arises when we look for its possible macroconch dimorph, if the theory of sexual dimorphism is accepted.

As for the vertical range, *S. aurigera* is considered a Lower Bathonian species by practically all authors.

SIEMIRADZKIA n. sp. ind.
Plate 24, figs. 7a-b.

This is a very coarsely ribbed Perisphinctid, characterized by a peculiar style of ribbing, in which of every three primaries two are bunched or united; these, at the ventralateral edge, form parabolic nodes, by reason of which I place it in *Siemiradzkia*.

The coiling is very evolute and the whorl section quadrate. In general aspect there is striking resemblance to the inner an middle whorls of the much younger *Peltoceras* s.s.

A single specimen is known, from the topmost Yeovilensis subzone of the Bas Auran section (bed 2).

SIEMIRADZKIA spp. plur. ind.

The nuclei of at least four different species of *Siemiradzkia* constitute an important part of the ferruginous assemblage from the Upper Bathonian of Chaudon. Some of them show a narrow but distinct interruption of the secondaries on the median line, as in *Grossouvria*. They are however too small to allow an attempt at specific identification.

Other specimens of *Siemiradzkia* sp. ind. also occur in the Progracilis zone of the Bas Auran section (bed 1), as well as in the Lower Bathonian assemblage from the Col de Pierre Basse.

PSEUDOPERISPHINCTES cf. ROTUNDATUS (Roemer)
Plate 24, figs. 2a-b, 3

1958 *Siemiradzkia (Pseudoperisphinctes) rotundatus* (Roemer) - Westermann 1958; p. 83; pl. 40, figs. 2-3; pl. 43. figs. 1-2. (*Cum syn.*).

EXPLANATION OF PLATE 24

Fig. 1,4a-b, 5a-b - *Siemiradzkia aurigera* (Oppel).
Fig. 1. Fragmentary specimen, showing the coarsening of the ribs near the end of the body chamber. Bas Auran, Yeovilensis subzone (bed 2).
Figs. 4a-b. Specimen showing the zigzag nucleus (see also Plate 18, fig. 3). Bas Auran, Yeovilensis subzone (bed 2).
Figs. 5a-b. Morphotype with denser parabolic nodes. Bas Auran, basal Yeovilensis subzone (bed 6). Pag. 53.

2a-b, 3 - *Pseudoperisphinctes* cf. *rotundatus* (Roemer).
Both specimens from Bas Auran, Lower Bathonian, Yeovilensis subzone (beds 2 and 3, respectively). Pag. 54.

6 - *Procerites? (Gracilisphinctes?)* sp. ind. Bas Auran, from either bed 2 (Yeovilensis subzone) or 1 (Progracilis z.). Pag. 45.

7a-b - *Siemiradzkia* n. sp. ind. Bas Auran, Yeovilensis subzone (bed 2). Pag. 54.

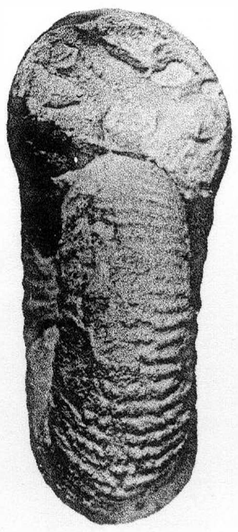
8-9 - *Wagnericeras fortecostatum* (De Grossouvre). Both specimens from Bas Auran, Middle Bathonian, Progracilis zone (bed 1). Pag. 46

All photos. natural size.

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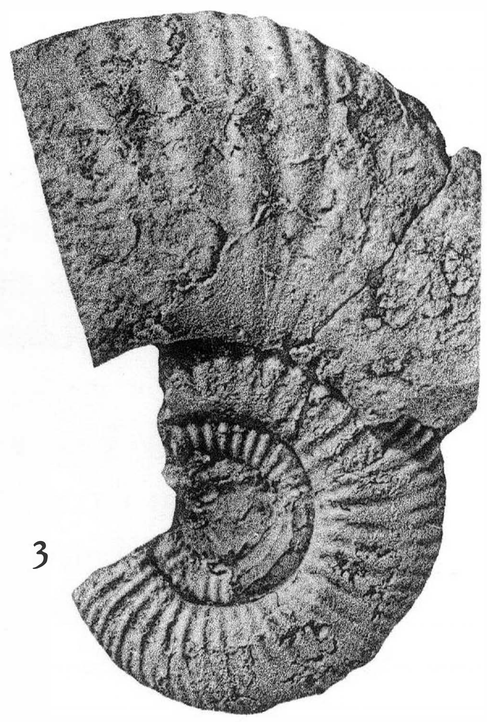
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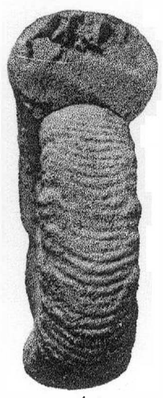
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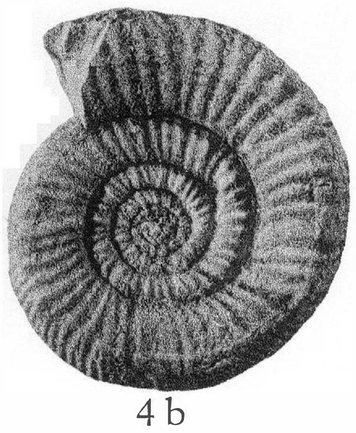
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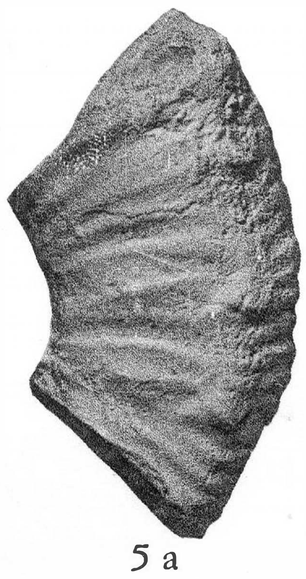
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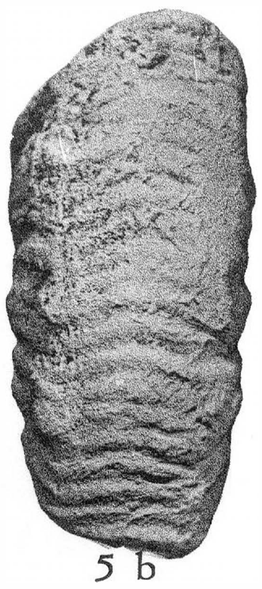
4 a



4 b



5 a



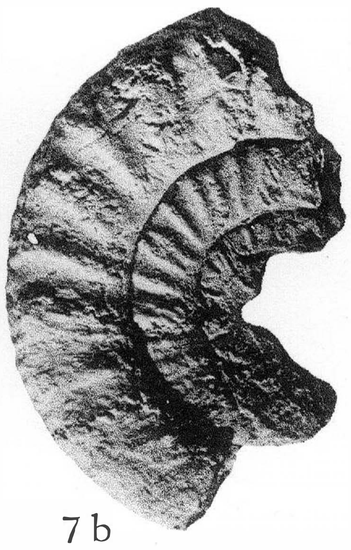
5 b



6



7 a



7 b



8



9

1959 *Pseudoperisphinctes rotundatus* (Roemer) - Arkell 1951-59; p. 213; text-fig. 83/1 (reprod. of the type fig.).

Two specimens from the Yeovilensis subzone of the Bas Auran section (bed 3), show rather close agreement with the lectotype, being just a little more evolute. The whorl section is rounded, almost circular in outline.

The smaller, but complete specimen figured on Plate 24, figs. 2a-b, measures: max. 41 mm (wholly septate and certainly incomplete); at 40 mm: .40; .42; .38 (at the same diameter one of the topotypes figured by Westermann measures: .39; .39; .36). The nucleus is exposed on both sides of it and is of the zigzag type, up to 5-6 mm; then, for a whorl more and up to 10 mm, follows a stage with recurrent parabolic ribs, just as in *Siemiradzkia*; on the next whorls the ribbing is dense and regular, biplicate or simple, with no parabolic nodes.

The other specimen (Plate 24, fig. 3) is larger but fragmentary, and it is still septate at an estimated diameter of about 70 mm. The ribbing, on the last visible whorl, is strikingly similar to that of the lectotype.

If these specimens really belong to *Pseudoperisphinctes* (and there are no reasons to think they don't), the peculiar style of ribbing of their nuclei confirms the existence of a close relationship with *Siemiradzkia,* as supposed by Westermann.

The strong difference in age alone restrains me to identify them beyond any doubt with the type species, which is Upper Bathonian.

APPENDIX
THE BATHONIAN SECTION AT LES BLACHES DE CASTELLANE

In order to check the faunal succession observed at Bas Auran and Chaudon within the Lower Bathonian and to see whether the Middle and Upper Bathonian, known to be represented by the « limestone-marl » facies in the vicinity of Castellane, could afford a similarly detailed analysis, the author spent several days at this locality during the 1966 summer season.

The Bathonian section at Les Blaches lies 2 km North of Castellane, midway between this town and the Castillon dam, on the crest stretching N-S between « la Blache pyramide » and the unnamed peak 1177. Garnier (1872, pp. 733-735, text-fig. 1) has given a good description of the stratigraphy, so that only a few additional details are needed.

The Upper Bajocian and the whole Bathonian are represented by 30 metres of grey limestones with marly interbeds, much the same as at Bas Auran; they rest unconformably upon strongly reduced and condensed Toarcian (in the form of a ferruginous hard ground on top of the Domerian limestones), and are in turn unconformably overlain by the « terres noires », which have yielded a splendid Upper Callovian fauna of the Athleta zone at their very base.

The first 15 metres of the limestone-marl sequence are rather poor in ammonites, apart from *Nannolytoceras tripartitum* and Phylloceratids, and probably belong in the Parkinsoni zone.

The next 5 to 6 metres are much richer in well preserved ammonites; several successive assemblages, practically identical with those described at Bas Auran and representative of the Bomfordi, Convergens and Macrescens subzones respectively, may be easily recognized. Among the more interesting species collected here we may notice: abundant *Parkinsonia (Gonolkites) convergens, P. (G.) subgaleata* and *P. schloenbachi* in the Convergens subzone; *Zigzagiceras (Proceroziгzag) crassizigzag, Z. (P.) postpollubrum postpollubrum, Morphoceras macrescens, Oxycerites yeovilensis* and *Strigoceras dorsocavatum* (Quenstedt) in the Macrescens subzone. The last record, completely new for this region, is particularly interesting because it confirms *S. dorsocavatum* to be a Bathonian species.

Ammonites become excedingly rare in the 8 to 10 metres next above, which are nevertheless presumed to include the topmost Lower and the whole Middle Bathonian (no gaps in the lithological sequence are visible), since an Upper Bathonian assemblage (including *Ptychophylloceras flabellatum, Cadomites* sp., *Bullatimorphites* sp., *Choffatia* cfr. *subbackeriae* (d'Orbigny), *C.* (*Subgrossouvria*) *cerealis* Arkell and *Siemiradzkia* sp.) has been collected just a few inches below the topmost limestone bed, which ends with a spectacular hard-ground, already noticed by Garnier.

As for the first purpose of this revision, I can say that the subzonal scheme worked out at Bas Auran for the Lower Bathonian received a sound confirmation, even though the section at Les Blaches does not seem to be as richly fossiliferous and therefore as suitable for a detailed biostratigraphical analysis, as Bas Auran. The search for Middle Bathonian ammonites was on the contrary a complete deception, the corresponding part of the section being practically devoid of fossils.

ESSENTIAL BIBLIOGRAPHY

A) *Works dealing with the Middle Jurassic stratigraphy and/or with the general geology of the Subalpine Ranges and adjacent regions:*

GARNIER, A., 1872, Réunion extraordinaire à Digne: Bull. Soc. Géol. France, 2d ser., vol. 29, pp. 626-656, pl. 8.

GOGUEL, J., 1936, Description tectonique de la bordure des Alpes de la Bléone au Var: Mém. Carte Géol. France, 360 pp., 253 figs., 2 pls.

GUILLAUME, L., 1938, Observations sur la limite inférieure des marnes à *Posidonomya alpina* entre Digne et Castellane: C.R.S.S. Soc. Géol. France, 1938, pp. 198-199.

HAUG, E., 1891, Les Chaines Subalpines entre Gap et Digne: Bull. Serv. Carte Géol. France, vol. 3, n. 21, 192 pp., 20 figs., 4 pls.

LANQUINE, A., 1929, Le Lias et le Jurassique des Chaines Provençales. 1, Le Lias et le Jurassique inférieur: Bull. Serv. Carte Géol. France, vol. 32, n. 173, 385 pp., 16 figs., pls. A-H, 1-12.

—, 1935, Le Lias et le Jurassique des Chaines Provençales. 2, Le Jurassique moyen et supérieur: Bull. Serv. Carte Géol. France, vol 38, n. 191, 135 pp., 3 figs., pls I-M, 13-20.

PARENT, H., 1938, Sur un important gisement d'ammonites bathoniennes au Nord du Département du Var: C.R. Acad. Sci. Paris, vol. 207, pp. 375-377.

PARENT, H. & GERMAIN, J., 1939, Gisement bathonien de Saint-Martin-des-Palières (Var): Bull. Soc. Géol. France, ser. 5, vol. 8; pp. 639-643.

ZURCHER, Ph., 1895, Compte rendu de la course du 23 septembre de Digne à Barrême: Bull. Soc. Géol. France, 3d ser., vol. 23, pp. 866-873.

B) *Other works dealing with Middle Jurassic faunas and stratigraphy. But for a few exceptions, reference to those published prior to 1958 may be found in the extensive bibliographic lists given by Arkell (1951-59, 1956), Westermann (1958), Wendt (1964) and Sturani (1964a, 1964b), and it is therefore not repeated here.*

ARKELL, W. J., 1951, A Middle Bathonian ammonite fauna from Schwandorf, Northern Bavaria: Mém. Suiss. Pal., vol. 69, n. 1, 18 pp., 3 pls.

—, 1951-59, A monograph of English Bathonian ammonites: Pal. Soc. vols. 104-112, pp. VIII + 264, 83 figs., 33 pls.

—, 1956, Jurassic geology of the world: 806 pp., 102 figs.. 27 tabs., 46 pls., Oliver & Boyd Ltd. ed., London.

— and others, 1957, Treatise on Invertebrate Palaeontology. Part L, Cephalopoda Ammonoidea: pp. XXII + 490, 558 figs., Geol. Soc. America & Univ. Kansas press ed.

BEHRENDSEN, O., 1884, Die Cephalopoden der Hildesheimer Juraformation: Prog. Gymn. kgl. Andrean. Holdesheim, pp. 3-20.

BONCEV, E., & DIMITROV, C., 1965, Karpato-Balkanische Geologische Assoziation, 7 th congress, sept. 1965, Exkursionsführer Sofia - Belogradcik - Sofia.

CALLOMON, J. H., 1963, Sexual dimorphism in Jurassic ammonites: trans. Leicester Lit. Phil. Soc., vol. 57, pp. 21-56, 9 figs., 1 pl.

Colloque du Jurassique à Luxembourg 1962: published in 1964 by the Section des Sciences nat., phys., math. de l'Institut Granducal, with contribution by several authors, 948 pp.

DEAN, W. T., DONOVAN, D. T., & HOWARTH, M. K., 1961, The Liassic ammonite zones and subzones of the North-West European province: Bull. Brit Mus. (N.H.), Geol. vol. 4, n. 10, pp. 435-505, pls. 63-75.

DIENI I., MASSARI, F., & STURANI, C., 1966, Segnalazione di Ammoniti nel Giurese della Sardegna orientale: Acc. Naz. Lincei, Rend. Cl. Sc. fis., mat., nat., 8th ser., vol. 40, pp. 99-107, 2 pls.

DOUVILLÉ, R., 1915, Etudes sur les Cosmocératidés: Mém. Carte Géol. France, 75 pp., 34 figs., 24 pls.

DREYFUSS, M., 1956, Laedonien (et Lédonien): Lex. Strat Int., vol. 1, fasc. 4 a V (Jurassique s. str.); 169 pp.

ELMI, S., 1961, Les marnes du Jurassique moyen et l'Argovien entre Aubenas et le col de l'Escrinet (Ardèche): C.R.S.S. Soc. Geol. France, 1961, pp. 103-104.

—, 1962, Considérations sur *Choffatia* (*Subgrossouvria*) (Ammonitina, Pseudoperisphinctinae): C.R.S.S. Soc. Géol. France, 1962, pp. 205-206.

GILLET, S., 1937, Les Ammonites du Bajocien d'Alsace et de Lorraine: Mém. Serv. Carte Géol. Alsace Lorraine, n. 5, 130 pp., 5 pls., 71 text-figs.

JEFFERIES, R. P. S., & MINTON, P., 1965, The mode of life of two Jurassic species of « *Posidonia* » (Bivalvia): Paleontology, vol. 8, pp. 156-185, 12 figs., pl. 19.

MAKOWSKI, H., 1963, Problem of sexual dimorphism in ammonites: Pal. Polonica, n. 12, 92 pp., 14 figs., 12 text-pls., 20 pls.

MANGOLD, Ch., ENAY, R., & DOMINJON, P., 1965, Note préliminaire sur le Bathonien inférieur du Bugey (Jura méridional): Bull. Soc. Géol. France, 7th ser., vol. 6, pp. 529-534.

MAUBEUGE, P. L., 1955, Les Ammonites aaléniennes, bajociennes et bathoniennes du Jura Suisse septentrional: Mém. Suiss. Pal., vol. 71, 48 pp., 11 pls.

—, 1965, Sur les étages Vésulien et Koujavien (Jurassique moyen): C. R. Acad. Sci. Paris, vol. 261, pp. 5157-5160.

MENZEL, H., 1902, Der Galgenberg und das Vorholz bei Hildesheim: N. Jb. Min., Geol., Pal., Jahrg. 1902, vol. 1, pp. 35-59.

MOUTERDE, R., 1953, Études sur le Lias et le Jurassique des bordures Nord et Nord-Est du Massif Central Français: Bull. Serv. Carte Géol. France, vol. 50, pp. 63-521, 40 figs., 7 tabs., 14 pls.

PUGIN, L., 1964, Étude critique des Lytoceratina du Dogger: Mém. Suiss. Pal., vol. 80, 67 pp., 10 figs., 4 pls.

RIOULT, M., 1961, Sur l'âge du « Calcaire de Caen » et la stratigraphie du Bathonien en Normandie: Bull. Soc. Linn. Normandie, 10th ser., vol. 2, pp. 51-61.

RUGET-PERROT, C., 1961, Études stratigraphiques sur le Dogger et le Malm inférieur du Portugal au Nord du Tage: Mem. Serv. Geol. Portugal, n. ser., n. 7, 197 pp., 45 figs., 5 tabs., 3 maps, 11 pls.

STEPHANOV, J.. 1963, Bathonian ammonites of the superfamily Stephanocerataceae in Bulgaria: Bulg. Ac. Sci., Trav. Géol. Bulg., sér. Pal., vol. 5, pp. 167-209, text-figs. A-D, pls. 1-6 (in bulgarian, with english and russian summaries).

—, 1966, The Middle Jurassic ammonite genus *Oecotraustes* Waagen: Ac. Bulg. Sc., Trav. Géol. Bulgarie, ser. pal., vol 8; pp. 29-69; pls. 1-7.

STURANI, C., 1964a, La successione delle faune ad Ammoniti nelle formazioni mediogiurassiche delle Prealpi Venete occidentali: Mem. Ist. Geol. Min. Univ. Padova, vol. 24, 63 pp., 16 figs., 1 tab., 6 pls.

—, 1964b, Ammoniti mediogiurassiche del Veneto. Faune del Baiociano terminale (zone a Garantiana e a Parkinsoni): Mem. Ist. Geol. Min. Univ. Padova, vol. 24, 43 pp., 30 figs., 4 pls.

TINTANT, H., 1963, Les Kosmocératidés du Callovien inférieur et moyen d'Europe Occidentale: Publ. Univ. Dijon, n. 29, 500 pp., 92 figs.. 58 pls.

TORRENS, H. S., 1964, Two geological exposures at Sherborn: Proc. Dorset Nat. Hist. & Archaeol. Soc., vol. 85, pp. 38-39.

—, 1965, Revised zonal scheme for the Bathonian stage of Europe: Carpato-Balkan Geol. Ass., 7th congr., reports, part II, vol. 1, pp. 47-55, 2 figs.

WENDT, J., 1964, Stratigraphisch-paläontologische Untersuchungen im Dogger Westsiziliens: Boll. Soc. Pal. It., vol. 2, n. 1, pp. 57-145, pls. 6-24, 4 figs.

WESTERMANN, G., 1958, Ammoniten-Fauna und Stratigraphie der Bathonien NW-Deutschlands: Beih. Geol. Jb., n. 32, 103 pp., 9 figs., 2 tabs., 49 pls.

—, 1964, Sexual-Dimorphismus bei Ammonoideen und seine Bedeutung für die Taxionomie des Otoitidae: Palaeontographica, Abt. A, vol. 124, pp. 33-73, 14 figs., 5 tabs., pls. 6-9.

—, 1965, Septal and sutural patterns in evolution and taxonomy of Thamboceratidae and Clydoniceratidae (M. Jurassic, Ammonitina): Jour. Pal., vol. 39, n. 5, pp. 864-874, pls. 101-102, 4 text-figs.

WETZEL, W., 1966, Über einige umstrittene Bath-Ammoniten nebst paläobiologischen Bemerkungen über die Neoammoniten: N. Jb. Geol. Pal., Abh., vol. 124, n. 1, pp. 84-102, pls. 12-14, 1 text-fig.

ZEISS, A., 1959, Hecticoceratinae: Foss. Cat., Animalia, pars 96, 143 pp.