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AMMONITES AND STRATIGRAPHY
OF THE "POSIDONIA ALPINA" BEDS
OF THE VENETIAN ALPS

(MIDDLE JURASSIC, MAINLY BAJOCIAN)

(With 46 text-figures and 16 plates)



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INTRODUCTION AND SUMMARY

The Jurassic of the Venetian Alps has been long renowned for its rich ammonite faunas: one need only mention those from the Aalenian of Cape San Vigilio, Monte Grappa and the Feltrine Alps, or those from the « Rosso ammonitico veronese », ranging in age from the topmost Bajocian up to the Tithonian. Among the richest and most interesting, but yet incompletely known, are those from the « *Posidonia alpina* beds » of the Sette Comuni and a few other localities.

The first account of this formation (variously known as « Strati a *P. alpina* », « Strati a *P. alpina* del Veneto », « Lumachella a *P. alpina* », etc.) is to be found in Oppel's classic paper « *Ueber das Vorkommen von jurassischen Posidonomyen-Gesteinen in den Alpen* » (1863), where the fine section near Brentonico was described and compared to the Klaus beds of the Austrian Alps, and a first list of fossils — including several ammonites — was given.

Further details of the « *Südalpinen Posidonomyen-Gesteinen* » outcropping in the Venetian Alps (Brentonico, Ponte di Tierno, Madonna del Monte by Rovereto, Torri al Benaco and Nomi), with additional faunal lists, were published by BENECKE (1865). Both authors regarded the *P. alpina* beds of this region as a perfect equivalent of the Klaus beds in the Austrian Alps; the latter were stated to fall within the « *obersten Horizonten des Unteroolith* » and to include the « alpine equivalent of the extraalpine Bathonian » as well. In the case of the Brentonico section, we shall see that this chronological attribution is still valid.

BENECKE's paleoecological analysis is also worth noting, for the time when it was written. According to him, the great accumulations of disarticulated crinoid ossicles which occur locally in the *P. alpina* beds, could be taken as evidence that the sea bottom had been uplifted, so that the crinoid forests, which, by comparison with living forms, must have covered it in calm, deep waters, had been disrupted and their remains washed up along the sea shore by wave action; the brachiopods and the *Posidonomyas* (= *Bositra*), on the other hand, must have lived gregariously in the « *Vertiefungen und Fiorden* » sheltered from wave agitation, so that their occurrence in areally separated clusters and patchy accumulations could also be explained.

The first — and still one of the best available accounts of the geology of the Sette Comuni was published by VACEK a few years later (1877, 1878); he gave an excellent description of the *P. alpina* beds, also listing a few fossils, among which are *Oppelia fusca*, *Sphaeroceras brongniarti*, Phylloceratids and various brachiopods.

VACEK's description of the *P. alpina* beds in the Sette Comuni was confirmed by TARAMELLI (1880), who listed a few other fossils from Camporovere. These were monographed in the same year by PARONA (1880); as to their age, after reviewing OPPEL's and BENECKE's opinions, PARONA did not commit himself to a more precise evaluation.

In 1886 A. de GREGORIO established a new sub-stage — the Ghelplinian — as a substitute for the « *Posidonia alpina* or *Terebratula curviconcha* zone » of previous authors, and monographed the fossils from the type locality (the Ghelpach valley in the Sette Comuni). The palaeontological part of de GREGORIO's monograph will be discussed in detail further on (p. 61); as to the Ghelplinian substage, it was regarded by de GREGORIO as the upper part of the Alpinian stage, which he defined as follows: « L'étage Alpinien comprend les faunes citées par les différents auteurs sous le titre vague de Juralias et de Dogger. Il correspond particulièrement à l'étage Bajocien d'ORB., comprenant en partie le Bathonien d'ORB.. Il s'étend à peu près à travers toutes les couches alpha-epsilon du Jura brun de Quenstedt et à travers les couches epsilon-zeta du Lias supérieur du même auteur. C'est à dire il s'étend des lambeaux supérieur de la zone à *Harpoceras falciifer* jusqu'à la zone à *Harp. sowerbyi* Mill. ». It is not surprising that de GREGORIO's names never came into use.

The main contribution, in de GREGORIO's monograph, is a general account of the *P. alpina* beds of the Venetian Alps written by E. NICOLIS, who mentioned the discovery of a new fossil locality at Acque Fredde on the Garda lake, whence a rich fauna of pygmy ammonites and gastropods had been collected. These fossils were described and figured by PARONA several years later (1894) and stated to be Callovian in age.

In 1896 Parona published a third monograph, to illustrate the much richer assemblages from the *P. alpina* beds of Monte Meletta, Monte Longara, Ponte sul Ghelpach and Camporovere, all in the Sette Comuni. In this too he assigned the faunas to the Callovian.

PARONA's identifications have subsequently been criticized by E. HAUG (1910, p. 1029), S. S. BUCKMAN (1922, pp. 418-419) and W. J. ARKELL (1956, pp. 175-176); all three pointed out that the assemblages monographed by PARONA included several undoubtedly Bajocian species, while there was little or no evidence for a Callovian age. Similar criticisms had already been made by G. DAL PIAZ in his classic work on the Feltrine Alps (1907); in that region G. DAL PIAZ had been able to demonstrate that the coquina facies, yielding *Bositra buchi* (= *P. alpina* auctt.) and several characteristic brachiopods, graded laterally into micritic limestones with abundant Stephanoceratids and other ammonites of the Sauzei - Humphriesianum zones.

In 1964 (STURANI 1964a), I published an essay on the succession of the ammonite faunas within the Middle Jurassic of the Western Prealpi Venete; on that occasion I reviewed the previous literature (including several papers not mentioned here, which deal more or less directly with the *P. alpina* beds), revised most of the

sections and fossil localities mentioned by previous authors and gave a description of the *P. alpina* beds in the Sette Comuni area, including a preliminary account of their sedimentary features and palaeoecology. The latter two subjects have subsequently been developed in a short paper (STURANI 1967b) on the palaeogeographic significance of the coquina facies (« lumachella a *P. alpina* » of Italian authors) in the Middle Jurassic of the Mediterranean region, also taking into account other areas beside the Venetian Alps.

Since the publication of this last paper, in the light of more modern literature on carbonate shelf sedimentology (A. G. FISCHER 1964; B. D'ARGENIO 1966, 1967; etc.), I have done more field work and have been able to discover — or to reinterpret more correctly — several sedimentary features of the *P. alpina* beds all over the Trento ridge. This led to a partially renewed and more complete interpretation of their sedimentary features and palaeogeographic significance, as will be discussed in detail in the first part of this memoir.

Since 1964 I also went on collecting more fossils in the *P. alpina* beds, both at previously known and at newly discovered localities; over five thousand ammonites have been thus collected and prepared for study. At the same time I was able to gather in Turin for revision all the ammonites monographed by PARONA in his different papers (de GREGORIO's specimens, unfortunately, turned out to be probably lost and could not be restudied).

The main results of this study can be summarized as follows.

The palaeogeographic evolution of the Trento ridge, now corresponding to the Western Venetian Prealps, begins in the Lower Lias with the establishment of a wide shelf where rapid subsidence was counterbalanced by an active carbonate sedimentation of Bahamian type. During this period, the Lower to Middle Liassic « Noriglio grey limestones » and the Upper Liassic « Cape San Vigilio oolite » were deposited. By the end of the Aalenian (locally earlier) subsidence and sedimentation rates had come to an abrupt halt, while the central part of the shelf, now corresponding to the Sette Comuni area, was an emergent area, in the form of a low, flat island, from the beginning of the Toarcian.

Short before the end of the Bajocian the Trento ridge sank and was transformed into a pelagic, intrageosynclinal swell, on which the « Ammonitico rosso veronese » started to form.

Deposition of the *P. alpina* beds was sporadic both in time and in space and took place in the period of extremely reduced subsidence intervened between the end of the Bahamian-type, massive carbonate deposition and the sinking of the shelf; *i.e.*, mainly during the Lower and early Upper Bajocian.

In the Sette Comuni area the *P. alpina* beds rest unconformably upon the « Noriglio grey limestones ». They consist of a spar-cemented coquina, grading locally into red biomieritic limestones, which occur either as the cement of a solution breccia, or as the infilling of solution cavities and fissures in the topmost 0.50 - 2.50 metres of the Liassic bedrock. The shell gravel and the lime muds were picked up from the offshore environments by exceptionally high, hurricane-induced tides, and were cast

ashore on a flat, rocky island; here they were trapped within the karstic fissures as part of the flood drained away percolating through the vadose zone. Chemical deposition of drusy spar followed later, always under supratidal conditions.

The diminutive size of the fossils may thus be explained in part as due to mechanical sorting; yet, it may to some extent be also a primary character: a palaeoecological analysis of the faunal assemblages shows that most species, including the ammonites, belong to the epifaunal community and must have lived at a shallow depth on a rocky, almost sediment-free bottom covered with algal meadows. It is well known that the biota of recent algal meadows consists mainly of small sized species, especially the molluscs.

As for the ammonites, it turned out that representatives of the various families probably had different life cycles. Phylloceratina and most of the Lytoceratina are represented by juvenile specimens only: in this case, algal meadows may well have been their breeding grounds, while the open sea was the normal habitat of the adults, outside the spawning season. Many Ammonitina are on the contrary represented by mature microconchs and juvenile macroconchs only: in this case some segregation of sexes outside the spawning period may well have occurred, the microconchs being neritic in habit throughout their life. Finally, in the case of extremely small sized forms (*Bajocia*, *Poecilomorphus*, *Stegoxytes*, *Toxalambites* and the Sphaeroceratids), both sexes seem to have been confined to a neritic habitat.

As for the age of the *P. alpina* beds of the Sette Comuni, it turned out that different coquina patches, often a few tens of metres away from each other, have different ages, each of them representing an extremely short stratigraphic interval (part of single subzones) within the Humphriesianum, Subfurcatum and Garantiana zones of the Bajocian. This shows that such environmental conditions lasted through a rather long time (roughly, between 2 and 3 millions of years); that sedimentation was highly discontinuous in occurrence but almost instantaneous in duration, and that subsidence was practically absent.

On other parts of the Trento ridge, outside the Sette Comuni area, the *P. alpina* beds accumulated at a shallow depth either as subaqueous bars of crinoidal sands (Rovereto), or as partially emergent banks of shell gravel (Brentonico), or as the infilling of gaping crevices which opened downward into a rocky bottom covered with algal meadows (Acque Fredde). Far more frequently, however, the bottom was kept clear of sediments because the lack of subsidence during a long period kept it above erosion base level, at a shallow depth. This explains the sporadic occurrence of the *P. alpina* beds and the gap which is more frequently observed instead, between the Ammonitico rosso veronese and the underlying carbonate shelf formations.

Except for the great abundance of Phylloceratina and Lytoceratina of Tethyan type, the ammonite assemblages found in the *P. alpina* beds of Veneto do not differ markedly from those of North Western Europe. This confirms that the Bajocian was a period of reduction in faunal barriers — at least for the ammonites — when compared with the preceding and the following stages.

Over 90 species and subspecies, 20 of which are new, are described in the second part of this memoir. On the other hand, over 35 pre-existing specific names have been dropped as junior synonyms.

Two genera (*Torrensia* n. gen. and *Patrulia* n. gen.), as well as three subgenera (*Microlissoceras* n. subg., *Microtoxalambites* n. subg. and *Micropoecilomorphus* n. subg.) are also new.

The discovery of these new taxa, as well as the revision of others in the light of ammonite dimorphism and its taxonomic implications, have often led to changes in the arrangement adopted by ARKELL in the « Treatise ». The main departures from this classification, at the family level, may be summarized as follows: Haplocerataceae is here regarded as a polyphyletic unit, derived in part from Hammatoceratids (the family Strigoceratidae), in part from Graphoceratids (Haploceratidae and ? Oppeliidae). *Bradfordia*, *Poecilomorphus* and *Stegoxytes* are here regarded as belonging to the Haploceratids, whilst *Cadomoceras* is removed from the latter family and transferred to the Strigoceratidae, being the microconch dimorph of *Strigoceras*. Parkinsoniidae, too, are regarded as a merely morphological, polyphyletic unit, being probably evolved in part (*Parastrenoceras*) from *Bajocia*, in part (*Orthogarantiana*, which is in turn ancestral to the dimorph pair *Garantiana* (M) - *Strenoceras* and *Pseudogarantiana* (m)) from Stephanoceratids, and in part (*Caumontisphinctes*) from early Leptosphinctinae.

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Other of PARONA's specimens were obtained on loan from the following institutions: Museo Civico di Storia Naturale, Verona; Istituto di Geologia, University of Pisa, and Istituto di Paleontologia, University of Pavia. The writer is much indebted to the Directors and the Curators of these Institutions — Prof. S. RUFFO and Mrs. PASA, Prof. G. TAVANI, Prof. G. SACCHI VIALLI, respectively — for their kindness in providing such facilities.

The author's thanks are also due to Mr. R. V. MELVILLE and Dr. H. C. IVIMEY COOK for allowing him to study Buckman's collection at the Geological Survey Museum in London and for sending plaster casts of several type-specimens, as well as to Dr. M. K. HOWARTH, who afforded similar facilities at the British Museum (Nat. Hist.).

Valuable information about the vertical range of species described by BUCKMAN, in their type region, was obtained from Mr. COLIN PARSONS of the University of Keele.

During the International Field Symposium on the British Jurassic, held in April 1969, the writer had the pleasure of meeting Brigadier G. BOMFORD, who allowed him to quote unpublished data from his splendid collection of Inferior Oolite ammonites.

On this same occasion, as well as later, Dr. J. H. CALLOMON discussed the taxonomic problems raised by the recognition of sexual dimorphism in ammonites.

Prof. R. ASSERETO and Prof. B. D'ARGENIO discussed some aspects of carbonate shelf sedimentology and assisted with references to the relevant modern literature; while Prof. M. MASALI helped with the statistical points arising in the work and Dr. M. SAMPÒ helped with the identification of the smaller foraminifera.

Prof. E. MUTTI read the first draft of the manuscript, while Dr. A. FERRARI kindly sent for study the ammonites he had collected in the coquina facies at Monte Peller.

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The writer would therefore like to express his warmest thanks to all these colleagues — and especially to Dr. H. S. TORRENS — without whose help this work would have been seriously delayed and handicapped. It is not to be inferred, however, that all of them necessarily approve of the author's deductions.

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REGIONAL SETTING

The Jurassic of the Western Venetian Prealps is composed mainly of carbonates; these sediments were laid down on a wide intrageosynclinal ridge, known as the « Trento ridge », that was bounded on the West by the « Lombardy trough » and on the East by the « Belluno trough » (J. AUBOUIN 1964). Its paleogeographic evolution may be easily divided into two main phases and begins in the Lower Lias with the establishment of a wide shelf, where rapid subsidence was counterbalanced by an active carbonate sedimentation of Bahamian type.

On the central part of the shelf, now corresponding to the Lessini and Sette Comuni regions, the Lower and Middle Lias are developed as shelf-lagoon facies, known as the « *Noriglio grey limestones* » formation.

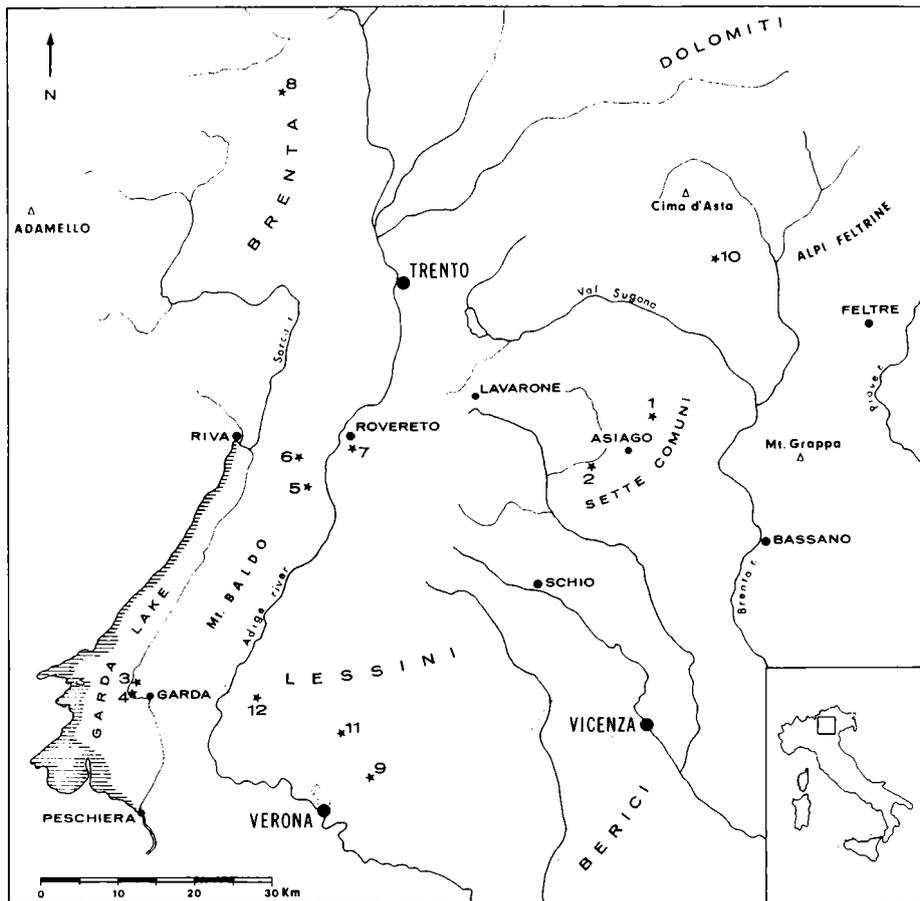


FIG. 1

Index map showing location of the main fossil localities and sections mentioned in the text. A dotted line marks the boundary between the Quaternary deposits of the plain and the older formations.

1: Monte Longara (see text-fig. 24); 2: Cima Tre Pezzi (see text-fig. 25); 3: Acque Fredde; 4: Cape San Vigilio; 5: Brentonico (see text-figs. 26-27); 6: Loppio; 7: Rovereto; 8: Monte Peller; 9: Mizzole quarry; 10: Monte Agaro; 11: Grezzana (Vajo del Paradiso, Magnavacca quarry and La Pergola quarry); 12: Monte Pastello.

The lithofacies range from clean-washed calcarenites, through calcarenites with a micritic matrix, to featureless calcilutites. The latter usually contain a rather high proportion of organic matter (hence the dominantly grey colour). The calcarenites are lighter coloured and consist of fossil clasts, intraclasts, oolites, oncoids and compound lumps.

The biota, especially within the lower-energy facies, is little varied and often monotypic; the more conspicuous being represented by great banks of oyster-like (*Lithiotis problematica* GUEMB.), mussel-like (*Gervillia* spp. plur.) and Megalodontid clams (*Pachyrisma* spp. plur.), still in life position. Other beds are crowded with large Terebratulid brachiopods, large arenaceous forams (*Orbitopsella*) and elongated Nerineid gastropods (*Aptyxiella* spp.). Red and green algae (*Palaeocladus mediterraneus*, *Thaumatoporella*, *Solenopora*), as well as a few corals are also occasionally found within such facies.

Ammonites are virtually absent: only two or three specimens, including the type of *Protogrammoceras cornacaldense* (TAUSCH), are known from the whole formation.

All these fossils, but especially *Orbitopsella*, allow us to place the more fossiliferous upper part of the formation in the Domerian. Within this upper part, a few coal seams and a rich, perfectly preserved land flora, with *Equisetites*, ferns, cycads and conifers, are known to occur (Vajo del Paradiso, North of Verona, and Rotzo in the Sette Comuni; see A. WESLEY 1956).

The facies sequence consists of a roughly cyclic repetition of sub-, inter- and supratidal lithologies recalling the Lofer cyclothems in the Triassic of the Austrian Alps (A. G. FISCHER 1964). In particular, the plant bearing beds usually correspond to marsh deposits and may also yield a few molluscs of brackish water type. Carbonized rootlets, still in life position, locally occur within these beds, which are in turn overlain by black, carbonaceous shales or by the coal seams. On top of these, another subtidal *Lithiotis* bed starts the next cyclothem.

Dessiccation as well as solution open-space structures, due to repeated subaerial exposure, are particularly widespread in the topmost beds of the « Grey limestones » in the Sette Comuni (see further on).

Along a wide peripheral belt excluding the central part of the Trento ridge only (Sette Comuni, Eastern Lessini), the shelf-lagoon facies of the « Grey limestones » grade upwards into higher-energy, yellowish coloured detrital limestones of Toarcian-Aalenian age, known as the « Cape San Vigilio oolite ». The dominant lithology is represented by medium to well winnowed calcarenites, grading from purely oolitic to skeletal in composition. Cross, as well as oblique lamination is fairly common within the thickest beds.

This formation wedges out from the periphery to the center of the shelf (Sette Comuni), where it is missing altogether: this must have corresponded to an emergent area from the beginning of the Toarcian.

By the time the « Cape San Vigilio oolite » was laid down, a continuous reef complex did not seem to exist bordering the shelf. Patch reefs, on the other hand, became locally quite widespread. The biota was more varied within and near such reefs: one need only mention the well known « fauna coralligena » from Monte Pastello, on the Western border of the Lessini (G. DAL PIAZ 1912; also C. STURANI 1964a, for a stratigraphic revision). This includes abundant reef building corals and sponges, accompanied by a host of small sized gastropods, Trigoniids, Pectinids, regular sea urchins (*Pseudodiadema*), crinoids and small Rhynchonellids (« *Rhynchonella clesiana* LEPS., « *R.* » *lessinorum* DAL PIAZ, *Stolmorhynchia bilobata* (BENECKE)).

Crinoids, *Pseudodiadema* and Rhynchonellids are still frequent within the even bedded skeletal calcarenites, but, as one would expect, they become much scarcer in the purely oolitic, often cross-bedded facies, which must have corresponded to mobile bars: an environment notoriously hostile to the settling of a permanent biota.

Ammonites are of sporadic occurrence within such facies, but become more frequent in the topmost beds of the formation at such celebrated fossil localities as Cape San Vigilio, Tenno, Monte Peller (topmost Toarcian) and the Feltrine Alps, all of which must have lain along the outermost rim of the shelf, at its junction with

the talus slope. Such a location is strongly supported by the appearance at these localities of diasthems, condensed beds with stratigraphically mixed assemblages, limonitic nodules and crusts, worn and iron-coated ammonites, and especially of thin, ammonite rich, red coloured micritic beds, already in a pelagic facies.

Cross-bedded, clean-washed crinoidal calcarenites, practically devoid of oolites and containing occasional shell bed concentrates of brachiopods, ammonites and *Bositra*, were locally developed from the beginning of the Aalenian at Monte Agaro (see p. 70) and a few other localities; they must have corresponded to shallow, wave-swept banks along the periphery of the shelf. Since they are lithologically closer to the younger, *Bositra*-bearing coquinas of Bajocian-Lower Bathonian age, formed under the same environmental conditions, they seem to be best placed within the *P. alpina* beds and will be discussed with them.

By the end of the Aalenian (in some places a little bit earlier) the rate of subsidence on the whole Trento ridge came to an abrupt halt, which marked the end of the deposition of the carbonate shelf facies. This was later followed by the sinking of the ridge and its transformation into a pelagic, intrageosynclinal swell, characterized by « rosso ammonitico calcareo » facies.

The onset of this condensed, pelagic sedimentation took place at different times over the various parts of the ridge, and was often reinterrupted up into the Upper Oxfordian (Upper Callovian and Lower Oxfordian sediments are missing throughout the whole Trento ridge). But it was preceded by a period during which thin, peculiar sediments, known as the « *Posidonia alpina beds* » (or « *P. a. coquina* ») were laid down in extremely localized patches. Such sediments grade from red biomicrites packed with crinoid ossicles and *Bositra buchi* (RÖEM.), formed below wave base and filling Neptunian dykes (Loppio section), through clean-washed crinoidal sands (Rovereto) and spar-cemented, *Bositra* bearing coquinas (Acque Fredde, Sowerbyi zone; Brentonico; Monte Agaro), which must have corresponded to shallow, wave-swept banks, to the lithologically more complex *P. alpina* beds of the Sette Comuni, that contain incredibly rich brachiopod, gastropod and ammonite assemblages, and occur as the filling of subaerial karstic fissures flooded from time to time by hurricane-induced tides.

Along the shelf rim, that is in the Cape San Vigilio and Alpi Feltrine regions, onset of pelagic sedimentation took place earlier, with the deposition of cream to pink or red coloured biomicritic limestones, yielding normal sized ammonites (mainly macroconch Stephanoceratids, *Emileia* and Phylloceratids) of the Sowerbyi-Humphriesianum zones, known in the literature as « *Campotorondo limestones* » (CASATI 1969) or « Calcari a *Skirroceras* del Capitello » (STURANI 1964a). Such limestones, though rarely nodular, are already close to the « rosso ammonitico calcareo » facies; they are partly synchronous with the *P. alpina* beds, with which they can interfinger laterally (Acque Fredde, Alpi Feltrine).

The stratigraphic relations of the *Posidonia alpina* beds are schematized in text-fig. 2. This formation, as a whole, may range in age from the base of the

Aalenian to the Zigzag zone of the Lower Bathonian, inclusive. Such a situation, however, is known only at Monte Agaro (see p. 70); on other parts of the Trento ridge the *P. alpina* beds may represent only a fraction of this stratigraphic interval, or may be absent altogether. The vertical extent of the corresponding gaps has been schematized in the same text-figure. From this, it also appears that the *P. alpina* beds, as a whole, are partially synchronous — and therefore heteropic — with: 1) the upper part of the Cape San Vigilio oolite, known as « *Stolmorhynchia bilobata* beds » and mainly of Aalenian age (Monte Peller, Monte Agaro); 2) the Campotorondo limestones, mentioned above (Acque Fredde, Alpi Feltrine); 3) the lowermost part of the « Rosso ammonitico veronese » (Monte Giovo near Brentonico and Monte Agaro sections).

All this is good evidence that, during the change-over from carbonate shelf to pelagic sedimentation, the paleogeographic evolution did not proceed at a uniform pace on the different parts of the Trento ridge.

After the sinking of the shelf, deposition of the « *Rosso ammonitico veronese* » started just before the end of the Bajocian (Parkinsoni zone) over a large part of the Trento ridge, including the Lessini and the Sette Comuni regions, and went on at a slow rate, with several interruptions, until it was widespread over the whole ridge by the beginning of the Upper Oxfordian.

In the type area, North of Verona, this formation does not exceed a thickness of about 25 metres, approximately half of which belongs to the basal « Nembro chiaro » member of Middle Jurassic age (topmost Bajocian to basal Middle Callovian). This is obviously very thin when compared to the thickness of about 450-600 metres reached by the underlying carbonate shelf formations (Noriglio grey limestones and Cape San Vigilio oolite), of Liassic-Aalenian age.

The importance of recurrent syndimentary solution, later followed by postdiagenetic solution along stylolites, has already been stressed by others (R. HOLLMANN 1964) in order to explain the nodular texture as well as the reduced thickness and the condensed nature of this formation. The same remark applies to the repeated and areally widespread ferromanganese crusts, marking gaps at the base or within the formation, as well as to the stratigraphically mixed assemblages, which occur at several horizons.

There is one more feature, however, rather overlooked until now, which should be pointed out: that is, the presence of stromatolitic structures within the « Rosso ammonitico veronese ». These occur both as smooth to dome surfaced continuous layers and as isolated domes. The former are always associated with the major stratigraphic gaps, at the base or within the formation, lying just above the surface of discontinuity. In some cases they are sandwiched between two ferromanganese crusts, that is between two surfaces of discontinuity: this situation is particularly frequent in the Sette Comuni, where the basal member of the « Rosso ammonitico veronese », of Middle Jurassic age, is reduced to just the stromatolitic layer (C. STURANI 1964a, pl. 2).

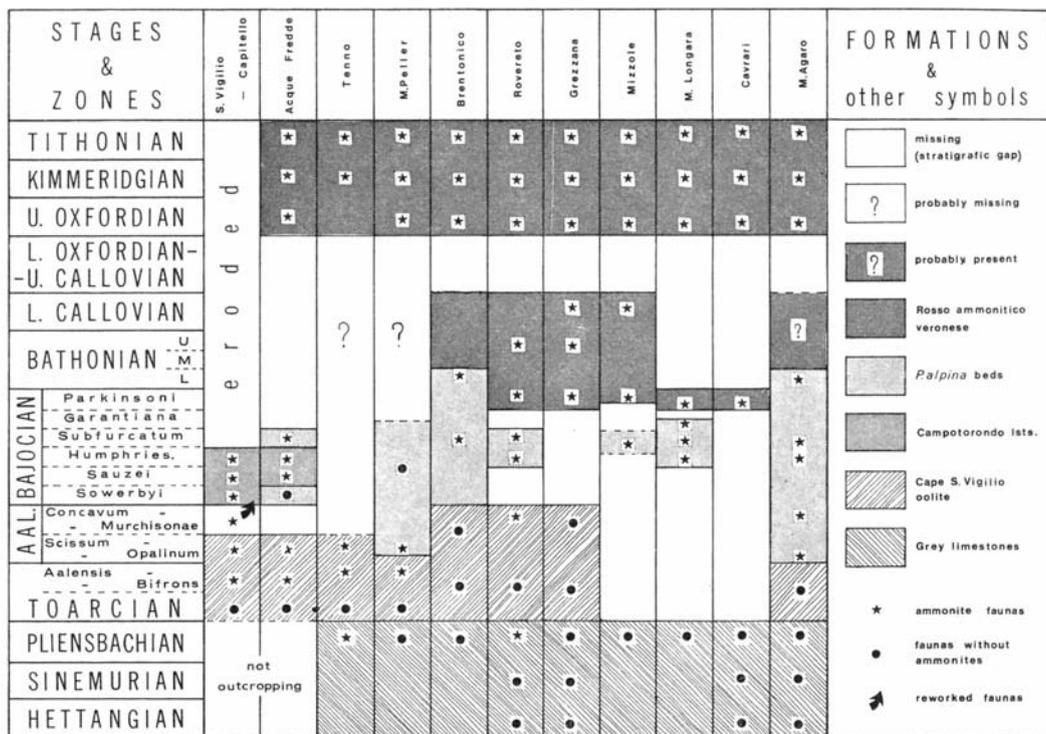


FIG. 2

Schematic diagram showing the stratigraphic relationships of the Jurassic formations and the vertical extent of the main stratigraphic gaps at various localities all over the Trento ridge. The height of each column is not in scale with the observed thickness.

« M. Longara » includes Troch, Rotherbrunn and Longara di Sotto fossil localities. Cavrari is a locality of the Sette Comuni, near Ponte sul Ghelphach, where the *P. alpina* beds are missing (see STURANI 1964 a. pl. 2).

The isolated domes usually occur scattered above synsedimentary solution surfaces, which mark shorter gaps, and are preferentially localized on top of the Ammonites, the upper half of which has been removed by submarine solution.

In the case of the « Rosso Ammonitico Veronese », both the smooth layers and the isolated domes I have seen to date, completely lack such dessiccation structures as small scale sheet and prism cracks or shrinkage pores, that are so characteristic of supratidal and intertidal, recent and fossil stromatolites or algal mats. In this respect they are perfectly comparable to the stromatolitic structures recently described by H. JENKYNs & H. TORRENS (1969) in the Middle Jurassic of Western Sicily, as well as to the examples from the polish Jurassic illustrated by M. SZULCZEWSKI (1968). This, at least, proves that they were entirely subtidal. If an algal origin is to be accepted in this case too, then the depth range must have fallen within the photic zone, that is between zero and a maximum of 150 metres (J. H. RYTHER 1956). A rather shallow depth seems furthermore confirmed by the association of such stromatolitic layers and isolated domes with unquestionable lithodome borings (STURANI 1969, f. 6; also this work, p. 42 and text-figs. 3, 23).

It would however be unsafe, in my opinion, to assume such a shallow depth throughout the whole period during which the « Ammonitico rosso veronese » was

deposited. One should not forget that the lithologies are far from being uniform throughout the whole thickness of this formation and that it covers the whole Upper and a good part of the Middle Jurassic, over several millions of years: it seems rather unlikely that the depth of the floor of the Trento ridge remained the same throughout.

The constant association of stromatolitic structures with discontinuity surfaces may well be in close relationship with periods of either tectonic uplift or of eustatic fall of sea level, during which the bottom reached into the photic zone and the lime muds were more likely to be winnowed away or re-dissolved by the combined action of waves or currents and microscopic blue-green algae (M. SZULCZEWSKI 1968).

In other words, within the « Ammonitico rosso veronese » the negative phases of sedimentation (joints, diasthems, hard grounds) and the associated stromatolitic structures alone, may be indicative of periods of reduced depth. This may be easily explained if we take into account the close relationship existing between A) the rate and nature of sedimentation, B) the rate of subsidence and C) the hydrodynamic conditions (J. C. FISCHER 1969, p. 304). In this connection, several authors (see M. DREYFUSS 1955, p. 429, for references) have shown that, in the absence of subsidence, sedimentation is extremely reduced or interrupted on those parts of the (continental) shelf that are subject to a strong water agitation. Similar conditions probably exist also at greater depths, on seamounts swept by deep currents (stratigraphic gaps not associated with stromatolitic structures).

This, however, does not apply to the positive phases of sedimentation, which are represented in the case under discussion by biomicrites with abundant pelagic fossils (Ammonites, Belemnites; *Bositra*, in the lower part of the formation; *Saccocoma*, Tintinnids and calcareous nannoplankton in the upper part), although the bottom communities are much scantier (a few Brachiopods, stalked Crinoids, *Pleurotomaria*, *Discohelix*, *Ceromya*, *Cuspidaria*, *Inoceramus*, *Collyrites*). These sediments may have formed at any depth between wave base and the CaCO₃ compensation depth during Jurassic times (a depth above wave base is discounted because it would require a sheltered, low-energy environment such as a back reef lagoon: but one could hardly envisage the « ammonitico rosso calcareo » as a back reef facies!).

While wave base cannot have been very far from present day values, we know next to nothing about the CaCO₃ C. D. during the Jurassic (HUDSON 1967). Several alternative interpretations are therefore possible: A) depth between wave base and the lower limit of the photic zone, during periods of slow subsidence when the hydrodynamic conditions allowed the deposition of lime muds but were on the other hand unfavourable to the settling of algal mats and stromatolites (C. D. GEBELEIN 1969). B) Depth just below the lower limit of the photic zone, so that slight fluctuations relative to sea level (be they of eustatic or of tectonic nature) could alternatively allow deposition or the removal of sediments and the settling of stromatolites. C) Depths well below the lower limit of the photic zone. The first two alternatives may both be valid for the lower part of the « Ammonitico rosso veronese » formation, where the stromatolitic structures and the sedimentary gaps

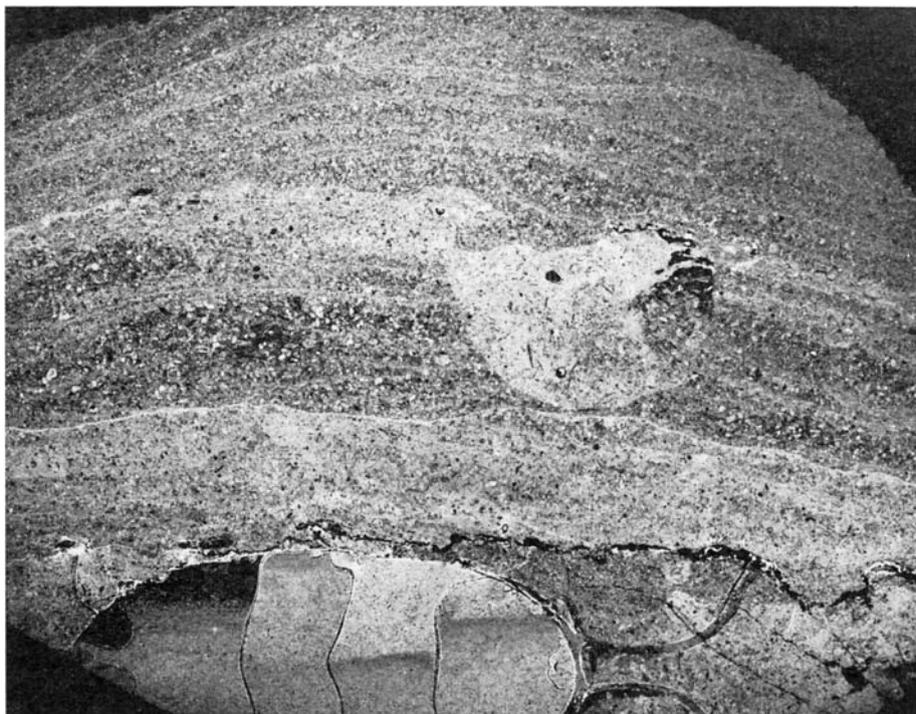


FIG. 3

Stromatolitic dome built upon a Phylloceratid, the upper half of which had been removed by submarine solution. Note the geopetal structures within the gas chambers of the ammonite, as well as the complete absence of shrinkage structures within the stromatolite.

A lithodome boring, drilled into the middle laminae of the stromatolitic dome, is also clearly visible. As to its bathymetric significance, it should be noted that, although most species of recent rock-boring bivalves live from the middle of the intertidal zone to depths of a few fathoms, some are known to range to considerable depths (*Hiatella arctica* (L.) and *Pholadidea loscombiana* TURTON, for instance; see N. TEBBLE 1966).

Lowermost part of the « Ammonitico rosso veronese » formation; topmost Bajocian, Parkinsoni zone, Magnavacca quarry near Grezzana. Thin section, plane light, negative print; $\times 5$.

are more widespread; the third could on the other hand apply to the upper part of the formation, mainly of Tithonian age, where no stromatolitic structures are known to occur, while such allegedly deep water facies as *Aptychus* limestones with bands of chert nodules are often interbedded at this level.

A more precise evaluation of depth between such rather vague and wide boundaries requires a more thorough study of the whole formation than is available at present and a more sophisticated approach: for the time being, it seems beyond the resolution power of current paleontological methods: as already pointed out by A. HALLAM (1969) the wealth and diversity of the bottom communities, and their bathymetric distribution, seem to depend more strictly on food supply than on merely physical environmental factors, such as temperature, depth, etc.

In this connection, a comparison with the supposedly deep water limestones and radiolarites of the Unken region, recently discussed by R. E. GARRISON & A. G. FISCHER (1969), is certainly of great interest, even though the palaeogeographic evolution of the Unken basin during the Jurassic is more closely comparable to that of the Lugano swell (D. BERNOULLI 1964), than to the Trento ridge. In their first model (*op. cit.*, fig. 20) the basic assumptions are that the calcite and aragonite compensation depths shifted downwards during

Jurassic times, from levels above 2.000 m to those of today, while the rate of subsidence (assumed to be 100 m/ million years) remained constant. In their second model (*ibid.*, fig. 21) the basic assumptions are that the calcite and aragonite C. D. have remained about the same from Jurassic to the present (i. e. 4,500 and 4,100 m, respectively), while the subsidence went on at a rate of about 270 m/ million years during the Lower Jurassic, ceased during the Middle Jurassic and was followed by a gentle uplift thereafter. In the first case *Aptychus* limestones may have formed at variable depths as the CaCO₃ compensation depth shifted down; in the second case only between 4,100 and 4,500 m.

Both models, however, appear to be oversimplified, because the basic assumptions are questionable, with regard to the role of subsidence and its estimated rates, on one hand, and the assumed values for the CaCO₃ compensation depths during Jurassic times, on the other (cf. A. HALLAM 1969).

The rate of subsidence relative to sea level is given by the rate of sediment accumulation plus the net increase (or decrease) in depth during the palaeogeographic evolution of a given basin. While the former factor is recorded by the thickness of the stratigraphic column plotted against the absolute time scale, the second is much more difficult to evaluate with reliable accuracy, especially for intermediate to deep water facies. In the case of carbonate platforms, such as the Trento ridge during Liassic times, depth as well as depth increase were negligible, so that the rate of subsidence is practically equal to the rate of sediment accumulation. But this does not apply to intermediate or deep water intrageosynclinal swells: if we do not know the exact depth and its increase rate, how can we evaluate the rate of subsidence? And, inversely, how can we safely assume that the latter was constant throughout Jurassic times, in order to infer the depth from the subsidence rates? Moreover, how shall we interpret gaps in the sedimentary record? Are they due to a cessation of subsidence or completely independent from it, as R. E. GARRISON & A. G. FISCHER implicitly seem to admit? According to these authors, biogenic sedimentation in the Unken region went on at rates of 1,000 m/ million years in the intertidal zone, 100 m/ million years in shallow-water reefs and lagoons, less than 10 m/ million years at water depths of 50 to 100 metres, and was on the order of 1 m/ million years in the bathial and abyssal zones. As to the cause of basin starvation (i. e. reduced sedimentation rate) they state « Even a temporary increase in subsidence rate relative to sea level » (over values of 100 m/ million years) « — be it due to local tectonic or to eustatic factors — which produced water depths in excess of 20 metres, would have plunged bottoms into a zone of drastically lowered carbonate production, from which there is no recovery, so in other words, would have initiated bottom starvation ». This sounds rather sensible and is certainly the case for the Jurassic sediments of the Unken syncline, but it would in my opinion be unsafe to generalize about such an assumption and extend it to similar facies, all over the Tethyan realm.

As we shall see in more detail in the following pages, the role of subsidence during the paleogeographic evolution of the Trento ridge was nearly opposite to that assumed by GARRISON and FISCHER: in this case the passage from massive carbonate production to basin starvation was not due to an abrupt deepening of the sea floor because of a rapid increase in the rate of subsidence: on the contrary, it was preceded and accompanied by a prolonged halt in subsidence at very shallow depths, the sedimentation rate during the deposition of the *P. alpina* beds being comprised between zero and a maximum of 2 m/million years, both above and below mean sea level, and both below and above wave base.

Later on, the rate of increase in depth during the deposition of the « Rosso ammonitico veronese » may well have been faster than sedimentation; this, however,

was by no means achieved through a constant rate of subsidence, as shown by the recurrence of stratigraphic gaps, stromatolitic layers and condensed assemblages up into the Lower Kimmeridgian (R. HOLLMANN 1964).

Uniform basinal conditions were not established until the Tithonian: at this time marly, strongly nodular limestones with aptychi and deeply corroded ammonites, locally associated with bedded cherts, became widespread over the whole Trento ridge. They were later followed by more massive, cream to pale pink micritic limestones, characterized by extremely abundant Tintinnids, *Pygope* and well preserved ammonites of topmost Tithonian - Berriasian age.

As to the environmental setting of the « Ammonitico rosso veronese », recent, non magnetic tablemounts (guyots) seem to be the best actualistic model (STURANI 1967b, p. 463; also H. JENKYN & H. TORRENS 1969), taking into account the probability that long periods with no subsidence may have alternated with periods of rapid sinking or uplift.

THE POSIDONIA ALPINA BEDS OF THE SETTE COMUNI AREA

LITHOFACIES AND ENVIRONMENT OF DEPOSITION

In the different localities of the Sette Comuni, where they have been observed (see figs. 1, 24 and 25 for location maps), the *P. alpina* beds lie unconformably upon the « Noriglio grey limestones », and are in turn overlain by the « Ammonitico rosso veronese ». The topmost beds of the former contain fossils of Domerian age (*Orbitopsella*, *Lithiotis*, etc.), while the basal part of the latter has locally yielded a few ammonites (Phylloceratids, *Lytoceras eudesianum* (d'ORB.), *Dimorphinites dimorphus* (d'ORB.)) of the topmost Bajocian, Parkinsoni zone.

The age of the *P. alpina* beds of the Sette Comuni, as we shall see in detail further on, varies from one locality to another; in each case it corresponds to an extremely short stratigraphic interval (part of single subzones) within the Bajocian, ranging from the basal Humphriesianum to the Garantiana zones.

Thus, both the lower and the upper boundaries of the *P. alpina* beds correspond to stratigraphic gaps. The lower one is the bigger, since it embraces the Toarcian, the Aalenian and part of the Lower Bajocian, up to the Sauzei zone inclusive; as already pointed out, this gap is due to the emersion of the central part of the shelf, in the form of a low, flat island, during the time when the « Cape San Vigilio oolite » was forming on the outer belt.

The geometric relationships with the underlying « Grey limestones » are rather complex: the *Posidonia alpina* beds occur either as the infilling of large solution cavities and fissures within the topmost 0.50 - 2.50 metres of the Liassic bedrock; or as the matrix of a peculiar solution breccia, formed at the expense of a Liassic

edgewise breccia through the leaching of the pre-existing matrix; or eventually as the infilling of shallow depressions of the original topographic surface. These possibilities may occur separately or combined in various ways, but the former two are by far the more widespread.

As for their lithology, the *P. alpina* beds are here represented by a sugar-white, spar-cemented coquina, which grades locally into a red biomicritic limestone. The vivid colours of these facies make a striking contrast against the light-tan coloured bedrock in which the fissures are cut, giving the whole rock a most beautiful and unusual aspect (Pl. 1).

The liassic bedrock. Towards the top of the « Grey limestones », cyclothems begin to appear (fig. 17), which recall the Triassic ones described by A. G. FISCHER (1964) in the Lofer Mountains: each subtidal member (massive, *Lithiotis*-bearing limestone, for instance) ends with a subaerially eroded surface, coated with a thin layer of red, argillaceous calcilutites, which also fill small solution cavities within the topmost part of the underlying member. Next above comes a thin bed of sterile to scarcely fossiliferous micrite, often riddled by desiccation fissures (FISCHER's « member B »).

The topmost cyclothem is incomplete and seems to reflect a tendency to more prolonged low stands of sea level, which preceded the permanent exundation of this part of the Trento ridge during Toarcian and Aalenian times: in fact, member B, characterized by desiccation structures, expands here to a much greater thickness, up to 2.50 metres, while member C (subtidal) is missing.

The fissures and solution cavities filled by the *P. alpina* beds are usually confined here; since their pattern is to a great extent determined by the pre-existing fabric of the Liassic bedrock, in particular of the greatly expanded member B, this deserves a more detailed description.

This member consists of homogeneous micrite, light tan in colour and usually devoid of fossils. In a few instances (Cima Tre Pezzi section, see figs. 17-18) the whole member or its lower part alone may show dark brown mottling due to bioturbation (network of burrows). In this case, the micrite contains scattered fossil debris. Unbroken fossils are occasionally present in the undisturbed facies as well, though by no means common: crinoid ossicles, echinoid plates and spines, unpaired valves of large Terebratulid brachiopods and bivalves (including small-sized *Ostraea* sp., *Pachyrisma* sp. and *Lithiotis*), a few gastropods, smooth-shelled ostracods, *Glomospira* and exceedingly rare *Orbitopsella*, which clearly indicate a Domerian age.

Small-scale lamination of stromatolitic origin is also occasionally present, but it is never so conspicuous as in the Triassic « Loferites » described by A. G. FISCHER (1964, pp. 124-129). This is probably due to the extremely fine and homogeneous grain of these Domerian calcilutites.

By comparison with the recent environmental setting described by P. O. ROHEL (1967) and by SHINN, LLOYD & GINSBURG (1969) on Andros island, such sediments probably formed in supratidal marshes periodically exposed to subaerial conditions.

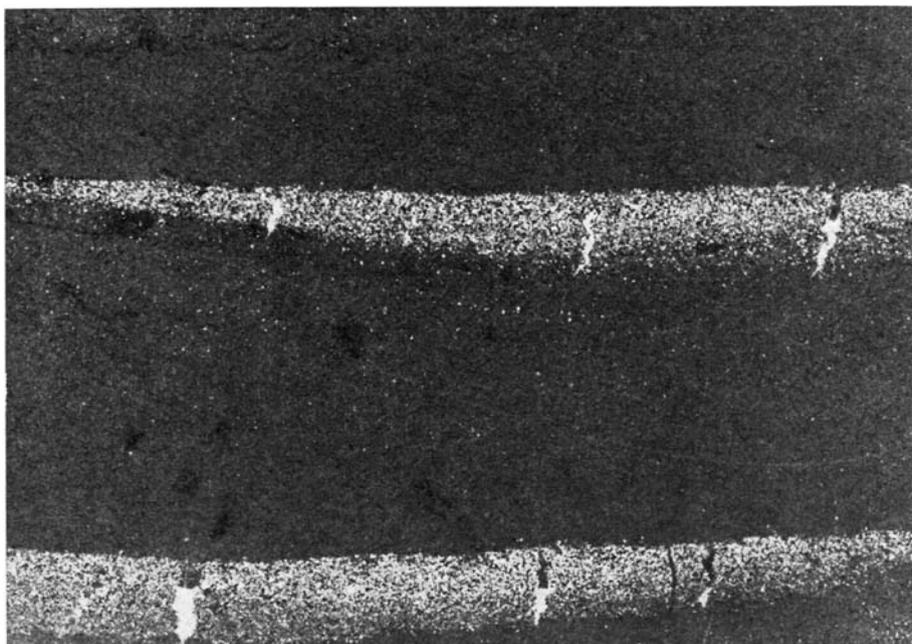


FIG. 4

Preferential dolomitisation along subaerially exposed, sun-cracked surfaces, within a sterile calcilutite. Thin section of an angular fragment of « Grey limestones » embedded within the *P. alpina* beds. Troch n. 1 fossil locality. Plane light, positive print; $\times 10$.

While part of the fauna may well have been indigenous to this environment (the smooth-shelled ostracods, *Glomospira*), other fossils (such as the echinoderms and the brachiopods) were probably channelled from time to time by abnormally high tides.

Evidence of prolonged and repeated subaerial exposure is given by the widespread and varied dessiccation structures, on one hand, and by partial dolomitisation, on the other.

Dolomite occurs either as tiny crystals scattered throughout the micrite, or as thin crusts along subaerially exposed, sun-cracked surfaces (fig. 4).

The shrinkage fissures represent one of the more striking features of the rock under discussion, both fossiliferous and sterile: the whole bed is riddled by two fissure systems, filled with penecontemporaneous internal sediments, the younger of which cuts the older one (figs. 5-6).

The fissures of the older set are mainly of the sheet-crack type (see A. G. FISCHER 1964, pp. 114-116, for a definition of this term), from 0.2 to 8 mm wide and up to 10 cm long. Their filling is given by homogeneous micrite of about the same colour as the surrounding rock, so that these fissures are barely visible, only on polished surfaces or in thin section (figs. 5-6). Such internal sediments may contain smooth-shelled ostracods and have usually settled within the fissure, forming horizontal floors. The remaining void, if any, has been later filled with clear, blocky spar. Other sheet-cracks of this same set may be entirely filled by sparry calcite and thus weather out more conspicuously.

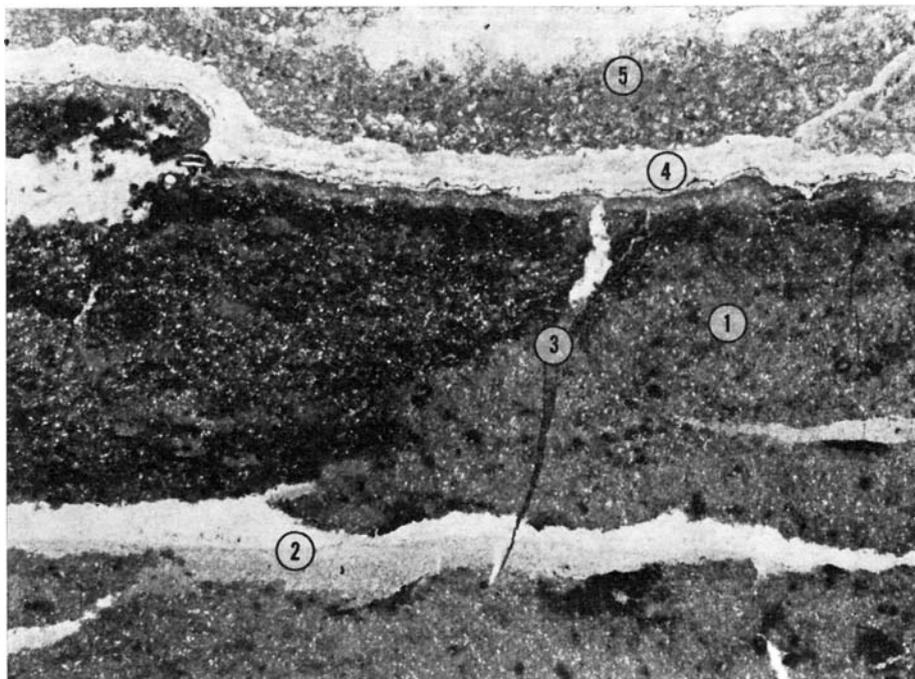


FIG. 5

The two sets of shrinkage fissures occurring within the topmost bed of the « Grey limestones » at Longara di sotto quarry. Plane light, positive print; $\times 10$.

1: sterile to scarcely fossiliferous calcilutite (A. FISCHER's « m1 »); 2: sheet-crack of the older set, filled with penecontemporaneous lime mud (m2) and blocky spar (s2); 3: small, internal prism-crack of the younger set, filled partly with red, fossiliferous micrite and partly with clear spar, which cuts through the preceding one. 4 - 5: This prism-crack opens upward into a wider sheet-crack of the same set, filled with partially calichified, Liassic internal sediments (5). A turbid spar crust of neomorphic origin (4) has crystallized *within* these internal sediments, along the periphery of the crack.

After the first fissure system just described was plugged with internal sediments and sparry calcite (hence, presumably, after incipient lithification had begun), a second set of prism- and sheet-cracks opened, which cut through A) the preceding ones (figs. 5-6), B) the dolomitic crusts, and C) the shell of the oysters.

These younger fissures consist of somewhat irregular sheet-cracks, up to 3 cm wide and 20 cm long, roughly parallel to the bedding planes of the host rock and connected by vertical prism-cracks. Together, they divide the rock into flat to slightly warped polygonal prisms, up to 5 cm thick and 30 cm wide. The latter have usually undergone but little mutual displacement and have been recemented by the internal sediments which fill the shrinkage cracks. The resulting rock — prior to its further transformations — was thus a peculiar edgewise breccia (figs. 6a-b), due to the fracturing and buckling of a semilithified limestone, rather than to mud-cracking.

One of the more striking features is that both the floor and the roof of the wider sheet-cracks of the younger set are riddled by small-scale, V-shaped internal prism-cracks (figs. 5-13) and are coated all over by a dark-red hematitic film.

As to the environmental conditions favourable to the opening of these fissures of the younger set, they must have been partially similar to those responsible for the genesis of recent caliche. The open-space structures just described are in fact strongly reminiscent of some features shown by caliche: *e. g.*, the « buckle-cracks »



FIG. 6 A

Solution breccia, formed at the expense of a Liassic edgewise breccia. The Liassic internal sediments that bound the flat pebbles have been partially leached away and replaced by a much younger, *Bostrea*-bearing micrite. *Posidonia alpina* beds. Longara di sotto quarry: polished slab cut normal to the bedding planes. See also figs. 6 B and 6 C for further details.

described by C. C. REEVES (1970; pp. 358-359; pl. 3) on one hand, and the fracture pattern shown by cobbles embedded in caliche (R. G. YOUNG 1964) on the other. In the present case, however, « calichifying » did not proceed beyond the stage of drying, fracturing, buckling and subsequent expansion of the topmost few feet of the semilithified Domerian sediments. Complete destruction of the parent rock and subsequent development of massive, typical caliche profiles (C. C. REEVES 1970, f. 1) never occurred here, perhaps because the climatic conditions were too arid.

As shown by the age of the internal sediments which fill the younger set of fissures (see below), all this took place immediately after deposition of the « Grey limestones » had ceased, at the beginning of the long period of emergence that followed during Toarcian and Aalenian times.

The fissures of the younger set, soon after their opening, became filled with brick-red micrite, packed with ostracods (most, but not all of which, smooth-shelled),

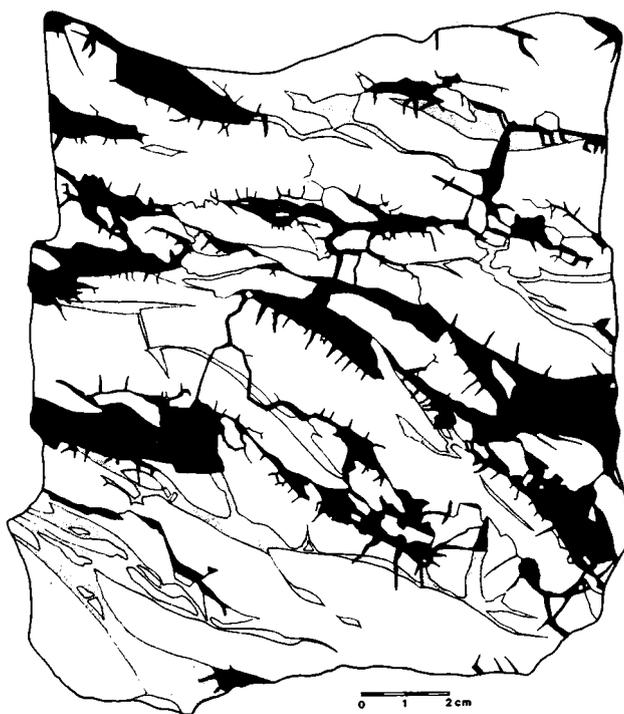


FIG. 6 B

Same as fig. 6 A. In this figure the two sets of Liassic shrinkage fissures alone have been schematized: the younger one (black) clearly cuts through the older one (ruled). For sake of clarity, the *Bositra*-bearing micrite has been omitted in this figure, which gives thus an idea of the Liassic edgewise breccia, prior to the deposition of the *P. alpina* beds.

small-sized *Trocholina* sp. and extremely abundant *Involutina impressa* (KRISTAN-TOLLMANN) (fig. 10). The known vertical range of the latter species was Norian-Lower Lias (KOHEN-ZANINETTI 1969; BRÖNNIMAN, POISSON & ZANINETTI 1970), but must now be extended to include the whole Middle Lias, at least, as shown by the present example.

From a palaeoecological point of view, the presence of this interstitial fauna shows that elevation of the ground above sea level must still have been rather small, to allow the temporary inflow of brackish (to hypersaline) water into the fissure system (see also F. MASSARI 1968, p. 33).

The Bajocian solution breccia. The Liassic internal sediments just described were more easily soluble than the surrounding, slightly dolomitic host rock: as a consequence they have often been leached away during the Bajocian morphogenetic cycle and have been partially or completely replaced by a much younger, Bajocian biomicrite (figs. 8-9) of about the same brick-red colour.

Distinction between the red Liassic internal sediments and the Bajocian biomicrite, which often occur side by side within the same fissure, is easy only in thin section: the latter, in fact, contains a completely different faunal assemblage: thinly comminuted *Bositra* and ammonite shells, crinoid ossicles, *Globochaete*, « protoglobigerinas » and other foraminifera.

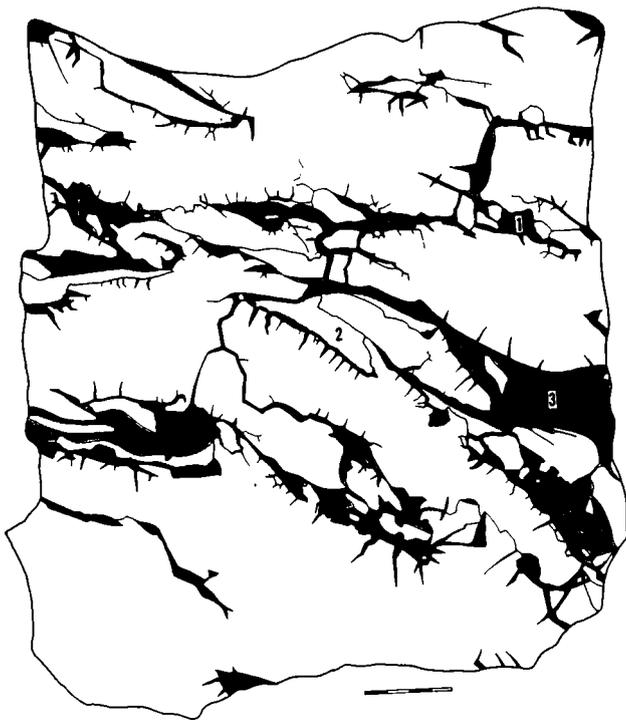


FIG. 6 C

Same as figs. 6 A and 6 B. This figure shows the Liassic internal sediments of the younger set (1), partially transformed into patches of milky-white caliche (2). Cavities resulting from the leaching and/or the mechanical removal of this caliche became filled with brick-red, argillaceous, laminated, *Bositra*-bearing micritic limestones of Bajocian age (*P. alpina* beds) (3). In this figure the older set of Liassic sheet-cracks has been omitted, for sake of clarity.

Removal and substitution of the Liassic internal sediments was nearly complete (but for a thin peripheral rim) within most of the wider sheet- and prism-cracks; on the contrary, they remained unaltered within the smaller, internal prism-cracks (figs. 8-9). The first phase of this process was sometimes preserved without further modifications and can thus be studied. It consisted in a sort of « calichifying » of the red Liassic internal sediments, which were transformed into a milky-white, loose micrite, barren of fossils. The contacts between this sort of caliche, when preserved, and the Bajocian biomicrite, may be both erosional and gradational, showing that it could either be washed away by the current which carried the new internal sediments, or mix up with them, according to different instances (fig. 6a).

During the subsequent phase of diagenesis, thin, concentric spar crusts, turbid because of micritic inclusions, crystallized *within* both the patches of calichified Liassic internal sediments (fig. 11) and the newly introduced Bajocian lime muds (fig. 9), starting from the periphery of the fissure. The neomorphic crystallisation of these spar crusts within a cavity filled with internal sediments should not be mistaken for the free growth of drusy spar linings on the walls of an empty cavity (S1 of A. G. FISCHER). This same phenomenon has been observed and described by F. MASSARI (1968, pp. 26-29), whom see for a more thorough discussion.

In some instances (figs. 12-13) the fabric of the Domerian host rock has been more thoroughly disrupted, so that the flat pebbles of the Liassic edgewise breccia

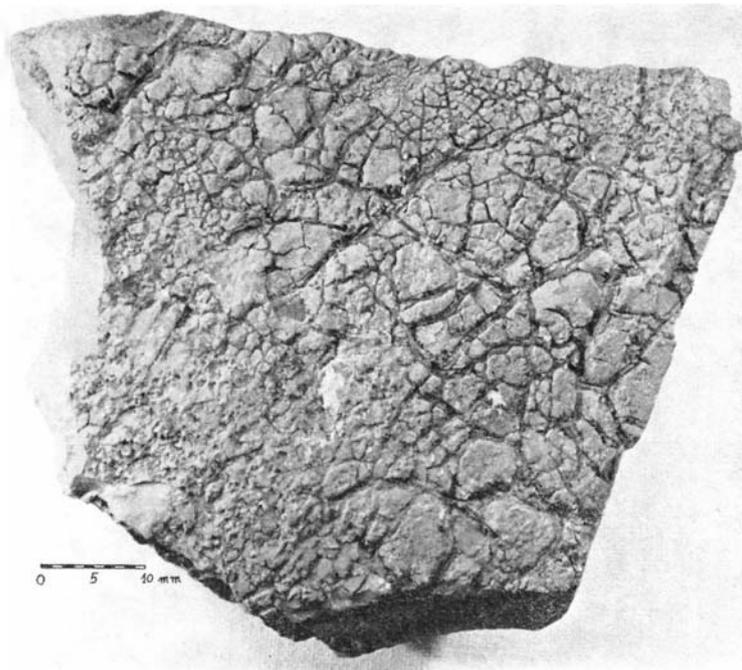


FIG. 7

A flat pebble of the Liassic edgewise breccia, from the topmost bed of the « Grey limestones » at Cima Tre Pezzi quarry, showing a dense network of small-scale, internal prism-cracks on one face.

have undergone some displacement (but no appreciable wear) and float within the red. *Bositra* bearing micritic limestone.

To summarize, the rather puzzling features of the Bajocian solution breccia, as we can now see it, result from the succession of the following events:

- 1) deposition of lime muds in a supratidal marsh (Domerian);
- 2) short, repeated subaerial exposures; partial dolomitisation and shrinkage of the lime muds (Domerian);
- 3) deposition of penecontemporaneous internal sediments and sparry calcite within the first set of dessiccation fissures (Domerian);
- 4) a long period of permanent exundation begins, under very arid climatic conditions; the weakly lithified topmost bed of the « Grey limestones » undergoes a second phase of drying, fracturing and buckling (topmost Domerian);
- 5) the resulting network of fissures is colonized by an interstitial fauna of brackish water type and becomes plugged with internal sediments (topmost Domerian or slightly later);
- 6) calichifying of the younger Liassic internal sediments and partial leaching of the resulting caliche, always under subaerial, but perhaps less arid conditions (any time between 5 and 7);
- 7) mechanical introduction of the *Bositra*-bearing lime muds within the re-opened fissures, and 8) diagenesis of the *Bositra*-bearing lime muds (7 and 8 took place alternately throughout the Humphriesianum, Subfurcatum and Garantiana zones of the Bajocian).

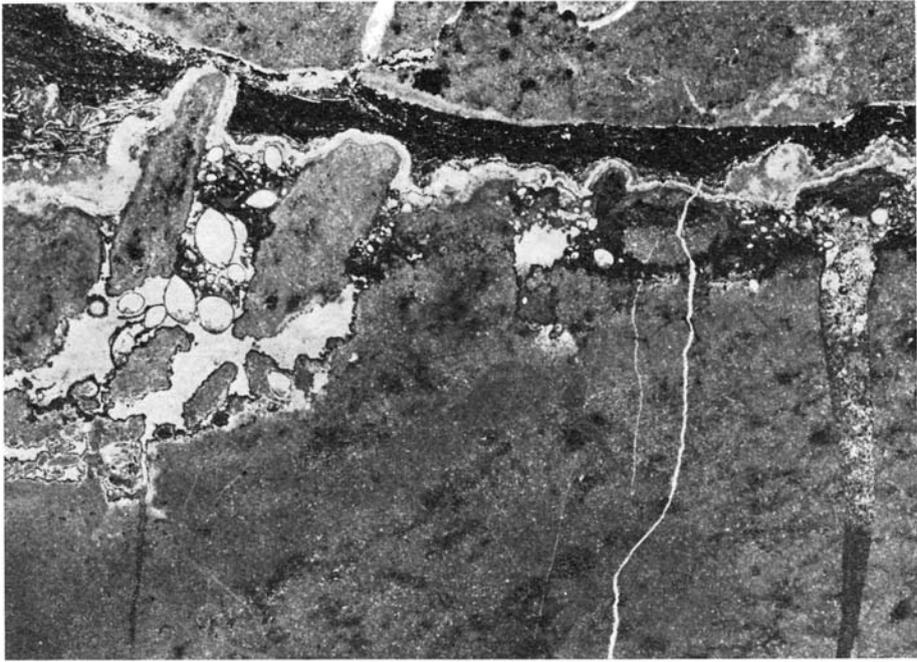


FIG. 8 A

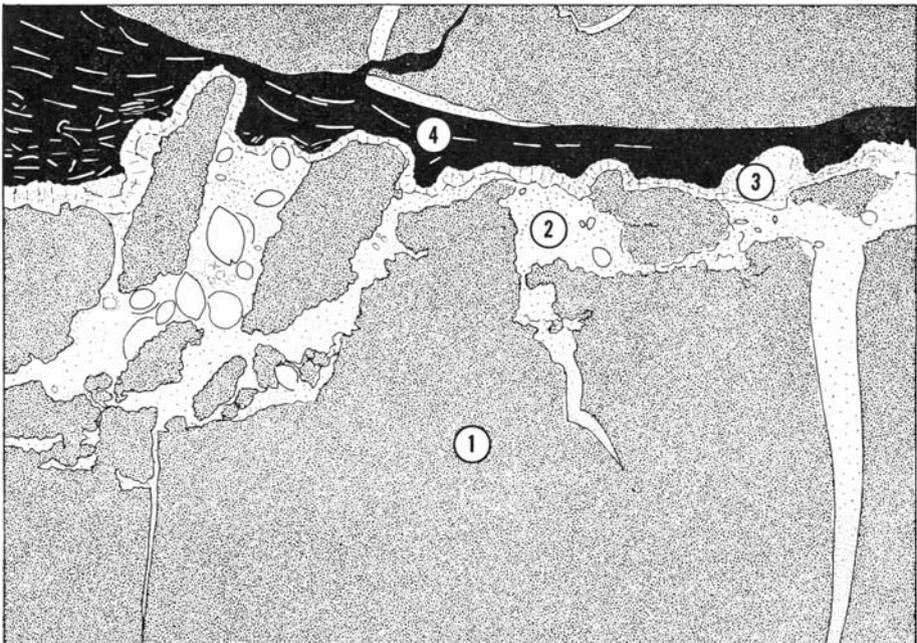


FIG. 8 B

Featureless, Domerian calcilitites (1) cut by a wide, irregularly shaped shett-crack into which open smaller, sharp-edged prism-cracks, both lined by a dark hematitic film. The Liassic internal sediments which fill such cracks (2) contain abundant smooth-valved ostracods. In the upper part of the wider sheet-crack, these internal sediments underwent partial calichifying. A neomorphic spar crust, turbid because of micritic inclusions (3), formed at the boundary between the calichified and the untransformed internal sediments. After the caliche was leached away, the resulting cavity became filled with brick-red, thinly laminated, argillaceous micrite, packed with *Bositra* debris (4). The latter is Upper Bajocian in age and belongs to the *P. alpina* beds. Longara di sotto quarry. Thin section; plane light; positive print; $\times 7.5$.



FIG. 9

Same as fig. 8. 1: Slightly dolomitic, Domerian calcilitite. 2: Liassic internal sediments with abundant *Involutina impressa* (KRISTAN - TOLLMANN), filling a prism-crack and preserved as a thin peripheral rim along the edges of a wider sheet-crack (upper half of the figure). 3-4: Red, Bajocian micrite, packed with thinly comminuted *Bositra* and ammonite shells (4), which has replaced the Liassic internal sediments within the wider sheet-crack, after their removal. A thin rim of turbid spar (3) has crystallized within the *Bositra*-bearing micrite, along the periphery of the fissure. Longara di sotto quarry. Thin section, plane light, positive print; $\times 40$.

The larger solution cavities and fissures. Disgregation of the topmost few feet of the exposed bedrock, through the leaching of the Liassic internal sediments, was accompanied and followed by the opening of larger solution cavities and fissures.

Fissures opening into carbonate rocks may form in three ways, according to A. G. FISCHER (1964, p. 133): through tectonic fracturing; through mud-cracking on a very large scale; through karstic solution. The collapse of large rock fragments undermined by karstic cavities may also play a minor role.

While the opening of fissures because of tectonic shattering may occur at any depth below sea level, and seems to be at the origin of most Neptunian dykes described to date in the Mediterranean Jurassic (WENDT 1965; CASTELLARIN 1966;

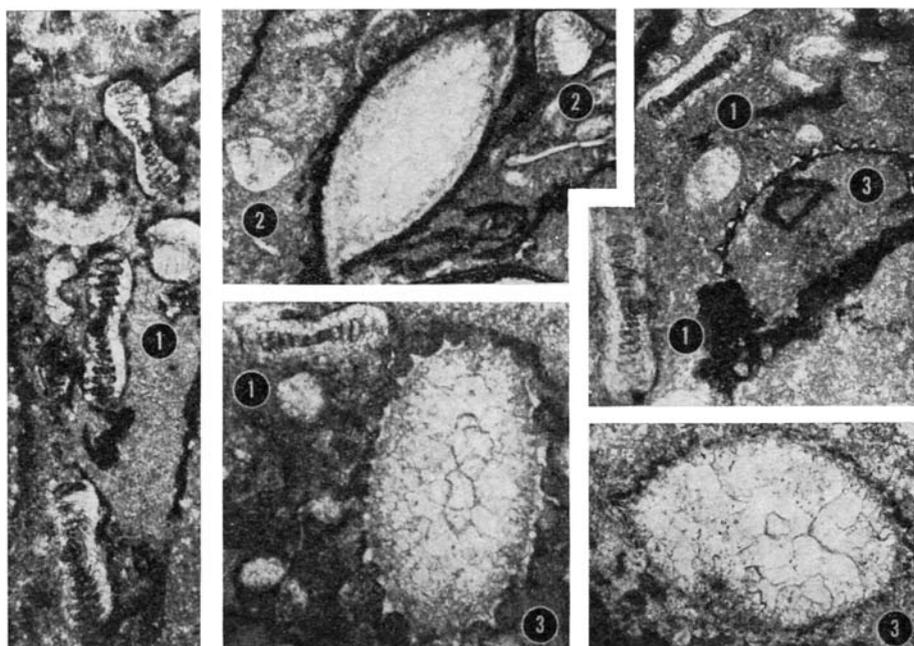


FIG. 10

Microfauna of the internal sediments which fill the younger set of Liassic shrinkage cracks, within the topmost bed of the « Grey limestones » at Cima Tre Pezzi quarry. Thin section, plane light, positive print; $\times 60$. 1: *Involutina impressa* (KRISTAN-TOLLMANN). 2: *Trocholina* sp.. 3: Strongly reticulated ostracods; as shown by tangential sections (not figured here), their ornamentation is given by strong longitudinal costae, crossed by denser, transversal bars. Confusion with Characeae gyrogonites is impossible, because the latter have much thicker walls and do not split into symmetrical halves.

The age of this interstitial fauna, of brackish to hypersaline type, is probably topmost Domerian.

STURANI 1967), the other two possibilities are more likely to occur in a subaerial environment during periods of emergence, even though it is still debated whether shrinkage of lime muds and karstic solution of lithified limestones can also take place under normal marine water (A. G. FISCHER 1964, p. 119; B. D'ARGENIO 1967, p. 114).

Beside the smaller ones epigenetic on the pre-existing network of the Liassic desiccation cracks, the fissures and cavities filled by the *P. alpina* beds can take a variety of shapes, from planar, interstratal fissures up to 10 cm wide and several metres long (fig. 17), to lenticular or more irregularly shaped cavities up to 0.50 metres wide and two or three metres long (fig. 14).

In the case under discussion a tectonic origin seems most unlikely, for several reasons. Tectonically opened fissures usually reach down to far more considerable depths within the bedrock (up to some hundred metres, according to the examples illustrated by F. MASSARI (1968)).

In the present case, on the contrary, the cavities and fissures, beside being associated with a major unconformity, are confined to the topmost 0.50-2.50 metres of the « Grey limestones », whilst the immediately underlying beds have remained undisturbed. Moreover, tectonically opened Neptunian dykes are usually sharp edged, without any important loss of the host rock, whose joints have been simply set

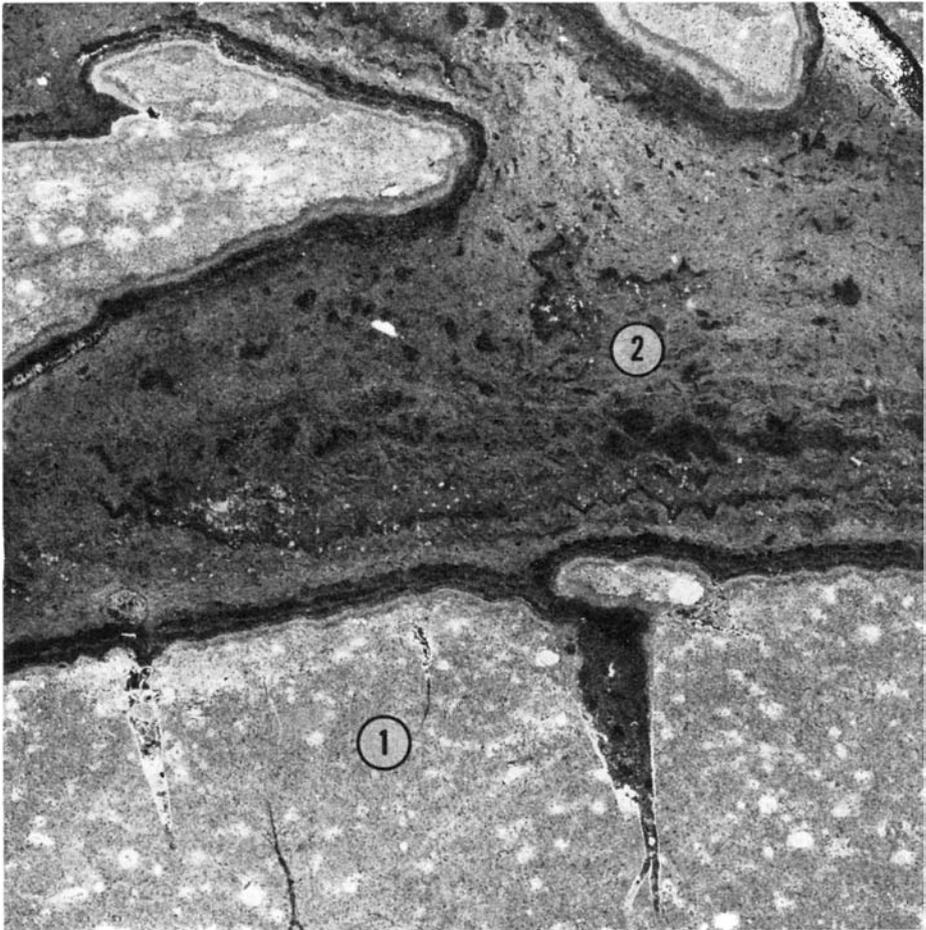


FIG. 11

Featureless Domerian calcilitites (1), cut by sheet- and prism-cracks of the younger set. The Liassic internal sediments that filled the wider sheet-crack have been transformed into a sterile, milky-white dismicrite reminiscent of caliche (2). Concentric spar crusts, of ghostly appearance, have crystallized *within* this sort of caliche, especially along the edges of the crack.

Longara di sotto quarry, topmost bed of the « Grey limestones ». Plane light, negative print; $\times 8$.

apart. On the contrary, in the case of the larger and of the more irregularly shaped cavities under discussion (figs. 14-15) there is clear evidence that solution of the Liassic bedrock actually occurred.

Dessiccation could be invoked to explain the origin of the interstratal fissures occurring at Cima Tre Pezzi quarry (figs. 17-19), which actually look like some of the giant sheet-cracks described by A. G. FISCHER and others. If it was so, however, one wonders how many millions of years such a fissure must have remained gaping, from its opening in the late Middle Lias to its filling in the early Upper Bajocian!

Karstic solution, accompanied by small scale collapse fracturing beneath the surface, and perhaps by thermoclastic weathering upon the surface, remains thus the more logical explanation and is — to my mind — good evidence that this part of the Trento ridge was still emerged, at least until the time when the fissures began to be filled with the *Posidonia alpina* beds.



FIG. 12

Polished slab of the Bajocian solution breccia, Longara di sotto quarry. $\times 0.7$.

The Liassic flat pebbles, riddled by small-scale prism-cracks, have been re-exhumated through the leaching of the internal sediments that bound them into an edgewise breccia. After little transport and practically unworn, they were recemented by a red, *Bositra*-bearing micritic limestone of Bajocian age. The white patches correspond to sites of incipient « calichifying » within the Bajocian biomicrite.

Lithology of the Posidonia alpina beds: the filling of the larger fissures. The larger solution cavities became filled with: 1) angular fragments of Domerian limestones dropped off the roof; 2) mechanically introduced marine shells, both unbroken and thinly comminuted; 3) mechanically introduced micrite and red clayey material; 4) chemically precipitated CaCO_3 , in the form of drusy, radiaxial spar crystals, several millimetres long.

Different cavities may show different sequences of events during their filling. In most instances this started with the mechanical introduction of the shell gravel.

The resulting coquina facies (Pl. 1, f. 1; text-fig. 16) is made of an amazing accumulation of tiny marine shells, in mutual contact. From one cavity fill to another, *Bositra*, ammonites, brachiopods or crinoid ossicles may be the dominant element.

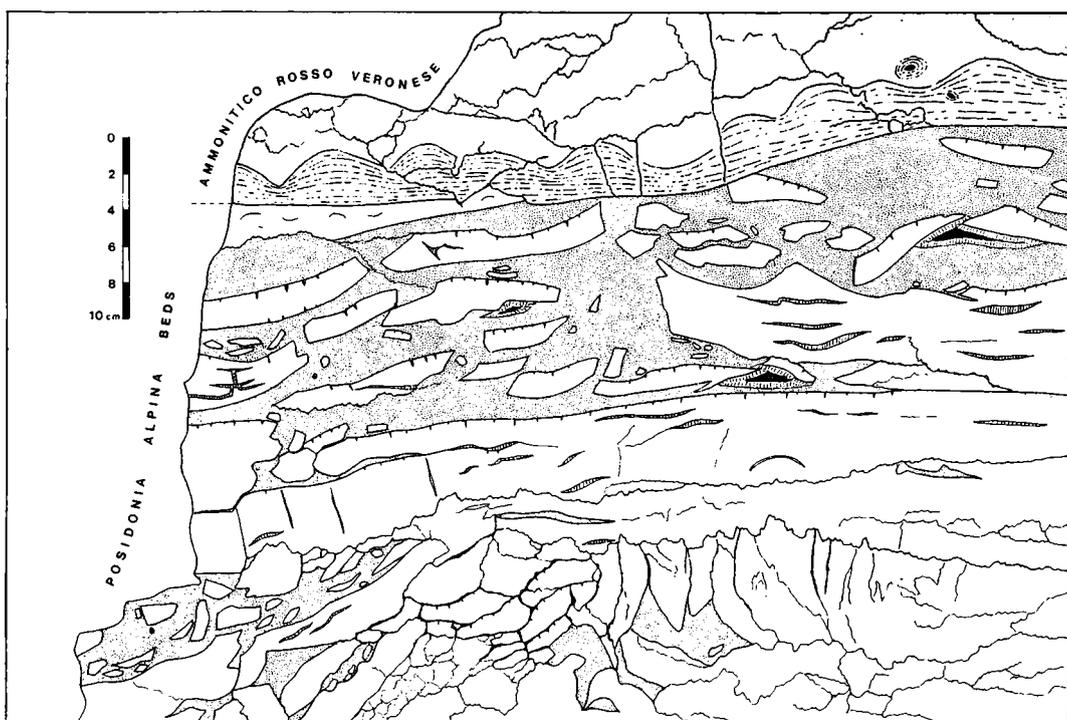


FIG. 13

Outcrop view of the *P. alpina* beds at Longara di sotto quarry. Same explanation as for fig. 12. The Domerian calcilutites (« Grey limestones ») have been left blank; the *Bositra*-bearing micritic limestones are stippled. Drusy spar (vertically ruled) fills sheet-cracks in the « Grey limestones » and lines trigonal cavities sheltered beneath slabs of « Grey limestones », lodged upon the *Bositra*-bearing micrite. Note the even, sharply cut erosional surface upon which lies the basal stromatolitic layer of the « Ammonitico rosso veronese » formation.

Within the larger cavities the coquina facies usually displays a regular fore-set bedding, each lamina dipping away from the gap through which the cavity was filled (figs. 14, 15). The size of the shell gravel, moreover, decreases rather regularly from the lowermost laminae, close to the gap, to the uppermost and more distant ones: the former consist of shells, both fragmentary and unbroken, with an average diameter of 10-30 mm, while the latter consist only of tiny shells and shell debris of increasingly smaller diameter. Red micrite appears in increasing amounts within the topmost laminae, until they consist almost entirely of lime mud and may eventually fill the cavity up to the roof.

In other instances the filling of the cavity consists mainly of purplish-red to brick-red, not distinctly laminated micritic limestone, with only a few shells. The ammonites, in this case, instead of settling towards the bottom tend to accumulate towards the topmost part of the cavity: their shells, being lighter because of the gas-filled chambers, migrated through the semiliquid calcareous ooze until they reached the roof. Gas bubbles, probably originated from the decaying carcasses of the molluscs, often filled reentrants in roofs, which were later lined by drusy spar (fig. 21).

The sedimentary structures just described, especially those shown in figs. 14-15, are strongly reminiscent of the miniature debris fans formed in temporary ponds after

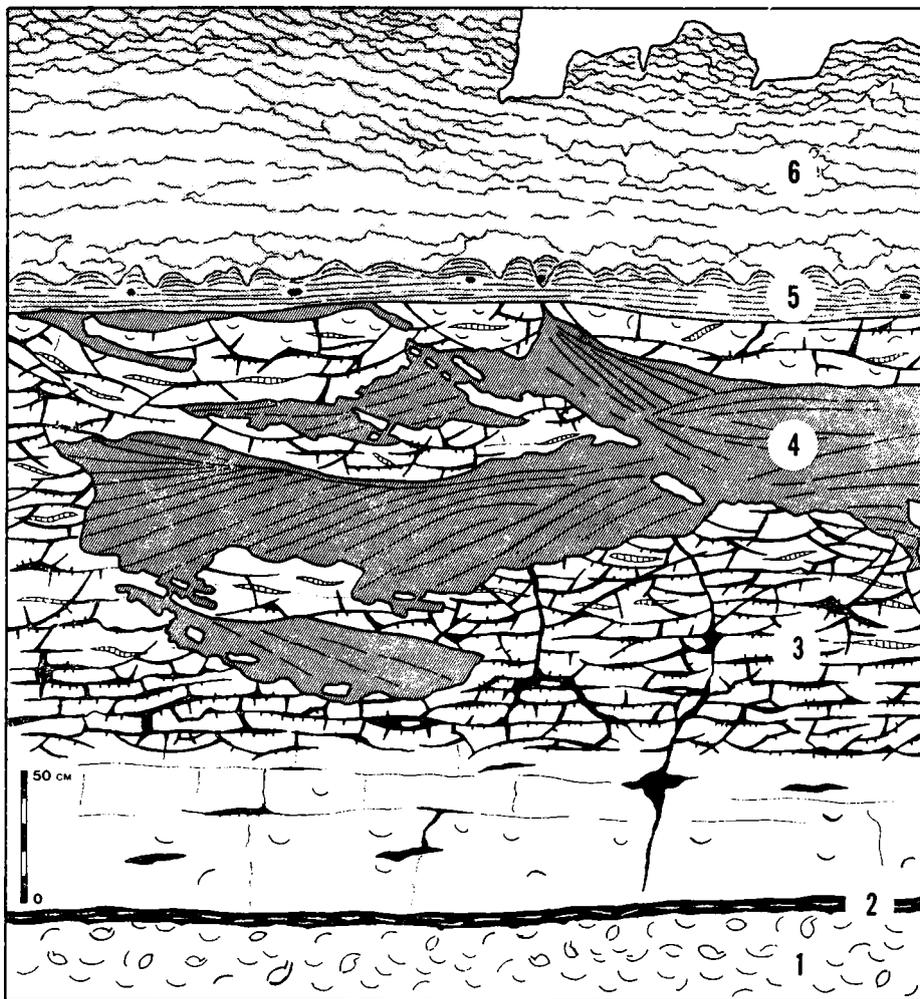


FIG. 14

Outcrop view of the section exposed at Longara di sotto quarry. 1: Cream to light-tan coloured micritic limestone, packed with large terebratulid brachiopods and *Orbitopsella praecursor* (« Grey limestones » formation; Domerian; subtidal member). 2: Ochreous coloured, argillaceous calcilutite, with worn fossils reworked from the underlying bed (« Grey limestones » formation; Domerian; subaerial member); 3: Light-tan coloured, slightly dolomitic calcilutite, with rare, scattered fossils (*Lithiotis*, *Ostraea*, crinoid ossicles, *Glomospira*, *Orbitopsella*). This corresponds to a marsh deposit and is riddled by two systems of shrinkage cracks. A red, *Bositra*-bearing micrite of Bajocian age has however replaced most of the Liassic internal sediments within the cracks of the younger set (compare with fig. 6).

Much wider solution cavities, within this same bed, are filled with a spar-cemented coquina (4), which displays a regular fore-set bedding (*P. alpina* beds; Subfurcatum zone, Polygralis subzone).

5: Basal stromatolitic layer of the « Ammonitico rosso veronese » formation, with scattered ferromanganese nodules (topmost Bajocian, Parkinsoni zone). 6: Red, strongly nodular limestones (Ammonitico rosso veronese; Upper Oxfordian).

The outline of the wider solution cavities, as well as the fore-set bedding within the coquina facies, have been redrawn from a photograph; the remaining features, on the contrary, have been schematized.

As shown by the different slope of the fore-set laminae dipping in opposite directions, slight tilting of the whole bedrock probably occurred, prior to the deposition of the « Ammonitico rosso veronese ».



FIG. 15

Same as fig. 14. 1: Bajocian solution breccia, formed at the expense of the Liassic edgewise breccia, 2: Spar-cemented coquina, 3: « Ammonitico rosso veronese ».

Note the fore-set bedding of the coquina facies, within the larger solution cavities, and the decrease in grain size from the lowermost to the uppermost laminae. The latter (in the center of the figure) consist mainly of red micrite. The larger solution cavities have been outlined with ink.

heavy rain, on one hand, and of the detrital « half-cones » formed within small downsloping caves, on the other (J. M. GOOD 1957). This suggests that the mechanically introduced sediments were carried by a sudden stream which entered an empty cavity (*i.e.*, a karstic cavity lying in the vadose zone, above the water table), and that this phase of the filling was probably rather rapid: it may have taken only a few days, or perhaps hours. As we shall see, this is confirmed by the stratigraphically homogeneous nature of the faunas found within the coquina patches: their age may show strong differences (of the order of two ammonite zones) from one cavity fill to another; each, however, represents an extremely short stratigraphic interval (part of single subzones).

More evidence that the shells were accumulated rather rapidly by current action arises from their state of preservation: even within the coarser grained laminae brachiopod valves are often found unpaired, and this is also the rule for *Bositra* and the other bivalves; about 25-30 % of the ammonites, especially the larger specimens, are represented by broken body chambers, often telescoped within each other like Chinese boxes. Other specimens, although retaining their complete body chamber, have the shell perforated, as may be seen from the fact that the radiaxial spar crystals have grown out through the breach. Smaller fossils are often found tightly wedged into the aperture of larger ammonites. As a whole, however, unbroken specimens are fairly abundant.

This is closely matched by what I could observe along the Hyblean coast of Sicily, North of Syracuse, after heavy winter storms, when large quantities of shells

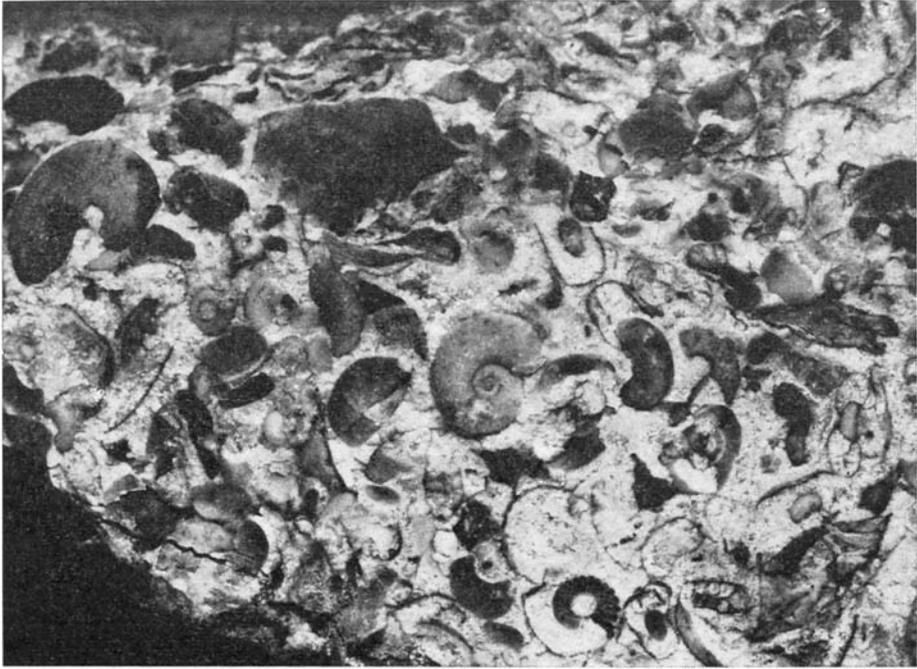


FIG. 16

Close view of the coquina facies. The shells (mainly ammonites, in the present case) are bound and filled by clear, drusy spar. Their test has been leached away and replaced by thin hematitic films. Troch n. 1 fossil locality; Humphriesianum zone, Cycloides subzone. $\times 1.7$.

— both dead and living — are cast by waves on low, rocky shores and accumulate in the more sheltered positions (crevices, etc.).

The features of the coquina facies, previously described, are clearly consistent with a very high-energy agent of transport and deposition, whose action, however, did not last long enough for all the shells to be ground to small fragments, nor for all the micrite to be washed away.

More evidence of current action is also strongly indicated by some cavities that are completely filled with either shell gravel, or biomicrite, or both (fig. 15): as already noted by R. J. DUNHAM (1969, p. 160), reentrants in roofs cannot be filled to the top by simple infiltrating of the lime muds or by gravity settling of the shell gravel, within a cavity filled with stagnant water.

Current velocity must have been considerable, to pick up and carry shells up to 30 mm (exceptionally 60 mm) in diameter and to telescope the broken body chambers of the ammonites.

Only two hypothesis, in my opinion, may account for the steep hydraulic gradient necessary to start currents of the required energy.

The first alternative is a sudden flooding on a flat, rocky island, rising just a few feet above sea level, induced either by an abnormally high tide, or a hurricane, or a tsunami. The geologic importance of such uncommon daily occurrences has recently been stressed by several authors. In this context it seems suitable to quote P. O. ROHEL's statements on a similar present day setting in the Bahamas (ROHEL 1967, p. 1990):

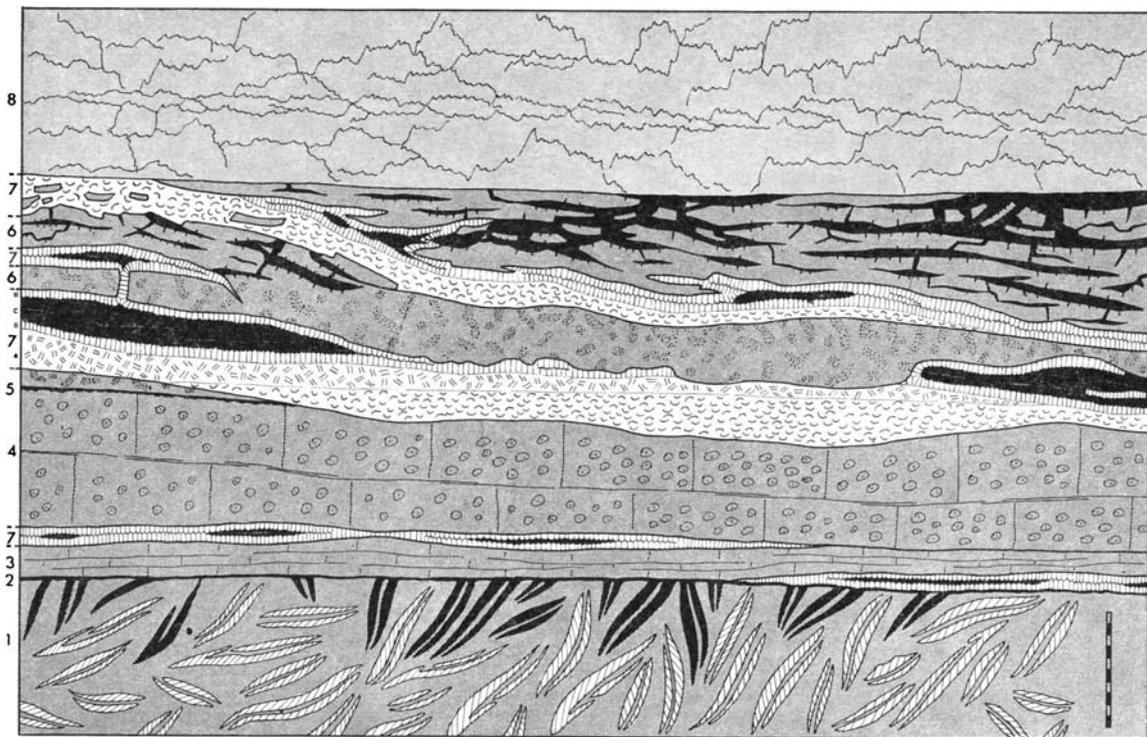


FIG. 17

Outcrop view of the section exposed at Cima Tre Pezzi quarry, redrawn from a photograph. The rule in the lower right corner is 10 cm long.

1: massive limestone bed, packed with *Lithiotis problematica* still in life position; their shell has been leached away during early diagenesis and replaced by drusy spar (« Grey limestones » formation; Domerian; subtidal member). 2: Bed 1 ends with a subaerially eroded surface, coated by a thin layer of red, argillaceous calcilutite, which also fills the empty casts of *Lithiotis* lying closer to this surface (« Grey limestones »; Domerian; subaerial member). 3: Light tan coloured, barren calcilutite, with shrinkage structures (« Grey limestones »; Domerian; supratidal marsh deposit). 4: Intraspartitic, fossiliferous calcarenite, with «*Vidalina*» *martana* FARINACCI, etc. (« Grey limestones »; Domerian; subtidal member). 5: like 2. 6: Scarcely fossiliferous, slightly dolomitic calcilutite, with traces of bioturbation. In its upper part this bed is riddled by shrinkage cracks, filled with red, penecontemporaneous internal sediments (black, in this figure) (« Grey limestones »; Domerian; supratidal marsh deposit). 7: *P. alpina* beds: large, mainly interstratal solution cavities partly filled with a spar-cemented coquina, which grades upwards into a crinoidal calcarenite (7 A). Thick linings of radiaxial spar (7 B) have grown on both the roof of the solution cavity and the floors formed by the coquina facies. Voids left between two such linings were later filled with brick-red, argillaceous, thinly laminated biomicrite, packed with comminuted *Bositra* shells (7 C; see fig. 20). The age of the coquina facies is the same in all cavities: Subfurcatum zone, Banksi subzone. 8: Red, nodular, crinoid-rich limestones (« Ammonitico rosso veronese » formation; ? Upper Oxfordian). They also fill a vertical, sharp-edged Neptunian dyke (not shown in this figure), that penetrates into bed 1 and farther-below.

« In this setting the sediment source for fabric construction is the same for all local environments; *i. e.*, the transport of mud, pellets and bioclastic material is in the shoreward direction and so is shared by all of the sites of deposition and trapping, even though the sharing usually is unequal. To provide the energy to pick up the accumulated offshore fine sediment and other debris for delivery into the supratidal zone, one or a combination of storm, hurricane or spring high tides is required. The normal tide range does not exceed 3 feet (1 m) and, except for seasonal or wind-generated patterns, it usually conforms with existing bathymetric conditions. During major storms, however, the bottom profiles on the shallow platform are disturbed and tides of several feet discharge a large sediment load far inland from the intertidal zone. The storm also disrupts the unprotected or weakly lithified surfaces in the supratidal zone.

Although all of the sand-size and smaller sediment is easily suspended for transport during spring-tide or storm-tide movement, the gradual reduction of sheet flow and current velocity onshore into the supratidal zone results in deposition of graded beds. In general, the finest or lightest material is carried farthest inland. Much of this is a « lime-mud » fraction. Some of it also is channelled back toward the shoreline under reduced energy conditions. This provides an additional fine sediment layer which accentuates the gradation of the recently deposited flood layer beneath. The sediment profile is thus somewhat unique in that it is the product of two opposed current systems.

The seemingly paradoxical situation is expectable from the geological point of view. In spite of the general day-to-day low-energy state of the tidal-flat and shoreline environment, the requirement for renewed sediment distribution, processing, and lateral offlap deposition is for repeated high-energy hydraulic and climatic events. These uncommon daily occurrences are nevertheless common in the context of geologic time ».

In the case under discussion, part of the flood must have poured through the sinkholes until it reached the water table, loosing the sediment load on its way down: the shell gravel and the lime mud stirred up from the offshore environments, as well as the thin weathering mantle of « terra rossa » washed by the flood on its way inland, were thus trapped within the fissure system. Whilst the shell gravel could accumulate only within the larger solution cavities, the lime mud and the finer shell debris could infiltrate through the network of the smaller fissures until this was completely plugged up.

The second alternative is a periodical sinking of the island below sea level, so that the karstic fissures were transformed into surge channels or tidal channels, swept by strong currents of alternate direction, which could concentrate the drifting shells.

In this case too, both recent and fossil equivalents of such an environmental setting are known: one may just mention the « blue holes » of the Bahamas (G. J. BENJAMIN 1970), which originated as a subaerial karstic system during the eustatic fall of the sea level in the Quaternary and are now swept by strong tidal currents; or the goniatite shell bed concentrate occurring at Cowlow Nick, England, as the filling of an abandoned surge channel within a Carboniferous reef complex (T. D. FORD, 1965).

Before making a choice between such alternatives, it is important to note that both imply a very little height or depth relative to sea level: in the subaerial alternative, the island must have raised only a few feet above sea level, otherwise it would never have been reached by storm floods; in the submarine alternative, the

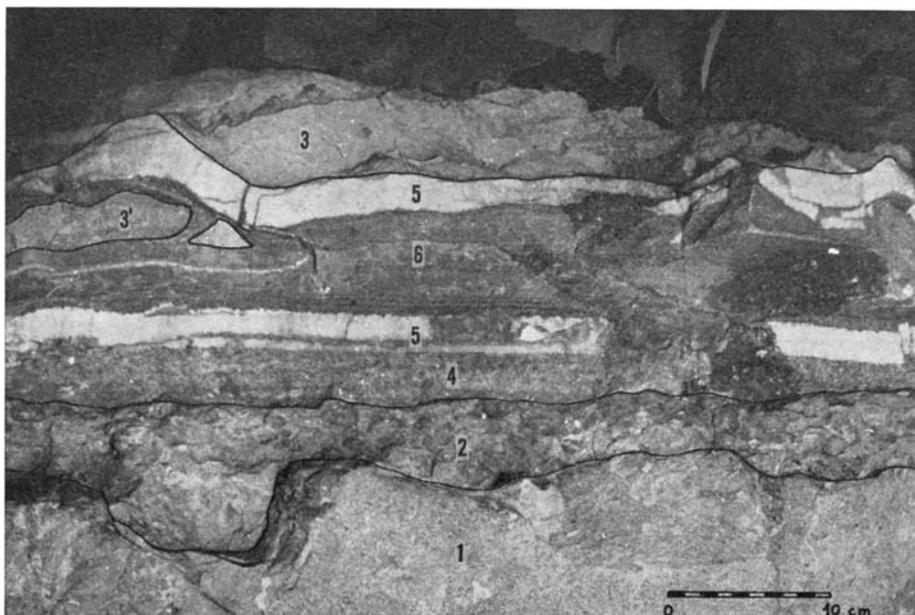


FIG. 18

Same as fig. 17. 1: Fossiliferous intrasparite; 2: scarcely fossiliferous, bioturbated calcilutite; 3: sterile, featureless calcilutite, riddled by shrinkage fissures. Beds 1 to 3 belong to the « Grey limestones » formation and are Domerian in age. A wide solution fissure, between beds 2 and 3, became filled with: spar-cemented coquina (4), linings of drusy spar (5) and brick-red, laminated biomicrite (6) (*P. alpina* beds; Upper Bajocian).

sea floor must have lain above wave base, if the karstic fissures were to act as surge channels.

While I can see no objections against the first alternative, several can be raised against the second.

First, the shape and size of the cavities under discussion, do not seem the fittest for a surge or a tidal channel system.

Second, if the larger solution cavities were temporarily submerged below sea level, even for brief periods, one would expect their walls either to be encrusted with marine benthos (Serpulid worms, Corals, etc.) or to bear the traces of boring organisms, such being the normal conditions of submarine crevices at a shallow depth. One of the finest fossil examples of such a setting has been figured by A. FARINACCI (1967, f. 13) from the Jurassic of Monte Lacerone (Central Appennines): a wide desiccation (?) fissure was temporarily submerged and encrusted by Serpulids on its roof, whilst small drifting ammonites accumulated on its floor.

Nothing like this, however, has been observed to date in the Sette Comuni.

Third and more important, the sedimentary structures observed are more consistent with a downward moving current of short duration, as one would expect in the first alternative, than with a current running permanently in alternate directions, as would be the case in the second alternative.

On the other hand, among the brachiopods and the ammonites (especially the Phylloceratids and *Poecilomorphus*, which are the commonest forms) there is an

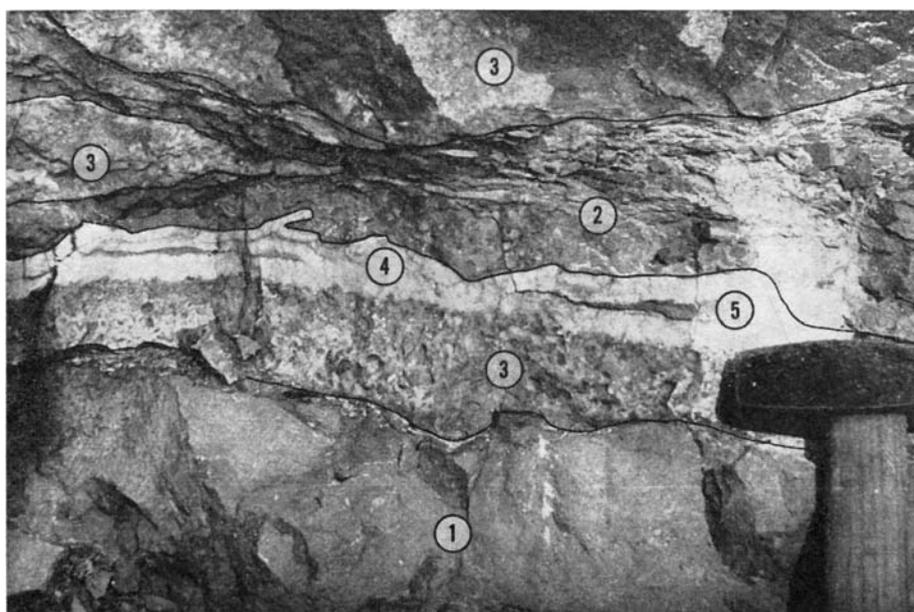


FIG. 19

Same as figs. 17-18. 1: fossiliferous, intraspartitic calcarenite; 2: sterile, featureless calcilitite riddled by shrinkage fissures. Beds 1 and 2 belong to the « Grey limestones » formation and are cut by several solution cavities, both inter- and intrastratal, filled with: spar-cemented coquina (3); drusy spar linings (4); brick-red, laminated biomicrite (5) (*P. alpina* beds; Upper Bajocian).

astonishingly high proportion of juvenile specimens at different stages of growth, still retaining the complete body chamber in the case of the ammonites. This may be explained by mass mortality alone, and it is again more consistent with the hypothesis of a hurricane-flood as the causative agent that cast them ashore.

The phase of mechanical filling was later followed by chemical deposition of drusy, radiaxial spar in the remaining voids, both within and between the shells (fig. 16). When larger voids were still left, either because the cavity had not been filled up to the roof or because rock fragments, dropped off the roof and lodged upon the shell gravel, had sheltered a void underneath from further filling, the radiaxial spar could eventually grow freely and form continuous drusy linings, up to 2 cm thick (figs. 13, 17-20). The latter are strikingly similar to the calcareous dripstone which lines recent karstic fissures, occurring in the same quarries where the *P. alpina* beds have been studied.

If some voids still remained, they were eventually filled by a second generation of mechanically introduced argillaceous biomicrites (figs. 17-20); these are brick red in colour and thinly laminated, each lamina, less than 1 mm thick, being coated with a red clayey film.

During this late phase, fragments of the radiaxial spar lining often dropped off the roof and lodged on the laminated biomicrites.

Occurrence of drusy spar crusts, like those just described, is obvious in the vadose zone of recent and fossil karst. Occurrence of drusy cement (consisting either of aragonite or high magnesium calcite and a few microns thick) has also been



FIG. 20

Brick-red, laminated, argillaceous biomicrite, packed with thinly comminuted *Bositra* and ammonite shells, *Globochaete*, etc.. These sediments fill the cavity left between two opposite crusts of radiaxial spar crystals (only one is shown here).

P. alpina beds; Cima Tre Pezzi quarry (compare with 7 C of fig. 17). Polarized light; $\times 20$.

reported in recent marine sediments, under exceptional conditions, but it does not seem to represent a good match for the spar linings dealt with here. The exhaustive discussion of submarine versus subaerial origin of cement in recent carbonates published by R. J. DUNHAM (1969, pp. 168-174) makes further comments unnecessary.

After the phase of cementation was completed, the aragonitic shell of the ammonites either underwent complete recrystallisation or was leached away; thin ferromanganese films, pale pink to brilliant red to black with a metallic shining, then formed all over the internal moulds.

Partial « calichifying » of the red, *Bositra*-bearing micritic limestone (like that shown by the Liassic internal sediments) is frequently observed within the filling of some cavities. In this case, too, the original sediment was transformed into a milky-white to pale pink dismicrite, within which concentric, « ghostly » spar crusts have crystallized.

In this general context it is important to note the striking similarities which exist between the *P. alpina* beds of the Sette Comuni, on one hand, and the « Marmi di Vitulano superiori » on the other. The latter have been recently described by B. D'ARGENIO (1967, pp. 113-118) in the Upper Cretaceous of the Southern Appennines, and have been interpreted — on sound evidence — as a complete holofossil karst, formed during a period of emergence

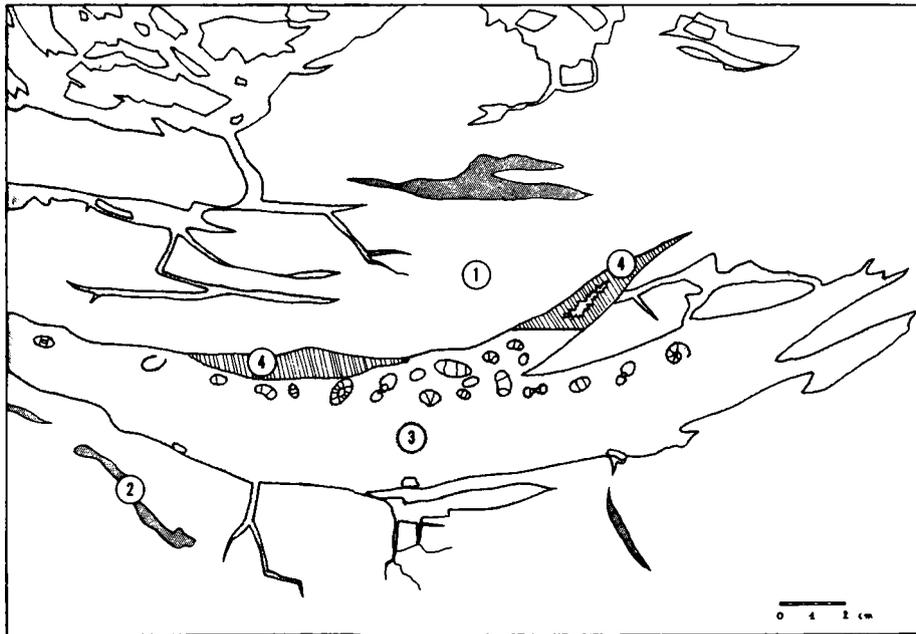


FIG. 21

Outcrop view of the *P. alpina* beds at Longara di sotto quarry (redrawn from a colour slide). 1: Slightly dolomitic, light-tan coloured Domerian calcilitites (« Grey limestones »). 2: Spar-filled. Liassic sheet-cracks. 3: Red, Upper Bajocian micritic limestone with ammonites and other fossils, which has almost completely replaced the Liassic internal sediments (not differentiated in this figure) within a younger set of sheet-cracks.

Gas bubbles, probably originated from the decaying carcasses of the ammonites, have filled re-entrants in roof and have been later filled with drusy spar (4). Compare with Pl. 1, fig. 2.

of that carbonate shelf. In both instances the shape and size of the cavities are about the same; so is the filling, which there too consists of both mechanically introduced clasts and chemically precipitated spar. The main difference is that in the « Marmi di Vitulano superiori » oncolites and fragmentary stromatolites are the only organic remains found within the fissures (apart from older fossils reworked from the local bedrock); a greater elevation of the ground above sea level, or a greater distance from the shoreline and the open sea, may however easily account for such differences.

Another good match for the *P. Alpina* beds of the Sette Comuni are the pene-contemporaneous cave deposits which occur within the Palisades reef complex, in the Silurian of Iowa (M. E. PHILCOX 1970). In that case the host rock is represented by crinoidal dolomite, whilst the infill consists of both shell gravel (with abundant brachiopods and « nautiloid shells usually in the form of disarticulated, concave-up septa ») and finer grained sediments. Opening of the caves by solution is tentatively interpreted by M. E. PHILCOX as evidence of subaerial exposure of the host rock, but whether the phase of mechanical filling took place above or below sea level is not discussed.

A third term of comparison, worth mentioning, are the paleokarsts recently described by CROS & P. LAGNY (1969) in the Triassic of the Dolomitic region. According to their remarkable account, the more numerous and the more important karstic fissures they observed are epigenetic on tectonic fractures which opened during phases of uplift of the carbonate shelf and which were later widened by solution under subaerial conditions. While still gaping, some of these cavities were later submerged below sea level and became filled with a variety of marine sediments, including red, nodular, micritic limestones, with ammonites and thin-shelled, pelagic bivalves (« filaments »). No equivalent of the spar-cemented coquina

facies, however, seems to occur in the setting described by the french authors. In that case, elevation of the ground above sea level, during the subaerial phase, must have exceeded the height reached by storm waves and floods, as shown by the remarkable depth attained by those karstic fissures within the bedrock (their depth is in fact a function of the tectonic uplift, or « *exhaussement* », at the beginning of the subaerial phase).

Coquinas of different age often occur as the infill of cavities only a few metres distant: at Longara di sotto quarries there are at least two systems, representing the Subfurcatum zone (Polygyralis subzone) and the Garantiana zone respectively; at the Troch fossil localities, 750 metres to the South of Longara di sotto quarries, the basal Humphriesianum zone and the topmost Subfurcatum zone are represented by coquina patches only 50 metres distant. As shown by the example of figs. 22a-b, younger fissures may cut through the already lithified fills of older ones.

This means that the environmental conditions favourable to the opening of new fissures through karstic solution, and their filling by storm-floods, persisted after the older ones had already been completely sealed.

As shown by the different ages of the coquina at different, but often neighbouring localities, this environmental setting lasted through the whole Humphriesianum and Subfurcatum zones and a good part of the Garantiana zone; *i.e.*, through a period of more than two million years, if we accept a mean duration of one million years for each ammonite zone. This means a great stability of the shelf, with practically neither subsidence nor uplift. Yet, it would be wrong to regard these as condensed deposits: the sedimentary processes involved, especially during the phase of mechanical filling, were simply of discontinuous and sporadic occurrence in time, but extremely rapid, almost instantaneous in duration. This offers us the rather unique chance of studying strictly synchronous faunal assemblages, in the sense that all the shells from a single coquina patch were probably cast ashore by the same storm-flood!

The homogeneous nature of the newly collected assemblages, as well as of most of the previously known ones, has been confirmed also on stratigraphical grounds, through their accurate study or revision.

In a single case reworking from older coquina patches has been observed: a single specimen of *Bajocia farcyi* BRASIL, a form of the basal Humphriesianum zone, was found at fossil locality Troch n. 2 within a rich assemblage, otherwise indicative of the Subfurcatum zone; but it stood out among all other specimens in being the only one coated with a red hematitic film, a feature characteristic of the ammonites from fossil locality Troch n. 1, which lies only 50 metres away and which has yielded a rich assemblage of the basal Humphriesianum zone, including *B. farcyi*.

The sinking of the shelf and the transgression of the « Rosso ammonitico veronese ». When the island eventually sank below sea level, shortly before the end of the Bajocian, the topmost few feet of the Liassic bedrock were planed off by erosion and an even, flat surface was developed. This cuts sharply across the pre-existing karstic system and its *P. alpina* filling, so that the cavities lying closer to the original topographic surface have lost part or the whole of their roof and could be mistaken for shallow, widely open superficial depressions.



FIG. 22 A

Outcrop view of the *P. alpina* beds at Longara di sotto quarry (redrawn from a colour slide; the coin is 23 mm in diameter).

1: slightly dolomitic, light-tan coloured Domerian calcilitites (« Grey limestones »). 2: Spar-filled sheet-cracks. 3: Red, Upper Bajocian micritic limestone with ammonites and other fossils, which has partially replaced the Liassic internal sediments (not differentiated in this figure) within a younger set of shrinkage cracks. A further phase of karstic solution, accompanied by small-scale collapse fracturing, has re-opened some fissures. Small-sized ammonite shells (pointed by arrows), became trapped within these new fissures, which were later filled with a milky-white to pale pink micrite (4), grading upward into a brick-red, laminated biomicrite (5). A spar-filled tectonic fracture of alpine age (6) cuts through all pre-existing structures.

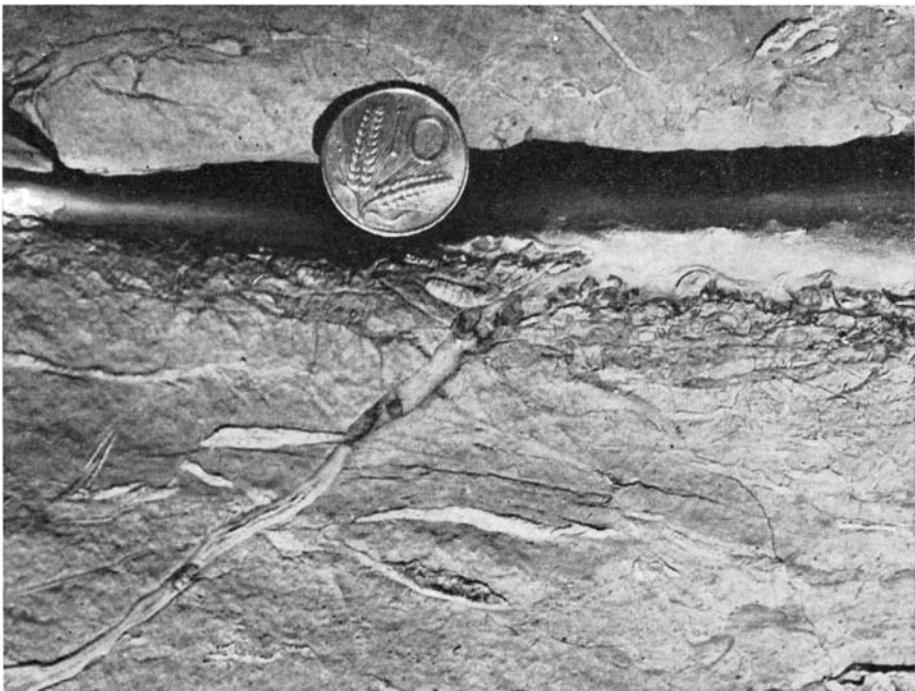


FIG. 22 B

Detail of fig. 22 A. Compare with Pl. 1, fig. 2.

A stromatolitic layer then started to form. This layer already belongs to the « Ammonitico rosso veronese » formation and can reach a maximum thickness of about 25 cm; the lower half consists of perfectly smooth laminae, whilst in the upper half these build dome-like mounds separated by narrow grooves.

Since no dessiccation structures occur, they must have grown in a permanently submerged environment. The depth, however, must have been rather small, as proven by the finding of few, but absolutely unmistakable lithodome borings: one has been

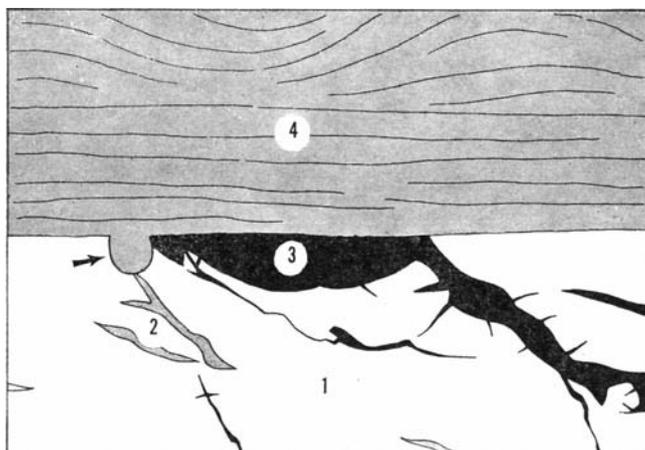


FIG. 23

Detail of the basal contact of the « Ammonitico rosso veronese » formation at Longara di sotto quarry (redrawn from a colour slide; about one-half natural size).

1: sparsely fossiliferous Domerian calcilutites (topmost bed of the « Grey limestones »). 2: Spar-filled Liassic sheet-cracks. 3: Brick-red Liassic internal sediments (partially replaced by a Bajocian, *Bositra*-bearing micrite, not differentiated in this figure), filling a younger set of sheet-cracks. 4: Purplish-red, distinctly laminated stromatolitic layer, already belonging to the « Ammonitico rosso veronese » and filling a lithodome boring (arrow).

observed at Longara di sotto quarries, on the sharply cut erosional surface upon which lies the stromatolitic layer (fig. 23); another one occurs *within* the stromatolitic layer, in the lowermost, smooth laminae, and may be seen at the center of the polished slab I figured in a previous paper (STURANI 1964a, pl. 2). The latter is filled with coarse crinoidal debris and is reduced to a fraction of the original depth, showing that the accretion of the stromatolitic layer was often interrupted by periods of solution or of mechanical removal of the last formed laminae.

Scattered, concretionary ferromanganese nodules with a limestone core, as well as a few belemnites, brachiopods and normal sized ammonites of the Parkinsoni zone (see p. 17) also occur within the stromatolitic layer. On top, this is coated by a ferromanganese crust (STURANI 1964a, pl. 2), marking an important gap, without any evidence of emersion. Next above, in fact, comes the characteristic, nodular facies of Upper Oxfordian age.

PALEOECOLOGICAL REMARKS

By study of the sedimentary features alone we have come to the conclusion that the incredibly rich, entirely marine faunas from the coquina facies of the Sette Comuni were cast ashore by storm-floods and got trapped within the karstic fissures.

The point now is, what may we infer about the original environment(s) in which all these animals thrived, from a paleoecological analysis of the thanatocoenosis?

Undoubtedly, the benthonic forms must have lived on the subtidal shoals surrounding the island, at depths not exceeding that reached by storm waves, otherwise they could never have been cast ashore (cf. W. NESTEROFF 1966, p. 108).

A brief survey shows that all species but one (*Collyrites* sp.) belong to the epifaunal community, being either sessile organisms (brachiopods; cemented bivalves, such as *Placunopsis*; byssally fixed bivalves, such as *Lima*, *Arca* and *Modiola*; crinoids; exceedingly rare solitary corals), or free living forms (Astacoid crustaceans, such as *Eryma*, a few regular echinoids and many small sized gastropods). In the light of modern ecological data the presence of such a diverse epifauna is consistent with a firm, rocky bottom (CRAIG & JONES 1966), probably covered with plants (R. G. JOHNSON 1964, p. 123), hence with a shallow, high-energy environment. The only representative of the infauna, i.e., the irregular echinoid *Collyrites*, may well have thrived within sheltered patches of shell gravel, as recent analogues are known to do (L. LAUBIER 1966).

All the gastropods, most of which are very small sized adult specimens, belong to genera that usually feed on algae: *Littorina*, *Trochus*, *Turbo*, *Emarginula*, *Scurria*, *Cerithium*, *Rissoina*, *Nerita*, *Neritopsis*, etc. Many among these genera are still living today, usually at very shallow depths (littoral to inner neritic zones). In particular, recent *Trochus* and Rissoidae are confined to algal or Eelgrass meadows (W. WENZ 1938-62, p. 22); recent representatives of *Scurria* thrive on rocks or on the giant kelp *Macrocystis* (P. FISCHER 1887, p. 866); the same applies to *Emarginula*, which in the Mediterranean is especially common in the Eelgrass meadows and also on the coralligenous bottoms of the circalittoral (outer neritic) zone.

The picture we obtain is that of shallow, almost sediment free rocky shoals, covered by algal meadows (Zosteraceae, presumably, had not yet appeared by the Middle Jurassic), with occasional patches of shell gravel in the more sheltered positions.

Let us now turn to the other ecological groups: we first find a few nectonic forms, such as shell eating fishes (represented by their teeth) and belemnoids (*Ausseites*), which fit well into the picture.

Then come, by thousands, the thin shelled Bositras (*B. buchi* (ROEM.) the correct name for « *Posidonia alpina* » of ancient authors). JEFFERIES and MINTON (1965) have recently shown, on convincing evidence, that this was a free swimming

pelagic form. On many specimens from the Sette Comuni I was able to discover a new feature which is strongly consistent with such a mode of life; above a certain diameter the valves of these specimens (Pl. 16, fig. 5) become flared outward along their whole free margin, so that they can no longer fit together and close tightly. This could have some functional meaning (perhaps of a hydrodynamic nature) only in a free swimming form; certainly none in a bottom dwelling one.

Bositra may have been driven shoreward by heavy storms, like the epipelagic gastropod *Janthina*, or like jellyfish, in some recent areas.

There now remain the ammonites: were they indigenous to these shallow shoals, swimming around as vagile benthos, or did they come from the open sea as floating, empty shells? The unusually high proportion of juvenile specimens, still retaining their whole body chamber, is best explained by mass mortality because of the storm-floods, hence it seems to support the first hypothesis. But there is more: among these ammonites we find quite a high percent of sphaerocones (Sphaeroceratids), cadicones (some Stephanoceratids), oxycones (Oppeliids, Strigoceratids) and serpenticones (Perisphinctids, *Caumontisphinctes*, *Bajocia*), often provided with huge lappets (*Cadomoceras*, *Oecotraustes*, *Infraparkinsonia*, etc.), strong projecting spines (*Strenoceras*), dense, strong ribs and a body chamber exceeding two thirds of the last whorl. As experimentally shown by REYMENT (1958) « the shells of chambered cephalopods are delicately poised and will either just float or just sink when empty »; if so, then all the above mentioned features are the very ones listed by REYMENT as the main hindrances against flotation!

It seems therefore likely that the ammonites too were part of the indigenous biota of the shoals under discussion.

PALEOECOLOGICAL EVIDENCE FROM «STUNTED» FAUNAS

One of the more striking features of the faunal assemblages from the *P. alpina* beds of the Sette Comuni is the diminutive size of all the fossils, so that ancient authors often called them « *faune nane* » (stunted faunas). In the light of the sedimentary features displayed by the coquina facies, this may seem an oversimplification. Sorting by storm-floods, in fact, certainly played a major role, in the sense that large shells, if present, must have been dropped first, just past the shoreline, while smaller ones were carried farther inland as the flood wave went on losing its energy. No such separate accumulation of normal sized Ammonites has ever been observed to date in the Sette Comuni; they occur, however, some 30 km to the West, at Brentonico (see p. 65), where the *P. alpina* beds were probably deposited in the form of a shallow bar.

The width of the sinkholes through which the shells entered the karstic fissures is another important factor in limiting their size: large shells, if present, must have been blocked at the entrance.

Even so, there still remains the fact that many taxa (all the gastropods and many of the ammonite species) are represented by tiny adult specimens, and that the same feature (diminutive size of all the fossils) is also shown by the assemblage from Acque Fredde, which bears no evidence of mechanical sorting (see further on, p. 63). A careful discussion, also taking into account ammonite dimorphism and their stage of growth when cast ashore, is therefore needed.

In the faunal assemblages from the Sette Comuni Phylloceratina and Lytoceratina are represented either by fully grown, but small sized forms (some *Nannolytoceras*) or by juvenile specimens, at various stages of growth, often retaining the whole body chamber and not exceeding 30-40 mm in diameter. Only four fragments of adult shells were observed, amongst several hundred specimens.

Among Sonniniidae, macroconchs are represented by a few immature *Dorsetensia*; microconchs by a new, very small sized species of *Bajocia* (*B. rarinoda* n. sp.); also *B. farcyi*, the micro- or macroconch nature of which could not be ascertained, being at any rate a small sized form.

Among Strigoceratidae, the macroconch genus *Strigoceras* is represented by small immature specimens and a few fragments of adult ones, while its microconch counterpart — *Cadomoceras* — is represented by adults, along with fewer immature specimens (Pl. 5, fig. 13). The same applies to *Lissoceras*, the tiny microconch counterpart of which — *Microlissoceras* n. subg. — was previously unknown, as well as to the couple *Oppelia* (M) - *Oecotraustes* (m). Other macroconch Haploceratids such as *Toxalambites*, *Stegoxytes* and *Poecilomorphus*, do not seem to exceed a very small size — 25 to 40 mm — when fully grown; these are among the commonest forms in the *Humphriesianum* zone assemblage from fossil locality Troch n. 1, and are represented by specimens at all stages of growth. Their tiny microconch counterparts (*Microtoxalambites* n. subg. and *Micropoecilomorphus* n. subg., both previously unknown) do not exceed a diameter of 5-12 mm when adult, and are also very common.

Among Stephanoceratids, macroconchs are exceedingly rare and represented by either immature specimens or small fragments, while the microconchs form an overwhelming majority; amongst the latter, fully grown specimens provided with lappets usually belong to very small-sized species, up to only 10-20 mm in diameter, the larger sized species being only represented by immature or incomplete specimens.

Sphaeroceratids are all small to very small sized species, represented here both as immature and as adult specimens; most of the latter appear to be microconchs, but a few macroconchs are also present.

Parkinsoniids and Perisphinctids, likewise, are represented mainly by microconch species, both adult and immature, while macroconchs are, as a rule, immature or fragmentary.

It seems as if small sized shells alone were seized by the storm, whether immature specimens or very small sized adults, and whether micro- or macroconchs.

Larger specimens, on the other hand, either did not thrive normally on the shallow nearshore shoals, or were able to escape the storm being stronger swimmers.

The presence of small sized gastropods, all belonging to genera which feed on algae, is strong evidence that the bottom was covered by algal meadows: the pseudostunted character of recent and fossil assemblages from such biotopes is well known (see C. STURANI 1967, for references; also H. JENKYN & H. S. TORRENS 1969, p. 10): it seems as if thick algal or Eelgrass meadows act as biometric sieves, that harbour only small sized species or the young of those species which migrate into other biotopes on reaching a larger size (¹).

On the other hand, recent cephalopods such as Squids and Cuttlefish are known to perform seasonal migrations from deep to shallow waters, owing to the spawning period (R. A. REYMENT 1958, p. 108; M. L. CLARKE 1966).

It is then tempting to regard algal meadows as a possible spawning ground for the ammonites: in some species — taken here in the biological meaning, not in the palaeontological-taxonomical one — the adults probably withdrew to the open sea or to greater depths after every spawning season, while their newly hatched young remained sheltered among the algal meadows (all the *Phylloceratina*, for instance); in others, some segregation of sexes outside the spawning period may well have occurred, the microconchs being neritic in habits throughout their life; but in some particularly small sized forms (*Poecilomorphus* (M and m), *Sphaeroceras*), both sexes seem to have been confined to a neritic habitat (see also G. E. G. WESTERMANN 1964, pp. 39-40, P. C. SYLVESTER BRADLEY 1969 and B. ZIEGLER 1967, p. 460).

In this connection it is interesting to note that the only microconch Coeloceratid genera known to date, *i.e.* *Pimelites* and *Diaphorites* from the Pliensbachian of Western Tuscany, occur in a coquina facies (*Diotis janus* coquina), that is extremely similar to those under discussion according to A. FUCINI (1897).

Neither it is surprising that the assemblages from the Campotorondo limestones of Cape San Vigilio and the Feltrine Alps, partially synchronous with the *P. alpina* beds but pelagic in facies, consist almost entirely of adult, large sized Phylloceratids, Lytoceratids and macroconch Stephanoceratids, with extremely few or no microconchs and no immature specimens at all.

(¹) Two of the best examples of such fossil pseudostunted biota, for both of which there is no evidence of mechanical sorting because of post-mortem transport, are represented by the celebrated Sinemurian fauna from Masseria del Casale (Western Sicily; cf. W. J. ARKELL 1956, p. 210) on one hand, and the Ladinian fauna from Vallone di Cavoira (Cottian Alps), in the Triassic of the « Schistes lustrés » zone, on the other, (A. MICHARD & C. STURANI 1963).

The former — part of which I was able to see in the Department of Geology at Catania — includes over 60 different species of gastropods, most of which are small sized species belonging to genera or families of phytophagous habits; 11 species of Polyplacophora; over 30 species of bivalves, all small sized and epifaunal in habits; 217 specimens, belonging to 65 species of ammonites: of these only 7 range in size between 67 and 94 mm, the large majority of the others being less than 35 mm (Phylloceratids make up 25 %, both as species and as specimens). Several brachiopods, along with a few belemnoids, corals and Pennatularia are also present. All these fossils are found in typical carbonates shelf facies (oncoïd-rich limestones), from which calcareous green algae (*Palaeocladus mediterraneus*) have also been reported to occur.

The Ladinian assemblage from Vallone di Cavoira includes extremely small sized ammonoids, aulacoceratids and orthoceratids and is again intimately associated with plenty of calcareous green algae (*Diplopora*, *Gyroporella*, *Teutloporella*).

SOURCE, COMPOSITION AND AGE OF THE FOSSIL ASSEMBLAGES

NEW COLLECTIONS

Since 1962, fossils have been collected by the present writer at several localities in the Sette Comuni. All but one (Cima Tre Pezzi quarry) fall within a narrow area North of Gallio (see fig. 24 for location map), called Longara di sotto, on the South West slopes of Monte Longara. This place was already known as a fossil locality by T. TARAMELLI, who mentioned it as « Rotherbrunno di Gallio »: Rotaprunli (from the German *rother Brunn*, red spring) is a local toponym, not mentioned on the Italian ordnance survey map, for a small spring issuing out of the « Ammonitico rosso veronese » limestones. It is rather amusing to see that « Rotherbrunn », in A. de GREGORIO's monograph (1886), has become the name of « a German professor who collected fossils near Gallio »!

Other sections in the Sette Comuni were also visited and measured while tracing laterally the outcrops of the *P. alpina* beds; none, however, yielded faunas worthy of being collected.

As to the age of the faunal assemblages studied herein, it should be stressed that, although each of them is stratigraphically homogeneous and represents an extremely short lapse of time, their mutual stratigraphic relationships are by no means clear on field evidence alone, since they do not occur within a regular succession of beds, but come from areally separated patches of the coquina rock, which represent different episodes in the filling of the karstic fissures.

On faunal evidence it was a rather simple matter to decide which Ammonite zone each assemblage must belong to. Things became more difficult, however, when some nine separate assemblages, all falling within the Subfurcatum zone but all differing from each other to a greater or lesser extent, had to be placed in their correct biostratigraphic succession. This has been possible, more or less accurately according to circumstances, by trying to fit them into well established subzonal schemes, such as that worked out by G. PAVIA and the present writer on the splendid Bajocian sections around Digne, in the French Basses-Alpes (G. PAVIA & C. STURANI 1968; G. PAVIA 1969) and that established earlier by S. BUCKMAN in Dorset, new information on which was obtained through the kindness of H. S. TORRENS and C. PARSONS.

It should however be pointed out that the small faunal differences observed between some of these assemblages from the Subfurcatum zone (especially those from the upper part of it) may not depend entirely on differences in age but also on other factors: while collecting shells stranded on recent beaches, it is a common

experience that the assemblages may show rather strong differences from place to place along the same coast, even over short distances, or from one season to another at the same place, owing to the presence of several separate microenvironments offshore or to seasonal changes of the biocenosis.

THE SUBZONAL SCHEME

Before describing the different assemblages and discussing their age, it seems advisable to make a few comments on the subzonal scheme adopted in this paper.

As for the Parkinsoni zone, this may be divided into a *Parkinsonia bomfordi* subzone above, a *P. densicosta* subzone in the middle and a *P. acris* subzone below (cf. G. E. G. WESTERMANN 1967; G. PAVIA & C. STURANI 1968, pp. 314-316); the *Acris* subzone was formerly included within the Garantiana zone by several authors, including the present writer (STURANI 1964b), but seems now best placed within the Parkinsoni zone. The base of the Parkinsoni zone coincides thus with the first appearance of the earliest *Parkinsonia* s. s., at least in the Digne area, where some of the best standards of reference are to be found (Chaudon section). In the Venetian Alps the Parkinsoni zone is either absent because of local non-sequences or entirely represented within the lowermost beds of the « Ammonitico rosso veronese » formation (STURANI 1964a, 1964b). Only at Brentonico it must be developed as coquina facies, since the *P. alpina* beds of this locality have yielded a Lower Bathonian assemblage at their top (see p. 67), but it is devoid of ammonites.

As for the Garantiana zone, following WESTERMANN (1967, tab. I) and PAVIA & STURANI (1968, fig. 3), we shall adopt a threefold subdivision, with a *Tetragona* subzone at the top, a *Subgaranti* subzone in the middle and a *Dichotoma* subzone at the base; *Garantiana subgaranti*, rather than *G. garantiana*, has been preferred to avoid the use of the latter index for both zonal and subzonal purposes.

Only two assemblages (Longara di Sotto n. 2 and Ponte sul Ghelpach n. 4) belong to the Garantiana zone: none of them, however, is rich enough to be assigned unquestionably to any particular subzone.

As for the Subfurcatum zone, a fourfold subdivision, like that adopted by PAVIA & STURANI (*loc. cit.*) for the Digne region, seems to be the more suitable for the assemblages discussed here. From top to bottom the Subfurcatum zone may thus be divided into the following subzones: *Orthogarantiana schroederi* subzone, *Spiroceras baculatum* subzone, *Caumontisphinctes polygyralis* subzone and *Teloceras banksi* subzone. All four are represented in the *Posidonia alpina* beds of the Sette Comuni and deserve a few additional comments.

The section at Bielefeld brickpit described by BENTZ (1928, p. 142; « *Obere Subfurcatus Scht.* ») seems to represent the best standard of reference for the *Schroederi* subzone, since in the Digne region this is almost devoid of fossils. In Germany, the *Schroederi* subzone is characterized by a great wealth of *Orthogarantiana*, which reaches its acme at this level (representatives of this genus, however, appear much

earlier, towards the top of the Banksi subzone, at least in the Digne region; G. PAVIA 1969, p. 451). Several assemblages from the Sette Comuni probably belong here, including those from Monte Meletta and Monte Longara studied by PARONA (¹).

In the Digne region, as well as elsewhere, the Baculatum subzone is characterized by extremely abundant *Garantiana baculata*, *Spiroceras baculatum* and *Strenoceras* spp.. The Ravin du Feston section, near Digne (PAVIA & STURANI 1968, p. 313-314), is richly fossiliferous and might be taken as the standard of reference; in the succession at Bielefeld this subzone corresponds to BENTZ's « *Untere Subfurcatus Schichten* ». In the Sette Comuni there is only one assemblage, from Rotherbrunn, which could fall within this subzone.

The Polygyralis subzone is equivalent to the Phaulus/Polygyralis subzone as originally proposed by PAVIA & STURANI (1968, text. - f. 3); WESTERMANN's *Infraparkinsonia phaula* subzone may either be an equivalent or — more likely — may also include part or the whole of the Banksi subzone below. In order to avoid any confusion which may arise from such uncertainties, it seems preferable to use *Caumontisphinctes polygyralis*, rather than *C. (I.) phaulus*, as subzonal index. The latter, however, is at any rate confined to this subzone, being the microconch dimorph of *C. polygyralis*. The dimorph pair *C. bifurcus* BUCKM. - *C. (Infraparkinsonia) inferior* (BENTZ) is also confined here, while *Strenoceras subfurcatum* makes its first appearance towards the top of the subzone, at least in the Digne region, where the best standard of reference is to be found. In the Sette Comuni the assemblage from Longara di sotto n. 1 clearly belongs here.

The Banksi subzone is perfectly equivalent to the Aplous subzone as originally proposed by PAVIA & STURANI. Recent work by Mr. C. F. PARSONS at one of BUCKMAN's old localities, Frogden quarry, has shown that « using BUCKMAN's bed numbers (QJCS, 1893, n°. 196) the Subfurcatum zone is clearly divisible into three distinct faunal horizons, what he later called the Niortensis (bed 3), Leptosphinctes (bed 4) and Banksi (bed 5) hemerae. These divisions however seem to coincide with the subzonal divisions you described in your last paper with PAVIA. The Niortensis « hemera » can be defined by the presence of *Garantiana baculata*, *Strigoceras* spp., *Lissoceras* spp., *Cadomoceras* sp. and *Spiroceras* sp. and is thus the equivalent of your Baculatum subzone. The Leptosphinctes « hemera » can be defined by the appearance of *Orthogarantiana* cf. *densicostata* and *Strenoceras* sp. the equivalent of the Phaulus/Polygyralis subzone. Below this horizon is a series of thin earthy ironshot limestones, containing numerous Perisphinctids, *Cleistosphinctes*, *Caumontisphinctes* and *Teloceras banksi*: the Banksi « hemera » ».

In the present case, BUCKMAN's « hemerae » appear to be valid subdivisions of subzonal rank and *Teloceras banksi*, rather than *Caumontisphinctes aplous*, seems worth maintaining as the subzonal index, on grounds of priority.

(¹) According to Dr. H. S. TORRENS (personal communication), the validity of the Schroederi subzone, i. e. its separation from the Baculatum subzone, is « a bit unproven as yet ». I agree that this point needs further investigations and that the evidence from the sections in the Digne area on one hand, and the assemblages from the Sette Comuni on the other, is not decisive.

The Banksi subzone is thus characterized by the association of *Teloceras* spp., *Normannites* spp., *Stemmatoceras* sp. and other Stephanoceratids (all of which appeared earlier, but for, perhaps, the subzonal index) with various *Leptosphinctes*, *Cleistosphinctes* and *Caumontisphinctes aplous* (see G. PAVIA 1969). As a standard of reference, the fine section studied by PAVIA along the Ravin de la Coueste, near Chaudon, in the Digne region, seems to be the most suitable, also for fixing the base of the Subfurcatum zone.

In the Sette Comuni there are at least two assemblages (Cima Tre Pezzi and Ponte sul Ghelpach n. 2) which certainly belong here.

As for the Humphriesianum zone, its lower part alone is represented in the Sette Comuni (Troch n. 1, Camporovere and Ponte sul Ghelpach n. 1 assemblages). Palaeontologically, it is characterized by a great wealth of *Poecilomorphus*, *Sphaeroceras brongniarti brongniarti*, and *Normannites* (*anceps*, *portitor*, etc.), in association with *Stegoxytes parvicarinatus*; it is thus the equivalent of BUCKMAN's *Epalxites* «hemera», WESTERMANN's Frechi subzone and PAVIA & STURANI «*Poecilomorphus*» subzone. Since *Stemmatoceras frechi* has a long vertical range, throughout the whole Humphriesianum zone, it seems preferable to select a more suitable subzonal index: it is here formally proposed that this should be *Poecilomorphus cycloides*.

No attempt will be made here, however, to discuss whether it is necessary to distinguish a separate subzone between the Cycloides subzone below and the Blagdeni subzone above; in other words, whether a twofold subdivision of the Humphriesianum zone is justified and sufficient, or not.

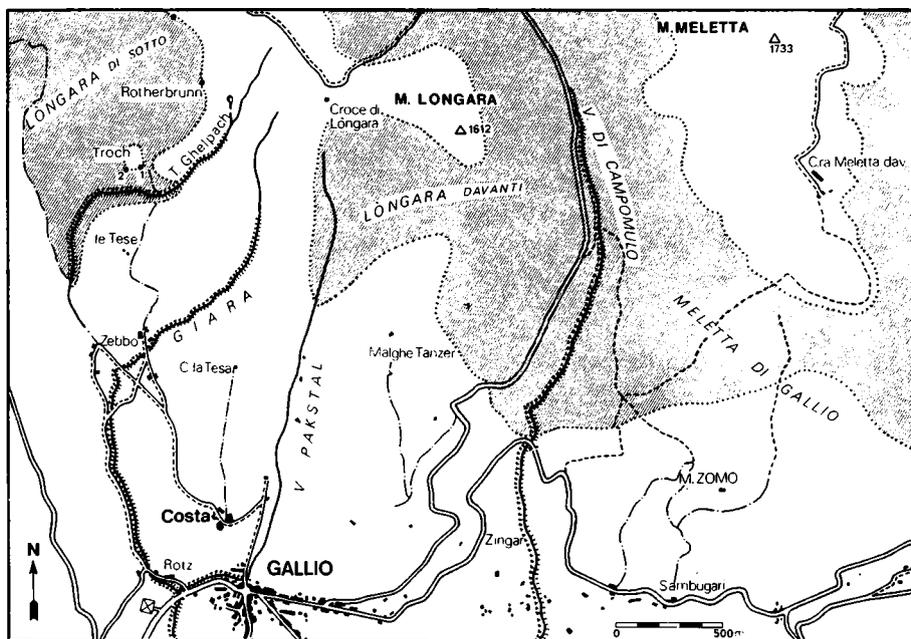


FIG. 24

Index map showing location of the main fossil localities North of Gallio, in the Sette Comuni region. Ruled area: formations older than the *P. alpina* beds. Blank area: formations younger than the *P. alpina* beds. Outcrops of the *P. alpina* beds occur scattered along the dotted line.

FOSSIL LOCALITY TROCH N. 1

This locality (not named on the Italian ordnance survey map) lies at 1350 m above sea level on the South - West slopes of Monte Longara, North of Gallio (see fig. 24 for location map and STURANI 1964a, fig. 5 for the local stratigraphy).

The following ammonites were collected here:

- Pseudophylloceras kudernatschi* (HAUER),
Partschiceras abichi (UHLIC),
Partschiceras cf. *besnosovi* n. sp.,
Partschiceras striatoplicatum BESNOSOV,
Calliphylloceras disputabile (ZITTEL),
Holcophylloceras mediterraneum (NEUM.),
Ptychophylloceras cf. *rosiwali* (TRAUTH),
Lytoceras adela (d'ORB.),
Nannolytoceras pygmaeum (d'ORB.),
Nannolytoceras polyhelictum (BÖCKH),
Lissoceras oolithicum (d'ORB.),
Lissoceras aff. *oolithicum* (d'ORB.),
Lissoceras (*Microlissoceras* n. subg.) *pusillum* n. sp.,
Toxalambites fasciculatus n. sp.,
Toxalambites densicostatus n. sp.,
Toxalambites (*Microtoxalambites* n. subg.) *parvus* n. sp.,
Toxalambites (*Microtoxalambites* n. subg.) *pauper* n. sp.,
* *Stegoxytes parcarinatus* S. BUCKM.,
Stegoxytes aff. *parcarinatus* S. BUCKM.,
Stegoxytes (n. microconch subg.) n. sp. ind.,
* *Poecilomorphus cycloides* (d'ORB.) (with several morphotypes),
Poecilomorphus (*Micropoecilomorphus* n. subg.) *vicetinus* (PARONA),
Oppelia subradiata (SOW.),
Oppelia flexa (S. BUCKM.),
Oecotraustes genicularis WAAG.,
* *Strigoceras bessinum* BRASIL,
Strigoceras sp. ind. juv. aff. *strigifer* (S. BUCKM.),
* *Cadomoceras sullyense* BRASIL,
Cadomoceras n. sp. aff. *sullyense* BRASIL,
* *Dorsetensia* sp. ind. juv.,
* *Bajocia farcyi* BRASIL,
Bajocia (? n. subg.) *rarinoda* n. sp.,
* *Normannites flexus* WESTERMANN,
* cf. *Normannites latansatus* (S. BUCKM.),
* cf. *Normannites formosus* (S. BUCKM.),
* cf. *Normannites pinguis* WESTERMANN,
cf. *Normannites anceps* (QUENST.),
cf. *Normannites portitor* (MAUBEUGE),
cf. *Normannites* n. sp. aff. *portitor* (MAUB.),
Normannites (?) *globulus* n. sp.
Stephanoceratidae gen. et spp. plur. ind. juv. (nuclei),
Sphaeroceras brongniarti (SOW.),

- Sphaeroceras pusillum* n. sp.,
 * *Sphaeroceras (Chondroceras) wrighti minor* (WESTERM.),
Sphaeroceras (Chondroceras) aff. flexuosum n. sp.
Sphaeroceras (Schmidtoceras) callomoni n. sp.,
 Aptychi.

The species marked with * are elsewhere confined to the Humphriesianum zone.

The association of extremely abundant *Poecilomorphus cycloides* with *Normannites* spp. plur. (especially *N. anceps* and *N. portitor*, previously assigned to *Epalxites*) and *Stegoxytes* is indicative of the basal part of the Humphriesianum zone, which has been called here (p. 50) the Cycloides subzone.

CIMA TRE PEZZI FOSSIL LOCALITY

The stratigraphical details are shown in text-fig. 17. This section was measured along the front of an abandoned quarry, just below Cima Tre Pezzi, on the spur that towers above the confluence of the Valle del Ghelpach and Val d'Assa canyons, two km West of Ponte sul Ghelpach (fig. 25). The assemblage from this locality includes :

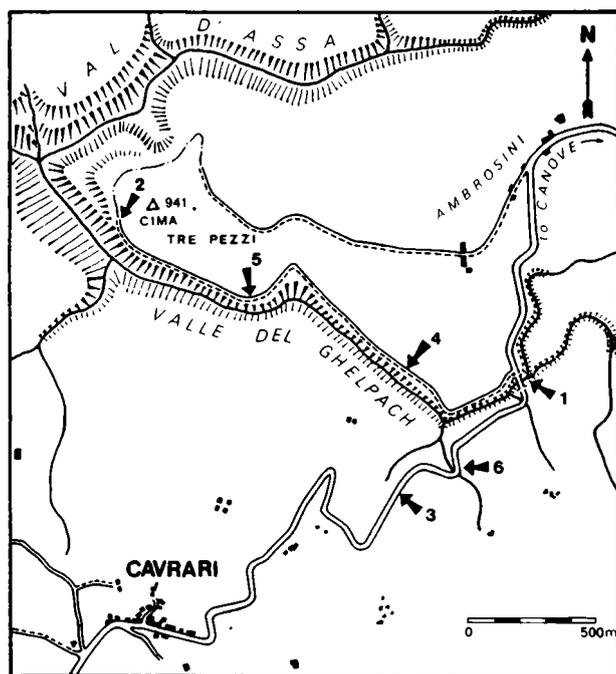


FIG. 25

Index map showing location of the more interesting sections exposed along the lower Ghelpach valley. 1: Ponte sul Ghelpach. 2: Cima Tre Pezzi quarry. 3 to 6: sections figured in my previous paper (STURANI 1964a; Pl. 2, and text-figs. 6, 7 and 12 respectively).

- Partschiceras* spp. plur. ind. juv.
Calliphyloceras disputabile (ZITTEL),
Holcophylloceras mediterraneum (NEUM.),
Ptychophylloceras cf. rosiwali (TRAUTH),

Nannolytoceras polyhelictum (BÖCKK),
Lissoceras oolithicum (d'ORB.),
Oppelia cf. *subradiata* (SOW.) (fragm.),
Oppelia subtilicostata PARONA,
Strigoceras aff. *bessinum* BRASIL,
Strigoceras sp. ind. juv. aff. *septicarinatum* (S. BUCKM.),
 cf. *Normannites* spp. plur. ind. juv. (see Pl. 12, fig. 17),
Polyplectites (?) *venetus* (PARONA),
Torrensia n. gen. aff. *gibba* (PARONA),
Parastrenoceras lucretius (d'ORB.),
Parastrenoceras sp. ind.
Leptosphinctes (? subg.) sp. ind. juv. (nuclei),
Patrulia n. gen. *aenigmatica* n. sp.,
Sphaeroceras brongiarti (SOW.) ssp. *globus* BUCKM.,
Sphaeroceras (*Chondroceras*) *canovenese* (de GREGORIO).

The association of primitive Perisphinctaceae (*Parastrenoceras*, *Torrensia*, *Leptosphinctes*) with *Normannites* is highly indicative of the lowermost part of the Subfurcatum zone (basal Banksi subzone: cf. G. PAVIA 1969; also C. F. PARSONS, personal communication). The assemblage from Cima Tre Pezzi is close in composition — and therefore in age — to that from Ghelpach loc. n. 2 (Pisa Museum) and that monographed by de GREGORIO (see p. 61).

LONGARA DI SOTTO N. 1 FOSSIL LOCALITY

For stratigraphic details see text-figs. 13-15. This section has been measured along the front of an old quarry abandoned since 1959 (see fig. 24 for location map). Two different assemblages were collected here from two separate coquina patches; the stratigraphically older one includes:

Partschiceras besnosovi n. sp.,
Partschiceras striatoplicatum BESNOSOV,
Partschiceras abichi (UHLIG),
Pseudophylloceras kudernatschi (HAUER),
Calliphylloceras disputabile (ZITT.),
Holcophylloceras mediterraneum (NEUM.),
Ptychophylloceras longarae n. sp.,
Ptychophylloceras cf. *rosiwali* (TRAUTH),
Lytoceras eudesianum (d'ORB.),
Lytoceras adela (d'ORB.),
Nannolytoceras polyhelictum (BÖCKH),
Lissoceras oolithicum (d'ORB.),
Oppelia subtilicostata PARONA,
Oppelia cf. *flexa* (S. BUCKM.) juv.,
Oecotraustes westermanni STEPHANOV,
Oecotraustes longarae n. sp.,
Strigoceras truellei (d'ORB.),
Strigoceras paronai (TRAUTH),

Strigoceras aff. *bessinum* BRASIL
Strigoceras sp. ind. juv. aff. *septicarinatum* (S. BUCKM.),
Cadomoceras cf. *cadomense* (DEFR.),
Cadomoceras aff. *nepos* PARONA,
Polyplectites (?) *venetus* (PARONA),
Torrensia n. gen. aff. *gibba* (PARONA),
Caumontisphinctes polygyralis S. BUCKM.,
C. (Infraparkinsonia) phaulus S. BUCKM.,
Orthogarantiana sp. ind. juv.,
Leptosphinctes (? subg.) spp. plur. ind.,
Sphaeroceras talkeetanum IMLAY (microconchs),
Sphaeroceras auritum PARONA, primitive morphotype,
Sphaeroceras (Chondroceras) canovense (de GREG.) (M. & m),
Sphaeroceras (Chondroceras) flexuosum n. sp. (M & m).

This association clearly belongs to the *Polygyralis* subzone of the *Subfurcatum* zone, as shown by the association of *Caumontisphinctes polygyralis* and *C. (Infraparkinsonia) phaulus* (see p. 49).

ROTHERBRUNN FOSSIL LOCALITY

This fossil locality lies at 1375 m above sea level, on the South - West slopes of Monte Longara, at midway between the Troch and Longara di Sotto localities, one hundred metres West of a small spring locally called Rotherbrunn or Rotaprunli (text-fig. 24). The assemblage from this locality includes:

Partschiceras abichi (UHLIG),
Partschiceras besnosovi n. sp.
Calliphylloceras disputabile (ZITT.),
Holcophylloceras mediterraneum (NEUM.),
Ptychophylloceras cf. *rosivali* (TRAUTH),
Ptychophylloceras longarae n. sp.,
Nannolytoceras polyhelictum (BÖCKH),
Lissoceras meletense (PARONA),
Oppelia cf. *flexa* (S. BUCKM.) juv.,
Oppelia cf. *subtilicostata* PARONA,
Strigoceras truellei (d'ORB.) juv.,
Cadomoceras cadomense (DEFR.),
Bajocia (?) n. sp.,
Cadomites (or *Polyplectites*) sp. ind. (fragm.),
Torrensia n. gen. *gibba* (PARONA),
Orthogarantiana schroederi (BENTZ),
Orthogarantiana cf. *conjugata* (QUENST.) (fragm.),
Strenoceras subfurcatum (SCHLOTH.),
Parastrenoceras cf. *tlaxiacense* OCHOTERENA,
Caumontisphinctes cf. *polygyralis* (S. BUCKM.),
Caumontisphinctes (Infraparkinsonia) sp. ind.,
Spiroceras cf. *baculatum* (QUENST.),

Leptosphinctes (? subg.) *rotula* (PARONA),
Leptosphinctes (? subg.) sp. ind. juv.,
Sphaeroceras auritum PARONA.

This assemblage clearly belongs to the Subfurcatum zone, probably *Spiroceras baculatum* subzone, as suggested by the presence of *Spiroceras* cf. *baculatum* in association with *Strenoceras subfurcatum*.

FOSSIL LOCALITY TROCH N. 2

This fossil locality lies some fifty metres West of Troch n. 1. but the faunal assemblage is completely different, including:

Partschiceras spp. plur. ind. juv. (nuclei),
Calliphylloceras disputabile (ZITT.),
Holcophylloceras mediterraneum (NEUM.),
Ptychophylloceras longarae n. sp.,
Ptychophylloceras cf. *rosiwali* (TRAUTH),
Nannolytoceras pluriannulatum (PARONA),
Nannolytoceras polyhelictum (BÖCKH),
Lissoceras meletense (PARONA),
Oppelia sp. ind. juv. cf. *flexa* (S. BUCKM.),
Strigoceras truellei (d'ORB.) juv.,
Strigoceras paronai (TRAUTH),
Cadomoceras cadomense (DEFR.),
Bajocia farcyi BRASIL,
Torrensia n. gen. *gibba* (PARONA),
Orthogarantiana schroederi (BENTZ) juv.,
Orthogarantiana conjugata (QUENST.) juv.,
Caumontisphinctes sp. ind.,
Strenoceras sp. ind. juv. (aff. *bigoti* BRASIL),
Sphaeroceras auritum PARONA.
Sphaeroceras (*Chondroceras* ?) *fasciculatum* n. sp.,
Leptosphinctes (? subg.) sp. ind. juv..

This assemblage (apart from *Bajocia farcyi*, which is obviously reworked; see p. 40), belongs to the Subfurcatum zone, probably *Schroederi* subzone, like those from Monte Meletta and Monte Longara (Padua Museum), which are similar in composition.

LONGARA DI SOTTO N. 2

The stratigraphically youngest assemblage from Longara di sotto quarry, apart from very abundant *Bositra buchi*, includes only a few, extremely small-sized ammonites, most of which are immature:

Phylloceratids,
Strigoceras cf. *truellei* (d'ORB.),
Cadomoceras sp.,

Oppelia sp. ind..

Orthogarantiana (or ? *Garantiana*) sp. ind.,

Spiroceras obliquecostatum (QUENST.) (extremely common),

Sphaerocheras tenuicostatum n. sp. *glabrum* n. ssp. (rather common; all tiny adult specimens).

The age, as suggested by the presence of *Spiroceras obliquecostatum*, is *Garantiana* zone.

OLD COLLECTIONS

CAMPOROVERE (C. F. PARONA 1880)

Shortly before 1880, Prof. BEGGIATO and Capt. NALLI collected a few small pieces of the coquina rock from the *P. alpina* beds near Camporovere (Sette Comuni region) and gave them to Prof. T. TARAMELLI. More details of the exact location of the outcrops they collected from are not available. T. TARAMELLI published a first list of species in his monograph on the Lias of the Venetian Provinces (1880, p. 25), and entrusted a more accurate study of the fauna to C. F. PARONA, then his assistant at Pavia University. A few additions and emendations to his first paper (PARONA 1880) were subsequently published by PARONA himself in the 1896 monograph.

But for a few specimens, the assemblage from Camporovere is still extant and it is deposited in the palaeontological collections of the University of Pavia. I have been able to revise the material through the kindness of Prof. G. SACCHI VIALLI and Dr. G. M. CANTALUPPI.

This is the revised list of the Ammonites from Camporovere that are still extant.

PARONA 1880	THIS WORK
<i>Phylloceras kudernatschi</i> VON HAUER	<i>Partschiceras</i> cf. <i>abichi</i> (UHLIG),
<i>Phylloceras zignodianum</i> d'ORB.)	<i>Holcophylloceras mediterraneum</i> (NEUM.) juv.,
<i>Phylloceras subpartitum</i> n. sp.)	
<i>Phylloceras</i> sp. (1 st))	
<i>Phylloceras</i> sp. (2 d)	<i>Calliphylloceras disputabile</i> (ZITT.),
<i>Lytoceras</i> cf. <i>quadrisulcatum</i> d'ORB.	<i>Nannolytoceras polyhelictum</i> (BÖCKH),
<i>Oppelia fusca</i> QUENST.	<i>Strigoceras</i> sp. ind. juv. aff. <i>strigifer</i> (S. BUCKM.),
<i>Oppelia</i> sp. (pars) (unidentified frgm)	<i>Strigoceras bessinum</i> BRASIL,
<i>Oppelia</i> sp. (pars) (unidentified frgm)	<i>Cadomoceras sulliense</i> BRASIL,
<i>Oppelia</i> sp. (pars) (unidentified frgm)	<i>Oppelia</i> cf. <i>subradiata</i> (SOW.),
<i>Harpoceras pingue</i> n. sp.	<i>Stegoxytes parvicarinatus</i> BUCKM.,
	<i>Toxalambites fasciculatus</i> n. sp.,
	<i>Poecilomorphus cycloides</i> (d'ORB.),

<i>Harpoceras minutum</i> n. sp.	<i>Poecilomorphus cycloides</i> (d'ORB.), (a moderately evolute morphotype).
<i>Haploceras vicentinum</i> n. sp. (= <i>Oppelia vicetina</i> PAR. 1896)	<i>Poecilomorphus</i> (<i>Micropoecilomorphus</i> n. subg.) <i>vicetinus</i> (PARONA),
<i>Stephanoceras rectelobatus</i> HAUER	<i>Normannites</i> (?) <i>globulus</i> n. sp.,
<i>Stephanoceras brongniarti</i> SOW.	<i>Sphaeroceras brongniarti</i> (SOW.).

All the species listed above are also found in the newly collected assemblage from fossil locality Troch n. 1; the age is therefore the same: basal Humphriesianum zone, Cycloides subzone.

MONTE LONGARA (PADUA MUSEUM)

A rich faunal assemblage that is stated to come from Monte Longara on the accompanying labels is deposited in the Palaeontological collections of the University of Padua. Details about the person who collected it are missing (possibly Sig. MENEGUZZO, as with the fossils from M. Meletta). This assemblage was studied by PARONA for his 1896 monograph.

This is the revised list of the ammonites, a few of which were figured by PARONA:

- Phylloceras trifoliatum* NEUM.,
- Pseudophylloceras kudernatschi* (HAUER),
- Partschiceras abichi* (UHLIC),
- Partschiceras besnosovi* n. sp.,
- Partschiceras striatoplicatum* BESNOSOV,
- Calliphylloceras disputabile* (ZITT.),
- Holcophylloceras mediterraneum* (NEUM.),
- Ptychophylloceras longarae* n. sp.,
- Ptychophylloceras* cf. *rosiwali* (TRAUTH),
- Lytoceras adela* (d'ORB.),
- Nannolytoceras polyhelictum* (BÖCKH),
- Nannolytoceras pluriannulatum* (PARONA),
- Lissoceras oolithicum* (d'ORB.),
- Lissoceras psilodiscus* (SCHLOENB.) *inflatum* WETZEL,
- Lissoceras meletense* (PARONA),
- Oppelia* cf. *flexa* (S. BUCKM.) juv.,
- Oppelia* cf. *subtilicostata* PARONA (fragm.),
- Oecotraustes westermanni* STEPHANOV,
- Oecotraustes pulcher* (S. BUCKM.),
- Strigoceras truellei* (d'ORB.) juv.,
- Strigoceras paronai* (TRAUTH),
- Cadomoceras nepos* PARONA,
- Cadomites* (or *Polyplectites*) sp. ind. (fragm.),
- Torrensia* n. gen. *gibba* (PARONA),
- Orthogarantiana conjugata* (QUENST.),

Orthogarantiana densicostata (QUENST),
Strenoceras apleurum S. BUCKM.,
Strenoceras sp. ind.,
Caumontisphinctes prorsicostatus n. sp.,
Leptosphinctes (? subg.) *perspicuus* (PARONA),
Leptosphinctes (? subg.) *rotula* (PARONA),
Leptosphinctes (*Cleistosphinctes*) *cleistus* S. BUCKM.,
Sphaeroceras auritum PARONA.

This assemblage is practically identical in composition, average size and state of preservation to that from Monte Meletta. The age is therefore the same: Subfurecatum zone, probably Schroederi subzone.

MONTE MELETTA (TURIN MUSEUM)

The bulk of the fossils studied by PARONA in his 1896 monograph and stated by him to come from Monte Meletta, North East of Gallio, were purchased from Sig. G. MENEGUZZO, a fossil dealer at Gallio, and are deposited in the palaeontological collections of the University of Turin. The only original data about this fossil locality are very vague: they were given by G. MENEGUZZO in a rather amusing card sent to PARONA, that I have already related in full (STURANI 1964a, p. 24). During several trips to Monte Meletta I was unable to find any more well preserved fossils: the *P. alpina* beds were either absent or poorly fossiliferous at this locality. Any doubts about whether Sig. MENEGUZZO gave a wrong locality on purpose are therefore well-founded.

The revised list of the ammonites is as follows:

PARONA 1896	.....	THIS WORK
<i>Phylloceras kunti</i> NEUM.	.....	<i>Pseudophylloceras kudernatschi</i> (HAUER),
<i>Phylloceras subobtusum</i> KUD.	.....	<i>Partschiceras abichi</i> (UHLIG),
<i>Phylloceras viator</i> d'ORB. (pars)	.....	<i>Partschiceras besnosovi</i> n. sp.,
<i>Phylloceras viator</i> d'ORB. (pars)	.....	<i>Partschiceras striatoplicatum</i> BESN.,
<i>Phylloceras slamisum</i> de GREG.	.....	<i>Calliphylloceras disputabile</i> (ZITT.),
<i>Phylloceras ovale</i> POMP.?	}	<i>Ptychophylloceras</i> cf. <i>rosiuali</i> (TRAUTH),
<i>Phylloceras subortisulcatum</i> POMP.		
<i>Phylloceras mediterraneum</i> NEUM. (pars)	.....	<i>Ptychophylloceras longaruae</i> n. sp.,
<i>Phylloceras mediterraneum</i> NEUM. (pars)	}	<i>Holcophylloceras mediterraneum</i> (NEUM.),
<i>Phylloceras subpartitum</i> PAR.		
<i>Lytoceras adeloides</i> KUD.	.....	<i>Lytoceras adelae</i> (d'ORB.),
<i>Lytoceras pluriannulatum</i> n. f.	.....	<i>Nannolytoceras pluriannulatum</i> (PAR.),
<i>Lytoceras nicolisi</i> PAR. 1896 (non PAR. 1894)		<i>Nannolytoceras polyhelictum</i> (BÖCKH).
<i>Lytoceras meletense</i> n. f. (unidentified)	.....	<i>Lissoceras meletense</i> (PAR.),
(unidentified)	.....	<i>Lissoceras oolithicum</i> (d'ORB.).
	.....	<i>Lissoceras psilodiscus</i> (SCHLOENB.) ssp. <i>inflatum</i> WETZEL,

<i>Hecticoceras</i> (?) <i>pingue</i> PAR. 1896 (non PAR. 1880)	}	.....	<i>Sirigoceras truellei</i> (d'ORB.),
<i>Lunuloceras canovincola</i> de GREG.				
<i>Cadomoceras nepos</i> n. f.		.....	<i>Cadomoceras nepos</i> PARONA,
<i>Oecotraustes minor</i> n. f.		.....	<i>Cadomoceras cadomense</i> (DEFR.),
<i>Lunuloceras stevensoni</i> de GREG.		.....	<i>Oppelia</i> cf. <i>flexa</i> (S. BUCKM.) juv.,
<i>Oppelia subtilicostata</i> n. f. (pars)		.....	<i>Cecotraustes westermanni</i> STEPHANOV,
<i>Reineckeia sansonii</i> n. f.		.....	<i>Orthogarantiana conjugata</i> (QUENST.),
<i>Reineckeia greppini</i> OPP.	}			
<i>Cosmoceras uhligi</i> (nom. nud.; non PAR. & BON. 1897)		}	<i>Orthogarantiana densicostata</i> (QUENST.).
(unidentified)			<i>Orthogarantiana schroederi</i> (BENTZ),
<i>Stephanoceras gibbum</i> n. f.		.....	<i>Torrensia</i> (n. gen.) <i>gibba</i> (PAR.),
<i>Cosmoceras pollux</i> REIN.		.....	<i>Strenoceras apleurum</i> S. BUCKM.,
<i>Parkinsonia bonarellii</i> n. f.		.....	<i>Caumontisphinctes (Infraparkinsonia)</i> <i>bonarellii</i> (PAR.),
<i>Peltoceras chauvinianum</i> d'ORB.		.....	<i>Caumontisphinctes prorsicostatus</i> n. sp.,
<i>Morphoceras dimorphoides</i> n. f.		.....	<i>Dimorphinites</i> (?) <i>dimorphoides</i> (PAR.),
<i>Stephanoceras rotula</i> n. f.		.....	<i>Leptosphinctes</i> (? subg.) <i>rotula</i> (PAR.),
<i>Perisphinctes subtilis</i> NEUM. (pars)		.....	<i>Leptosph.</i> (<i>Cleistosphinctes</i>) <i>cleistus</i> S. BUCKM.,
<i>Perisphinctes subtilis</i> NEUM. (pars)	}	.....	<i>Leptosphinctes</i> (? subg.) <i>perspicuus</i> (PAR.),
<i>Perisphinctes perspicuus</i> n. f.				
<i>Perisphinctes torquis</i> n. f.			<i>Leptosphinctes</i> (? subg.) <i>torquis</i> (PAR.),	
<i>Sphaeroceras auritum</i> n. f.	}			
<i>Sphaeroceras disputabile</i> n. f.		}	<i>Sphaeroceras auritum</i> PARONA
<i>Sphaeroceras pilula</i> n. f.				
<i>Perisphinctes conclusus</i> n. f. (pars)			<i>Sphaeroceras (Schmidtoceras) cf. evolutum</i> (WESTERM.).	

The association of *Strenoceras*, *Caumontisphinctes*, *Cleistosphinctes* and abundant *Orthogarantiana* fits well within the Subfurcatum zone; as to the subzone, it could be *Schroederi* sbz., *Orthogarantiana schroederi* being present.

PONTE SUL GHELPAK (PISA MUSEUM)

A rich fauna from this locality (or more likely, as we shall see, from several localities near Ponte sul Ghelpach) was purchased in the last decades of the nineteenth century by either Prof. MENECHINI or Prof. CANAVARI and was included by PARONA in his 1896 monograph. This fauna is deposited in the palaeontological collections at the University of Pisa, and I have been able to revise it through the kindness of Prof. G. TAVANI.

A first inspection clearly suggests that several stratigraphically separate assemblages are represented among the Pisa material: this is proved by the fact that the fossils, in state of preservation, matrix and stratigraphical significance fall easily into four separate groups, and it is confirmed by the original accompanying labels that read « Various localities near the bridge on the Ghelpach river, Sette Comuni ».

During my researches in the Sette Comuni I measured a section just beneath this bridge, on the right side of the river. The *P. alpina* beds show the same lithological and stratigraphical features seen at other localities nearby (Cima Tre Pezzi, for instance). The coquina facies fills a complex network of fissures within the topmost beds of the « Grey limestones » and is crowded with extremely small-sized ammonites. The few forms that I was able to identify are indicative of the basal Subfurcatum zone (Banksi sbz.). More outcrops of the fossiliferous rock are to be seen along the narrow road that leads Westward to Cima Tre Pezzi quarry, but ammonites are very rare, *Bositra buchi* becoming the main component of the coquina.

Among the Pisa Museum material, the stratigraphically oldest assemblage (Ghelpach n. 1) is distinguished by the presence of a red hematitic film coating the fossils and consists of only a few species (*Phyllocerats*, *Poecilomorphus cycloides*, *Sphaeroceras brongniarti*) indicative of the basal Humphriesianum zone, Cycloides subzone.

A second, much richer assemblage (Ghelpach n. 2), is characterized by the relatively larger size of the fossils, which are preserved as internal casts, sugar white to pale pink in colour. This includes :

- Ptychophylloceras* cf. *rosiwali* (TRAUTH),
- Ptychophylloceras longarae* n. sp.,
- Pseudophylloceras kudernatschi* (HAUER),
- Nannolytoceras polyhelictum* (BÖCKH),
- Lissoceras oolithicum* (d'ORB.),
- Strigoceras truellei* (d'ORB.),
- Oppelia subtilicostata* PARONA (incl. the lectotype),
- Polyplectites* (?) *venetus* (PARONA) (incl. the holotype),
- Torrensia* (n. gen.) n. sp. ind.,
- Parastrenoceras* aff. *caumonti* (d'ORB.),
- Parastrenoceras lucretius* (d'ORB.),
- Leptosphinctes* (? subg.) *conclusus* (PARONA) (incl. the lectotype),
- Patrulia* n. gen. *aenigmatica* n. sp.,
- Sphaeroceras brongniarti* (SOW.) ssp. *globus* S. BUCKM.,
- Sphaeroceras* (*Chondroceras*) *flexuosum* n. sp.,
- Sphaeroceras* (*Chondroceras*) *canovense* (de GREGORIO).

Most of the species listed above also occur in the newly collected assemblage from Cima Tre Pezzi quarry (which lies only about 1 km West of the bridge on the Ghelpach river) and are therefore of the same age (or just slightly younger, owing to the absence of *Normannites* in the present case): Sufurcatum zone, Banksi subzone.

Next comes assemblage n. 3, which is distinguished by the fact that the ammonites are preserved with their test, while the matrix is a yellowish marnomicrite. Only a few species belong here :

- Holcophylloceras mediterraneum* (NEUM.),
- Nannolytoceras nicolisi* (PAR.),
- Nannolytoceras pluriannulatum* (PAR.),
- Nannolytoceras polyhelictum* (BÖCKH)
- Sphaeroceras auritum* PARONA.

They are probably indicative of the Subfurcatum zone, Schroederi subzone, as with the Monte Meletta assemblage.

The fourth assemblage (Ghelpach n. 4) is stratigraphically younger and is characterized by the fact that all the ammonites are calcined. According to PARONA, this method had often to be used in order to extract the fossils unbroken from particularly well cemented coquina blocks. The following species are present:

- Ptychophylloceras longarae* n. sp.,
- Lissoceras oolithicum* (d'ORB.),
- Lissoceras psilodiscus* ssp. *inflatum* WETZEL,
- Strigoceras* cf. *truellei* (d'ORB.) juv.,
- Strigoceras paronai* (TRAUTH),
- immature Oppeliids,
- Orthogarantiana* sp. ind. juv.
- Pseudogarantiana minima* (WETZEL),
- Spiroceras waltoni* (MORRIS),
- Leptosphinctes* (? subg.) sp. ind. juv.,
- Sphaeroceras tenuicostatum* n. sp.,
- S.* (*Schmidtoceras*) cf. *evolutum* (WESTERM.),
- S.* (*Schmidtoceras*) cf. *crassum* (WESTERM.).

Pseudogarantiana minima and *Spiroceras waltoni* are clearly indicative of the Garantiana zone.

DE GREGORIO'S MONOGRAPH

The fossils from the *P. alpina* beds monographed in 1886 by de GREGORIO also came from the Sette Comuni; they were collected at two different localities, lying a few hundred metres apart, along the Ghelpach valley near Canove (de GREGORIO 1886, p. 5); that is, in the close vicinity of the bridge on the Ghelpach. A search for this fauna in Palermo, by Prof. RUGGIERI and his staff, was unsuccessful: it is probably lost.

The point is, unfortunately, that all the ammonite species and subspecies were described by de GREGORIO as new, so that a revision — even though based on the original figures and descriptions alone — is still necessary.

A few of de GREGORIO's new names were later adopted by PARONA in the 1896 monograph — with several misinterpretations, as we shall see. Subsequently they have fallen into complete oblivion.

Since the specimens are probably lost, their descriptions inadequate, most of the figures atrocious and all species but one (*Sphaeroceras brongniarti* mut. *canovensis*) are based on tiny immature specimens, it seems essential to regard de GREGORIO's names as *nomina oblita*, except for *Sphaeroceras canovense* (for which see further on, p. 146) and those that were subsequently adopted by PARONA. Fortunately enough, the latter are all junior subjective synonyms of well known species.

The following is a tentative revised list of de GREGORIO's species which must be regarded as *nomina oblita* except for nos 1, 9, 13, 15 and 18 (reference to the original figures is given within brackets):

- 1) *Stephanoceras* (*Sphaeroceras*) *brongniarti* mut. *canovens* de GREG. (pl. 1, ff. 3 a-e): *Sphaeroceras* (*Chondroceras*) *canovense* (de GREGORIO).
- 2) *Stephanoceras bifplicum* de GREG. (pl. 1, ff. 4 a-c, 5 a-d): a senior subjective synonym of *Polyplectites* (?) *venetus* (PARONA), based on immature specimens (compare de GREGORIO's pl. 1, f. 4 a-c with Pl. 13, fig. 2 of the present work).
- 3) *Stephanoceras alpinus* de GREG. (pl. 1, ff. 6 a-b): a senior subjective synonym of ? *Torrensia gibba* (PAR.) (very uncertain).
- 4) *Stephanoceras betinus* de GREG. (pl. f. 7); *S. gamminus* de GREG. (pl. 1, ff. 8 a-c): both based on unidentifiable nuclei.
- 5) *Stephanoceras deltinus* de GREG. (pl. 1, f. 9); *S. epsilinus* de GREG. (pl. 1, ff. 10 a-b) and *S. zetinus* de GREG. (pl. 1, ff. 12 a-b): all based on ? Perisphinctid nuclei.
- 6) *Stephanoceras etinus* de GREG. (pl. 1, f. 12): based on a ? Sphaeroceratid nucleus.
- 7) *Perisphinctes* (*Parkinsonia*) *unicensis* de GREG. (pl. 1, ff. 13 a-b): either a *Caumontisphinctes* or a *Leptosphinctes* (s. l.) (inner whorls).
- 8) *Lytoceras guiscardii* de GREG. (pl. 1, ff. 14 a-b, 21 a-b): a *Nannolytoceras*; perhaps a subjective syn. of *N. polyhelictum* (BÖCKH).
- 9) *Harpoceras canovincola* de GREG. (pl. 1, ff. 15 a-c) and *H. canovincola* mut. *pluricosta* de GREG. (pl. 1, ff. 16 a-b): both based on nuclei of *Strigoceras*, probably *S. truellei* (d'ORB.); de GREGORIO's name was later adopted also by PARONA.
- 10) *Harpoceras ramiatum* de GREG. (pl. 1, ff. 17 a-b) and *H. campoverense* de GREG. (pl. 1, ff. 20 a-b): both based on nuclei of *Strigoceras*, probably a stoutly whorled morphotype of *S. truellei*.
- 11) *Ammonites zellus* de GREG. (pl. 1, ff. 18 a-b) and *A. mirmidosus* de GREG. (pl. 1, f. 22): both based on nuclei too small for an attempt at specific identification.
- 12) *Lytoceras posidonomiensis* de GREG. (pl. 1, f. 19): *Lytoceras adela* (d'ORB.).
- 13) *Ammonites stevensoni* de GREG. (pl. 1, ff. 23 a-c): based on the inner whorls of *Oppelia* sp. (probably *O. subradiata* (SOW.)); this specific name was also adopted by PARONA for nuclei of *Oppelia flexa* (S. BUCKM.).
- 14) *Ammonites chirchius* de GREG. (pl. 1, ff. 24 a-b) and *Oppelia fractina* de GREG. (pl. 1, ff. 26 a-b): both based on fragmentary specimens of *Partschiceras abichi* (UHLIC).
- 15) *Oppelia propefusca* de GREG. (pl. 1, f. 25): according to the original figures and descriptions there is little doubt that this is an Oppeliid (either a junior synonym of *Oppelia subradiata* (SOW.) or — less likely — a senior subjective synonym of *O. subtilicostata* PARONA). In any case de GREGORIO's type seems to be neither congeneric nor conspecific with *Oppelia propefusca* PARONA non de GREGORIO (PARONA 1896; pl. 1, ff. 8-9), the correct name for the latter being *Strigoceras paronai* (TRAUTH).
- 16) *Phylloceras posalpinum* de GREG. (pl. 1, ff. 27 a-h) and *P. posalpinum* mut. *crassiusculum* de GREG. (pl. 1, ff. 28 a-e): both based on Phylloceratid nuclei too small for an attempt at specific identification (? *Partschiceras* sp.).
- 17) *Haploceras blandum* de GREG. (pl. 1, ff. 29 a-e): based on nuclei of ? *Lissoceras* sp.
- 18) *Haploceras slamisum* de GREG. (pl. 1, ff. 30 a-b): like the specimens subsequently described by PARONA under this name, it is probably based on nuclei of *Calliphylloceras disputabile* (ZITT.).

As to the age of the assemblage described by de GREGORIO, it may be Subfurcatum zone, either Banksi or Polygyralis subzone, since it is close in composition to both those from Ponte sul Ghelpach (Pisa Mus. n. 2) and Cima Tre Pezzi, on one hand, and that from Longara di sotto n. 1. on the other.

OTHER OUTCROPS OF THE P. ALPINA BEDS, OUTSIDE THE SETTE COMUNI AREA

A C Q U E F R E D D E

This celebrated fossil locality lies on the Eastern coast of the Garda lake, between Cape San Vigilio and Torri. The stratigraphical succession here (C. STURANI 1964a, pp. 11-13, f. 2) is as follows: the topmost beds of the Cape San Vigilio oolite have yielded *Tmetoceras scissum* (BENECKE) and *Erycites fallifax* ARK. of the Scissum zone. Representatives of the Murchisonae and Concavum zones are missing. A white, spar cemented coquina follows unconformably; it is packed with *Bositra buchi* but apparently devoid of other fossils. A few hundred metres to the South, near Cascina Brancolino, the spar cemented coquina disappears, its place being taken by pink micritic limestones that contain ammonites of the Sowerbyi zone (*Docidoceras*, *Trilobitoceras*, *Eudmetoceras*) (« Campotorondo limestones »).

Upward, the coquina grades into similar, pink to red coloured biomicritic limestones from which a fine assemblage of large-sized Ammonites of the Sauzei-Humphriesianum zones has been collected (Phylloceratids, *Lytoceras subfrancisci* STURANI, *Bradfordia* sp., *Emileia polyschides* (WAAG.), *Frogdenites* sp., *Labyrinthoceras* sp., *Otoites* sp., *Skirroceras* spp., *Stephanoceras* spp., *Stemmatoceras* spp.).

On top of these red, fossiliferous limestones, an erosion surface covered with black manganese nodules may be observed. The upper member of the « Ammonitico rosso veronese », yielding Upper Oxfordian ammonites and belemnites near its base, follows unconformably.

In 1885 E. NICOLIS discovered at this same locality some small patches of a white, chalky rock crowded with tiny gastropods and ammonites, that « filled cavities within a bed of hard, pink to red coloured limestone, containing only a few ammonites » (C. F. PARONA 1894, p. 365). Although subsequent works to widen the road seem to have destroyed what remained of this peculiar, fossiliferous rock, there is however little doubt that it only occurred infilling cavities within the Lower Bajocian micritic limestones of the Sauzei-Humphriesianum zones.

The fauna, which is deposited partly at the Natural History Museum of Verona and partly at the Istituto di Geologia in Padua, was monographed by PARONA in 1894 and thought by him to be of Callovian age. In fact it clearly belongs to the Subfurcatum zone of the Upper Bajocian, as one may easily ascertain from the revised list of the ammonites:

PARONA 1894

THIS WORK

<i>Phylloceras subobtusum</i> KUD. (pl. 1, f. 1)	<i>Partschiceras abichi</i> (UHLIG)
<i>Phylloceras mediterraneum</i> NEUM.	}
<i>Phylloceras subpartitum</i> PAR. (pl. 1, f. 2)	
<i>Phylloceras Julii</i> n. sp. (pl. 1, ff. 7-9)	
<i>Phylloceras slamisum</i> de GREG. (pl. 1, ff. 3-6)	<i>Calliphyloceras disputabile</i> (ZITT.)
<i>Lytoceras nicolisi</i> n. sp. (pl. 1, ff. 10-13)	<i>Nannolytoceras nicolisi</i> (PAR.)
<i>L. nicolisi</i> var. <i>pluriannulata</i> (pl. 1, f. 14)	<i>Nannolytoceras pluriannulatum</i> (PAR.)
<i>Sphaeroceras brongniarti</i> Sow.	<i>Sphaeroceras auritum</i> PAR.
<i>Peltoceras</i> cf. <i>pottingeri</i> Sow.	? <i>Caumontisphinctes</i> sp. ind. juv.
<i>Crioceras annulatum</i> DESH.	<i>Spiroceras</i> sp. ind.

Unfigured syntypes of *Lytoceras nicolisi*, in the palaeontological collections at Padua, also include some specimens of *Nannolytoceras polyhelictum* (BÖCKH).

The fossils from Acque Fredde are usually preserved with their test and are in a white, chalky, friable micritic matrix. The ammonites, among which Phylloceratids and *Nannolytoceras* alone are represented by numerous specimens, usually retain the complete body chamber and are all small sized, immature specimens (but for *S. auritum* and *N. pluriannulatum*). The rest of the fauna is dominated by extremely small sized gastropods (over 30 species, none of which exceeds a height of 18 mm, even though most specimens possess the adult, flared peristome), with a few additional bivalves (including *Bositra buchi*, represented only by a few specimens), small sharks teeth, spines of regular echinoids (*Cidaris*) and an Astacoid crustacean (*Eryma*). Brachiopods and crinoids are completely absent.

In the present case the small size of the fossils is certainly a primary character, since no sorting by waves or currents can be postulated because of the presence of a micritic matrix. Any evidence of subaerial exposure, as well, is missing altogether. This, with the great abundance of gastropods, all belonging to genera of browsing habits, is strong evidence that the fauna under discussion thrived among algal meadows on a rocky, almost sediment free bottom and was fossilized almost untransported. Crevices opening downwards were probably the only sheltered places where the dead shells, as well as the fine grained sediments could accumulate and be protected against further removal: while skin-diving along the Hyblean coast of Sicily I have seen how frequently a similar environmental setting occurs on shallow, calcareous shoals.

ROVERETO

Near Rovereto, in the Adige Valley (C. STURANI 1964a, pp. 16-19, fig. 3), the *P. alpina* beds are represented by a pink, purely crinoidal limestone, very well sorted and winnowed, with little or no cement, in the form of a bed up to half a metre in thickness. It rests unconformably upon pink to orange coloured oosparitic limestones, yielding *Stolmorhynchia bilobata* (BEN.), crinoids, regular echinoids and *Planammatoceras planinsigne* (VACEK), which are indicative of the Aalenian. On

top, it is unconformably overlain by the brick-red, crinoid rich biomicrites of the « Rosso ammonitico veronese » formation, which contain a few brachiopods and ammonites probably indicative of the Upper Bathonian (*Cadomites* sp., *Tubithyris* cf. *globata*, etc.).

In places the crinoidal limestone is cross bedded and contains thin lenticular accumulations of *Bositra buchi*, brachiopods, belemnites and ammonites, which have remained void except for a thin lining of spar crystals. One of these coquina patches has yielded *Poecilomorphus cycloides* (d'ORB.) (with several morphotypes), *Toxalambites densicostatus* n. sp., *Sphaeroceras brongniarti* (SOW.), *Chondroceras* sp. and *Stemmatoceras frechi* RENZ, which are indicative of the Humphriesianum zone, Cycloides subzone (= Frechi sbz. of others). A large specimen of *Teloceras banksi* (SOW.), indicative either of the Blagdeni or of the Banksi subzones, has also been found not *in situ* (C. STURANI 1964a, pl. 5, f. 5). The presence of these large-sized macroconch Stephanoceratids represents a difference worth noting, by comparison with the coquina facies of the Sette Comuni. Another distinguishing feature is the absence of any evidence of subaerial exposure. On the other hand, the very well sorted and winnowed character of these crinoidal limestones, as well as the cross bedding, are consistent with a high-energy, wave- or current-swept environment. They were probably deposited in the form of mobile bars supplied by crinoid forests nearby. In this connection, it is important to note that both stalked crinoids and brachiopods are poor bathymetric indexes, *per se*, since it is very unlikely that also in the Jurassic they were confined to rather deep waters, as they are today.

MONTE GIOVO BY BRENTONICO

This section was first described by A. OPPEL in his classic paper « *Ueber das Vorkommen von jurassischen Posidonomyen-Gesteinen in den Alpen* » (1863, pp. 193-195) and can be measured along the old carriageway between Besagno and Brentonico (see figs. 26, 27) where this climbs over the Monte Giovo cliffs near their Southern end.

The relationships between the *P. alpina* beds and the underlying older formations are concealed, along the road, by the presence of a peculiar breccia that probably fills a large Neptunian dyke: it is made of angular, poorly sorted clasts of « Biancone » (*i.e.* of Lower Cretaceous pelagic biomicrite, with *Calpionellites darderi* and other Tintinnids) bound by sparry calcite.

Upward, the *Posidonia alpina* beds are unconformably overlain by buff coloured, apparently sterile micritic limestones, up to 7 metres thick, that are quarried on the Western slopes of Monte Giovo; these, in turn, are unconformably overlain by the stratigraphically condensed (Bimammatum - Beckeri zones) red, nodular limestones which have been the object of a detailed sedimentological analysis by R. HOLLMANN (1964). The pink to white coloured, *Pygope*-rich nodular limestones of the Tithonian complete the sequence higher up.

The *P. alpina* beds attain here a thickness of over 10 metres (lower contact not seen). Both vertically and laterally, almost pure, micrite-free coquinas alternate with crinoidal biomicrites. Some of the coquina beds, up to 2 metres thick, consist almost entirely of spar cemented *Bositra* shells, lying convex side up parallel to the bedding planes: OPPEL wrote, on this subject: « *Ich habe nie eine gleich bedeutende Entwicklung von Posidonomyen, Monotis- oder ähnlichen Muschel-Gesteinen gesehen* ».

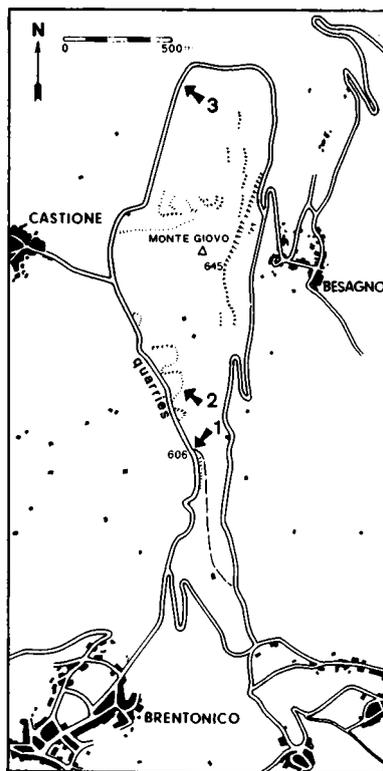


FIG. 26

Index map showing location of the more interesting sections at Monte Giovo near Brentonico. 1: Fossil locality, with ammonites of Lower Bathonian age, at the top of the *P. alpina* beds. 2: Section in the upper part of the « Ammonitico rosso veronese » described by R. HOLLMANN (1964). 3: At this place the *P. alpina* beds are missing and the « Ammonitico rosso veronese » rests directly upon the « Cape San Vigilio oolite ».

Other beds, however, consist mainly of comminuted shells. Unlike those of the Sette Comuni, the ammonites are here as a rule fragmentary; fragments of large-sized specimens, especially of *Phylloceratids*, are on the other hand fairly common.

This suggests that the shells remained for a rather long time in a wave pounded environment, such as one may find on the shoreface of a beach ridge or on shallow, partially emergent bars. Whether lithification of the coquina took place soon after each bed was deposited, through the action of percolating freshwater gathered on the emergent crests of the bars, or followed later, is open to discussion.

Evidence of emergence and subaerial erosion does exist, however, at the very top of the formation: the contact with the overlying buff-coloured limestones is an irregular surface, jagged with sharp, fluted pinnacles, up to 20 cm high, carved

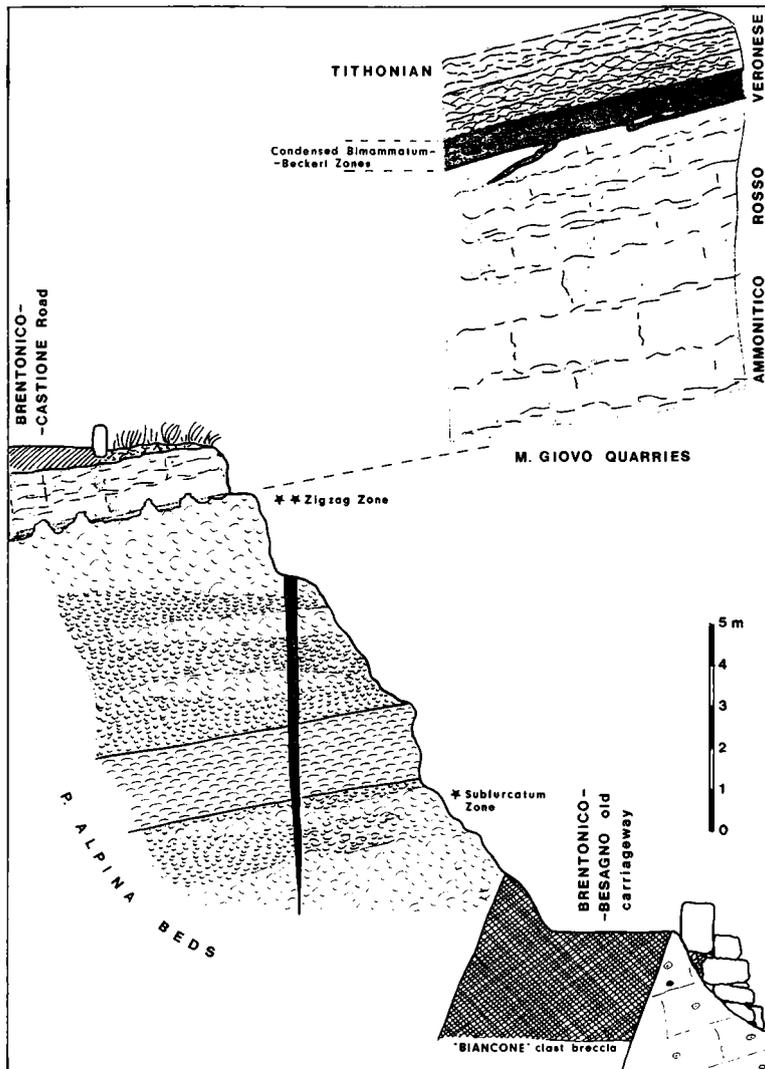


FIG. 27

The sections in the *P. alpina* beds and in the « Ammonitico rosso veronese » at Monte Giovo near Brentonico. Shaded patches within the *P. alpina* beds correspond to the presence of a primary micritic matrix, whilst sparry cement, in the coquina facies, has been left blank.

into the spar cemented coquina. Such a morphology is fairly characteristic of recent low benches in the spray zone, along limestone shores, under warm climates.

As to the age of the *P. alpina* beds of Monte Giovo, the new collections brought some rather unexpected results; the Ammonites collected within the topmost beds of the coquina (*Partschiceras subobtusum* (KUD.), *Calliphylloceras disputabile* (ZITT.), *Holcophylloceras mediterraneum* (NEUM.), *Ptychophylloceras hommairei* (d'ORB.), *Nannolytoceras tripartitum* (RASP.), *Lissoceras psilodiscus* (SCHL.), *Oecotraustes bomfordi* ARKELL, *Cadomites rectelobatus* (HAUER), *C. cf. deslongchampsii* (DEFR.), *Morphoceras multiforme* ARKELL, *Asphinctites pingue* (DE GROSS.) and *Polysphinctites polysphinctus* S. BUCKM.) are indicative of the Lower Bathonian, Zigzag zone, topmost part of the Macrescens subzone (C. STURANI 1967; also S. ELMI, C. MANGOLD *et alii* 1969, p. 7) ⁽¹⁾.

⁽¹⁾ These will be described and figured separately, along with the Bathonian ammonites from the « Ammonitico rosso veronese », in another paper.

A second assemblage, collected some 8 metres below, yields among others *Sphaeroceras* (*Chondroceras*) *canovense* (de GREG.) of the Subfurcatum zone.

Thus, the *Posidonia alpina* beds at Monte Giovo embrace the whole Upper Bajocian and nearly the whole Lower Bathonian. In their upper part they are therefore synchronous and heteropic with the lowermost beds of the « Rosso ammonitico veronese » of the Lessini mountains and of other localities (it should however be noted that no ammonites of unquestionably Lower Bathonian age have ever been reported to date from the Ammonitico rosso veronese, even though it has often yielded profuse assemblages of the Parkinsoni zone just above its base; this may be due to a non-sequence).

In this case too, subsidence rates were extremely small (about 2 m / million years), which means that the depth remained nearly unchanged here for more than 4 million years!

One may note in addition that the coquina facies disappears one kilometre North of the measured section: at the opposite end of M. Giovo cliffs, along the Castione-Besagno road, red, nodular limestones of the Ammonitico Rosso Veronese formation are seen to rest directly upon the Cape San Vigilio oolite.

L O P P I O

A few kilometres North of Monte Giovo the *Posidonia alpina* beds have been recently described by A. CASTELLARIN (1966) near Loppio. They are represented here by a red biomicrite, packed with *Bositra buchi* and Crinoid ossicles, up to 1 metre thick, lying between the Cape San Vigilio oolite and the Ammonitico rosso veronese. The same biomicrites also fill a complex network of Neptunian dykes within the underlying Cape San Vigilio oolite. As convincingly shown by CASTELLARIN, the filling of the dykes was in this case instantaneous, in the sense that the still unconsolidated calcareous ooze lining the rocky bottom were suddenly sucked by vacuum into the fissures as they opened, because of mild tectonic activity.

As shown by the presence of abundant micrite and the lack of a rich, diverse biota the environment of deposition was certainly deeper than at Rovereto or Monte Giovo, well below wave base.

M O N T E P E L L E R

This locality, which lies along the Northwestern border of the Trento ridge, is noteworthy because conditions favourable to the deposition of the coquina facies occurred earlier here than elsewhere on the Trento ridge (C. STURANI 1967, p. 447).

The Toarcian is represented here by oolitic limestones with abundant crinoids and brachiopods (« *Rhynchonella* » *clesiana* LEPS., « *R.* » *vigilii* LEPS.); they are

locally (Val Formiga) overlain by a richly fossiliferous bed which contains a stratigraphically mixed assemblage of topmost Toarcian - ? basal Aalenian age (*Dumortieria* spp., *Catulloceras dumortieri* (THIOLL.), *Pleydellia* spp., *Polyplectus discoides* (ZIET.), *Hammatoceras* spp.) (V. VIALLI 1937, 1938).

A few kilometres to the West of the Val Formiga fossil locality (Passo della Nana, head of Val Cavai) H. FINKELSTEIN (1899) and, more recently, Dr. A. FERRARI (personal communication) found lenticular patches of a coquina facies, packed with brachiopods, tiny ammonites, crinoid ossicles and only a few specimens of *Bositra buchi*, which is lithologically identical to that of the Sette Comuni: the fossils are bound and filled by drusy, radiaxial spar; their test has been leached away and a dark-red hematitic film has formed in the resulting void. Even though the exact geometric relations between the coquina facies and the underlying beds are unknown to me, the state of preservation alone is, in my opinion, good evidence that these shells were fossilized in the same way as those of the Sette Comuni. The few Ammonites I have been able to identify, along with those mentioned by FINKELSTEIN, are however indicative of the Scissum zone of the Aalenian (*Tmetoceras scissum* (BEN.), *Erycites fallifax* ARK., etc.).

Poorly cemented crinoidal limestones, locally with abundant brachiopods and up to 20 metres in thickness, follow higher up and are believed by V. VIALLI to represent the Bajocian. They are in turn overlain by the red, nodular pelagic facies of the « Ammonitico rosso veronese ».

M I Z Z O L E Q U A R R Y

This large quarry, a few kilometres North East of Verona, provides a splendid section of the whole « Ammonitico rosso veronese », which lies here with a slight disconformity upon the « Noriglio grey limestones » and is well dated just above its base by a rich assemblage of the Parkinsoni zone, Densicosta subzone: *Pseudophylloceras kudernatschi* (HAUER), *P. kunthi* NEUM., *Calliphylloceras disputabile* (ZITT.), *Holcophylloceras mediterraneum* (NEUM.), *Ptychophylloceras* n. sp. ind., *Lytoceras adela* (d'ORB.), *L. eudesianum* (d'ORB.), *Nannolytoceras* cf. *polyhelictum* (BÖCKH.), *N. tripartitum* (RASP.), *Lissoceras monachum* (GEMM.), *L. psilodiscus* (SCHL.) ssp. *inflatum* WETZEL, *Strigoceras truellei* (d'ORB.), *S. dorsocavatum* (QUENST.), *Oppelia subcostata* (J. BUCKM.), *O. plicatella* GEMM., *Cadomites psilacanthus* (WERMBTER), *C. rectelobatus* (HAUER), *C. daubenyi* (GEMM.), *C. deslongchampsii* (DEFR.), *Parkinsonia parkinsoni* (SOW.), *P. densicosta* (QUENST.), *Dimorphinites dimorphus* (d'ORB.), *Leptosphinctes* (*Leptosphinctes*) *martinsi* (d'ORB.) (a macroconch species; cf. STURANI 1964b, pp. 31-33, text-ff. 25-28; pl. 4, f. 6), *Leptosphinctes* (*Leptosphinctes*) spp. plur., *Procerites costulatus* (S. BUCKM.), *P. (Lobosphinctes) intersertus* (S. BUCKM.), *Pleurotomaria* (s. l.) sp., *Discohelix* sp., *Ceromya* sp., *Cuspidaria* sp., ? *Collyrites* sp..

A peculiar breccia, up to half a metre in thickness, is locally present between the « Noriglio grey limestones » and the « Ammonitico rosso veronese », just below the stromatolitic layer at the base of the latter formation. The clasts, very angular, are in part derived from the underlying Grey limestones and in part from a broken stromatolitic (?) crust; the matrix is given by a brick red crinoidal calcarenite, packed with limonitic nodules and sharks teeth (*Orthacodus*, *Asteracanthus*).

In other parts of the quarry the topmost 0.50 - 1 m of the Grey limestones is intersected by small, sharp edged dykes filled with red biomicrites; these contain *Bositra buchi*, tiny brachiopods, crinoid ossicles and a few indeterminable ammonites. This setting is more reminiscent of that described at Loppio by CASTELLARIN, than of the karstic fissures occurring in the Sette Comuni.

M O N T E A G A R O

A development of the *Posidonia alpina* beds similar both in facies and in thickness to that seen at Monte Giovo near Brentonico, occurs on the Southern slopes of Monte Agaro (Valsugana) and may be easily studied along the road from Castel Tesino to Passo Brocon, in the vicinity of the Albergo Monte Agaro.

This fossil locality has been well known for a long time, thanks to the works of BÖSE & FINKELSTEIN (1892), S. VENZO (1946), BOURROUILH & RASPLUS (1963) and others.

The coquina (biosparite) facies extends here from the lowermost Aalenian to the Lower Bathonian, both inclusive, and reaches a total thickness of about 60 metres. *Bositra buchi* is present throughout, but becomes the main component of the coquina only in the topmost 15-20 metres. According to BÖSE & FINKELSTEIN (1892), *Morphoceras*, *Sphaeroceras*, *Poecilomorphus* (mentioned as *Harpoceras minutum* PARONA, for which see p. 102), *Cadomites* and other ammonite genera have been found at this level; even though the specific identifications, as published by these authors, may not be entirely reliable, the generic ones constitute enough evidence that the Lower Bathonian, as well as a good part of the Bajocian down to the Humphriesianum zone, are represented here.

The remaining part of the formation was once known as « *Lioceras opalinum* beds », but covers the whole Aalenian and perhaps part of the Lower Bajocian, as shown by the presence of *Haplopleuroceras* cf. *subspinatum* BUCKM. in its upper part (BOURROUILH & RASPLUS 1963). The lithology is given by white coloured, coarse, clean-washed crinoidal calcarenites, in massive beds up to several metres thick, displaying large scale cross-lamination. Lenticular shell bed concentrates of spar lined brachiopods, ammonites and occasional *Bositra* occur at various levels. Scattered oolites are also present, but only towards the base. Below this, cream coloured oolitic limestones of Toarcian age complete the section.

PALEOGEOGRAPHIC SIGNIFICANCE OF THE POSIDONIA ALPINA BEDS IN THE EVOLUTION OF THE TRENTO RIDGE

At the time when the *P. alpina* beds were forming, we may imagine the Trento ridge as a wide, shallow and stable platform surrounded by open seas on all sides. Subsidence had come to an abrupt stop on the outer belt after the end of the Aalenian, whilst the central part of the ridge had already emerged. A bordering reef complex as well as isolated patch reefs no longer existed, so that these shallow banks were no longer sheltered from wave action, neither the low, flat islands from storm-floods.

The close relationship between the rate of subsidence, the hydrodynamic conditions and the rate and nature of sedimentation has already been mentioned (see p. 14), as well as the fact that, in the absence of subsidence, sedimentation is extremely reduced or even interrupted on those parts of the shelf that are subject to strong agitation of the water.

The sedimentary features of the *P. alpina* beds at the various localities described above show that this is exactly what must have happened in the case under discussion.

These shallow banks, as we have seen, were locally covered with algal meadows and crinoid forests; the former sheltered pseudostunted assemblages, with young as well as small-sized adult ammonites, brachiopods, gastropods, etc. Schools of pelagic *Bositra* swam around while burrowing bottom dwellers were practically absent, owing to the hard nature of the substrate.

The fine grained sediments were winnowed away towards the deeper parts of the platform, below wave base, where they settled as a thin blanket of calcareous ooze, packed with the empty shells of *Bositra* (Loppio) or those of large macroconch ammonites (Campotorondo limestones). Fissures opening here into the bedrock after earthquakes were simultaneously filled by such sediments.

The coarser detritus (mainly shells) forming on the shallower parts of the platform could locally accumulate as mobile bars (Rovereto) and partially emergent (?) banks (Brentonico, Monte Agaro). From time to time, particularly severe storms or hurricanes stirred up the bottom sediments (patches of shell gravel, as well as calcareous oozes from the deeper parts of the platform, usually unaffected by normal waves) and cast them ashore along with myriads of living shells. The flood redistributed them over the flat, rocky islands, where they provided a matrix for the breccia formed at the expense of the superficial rubble, as well as the filling of the karstic fissures (Sette Comuni).

Finally, a few dead shells and small amounts of finer grained sediments were trapped within the gaping crevices that opened into the shallow rocky shoals covered with algal meadows (Acque Fredde. Subfurcatum zone). But for the latter example

and the mobile bars of crinoidal sand or of shell gravel, the substrate was therefore kept practically free of sediments at a shallow depth because of wave action.

It is amazing to think that, had some islands not existed, little or no record of such an incredibly rich biota would probably have been preserved: we would just have noticed the existence of a stratigraphic gap between the « Ammonitico rosso veronese » and the underlying carbonate shelf formations, as it actually happens on the major part of the Trento ridge, where the *Posidonia alpina* beds are missing.

The seemingly paradoxical occurrence of the richest and best preserved faunas as the infilling of fissures, both subaerial (Sette Comuni) and subaqueous (Acque Fredde), is thus easily explained: these were in fact the only places where the shells could escape further removal or destruction; in both cases thanks to the « roofing » effect of the older consolidated rocks in which the fissure was cut (J. WENDT 1965, p. 303); in the first, also thanks to early diagenesis by rapid cementation.

The absence of coral reefs as well as of oolitic sediments under such conditions (shallow depth, clean agitated water, etc.) may be at first sight surprising. The complete lack of subsidence seems to have been the primary cause of it, even though other factors such as a cooling of the climate may also have played a role (A. FARINACCI 1967, pp. 450-451; also F. FABRICIUS & *al.* 1970, p. 823).

As to the lack of subsidence, the role of this has already been pointed out by M. DREYFUS (1954, p. 49): the Upper Jurassic coral reefs he studied could grow only in those areas where the subsidence rates were of at least 30 metres per ammonite zone (*i. e.* 30 m / million years), while none occurred on the stable swells, usually marked by sedimentary gaps.

While the lack of subsidence is easy to prove in the case under discussion, paleotemperature data for the Tethyan Middle Jurassic are still insufficiently known for the likelihood of the alternative interpretation to be taken into reasonable account. Both hypothesis, however, are not mutually exclusive.

We may thus conclude that the *Posidonia alpina* beds correspond to a peculiar, well defined phase in the paleogeographic evolution of the Trento ridge: it took place during the change-over from massive production of Bahamian sediments on a carbonate shelf, to condensed, pelagic sedimentation on a submarine swell, while the depth was still very shallow and the subsidence had come to an abrupt halt.

RECENT AND PAST EQUIVALENTS OF THE P. ALPINA BEDS (COQUINA FACIES)

While it is relatively easy to find recent models (e.g. the Bahamas) for the Tethyan carbonate shelves during phases of regular subsidence and rapid sedimentation, it is apparently more difficult to find an equivalent for these same platforms during phases of no subsidence at a shallow depth.

This, however, applies to a large shelf taken as a whole, not to its different physiographic elements taken separately: shallow bars and coquina littoral dunes made entirely of shells; low islands periodically flooded by storm- or hurricane-induced tides; sediment-free rocky bottoms covered with algal meadows, etc., are all common features (see for instance B. D'ARGENIO 1966, pp. 449-501).

As to the past equivalents, a rapid survey of the Tethyan Jurassic (C. STURANI 1967) has shown that such coquina facies, containing small sized Ammonites, had a scattered, though rather widespread occurrence, especially in the Middle Jurassic (Aalenian, Bajocian), but also earlier and later. One need only mention those of Western Sicily described by J. WENDT (1964, 1965) and H. C. JENKINS & H. S. TORRENS (1969), which are often found as the infilling of Neptunian dykes and sills (Rocca Busambra); those of Northeastern Sicily, discovered by DI STEFANO and SEGUENZA at Capo Sant'Andrea near Taormina and redescribed by the present writer (C. STURANI 1967, p. 457, 460), of topmost Toarcian and late Bajocian (Subfurcatum zone) age; those occurring on the Liassic horsts scattered along the Umbro-marchigiana trough, which are locally associated with sheet-cracked sediments (A. FARINACCI 1967); those of Lower to early Middle Liassic age of Western Tuscany, that lie between the « Calcare massiccio » and the « Rosso ammonitico toscano » and contain *Pimelites* and *Diaphorites* (cf. pag. 46); those of the Austrian Alps (Vils, Klausalpe), described by OPPEL (1863) and ROTHPLETZ (1886), which are of about the same age as those on the Trento ridge; and finally those of the Babierzowka Klippe, in the Pienid zone of the Northern Carpathians (V. UHLIG 1878, 1881). The faunal assemblage from the latter locality is so strikingly similar in « biofacies » to those of the Sette Comuni, that PARONA thought them to be strictly synchronous: in fact it is younger, certainly of Callovian age, as shown by the presence of *Bomburites* and *Grossouvria* among the Ammonites.

In all instances mentioned above the coquina facies appears to be confined to intrageosynclinal ridges, and is usually overlain by « ammonitico rosso calcareo » facies, to which it may also grade laterally. The underlying formations may either be represented by carbonate shelf facies, or by thin, condensed deposits of the « Hirlatz » and/or « Adneth » types, as at Rocche Rosse in the Peloritani mountains of Northeastern Sicily (STURANI 1967).

In both cases, the presence of such coquinas, be they associated with evidence of emersion or not, testify to the former existence of open sea platforms, with no subsidence over long periods, at a very shallow depth. Such platforms may either have corresponded to persistent swells, or to carbonate shelves where the subsidence had come to an abrupt stop.

SYSTEMATIC DESCRIPTIONS

REPOSITORY OF TYPES

Specimens collected by the present writer, which have been selected as types and figured are deposited in the paleontological collections at the Istituto di Geologia of the University of Turin. Holotypes and lectotypes of the species described by PARONA are deposited in the following Institutions: Istituto di Geologia, University of Turin; Istituto di Geologia, University of Padua; Istituto di Geologia, University of Pisa; Istituto di Paleontologia, University of Pavia; Museo Civico di Storia Naturale of Verona, as specified in each case.

MEASUREMENTS

With regard to the dimensions, the usual measurements are given (cf. H. TINTANT 1963; f. 2): diameter in mm (D); whorl height (H), whorl width (between two opposite ribs, in the case of ornamented species) (L), and umbilical width (O). The latter three measurements are given as percentages of the diameters at which they were taken. All measurements have been usually made on the internal mould because the test was seldom preserved. Rib frequency (R) refers to the number of primaries per whorl, unless otherwise stated.

The measurements of specimens smaller than 25 mm in diameter have been taken from enlarged camera lucida drawings.

SUTURE LINES

Only in a very few cases has it been possible to draw the suture lines by means of a camera lucida, because they were seldom visible owing to the particular state of preservation (internal moulds of sparry calcite) and to the very small size of most specimens studied.

STATISTICAL METHODS

Statistical methods have been used only in the study of the extremely profuse and highly variable population of *Poecilomorphus cycloides* (d'ORB.) from fossil locality Troch n. 1. They will be discussed briefly in the systematic description of this species (see p. 102).

AMMONITE DIMORPHISM AND TAXONOMY

This subject has recently been dealt with at length by several authors who suggest different solutions (see the articles by CALLOMON, ELMI, PALFRAMAN, WESTERMANN, ZEISS and BLACKWELDER published in the volume on « Sexual dimorphism in fossil Metazoa and taxonomic implications », edited by G. E. G. WESTERMANN (1969)). CALLOMON's views are shared by the present writer as the more practical and the more realistic for the time being.

The pairing of ammonite dimorphs, both at specific and at generic (subgeneric) level, as far as morphological similarity is concerned, is a rather subjective matter (STURANI 1967, p. 19); needless to say, it will never become objective, since ammonites are an extinct group.

I agree that in a few cases (e.g. Sphaeroceratids) the morphological differences between dimorphs are small and their pairing is sufficiently evident to allow the use of a biospecific nomenclature. But far more frequently the evidence for such pairing is by no means clear: if one was to apply the rules of zoological nomenclature rigidly in these cases too, and give the same specific name to any pair of would-be ammonite dimorphs, such hasty marriages could be soon followed by divorce and different remarriages when reinvestigated by other paleontologists. An endless and more complete taxonomic confusion would result.

At any rate, and for the sake of clarity, separate descriptions (perhaps also separate lists of synonyms) would still be necessary for the micro- and the macroconch representatives of each biospecies, even if they were to be given a single name: no economy, except in the number of one class of names, would thus be achieved.

The problem is particularly delicate, however, when the previously unknown microconch dimorph of an existing macroconch species or genus is discovered (and vice versa), as happens here with several taxa from the *Posidonia alpina* beds of the Sette Comuni. Is one to introduce new names for such « monosexual » parataxa or shall one follow neontological practice? In other words, should one adopt, in the same paper, a dual system, treating certain dimorphs with the same specific name, if one or both had not yet been described, and distinguishing others at subgeneric level, if they belong to previously described taxa? Should one be consistent at any price? Or should one follow the first alternative if their differences are small and the second if their differences are stronger?

I see no inconveniences or harm in the use of a nomenclature based on « monosexual » morphospecies: it by no means prevents the achievement of a natural classification, in which the higher taxonomic categories are defined on phylogenetic rather than on merely morphological grounds. At least, it has no more inconveniences than the excessive proliferation of « new » species by splitters or the rash pruning of previously existing names by lumpers: after all, it is not the use of an allegedly biospecific classification or that of a classification based on morphospecies that makes good or bad palaeontology, but the palaeontologists themselves.

For these reasons I shall adopt in all cases (with the only exception of Sphaeroceratids) the subgeneric category as the more « suitable nominal taxon for incorporating the morphological manifestations of dimorphism into a morphological classification » (J. H. CALLOMON 1969, p. 116). In each case I shall indicate which microconch morphospecies seems to be best paired with each macroconch one, and vice versa, leaving others to judge for themselves whether it is a happy coupling or not.

SUBORDER LYTOCERATINA HYATT, 1889
SUPERFAMILY LYTOCERATACEAE NEUM., 1875

FAMILY LYTOCERATYDAE NEUM., 1875

GENUS LYTOCERAS SUESS, 1865

Lytoceras adela (d'ORBIGNY)

(Pl. 3, figs. 1, 2)

1894 *Lytoceras adeloides* ? - PARONA 1894; p. 15.

1896 *Lytoceras adeloides* (non KUD.) - PARONA 1896; p. 10.

1964 *Lytoceras adela* (d'ORB.) - PUGIN 1964; pp. 13-20; pl. 1, f. 2; text-f. 3 (*cum syn.*).

Five specimens from Monte Meletta (Subfurcatum zone, probably Schroederi subzone), which had been erroneously identified as *L. adeloides* by PARONA, as well as 13 others from Troch n. 1 fossil locality (Humphriesianum zone, Cycloides subzone) and one more from Longara di sotto n. 1 fossil locality (Subfurcatum zone, Polygyralis sbz.), clearly belong to d'ORBIGNY's species and show the following features.

Coiling evolute, with barely tangent whorls which enlarge rapidly. Whorl section high oval, exceptionally isodiametric and circular in outline. Beyond a diameter of 10-15 mm weak radial constrictions appear (usually five to a whorl), accompanied by a thin, raised, simple collar. Between such collars the test is covered with dense, fine, simple lyrae.

The specimen figured on pl. 3, fig. 1 measures: D 19 mm; H, 0.38; L, 0.342; O, 0.38. Other fragmentary specimens would have attained, if complete, an estimated diameter of about 30 mm.

L. adela is known to range from the Upper Bajocian to the top of the Callovian. Its occurrence at Troch n. 1 fossil locality shows that it is already present in the Humphriesianum zone.

For further details of this species, see PUGIN.

Lytoceras eudesianum (d'ORBIGNY)

1964 *Lytoceras eudesianum* (d'ORB.) - PUGIN 1964; pp. 28-33; pl. 2, f. 1; t. f. 5 (*cum syn.*).

Material. A single small fragment of a large specimen, which could have reached a diameter of 100 mm when complete, was found at the Longara di sotto

n. 1 fossil locality (Subfurecatum zone, Polygyralis subzone). Notwithstanding its small size, this fragment can be identified beyond doubt with d'ORBIGNY's species, since it bears the highly characteristic flared collars (cf. PUGIN 1964, p. 30).

The vertical range, according to the Swiss author, is Lower Bajocian. Humphriesianum zone - Lower Bathonian.

FAMILY NANNOLYTOCERATIDAE SPATH, 1927

GENUS NANNOLYTOCERAS BUCKMAN, 1905

Nannolytoceras pygmaeum (d'ORBIGNY)

(Pl. 3, fig. 3, 6)

1880 *Lytoceras* cf. *quadrisulcatum* d'ORB. - PARONA 1880; p. 261.

1964 *Nannolytoceras pygmaeum* (d'ORB.) - PUGIN 1964; pp. 46-48 (cum syn.).

Material. There are 19 specimens from the Humphriesianum zone, Cycloides subzone of Troch n. 1 fossil locality and a few more from Camporovere (same horizon), which fit perfectly the exhaustive description of *N. pygmaeum* given by PUGIN (1964).

In this small population from the Sette Comuni the number of constrictions (which are barely visible when the test is preserved) varies from 3 to 5 to a whorl. The largest specimen (a fragment of body chamber) might have reached a diameter of about 30 mm, when complete. None of these specimens shows the adult peristome, however.

The type level is also Humphriesianum zone; according to PUGIN, *N. pygmaeum* ranges also higher up, into the Zigzag zone of the Lower Bathonian.

N. subovale BUCKM., also from the Humphriesianum zone, is only doubtfully distinct from *N. pygmaeum*, the main differences consisting only in its slightly stouter whorls, with more gently rounded umbilical slopes. When more specimens from the type area will become available for a revision, I should not be surprised if *N. subovale* turned out to be a simple morphotype and therefore a junior synonym of *N. pygmaeum*.

The measurements of some specimens from Troch n. 1 fossil locality are as follows: Pl. 3, fig. 3 (test preserved) - D 19.5 mm; H, 0.282; L, 0.256; O, 0.512. Pl. 3, fig. 6 (int. mould) - D 17.1 mm; H, 0.263; L, 0.207; O, 0.555. D 18.6 mm (int. mould); H, 0.242; L, 0.20; O, 0.548. D 15 mm (test preserved); H, 0.266; L, 0.233; O, 0.533. D 18.7 mm (int. mould); H, 0.246; L, 0.219; O, 0.561. D 13 mm (int. mould); H, 0.277; L, 0.242; O, 0.511.

Nannolytoceras nicolisi (PARONA)

(Pl. 16, fig. 8)

1894 *Lytoceras nicolisi* PARONA 1894; p. 16; pl. 1, ff. 10-13 (non f. 14).

non 1896 *Lytoceras nicolisi* (non PAR., 1894) - PARONA 1896; p. 10 (= *N. (Eurystomiceras) polyhelictum*).

? 1958 *Nannolytoceras stenosulcatum* - BESNOSOV 1958; pp. 106-107; pl. 34 ff. 8 a-b; text-f. 42.

Syntypes. Most of the syntypes, from the Subfurcatum zone of Acque Fredde on the Garda Lake, are in the palaeontological collections of the Geological Institute at Padua, but for that figured by PARONA (1894) on pl. 1, f. 10, which is in the Natural History Museum of Verona and which is here designated lectotype (this work, Pl. 16, fig. 8).

It is perfectly preserved, with the test, and measures: D 17.4 mm; H, 0.29; L, 0.256; O, 0.51.

Other specimens. A single, immature specimen from Ponte sul Ghelpach n. 3 assemblage (Subfurcatum zone; Pisa Museum).

Description. The whorl section is high oval in shape, with short, rounded umbilical slopes, gently convex flanks and a broadly rounded venter. Each whorl bears five constrictions, which are gently convex adorally and slightly proverse on the flanks, and almost imperceptibly concave forward on the venter. Each constriction is followed by a well marked, blunt ridge.

Even though the relative measurements are about the same, *N. nicolisi* may be easily distinguished from *N. pygmaeum* because of the blunt ridges after each constriction, which are completely missing in d'ORBIGNY's species. *N. (Eurystomiceras) polyhelictum* has a more isodiametric whorl section, deeper constrictions (also on specimens with the test preserved) and sharper, though lower ridges.

N. stenosulcatum BESNOSOV is probably a junior subjective synonym of *N. nicolisi*.

It should also be noted that several unfigured syntypes from Acque Fredde, as well as all the specimens from Monte Meletta that PARONA subsequently (1896) assigned to *N. nicolisi*, are not conspecific with the lectotype and the other figured syntypes, but belong to *N. (E.) polyhelictum* (BÖCKH).

SUBGENUS EURYSTOMICERAS BESNOSOV, 1958

Nannolytoceras (Eurystomiceras) polyhelictum (BÖCKH)

(pl. 3, fig. 4)

1896 *Lytoceras nicolisi* (non PAR. 1894) - PARONA 1896; p. 10.

1964 *Nannolytoceras nicolisi* (non PAR.) - STURANI 1964 a; pl. 4, f. 4.

1964 *Eurystomiceras polyhelictum* (BÖCKH) - PUGIN 1964; pp. 42-45; pl. 2, ff. 4-5; pl. 3, f. 7; text-f. 8 (*cum syn.*).

There are over 80 specimens from almost all fossil localities: 18 are from Troch n. 1, two from Ponte sul Ghelpach n. 2 assembl. (Pisa Mus.), one from Cima Tre Pezzi, 4 from Rotherbrunn, one from Troch n. 2, over 20 from Monte Meletta (Turin Mus.), about 10 from Monte Longara (Padua Mus.), 3 from Ponte sul Ghelpach n. 3 (Pisa Mus.) and over 20 from Acque Fredde on the Garda Lake (Padua Mus.), ranging thus through the Humphriesianum and the Subfurcatum zones.

The largest specimen (a fragment of body chamber from M. Meletta) if complete would have attained a diameter of about 45 mm.

As a whole, these specimens show very good agreement with the type figures (BÖCKH 1881; pl. 1, ff. 2-3), as well as with the specimen figured by NEUMAYR and UHLIG (1892; pl. 3, f. 2 a-d).

The whorl section is rounded - quadrangular in outline, either isodiametric (in the specimens from M. Meletta) or slightly higher than wide (in the population from Troch n. 1 fossil locality). Beyond a diameter of about 7 mm each whorl bears five constrictions, which are also well marked on the outer surface of the test. On the flanks they are slightly to strongly prorsiradiate and gently arched forward; on the venter they are nearly straight or almost imperceptibly concave forward. The posterior wall of each constriction has a gentle slope, whilst the anterior one is nearly vertical and forms a sharp, often slightly raised edge which bounds the next whorl segment.

None of these specimens shows the adult peristome, so that it has been impossible to observe the median furrow, which should appear on the internal mould after the last constriction, and which represents the main distinguishing character of *Eurystomiceras* according to BESNOSOV and PUGIN. This feature, at any rate, is not visible on BÖCKH's type-figure of *N. polyhelictum* and does not seem to me to have such a great importance: whether *Eurystomiceras* is worthy of being distinguished from *Nannolytoceras* at generic level, or not, is therefore rather doubtful; that is why I have regarded it as a simple subgenus.

As for the measurements, on these specimens from the Sette Comuni H varies between 0.291 and 0.304; L between 0.258 and 0.313; O between 0.46 and 0.509.

N. (E.) polyhelictum has a long vertical range, being found throughout the whole Bajocian stage (PUGIN 1964. p. 44).

Nannolytoceras (Eurystomiceras?) pluriannulatum (PARONA)

(Pl. 16, figs. 6-7; text-fig. 28)

1894 *Lytoceras nicolisi* var. *pluriannulata* - PARONA 1964; p. 16; pl. 1, f. 14.

1896 *Lytoceras pluriannulatum* - PARONA 1896; p. 11.

Syntypes. There are 8 specimens from Monte Meletta, 7 from Monte Longara and 1 from Ponte sul Ghelpach n. 3 assemblage (all from the Subfurcatum zone). The only specimen figured by PARONA (1894; pl. 1, f. 14), from the Subfurcatum zone of Acque Fredde, is probably lost. None the less, since on grounds of ICZN article 10 b the binomen *Lytoceras pluriannulatum* PARONA takes the date of its elevation to the rank of the species-group, that is 1896, all specimens mentioned above may be regarded as syntypes.

The complete adult shown on text-fig. 28 is designated lectotype; it is from Monte Longara (Padua Mus.; Subfurcatum zone, probably Schroederi subzone), has

most of the test preserved and measures: D 21.5 mm; at 20 mm H is 0.25; L, 0.20; O, 0.565.

Description. Adult shells consist of only four whorls and range in size between 21.5 and 13 mm. The whorl section is higher than wide and compressed-elliptical in shape, with rounded umbilical slopes, slightly convex flanks and a narrow, feebly arched venter.

The first two whorls are smooth; the third bears 5 to 6 weak constrictions; these become twice as frequent (10-12) on the last whorl (body chamber) and are also increasingly stronger and denser as they approach the mouth border. On the

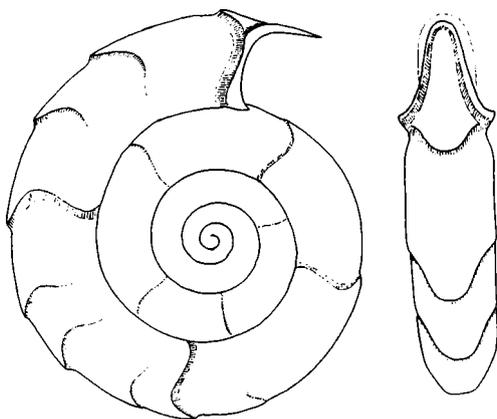


FIG. 28

Nannolytoceras (? *Eurystomiceras*) *pluriannulatum* (PARONA). Lectotype; Monte Longara (Padua Mus.); Subfurcatum zone, Schroederi subzone. Camera-lucida drawing; $\times 25$.

flanks the constrictions are straight and rather strongly prorsiradiate almost to the periphery, where they are swept strongly backward and pass over the venter forming a deep, narrow sinus. In each constriction the anterior wall is higher and steeper than the posterior, especially on the venter; this, coupled with the presence of the narrow ventral sinus, gives them the appearance of reversed chevrons, in ventral view.

The adult peristome, just past the last constriction, has two broad lateral sinuses and a narrow, long, tapering ventral rostrum, instead of two lateral lappets as shown by other *Nannolytoceras* such as *N. tripartitum* (see Pl. 3, fig. 5). This feature is perhaps homologous with the thickening of the shell along the middle of the venter, shown by adult *N. (E.) polyhelictum*.

N. pluriannulatum is easily distinguished from all other congeneric forms because of its much smaller adult size, wider umbilicus, more compressed whorl section, and especially because of its dense, peculiar constrictions.

If present knowledge is not modified by future discoveries, the range of *N. pluriannulatum* seems to be confined to the upper part of the Subfurcatum zone (Schroederi subzone).

SUBORDER PHYLLOCERATINA ARKELL, 1950
SUPERFAMILY PHYLLOCERATAEAE ZITTEL, 1884

FAMILY PHYLLOCERATIDAE ZITTEL, 1884

GENUS PHYLLOCERAS SUESS, 1865

Phylloceras trifoliatum NEUMAYR

1964 *Phylloceras trifoliatum* NEUM. - STURANI 1964 b; p. 9; pl. 1, f. 3 a-b; text-f. 1 (*cum syn.*).

A single specimen from Monte Longara (Padua Mus.), wholly septate at a diameter of 45 mm, shows perfect agreement with the type figures as well as with the specimens from the Parkinsoni zone of the Lessini Mountains described in my previous paper (STURANI 1964b), which see for description.

P. trifoliatum is known to range throughout the whole Bajocian stage (see also PAVIA & STURANI 1968, text-f. 3).

GENUS CALLIPHYLLOCERAS SPATH, 1927

Calliphylloceras disputabile (ZITTEL)

(Pl. 2, figs. 5, 6, 8)

v 1880 *Phylloceras* sp. - PARONA 1880; pp. 260-261.

? 1886 *Phylloceras slamisum* - de GREGORIO 1886; p. 14; pl. 1, f. 30.

v 1894 *Phylloceras slamisum* (? non de GREG.) - PARONA 1894; pp. 13-14; pl. 1, ff. 3-6.

v 1896 *Phylloceras slamisum* (? non de GREG.) - PARONA 1896; p. 9.

1958 *Calliphylloceras disputabile* ZITTEL - BESNOSOV 1958; pp. 23-25; pl. 2, ff. 1-3; pl. 3, f. 1 a-b; text-ff. 2, 6 (*cum syn.*).

v 1964 *Calliphylloceras disputabile* (ZITTEL) - STURANI 1964 b; pp. 10-11; pl. 1, ff. 2, 5 a-b; text-f. 5 (*cum syn.*).

1965 *Calliphylloceras disputabile* (ZITTEL) - RAKUS 1965; pp. 167-168; pl. 10, f. 1; text-fig. 1.

v 1967 *Calliphylloceras disputabile* (ZITTEL) - STURANI 1967; p. 21.

For description see NEUMAYR (1871), POPOVICI-HATZEG (1907) and BESNOSOV (1958).

There are 47 specimens from Troch n. 1 fossil locality, 2 from Cima Tre Pezzi, 2 from Longara di sotto n. 1, one from Rotherbrunn, 6 from Troch n. 2, 10 from Monte Meletta (Turin Mus.), 10 from Monte Longara (Padua Mus.) and 33 from Acque Fredde (Padua Mus.).

All these specimens are immature, the largest one (fragmentary) being only 45 mm in diameter. Many of them, however, have part or whole of the body chamber preserved.

Since the types are lost, it is difficult to judge whether *Phyll. slamisum* DE GREGORIO, which was based on nuclei, is a junior subj. synonym of *C. disputabile* or belongs to *Ptychophylloceras*. De GREGORIO's species, at any rate, ought to be regarded as a *nomen oblitum*. The immature specimens from various localities which

PARONA subsequently assigned to de GREGORIO's species, clearly belong to *C. disputabile*.

C. disputabile is known to range from the base of the Bajocian (PAVIA & STURANI 1968) to the Lower Callovian (BESNOSOV 1958).

GENUS *HOLCOPHYLLOCERAS* SPATH, 1927

Holcophylloceras mediterraneum (NEUMAYR)

(Pl. 2, figs. 7, 9, 10; Pl. 16, fig. 4)

- 1880 *Phylloceras subpartitum* - PARONA 1880; p. 259; pl. 5, f. 4 a-b.
v 1894 *Phylloceras mediterraneum* NEUM. - PARONA 1894; p. 12.
v 1894 *Phylloceras subpartitum* PAR. - PARONA 1894; pp. 12-13; pl. 1; f. 2 a-c.
v 1894 *Phylloceras* (?) *julii* - PARONA 1894; pp. 14-15; pl. 1, ff. 7-9.
1895 *Phylloceras deslongchampsii* - BRASIL 1895; pp. 29-30; pl. 1, ff. 6-8.
v 1896 *Phylloceras mediterraneum* NEUM. - PARONA 1896; p. 9 (*pro parte*).
v 1896 *Phylloceras subpartitum* PAR. - PARONA 1896; p. 10.
1958 *Holcophylloceras zignodianum* d'ORB. - BESNOSOV 1958; pp. 54-58; pl. 9, ff. 1-3; pl. 10, ff. 1-2 a-b; pl. 11, ff. 1-3; text-ff. 23, 25 (*cum syn.*).
v 1964 *Holcophylloceras mediterraneum* (NEUM.) - STURANI 1964 b; pp. 11-12; pl. 1, ff. 4-6; text-f. 6 (*cum syn.*).
v 1967 *Holcophylloceras mediterraneum* (NEUM.) - STURANI 1967; p. 22; pl. 3, ff. 5-6; pl. 5, f. 5.

Holcophylloceras mediterraneum is present in practically all assemblages from the *Posidonia alpina* beds of the Venetian Alps.

The largest population is that from Troch n. 1 fossil locality (Humphriesianum zone, Cycloides sbz.), which includes over 80 specimens. Except for those found at Brentonico (Lower Bathonian), all other specimens are immature, and usually have the body chamber preserved.

The following species should be added to the list of junior subjective synonyms of *H. mediterraneum*:

1) *Phylloceras subpartitum* PARONA, 1880: even though the types are probably lost, the original figures and description leave little doubt that it is based on extremely young specimens of *H. mediterraneum*, like that shown on Pl. 2, fig. 7 (this work).

2) *Phylloceras* (?) *julii* PARONA, 1894: the type (this work, Pl. 16, fig. 4) is an immature *H. mediterraneum* with the test perfectly preserved.

3) *Phylloceras deslongchampsii* BRASIL, 1895: this too appears to be based on immature specimens of *H. mediterraneum*, the geographical range of which is thus extended to include also the Normandy coast.

GENUS *PSEUDOPHYLLOCERAS* BESNOSOV, 1957

Pseudophylloceras kudernatschi (HAUER)

(Pl. 2, fig. 1)

- 1896 *Phylloceras kunthi* (non NEUM.) PARONA 1896; p. 9.
1958 *Pseudophylloceras kudernatschi* (HAUER) - BESNOSOV 1958; pp. 62-64; pl. 2, ff. 1-3; text-ff. 27-28 (*cum syn.*).
1964 *Phylloceras kudernatschi* (HAUER) - STURANI 1964 b; text-f. 2.
1967 *Phylloceras kudernatschi* (HAUER) - STURANI 1967 a; p. 20.

Material. Troch n. 1 fossil locality (5 specimens); Longara di sotto n. 1 fossil locality (4 specimens); Monte Meletta (a single, complete immature specimen, 18 mm in diameter); Monte Longara (Padua Mus., two complete immature specimens, both 19 mm in diameter). The latter three specimens had been erroneously assigned to *P. kunthi* by PARONA. A direct comparison with the inner whorls of large, typical *P. kudernatschi* and *P. kunthi* from the Ammonitico rosso veronese (STURANI 1964b) has shown a perfect agreement only with the former species, since the nuclei of the latter are much more compressed than the specimens under discussion, already at a small diameter.

By a diameter of 18-19 mm the fine, dense, sinuous lyrae alone are present, on both the internal mould and the outer surface of the test. On the larger fragments from Troch n. 1 fossil locality, the characteristic blunt radial folds also appear.

P. kudernatschi is known to range up into the Callovian.

GENUS PARTSCHICERAS FUCINI, 1923

Partschiceras abichi (UHLIG)

(Pl. 2, fig. 3; Pl. 16, figs. 2, 3)

- v 1880 *Phylloceras kudernatschi* (non HAUER) - PARONA 1880; pp. 258-259.
- 1886 *Ammonites chirchius* sp. dub. - de GREGORIO 1886; pl. 13; pl. 1, f. 24.
- 1886 *Oppelia fractina* sp. dub. - de GREGORIO 1886; p. 13; pl. 1, f. 26.
- 1892 *Phylloceras abichi* UHLIG n. sp. - NEUMAYR & UHLIG 1892; pp. 38-39; pl. 1, f. 2.
- v 1894 *Phylloceras subobtusum* (non KUD.) - PARONA 1894; pp. 11-12; pl. 1, f. 1.
- v 1896 *Phylloceras viator* (non d'ORB.) - PARONA 1896; p. 8 (*pro parte*).
- v 1896 *Phylloceras subobtusum* (non KUD.) - PARONA 1896; p. 9 (*pro parte*).
- 1958 *Partschiceras abichi* (UHL.) - BESNOV 1958; pp. 40-42; pl. 7, ff. 1-2; text-f. 15 (*cum syn.*).

This is one of the commonest ammonites in the *Posidonia alpina* beds of the Sette Comuni and it is present in almost all assemblages, including those of the Humphriesianum zone.

Specimens from Monte Meletta and Monte Longara (Padua Mus.) assemblages had been erroneously assigned partly to *P. subobtusum* and partly to *P. viator* by PARONA.

None are adult, the largest one being only 30 mm in diameter (est.). As a whole, the population from the Sette Comuni shows perfect agreement with both the type-figure and the small specimens figured by BESNOV.

The coiling is very involute and the umbilicus extremely small, at all diameters. The whorl section is higher than wide and compressed-oval in shape. The umbilical walls are short, rounded and partially overhanging. The flanks are divided into three parts by two spiral edges: the inner third forms a funnel-shaped periumbilical depression, wider than that shown by *P. subobtusum*; next comes a flattened band bound by the spiral edges, in the middle of the flanks; the outer third is gently convex and grades into the regularly rounded venter. The shell is perfectly smooth up to a diameter of about 15-20 mm (Pl. 2, fig. 3); thereafter ribbing appears,

first on the peripheral part, then also on the inner and middle parts of the flanks (Pl. 16, fig. 3).

On the funnel-shaped periumbilical depression and on the flattened spiral band the ribs appear as fine, strongly prorsiradiate striae. After a bend at the outer spiral edge, they become rectiradiate and rapidly increase in strength, passing over the venter; here they are strong, dense, rounded and separated by spaces as wide as the ribs themselves (Pl. 16, figs. 2, 3).

For more details, see UHLIG's and BESNOSOV's descriptions.

P. abichi is very close to *P. subobtusum*, but can nevertheless be distinguished because of its wider funnel-shaped periumbilical depression and its slightly stronger ribbing on the venter.

P. abichi does not seem to cross the Bajocian - Bathonian boundary.

The specimen figured on Pl. 2, fig. 3 measures: D 23 mm; H, 0.59; L, 0.35; O, 0.07.

Partschiceras besnosovi n. sp.

(Pl. 2, fig. 2; Pl. 16, fig. 1)

1958 *Partschiceras haloricum* (non HAUER) - BESNOSOV 1958; pp. 42-43; pl. 6, f. 3 a-b; text-f. 16.

Remarks. The type of *Ammonites haloricus* HAUER (1854; pl. 4, ff. 9-11) is completely smooth at a diameter of about 57 mm and has a wide, funnel-shaped periumbilical depression, flattened flanks and a broad, weakly arched venter; its suture line is different from that of any known *Partschiceras*, being much closer to that shown by representatives of *Ptychophylloceras*. It is therefore rather difficult to understand the reasons why BESNOSOV assigned specimens that clearly belong to *Partschiceras* to HAUER's species, which are already ribbed by a diameter of 30 mm.

The species which was before BESNOSOV is however worthy of being maintained, and is here renamed *Partschiceras besnosovi* n. sp.; the specimen figured on Pl. 16, fig. 1 is the holotype and measures: D, 32.5 mm; H, 0.566; L, 0.384; O, 0.09. It is particularly close to the specimen from the Parkinsoni zone, probably Acris subzone of Ghigatly - Uruk, Daghestan, figured by BESNOSOV (1958; pl. 6, f. 3a-b; text-f. 16), which measures: D, 51 mm; H, 0.61; L, 0.35; O, 0.09.

The holotype is from the Subfurcatum zone, probably Schroederi subzone of Monte Meletta.

Material. There are 16 specimens from Monte Meletta (including the holotype) and ten from Monte Longara (Padua Mus.), which had been labelled as « *Ph. subobtusum* » by PARONA. A few fragmentary ones have also been collected at Longara di sotto n. 1 fossil locality; another four immature specimens from Troch n. 1 fossil locality (including that shown on Pl. 2, fig. 2) may also belong here, but are too immature for a definite identification.

Description. The coiling is involute and the umbilicus small (0.09 - 0.10). The whorl section is compressed-elliptical; the umbilical walls are rounded and

higher than those of *P. abichi*; the periumbilical, funnel-shaped depression occupies the inner fourth of the flanks, has steeper walls than that shown by *P. abichi* and is bounded ventrally by a blunt spiral ridge, where the maximum whorl width is reached. Beyond this there is a very shallow, broad spiral furrow; a second spiral edge, like that shown by *P. abichi*, is missing. The outer part of the flanks is gently convex and passes gradually into the regularly rounded venter.

The ribs appear by a diameter of about 25 mm and are confined to the outer part of the flanks and the venter. At first they are weak and blunt, but become coarser and more spaced by a diameter of 40 mm, as shown by BESNOSOV's specimen as well as by an unfigured fragment from Monte Meletta.

P. besnosovi n. sp. is close to *P. abichi* and *P. subobtusum*, but may be distinguished from both because of its coarser, blunter and more widely spaced ribbing, and because of the presence of a spiral bulge that bounds the periumbilical depression.

Partschiceras striatoplicatum BESNOSOV

(Pl. 2, fig. 4)

1958 *Partschiceras striatoplicatum* - BESNOSOV 1958; pp. 45-46; pl. 7, f. 5 (holotype) (? non fig. 4); text-f. 19 b (? non 19 a).

Remarks. The two specimens figured by BESNOSOV, which are from stratigraphically separate horizons, show a rather different style of ribbing and may not be conspecific. The holotype (BESNOSOV 1958; pl. 7, f. 5), from the Humphriesianum zone of Daghestan, is closely matched by several specimens from the Sette Comuni: there are over 40 from Troch n. 1 fossil locality, 2 from Longara di sotto n. 1 and 15 more from Monte Meletta. The latter had been erroneously assigned to *P. viator* by PARONA.

The largest one (Pl. 2, fig. 4) measures: D 25 mm; H, 0.62; L, 0.40; O, 0.06.

The coiling is very involute and the umbilicus extremely small. The whorl section is higher than wide and elliptical in shape. The umbilical walls are rounded and short. The flanks are convex, with the maximum thickness at about mid-height; the inner halves are gently convex and divergent, forming a broad, shallow periumbilical depression; the outer halves are also gently convex but convergent, grading regularly into the narrowly rounded venter. A weak, almost imperceptible spiral edge runs in the middle of the flanks, where the maximum width is reached. A spiral flattened band, like that shown by *P. abichi*, is completely missing.

On the specimens from the Sette Comuni the characteristic lyrae described by BESNOSOV are not visible, because the test is seldom preserved. Weak radial folds begin to appear on the venter by a diameter of about 20 mm, as in the holotype.

P. striatoplicatum is distinguished from *P. abichi*, *P. subobtusum* and *P. besnosovi* n. sp. because of its more convex flanks, its wider and shallower periumbilical depression and its slightly stouter whorl section.

GENUS PTYCHOPHYLLOCERAS SPATH, 1927

Ptychophylloceras cf. *rosiwali* (TRAUTH)

(Pl. 2, figs. 11, 14-17)

- v 1896 *Phylloceras ovale* POMP. (?) - PARONA 1896; p. 9.
 v 1896 *Phylloceras subtortisulcatum* POMP. (?) - PARONA 1896; p. 10.
 1923 *Phylloceras rosiwali* - TRAUTH 1923; pp. 220-222; pl. 2, ff. 4-5.

Material. This is one of the commonest Phylloceratids in the *Posidonia alpina* beds of the Sette Comuni, being represented in almost all assemblages; the richest populations are from Troch n. 1 fossil locality (Humphriesianum zone, Cycloides sbz.) (78 specimens) and Monte Meletta (Subfurcatum zone, probably Schroederi sbz.) (22 specs.).

The largest specimen, from Monte Meletta assemblage (Pl. 2, fig. 11) measures: D 39 mm; H, 0.602; L, 0.41; O, 0.06. Other specimens measure: (Pl. 2, fig. 14) D 17 mm; H, 0.53; L, 0.382; O, 0.147. (Pl. 2, fig. 15) D 17.5 mm; H, 0.525; L, 0.38; O, 0.137. (Pl. 2, fig. 16) D 17 mm; H, 0.576; L, 0.40; O, 0.094. (Pl. 2, fig. 17) D 15.5 mm; H, 0.567; L, 0.412; O, 0.096. (M. Meletta, unfigured) D 23 mm; H, 0.55; L, 0.40; O, 0.09. (M. Meletta, unfigured) D 19.8 mm; H, 0.572; L, 0.39; O, 0.106.

Description. Coiling involute, umbilicus very small (it is proportionally wider in the inner whorls, but smaller at any comparable diameter than that of *P. hommairei* (d'ORB.) (= *P. flabellatum* (NEUM.))).

Whorl section higher than wide and regularly elliptical in shape, with rounded umbilical walls, gently convex flanks and a regularly rounded venter.

Each whorl bears five weak, superficial constrictions, which appear on both the internal mould and the outer surface of the test, but are often difficult to see. The constrictions are prorsiradiate and weakly sinuous: they are gently concave forward up to the middle of the flanks, where they form a blunt bend, then become again gently arched forward; passing over the venter they form a chevron-shaped, adorally convex arch, narrower than that shown by *P. hommairei* and *P. euphyllum*. Up to a diameter of 40 mm (the size of the largest specimen) the constrictions are not accompanied by ventral ridges. In general proportions, shape of the whorl section and suture, these specimens show a reasonably good agreement with TRAUTH's original description and figures. According to TRAUTH, however, *P. rosiwali* does not possess constrictions: it should be noted that on the specimens from Sette Comuni these are very weak and superficial, and often difficult to see. Their apparent absence on the type specimens could be due only to a different type of preservation.

The immature specimens from Monte Meletta are characterized by a slightly wider umbilicus and more flattened flanks, when compared with those from Troch n. 1 fossil locality, but are otherwise identical in the remaining features.

P. cf. rosiwali is easily distinguished from the younger *P. hommairei* (d'ORB.) (= *P. flabellatum* (NEUM.)) because of its higher and less stout whorl section, its narrower umbilicus, more narrowly arched venter, more prorsiradiate and less sinuous constrictions. *P. euphyllum* (NEUM.) has a slightly stouter whorl section and more

rectiradiate constrictions, especially across the venter. *P. longarae* n. sp. is more compressed laterally and has flattened to spirally grooved flanks.

The range of *P. cf. rosiwali* in the Sette Comuni is Humphriesianum zone - Subfurcatum zone.

Ptychophylloceras longarae n. sp.

(Pl. 2, figs. 12-13)

v 1896 *Phylloceras mediterraneum* (non NEUM.) - PARONA 1896; p. 9 (*pro parte*).

Material. There are 22 specimens from Longara di sotto n. 1 fossil locality (Subfurcatum zone, Polygyralis sbz.), 16 from Monte Meletta (Subfurcatum zone, probably Schroederi sbz.), 5 from Monte Longara (Padua Mus., same age as for Monte Meletta), 13 from Troch n. 2 fossil locality (Subfurcatum zone, Schroederi sbz.), 3 from Ponte sul Ghelpach n. 2 assemblage (Pisa Mus., Subfurcatum zone, Banksi subzone) and another three from Ponte sul Ghelpach n. 4 assemblage (Pisa Mus., Garantiana zone). Most of them had been erroneously assigned to *P. mediterraneum* by PARONA.

The holotype (Pl. 2, fig. 13) is from the Subfurcatum zone, Polygyralis subzone of Longara di sotto n. 1 fossil locality, and measures: D 17 mm; H, 0.53; L, 0.335; O, 0.135. The paratype figured on Pl. 2, fig. 12, is from the same locality and horizon; its measurements are: D 17.5 mm; H, 0.534; L, 0.344; O, 0.126. The largest paratype, from the Monte Meletta assemblage, is wholly septate at a diameter of 28 mm and measures: H, 0.546; L, 0.341; O, 0.112.

The coiling is involute and the umbilicus small. The whorl section is compressed-elliptical, with rounded and proportionally high umbilical walls, flattened, subparallel flanks and a regularly arched venter. Above a diameter of about 10-15 mm, a shallow, broad spiral groove appears on the inner half of the flanks. Between this groove and the narrow periumbilical depression there is a blunt spiral bulge, where the maximum whorl width is reached.

Each whorl bears six shallow, weak constrictions, which are best marked within the periumbilical depression, where they form a rosette, and at the periphery; while on crossing the spiral groove they become almost obsolete. On the holotype and the other paratypes from the Subfurcatum zone the constrictions are falcoid in shape and, as a whole, prorsiradiate, with a knee-bend on the middle of the flanks, just past the spiral groove. On the venter they form a narrow, chevron-shaped, adorally convex arch.

Because of its falcoid constrictions *P. longarae* n. sp. is vaguely similar to *H. mediterraneum*; the distinction, however, is easy, because of the characteristic spiral groove in the inner half of the flanks, the more involute coiling, the weaker constrictions and the completely different sutures.

Ptychophylloceras longarae n. sp. is easily distinguished from all other congeneric forms because of its much more compressed whorl section, with spirally grooved flanks.

The known range is Subfurcatum zone - Garantiana zone.

SUBORDER AMMONITINA HYATT, 1889
SUPERFAMILY HAPLOCERATACEAE ZITTEL, 1884

General remarks. According to ARKELL (1957, pp. 271, 273, 275), all three families belonging to Haplocerataceae — i.e. Strigoceratidae, Haploceratidae and Oppeliidae — had a common origin in Hammatoceratidae (e.g. *Eudmetoceras*) early in the Bajocian. The same view is also shared by GECZY (1967, p. 221) who regards *Hammatoceras* (*Pseudaptetoceras*) as the common ancestor of both Haploceratids and Oppeliids, while Strigoceratids are regarded as derivatives of *H.* (*Csernyeiceras*). According to WESTERMANN (1969, pp. 51, 69) another Hammatoceratid genus — *Eudmetoceras* — should be regarded as the common ancestor of both Strigoceratids and Oppeliids.

As for the Strigoceratids, these views are certainly valid: *Praestrigites* and *Strigoceras* are probably direct descendants of *Eudmetoceras*, of which they retain the floored hollow keel, the highly frilled sutures and — to some extent — the style of ribbing.

Lissoceras semicostulatum BUCKM., of the ? Sowerbyi zone, is said by ARKELL to be the earliest known Haploceratid; as he pointed out, it bears strong resemblance to representatives of *Bradfordia* from a similar horizon. Since the latter genus appears a little earlier, in the Discites subzone, it seems therefore likely that *Lissoceras* — hence all younger Haploceratids — originated as an early lateral offshoot of *Bradfordia*, rather than simultaneously and independently from a common ancestor. As to *Bradfordia*, most authors who have recently dealt with Aalenian and Early Bajocian ammonites regard it as a direct derivative of Hammatoceratids. However, representatives of *Bradfordia* show features that are more reminiscent of those possessed by Graphoceratids, such as the absence of a floored hollow keel, the relatively simple sutures with a proportionally short ventral lobe, and the raised umbilical edge. Unless these features are interpreted as a remarkable example of homeomorphy (GECZY 1967, p. 225), the hypothesis that *Bradfordia* (and hence also *Lissoceras*) is phyletically related to the Graphoceratids rather than to the Hammatoceratids is worthy of consideration. On the other hand it is to my mind rather doubtful whether *Bradfordia* can be regarded as directly ancestral to *Oppelia*, as assumed by most authors, or not: *Hebetoxytes*, such as *H. incongruens* and *H. clypeus* of the Sowerbyi zone, seem to be much better ancestors, unless this too is again interpreted as an extraordinary case of homoeomorphy. At any rate the latter genus does not seem to be well placed in the family Strigoceratidae, because it lacks the floored hollow keel characteristic of macroconch Strigoceratids.

If these hypothesis were confirmed by a revision of early Bajocian Haplocerataceae, this superfamily would be demonstrably polyphyletic.

FAMILY HAPLOCERATIDAE ZITTEL, 1884

According to the « Treatise » Haploceratidae are represented in the Bajocian by the following genera: *Lissoceras* BAYLE, 1879, *Toxalambites* BUCKMAN, 1924, *Protoecotraustes* SPATH, 1928 and *Cadomoceras* MUNIER-CHALMAS, 1892. As to the latter genus, it is here regarded as the microconch counterpart of *Strigoceras* and should be transferred to the family Strigoceratidae (see further on, p. 122).

Toxalambites, which is known to occur also in the Humphriesianum zone, seems to be a derivative of either *Lissoceras semicostulatum* or, less likely, of some *Bradfordia* sp., on the evolutionary line leading to *Poecilomorphus*. Both genera, along with their newly discovered dimorph subgenera (*T.* (*Microtoxalambites*) n. subg. and *P.* (*Micropoecilomorphus*) n. subg.), are here regarded as belonging to Haploceratidae.

Stegoxytes, like *Toxalambites* and some species of *Lissoceras*, has outer ribs which pass over the venter in the form of blunt chevrons and Haploceratid rather than Oppeliid sutures, with a proportionally short ventral lobe; for this reason it seems better placed within Haploceratidae, along with its newly discovered microconch counterpart (see p. 98).

Protoecotraustes (see J. SAPUNOV 1963), of the Sowerbyi and Sauzei zones, probably represents the microconch counterpart of *Bradfordia*, since there are no other macroconch genera with the same vertical range it could usefully be paired with (the species *P. laevigatus* SAP., however, can be best paired with *Lissoceras semicostulatum* or another allied form and should therefore be transferred to *L.* (*Microlissoceras*) n. subg., for which see p. 93). If it became confirmed that *Bradfordia* (incl. *Preoppelia* WEST. as a subgenus) is not directly ancestral to *Oppelia* but more closely related to *Lissoceras* and *Toxalambites*, both *Bradfordia* and *Protoecotraustes* would be well placed within Haploceratidae; otherwise, the latter ought to be transferred to Oppeliidae.

One more remark concerns the Haploceratids of the Upper Callovian and the Oxfordian: these have until now been ascribed to *Lissoceratoides* SPATH, 1923, just because of the wide stratigraphic gap between them and the last *Lissoceras*, but are morphologically undistinguishable. Recent contributions by several authors (e.g. STURANI 1967, p. 24; also J. H. CALLOMON, *in litt.*) have shown that in reality such a gap does not exist: *Lissoceratoides* should therefore be considered a junior subjective synonym of *Lissoceras*. As to the microconch dimorph of the latter, see further on under *L.* (*Microlissoceras*) n. subg..

It appears, after the preceding brief discussion, that the main distinguishing feature common to all Haploceratidae is given by the presence of a much shorter and narrower external lobe than the first lateral, rather than by the absence of ornamentation. If ribbing is present, the ribs either fade out on the middle of the venter or, more often, cross it as blunt chevrons. A blunt, open keel is developed only in *Poecilomorphus* and *Stegoxytes*; all other genera have a rounded venter.

GENUS LISSOCERAS BAYLE, 1879

Lissoceras oolithicum (d'ORBIGNY)

(Pl. 6, fig. 2)

- 1845 *Ammonites oolithicus* - d'ORB. 1842-49; pp. 383-384; pl. 126, ff. 1-4.
1858 *Ammonites oolithicus* d'ORBIGNY - QUENSTEDT, « Der Jura »; p. 396; pl. 55, f. 20.
1887 *Ammonites oolithicus* d'ORBIGNY - QUENSTEDT, « Ammoniten »; pp. 563-564; pl. 69, f. 4 (non f. 5).
1913 *Lissoceras oolithicum* (d'ORB.) - R. DOUVILLÉ 1913; text-f. 4.
1927 *Lissoceras oolithicum* (d'ORB.) - ROMAN & PETOURAUD 1927; p. 48; pl. 5, f. 13 (non ff. 12, 14).
? 1962 *Lissoceras bakeri* - IMLAY; pp. 6-8; pl. 1, ff. 1-6, 9-12.
? 1964 *Lissoceras bakeri* IML. - IMLAY 1964; p. 38; pl. 23, f. 1.
non 1928 *Lissoceras oolithicum* - DORN 1928; pp. 245-246; pl. 7, f. 3; text-f. 13 (= *L. ferrifex*).

There are 9 specimens from Troch n. 1 fossil locality, 3 from Cima Tre Pezzi, one from Longara di sotto n. 1 f. loc., one from Monte Longara assemblage (Padua Mus.) and one from Ponte sul Ghelpach n. 4 assemblage (Pisa Mus.). They are all immature, the largest being 18 mm in diameter, with part of the body chamber preserved.

These specimens are moderately involute (O is about 0.255), completely smooth on both the internal mould and the surface of the test (except for almost imperceptible growth lines) and have a high-oval whorl section (H is about 0.47; L is 0.32), thus showing near perfect agreement with the type figures.

As for the differences with other congeneric forms, *L. oolithicum* is neither as inflated as *L. meletense* (PAR.) and *L. haugi* STURANI, nor as compressed as *L. psilodiscus* (SCHLOEMB.) and *L. psilodiscus inflatum* WETZEL. *L. monachum* (GEMM.) has a slightly stouter whorl section, with more flattened sides and a less regularly arched venter; *L. ventriplanum* WENDT is distinguished because of its flattened venter; *L. ferrifex* (ZITT.) is more evolute, while *L. semicostulatum* BUCKM., besides having a stouter whorl section, is distinctly ribbed.

L. bakeri IMLAY, on the other hand, is but doubtfully distinct from d'ORBIGNY's species, the main difference lying in the suture line.

L. oolithicum is known to range from the basal Humphriesianum zone (MOUTERDE 1953, p. 92) up to the Parkinsoni zone (RIOULT 1964, p. 246). A record from the Bathonian of Provence by LANQUINE (1929, p. 321; no figures) seems rather suspect and may refer to a stratigraphically younger species.

Lissoceras sp. ind. aff. *oolithicum* (d'ORB.)

(Pl. 6, figs. 3-4)

- ? 1887 *Ammonites oolithicus* (? non d'ORB.) - QUENSTEDT « Ammoniten »; pl. 69, f. 5 (only).

Eight specimens from Troch n. 1 fossil locality differ from those referred to *L. oolithicum* in being more stoutly whorled. These too are immature; the largest one (Pl. 6, fig. 3) measures: D 19 mm (with part of the body chamber preserved); H, 0.477; L, 0.35; O, 0.23.

At such a small diameter the internal mould is smooth; but dense, fine falcate ribs appear on the outer surface of the test; at the peripheral margin they are gently projected to pass over the venter as blunt chevrons, without fading.

The same features are also shown by a well preserved complete specimen from the ironshot oolite of Bayeux, in the palaeontological collections at Turin; this is septate up to a diameter of 25 mm and measures: H, 0.48; L, 0.344; O, 0.24. On this specimen, above a diameter of about 20 mm, the ribs become stronger at the peripheral margin, but tend to fade on the ventral part as seen in *L. semicostulatum*.

Until more larger specimens are found, it is uncertain whether these represent just another morphotype of *L. oolithicum*, slightly stouter than the one figured by d'ORBIGNY and perhaps transitional to *L. semicostulatum*, or belong to a distinct species.

Lissoceras psilodiscus (SCHLOENBACH) *inflatum* WETZEL

(Pl. 6, fig. 1)

1927 *Lissoceras oolithicum* (non d'ORB.) - ROMAN & PETOURAUD 1927; pl. 5, ff. 12-14 (only).

1950 *Lissoceras inflatum* (cum spp.) - WETZEL 1950; pp. 81-82; pl. 8, ff. 6 a-b - 8.

There are two specimens from Monte Longara assemblage (Padua Mus.), one from Monte Meletta (Turin Mus.) and one from Ponte sul Ghelphach n. 4 assemblage (Pisa Mus.). The largest one (Pl. 6, fig. 1) is wholly septate at a diameter of 40 mm and measures: H, 0.50; L, 0.26; O, 0.225.

The whorl section is compressed-oval, almost lanceolate, intermediate in shape between that of *L. oolithicum* and that of *L. psilodiscus psilodiscus*. Faint, slightly prorsiradiate peripheral riblets are visible on the internal mould.

These are the same features shown by *L. inflatum* WETZEL (cum spp.), based on specimens from the topmost Upper Bajocian (*obere Parkinsonien-Schichten*) and the basal Lower Bathonian (*untere Wuerttembergica-Schichten*) of Northern Germany.

According to ARKELL (1951-59; p. 50), in the British isles *L. inflatum* has been found only below the base of the Bathonian. WESTERMANN (1958, p. 55), on the other hand, regards it as probably synonymous with *L. psilodiscus*. In my opinion it should nevertheless be maintained as a chronosubspecies of *L. psilodiscus*, earlier than the nominate one and less compressed laterally. Records of *L. psilodiscus* in the Upper Bajocian by several authors (e.g. RIOULT 1964, p. 246) may well refer to this subspecies.

The suture line is but slightly different from that of the nominate subspecies.

Lissoceras meletense (PARONA)

(Pl. 6, figs. 5, 6; text-fig. 29)

1896 *Lytoceras meletense* - PARONA 1896; p. 11; pl. 1, f. 3.

There are 16 syntypes from Monte Meletta (Turin Mus.), 10 more from Monte Longara (Padua Mus.), 2 specimens from Rotherbrunn and 7 from Troch n. 2 fossil localities. The largest one, from Monte Meletta, is 24 mm in diameter, with nearly half a whorl of body chamber (the peristome, however, is missing). The specimen

figured on Pl. 6, fig. 6, also from Monte Meletta, has been chosen as lectotype; it measures: D, 15.5 mm; H, 0.493; L, 0.638; O, 0.212.

L. meletense is distinguished from all other congeneric forms (including *L. haugi* STURANI) because of its extremely inflated whorl section, wider than high and depressed-oval in shape. The internal mould is smooth, while the test shows faint growth lines.

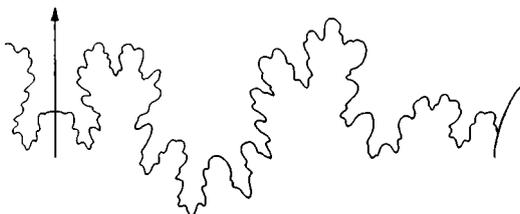


FIG. 29

Suture line of *Lissoceras meletense* (PARONA); paratype; Monte Longara (Padua Mus.); Subfurcatum zone, Schroederi subzone. Much enlarged.

The suture line (text-fig. 29) is typically Haploceratid and confirms that this is not a *Lytoceras*, as thought by PARONA.

L. meletense also occurs in the Truellei bed of Burton Bradstock, Dorset: I have seen three specimens from this locality and horizon, one in the Bomford collection (n. 2919) and two others in the Geological Survey collections (G.S.M. 3638 and 69993); the latter were labelled as « *Lissoceras* sp. nov. cf. QUENSTEDT pl. 69, f. 5 ».

SUBGENUS MICROLISSOCERAS n. subg.

General remarks. Until recently *Cadomoceras* was — implicitly or explicitly — regarded by several authors as the microconch dimorph of *Lissoceras*. In the present writer's interpretation, however, *Cadomoceras* is best paired with *Strigoceras* and is not a Haploceratid.

On the other hand, in the faunal assemblage from Troch n. 1 fossil locality (basal Humphriesianum zone) there are several specimens of a new, microconch morphospecies, that clearly represents the dimorph of *Lissoceras* (either *L. oolithicum*, or *L. aff. oolithicum*, or both).

Morphologically, it is close to *Glochiceras* spp. from a much younger horizon (Oxfordian - Kimmeridgian, according to the « Treatise »). Since MAKOWSKI (1963, p. 71) regarded *Glochiceras* as the microconch dimorph of *Lissoceratoides* and the latter is probably a junior synonym of *Lissoceras* (see before, p. 90), it would seem logical to place this new species within *Glochiceras*.

The point, however, is that the type species — *G. nimbatum* (OPPEL), from the Lower Kimmeridgian of Germany — is younger than any known *Lissoceras* (including *Lissoceratoides*) and probably represents the microconch dimorph of some *Haploceras*. Unless we regard *Lissoceras* (and *Lissoceratoides*) as subjective synonyms

of *Haploceras*, which does not seem justified, a new subgeneric name (*Microlissoceras* n. subg.) is needed.

Diagnosis. Very small sized, smooth Haploceratids, provided with small ventral rostrum and narrow lateral lappets. The coiling is moderately evolute and the whorl section elliptical to compressed oval. Ribbing is usually absent, but for fine growth lines and thin, sinuous riblets toward the end of the body chamber on some specimens. A median lateral groove, like that shown by *Glochiceras* (incl. *G. nimbatum*) is missing.

Type species: *L. (Microlissoceras) pusillum* n. sp.

Lissoceras (Microlissoceras n. subg.) *pusillum* n. sp.

(Pl. 6, figs. 7-10; Pl. 7, fig. 16)

Type series. There are over 40 adult specimens from the basal Humphriesianum zone of Troch n. 1 fossil locality. That figured on pl. 6, fig. 7 has been selected as holotype and measures: D, 8.6 mm; H, 0.356; L, 0.324; O, 0.356.

This is an extremely small, almost featureless ammonite, ranging in size between 6 and 10 mm. Most specimens are smooth on both the internal mould and the test surface. On a few, however, thin, scattered falcoid riblets appear towards the end of the body chamber, which occupies nearly half a whorl; they pass over the venter as blunt chevrons.

In some cases distinction from *Toxalambites (Microtoxalambites* n. subg.) *pauper* n. sp. may be difficult; the latter species has a proportionally higher whorl section, with more flattened sides, and is more distinctly ribbed.

As to the macroconch dimorph, *L. (Microlissoceras) pusillum* n. sp. may be paired with either *L. oolithicum*, or *L. aff. oolithicum*, or both.

GENUS TOXALAMBITES S. BUCKMAN, 1924

General remarks. This is a small sized macroconch genus, characterized by possessing falcoid ribs which are projected to pass as blunt chevrons over the rounded venter. Early representatives of *Oppelia* (e.g. *O. subradiata* (Sow.) and *O. flexa* (BUCKM.)) may show a similar style of ribbing in side view, but the ribs never pass over the venter, which is always more or less sharply fastigate.

Some densely ribbed and laterally compressed morphotypes of *Poecilomorphus cycloides* (d'ORB.) (see Pl. 8, figs. 19-20) may show ventral chevrons, but possess a blunt keel that allows distinction from *Toxalambites fasciculatus* n. sp., which is otherwise similarly ribbed.

Toxalambites is here regarded as arising from *Bradfordia*, either directly or — more likely — through *Lissoceras semicostulatum*, on the evolutionary lines leading to *Poecilomorphus* on one hand, and to *Stegoxytes* on the other.

The holotype — and only known specimen — of the type species, *T. arcifer* S. BUCKM., is labelled « Sauzei sbz. (or higher?) - Dundry, Somerset ».

Other unnamed, probably congeneric forms are recorded by MOUTERDE (1953; pp. 92, 128) as « *Oppelia* cf. *arcifer* S. BUCKM. (*Toxalambites*) T. A., pl. 473, moins épaisse », and « *Oppelia* cf. *arcifer* S. BUCKM. T. A., pl. 473 (*Toxalambites*), côtes plus fortes, plus espacées ». Both are from the basal Humphriesianum zone (« héméra Epalxites ») of the borders of the Massif Central.

In the faunal assemblage from Troch n. 1 fossil locality (basal Humphriesianum zone), *Toxalambites* is represented by two species, both new: *T. fasciculatus* n. sp. and *T. densicostatus* n. sp., as well as by their microconch dimorphs, which have been placed in *T. (Microtoxalambites)* n. subg.

Toxalambites fasciculatus n. sp.

(Pl. 7, figs. 4-7)

1964 *Oppelia subtilicostata* (non PAR.) - STURANI 1964 a; pl. 4, f. 9.

There are 27 complete specimens, at various stages of growth, and over 20 fragmentary ones, all from Troch n. 1 fossil locality. A few fragmentary specimens are also present in the assemblage from Camporovere (Pavia Mus.).

The one figured on pl. 7, fig. 6 has been selected as holotype. It measures: D, 18.8 mm; H, 0.49; L, 0.428; O, 0.207; r about 60.

The largest paratype (fragmentary) has an estimated diameter of about 25 mm; others, at slightly smaller diameters already appear to be fully grown (see below).

The whorl section is higher than wide, elliptical in shape and somewhat flattened laterally, being more compressed than in *T. arcifer*. The coiling is moderately involute and the umbilicus narrower than in the type species. The umbilical slope is rounded.

The ribs are parallel to the growth lines and falcoid in shape. On the outer whorl there are about 60 peripheral ribs; these are bundled in threes or fours on the middle of the flanks to form blunt, more or less prominent primary folds, separated by narrow sinuous grooves. On the external part, which is rounded or bluntly fastigate in different specimens, and nearly smooth, the secondaries fade out, but for a few that cross the venter as blunt chevrons at irregular intervals (one every two to four secondaries). On several paratypes, however, such chevrons become denser and stronger toward the end of the body chamber (Pl. 7, fig. 4); this may be interpreted as evidence that the adult stage has been reached. The body chamber occupies from two thirds to slightly more than one half of the last whorl.

The adult peristome is sinuous, without lateral lappets, as in the type species.

The figured paratypes measure: (Pl. 7, fig. 4) D, 17 mm; H, 0.475; L, 0.325; O, 0.25. (Pl. 7, fig. 5) D, 20 mm; H, 0.46; L, 0.333; O, 0.235. (Pl. 7, fig. 7) D, 18 mm; H, 0.48; L, 0.27; O, 0.23.

Toxalambites densicostatus n. sp.

(Pl. 7, figs. 12-15)

There are over forty specimens from Troch n. 1 fossil locality and another from Rovereto, also from the basal Humphriesianum zone. The latter is the largest, with a diameter of 25 mm and slightly more than a whorl of the body chamber preserved.

The holotype is figured on Pl. 7, fig. 13 and comes from Troch n. 1 fossil locality. It measures: D, 19.2 mm; H, 0.484; L, 0.269; O, 0.234; r over 80.

This species differs from *T. fasciculatus* n. sp. in being more laterally compressed and much more densely and finely ribbed. The largest specimen, from Rovereto, has over 90 secondaries per whorl; the holotype has over 80. The venter is more regularly rounded than in the preceding species.

The style of ribbing, apart from the higher density of the ribs, is similar: the secondaries are bundled in groups of twos to fours at their base, each bundle being separated from the next by a thin, sinuous groove that crosses the venter, so that a blunt chevron is formed every two to four secondaries.

The figured paratypes measure: (Pl. 7, fig. 12) D, 18 mm; H, 0.464; L, 0.28; O, 0.24. (Pl. 7, fig. 14) D, 17 mm; H, 0.48; L, 0.26; O, 0.24. (Pl. 7, fig. 15) D, 14 mm; H, 0.475; L, 0.30; O, 0.262.

SUBGENUS MICROTOXALAMBITES n. subg.

General remarks. This includes the microconch dimorphs of *Toxalambites*. The differences from the macroconch, nominate subgenus consist in the much smaller size (9 to 13 mm) and the presence of short, narrow lateral lappets. As also happens with *Microliissoceras* n. subg., *Micropoecilomorphus* n. subg. and the unnamed microconch dimorph of *Stegoxytes*, when compared to their macroconch dimorphs, the coiling is proportionally more evolute. Apart from this, all other features are identical to those of *Toxalambites*.

Two species, both previously unknown, occur at fossil locality Troch n. 1: *T. (Microtoxalambites) parvus* n. sp. which can be paired with *T. fasciculatus* n. sp. and *T. (Microtoxalambites) pauper* n. sp., which can be paired with *T. densicostatus* n. sp.. The former is here chosen as the type species.

Toxalambites (Microtoxalambites) parvus n. sp.

(Pl. 7, figs. 8-11)

This is the microconch dimorph of *T. fasciculatus*, whose features it repeats in miniature. There are 15 adult specimens, all from Troch n. 1 fossil locality, ranging in size between 9 and 11.5 mm. The one figured on Pl. 7, fig. 8 is the holotype; it measures: D, 11 mm; H, 0.40; L, 0.31; O, 0.31.

The other figured paratypes measure: (Pl. 7, fig. 9) D, 11.3 mm; H, 0.42; L, 0.31; O, 0.28. (Pl. 7, fig. 10) D, 9 mm; H, 0.41; L, 0.32; O, 0.31. (Pl. 7, fig. 11) D, 10.5 mm; H, 0.42; L, 0.32; O, 0.29.

T. (M.) pauper n. sp. differs from the present species in being slightly more compressed and in having much fainter ribs.

Distinction from the densely and weakly ribbed morphotypes of *Poecilomorphus (Micropoecilomorphus) vicetinus* (PAR.) (Pl. 7, fig. 17) may be difficult in some instances; the latter, however, are as a rule more evolute.

Toxalambites (*Microtoxalambites*) *pauper* n. sp.

(Pl. 7, figs. 18-19)

This is the microconch dimorph of *T. densicostatus* n. sp..

There are 18 specimens from fossil locality Troch n. 1, all adults and ranging in size between 9.5 and 13 mm, when complete.

Up to the first half of the body chamber the whorls are smooth, but for weak, sinuous primary folds on the middle of the flanks on some specimens. On the second half of the body chamber extremely thin and dense riblets appear, bundled in threes or fours as in the macroconch counterpart. Each bundle of ribs passes over the venter as a blunt, flattened chevron, so that the outline of the periphery, toward the end of the body chamber, becomes polygonal instead of following a regular spiral (Pl. 7, fig. 19).

As in the preceding species, the lateral lappets are short and narrow, and are placed closer to the umbilical margin than to the blunt ventral rostrum.

As to the differences with *T. (M.) parvum* n. sp., see under that species.

Distinction from *Lissoceras* (*Microlissoceras*) *pusillum* n. sp. may in some instances be difficult; the latter, however, is more evolute, less compressed laterally and its riblets, when present, are not bundled (Pl. 7, fig. 16).

The holotype (Pl. 7, fig. 18) measures: D, 11.5 mm; H, 0.38; L, 0.30; O, 0.34.

GENUS *STEGOXYTES* S. BUCKMAN, 1924

Stegoxytes parvicarinatus BUCKMAN

(Pl. 6, fig. 15)

v 1924 *Stegoxytes parvicarinatus* - S. BUCKMAN, T. A., pl. 474.

The holotype comes from the lower part of the Humphriesianum zone of Frogden Quarry, Osborne, Dorset (GSM 37322). It is fully grown, with nearly half a whorl of body chamber preserved, at a diameter of about 33 mm; the peristome, however, is broken.

The specimen figured on Pl. 6, fig. 15 shows very close agreement with the holotype; it is 18 mm in diameter, with part of the body chamber preserved, and comes from Troch n. 1 fossil locality (basal Humphriesianum zone).

The following description is based on both this specimen and the holotype. Shell discoidal, compressed, involute. There is a short, vertical umbilical wall and a raised, rounded umbilical edge. The inner third of the flanks is concave and limited ventrally by a blunt spiral ridge, where the maximum whorl width is attained. Beyond the spiral ridge the flanks become gently convex and converge ventrally, towards the well marked ventrolateral edges. A weak spiral furrow, on the outer side of the spiral ridge appears just past the last septum, on the holotype. The venter is narrow and almost tabulate, but for a weak, narrow, raised median keel: on the body chamber of the holotype the venter becomes at first fastigate, then bluntly rounded, while the ventrolateral edges disappear.

The ribs are regularly falcoid in shape, very fine and dense. At small diameters the primaries appear as weak prorsiradiate folds, which bend just past the spiral ridge, giving rise to bundles of 2-3 secondaries. Above 15 mm in diameter they tend to fade, and very fine growth lines alone remain visible. The deeply arched secondaries are best marked at the ventrolateral edges: here they are strongly projected and pass over the venter as very small chevrons, without fading.

The suture line is relatively simple, with the first lateral lobe much longer than the ventral one, as in all other Haploceratids.

As to the taxonomic position, *S. parvicarinatus* was first figured by S. BUCKMAN as the type species of *Stegoxytes*. Later, it was mentioned as *Oppelia parvicarinata* by MOUTERDE (1953; p. 92). ARKELL (1957, p. 276) regarded *Stegoxytes* as a ? subgenus of *Oecotraustes*, probably because of the characteristic spiral ridge, the falcoid ribs and the relatively small size. No other species have ever since been described as belonging to *Stegoxytes*.

In the present writer's interpretation *Stegoxytes* is a small sized macroconch Haploceratid, close to *Toxalambites*, from which it may have arisen, and to *Poecilomorphus*, as shown by the Haploceratid rather than Oppeliid sutures and by the presence of small ventral chevrons.

The adult peristome of the holotype is unfortunately broken, so that one cannot say whether it was auriculate or simple. However, the existence of a microconch counterpart (*Stegoxytes* (n. subg. ind.) n. sp. ind., see further on, p. 98) and the extremely small size of the latter, is a good evidence that *S. parvicarinatus* is a macroconch.

The distinguishing features of *Stegoxytes*, when compared to the more compressed and more finely ribbed species of *Toxalambites* (*T. densicostatus* n. sp., for instance), are the presence of a small keel and of well marked ventrolateral edges.

Stegoxytes aff. *parvicarinatus* S. BUCKMAN

(Pl. 6, fig. 16)

Four other specimens, also from Troch n. 1 fossil locality, differ from the preceding specimens in lacking the spiral ridge and the lateral groove; the whorl section is as a consequence more compressed and the general shape more discoidal. All other features — style of ribbing, tabulate-parvicarinate venter, coiling, etc. — are otherwise identical.

The largest specimen (Pl. 6, fig. 16) is wholly septate and measures: D, 15.5 mm; H, 0.52; L, 0.26; O, 185.

It seems likely that this is just another morphotype of *S. parvicarinatus*, rather than a different species.

Stegoxytes (n. subg. ind.) n. sp. ind.

This is the microconch counterpart of *S. parvicarinatus*, the features of which it repeats at a much smaller diameter.

The only known specimen is 11 mm in diameter, with half a whorl of body chamber (the mouth border is broken). There is however little doubt that it is adult, because of the rapid widening of the umbilicus and the excentring coiling shown by the last half whorl. It comes from Troch n. 1 fossil locality.

The ventral part, bounded by very well marked ventrolateral edges, is fastigate - or better, parcarinate; extremely fine and dense outer ribs appear on the body chamber alone; as in the macroconch counterpart they are strongly projected. A weak spiral ridge is also present, on the body chamber alone. The suture line is practically identical to that of *S. parcarinatus*. Immature specimens of the latter may be distinguished from that under discussion only because of their more involute coiling and smaller umbilicus, as is also shown by the couples *Toxalambites* - *Microtoxalambites* and *Poecilomorphus* - *Micropoecilomorphus*.

Distinction from *Microtoxalambites* is easy because of the characteristic fastigate - parcarinate venter.

The present species will not be formally named until more specimens, showing the complete peristome, are discovered.

GENUS POECILOMORPHUS S. BUCKMAN, 1889

General remarks. *Poecilomorphus* has hitherto been regarded as a microconch Sonniniid by most recent authors (ARKELL & alii 1957, p. L 270; HUF 1968). Several auriculate Sonniniid microconchs have in fact, originally or subsequently, been assigned here (e.g. *P. macer* S. BUCKM., *P. schlumbergeri* HAUG, *P. boweri* S. BUCKM., *P. mayalis* BRASIL, etc.); however, these have been later transferred from *Poecilomorphus* to other genera (*Maceratites*, *Pelekodites*). On the other hand, there is hardly any doubt that the type species — *P. cycloides* (d'ORB.) — has a plain mouth border and is a small-sized macroconch; its tiny microconch dimorph, the existence of which was hitherto unsuspected, had been described long ago by PARONA (1880) as *Haploceras vicentinum* (later corrected into *Oppelia vicetina* by PARONA himself).

As to the taxonomic position, *Poecilomorphus* (including its microconch dimorph as a subgenus - *Micropoecilomorphus* n. subg.) is here regarded as a direct derivative of *Toxalambites arcifer*, of the Sauzei zone, by the development of a carinate - tabulate or of a carinate - bisulcate venter and by loss of the ventral chevrons (on a few specimens of *Poecilomorphus cycloides*, however, chevrons may occur towards the end of the body chamber; this may be interpreted as the exceptional reappearance of an ancestral feature). Like *Toxalambites*, *Poecilomorphus* is therefore placed within Haploceratidae.

After an extraordinary burst in the lowermost part of the Humphriesianum zone (*Cycloides* subzone), *Poecilomorphus* soon became extinct, without leaving any apparent descendants.

Poecilomorphus cycloides (d'ORBIGNY)

(Pl. 8, figs. 1-21; Pl. 9, figs. 12-16; text-figs. 30-41)

- v 1844 *Ammonites cadomensis* (non DEFRANCE) - d'ORBIGNY, *Pal. Fr., Céph. Jur.*; pl. 121, ff. 1-6 (non pl. 129, ff. 4-6).
- v 1845 *Ammonites cycloides* - d'ORBIGNY; *Pal. Fr., Ceph. Jur.*; p. 370.
- v 1880 *Harpoceras pingue* - PARONA 1880; pp. 256-257; pl. 5, f. 2 a-b.
- v 1880 *Harpoceras minutum* - PARONA 1880; pp. 257-258; pl. 5, f. 3 a-b.
- v 1889 *Poecilomorphus cycloides* (d'ORB.) - S. BUCKMAN, *Inf. Ool. Amm.*; pp. 117-121; pl. 22, ff. 1-22; pl. A, ff. 31-32, (cum syn.).
- v 1896 *Harpoceras minutum* PAR. - PARONA 1896; pp. 11-12; pl. 1, f. 4.
- v 1927 *Poecilomorphus regulatus* - S. BUCKMAN, *T. A.*; pl. 746.
- v 1927 *Poecilomorphus primiferus* - S. BUCKMAN, *T. A.*; pl. 756 A-B.
- v 1928 *Poecilomorphus regulatus* - S. BUCKMAN, *T. A.*; vol. 7, p. 10.
- 1928 *Poecilomorphus umbilicatus* - S. BUCKMAN, *T. A.*; vol. 7, p. 10.
- v 1928 *Poecilomorphus evolutus* - S. BUCKMAN, *T. A.*; vol. 7, p. 10.
- v 1928 *Poecilomorphus fasciatus* - S. BUCKMAN, *T. A.*; vol. 7, p. 10.
- v 1928 *Poecilomorphus inclusus* - S. BUCKMAN, *T. A.*; vol. 7, p. 10.
- v 1928 *Poecilomorphus capillaceus* - S. BUCKMAN, *T. A.*; vol. 7, p. 10.
- 1955 *Poecilomorphus* cf. *cycloides* d'ORB. - MAUBEUGE 1955; p. 36; pl. 7, f. 2 a-b.
- 1966 *Poecilomorphus buckmani* - MAUBEUGE; p. 36; pl. 7, f. 3 a-c.
- v 1964 *Poecilomorphus* aff. *cycloides* (d'ORB.) - STURANI 1964 a; pl. 4, f. 1.
- v 1964 *Poecilomorphus umbilicatus* BUCKM. - STURANI 1964 a; pl. 4, f. 2.
- v 1964 *Poecilomorphus minutus* (PAR.) - STURANI 1964 a; pl. 4, f. 3.
- ? 1968 *Sonninia (Poecilomorphus) umbilicatus* (S. BUCKM.) - HUF 1968; pp. 29-31; pl. 1, ff. 1 a-b, 3 a-b (non f. 2 a-b).

Historical. D'ORBIGNY figured as *Ammonites cadomensis* (non DEFR.) (subsequently renamed *A. cycloides*) three apparently rather different ammonites.

In the monograph on the Inferior Oolite ammonites, S. BUCKMAN described and figured several different morphotypes of *Poecilomorphus cycloides*, from the Humphriesianum zone of Sherborne, Osborne and Wyke quarry, treating them as a single, polymorphic species. His description of *P. cycloides*, as well as his account of its variability, hardly need any improvement. It is also important to note that BUCKMAN (*Inf. Ool. Amm.*; p. 119) correctly separated from *P. cycloides* such auriculate microconchs as *Sonninia (Pelekodites) boweri*, which had until then been often confused with d'ORBIGNY's species.

Subsequently, however, BUCKMAN thought it advisable « for the sake of clarity » to give new specific names to the different morphotypes figured by d'ORBIGNY and himself, as well as to a few others, which had not yet been figured (*Type Ammonites*; vol. 7, p. 10).

In this way, the name *Poecilomorphus cycloides* became restricted to the more stoutly whorled, involute and strongly ribbed specimens, like d'ORBIGNY's pl. 121, ff. 1-2, which BUCKMAN selected as lectotype.

As to the vertical range of all the *Poecilomorphus* from England named by BUCKMAN, it was stated to fall entirely within the lower part of the Humphriesianum zone (*Inf. Ool. Amm.*; p. 119), and subsequently specified to be, presumably, about Epalxites hemera (*Type Amm.*; vol. 7, p. 11). The same is valid also for the Digne region (PAVIA & STURANI 1968), where *P. cycloides* is confined to the lowermost part of the Humphriesianum zone (Cycloides subzone, see p. 50). Also

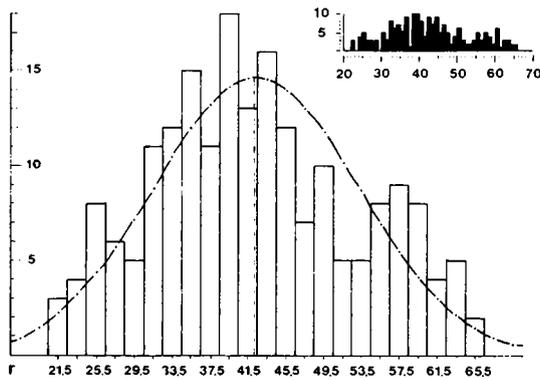


FIG. 30

Poecilomorphus cycloides (d'ORB.); population from Troch. n. 1 fossil locality (Humphriesianum zone, Cycloides subzone). Frequency distribution of the number of outer ribs to a whorl, for the whole sample, with class interval = 1 (upper right corner) and = 2 (below).

in the type region (Normandy) *P. cycloides* is found only in the « Conglomérat de Bayeux », that is, in the Humphriesianum zone (RIOULT 1964, p. 245).

Material. There are over 400 specimens from the Troch n. 1 fossil locality, at all stages of growth and up to 30 mm in diameter; 197 are fairly complete and allow us to make every type of measurements, by means of enlarged camera-lucida drawings.

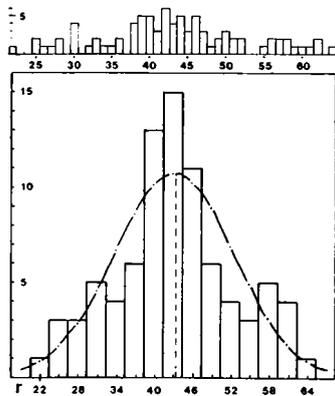


FIG. 31

Poecilomorphus cycloides (d'ORB.); population from Troch. n. 1 fossil locality (Humphriesianum zone, Cycloides subzone). Frequency distribution of the number of outer ribs to a whorl, for specimens between 11 and 13.9 mm in diameter, with class interval = 1 (above) and = 3 (below).

Another five specimens are from Ponte sul Ghelpach n. 1 assemblage (Pisa Mus.). To these should also be added what remains of the syntypes of *P. pinguis* (PARONA) and *P. minutus* (PARONA) from Camporovere (Pavia Mus.). As to the former, PARONA gave the measurements of two specimens; only one is still extant, while the one figured (PARONA 1880; pl. 5, f. 2a-b) is lost. *P. pinguis* is certainly a junior subjective synonym of *P. cycloides*, even if the latter is interpreted in the

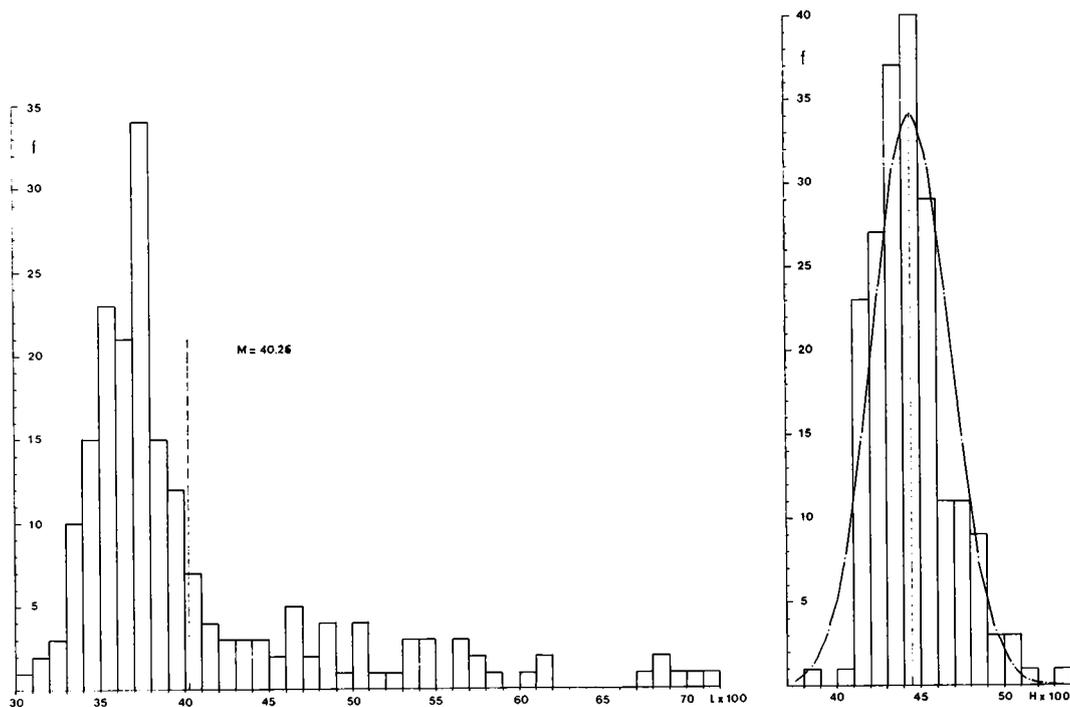


FIG. 32

Poecilomorphus cycloides (d'ORB.); population from Troch n. 1 fossil locality (Humphriesianum zone, Cycloides subzone). Frequency distributions of the whorl width (left) and of the whorl height (right), for the whole sample.

more restricted sense. As to *P. minutus*, PARONA stated that he had seen over 50 specimens; only about 15, most of which fragmentary, are still extant; the one figured (PARONA 1880; pl. 5, f. 3a-b; PARONA 1896; pl. 1, f. 4) is lost. Most of these, as well as the original figures, are very close to d'ORBIGNY's pl. 121, ff. 4-5 (holotype of *P. umbilicatus* S. BUCKM.).

Range of variability and statistical measurements. *Poecilomorphus* from Troch n. 1 fossil locality show an extremely high degree of variability (see Pl. 8), from very involute and stoutly whorled specimens nearly identical to the lectotype of *P. cycloides* (e.g., Pl. 9, fig. 13) to more evolute, compressed and densely ribbed ones, like those shown on Pl. 8, fig. 19 and Pl. 9, fig. 16.

By a merely subjective evaluation this sample can be split into several morphological groups: most of them correspond to previously described « species ». Thus, if a merely typological classification was adopted, the specimen shown on Pl. 9, fig. 13 could be called *P. cycloides* (d'ORB.), that shown on Pl. 9, fig. 15 could be called *P. umbilicatus* S. BUCKM., that of Pl. 8, fig. 6 *P. asper* S. BUCKM., that of Pl. 8, fig. 21 *P. evolutus* S. BUCKM., and so forth.

Yet, these morphological groups are by no means clearly separate from each other: far from this, they form a sort of gradational relay series, so that it would be very difficult to allocate specimens which fall midway between two adjoining groups.

Had these « groups » been found in a regular vertical succession (from « cycloides » to « evolutus » or vice versa), they would have provided a splendid example of evolutionary line, or transient species, and could have been dealt with as separate, successive chronosubspecies or species. Had they, instead, a different geographical distribution, they would represent a fine topocline of synchronous geographical subspecies. The point, however, is that all specimens under discussion

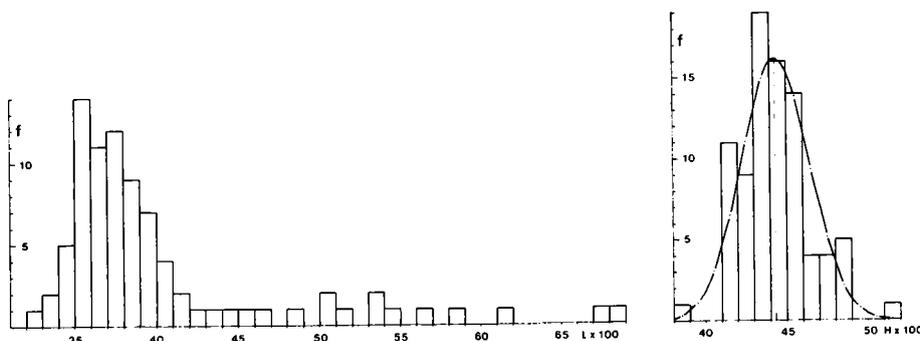


FIG. 33

Poecilomorphus cycloides (d'ORB.); population from Troch. n. 1 fossil locality (Humphriesianum zone, Cycloides subzone). Frequency distributions of the whorl width (left) and of the whorl height (right), for specimens between 11 and 13.9 mm in diameter.

are strictly synchronous and sympatric, since they come from a single patch of the coquina facies, less than half a cubic metre in volume.

Only two alternatives are therefore left: 1) the whole sample belongs to a single, highly variable biospecies; 2) several separate biospecies, whose ranges of variability may be partially overlapping, are represented within the sample.

Such alternatives may be tested by means of statistical measurements: if these show that the frequency distributions of all the different parameters follow a Gaussian curve — or in other words, show that their variability is continuous — the second alternative may be easily ruled out.

On the contrary, if statistical measurements show that the frequency distribution of at least one parameter does not follow a Gaussian curve (because the sample under discussion is affected by discontinuous polymorphism, for instance) this is not yet an evidence for discarding the first alternative, since the existence of discontinuous infraspecific polymorphism — apart from sexual dimorphism — in ammonites cannot be dismissed *a priori*, even though it was stated by TINTANT (1963, p. 24) to be « *heureusement peu probable et ... pas connu dans les types actuels* (= the living Cephalopods) ». Moreover, the observation of other non-Gaussian frequency distributions (e.g., unimodal but strongly skewed) may not be in contrast with the first alternative (i.e., a single, variable species), if the parameters showing such distributions do not vary under the influence of merely environmental but also of genetic factors.

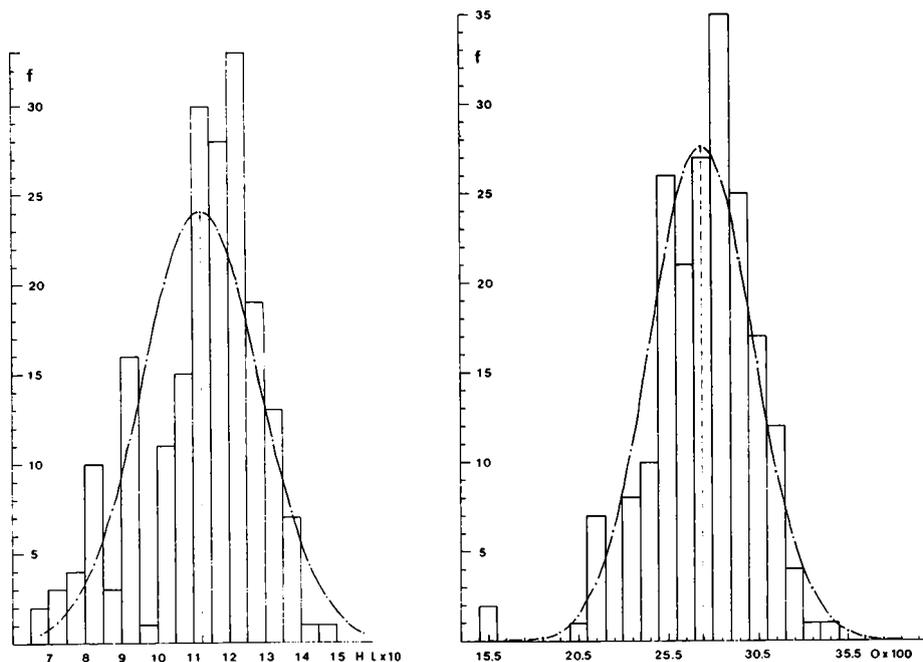


FIG. 34

Poecilomorphus cycloides (d'ORB.); population from Troch. n. 1 fossil locality (Humphriesianum zone, Cycloides subzone). Frequency distributions of the whorl section ($10 H/L$) (left) and of the umbilical width (right), for the whole sample.

Five parameters (relative whorl height (H), relative whorl width (L), relative umbilical width (O), whorl section ($H/L \times 10$) and rib density (r, since it refers to the outer ribs)) have been measured to determine, by means of a chi squared test, whether their frequency distribution follows a Gaussian curve or not.

Scatters for bivariate distributions ($H/L \times 10$ against r; $H/L \times 10$ against O; H against L) have also been prepared.

Before discussing the results of these statistical measurements, a few more points about the sample need to be stressed.

The first point is that some bias towards frequency increase of rare morphotypes and tail-forms may have been unconsciously introduced while extracting the specimens from the rock: *Poecilomorphus*, being extremely abundant, often occurred in clusters of three or four specimens side by side and some had to be broken into pieces to extract the others intact. Another possible cause of bias is that unbroken specimens only could be taken into account for the measurements, while many, more or less fragmentary, had to be discarded.

As a whole, 197 specimens above 9 mm in diameter could be measured (very young specimens below 9 mm have not been taken into account). Of these, 191 range in size between 9 and 18 mm and are therefore more or less immature, while only 6 specimens exceed a diameter of 18 mm (by the way, it must also be noted that the diameter at which maturity is attained is rather variable, according to specimens, as also shown by the microconch dimorphs, *Poecilomorphus* (*Micropoecilomorphus*) *vicetinus* (PAR.) from the same assemblage).

Measurements taken on the same specimen at different diameters (at the end of the last preserved whorl and at 180° from this, respectively) show that all five parameters are affected by small, but significant changes during growth; for instance, on the same specimen the relative umbilical width (O) may decrease from 0.266 to 0.232 between diameters of 10.9 and 15.5 mm, while the whorl section becomes more compressed (H/L changes from 1.15 to 1.32) and the secondaries become

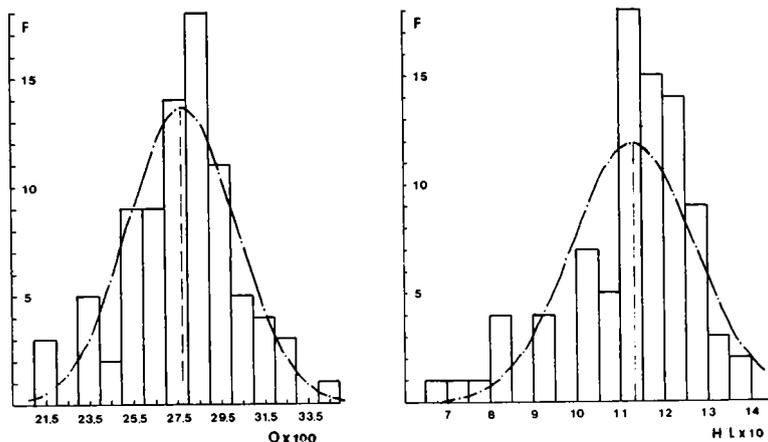


FIG. 35

Poecilomorphus cycloides (d'ORB.); population from Troch. n. 1 fossil locality (Humphriesianum zone, Cycloides subzone). Frequency distributions of the umbilical width (left) and of the whorl section (10 H/L) (right), for specimens between 11 and 13.9 mm in diameter.

more numerous (from about 36 to 43). As a consequence of their disharmonic growth, the frequency histograms of the different parameters as well as the scatters for bivariate distributions will be more or less strongly biased and their interpretation rendered more delicate (TINTANT 1963, pp. 43, 45-46).

In order to reduce the effects of the latter inconveniences, the frequency distributions of the different parameters have been calculated twice: first on the whole sample (N = 197) and then on specimens falling within a much narrower size range, i.e. between diameters of 11 and 13.9 mm. The latter were still numerous enough (N = 84) to allow the use of a chi squared test (LAMOTTE 1948, p. 310).

Rib density. The frequency histogram for the whole sample is shown in text-fig. 30. First order classes (class interval = 1) have been regrouped two by two, so that the class interval used in the histogram is = 2; the resulting second order classes have been defined by their median point; the range (referring to the outer limits of the classes) is from 21 to 66 secondaries / last visible whorl; the mode is 39.5; the mean is 42.36 (by the way, this is not an absurdity, because the number of ribs to a whorl is not necessarily a whole number); the standard deviation is ± 10.79 ; the coefficient of variability is very high (25.47 %). The histogram, even though possessing a main peak, is roughly polymodal. The same parameters have been used to calculate the normalized distribution curve and the chi squared

test: the difference between the observed and the calculated frequencies turned out to be significant, P being comprised between 5 and 4 %.

When the same parameter (r) is measured on specimens between 11 and 13.9 mm (test-fig. 31), the coefficient of variability decreases to 21.7 % while the differences between the observed and the calculated frequencies are no longer significant ($P = 17$ %).

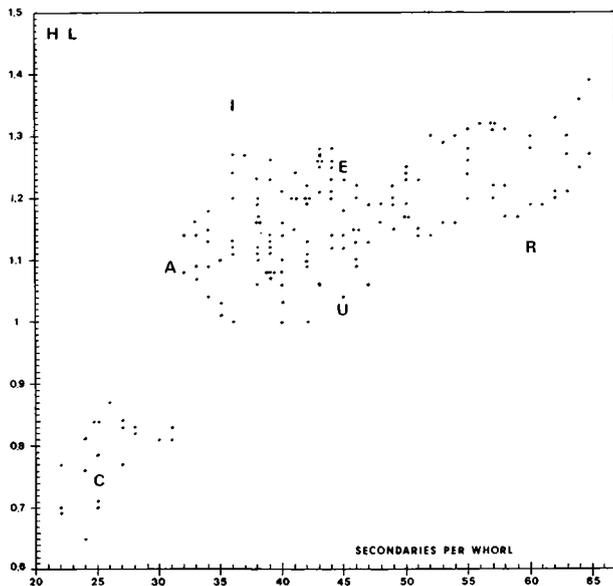


FIG. 36

Poecilomorphus cycloides (d'ORB.); population from Troch. n. 1 fossil locality (Humphriesianum zone, Cycloides subzone). Scatter of whorl section (H/L) against rib density, for the whole sample. The capital letters indicate the plots of the holotypes (or lectotypes) of *P. cycloides* (C), *P. asper* (A), *P. umbilicatus* (U), *P. inclusus* (I), *P. evolutus* (E) and *P. regulatus* (R).

We may conclude that, as for rib density, the sample is therefore homogeneous.

Whorl height. The frequency histogram for the whole sample ($N = 197$) is shown in text-fig. 32; the mean is 44.49; the standard deviation is ± 2.306 ; the coefficient of variability is moderately low (5.1 %). Even though the resulting histogram is somewhat skewed, the observed frequency distribution can still be regarded as normal, the degree of probability given by the chi squared test being just above the significance threshold ($P = 5.8$ %).

The same histogram for specimens between 11 and 13.9 mm in diameter (text-fig. 33) shows a slightly lower standard deviation (± 2.079) and a slightly lower coefficient of variability (4.69 %); the observed frequency distribution may be regarded as normal ($P = 12.5$ %).

As for whorl height too, we may therefore regard the sample as homogeneous.

Whorl width. The frequency histogram for the whole sample ($N = 197$) is shown in text-fig. 32; the range of variability is wide, from 0.30 to 0.71; the mode is 0.37; the mean is 0.4025; the standard deviation is ± 8.149 ; the coefficient of

variability is rather high (20.14 %). The histogram shows a single, main peak for $L = 0.37$, but is strongly skewed, with a long tail towards increasingly higher values of L , which correspond to the more stoutly whorled specimens of the « cycloides » group. Calculation of the chi squared test, using the same parameters, gave an exceedingly low degree of probability so that the observed frequencies cannot fit a Gaussian distribution, but are rather reminiscent of a Poisson distribution.

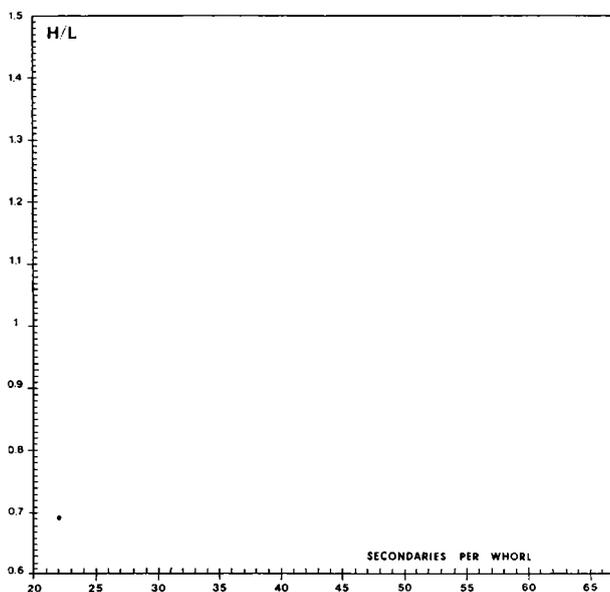


FIG. 37

Same as fig. 36. Specimens between 11 and 13.9 mm in diameter only.

This sort of distribution, however, is not incompatible with the first alternative (*i.e.*, with the whole sample belonging to a single, highly variable species): it just means that the parameter under discussion is not affected by a merely phenotypic variability. According to LAMOTTE (1948, p. 91) distributions of this type are observed in genetics to represent the frequency of a character or phenotype (« stoutly whorled », in the present case), which has very low chances of being produced. Notwithstanding the rather wide range of variability shown by the whorl width, such a distribution may mean that the adaptative significance of, or alternatively, the selection pressure on this character may have played a significant role.

The same remarks apply to the histogram based on specimens between 11 and 13.9 mm in diameter (text-fig. 33).

Umbilical width. The frequency histogram for the whole sample (text-fig. 34) shows a rather wide range of variability, between 0.15 and 0.35, and a moderately high coefficient of variability (10.37 %); the mode is 0.285, the mean is 0.2745, the standard deviation is ± 2.848 . The difference between the observed and the calculated frequencies is significant ($P = 1\%$).

When this same parameter is measured on specimens between 11 and 13.9 mm in diameter (text-fig. 35) the coefficient of variability is reduced to 8.87 % and the observed frequency distribution becomes perfectly normal ($P = 70 \%$).

When the negative influence of growth rate is suppressed, the sample may therefore be regarded as homogeneous also with regard to the umbilical width.

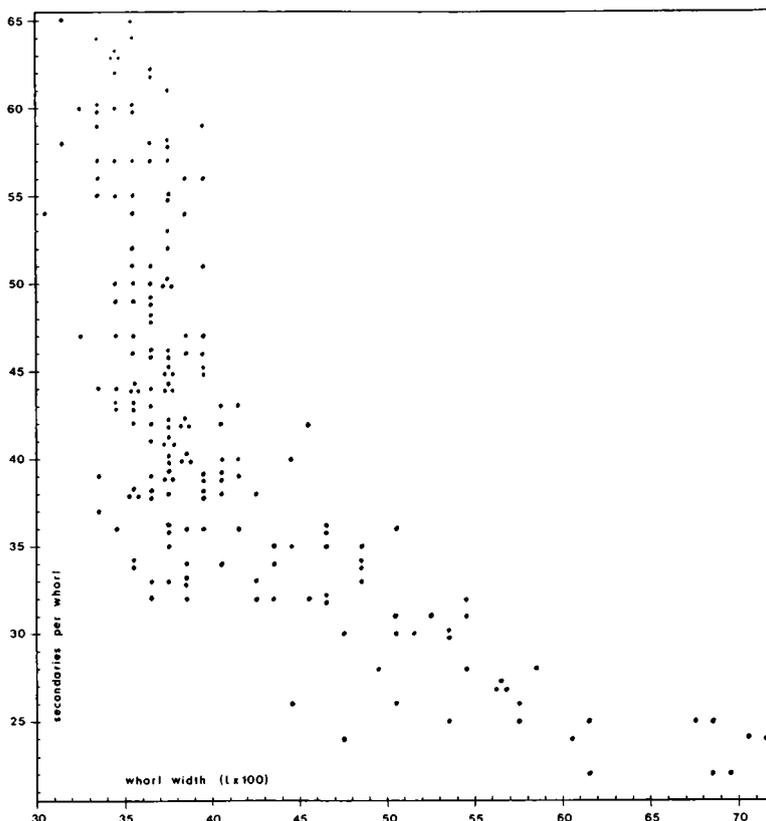


FIG. 38

Poecilomorphus cycloides (d'ORB.); population from Troch. n. 1 fossil locality (Humphriesianum zone, Cycloides subzone). Scatter of rib density against whorl width, for the whole sample.

Whorl section ($H/L \times 10$). The frequency histograms based on both the whole sample (text-fig. 34) and the specimens between 11 and 13.9 mm (text-fig. 35) do not follow a normal distribution: the difference between the observed and the calculated frequencies is highly significant (P is less than 0.5 %) in the first case and significant ($P = 2 \%$) in the second case. This is a direct consequence of the similarly abnormal distribution of L , which enters directly in the calculation of $H/L \times 10$; the interpretation is therefore the same.

Covariation. The scatter of whorl section ($H/L \times 10$) against rib density for the whole sample (text-fig. 36) shows a strong positive correlation (the coefficient of correlation is 0.44), without any obvious clusters or discontinuities. The same observation is still valid when the scatter is made for specimens between 11 and 13.9 mm (text-fig. 37).

The scatter of whorl width against rib density is analogous (text-fig. 38) and shows a strong negative correlation; in this case, too, the regression is curvilinear rather than rectilinear.

BUCKMAN's law of covariation (cf. WESTERMANN 1966, p. 305; also TINTANT 1963, pp. 83, 127-128) is thus confirmed also for *Poecilomorphus* (the stouter the whorls, the stronger the ribbing).

The scatters of whorl section ($H/L \times 10$) against relative umbilical width (text-figs. 39, 40) show a very weak, but doubtfully significant, positive correlation, without any obvious clusters.

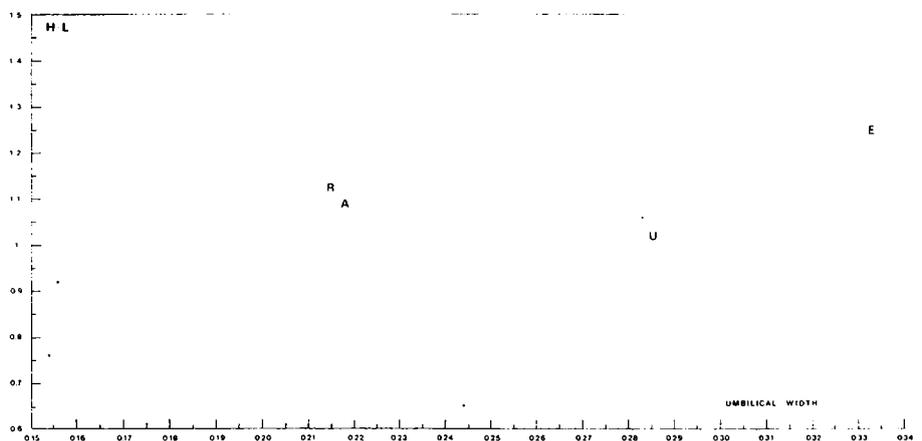


FIG. 39

Poecilomorphus cycloides (d'ORB.); population from Troch n. 1 fossil locality (Humphriesianum zone, Cycloides subzone). Scatter of whorl section (H/L) against umbilical width, for the whole sample. The capital letters indicate the plots of the holotypes (or lectotypes) of *P. regulatus* (R), *P. asper* (A), *P. umbilicatus* (U) and *P. evolutus* (E). Those of *P. cycloides* and *P. inclusus* would fall just out of the graph, their relative umbilical width being less than 0.15.

The scatter of whorl height ($H \times 100$) against whorl width ($L \times 100$) (text-fig. 41) shows a good positive correlation (0.50); the representative points, however, form a comet-like pattern, with an important cluster for values of $H \times 100$ comprised between 41 and 46 and values of L comprised between 34 and 40; this « head » is followed by a long « tail » towards increasingly high values of L , i.e. towards stoutly whorled specimens of the « cycloides » group. This particular pattern is obviously dependent on the strongly skewed frequency distribution of L .

To summarize, we may conclude that, once the effects of disharmonic growth have been eliminated, the frequency distributions of all parameters, as well as the scatters for bivariate distributions seem to be in reasonable accordance with the hypothesis that the population of *Poecilomorphus* under discussion belongs to a single, highly variable species. While the frequency distributions of most parameters may be regarded as normal, those of whorl width (L), and hence also of the H/L ratio are strongly skewed, even though unimodal. This feature may be due, as we have seen, to the adaptative significance of, or alternatively to the selection pressure acting on this character (whorl width), while the others are not significantly affected.

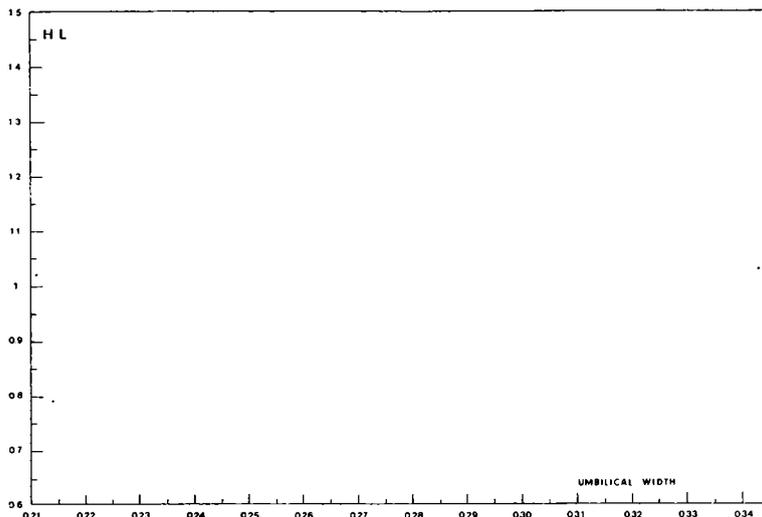


FIG. 40

Same as fig. 39. Specimens between 11 and 13.9 mm. in diameter only.

Ribbing anomalies and pathologic specimens. On a few, apparently fully grown specimens, towards the end of the body chamber the secondaries are projected to cross the keel as blunt chevrons, instead of ending at the ventrolateral edges. This may be interpreted as the abnormal reappearance of an ancestral feature, reminiscent of that shown by *Toxalambites* (Pl. 9, fig. 12).

Another five specimens, like that shown on Pl. 14, fig. 20, are clearly pathologic; on these, the ventral part of the mantle, responsible for the secretion of the keel, has been injured; after the injury was repaired, the scarred part of the mantle shifted to the middle of one flank, so that the ribs of the opposite side became prolonged across the newly formed venter and a new symmetry was roughly restored. The siphuncle, which lay behind the injured point when the injury occurred, has not suffered any displacement.

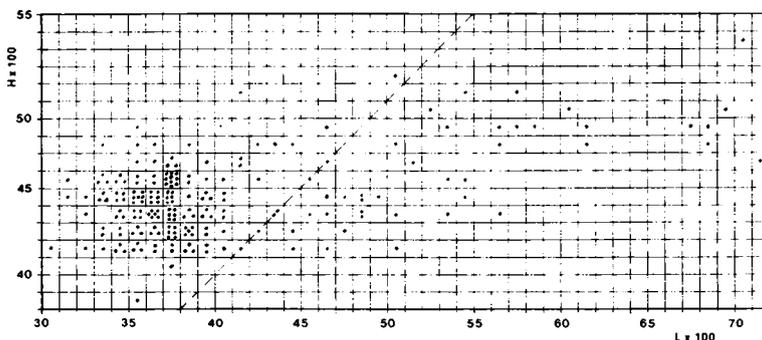


FIG. 41

Poecilomorphus cycloides (d'ORB.); population from Troch. n. 1 fossil locality (Humphriesianum zone, Cycloides subzone). Scatter of whorl height against whorl width, for the whole sample. The dotted line joins the plots of specimens having $H/L = 1$.

SUBGENUS MICROPOECILOMORPHUS n. subg.

Diagnosis: dwarf, auriculate dimorphs of *Poecilomorphus*.

Type species: *Haploceras? vicentinum* PARONA, 1880 (= *Poecilomorphus* (*Micropoecilomorphus*) *vicetinus* (PARONA)).

Type region: Venetian Alps, Sette Comuni.

Type level: Humphriesianum zone, Cycloides subzone.

Poecilomorphus (*Micropoecilomorphus* n. subg.) *vicetinus* (PARONA)

(Pl. 9, figs. 1-11)

1880 *Haploceras? vicentinum* - PARONA 1880; pp. 262-263; pl. 5, f. 7a-b.

1896 *Oppelia vicetina* (PARONA) - PARONA 1896; p. 13; pl. 1, f. 10.

The type series. The specimen from Camporovere (Humphriesianum zone, Cycloides sbz.) figured by PARONA (1880; pl. 5, f. 7a-b; this work, Pl. 9, fig. 10) may be chosen as lectotype. It measures: D 13 mm; H, 0.379; L, 0.279; O, 0.367. The whorl section is compressed-elliptical, with rounded umbilical slopes, slightly convex flanks and a bluntly fastigate venter. The coiling is moderately evolute; the umbilicus widens rapidly towards the end of the body chamber. The peristome is preceded by a weak sinuous furrow and is provided with short, narrow lateral lappets and a blunt ventral rostrum. Moderately dense, but almost obsolete falcooid ribs occur on the outer half of the flanks (the inner half is nearly smooth). Towards the end of the body chamber the last few ribs cross the fastigate venter as blunt, almost imperceptible chevrons.

Only two out of the remaining syntypes are certainly conspecific; one is shown on Pl. 9, fig. 9. Another two fragmentary syntypes do not seem to belong to this same taxon, but are just immature *Poecilomorphus cycloides*.

The population from Troch n. 1 fossil locality. *P.* (*Micropoecilomorphus* n. subg.) *vicetinus* (PAR.) is also well represented in the assemblage from Troch n. 1 fossil locality: there are 110 complete adult specimens, ranging in size between 6 and 11.5 mm. None reaches as large a size as the lectotype; none the less, the latter still seems to fall within the range of size-variability as a tail-form; the remaining features (ribbing, shape of whorl section, etc.) being at any rate closely matched by those of several specimens from Troch.

This profuse sample shows as high a degree of variability as that shown by the macroconch dimorph, *Poecilomorphus cycloides*: every morphotype of the latter is closely matched here in miniature (Pl. 9, fig. 1-11), the only difference being that the microconch specimens (*P.* (*M.*) *vicetinus*) are as a rule proportionally more evolute than the corresponding macroconch morphotypes of *P. cycloides*. As a consequence, distinction between adult microconchs and immature macroconchs remains possible and is usually easy.

In this case too there is a strong degree of correlation between the different parameters and their variability: as the H/L ratio increases (i.e. the whorl section

becomes less stout) rib density, umbilical width and adult size also increase, while the strength of ribbing gradually decreases, so that the more evolute and more densely ribbed specimens are nearly smooth. The venter, as well, varies from bisulcate to bluntly fastigate, through weakly carinate, as the H/L ratio increases.

In this respect, the lectotype appears to be a tail-form also for the other features, besides the adult size.

Intergradation between the extreme morphotypes (such as the lectotype and the specimen figured on pl. 9, fig. 11, on one hand, and that shown on pl. 9, fig. 1, on the other) is complete. No statistical measurements have been made, however, to ascertain whether the frequency histograms for the different parameters can be reduced to normal distribution curves or not, as happens with the macroconch dimorphs.

FAMILY OPPELIIDAE BONARELLI, 1894

SUBFAMILY OPPELIINAE BONARELLI, 1894

General remarks. According to the « Treatise » this subfamily is represented, in the Bajocian, by the following genera: *Bradfordia* (Sowerbyi - Sauzei zones), *Oppelia* (Sauzei - Parkinsoni zones), *Oxycerites* (U. Baj. - Callovian), *Oecotraustes* (U. Baj. - M. Callovian), *Stegoxytes* (Humphriesianum zone), *Trimarginia* and *Margarina*. I have already explained the reasons for thinking *Bradfordia* and *Stegoxytes* are better placed within Haploceratidae, while *Hebetoxytes*, previously thought to be a Strigoceratid, is here regarded as an ancestral Oppeliid.

GENUS OPPELIA WAAGEN, 1869

Oppelia subradiata (Sow.)

(Pl. 7, figs. 2-3)

- v 1823 *Ammonites subradiatus* - J. de C. SOWERBY, Min. Conch.; p. 23; pl. 421, f. 2 (holotype).
1845 *Ammonites subradiatus* SOWERBY - d'ORBIGNY 1842-49; pl. 118, f. 3 (? non pl. 118, ff. 1, 2, 4 - type of *O. subcostata* (J. BUCKM.); non pl. 129, f. 3 = *Oecotraustes pulcher* (S. BUCKM.)).
? 1886 *Oppelia propefusca* - de GREGORIO 1886; p. 13; pl. 1, f. 25.
? 1886 *Harpoceras stevensoni* - de GREGORIO 1886; p. 13; pl. 1, f. 23.
1952 *Oppelia subradiata* Sow. - ARKELL 1951-59; pp. 50-51; text-f. 1 a-b (holotype) (? text-f. 2).

There are over 20 immature specimens from Troch n. 1 fossil locality and another two from Cima Tre Pezzi, ranging in size from 10 to 35 mm (est.) and often retaining part or the whole of the body chamber. They show particularly close agreement with d'ORBIGNY's pl. 118, f. 3; as already stated by J. BUCKMAN (1881, p. 61), among all published figures this appears nearest to the holotype. The latter — which I was able to study at the British Museum (Nat. Hist.) — has recently been refigured by ARKELL. It is a wholly septate specimen, characterized by very dense and fine falcoid ribs (over 90 secondaries on the last visible whorl),

a narrow umbilicus, compressed whorls and a fastigate venter. Up to a diameter of about 35 mm the weak primary ribs, after the bend in the middle of the flanks, give rise to 2-3 secondaries each; these are all of the same strength and not regularly arched, but gently concave and rursiradiate up to the ventrolateral edge where they become strongly projected. Just beyond this point the secondaries end abruptly, leaving a narrow smooth band on both sides of the fastigate venter. Beyond a diameter of 35 mm the primaries tend to fade, while the secondaries become shorter, but for a few at more or less regular intervals.

The measurements of the holotype, as given by ARKELL, are: D 50 mm; H, 0.56; L, 0.24; O, 0.10.

In ARKELL's view, *O. aspidoides* var. *bajocensis* FAVRE (1912, pl. 1, f. 7) and *O. lectotypa* S. BUCKM. (1924, T.A., pl. 524) are probably junior synonyms of *O. subradiata* (Sow.) and represent its fully grown state. Notwithstanding ARKELL's different opinion, such specimens are certainly closer to d'ORBIGNY's pl. 118, ff. 1-2, which is the type of *O. subcostata* (J. BUCKM.). The inner whorls of *O. subcostata* seem on the other hand to be best represented by such specimens as those figured by FAVRE (1912; pl. 1, ff. 1b, 3; *non cet.*) and ROMAN & PETOURAUD (1927; pl. 7, f. 7). At a comparable diameter these differ from the holotype of *O. subradiata* in being less densely ribbed and slightly more evolute. The point then is: shall we regard *O. subcostata* (J. BUCKM.) as a valid species or a simple morphotype within *O. subradiata* (Sow.)? This obviously needs a careful revision of the rich assemblages from Southern England and the Normandy coast, and is therefore beyond the scope of the present paper.

Returning to the specimens from the Sette Comuni, they form a morphologically uniform population that shows, as a whole, particularly close agreement with both the holotype and d'ORBIGNY's pl. 118, f. 3, and allow the description of the early development of ribbing style.

Up to about 8 mm the shell is smooth and has a rounded venter. Thereafter dense, regularly arched outer ribs appear, while the venter becomes sharp and the inner half on the flanks remains smooth. By a diameter of about 15 mm, and up to about 25 mm, all the secondaries — still regularly arched — extend dorsally to the bending point, just past the middle of the flanks; here they are bundled by twos or threes and pass into blunt, prorsiradiate primaries (see Pl. 7, fig. 3). The venter is sharply fastigate, but well marked ventrolateral edges are still missing. Most of the specimens from the Sette Comuni do not pass beyond this stage. On a single, larger fragment (est. diam. 35 mm) the ventrolateral edges eventually appear and the outer ribs are no longer regularly arched, but almost straight and rursiradiate up to the ventrolateral edges, after which they become projected: this is exactly the style of ribbing shown by the holotype at the beginning of its last visible whorl, at a comparable diameter.

As to the horizon of *O. subradiata* s. s., the type level is « probably Sauzei zone » according to ARKELL. More recent work by C. F. PARSONS shows that the

basal part of the Humphriesianum zone is also represented in the presumed type horizon, the « Brown Ironshot » of Dundry. In the Digne region, densely ribbed specimens almost identical to the type occur in the lowermost beds of the Humphriesianum zone. In the Sette Comuni it reaches the base of the Subfurcatum zone, at Cima Tre Pezzi fossil locality, but does not seem to range higher. Records from the higher zones of the Bajocian are difficult to assess, since they may refer to other congeneric species.

Both *Harpoceras stevensoni* DE GREGORIO and *Oppelia propefusca* DE GREGORIO, the types of which are probably lost, seem to be based on immature specimens of *O. subradiata*, at least to judge from the type figures and descriptions.

Oppelia flexa (S. BUCKMAN)

(Pl. 6, fig. 14; Pl. 7, fig. 1)

- 1912 *Oppelia subradiata* (non SOW.) - FAVRE 1912; pl. 1, f. 1 a (non cet.).
 1918 *Oppelia subradiata* (non SOW.) - DE GROSSOUVRE 1918; pl. 13, f. 7.
 1924 *Flexoxytes flexus* - S. BUCKMAN, T. A., pl. 525 A, (holotype).
 1924 *Flexoxytes flexus* - S. BUCKMAN, T. A., pl. 525 B (paratype).
 1935 *Oppelia subradiata* (non SOW.) - BIRCHER 1935; pl. 9, f. 6 (non cet.).
 1939 *Oppelia flexa* BUCKM. - ROCHÉ 1939; p. 165; pl. 6, ff. 1-2.
 1964 *Oppelia* sp. of the *subradiata* group of authors - STURANI 1964 b; pl. 2, f. 4; text-f. 14 (non cet.).
 ? 1964 *Oecotraustes genicularis* (non WAAG.) - STURANI 1964 a; pl. 4, f. 8.

The fine specimen from Troch n. 1 fossil locality figured on Pl. 7, fig. 1 shows particularly good agreement with both the holotype and paratype. It is certainly not fully grown, but retains part of the body chamber.

The main differences from *O. subradiata* s. s. consist of: a stouter whorl section; a wider umbilicus; a blunter venter, with a wider smooth band, and a different style of ribbing. Up to about 20-25 mm diameter there are only short outer ribs, that do not extend dorsally to the middle of the flanks; they are slightly arched and gently rursiradiate. At higher diameters, between every third or fourth outer rib there is one stronger and more rursiradiate that reaches to the middle of the flanks and passes, after a sharp bend, to a weak prorsiradiate primary. The next two or three shorter secondaries that follow each stronger one are bunched to it in such a way to give a somewhat virgatotome appearance to the style of ribbing.

Other specimens from the same locality as well as from younger assemblages (Monte Meletta, Monte Longara, etc.) probably belong to this same species but are much smaller. They can however be distinguished from those of *O. subradiata* at comparable diameters, because of their strong, less arched and usually rursiradiate outer ribs. The specimen from Monte Longara figured by PARONA as *Lunuloceras stevensoni* (non de GREGORIO) (1896; pl. 1, f. 7) falls within this lot and is 15 in diameter; it differs from de GREGORIO's type figure (1886; pl. 1, f. 23) because of its less dense and strongly rursiradiate outer ribs.

The horizon of the English paratype is Subfurcatum zone, « *Leptosphinctes hemera* »; the type is from Normandy.

Oppelia subtilicostata PARONA

(Pl. 6, figs. 17, 21)

v 1896 *Oppelia subtilicostata* - PARONA 1896; pp. 13-14; pl. 1, f. 11.

? 1935 *Oppelia* sp. - BIRCHER 1935; p. 136; pl. 9, f. 7; tex-f. 16.

non *Oppelia subtilicostata* - STURANI 1964 a - pl. 4, f. 9.

The lectotype (Pl. 6, fig. 21) (PARONA 1886; pl. 1, f. 11) is from Ponte sul Ghelpach n. 2 assemblage (Pisa Museum), that is from the Subfurcatum zone, Banksi subzone. It is 27.5 mm in diameter, with part of the body chamber preserved; at 20 mm the other measurements are: H, 0.48; L, 0.25; O, 0.23.

Other syntypes include over ten smaller specimens from the same assemblage and a few fragments from Monte Longara (Padua Mus.). Specimens belonging to *Oecotraustes pulcher* (S. BUCKM.), *O. genicularis* WAAG. and *O. westermanni* STEPH., from Monte Meletta and Monte Longara, had also been labelled as « *Oppelia subtilicostata* » by PARONA.

This species has also been found at Cima Tre Pezzi (over 20 specimens, either small nuclei or fragments), Longara di sotto n. 1 (6 specimens) and Rotherbrunn (1 fragm.) fossil localities.

Description. Shell discoidal, compressed, involute, about 3/4 of each whorl being covered by the next. There is a short, well marked umbilical wall; the umbilical edge is rounded. The flanks are gently convex and converge ventrally, ending at well marked ventrolateral edges; the venter is narrow and fastigate. The peripheral ribs are dense, fine, regularly arched and strongly projected at the periphery; on the middle of the venter they are interrupted by a narrow median smooth band. Towards the middle of the flanks they tend to fade and are bundled in twos or threes to form blunt, sinuous, almost obsolete primary folds.

O. subtilicostata is close to *O. subradiata*, from which, however, it may be easily distinguished by its more discoidal shape, as well as by its slightly denser and more regularly falcate style of ribbing, with more strongly projected ribs at the periphery.

The style of ribbing is very close to that of *Stegoxytes parvicarinatus*: in the latter species, however, the ribs pass uninterrupted over the parvicarinate venter and the flanks are spirally grooved.

To judge from the available specimens, and also taking into account the very small size of *Oecotraustes longarae* n. sp. — its microconch dimorph — *O. subtilicostata* does not seem to have reached such large a size as most other congeneric forms.

GENUS OECOTRAUSTES WAAGEN, 1869

General remarks. After a study of BUCKMAN's types at the Geological Survey Museum, I have hardly any doubt that *Oppeliina* S. BUCKMAN, 1926 must be added to the genera listed by J. STEPHANOV (1966, p. 37) as junior synonyms of *Oecotraustes*.

Oecotraustes genicularis WAAGEN

(Pl. 6, figs. 11-13)

1966 *Oecotraustes* (*Oecotraustes*) *genicularis* WAAGEN - STEPHANOV 1966; pp. 38-39; pl. 1, f. 1 (lectotype) (*cum syn.*).
non 1964 *Oecotraustes genicularis* - STURANI 1964 a; pl. 4, f. 8.

For description see STEPHANOV. There are 13 specimens from the basal Humphriesianum zone of Troch n. 1 fossil locality, varying in size between 10 and 22 mm; only one of them, at an estimated diameter of 18 mm shows the base of the adult lappets; all others, though retaining part or whole of the body chamber, have the peristome broken.

The peripheral ribs are rather dense (the lectotype has about 60 secondaries on the last visible whorl; the specimen figured on Pl. 6, fig. 11 has about 64 and closely matches the lectotype); they cover nearly the whole outer half of the flanks (the inner half being completely smooth) and are rounded. According to different specimens or on the same specimen at different diameters, the ribs may either be gently arched and prorsiradiate or nearly straight and rursiradiate, with all gradations in between.

The venter is fastigate, but less sharp than in other congeneric Bajocian species; it becomes bluntly rounded towards the end of the body chamber. The specimen figured on Pl. 6, fig. 11 measures: D, 17.1 mm; H, 0.427; L, 0.251; O, 0.28.

O. umbilicatus (BUCKM.), thought by ARKELL to be a junior synonym of *O. genicularis* (1951-59; p. 54) has about the same proportions but a different style of ribbing, which recalls that shown by *Oppelia flexa*: faint primaries occur on the inner half of the flanks; while the outer ribs, besides being sharper, are strongly rursiradiate almost to the periphery, where they are sharply bent and projected.

Nuclei of *Oppelia* (both *O. subradiata* and *O. flexa*), at any comparable diameter are less flattened laterally, with a slightly stouter and more regularly ogival whorl section. The spiral angle is also different (see Pl. 6, fig. 14).

Oecotraustes westermanni STEPHANOV

(Pl. 6, fig. 19; Pl. 16, fig. 13)

1966 *Oecotraustes* (*O.*) *westermanni* - STEPHANOV 1966; pp. 39-40; pl. 1 f. 4 (*cum syn.*).

For description see STEPHANOV. There are two specimens from the Subfurcatum zone, Schroederi subzone (one from Monte Longara and one from Monte Meletta); another four specimens are from Longara di Sotto n. 1 fossil locality (Polygyralis subzone).

Both specimens figured (Pl. 6, fig. 19, and Pl. 16, fig. 13) have part of the body chamber preserved, but lack the auriculate peristome. But for their smaller size, both show good agreement with the holotype.

O. westermanni is distinguished from *O. genicularis* in being more compressed laterally and in possessing much shorter outer ribs. *O. pulcher* is more involute; *O. umbilicatus* has a different style of ribbing.

Oecotraustes pulcher (S. BUCKMAN)

(Pl. 6, fig. 20)

1846 *Ammonites subradiatus* (non Sow.) - d'ORBIGNY 1842-49; pl. 129, f. 3 (*non cet.*).

1909 *Oecotraustes genicularis* (non WAAG.) - R. DOUVILLÉ. Pal. Univ., pl. 134, 134 a; ff. 1 b-c, C4, C4 a-b (*non cet.*).

v 1926 *Oppeliina pulchra* - S. BUCKMAN, T. A., pl. 670 (holotype).

The holotype (GSM 49271) comes from the early middle part of the Subfurcatum zone (« Leptosphinctes » hemera) of Frogden Quarry, Osborne, Dorset. It is fully grown at a diameter of 35 mm and has slightly more than half a whorl of body chamber. The other measurements are: H, 0.474; L, 0.217; O, 0.214.

The coiling is moderately involute, without any tendency to become elliptical or contracted. The whorl section is high and compressed, with a short, nearly vertical umbilical wall, a well marked umbilical edge, slightly convex sides, with the maximum thickness at mid-height. The venter is narrow and sharply fastigate up to the mouth border. This is preceded by a sinuous furrow and bears well developed spatulate lappets and a short ventral rostrum.

On the inner half of the flanks the primaries appear as weak striae, visible on both the internal mould and the surface of the test. Past the sharp bend they become stronger and bifurcate; the secondaries become increasingly stronger as they approach the periphery, where they end abruptly, leaving a narrow smooth band along the middle of the sharply fastigate venter. From the middle of the flanks to the ventrolateral edges the outer ribs are slightly arched and rursiradiate. At the periphery, short before they terminate, they become strongly projected. On the holotype there are about 68 outer ribs on the last whorl. Especially on the body chamber they are sharp and separated by interspaces as wide as the ribs themselves: this gives a machine-made aspect (ARKELL 1951-59; p. 69).

Among the material from the Sette Comuni, the wholly septate specimen from the Monte Longara assemblage (Padua Mus.) figured on Pl. 6, fig. 20 shows near perfect agreement with the septate whorls of the holotype. A few more specimens from the same assemblage also seem to belong here, but are more fragmentary.

Oecotraustes genicularis is more evolute, less compressed laterally and less sharply ribbed.

Oecotraustes longarae n. sp.

(Pl. 6, fig. 18; Pl. 16, figs. 11-12)

The holotype (Pl. 16, fig. 12) comes from the Subfurcatum zone, Polygyralis subzone of Longara di Sotto n. 1 fossil locality. It is only 13 mm in diameter but certainly adult, since it shows on both sides short lateral lappets. The coiling is

involute; the whorls compressed, with a short, rounded umbilical wall, slightly convex sides and a narrow, fastigate venter. The ribs appear only on the body chamber, which occupies about 2/3 of the last whorl, and are extremely fine, dense and regularly falcate; on the inner half of the flanks they appear as almost imperceptible prorsiradiate striae, while on the outer half they become more evident and are regularly arched forward, until they become strongly projected at the periphery. *O. longaræ* n. sp. looks like a miniature *Oppelia subtilicostata* PAR. and probably represents its microconch dimorph.

Apart from the holotype, there are six paratypes from the same locality and horizon.

O. pulcher (BUCKM.) is almost three times as large, but otherwise similar; its outer ribs, however, are not so strongly projected at the periphery as those of *O. longaræ* n. sp..

The measurements of the holotype are: D 13 mm; H, 0.45; L, 0.275; O, 0.25.

FAMILY STRIGOCERATIDAE BUCKMAN, 1924

General remarks. *Hebetoxytes*, previously placed within this family is here regarded as an ancestral Oppeliid; on the other hand *Cadomoceras*, previously placed in the Haploceratidae, is here believed to represent the microconch dimorph of *Strigoceras*.

GENUS STRIGOCERAS QUENSTEDT, 1886

Strigoceras bessinum BRASIL

(Pl. 4, figs. 16-19)

1895 *Strigoceras bessinum* - BRASIL 1895; pp. 43-44; pl. 4, ff. 6-7.

Fifty specimens from Troch n. 1 fossil locality, ranging in size between 10 and 20 mm, form a rather uniform population and show perfect agreement with the holotype, which is also from the Humphriesianum zone. More specimens have also been found in the Subfurcatum zone at Longara di Sotto n. 1 and Cima Tre Pezzi fossil localities; these, however, are slightly different from both the holotype and the population from Troch n. 1 fossil locality, so that their identification is not completely sure.

BRASIL's original description hardly needs any improvement. Shell compressed, discoidal, carinate, extremely involute. Umbilicus very small, with short overhanging walls; umbilical edge rounded; flanks nearly flattened and subparallel; keel small, narrow and solid; when it is removed, the venter appears bluntly rounded. Ribs falcoid, almost obsolete, especially on the outer half of the flanks; some specimens are nearly smooth, but for blunt, prorsiradiate primary folds confined to the inner half of the flanks and radiating from the umbilical margin. Strigiation absent.

S. bessinum does not seem to reach as large a size as the other congeneric forms and is easily distinguished because of its flattened, almost parallel flanks and its nearly smooth aspect.

Strigoceras sp. ind. juv. cf. *strigifer* (BUCKMAN)

(Pl. 4, figs. 11-15; Pl. 16, fig. 10)

1964 *Strigoceras* aff. *strigifer* (BUCKM.) - STURANI 1964 a; pl. 4, f. 6.

In the assemblage from Troch n. 1 fossil locality (Humphriesianum zone, Cycloides subzone), apart from *S. bessinum* BRASIL there is another species of *Strigoceras*, represented by over 60 specimens. They are all immature, but often retain part of the body chamber; the largest being 25 mm in diameter (Pl. 4, fig. 13).

The shell is compressed, involute and sharply keeled. The whorl section is lanceolate, more compressed than that of *S. truellei* at any comparable diameter. The whorl height increases at a much faster rate than the whorl width, so that the nucleus is proportionally stouter than the middle whorls. Umbilicus small; umbilical walls rounded and partially overhanging. The inner halves of the flanks are smooth, flattened and slightly divergent up to the point where the maximum whorl width can be measured. The outer halves of the flanks are gently convex and converge toward the narrow, sharply keeled venter; from a diameter of about 7 mm onward they are covered with blunt, gently arched outer ribs, which increase regularly in strength as they approach the venter. The hollow, floored keel is tall, narrow and sharp; when it is removed the venter appears still sharper than in most other congeneric forms (especially *S. bessinum* and *S. paronai*).

As to the density and strength of the ribs, two extreme morphotypes may easily be distinguished within this rich population from the Sette Comuni: some specimens (Pl. 4, figs. 13-15; Pl. 16, fig. 10) are more densely ribbed (up to 43 outer ribs per whorl, at a diameter of about 24 mm), more compressed laterally and more involute; others (Pl. 4, figs. 11-12) have fewer and stronger ribs (26 per whorl at a diameter of 17 mm), a stouter whorl section, a slightly wider umbilicus and a taller keel. Since all intermediate gradations also occur they seem to be best placed within a single, variable species. The same degree of variability, in the strength of the ornamentation, is also shown by *Cadomoceras sullyense*, which is likely to be the microconch dimorph of the form under discussion.

The more densely ribbed specimens may be compared to the inner whorls of mature *S. languidum* (BUCKM.), that I could examine in the Geological Survey collections; while the more strongly ribbed ones are closer to the paratype of *S. strigifer* (BUCKMAN) (T.A., pl. 479B), which has subsequently been assigned to *S. pseudostrigifer* (MAUB.). These specimens from the Sette Comuni certainly belong to a single species (see above), but are too immature for a definite identification. Moreover, I should not be surprised if *S. strigifer*, *S. pseudostrigifer* and *S. lan-*

guidum turned out to be conspecific with *S. compressum* (ETHERIDGE), which has priority. At any rate, this will be dealt with soon, in the revision of BUCKMAN's « Type Ammonites », now in preparation.

Strigoceras truellei (d'ORB.)

(Pl. 4, figs. 6-9)

- ? 1886 *Harpoceras canovincola* - de GREGORIO 1886; p. 12; pl. 1, ff. 15-16.
? 1886 *Harpoceras ramiatum* - de GREGORIO 1886; p. 13; pl. 1, f. 17.
? 1886 *Harpoceras campoverense* - de GREGORIO 1886; p. 13; pl. 1, f. 20.
v 1896 *Hecticoceras* (*Lanuloceras*) *canovincola* de GREG. - PARONA 1896; p. 13; pl. 1, f. 6.
v 1896 *Hecticoceras* (?) *pingue* (non PARONA 1880) - PARONA 1896; p. 12; pl. 1, f. 5.
v 1964 *Strigoceras truellei* (d'ORBIGNY) - STURANI 1964 b; p. 14; pl. 2, f. 1 (*cum syn.*).

Over 40 specimens, mainly nuclei and youngs, from Monte Meletta assemblage (Turin Mus.). More nuclei, probably belonging to this species, are from Monte Longara (Padua Mus.), Rotherbrunn, Longara di Sotto n. 1, Longara di Sotto n. 2, Troch n. 2 and Ponte sul Ghelbach n. 4 assemblages.

The specimen figured on Pl. 4, fig. 9 is particularly close to d'ORBIGNY's pl. 129, ff. 1-2, as well as to the inner whorls of larger specimens from the Parkinsoni zone of the Lessini Mountains (STURANI 1964a; pl. 5, f. 6), that are in turn identical to the lectotype (d'ORBIGNY's pl. 177, ff. 1-3).

The specimen figured on Pl. 4, fig. 7 belongs to another morphotype, with stouter whorls, a wider umbilicus and much stronger ribs, which then resembles the more coarsely ribbed morphotypes of *Poecilomorphus cycloides*. This explains why PARONA, in his 1896 monograph, regarded this specimen as conspecific with those from Campoverere he had described in 1880 as *Harpoceras pingue*, which actually belong to *Poecilomorphus* and are from a different horizon.

Immature specimens belonging to this stoutly whorled morphotype of *S. truellei* also exist in the Geological Survey collections (G.S.M. 25321, Sherborne Dorset, no history, presumed Truellei bed).

Since all intermediate gradations also occur (this work, Pl. 4, fig. 6) there is no reason to place them in a separate species.

In Great Britain *S. truellei* has been used by BUCKMAN and others as a (sub) zonal index for the lower and middle part of the Parkinsoni zone. In the Digne region, where it is rather common, *S. truellei* is known to range throughout the whole Upper Bajocian (PAVIA & STURANI 1968).

Strigoceras sp. ind. juv. cf. *septicarinatum* (S. BUCKM.)

(Pl. 16, fig. 9)

Several immature specimens from Longara di Sotto n. 1 and Cima Tre Pezzi fossil localities belong here. The largest one is 24 mm in diameter (Pl. 16, fig. 9). They are intermediate in shape between the more strongly ribbed morphotype of *S. cf. strigifer* of the Humphriesianum zone, and the more compressed morphotype of *S. truellei*. They differ from the former in having a proportionally stouter nucleus,

a slightly wider umbilicus and weak primary ribs on the inner half of the flanks. They are distinguished from *S. truellei* by being more compressed, more involute and less coarsely ribbed.

These specimens may perhaps belong to *S. septicarinatum* (S. BUCKM.), the type of which is from the Shell bed of Burton Bradstock, but are too immature for a definite identification.

Strigoceras paronai (TRAUTH)

(Pl. 4, figs. 1-5, 10)

- v 1896 *Oppelia propesufca* (non de GREGORIO) - PARONA 1896; pp. 14-15; pl. 1, ff. 8-9.
1922 *Oppelia paronai* - TRAUTH 1922; pp. 183, 189 (new name for *Oppelia propesufca* PARONA non de GREGORIO).
v 1924 *Plectostrigites symplectus* - S. BUCKMAN, *T. A.*, pl. 471, 471*.
non 1886 *Oppelia propesufca* - de GREGORIO 1886; p. 13; pl. 1, f. 25 (probably = *O. subradiata* (Sow.)).
? 1878 *Oppelia truellei* (non d'ORB.) - BAYLE 1878; pl. 89, ff. 2, 5 (*non cet.*).
? 1923 *Strigoceras truellei* (non d'ORB.) - FALLOT & BLANCHET 1923; pl. 4, f. 8; pl. 6, f. 5 a-c; pl. 9, f. 4 (*non cet.*).

As already stated when discussing de GREGORIO's monograph, it is nearly certain that the specimens figured and described by PARONA as *Oppelia propesufca* are neither conspecific nor congeneric with de GREGORIO's type. TRAUTH, who was of this same opinion, renamed them *Oppelia paronai*. Two years later, S. BUCKMAN described quite independently the same species, on English material, as *Plectostrigites symplectus*. BUCKMAN's name is therefore a junior subjective synonym of TRAUTH's: the specific identity has been confirmed through a direct comparison between PARONA's specimens from the Sette Comuni and the holotype of *S. symplectus*.

Material. The syntypes include over 40 specimens from Monte Meletta (including the ones figured by PARONA) and a few more from Monte Longara assemblage (Padua Mus.); the horizon is in both cases Subfurcatum zone, Schroederi subzone. Another specimen, which had been labelled by PARONA as *Lunuloceras canovincola*, is from Ponte sul Ghelpach n. 4 assemblage (Pisa Mus.; Garantiana zone). More specimens have been collected by the present writer at Troch n. 2 fossil locality (Subfurcatum zone, Schroederi subzone) and at Longara di Sotto n. 1 (Subfurcatum zone, Polygyralis sbz.).

Lectotype. The syntype from Monte Meletta figured on Pl. 4, fig. 1 is here selected as lectotype. It measures: D, 26.5 mm; H, 0.57; L, 0.275; O, 0.10. PARONA's pl. 1, f. 8 is stated to be natural size; the nearest looking syntype, from which PARONA copied the suture line, is however much smaller (Pl. 4, fig. 10): this means either that the figure is a synthetograph or that a wrong enlargement was given.

All the specimens from the Sette Comuni are immature: none the less they show as a whole fairly good agreement with the holotype of *S. symplectus* (BUCKM.), which is fully grown at an estimated diameter of about 160 mm.

Description. The shell is discoidal, compressed and involute. The umbilicus small, with partially overhanging rounded walls. The flanks are flattened and almost

parallel. The hollow, floored keel is narrow and not very tall; when it is removed, the venter becomes bluntly rounded as in *S. bessinum*, not so sharp and narrow as in *S. cf. strigifer* and *S. truellei*.

Some specimens are smooth up to a diameter of about 18 mm; others are already ribbed at about 8 mm. Up to about 20-25 mm in diameter the blunt outer ribs alone are present (about 35 on a whorl). Thereafter faint, almost imperceptible primaries begin to appear, as well as two spiral grooves.

S. paronai is easily distinguished from *S. languidum*, *S. strigifer*, *S. pseudostrigifer*, *S. compressum* and *S. septicarinatum* because of its more flattened sides, more bluntly rounded venter (when the keel is removed) and much less sinuous ribs. *S. truellei* is stouter and more coarsely ribbed at all stages of growth. *Strigoceras kellumi* (IMLAY, 1962; originally described as the type species of *Oppelia* (*Lyroxites*)) is similarly ribbed, but has a sharper venter. It is difficult to judge whether *S. symplectum* mentioned, but not figured, by WESTERMANN (1954, p. 25) from the Blagdeni subzone of Gerzen, Germany, is also to be assigned to *S. paronai*.

S. paronai is likely to be the macroconch dimorph of *Cadomoceras nepos* PARONA.

The known vertical range, in the Sette Comuni, is Subfurcatum zone, Polygyralis subzone - Garantiana zone, either Dichotoma or Subgaranti subzone. In England this species has been found in the Subfurcatum zone.

GENUS CADOMOCERAS MUNIER - CHALMAS, 1892

General remarks. *Cadomoceras* has usually been regarded as belonging to the family Haploceratidae and paired with *Lissoceras* (ARKELL 1951-59, p. 49). In fact most, if not all species of *Cadomoceras* possess a small keel, at least in the middle whorls - a feature that is missing in all Haploceratids, with the exception of *Stegoxytes* and *Poecilomorphus*. Moreover, *Cadomoceras* cannot be paired satisfactorily with any of the Bajocian macroconch Haploceratid genera. On the other hand, no microconch genus has ever been paired with *Strigoceras*: *Cadomoceras* seems to fit this role well on both stratigraphical and morphological grounds. As shown by the specimens from the Sette Comuni, nuclei of *S. truellei*, below a diameter of 5 mm, are often difficult to distinguish from immature *C. cadomense*. The suture line too (cf. COEMME 1917, text-figs. 1 and 2) is much closer to that of immature *Strigoceras* than to that of any Bajocian Haploceratid.

Cadomoceras seems therefore to be best placed within Strigoceratidae as the microconch dimorph of *Strigoceras*.

Cadomoceras sullyense BRASIL

(Pl. 5, figs. 1-5)

- 1917 *Cadomoceras sullyense* BRASIL - COEMME 1917; pp. 48-50; pl. 6, ff. 1-3; text-f. 2 (*cum syn.*).
? 1923 *Cadomoceras ellipticum* - S. BUCKMAN, *T. A.*, pl. 455.
1964 *Cadomoceras sullyense* BRASIL - STURANI 1964 a; pl. 4, f. 7.

There are 80 specimens, almost all of which adult, from Troch n. 1 fossil locality and one from Camporovere assemblage (Pavia Mus.) (both basal Humphriesianum zone).

As a whole they show good agreement with BRASIL's type as well as with the topotypes figured by COEMME, whom see for a detailed description.

This large population from the Sette Comuni shows a certain degree of variability, especially in the presence or absence (and strength) of ribbing as well as in the size of adult specimens, which varies between 13 and 26 mm. About 25 % of the specimens show faint peripheral folds (« bourrelets ») on the terminal part of the body chamber; these may be paired with the more strongly ribbed morphotype of *Strigoceras* cf. *strigifer* from the same assemblage. The remaining 75 % are completely smooth throughout; these can be paired with the more densely, but less strongly ribbed morphotype of *S.* cf. *strigifer*.

Several specimens (Pl. 5, fig. 4) possess a weak open keel, which usually disappears on the second half of the body chamber.

C. sullyense is distinguished from all congeneric forms in being the more involute. *C. ellipticum* BUCKM., from the Sauzei zone of Dundry, Somerset, is practically identical but for the fact that the weak keel persists up to the end of the body chamber; since this seems to be a variable character (COEMME 1917, p. 48), BUCKMAN's species is likely to be a junior synonym of *C. sullyense*. *C. carinatum* BUCKM., also from the Sauzei zone of Dundry, differs from *C. sullyense* in possessing a slightly wider umbilicus and a less strongly contracted body chamber.

The type level, in Normandy, is also Humphriesianum zone, as in the Sette Comuni.

Cadomoceras n. sp. aff. *sullyense*

(Pl. 5, fig. 6)

Among the rich population of *Cadomoceras* from the basal Humphriesianum zone of Troch n. 1 fossil locality, there are three specimens which differ from those placed in *C. sullyense* in being much smaller (9-10 mm), less compressed laterally, less elliptically coiled and slightly more evolute (the umbilicus is one and a half to two times wider).

Until more specimens are not found, it is difficult to decide whether they are just a morphotype of *C. sullyense* or belong to a different, new species. If the latter, they may well represent the microconch dimorphs of *Strigoceras bessinum*.

Cadomoceras nepos PARONA

(Pl. 5, figs. 7-10)

- 1896 *Cadomoceras nepos* - PARONA 1896, pp. 15-16; pl. 1, f. 13.
1917 *Cadomoceras cadomense* var. *acostatum* - COEMME 1917, pp. 47-48 (objective synonym).
1917 *Cadomoceras cadomense* (non DEFR.) - COEMME 1917; pl. 6, f. 8 (only).
1924 *Cadomoceras simulacrum* - BUCKMAN, T. A., pl. 458.

In the original description PARONA states that he had only five specimens from Monte Meletta. In fact there are many more (18): most of the immature ones had either been misidentified as Phylloceratid nuclei or were confused with specimens of *Strigoceras paronai* (TRAUTH).

Another two specimens from Monte Longara (Padua Mus.) had been labelled by PARONA as « *Oppelia vicetina* »; a question mark, in a different handwriting, has later been added to the labels.

The specimen figured by PARONA (this work, Pl. 5, fig. 8) has the peristome beautifully preserved on both sides, but has most of the body chamber broken (PARONA's figure is restored). The specimen figured on Pl. 5, fig. 7 is one of the other syntypes and is here selected as lectotype, being more complete.

The shell is discoidal and rather involute up to the beginning of the body chamber, which occupies about 4/5 of the last whorl. Thereafter, and for nearly half a whorl more, the whorl height continues to increase rapidly, while the umbilicus begins to widen. On the last portion of the body chamber the whorl height decreases abruptly, then remains constant up to the mouth border, so that the body chamber makes a sharp bend and the coiling becomes elliptical. In the last whorl the umbilicus is proportionally wider than in *C. sullyense*, but narrower than in *C. cadomense*. The whorls, up to the sharp bend just mentioned, are much higher than wide and possess a small, blunt keel. They are usually smooth, but on a few specimens faint falcoid striae and peripheral riblets, which recall the style of ribbing of *Strigoceras paronai*, are visible under very oblique light. Towards the end of the body chamber there are from three to six peripheral folds of increasing strength, separated by a smooth band on the middle of the venter. The peristome, as in other congeneric forms, is provided with two large spatulate lappets and a short ventral rostrum; a narrow groove, which passes into the narrow stalk of the lappets, precedes the peristome.

C. nepos, which may be regarded as the microconch dimorph of *Strigoceras paronai*, is easily distinguished from *C. cadomense* in being more involute, more compressed and less coarsely ribbed at all stages.

C. simulacrum BUCKM., the type of which I was able to study at the Geological Survey Museum, is identical to *C. nepos* and must fall in synonymy; it is also from the Subfurcatum zone.

Cadomoceras n. sp. aff. *nepos* PARONA

Material. There are four adult specimens from the Longara di sotto n. 1 fossil locality (Subfurcatum zone, Polygyralis subzone), which differ from *C. nepos* in reaching a much larger size, up to 30 mm (adult specimens of *C. nepos* range between 17 and 23 mm in diameter). The coiling is less elliptical and slightly more involute: when measured at 180° from the mouth border, O is 0.15 in the present species, 0.19 in *C. nepos*.

Cadomoceras sullyense, on the other hand, is more involute — at least on the inner and middle whorls — and more elliptically coiled than the form under discussion.

More specimens are however needed before this new species can be properly defined and named.

Cadomoceras cadomense (DEFRANCE)

(Pl. 5, figs. 11-15)

- v 1896 *Oecotraustes minor* - PARONA 1896; p. 15; pl. 1, f. 12.
1909 *Ammonites cadomensis* DEFRANCE - R. DOUVILLÉ, Pal. Univ., pl. 134, 134a, ff. 1, 1^a, C¹⁻³ (non ff. 1^{b-c}, C⁴).
1917 *Cadomoceras cadomense* DEFR. - COEMME 1917, pp. 44-47; pl. 6, ff. 4-7 (non f. 8); text-f. 1 (*cum syn.*).
v 1920 *Cadomoceras costatum* - S. BUCKMAN, T. A., pl. 189.
? 1963 *Oecotraustes nodifer* (non BUCKM.) - KRIMHOLTZ & STANKEVITCH 1963; pp. 113-114; pl. 1, f. 8.

Apart from the two syntypes of *Oecotraustes minor* PARONA (this work, pl. 5, figs. 12 and 14), there are ten more conspecific specimens from the same assemblage (Monte Meletta), most of which had been mistaken for nuclei of *Strigoceras truellei* (= *Lunuloceras stevensoni* de GREG.). More specimens have been found at Longara di sotto n. 1, Rotherbrunn and Troch n. 2 fossil localities.

When compared with DEFRANCE's types (refigured by R. DOUVILLÉ in the *Palaeontologia Universalis*), the syntypes of *C. minor* (PARONA) appear to be clearly conspecific: both are more evolute and more stoutly whorled at all stages than all other congeneric forms; moreover, both are coarsely ribbed also on the phragmocone. Under this regard, it should be noted that DEFRANCE's original figure, reproduced in the « Treatise » (f. L314/6a-b), is misleading, since it shows the whorls to be completely smooth up to the second half of the body chamber, which is not the case. As already stated by COEMME, and confirmed by the study of the specimens from the Sette Comuni, *C. cadomense* is a variable species. Some specimens (Pl. 5, figs. 11 and 13) may be more compressed and less coarsely ribbed than the types, while others (Pl. 5, fig. 15) are more coarsely ribbed and have a stouter whorl section. The latter are almost identical to *C. costatum* BUCKM., which is here regarded as a simple morphotype of *C. cadomense*. The same variability is also shown by *Strigoceras truellei*, which is likely to be the macroconch dimorph of *C. cadomense*.

As to the vertical range, *C. cadomense* is known to range from the Subfurcatum to the Parkinsoni zone (COEMME 1917, p. 47; RIOULT 1964, pp. 245-246); also on stratigraphical grounds it can therefore be paired with *S. truellei*.

It should also be noted that the ammonite figured by KRIMHOLTZ & STANKEVITCH (1963, pl. 1, f. 8) as *Oecotraustes nodifer* (non BUCKM.) is certainly congeneric and probably conspecific with *C. cadomense* (see also J. STEPANOV 1966, p. 65). It is associated with *Strigoceras kuznetsovi* KRIM. & STANK. (which in turn seems to be a subjective synonym of *S. truellei*), *Pseudocosmoceras michalskii* (BORISSJAK) and *P. masarovici* MURASCHKIN. The bathonian age assumed by KRIMHOLTZ & STANKEVITCH for this assemblage seems rather doubtful.

FAMILY SONNINIIDAE BUCKMAN, 1892

GENUS DORSETENSIA BUCKMAN, 1892

Dorsetensia sp. ind. juv.

(Pl. 3, fig. 17)

There are five immature specimens from Troch n. 1 fossil locality (basal Humphriesianum zone), ranging in size between 6 and 15 mm, which show the following features: coiling moderately involute, with about 2/5 of each whorl covered by the next one; whorl section elliptical, higher than wide; umbilical slope rounded; flanks gently convex; venter flattened to slightly bisulcate, with a narrow keel. Ribs sinuous, prorsiradiate, simple, ending at the ventrolateral edges and often bundled in twos at the umbilical margin.

These specimens probably belong to *Dorsetensia* (they have been directly compared with the inner whorls of several species of *Dorsetensia* from England, in the Geological Survey Museum), but are too immature for an attempt at definite identification.

The largest one (Pl. 3, fig. 17) measures: D 15 mm (est); at 13 mm: H, 0.433; L, 0.362; O, 0.303; R 31.

GENUS BAJOCIA BRASIL, 1895

Bajocia farcyi BRASIL

(Pl. 3, figs. 7-9)

1895 *Bajocia farcyi* - BRASIL 1895; pp. 35-36; pl. 2, ff. 9-11.

? 1912 *Bajocia farcyi* BRASIL - ROMAN & GENNEVAUX 1912; p. 270; pl. 3, ff. 6 a-b.

1964 *Bajocia farcyi* BRASIL - STURANI 1964 a; pl. 4, f. 5.

Over 25 specimens of this rare species have been found at Troch n. 1 fossil locality (basal Humphriesianum zone); another, obviously reworked, has been found at fossil locality Troch n. 2 (Subfurcatum zone). They range from nuclei 7 mm in diameter to fragments of much larger, probably fully grown specimens (est. diameter: 50 mm), and show, as a whole, perfect agreement with BRASIL's type.

This is a small sized, extremely evolute, serpenticone species. The whorl section is subquadrate-isodiametric to depressed-subrectangular, with the maximum thickness at the well marked ventrolateral edges. The umbilicus is very wide, without umbilical walls. The venter is gently arched. The ribbing has a very regular appearance due to dense, straight, rectiradiate to slightly prorsiradiate primaries, which are raised to form small, node-like elevations on the ventrolateral edges. Beyond this point each primary gives rise to 1-2 very weak secondaries, which cross the venter with a gentle, adorally convex curve. At a diameter of 20 mm there are 55 primaries to a whorl; the secondaries are about one and a half times more numerous. The latter are so weak, that the venter seems nearly smooth and a very oblique light is needed to see them. On the body chamber of adult specimens the primaries become still denser, while the secondaries are as dense and almost as strong as the primaries.

The relatively simple suture (BRASIL 1895; pl. 2, f. 11) has a narrow ventral lobe, longer than the first lateral, and is vaguely similar to that of *Parastrenoceras* and the earliest *Spiroceratids*. This suggests the possibility of a phyletic link between *Bajocia* and one (or both) of the younger taxa listed above. As to the ancestors of *Bajocia*, I agree with ARKELL (1957, p. L271) that this genus has probably arisen from the dimorph pair *Haplopleuroceras* (M) - *Zurcheria* (m), by loss of the keel.

Whether *B. farcyi* is a macroconch species or not is still unknown.

The figured specimens measure: (Pl. 3, fig. 7) D, 17 mm; H, 0.18; L, 0.22; O, 0.65; R, 54. (Pl. 3, fig. 8) D, 15.5 mm; H, 0.20; L, 0.21; O, 0.62; R, 52. (Pl. 3, fig. 9) D, 18 mm; H, 0.19; L, 0.19; O, 0.65; R, 53.

As for the ammonite figured by ROMAN & GENNEVAUX (1912, pl. 3, fig. 6) as *Bajocia farcyi*, it is rather difficult to state whether it could really belong here or it is a nucleus of *Leptosphinctes*, since it comes from a condensed (or mixed) assemblage which has also yielded species of the early Upper Bajocian.

Bajocia (? n. subg.) *rarinoda* n. sp.

(Pl. 3, figs. 10-15)

A small sized microconch species with a highly characteristic ornamentation.

Whorl section subquadrate-isodiametric to slightly depressed; umbilicus wide; coiling evolute. Flanks nearly smooth, but for distant weak, blunt folds ending in very strong, claviform nodes at the ventrolateral edges (10-12 to a whorl). Faint, dense, adorally convex outer ribs are sometimes visible on the gently arched venter. The nodes disappear on the last part of the body chamber, which bears blunt primaries as dense as in *B. farcyi*. The peristome is provided with large spatulate lappets (Pl. 3, fig. 14).

The specimens figured on pl. 3, fig. 14 is the holotype; it measures: D, 16 mm; H, 0.24; L, 0.24; O, 0.575. The other paratypes figured measure: (Pl. 3, fig. 10) D, 9 mm; H, 0.26; L, 0.39; O, 0.52. (Pl. 3, fig. 11) D, 14 mm; H, 0.26; L, 0.26; O, 0.57. (Pl. 3, fig. 12) D, 8.6 mm; H, 0.26; L, 0.34; O, 0.545. (Pl. 3, fig. 13) D, 10 mm; H, 0.24; L, 0.34; O, 0.57.

Over 20 specimens are known, all from Troch n. 1 fossil locality (Humphriesium zone, Cycloides subzone).

The characteristic ornamentation is reminiscent of *Zurcheria*, on one hand, and *Zigzagiceras* on the other; in the present case, however, the nodes are not parabolic.

If new, complete specimens show *B. farcyi* to be a macroconch species, *B. rarinoda* may well be its microconch dimorph.

Bajocia (?) n. sp.

(Pl. 3, fig. 16)

Two small and presumably immature specimens from Rotherbrunn fossil locality (Subfurcatum zone, Baculatum subzone) differ from *B. farcyi* in being much more strongly ribbed. The whorl section is slightly wider than high, with convex flanks and a gently concave venter.

The ribs are less numerous than in *B. farcyi* (21 to a whorl) and much stronger, straight and slightly prorsiradiate, ending at small projecting nodes at the ventrolateral edges. The venter is smooth. The suture line and the adult peristome are unknown.

The specimen figured on Pl. 3. fig. 16 measures: D. 8.2 mm; H, 0.29; L. 0.32; O, 0.516; R, 23.

More specimens are needed before this species can be named and its taxonomic position ascertained beyond doubt (see also p. 165).

SUPERFAMILY STEPHANOCERATAE NEUMAYR, 1875

FAMILY STEPHANOCERATIDAE NEUMAYR, 1875

General remarks. At fossil locality Troch n. 1 (Humphriesianum zone, Cycloides subzone) Stephanoceratids are represented by no less than 11 species (many of them, however, will not be described or figured, being represented by nuclei only); four or five more occur in the Subfurcatum zone (Cima Tre Pezzi, Monte Longara, Rotherbrunn, Monte Meletta, Ponte sul Ghelpach n. 2 assemblages).

Of these, only three species include at least one adult specimen (*Normannites flexus* (WEST.), ? *Normannites globulus* n. sp. and *Polyplectites venetus* (PAR.)); all others are represented by immature specimens or by small fragments of adult ones, so that it is usually rather difficult to know whether they belong to macro- or microconch genera. On the other hand, the *Posidonia alpina* beds at Rovereto have yielded a fully grown specimen of *Teloceras banksi* (Sow.) and several specimens of *Stemmatoceras frechi* (RENZ), not fully grown, but large enough to allow identification.

None the less, the study of these immature Stephanoceratids turned out to be of great interest for a better understanding of the family, since it showed that in many species the whorls increase by segments between weak constrictions - a feature whose occurrence was previously unsuspected in Stephanoceratids and which is probably confined to the inner whorls. This sort of incipient constriction may often be easily recognized by a sudden increase in the whorl section, every 90° or 120°, while the last two or three outer ribs which precede each periodical widening of the whorl section are stronger than those immediately following it (Pl. 12, fig. 16). In this case there is close agreement to the « growth by segments » between true constrictions shown by most of the early Leptosphinctinae, especially *Bigotites* (see NICOLESCO 1931; also STURANI 1967, p. 41). In other instances the periodical widening of the whorl section is not so evident, but the secondaries are still strengthened at regular intervals (60°, 72° or 90°).

The same feature is also shown by early Parkinsoniids of the genus *Orthogarrantiana* (see under *O. conjugata* (QUENST.)), which are here regarded as direct

derivatives of some Stephanoceratid genus of the Humphriesianum zone (e.g. *Stemmatoceras*).

On the other hand, the Stephanoceratids of the Humphriesianum zone that show such incipient constrictions are not believed to be the direct forerunners of the younger Leptosphinctinae, but rather a parallel development, in which emphasis was put on other characters of the ornamentation, such as the ventrolateral tubercles, etc. In fact, Perisphinctids with well marked constrictions are already found in the Sauzei zone of Alaska (*Parabigotites crassicostatus* IMLAY and its microconch counterpart *P.* (n. subg.) *kialagvikensis* (IMLAY)).

Turning now to the taxonomy of the Stephanoceratidae, it must be said that this is most unsatisfactorily confused, notwithstanding several attempts by different authors to work out a natural scheme of classification. WESTERMANN's recent attempt (1964) marks an improvement when compared with previous ones, since he has taken the existence of dimorphism into account; yet, it is in my opinion still unsatisfactory, especially with regard to the pairing of dimorphs and its taxonomic implications.

As a matter of fact, many genera and subgenera described to date among the Stephanoceratids, both micro- and macroconch, seem to be redundant. The first step is therefore to see — separately for macro- and microconchs — which are to be retained and which are to be dropped. In doing so, one should not forget that each taxon of the genus group is objectively defined only by reference to its type species, not by the whole assemblage of species originally or subsequently assigned to it. Therefore, the statement by WESTERMANN (1969, p. 237) that « if in a hierarchical system, two groups (taxa) of any category are identical, then all higher, inclusive categories are also identical » seems to be in contrast with the rules of zoological nomenclature (ICZN article 42 b).

The next, and more hazardous step will then be to decide how the macro- and microconch genera and subgenera can be paired in the most satisfactory way. In this second case, unfortunately, it will be seldom that the type species of a given macroconch genus can be actually paired with the type species of the would-be microconch dimorph taxon; this particular difficulty may be overcome only if all species which are not closely related to the type species are pruned off from each genus or subgenus, until these become units as natural as possible.

A few examples will render this concept clearer.

To state that *Itinsaites* part. + *Normannites* (s.s.) part. may be paired with *Stephanoceras* s.s., while another *Itinsaites* part. + *Platystomites* represent the microconch counterpart of *Stemmatoceras* + ? *Teloceras* part. (*Gibbistephanus*) (WESTERMANN 1964, p. 67), is not a great help in solving such taxonomical complications; on the other hand it implicitly contains the acknowledgement that *Itinsaites* is not a natural unit: some of the « species » that were placed within this genus by WESTERMANN himself in 1954 ought to be transferred *Normannites* (in the present writer's interpretation these are: *I. itinsae*, the type species, and the closely allied *I. mackenzii* (Mc LEARN) (cum ssp.), *I. crickmayi* (Mc LEARN) and

I. rhomboidalis WEST., all of which are morphologically close to *Normannites orbigny* and have about the same vertical range; in this way *Itinsaites* becomes a junior subjective synonym of *Normannites*); part, instead, could be transferred to *Platystomites* (these may be *I. latansatus* (BUCKM.), *I. formosus* (BUCKM.) and *I. varicostatus* WEST.).

Now let's turn to check some of the suggested dimorph pairs.

Normannites, according to WESTERMANN, may be paired with both *Stephanoceras* s.s. and *S.* (*Skirroceras*) and should therefore be considered a microconch subgenus of the former. The point, however, is that the type species of *Normannites* (*N. orbigny*) ranges much higher than any known *Stephanoceras* s.s., up into the Banksi subzone of the Subfurcatum zone (PAVIA 1969), being usually associated with *Teloceras* spp.. On the other hand, *Epalxites anceps* (QUENST.), which apparently looks like a miniature *Teloceras*, is much older than any representative of the latter genus and may be best paired with either *Skirroceras* or *Stephanoceras* s.s., also on morphological grounds (comparison should in fact be made with the inner whorls of the would-be macroconch counterpart, not with the adult ones, owing to the neotenic character usually displayed by the microconchs).

This is just to show the amount of work that is still waiting to be done. the sort of difficulties one is likely to come across and the amount of confusion that can be made by unexperienced palaeontologists because of the highly subjective nature of the working methods involved. By the way, these problems are the main reason restraining me from acceptance of the idea that one should immediately use a single specific (and generic) name whenever one believes one has discovered a pair of would-be ammonite dimorphs.

However, it is not my intention, for the time being, to go any further into the revision of the early Bajocian Stephanoceratids. That is why I shall provisionally ascribe the microconch species found in the Humphriesianum zone at Troch n. 1 fossil locality to a single genus, *Normannites*.

GENUS NORMANNITES MUNIER CHALMAS, 1892

Normannites flexus WESTERMANN

(Pl. 12, figs. 5, 15)

? 1954 *Normannites* (*Normannites*) n. sp. - WESTERMANN 1954; pp. 199-201; pl. 14, ff. 4 a-b; text-f. 70.

1954 *Normannites* (*Parallites*) *flexus* - WESTERMANN 1954; pp. 215-218; pl. 17, ff. 2-4; text-ff. 79-80.

There are 21 specimens from the basal Humphriesianum zone of Troch n. 1 fossil locality. As a whole they show good agreement with WESTERMANN's types in every detail, but for the rib density which is slightly less.

The main distinguishing feature of this species is the strongly prorsiradiate character of the primary ribs.

The largest specimen (Pl. 12, fig. 5) is fully grown at a diameter of 18 mm and still retains one of the lateral lappets; the other measurements, at a diameter of 14 mm, are: H, 0.33; L, ?; O, 0.43; R 28. The body chamber is about 270°

long and there are 28 strongly prorsiradiate, sharp primaries on the last whorl, which has a rounded-depressed section, without ventrolateral edges.

The other specimen figured (Pl. 12, fig. 15) is also fully grown, notwithstanding its very small size, since in the second half of the last visible whorl (body chamber) it shows a rapid widening of the umbilicus, so that the base of the secondaries of the preceding whorl becomes exposed. When complete (the last part of the body chamber is missing) it would have measured about 13 mm; at a diameter of 11.2 mm the measurements are: H, 0.333; L, 0.48; O, 0.433; R 28.

As visible on other unfigured specimens, the whorl section changes regularly from the inner to the outer whorls. Up to a diameter of about 4-6 mm the general shape is coronate, with well marked ventrolateral edges and a trapezoid, depressed whorl section; the venter is but slightly arched. Thereafter the flanks become more regularly convex, the ventral part more strongly arched and the ventrolateral edges less marked, until they completely disappear by the beginning of the body chamber, or even earlier. The umbilicus is moderately wide throughout (0.434 - 0.45).

The measurements of other unfigured specimens are: D 12.1 mm; H, 0.29; L, 0.57; O, 0.446; R 24. D 11.6; H, 0.31; L, 0.60; O, 0.45; R 22. When fully grown these specimens would have attained a greater size than the ones figured.

At a small diameter the primaries end at small ventrolateral nodes, which tend to disappear as the ventrolateral edges fade out; each primary usually gives rise to two secondaries.

The type level, in Germany, is also Humphriesianum zone.

Cf. *Normannites latansatus* (BUCKMAN)

(Pl. 12, fig. 2)

1954 *Itinsaites latansatus* (S. BUCKMAN) - WESTERMANN 1954; pp. 254-258; pl. 22, ff. 1-3; text-ff. 101, 102, 106, (cum syn.).

There are 6 immature specimens and the detached body chamber of a seventh, fully grown (est. diam. about 50 mm, the peristome is not preserved), all from Troch n. 1 fossil locality. That figured (Pl. 12, fig. 2) has part of the body chamber preserved at a diameter of about 23 mm; the other measurements, at a diameter of 20 mm, are: H, 0.35; L, 0.55; O, 0.39; R 24.

For a detailed description see WESTERMANN.

Both in the type region, in Germany and in the Basses-Alpes *I. latansatus* is found in the lower part of the Humphriesianum zone, as in the Sette Comuni.

The whorl section does not increase at a constant rate, but widens rather abruptly every 90° (see above).

Cf. *Normannites formosus* (BUCKMAN)

(Pl. 2, fig. 1)

1954 *Itinsaites formosus* (S. BUCKM.) - WESTERMANN 1954; pp. 259-261; pl. 22, f. 4; pl. 23, f. 1; text-ff. 101, 102, 107.

There are 10 immature specimens from Troch n. 1 fossil locality. The largest (Pl. 12, fig. 1) has part of the body chamber preserved at a diameter of 23 mm; the other measurements, at a diameter of 20 mm, are: H, 0.325; L, 0.60; O, 0.40; R 29.

The primaries (29 to a whorl) are denser and slightly shorter than in the preceding species. The whorl section, in this case too, widens discontinuously every 90°.

These specimens, and especially the largest one mentioned above agree with BUCKMAN's type in every detail but one: they have a slightly higher rib-density.

BUCKMAN's type is from the « *Epalxites hemera* », that is, from the lower part of the Humphriesianum zone, as in the Sette Comuni.

Cf. *Normannites pinguis* (WESTERMANN)

(Pl. 12, figs. 3-4)

1954 *Platystomites pinguis* - WESTERMANN 1954; pp. 222-224; pl. 18, ff. 1-2; text-ff. 82, 85, 88.

There are four immature specimens, all from Troch n. 1 fossil locality, which show near perfect agreement with the holotype. The largest one (Pl. 12, fig. 3) is 18 mm in diameter and measures: H, 0.352; L, 0.71; O, 0.377. The other specimen figured (Pl. 12, fig. 4) measures: D, 16 mm; H, 0.352; L, 0.66; O, 0.40. Both have part of the body chamber preserved and show three weak, but clearly visible constrictions to a whorl. The type level is also Humphriesianum zone.

Cf. *Normannites anceps* (QUENST.)

(Pl. 12, fig. 11)

1954 *Epalxites anceps* (QUENST.) - WESTERMANN 1954; pp. 297-301; pl. 28, ff. 1-2; pl. 27, f. 4; text-f. 124, 126, 127 (*cum syn.*).

1964 *Epalxites anceps* (QUENST.) - STURANI 1964 a; pl. 4, f. 11.

Over 15 specimens from Troch n. 1 fossil locality show as a whole very good agreement with the german specimens (including the holotype) described and figured by WESTERMANN, whom see for a detailed description.

The largest one (Pl. 12, fig. 11) is wholly septate and measures: D 17 mm; H, 0.356; L, 0.66; O, 0.40; R 20.

N. anceps is known to range from the upper part of the Sauzei zone up to the lower part of the Humphriesianum zone.

Cf. *Normannites portitor* (MAUBEUGE)

(Pl. 12, fig. 6)

1954 *Epalxites portitor* MAUBEUGE - WESTERMANN 1954; pp. 304-307; pl. 28, f. 9; pl. 29, f. 1; text-ff. 124, 125, 130 (*cum syn.*).

There are ten immature specimens and a few fragments of adults, from Troch n. 1 fossil locality, which differ from « *N.* » *anceps* in being more coarsely ribbed,

with a more depressed whorl section and a less arched venter. For a detailed description see WESTERMANN.

The specimen figured on Pl. 12, fig. 6 is septate throughout and measures: D, 13.5 mm; H, 0.32; L, 0.76; O, 0.46; R 17.

It should be noted that the secondaries, on this immature specimen, are strengthened at regular intervals, every 60°.

The agreement with the German specimens figured by WESTERMANN is nearly perfect, also in the proportions.

« *N.* » *portitor* has the same vertical range as « *N.* » *anceps*.

Normannites n. sp. aff. *portitor*

(Pl. 12, fig. 7)

1964 *Epalxites* n. sp. - STURANI 1964 a; pl. 4, f. 13.

Over 15 specimens, also from Troch n. 1 fossil locality, differ from those referred to *N. portitor* in possessing a still wider and more depressed whorl section, a narrower and deeper umbilicus and less coarse secondaries.

Since intermediate forms are missing, I regard this as a new species, distinct from *N. portitor*; I am however leaving it in open nomenclature until fully grown specimens are found.

The largest specimen is still septate at an estimated diameter of 16 mm. The one figured on Pl. 12, fig. 7 measures: D, 10.7 mm; H, 0.32; L, 0.82; O, 0.41; R 17. It shows a strengthening of the secondaries at regular intervals, every 72°.

Cf. *Normannites* sp. ind. juv.

(Pl. 12, fig. 17)

In the assemblage from Cima Tre Pezzi Quarry (basal Subfurcatum zone, Banksi subzone) Stephanoceratid nuclei are rather common; they belong to at least three different species, but are too immature for an attempt at specific identification. As to their generic position, they show the closest similarity with nuclei of *Normannites* from earlier horizons and are on the other hand quite distinct from those of *Polyplectites venetus* or *Leptosphinctes* (subg. ?) sp. ind. from the same assemblage, or those of *Torrensia* n. gen. *gibba* (PAR.) and *Orthogarantiana* spp. from younger assemblages.

The largest specimen has been figured on Pl. 12, fig. 17.

In the Digne region *Normannites* is known to range up into the Banksi subzone of the Subfurcatum zone, where three species (*N. orbigny*, *N. quenstedti* and *N. mckenziei*) are found in association with the earliest representatives of *Caumontisphinctes* and *Leptosphinctes* (PAVIA 1969). The discovery of similar associations in the Sette Comuni is therefore in no way surprising.

Normannites (?) *globulus* n. sp.

(Pl. 12, figs. 8-10, 13; Pl. 16, fig. 14)

One of the smallest and also of the commonest ammonites at Troch n. 1 fossil locality (Humphriesianum zone, Cycloides subzone).

Over 70 specimens are known, 22 of which possess the auriculate adult peristome. The latter range in size between 4.6 and 9 mm; other incomplete specimens would have attained, when fully grown, an estimated diameter of about 12 mm.

The general shape is reminiscent of *Otoites* or *Trilobiticas*. The inner and middle whorls (Pl. 12, figs. 10, 13) are nearly globular, with a deep, narrow umbilicus. The gently convex flanks are very short and form the umbilical walls; they end at well marked ventrolateral edges. The venter is very broad and more or less strongly arched, in different specimens, but usually less than in most species of *Otoites*. Each whorl covers the preceding one at its ventrolateral edges.

The ribbing is formed by a row of blunt tubercles on each ventrolateral edge (13-16 to a whorl); each tubercle gives rise to three (rarely two) secondaries, which are almost straight. Every quarter of a whorl there is an almost imperceptible constriction, marked by the last two or three secondaries that precede it being stronger than those immediately following it.

At this stage, the specimens figured on Pl. 12, fig. 10 and 13 measure: (Pl. 12, fig. 10) D 7.8 mm; H, 0.416; L, 0.82; O, 0.29. (Pl. 12, fig. 13) D 9.5 mm; H, 0.412; L, 0.83; O, 0.281.

On other specimens (Pl. 16, fig. 14) the umbilicus is much wider (up to 0.45) but the whorl width remains about the same ($\cong 0.80$); the whorl height is proportionally lower and the venter less strongly arched. Such specimens are somewhat reminiscent of *Torrensia* n. gen. *gibba* (PAR.) (see p. 154). Since all intermediate morphotypes also occur, they are however regarded as conspecific with the much more common involute morphotype of *N.* (?) *globulus* n. sp..

The body chamber occupies slightly more than half a whorl. The maximum whorl width is attained at about 180°-140° from the peristome, that is, shortly after the beginning of the body chamber; thereafter it remains constant for a while, then decreases rather sharply, while the umbilicus widens and becomes excentric and the ventrolateral edges tend to fade. The last two or three outer ribs are much stronger and coarser than the preceding ones.

The peristome is provided with long lappets, often provided with a small node at their base.

The measurements taken at the end of the body chamber are: (Pl. 12, fig. 8) D 6.8 mm; H, 0.30; L, 0.50; O, 0.46. (Pl. 12, fig. 9) D 8.6 mm; H, 0.355; L, 0.523; O, 0.46.

The specimen figured on Pl. 12, fig. 9 has been chosen as holotype.

GENUS POLYPLECTITES MASCKE, 1907

Polyplectites (?) *venetus* (PARONA)

(Pl. 13, figs. 2-3)

v 1896 *Stephanoceras venetum* - PARONA 1896; p. 18; pl. 1, ff. 21, 21 a.

non 1964 *Polyplectites* ? *venetus* (PARONA) - WENDT 1964; pp. 132-133; pl. 21, ff. 2 a-b; pl. 24, f. 5.

1964 *Otoites delicatus* (non BUCKMAN) - STURANI 1964 a; pl. 4, f. 12.

The holotype (Pl. 13, fig. 3) is from the Ponte sul Ghelpach n. 2 assemblage (Subfurcatum zone, Banksi subzone) and is broken into two pieces; one consists of the phragmocone and the beginning of the body chamber, while the other consists of the terminal part of the body chamber with the adult peristome. The latter is largely incomplete, but seems to include the base of a lateral lappet; this feature, however, is not entirely sure (hence the question mark).

Both pieces certainly belong to the same specimen, even though they do not fit together, because the intermediate portion of the body chamber is missing. PARONA's original figure appears to be much restored and — to some extent — rather misleading; so is the diameter (29 mm) given by this author, which was measured by joining the two fragments together, without taking into account the missing part.

The maximum diameter is about 34 mm (est.); at 26 mm the other measurements are: H, 0.36; L about 0.50; O, 0.39; R about 35.

Apart from the holotype, there are a few nuclei from the same assemblage (labelled by PARONA as *Stephanoceras* sp.) and about 30 nuclei and immature specimens from Cima Tre Pezzi (Banksi subzone), including the one I figured as *Otoites delicatus* (non BUCKM.) in 1964, before I was able to examine the holotype. Another nine specimens are from Longara di sotto n. 1 fossil locality (Subfurcatum zone, Polygyralis subzone).

The whorl section is wider than high and proportionally stout, especially in the inner and middle whorls, with regularly convex flanks, ventrolateral edges marked by a row of weak nodes and a broad, strongly arched venter. The umbilicus is deep and moderately narrow in the inner and middle whorls, but widens with age, especially after the beginning of the body chamber.

The small specimen from Cima Tre Pezzi figured on Pl. 13, fig. 2 closely matches the inner whorls of the holotype and measures: D 10.6 mm; H, 0.40; L, 0.67; O, 0.29; R 25.

The ribbing is dense and sharp; on the phragmocone the primaries are usually bifurcate; on the body chamber each gives rise, after the ventrolateral nodules, to 2-3 secondaries, which are blunter than those on the inner and middle whorls. Near the end of the body chamber the last secondaries become coarser.

On all specimens, up to a diameter of about 16 mm, the whorls are clearly constricted every 90°. As in the other *Stephanoceratids* described in the preceding pages, each constriction is preceded by one or two stronger secondaries. As a consequence of the constrictions the umbilicus does not widen at a regular rate,

but follows a polygonal spiral, as is clearly visible on the inner and middle whorls of the holotype.

The ventral furrow appearing on the body chamber of the holotype and mentioned by PARONA, does not even follow the median line regularly and is clearly a pathological feature.

The suture line is substantially similar to that of other congeneric forms.

The specimen from the Lower (?) Bathonian of Western Sicily figured by WENDT as *Polyplectites? venetus* has much denser secondaries and does not seem to be conspecific with PARONA's type; it could rather belong to *P. globosus* WESTERMANN.

Cadomites (or *Polyplectites*) sp. ind.

Several fragmentary specimens from Rotherbrunn fossil locality and Monte Longara assemblage (Padua Mus.), differ from *Polyplectites (?) venetus* in being more sharply ribbed, in having more coronate whorls, with stronger ventrolateral nodes and a less strongly arched venter, and in lacking the constrictions.

The largest one, from Monte Longara, would have attained a diameter of 40 mm, when complete. It has a stout, depressed whorl section.

These specimens are too incomplete to decide whether they belong to *Cadomites* or *Polyplectites*.

FAMILY SPHAEROCERATIDAE BUCKMAN, 1920

GENUS SPHAEROCERAS BAYLE, 1878

General remarks. *Sphaeroceras* is distinguished from *Chondroceras* mainly because of its nearly occluded umbilicus, more globular phragmocone and more strongly contracted body chamber. Notwithstanding WESTERMANN's different statements, many *Sphaeroceras* do possess a flared ventral collar, so this feature can no longer be regarded as characteristic of *Chondroceras*. In my opinion the distinction between them is only valid at subgeneric level. Both are here regarded as direct derivatives of *Frogdenites*, of the Sauzei zone, by loss of the lateral nodes.

The following species and subspecies of *Sphaeroceras* s.s. have hitherto been described (those subsequently transferred to other genera, such as *Emileia*, *Chondroceras*, *Treptoceras*, and the like, do not concern us here): *S. brongniarti* (SOWERBY, 1818); *S. brongniarti canovense* (de GREGORIO, 1886); *S. pilula* PARONA, 1896; *S. auritum* PARONA, 1896; *S. disputabile* PARONA, 1896; *S. tutthum* S. BUCKMAN, 1921; *S. globus* S. BUCKMAN, 1927; *S. brongniarti terpartitum* WESTERMANN, 1956; *S. renzi* (CHRIST, 1960); *S. talkeetnanum* IMLAY, 1962.

In his revision of the genus, WESTERMANN (1956) completely ignores DE GREGORIO's as well as PARONA's species, and regards *S. globus* and *S. tutthum* as probably synonymous with *S. brongniarti*.

As we shall see in the following pages, many of the previously existing names must fall in synonymy (thus, *S. pilula*, *S. disputabile*, *S. tutthum* and *S. renzi* are all subjective synonyms of *S. auritum*, while *S. brongniarti terpartitum* is here regarded as synonym with *S. brongniarti brongniarti* and *S. globus* is reduced to subspecific rank).

On the other hand, the profuse assemblages from the *Posidonia alpina* beds of the Sette Comuni have yielded two hitherto undescribed species (*S. pusillum* n. sp. and *S. tenuicostatum* n. sp.) and one subspecies (*S. tenuicostatum* n. sp. *glabrum* n. ssp.), in addition to all previously known forms.

This allows us to define on stronger evidence the vertical ranges of the different taxa, as well as their phyletic relationships.

From the study of this extremely profuse material (over 900 specimens have been examined, most of which adults), and notwithstanding WESTERMANN'S different opinion, it emerges that the shape of the flared collar that precedes the terminal constriction is fairly constant within each population and provides the best character for distinction at specific and subspecific level.

It also follows that immature or incomplete specimens, without the terminal part of the body chamber, can seldom — if ever — be identified at specific level, unless they are found in association with complete adults.

Sphaeroceras brongniarti (SOWERBY)

(Pl 10, figs. 2, 6-10, 12; text-figs. 42/8-9, 43, 44)

1956 *Sphaeroceras brongniarti* (Sow.) - WESTERMANN 1956; pp. 28-35; pl. 14, ff. 1-7; text-ff. 3-8 (incl. ssp.; cum syn., excl. *S. tutthum* BUCKM.).

General remarks. A thorough study of the extremely rich populations from the Sette Comuni, as well as of several topotypes (including the holotype) and other specimens from England, shows that *S. brongniarti* ranges from the base of the Humphriesianum zone up into the lowermost part of the Subfurcatum zone (Banksi sbz.).

The populations of the Humphriesianum zone are characterized by the presence of a raised ridge or of a flared collar behind the terminal constriction in about 95 % of the individuals; in these populations variability affects only the density of the ribs and the shape of the whorl section, which may be more or less stout.

The population from the Subfurcatum zone, Banksi subzone, of Cima Tre Pezzi quarry, as well as all the specimens of *S. brongniarti* from the Subfurcatum zone figured by previous authors (ROMAN 1935; pl. 3, f. 10; BIRCHER 1935; pl. 9, ff. 9, 11-14 (*non* f. 10); WESTERMANN 1956; pl. 14, ff. 7a-c only), are on the contrary characterized by the complete absence of such a flared collar and even of a raised ridge behind the terminal constriction, all other features being the same.

Because of this constant difference, the populations of the Humphriesianum zone, on one hand, and those of the Subfurcatum zone, on the other, seem worthy of distinction at subspecific level. A thorough examination of the holotype is therefore needed, to decide which subspecies must be the nominate one.

SOWERBY's type has recently been refigured and shortly redescribed by ARKELL (1951-59; pp. 76-78; text-f. 20/2a-c). I have had the opportunity of restudying it at the British Museum, Nat. Hist.. Most of the peristome is broken away; none the less, enough of it is preserved to show the presence of a slightly raised ridge behind the terminal constriction; this feature is also well portrayed in SOWERBY's type-figure. As for the type level, it is stated by SOWERBY to be the same for both *S. brongniarti* and *C. gervillii* (« in the same stratum »); it should therefore be Humphriesianum zone. According to RIOULT's recent revision of the Bajocian stratotype (1964, p. 245) whence came the holotype, *S. brongniarti* is reported to occur only in the « Conglomérat de Bayeux », that is, in the Humphriesianum zone.

The raised flared collar is even more conspicuous on the fine topotypes figured by BAYLE (1878) (this work; pl. 10, figs. 6-7).

It seems therefore justified that the subspecific trinomen *Sphaeroceras brongniarti brongniarti* (Sow.) ought to be restricted to the populations of the Humphriesianum zone.

As for the name of the younger subspecies, of the basal Subfurcatum zone, this should be, in my opinion, *S. brongniarti* (Sow.) *globus* S. BUCKM.: BUCKMAN's form (T.A., pl. 735), which is from the lower part of the Subfurcatum zone and was regarded by WESTERMANN as a junior synonym of *S. brongniarti*, differs from SOWERBY's type only in missing the raised ridge.

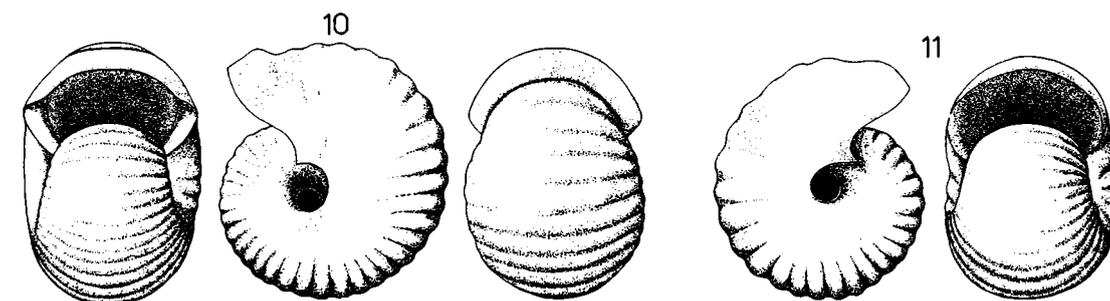
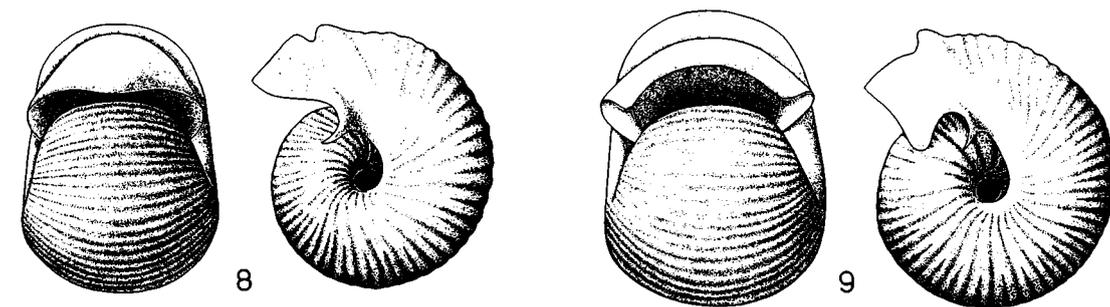
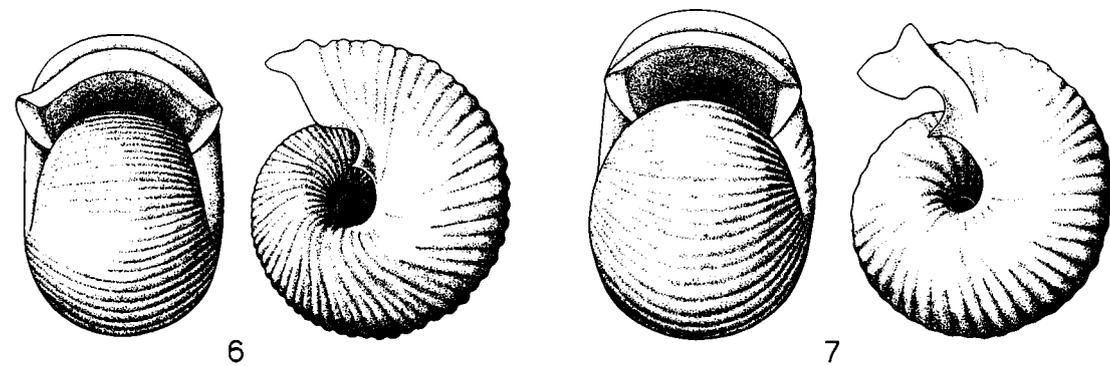
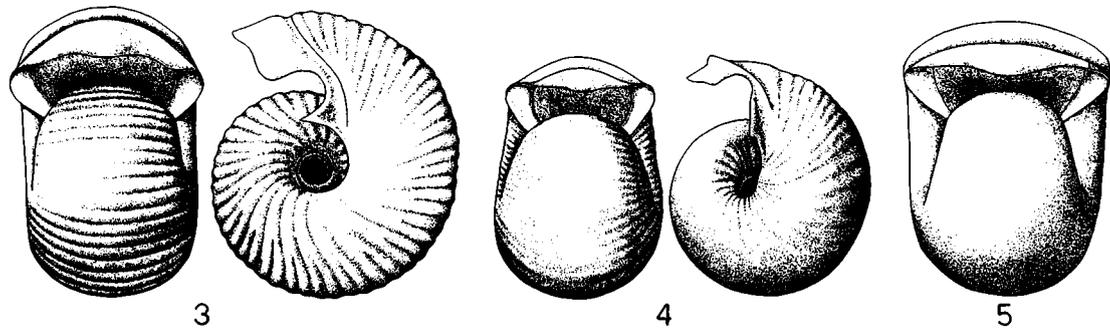
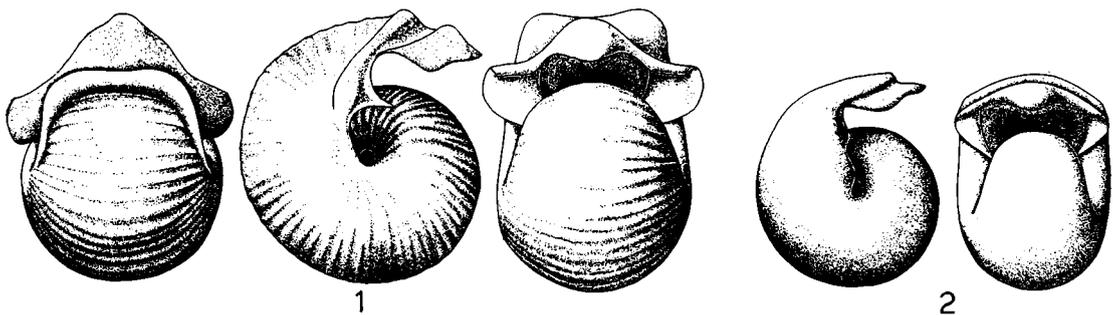
The validity of *S. brongniarti terpartitum* WESTERMANN as a separate subspecies is on the other hand wholly unwarranted, as we shall see in discussing the intraspecific variability.

Populations of the Humphriesianum zone (S. brongniarti brongniarti). There are over 200 specimens from Troch n. 1 fossil locality, 150 of which are complete and show the adult peristome; 4 specimens are from Ponte sul Ghelpach n. 1 assemblage (Pisa Mus.) and a few incomplete ones from Campoverve (cf. PARONA 1880; pl. 5, f. 8). The horizon is Humphriesianum zone, Cycloides subzone in all three cases.

Adult specimens from Troch n. 1 fossil locality fall within two quite separate size groups (text-figs. 43-44): about 96% of them range in size between 4.1 and 15 mm; their frequency histogram, however, is strongly skewed. The remaining 4% (a single complete specimen and several immature or fragmentary ones) attain — or would have attained — a much larger size, well over 20 mm.

FIG. 42 (facing page)

Restored camera-lucida drawings of some Sphaeroceratids of the *Posidonia alpina* beds. All microconch specimens. 1: *Sphaeroceras* (*S.*) *auritum* PARONA; holotype; Monte Meletta (Subfurcatum zone, Schroederi subzone); × 3.3. 2, 5: *Sphaeroceras* (*S.*) *tenuicostatum* n. sp. *glabrum* n. ssp.; holotype (2) and paratype (5); Longara di sotto n. 2 fossil locality (Garantiana zone); both × 6. 3, 6: *Sphaeroceras* (*Chondroceras*) *canovense* (de GREGORIO); both specimens from Longara di sotto n. 1 fossil locality (Subfurcatum zone, Polygyralis subzone); × 4.3. 4: *Sphaeroceras* (*S.*) *tenuicostatum* n. sp. holotype; Ponte sul Ghelpac n. 4 assemblage (Pisa Mus.; Garantiana zone); × 4.3. 7: *Sphaeroceras* (*S.*) *talkeetnanum* IMLAY; Longara di Sotto n. 1 fossil locality (Subfurcatum zone, Polygyralis subzone); × 4.3. 8-9: *Sphaeroceras* (*S.*) *brongniarti brongniarti* (Sow.); both specimens from Troch n. 1 fossil locality (Humphriesianum zone, Cycloides subzone); × 4.3. 10-11: *Sphaeroceras* (*S.*) *pusillum* n. sp.; holotype (10) and paratype (11), both from Troch n. 1 fossil locality (Humphriesianum zone, Cycloides subzone); × 5.4.



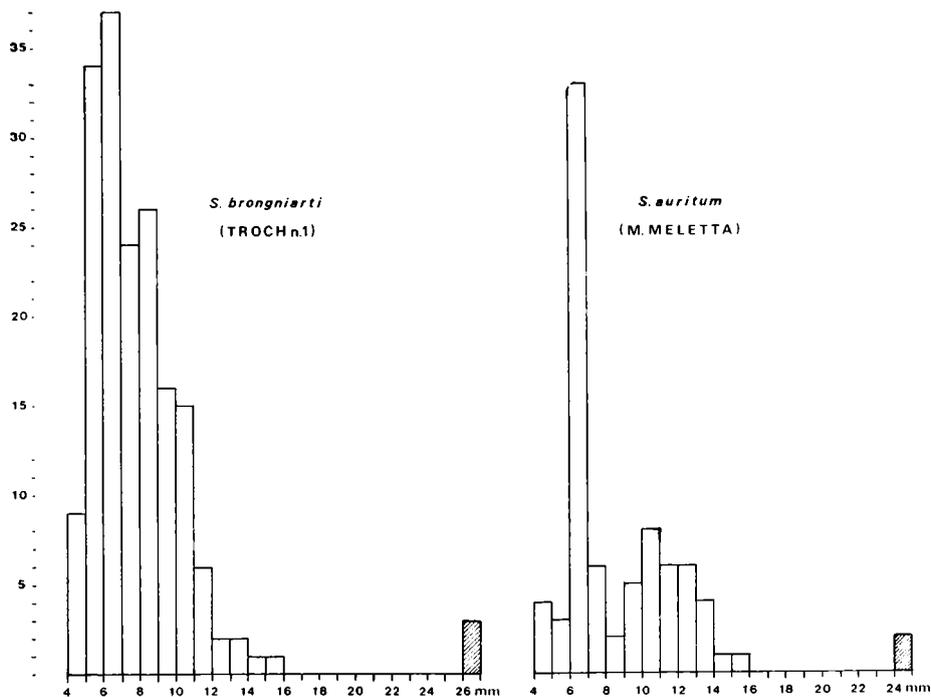


FIG. 43

Frequency distribution of the diameter of adult shells of *Sphaeroceras* (*S.*) *brongniarti brongniarti* (Sow.) (population from Troch n. 1 fossil locality; Humphriesianum zone, Cycloides subzone) (left) and *Sphaeroceras* (*S.*) *auritum* PARONA (population from Monte Meletta; Subfurcatum zone, Schoederi subzone) (right). In both histograms the ruled area corresponds to the plots of macroconch specimens.

It seems logical to regard the former as the microconchs and the latter as the macroconchs. Apart from the difference in size and the peristome (fig. 44), all other features are quite similar, but for the venter, which is less strongly arched in the microconchs, while in the macroconchs it is as perfectly rounded as in the holotype and the large topotypes figured by BAYLE (this work; Pl. 10, figs. 6-7).

The variability displayed by this rich population concerns rib density and whorl width. As to the former parameter, all transitions may be observed between densely ribbed specimens, with most of the ribs triplicate, and specimens which possess only biplicate ribs. In most, but not all, instances, the smaller the specimen the coarser the ribbing. *S. brongniarti terpartitum* WESTERM. seems therefore to have no validity as a separate subspecies, being just a morphotype. As to the second character, some specimens (Pl. 10, fig. 2) have an extremely broad and depressed whorl section, the relative whorl width being well above 1.00 in the inner and middle whorls; others are more regularly globular, with $L = 1.00$ or just slightly below this value; all gradations exist in between. The peristome proper, past the terminal constriction (« hood »), is also rather variable, according to different specimens.

Population of the Subfurcatum zone, Banksi sbz. (S. brongniarti globus). There are over 25 specimens from Cima Tre Pezzi quarry, seven of which show the adult peristome, and almost as many from Ponte sul Ghelpach n. 2 assemblage (Pisa

Mus.), only one of which is complete. They differ from both the type and the specimens from Troch n. 1 only in lacking the raised flared collar, all other features being perfectly comparable (Pl. 10, fig. 12). In particular, the umbilicus is as narrow and nearly occluded as in the latter.

Sphaeroceras talkeetnanum IMLAY

(Pl. 10, figs. 11-13; Pl. 16, fig. 22; text-fig. 42/7)

1962 *Sphaeroceras talkeetnanum* - IMLAY 1962; pp. A 11-12; pl. 5, ff. 1-4.

Material. There are 31 specimens (16 of which possess the adult peristome) from Longara di Sotto n. 1 fossil locality (Subfurcatum zone, Polygyralis subzone). They range in size between 4.2 and 16.5 mm, and differ from *S. brongniarti* *brongniarti* in the following features.

The phragmocone is nearly globular, with an extremely small, almost occluded umbilicus, and a perfectly rounded venter; near the end of the body chamber the whorl width is more strongly contracted than in *S. brongniarti*, while the whorl height is less, so that the aperture is taller and narrower and the adult shells are, as a whole, less stout and globular.

The ribbing is sharper, slightly coarser (R 20-28) and constantly biplicate on specimens up to 13 mm in diameter; larger specimens may have a few additional free secondaries. The terminal constriction is constantly preceded by a strong, projecting flared collar, which is much sharper, taller and narrower than that shown by *S. brongniarti* *brongniarti*.

Such differences, even though not very conspicuous at first sight, are nevertheless fairly constant and justify distinction from *S. brongniarti* at specific level.

But for the smaller size, these specimens show good agreement with the holotype, which is from the late Bajocian (probably Subfurcatum zone) of Alaska. The difference in size can be easily explained, however, taking into account that IMLAY's type is a macroconch specimen, whilst mine are all microconchs.

Sphaeroceras auritum PARONA

(Pl. 10, figs. 17, 19, 21, 23; text-figs. 42/1, 43)

- v 1894 *Sphaeroceras brongniarti* (non Sow.) - PARONA 1894, p. 17.
- v 1896 *Sphaeroceras pilula* - PARONA 1896; p. 16; pl. 1, ff. 14, 15.
- v 1896 *Sphaeroceras auritum* - PARONA 1896; pp. 16-17; pl. 1, f. 16.
- v 1896 *Sphaeroceras disputabile* - PARONA 1896; p. 17; pl. 1, f. 17.
- v 1921 *Sphaeroceras tutthum* - S. BUCKMAN, *T. A.*, pl. 258.
- 1960 *Oecophychius renzi* - CHRIST 1960; pp. 91-92; pl. 5, ff. 8 a-b.

General remarks. Even though it has been mentioned very rarely, this species has received five different names. As for PARONA's, it is quite evident that *S. auritum* and *S. disputabile* apply to the same species: the first (which is here retained as the valid name) is based on specimens showing their mature peristome; the second,

on two freak (pathologic) specimens. Also *S. pilula* PAR., which occurs in the same assemblages as the preceding two, seems to be conspecific, but a judgement is rendered more delicate, because this form was described on immature or incomplete specimens, which lack the highly characteristic adult peristome (see also further on, p. 143).

Material. The syntypes (i.e., only the specimens originally included by PARONA within *S. auritum*) are from Monte Meletta (Subfurcatum zone, probably Schroederi sbz.; 79 specimens, 46 of which possess the adult peristome), Monte Longara (Padua Mus.; same horizon; about 50 specimens, a few of which are complete) and Ponte sul Ghelpach n. 3 assemblage (Pisa Mus.; Subfurcatum zone, probably Schroederi sbz.; two specs., one of which is complete and retains the test).

The specimen figured by PARONA (1896; pl. 1, f. 16; this work, Pl. 10, fig. 19), from the Subfurcatum zone, probably Schroederi subzone of Monte Meletta may be selected as lectotype and is 13 mm in diameter.

The syntypes from Monte Meletta range in size, when fully grown, between 4 and 15 mm; all classes between these two are represented, but the frequency histogram (text-fig. 43) does not follow a Gaussian distribution.

Other specimens are from Acque Fredde (Verona Mus.; Subfurcatum zone; a single specimen originally assigned to *S. brongniarti* by PARONA); Troch n. 2 fossil locality (Subfurcatum zone, Schroederi sbz.; 132 specimens, 26 of which are complete adults ranging in size between 4.1 and 5.1 mm); Rotherbrunn fossil locality (Subfurcatum zone, Baculatum sbz.; 18 specimens, 3 of which are complete) and Longara di sotto n. 1 fossil locality (Subfurcatum zone, Polygyralis sbz.; 4 complete specimens + (?) 3 incomplete ones).

To these can be added the two syntypes of *S. disputabile* from Monte Meletta and — almost certainly — 24 out of the 27 syntypes of *S. pilula*, also from Monte Meletta.

Description. Shell nearly globular, with a broadly and regularly rounded venter. Umbilicus extremely small, nearly occluded and comma shaped on most specimens. Second half of the body chamber strongly contracted. The terminal constriction starts as a deep, pit-like and radially elongated depression near the umbilical seam, then becomes shallower and strongly projected forward. It is preceded by a highly characteristic, bilobate flared collar, its two prongs being separated by a median depression. The peristome proper (« hood »), past the terminal constriction, is provided with two strong, lappet-like lateral projections (hence the specific name) and with a well developed, triangular ventral rostrum, the base of which is raised to form a blunt, median tubercle. It should be stressed that the lappet-like projections are easily broken and therefore seldom preserved.

The ribbing is fine and dense, regularly biplicate but with additional free secondaries on the second half of the body chamber. The primaries (about 26-34 on the last whorl of specimens above 10 mm in diameter) are slightly longer than in *S. brongniarti*. On very small specimens, like that shown on Pl. 10, fig. 17,

the ribbing is proportionally stronger and coarser, as also shown by small specimens of *S. brongniarti*.

On most specimens the ribs appear on both the internal mould and the outer surface of the test. However, on 12 syntypes from Monte Meletta, as well as on the specimens from Ponte sul Ghelpach n. 3 assemblage, the internal mould is completely smooth; since intermediate gradations also occur, these are here regarded as a simple morphotype (see further on, about *S. tutthum* and *S. renzi*).

Three out of the 27 syntypes of *S. pilula* PARONA, including the largest one figured by PARONA (1896; pl. 1, f. 14), would have reached, if complete, a much larger size than all syntypes of *S. auritum*, well above 20 mm. The other features, however, are quite similar (but for the adult peristome, which is missing and unknown). It is possible that these represent the macroconch dimorphs, just as it happens with *S. brongniarti* from Troch n. 1 fossil locality (see p. 140). In both cases, the numerical disproportion between macro- and microconchs may be due to size-sorting by waves and surf.

S. tutthum BUCKM., from the upper part of the Subfurcatum zone of England, is identical to, and therefore a junior subjective synonym of *S. auritum*, as I was able to ascertain restudying BUCKMAN's type at the Geological Survey Museum in London, as well as chorotypes collected by Mr. Colin Parsons, at the University of Keele. The fact that all specimens from England, hitherto assigned to *S. tutthum*, possess a smooth internal mould does not warrant their separation from *S. auritum*, since similar specimens also occur within the type series of the latter, as simple morphotypes. The very same remarks apply to « *Oecoptychius* » *renzi* CHRIST, which is from the Upper Bajocian of Rocca Busambra in Western Sicily (see WENDT 1965; p. 301), and not from the Oxfordian, as originally stated by CHRIST.

A few more remarks concern the specimens from Rotherbrunn (Subfurcatum zone, Baculatum sbz.) and Longara di sotto n. 1 (Subfurcatum zone, Polygyralis sbz.); these, and especially the latter, are probably transitional between *S. brongniarti* and typical *S. auritum*, as shown by the shape of the flared collar, which shows only a shallow depression along the median line and is not yet as strongly bilobate as in the specimens from younger horizons.

S. auritum is thus known to range from the Polygyralis subzone (primitive morphotype) up to the Schroederi subzone of the Subfurcatum zone. As to the geographical range, it is known from Southern England, Normandy (RIOULT 1964, p. 245; I have seen myself several fine specimens from Bayeux at the École des Mines in Paris), Venetian Alps and Western Sicily.

Sphaeroceras tenuicostatum n. sp.

(Pl. 10, fig. 24; text.fig. 42/4)

Material. There are 44 specimens from Ponte sul Ghelpach n. 4 assemblage (Pisa Mus.; Garantiana zone). Of these, 16 are adult and 5 show part or whole of the peristome. The latter range in size between 6.5 and 8 mm. Other incomplete

specimens would have reached. when fully grown, an estimated diameter of about 10-11 mm.

The holotype is shown on Pl. 10, fig. 24 and text-fig. 42/4.

Description. The general shape is globular and similar to that of *S. auritum*, but for the body chamber, which is less strongly contracted. The umbilicus is nearly occluded; on the last whorl the umbilical seam appears as a narrow, sinuous, } shaped fissure. The venter is broadly and regularly rounded.

The terminal constriction is preceded by a thin, sharp, slightly raised continuous ridge, which is strongly prorsiradiate in side view and forms a narrowly arched curve in ventral view. The primary ribs persist up to the terminal constriction and are extremely thin, wiry and dense (28-30 on the last whorl); they are proportionally long and bifurcate in the outer half of the flanks; the secondaries, entirely confined to the venter, are even weaker and often almost obsolete.

S. tenuicostatum n. sp. is easily distinguished from *S. auritum* because of the continuous instead of bilobate flared collar; its finer and longer primaries; its much weaker secondaries, and the sinuous umbilical seam. From *S. brongniarti* it is distinguished in being much more densely and finely ribbed, in possessing a thinner and more prorsiradiate raised ridge behind the terminal constriction, as well as a narrower and more sinuous umbilical seam.

Sphaeroceras tenuicostatum n. sp. *glabrum* n. spp.

(Pl. 10, figs. 20,22; text-figs. 42/2, 42/5)

Material. There are over 20 specimens from Longara di Sotto n. 2 fossil locality (Garantina zone), 10 of which show the adult peristome; they range in size between 4 and 6 mm.

The holotype is shown on Pl. 10, fig. 22.

This form differs from the nominate subspecies in being completely smooth on both the internal mould and the outer surface of the test. Another difference is that the whorl width continues to increase regularly almost to the end of the body chamber, so that the phragmocone is proportionally less inflated and globular than in all other *Sphaeroceras*, including the nominate subspecies.

The terminal constriction is preceded by a sharp raised ridge, which follows a broadly arched curve in ventral view. The peristome proper is provided with a short ventral rostrum and two lateral lappet-like projections (Pl. 10, fig. 20).

In the same assemblage, a fragmentary, much larger specimen has been found (part of the body chamber with the adult peristome; est, diameter about 11 mm). This possesses fine ribs up to the flared collar, and may perhaps represent the macroconch dimorph, while the much smaller, smooth specimens could be the microconchs.

The associated fauna does not allow us to decide whether *S. tenuicostatum glabrum* is younger or older than the nominate subspecies. The horizon, at any rate, is probably slightly different.

Sphaeroceras pusillum n. sp.

(Pl. 10, figs. 1, 3-5; text-figs. 42/10-11)

Material. There are 146 specimens, 124 of which possess the adult peristome; they are all from the Humphriesianum zone, Cycloides subzone of Troch n. 1 fossil locality and range in size between 2.8 and 9 mm (average size about 6 mm), including thus the smallest adult ammonites known to date (hence the specific name).

The holotype is shown on Pl. 10, fig. 1 and measures: D 6.3 mm; H, 0.445; L, 0.648; O, 0.185; R 15. On the phragmocone, the umbilical width is about 0.13.

Description. The shell is more or less globular, according to different specimens. The umbilicus is small, but widens in the last half whorl. The venter is broadly and regularly rounded. The body chamber occupies from 2/3ds to slightly more than one half of the last whorl, and is strongly contracted near its end. The terminal constriction, however, is broad and not bounded posteriorly by a ridge or a flared collar, but still covered with ribs. Past the terminal constriction there is a more or less sharply delimited flared hood.

The ribs are very coarse and sharp, rectiradiate, almost straight and usually biplicate (simple as well as triplicate ribs, however, also occur); the point of furcation lies rather low, so that the primaries are proportionally short. The secondaries increase rapidly in strength with age. According to different individuals, the ribbing may be more or less coarse, but it is in any case coarser than in all other congeneric forms.

It is interesting to note that *S. pusillum* n. sp. shows a certain degree of similarity with *Eocephalites* IMLAY, 1967, from the Late Bajocian of Alaska, which is regarded by several authors as an ancestral Cardioceratid.

SUBGENUS CHONDROCERAS MASKE, 1907

Sphaeroceras (Chondroceras) wrighti (BUCKM.) *minor* (WESTERM.)

(Pl. 11, figs. 1-3, 5, ? 6)

1956 *Chondroceras wrighti minor* - WESTERMANN 1956; pl. 61; pl. 3, ff. 2-3.

Material. There are 66 specimens from Troch n. 1 fossil locality (Humphriesianum zone, Cycloides subzone), which form a rather uniform population. They are all immature, but for the specimens shown on Pl. 11, figs. 1 and 2. The first has most of the adult body chamber preserved at a diameter of 16 mm (if complete, it would have reached 17 mm); the other measurements are: H, 0.45; L, 0.74; O, 0.206; R 32. The second shows the adult peristome at a diameter of 15.3 mm, the other measurements being: H, 0.38; L, 0.60; O, 0.24; R about 35; at 8.6 mm in diameter (end of phragmocone) it measures: H, 0.50; L, 0.79; O, 0.20.

Other specimens measure: (Pl. 11, fig. 3) D 12 mm; H, 0.43; L, 0.767; O, 0.24; R 32; (Pl. 11, fig. 5) D 11.2 mm; H, 0.44; L, 0.673; O, 0.235; R 32.

The whorl section is depressed-reniform, much wider than high, with high, rounded and partially overhanging umbilical walls, short rounded flanks and a broadly arched venter. The ribbing is dense (32-35 primaries to a whorl), fine, regular, prorsiradiate, mainly biplicate but often with additional free intercalatories. The terminal constriction is preceded by a blunt, raised ventral ridge.

The nearest looking form is *C. wrighti minor* WESTERMANN, which has about the same adult size, general proportions and ribbing style. The type level is also Humphriesianum zone.

Both WESTERMANN's types and the adult specimens from Troch n. 1 fossil locality clearly belong to a microconch « species », whose macroconch dimorph could be represented either by *C. gervillii* (Sow.), or, less likely, by *C. wrighti wrighti* BUCKM., also from the Humphriesianum zone. The available specimens, however, are not sufficient to clarify this point.

Sphaeroceras (Chondroceras) canovense (de GREGORIO)

(Pl. 10, figs. 14-17; Pl. 11, fig. 10; text-figs. 42/3, 42/6, 44, 45)

1886 *Stephanoceras (Sphaeroceras) brongniarti* Sow. mut. *canovensis* - de GREGORIO 1886; p. 11; pl. 1, ff. 3 c-e (non f 3 b; ? ff. 3 a, 3 f).

General remarks. This taxon was originally described by de GREGORIO as « une forme ou bien une mutation de l'espèce de SOWERBY (= *S. brongniarti*) à faciès de petite taille ».

From the original figures and description it is however evident that some, if not all, of de GREGORIO's specimens (especially those of pl. 1, ff. 3c-e) differed markedly from SOWERBY's type not only in size — which would have little taxonomic importance — but especially in possessing a much wider, open umbilicus. The same feature is also shown by several specimens of *Sphaeroceras* (s. l.) collected by the present writer: these show perfect agreement with de GREGORIO's pl. 1, ff. 3c and 3d-e, and are certainly not conspecific with *S. brongniarti*.

Sphaeroceras canovense (de GREG.) seems therefore worth maintaining as a valid name of specific rank.

The types. De GREGORIO's pl. 1, fig. 3c represents an adult microconch specimen, which can be selected as lectotype. As shown by the associated fauna, the type level must be Subfurcatum zone, either Banksi or Polygyralis subzone (see p. 63).

The original specimens, however, are probably lost (see p. 61). In spite of this, designation of a neotype does not seem to be justified, on grounds of ICZN article 75(b). Would such a necessity arise in the future, a neotype could be chosen among the specimens described and figured in the present paper, which are from the same region and the same horizon as the syntypes.

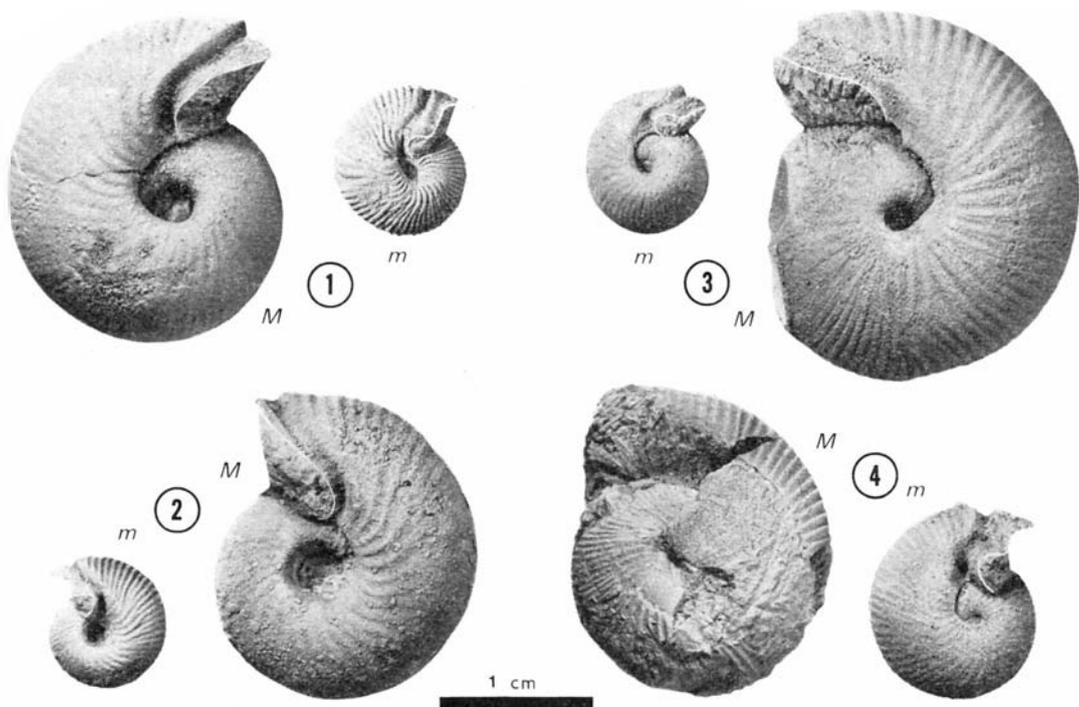


FIG. 44

Sexual dimorphism in some Bajocian Sphaeroceratids. All specimens $\times 2$.

1: *Sphaeroceras (Chondroceras) canovense* (de GREGORIO), involute morphotype. Both specimens from Longara di sotto n. 1 fossil locality (Subfurcatum zone, Polygyralis subzone).

2: *Sphaeroceras (Chondroceras) canovense* (de GREGORIO), evolute morphotype. Both specimens from Longara di sotto n. 1 fossil locality (Subfurcatum zone, Polygyralis subzone).

3: *Sphaeroceras (S.) brongiarti brongiarti* (Sow.); both specimens from Troch n. 1 fossil locality (Humphriesianum zone, Cycloides subzone).

4: *Sphaeroceras (S.) auritum* PARONA; both specimens from Monte Meletta (Subfurcatum zone, Schroederi subzone). 4M is one of the syntypes of *Sphaeroceras pilula* PARONA.

Note the more sinuous outline of the peristome, in the microconch specimens, owing to the presence of lappet-like projections and rostrum.

In the case of *S. (S.) brongiarti brongiarti* (Sow.) and *S. (S.) auritum* PARONA microconch specimens also exist, which are much smaller than those figured here (see fig. 43).

Material. Both micro- and macroconch specimens are known, from the following localities and horizons: Cima Tre Pezzi quarry, Subfurcatum z., Banksi sbz. (3m and 25M, the latter all immature); Ponte sul Ghelpach n. 2 assemblage (Pisa Mus.), Subfurcatum z., Banksi sbz. (4m and 4M, the latter all immature); Longara di sotto n. 1 fossil locality, Subfurcatum z., Polygyralis sbz. (42m and 27M; 5 of the latter are fully grown); Monte Giovo by Brentonico, Subfurcatum zone (a single, complete microconch specimen).

Description. Micro- and macroconch specimens will be described separately.

Microconch specimens range in size, when adult, between 8 and 11.7 mm. The umbilicus, at all stages, is wider than that of all known *Sphaeroceras* s. s., but narrower than that of any previously known *Chondroceras*: on the phragmocone O varies between 0.10 and 0.18, according to specimens, while at the end of the

body chamber it is comprised between 0.18 and 0.24. The terminal egression of the body chamber is less marked than in other species of *Chondroceras*, especially those of the *Humphriesianum* zone.

The ribbing is moderately strong and dense (there are from 23 to 29 primaries on the last whorl, according to specimens). Most ribs are biplicate, but a few additional free secondaries also occur. The terminal constriction is very strong, without any flared collar or raised ridge behind it. The peristome proper (« hood ») has short lateral lappet-like projections and a blunt ventral rostrum.

Like the umbilical width, the whorl width varies between rather wide boundaries, according to specimens: when measured just before the terminal constriction, it is comprised between 0.63 and 0.75 (fig. 45); on the phragmocone it is comprised between 0.75 and 0.90. As a rule, the more stoutly whorled specimens are also the more involute, and *vice versa*.

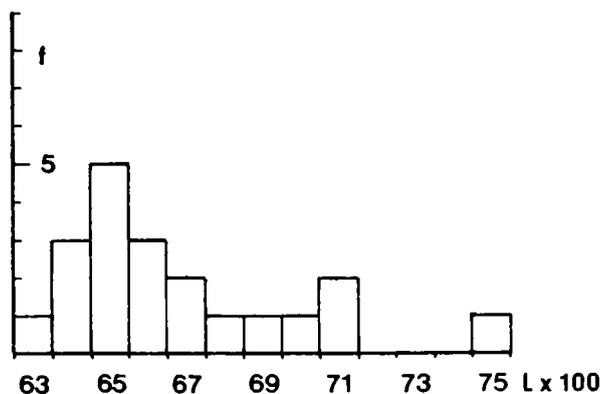


FIG. 45

Sphaeroceras (Chondroceras) canovense (de GREG); population from Longara di sotto n. 1 fossil locality (Subfurcatum zone, Polygyralis subzone); microconch specimens only. Frequency distribution of the whorl width (measured just behind the terminal constriction).

The extreme morphotypes, like Pl. 10, figs. 15 and 18, respectively, are therefore rather different: the more evolute look like *Chondroceras*, while the more involute look closer to *Sphaeroceras* s. s., especially *S. brongniarti globus*, which is often found in the same assemblages as the present species (at Cima Tre Pezzi, for instance). Since all intermediate gradations between the extreme morphotypes also occur, however, this is best interpreted as a result of intraspecific variability.

Distinction of the more involute morphotypes of *S. (C.) canovense* (microconch) from *S. brongniarti globus* (microconch) is at any rate easy: the latter is always much more involute (the relative umbilical width is about 0.05 or less on the phragmocone) and more stoutly whorled (L is always > 1 on the phragmocone).

The more evolute morphotype, on the other hand, is vaguely similar to *S. (C.) flexuosum* n. sp., also found in the same assemblages (Longara di sotto n. 1, for instance). The latter, however, besides being smaller, has a different style of ribbing, with much denser, more flexuous and more strongly projected ribs.

Macroconch specimens range in size, when adult, between 20 and 23 mm. Besides being much larger, they differ from the microconchs in missing the hood and the lappet-like projections and in being more densely ribbed: on the last whorl R varies between 27 and 31, according to specimens, while on the phragmocone it is usually higher, up to 42 (Pl. 11, f. 10). The latter feature is common to all dimorph pairs of *Sphaeroceratids* studied by the present writer. The general proportions, as well as the ribbing style, are otherwise about the same as those of the microconchs.

Macroconch specimens, too, display a certain variability, which affects simultaneously the umbilical width (which varies between 0.17 and 0.20 on the phragmocone and between 0.21 and 0.27 at the end of the body chamber) and the whorl width (comprised between 0.70 and 0.80 on the phragmocone, and between 0.57 and 0.63 just before the terminal constriction). In this case too, the extreme morphotypes (text-fig. 44) look closer to *Chondroceras* or to *Sphaeroceraceras* s. s., respectively.

By this reason, the subgeneric position of *S. canovense* is not very clear. However, taking into account that the more involute morphotypes are still more evolute than all known *Sphaeroceraceras* s. s., *S. canovense* is here placed in the subgenus *Chondroceraceras*.

Vertical and horizontal range. *S. (C.) canovense* (de GREG.), in the Venetian Alps, is known from both the Banksi and the Polygyralis subzones of the Subfurcatum zone. This same species has recently been found also in England by Mr. C. PARSONS at Frogden Quarry, Osborne, Dorset, in BUCKMAN's bed 4, that is in the Polygyralis subzone (see p. 49).

Sphaeroceraceras (Chondroceraceras) flexuosum n. sp.

(Pl. 11, fig. 18; Pl. 16, figs. 17, 18, 20, 21)

Material. There are 50 specimens from Longara di sotto n. 1 fossil locality (Subfurcatum zone, Polygyralis sbz.) and 4 from Ponte sul Ghelapach n. 2 assemblage (Pisa Mus.; Subfurcatum zone, Banksi sbz.).

The specimen from Longara di sotto n. 1 fossil locality, shown on Pl. 16, fig. 18 is designated holotype. It is fully grown at a diameter of 7 mm, and measures: H, 0.40; L, 0.647; O, 0.26. The other paratypes figured measure: (Pl. 16, fig. 17) D 6.6 mm; H, 0.415; L, 0.615; O, 0.28; (Pl. 16, fig. 20; not fully grown) D 9 mm; H, 0.442; L, 0.662; O, 0.243; (Pl. 16, fig. 21) D 7 mm; H, 0.456; L, 0.65; O, 0.20; (Pl. 11, fig. 18) D 8.1 mm; H, 0.446; L, 0.58; O, 0.26.

As for the adult size, these specimens easily fall within two separate groups: a first one, with average adult sizes of 6.5-7 mm (9 complete adult specimens), and a second, with average adult sizes of 13-14 mm (many immature specimens and a fragmentary body chamber with the adult peristome). But for the difference in size, these two groups show the very same features and probably represent different sexes of a single biospecies.

The main distinguishing feature of this new species, when compared with the previously known ones, is given by its smaller size and especially by its more flexuous ribs, which are more projected at the periphery and pass over the venter with a more narrowly arched curve.

According to different specimens, the terminal constriction may, or may not, be preceded by a low, blunt ventral ridge.

The type horizon is Subfurcatum zone, Polygyralis subzone; *S. (C.) flexuosum* n. sp. seems to be confined to the lower two subzones of the Subfurcatum zone, at least in the Sette Comuni.

Sphaeroceras (Chondroceras) aff. flexuosum n. sp.

(Pl. 11, fig. 4)

There are three specimens from Troch n. 1 fossil locality (Humphriesianum zone, Cycloides subzone); that shown on pl. 11, fig. 4 is fully grown, since it shows the terminal constriction, and measures: D 7.5 mm; H, 0.435; L, 0.615; O, 0.225. The other two are still septate at a diameter of 10 mm.

These specimens are characterized by an extremely dense and fine ribbing. Their size, proportions and general aspect are about the same as those of *S. (C.) flexuosum* n. sp. In the present case, however, the ribs are less sinuous and slightly less projected, especially at the periphery.

S. (C.) gracile (WESTERM.), also characterized by very dense and fine ribs, is more evolute.

More specimens are needed, at any rate, before the correct taxonomic position of this taxon can be ascertained.

Sphaeroceras (Chondroceras ?) fasciculatum n. sp.

(Pl. 11, figs. 13-17)

Material. There are 26 specimens from Troch n. 2 fossil locality (Subfurcatum zone, Schroederi sbz.); that shown on Pl. 11, fig. 16 is designated holotype and measures: D 6.3 mm; H, 0.477; L, 0.59; O, 0.166. The other paratypes measure: (Pl. 11, fig. 13) D 8 mm; H, 0.43; L, 0.582; O, 0.18; (Pl. 11, fig. 14) D 5.5 mm; H, 0.50; L, 0.625; O, 0.165; (Pl. 11, fig. 15) D 6.7 mm; H, 0.45; L, 0.571; O, 0.18; (Pl. 11, fig. 17) D 5.9 mm; H, 0.472; L, 0.60; O, 0.16.

Description. Shell involute, moderately compressed laterally; umbilicus very small for a *Chondroceras*. Whorl section stoutly oval in shape and slightly wider than high, with short vertical umbilical walls, rounded umbilical edges, gently convex, convergent flanks and a regularly rounded venter, narrower than in most congeneric forms.

The ribbing is formed by 16-20 very short primary folds, entirely confined to the inner third of the flanks and adorally concave. Each gives rise to bunches of 4 (seldom 2) fine, sinuous and strongly prorsiradiate secondaries. At increasing

diameters, these increase regularly and rather rapidly in strength. The style of ribbing is sometimes almost virgatotome and strongly reminiscent of that shown by *Morphoceras* (but for the absence of constrictions).

Even though no specimen showing the adult peristome is known, it seems likely that this too — like the closely allied *C. flexuosum* — is a dwarf species.

Taking into account the highly distinctive features and relatively large number of available specimens, it seems better to give this form a new name, rather than leaving it in open nomenclature.

SUBGENUS SCHMIDTOCERAS WESTERMANN, 1956

Sphaeroceras (*Schmidtoceras*) *callomoni* n. sp.

(Pl. 11, figs. 7-9, 11-12)

Material. There are 25 specimens, 10 of which with the adult peristome, from Troch n. 1 fossil locality (Humphriesianum zone, Cycloides sbz.).

The holotype is shown on Pl. 11, fig. 7 and measures: D 11 mm; H, 0.32; L, 0.567; O, 0.39; R 13; at 6.6 mm the measurements are: H, 0.45; L, 0.83; O, 0.25.

The other paratypes figured measure: (Pl. 11, fig. 8) D 8 mm; H, 0.333; L, 0.571; O, 0.40; R 19; (Pl. 11, fig. 9) D 8.6 mm; H, 0.326; L, 0.552; O, 0.36; R 20; (Pl. 11, fig. 11) D 8 mm; H, 0.36; L, 0.80; O, 0.29; R 14; (Pl. 11, fig. 12) D 7.8 mm; H, 0.357; L, 0.547; O, 0.38; R 21.

Description. Inner and middle whorls cadicone (Pl. 11, fig. 11), moderately involute, with a trapezoidal-depressed whorl section, much wider than high (L, at this stage, varies between 0.74 and 0.83). Umbilicus moderately wide, for the family (0.25-0.29), deep and crater-like. Flanks extremely short, gently convex and strongly divergent; they form the umbilical walls and end at blunt, but well marked ventrolateral edges, where the maximum whorl width is attained. Venter broad, regularly arched.

The body chamber, which occupies from 4/5ths to 3/4ths of the last whorl, is more or less strongly contracted and excentrically coiled, according to different specimens, but usually more than in other *Schmidtoceras*.

On most specimens, including the holotype, the primaries are exceedingly short and raised at the ventrolateral edges in the form of strong, blunt tubercles (13-17 to a whorl); each tubercle gives rise to two-four blunt, rounded and nearly straight secondaries. The branching is often virgatotome.

A few specimens, like those shown on Pl. 11, figs. 8 and 12, have a less stout whorl section and a slightly wider umbilicus. On these, the primaries are slightly denser (19-21 to a whorl) and longer, just raised at the ventrolateral edges without forming true tubercles. Since intermediate gradations also occur (Pl. 11, fig. 9) these seem to be best incorporated as a simple morphotype, probably transitional to *S. (S.) orbignyianum crassicostratum* WESTERM.

Sphaeroceras (*Schmidtoceras*) *callomoni* n. sp., including the more densely ribbed morphotype just mentioned, is distinguished from all other *Schmidtoceras* because of its stouter and more depressed whorl section and its coarser and shorter primaries, raised at well marked ventrolateral edges.

The peristome is delphinulate and preceded by a broad terminal constriction.

It should be noted in addition that the inner and middle whorls are almost homoemorphic with those of *Normannites* (?) *globulus* n. sp., also from the same assemblage. The latter, however, have sharper ventrolateral nodes and stronger secondaries, which allow a distinction.

Sphaeroceras (*Schmidtoceras*) cf. *evolutum* WESTERMANN

(Pl. 11, figs. 19-20)

1956 *Chondroceras* (*Schmidtoceras*) *evolutum* - WESTERMANN 1956; pp. 87-91; pl. 9, ff. 6-9; text-f. 50-54.

There is one specimen from Monte Meletta (Subfurcatum zone, probably Schroederi sbz.) (Pl. 11, fig. 19) and another four from Ponte sul Ghelpach n. 4 assemblage (Pisa Mus.; Garantiana zone). None shows the adult peristome. That from Monte Meletta had been labelled by PARONA as « *Perisphinctes conclusus* »; since in his 1896 monograph this species was mentioned to occur only at Ponte sul Ghelpach, this probably means that PARONA received this specimen after the monograph was published. It is 10.5 mm in diameter, with part of the body chamber preserved, and measures: H, 0.41; L, 0.50; O, 0.307; R 35.

The specimens from Ponte sul Ghelpach n. 4 assemblage, had been labelled as « *Reineckeia* sp. »; that shown on Pl. 11, fig. 20 measures: D 7.2 mm; H, 0.396; L, 0.515; O, 0.317; R about 31.

When compared with the holotype, these specimens agree rather well, but for the coiling, which is slightly more involute (O is 0.307 to 0.317 against 0.33 to 0.35, while the whorl height is 0.396 to 0.41 against 0.35-0.36).

In the type region S (*S.*) *evolutum* occurs earlier than in the Sette Comuni, just below the base of the Blagdeni subzone (WESTERMANN, l. c.).

Sphaeroceras (*Schmidtoceras*) cf. *crassum* WESTERMANN

(Pl. 11, fig. 21)

1956 *Chondroceras* (*Schmidtoceras*) *crassum* WESTERMANN 1956; pp. 87-88; pl. 9, ff. 4-5; text-ff. 42, 49.

A single, incomplete specimen from Ponte sul Ghelpach n. 4 assemblage (Pisa Mus.; Garantiana zone), differs from those compared to *S.* (*S.*) *evolutum* in being much more coarsely ribbed, and is on the other hand much closer to the types of *S.* (*S.*) *crassum* WESTERM., especially the paratype (WESTERMANN 1956; pl. 9, f. 5a-b).

In this case too, the type level (Humphriesianum zone) is older than the occurrence in the Sette Comuni.

SUPERFAMILY PERISPHINCTACEAE STEINMANN, 1890

General remarks. According to the « Treatise », Perisphinctaceae are represented in the Bajocian by the families Perisphinctidae (subf. Leptosphinctinae), Parkinsoniidae and Morphoceratidae.

As already pointed out by ARKELL (1957, p. L308), in Europe the earliest known Leptosphinctinae and Parkinsoniidae appear suddenly in quantity at the base of the Subfurcatum zone. In Alaska, however, true Leptosphinctinae are already present in the Sauzei zone (see p. 129). *Leptosphinctinae* (and hence all younger Perisphinctids) may have arisen from early Stephanoceratids, such as *Kumatostephanus* or independently of Stephanoceratids from *Erycites* (cf. ARKELL, loc. cit.).

As for Parkinsoniidae, it will be shown in greater detail in the following pages that this family must now be regarded as a polyphyletic, merely morphological unit.

The only feature common to all Parkinsoniidae is the ventral interruption of the ribs; but this character seems to have appeared at different times and quite independently, along separate evolutionary lines.

The earliest representatives of this family — *Orthogarantiana*, *Torrensia* n. gen., *Caumontisphinctes* (s. l.) and *Parastrenoceras* — appear almost simultaneously at the base of the Subfurcatum zone and are already well differentiated from their first occurrence, so that a common origin for all of them seems rather unlikely.

Orthogarantiana (and its probable microconch dimorph, *Torrensia* n. gen.) must clearly have evolved from Stephanoceratids, such as *Stemmatoceras*, from which they differ only in possessing a narrow and often very weak ventral furrow.

In turn, the couple *Garantiana* (M) - *Strenoceras* and *Pseudogarantiana* (m) probably originated as an early lateral offshot of *Orthogarantiana* (M) — *Torrensia* (m), but subsequently evolved at a much faster rate.

Parastrenoceras, on the contrary, seems to have a completely different origin, from the Sonniniid genus *Bajocia*, either on the evolutionary line leading to the uncoiled Spiroceratids or, more likely, as a parallel development.

Caumontisphinctes and its microconch dimorph *Infraparkinsonia* have probably evolved from the main Perisphinctid stock (*Leptosphinctinae*, which also in Europe appear slightly earlier than the first representatives of *Caumontisphinctes*; see G. PAVIA 1969).

As for *Parkinsonia* (s. l.), which gives its name to the family, two alternatives may be taken into account: it may either have evolved from *Caumontisphinctes* (s. l.) as supposed by WESTERMANN (1956) or from *Garantiana* (s. l.). In the first alternative, however, there is a rather wide stratigraphic gap (*Garantiana* zone) between the younger representatives of *Caumontisphinctes* (s. l.) and the earliest *Parkinsonia* (s. l.).

In conclusion, it turns out that the Bajocian Perisphinctaceae as well are all the more a merely morphological, polyphyletic unit. If such higher taxonomic categories ought to reflect only phyletic links rather than homoeomorphy, the question now arises whether Perisphinctaceae (sensu ARKELL 1957) is worth maintaining.

FAMILY PARKINSONIIDAE BUCKMAN, 1920

GENUS TORRENSIA n. gen.

Diagnosis. Dwarf microconch Parkinsoniidae with cadicone inner and middle whorls, enlarging by segments, and a strongly contracted, often elliptically coiled body chamber. Secondaries never completely interrupted, but often weakened by a shallow median furrow. Peristome provided with long lateral lappets and preceded by a strong ridge, with well marked angular shoulders at base of lappets.

Type species: *Stephanoceras gibbum* PARONA, 1896 (= *Torrensia* n. gen. *gibba* (PAR.)).

Type region: Sette Comuni, Venetian Alps. Specimens which are certainly congeneric and probably also conspecific with *Torrensia* n. gen. *gibba* (PAR.) have recently been found also in the Subfurcatum zone of England (Frogden Quarry and Osborne Wood, Dorset) by Mr. Colin PARSONS.

Known range of genus: Subfurcatum zone.

Origin of name: in honour of Dr. H. S. TORRENS.

Relationships. *Torrensia* n. gen. shows strong homoeomorphy with *Trilobitoceras*, which is however from a much older horizon (Sowerbyi zone, Discites subzone). As to the macroconch dimorph, representatives of *Orthogarantiana* (especially *O. conjugata* (QUENST.)) which occurs in the same assemblages as *Torrensia* n. gen. *gibba* (PARONA)), are to my mind the only possible match for *Torrensia* n. gen.

Torrensia n. gen. *gibba* (PARONA)

(Pl. 13, figs. 10-14)

1896 *Stephanoceras gibbum* - PARONA 1896; pp. 17-18; pl. 1, f. 19.

Material. There are 29 syntypes from Monte Meletta and 18 from Monte Longara assemblages (Subfurcatum zone, probably Schroederi subzone in both cases). More specimens have been collected at Rotherbrunn (2 specs.; Subfurcatum zone, probably Baculatum subzone) and Troch n. 2 fossil localities (1 spec.; Subfurcatum zone, Schroederi subzone).

Nine specimens possess the adult peristome and range in size between 6 and 9 mm.

Lectotype. No syntype is identical to PARONA's original figure, which is probably a synthetograph. That from the M. Longara assemblage figured on Pl. 13, fig. 14 is the nearest and is here selected as lectotype.

Description. The inner and middle whorls look like a miniature *Teloceras blagdeni*; the general shape is typically cadicone, with a trapezoidal-depressed whorl

section, much wider than high (L varies between 0.86 and 0.74). The short and gently convex flanks form the umbilical walls; they end at well marked, angular ventrolateral edges. The venter is broad and but slightly arched. On the phragmocone the whorls enlarge by segments between weak constrictions, usually preceded by a stronger secondary. Shortly after each constriction the whorl width increases rather abruptly.

The body chamber occupies slightly more than half a whorl. Over its first part the whorl section increases regularly, until the maximum whorl width is reached. On its last part (90°-120°), however, the body chamber becomes strongly contracted and the whorl width shifts rapidly down to values of 0.62-0.50. On one specimen the contraction is so abrupt, that L varies from 0.791 to 0.66 between diameters of 6.7 and 6.8 mm respectively; a sharp step is then formed along the ventrolateral edge on one side. As a consequence of the contraction, the coiling may, in some (but not all) specimens, become elliptical (Pl. 13, fig. 12).

The ribbing is formed by blunt primaries (about 20 to a whorl), which are raised to form strong ventrolateral nodes; each node gives rise to two to three straight to slightly arched secondaries; free intercalatories are also present. On the last part of the body chamber the ribbing becomes coarser, especially the secondaries. On the body chamber of most specimens the secondaries are weakened (but not wholly interrupted) by a shallow, almost imperceptible median furrow, in much the same way as shown by nuclei of *Orthogarantiana conjugata* at a comparable diameter (cf. Pl. 13, figs. 1 and 12).

The peristome is preceded by a strong, quadrangular ridge, with well marked shoulders, and bears long lateral lappets, which are divaricated at their distal end and lie almost normal to the plane of coiling. They delimit a central aperture, nearly circular in outline, and two smaller apertures laterally.

Torrensia aff. *gibba* (PARONA)

(Pl. 13, fig. 9)

Six specimens from Longara di sotto n. 1 fossil locality (Subfurcatum zone, Polygyralis subzone) differ from those of typical *T. gibba* in possessing a narrower whorl section (L is 0.66 on the phragmocone and 0.45 near the peristome), a more flattened venter, a slightly wider umbilicus (0.47), denser ventrolateral nodes, mainly biplicate ribs and almost obsolete constrictions.

They probably belong to a new subspecies, older than the nominate one, but more and better preserved material is needed before it can be named. A few fragments from Cima Tre Pezzi (Banksi subzone) may also belong here.

Torrensia n. sp. ind.

Three specimens from Ponte sul Ghelpach n. 2 assemblage (Pisa Mus.; Subfurcatum zone, Banksi subzone), none of which retains the adult peristome, differ from *T. gibba* in being much more finely and densely ribbed (R is about 28) and

in possessing a more convex venter. The size is also greater than in the type species, since the largest specimen shows the beginning of the body chamber at a diameter of 9 mm.

More material is needed before this new species can be named.

GENUS ORTHOGARANTIANA BENTZ, 1928

General remarks. Originally described as a subgenus of *Garantiana*, *Orthogarantiana* deserves, in my opinion, full generic status. As to the vertical range, according to BENTZ (1928, p. 142) *Orthogarantiana* is particularly common in the topmost part of the Subfurcatum zone (Schroederi subzone); in the Digne region *O.* cf. *densicostata* appears earlier than representatives of *Garantiana* s. s. (*G. baculata*), being already present in the Banksi subzone (PAVIA 1969, p. 451). On the other hand, I have seen two fine specimens of *Orthogarantiana* sp. ind. in the BOMFORD collection (B. coll. 3043, 3221), which came from the Truellei bed of Burton Bradstock, that is, from the Parkinsoni zone.

Infragarantiana WESTERMANN, 1956, based on « *Garantiana* » *primitiva* WETZEL (itself based on one incredibly poor specimen from the « *Präbigotiten Knollen* » of Bielefeld (= condensed Banksi + Polygyralis + ? Baculatum subzones)), does not seem worthy of distinction from *Orthogarantiana*.

The general shape; the style of ribbing, with strong lateral tubercles and straight secondaries; the presence of weak constrictions on the inner whorls, and the very weak ventral interruption of the ribs (which in some species is visible on the internal mould only), clearly suggest a direct link with Stephanoceratids (e. g. *Stemmatoceras*) of the Humphriesianum zone. In this connection it should be noted that WESTERMANN (1954, pl. 33, ff. 9-10) has figured two specimens of *Normanites* from the upper part of the Humphriesianum zone showing an incipient interruption of the ribs along the middle of the venter.

On the other hand, shortly after its own appearance, (that is in the lower two subzones of the Subfurcatum zone), *Orthogarantiana* may have been the origin of *Garantiana*, which subsequently evolved at a much faster rate, while the former persisted almost unchanged up into the Parkinsoni zone (see before).

The possibility that *Orthogarantiana* represents the link between Lower Bajocian Stephanoceratids and the Upper Bajocian genus *Ermoceras* is also worth taking into account and is not incompatible with *Orthogarantiana* being also ancestral to *Garantiana*.

The microconch counterpart of *Orthogarantiana* could be represented by *Torrensia* n. gen., which has a similar vertical range and is a good match also morphologically. But for the presence of a narrow (and often almost imperceptible) median furrow, both genera have a Stephanoceratid, rather than a Parkinsoniid aspect. At any rate they may be regarded as a link between other representatives of these two families (see before), so that it becomes only a matter of convenience whether to assign them to Stephanoceratidae or to Parkinsoniidae.

Orthogarantiana conjugata (QUENSTEDT)

(Pl.13. figs. 1, 4, 8)

- 1887-88 *Ammonites garantianus conjugatus* - QUENSTEDT. « Ammoniten »; p. 593; pl. 71, f. 10.
v 1896 *Reineka sansonii* - PARONA 1896; pp. 19-20; pl. 1, f. 20.
1915 *Garantia longoviciensis* (non STEINM.) - R DOUVILLÉ 1915; pl. 6, ff. 5-5 a (only).
1925 *Garantia conjugata* QUENT. - BENTZ 1925; pp. 162-163; pl. 6, ff. 5-6; tex-f. 11 (cum syn.).
1928 *Garantiana (Orthogarantiana) conjugata* BTZ. - BENTZ 1928, p. 133.

The syntypes of *Reineckeia sansonii* PARONA are partly from Monte Meletta assemblage (over 25 specimens, including the one figured by PARONA) and partly from Monte Longara assemblage (Padua Mus.; over ten specimens). They are all immature, even though often retaining part of the body chamber; the one figured on Pl. 13, fig. 4 measures: D 17.6 mm; H, 0.36; L, 0.53; O, 0.41; R 23. The specimen figured by PARONA (this work, Pl. 13, fig. 8; part of the last whorl removed) measures: D 13.5 mm; H, 0.344; L, 0.60; O, 0.426; R 24.

The inner whorls (Pl. 13, fig. 1) have a depressed - rhomboid section, which becomes progressively higher and proportionally less wide as the diameter increases.

The ribbing is strong and sharp; the slightly prorsiradiate primaries increase regularly in height from the umbilical to the ventrolateral margin, where they form strong nodes; each gives rise to 2-3 straight secondaries. Along the median line these are weakened, but not completely interrupted, by a narrow superficial groove, almost imperceptible until a diameter of about 10 mm is reached. Ventral tubercles are completely missing. The ventral groove, as may be clearly seen from the impression of the ribs on the dorsal area of the whorls, appears only on the internal mould and is completely missing on the outer surface of the test; on this, the outer ribs are extremely sharp and lamellar.

On all specimens the shell is clearly constricted every 90°, each constriction being preceded by a stronger secondary. The same feature is also shown by one of the paratypes of *O. Schroederi* - the type species (BENTZ 1925; pl. 5, ff. 4a-b).

As a whole, the specimens from the Sette Comuni show very good agreement with QUENSTEDT's type, so that the synonymy between *R. sansonii* PARONA and QUENSTEDT's species seems to be beyond doubt.

Orthogarantiana schroederi (BENTZ)

(Pl. 13. fig. 5)

- 1925 *Garantiana schroederi* - BENTZ 1925; pp. 156-159; pl. 5, ff. 2-4; pl. 6, f. 7; text-f. 7 (cum syn.).
1928 *Garantiana (Orthogarantiana) schroederi* BENTZ - BENTZ 1928; pp. 184-185; pl. 18, f. 1.
1935 *Garantia (Orthogarantia) schroederi* BENTZ - BIRCHER 1935; pp. 160-161; pl. 11, f. 9; text-f. 29.

Four specimens, one from Monte Meletta, one from Rotherbrunn and two more from Troch n. 2 fossil localities, differ from those ascribed to *O. conjugata* in possessing a deeper ventral groove, which completely interrupts the ribs; the ribbing is also somewhat stronger and mainly biplicate.

For a more detailed description see BENTZ.

Orthogarantiana densicostata (QUENSTEDT)

- 1896 *Reineckeia greppini* (non OPPEL) - PARONA 1896; p. 19.
1896 *Cosmoceras uhligi* - PARONA 1896, p. 21 (*nomen nudum*; non *C. uhligi* PAR. & BON. 1897).
1925 *Garantia densicostata* QUENST. - BENTZ 1925; pp. 163-164; pl. 6, ff. 8-9; pl. 7, ff. 1-2; text-f. 12-13 (*cum syn.*).
1928 *Garantiana* (*Orthogarantiana*) *denicostata* DOUV. - BENTZ 1928; p. 186.
1935 *Garantia* (*Orthogarantia*) *densicostata* QUENST. - BIRCHER 1935; p. 163.

A few fragmentary specimens from Monte Meletta and Monte Longara assemblages, which had been erroneously identified by PARONA as *Reineckeia greppini* (non OPP.) and *Cosmoceras uhligi* (non PAR. & BON.). They are characterized by dense, triplicate ribs and are not worthy of being figured.

GENUS PSEUDOGARANTIANA BENTZ, 1928

Pseudogarantiana minima (WETZEL)

(Pl. 13, fig. 19)

- 1896 *Cosmoceras* n. f. - PARONA 1896; pl. 2, f. 2.
1911 *Garantiana minima* - WETZEL 1911; pp. 167-169; pl. 11, ff. 11-16.
1925 *Garantiana minima* WETZEL - BENTZ 1925; pp. 171-172; pl. 7, ff. 8-9.
1928 *Garantiana* (*Pseudogarantiana*) *minima* WETZEL - BENTZ 1928; p. 200; pl. 19, f. 1.
1937 *Garantiana minima* WETZEL - WETZEL 1937; p. 92 (excl. var.).

A single specimen from Ponte sul Ghelpach n. 4 assemblage (Pisa Mus.; *Garantiana* zone) is 18 mm in diameter (est.) and shows the beginning of the body chamber; the other measurements, at a diameter of 15.5 mm, are: H, 0.353; L, 0.407; O, 0.40.

The whorl section is slightly wider than high and almost circular in outline; the umbilicus is proportionally wide. On the last visible whorl there are about 30 primaries; each gives rise to two secondaries, without forming a lateral tubercle; the secondaries end at well marked, small ventral nodes. The latter delimit a moderately wide median smooth band.

As the adult peristome is missing, one might regard this specimen as an immature *Garantiana* s. s. (that is, a macroconch species). However, at a comparable diameter the inner whorls of all known *Garantiana* s. s. have either a much narrower umbilicus, or a much stouter whorl section, or both. On the other hand, there is very good agreement, in the proportions as well as in the style of ribbing, with WETZEL's types, especially the one figured on pl. 11, ff. 14-16 of WETZEL's monograph.

According to BENTZ (1928, pp. 140-142) *P. minima* has been found in the topmost part of the « *untere Pseudogarantianen Schichten* », that is, about at mid height within the *Garantiana* zone. According to WETZEL (1954, text-f. 7) *P. minima* also occurs at the base of the « *untere Parkinsonien Schichten* » (= *Acris* subzone), while spp. *postrema* WETZEL occurs at the top of the same horizon.

GENUS STRENOCERAS HYATT. 1900

General remarks. Taking into account the early development of the style of ribbing, which passes through stages reminiscent of *Orthogarantiana* and *Garantiana* (WETZEL 1954; see also this work, under *Strenoceras* sp. ind., p. 160), I am now convinced that *Strenoceras* can be best paired with the earliest representatives of *Garantiana* s. s., such as *G. baculata* of the Subfurcatum zone, as supposed by CALLOMON (1964, 1969), rather than with the uncoiled Spiroceratids (STURANI 1967, pp. 19-20).

BENTZ (1928) included *S. apleurum* BUCKM., *S. bigoti* BRASIL, *S. praecontrarium* DOUV. and *S. semicostatum* (BENTZ), all from the Subfurcatum zone, within *Epistrenoceras*, along with *E. contrarium* (d'ORB.) (type species), *E. haugi* (DOUV.), *E. histricoides* (ROLL.) and *E. subcontrarium* (BEHR.), which are late Bathonian in age. Since the phyletic relationship between these Upper Bathonian *Epistrenoceras* and the forementioned Upper Bajocian species are not clear, the latter seem to be best placed within *Strenoceras* s. s.

Strenoceras subfurcatum (SCHLOTHEIM)

(Pl. 13, fig. 20)

- 1925 *Strenoceras subfurcatum* (SCHLOTH.) ZIETEN - BENTZ 1925; pp. 138-140; pl. 4, ff. 1 a-b (*cum syn.*).
 1928 *Strenoceras (Strenoceras) subfurcatum* ZIETEN - BENTZ 1928; pp. 150-151, 156-157; pl. 14, ff. 1-2.
 non 1927 *Strenoceras subfurcatum* (non SCHLOTH.) - ROMAN & PETOURAUD 1927; pp. 38-41; pl. 6, ff. 1-6. 12-17
 (= *Pseudogarantiana dichotoma*).

For description see BENTZ. There is a single, immature specimen from Rotherbrunn fossil locality (Pl. 13, fig. 20). At a diameter of 9 mm the other measurements are: H, 0.345; L, 0.46; O, 0.384.

Almost every other rib is bifurcated, for which reason this specimen seems to be best placed within *S. subfurcatum*. It shows good agreement with SCHLOTHEIM's smallest syntype (BENTZ 1928, pl. 14, ff. 2a-b).

S. subfurcatum is confined to the middle and upper part of the zone it gives the name to.

Strenoceras apleurum S. BUCKMAN

(Pl. 13, figs. 22-23)

- 1896 *Cosmoceras pollux* (non REIN.) - PARONA 1896; pp. 20-21; pl. 2, f. 1.
 1921 *Strenoceras apleurum* - BUCKMAN, T. A., pl. 239.
 1928 *Epistrenoceras apleurum* BUCKM. - BENTZ 1928; pp. 164-165.

There are four specimens from Monte Longara (including the one figured by PARONA; this work, Pl. 13, fig. 23), six from Monte Meletta assemblage and one from Rotherbrunn fossil locality.

The specimen figured on Pl. 13, fig. 23 is probably fully grown at a diameter of 13 mm, since it shows a crowding of the spines near the end of the body chamber and the flaring of the peristome that precedes the formation of lappets.

The other specimen figured (Pl. 13, fig. 22), from Monte Meletta, measures: D 18 mm; H, 0.34; L, 0.445; O, 0.41. Another fragment, also from Monte Meletta shows the beginning of the body chamber at an estimated diameter of about 25 mm.

The main distinguishing features of *S. apleurum* are given by almost obsolete primary ribs, in the form of blunt folds (14-15 to a whorl), which fade out completely on the body chamber; no secondary ribs; extremely strong, conical spines, those of the ventral rows being slightly stronger than the ventrolateral ones, but the same in number. Each row of spines is slightly displaced with regard to the other three.

A single, immature specimen from Monte Meletta, 10 mm in diameter, differs from all others in possessing sharp primary ribs; it has no secondaries and strong conical spines on all four rows. This probably represents a morphotype transitional to the normally ribbed congeneric forms.

Strenoceras sp. ind.

(Pl. 13, figs. 6, 15-18, 21)

Over 30 immature specimens from Troch n. 2 fossil locality are too small for an attempt at specific identification, but allow us to study the early development of the style ribbing.

The nuclei are rather involute, almost cadicone in shape, with a narrow umbilicus, a stout whorl section, much wider than high, and a broadly rounded venter. The ribbing is fine and dense, regularly biplicate, with small ventrolateral nodes and a weak, narrow ventral furrow. At this stage, which may last up to a diameter of 4 mm but usually ends much earlier, the aspect is like a tiny *Orthogarantiana*.

Next comes a stage in which the secondaries are interrupted by an increasingly broader median smooth band and raised at their distal portion; this looks like *Garantiana* s. s. (Pl. 13, fig. 6). Then comes an extremely short stage, in which the ribs are still biplicate, while the ventral nodes appear and the secondaries are weakened at their base; this looks like an adult *S. subfurcatum*.

Thereafter bifurcation ceases and the secondaries tend to fade out, while the transversally elongated ventral tubercles become increasingly stronger and more spaced, until in some specimens they become less numerous than the ventrolateral ones, as shown by *S. bigoti* BRASIL (Pl. 13, figs. 16, 17, 21).

According to different specimens each stage may start at variable diameters.

A fragmentary adult specimen from Monte Longara assemblage can perhaps belong to this same species. It has strong, sharp and gently prorsiradiate primaries ending at well marked ventrolateral nodes. The transversally compressed ventral nodes are much stronger and alternate in position with the ventrolateral nodes, being as numerous as the latter. In the depressed spiral band running between the ventral and ventrolateral rows of tubercles very weak secondaries occur; they

are twice as numerous as the primaries and looped to both the ventral and the ventrolateral tubercles in such a way to give a regular zigzag pattern. The ventral furrow is very broad and rather deep.

GENUS PARASTRENO CERAS OCHOTERENA, 1963

General remarks. Only two species (*P. caumonti* (d'ORB.) and *P. lucretius* (d'ORB.)) of this rare and interesting genus were hitherto known to occur in Europe, while three more have been recently described from Mexico by OCHOTERENA.

In the assemblages from the Sette Comuni there are six small, fragmentary specimens which certainly belong to *Parastrenoceras* and may be shared between three different species. A fourth species, here identified with *P. lucretius* (d'ORB.), is also present and is tentatively ascribed to this same genus.

Apart from one, these species occur in the lowermost part of the Subfurcatum zone (Banksi subzone; Cima Tre Pezzi f. loc. and Ponte sul Ghelbach n. 2 assemblage). Also in Mexico *Parastrenoceras* occurs at about the same horizon, since it is found in association with *Oppelia* aff. *subradiata*, *Sphaeroceras* sp., Perisphinctids, « *Dactylioceras* » (see p. 176) and Stephanoceratids (ERBEN 1956, pp. 28-29, 83, 86, 93). As to the Stephanoceratids, they were regarded by ARKELL as misidentified *Procerozigzag*, hence Lower Bathonian in age, but seem to be best placed within *Stemmatoceras* and / or *Teloceras*, to judge by the figures given by C. BURCKHARDT (1927, pl. 12); *Stemmatoceras* and *Teloceras* are known to occur as high as the Banksi subzone of the Subfurcatum zone also in other regions (PAVIA 1969).

This is rather important, since it rules out the possibility that *Parastrenoceras* is a derivative of *Strenoceras*: representatives of the latter genus appear later, toward the top of the Polygyralis subzone (PAVIA & STURANI 1968). The similarity between these two genera may therefore be due to convergence rather than to a direct link. As to the ancestor of *Parastrenoceras*, we shall see with more detail in the discussion of *P. lucretius* (d'ORB.), that the present genus may well have evolved from *Bajocia*.

Parastrenoceras cf. *tlaxiacense* OCHOTERENA

1963 *Parastrenoceras tlaxiacense* - OCHOTERENA 1963; pp. 15-17; pl. 4, ff. 2-3; text-ff. 8-9.

A small fragment from Rotherbrunn fossil locality (Subfurcatum zone, Baculatum subzone) shows good agreement with the types, but is too incomplete for its identification to be entirely beyond doubt.

It has strongly and moderately spaced primary ribs, which end at strong ventrolateral nodes. Secondary ribs are missing. The ventral nodes are very dense (three for every primary) and close to each other, so that they form an almost continuous crenulated ridge that bounds the narrow, deep ventral groove, and thus recall the style of ribbing of *Hybonotoceras*.

Parastrenoceras sp. ind.

(Pl. 14, fig. 14)

Two fragmentary specimens from Cima Tre Pezzi (Subfurcatum zone, Banksi subzone). The whorl section is wider than high (at a whorl height of 3.5 mm the whorl width is 4.5 mm), with convex flanks. The primary ribs are very strong, well spaced and form strong tubercles at the ventrolateral edges. Two or three well marked secondaries rise from each tubercle, which form ventral nodes at their end. The latter are not fused to form a continuous ridge, as in the preceding form; the ventral groove is less deep.

The present species is easily distinguished from *P. caumonti* because of its stronger ribs and stouter whorl section.

Parastrenoceras aff. *caumonti* (d'ORBIGNY)

(Pl. 14, fig. 13)

A complete immature specimen, 9 mm in diameter, and two fragments of larger ones (body chambers), from Ponte sul Ghelphach n. 2 assemblage (Subfurcatum zone, Banksi subzone).

On the largest fragment (Pl. 14, fig. 13) the flanks are flattened and slightly convergent ventrally, while the venter is almost tabulate and the ventrolateral edges very well marked, so that the whorl section is trapezoidal in shape and probably higher than wide.

The primaries are straight and gently prorsiradiate; they are slightly denser than in the type of *P. caumonti*. While some form strong ventrolateral spines, others end in much smaller tubercles. The secondaries (about 3 for every primary) are very faint and almost obsolete. The ventral nodes are missing and the ventral groove is very shallow.

The complete smaller specimen is very evolute (0 is 0.55), with subquadratic whorls and dense primaries (about 38 to a whorl). The ventral furrow appears at a diameter of about 7.5 mm; at lower diameters the very weak secondaries fade on the middle of the venter, which is smooth, but for a few stronger ones which pass over it uninterrupted. At this stage there is a strong resemblance to *Bajocia farcyi*.

P. caumonti has a similar whorl section, but differs in being slightly less densely ribbed, in possessing smaller ventrolateral tubercles and stronger secondaries.

Parastrenoceras lucretius (d'ORBIGNY)

(Pl. 14, figs. 1, 2, 4)

1847 *Ammonites lucretius* - d'ORBIGNY 1842-51; p. 616 (nomen nudum).

1850 *Ammonites lucretius* - d'ORBIGNY 1850; p. 262.

?? 1891 *Perisphinctes lucretius* d'ORB. - HAUG 1891; pp. 76-77.

1909 *Ammonites lucretius* - Ann. de Paléont., vol. 4, p. 112 (« Types du prodrome »).

non 1923 *Bigotites lucretius* - FALLOT & BLANCHET 1923; pp. 107-109; pl. 1, ff. 1-2; text-f. 3.

- non 1924 *Baculatoceras* (*Strenoceras* ?) *lucretius* d'ORB. - WETZEL 1924; p. 214.
non 1925 *Bigotites lucretius* d'ORB. - BENTZ 1925; pp. 178-179; pl. 8, ff. 7-8.
non 1928 *Strenoceras* ? (n. subg. ?) *lucretius* d'ORB. - BENTZ 1928; pp. 172-173; pl. 15, ff. 2 a-d.
non 1931 *Bigotites lucretius* d'ORB. - SCHMIDTILL & KRUMBECK 1931; p. 883; pl. 90, ff. 5 a-c.
non 1963 *Parastrnoceras lucretius* (d'ORB.) - OCHOTERENA 1963; pp. 21-22; pl. 5, ff. 3 a-d.

Historical. D'ORBIGNY's original description reads: « *Espèce petite à tours carrés à découvert, ornée de côtes simples qui partent de l'intérieur et se terminent en dehors en une pointe d'où partent deux côtes qui passent sur le dos où elles forment des zigzags réguliers* ». As to the horizon, *A. lucretius* had been listed in the *Paléontologie Française* as characteristic of the Bajocian stage. No figures were ever given by d'ORBIGNY.

By 1909 the type(s) were regarded as lost by the editors of the « *Types du Prodrome* » (*Annales de Paléontologie*, vol. 4, p. 112).

Subsequently, d'ORBIGNY's name has been applied to at least two different species, none of which, in my opinion, agrees with the original description.

The specimens figured by FALLOT & BLANCHET (1923), BENTZ (1925) and SCHMIDTILL & KRUMBECK (1931) as *Bigotites lucretius* have a rounded whorl section and cannot therefore belong to d'ORBIGNY's species (stated to have « *tours carrés* »).

On the other hand, the specimen mentioned by WETZEL in 1924, and figured by BENTZ (1928) and OCHOTERENA (1963), while possessing a quadrangular whorl section, has three (seldom two) very weak secondaries for every primary, which are moreover interrupted by a well marked, broad median smooth band.

According to BENTZ (1928) the specimen under discussion, which is kept in the Geo-Palaeontological Museum at Kiel, had been labelled by a mineral dealer in Paris (Alexander Stuer) as « *Ammonites lucretius* d'ORBIGNY (espèce msc. du Prodrome) ».

This does by no means constitute any evidence that it is d'ORBIGNY's type, as OCHOTERENA seems to believe (1963, p. 21). On the other hand, if it was so, one wonders why d'ORBIGNY did not mention the presence of the well marked median smooth band as well as of the triplicate ribs. As for the taxonomic position this specimen is probably conspecific with the type of *P. caumonti* (d'ORB.); the apparent difference in the ribbing style is due to the latter (cf. OCHOTERENA 1963, pl. 5, ff. 2a-c) not being fully grown, while the specimen under discussion is a fragmentary adult body chamber. Both show a strong resemblance to *Subcollina yeovilensis* SPATH (see further on, p. 164).

New specimens from the Sette Comuni. Over ten specimens from Cima Tre Pezzi fossil locality and two more from Ponte sul Ghelpach n. 2 assemblage (Subfurcatum zone, Banksi subzone in both cases), correspond perfectly to d'ORBIGNY's original description.

The whorl section is quadrangular, slightly wider than high, with a gently convex umbilical slope, parallel flanks, well marked ventrolateral edges and a broad, slightly arched venter. The coiling is evolute and the umbilicus wide. The immature

specimen figured on Pl. 14, fig. 1 measures: D 10 mm; H, 0.28; L. 0.35; O, 0.506; R 31.

The primary ribs are dense (about 31 to a whorl, on the middle whorls), strong, but not very sharp, straight and gently prorsiradiate. They end at small ventrolateral nodes; each node gives rise to two (exceptionally one) straight secondaries; since the ventrolateral nodes of one side alternate with those of the opposite side, the secondaries pass across the venter following a regular zigzag pattern (Pl. 14, fig. 4). At a very small diameter (below 10 mm) very weak constrictions are also present; they appear as feeble transversal furrows across the venter and are usually preceded by a simple, undivided rib (Pl. 14, fig. 1, left); the same feature is also shown by the nuclei of the type species — *P. mixteca mixteca* — (OCHOTERENA 1963; pl. 3, f. 1a).

On other specimens (Pl. 14, fig. 2), at a higher diameter, the secondaries are weakened (but not wholly interrupted) along the median line by a feeble, superficial furrow. This, however, seems to disappear on the body chamber of still larger specimens, such as the fragmentary one figured on Pl. 14, fig. 5, which would have attained a diameter of about 30 mm, if complete.

The suture line, at a comparable diameter, is similar to that of *P. mixteca mixteca* (OCHOTERENA 1963, text-f. 2), but also recalls that of *Bajocia farcyi*.

As to the generic position, the present species seems to be best placed within *Parastrenoceras*, because of its evolute coiling, wide umbilicus, well marked ventrolateral edges, straight primaries ending at ventrolateral nodes and because of the presence — at some stages of growth at least — of a weak ventral furrow. The style of ribbing recalls that of other congeneric forms at proportionally smaller diameters, and should therefore be regarded as a primitive feature.

On the other hand, it must be noted that *P. lucretius* also shows a certain similarity to representatives of *Bajocia*, both in the general shape and as for the suture lines; by this reason it could be regarded as directly evolved from the latter genus.

In this connection, the following remarks kindly supplied by H. S. TORRENS are of great interest: « A further ammonite which may represent a link between *Bajocia* and *Parastrenoceras* must also be mentioned. This is the specimen collected and figured by WRIGHT (1880-82, p. 350; pl. 38, ff. 5-6) from near Yeovil, England, and renamed by SPATH (1925, p. 171) as *Subcollina* n. gen. *yeovilensis* n. sp. The horizon given by WRIGHT was Jamesoni zone, but DONOVAN (1954, p. 38) regarded it as Upper Lias and in the « Treatise » this ammonite was regarded as a Toarcian Dactylioceratid. Since then the specimen, not traced by DONOVAN, has been located in the British Museum (Nat. Hist.) collections (B.M. N.H. C 1932) by Dr. M. K. HOWARTH who is of the opinion it is certainly not a Dactylioceratid.

Examination of the matrix of the ammonite confirms the horizon is also not Toarcian, if the locality given by WRIGHT and still inked on the specimen is correct, and there seems little reason to question it. The type horizon must be somewhere in the Inferior Oolite. The lithology of the body chamber is a yellow

oolitic limestone with laminated limonite material in the originally void septate portion. There are several horizons which might yield ammonites of this preservation in the Yeovil area, notably the Irony Bed (COPE et al. 1969, p. A29) (highly condensed Subfurcatum and Humphriesianum zones) ».

The morphological features common to *Subcollina yeovilensis* SPATH, *Bajocia farcyi* BRASIL, *Parastrenoceras lucretius* (d'ORB.) and *P. caumonti* (d'ORB.) are the evolute, almost serpentine coiling, the subquadrate whorl section with well marked ventrolateral edges and the relatively simple sutures, with a cruciform first lateral lobe. Furthermore, *Subcollina yeovilensis* and representatives of *Parastrenoceras* (especially *P. caumonti*) share a similar style of ribbing, with strong, straight primaries ending at ventrolateral nodes, which alternate in position on both sides and give rise to weak, bi- or triplicate secondaries, interrupted by a smooth band along the middle of the venter (the latter feature is visible towards the end of the body chamber of *S. yeovilensis*, on WRIGHT's type figure).

It should still be noted that the nuclei from the Subfurcatum zone of Rotherbrunn fossil locality (Pl. 3, f. 16) which have been described on page 127 as *Bajocia* (?) n. sp., also show a remarkable similarity to the inner whorls of *Subcollina*.

If it was confirmed by the finding of new specimens that the exact horizon of *S. yeovilensis* falls within the Subfurcatum zone, the point would be raised whether *Parastrenoceras* and *Subcollina* are still worth maintaining as separate genera; in the case they ought to be regarded as subjective synonyms, *Subcollina* has priority.

GENUS CAUMONTISPHINCTES BUCKMAN, 1920

Caumontisphinctes polygyralis BUCKMAN

(Pl. 16, fig. 19)

1920 *Caumontisphinctes polygyralis* - BUCKMAN, *T. A.*, pl. 163.

1943 *Caumontisphinctes polygyralis* BUCKM. - ROCHÉ 1943; p. 22; pl. 1, f. 4.

1969 *Caumontisphinctes polygyralis* BUCKM. - PAVIA - f. 3-7.

There are 20 immature or fragmentary specimens from Longara di sotto n. 1 and two more from Rotherbrunn fossil localities (the latter two are only doubtfully identified with BUCKMAN's species). The largest one (a fragment of body chamber with the adult, simple peristome) when complete would have attained as large a size as the holotype.

As a whole, the population from Longara di sotto n. 1 f. loc. shows perfect agreement with the holotype, that I could study at the Geological Survey Museum.

The innermost whorls have a rounded-depressed section; this becomes isodiametric and nearly circular in outline between diameters of 15 and 25 mm; thereafter the whorl section becomes increasingly higher and regularly elliptical in shape.

The ribbing is very dense throughout; the primaries are mainly biplicate, but a few remain simple; the point of furcation, on the middle and outer whorls, lies just beyond the middle of the flanks, so that the secondaries are rather long.

Both the primaries and the secondaries are prorsiradiate, the latter more than the former. The ventral smooth band appears by a diameter of about 10 mm; on both sides of it the secondaries may or may not alternate, according to individuals and to the diameter at which this feature is observed (on the outer whorls they are more likely to be slightly displaced).

On the holotype, very small, sharp nodes occur at the point of furcation, almost to the end of the phragmocone, but they seem to be entirely confined to the outer surface of the test and do not appear where this has been removed.

C. polygyralis is easily distinguished from all other congeneric forms by its very dense ribbing.

In the Digne region, where it is rather common, the present species is confined to the Polygyralis subzone and has been chosen as subzonal index (PAVIA & STURANI 1968, p. 313).

Caumontisphinctes prorsicostatus n. sp.

(Pl. 14, figs. 8, 9, 12; text-f. 46)

? 1894 *Peltoceras* cf. *pottingeri* (non SOW.) - PARONA 1894; pp. 17-18.

v 1896 *Peltoceras chauvinianum* (non d'ORB.) - PARONA 1896; p. 24; pl. 2, f. 9.

There are ten specimens from Monte Meletta, including the one figured by PARONA, and twelve more from Monte Longara assemblage (Padua Mus.). They are either not fully grown or fragmentary, but allow, as a whole, a fairly satisfactory definition of all the specific characters. Some fragments are still septate at an est. diameter of about 40 mm, showing that the present species could attain as large a size as the other congeneric ones.

At a small diameter the whorl section is quadrangular, wider than high, with very well marked ventrolateral edges and a gently arched, polygonally shaped venter. At higher diameters the whorl height increases at a slightly faster rate than the whorl width, so that the section of the outer whorls becomes isodiametric. The umbilical slope is gently rounded and the flanks slightly convex throughout. The venter becomes increasingly arched as the diameter increases, but its outline remains polygonally shaped, with two slopes converging from the ventrolateral edges to the flattened, smooth median band. The umbilicus is wide throughout (0.522 - 0.55).

The style of ribbing has a highly characteristic, geometric appearance, with nearly straight, strong, prorsiradiate primaries, raised at the ventrolateral edges to form small nodes, from which rise strongly projected, short secondaries. The latter increase in strength from the ventrolateral nodes to their distal end, where they are interrupted and often also displaced by a median smooth band. The ribbing is mainly biplicate, but many ribs remain simple. As to the rib density, this varies according to specimens; the extreme morphotypes are figured on Pl. 14, figs. 9 and 12, respectively.

The specimen figured on text-fig. 46 has been selected as holotype; it comes from Monte Longara assemblage, it is not fully grown and measures: D 12 mm; H, 0.26; L, 0.40; O, 0.525; R 30.

The specimen figured by PARONA (this work, Pl. 14, fig. 8) is almost identical as for the style of ribbing, but has a much slenderer whorl section. its measurements being: D 10 mm; H, 0.23; L. 0.33; O, 0.55; R 28.

The main distinguishing feature of *C. prorsicostatus* n. sp. is given by the strongly projected secondaries. whence the specific name.



FIG. 46

Holotype (1) and paratype (2) of *Caumontisphinctes* (*O.*) *prorsicostatus* n. sp.; both specimens from Monte Longara (Padua Mus.); Subfurcatum zone. Schroederi subzone. $\times 3.5$.

The nearest looking congeneric form is *C. bifurcus* BUCKM., the holotype of which I was able to see at the Geological Survey Museum in London (*C. rota* (BENTZ ex SCHROEDER) is a junior subjective synonym of BUCKMAN's species). This, however, has rectiradiate primaries, less projected secondaries, a broader median smooth band and a less arched venter at any comparable diameter.

C. nodatus BUCKM. has an elliptical whorl section, with a broadly rounded venter, much longer and less projected secondaries. *C. polygyralis* is much more densely and finely ribbed.

The type level is Subfurcatum zone, Schroederi subzone, this being thus the youngest *Caumontisphinctes* s. s. known to date.

SUBGENUS CAUMONTISPHINCTES (INFRAPARKINSONIA) WESTERMANN, 1956

General remarks. The holotype of the type species, *I. inferior* (BENTZ) (BENTZ 1925. pp. 174-175; pl. 8, f. 4) is a small sized ammonite, 36 mm in diameter, and does not possess the adult peristome, so that one cannot say whether it had lappets or not. However, specimens nearly identical to the holotype and possessing short spatulate lappets are extremely common in the Polygyralis subzone of the Digne region (mentioned as *Caumontisphinctes phaulus* (non BUCKM.) in PAVIA & STURANI 1968, p. 313), where they are constantly associated, as in Germany, with the macroconch species *C. bifurcus* BUCKM. (= *Caumontisphinctes rota* BENTZ ex SCHROEDER).

On the other hand, WESTERMANN has subsequently ascribed to *Infraparkinsonia* also *C. phaulus* BUCKM., which is a certain microconch species.

It seems therefore justifiable to maintain *Infraparkinsonia* as a microconch subgenus of *Caumontisphinctes*.

Caumontisphinctes (Infraparkinsonia) phaulus BUCKMAN

(Pl. 16, figs. 15, 16)

v 1920 *Caumontisphinctes phaulus* - S. BUCKMAN, T. A., pl. 169.
non 1968 *Caumontisphinctes phaulus* - PAVIA & STURANI 1968; p. 313 (= *C. (I.) inferior* (BENTZ)).

There are six immature or fragmentary specimens from Longara di Sotto n. 1 fossil locality (Subfurcatum zone, Polygyralis subzone). Two of these fragments consist of the distal part of the body chamber, with the auriculate peristome (Pl. 16, fig. 16).

As a whole, they show perfect agreement, in size as well as in the style of ribbing, with the holotype, that I was able to study at the Geological Survey Museum in London.

The main distinguishing feature of *C. (I.) phaulus* is given by the fact that the small nodes formed at the points of furcation lie in the middle of the flanks, so that the secondaries are as long as the primaries, or even longer. In the other congeneric forms (*C. (I.) inferior* (BENTZ) and *C. (I.) bonarellii* (PAR.)) the point of furcation lies much closer to the periphery, so that the secondaries are much shorter than the primaries.

It should also be noted that the secondaries are slightly displaced on both sides of the median smooth band, on the holotype as well as on the specimens from the Sette Comuni.

Since they are found in the same assemblage and are morphologically similar, *C. (I.) phaulus* and *C. polygyralis* seem to form a good dimorphic pair.

Caumontisphinctes (Infraparkinsonia) bonarellii (PARONA)

(Pl. 14, figs. 3, 7, 10, 11)

v 1896 *Parkinsonia bonarelli* - PARONA 1896; p. 20; pl. 1. f. 22.

There are 8 syntypes from Monte Meletta; the specimen figured by PARONA, which is here selected as lectotype (Pl. 14, fig. 3), and three others are fully grown.

This is a very small sized species, which attains the adult stage at a diameter of 10.5-20 mm. The whorl section is circular in outline and slightly wider than high up to the mouth border. The umbilical wall is gently rounded; the flanks and the venter regularly convex, without ventrolateral edges; the umbilicus is wide.

The ribbing is dense and regular, with long, slightly arched and gently prorsiradiate ribs, which bifurcate in the outer fourth of the flanks, but often remain simple. The outer ribs are very short and projected; along the median line

they are weakened but not wholly interrupted by a narrow, superficial furrow: on both sides of this they may be slightly displaced. At the point of furation the primaries are raised but do not form a true tubercle.

On the lectotype there are 36 primaries on the last whorl. The peristome is provided with two long lappets. On another specimen (Pl. 14, fig. 11) the ribs are a little stronger and more rod-like, while the lappets are shorter.

C. (I.) phaulus has much shorter primaries; *C. (I.) inferior*, besides being larger, has straighter, rectiradiate primaries and a broader median smooth band.

The type level is Subfurcatum zone, Schroederi subzone.

Since they occur together, it seems likely that *C. (I.) bonarellii* is the microconch dimorph of *C. prorsicostatus* n. sp.

FAMILY SPIROCERATIDAE HYATT, 1900

General remarks. Since the publication of the « Treatise », where this family was placed in the suborder Lytoceratina, several authors have stressed the much closer affinities existing between Spiroceratids and Parkinsoniids (e. g. *Strenoceras* and / or *Parastrenoceras*), so that they seem to be best placed next to Parkinsoniidae.

The earliest true Spiroceratids (*S. baculatum*) appear at the base of the Baculatum subzone of the Subfurcatum zone (PAVIA & STURANI 1968; p. 314), at about the same level as *Strenoceras*.

Since all known Spiroceratids have a simple peristome and may therefore be regarded as macroconchs (cf. QUENSTEDT, Ammoniten, pl. 70, f. 12; also this work, Pl. 14, fig. 18), when searching for a possible microconch dimorph I put forward the hypothesis that this could have been *Strenoceras*, in the Subfurcatum zone, and *Pseudogarantiana* in the Garantiana zone (STURANI 1967). However, having studied in more detail the early development of the style of ribbing in *Strenoceras*, I now agree that such an hypothesis is no longer tenable. In this connection it should be noted that, while several *Strenoceras* and all *Pseudogarantiana* have bifurcate ribs, bifurcation is very rarely, if ever, shown by Spiroceratids (the name of the type species of *Spiroceras*, *S. bifurcati* (QUENST.), even though often misspelt (*S. bifurcatum*) refers in no way to a biplication of ribs).

The microconch dimorphs of Spiroceratids, if any, remain therefore a mystery.

As to their possible ancestor, this must have occurred earlier than their first appearance in the Baculatum subzone, and must have shown certain morphological features, such as an extremely evolute, many-whorled form, with a very weakly impressed dorsal area, and provided with strong, simple ribs as well as with sutures built on much the same pattern as those of *Spiroceras*. *Parastrenoceras* meets many of these requirements, including the stratigraphical ones, but shows a highly specialized ornamentation, with bi- or triplicate ribs; in my opinion it may represent a parallel development from a common stem, rather than the direct ancestor of *Spiroceras*. *Bajocia*, under this regard, seems to fit this role better. Needless to say, all this is rather conjectural, until intermediate links are discovered.

GENUS SPIROCERAS QUENSTEDT, 1858

Remarks. *Apsorroceras* HYATT, 1900, does not seem to be sufficiently distinct from *Spiroceras* to be maintained as a separate genus.

Spiroceras obliquecostatum (QUENSTEDT)

(Pl. 14, figs. 16, 17)

- 1927 *Apsorroceras obliquecostatum* QUENST., - ROMAN & PETOURAUD 1927; pp. 37-38; pl. 3, ff. 1-6 (*cum syn.*)
1929 *Spiroceras bifurcatum* var. *obliquecostatum* QUENST. - POTONIÉ 1929; p. 235.

This is the commonest ammonite in the assemblage from Longara di sotto n. 2 fossil locality. All specimens seem to be immature, the largest one being about 40 mm in length (est.). As a whole, they show near perfect agreement with those from the « Ciret » figured by ROMAN & PETOURAUD, whom see for a detailed description. As shown by ARKELL (1956; pp. 77-78) only the Garantiana zone is represented within the « Ciret » formation.

Spiroceras waltoni (MORRIS)

(Pl. 14 fig. 18)

- 1845 *Ancyloceras waltoni* - MORRIS 1845; p. 33; pl. 6, ff. 5 a-c.
? 1886-87 *Hamites enodus* - QUENSTEDT, Ammoniten; p. 585; pl. 70, f. 26.
v 1896 *Crioceras annulatus* (non DESH.) - PARONA 1896; p. 18.
1925 *Spiroceras waltoni* (MORRIS) - S. BUCKMAN, *T. A.*, pl. 540.
? 1929 *Spiroceras bifurcatum* var. *costatum* MORRIS - POTONIÉ 1929; pl. 18, f. 28 (*excl. syn.*).

Three fragmentary specimens from Ponte sul Ghelpach n. 4 assemblage. The largest one (Pl. 14, fig. 18) has the flared adult peristome, showing this to be a small sized species (the aperture measures: H, 4.5 mm; L, 4.4 mm). The dorsal area is completely smooth; the ribs appear at the base of the flanks and increase regularly in strength until they end at small ventral tubercles; the lateral nodes are either completely missing or so small as to become visible only under very oblique light. The ventral groove is not very deep. The ribs are sharper and more spaced than in *S. obliquecostatum*.

One of the unfigured specimens is twisted; this suggests a helicoidal coiling.

These specimens show near perfect agreement with chorotype material from the Garantiana zone of Burton Bradstock, that I was able to examine at the Geological Survey Museum in London.

Spiroceras cf. baculatum (QUENSTEDT)

(Pl. 14, fig. 15)

- 1923 *Rhabdodites rhabdodites* - S. BUCKMAN, *T. A.*, pl. 374.
1929 *Apsorroceras baculatum* QUENST. - POTONIÉ 1929; pp. 227-229; pl. 17, ff. 1-2 (*cum syn.*).

There are several fragmentary, immature specimens from Rotherbrunn fossil locality (Subfurcatum zone, Baculatum subzone). They show an isodiametric, circular

cross section and are nearly straight, for which reason they seem best placed within *S. baculatum* rather than within *S. bifurcati bifurcati*, the only other *Spiroceras* known to occur in the Subfurcatum zone.

The ribs are sharp and bear both lateral and ventral tubercles; on the dorsal part they are weakened but do not fade, and become gently projected.

S. baculatum, in Germany as well as in the Digne region, is confined to the middle part of the Subfurcatum zone (BENTZ's « Baculatoceras Horizont », that is, *Spiroceras baculatum* subzone).

The very small size and the fragmentary status of these specimens do not allow their absolutely certain identification.

FAMILY PERISPHINCTIDAE STEINMANN, 1890
SUBFAMILY LEPTOSPHINCTINAE ARKELL, 1950

GENUS LEPTOSPHINCTES BUCKMAN, 1920
Leptosphinctes (subg. ?) *perspicuus* (PARONA)

(Pl. 15, figs. 3-6, 10, 11)

1896 *Perisphinctes perspicuus* - PARONA 1896; pp. 23-24; pl. 2, f. 5 (non f. 6).

1896 *Perisphinctes subtilis* (non NEUM.) - PARONA 1896; pp. 22-23; pl. 2, f. 3.

non 1928 *Perisphinctes perspicuus* (non PAR.) - DORN 1928; p. 244; pl. 7, f. 2 (= *Planisphinctes tenuissimus* (SIEM.)).

Lectotype. The specimen figured by PARONA (1896, pl. 2, f. 2; this work, Pl. 15, fig. 6) even though it is badly preserved, incomplete and much worn on both sides, must be selected as lectotype, in accordance with ICZN recommendation 74B, since the other unfigured syntypes are even more fragmentary. The incomplete specimen, showing an auriculate peristome, figured by PARONA as *Perisphinctes perspicuus* (?) (1896; pl. 2, f. 6) must on the other hand be excluded from the type-series, in accordance with ICZN article 72b.

All this is particularly unfortunate, because several, much better preserved specimens (this work, Pl. 15, figs. 3-5) which had been erroneously identified by PARONA as *Perisphinctes subtilis* (non NEUM.), are clearly conspecific with the syntypes of *L. perspicuus* (PAR.). The differences noted by PARONA between *L. perspicuus* and the specimens just mentioned are either not relevant for a distinction at specific level or just do not exist.

Material. As a whole, there are over 15 unbroken specimens from Monte Meletta and four more from Monte Longara. Fragmentary specimens and nuclei are very common in both assemblages.

Description. Shell planulate, moderately evolute, with about 1/3 of each whorl covered by the next; the umbilicus is wide (0.45 - 0.463). The whorl section is almost isodiametric and circular in outline, with a short, rounded umbilical slope, gently convex flanks and a broadly rounded venter.

The primary ribs are blunt and moderately dense (39 - 42 to a whorl, at a diameter of about 30 mm); they are mainly biplicate, seldom triplicate or with free intercalatories, and gently proverse. The point of furcation lies in the middle of the flanks; the secondaries are weakened, to a greater or lesser degree according to specimens, along the median line, but are never completely interrupted.

The inner whorls, up to a diameter of about 10-12 mm, are subcoronate, with the primaries raised at the ventrolateral edges. This feature completely disappears at greater diameters. The inner and middle whorls, up to about 20 mm in diameter, bear weak constrictions (one every 90°), which fade out completely at higher diameters.

It is impossible to say whether these specimens are nearly adult or still immature: none of them shows the peristome and that figured by PARONA (1896; pl. 2, f. 6), which has lappets, is too incomplete to decide whether it belongs to the same species or not. In the first case, *L. perspicuus* (PAR.) would be close to *L. (Cleistosphinctes) cleistus* (BUCKM.), from which it may be distinguished because of its rounded, nearly isodiametric whorl section. In the second case it would be close to *L. (L.) leptus* (BUCKM.) and *L. (L.) subdivisus* (BUCKM.); at a comparable diameter, however, the former is more densely ribbed than *L. (subg. ?) perspicuus*, while the latter is less densely ribbed.

The figured specimens measure: (Pl. 15, fig. 3) D 31 mm; H, 0.33; L, 0.385; O, 0.45; R 39. (Pl. 15, fig. 4) D 33 mm; H, 0.315; L, 0.333; O, 0.463; R 39. (Pl. 15, fig. 5) D 29 mm; H, 0.327; L, 0.334; O, 0.458; R 42. (Pl. 15, fig. 6; lectotype) D 30 mm; H, 0.327; L, 0.344; O, 0.458; R 40. (Pl. 15, fig. 10; same as PARONA 1896, pl. 2, f. 3) D 18 mm; H, 0.322; L, 0.388; O, 0.461; R 37.

Leptosphinctes (subg. ?) *conclusus* (PARONA)

(Pl. 15, fig. 12)

1896 *Perisphinctes conclusus* - PARONA 1896; p. 22; pl. 2, f. 4.

There are three syntypes from Ponte sul Ghelpach n. 2 assemblage (Pisa Mus.; Subfurcatum zone, Banksi subzone). The largest one, already figured by PARONA, is designated lectotype (this work, Pl. 15, fig. 12). It is only 13 mm in diameter and certainly immature; PARONA's statement that it shows the adult peristome and has lateral lappets is merely fantastic.

L. conclusus differs from the other congeneric forms found in the Sette Comuni in being more involute and much more stoutly whorled (at comparable diameters). The measurements of the lectotype are: D 13 mm; H, 0.344; L, 0.50; O, 0.412. The whorls enlarge by segments between well marked constrictions (one every 90° on the lectotype; one every 120° on the smaller syntypes).

In this case too it is absolutely impossible to say whether this is a macro- or a microconch form.

Leptosphinctes (subg. ?) *torquis* (PARONA)

(Pl. 15, figs. 7-9)

1896 *Perisphinctes torquis* - P394k3 1896; p. 23, pl. 2, f. 7.

There are 12 syntypes from Monte Meletta assemblage. Since the specimen figured by PARONA is badly preserved and there are other better preserved syntypes, one of these has been selected as lectotype (Pl. 15, fig. 7).

Shell evolute, with less than 1/3 of each whorl covered by the next one; umbilicus wide (0.50 - 0.51); whorl section nearly isodiametric and circular in outline. The primary ribs (about 36 to a whorl at a diameter of 30 mm) are moderately sharp and bifurcate on the middle of the flanks. Triplicate ribs or free intercalatories are also present. There are three to four proverse constrictions on each whorl, accompanied by stronger secondaries. In the segments between constrictions the other secondaries are weakened and sometimes interrupted along the median line.

The specimens figured measure: (Pl. 15, fig. 7; lectotype) D 30 mm; H, 0.28; L, 0.296; O, 0.51; R 36. (Pl. 15, fig. 8) D 17 mm; H, 0.266; L, 0.343; O, 0.516; R 38. (Pl. 15, fig. 9) D 16 mm; H, 0.28; L, 0.343; O, 0.50; R 32.

L. (subg. ?) *torquis* is very close to, and perhaps a senior subjective synonym of *L.* (*Cleistosphinctes*) *otiophorus* (BUCKM.) (T. A., pl. 191), also from the Subfurcatum zone. This question, however, cannot be settled until adult specimens, showing *L. torquis* to be a microconch species like BUCKMAN's, are found.

SUBGENUS LEPTOSPINCTES (CLEISTOSPINCTES) ARKELL, 1953

Leptosphinctes (*Cleistosphinctes*) *cleistus* BUCKMAN

(Pl. 15, figs. 1,2)

v 1920 *Leptosphinctes cleistus* - S. BUCKMAN, T. A., pl. 161.

? 1927 *Perisphinctes martinsi* (non d'ORB.) - ROMAN & PETOURAUD 1927; pp. 42-43; pl. 5, ff. 1, 2, 5 (non ff. 3, 4); text.f. 7.

? 1943 *Leptosphinctes cleistus* BUCKM. - ROCHÉ 1943; pl. 1, f. 3.

Six specimens from Monte Meletta and another one from Monte Longara assemblages (Subfurcatum zone, Schroederi subzone), which had been labelled by PARONA as « *Perisphinctes subtilis* » (non NEUM.), show near perfect agreement with the holotype, with which a direct comparison has been made.

The largest one, figured on Pl. 15, fig. 1, is also the largest complete ammonite recovered from the *Posidonia alpina* beds of the Sette Comuni, with a diameter of 58 mm. It is adult and shows the auriculate peristome; the lappets are shorter than those of the holotype, but this probably depends on the fact that the specimen under discussion died before its lappets could attain their maximum development. Another fine specimen is figured on Pl. 15, fig. 2; this measures: D 34 mm; H, 0.29; L, 0.27; O, 0.50; R 41. The measurements of the holotype, at a diameter of 40 mm, are: H, 0.306; L, 0.26; O, 0.485; R 41.

The main distinguishing feature is the whorl section, which is higher than wide and ovably shaped, with rounded, short umbilical walls, convex and gently convergent flanks and a narrowly rounded venter. The umbilicus is wide. The ribs regular, proverse, mainly biplicate, seldom simple, with the point of furcation in the middle of the flanks or slightly lower. The inner whorls, up to a diameter of about 10 mm are subcoronate, with the primaries raised at the ventrolateral edges. On the outer whorls the secondaries are interrupted by a narrow, smooth median band; toward the end of the body chamber they become stronger and pass uninterrupted over the venter.

On both the holotype and the specimens from the Sette Comuni weak constrictions, often difficult to see, occur at irregular intervals on the middle whorls.

L. (Cleistosphinctes) cleistus is very common also in the Digne region, where it is known to range throughout the whole Subfurcatum zone (PAVIA & STURANI 1968, p. 313). The type level, in England, is also Subfurcatum zone.

Leptosphinctes ? (subg. ?) *rotula* (PARONA)

(Pl. 15, figs. 13-15)

1896 *Stephanoceras rotula* · PARONA 1896; p. 18; pl. 1, f. 18.

Material. There are 20 syntypes from Monte Meletta (Subfurcatum zone, Schroederi subzone), 8 specimens from Monte Longara assemblage (same horizon) and another from Rotherbrunn fossil locality (Subfurcatum zone, Baculata subzone). They range from nuclei less than 5 mm in diameter to fragments of larger specimens, about 18 mm in diameter (est.). None has the adult peristome preserved.

The specimen from Monte Meletta figured by PARONA (this work, Pl. 15, fig. 14) is selected as lectotype; it is partly broken on one side, but otherwise beautifully preserved, and measures: D 12 mm; H, 0.294; L ?; O, 0.485; R 26. The other figured syntypes measure: (Pl. 15, fig. 13) D 12.3 mm; H, 0.271; L, 0.423; O, 0.507; R 23. (Pl. 15, fig. 15) D 10.5 mm; H, 0.27; L, 0.45; O, 0.50; R 23.

Description. The whorl section is coronate throughout, depressed-rectangular in shape, with gently rounded umbilical slopes, short, almost parallel flanks, very well marked ventrolateral edges and a broad, slightly arched venter. The coiling is evolute.

From the nucleus to the middle and outer whorls the umbilical width increases at a faster rate than both the whorl width and the whorl height, so that the nuclei, below a diameter of 5 mm, are almost cadicone, with stout whorls (L, 0.62 - 0.71) and have a narrow umbilicus (O, 0.30 to 0.40), while specimens over 10 mm are proportionally more widely umbilicated.

The primary ribs (23 to 26 to a whorl, above 10 mm in diameter) are strong, straight, rectiradiate and raised at the ventrolateral edges to form small nodes. From each node three (or more rarely two) finer secondaries arise, which are slightly arched forward. On each whorl there are four well marked constrictions,

preceded by a stronger secondary and followed by a weaker primary. The whorl section enlarges just after each constriction, then remains nearly constant until the next.

The umbilical lobe is not retracted on specimens which are about 10 mm in diameter.

Taxonomic position. The present species shows a peculiar admixture of Stephanoceratid and Perisphinctid features; this, as well as the fact that its macro- or microconch nature is still unknown, makes its taxonomic position difficult to ascertain. BUCKMAN's opinion (1922, p. 418), that « *Stephanoceras* » *rotula* is based on coronate nuclei of a large, macroconch *Leptosphinctes*, close, but not identical to *L. coronarius* BUCKM., is provisionally adopted here, until fully grown specimens are discovered. It should however be noted that no known *Leptosphinctes* (s. l.) is so strongly coronate at a comparable diameter.

FAMILY MORPHOCERATIDAE HYATT, 1900

GENUS DIMORPHINITES BUCKMAN, 1923

Dimorphinites? dimorphoides (PARONA)

(Pl. 14, fig. 19)

1896 *Morphoceras dimorphoides* - PARONA 1896; pp. 21-22; pl. 2, f. 8.

A single specimen from the Monte Meletta assemblage, already figured and described by PARONA. As already noted by this author, it is filled with a brownish-grey micritic limestone, totally different from the sparry matrix of other fossils from the same assemblage: it is therefore far from certain that this specimen comes from the same horizon (Subfurcatum zone, Schroederi subzone).

The measurements are: D 8.5 mm; H, 0.32; L, 0.42; O, 0.40.

The inner and middle whorls are sphaerocone and very involute; at the beginning of the body chamber the umbilicus widens rapidly and the coiling becomes planulate. Near the end of the body chamber the whorl section is wider than high and depressed-reniform in shape. The umbilical slope and the flanks are gently rounded; the venter is broadly and regularly arched.

On the last whorl there are six narrow and gently proverse constrictions, which pass across the venter and are followed by a slightly raised ridge. Between such constrictions the flanks are covered with weak, blunt ribs, which fade out on the middle of the venter, short after bifurcating. The venter is smooth; the ventral furrow said by PARONA to occur is completely missing. So are the lateral lappets, also mentioned by this author; it is however uncertain whether the final mouth border is actually present or if it is missing by a few tenths of a mm. At any rate, the abrupt widening of the umbilicus in the last whorl can be taken as evidence that maturity had been reached, notwithstanding the very small size.

As already noted by PARONA, the general aspect is strongly reminiscent of *Dimorphinites dimorphus* (d'ORB.). The latter species is of course much larger than PARONA's (40 to 80 mm), but I have seen in the British Museum N. H. a specimen of *Dimorphinites* sp. ind. from the Inferior Oolite of Normandy (B. M. 26910), which was wholly grown by a diameter of about 15 mm and differed from *D. dimorphoides* (PAR.) only in possessing well marked secondaries.

Dimorphinites (n. subg.) *defrancei* (d'ORB.) — the microconch dimorph of *D. dimorphus* — has much more evolute inner whorls.

If the horizon is correct, this would be the earliest known Morphoceratid, showing that the derivation of this family from the ancestral Perisphinctid stock (see STURANI 1964b; p. 28) took place in the Subfurcatum zone.

SUPERFAMILY PERISPHINCTACEAE

FAMILY UNCERTAIN

PATRULIA n. gen.

Diagnosis: small, evolute planulates, with bifurcating and in part simple ribs, which pass across the venter with gentle forward inclination. They show very strong homoeomorphy with Lower Toarcian Dactylioceratids, such as *Dactylioceras* and *Zugodactylites*.

Type species: *Patrulia* n. gen. *aenigmatica* n. sp.

Type level: Subfurcatum zone, Banksi subzone.

Type region: Sette Comuni, Venetian Alps.

Origin of name: In the honour of the distinguished Rumanian geo-palaeontologist, Dr. Dan PATRULIUS.

Remarks. BURCKHARDT (1927; pl. 11, ff. 5-9) has figured as « *Dactylioceras* sp. ind. » several planulate ammonites from the Middle Bajocian (probably Humphriesianum zone) of Mexico, where they occur in association with *Stemmatoceras* spp. From the original figures it is difficult to state whether these could belong to *Patrulia* n. gen.; at any rate they differ from the type-species and have a more perisphinctoid aspect.

« *Dactylioceras* » has also been recorded by ERBEN from the same region, but at a different horizon (basal Subfurcatum zone), in association with *Sphaeroceras*, *Oppelia* aff. *subradiata*, *Parastrenoceras* spp. and Perisphinctids (ERBEN 1956; p. 86). In this second case the horizon and the associated fauna are in perfect agreement with those of *Patrulia* n. gen. *aenigmatica* n. sp.; unfortunately, however, ERBEN gives no figure of this « *Dactylioceras* ». It would therefore be of great interest if someone could redescribe and refigure this ammonite adequately.

Patrulia n. gen. *aenigmatica* n. sp.

(Pl. 14, figs. 5, 6)

Material. Two specimens only are known; one is from Ponte sul Ghelpach n. 2 assemblage (Pisa Mus.; Subfurcatum zone, Banksi subzone) and is here chosen as holotype (Pl. 14, fig. 3). The second (Pl. 14, fig. 6) is a small fragment from Cima Tre Pezzi quarry (Subfurcatum zone, Banksi subzone).

Description. The holotype is wholly septate at a diameter of 19 mm and partially broken. The other measurements are: H, 0.325; L, 0.256; O, 0.443; R about 30 (est.).

The coiling is evolute and the umbilicus rather wide. The whorl section is higher than wide and compressed-elliptical in shape, with short, rounded umbilical slopes; flattened, subparallel flanks and a rounded venter, bounded by almost imperceptible, blunt ventrolateral edges.

The primaries are straight, rectiradiate and long. They are almost imperceptibly raised at the periphery, before giving rise to two weaker secondaries each; the latter pass across the venter with a gentle forward inclination.

On the paratype the point of furcation lies slightly lower, some ribs remain simple and the venter is more narrowly arched; as a whole, however, it appears to be clearly conspecific with the holotype.

The suture line, which is barely visible on the holotype (but which cannot be drawn), is built on about the same pattern as those of *Bajocia* and *Caumontisphinctes*.

Owing to its peculiar aspect, quite distinct from that of any Late Bajocian ammonite known so far, the present taxon seems worth naming, notwithstanding the fact that only two, imperfectly preserved specimens are known.

R I A S S U N T O

Nella parte introduttiva del lavoro viene delineata l'evoluzione paleogeografica della Ruga di Trento durante il Giurassico. Essa inizia nel Lias inferiore con l'instaurarsi di un'ampia piattaforma la cui rapida subsidenza è controbilanciata da un'attiva sedimentazione carbonatica di tipo bahamiano. Durante questa fase si depositano i « Calcari grigi di Noriglio » (Lias inf. - medio) e (in condizioni di più elevata energia ambientale e di più ampia comunicazione col mare aperto) l'« Oolite di Capo San Vigilio » (Toarciano - Aaleniano). Verso la fine dell'Aaleniano (localmente anche un po' prima) sia la subsidenza che la sedimentazione subirono un brusco arresto, mentre la parte centrale della piattaforma, ora corrispondente ai Sette Comuni, era già emersa dall'inizio del Toarciano, sotto forma di bassa isola rocciosa.

Poco prima della fine del Baiociano, un nuovo scatto della subsidenza portò allo sprofondamento della piattaforma carbonatica e alla sua trasformazione in soglia pelagica intra-geosinclinale, su cui incominciò a depositarsi il « Rosso ammonitico veronese ».

Il deposito degli « Strati a *P. alpina* » fu sporadico sia nel tempo che nello spazio ed ebbe luogo durante la fase di subsidenza quasi nulla, intercorsa tra la fine della sedimentazione carbonatica di piattaforma e lo sprofondamento della piattaforma stessa, vale a dire, principalmente nel Baiociano.

Nei Sette Comuni gli « Strati a *P. alpina* » poggiano direttamente sui « Calcari grigi di Noriglio » e sono rappresentati da una lumachella a cemento spatico, passante lateralmente a calcari biomicritici rossi. Questi sedimenti formano sia il cemento di una breccia da dissoluzione, che il riempimento di cavità carsiche entro i livelli sommitali (0,50 - 2,50 m) del substrato liassico. Secondo l'interpretazione proposta in questo lavoro, tanto le conchiglie che il fango calcareo, spazzati dall'onda di marea in occasione di uragani eccezionali, furono spiaggiati su di una bassa isola rocciosa e si accumularono entro le fessure carsiche, trascinati dall'acqua che defluiva attraverso la zona vadosa. Questa fase di riempimento meccanico delle fessure carsiche fu seguita dal deposito chimico di calcite spatica in grossi cristalli, sempre in condizioni sopracotidali.

Il « nanismo » delle faune in questione può quindi risultare — almeno in parte — da una classazione puramente meccanica ad opera dell'agente di trasporto. In parte almeno, tuttavia, esso sembra corrispondere ad un carattere originario delle biocenosi spazzate dall'uragano: l'analisi paleoecologica mostra che la stragrande maggioranza delle specie presenti (ammoniti comprese; *Bositra* escluse) dovevano appartenere ad una comunità bentonica epibionte, comprendente tanto forme sessili che forme vagili, installata su bassi fondali rocciosi, coperti da praterie di alghe e praticamente privi di sedimenti sciolti. E' noto che le biocenosi attuali delle praterie di alghe sono caratterizzate dalle ridotte dimensioni degli animali che le compongono, specialmente per ciò che riguarda i molluschi.

Per ciò che riguarda le ammoniti, si è potuto constatare che i rappresentanti delle diverse famiglie dovevano probabilmente avere cicli biologici differenti. I Filloceratidi e la maggior parte dei Lytoceratini sono rappresentati, nella lumachella, esclusivamente da esemplari immaturi: in questo caso, le praterie di alghe potevano corrispondere ai luoghi di riproduzione e di sviluppo, mentre l'habitat normale degli adulti, al di fuori del periodo riproduttivo, era rappresentato dal mare aperto (come si osserva in numerosi Teutoidei pelagici attuali). Molti Ammonitini sono invece rappresentati da esemplari microconchi adulti e da esemplari macroconchi immaturi: in questo caso è possibile che sia esistita una separazione ecologica dei sessi al di fuori del periodo riproduttivo; gli individui microconchi (pro-

habilmente di sesso maschile) sembrano esser stati confinati ad un ambiente neritico durante tutta la loro esistenza, mentre quelli macroconchi tornavano al mare aperto dopo l'epoca della riproduzione, pur essendo anch'essi legati all'ambiente neritico durante i primi stadi del loro sviluppo. Infine, nel caso di forme di dimensioni molto ridotte (*Bajocia*, *Poecilomorphus*, *Stegoxytes*, *Toxalambites*, *Sphaeroceras*) entrambi i sessi sembrano essere stati confinati ad un ambiente neritico.

Per quanto riguarda l'età degli « Strati a *P. alpina* » dei Sette Comuni, è risultato che differenti tasche lumachelliche, spesso distanti poche decine di metri l'una dall'altra, hanno età diversa: ciascuna rappresenta infatti un intervallo stratigrafico estremamente ridotto (parte di singole sottozone) entro le zone ad *Humphriesianum*, a *Subfurcatum* e a *Garantiana* del Baiociano. Ciò prova che le condizioni ambientali si mantennero inalterate durante un periodo piuttosto lungo (tra 2 e 3 milioni di anni), che i processi sedimentari furono fortemente discontinui nel tempo ma quasi istantanei in durata e che la subsidenza era praticamente nulla.

Su altre parti della Ruga di Trento, al di fuori dei Sette Comuni, gli « Strati a *P. alpina* » si depositarono a bassa profondità, sotto forma di barre sabbiose sommerse dovute all'accumulo di frammenti di crinoidi (Rovereto), o sotto forma di banchi parzialmente emersi di ghiaie conchigliari (Brentonico), od ancora come riempimento di fessure apertisi in bassi fondali coperti di alghe (Acque Fredde). Assai più spesso, tuttavia, il fondo doveva essere del tutto privo di sedimenti, in quanto l'arresto della subsidenza lo manteneva per lunghi periodi al di sopra del livello di base dell'erosione. Ciò spiega la distribuzione sporadica degli « Strati a *P. alpina* » e la lacuna che si osserva assai più di frequente in loro vece, tra il « Rosso ammonitico veronese » e le sottostanti formazioni della piattaforma carbonatica.

In uno speciale paragrafo sono infine discusse le caratteristiche paleoambientali (e, in particolare, batimetriche) verificatesi dopo lo sprofondamento della piattaforma carbonatica, in concomitanza con il deposito del « Rosso ammonitico veronese ». Entro a quest'ultima formazione vengono per la prima volta segnalate strutture stromatolitiche, di regola associate con lacune di sedimentazione e talora interessate da perforazioni di bivalvi litofagi.

Venendo ora alla parte paleontologica del lavoro, questa comprende la descrizione di oltre 90 specie e sottospecie, 20 delle quali nuove. D'altro canto, oltre 35 nomi specifici preesistenti sono stati posti in sinonimia ed abbandonati.

Due generi (*Torrensia* n. gen. e *Patrulia* n. gen.) e tre sottogeneri (*Microlissoceras* n. subg., *Microtoxalambites* n. subg. e *Micropoecilomorphus* n. subg.) sono istituiti in questo lavoro.

La scoperta di questi nuovi taxa, insieme alla revisione di altri alla luce del dimorfismo e delle sue implicazioni tassonomiche, hanno portato in numerosi casi a modificare la classificazione adottata da W. J. ARKELL nel « Treatise ». Le innovazioni più importanti, a livello delle famiglie, possono essere così riassunte. La superfamiglia Haplocerataceae viene qui considerata come un raggruppamento puramente morfologico, sicuramente polifiletico, derivato in parte da rappresentanti degli Hammatoceratidae (la fam. Strigoceratidae), in parte dai Graphoceratidae (le fam. Haploceratidae ed ?Oppeliidae). *Bradfordia*, *Poecilomorphus* e *Stegoxytes* vengono qui attribuiti agli Haploceratidae, mentre *Cadomoceras* viene rimosso da quest'ultima famiglia e trasferito agli Strigoceratidae, essendo il partner microconco di *Strigoceras*. Anche la famiglia Parkinsoniidae viene qui considerata un raggruppamento puramente morfologico e sicuramente polifiletico, derivato in parte (gen. *Caumontisphinctes*) da rappresentanti primitivi della sottofamiglia Leptosphinctinae; in parte (gen. *Orthogarantiana* (M) e *Torrensia* (m) — a loro volta ancestrali rispetto alla coppia *Garantiana* (M) — *Strenoceras* e *Pseudogarantiana* (m)) dagli Stephanoceratidae; in parte, infine (gen. *Parastreoceras*), da un ramo laterale dei Sonniniidae (*Bajocia*).

Se si eccettua la grande abbondanza di Phylloceratina e Lytoceratina di tipo mediterraneo, le faune ad ammoniti degli « Strati a *P. alpina* » del Veneto non differiscono sensibilmente da quelle coeve dell'Europa nordoccidentale. Ciò conferma la riduzione delle barriere faunistiche — almeno per ciò che riguarda le ammoniti — verificatesi durante il Baiociano, in contrasto con quanto si osserva per le faune dei piani sotto- e soprastanti.

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I N D E X

INTRODUCTION AND SUMMARY	Pag. 3
ACKNOWLEDGEMENTS	» 7
REGIONAL SETTING	» 8
<i>Noriglio grey limestones</i>	» 8
<i>Cape San Vigilio oolite</i>	» 10
<i>Posidonia alpina beds</i>	» 11
<i>Campotorondo limestones</i>	» 11
<i>Rosso ammonitico veronese</i>	» 12
THE POSIDONIA ALPINA BEDS OF THE SETTE COMUNI AREA	» 17
LITHOFACIES AND ENVIRONMENT OF DEPOSITION	» 17
<i>The Liassic bedrock</i>	» 18
<i>The Bajocian solution breccia</i>	» 22
<i>The larger solution cavities and fissures</i>	» 26
<i>Lithology of the Posidonia alpina beds: the filling of the larger fissures</i>	» 29
<i>The sinking of the shelf and the transgression of the «Rosso ammonitico veronese»</i>	» 40
PALAEOECOLOGICAL REMARKS	» 43
PALAEOECOLOGICAL EVIDENCE FROM «STUNTED» FAUNAS	» 44
SOURCE, COMPOSITION AND AGE OF THE FOSSIL ASSEMBLAGES	» 47
NEW COLLECTIONS	» 47
THE SUBZONAL SCHEME	» 48
FOSSIL LOCALITY TROCH N. 1	» 51
CIMA TRE PEZZI FOSSIL LOCALITY	» 52
LONGARA DI SOTTO N. 1 FOSSIL LOCALITY	» 53
ROTHERBRUNN FOSSIL LOCALITY	» 54
FOSSIL LOCALITY TROCH N. 2	» 55
LONGARA DI SOTTO N. 2	» 55
OLD COLLECTIONS	» 56
CAMPOROVERE (C. F. PARONA 1880)	» 56
MONTE LONGARA (PADUA MUSEUM)	» 57
MONTE MELETTA (TURIN MUSEUM)	» 58
PONTE SUL GHELPACH (PISA MUSEUM)	» 59
DE GREGORIO'S MONOGRAPH	» 61

OTHER OUTCROPS OF THE P. ALPINA BEDS. OUTSIDE THE SETTE COMUNI AREA	» 63
ACQUE FREDDE	» 63
ROVERETO	» 64
MONTE GIOVO BY BRENTONICO	» 65
LOPPIO	» 68
MONTE PELLER	» 68
MIZZOLE QUARRY	» 69
MONTE AGARO	» 70
PALEOGEOGRAPHIC SIGNIFICANCE OF THE POSIDONIA ALPINA BEDS IN THE EVOLUTION OF THE TRENTO RIDGE	» 71
RECENT AND PAST EQUIVALENTS OF THE P. ALPINA BEDS (COQUINA FACIES)	» 72
SYSTEMATIC DESCRIPTIONS	» 75
REPOSITORY OF TYPES	» 75
MEASUREMENTS	» 75
SUTURE LINES	» 75
STATISTICAL METHODS	» 75
AMMONITE DIMORPHISM AND TAXONOMY	» 76
SUBORDER LYTOCERATINA HYATT, 1889	» 77
FAMILY LITOCERATIDAE NEUM., 1875	» 77
FAMILY NANNOLYTOCERATIDAE SPATH, 1927	» 78
SUBORDER PHYLLOCERATINA ARKELL, 1950	» 82
FAMILY PHYLLOCERATIDAE ZITTEL, 1884	» 82
SUBORDER AMMONITINA HYATT, 1889	» 89
FAMILY HAPLOCERATIDAE ZITTEL, 1884	» 90
FAMILY OPPELIIDAE BONARELLI, 1894	» 112
FAMILY STRIGOCERATIDAE BUCKMAN, 1924	» 118
FAMILY STEPHANOCERATIDAE NEUM., 1875	» 128
FAMILY SPHAEROCERATIDAE BUCKMAN, 1920	» 136
FAMILY PARKINSONIIDAE BUCKMAN, 1920	» 154
FAMILY SPIROCERATIDAE HYATT, 1900	» 169
FAMILY PERISPINCTIDAE STEINMANN, 1890	» 171
FAMILY MORPHOCERATIDAE HYATT, 1900	» 175
FAMILY UNCERTAIN	» 176
RIASSUNTO	» 178
REFERENCES CITED	» 180

PLATE I.

EXPLANATION OF PLATE I.

FIG. 1 - Outcrop view of the *Posidonia alpina* beds at Longara di sotto quarry (Sette Comuni region). Detail of the filling of a large solution cavity (the outline of which is not visible in this figure) within the topmost bed of the « Grey limestones ». In the present case the filling is given mainly by a brick-red, fossiliferous micritic limestone grading locally into patches of sugar-white, spar-cemented coquina. Angular fragments of the Liassic bedrock (light tan coloured calcilutites) have dropped off the roof of the cavity and have become embedded within the younger sediments. About one-half natural size; right side up.

FIG. 2 - Another detail of the same outcrop, just below the floor of the large solution cavity shown in fig. 1. More solution cavities and fissures of smaller dimensions, some of which show two distinct phases of filling, stand out against the light tan coloured Liassic bedrock. For further details, compare with text-figs. 21 and 22 A-B. About one fourth natural size; right side up.

PLATE II.

EXPLANATION OF PLATE II.

- | | |
|--|---------|
| FIG. 1 - <i>Pseudophylloceras kudernatschi</i> (HAUER); Monte Longara assemblage (Padua Mus.); Subfurcatum zone, Schroederi sbz. (× 2) | Pag. 83 |
| FIG. 2 - <i>Partschiceras</i> cf. <i>besnosovi</i> n. sp.; Troch n. 1 fossil locality; Humphriesianum zone, Cycloides sbz. (× 2) . | » 85 |
| FIG. 3 - <i>Partschiceras abichi</i> (UHLIG); Troch n. 1 fossil locality; Humphriesianum zone, Cycloides sbz. (× 2) | » 84 |
| FIG. 4 - <i>Partschiceras striatoplicatum</i> BESNOSOV; Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. (× 2) | » 86 |
| FIGS. 5-6, 8 - <i>Calliphylloceras disputabile</i> (ZITT.); all specs. from Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 2) | » 82 |
| FIGS. 7,9 - 10 - <i>Holcophylloceras mediterraneum</i> (NEUM.); immature specimens, preserved as internal moulds and retaining the whole body chamber; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 2) | » 83 |
| FIG. 11 - <i>Ptychophylloceras</i> cf. <i>rosiwali</i> (TRAUTH); Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. (× 1) | » 87 |
| FIGS. 12-13 - <i>Ptychophylloceras longarae</i> n. sp.; holotype (fig. 13) and paratype (fig. 12), both from Longara di sotto n. 1 fossil loc.; Subfurcatum zone, Polygyralis sbz. (× 2.2) . | » 88 |
| FIGS. 14-15 - <i>Ptychophylloceras</i> cf. <i>rosiwali</i> (TRAUTH); Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. (× 2) . | » 87 |
| FIGS. 16-17 - <i>Ptychophylloceras</i> cf. <i>rosiwali</i> (TRAUTH); Troch n. 1 fossil loc.; Humphriesianum zone. Cycloides sbz. (× 2) . | » 87 |



FIG. 1



FIG. 2

PLATE III.



EXPLANATION OF PLATE III.

-
- FIG. 1 - *Lytoceras adela* (d'ORB.); Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. ($\times 2.4$) Pag. 77
- FIG. 2 - *Lytoceras adela* (d'ORB.); Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. ($\times 2.4$) » 77
- FIGS. 3,6 - *Nannolytocras pygmaeum* (d'ORB.); Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz.; the specimen of fig. 3 has the test preserved ($\times 2.4$) » 78
- FIG. 4 - *Nannolytocras (Eurystomiceras) polyhelictum* (BöCKH); Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. ($\times 2.4$) » 79
- FIG. 5 - *Nannolytocras* cf. *tripartitum* (RASP.); Monte Giovo near Brentonico; *P. alpina* beds, Lower Bathonian; detached peristome with lappets, in ventral view, figured here for comparison.
- FIGS. 7-9 - *Bajocia farcyi* BRASIL; all specs. from Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. ($\times 2.5$) » 126
- FIGS. 10-15 - *Bajocia* (? new microconch subgenus) *rarinoda* n. sp.; holotype (fig. 14) and paratypes, all from Troch n. 1 fossil locality; Humphriesianum zone, Cycloides sbz. ($\times 2.5$) » 127
- FIG. 16 - *Bajocia* (?) n. sp. ind.; Rotherbrunn fossil loc.; Subfurcatum zone, Baculatum sbz. ($\times 4$) » 127
- FIG. 17 - *Dorsetensia* sp. ind. juv.; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. ($\times 2.5$) » 126

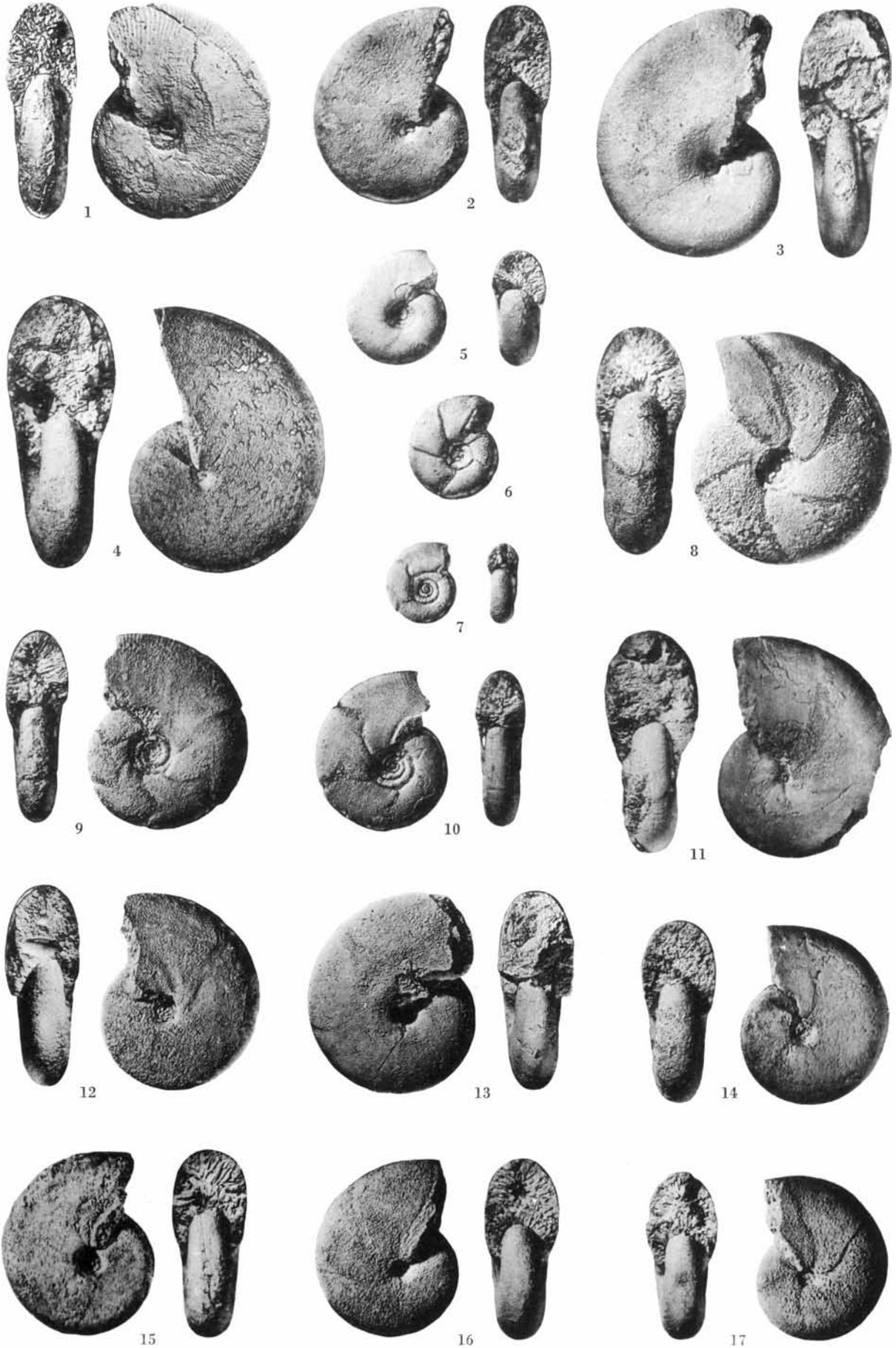


PLATE IV.

EXPLANATION OF PLATE IV.

- FIGS. 1-5, 10 - *Strigoceras paronai* (TRAUTH); lectotype (fig. 1) and other syntypes, all from Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. (all figs. $\times 1.8$) Pag. 121
- FIGS. 6-9 - *Strigoceras truellei* (d'ORB.); immature specimens, belonging to different morphotypes, all from Monte Meletta; Subfurcatum zone, Schroederi sbz.. The specimen of fig. 7 had already been figured by PARONA (1886; pl. 1, f. 5) as *Hecticoceras* (?) *pingue* (non PARONA 1880). (All figs. $\times 2.1$) » 120
- FIGS. 11-15 - *Strigoceras* sp. ind. juv. aff. *strigifer* (S. BUCKMAN); different morphotypes, all from Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (all figs. $\times 1.7$) » 119
- FIG. 16 - *Strigoceras* aff. *bessinum* BRASIL; Longara di sotto n. 1 fossil loc.; Subfurcatum zone, Polygyralis sbz. ($\times 1.7$) » 118
- FIGS. 17-19 - *Strigoceras bessinum* BRASIL; all specs. from Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. ($\times 1.7$) » 118

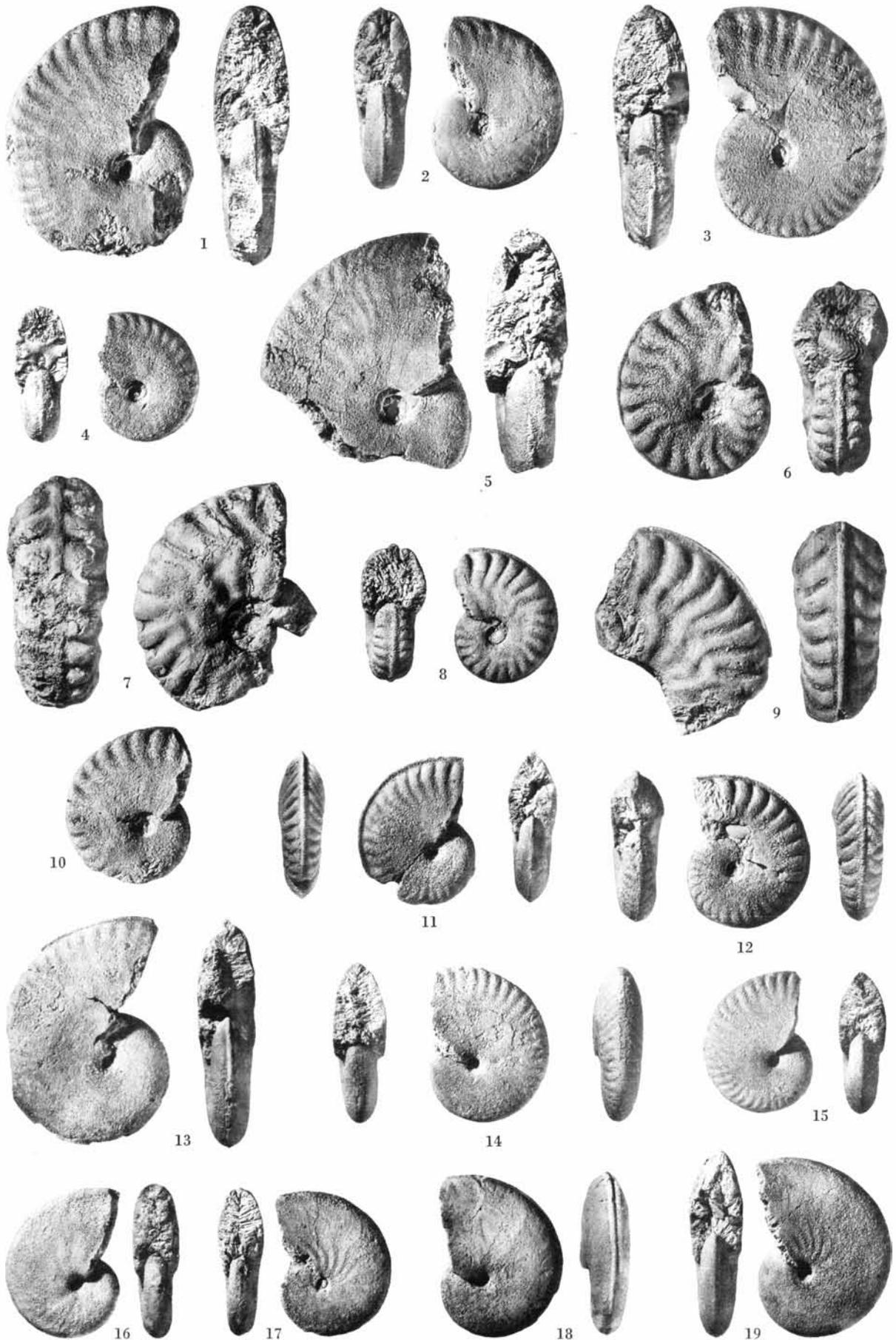


PLATE V.

EXPLANATION OF PLATE V.

- FIGS. 1-5 - *Cadomoceras sullyense* BRASIL; all specimens from Troch n. 1 fossil locality; Humphriesianum zone, Cycloides sbz. ($\times 2.7$) . Pag. 122
- FIG. 6 - *Cadomoceras* n. sp. aff. *sulliense* BRASIL; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. ($\times 3$) . » 123
- FIGS. 7-8, 10 - *Cadomoceras nepos* PARONA; lectotype (fig. 7) and two syntypes, all from Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. ($\times 2.5$) . » 123
- FIG. 9 - *Cadomoceras nepos* PARONA; another syntype, from Monte Longara assemblage (Padua Mus.); Subfurcatum zone, Schroederi sbz. ($\times 2.5$) . . . » 123
- FIG. 11 - *Cadomoceras* cf. *cadomense* (DEFR.); a weakly ribbed morphotype; Longara di sotto n. 1 fossil locality; Subfurcatum zone, Polygyralis sbz. ($\times 2.5$) . . . » 125
- FIGS. 12-15 - *Cadomoceras cadomense* (DEFR.); these are the syntypes of *Oecotraustes minor* PARONA, a junior synonym of DEFRANCE's species; Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. ($\times 2.5$) . . . » 125

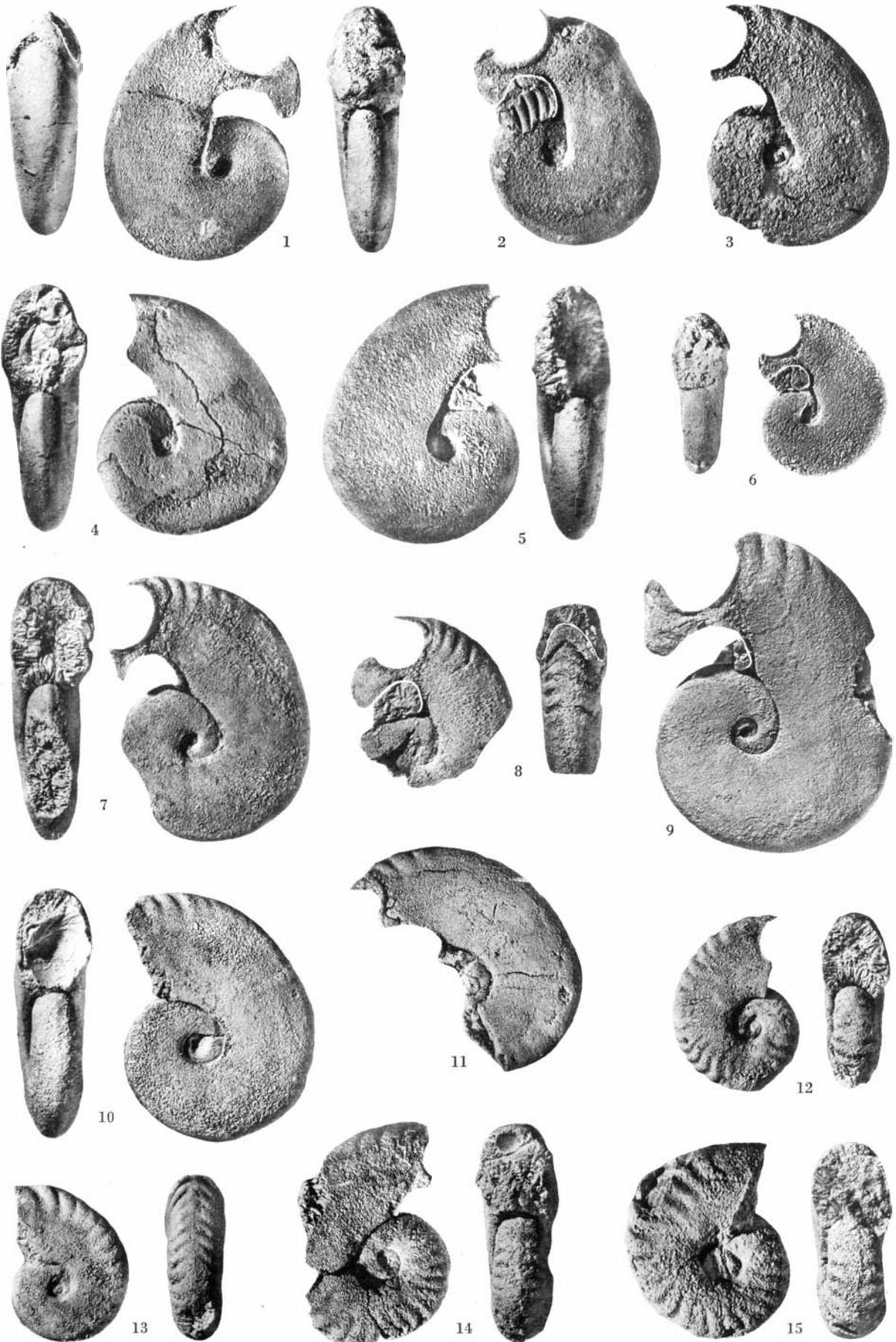


PLATE VI.

EXPLANATION OF PLATE VI.

FIG. 1 - <i>Lissoceras psilodiscus</i> (SCHLOENB.) ssp. <i>inflatum</i> WETZEL; Monte Longara assemblage (Padua Mus.); Subfurcatum zone, Schroederi sbz. (× 1)	Pag. 92
FIG. 2 - <i>Lissoceras oolithicum</i> (d'ORB.); Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 2.3) .	» 91
FIGS. 3-4 - <i>Lissoceras</i> aff. <i>oolithicum</i> (d'ORB.); Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 2.3)	» 91
FIGS. 5-6 - <i>Lissoceras meletense</i> (PARONA); the lectotype (fig. 6) and another syntype, both from Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. (× 2)	» 92
FIGS. 7-10 - <i>Lissoceras</i> (<i>Microlissoceras</i> n. subg.) <i>pusillum</i> n. sp.; holotype (fig. 7) and paratypes; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (all figs. × 3) .	» 94
FIGS. 11-13 - <i>Oecotraustes genicularis</i> WAAGEN; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 1.8) .	» 116
FIG. 14 - <i>Oppelia</i> cf. <i>flexa</i> (S. BUCKM.) juv.; Monte Meletta; Subfurcatum zone, Schroederi sbz. (× 2)	» 114
FIG. 15 - <i>Stegoxytes parcarinatus</i> S. BUCKMAN; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 2) .	» 97
FIG. 16 - <i>Stegoxytes</i> aff. <i>parcarinatus</i> S. BUCKM.; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 2) .	» 98
FIG. 17 - <i>Oppelia subtilicostata</i> PARONA; Cima Tre Pezzi quarry; Subfurcatum zone, Banksi sbz. (× 2) .	» 115
FIG. 18 - <i>Oecotraustes longarae</i> n. sp.; paratype; Longara di sotto n. 1 fossil loc.; Subfurcatum zone, Polygyralis sbz. (× 2) .	» 117
FIG. 19 - <i>Oecotraustes westermanni</i> STEPHANOV; Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. (× 2) .	» 116
FIG. 20 - <i>Oecotraustes pulcher</i> (S. BUCKM.); Monte Longara assemblage (Padua Mus.); Subfurcatum zone, Schroederi sbz. (× 2) .	» 117
FIG. 21 - <i>Oppelia subtilicostata</i> PARONA; lectotype; Ponte sul Ghelpach n. 2 assemblage (Pisa Mus.); Subfurcatum zone, Banksi sbz. (× 2.2)	» 115

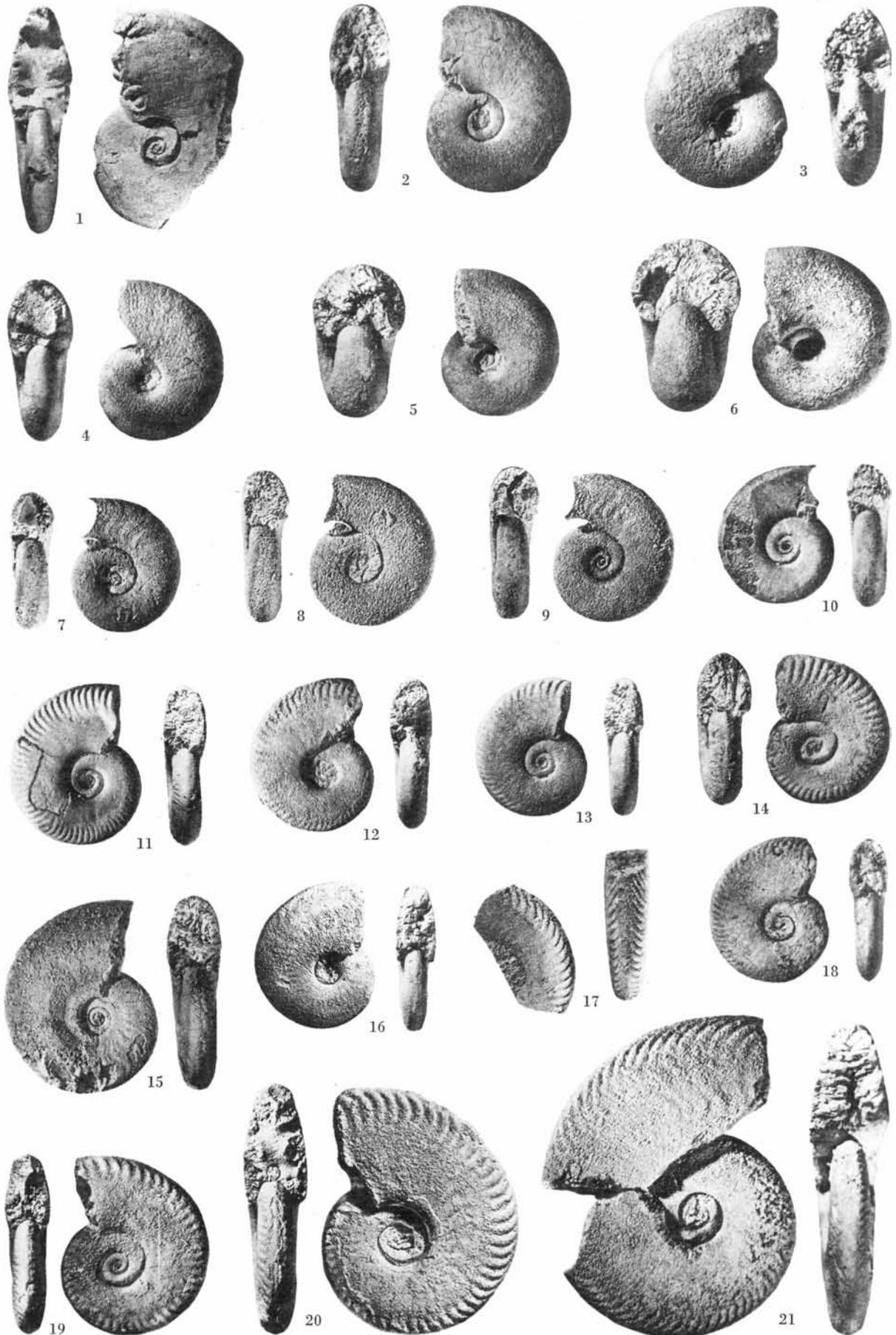


PLATE VII.

EXPLANATION OF PLATE VII.

- | | |
|---|-----------------|
| <p>FIG. 1 - <i>Oppelia flexa</i> (S. BUCKMAN); Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. ($\times 1.2$) .</p> | <p>Pag. 114</p> |
| <p>FIGS. 2-3 - <i>Oppelia subradiata</i> (Sow.) juv.; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (both figs. $\times 1.8$) .</p> | <p>» 112</p> |
| <p>FIGS. 4-7 - <i>Toxalambites fasciculatus</i> n. sp.; holotype (fig. 6) and paratypes; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (all figs. $\times 1.8$) .</p> | <p>» 95</p> |
| <p>FIGS. 8-11 - <i>Toxalambites</i> (<i>Microtoxalambites</i> n. subg.) <i>parvus</i> n. sp.; holotype (fig. 8) and paratypes; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (all figs. $\times 3$) .</p> | <p>» 96</p> |
| <p>FIGS. 12-15 - <i>Toxalambites densicostatus</i> n. sp.; holotype (fig. 13) and paratypes; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. ($\times 2$) .</p> | <p>» 95</p> |
| <p>FIG. 16 - <i>Lissoceras</i> (<i>Microlissoceras</i> n. subg.) <i>pusillum</i> n. sp.; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. ($\times 3$) .</p> | <p>» 94</p> |
| <p>FIG. 17 - <i>Poecilomorphus</i> (<i>Micropoecilomorphus</i> n. subg.) <i>vicetinus</i> (PARONA); Troch n. 1 fossil locality; Humphriesianum zone, Cycloides sbz.. A weakly ribbed morphotype, figured here for comparison with <i>Microtoxalambites</i>. ($\times 3$)</p> | <p>» 111</p> |
| <p>FIGS. 18-19 - <i>Toxalambites</i> (<i>Microtoxalambites</i> n. subg.) <i>pauper</i> n. sp.; holotype (fig. 18) and paratype; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. ($\times 3$) .</p> | <p>» 97</p> |

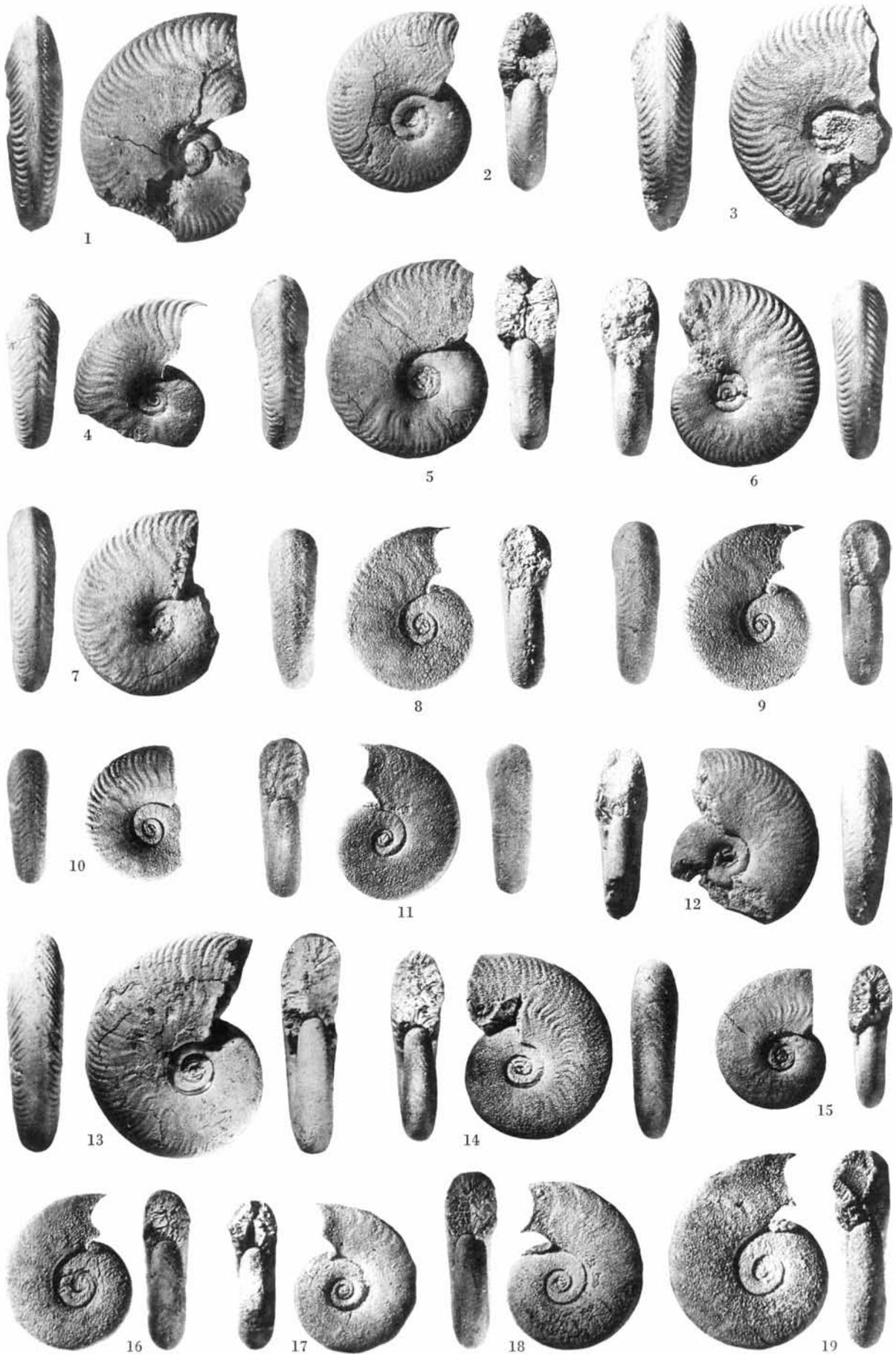


PLATE VIII.

EXPLANATION OF PLATE VIII.

FIGS. 1-21 - *Poecilomorphus cycloides* (d'ORB.); different morphotypes, all from Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (all specimens $\times 2$) .

Pag. 100

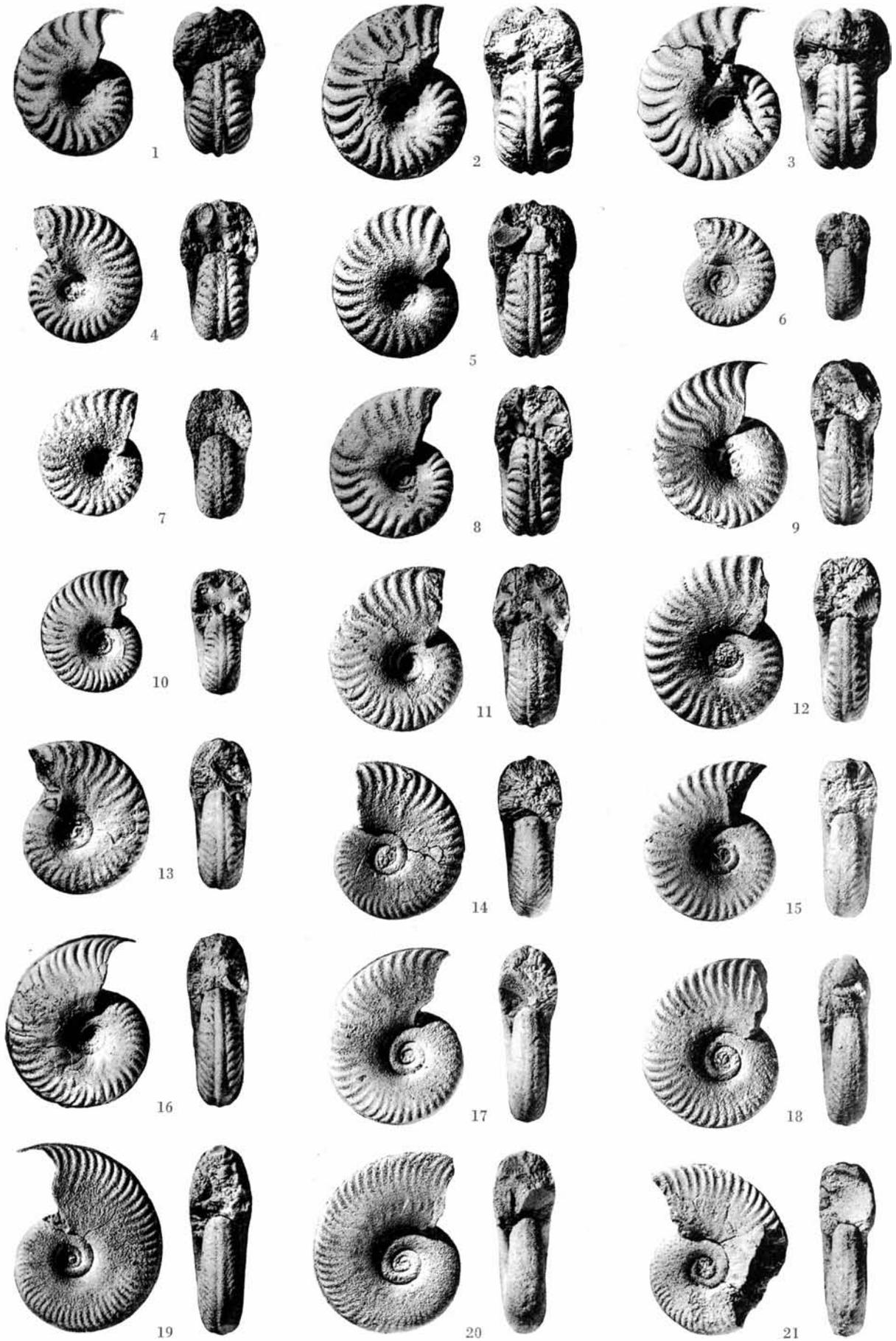


PLATE IX.

EXPLANATION OF PLATE IX.

- FIGS. 1-8, 11 - *Poecilomorphus* (*Micropoecilomorphus* n. subg.) *vicetinus* (PARONA); all adult specimens, belonging to different morphotypes; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (all figs. $\times 3$) Pag. 111
- FIG. 9 - *Poecilomorphus* (*Micropoecilomorphus* n. subg.) *vicetinus* (PAR.); topotype; Camporovere (Pavia Mus.); Humphriesianum zone, Cycloides sbz. ($\times 3$) » 111
- FIG. 10 - *Poecilomorphus* (*Micropoecilomorphus* n. subg.) *vicetinus* (PAR.); lectotype; Camporovere (Pavia Mus.); Humphriesianum zone, Cycloides sbz. ($\times 3.5$) » 111
- FIGS. 12-16 - *Poecilomorphus cycloides* (d'ORB.); different morphotypes; Troch n. 1 fossil locality; Humphriesianum zone, Cycloides sbz. ($\times 2$) » 100



PLATE X.

EXPLANATION OF PLATE X.

- FIGS. 1, 3-5 - *Sphaeroceras* (S.) *pusillum* n. sp.; holotype (fig. 1) and paratypes; all adult specimens; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (all figs. $\times 4$) . Pag. 145
- FIGS. 2, 8-10 - *Sphaeroceras* (S.) *brongniarti brongniarti* (Sow.); adult microconchs; Troch n. 1 fossil loc.; Humphriesianum zone; Cycloides sbz. (all figs. $\times 2.5$) . » 137
- FIGS. 6-7 - *Sphaeroceras* (S.) *brongniarti brongniarti* (Sow.); two macroconch chorotypes from St. Vigor (Bayeux); the smaller one had already been figured by BAYLE (1878; pl. 53, f. 3). Plaster casts (the original specimens are at the École des Mines in Paris) (both specs. $\times 1$) . » 138
- FIGS. 11, 13 - *Sphaeroceras* (S.) *talkeetnanum* IMLAY; microconch specs.; Longara di sotto n. 1 fossil loc.; Subfurcatum zone, Polygyralis sbz. ($\times 2.5$) . . . » 141
- FIG. 12 - *Sphaeroceras* (S.) *brongniarti* (Sow.) ssp. *globus* S. BUCKM.; microconch spec.; Cima Tre Pezzi quarry; Subfurcatum zone, Banksi sbz. ($\times 2.8$) . . . » 140
- FIGS. 14-16, 18 - *Sphaeroceras* (*Chondroceras*) *canovense* (de GREG.); different morphotypes, all microconch specs.; Longara di sotto n. 1 fossil loc.; Subfurcatum zone, Polygyralis sbz. ($\times 2.5$) . » 146
- FIG. 17 - *Sphaeroceras auritum* PARONA; microconch spec.; Troch n. 2 fossil loc.; Subfurcatum zone, Schroederi sbz. ($\times 4.5$) . » 141
- FIGS. 19, 21, 23 - *Sphaeroceras auritum* PARONA; the lectotype (fig. 19) and two syntypes (all microconch specs.); Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. ($\times 2.5$) » 141
- FIGS. 20, 22 - *Sphaeroceras tenuicostatum* n. sp. *glabrum* n. sp.; the holotype (fig. 22) and a paratype; both microconch specs.; Longara di sotto n. 2 fossil loc.; Garantiana zone ($\times 4.5$) . » 144
- FIG. 24 - *Sphaeroceras tenuicostatum* n. sp.; holotype; Ponte sul Ghelphach n. 4 assemblage (Pisa Mus.); Garantiana zone ($\times 4$) . » 143

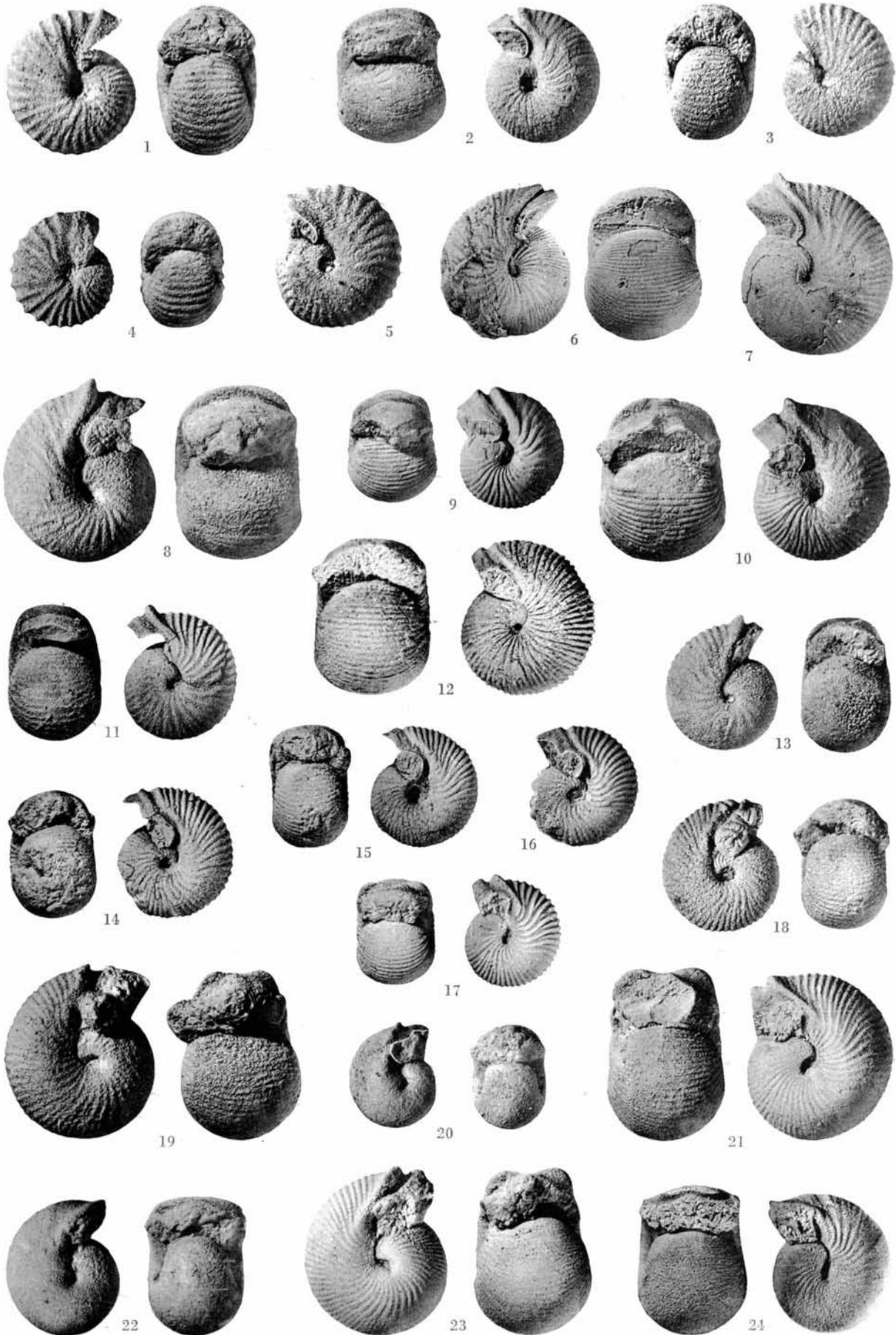


PLATE XI.

EXPLANATION OF PLATE XI.

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|--|-----------------|
| <p>FIGS. 1 - 3,5 - <i>Sphaeroceras (Chondroceras) wrighti</i> S. BUCKM. ssp. <i>minor</i> WESTERM.; all microconch specs.; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 2) .</p> | <p>Pag. 145</p> |
| <p>FIG. 4 - <i>Sphaeroceras (Chondroceras) aff. flexuosum</i> n. sp.; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 4) .</p> | <p>» 150</p> |
| <p>FIG. 6 - <i>Sphaeroceras (Chondroceras) sp. ind. juv.</i>; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 2)</p> | |
| <p>FIGS. 7-9, 11, 12 - <i>Sphaeroceras (Schmidtoceras) callomoni</i> n. sp.; holotype (fig. 7) and paratypes; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (all figs. × 2.75)</p> | <p>» 151</p> |
| <p>FIG. 10 - <i>Sphaeroceras (Chondroceras) canovense</i> (de GREG.); inner whorls of a macroconch spec.; Longara di sotto n. 1 fossil loc.; Subfurcatum zone, Polygyralis sbz. (× 2.5) .</p> | <p>» 146</p> |
| <p>FIGS. 13-17 - <i>Sphaeroceras (Chondroceras ?) fasciculatum</i> n. sp.; holotype (fig. 16) and paratypes; Troch n. 2 fossil loc.; Subfurcatum zone, Schroederi sbz. (all figs. × 4) .</p> | <p>» 150</p> |
| <p>FIG. 18 - <i>Sphaeroceras (Chondroceras) flexuosum</i> n. sp.; paratype; Ponte sul Ghelpach n. 2 assemblage (Pisa Mus.); Subfurcatum zone, Banksi sbz. (× 3.5)</p> | <p>» 149</p> |
| <p>FIG. 19 - <i>Sphaeroceras (Schmidtoceras) cf. evolutum</i> WESTERM.; Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. (× 2.5) .</p> | <p>» 152</p> |
| <p>FIG. 20 - <i>Sphaeroceras (Schmidtoceras) cf. evolutum</i> WESTERM.; Ponte sul Ghelpach n. 4 assemblage (Pisa Mus.); Garantiana zone (× 3.5) .</p> | <p>» 152</p> |
| <p>FIG. 21 - <i>Sphaeroceras (Schmidtoceras) cf. crassum</i> WESTERM.; Ponte sul Ghelpach n. 4 assemblage (Pisa Mus.); Garantiana zone (× 3.5) .</p> | <p>» 152</p> |



PLATE XII.

EXPLANATION OF PLATE XII.

FIG. 1 - cf. <i>Normannites formosus</i> (S. BUCKM.); Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 2) .	Pag. 131
FIG. 2 - cf. <i>Normannites latansatus</i> (S. BUCKM.); Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 2) .	» 131
FIGS. 3-4 - cf. <i>Normannites pinguis</i> (WESTERM.); Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 2) .	» 132
FIGS. 5, 15 - <i>Normannites flexus</i> WESTERM.; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 2)	» 130
FIG. 6 - cf. <i>Normannites portitor</i> (MAUB.); Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 2) .	» 132
FIG. 7 - <i>Normannites</i> n. sp. aff. <i>portitor</i> ; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 3) .	» 133
FIGS. 8-10, 13 - <i>Normannites</i> (?) <i>globulus</i> n. sp.; holotype (fig. 9) and paratypes; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (all figs. × 3.3) .	» 134
FIG. 11 - cf. <i>Normannites anceps</i> (QUENST.); Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 2)	» 132
FIGS. 12, 14, 16 - Immature Stephanoceratids (cf. <i>Normannites</i> spp. plur. ind.); Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz.; note strong constriction on fig. 16 (all figs. × 3) .	» 128
FIG. 17 - Immature Stephanoceratid (cf. <i>Normannites</i> sp. ind.); Cima Tre Pezzi quarry; Subfurcatum zone, Banksi sbz. (× 3)	» 133

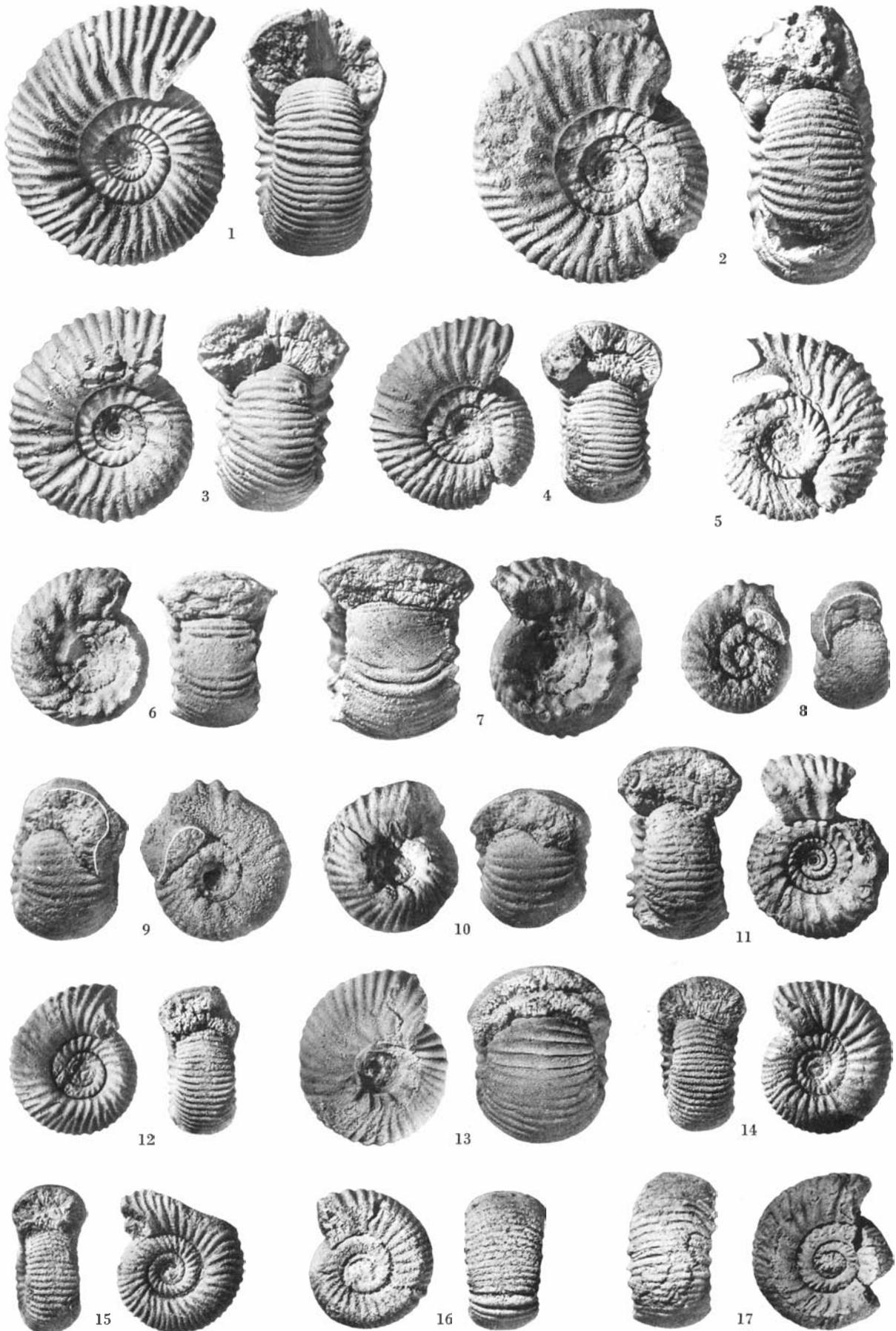


PLATE XIII.

EXPLANATION OF PLATE XIII.

FIGS. 1, 4, 8 - <i>Orthogarantiana conjugata</i> (QUENST.); Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. (all figs. $\times 2$)	Pag. 157
FIG. 2 - <i>Polyplectites</i> (?) <i>venetus</i> (PARONA); Cima Tre Pezzi quarry; Subfurcatum zone, Banksi sbz. ($\times 2$) .	» 135
FIG. 3 - <i>Polyplectites</i> (?) <i>venetus</i> (PARONA); holotype; Ponte sul Ghelpach n. 2 assemblage (Pisa Mus.); Subfurcatum zone, Banksi sbz. ($\times 2$) .	» 135
FIG. 5 - <i>Orthogarantiana schroederi</i> (BENTZ) juv.; Troch n. 2 fossil loc.; Subfurcatum zone, Schroederi sbz. ($\times 3$) .	» 157
FIG. 6 - <i>Strenoceras</i> sp. ind. juv. (nucleus); Troch n. 2 fossil loc.; Subfurcatum zone, Schroederi sbz. ($\times 4$). Compare with fig. 5 .	» 160
FIG. 7 - <i>Orthogarantiana</i> cf. <i>inflata</i> BENTZ; Burton Bradstock, Dorset, « Astarte bed ». Figured here for comparison ($\times 2$)	
FIG. 9 - <i>Torrensia</i> n. gen. aff. <i>gibba</i> (PARONA); Longara di sotto n. 1 fossil loc.; Subfurcatum zone, Polygyralis sbz. ($\times 3$) .	» 155
FIGS. 10, 12, 13 - <i>Torrensia</i> n. gen. <i>gibba</i> (PARONA); three syntypes from Monte Meletta; Subfurcatum zone, Schroederi sbz. ($\times 3$)	» 154
FIG. 11 - <i>Torrensia</i> n. gen. <i>gibba</i> (PARONA); Troch n. 2 fossil loc.; Subfurcatum zone, Schroederi sbz. ($\times 3$)	» 154
FIG. 14 - <i>Torrensia</i> n. gen. <i>gibba</i> (PARONA); lectotype; Monte Longara assemblage (Padua Mus.); Subfurcatum zone, Schroederi sbz. ($\times 3$)	» 154
FIGS. 15-18, 21 - <i>Strenoceras</i> sp. ind. juv.; Troch n. 2 fossil loc.; Subfurcatum zone, Schroederi sbz. (all figs. $\times 4$) .	» 160
FIG. 19 - <i>Pseudogarantiana minima</i> (WETZEL); Ponte sul Ghelpach n. 4 assemblage (Pisa Mus.); Garantiana zone ($\times 2.2$) .	» 158
FIG. 20 - <i>Strenoceras subfurcatum</i> (SCHLOTHEIM); Rotherbrunn fossil loc.; Subfurcatum zone, Baculatum sbz. ($\times 3$) .	» 159
FIG. 22 - <i>Strenoceras apleurum</i> BUCKM.; Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. ($\times 2.2$) .	» 159
FIG. 23 - <i>Strenoceras apleurum</i> BUCKM.; Monte Longara assemblage (Padua Mus.); Subfurcatum zone, Schroederi sbz. ($\times 2.8$) .	» 159

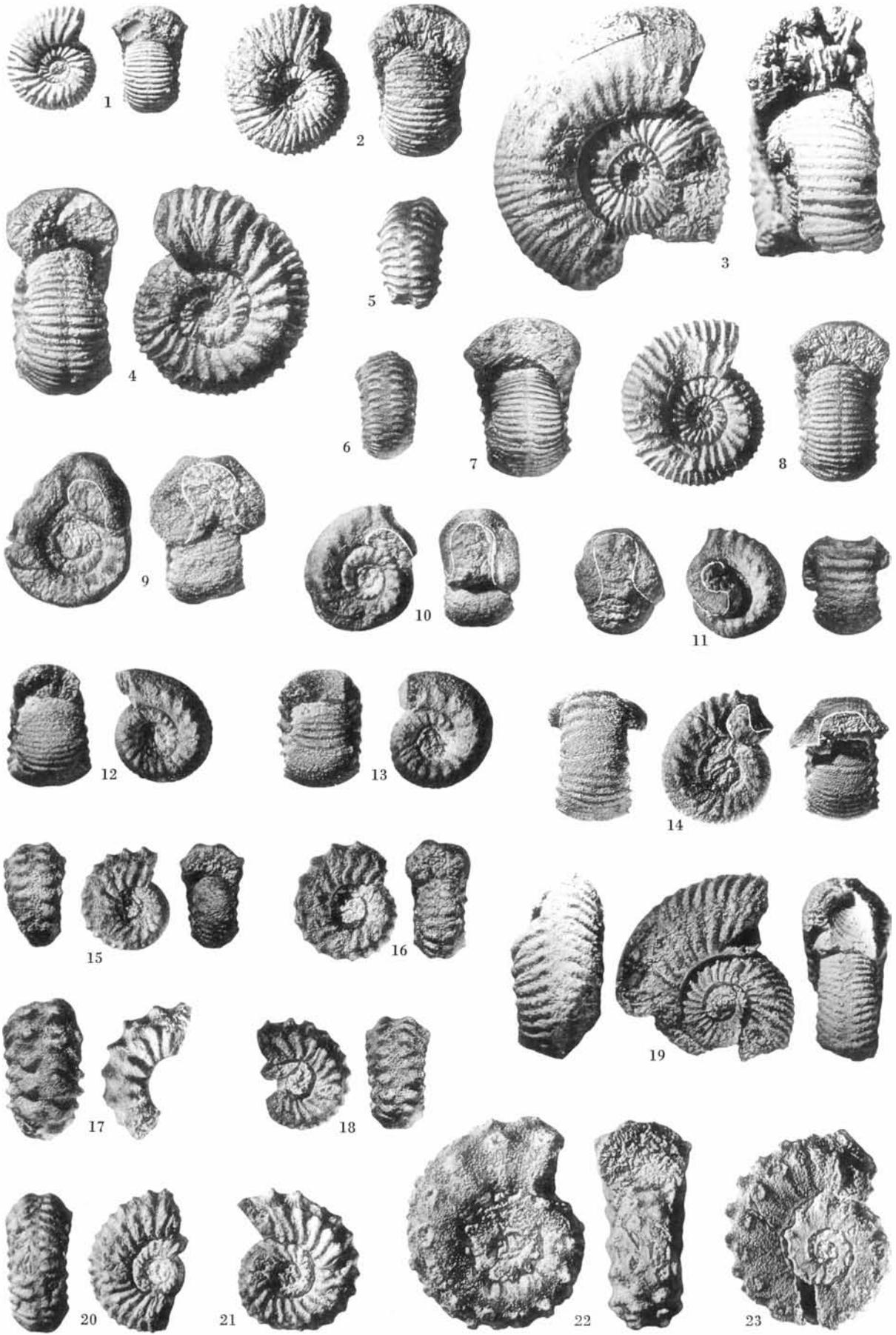


PLATE XIV.

EXPLANATION OF PLATE XIV.

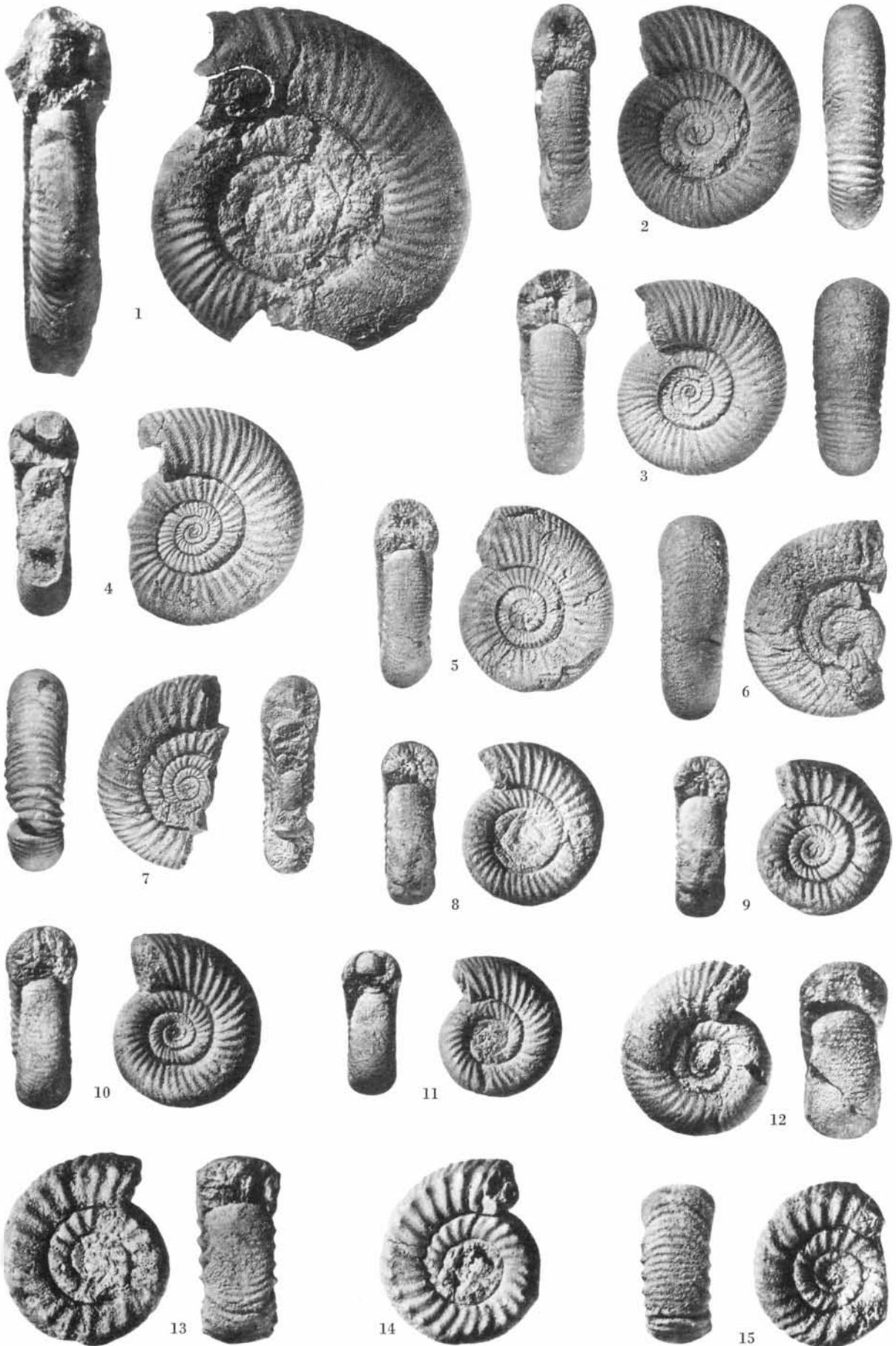
FIGS. 1-2 - <i>Parastrenoceras lucretius</i> (d'ORB.); Cima Tre Pezzi quarry; Subfurcatum zone, Banksi sbz. (× 3) .	Pag. 162
FIGS. 3, 7, 10, 11 - <i>Caumontisphinctes (Infraparkinsonia) bonarellii</i> (PARONA); lectotype (fig. 3) and three other syntypes; Monte Meletta; Subfurcatum zone, Schroederi sbz. (all figs. × 3) .	» 168
FIG. 4 - <i>Parastrenoceras lucretius</i> (d'ORB.); Ponte sul Ghelpach n. 2 assemblage (Pisa Mus.); Subfurcatum zone, Banksi sbz. (× 3)	» 162
FIG. 5 - <i>Patrulia</i> n. gen. <i>aenigmatica</i> n. sp.; holotype; Ponte sul Ghelpach n. 2 assemblage (Pisa Mus.); Subfurcatum zone, Banksi sbz. (× 2.5)	» 177
FIG. 6 - <i>Patrulia</i> n. gen. <i>aenigmatica</i> n. sp.; paratype; Cima Tre Pezzi quarry; Subfurcatum zone, Banksi sbz. (× 2.5)	» 177
FIGS. 8-9 - <i>Caumontisphinctes (C.) prorsicostatus</i> n. sp.; paratypes; Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. (both figs. × 3)	» 166
FIG. 12 - <i>Caumontisphinctes (C.) prorsicostatus</i> n. sp.; paratype; a densely ribbed morphotype; Monte Longara assemblage (Padua Mus.); Subfurcatum zone, Schroederi sbz. (× 3)	» 166
FIG. 13 - <i>Parastrenoceras</i> aff. <i>caumonti</i> (d'ORB.); Ponte sul Ghelpach n. 2 assemblage (Pisa Mus.); Subfurcatum zone, Banksi sbz. (× 3)	» 162
FIG. 14 - <i>Parastrenoceras</i> sp. ind.; Cima Tre Pezzi quarry; Subfurcatum zone, Banksi sbz. (× 3; slightly oblique ventral view) .	» 162
FIG. 15 - <i>Spiroceras</i> cf. <i>baculatum</i> (QUENST.) juv.; Rotherbrunn fossil loc.; Subfurcatum zone, Baculatum sbz. (× 3.5)	» 170
FIGS. 16-17 - <i>Spiroceras obliquecostatum</i> (QUENST.); Longara di sotto n. 2 fossil loc.; Garantiana zone (both figs. × 3.5) .	» 170
FIG. 18 - <i>Spiroceras waltoni</i> (MORRIS); Ponte sul Ghelpach n. 4 assemblage (Pisa Mus.); Garantiana zone (× 3)	» 170
FIG. 19 - <i>Dimorphinites</i> (?) <i>dimorphoides</i> (PARONA); holotype; Monte Meletta assemblage; ? Subfurcatum zone, Schroederi sbz. (× 3) .	» 175
FIG. 20 - <i>Poecilomorphus cycloides</i> (d'ORB.); a freak specimen; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. (× 3) .	» 110



PLATE XV.

EXPLANATION OF PLATE XV.

- FIGS. 1-2 - *Leptosphinctes* (*Cleistosphinctes*) *cleistus* S. BUCKM.; Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. (both figs. $\times 1.2$) Pag. 173
- FIG. 3 - *Leptosphinctes* (subg.?) *perspicuus* (PARONA); Monte Longara assemblage (Padua Mus.); Subfurcatum zone, Schroederi sbz. ($\times 1.2$) » 171
- FIGS. 4-6, 10-11 - *Leptosphinctes* (subg.?) *perspicuus* (PARONA); the lectotype (fig. 6) and four topotypes originally assigned by PARONA to *Perisphinctes subtilis* (non NEUM.); Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. (figs. 4-6 $\times 1.2$; figs. 10-11 $\times 1.8$) » 171
- FIGS. 7-9 - *Leptosphinctes* (subg.?) *torquis* (PARONA); the lectotype (fig. 7) and two other syntypes; Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. (fig. 7 $\times 1.2$; figs. 8-9 $\times 1.8$) » 173
- FIG. 12 - *Leptosphinctes* (subg.?) *conclusus* (PARONA); lectotype; Ponte sul Ghelpach n. 2 assemblage (Pisa Mus.); Subfurcatum zone, Banksi sbz. ($\times 2.5$) » 172
- FIGS. 13-15 - ? *Leptosphinctes* (subg.?) *rotula* (PARONA); the lectotype (fig. 14) and two syntypes; Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. (all figs. $\times 3$) » 174



· P L A T E X V I .

EXPLANATION OF PLATE XVI.

FIG. 1 - <i>Partschiceras besnosovi</i> n. sp.; holotype; Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. ($\times 1.5$)	Pag. 85
FIGS. 2-3 - <i>Partschiceras abichi</i> (UHLIG); Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. (both $\times 1.5$)	» 84
FIG. 4 - <i>Holcophylloceras mediterraneum</i> (NEUM.) juv.; Acque Fredde (Verona Mus.); Subfurcatum zone; type specimen of <i>Phylloceras? julii</i> PARONA 1894 ($\times 2.1$)	» 83
FIG. 5 - <i>Bositra buchi</i> (ROEMER); specimen showing an outward flaring of the valves, along their peripheral margin; Troch n. 1 fossil locality; Humphriesianum zone, Cycloides sbz. ($\times 1.5$)	» 44
FIGS. 6-7 - <i>Nannolytoceras (Eurystomiceras ?) pluriannulatum</i> (PARONA); two syntypes; that of fig. 6 has the test preserved; Monte Meletta assemblage; Subfurcatum zone, Schroederi sbz. (both $\times 2.1$)	» 80
FIG. 8 - <i>Nannolytoceras nicolisi</i> (PARONA); lectotype; Acque Fredde (Verona Mus.); Subfurcatum zone; test preserved ($\times 2.1$)	» 78
FIG. 9 - <i>Strigoceras</i> sp. ind. juv. cf. <i>septicarinatum</i> (S. BUCKM.); Longara di sotto n. 1 fossil loc.; Subfurcatum zone, Polygyralis sbz. ($\times 1.5$)	» 120
FIG. 10 - <i>Strigoceras</i> sp. ind. juv. cf. <i>strigifer</i> (S. BUCKM.); Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. ($\times 1.5$)	» 119
FIGS. 11-12 - <i>Oecotraustes longarae</i> n. sp.; holotype (fig. 12) and paratype; Longara di sotto n. 1 fossil loc.; Subfurcatum zone, Polygyralis sbz. (both $\times 2$)	» 117
FIG. 13 - <i>Oecotraustes westermanni</i> STEPHANOV; Monte Longara assemblage (Padua Mus.); Subfurcatum zone, Schroederi sbz. ($\times 1.5$)	» 116
FIG. 14 - <i>Normannites</i> (?) <i>globulus</i> n. sp.; paratype; an evolute morphotype; Troch n. 1 fossil loc.; Humphriesianum zone, Cycloides sbz. ($\times 4$)	» 134
FIGS. 15-16 - <i>Caumontisphinctes (Infraparkinsonia) phaulus</i> S. BUCKM.; Longara di sotto n. 1 fossil loc.; Subfurcatum zone, Polygyralis sbz. (both $\times 2$)	» 168
FIGS. 17, 18, 20, 21 - <i>Sphaeroceras (Chondroceras) flexuosum</i> n. sp.; holotype (fig. 18) and paratypes; that of fig. 20 is an immature macroconch, the others are adult microconchs; Longara di sotto n. 1 fossil loc.; Subfurcatum zone, Polygyralis sbz. (all figs. $\times 4$)	» 149
FIG. 19 - <i>Caumontisphinctes (C.) polygyralis</i> S. BUCKMAN; Longara di sotto n. 1 fossil loc.; Subfurcatum zone, Polygyralis sbz. ($\times 2$)	» 165
FIG. 22 - <i>Sphaeroceras (S.) talkeetnanum</i> IMLAY; microconch spec.; Longara di sotto n. 1 fossil loc.; Subfurcatum zone, Polygyralis sbz. ($\times 2$)	» 141

