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DEVONIAN TRILOBITES OF THE SOUTHERN CANTABRIAN MOUNTAINS (NORTHERN SPAIN) WITH A SYSTEMATIC DESCRIPTION OF THE ASTEROPYGINAE

BY

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SUMMARY

This paper shows the results of a research into the Devonian trilobites of the southern Cantabrian Mountains.

The systematics of the most common group, the subfamily of the Asteropyginae, forms the major part of this work. More than 50 species, belonging to sixteen (sub)genera are distinguished; thirteen species are newly described and four species are redescribed. It turned out that many species recently described from Aragón, Asturias and the Armorican Massif also occur in the southern Cantabrian Mountains. The find of *Metacanthina lavidensis* n.sp. in the La Vid Fm. makes it probable that the genus *Metacanthina* descended from *Pilletina* in the Siegenian. The morphological features and age of *Delocare*? *dalii* n.sp. support the theory that *Delocare* descended from *Paracryphaeus* in the Siegenian. A first time a *Neocalmonia* species (*N. cantabrica* n.sp.) has been found outside Afghanistan. Its morphological features and occurrence in the Huergas Fm. indicate it descended from the genus *Bradocryphaeus* in the lowermost Givetian. The genus *Neocalmonia* therefore originated in Europe. The find of *G. (Greenops) ultimus* n.sp. in the Portilla Fm. prolongs the known existence of the genus *Greenops* far into the Frasnian. *Bradocryphaeus sexspiniferus* n.sp. is the first species of Frasnian age with six pairs of lateral pygidial spines which has been found outside Afghanistan. Meraspides of *Kayserops obsoletus* are discussed.

Apart from the Asteropyginae more than 60 other trilobite species are mentioned per stratigraphic level and for the greater part depicted.

In the Devonian the trilobite faunas of the Asturo-Leonese and Palentian Basins show a gradually growing difference. In the Gedinnian and Siegenian the difference is not very marked. In the Emsian the Palentian Basin yields, beside common species with the Asturo-Leonese Basin, many elements which indicate a deeper water environment (*Odontochile, Reedops, Cheirurus (Pilletopeltis), Xiphogonium* and *Astycoryphe*). In the Middle and Upper Devonian the two basins do not have any species in common. In the Asturo-Leonese Basin Asteropyginae and some subspecies of the "North American" *Phacops rana* dominate; in the Palentian Basin a restricted fauna occurs which indicates a deeper water environment (with *Eocryphops, Paraaulacopleura* and *Trimerocephalus*).

It has been attempted to correlate the deposits in both basins with other areas (a.o. Aragón and the Armorican Massif). Most striking are the correlations which have been made of the Requejada Member (Abadía Fm.; Palentian Basin) with the upper part of the Faou Fm. (Armorican Massif) and of the upper part of the limestone member of the La Vid Fm. (Asturo-Leonese Basin) with the lower part of the Mariposas Fm. (Aragón).

As a result of correlations with Asteropyginae within the Ibero-Armorican region a provisional zonation has been designed.

It turned out that the Asteropyginae, which originated in the Lower Gedinnian in Europe (or northern Africa) and extended in the Middle Devonian to the east and the west, were restricted to the tropical part of the southern hemisphere.

SAMENVATTING

Deze publikatie geeft de resultaten van een onderzoek betreffende devonische trilobieten van de zuidrand van het Cantabrisch Gebergte.

De systematiek van de meest voorkomende groep, de onderfamilie der Asteropyginae, vormt het belangrijkste deel van deze studie. Meer dan 50 soorten, behorende tot zestien (sub)genera, worden onderscheiden. Hiervan worden dertien soorten nieuw beschreven en van vier soorten wordt een nieuwe beschrijving gegeven. Verder blijkt dat veel soorten, die kort geleden beschreven zijn uit Aragón, Asturië en het Armorikaans Massief, ook in het zuidelijk deel van het Cantabrisch Gebergte voorkomen. De vondst van *Metacanthina lavidensis* n.sp. in de La Vid-Fm. versterkt het vermoeden dat het genus *Metacanthina* in het Siegenien uit *Pilletina* ontstaan is. Morfologische kenmerken en ouderdom van *Delocare*? *dalii* n.sp. wijzen erop dat *Delocare* in het Siegenien uit *Paracryphaeus* ontstaan is. Voor het eerst is een *Neocalmonia*-soort (*N. cantabrica* n.sp.) buiten Afghanistan aangetroffen. De morfologische kenmerken en het voorkomen in de Huergas-Fm. van deze soort wijzen erop, dat het genus *Neocalmonia* in het onderste Givetien uit *Bradocryphaeus* is ontstaan en een Europese oorsprong heeft. De vondst van *G. (Greenops) ultimus* n.sp. in de Portilla-Fm. breidt het tot nu toe bekende voorkomen van het genus *Greenops* uit tot ver in het Frasnien. *Bradocryphaeus sexspiniferus* n.sp. is de eerste soort uit het Frasnien met zes paar zijstekels aan het pygidium, die buiten Afghanistan is gevonden. Verder worden enkele meraspide stadia van *Kayserops obsoletus* besproken.

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Behalve de Asteropyginae worden meer dan 60 andere trilobietesoorten genoemd en merendeels afgebeeld per stratigrafisch niveau.

Het verschil tussen de trilobietenfauna's van het Asturo-Leonese en Palentijnse bekken neemt in de loop van het Devoon geleidelijk toe. In het Gedinnien en Siegenien zijn deze verschillen niet erg duidelijk. In het Emsien kent de fauna uit het Palentijnse bekken, naast gemeenschappelijke soorten met het Asturo-Leonese bekken, talrijke elementen die kenmerkend zijn voor een dieper milieu (*Odontochile, Reedops, Cheirurus (Pilletopeltis), Xiphogonium* en *Astycoryphe*). In het Midden- en Boven-Devoon worden geen gemeenschappelijke soorten gevonden. In het Asturo-Leonese bekken domineren Asteropyginae en ondersoorten van de "Noordamerikaanse" soort *Phacops rana*; in het Palentijnse bekken komt een beperkte fauna voor van elementen, die kenmerkend zijn voor een dieper milieu (o.a. *Eocryphops, Paraaulacopleura, Trimerocephalus*).

Getracht werd de afzettingen uit de 2 bekkens te korreleren met die uit andere gebieden (o.a. Aragón en het Armorikaans Massief). De korrelaties van de Requejada-Member (Abadía-Fm.; Palentijnse bekken) met het bovenste deel van de Faou-Fm. (Armorikaans Massief) en van het bovenste deel van de kalksteen-member van de La Vid-Fm. (Asturo-Leonese bekken) met het onderste deel van de Mariposas-Fm. (Aragón) zijn de meest opvallende.

Op grond van korrelaties met Asteropyginae binnen het Ibero-Armorikaans gebied werd een voorlopige zonering opgesteld.

Het voorkomen van de Asteropyginae beperkte zich tot het tropische deel van het zuidelijk halfrond. Hun oorsprong ligt in Europa (of Noord-Afrika), vanwaar ze zich in het Midden-Devoon in oostelijke en westelijke richting hebben verbreid.

SUMARIO

Esta publicación da a conocer los resultados de una investigación acerca de los trilobites devónicos de la parte meridional de la Cordillera Cantábrica.

La sistemática del grupo más predominante, la subfamilia Asteropyginae, constituyen el capítulo más importante. Se pueden distinguir más que 50 especies, pertenecientes a dieciseís (sub)géneros. De ellas, trece especies se describen como especies nuevas, mientras de cuatro otras se dan las nuevas descripciónes. Resulta que en el terreno estudiado hay muchas especies que fueron descritas en Aragón, Asturias y el Macizo Armoricano recientemente. El hallazgo de *Metacanthina lavidensis* n.sp. corrobora la opinión que el género *Metacanthina* ya se originó de *Pilletina* en el Siegeniense. Los characterísticos morfológicos y la época de *Delocare*? *dalii* n.sp. refuerzan la suposición que *Delocare* se desarrolló de *Paracryphaeus* en el Siegeniense. Por primera vez se ha encontrado una especie de *Neocalmonia (N. cantabrica* n.sp.) fuera del Afganistán. Los characterísticos morfológicos y la época de esta nueva especie demuestran que el género *Neocalmonia* se originó de *Bradocryphaeus* en la parte más inferior del Givetiense y que su origen es europeo. El hallazgo de *G. (Greenops) ultimus* n.sp. en la Formación de Portilla amplía el campo de aparición hasta ahora conocida del género *Greenops* hasta el Frasniense. Con *Bradocryphaeus sexspiniferus* n.sp. se ha encontrado una especie del Frasniense con seis pares de espinas laterales en el pigidio por primera vez fuera del Afganistán. Además, algunos estadios meraspide de *Kayserops obsoletus* son también tratados.

Los demás trilobites devónicos, más que 60 especies, son nombrados según el nivel estratigráfico y la mayoría de ellos se ilustra por fotografías.

Las diferencias entre las faunas trilobitas de las Cuencas Astur-Leonesa y Palentina se agrandan durante el Devónico. En el Gediniense y Siegeniense las faunas de ambas cuencas se parecen mucho. Aparte de las especies comunes con la Cuenca Astur-Leonesa, la fauna palentina del Emsiense posee varios elementos característicos de un medio ambiente más profundo (*Odontochile, Reedops, Cheirurus (Pilletopeltis), Xiphogonium* y *Astycoryphe*) En el Devónico Medio y Superior no se hallan las especies comunes. En la Cuenca Astur-Leonesa dominan los Asteropyginae y subespecies de la especie "norteamericana" *Phacops rana*, mientras en la Cuenca Palentina se encuentra una limitada fauna de elementos que son propios de un medio ambiente más profundo (entre otros *Eocryphops, Paraaulacopleura* y *Trimerocephalus*).

Se intentó establecer una correlación entre las dos cuencas y otros territorios (Aragón y el Macizo Armoricano entre otros). Las correlaciones del Miembro de Requejada (Formación de Abadía, Cuenca Palentina) con la parte superior de la Formación de Faou (Macizo Armoricano) y de la parte superior del miembre de caliza de la Formación de La Vid (Cuenca Astur-Leonesa) con la parte inferior de la Formación de Mariposas (Aragón) son las más llamativas.

A base de las correlaciones con Asteropyginae dentro del territorio Ibero-Armoricano, se ha establecido una distribución en las zonas provisionales.

Los Asteropyginae se limitaban hasta la zona tropical del hemisferio meridional; su origen se sitúa en Europa (o el Africa del Norte). En el Devónico Medio se extendían en dirección al este y oeste.

CONTENTS

CHAPTER I

INTRODUCTION

SCOPE OF THE WORK

The present study is part of a stratigraphic and palaeontologic investigation of the Palaeozoic of the southern Cantabrian Mountains, carried out by the Department of Stratigraphy and Palaeontology of the University of Leiden under the supervision of Prof.Dr. A. Brouwer. Beside stratigraphic studies, a number of palaeontologic studies dealing with Devonian crinoids, brachiopods, stromatoporoids, ostracods and conodonts have been published.

This paper deals with the Devonian trilobites. The subfamily Asteropyginae which dominates in the trilobite faunas of the southern Cantabrian Mountains, is systematically described and a provisional zonation based on this group has been developed. The other trilobites collected have been identified but are not described. They are referred to by stratigraphic level and for the greater part depicted. The number of species known from the Cantabrian Mountains has been enlarged from about 55 to 120. Finally correlations between the Devonian succession of the southern Cantabrian Mountains and adjacent areas based on trilobites have been made.

MATERIAL

The trilobites were collected by students of the University of Leiden and by the author during fieldtrips in the summers of 1965, 1966, 1967, 1976, 1977 and 1982. The material was prepared with use of unflexible needles and by grinding the surrounding rock. Casts were made of silicone rubber PS 56 (Polyservice). For normal photography most specimens were dyed with black aniline solved in aceton and thereafter whitened with MgO for a good contrast. Some small specimens were coated with gold and photographed under scanning electron microscope (SEM).

The studied specimens are stored in the Rijksmuseum van Geologie en Mineralogie (Leiden, The Netherlands).

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PREVIOUS WORK ON DEVONIAN TRILOBITES OF THE CANTABRIAN MOUNTAINS

After de Verneuil (1850) had described the first trilobites from this area, till 1970 many researchers have mentioned trilobites as an accessory part of the marine fauna. Most authors did not give any description and/or illustration and the majority of the names has already become obsolete. In the following survey the names of the species, as they are used in this paper, will be given between major brackets.

De Verneuil (1850) has described three species found near Sabero. There is no doubt that these trilobites originated from the limestone member of the La Vid Fm. near Colle: "*Phacops latifrons*" [= *Phacops saberensis*] "*Cryphaeus calliteles*" [= partly *Pilletina collensis* and probably *Kayserops obsoletus*] and "*Homalonotus Pradoanus* n.sp.", a species which has been established after the find of a cephalon (Arbizu, pers. comm.) to the genus *Burmeisteria* [=*Burmeisteria pradoana*].

Mallada (1875, 1892) also mentioned, beside the three species of de Verneuil, "*Proetus cuvieri* Steininger" from the La Vid Fm. [= probably *Proetus* (n.sg.) n.sp.] as well as from the Huergas Fm. [= probably *Proetus (Proetus) aff. granulosus*] and "*Bronteus castroi* Mallada, 1875" from the La Vid Fm. [= probably *Platyscutellum* sp.]. Furthermore he mentioned "*Dalmanites (Cryphaeus) calliteles* Green" from the locality "Levanza" [= probably *Treveropyge lebanzaensis*].

Barrois (1882) mentioned from the Devonian of Asturias "*Phacops latifrons*, Bronn" from several formations and *Homalonotus Pradoanus*, Vern" from the lower part of the Nieva Fm. Because Barrois has not provided any illustration, no reliable deduction can be made which species were meant. Most likely the *Phacops* material from the Moniello Fm. belongs to *Phacops moniellensis* and that from the Candás Fm. to *Phacops rana*. Furthermore, it is improbable that the "*Homalonotus*" sp. is a real *Burmeisteria pradoana* (Arbizu, pers. comm.).

From the area around Santa Lucía (prov. León) Oehlert & Oehlert (1896) have described trilobites which probably all were found in the Santa Lucía Fm. Apart from a new species "*Cryphaeus (Malladaia) luciae* nov.sp." [= *Malladaia luciae*] and "*Cryphaeus sublaciniatus* de Vern" [= probably *Treveropyge henryi*] they also described material carrying the names "*Cryphaeus Munieri* Oehlert" and "*Phacops Potieri* Bayle" of which at present no definite conclusion can be drawn about the specific determinations.

Quiring (1939) mentioned "*Phacops latifrons*" from the San Julián Massif (which he considered as an equivalent of the Lebanza Fm.). Because no other *Phacops* material has ever been found in the Lebanza Fm. it is probable that it concerns material from the overlying Abadía Fm., which is rich in *Phacops*.

Comte (1959) mentioned a number of trilobites in his extensive work concerning the Cantabrian Mountains. Because he has not given any illustration or description it is difficult to retract which species he meant within the framework of our current knowledge. From the upper part of the San Pedro Fm. he mentioned "*Homalonotus roemeri* var. *cantabricus*". It is not clear whether it concerns *Digonus aff. roemeri* (mentioned in this paper) or *Trimerus acuminatus* which has been mentioned by Arbizu (1979). Of "*Acastella spinosa*" from the same level, it is certain that we have to deal with a wrong identification (R. & E. Richter, 1954). Furthermore Comte mentioned from the La Vid Fm. "*Homalonotus pradoanus*" [= *Burmeisteria pradoana*] and "*Phacops fecundus* var. *major*"[= *Phacops saberensis*] and from the Huergas Fm. "*Phacops potieri*" [= probably *Phacops* sp.5] and "*Asteropyge laciniatus* Roemer" of which cannot be established which species we have to deal.

Radig (1961) mentioned three species from Asturias. From the Aguión Fm. he mentioned "*Malladaia luciae* Oehlert", which is the same species as Arbizu (1978) described as *Malladaia truyolsi*. From the Candás Fm. "*Asteropyge* sp. aff. *nasocostata* (Paeckelmann)" [= *Heliopyge asturica*] and "*Asteropyge cf. hispanica* R. & E. Richter" [= *Heliopyge iberica*] were mentioned.

Erben (1962, p. 52) noted "3. Aus den Kalkschiefern und Mergelkalken der La-Vid-Schichten sind reiche rheinische Faunen bekannt. Daneben stellte ich jedoch in den von Prof. de Sitter und seinen Schülern gesammelten und mir zur Bestimmung vorgelegten Trilobitenfaunen auch folgende hercynische Elemente fest: *Odontochile, Otarion (Otarion), Proetus*...". After studying the correspondence between Erben and students of Prof. de Sitter it becomes obvious that these last conclusions were based on material from the Requejada Member (Abadía Fm., Palentian Basin) and not on material from the La Vid Fm. (Leonese Basin). Although *Otarion* and *Proetus* are also found in the La Vid Fm., the very characteristic "bohemian" *Odontochile* is not present in this formation.

Koopmans (1962) mentioned "*Psychopyge* sp." (identification of W. Struve, Frankfurt-a-M.) from a micaceous, sandy siltstone of "Lower Couvinian" age. Unfortunately the material has been lost and the locality is not accessible anymore because of inundation in the Camporredondo Lake. But very likely it concerns material from one of the species, which also occur at the base of the Huergas Fm.: *Bradocryphaeus? cantarmoricus* or *Alcaldops? argovejensis*.

De Sitter & Boschma (1966) mentioned trilobite faunas from the Palentian Basin (identification of Prof. H.K. Erben, Bonn). For a part this material was at the disposal of the author of this paper and has also been described here. From the upper part of the Lebanza Fm. are mentioned "*Asteropyge* n.sp. (aff. *wallacei*) = ex parte "*sublaciniata* (de Verneuil)" [= *Treveropyge lebanzaensis*] and "*Comura (Delocare)* n.sp. (aff. *boopis*)" of which is not known which species was meant. From the Requejada Member (Abadía Fm.) they mentioned: "*Asteropyge* aff. *munieri*" [= *Pilletina aulnensis*], "*Comura (Delocare)* spec." [= probably *Paracryphaeus caboi*], "*Phacops cf. potieri* Bayle" [= *Phacops saberensis*] and "*Homalonotus* spec." [= *Trimerus (Dipleura)* sp.]. Furthermore from the Polentinos Member (Abadía Fm.) "*Phacops* spec. ex gr. *latifrons*" and "*Phacops (Reedops) broussi* (Barrande)" [= *Phacops* sp.3, sp.4 and/or *Phacops oehlerti*] are mentioned. Finally from a locality east of Mudá are mentioned: "*Phacops (Phacops)* aff. *batracheus* (Whitborne)" [= *Phacops* sp.],"*Cheirurus (Crobalocephalus)* sp. (*myops*, Roemer?)" [= *Cheirurus (Pilletopeltis)* sp.] and "*Proetus (Proetus)* sp." which has not been found again.

Reijers (1972) mentioned trilobites from the Portilla Fm., identified by the author of this paper. The determination of "*Neocalmonia (Heliopyge) iberica* Haas, 1970", however, should be corrected [= *Heliopyge asturica*]. Furthermore he mentioned *Phacops (Phacops)* n.sp. [= *Phacops rana* aff. *rana*], *Scutellum* sp., *Otarion* sp. and *Proetus (Proetus)* sp.

1970 marks the beginning of a new phase in the study of trilobites.

Morzadec (1970) has redescribed the *Phacops* collection of de Verneuil from Colle as "*Phacops (Phacops) saberensis* nov.sp." [= *Phacops saberensis*].

Haas (1970) has described the Asteropyginae material, collected by Radig in Asturias, as "*Pseudocryphaeus occidentalis* n.sp." [= *Paracryphaeus occidentalis* + *Delocare rostrata*] from the Ferroñes Fm., *Greenops (Greenops) boothi* and "*Neocalmonia (Bradocryphaeus) psilus* n.sp." [= *Bradocryphaeus psilus*] from the lower part of the Candás Fm. and "*Neocalmonia (Heliopyge) asturica* n.sp." [= *Heliopyge asturica*] and "*Neocalmonia (Heliopyge) iberica* n.sp." [= *Heliopyge iberica*] from the upper part of the Candás Fm.

Morzadec & Arbizu (1978) have described a species common to the Armorican Massif and the Huergas Fm. in the Cantabrian Mountains: "*Kayserops? cantarmoricus* nov.sp." [= *Bradocryphaeus? cantarmoricus*].

Arbizu (1978) introduced the new subfamily of Malladaiinae of the up to then in Europe unknown family of Synphoriidae and described the already known species *Malladaia luciae* and the new species *Malladaia truyolsi* and also the new genus *Furacopyge* with the new species *F. progenitor, F. sotoi* and *F. morzadeci*.

Arbizu (1979) described twenty species of the subfamily of Asteropyginae; sixteen from Asturias and four from León. Apart from these species he mentioned the following species in Asturias: from the top of the Furada Fm. *Acastella heberti* (Gosselet), *Acastella elsana* R. & E. Richter, *Acastella fresnoensis* Arbizu nom.nud. and *Digonus vialai* (Gosselet), from the Nieva Fm. *Acastella* cf. *rouaulti* (Trom.& Lebesc.) and from the lower part of the Candás Fm. *Phacops (Geesops?)* sp. [= probably *Phacops rana* ssp.]. In León he mentioned from the top of the San Pedro Fm. *Trimerus acuminatus* (Trom.& Lebesc.) and from the La Vid Fm. a.o. three *Pseudocryphaeus* species [= probably a.o. *Pseudocryphaeus? demoulini* and *Pseudocryphaeus* *cossensis*].

Arbizu et al. (1979) mentioned trilobites from the Moniello Fm. with the new elements *Phacops moniellensis, Proetus cf. cuvieri* Steininger, 1831 and *Scabriscutellum* sp.

Before the present study a number total of 55 species were more or less known in the Cantabrian Mountains.

CHAPTER II

THE DEVONIAN SUCCESSION IN THE CANTABRIAN MOUNTAINS

GENERAL GEOLOGICAL SETTING

The Cantabrian Mountains form part of the Hesperian Massif which can be divided in a central crystalline axis (Galicia - Castillian zone) and four sedimentary zones, two zones on both sides of the axis (Lotze, 1945; Fig. 1, inset-map). The northern sedimentary zones are the Westasturian-Leonese zone and the Cantabrian zone. The Cantabrian zone is intersected by some deep-seated structural lines which divide the zone in several facies areas (Fig. 1).

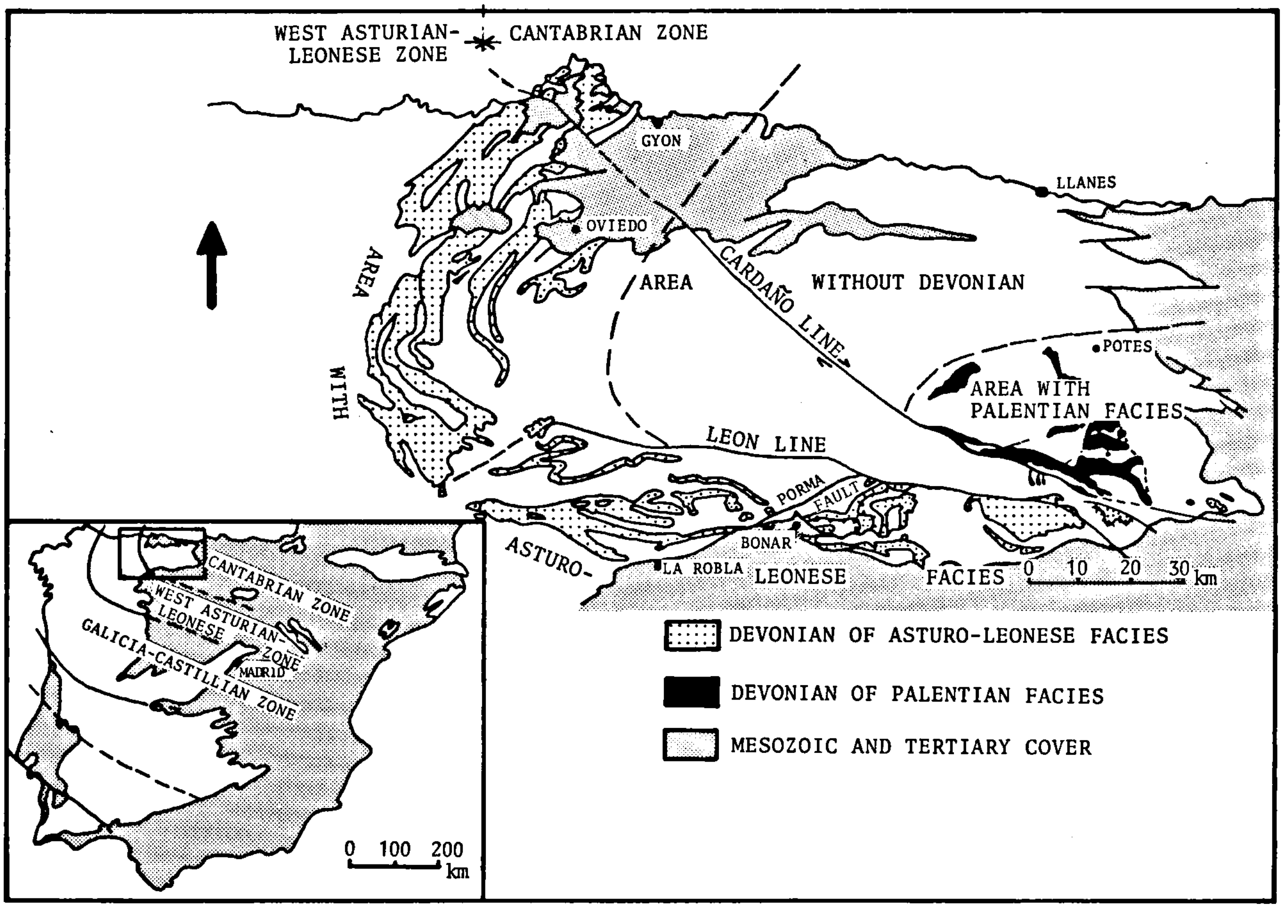


Fig. 1. The Cantabrian Mountains with Devonian outcrop. The León Line and the Cardaño Line divide the area in two regions with different facies: the Asturo-Leonese and the Palentian facies area. Inset-map: The Iberian peninsula with the structural zones after Lotze (1945).

The Asturian geanticline occupies the central part of the zone and is bounded by the León Line in the south. It was a positive area for most of the time from middle Ordovician to late Famennian.

The Asturo-Leonese facies occupies the area south of the León Line and also bounded the Asturian geanticline along its western margin during the Devonian. This facies developed in a shallow-marine sedimentary basin, or, to be more specific, on a platform (Brouwer, 1982) on which sedimentation was almost continuous from Cambrian to Late Carboniferous. The Devonian deposits are reefal limestones alternating with siliciclastics and represent subtidal to tidal environments on a relatively stable shelf. Most deposits have an abundant benthonic fauna of brachiopods, bryozoans, crinoids, corals and stromatoporoids. The trilobites constitute an accessory faunal element in most deposits.

The Palentian facies area occurs in the southeastern part of the Cantabrian zone; in the southwest it is bounded by the Cardaño Line. The oldest deposits from the Silurian are hardly different from those in the Asturo-Leonese facies area. The differences become more conspicuous in Middle and Upper Devonian. The facies represents an environment of relatively deep marine restricted sedimentation, a condensed sequence of mainly nodular limestones and shales, which was interrupted by an influx of siliciclastics during the early Famennian. In the Lower Devonian deposits the faunal differences with the other facies area are not striking, but in the Middle and Upper Devonian formations the fauna is conspicuously pelagic and consists of cephalopods, dacryoconarids, trilobites, conodonts, pelecypods and a few solitary corals. The trilobite fauna is rather abundant and even constitutes a major faunal element in some of the Devonian deposits (Abadía Fm.). The Palentian facies area probably represents a relatively small and deep marine basin.

Since the Late Carboniferous orogenesis with its development of conspicuous decollement structures (Savage, 1979) has obliterated all lateral stratigraphic coherence between the three facies areas, palinspastic reconstruction of the Devonian position of the Palentian facies area in relation to the other facies areas is largely a matter of conjecture.

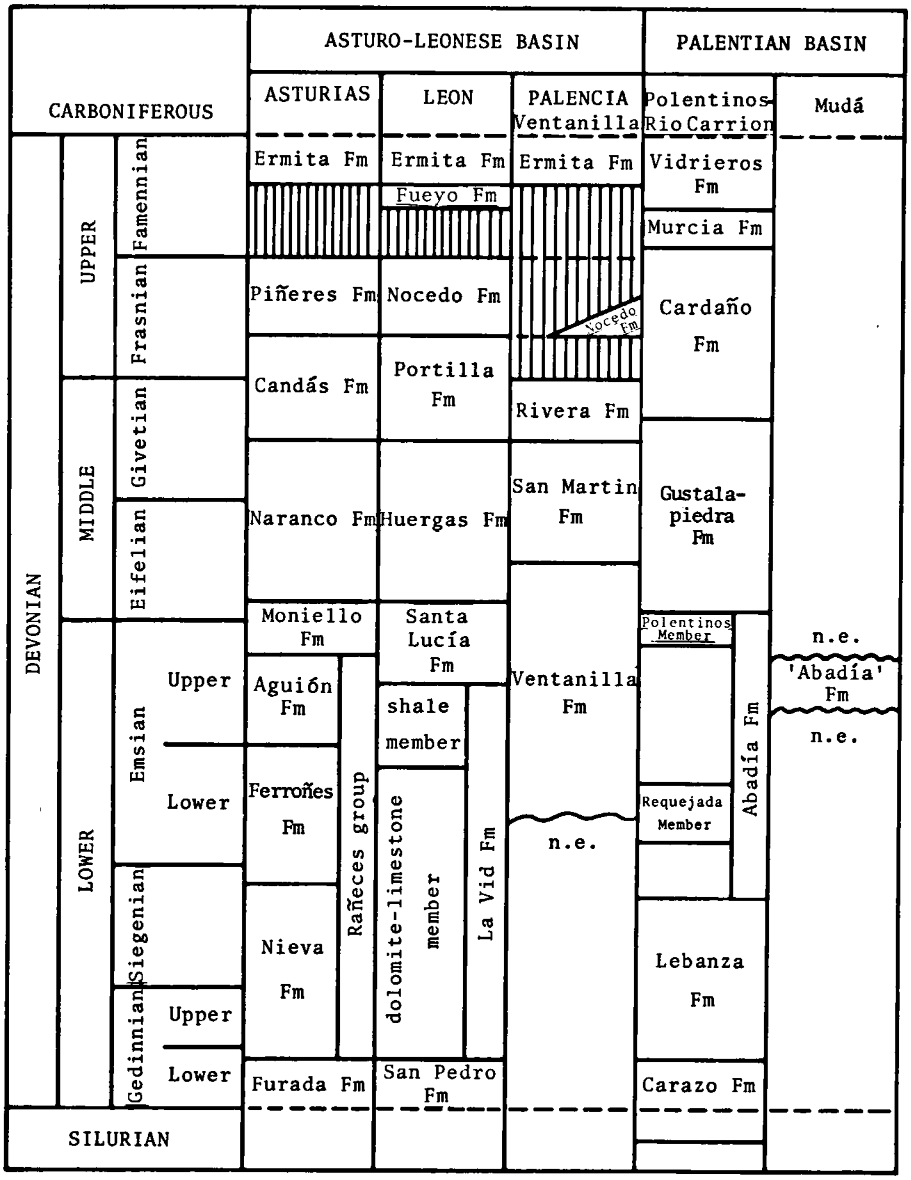


Fig. 2. Time-stratigraphic table of Devonian formations throughout the Cantabrian Mountains (modified after Brouwer, 1968).

In the next paragraphs the individual formations of the Asturo-Leonese and Palentian basins are reviewed by summarising their latest general descriptions (Savage & Boschma, 1980). General biostratigraphic and time-stratigraphic data are given for each formation. The trilobite localities in each formation are enumerated; more information about these localities is given in Chapter V.

Since this paper is concerned only with the Devonian succession in the southern Cantabrian Mountains the lithostratigraphic review is restricted to the Devonian formations of the Leonese part (San Pedro Fm., La Vid Fm., Santa Lucía Fm., Huergas Fm., Portilla Fm., Nocedo Fm., Fueyo Fm. and Ermita Fm.) and the Ventanilla region (Ventanilla Fm., San Martin Fm., Rivera Fm., Nocedo Fm. and Ermita Fm.) of the Asturo-Leonese Basin and the Devonian formations of the Palentian Basin (Carazo Fm., Lebanza Fm., Abadía Fm., Gustalapiedra Fm., Cardaño Fm., Murcia Fm. and Vidrieros Fm.). The correlation of the formations enumerated is depicted in Fig. 2.

DEVONIAN FORMATIONS OF THE ASTURO-LEONESE BASIN

The San Pedro Formation (Comte, 1959; van den Bosch, 1969) straddles the Silurian-Devonian boundary, its age being Upper Wenlockian (Comte, 1959) to Lower Gedinnian (Brouwer, 1968). The San Pedro Fm. can be subdivided in three members: a basal member composed of thick red channeling sandstone beds with hematite ooids, a middle member composed of green shales alternating with red and greenish sandstones with hematite and chamosite ooids respectively, and an upper member composed of alternating white quartzites and black shales. The thickness of the formation averages 100 - 200 m in the larger part of the basin and decreases toward the León Line. The depositional environment represents most likely a shelf sea, seaward of the surf zone but in reach of tidal currents. Its age is derived from brachiopods. Trilobites are found in locality L1.

The La Vid Formation (Comte, 1959; van den Bosch, 1969) occupies the uppermost Lower Gedinnian (this paper) to Upper Emsian interval. The transition from the San Pedro Fm. is commonly of a gradual nature but locally erosional contacts have been found. The lithology is a well-bedded alternation of detrital fossiliferous limestones and shales, which can be divided according the dominant lithology into a lower dolomite-limestone member and an upper shale member. In the western part of the Leonese Basin the dolomite-limestone member is sometimes underlain by a limestone unit (Abelgas unit). The total thickness varies from 200 m to 800 m from east to west. The formation represents a shallow marine shelf environment, possibly at some distance from the coast without supply of terrigenous sediment. The fauna is abundant and includes brachiopods, corals, crinoids, bryozoans and trilobites. Trilobites have been found in the localities L2-13 and X1-6.

The Santa Lucía Formation (Comte, 1959; Evers, 1967; de Coo, 1974) ranges from uppermost Emsian to lowermost Eifelian (de Coo, 1974) based on brachiopods, conodonts and ostracods. The formation consists of limestones with some thin shale intercalations. De Coo (1974) distinguished a grainstone facies, deposited in an open marine (sub)tidal environment, a packstone/wackestone facies representing the protected (sub)tidal environment, a biostromal boundstone facies and a mudstone facies of the protected (inter)tidal environment. The total thickness of the formation varies between 150 m and 230 m. The fauna is abundant and contains brachiopods, corals, stromatoporoids, crinoids, bryozoans, sponges and ostracods. Trilobites are quite rare, but have been found in the localities X7,8.

The Huergas Formation (Comte, 1959; van den Bosch, 1969) occupies the Lower Eifelian to Lower Givetian and consists of siliciclastic deposits: shales, siltstones, sandstones and quartzites. The formation is slightly ferruginous with locally iron-rich layers. The sandstones are often decalcified and a few horizons rich in fossils do occur. The Huergas Fm. represents beach to subtidal environments (van den Bosch, 1969) with slightly reducing conditions. The thickness ranges from 100 m to 330 m and generally decreases to the north. The fauna consists of brachiopods, crinoids, bryozoans, cephalopods, some pelecypods and trilobites. The trilobites have been found in the localities L14-20, X9-11.

The Portilla Formation (Comte, 1959; Evers, 1967; Reijers, 1972) ranges from Lower/Middle Givetian to Lower Frasnian. Reijers (1972) discussed the implications of the available biostratigraphic data including brachiopods, conodonts and ostracods. The formation consists of limestones not unlike the Santa Lucía Fm., displaying protected intertidal mudstone environments; reefal complexes often with biohermal aspects forming barriers; (sub)tidal wacke- and packstones and grainstones, locally oolithic, which represent open marine subtidal environments. The thickness of the formation averages 200 m and generally decreases toward the León Line. In the Portilla Fm. fossils abound: brachiopods, bryozoans, crinoids, corals, biostromal structures caused by algal coating and relatively few stromatoporoids can be observed. Trilobites have been found in the localities L21,22 and X12-16.

The Nocedo, Fueyo and Ermita Formations. The Portilla limestone sedimentation in the Asturo-Leonese Basin is followed by a mainly siliciclastic sequence: the Nocedo, Fueyo and Ermita Fms., which together occupy the upper part of the Frasnian and the Famennian. The top of the Ermita Fm. commonly has a Tournaisian or even Lower Viséan age. The formations were recently studied in some detail (van Loevezijn, 1983; van Loevezijn & Raven, 1983; Raven, 1983). They represent a range of facies areas from thick storm deposits (southern part of the Nocedo and Fueyo Fms.) to a thin sequence of residual microconglomerates and coarse sandstones (northern part of the Ermita Fm.). In the central part of the basin the Nocedo Fm. is developed as a fairly thick (about 300 - 500 m) mainly shallow marine siliciclastic succession with some limestone bodies. The formations are rather poor in fossils but a thorough investigation (Raven, 1983) established their respective chronostratigraphic intervals by identification of the conodonts. Below the Ermita Fm. generally there is a large hiatus covering the major part of the Famennian or even more up to the Cambrian. Trilobites have been found only in the Nocedo Fm. in the localities X17,18.

In the eastern part of the Leonese Basin, the Ventanilla region, a separate lithologic subdivision of the Devonian succession is used (Kanis, 1956). From the Lower Emsian onward the Ventanilla Fm., San Martin Fm. and Rivera Fm. are distinguished. The Rivera Fm. is covered by the Nocedo Fm. developed identically as described above. The base of the succession is not exposed.

The Ventanilla Formation is a limestone-shale sequence, time-equivalent to the shale member of the La Vid Fm., the Santa Lucía Fm. and the base of the Huergas Fm. Its limestones have a more pronounced biohermal facies than the limestone formations described above, but in other aspects show a striking similarity. Trilobites have not been found in this formation.

The San Martin Formation is dominantly a shallow marine ferruginous siliciclastic formation, nearly time-equivalent to the Huergas Fm. Trilobites have been found at the base of this formation in locality V1.

The Rivera Formation is a typical biohermal limestone, with compound rugose corals and bryozoans as dominant faunal elements. This formation is time-equivalent to the lower part of the Portilla Fm. Trilobites have been found in the localities V2,3.

DEVONIAN FORMATIONS OF THE PALENTIAN BASIN

The Carazo Formation (Binnekamp, 1965; van Veen, 1965; Ambrose, 1974) is a siliciclastic formation, nearly time-equivalent to the San Pedro Fm. and lithologically quite similar. Its base was redefined by Ambrose (1974). Its age, inferred from the brachiopod fauna (Binnekamp, 1965), is uppermost Silurian to Lower Gedinnian. The formation comprises a basal sandstone member, consisting mainly of well-bedded often ferruginous sandstones, sometimes cross-bedded, which are interbedded with shales, and a shale member, silty in the lower part and calcareous in the upper part. The thickness of the formation varies from 100 m in the north and southeast to 400 m at the Peña Carazo. The formation must have been deposited mainly in a shallow, open-marine environment. The fauna is abundant especially in the shale member, major faunal elements being brachiopods, pelecypods, ostracods, gastropods and trilobites. Trilobites have been found in the localities P1,2.

The Lebanza Formation (Binnekamp, 1965; van Veen, 1965; Krans, Guit & van Ofwegen, 1982) is essentially a bioclastic limestone unit, indicating an open-marine shallow environment (Krans et al., 1982). The formation is of the same age as the lower part of the limestone member of the La Vid Fm. and represents a similar depositional environment. The age of the formation, as inferred from brachiopods, acritarchs and trilobites (various authors, cited in Krans et al., 1982; this paper) is uppermost Lower Gedinnian to Upper Siegenian. Krans et al. subdivide the formation in five members, through which the lithology ranges from basinal shales through open-marine grainstones and packstones to biostromal coral limestones and stromatoporoidal boundstones with abundant bioclastic packstones and wackestones to protected sub- to intertidal mudstones. The Lebanza Fm. in its type area has a thickness of about 160 m and thins out to the north and the northwest. Throughout the formation the fauna is extremely rich: brachiopods, pelecypods, tentaculites, trilobites, bryozoans, rugose corals and stromatoporoids. Trilobites have been found in the localities P3-7.

The Abadía Formation (van Veen, 1965) is the first rock unit that marks the differentiation of a Palentian Basin with its own distinct lithology. The formation is essentially a shaly interval with several levels of limestones. Two limestone levels are distinguished as members, the lower Requejada Member and the upper Polentinos Member. The shales are remarkably sandy and silty with recurring marly layers. The Requejada Member is a dark thin-bedded silty limestone (often found as a yellow-weathered decalcified siltstone) at the base which passes upward into lighter-coloured limestones. The Polentinos Member consists of wavy-bedded limestones with thin shaly layers. The formation was deposited in a quiet environment. The limestone members are of Lower Emsian and Upper Emsian to Lower Eifelian age respectively, as indicated by conodonts (van Adrichem Boogaert, 1967) and trilobites (this paper). The thickness of the formation is about 200 m. The fauna consists of goniatites, conodonts, trilobites, dacryoconarids and less numerous brachiopods, corals, ostracods and pelecypods. Trilobites have been found in the localities P8-24.

The Gustalapiedra Formation (van Veen, 1965) consists of 50 - 70 m dark grey to black shales alternating with argillaceous black limestones. The shales contain crystalloblasts of chloritoid and sericite. The limestones are medium crystalline and pyritic. The formation conformably overlies the Abadía Fm. and stresses the separation between the Palentian and the Asturo-Leonese facies areas. The fauna is relatively poor and restricted, consisting of dacryoconarids, goniatites, trilobites, pelecypods and conodonts, which yielded ages ranging from Lower Eifelian to Upper Givetian (van Adrichem Boogaert, 1967; this paper). There is a gradual passage to the overlying nodular limestones. Trilobites occur in the localities P25,26.

The Cardaño Formation (van Veen, 1965) consists of very fine-grained grey nodular limestones, with dark shaly partings, grading to shales with limestone nodules (peanut shales). The formation is suspected to be a condensed sequence. The thickness varies from 10 - 40 m. The fauna is restricted and contains some goniatites, a few trilobites and abundant conodonts. The age ranges from uppermost Givetian to lowermost Famennian (Raven, pers. comm.). Trilobites have been found in locality P27.

The Murcia Formation (van Veen, 1965). The Upper Devonian deposits of condensed nodular limestones is interrupted during the lower Famennian by the influx of siliciclastic turbidites: well-bedded quartzitic sandstones to quartzites alternating with thin layers of dark coloured shales, locally interrupted by a lens of nodular limestones. This rock unit, known as the Murcia Fm., is up to 200 m in thickness. It is conformably overlain by another sequence of nodular limestones and peanut shales. The fauna consists of small pelecypods (*Buchiola*); no trilobites have been found.

The V i d r i e r o s F o r m a t i o n (van Veen, 1965) is a younger lithologic equivalent of the Cardaño Fm., averaging 20 m in thickness and of Lower Famennian to lowermost Tournaisian age (van Adrichem Boogaert, 1967; Raven, pers. comm.). The fauna consists of conodonts, trilobites, goniatites and some pelecypods. Trilobites have been found at the base of the formation in locality P28.

CHAPTER III

SYSTEMATICS OF THE ASTEROPYGINAE
with notes on the other trilobites

INTRODUCTION

The Asteropyginae, the most common group of trilobites in the Devonian of the Cantabrian Mountains, have a restricted geographical (Fig. 12) and stratigraphical distribution. In Europe the stratigraphical distribution ranges from Lower Gedinnian to uppermost Frasnian. They evolved from the Acastavinae in the Lower Gedinnian and passed through a first acme in the Siegenian - Emsian. At the end of the Lower Devonian most genera became extinct. A second, short acme followed in the Givetian - Frasnian. Toward the end of the Frasnian they died out definitely.

The Asteropyginae were nectobenthonic organisms, which were restricted to shallow water environments. Because the species have a relative short stratigraphical range in theory they should be excellent guide fossils. However, their usefulness for correlation purposes is limited, because of their restricted geographical distribution and facies dependency.

Apart from the Asteropyginae representatives of many other trilobite families have been found. Of these trilobites no description is given but because of their importance some observations are included at the end of this chapter.

Previous work
The knowledge of Asteropyginae is based on the work of R. Richter (1909) and R. & E. Richter (1926, 1943, 1952). Recently Asteropyginae have been described by Stumm (1953, 1965) from northeastern North America, Haas (1968) from Turkey, Haas (1970) from Asturias and Harz Mts., Haas & Mensink (1970) from Afghanistan, Gandl (1972) from the Celtiberian Chain and Guadarrama, Pillet (1973) and Morzadec (1969, 1971, 1976a,b,c, 1980, 1981) from the Armorican Massif, Arbizu (1979) from Asturias, and Farsan (1981) from Afghanistan.

Terminology
For the terminology is referred to Harrington, Moore & Stubblefield (1959): Glossary of trilobite morphological terms. However, the lateral glabellar furrows and lobes are numbered from posterior to anterior respectively S1, S2, S3 and L1, L2, L3 according to Jaanusson (1956). For the pygidial segmentation patterns we refer to Struve (1959a) for the *prorotundifrons, boothi, cometa* and *supradevonica* pattern, to Haas (1970) for the modified *prorotundifrons* pattern, to Gandl (1972) for the *michelini* pattern, and to Arbizu (1979) for the *alcaldei* pattern; for the cephalon types we refer to Gandl (1972).
Measurements. - Unless otherwise stated the length of the cephalon is measured sagitally (without genal spines); the pygidium is measured w i t h lateral and posterior spines (lappets).
Abbreviations. - pr = pair(s); (ex)sag. = (ex)sagittal; tr. = transversal; f.s. = facial suture; α = frontal point of the facial suture; ω = posterior point of the facial suture on the lateral margin; palp. = palpebral; ant./post. pl. band = anterior/posterior pleural band; (inter)pl. furrow = (inter)pleural furrow; glab. = glabellar.

SYSTEMATICS OF THE ASTEROPYGINAE

Subfamily ASTEROPYGINAE Delo, 1935

PARACRYPHAEUS Gandl, 1972

Genotype. - *Cryphaeus jonesi* Oehlert, 1877.
Diagnosis. - See Gandl (1972, p. 81).
Occurrence. - Armorican Massif, Asturias, León, Palencia, Aragón, Guadarrama and Turkey; lowermost Siegenian-lower Upper Emsian.

Paracryphaeus cf. jonesi (Oehlert, 1877)
Pl. 1 figs. 1-3

Material. - 2 Pygidia (RGM 339000-01) from loc. P5; 1 pygidium (RGM 339002) from loc. P6; 1 pygidium (RGM 339003) from loc. P7.
Discussion. - The pygidial segmentation, as well as the shape and the truncation of lateral and posterior lappets of the material are completely similar to those of *P. jonesi* from the

Armorican Massif, which has been redescribed by Morzadec (1971, p. 172). Neither is there any difference with the material from Aragón, described by Gandl (1972, p. 84). Our material, however, is too poorly preserved to come to a definite determination.
Occurrence. - At the top of the Lebanza Fm.; Middle-Upper Siegenian. Outside the Cantabrian Mountains *P. jonesi* has been found in the Armorican Massif (Middle Siegenian; *Athyris undata* zone) and in the Nogueras Fm. and the Santa Cruz Fm. (d2cβ - d3bγ) in Aragón.

Paracryphaeus? sp.
Pl. 1 fig. 4

Material. - 3 Pygidia (RGM 339004-06) from loc. P4.
Description. - Pygidium: Wide triangular outline with slightly convex sides. Axis round arched, anteriorly as wide as pleural field, tapering backwards till 5th ring at an angle of 25°-30°, behind that point subparallel and with rounded end. 10(11) Axial rings, the first egg-glass shaped, first 3 pointing to the front, first 5 distinctly separated. Pleural fields slightly vaulted, with 5 pr of ribs of *michelini* pattern, ribs decreasing in length backwards, 5th pr unfurrowed. Interpleural furrows narrow and shallow, convex to the front, abaxially ending in the border furrow. Pleural furrows deep, U-shaped, a little narrower than pleural bands, ending in border furrow at same level as interpl. furrows. Ant. and post. pleural bands of the same height and width, both fading near border furrow. Ant. pl. bands adaxially wedging out against posterior. Border furrow and narrow border present. 5 Pr of pointed, slightly backwards curved, lateral spines (length = ½ length of corresponding rib), with large interspace; 5th pr parallel. Posterior spine triangular with concave sides, 2 x length and 2 x width of 5th pr of lateral spines.

Ornamentation: Fine granulation on axial rings, ribs and spines.

Measurements: Pygidium: length 8 mm, width 12 mm.

Discussion. - On account of the *michelini* segmentation and the posterior spine, which is longer than the lateral ones, this species is with reserve classified with *Paracryphaeus*. The truncation of the lateral spines, which characterizes this genus, however, is not present.
Occurrence. - At the top of the Lebanza Fm.; Middle-Upper Siegenian.

Paracryphaeus izensis (Morzadec, 1971)
Pl. 1 figs. 5-11

* 1971 *Pseudocryphaeus izensis* n.sp. - Morzadec: p. 174, pl. 17 figs. 12-15.

Material. - 4 Cephalons (RGM 339007-10) and 2 pygidia (RGM 339011-12) from loc. X2; 5 cephalons (RGM 339013-17) and 8 pygidia (RGM 339018-25) from loc. X3.
Description. - Since Morzadec (1971) has described only the pygidium of this species, a complete description follows here, based on material from the La Vid Fm.

Cephalon: Outline ogival; narrow frontal border, a little widening mesially; middle-long genal spines. Axial furrows from behind till the mid of L3 diverging at an angle of 35°, at S3 strongly curved to glabella, more to the front steeply sloping and running sideways to the margin, at S3 deeply incised. Frontal glab. lobe strongly convex, abaxially protruding before the eyes, rounded frontal margin, strongly sloping both to the front and sideways, reaching the border at an angle of 60°, postero-median depression surrounded by 3-5 pits, posteriorly joint with central area. L3 and L2 of the same length (exsag.). swollen and in anterior view rising abaxially above frontal glab. lobe, both separated from central area. L1 far below L2 abaxially. S3 oblique, on external mould deep, V-shaped; S2 transversal, narrow, V-shaped, abaxially fading but reaching axial furrows; S1 wide and deep, adaxially curving to S3. Central area wide, round arched. Occipital furrow very deep, V-shaped; occ. ring wide (tr.) and long (sag.). Posterior border furrow adaxially narrow, deep and V-shaped, fading on cheek. Posterior border strongly convex, abaxially passing into genal spine. Cheeks below the eyes narrow, concave-convex with thick border, but without border furrow. Genal spines middle-long, slightly furrowed with wide base and pointed distally. Large eyes rising above glabella, anteriorly at the side of anterior part of L3 and close to glabella, posteriorly retreating the width of post. border from post. border furrow and 1½ width of post. border from axial furrow. Palpebral lobe strongly curved and distinct, posteriorly higher than anteriorly; palp. furrow distinct anteriorly, faint posteriorly; palp. area narrow, strongly sloping to glabella and posterior border furrow. Visual surface large: cephalon RGM 339008 (Pl. 1 fig. 6) has 21 vertical rows with a max. of 7 lenses per row, in total 126 lenses per eye; lenses pattern: anterior 45677 . 77777 . 77667 . 66554 . 3 posterior. Subocular furrow distinct, situated just above cheek. Facial suture at α parallel with frontal margin and retreating from glabella.

Pygidium: Outline triangular to oblong owing to long posterior spine. Axis robust, round arched, wider than pleural field, tapering backwards till 5th ring at an angle of 25°-30°, behind that point subparallel and with rounded end. 10(11) Narrow (sag.) axial rings, first 5 distinctly separated and taking up 3/5 of length of axis. Pleural fields vaulted, inner part horizontal, outer part sloping at an angle of 45° abaxially, with 5 pr of ribs of *michelini* pattern with a tendency to *boothi* pattern. First 3 pr of ribs distinctly furrowed, 4th pr faintly furrowed, 5th pr unfurrowed, ribs decreasing in length backwards. Interpl. furrows very narrow and shallow, V-shaped, distinctly crossing border and extending till margin between lateral spines, abaxially strongly curving backwards. Pleural furrows deep and straight, ending at base of lateral spines. Post. pl. bands wider and a little higher than anterior ones, at base of lateral spines 2 x as wide as anterior ones. Shallow border furrow and very narrow border present. 5 Pr of lateral spines, all as long as 3rd pr of ribs, at base closely together, pointed, n o t t r u n c a t e d ; all spines pointing backwards, 5th pr parallel and close to posterior spine. Robust posterior spine, 2-3 x as long as and 1½-2 x as wide as lateral ones. Very narrow doublure.

Ornamentation: The whole exoskeleton is covered with a dense middle-coarse, pointed granulation; on glabella, palpebral lobe and below the eyes is still a coarser granulation present. On the cheeks just below the eyes there also is an ornamentation of little pits.

Measurements: Cephalon: length 5-13 mm, width 9-22 mm; pygidium: length 4-6 mm, width 4-6 mm.

Discussion. - The small pygidia of the Spanish material, which do not show truncation of lateral spines, resemble *P. izensis* (Morzadec, 1971) so much, that we may consider them to be of the same species. Because of the material from the Armorican Massif only the pygidium is known, this resemblance is not based on the cephalon. *P. caboi* n.sp. differs from *P. izensis* by its smaller eyes, shorter genal spines and truncated, pygidial lateral spines. Probably this spe-

cies is a direct descendant of *P. izensis*.
Occurrence. - In the lower part of the limestone member of the La Vid Fm. near Aviados and La Vid; Upper Siegenian-lowermost Emsian. Outside the Cantabrian Mountains *P. izensis* is found in the Armorican Massif (*Athyris undata* zone).

Paracryphaeus caboi n.sp.
Pl. 1 figs. 12-15; Pl. 2 figs. 1-5

Derivatio nominis. - Named after Felix Cabo, inhabitant of Cervera de Pisuerga (prov. Palencia).
Holotypus. - Cephalo-thorax with hypostome, RGM 339026 (Pl. 1 fig. 12).
Locus typicus. - Loc. P8: 100 m west of the village of Lebanza.
Stratum typicum. - Yellow decalcified siltstones of the Requejada Member (Abadía Fm.); lowermost Emsian.
Paratypes. - 2 Complete specimens (RGM 339027-28), 1 hypostome (RGM 339029), 8 cephalons (RGM 339030-37) and 6 pygidia (RGM 339038-43) from the type locality P8; 2 cephalons (RGM 339044-45) and 1 pygidium (RGM 339046) from loc. P10; 1 cephalon (RGM 339047) and 1 pygidium (RGM 339048) from loc. P14.
Diagnosis. - A small *Paracryphaeus* species characterized by:

Cephalon: L3/L2 slightly separated from central area; S2 extending to axial furrow; short, pointed genal spines; small eyes situated high on the cheeks.

Pygidium: Outline triangular; short axis with 9(10) rings; first 4 rings distinctly separated. Segmentation of *michelini* pattern with tendency to *boothi* pattern: post. pl. bands a little wider than anterior ones. 5 Pr of short, saw-tooth shaped, truncated, lateral spines. Posterior spine robust, 2 x as wide and 2-5 x as long as lateral spines.

Description. - Cephalon: Outline semicircular to ogival. Axial furrows distinct and strongly diverging to the front, at S3 curved to glabella and deeply incised. Large frontal glab. lobe, diamond-shaped, gradually sloping to the front and sideways, with postero-median depression surrounded by 4 pits, connected with central area. L3 and L2 slightly swollen, abaxially extending above frontal glab. lobe, adaxially slightly separated from central area (especially on internal mould); L1 adaxially curved to the front, abaxially narrow and far below L3/L2 level. S3 sigmoidal, narrow, deeply incised V-shape; S2 transversal, sharply incised, extending to axial furrow; S1 deeply incised, concave to the front, adaxially curving to S3. Occipital furrow distinct, abaxially deeply incised; occ. ring narrow (exsag.) with median tubercle. Post. border furrow narrow and deep, abaxially fading, curving backwards and extending to the outer margin of genal spine. Posterior border adaxially narrow, abaxially widening and merging into genal spine. Short, pointed genal spines. Cheeks concave with swollen border, without lateral border furrow; very narrow anterior border, pointed mesially. Small eyes, high on the cheeks and rising above glabella, anteriorly at the side of anterior part of L3, posteriorly at a distance of 2 x width of posterior border (exsag.) from posterior border furrow. Palpebral lobe strongly curved and swollen; furrows distinct and in the mid deeply incised; area narrow. Small visual surface: The eyes of cephalon RGM 339047 have 21 vertical rows with a max. of 4 lenses per row and a total of about 60 lenses per eye. Facial suture at α parallel with margin; wide triangular intrasutural area present; posterior part of facial suture strongly curved to the front and intersecting lateral margin at the side of posterior part of eye.

Thorax: Axis wide, round arched, widest near 6th segment; axial rings without tubercles. Pleural fields adaxially horizontal, halfway strongly curved downwards. Segments of *michelini* pattern and with truncated ends.

Pygidium: Outline triangular. Axis short, anteriorly wider than pleural field, strongly tapering backwards till 4th ring, behind that point subparallel, low and rounded end. 9(10) Axial rings, first 4 distinctly separated. Pleural fields narrow with 5 pr of short ribs of *michelini* pattern with tendency to *boothi* pattern; ribs widening abaxially, 4th pr faintly furrowed, 5th pr incomplete and unfurrowed. Interpl. furrows narrow and shallow, faintly crossing the border and reaching the margin between lateral spines. Pleural furrows deep, narrow, incised V-shape, ad- as well as abaxially fading out. Post. pl. bands a little wider than anterior ones; ant. pl. bands both ad- and abaxially wedging out against posterior ones. Border furrow and border indistinct. 5 Pr of short, saw-tooth shaped, truncated lateral spines, pointing backwards and all of the same length; width decreasing backwards; 5th pr close to posterior spine. Robust posterior spine, 2 x as wide and 2-5 x as long as 5th pr of lateral spines, on internal mould lanceolate.

Ornamentation: Whole exoskeleton covered with a dense, middle-coarse granulation. The hypostome has a dense, very fine granulation.

Measurements: Holotype: cephalon length 9 mm, width 15 mm; other cephalons: length 5-11 mm, width 8-16 mm; pygidia: length 4-7 mm, width 5-9 mm.

Discussion. - Most related to *P. caboi* n.sp. and possibly direct ancestor is *P. izensis* (Morzadec, 1971); for comparison we refer to the discussion of last species. Strikingly is the resemblance of *P. caboi* with species such as *Pelitlina goltzi* (described by Haas, 1968, as Acastavinae species) and *Pseudocryphaeus? demoulini* n.sp. Both also have small eyes, short genal spines and truncated, thoracic and pygidial, lateral spines, but the characteristic, long posterior spine of *Paracryphaeus* species is not present. *P. jonesi* (Oehlert, 1877) differs because of its size and bulgier glabella.
Occurrence. - In the Requejada Member of the Abadía Fm.; lowermost Emsian.

Paracryphaeus occidentalis (Haas, 1970)
Pl. 2 fig. 6

* 1970 *Pseudocryphaeus occidentalis* n.sp. - Haas: p. 118, pl. 3 fig. 6 (non fig. 7 = *Delocare rostrata* Arbizu, 1979).
1979 *Pseudocryphaeus occidentalis* Haas, 1970 - Arbizu: p. 69, pl. 1 fig. 6, pl. 2 figs. 1, 2.

Material. - 1 Pygidium (RGM 339049) from loc. L11.
Description. - For an extensive description see Arbizu (1979).
Discussion. - Haas (1970) has described material from the Ferroñes Fm. (Asturias) as "*Pseudocryphaeus occidentalis* n.sp.". After a further study of material from the type locality by Arbizu (1979) it turned out that the cephalon described by Haas belongs to another species (*Delocare rostrata* Arbizu, 1979). After the curtailment of *Pseudocryphaeus* and the introduc-

tion of the new genus *Paracryphaeus* by Gandl (1972) our species belongs, because of its long posterior spine, to *Paracryphaeus*. The pygidium of the La Vid Fm. is completely similar to the holotype of *P. occidentalis*. Related to this species is *P. jonesi* (Oehlert, 1877) which, however, differs because of its wider pleural furrows and longer and more slender lateral spines. Probably *P. occidentalis* is a direct descendant of *P. jonesi*.
Occurrence. - In the shale member of the La Vid Fm. near Adrados; transition Lower-Upper Emsian. In Asturias this species has been found at the top of the Ferroñes Fm.

PSEUDOCRYPHAEUS Pillet, 1954

Genotype. - *Phacops michelini* Rouault, 1851.
Diagnosis. - See Gandl (1972: p. 90).
Occurrence. - Armorican Massif, León, Palencia, Aragón, Guadarrama, Portugal, ?Turkey; Middle Siegenian-Upper Emsian.

Pseudocryphaeus cf. michelini (Rouault, 1851)
Pl. 2 figs. 7, 8

Material. - 3 Pygidia (RGM 339050-52) from loc. P5.
Discussion. - The material of the Lebanza Fm. is quite similar to *Ps. michelini* from the Armorican Massif, which is redescribed by Morzadec (1971: p. 169). Because the Spanish material is poorly preserved, it will be referred to as *Ps. cf. michelini*. Closely related are *Ps. oehlerti* Morzadec, 1971, *Ps. cossensis* Morzadec, 1971, *Paracryphaeus izensis* (Morzadec, 1971) and *Paracryphaeus vernensis* (Morzadec, 1971) all described from the *Athyris undata* zone of the Armorican Massif. *Ps. oehlerti* is distinguished by its shorter pygidial lappets, which are all of the same length. *Ps. cossensis* is distinguished by its shorter, stronger truncated, pygidial lappets, all of the same length. *P. izensis* and *P. vernensis* differ because of their oblonger pygidium with robust posterior lappet.
Occurrence. - At the top of the Lebanza Fm.; Middle-Upper Siegenian. Outside the Cantabrian Mountains *Ps. michelini* has been found in the Armorican Massif (*Athyris undata* zone), in the Guadarrama (Cercadillo Fm.) and probably in Portugal.

Pseudocryphaeus cf. oehlerti Morzadec, 1971
Pl. 2 figs. 9, 10

Material. - 2 Pygidia (RGM 339053-54) from loc. P5; 2 pygidia (RGM 339055-56) from loc. P6.
Discussion. - The Spanish material is of a too bad quality to allow a definite determination. No differences have been found with *Ps. oehlerti*, described by Morzadec (1971: p. 175) from the Armorican Massif. Closely related to our species is *Ps. michelini* (Rouault, 1851), which, however, has longer lateral lappets.
Occurrence. - At the top of the Lebanza Fm.; Middle-Upper Siegenian. Outside the Cantabrian Mountains *Ps. oehlerti* has been described from the Armorican Massif (*Athyris undata* zone).

Pseudocryphaeus sp.
Pl. 2 figs. 11, 12

Material. - 3 Pygidia (RGM 339057-59) from loc. P4.
Description. - Pygidium: Outline triangular with slightly convex sides. Axis round arched, as wide as pleural field anteriorly, tapering backwards till 5th axial ring at an angle of 30°, behind that point subparallel, with rounded end. 10(11) Axial rings, the first egg-glass shaped and high above rest of axis. Pleural fields slightly vaulted, with 5 pr of ribs of the *michelini* pattern; 5th pr unfurrowed. Interpleural furrows narrow and shallow, abaxially a little widening. Pleural furrows U-shaped and ending in border furrow. Ant. and post. pl. bands of the same height and width, both ending at the same level near the border furrow. Border furrow and border present 5 Pr of not truncated, middle-long, sickle-shaped, lateral lappets. Posterior lappet escutcheon-shaped, 1½ x as wide as and as long as 5th pr of lateral lappets.

Ornamentation: Dense, middle-coarse granulation on axial rings, ribs and lappets.

Measurements: Pygidium: length 11-14 mm, width 14-20 mm.

Discussion. - The occurrence of *michelini* segmentation and of pygidial lappets, which are all of the same length, make it probable that the pygidia belong to *Pseudocryphaeus*. However, contrary to the diagnosis of this genus are the sickle-shaped lappets instead of truncated lappets. Our material resembles most *Paracryphaeus vernensis* (Morzadec, 1971), which, however, has shorter lateral lappets and a somewhat longer posterior lappet. There is also a resemblance with *Pseudocryphaeus* sp., described by Morzadec (1976a: p. 291) from the St. Céneré Fm. (Armorican Massif), which neither has truncated, sickle-shaped, lateral lappets, but differs because of its robuster posterior lappet.
Occurrence. - At the top of the Lebanza Fm.; Middle-Upper Siegenian.

Pseudocryphaeus cossensis Morzadec, 1971
Pl. 2 figs. 13, 14; Pl. 3 figs. 1, 2

1935 *Asteropyge michelini* - Renaud: p. 3 (non *michelini* Rouault).
* 1971 *Pseudocryphaeus cossensis* n.sp. - Morzadec: p. 177, pl. 19 figs. 8-13.

Material. - 1 Complete specimen (RGM 339060) from loc. L2; 1 complete specimen (RGM 339061) from loc. X2; 1 complete specimen (RGM 339062), 2 cephalons (RGM 339063-64) and 3 pygidia (RGM 339065-67) from loc. X3; 2 pygidia (RGM 339068-69) from loc. X4.
Description. - Since Morzadec (1971) has described only the pygidium of this species, here a description follows based on the complete Spanish specimens.

Cephalon: Convex. Outline wide ogival to semicircular; frontal border widening mesially. Glabella pentagonal with wide base. Axial furrows till the mid of L3 diverging to the front at an angle of 35°, at S3 curved towards glabella, at the front strongly sloping to the frontal-lateral margin. Frontal glab. lobe with rounded frontal margin, abaxially slightly protruding before the eye, gradually sloping to the front and sideways, reaching frontal border at an angle of 60°, 3 postero-median depressions especially distinct on internal mould, connected with central area. L3 and L2 strongly developed, abaxially fused; L3 abaxially rising above frontal glab. lobe; L2 strongly convex posteriorly; L1 narrow (exsag.). below L3/L2 level. S3 on external mould wide, incised V-shape; S2 on ext. mould narrow, V-shaped, transversal and abaxially retreating from axial furrows; S1 deeply incised, concave to the front. Central area wide (tr.) and short (sag.). Occipital ring wide (tr.) and long, with a small tubercle on posterior margin. Posterior border furrow narrow, V-shaped, abaxially fading. Posterior border abaxially widening and passing into genal spines. Cheeks almost completely covered with eyes; lateral border very narrow, slightly concave, with thick margin; no lateral border furrow. Genal spines short to middle-long, faintly furrowed and sharp. Very large eyes, anteriorly close to glabella at S3, almost touching posterior border furrow posteriorly. Palpebral lobe swollen and above glabella; furrow vague, area vaulted with wide base. Large, strongly curved visual surface with many lenses: specimen RGM 339060 (Pl. 3 fig. 2) has 25 vertical rows, a max. of 10(11) lenses per row and a total of 208 lenses per eye, lenses pattern: anterior 46789. 10 10 10 10 10 . 11 10 10 10 10 . 10 10 10 9 9 . 7? 6? 5? 4? 3 posterior. The much smaller cephalon RGM 339063 (Pl. 3 fig. 1) has 25 rows, with a max. of only 9 lenses per row and a total of only 170 lenses per eye: lenses pattern (left eye) anterior 45678 . 79898 . 98988 . 87766 . 56543 posterior. Subocular furrow faint; no eye platform. Facial suture at α parallel with frontal margin and retreating from glabella.

Thorax: Wide axis, greatest width near 6th segment; rings low, round arched, without tubercles. Pleural field narrow, slightly vaulted. Segments with narrow, V-shaped, pleural furrows, which are ending at 2/3 from axis; truncated segmental ends.

Pygidium: Outline wide triangular to semicircular. Axis short and wide, low round arched, till 5th ring tapering at an angle of 20°-25°, behind that point subparallel; wide, low and rounded end. Axial furrows shallow. 10(11) Axial rings, first 4 pr distinctly separated and taking up 1/2 of length of axis. Pleural fields slightly vaulted with 5(6) pr of wide ribs of *michelini* pattern, 5th and 6th pr unfurrowed and much shorter than first pr; ribs widening abaxially. Interpl. furrows narrow, crossing border and extending to margin between lateral lappets abaxially. Pleural furrows narrow, deep, incised V-shape and ending in border furrow. Post. and ant. pl. bands of same height and halfway pleural field of the same width. Post. pl. band along the whole length same width and height. Anterior pl. bands adaxially wedging out against posterior, abaxially narrowing (tendency to *boothi* pattern) Shallow border furrow and narrow border present. 5 Pr of short, wide lateral lappets, pointing backwards and situated closely together (interspace 1/4 of width). All lappets truncated and of the same length (width = length). Posterior lappet also truncated, as long as and 1½ x as wide as lateral lappets.

Ornamentation: Glabella, thoracic and pygidial axis and ribs have a fine granulation, lateral lappets a coarser one.

Measurements: Cephalon: length 7-13 mm, width 13-20 mm; pygidium: length 10 mm, width 13 mm.

Discussion. - Our pygidia are similar to those of *Ps. cossensis*, described by Morzadec (1971) from the Armorican Massif. Comparison of the cephalons is not possible, because they have not been found in Bretagne. Closely related are *Ps. michelini* (Rouault, 1851), *Ps. oehlerti* Morzadec, 1971 and *Ps. baconnierensis* Morzadec, 1971. The first one is distinguished by eyes situated higher on the cheeks, its longer pygidial lappets and its posterior lappet, which is longer than the lateral ones. The second one is distinguished by its smallness, its eyes situated higher on the cheeks, its rounded ends of the pygidial lateral lappets and its somewhat longer posterior lappet. The latter is distinguished by its rounded ends of pygidial lateral lappets and a wider posterior lappet. Also related is *Ps. astrictus* Gandl, 1972, which has been found together with *Ps. cossensis* in the same stratigraphic level of the La Vid Fm. *Ps. astrictus*, however, is distinguished by its shorter, wider, very close to each other situated, lateral lappets and its trilobated posterior lappet, which is 3 x as wide as the lateral lappets.

Occurrence. - In the lowermost part of the limestone member of the La Vid Fm. near Grandoso, Aviados and La Vid; Upper Siegenian-Lower Emsian. Outside the Cantabrian Mountains this species has been found in the Armorican Massif (*Athyris undata* zone).

Pseudocryphaeus astrictus Gandl, 1972
Pl. 3 fig. 3

1968 *Acastava sublaciniata* (de Verneuil, 1850) - Gandl in Carls & Gandl: p. 463.

* 1972 *Pseudocryphaeus astrictus* n.sp. - Gandl: p. 92, pl. 6 figs. 1-7.

Material. - 1 Pygidium (RGM 339070) from loc. X3.

Description. - See Gandl (1972).

Discussion. - Our pygidium is completely similar to the Aragonese material of *Ps. astrictus*. Closely related is *Ps. barroisi* (Pillet, 1958), which, however, has a stronger vaulted pygidium with 2 axial rings more and a more distinct and longer 6th pr of ribs. Moreover it has been found in sediments of Late Emsian age. There is also an affinity to *Ps. spatulaeformis* Morzadec, 1971. This species also has a very wide, laterally lobed, posterior lappet, but is distinguished by its longer, less truncated, lateral lappets. *Ps. cossensis* Morzadec, 1971, differs by its longer and narrower lateral lappets and a much more slender posterior lappet (width 1½ x, instead of 3 x, width of lateral lappets).

Occurrence. - In the lower part of the limestone member of the La Vid Fm. near La Vid; lowermost Emsian. Outside the Cantabrian Mountains this species has been found in the Santa Cruz Fm. (d3bγ-δ) in Aragón.

Pseudocryphaeus? demoulini n.sp.
Pl. 3 fig. 4

Derivatio nominis. - Named after L.E. de Moulin, who collected the holotype.

Holotypus. - Complete specimen RGM 339071 (Pl. 3 fig. 4).

Locus typicus. - Loc. L2: 750 m NNE of the village of Grandoso (prov. León).

Stratum typicum. - Argillaceous limestones in the lower part of the limestone member of the La Vid Fm.; Lower Emsian.

Paratypes. - 2 Cephalons (RGM 339072-73) from the type locality L2.

Diagnosis. - An Asteropyginae species, probably belonging to the genus *Pseudocryphaeus* with the following characteristics:

Cephalon: Outline ogival with very short genal spines; L3 and L2 abaxially slightly swollen; all lateral glab. furrows extending to axial furrow; very small eyes, high on the cheeks but not reaching level of glabella.

Pygidium: Very low, wide axis; 9(+ 1) axial rings, first 5 distinctly separated. Strongly vaulted pleural fields with 5 pr of ribs of *michelini* segmentation; first 3 pr of ribs furrowed; 4th pr very faintly furrowed, 5th pr short and unfurrowed. 5 Pr of very short lateral lappets, width = 2 x length, saw-tooth shaped and truncated. Posterior lappet short, triangular to escutcheon-shaped, slightly pointing upwards.

Description. - Cephalon: Strongly vaulted. Outline ogival; glabella strongly arched. Axial furrows diverging to the front at an angle of 35°, with pit and small curvature to glabella at the side of S3. Frontal glab. lobe with rounded frontal margin and abaxially protruding before the eyes, gradually sloping to the front and sideways, reaching the border at an angle of 45°-50°, 3 postero-median pits present, posteriorly connected with central area. L3 and L2 slightly swollen, abaxially rising just above frontal glab. lobe adaxially situated below the level of central area; L3/L2 on external mould not separated from central area, on internal mould slightly separated; L1 narrow (exsag.) and far below L2 level. S3 sigmoidal, oblique, on external mould narrow and U-shaped, on internal mould wide incised U-shape. S2 transversal, slightly convex to the front, on external mould incised V-shape, on internal mould narrow incised U-shape, abaxially extending to axial furrows. S1 deep, strongly concave to the front, on external mould adaxially curving to adaxial part of S3. Central area slightly vaulted, anteriorly of the same height as frontal glab. lobe, posteriorly curving upwards to transglabellar ring. Occipital furrow distinct, abaxially deeply incised; occ. ring abaxially narrowing (exsag.) and with small median tubercle. Posterior border furrow on external mould deep, V-shaped. Cheeks narrow and steep below the eyes, slightly concave, without border furrow. Lateral margin strongly thickened. Frontal border laterally very narrow, mesially widening. Genal spines very short. Eyes very small, situated high on the cheeks, just below level of central area, anteriorly at some distance from axial furrows and at the side of the anterior part of L3, ending far before posterior border furrow posteriorly (distance to axial furrow = distance to post. border furrow = 2 x width of posterior border). Palpebral lobe strongly curved; furrow distinct and with pit; area sligthly sloping to glabella and posterior border furrow. Visual surface small: the holotype has 21 vertical rows with a max. of 6 lenses per row and a total of 105 lenses per eyes; lenses diagram: anterior 34565 . 66565 . 66666 . 55543 . 2 posterior. Narrow subocular furrow present. Facial suture at α parallel with frontal margin and retreating from frontal glab. lobe, posterior part on lateral margin strongly curving backwards.

Thorax: Axis wide and low, round arched, without tubercles, widest near 6th segment. Pleural fields narrower than axis, adaxially horizontal, halfway strongly curving downwards at an angle of 80°. Segments of *michelini* pattern; pleural bands of the same height and width, distally truncated. Pleural furrows of deeply incised V-shape.

Pygidium: Strongly vaulted. Outline semicircular. Axis wide, low round arched, anteriorly wider than pleural fields, strongly tapering backwards at an angle of 35°, end rounded and very low. Axial furrows straight and shallow. 9(+ 1) Axial rings, first 5 distinctly separated, last 4(+ 1) very narrow (sag.) and almost fused together. Pleural fields adaxially horizontal, halfway strongly curved downwards at an angle of 60°. 5 Pr of ribs of *michelini* pattern; ribs widening abaxially, decreasing in length backwards, first 3 pr furrowed, 4th pr very faintly furrowed, 5th pr unfurrowed. Interpl. furrows very narrow and shallow, strongly curved to the front, abaxially crossing narrow border and extending to margin between lateral lappets. Pleural furrows very deep, incised V-shape, slightly convex to the front, abaxially ending in shallow border furrow. Ant. and post. pl. bands of the same height, both abaxially (at 2/3) swollen. Post. pl. bands along the whole length of same width, only abaxially a little wider. Ant. pl. bands ad - as well as abaxially narrower than posterior. Faint border furrow and narrow border present. 5 Pr of very short, wide (length = 1/2 width), saw-tooth shaped and truncated, lateral lappets, closely together and pointing obliquely downwards. Posterior lappet short, triangular to escutcheon-shaped, as long as and 1½ x as wide as 5th pr of lateral lappets, pointing obliquely upwards.

Ornamentation: Glabella, occipital ring and palpebral lobes are covered with a dense, middle-coarse granulation; cheeks and border have a dense fine granulation; below the eyes an ornamentation of little pits. Thorax and pygidium have a sparse middle-coarse granulation on rings, ribs and lappets.

Measurements: Holotype, cephalon length 12 mm, width 17 mm; pygidium length 8 mm, width 11 mm.

Discussion. - *Ps? demoulini* n.sp. differs from all known *Pseudocryphaeus* species because of its very small eyes, very short genal spines and slender glabella with only slightly swollen L3/L2. The pygidium resembles *Ps. cossensis* Morzadec, 1971 and *Ps. oehlerti* Morzadec, 1971 best. *Ps. cossensis* differs because of having one axial ring and one rib (6th) more and lateral lappets truncated along a line parallel with the border (instead of saw-tooth truncation of *Ps.? demoulini*); *Ps. oehlerti* has longer lateral and posterior lappets. The general shape of the new species shows resemblance with *Pelitlina goltzi* Haas, 1968 from Emsian age of Turkey. Haas has classified this species with the subfamily of Acastavinae on account of the following characteristics: small eyes, situated far to the front, S2 abaxially pointing obliquely backwards, very short unfurrowed genal spines, only 3 of the 7 pygidial rings distinctly separated and a distinct pygidial segmentation. These Acastavinae features are not present in *Ps.? demoulini* which has small eyes indeed but situated at the normal place at the side of L3, S2 transversal, very short but furrowed genal spines, 5 of the 9 pygidial rings distinctly separated and a *michelini*-segmentation. *Ps? demoulini* resembles *P. goltzi* concerning shape of cephalon, truncated thoracic segments, outline pygidium and truncated lateral and posterior lappets.

Occurrence. - In the lower part of the limestone member of the La Vid Fm. near Grandoso, lowermost Emsian.

PILLETINA Haas, 1970

Genotype. - *Asteropyge (Metacanthina) oehlerti praecursor* Pillet, 1958.

Diagnosis. - See Haas (1970: p. 117).

Occurrence. - Armorican Massif, León, Palencia, Aragón, Portugal, Morocco, Roumania, Turkey, Harz Mts; Middle Siegenian-Upper Emsian.

Pilletina aequisulcata cf. matutina (Gandl, 1972)
Pl. 3 fig. 5

Material.- 1 Pygidium (RGM 339074) from loc. P5.
Discussion. - The pygidium of the Lebanza Fm., which is characterized by deep interpleural furrows, which are a little narrower than the pleural ones, belongs without doubt to *Pilletina aequisulcata* (Gandl, 1972). Our specimen bears the greatest similarity to the subspecies *P. aeq. matutina* (Gandl, 1972) of Aragón, on which the interpleural furrows are also a little narrower than the pleural ones. Our pygidium, however, has somewhat shorter and bulgier lateral lappets and a somewhat wider, more triangular posterior lappet than the Aragonese material. Shape of lateral and posterior lappets also resembles those of *P. lips mozoensis* (Gandl, 1972); this species is, however, distinguished by its weaker interpleural furrows. Also related is *P. incisa* (Haas, 1968) which also has strongly developed interpleural furrows, but is distinguished by a more semicircular outline of the pygidium, roof-shaped axis, only 5 pr of ribs (instead of 6, 7), a little longer lateral lappets and a narrower posterior lappet.
Occurrence. - At the top of the Lebanza Fm.; Middle-Upper Siegenian. Outside the Cantabrian Mountains *P. aeq. matutina* has been found at the top of the Nogueras Fm. (d2cβ) in Aragón and probably in Morocco and Portugal.

Pilletina sp.
Pl. 4 figs. 1-6

Material. - 3 Cephalons (RGM 339075-77) and 5 pygidia (RGM 339078-82) from loc. X2.
Description. - The cephalon does not show characteristic differences with other *Pilletina* species and shall not be described here.

Pygidium: Outline wide triangular with slightly convex sides. Axis round arched, strongly tapering backwards till 6th ring at an angle of 30°, behind that point subparallel, end rising high above pleural fields and ending abruptly. 12(+ 1) Axial rings, thickened laterally. Pleural fields slightly vaulted, with 4 pr of furrowed and 2 pr (big specimens even 3 pr) of unfurrowed ribs of modified *prorotundifrons* pattern, ribs decreasing in length backwards. Interpl. furrows distinct, abaxially wide and deep, ending in border furrow. Pleural furrows deep, U-shaped, wider than interpl. furrows, abaxially ending in border furrow at the same level as interpl. furrows. Pleural bands narrow; post. pl. bands on inner part of pleural field tapering sideways, on outer part again widening, faintly crossing the border. Anterior pl. bands adaxially lower than posterior and wedging out, abaxial 2/3 part wider and knee-shaped rising above posterior band, near border a little wider but of the same height as posterior. Border furrow distinct, narrow undulous border. 5 Pr of long, slender, backwards curved, sickle-shaped and keeled lateral lappets, decreasing in length backwards. Posterior lappet long-triangular, wider and a little longer than 5th pr of lateral lappets.

Ornamentation: A middle-coarse granulation on axial rings, ribs and lappets.

Measurements: Pygidium length 8-30 mm, width 6-25 mm.

Discussion. - This *Pilletina* sp., which is especially characterized by its long slender lappets, is distinguished from *P. aequisulcata matutina* (Gandl, 1972) by its weaker interpleural furrows, stronger knee-shaped ant. pl. bands and longer, more slender pygidial lappets. *P.* sp. is distinguished from *P. triangularis* (Gandl, 1972) by its less triangular pygidial outline, stronger knee-shaped ant. pl. bands and longer pygidial lappets. *P. primitiae* (Gandl, 1972) differs because of its segmentation pattern with *michelini* features (i.e. ribbands closely together).
Occurrence. - In the lower part of the limestone member of the La Vid Fm. near Aviados; transition Siegenian-Lower Emsian.

Pilletina lips mozoensis (Gandl, 1972)
Pl. 3 fig. 6

1968 *Metacanthina lips* R. & E. Richter, 1943 - Gandl in Carls & Gandl: p. 463.
* 1972 *Metacanthina lips mozoensis* n.ssp. - Gandl: p. 113, pl. 9 figs. 4-7.

Material. - 2 Pygidia (RGM 339083-84) from loc. X3.
Description. - See Gandl (1972).
Discussion. - The pygidia from the La Vid Fm. are completely similar to the Aragonese material. Closest related is *P. triangularis* (Gandl, 1972) which has been found both in León and in Aragón in the same level together with *P. lips mozoensis* and which is distinguished by a more triangular pygidium, strongly backwards protruding axis, shorter but sharper lateral spines decreasing in length backwards, and a narrower posterior lappet. Also related is *P. aequisulcata* (Gandl, 1972), which is distinguished by much deeper interpleural furrows.
Occurrence. - In the lowermost part of the limestone member of the La Vid Fm. near La Vid; lowermost Lower Emsian. This species also has been found in the Santa Cruz Fm. (d3bγ-δ) in Aragón.

Pilletina cf. triangularis (Gandl, 1972)
Pl. 4 figs. 7-9

Material. - 5 Pygidia (RGM 339085-89) from loc. X3; 1 pygidium (RGM 339090) from loc. X5.
Discussion. - The material is similar to *P. triangularis*, described by Gandl (1972, p. 101, pl. 7 figs. 2-6) from Aragón. The material, however, is too poorly preserved to allow a definite determination, and will here be referred to as *P. cf. triangularis*. Closely related is *P. lips mozoensis* (Gandl, 1972) which differs because of its more semicircular pygidium, somewhat longer sickle-shaped lateral lappets and a much wider and shorter posterior lappet.
Occurrence. - In the lower part of the limestone member of the La Vid Fm. near La Vid and Aralla; Siegenian-Lower Emsian transition. In Aragón *P. triangularis* has been found in the Santa Cruz Fm. (d3bγ-δ).

Pilletina aulnensis Morzadec, 1976
Pl. 4 figs. 10-16; pl. 5 figs. 1-6

* 1976 *Pilletina aulnensis* n.sp. - Morzadec(b): p. 41, pl. 6 figs. 1-4.

Material. - 3 Complete specimens (RGM 339091-93), 7 cephalons (RGM 339094-100) and 4 pygidia (RGM 339101-04) from loc. P8; 1 pygidium (RGM 339105) from loc. P10; 3 cephalons (RGM 339106-08) and 4 pygidia (RGM 339109-12) from loc. P12; 1 cephalon (RGM 339113) from loc. P11; 1 cephalon (RGM 339114) from loc. P9; 1 complete specimen (RGM 339115) and 1 pygidium (RGM 339116) from loc. P14.

Description. - See Morzadec (1976b) for an extensive description.

Discussion. - The material from the Requejada Member is completely similar to *P. aulnensis* from the upper part of the Faou Fm. (Armorican Massif): characteristics like antero-median indentation of frontal glab. lobe, backwards curved occipital, thoracic and pygidial tubercles, pygidial segmentation and shape of lateral lappets are identical. *P. aulnensis* is closely related to and probably the direct ancestor of *P. collensis* Arbizu, 1979. Their cephalons are identical except the stronger occ. tubercle of *P. aulnensis*. Their pygidia differ because of the stronger knee-shaped anterior pleural bands, the shorter lateral lappets and the wide semicircular posterior lappet of *P. collensis*. Of the *Pilletina* species, described by Haas (1968) from Turkey, *P. acinacifera* (Lower Emsian) is closely related to *P. aulnensis*. The pygidium of *P. acinacifera* has the same type of axis and lappets, its segmentation, however, is distinguished by the absence of knee-shaped anterior pleural bands.

Occurrence. - In the Requejada Member (Abadía Fm.); Lower Emsian. In the Armorican Massif this species has been found in the upper part of the Faou Fm.

Pilletina collensis Arbizu, 1979
Pl. 5 figs. 7-11

1850 *Cryphaeus calliteles* Green, 1837 - de Verneuil: p. 164, pl. 3 fig. 3a, ? 3b, c?

* 1979 *Pilletina collensis* n.sp. - Arbizu: p. 65, pl. 1 figs. 2-5.

Material. - 2 Complete specimens (RGM 339117-18), 3 cephalons (RGM 339119-21) and 3 pygidia (RGM 339122-24) from loc. L2; 1 pygidium (RGM 339125) from loc. L3; 1 pygidium (RGM 339126) from loc. L4; 2 pygidia (RGM 339127-28) from loc. L5.

Description. - See Arbizu (1979: p. 65) for a description of material of the type locality loc. L3.

Discussion. - *P. collensis* is closely related to and probably direct descendant of *P. aulnensis* Morzadec, 1976. Their cephalons are identical, the pygidium of *P. aulnensis*, however, has less knee-shaped ant. pl. bands, longer lateral lappets and a longer, triangular posterior lappet.

Occurrence. - In the lower part of the limestone member of the La Vid Fm. near Colle Grandoso, Aleje and Adrados; Lower Emsian.

TREVEROPYGE Struve, 1958

Genotype. - *Asteropyge (Asteropyge) prorotundifrons* R. & E. Richter, 1943

Diagnosis. - See Struve (1958: p. 228).

Occurrence. - Armorican Massif, Asturias, León, Palencia, Aragón, Portugal, Morocco, Turkey, Rhenish Mts., Harz Mts., Poland; (? Lower Gedinnian) Upper Gedinnian-lowermost Eifelian.

Treveropyge? cf. ebbae (R. & E. Richter, 1954)
Text-fig. 3

Material. - 1 Pygidium (RGM 339129) from loc. P2.

Discussion. - This pygidium from the Carazo Fm. is so far the oldest known representative of the Asteropyginae in the Cantabrian Mountains. It is completely similar to the material of *T.? ebbae*, described by R. & E. Richter (1954: p. 30, pl. 6 figs. 83-92) from the Hüinghausen Beds. Only the bad preservation justifies some reserve.

Occurrence. - In the upper part of the Carazo Fm. Age: Lower Gedinnian (*tiro* zone). Outside the Cantabrian Mountains this species has also been found in the Hüinghausen Beds (Eifel) and in the Anti-Atlas (Morocco), always together with *Acastella tiro* R. & E. Richter, 1954, which has a large distribution in Europe and northern Africa.

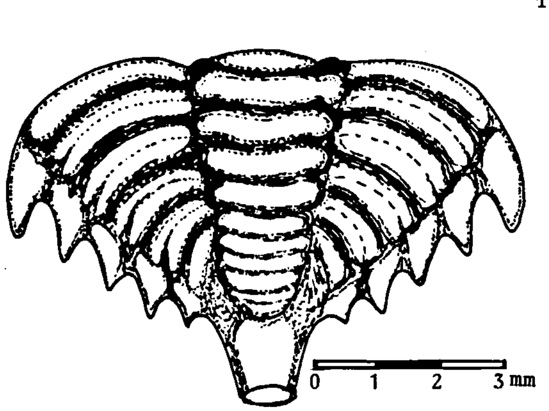


Fig. 3. Reconstruction of *Treveropyge? cf. ebbae* (R. & E. Richter, 1954). Internal mould of pygidium RGM 339129.

Treveropyge lebanzaensis n.sp.
Pl. 6 figs. 1-4

1966 *Asteropyge* n.sp. *(aff. wallacei)* = ex parte "*sublaciniata*" (de Verneuil) - de Sitter & Boschma: p. 200.

Derivatio nominis. - Named after the village of Lebanza (prov. Palencia).

Holotypus. - Cephalon RGM 339130 (pl. 6 fig. 1).

Locus typicus. - Loc. P4, 400 m southwest of Lebanza.

Stratum typicum. - Argillaceous limestones from the upper part of the Lebanza Fm. (E-Member);

Middle-Upper Siegenian.

Paratypes. - 1 Cranidium (RGM 339131) and 2 pygidia (RGM 339132-33) from the type locality P4; 2 pygidia (RGM 339134-35) from loc. P6.

Diagnosis. - A *Treveropyge* species characterized by:

Cephalon: Axial furrows diverging at an angle of 30°-35°; front. glab. lobe short and abaxially slightly swollen. L3 and L2 narrow (exsag.). The narrow (tr.) central area joins with frontal and lateral glab. lobes. S2 reaching axial furrows. Eyes with a max. of 10 lenses per vertical row. Small, semicircular frontal median process, on which facial suture retreats from glabella.

Pygidium: Triangular with wide axis with 11(+ 1) rings. 5 Pr of ribs of *prorotundifrons* pattern, the last unfurrowed, on external mould still a 6th pr of unfurrowed ribs. Faint border furrow. 5 Pr of pointed, sickle-shaped, lateral spines in straight continuation of the pleural segments. Triangular, slightly escutcheon-shaped, posterior spine which is as long as 5th pr of lateral spines and not pointing upwards.

Connexion. - Cephalons and pygidia have been found separate. The dense, fine granulation on both, which is not present on other species from the same locality, ensures that they belong to the same species.

Description. - Cephalon: Outline semicircular with short frontal median process. Axial furrows diverging at an angle of 30°-35° to the front ("real" *Treveropyge* species only 25°), slightly curved to glabella at the side of S3. Glabella short, with wide base. Frontal glabellar lobe short (sag.), abaxially protruding, gradually sloping to the front and reaching the frontal border at an angle of 60°, with oval postero-median depression surrounded by 4(5) pits. L3 and L2 narrow (exsag.). L1 narrow (exsag.) and below L3/L2 level. S3 distinct, strongly transversal, sigmoidal, almost extending to the middle part of glabella. S2 transversal, slightly convex anteriorly, abaxially weakened but extending to axial furrows. S1 distinct, adaxially deeply incised, concave anteriorly. Central area narrow (tr.), fused with frontal and lateral glab. lobes. Occipital furrow distinct, U-shaped, abaxially deeply incised. Occipital ring wide (tr.) mesially, tapering abaxially and without tubercle.

Posterior border furrow incised U-shape. Posterior border adaxially narrow, abaxially widening and gradually merging into short genal spines with wide base. Cheeks with faint border furrow and wide lateral border. Lateral border furrow posteriorly passing into posterior border furrow and together crossing genal spine to reach outer margin. Frontal border very narrow with short frontal median process. Eyes anteriorly close to anterior part of L3, posteriorly posterior border furrow approaching up to 1/2 width (exsag.) of posterior border and far off axial furrow. Palpebral lobes and furrows distinct; palp. area slightly vaulted. Visual surface with a max. of 10 lenses per vertical row. Subocular furrow present. Facial suture at α retreating from glabella and dividing frontal median process into intra- and extrasutural area (length intrasut. area = 1/2 length extrasut. area).

Pygidium: Strongly vaulted. Outline triangular with slightly convex sides. Wide, round arched axis, anteriorly as wide as pleural field, strongly tapering backwards till 6th ring at an angle of 30°, behind that point slightly tapering and ending abruptly. 11(+ 1) Axial rings, first 5 distinctly separated. 5 Pr of ribs of *prorotundifrons* pattern with tendency to *michelini* pattern; on external mould also a 6th pr of ribs present. Ribs decreasing in length backwards, first 4 pr furrowed, 5th (6th) pr unfurrowed. Interpl. furrows faint, abaxially becoming wider and deeper and retreating a little from the margin. Pl. furrows deep, incised U-shape, abaxially fading. Ant. and post. pl. bands of the same height and width. Border furrow faint; indistinct, narrow border. 5 Pr of sickle-shaped lateral spines, in straight continuation of pleural segments, pointing sideways and decreasing in length backwards; 5th pr subparallel. Posterior spine triangular to escutcheon-shaped, as long as 5th pr of lateral spines, not pointing upwards (unlike "real" *Treveropyge* species).

Ornamentation: Fine granulation on whole exoskeleton, moreover a coarser granulation on glabella and an ornamentation of little pits on palpebral area and cheeks.

Measurements: Cephalon (holotype): length 12 mm, width 24 mm; pygidia: length 11-13 mm, width 17-19 mm.

Discussion. - *T. lebanzaensis* n.sp. belongs to a group of *Treveropyge* species of Siegenian age, characterized by a central area which is not separated from the glabellar lobes, a faint pygidial border furrow and a downwards pointing posterior spine. This group also includes *T. munieri*, *T. wallacei*, *T. procerospinosa* and probably *T.? rothei*. Our new species bears the greatest affinity to *T. munieri* (Oehlert, 1877), which is redescribed by Morzadec (1971) and differs because of stronger diverging axial furrows (40° instead of 30°-35°), absence of intrasutural frontal area and a pygidium with more backwards pointing lateral spines and a wider and shorter posterior lappet. *T. wallacei* (Termier & Termier, 1950) differs because of wider lateral pygidial spines and a wide escutcheon-shaped posterior lappet. *T. procerospinosa* Gandl, 1972 is distinguished by its longer frontal glabellar lobe and genal spines, a coarser granulation on glabella and longer, more slender lateral and posterior spines. *T.? rothei* (Haas, 1970), of which only the pygidium has been described, differs because of deeper interpl. furrows, shorter, less pointed lateral spines and a very wide posterior lappet, which extends beyond the 5th pr of lateral spines.

Occurrence. - In the upper part of the Lebanza Fm.; Middle-Upper Siegenian.

Treveropyge? sp.

Pl. 6 figs. 5,6.

Material. - 2 Pygidia (RGM 339136-37) from loc. X4.

Description. - Pygidium: Convex; outline wide triangular with slightly concave sides. Axis roof-shaped, anteriorly as wide as pleural field, strongly tapering backwards till 5th axial ring, behind that point slightly tapering and ending abruptly. 10(+ 1) Rings, mesially narrow (especially on internal mould) and abaxially sloping at an angle of 60° into axial furrows. Pleural fields vaulted, reaching the border furrow at an angle of 30°, with 5 pr of ribs; ribs decreasing in length backwards, 5th pr unfurrowed. Interpl. furrows on external mould distinct but shallow, on internal mould adaxially fused with pl. furrows. Pl. furrows on external mould deep, ad- as well as abaxially becoming more narrow; on internal mould very wide and deep incised U-shape, abaxially becoming more narrow and ending in border furrow at base of lateral spines. Ribs with very characteristic segmentation related to the *prorotundifrons* pattern. On external mould the post. pl. bands adaxially somewhat widening, abaxially crossing the border furrow and passing into posterior part of the base of the lateral spines. Ant. pl. bands adaxially wedging out against posterior, at 1/3 from axial furrow of the same width and height as posterior, abaxially wider and higher than posterior, near border furrow again below level of ridge-shaped, post. pl. bands. On internal mould post. pl. bands sharp ridge shaped, widest near axial furrows; ant. pl. bands adaxially rapidly wedging out against posterior, at 2/3 from ax. furrow most strongly developed, near border furrow again fading, across border faintly passing into anterior part of the base of lateral spines. Narrow, sharply incised border furrow and narrow border present. 5 Pr of straight, sideways spreaded, pointed lateral spines, which are as long as second pr of ribs and in cross-section circular; 5th pr converging backwards. Posterior spine with wide base, triangularly pointed with biconcave sides, as long as lateral spines.

Ornamentation: Coarse granulation on axial rings, pleural bands and spines.

Measurements: Pygidium length 6-8 mm.

Discussion. - This species has been classified with the genus *Treveropyge* with reserve. Its pygidial segmentation with ant. pl. bands, which so strongly wedge out against posterior is unique, but somewhat related to that of *T. drevermanni* (R. Richter, 1909). The latter species, however, differs because of its more backwards pointing lateral spines and its upwards pointing posterior lappet. *T.*? sp. also has some resemblance to *T. procerospinosa* Gandl, 1972, which differs because of its backwards curved lateral spines and ant. pl. bands, which only slightly wedge out against the posterior ones.

Occurrence. - In the lower part of the limestone member of the La Vid Fm. near La Vid; Siegenian-Lower Emsian transition.

Treveropyge iberica Gandl, 1972
Pl. 6 figs. 7-9; Pl. 7 figs. 1, 2

e.p. 1968 *Treveropyge prorotundifrons* - Gandl in Carls & Gandl: p. 463.

* 1972 *Treveropyge prorotundifrons iberica* n.ssp. - Gandl: p. 121, pl. 10 figs. 6-10 (non pl. 9 figs. 8-10 = *Acastava* n.sp.).

Material. - 1 Complete specimen (RGM 339138), 3 cephalons (RGM 339139-41) and 6 pygidia (RGM 339142-47) from loc. L6.

Remark. - Gandl (1972) has described this species as a subspecies of *T. prorotundifrons*. In my opinion *T. iberica* and *T. prorotundifrons* are so different that they should be considered as two separate species. Therefore a new diagnosis follows.

Diagnosis. - A *Treveropyge* species characterized by:

Cephalon: frontal glab. lobe strongly flattened anteriorly and not distinctly separated from intrasutural frontal border. S2 distinct. Small eyes, distinctly retreated from lateral margin and post. border furrow, with a max. of 8 lenses per vertical row. Facial suture parallel to frontal margin.

Pygidium: Besides 4 pr of flat furrowed ribs, on internal mould yet a 5th and 6th pr and on external mould even a 7th pr of unfurrowed ribs present. Posterior lappet is not pointing upwards.

Description. - In my opinion the type-series of *T. iberica*, described by Gandl (1972) also contains an *Acastava* sp. Hereafter follows a description based on the holotype and the paratypes (pl. 10 figs. 6-9) of Gandl.

Cephalon: Outline wide semicircular to ogival. Glabella with wide base. Axial furrows straight, diverging at an angle of 25° to the front. Frontal glab. lobe short (sag.) and oval, with postero-median depression, not distinctly separated from intrasutural frontal border anteriorly, separated from lower lying central area posteriorly. L3 ≈ L2, both adaxially flat and separated from central area, abaxially fused together. L1 narrower (exsag.) and lower than L3/L2. S3 oblique, sigmoidal, on internal mould deeply incised, adaxially curving backwards to S1. S2 distinct on external mould abaxially retreating from ax. furrows, on internal mould mesially deep and abaxially faintly running to ax. furrows. S1 concave to the front. Central area narrow (tr.) slightly separated from glab. lobes. Occipital furrow distinct, abaxially deeply incised. Occipital ring wide round arched, without tubercle. Post. border furrow wide, incised U-shape. Post. border narrow (exsag.). Cheeks wide, slightly concave without border furrow. Genal spines short, triangular with wide base. Frontal border very narrow, pointed mesially. Small eyes at the side of anterior part of L3 anteriorly, retreating 1½ x the width of post. border (exsag.) from post. border furrow posteriorly. Eyes high on cheeks, far from lateral margin and rising above level of glabella. Palpebral lobe swollen; furrow deeply incised; area steeply inclining to axial furrow. Visual surface with a max. of 8 lenses per vertical row. Subocular furrow present. Facial suture running closely along frontal margin and shaping a small intrasutural area mesially.

Thorax: Axis wide, flat round arched, without median tubercles. Segments distally changing into flat, sickle-shaped lappets.

Pygidium: Outline wide triangular to semicircular. Axis as wide as pleural field anteriorly, strongly tapering backwards till 5th ring, behind that point subparallel, with rounded end. 11(12) Narrow (sag.) axial rings, the first egg-glass shaped and rising high above rest of low axis, first 5 rings separated by wide furrows. Pleural fields with 6, on external mould even 7, pr of wide, flat ribs of the *prorotundifrons* pattern, 5th-7th pr unfurrowed. Interpl. furrows adaxially faint, abaxially widening and deepening, reaching the margin between lateral lappets. Pleural furrows shallow with flat bottom, adaxially as wide as 1/3 of rib, abaxially becoming more narrow and fading out into base of lateral lappets. Ant. and post. pleural bands of equal height and width. Border furrow and border absent. 5 Pr of flat, sickle-shaped, lateral lappets in straight continuation of the segments, 5th pr parallel. Wide, triangular to escutcheon-shaped, posterior lappet, which is shorter than 5th pr of lateral lappets and does n o t point upwards.

Ornamentation: Whole exoskeleton covered with a fine granulation (dense on lateral parts), moreover a middle-coarse granulation on glabella.

Measurements: Cephalon: length 8-10 mm, width 15-25 mm; pygidium: length 8-10 mm, width 13-18 mm.

Discussion. - Gandl (1972) has interpreted some small pygidia from Aragón (pl. 9 figs. 8-10) as meraspides and juvenile holaspides of *T. iberica*. The most important characteristics of these specimens are: only 6(+ 1) pygidial rings, 4 pr of ribs and 4(5) pr of short lateral lappets. Besides specimens, which are completely similar to the holotype of *T. iberica*, in the La Vid Fm. likewise material occurs, which points to the meraspides and juvenile holaspides of Gandl.

After further study of the material of the La Vid Fm. as well as the Aragonese material, which is stored in the Senckenberg Museum (Frankfurt, F.R.G.) we may conclude that there is proof of an *Acastava* n.sp. (see Pl. 28 figs. 1-6). *Acastava* n.sp. differs from *T. iberica* because of: stronger diverging axial furrows (30°-35°; *T. iberica* 25°); much narrower, V-shaped, lateral glabellar furrows, which all retreat from axial furrows (see Pl. 28 fig. 6); glabellar lobes fused with central area; posterior border furrow narrower, V-shaped; palpebral lobe weaker developed; without subocular furrow; thoracic segments with truncated ends; pygidium with 6(+1) axial rings and 4(5) pr of ribs (*T. iberica* resp. 11(+1) and 6(7) pr); much shorter lateral lappets and a much finer granulation on the whole exoskeleton. Difference in size is not characteristic. *T. iberica* is related to *T. prorotundifrons* (R. & E. Richter, 1943). The latter one differs because of: frontal glab. lobe steeply sloping to the front and distinctly separated from intrasutural frontal border; S2 faint; large eyes with a max. of 12 lenses per vertical row; facial suture intersects frontal margin at α; pygidial ribs more swollen; 6th pr of ribs weaker and an upwards pointing posterior lappet. The group of *Treveropyge* species of Siegenian age (see discussion of *T. lebanzaensis*) differs because of glabellar lobes fused with central area, larger eyes, higher pygidial ribs and the presence of a faint pygidial border furrow. *T. rotundifrons* (Emmrich, 1839) differs because of stronger vaulted glabella, frontal glab. lobe rhomboedrical (instead of ovale), larger eyes, subocular furrow with keel, coarser granulation on glabella, pygidium with 2 axial rings more and stronger backwards pointing lateral lappets. Closely related to *T. iberica* is the pygidium, described by Morzadec (1981: pl. 35 fig. 13, *non* pl. 35 fig. 1) under the name "*T. (T.) aff. rotundifrons*" from the Marettes Fm. (Armorican Massif), which also has 11 axial rings and 6(7) pr of ribs; the cephalon (pl. 35 fig. 1), however, differs because of its larger eyes with 32 vertical rows with a max. of 12 lenses per row.
Occurrence. - In the upper part of the limestone member of the La Vid Fm. near Colle; upper Lower Emsian. *T. iberica* also occurs in the lower part of the Mariposas Fm. (d4aβ) in Aragón.

Treveropyge? acrifrons Gandl, 1972
Pl. 7 fig. 3

* 1972 *Treveropyge? acrifrons* n.sp. - Gandl: p. 124, pl. 11 figs. 1-5.
Material. - 3 Cephalons (RGM 339148-50) from loc. L6.
Description. - See Gandl (1972: p. 124).
Discussion. - The cephalons, which also carry the characteristic frontal median process with long intrasutural field, are completely similar to *T.? acrifrons* from the Mariposas Fm. (Aragón) Gandl (1972) has classified with some reserve this species with *Treveropyge* on account of both glabellar and pygidial features. *T.? acrifrons* resembles material of the Armorican Massif, described by Pichard (1928) under the name "*Cryphaeus kernfornei*". This species, which has the same large frontal median process with long intrasutural field, differs because of its larger eyes and strongly swollen L3.
Occurrence. - In the upper part of the limestone member of the La Vid Fm. near Colle; upper Lower Emsian. Outside the Cantabrian Mountains this species occurs in the lower part of the Mariposas Fm. (d4aβ) in Aragón.

Treveropyge henryi Arbizu, 1979
Pl. 7 figs. 4-7

? 1896 *Cryphaeus sublaciniatus* de Vern. - Oehlert & Oehlert: p. 839, pl. 26 fig. 15.
* 1979 *Treveropyge (Treveropyge) henryi* n.sp. - Arbizu: p. 64, pl. 1 fig. 1.
Material. - 1 Complete specimen (RGM 339151) from loc. P20; 2 pygidia (RGM 339152-53) from loc. P19; 2 cephalons (RGM 339154-55) and 2 pygidia (RGM 339156-57) from loc. P24; 2 cephalons (RGM 339158-59) from loc. P21; 3 pygidia (RGM 339160-62) from loc. P22.
Remark. - The diagnosis and description of *T. henryi*, given by Arbizu (1979) is only based on the holotype: a specimen with incomplete cephalon. On account of the material from the Polentinos Member, it is possible to give a better diagnosis, with the emphasis on the cephalon.
Diagnosis. - A *Treveropyge* species characterized by:

Cephalon: Frontal glab. lobe strongly sloping to the front; L3 and L2 swollen and forming a unity; L1 narrow (exsag.) and low; S1 adaxially connected with S3; central area round arched (tr.); posterior border abaxially wide; genal spines short, unfurrowed and triangular; frontal border mesially vaulted and with short, wide intrasutural process; large eyes close to glabella.

Pygidium: 13(14) Axial rings; 8(9) ribs; 5 pr of flat, sickle-shaped, lateral lappets; wide, very short, upwards pointing posterior lappet.

Description. - Cephalon: Outline semicircular with curvature at the side of S3. Glabella oblong pentagonal, as long as wide, moderately vaulted. Axial furrows diverging at an angle of 25° to the front, at S3 curved to glabella. Frontal glab. lobe of glabellar width at L3, steeply sloping to the front, with postero-median depression, separated from central area. L3/L2 slightly swollen, abaxially fused. L1 narrow and low. S3 fairly transversal, adaxially curved backwards to S1. S2 very faint, straight transversal, retreating from axial furrow. S1 adaxially deeply incised and curving to the front. Central area narrow and vaulted (tr.), below level of glab. lobes. Occipital furrow distinct, incised V-shape. Occipital ring round arched and without a tubercle. Post. border furrow abaxially curved to the front and merging into shallow lateral border furrow. Posterior border adaxially narrow (exsag.), abaxially becoming wider and passing into genal spines. Cheeks vaulted with faint border furrow. Frontal border narrow with wide and short (sag.) intrasutural process. Large eyes, high on cheeks and close to glabella, anteriorly at the side of anterior part L3, post. border furrow reaching posteriorly. Palpebral lobe swollen, rising above glabella; palp. area slightly convex. Visual surface large with about 31 vertical rows with a max. of 11 lenses per row. Narrow subocular furrow present. Facial suture parallel to frontal margin and at α retreating from glabella; posterior part of f.s. on cheek strongly curved to the front and curving backwards on border, ω at the side of post. border furrow.

Thorax: Axis round arched, widest near 6th segment. Segments distally passing into flat sickle-shaped lappets.

Pygidium: Outline triangular to semicircular. Axis with 13(14), distinctly separated, axial rings. Rings trilobated and carrying little tubercle mesially. 8(9) Ribs of *prorotundifrons* pattern: first 5 pr furrowed and distally passing into lateral lappets, 6th-8th(9th) pr unfurrowed. Interpl. furrows narrow, abaxially widening and extending to margin between the lappets. Pleural furrows distinct and fading at the base of lappets. Ant. and post. pleural bands of equal height and width, near the border posterior bands a little wider. Border furrow and border indistinct. 5 Pr of backwards curved, flat sickle-shaped lateral lappets, 4th pr parallel, 5th pr converging backwards. Posterior lappet very short and wide, pointing upwards. Doublure very narrow and sharply bended.

Ornamentation: Whole exoskeleton covered with a very fine granulation, dense on border and lappets, moreover on glabella, palp. lobes and axis a coarser granulation, which is visible both on internal and external mould.

Measurements: Cephalon: length (sag.) 13-16 mm, width 28-35 mm.

Discussion. - The material of the Polentinos Member is completely similar to *T. henryi* Arbizu, 1979. Probably the pygidium from the Santa Lucía Fm., described by Oehlert & Oehlert (1896: p. 839, pl. 26 fig. 15) under the name "*Cryphaeus sublaciniatus* de Vern" belongs to this species. It looks to be shorter, probably due to the fact that the first axial ring is broken off. Closely related with *T. henryi* is *T.* sp. described by Morzadec (1969: p. 39, pl. 4 fig. 6) from "niveau des schistes à nodules calcaires à *Arthrophyllum vermiculare* H. & G. Termier" of the Armorican Massif, which has 11 pygidial rings and 7 pr of ribs, but differs because of the presence of a faint furrow along the posterior border of the pygidium. There is some similarity to *T. celtica* Morzadec, 1969 which also is a species with a large pygidium (14 ax. rings, 9 ribs); however, its ribs are more vaulted and the lateral lappets more slender. There also is a resemblance to the cephalon, described by Morzadec (1981: pl. 35 fig. 1) under the name "*T. (T.) aff. rotundifrons*", which has the same large eyes with 32 vertical rows with a max. of 12 lenses per row as *T. henryi*.

Occurrence. - In the Polentinos Member (Abadía Fm.); Upper Emsian-Eifelian transition. In the middle part of the Moniello Fm. (Asturias) and probably in the Santa Lucía Fm.

METACANTHINA Pillet, 1954

Genotype. - *Cryphaeus barrandei* Oehlert, 1889.

Diagnosis. - See Struve (1959a: p. O482).

Occurrence. - Armorican Massif, Asturias, León; Lower Emsian-Lower Eifelian.

Metacanthina lavidensis n.sp.

Pl. 7 fig. 8

Derivatio nominis. - Named after the village of La Vid (prov. León).

Holotypus. - Pygidium RGM 339163 (Pl. 7 fig. 8).

Locus typicus. - Loc. X3; 1000 m east of La Vid along the road to Vegacervera.

Stratum typicum. - Lowermost part of the limestone member of the La Vid Fm.; transition Upper Siegenian-Lower Emsian.

Paratypes. - 3 Pygidia (RGM 339164-66) from the type locality X3.

Diagnosis. - A *Metacanthina* species with the following characteristics of the pygidium: Robust, round arched axis with 13(+1) axial rings; axis in lateral view curved. Strongly vaulted pleural fields with 5(6) pr of ribs (5(6)th pr unfurrowed) of the *boothi* pattern. Post. pl. bands along the whole length higher and wider than anterior. Post. pl. bands distally thickening and passing into lateral lappets. Ant. pl. bands abaxially fading out in border furrow. 5 Pr of short, bulgy, sickle shaped, lateral lappets and a wide, escutcheon-shaped, posterior lappet.

Description. - Cephalon and thorax are unknown.

Pygidium: Strongly vaulted. Outline triangular with convex sides. Axis round arched, anteriorly as wide as pleural field, tapering backwards till 6th ring at an angle of 25°, behind that point 10°, axis in lateral view curved (especially the last 5 rings). 13(+1) Axial rings, distinctly separated. Pleural field strongly vaulted, inner third sloping to axis at an angle of 20°, outer twothirds sloping sideways at an angle of 60°. 5(6) Pr of ribs of *boothi* pattern with some tendency to *michelini* pattern, only first 4 pr of ribs furrowed, 5th pr far from axis and a little shorter than first pr, 6th pr faint. Interpl. furrows distinct, however, adaxially shallow and narrow, abaxially becoming wider and deeper and ending in the border furrow. Pleural furrows deep, U-shaped, on external mould half as wide as ribs, ad- as well as abaxially narrowing and ending in border furrow. Post. pl. bands on external mould a little wider than pleural furrows, along the whole length rising above anterior, abaxially thickening and merging into base of lateral lappets. Ant. pl. bands adaxially wedging out against posterior and abaxially retreating from posterior, ending near border furrow. Narrow border interrupted by post. pl. bands. 5 Pr of short, bulgy, backwards pointing, sickle shaped, lateral lappets, which are in continuation of post. pl. bands and increase in length backwards. Wide, escutcheon-shaped, posterior lappet of same length as 5th pr of lateral lappets.

Ornamentation: rings, ribs and lappets are covered with middle-coarse, pointed, granules, which appear perforated and cause pits on internal mould of rings and ribs (not on lappets).

Measurements: Pygidium (holotype): length 26 mm, width 36 mm.

Discussion. - *M. barrandei* (Oehlert, 1889) differs from this new species because of its more slender axis, flatter ribs, more slender lateral lappets and a short triangular posterior lappet. The pygidium of *M. carlsi* Arbizu, 1979 has 1 rib more, a wide rounded posterior lappet and is covered with little perforations on external mould.

Occurrence. - In the lowermost part of the limestone member of the La Vid Fm. near La Vid; Upper Siegenian-lowermost Emsian.

KAYSEROPS Delo, 1935

Genotype. - *Cryphaeus kochi* Kayser, 1883.

Diagnosis. - See Gandl (1972: p. 128).

Occurrence. - Armorican Massif, León, Palencia, Aragón, ?Morocco, Turkey, Harz Mts., Rhenish

Mts.; Siegenian?, Lower Emsian-Upper Emsian.

Kayserops? cf. champagnensis (Morzadec, 1971)
Pl. 7 fig. 9

* 1971 *Pseudocryphaeus champagnensis* n.sp. - Morzadec: p. 178, pl. 19 figs. 1-7.
1973 *Pseudocryphaeus champagnensis* Morzadec, 1971 - Pillet: p. 253, pl. 56 fig. 9.

Material. - 1 Pygidium (RGM 339167) from loc. P4.
Discussion. - This pygidium is similar to *K.? champagnensis*, however, deformation justifies some reserve. The species has a pygidial segmentation pattern which shows, besides primitive *michelini* features (pleural bands of same width and height), more progressive *boothi* features as well (abaxially post. pl. bands more developed than anterior). Furthermore the long lateral and robust posterior spine suggest *Kayserops*. Possibly this species is a transition between *Paracryphaeus* and *Kayserops*. Resemblance shows *K. ogivalis* (Morzadec, 1976), but it differs because of its deeper interpleural furrows and its much weaker developed posterior spine. There is also a resemblance to *K. proteus* (Haas, 1968) from Turkey, which, however, has wider and deeper interpleural furrows.
Occurrence. - In the upper part of the Lebanza Fm.; Middle-Upper Siegenian. *K.? champagnensis* has also been found in the Armorican Massif (*Athyris undata* zone).

Kayserops ogivalis (Morzadec, 1976)
Pl. 8 figs. 1-6

* 1976 *Pseudocryphaeus ogivalis* n.sp. - Morzadec (b): p. 42, pl. 6 figs. 5-8.

Material. - 1 Complete specimen (RGM 339168) from loc. P8; 2 thorax-pygidia (RGM 339169-70) and 1 pygidium (RGM 339171) from loc. P13; 1 complete specimen (RGM 339172), 5 cephalons (RGM 339173-77), 2 thorax-pygidia (RGM 339178-79) and 5 pygidia (RGM 339180-84) from loc. P14.
Description. - See Morzadec (1976b: p. 42).
Discussion. - The material of the Requejada Member is completely similar to that of the Faou Fm. (Rade de Brest). The segmentation (*boothi* pattern) and shape of lateral spines point to *Kayserops*; the cephalon, however, does not show the strongly vaulted shape of the genotype *K. kochi*. Closely related is *K. asteriferus* (Haas, 1968) from Turkey, which is distinguished by the absence of an occipital tubercle, more slender genal spines, 1(2) pygidial rings more and ant. pleural bands just arising above posterior ones. Also related is *K. brevispinosus* Gandl, 1972. Its cephalon differs because of a more distinct frontal border, deeper S2, large eyes close to lateral border and more slender genal spines; the pygidium is almost the same. *K. obsoletus* Gandl, 1972 differs because of the presence of a frontal median process, robust axial spines and longer, more slender lateral spines.
Occurrence. - In the Requejada Member (Abadía Fm.); Lower Emsian. In the Armorican Massif *K. ogivalis* has been found in the upper part of the Faou Fm.

Kayserops obsoletus Gandl, 1972
Pl. 8 figs. 7-12; text-fig. 4

1968 *Kayserops* n.sp. *aff. diadema* - Gandl in Carls & Gandl: p. 463.
* 1972 *Kayserops obsoletus* n.sp. - Gandl: p. 128, pl. 12 figs. 1-7.
1976 *Kayserops obsoletus* Gandl, 1972 - Morzadec(b): p. 44, pl. 7 figs. 1-6.

Material. - 10 Cephalons (RGM 339185-94) and 13 pygidia (RGM 339195-207) from loc. L6; 4 cephalons (RGM 339208-11), 1 thorax (RGM 339212), 2 meraspid pygidia (RGM 339213-14) and 10 adult pygidia (RGM 339215-24) from loc. L7.
Description. - See Gandl (1972).
Ontogeny. - Whittington (1959: p. O135) has described in which way, during the ontogentic development of the meraspid to the holaspid stage, segments arise at the caudal part of the pygidium, while at the front segments are disjoined and pass into the posterior part of the thorax until the number of thoracic segments is complete. Among the material of *K. obsoletus* two small meraspid pygidia have been found, which confirm this ontogenetic development. The smaller one (Fig. 4, 1) of 2 mm length has 7 pr of lateral spines (this means 7 segments), the other (Fig. 4, 2) of 2½ mm length 6 pr. This means, that the younger one still has to disjoin 2 segments and the older one only one segment, before reaching the holaspid stage.
Discussion. - Among the specimens of *K. obsoletus* are some small differences: the ones of loc. L7 show shorter axial spines, a little shorter lateral spines and a wider posterior spine than those of loc. L6; the presence of the characteristic frontal median process, however, confirms that

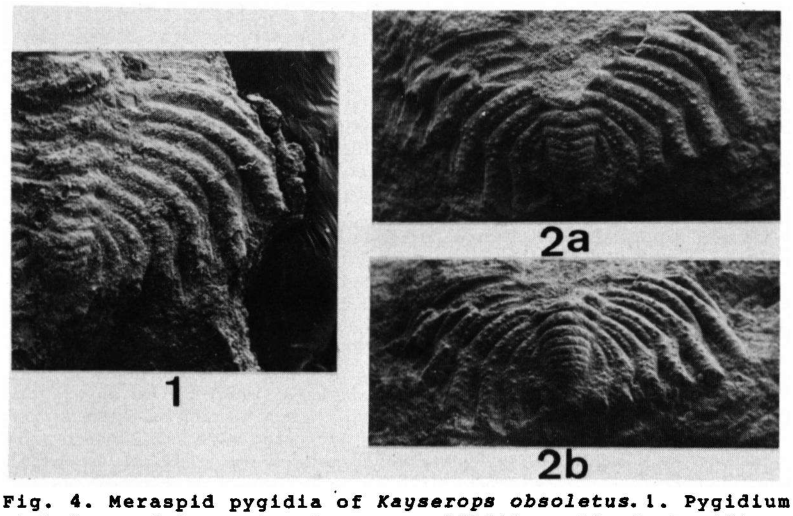


Fig. 4. Meraspid pygidia of *Kayserops obsoletus*. 1. Pygidium with 7 pr of lateral spines, RGM 339213, x 15. 2. Pygidium with 6 pr of lateral spines, RGM 339214, x 10; a. dorsal view; b. caudal view.

all material belongs to *K. obsoletus*. Closely related is *K. ogivalis* which differs because of the absence of a frontal median process and axial tubercles. *K. longispinosus* Haas, 1970 shows the same axial tubercles as our species, but differs because of its larger eyes and longer lateral spines; the presence of a frontal median process is not certain.
Occurrence. - In the upper part of the limestone member of the La Vid Fm. near Colle and Villayandre; upper Lower Emsian. Outside the Cantabrian Mountains, *K. obsoletus* has been described from the Mariposas Fm. (d4aβ) in Aragón and from the base of the Reun ar C'Hrank Fm. in the Armorican Massif.

Kayserops brevispinosus Gandl, 1972
Pl. 9 figs. 1-5

1968 *Kayserops* n.sp. *aff. kochi* - Gandl in Carls & Gandl: p. 463.
* 1972 *Kayserops brevispinosus* n.sp. - Gandl: p. 131, pl. 12 figs. 8-10, pl. 13 figs. 1-6.
1981 *Kayserops brevispinosus* Gandl, 1972 - Morzadec: p. 283, pl. 35 figs. 11, 16.

Material. - 2 Cephalons (RGM 339225-26), 1 meraspid pygidium (RGM 339227) and 5 adult pygidia (RGM 339228-32) from loc. P16; 2 cephalo-thoraces (RGM 339233-34) and 3 thorax-pygidia (RGM 339235-37) from loc. P17; 2 pygidia (RGM 339238-39) from loc. L13; 1 cephalon (RGM 339240) from loc. L11; 2 cephalons (RGM 339241-42) from loc. X6.
Description. - For an extensive description see Gandl (1972).
Discussion. - The material is completely similar to the Aragonese specimens, described by Gandl (1972) and no differences have been found with the material of this species from the Armorican Massif, described by Morzadec (1981). Closely related is *K. ogivalis* (Morzadec, 1976), which, however, differs because of less incised S2 which extend to axial furrows, wide cheeks below the eyes and longer lateral spines. Also related is *K. gahardensis* Morzadec, 1981 from the Marettes Fm. (Armorican Massif), which differs because of its longer, more sideways-spreaded lateral spines. *K. asteriferus* (Haas 1968: Lower! Emsian, Turkey) differs because of its bulgy pentagonal glabella with less incised S2 and a pygidium with narrower (exsag.) ribs and longer lateral spines. *K. kochi* (Kayser, 1884) differs because of the absence of a frontal border, strongly swollen frontal glab. lobe, narrower ribs and longer, more sideways-spreaded spines.
Occurrence. - In the Abadía Fm. just below the Polentinos Member and in the shale member of the La Vid Fm.; lower Upper Emsian. Outside the Cantabrian Mountains this species has been found in the upper part of the Mariposas Fm. (d4bβ), in Aragón and in the La Foulerie Fm. and lower part of the Marettes Fm. in the Armorican Massif.

RHENOPS R. & E. Richter, 1943

Genotype. - *Cryphaeus anserinus* R. Richter, 1916.
Diagnosis. - See R. & E. Richter (1943: p. 177).
Occurrence. - Armorican Massif, Palencia, Aragón, Morocco, Algeria, Eifel, Harz Mts.; lowermost Emsian-Upper Emsian (?Eifelian).

Rhenops circumapodemus n.sp.
Pl. 9 figs. 6-8

Derivatio nominis. - Named after the characteristic circular apodema between the axial rings.
Holotypus. - Complete specimen RGM 339243 (Pl. 9 fig. 8).
Locus typicus. - Loc. P18: Along the north-south streaming Arroyo de la Vega, 2 km southwest of Polentinos (prov. Palencia).
Stratum typicum. - Green-yellow marls at the base of the Polentinos Member (Abadía Fm.); Upper Emsian.
Paratypes. - 2 Complete specimens (RGM 339244-45), 2 cephalons (RGM 339246-47) and 2 pygidia (RGM 339248-49) from loc. P17.
Diagnosis. - A big *Rhenops* species, characterized by a thick-walled exoskeleton.

Cephalon: wide ogival; wide (tr.) frontal glab. lobe; L3/L2 slightly swollen; L1 distinct; S3 slightly oblique, convex anteriorly; S2 weakly reaching axial furrows; narrow (tr.) central area. Concave cheeks, without distinct border. Very long genal spines; large eyes.

Pygidium: Axis long and slender; 14(15) axial rings; 5 pr of small circular apodemes, high between axial rings. Segmentation with *michelini* as well as *boothi* features. 5 Pr of ribs of almost the same length, 5th pr unfurrowed. Very faint interpl. furrows; wide, U-shaped, pleural furrows. Post. pl. bands sloping to pleural furrows; ant. pl. bands abaxially a little higher and wider than posterior and ending abruptly. 5 Pr of sickle-shaped lateral lappets, increasing in length backwards, 5th pr the longest and most pointed. Posterior lappet reduced to rounded posterior border.
Description. - The thick-walled exoskeleton causes a marked morphological difference between internal and external mould.

Cephalon: Outline wide ogival; glabella with wide base strongly widening to the front. Axial furrows wide, incised U-shape, from occipital ring to mid of L3 diverging at an angle of 35° to the front, at S3 curved to glabella. Frontal glab. lobe diamond-shaped, abaxially protruding, gradually sloping to the front and sideways. Small postero-median depression. L3 > L2 > L1; L3 and L2 abaxially swollen and joining into one another; L3 abaxially rising above frontal glab. lobe; L2 lower than L3, sloping backwards; L1 distinct, abaxially below L2 level, adaxially rising just above central area. S3 on internal mould wide, U-shaped, slightly oblique, convex anteriorly; S2 transversal, abaxially weakened extending to axial furrows; S1 anteriorly strongly concave. Central area narrow (tr.) fused with glabellar lobes. Occipital furrow narrow (sag.), sharply incised. Occ. ring wide (tr.) and narrow (sag.), without tubercle. Post. border furrow on external mould narrow, sharply incised; on internal mould wide, U-shaped. Posterior border adaxially narrow, abaxially widening and gradually passing into adaxial part of genal spines. Cheeks below the eyes slightly concave, without distinct border furrow. Narrow frontal border. Genal spines very long, rectangular in cross-section, faintly furrowed abaxially. Eyes very large, high above glabella, anteriorly close to anterior part of L3, posteriorly the distance to post. border furrow is equal to the width of the post. border, and the distance to the axial furrow is 2 x the width of the post. border. Palpebral lobe strongly developed; furrow distinct; area vaulted and strongly sloping to L1. Visual surface with 29 vertical rows with a max. of 9 lenses per row and a total of 195-202 lenses per eye: lenses diagram of RGM 339244 anterior 34567 . 78999 . 99889 . 88888 . 77677 . 6543 posterior. Narrow subocular furrow present. Facial suture pointed at α, dividing frontal border in bands of each the same width; posterior part of f.s. on cheeks strongly curved to the front and lying in a shallow furrow.

Pygidium: Outline (without lappets) parabolic. Axis long, slender, slightly roof-shaped, narrower than pleural field anteriorly; tapering backwards till 6th ring at an angle of 20°-25°, behind that point 10°, end distinctly marked out. 14(15) Axial rings, on external mould separated by narrow V-shaped furrows, on internal mould by wide U-shaped furrows. The first 5 furrows between rings show small circular apodemes halfway the mid of axis and axial furrows, which are especially distinct on internal mould. Pleural fields slightly vaulted, inner part sloping to axis, outer part sideways, with 5 pr of ribs of the same length, 5th pr unfurrowed and withdrawn of axis. Segmentation pattern with *michelini* as well as *boothi* features. Interpl. furrows both on internal and external mould very weakly developed, straight and along the whole length of the same width and depth, ending in border furrow. Pleural furrows straight too, on external mould adaxially narrow and half as wide as the ribs, abaxially as wide as the ribs, ending in border furrow, on internal mould adaxially as wide as, abaxially 2 x as wide as ribs. Ribs widening abaxially, on internal mould ridge-shaped, on external mould flat. Post. pl. bands on external mould along the whole length of same width and slightly sloping to pleural furrows, strongly widening on the border and passing into lateral lappets, on internal mould very narrow and ridge-shaped. Ant. pl. bands on external mould adaxially wedging out against posterior, abaxially a little higher and narrower than posterior, ending in border furrow, on internal mould on the contrary abaxially distinctly wider and a little higher than posterior and already ending abruptly before border furrow. Border furrow, both on external and internal mould, wide and shallow. 5 Pr of sickle-shaped lateral lappets, first 4 pr bulgy and short, increasing a little in length backwards, pointing obliquely backwards, 5th pr 2 x length of 4th pr, pointed and parallel. Posterior lappet reduced to rounded posterior border.

Ornamentation: Whole exoskeleton covered with a sparse middle-coarse granulation.

Measurements: Complete specimen length 40-60 mm; cephalon length 12-19 mm; pygidium length 12-20 mm.

Discussion. - Closely related to this new species and probably its direct ancestor is *Rh. redonesianus* Morzadec, 1981, which has the same large eyes, quite long genal spines and round apodemes, but is distinguished by a shorter, wider axis with 12 (instead of 14(15)) axial rings and a longer triangular posterior lappet. Related is also *Rh. lethaeae* sensu Gandl, 1972, which also shows the characteristic apodemes, the same pygidial segmentation, large eyes and long genal spines, but is distinguished by the shape of the distally rounded lappets, which are all of the same length. There is also an appreciable affinity to material from Algeria, Morocco and the Armorican Massif. Le Maître (1952: p. 152, pl. 21 figs. 11,12) described material of early Eifelian age from Algeria under the name "*Asteropyge* du groupe *michelini* Rouault", which appears identical to our species. The pygidial segmentation as well as the anterior lateral lappets are quite the same; unfortunately the 5th pr of lateral and the posterior lappet have not been preserved, so that a comparison is not entirely possible. Termier & Termier (1950: p. 43; pl. 202 figs. 33-35, pl. 203 fig. 7) portray material of Morocco under the name "*Asteropyge Michelini*", that beats a strong affinity to *R. circumapodemus*. Finally Morzadec (1969: p. 40, pl. 7 figs. 1-5, pl. 8 figs. 1-8) described material from the Armorican Massif under the name "*Greenops? struvei* n.sp.", which resembles the new species. It shows the same pygidial segmentation but differs because of a longer posterior lappet and smaller eyes.

Occurrence. - In the Abadía Fm. just below the Polentinos Member; Upper Emsian.

GREENOPS Delo, 1935

Genotype. - *Cryphaeus boothi* Green, 1837.

Diagnosis. - See Delo (1935: p. 415).

GREENOPS (GREENOPS) Delo, 1935

Subgenotype. - *Cryphaeus boothi* Green, 1837.

Diagnosis. - See Struve (1959a: p. O480).

Occurrence. - Armorican Massif?, Asturias, León, Palencia, Aragón, northwestern Africa (Algeria, Syncl. of Zemmour) and North America (New York, Pennsylvania, Ohio, southwestern Ontario); Upper Emsian-Frasnian.

Greenops (Greenops) chaconae Arbizu, 1979
Pl. 10 figs. 1-8

* 1979 *Greenops (Greenops) chaconae* n.sp. - Arbizu: p. 73, pl. 2 figs. 3-7.

1979 *Greenops (Greenops) chaconae* Arbizu, 1978(!) - Arbizu in Arbizu et al.: p. 115, pl. 2, figs. 24,25.

Material. - 9 Cephalons (RGM 339250-58) and 4 pygidia (RGM 339259-62) from loc. P15; 3 cephalons (RGM 339263-65) from loc. P16; 2 enrolled specimens (RGM 339266-67), 1 cephalon (RGM 339268) and 3 pygidia (RGM 339269-71) from loc. P19.

Description. - See Arbizu (1979: p. 73).

Discussion. - The material from the Palentian basin is completely similar to the material, described by Arbizu, from the lower part of the Moniello Fm. (Asturias). Possibly strongly related is "*Pseudocryphaeus* sp." described by Morzadec (1969: p. 48, pl. 8 fig. 9) from the "schistes à nodules calcaires à *Arthrophyllum vermiculare*" from the Armorican Massif: this pygidium also has a lanceolate posterior spine and a faint border, which strongly widens backwards. *G. (G.) chaconae* can be considered as an early *G. (G.)* species with still distinct characteristics of *Paracryphaeus*.

Occurrence. - In the Abadía Fm. between the Requejada and the Polentinos Member and in the Polentinos Member; Upper Emsian. Further in the lower part of the Moniello Fm. (Asturias).

Greenops (Greenops) sp.
Pl. 10 figs. 9, 10

Material. - 1 Cephalon (RGM 339272) and 2 pygidia (RGM 339273-74) from loc. V3.

Description. - Cephalon: Outline semicircular to ogival. Axial furrows strongly diverging at an angle of 40-45° to the front, at S3 curved to glabella. Frontal glab. lobe wide; L3 and L2 fused abaxially; S3 V-shaped; S2 adaxially deeply incised and retreating from axial furrow; S1 concave anteriorly and deeply incised. Posterior border furrow very narrow and shallow, prematurely fading distally. Posterior border abaxially passing into genal spines. Cheeks without border furrow and border. Frontal border narrow. Genal spines middle-long, unfurrowed, in cross-section rectangular.

Pygidium: Outline triangular to semicircular. Axis with 10(11) rings, first one egg-glass shaped and pointing to the front. Pleural fields with 5 pr of wide, flat ribs of *boothi* pattern; ribs decreasing backwards in length, 5th pr unfurrowed. Interpl. furrows vague, convex anteriorly. Pleural furrows narrow, slightly convex anteriorly and reaching margin between lateral lappets. Border furrow hardly present. 5 Pr of short lateral lappets, strongly curved backwards and close to each other. Wide posterior lappet.

Ornamentation: A dense, middle-coarse granulation on glabella and pygidium.

Measurements: Cephalon length 7 mm; pygidium length 5-7 mm.

Discussion. - The material is strongly deformed, nevertheless it can be observed that it is related to *G. (G.) boothi* sensu Haas, 1970 from the Candás Fm. (Asturias). An affinity has also been observed with *G. (G.)* sp. *cf. boothi* described by Gandl (1972) from the Barreras Fm. (Aragón). More differences are present in the *G. (G.)* sp. which is described, under the name "*N. (Neometacanthus) stellifer* Burmeister, 1843", by Pillet (1961: p. 104, pl. 3 figs. 1-4, non 5,6) from late Givetian age of the Synclinorium of Zemmour (northwestern Africa). This species has longer pygidial lappets. The North American species *G. (G.) boothi* (Green, 1837) and *G. (G.) chilmanae* Stumm, 1965 also have these longer pygidial lappets.

Occurrence. - In the Rivera Fm. near Ventanilla; probably Upper Givetian.

Greenops (Greenops) sp. Gandl, 1972, *cf. boothi* (Green, 1837)
Pl. 10, fig. 11

1972 *Greenops (Greenops)* sp., *cf. boothi* (Green, 1837) - Gandl: p. 137, pl. 14 figs. 1-3.

Material. - 1 Cephalon (RGM 339275) from loc. X16.

Description. - See Gandl (1972).

Discussion. - The cephalon is similar to the Aragonese material. Both have a characteristic axial ridge on the frontal glab. lobe, postero-laterally pointing S2 and slightly concave cheeks without border furrow.

Occurrence. - In the upper part of the Portilla Fm. (base of D-Member) near Quejo; transition Givetian-Frasnian. Outside the Cantabrian Mountains it has been found in the Barreras Fm. in Aragón.

Greenops (Greenops) ultimus n.sp.
Pl. 11 figs. 1-6

Derivatio nominis. - Named *ultimus*, because it probably is the last species of *Greenops*.

Holotypus. - Pygidium RGM 339276 (Pl. 11 fig. 4).

Locus typicus. - Loc. L22: 750 m south of the village of Veneros (prov. León).

Stratum typicum. - Argillaceous limestones at the top of the Portilla Fm., 10 m below the Nocedo Fm.; Lower Frasnian.

Paratypes. - 2 Cephalons (RGM 339277-78), 2 cranidia (RGM 339279-80) and 2 pygidia (RGM 339281-82) all from the type locality L22.

Diagnosis. - A *Greenops (Greenops)* species characterized by:

Cephalon: Narrow glabella; axial furrows diverging at an angle of only 25°; frontal glab. lobe indented abaxially. S3 shallow, V-shaped, retreating from axial furrows. High cheeks without border furrow; post. border furrow abaxially fading prematurely; middle-long unfurrowed genal spines. Very small eyes, high on cheeks.

Pygidium: Low axis with 10(11) rings; 5 pr of wide, low ribs of *boothi* pattern. Interpleural furrows reduced; pleural furrows narrow, V-shaped; faint border furrow. 5 Pr of short, pointed lateral spines; posterior spine longer and wider than lateral ones.

Connexion. - Cephalons and pygidia have been found separate, however, in the same sample. Because both have *G. (G.)* characteristics, it is most probable that they belong to the same species.

Description. - Cephalon: Strongly vaulted with steep cheeks. Outline ogival; length/width = 5/8. Glabella narrow and situated high between the cheeks. Axial furrows shallow, at S3 with a pit and curved to glabella, diverging at an angle of 25°-30° to the front (most *G. (G.)* species 45°). Frontal glab. lobe long (sag.), narrow and abaxially indented, gradually sloping to the front and sideways, antero-laterally indistinct separated from cheeks, frontal margin rounded, fused with central area posteriorly. L3/L2 adaxially lower than central area-frontal glab. lobe, abaxially swollen and rising above lateral part of frontal glab. lobe. L3 and L2 adaxially of the same width (exsag.), abaxially L3 much wider than L2. L1 narrow and far below L3/L2 level, forming a distinct transglabellar ring. Lateral glabellar furrows characteristic: S3 very shallow, wide incised V-shape, abaxially not reaching axial furrow but ending in small depression, which is situated just behind the indentation of the lateral part of frontal glab. lobe. S2 transversal, adaxially deeply incised, abaxially both on internal and external mould weakly extending to axial furrows. S1 concave anteriorly, adaxially deeply incised, abaxially passing into axial furrows. Central area wide, vaulted (tr.), fused with frontal glab. lobe anteriorly, situated above level of lateral glabellar lobes. Occipital ring wide (sag.) with pointed tubercle on posterior margin. Post. border furrow very narrow, incised V-shape, on cheek prematurely fading halfway eye - lateral margin. Posterior border abaxially strongly widening and passing into genal spine. Cheeks steep (± 60°), without border furrow or border, concave (cephalon in frontal view bell-shaped). Narrow frontal border. Genal spines middle-long, unfurrowed and in straight continuation of cheeks, triangular and ending sharply. Eyes small, high on cheeks and just above glabella, anteriorly at the side of anterior part of L3 far from axial furrows, posteriorly retreating a distance of 2/3 width of posterior border from posterior border furrow and far from axial furrows.

Palpebral lobe very faint, slightly curved; furrow very faint; area very wide, moderately vaulted. Visual surface low, separated from cheek by shallow subocular furrow. Cephalon RGM 339277 has 23 vert. rows with a max. of 4 lenses per row, in total 77; lenses diagram: anterior 22334 . 44444 . 44444 . 44332 . 322 posterior. Facial suture divides narrow frontal border into intra- and extrasutural band each of same width, at the side of frontal glab. lobe strongly retreating from axial furrow. Posterior part of f.s. straightly crossing cheek and at ω strongly curved backwards.

Pygidium: Flat; outline wide triangular with convex sides. Axial furrows shallow and straight. Axis very low, round arched, anteriorly as wide as pleural field, tapering backwards at an angle of 25°, in lateral view slightly concave because articulation- and first ring rising high above axis. Axial end low, not distinctly separated from pleural field and as ridge passing into posterior spine.10(11) Rings, first 2 egg-glass shaped, first 5 pointing to the front, last rings indistinctly separated. Inner third of pleural field slightly sloping to axis, outer twothirds gradually sloping sideways and at an angle of 30° merging into lateral spines. 5 Pr of wide, low ribs of *boothi* pattern: on external mould first 4 pr very faintly furrowed, on internal mould all 5 pr furrowed; between 5th pr and axis still space, ribs decreasing in length backwards and increasing in width distally. Interpl. furrows on external mould only distinct on outer fourth part and reaching margin between lateral spines, on internal mould along the whole length visible but very narrow and shallow. Pleural furrows on external mould narrow, incised V-shape, along whole length of same depth and width, on internal mould shallow incised U-shape, ending in border furrow. Ant. and post. pl. bands of the same height. Post. pl. bands adaxially the width of lateral part of axial rings, outwards slightly narrowing and keeping this width along threefourth of length, the outer fourth part strongly widening and at border furrow taking 3/4 width of rib. Ant. pl. bands adaxially wedging out against posterior, halfway pleural field the greatest width (2/5 width of rib), more abaxially narrowing again and at border furrow only having 1/3 width of rib. Border furrow very faint and anteriorly interrupted by post. pl. bands, posteriorly not present. 5 Pr of short, pointed lateral spines, in straight continuation of segments, pointing obliquely sideways. Bases of spines close to each other. First pr of spines a little shorter and wider than 2nd-4th pr, the 5th pr a little shorter and sharper than 2nd-4th pr. Posterior spine wider and longer than lateral ones.

Ornamentation: Whole cephalon covered with middle-coarse granulation (also visible on internal mould), this granulation is dense on glabella, palpebral lobes, "border" and genal spines, sparse on the cheeks. Intrasutural frontal border shows 1 row of granules. Pygidium shows the same granulation: dense on posterior margin of axial rings and on spines, sparse on pleural field.

Measurements: Cephalon: length (sag.) 10 mm; width 16 mm. Pygidium (holotype): length (with posterior spine) 8 mm; width (with lateral spines) 11 mm.

Discussion. - *G. (G.) ultimus* n.sp. shows, besides a number of *G. (G.)* characteristics such as segmentation of glabella, prematurely fading of posterior border furrow, small eyes and segmentation pattern of pygidium, a number of features, by which it is easily distinguished from other *G. (G.)* species, i.e.: narrow frontal glabellar lobe with indentation laterally, small angle between axial furrows and rudimentary interpleural furrows. These last characteristics ought to be enough reason to introduce a new subgenus of *Greenops*, if *G. (G.) ultimus* was not the only and probably last species. Possibly the origin of the development of these features is a last failing effort of *Greenops* to survive.

Occurrence. - At the top of the Portilla Fm. near Veneros; Lower Frasnian.

GREENOPS (NEOMETACANTHUS) R. & E. Richter, 1948

Subgenotype. - *Phacops stellifer* Burmeister, 1843.

Diagnosis. - See Struve (1959a: p. O 480).

Occurrence. - Armorican Massif, León, Palencia, ?Sierra Morena, ?Portugal, northwestern Africa, Poland, Eifel, North America (New York, Michigan, Pennsylvania, Iowa); Lower Eifelian-Upper Givetian.

Greenops (Neometacanthus) perforatus (Morzadec, 1969)

Pl. 11 figs. 7,8

* 1969 *Asteropyge perforata* n.sp. - Morzadec: p. 33, pl. 6 figs. 1,2.

Material. - 3 Complete specimens (RGM 339283-85) and 1 pygidium (RGM 339286) from loc. L14; 1 cephalon (RGM 339287) from loc. X19; 1 cephalon (RGM 339288) from loc. P19; 1 cephalon (RGM 339289) from loc. P24.

Description. - See Morzadec (1969).

Discussion. - Our material is similar to that of a species from the Armorican Massif,described as "*Asteropyge perforata* n.sp." by Morzadec (1969). On account of the segmentation of the glabella, the pygidial *boothi* pattern and the lateral spines, which are spreaded sideways, this species belongs to the subgenus *G. (Neometacanthus)*. Pillet (1961) has described from the "marno-calcaires à *Werneroceras crispiforme*" of Zemmour (northwestern Africa) a cephalon under the name "*Pseudocryphaeus? mesocristata jacqueti* n.ssp." (pl. 1 fig. 10) and a pygidium "*Neometacanthus (Neometacanthus) stellifer* (Burmeister, 1843)" - pl. 3 fig. 5, non 6. Both show clear resemblances to our species, so that the cephalon and the pygidium probably belong to the same species. This *G. (Neometacanthus)* sp. also shows perforations and adaxially deeply incised S1, S2 and S3, but differs from *G. (N.) perforatus* by the presence of a narrow ridge running mesially over the frontal glabellar lobe. *G. (N.) stellifer* (Burmeister, 1843) differs because of fewer pygidial rings (9-10 instead of 12-14), more slender lateral spines and the absence of perforations. Some relation is present in the North American species *G. (N.) aequituberculatus* (Stumm, 1953) and *G. (N.) traversensis* (Stumm, 1953), which also show perforations. Both species, however, differ because of a shorter axis, more backwards pointing pygidial spines and a wider posterior lappet.

Occurrence. - At the base of the Huergas Fm. near Aleje and Lumajo and in the Polentinos Member (Abadía Fm.); lowermost Eifelian. In the Armorican Massif this species has been found in "niveau schisto-grauwackeux à *Euryspirifer* sp. groupe *intermedius*".

DELOCARE Struve, 1958

Genotype. - *Cryphaeus boopis* R. Richter, 1909.
Diagnosis. - See Struve (1958: p. 231).
Occurrence. - Eifel, Asturias, León, ?Palencia, ?Morocco; Lower Emsian-Upper Emsian.

Delocare? dalii n.sp.
Pl. 12 figs. 1-7

Derivatio nominis. - Named after the Spanish surrealistic painter Salvador Dali. The pygidial spines of this species remind of the "soft objects" painted by Dali.
Holotypus. - Pygidium RGM 339290 (Pl. 12 fig. 4).
Locus typicus. - Lox. X4: 1000 m east of the village of La Vid (prov. León) along the road to Vegacervera.
Stratum typicum. - Lower part of the limestone member of the La Vid Fm., transition Upper Siegenian-Lower Emsian.
Paratypes. - 5 Incomplete cephalons (RGM 339291-95), 2 genal spines (RGM 339296-97) and 9 pygidia (RGM 339298-306) all from the type locality.
Diagnosis. - An Asteropyginae species with both *Paracryphaeus* and *Delocare* characteristics:

Cephalon: Bold, subpentagonal glabella of *michelini* type (see Gandl, 1972: p. 38); L3 much larger than L2; L3/L2 swollen and separated from central area; L1 narrow and very low; narrow cheeks with horizontal border, which remains wide before frontal glab. lobe; intrasutural ridge; short to middle-long genal spines; large eyes.

Pygidium: Outline parabolical; 10 axial rings; ribs of *boothi* pattern with some affinity to *michelini* pattern; first 3 pr of ribs furrowed; very wide border furrow and strongly swollen border; 5 pr of middle-long voluminous lateral lappets and a very robust posterior lappet with median depression at base; all lappets characteristically curved.

Connexion. - The frequent occurrence in the same sample of one type of cephalons and one type of pygidia, both showing the characteristic wide border (furrow), ensures their connexion.
Description. - Cephalon: Vaulted; outline semicircular. Glabella of *michelini*-type: strongly vaulted, in outline pentagonally rounded, a little wider than long, a wide base. Axial furrows till halfway L3 diverging at an angle of 25°-30° to the front, at front of L3 strongly curved to glabella. Frontal glab. lobe steeply sloping at an angle of 60°-80° to the front and sideways, with rounded frontal margin, postero-median depression surrounded by some pits, separated from central area. Narrow intrasutural ridge (which is characteristic for *Delocare rostrata*) along frontal margin of frontal glab. lobe. L3/L2 swollen, separated from central area; L3 much larger and higher than L2, both rising above frontal glabellar lobe; L2 strongly swollen posteriorly, nowhere reaching level of central area; L1 narrow and far below L3/L2 level. S3 sigmoidal, on internal mould wide U-shaped, adaxially curving backwards to S1. S2 transversal to slightly oblique, deeply incised mesially, weakly reaching axial furrows. S1 deeply incised, concave anteriorly. Occipital furrow strongly incised; occ. ring not known. Posterior border furrow on internal mould very wide U-shape with sharp anterior margin. Posterior border abaxially thickened and merging into genal spines. Cheeks narrow (tr.) with thick horizontal border, which merges into deep border furrow. Genal spines short to middle-long. Large eyes close to lateral border, anteriorly near S3 at the height of L3, posteriorly almost reaching posterior border furrow. Palpebral lobes distinct, far above palpebral area; furrow wide U-shape; area with wide base and strongly sloping to axial furrow. Visual surface of cephalon RGM 339291 has 21 vertical rows with a max. of 7 lenses per row, in total about 122 lenses per eye. Narrow subocular furrow present. Facial suture parallel with margin anteriorly, dividing frontal border in extra- and intrasutural band (transglabellar ridge), of which the widths are in the proportion of 3 to 1.

Pygidium: Outline parabolic. Axis long, round arched, wider than pleural field anteriorly, tapering backwards till 5th ring at an angle of 25°, behind that point subparallel and abruptly ending. 10 Ax. rings, first 5 distinctly separated from each other. Pleural fields narrow, inner part slightly sloping to axis, outer part curved to border furrow, with 5 pr of ribs of (*michelini*) - *boothi* pattern. First 3 pr of ribs furrowed, 4th and 5th pr unfurrowed; ribs decreasing in length backwards. Interpl. furrows (on external mould only on first 3 pr of ribs) very shallow, halfway hardly visible, abaxially ending in border furrow, on internal mould hardly visible. On external mould pleural furrows U-shaped, wide and ending in border furrow; on internal mould very wide, U-shaped, as wide as the ribs. Posterior pleural bands a little higher and wider than the anterior ones, abaxially widening and passing into posterior part of lateral lappets. Ant. pl. bands ad- as well as abaxially wedging out against posterior ones, abaxially ending in w i d e border furrow. Border very wide, strongly swollen in a characteristic way and consisting of bases of lateral lappets, posteriorly at the level of axial end. 5 Pr of bulgy, strongly backwards curved, middle-long, lateral lappets, which are close to each other, oval in cross-section and sharply ending. Robust posterior lappet, 2 x as wide as and 1½ x as long as 5th pr of lateral lappets, at the base a median depression. The pygidial lappets have a striking shape: from the border they curve downwards and become horizontal more distally. This phenomenon reminders the "soft objects" of the painter Dali.

Ornamentation: Glabella has a coarse granulation, cheeks below the eyes have an ornamentation of little pits and the border has a dense, fine granulation. Pygidium is covered with a dense, fine granulation, especially on border and lappets.

Measurements: Cephalon length 6-9 mm; pygidium length 4-8 mm (holotype 7 mm).

Discussion. - *D.? dalii* n.sp. is easily distinguished from other Asteropyginae species by its wide border furrow, swollen border and characteristic shape of lateral lappets. There is an affinity to *D. rostrata* Arbizu, 1979 of which the pygidium also has reduced interpleural furrows, a deep border furrow and a median depression at the base of the posterior lappet. The cephalon of *D. rostrata*, however, differs because of a narrower glabella, smaller eyes and a robust frontal median process. The segmentation of the pygidium and the robust posterior lappet of the new species are conformable to most *Paracryphaeus* species. It is possible that *D.? dalii* is a transitary-species between *Paracryphaeus* and *Delocare*.
Occurrence. - In the lower part of the limestone member of the La Vid Fm. near La Vid; transition Upper Siegenian-Lower Emsian.

Delocare rostrata Arbizu, 1979
Pl. 12 figs. 8-12; Pl. 13 figs. 1-7

1970 *Pseudocryphaeus occidentalis* n.sp. - Haas: p. 118, pl. 3 fig. 7 (non fig. 6).
* 1979 *Delocare rostrata* n.sp. - Arbizu: p. 70, pl. 4 figs. 1-4.

Material. - 11 Incomplete cephalons (RGM 339307-17), 1 genal spine (RGM 339318) and 12 pygidia (RGM 339319-30) from loc. L6; 2 pygidia (RGM 339331-32) from loc. L7; 1 pygidium (RGM 339333) from loc. L8; 1 pygidium (RGM 339334) from loc. L10.

Description. - See Arbizu (1979).

Discussion. - The material of the La Vid Fm. shows the characteristic features of *D. rostrata*, such as: preglabellar ridge, furrow along lateral margin of cephalon (see Pl. 12 fig. 10b,12b), the same pygidial segmentation and shape of lateral spines. It is certain, that our material belongs to this species. Yet the material shows some differences, such as: longer frontal median process, only 5, instead of 6(7), pr of pygidial ribs and weaker interpleural furrows. These differences might be explained by the fact that our material is smaller: cephalon length: 6-11 mm, pygidium length: 3-9 mm (the material of the Ferroñes Fm. resp. 11-22 mm and 8-9 mm). The pygidium from loc. L10 shows some tendency to *D.? palenciae* n.sp., such as: the semicircular outline, more distinct border, distinct *boothi* segmentation. Probably *D.? palenciae* is a direct descendant of *D. rostrata*. *Delocare boopis* (R. Richter, 1909) differs from *D. rostrata* because of the absence of a preglabellar ridge, the low wedge-shaped central area, the pygidial segmentation, which shows more *cometa* features, the presence of tubercles on the abaxial part of the post.pl. bands and longer lateral spines. For comparison with *D.? palenciae* n.sp. is referred to the discussion of this species.

Occurrence. - In the upper part of the limestone member and at the base of the shale member of the La Vid Fm.; upper Lower Emsian-lowermost Upper Emsian. Furthermore in the Ferroñes Fm. in Asturias.

Delocare cf. boopis (R. Richter, 1909)
Pl. 13 figs. 8,9

Material. - 1 Cranidium (RGM 339335) and 2 pygidia (RGM 339336-37) from loc. X6.

Description. - For a description of *D. boopis* see R. & E. Richter (1943).

Discussion. - The Spanish material resembles *D. boopis* with reference to the low wedge-shaped central area and tubercles on the outer part of the post. pl. bands. The material, however, is too poorly preserved to make a conclusive determination. For comparison with *D. rostrata* Arbizu, 1979 is referred to the discussion of this species.

Occurrence. - At the top of the La Vid Fm. (2 m below Santa Lucía Fm.) near Barrios de Luna; Upper Emsian. Outside the Cantabrian Mountains *D. boopis* has been found in the Stadtfeld Beds (Eifel) and probably in Morocco.

Delocare? palenciae n.sp.
Pl. 13 figs. 10-12; Pl. 14 figs. 1-3

Derivatio nominis.- Named after the province of Palencia.

Holotypus. - Complete specimen RGM 339338 (Pl. 14 fig. 1).

Locus typicus. - Loc. P15: 400 m northeast of the village of Polentinos (prov. Palencia).

Stratum typicum. - Green shales between Requejada and Polentinos Member of the Abadía Fm.; Upper Emsian.

Paratypes. - 7 Cephalons (RGM 339339-45) and 4 pygidia (RGM 339346-49) from the type locality P15.

Diagnosis. - A small Asteropyginae species, probably belonging to *Delocare*, with the following characteristics:

Cephalon: Semicircular with robust, extrasutural frontal median process. Glabella of *prorotundifrons* type (Gandl, 1972: p. 37), frontal glab. lobe sloping to the front and ending abrupty abaxially. L3/L2 slighty fused; S3 faint, S2 very faint and retreating from axial furrows; cheeks with wide, concave border; middle-long genal spines; large eyes.

Pygidium: Semicircular; 8(+1) axial rings, 5 pr of ribs of *michelini-boothi* pattern; deep border furrow, distinct border, 5 pr of pointed lateral spines; posterior spine very sharp, longer and wider than lateral spines.

Description. - Cephalon: Outline wide-semicircular; with a robust, sharp and a little upwards pointing frontal median process. Glabella of *prorotundifrons* type: oblong pentagonal, as long as wide, slightly vaulted. Axial furrows shallow, diverging at an angle of only 25° to the front and with indentation at S3. Frontal glab. lobe oval, only gradually sloping to the front, abaxially ending abruptly near lateral margin. L3 a little longer (exsag.) than L2; L3 and L2 flat and abaxially fused; L1 narrow, below level of L3/L2. S3 shallow, sigmoidal, adaxially curved backwards to S1; S2 transversal, very faint, retreating from axial furrows; S1 adaxially deeply incised and curving to the front. Central area flat, connected with frontal glab. lobe, faintly separated from L3/L2. Posterior part of glabella is flat. Occipital furrow sharply incised, abaxially deep; occ. ring high above glabella, abaxially narrow (exsag.). Posterior border furrow abaxially widening and ending in lateral border furrow at base of genal spine. Cheeks with wide concave border, which narrows at lateral corner of frontal glab. lobe. Robust median frontal process, slightly pointing upwards. Middle-long, pointed genal spines, not distinctly furrowed. Large eyes, kidney shaped, anteriorly close to glabella at S3, retreating the half width of posterior border from posterior furrow and the width of L1 (exsag.) from axial furrow posteriorly. Palpebral lobe bulgy, rising above glabella; furrow faint; area slightly vaulted with narrow base. Visual surface with 23-25 vert. rows with a max. of 6-7 lenses per row. Narrow subocular furrow present. Facial suture parallel with margin of frontal glab. lobe; posterior part strongly curved to the front before reaching lateral margin. Frontal median process completely extrasutural.

Thorax: Wide axis with abaxially thickened rings. Segments distally changing into oblique, backwards pointing spines.

Pygidium: Outline wide semicircular. Axis short and anteriorly as wide as pleural field, strongly tapering and lowering backwards. 8+1 Axial rings; 5 pr of ribs of *michelini-boothi* pattern, decreasing in length backwards, 5th pr unfurrowed. Interpl. furrows abaxially widening and ending in border furrow. Pleural furrows along the whole length of the same width, ending in border furrow, Ant. and post. pl. bands of almost the same width and height, abaxially post. pl. band somewhat wider at the cost of the anterior ones. Border furrow and uninterrupted border distinct. 5 Pr of pointed lateral spines, decreasing in length backwards 4th pr parallel, 5th pr converging backwards. Posterior spine pointed, with wide base and concave sides, 1½ x as long as 5th pr of lateral spines

Ornamentation: Coarse, pointed granules on the middle part of the frontal glab. lobe, palpebral lobe and axial rings of thorax and pygidium; a very fine granulation on the whole glabella, palpebral area and cheeks.

Measurements: Holotype: length of complete specimen 17 mm; cephalon length 3-10 mm; pygidium length 2-5 mm.

Discussion. - *D.? palenciae* n.sp. has been classified with the genus *Delocare* with some reserve. The cephalon has features from both *Delocare* and *Treveropyge*; the pygidium has a completely own character by its primitive segmentation (transition *michelini-boothi* pattern) and its quite distinct border. *D.? palenciae* is most closely related to *D. rostrata* Arbizu, 1979, which, however, differs because of the presence of a preglabellar ridge, rounded (instead of pointed) frontal median process, smaller eyes which are further from the posterior border and axial furrows posteriorly, frontal glab. lobe also sloping sideways, less marked pygidial border and a vaguer pygidial segmentation. *D.? palenciae* bears also an affinity to *Treveropyge drevermanni* (R. Richter, 1909). The resemblance especially concerns the cephalons with robust pointed frontal median process, wide concave lateral border, middle-long genal spines. The frontal glab. lobe of *T. drevermanni*, however, is more diamond-shaped (instead of oval with *D.? palenciae*). The pygidium of *T. drevermanni*, however, differs strongly because of the *prorotundifrons* segmentation, the interrupted border and the posterior lappet which is shorter than the 5th pr of lateral ones

Occurrence. - In the Abadía Fm. between Requejada and Polentinos Member; Upper Emsian.

COMURA R. & E. Richter, 1926

Genotype. - *Cryphaeus cometa* R. Richter, 1909.
Diagnosis. - See Arbizu (1979: p. 77).
Occurrence. - ?Armorican Massif, Asturias, León, Palencia, Aragón, Sierra Morena, Morocco, Algeria, Rhenish Mts., Harz Mts.; Upper Siegenian-lowermost Eifelian.

Comura defensor R. & E. Richter, 1952
Pl. 14 fig. 4

* 1952 *Asteropyge (Comura) defensor* n.sp. - R. & E. Richter: p. 84, pl. 3 figs. 18,19.
? 1952 *Asteropyge? (Philonyx) philonyx* n.sp. - R. & E. Richter: p. 85, pl. 1 fig. 5, text-fig. 1.
1979 *Comura defensor* R. & E. Richter, 1952 - Arbizu: p. 78, pl. 5 fig. 5.

Material. - 1 Thorax-pygidium (RGM 339350) from loc. P19.
Description. - See R. & E. Richter (1952) and Arbizu (1979) for an extensive description.
Discussion. - Our specimen is quite similar to the holotype from the Heisdorf Beds, so that we can speak of a "real" *C. defensor*. The only difference is that the pygidial axis of the holotype retreats a little more from the posterior border. The paratype (pl. 3 fig. 19) is completely similar to our specimen. It is also similar to the pygidium described by Arbizu (1979) from the Moniello Fm. *C. nova* Arbizu, 1979 resembles *C. defensor*, but differs because of its 14 (instead of 10) axial rings and its not-backwards pointing pygidial rings. Possibly *C. nova* is a descendant of *C. defensor*. Furthermore there is some resemblance of our species to *C. cometa* (R. Richter, 1909). Last one, however, has only 7 ax. rings.
Occurrence. - In the Polentinos Member (Abadía Fm.); Upper Emsian-Eifelian transition. In the middle part of the Moniello Fm. in Asturias. Outside the Cantabrian Mountains this species has been found in the Heisdorf Beds and probably in the Lauch Beds of the Rhenish Mts.

Comura nova Arbizu, 1979

* 1979 *Comura nova* n.sp. - Arbizu: p. 77, pl. 6 figs. 1-3.

Description. - See Arbizu (1979).
Discussion. - For the sake of completeness this species is mentioned. The author, however, did not find material of this species.
Occurrence. - In the lower part of the Huergas Fm. near Huergas de Gordón; Lower Eifelian.

ALCALDOPS Arbizu, 1979

Genotype. - *Alcaldops alcaldei* Arbizu, 1979.
Diagnosis. - See Arbizu (1979: p. 79).
Occurrence. - Armorican Massif, León, ?Portugal; Eifelian-lowermost Givetian.

Alcaldops? argovejensis n.sp.
Pl. 14 figs. 5,6.

Derivatio nominis. - Named after the village of Argovejo (prov. León).
Holotypus. - Complete specimen RGM 339351 (Pl. 14 fig. 5).
Locus typicus. - Loc. L14: 700 m southeast of Argovejo.
Stratum typicum. - A decalcified ferruginous sandstone bed of the Huergas Fm., 15 m above the Santa Lucía Fm.; Lower Eifelian.
Paratype. - 1 Pygidium (RGM 339352) from the type-locality.
Diagnosis. - An Asteropyginae species, probably belonging to the genus *Alcaldops*, characterized by: Cephalon: Long keeled genal spines, posterior part of facial suture on the cheeks situated in furrow, on lateral border along a ridge. At ω an indentation of lateral margin.

Pygidium: Narrow axis with 15 ax. rings; rings without tubercles; 5 pr of ribs with interpleural openings and a 6th unfurrowed pair; 5 pr of lateral spines of the s a m e length, posterior spine a little shorter and wider.

Description. - Cephalon: Outline wide semicircular. Unfortunately it is not certain whether or not a frontal median process is present. Glabella bordered by deep axial furrows, which diverge at an angle of 40° to the front. Frontal glab. lobe robust, not protruding abaxially. L3 and L2 slightly fused abaxially and both separated from central area. L3 > L2 > L1: lateral glabellar lobes gradually decreasing in height and width (exsag.) backwards. S3 oblique and distinct; S2 transversal faintly incised and pit-shaped mesially, abaxially retreating from axial furrows; S1 adaxially deeply incised and curving to the front. Occipital furrow shallow mesially, abaxially deeply incised. Occ. ring narrow (sag.) with a little spine on posterior margin. Posterior border furrow narrow adaxially, abaxially strongly widens, U-shaped, at genal corner again narrowing and passing into lateral border furrow. Posterior border gradually widens abaxially. Cheeks with wide flat border, which merges into the genal spines. Large eyes, rising high above glabella, anteriorly at the side of anterior part of L3, posteriorly nearly reaching posterior border furrow at a great distance from axial furrow . Visual surface (of holotype) has 28 vertical rows with a max. of 8(9) lenses per eye, in total about 180-190 lenses per eye. Palpebral lobe swollen; furrow distinct; area strongly sloping to glabella. Subocular furrow and eye platform present; platform distinct especially at front and at back. Posterior part of facial suture on cheek situated in furrow, on lateral border on a ridge; indentation of lateral margin at ω.

Thorax: Posterior pleural bands (like posterior border of cephalon) adaxially very narrow, causing crevices between the thoracic segments, which are homologous with interpleural openings of the pygidium. Segments distally passing into sickle-shaped spines.

Pygidium: Outline triangular to semicircular. Slender axis, tapering backwards till 6th ring at an angle of 15°, behind that point subparallel, postaxial ridge present. 15 Ax. rings without median tubercle. Pleural fields slightly vaulted with ribs of the *alcaldops* pattern (see Arbizu, 1979); 5 pr of furrowed ribs, 6th pr faint and unfurrowed, all ribs of the same length. Interpl. furrows almost along the whole length open, only the most outer part is closed, ending in border furrow. Pleural furrows abaxially strongly widening and ending in border furrow. Post. pl. bands narrow, ridge shaped, abaxially swelling and passing into keeled lateral spines. Ant. pl. bands narrower and lower than posterior, fading into border furrow. The interpleural openings have the width of the post. pl. bands. 5 Pr of lateral spines all of the same length (= length of ribs), keeled at base, with concave antero-lateral side and convex to flat postero-axial side, more distally flat and blade shaped. Posterior spine a little wider and shorter than lateral spines.

Ornamentation: Glabella is covered with coarse granules. Preservation of the material is too bad to show possible finer granulation.

Measurements: Cephalon (holotype) length 12 mm, width 30 mm; pygidium length (with posterior spine) 18 mm, (without) 12 mm; width (with lateral spines) 28 mm, (without) 20 mm.

Discussion. - With some reserve *A.? argovejensis* n.sp. is classified with the genus *Alcaldops* on account of the great resemblance to *A. renaudae* (Morzadec, 1969) and *A. alcaldei* Arbizu, 1979. Conformable characteristics are: 5 pr of interpleural openings, shape of cephalon, posterior part of facial suture and genal spines. Our species differs, however, because of the same length of all the lateral spines and the absence of axial tubercles. Moreover the interpleural openings of *A.? argovejensis* are narrower and ending at greater distance from the border. Furthermore *A.? argovejensis* has an affinity to *Bradocryphaeus? cantarmoricus* (Morzadec & Arbizu, 1978) on account of the shape of its cephalon, posterior part of facial suture, and genal spines, its pygidial lateral spines all of the same length and the absence of axial tubercles. A difference, however, is the absence of interpleural openings and the abaxially rapidly fading of the anterior pleural bands. *A.? argovejensis* and *B.? cantarmoricus*, which have been found in the same stratigraphic level, possibly have common ancestors, from which are descended *B.? cantarmoricus* as precursor of the "real" *Bradocryphaeus* species and *A.? argovejensis* as direct ancestor of *A. renaudae* and *A. alcaldei*.

Occurrence. - In the lower part of the Huergas Fm. near Argovejo; Lower Eifelian.

Alcaldops alcaldei Arbizu, 1979
Pl. 14 figs. 7,8

* 1979 *Alcaldops alcaldei* n.g. n.sp. - Arbizu: p. 80, pl. 6 fig. 4 and pl. 7 figs. 1,2.

Material. - 1 Pygidium (RGM 339353) from loc. L18; 2 pygidia (RGM 339354-55) from loc. X11.

Description. - See Arbizu (1979).

Discussion. - The material is completely similar to the description of Arbizu. Most closely related to *A. alcaldei* is *A. renaudae* (Morzadec, 1969) from the Armorican Massif. The pygidium of the last one, however, has only 12 (instead of 16) axial rings and the lateral spines are a little shorter, furthermore the frontal median process is much shorter. Also related seems the material, described by Rodriguez-Mellado & Thadeu (1947: p. 284; pl. 5 figs. 1-10) under the name "*Asteropyge (Comura?) cfr. diadema* Rud. Richter" from Portugal. Their description and photographs, however, do not allow a good comparison. For a comparison with *A.? argovejensis* n.sp. is referred to the discussion of this species.

Occurrence. - In the middle part of the Huergas Fm. near Argovejo, Aleje and Santa Lucía; Upper Eifelian - ?Lower Givetian?

HELIOPYGE Haas & Mensink, 1970

Genotype. - *Asteropyge (Comura) helios* R. & E. Richter, 1926.

Diagnosis. - See Haas & Mensink (1970: p. 20) and Gandl (1972: p. 141).

Occurrence. - Ardennes, Asturias, León, Palencia (Ventanilla), Aragón, Afghanistan; Givetian-Frasnian.

Heliopyge sp.1 *aff. asturica* Haas, 1970
Pl. 15 figs. 1-2

Material. - 3 Pygidia (RGM 339356-58) from loc. X15.

Description. - Pygidium: Outline triangular with convex sides. Axis roof-shaped, strongly tapering backwards till 6th ax. ring, behind that point subparallel. 12(13) Axial rings with median tubercles, first 6(7) with a pair of postero-lateral perforations, last rings pointing backwards. Pleural fields with 6 pr of ribs of the *supradevonica* pattern, 5th and 6th pr of ribs unfurrowed. Interpl. furrows faintly incised, adaxially narrow, abaxially widening and ending in narrow border furrow, first 5 pr show chink shaped openings on adaxial third, the 6th pr only a pore. Pleural furrows wide U-shaped. First 4 pr of post. pl. bands have at 2/3 from axis a node on posterior margin; first 5 pr of post. pl. bands cross the border and continue into lateral spines. First 2(3) ant. pl. bands extend to border furrow, 4th pr fading out halfway pleural field. Ant. pl. bands narrow, low, abaxially withdrawn from post. pl. band. Border furrow and narrow border present; border interrupted by post. pl. bands. 5 Pr of keeled lateral spines, at base trapezoedrical, distally triangular in cross-section. Anterior 3 pr of lateral spines increase in length backwards, 3rd pr the longest, 4th and 5th pr decrease in length backwards in such a way that 3rd, 4th and 5th pr end at the same level; 4th and 5th pr converging backwards; 5th pr close to posterior lappet. Posterior lappet triangular with concave sides, pointed.

Ornamentation: Pleural bands, border and spines have a coarse granulation.

Measurements: Pygidium length (with posterior lappet) 8 mm.

Discussion. - The pygidia here described which are closely related to *H. asturica* Haas, 1970, differ because of 5 + 1 (instead of 4 + 1) and longer interpleural openings, the narrow, pointed, biconcave (instead of triangular) posterior lappet and coarser granulation.

Occurrence. - In the middle part (upper part B-Member) of the Portilla Fm. near Quejo; Givetian-Frasnian transition (*varcus* conodont Zone).

Heliopyge sp.2 *aff. asturica* Haas, 1970
Pl. 15 fig. 3

Material. - 1 Pygidium (RGM 339359) from loc. X13.

Description. - Pygidium: Slender axis, roof shaped, tapering backwards till 6th axial ring at an angle of 20°, behind that point subparallel. 10 Axial rings and an unsegmented part, anterior rings with median tubercle and pr of postero-lateral perforations. Pleural fields with 5 pr of ribs (5th pr unfurrowed) of the *supradevonica* pattern. Interpleural furrows distinct and abaxially ending in border furrow, anterior 3 pr have small openings on adaxial third. Pleural furrows U-shaped. Post. pl. bands widening abaxially, crossing border and continuing in lateral spines, anterior 4 pr have a node on the posterior margin at 2/3 from axis. 4 Pr of ant. pl. bands, low and of half width of post. pl. band, 4th pr approaching border furrow. Border furrow and narrow border present. First 3 pr of lateral spines not known, 4th and 5th pr partly present and strongly converging backwards. Posterior lappet triangular with slightly concave sides.

Measurements: Pygidium length (with posterior lappet) 10 mm.

Discussion. - This pygidium, which is related to *H. asturica* Haas, 1970 only has 3 pr of small interpleural openings, a shorter axis with 10(11) rings and 5 pr of ribs (instead of 5 pr openings, 13(14) rings and 6 pr of ribs with *H. asturica*).

Occurrence. - In the middle part (B-Member) of the Portilla Fm. near Mirantes; Givetian-Frasnian transition.

?*Heliopyge* sp.2 *aff. asturica* Haas, 1970?
Pl. 15 fig. 4

Material. - 1 Cephalon (RGM 339360) from loc. X13; 1 cephalon (RGM 339361) from loc. X14.

Description. - Cephalon: Outline ogival without "real" frontal median process. Axial furrows diverging at an angle of 35° to the front, posterior part of furrows shallow, at the side of S3 steeply sloping and pit-shaped. Frontal glab. lobe gradually sloping to the front and sideways, with postero-median pit. L3/L2 slightly swollen, separated from central area; L1 low and narrow. S3 sigmoidal, abaxially strongly widening, adaxially curving backwards to S1; S2 transversal, pit shaped; S1 pit shaped, adaxially curving to S3. Occipital furrow distinct, U-shaped, abaxially deeply incised. Occipital ring with obliquely backwards pointing node on posterior margin. Posterior border furrow narrow adaxially, widening abaxially. Posterior border narrow with metafixigenal node. Cheeks strongly concave, without furrow. Wide lateral border, which narrows at antero-lateral side of frontal glabellar lobe and widens again anteriorly. Very long, slender, keeled genal spines with furrow. Eyes rising above glabella, anteriorly at the side of S3 and ending close to posterior border furrow posteriorly. Palpebral lobe very distinct; furrow incised U-shape; area vaulted and steeply sloping backwards. Visual surface of RGM 339360 has 25 vertical rows with a max. of 6(7) lenses per row, in total about 124 lenses per eye. Lenses diagram: anterior 13456 . 66766 . 66666 . 65?5?5?5? . 4?5432 posterior. Deep subocular furrow present. Eye platform wide, granulated anteriorly, wedging out against facial suture postero-laterally. Anterior part of facial suture close to frontal glab. lobe; posterior part strongly curved and situated along a ridge.

Ornamentation: Glabella covered with coarse, strongly pointed granules; border with irregular, sparse ornamentation of fine pointed granules.

Measurements: Cephalon length (sag.) 15 mm.

Discussion. - The cephalons were found separate from the pygidium *Heliopyge* sp.2 *aff. asturica* in the same stratigraphic level. Because the cephalon of *H. asturica* Haas, 1970 is not well described thus comparison is not well possible. Our cephalon differs from *H. coallaguensis* Arbizu, 1979 because of the larger eyes and the wider completely extrasutural frontal border.

Occurrence. - In the middle part of the Portilla Fm. near Mirantes and Barrios de Gordón; Givetian-Frasnian transition.

Heliopyge asturica Haas, 1970
Pl. 15 figs. 5-10

* 1970 *Neocalmonia (Heliopyge) asturica* n.sp. - Haas: p. 115, pl. 3 fig. 3.
1979 *Heliopyge asturica* (Haas, 1970) - Arbizu: p. 84, pl. 8 figs. 1-3.

Material. - 1 Cranidium (RGM 339362), 1 librigenum (RGM 339363) and 4 pygidia (RGM 339364-67) from loc. L22.

Description. - See Haas (1970) and Arbizu (1979) for an extensive description of this species.

Discussion. - The specimens from the top of the Portilla Fm. are completely similar to *H. asturica* from the upper part of the Candás Fm. in Asturias.

Occurrence. - At the top of the Portilla Fm. (10 m below the Nocedo Fm.) near Veneros; Lower Frasnian. At the top of the Candás Fm. (Asturias).

BRADOCRYPHAEUS Haas & Mensink, 1970

Genotype. - *Cryphaeus supradevonicus* Frech, 1888.
Diagnosis. - See Haas & Mensink (1970: p. 15) and Gandl (1972: p. 144)
Occurrence. - Armorican Massif, Asturias, León, Aragón, Sierra Morena, Ardennes, Rhenish Mts., Afghanistan, Burma; Eifelian-Upper Frasnian.

Bradocryphaeus? cantarmoricus (Morzadec & Arbizu, 1978)
Pl. 15 figs. 11-14; Pl. 16 figs. 1,2

1930 *Cryphaeus laciniatus* F. Roemer? var. *occidentalis* Whidborne, 1897 - Pichard: p. 87, pl. 3 figs. 1,2.
1942 *Asteropyge caillaudi* de Tromelin & Lebesconte, 1876 - Renaud: p. 295, pl. 11 fig. 7.
* 1978 *Kayserops? cantarmoricus* n.sp. - Morzadec & Arbizu: p. 925, pl. 1 figs. 1-9.
1979 *Kayserops? cantarmoricus* Morzadec & Arbizu, 1978 - Arbizu: p. 76, pl. 5 figs. 1-4.

Material. - 3 Cephalons (RGM 339368-70) and 5 pygidia (RGM 339371-75) from loc. L17; 1 pygidium (RGM 339376) from loc. L15.
Description. - See Morzadec & Arbizu (1978).
Discussion. - Our material is completely similar to the specimens described by Morzadec & Arbizu (1978). They have placed this species with reserve in *Kayserops* on account of the cephalic segmentation, the presence of a frontal median process and long genal spines. They also indicated affinity to *Comura, Alcaldops* and *Heliopyge*. In my opinion, however, the general shape of cephalon with indentation at ω, shape of genal spines, the slender pygidial axis with 15 axial rings and the *cometa-supradevonica* segmentation are so characteristic for *Bradocryphaeus*, that this species is here classified with this genus. For comparison with *Alcaldops? argovejensis* n.sp. and other related species is referred to the discussion of this species.
Occurrence. - At the base of the Huergas Fm. near Villayandre, Sabero and Huergas de Gordón; Eifelian. Outside the Cantabrian Mountains this species can be found in the St. Fiacre Fm. in the Armorican Massif.

Bradocryphaeus? cf. quadratispinosus (Gandl, 1972)
Pl. 16 fig. 3

Material. - 1 Pygidium (RGM 339377) from loc. L21.
Discussion. - This species does not distinctly differ from the material described by Gandl (1972: p. 147) under the name "*Neocalmonia (Quadratispina) quadratispinosa* n.sg. n.sp.". Similarities are the ribs of modified *supradevonica* segmentation, the wide sickle shaped, lateral lappets with roof shaped base and the hypertrophical 3rd pr of lateral lappets. Our pygidium only is somewhat more oblong and has weaker axial tubercles. More important is a stratigraphic difference: our pygidium has a Givetian age, while Gandl posits a Frasnian age. *B. afghanicus* Haas & Mensink, 1970 from Givetian age also shows some resemblance. This species differs because of 9(10) axial rings (instead of 11(12)), presence of thickening along the posterior margin of post. pl. band and less flat lateral lappets, the 3rd pr much longer than 4th and 5th pr.
Occurrence. - In the lower part (15 m above the Huergas Fm.) of the Portilla Fm. near La Ercina; Givetian. Outside the Cantabrian Mountains *B.? quadratispinosus* has been found in the Bandera Fm. in Aragón; Frasnian.

Bradocryphaeus hispanicus (R. & E. Richter, 1926)
Pl. 16 figs. 4-11

1855 *Dalmanites laciniata*, Roemer - de Verneuil & Barrande: p. 999, pl. 28 fig. 1(+1a?)
* 1926 *Asteropyge (Asteropyge) hispanica* n.sp. - R. & E. Richter: p. 211, pl. 12 figs. 26-28.
? 1979 *Heliopyge hispanica* (R. & E. Richter, 1926) - Arbizu: p. 86, pl. 9 fig. 1.

Material. - 4 Cephalons (RGM 339378-81), 2 genal spines (RGM 339382-83) and 4 pygidia (RGM 339384 87) from loc. L22.
Description. - See R. & E. Richter (1926).
Discussion.- The material of the Portilla Fm. is quite similar to *B. hispanicus*, described by R. & E. Richter (1926) from Almadén (Sierra Morena). The pygidia are completely identical, the cephalons only have a narrower frontal border. Arbizu (1979) described a pygidium from the Candás Fm. (Asturias), which shows 7 pr of axial perforations; these perforations are not present in our pygidia. Strongly related with *B. hispanicus* is *B. fiacrensis*, described by Morzadec (1976c) from the base of the Porsguen Fm. (Armorican Massif), which only differs because of somewhat wider lateral lappets and a wider posterior lappet at the pygidium.
Occurrence. - In the upper part of the Portilla Fm. (10 m below the Nocedo Fm.) near Veneros; Lower Frasnian. Probably in the upper part of the Candás Fm. (Asturias). Outside the Cantabrian Mountains it has been described from Almadén (Sierra Morena).

Bradocryphaeus matallanensis n.sp.
Pl. 17 fig. 1

? 1855 *Dalmanites sublaciniata*, Verneuil, 1850 - de Verneuil & Barrande: p. 999, pl. 28 fig. 2 (non 2a,2b).

Derivatio nominis. - Named after the village of Matallana (prov. Léon).
Holotypus. - Pygidium RGM 339388 (pl. 17 fig. 1).
Locus typicus. - Loc. X17; just north of the village of Matallana-Estacion.
Stratum typicum. - Limestone bed at the base of the Nocedo Fm.; Middle Frasnian.
Paratypes. - None.
Diagnosis. - A species of the genus *Bradocryphaeus* with the following characteristics of the pygidium: Outline semicircular; 10(11) axial rings; 6(7) pr of narrow ribs of *supradevonica* pattern. Interpleural furrows indistinct. Ant. pl. bands badly developed and only present at first 3(4) pr of ribs. Without border furrow. 5 Pr of short downwards pointing lateral spines. Posterior lappet very short and very wide.
Description. - Pygidium: Convex. Outline semicircular; at the front lateral part of margin strongly curved backwards. Axis low, round arched, a little narrower than pleural field anteriorly, end gradually changing into

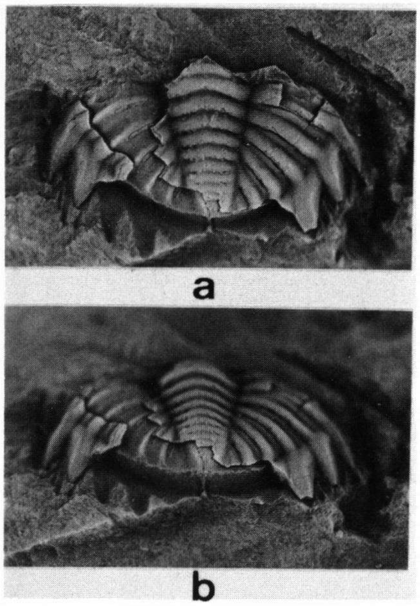


Fig. 5. *Bradocryphaeus maillieuxi* (R. & E. Richter, 1926), x 4, a. dorsal view; b. caudal view. From the type locality Les Abannets near Nismes (Belgium); with 5 pr of interpleural openings.

posterior border. Axial furrows shallow, anterior part converging backwards at an angle of 20°. 10(11) Axial rings, first 5 distinctly separated, last rings almost fused. Pleural fields strongly vaulted with 6(7) pr of narrow ribs of *supradevonica* pattern; first 3 pr of ribs furrowed, 4th pr with very faint anterior pleural band, 5th, 6th and 7th pr of ribs only consisting of post. pl. band and narrowing in this sequence (7th pr very faint): Length of ribs moderately decreasing backwards. No distinct interpleural furrow between posterior and anterior pleural band: the post. pl. band touches the lower situated ant. pl. band at an angle of 90°; this "furrow" is extending to outer margin between lateral spines. Pleural furrows narrow, shallow, incised V-shape and ending just before base of lateral spines. Post. pl. bands developed as narrow flat bands, slightly sloping to the front, posterior margin straight without any thickening. Ant. pl. bands faint, situated below the level of post. pl. bands and slightly sloping to pleural furrow. Border furrow not present. 5 Pr of very short lateral spines, all of the same length and in straight continuation of pleural segments, pointing downwards; 5th pr far of each other and separated by very wide, very short posterior lappet (= border).

Ornamentation: not visible.

Measurements: pygidium (holotype) length 5 mm; width 7 mm.

Discussion. - The only available pygidium of *B. matallanensis* n.sp. does not distinctly differ from the pygidium, described by de Verneuil & Barrande (1855: pl. 28 fig. 2) as "*Dalmanites sublaciniata*" from the Frasnian near Almadén (Sierra Morena). This pygidium has the same segmentation and also 6(7) pr of ribs, short lateral spines and very short, wide posterior lappet. Only the axis has 2 rings more and the axial segmentation is more distinct than of *B. matallanensis*. This new species is most closely related to *B. psilus* Haas, 1970 from the Candás Fm. (Givetian, Asturias); this species has more strongly developed ant. pl. bands, only 5(6) ribs, a border furrow and a less wide, triangular posterior lappet. *B. mosanus* (R. & E. Richter, 1926) shows, besides the same differences between *B. psilus* and the new species, also longer lateral spines. *B. matallanensis* also shows an affinity to *B. maillieuxi* (R. & E. Richter, 1926), which has the same segmentation with weakly developed ant. pl. bands. This species, however, has more distinct interpleural furrows with 5 pr of chink-shaped openings (Fig. 5), axial perforations, distinct border furrow, narrower posterior lappet and 4th pr of lateral spines longer than 5 pr.

Occurrence. - At the base of the Nocedo Fm. near Matallana; Middle Frasnian (*M. asymmetricus* conodont Zone). Besides in the Cantabrian Mountains probably also in the Sierra Morena.

Bradocryphaeus sexspiniferus n.sp.
Pl. 17 fig. 2

Derivatio nominis. - Named after the 6 pr of pygidial lateral spines.
Holotypus. - Pygidium RGM 339389 (Pl. 17 fig. 2).
Locus typicus. - Loc. X18: 750 m northwest of the village of Portilla de Luna (prov. León).
Stratum typicum. - Calcareous lens at the top of the A-Member of the Nocedo Fm.; Middle Frasnian.
Paratypes. - None.
Diagnosis. - A *Bradocryphaeus* species with the following characteristics of the pygidium: Axis with 13(14) rings; pleural fields with 7 pr of ribs of *supradevonica* segmentation; interpl. furrows biconvex anteriorly, pleural furrows wide, incised V-shape. Post. pl. bands high above anterior, with thickening on posterior margin; ant. pl. bands 1/2 - 1/3 width of posterior. 6 Pr of short, pointed lateral spines of almost the same length. Posterior spine reduced to thickened border.
Description. - Pygidium: Strongly vaulted. Outline oblongly triangular with convex sides. Axis long, roof shaped, tapering backwards till 9th ring at an angle of 20°; behind that point subparallel, end rounded with faint postaxial ridge. 13(14) Axial rings, the first 5(6) distinctly separated, first 8(9) with a median node, last rings very narrow (sag.) and almost fused. Pleural fields strongly vaulted, inner part horizontal, outer part sloping at an angle of 45° sideways. 7 Pr of narrow, high ribs of the *supradevonica* pattern, first 5(6) pr furrowed, ribs decreasing in length backwards. Interpl. furrows very shallow (reduced to angle of 90°), biconvex to the front (by a bulge on the posterior margin of post. pl. band), ending in shallow border furrow. Pleural furrows wide, incised V-shape, ending in border furrow. Post. pl. bands (semicircular in cross-section) rising high above anterior, with bulge on posterior margin at 1/2 - 1/3 from axis, abaxially passing into lateral spines. Ant. pl. bands of 1/2 - 1/3 width of posterior ones and situated far below level of posterior ones, only sloping backwards. Border furrow and narrow border faintly present. 6 Pr of short, pointed, roof shaped, lateral spines, length from first to 4th pr slightly increasing, from 4th to 6th pr again slightly decreasing. Posterior spine reduced to thickened border.

Ornamentation: Ribs covered with middle-coarse granules.

Measurements: Pygidium (holotype) length 4 mm, width (with lateral spines) 6 mm.

Discussion. - *B. sexspiniferus* n.sp. shows a late evolutionary trend within the Asteropyginae, namely the possession of 6 pr of lateral spines along the pygidium. Probably this trend occurs in several (sub)genera. Farsan (1981) has defined 2 subgenera of *Neocalmonia* for such species with 6 pr of lateral spines on the pygidium: *N. (Radiopyge)* and *N. (Hexacosta)*. Because the affinity of our new species is stronger with *Bradocryphaeus* than with these new subgenera, *B. sexspiniferus* will be classified with *Bradocryphaeus*. Our species is easily to distinguish from other *Bradocryphaeus* species by its 6 pr of lateral spines. *B. matallanensis* n.sp. also has 7 pr of ribs and short (however 5 pr) lateral spines, it differs, however, of *B. sexspiniferus* because of its much flatter ribs. *B. psilus* Haas, 1970 differs because of the fewer number of rings and ribs (10 rings, 6 ribs) and the triangular posterior lappet; the segmentation and short lateral spines, which are all of the same length, however, strongly resemble to *B. sexspiniferus*. Possibly our species is derived from *B. psilus* because of an increase of the number of segments in the pygidium. *B. maillieuxi* (R. & E. Richter, 1926) differs because of its much wider and flatter ribs. All other *Bradocryphaeus* species are distinguished by unequal length of the lateral spines.

Occurrence. - In the upper part of the A-Member of the Nocedo Fm. near Portilla de Luna; Middle Frasnian (Lower and Middle *asymmetricus* conodont Zone).

NEOCALMONIA Pillet, 1969

Genotype. - *Neocalmonia quadricosta* Pillet, 1969.

Diagnosis. - See Haas & Mensink (1970: p. 14 and 25).

Occurrence. - León, Afghanistan; lowermost Givetian-Frasnian.

Neocalmonia cantabrica n.sp.

Pl. 17 figs. 3-11; text-fig. 6

Derivatio nominis. - Named after the Cantabrian Mountains.

Holotypus. - Pygidium RGM 339393 (Pl. 17 fig. 3 and text-fig. 6).

Locus typicus. - Loc. L19: 600 m southeast of the village of Aleje (prov. León).

Stratum typicum. - A fossiliferous sandstone bed of the Huergas Fm. 60 m below the Portilla Fm.; Lower Givetian.

Paratypes. - 7 Cephalons (RGM 339394-400) and 7 pygidia (RGM 339401-07) from loc. L19; 1 pygidium (RGM 339408) from loc. L20.

Diagnosis. - A new species of *Neocalmonia* characterized by:

Cephalon: Outline parabolic, with indentation between frontal glab. lobe and eyes; frontal glab. lobe truncated abaxially and joined central area. L3 and L2 separated from central area; L3 much larger than L2. S2 pointing postero-laterally and retreating from axial furrows. Long genal spines; large eyes on platform.

Pygidium: 10(+1) Axial rings; 5 pr of ribs of *supradevonica* pattern; post. pl. bands with faint curvature on outer part of posterior margin (only on internal mould). Third ant. pl. band only adaxially present. 4 Or 5 pr of lateral spines from first to 3rd pr increasing in length; 3rd pr hypertrophical, 4th pr shorter than 3rd pr. Between 4th pr of lateral spines there is a very short, wide posterior lappet or a 5th pr of short lateral spines close to small triangular posterior lappet.

Description.-Cephalon: Outline wide parabolic with indentation between frontal glab. lobe and eyes. Axial furrows diverging to the front at an angle of 20°-25°, strong curvature and deeply incised at postero-lateral part of frontal glab. lobe. Frontal glab. lobe strongly sloping to the front and sideways, abaxially somewhat truncated, posteriorly connected with central area, postero-median depression is present and surrounded by some pits. L3 and L2 abaxially strongly swollen and connected, adaxially separated from central area. L3 much longer than L2; L2 strongly convex posteriorly; L1 narrow and far below L3/L2 level. S3 deeply incised, oblique to transversal, adaxially curving backwards to S1; abaxially wide and deep; S2 slightly pointing postero-laterally, pit shaped, retreating from axial furrow, convex to the front; S1 deeply incised, curved to the front adaxially. Central area narrow (tr.) Occipital furrow deeply incised abaxially; occ. ring high and wide (sag.), abaxially strongly narrowing, with median node on posterior margin. Posterior border furrow on external mould adaxially narrow and U-shaped, abaxially widening and passing into lateral border furrow, on internal mould wide U-shape. Posterior border abaxially strongly widening and passing into genal spines. Genal spines long, keeled, at base furrowed abaxially. Large eyes, anteriorly at the side of S3, at the same height as L3 and close to glabella, posteriorly almost touching posterior border furrow and situated above glabella level. Palp. lobe very distinct; furrow deep; area vaulted and sloping to axial furrow. Visual surface with 25 vertical rows with a max. of 6 lenses per row, a total of 105 lenses per eye. Lenses pattern of cephalon RGM 339394: anterior 23455 . 56666 . 66665 . 45544 . 43432 posterior. Subocular furrow and eye platform distinct. Cheeks concave, developed as wide lateral furrow which is slightly merging into genal spine posteriorly. Frontal border of moderate width. Facial suture close to margin of frontal glab. lobe anteriorly, on cheeks strongly curving to the front.

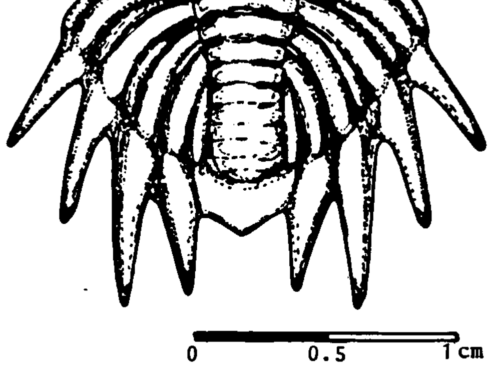


Fig. 6. *Neocalmonia cantabrica* n.sp holotype, RGM 339393.

Pygidium (holotype, Fig. 6, and 3 paratypes): Outline triangular with convex sides. Axis round arched, anteriorly a little narrower than pleural field, tapering backwards till 5th ring at an angle of 20°-25°, behind that point subparallel. 10(+1) Axial rings without median tubercle. 5 Pr of ribs of *supradevonica* segmentation; 5th pr close to axis and of 2/3 length of first pr of ribs, first 3 pr furrowed, 4th and 5th pr unfurrowed. Interpleural furrows on external mould only present on first 2 pr of ribs, along the whole length developed and reaching lateral margin between lateral spines, on 3rd pr of ribs only adaxially present, on internal mould not visible. Pleural furrows distinct, U-shaped, abaxially widening and ending in border furrow. Post. pl. bands backwards gradually decreasing in width, first 3 with thickening on outer part of posterior margin (especially on internal mould), first 4 pr crossing border and passing into lateral spines, 5th pr ending in border furrow. Anterior pl. bands lower and narrower than posterior, on first 2 pr of ribs along the whole length present and ending in border furrow, on 3rd pr of ribs only present adaxially. 4 Pr of long, slightly keeled, pointed lateral spines, from first to 3rd pr increasing in length, 3rd pr hypertrophical, 4th pr again shorter than 3rd pr and parallel. Very short, wide triangular posterior lappet (not much more than posterior border).

(Other paratypes): The pygidial part between the 4th pr of lateral spines differs from the description above, because of: the presence of a 5th pr of short lateral spines, close to small triangular posterior lappet and converging backwards. 5th Pr of post. pl. bands passing into 5th pr of lateral spines.

Ornamentation: Very coarse granulation on glabella. The material is too badly preserved to show finer granules.

Measurements: Cephalons: length 8-10 mm; pygidia: length 4-10 mm (holotype: length 10 mm, width 16 mm).

Discussion. - All specimens have been found in a fossiliferous sandstone bed of about 10 cm thickness. Among the 7 cephalons no difference has been observed; among the 8 pygidia there is one feature, namely the border between the 4th pr of lateral spines, which shows differences: some specimens (e.g. Pl. 17 fig. 5) have a 5th pr of short lateral spines close to a small triangular posterior lappet, others (e.g. holotype Pl. 17 fig. 3) only have a very wide, short posterior lappet. This difference is the only discriminating feature between the genera *Bradocryphaeus* and *Neocalmonia* (Haas & Mensink, 1970: p. 15 and p. 25). *Neocalmonia cantabrica* n.sp. consequently can be considered to be the transitary species between the ancestral genus *Bradocryphaeus* and the new-fashioned genus *Neocalmonia*. This latter genus, up to now only known from Afghanistan, appears to have an European origin. *N. cantabrica* n.sp. on the one hand shows relationship with *Bradocryphaeus afghanicus* Haas & Mensink, 1970 (of Late Eifelian-Givetian age) and on the other hand with *N. erbeni* Farsan, 1981 (of Middle Devonian-Frasnian age) and *N. quadricosta* Pillet, 1969, *N. batillifera* Haas & Mensink, 1970 and *N. thaumata* Haas & Mensink, 1970 (all of Frasnian age). The differences between these species and the new species chiefly concern the pygidia: The pygidium of *B. afghanicus* hardly differs from those of *N. cantabrica* with 5 pr of lateral spines: The shape of lateral spines is quite identical. *B. afghanicus*, however, differs because of stronger tapering axis, 3rd ant. pl. band reaching border furrow and more swollen post. pl. bands with more distinct curvature on the posterior margin. The pygidium of *N. erbeni* differs from those of *N. cantabrica* with 4 pr of lateral spines, because of shorter axis (2 rings fewer), 3rd ant. pl. band is reaching border furrow, stronger curvatures on posterior margin of first 3 pr of post. pl. bands and narrower triangular posterior lappet. The pygidium of *N. quadricosta* differs because of its ridge-shaped post. pl. bands with curvature on posterior margin, its wide, shallow pleural furrows and the longer axis (2 rings more). *N. batillifera* differs because of the 3rd and 4th pr of lateral and the posterior spine extend to the same level posteriorly (instead of shortening respectively). *N. thaumata* differs because of a longer axis, one furrowed rib more and its still wider posterior lappet.

Occurrence. - In the upper part of the Huergas Fm. near Aleje; Lower Givetian.

Subfamily ASTEROPYGINAE Delo 1935, incertae

PROTACANTHINA Gandl, 1972

Genotype. - *Protacanthina velillae* Gandl, 1972.

Diagnosis. - See Gandl (1972: p. 76).

Occurrence. - Guadarrama, Aragón, Palencia, Armorican Massif; Lower Gedinnian-Upper Siegenian.

Protacanthina n.sp.

Pl. 16 figs. 12,13; text-fig. 7

Remark. - With designating the holotype it is better to wait until more material is available.

Material. - 1 Pygidium (RGM 339390) and 2 pygidium fragments (RGM 339391-92) from loc. P4.

Description. - Pygidium: Strongly convex. Outline triangular with convex sides, which gradually fade into posterior spine. Axis long, wide round arched, anteriorly as wide as pleural field, tapering at an angle of 20° backwards, in lateral view slightly arched and sloping at an angle of 45° backwards, end not distinctly limited and as postaxial ridge passing into posterior spine. Axial furrows shallow and straight. 11(+1) Axial rings, first 8 distinctly separated, last rings pointing backwards. Pleural fields strongly vaulted, inner part horizontal, outer part border reaching at an angle of 70°-80°. 7 Pr of narrow, high ribs, strongly curving backwards. 6th And 7th pr unfurrowed, 7th pr short and close to axis. Interpl. furrows narrow, near border furrow becoming wider and deeper, weakly crossing border and reaching margin between lateral lappets. Pl. furrows wide and deep, U-shaped; ad- as well as abaxially narrowing and ending in border furrow at the same level as interpl. furrows at the base of the lateral lappets. Post. pl. bands adaxially a little higher and wider than anterior, near border furrow the reverse. Pl. bands near border furrow strongly fading and crossing border to continue in lateral lappets. Post. pl. bands continue in postero-adaxial part, ant. pl. bands in antero-lateral part of lappets. 7th Pr of pl. bands close to posterior spine. Posterior spine robust and pointing upwards.

Ornamentation: middle-coarse granulation on rings, ribs and lappets.

Measurements: Pygidium length 14 mm.

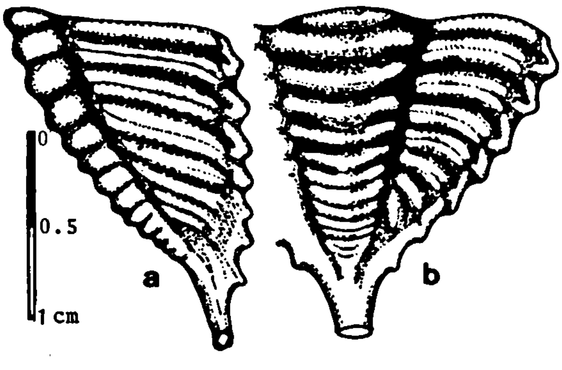


Fig. 7. *Protacanthina* n.sp. Internal mould of pygidium RGM 339390, a. lateral view; b. dorsal view.

Discussion. - The material doubtless belongs to *Protacanthina* on base of shape of axis and segmentation. Closely related is *P.* n.sp. described by Morzadec (1980: p. 291, pl. 38 fig. 12) from the Siegenian of the Armorican Massif, which also has 11 ax. rings and 7 pr of ribs, but differs because of its 6 pr of short tooth-like lateral lappets. Also related is *P. sagittaeformis* Morzadec, 1976, which differs because of its 6 pr of short tooth-like lateral lappets, only 10 ax. rings, 5(6) pr of ribs and a much wider posterior spine. *P.* n.sp. is distinguished from *Cryphina* species by its robuster posterior spine and more distinct lateral lappets. The *Gourdonia* species *G. destombesi* Struve, 1959 and *G. gourdoni* (Barrois, 1884) are distinguished by their 6 pr of short lateral lappets, post. pl. bands which abaxially do not pass into the lateral lappets and the absence of a border. *P.* n.sp. probably is a direct descendant from *P.* n.sp. Morzadec, 1980. *Occurrence.* - In the upper part of the Lebanza Fm. near Lebanza; Middle-Upper Siegenian.

PHYLOGENY OF THE ASTEROPYGINAE

After R. Richter (1909) had designed a first phylogeny of the Asteropyginae, based on species from the Rhenish Mountains, it lasted more than sixty years before Haas (1970) and Gandl (1972) almost simultaneously published a new phylogeny. Haas designed a monophyletic tree of (sub)genera based on the pygidial segmentation, Gandl a biphyletic tree of mainly Aragonese species based on both pygidial and cephalic characteristics. The most important problems within the phylogenetic development are the origins of the genus *Comura* (which descended from *Pseudocryphaeus* according to Haas, or from *Treveropyge* according to Gandl) and of the Middle Devonian genera *Bradocryphaeus, Heliopyge* and *Neocalmonia* of which Haas supposed they originated from the genus *Asteropyge* and of which Gandl suggested, they descended from *Comura*.

Studying the Asteropyginae of Asturias, Arbizu (1979) has introduced a new genus *Alcaldops* for the species which show intermediate characteristics between early *Comura* species and Middle Devonian species of *Heliopyge* and *Bradocryphaeus*.

After this study of the Asteropyginae of the southern Cantabrian Mountains and taking into account the recently described species from the Armorican Massif (Morzadec, 1980, 1981) and Rhenish Mountains (Timm, 1981) it is possible to adjust the phylogeny (Fig. 8). Many aspects, however, remain speculative.

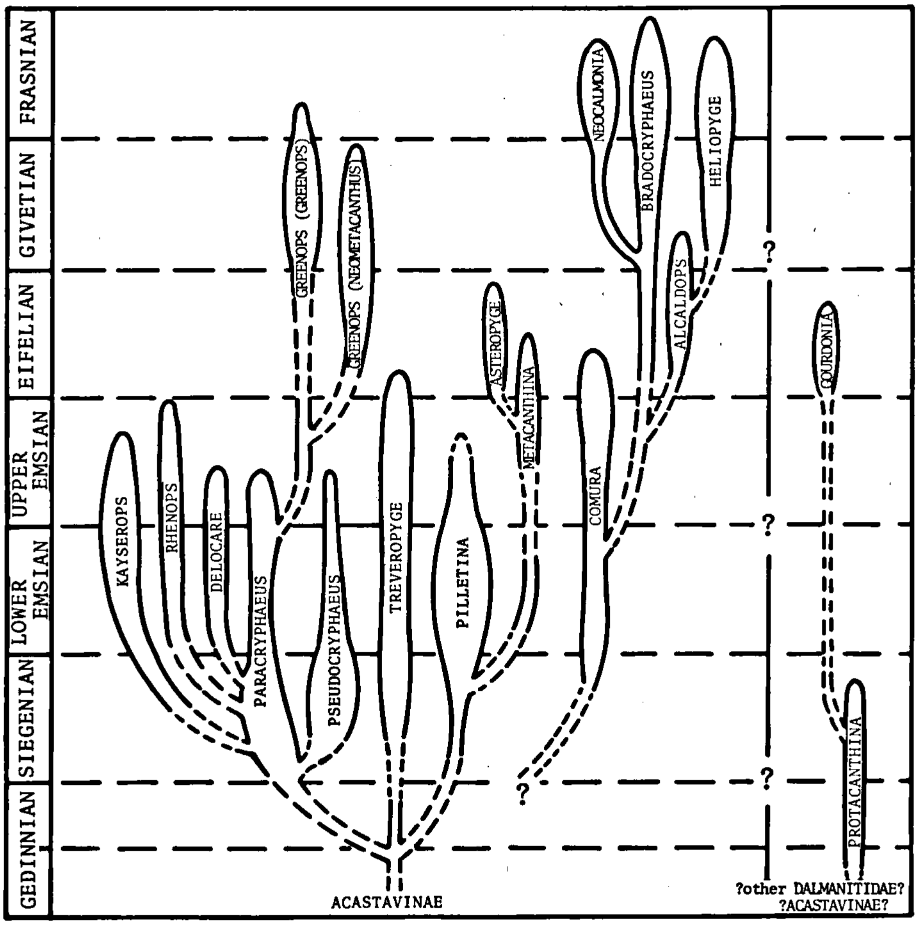


Fig. 8. Phylogeny of the most important (sub)genera of the Asteropyginae. Width of bars roughly corresponds to number of species described per stage of portion thereof

Doubtful genera as *Psychopyge, Feruminops* and *Turcopyge* have not been taken into account. The South American genera *Argentopyge, Australops* and *Chiarumanipyge* are rejected as Asteropyginae. *Echinopyge* is considerd as synonym of *Treveropyge* and *Philonyx* as synonym of *Comura*. Timm (1981) accurately described *Acastella* species and the oldest Asteropyginae species of the Rhenish Mountains. His supposition the Asteropyginae originated from *Acastella* in the Lower Gedinnian is accepted here. However, I do not agree with his opinion that *Treveropyge? ebbae* belongs to *Paracryphaeus*. The similarity of *T.? ebbae* to the Upper Gedinnian *Treveropyge* sp. (Morzadec, 1976a; pl. 58 figs. 3,4) may indicate that *T.? ebbae* is an early *Treveropyge* species. *Paracryphaeus* may be considered as a "primitive" genus which descended from the earliest *Treve-*

ropyge species and from which in their turn many genera descended in the Siegenian (*Pseudocryphaeus, Kayserops, Rhenops* and *Delocare*) and in the Emsian (*Greenops*). With its *michelini* pygidial segmentation but long lateral pygidial spines *Kayserops? champagnensis* makes it probable that *Kayserops* descended from *Paracryphaeus* in the Siegenian. *Delocare? dalii* n.sp. shows *Paracryphaeus* (*michelini*-cephalon type, *michelini-boothi* segmentation, long posterior spine) as well as *Delocare* (intrasutural ridge, reduction interpleural furrows and median depression on posterior spine) features which support the assumption that *Delocare* descended from *Paracryphaeus* in the Siegenian. The find of *G. (Greenops) ultimus* n.sp. prolongs the existence of *Greenops* into the Lower Frasnian. As *Paracryphaeus* the genus *Pilletina* may be descended from *Treveropyge* in the Gedinnian-Siegenian. The characteristics and age of *Metacanthina lavidensis* n.sp. suggests that *Metacanthina* descended from *Pilletina* in the Upper Siegenian. The descent of *Asteropyge* from *Metacanthina* remains most probable. The origin of *Comura* is still unknown. *Bradocryphaeus? cantarmoricus* and *Alcaldops argovejensis* n.sp. have a strong affinity which suggests these two species have common ancestors. The equal length of the pygidial spines of these species suggests their ancestors descended from *Comura* in an early evolution stage (Lower Emsian), before in this genus differentiation in length of the pygidial spines occurred. The descent of *Heliopyge* from *Alcaldops* is most probable on account of their interpleural openings. The characteristics and the age of *Neocalmonia cantabrica* n.sp. ensures *Neocalmonia* descended from *Bradocryphaeus* in the Lower Givetian.

The origin of *Protacanthina-Gourdonia* remains uncertain. Descent from Acastavinae (i.e. *Acastella*) is not impossible, the greater number of pygidial segments on *Protacanthina*, however, also indicates an affinity to other groups of Dalmanitidae.

SOME NOTES ON THE OTHER TRILOBITES

With the present study representatives of most of the Devonian trilobite families are known from the Cantabrian Mountains. The composition of the trilobite fauna does not show distinct differences from adjacent areas (Aragón, Armorican Massif).

The Dalmanitidae with their Asteropyginae are by far the most important family with regard to number of specimens as well as to number of species. Beside the Asteropyginae, Acastavinae (*Acastella* and *Acastava*) occur in the Asturo-Leonese as well as Palentian Basins. Dalmanitinae (*Odontochile*) are restricted to the Lower Emsian of the Palentian Basin.

In the Asturo-Leonese Basin the Phacopidae are only represented by the genus *Phacops*, which is dominating in the trilobite fauna of this area. In the Palentian Basin *Phacops* is also dominating in the Lower Devonian, but other genera also occur, e.g. *Reedops* (Emsian), *Eocryphops* (Eifelian) and *Trimerocephalus* (Famennian), which indicate a deeper water environment.

The Proetidae are moderately represented in both basins; *Proetus* and *Cornuproetus* occur in both basins. Moreover in the Palentian Basin *Warburgella* (Lower Gedinnian), *Xiphogonium* and *Eremiproetus* (both Upper Emsian) can be found.

The Homalonotidae especially dominate in the Lower Gedinnian to Lower Emsian. Representatives of *Digonus, Burmeisteria* and *Trimerus (Dipleura)* are found in both basins, the last subgenus is abundant in the Requejada Member (Abadía Fm.).

Furthermore representatives of the Scutelluidae, Odontopleuridae, Trochuridae (*Lobopyge*), Cheiruridae (only in the Palentian Basin), Harpidae, Aulacopleuridae and Tropidocoryphidae (*Astycoryphe* only in the Palentian Basin) take up a minor part of the Devonian trilobite fauna.

Striking is the absence of Calymenidae and *Acastoides* (Calmoniidae), which sometimes occur elsewhere abundantly.

CHAPTER IV

BIOSTRATIGRAPHY AND BIOGEOGRAPHY

Since most trilobite species are restricted to relatively short time intervals they are valuable tools for biostratigraphic correlations. In this chapter the stratigraphic data are given and worked out. The data of the Asteropyginae are schematically given in the time-stratigraphic table of Fig. 10. Data of the other trilobites are to be found in the list of localities in Chapter V. Those trilobites are for the greater part depicted in the Plates 18-35. A provisional biozonation by means of Asteropyginae is proposed in Fig. 11. Further the geographic distribution of the Asteropyginae is represented in Fig. 12.

CORRELATIONS WITHIN THE CANTABRIAN MOUNTAINS

Biostratigraphy within the Palentian Basin

In this area it is not always possible to attribute local limestone and shale deposits to a specific formation on lithostratigraphic data only. Sometimes the trilobite fauna may contribute to identify these deposits.

The limestones of the Requejada Member and those of the Polentinos Member (both Abadía Fm.) can be distinguished on account of their trilobite fauna.

The shales of loc. P15, which initially were mapped as Carazo Fm. (de Sitter & Boschma, 1966), yield an Upper Emsian trilobite fauna, which suggests that they belong to the Abadía Fm.

Likewise the shales of loc. P25, which were mapped as Abadía Fm., yield Eifelian trilobites, which indicate that they belong to the Gustalapiedra Fm.

On account of the occurrence of *Reedops cf. modestus* it was possible to date the reddish calcareous shales near Mudá (loc. M1) as contemporaneous to Upper Emsian marls of the Abadía Fm. (loc. P16).

Biostratigraphy within the Asturo-Leonese Basin
The trilobite fauna is hardly of any value to distinguish the formations in this area. All formations are clearly characterized lithostratigraphically. This is even true for the Ventanilla and Valsurvio regions in the east and Asturias in the northwest, where other formation names are used. On account of trilobites some correlations are possible between the Asturian and the Leonese part of the basin.

Delocare rostrata is found both in the marls of the upper half of the Ferroñes Fm. in Asturias and in the transitional part of the limestone-shale member of the La Vid Fm. (transition Lower-Upper Emsian).

Paracryphaeus occidentalis occurs both in marls at the top of the Ferroñes Fm. and in marls of the shale member of the La Vid Fm. in the Esla-Porma region (lowermost Upper Emsian).

Malladaia luciae occurs both in the Moniello Fm. (Asturias) and in the middle and upper part of the Santa Lucía Fm. (uppermost Emsian-lowermost Eifelian).

Heliopyge asturica together with *Bradocryphaeus hispanicus* occur both in limestones near the top of the Candás Fm. (Asturias) and the Portilla Fm. (Esla-Porma region), which suggests a contemporaneous termination of limestone deposition in the Lower Frasnian.

Correlation between the Palentian and the Asturo-Leonese Basin
Only a few data contribute to a correlation between the formations of both areas. The differences in the trilobite fauna of the Lower Devonian may be due to slight differences in age of the levels with trilobites in the Palentian and the Asturo-Leonese basins, so that the Asteropyginae species, with their short vertical distribution, were replaced by other species in the successive levels. In the Middle and Upper Devonian, correlations are obscured by the absence of Asteropyginae in the Palentian Basin, most probably due to environmental conditions. The following data, however, may contribute to a correlation between the two basins.

The occurrence of *Digonus aff. roemeri* both near the top of the Carazo Fm. and of the San Pedro Fm. confirms the supposition of a roughly contemporaneous termination of terrigenous deposition in the Lower Gedinnian in both areas. This supposition is strengthened by the occurrence of trilobites of upper Lower Gedinnian age both at the base of the Lebanza Fm., which overlies the Carazo Fm. and in the limestones (Abelgas unit) near the base of the La Vid Fm. in the western part of the Leonese Basin. No Gedinnian trilobites have been found in those sections of the La Vid Fm. which commence with dolomites.

The upper part of the Lebanza Fm. and the lower part of the limestone member (above the dolomites) of the La Vid Fm. near La Vid have the presence of *P. (Coniproetus) aff. foucauldi* and the absence of *Phacops* in common. The Asteropyginae of these levels, however, are different. The species *Pseudocryphaeus cf. michelini* and *Pseudocryphaeus cf. oehlerti* from the Lebanza Fm. and *Paracryphaeus izensis* and *Pseudocryphaeus cossensis* from the La Vid Fm. occur together in Middle and Upper Siegenian deposits in the Armorican Massif. Besides these species, however, the La Vid Fm. also yields Asteropyginae (sub)species (*Pilletina lips mozoensis, Pilletina cf. triangularis* and *Pseudocryphaeus astrictus*) which indicate a lowermost Emsian age for these deposits.

The appearance of the first *Phacops* species (i.e. *P. saberensis*) in both basins seems to be simultaneous at the transition Siegenian-Lower Emsian. In the Palentian Basin the first *Phacops* specimens have been found in shales just below the Requejada Member (Abadía Fm.). In the Esla-Porma region the first limestones (above the dolomites) of the La Vid Fm. yield *Phacops* contrary to the same limestones near La Vid and Aviados. This indicates that the first limestones in the Esla-Porma region may be slightly younger than those west of the Pardomino High.

The occurrence of *Acastava* n.sp. together with *Leonaspis aff. maura* and *C. (Cornuproetus)* n.sp. *aff. chouberti* at the transition from the Requejada Member to overlying siltstones in the Palentian Basin and in the upper part of the limestone member of the La Vid Fm. in the Esla-Porma region indicates that both are of the same age (upper Lower Emsian). The difference in the Asteropyginae fauna makes it probable that the Palentian fauna is slightly older.

The shales and marls between the Requejada and the Polentinos Member (Abadía Fm.) yield a rich trilobite fauna with many elements not found in the Asturo-Leonese Basin, which indicate quiet, deeper water (below wave base) conditions (e.g. *Xiphogonium, Reedops, Cheirurus (Pilletopeltis), Astycoryphe* and *Eremiproetus*). Only the Asteropyginae *Kayserops brevispinosus* and *G. (Greenops) chaconae* also occur in the shale member of the La Vid Fm. and at the base of the Moniello Fm. (Asturias) respectively and indicate an Upper Emsian age.

On account of its common species, *Treveropyge henryi* and *Comura defensor,* the Polentinos Member correlates with the middle part of the Moniello Fm. The deposits in Asturias are considered as "Couvinien Inférieur" (Arbizu et al., 1979).

The presence of *G. (Neometacanthus) perforatus* together with *C. (Diademaproetus) holzapfeli* ssp. and *P. (Proetus) aff. granulosus* both in the Polentinos Member and near the base of the Huergas Fm. might be an indication these stratigraphic levels are of the same age. However, this fauna in the Polentinos Member is accompanied by older Asteropyginae species *G. (Greenops) chaconae, Treveropyge henryi* and *Comura defensor*) than those which are found in the Huergas Fm. (*Bradocryphaeus? cantarmoricus* and *Comura nova*). The conclusion should be that the Polentinos Member was deposited at the transition Upper Emsian-Eifelian, while the deposition of the Huergas Fm. commenced in the Lower Eifelian.

In the Middle and Upper Devonian no trilobite data are available for correlation between the Palentian and Asturo-Leonese Basin.

CORRELATIONS WITH OTHER AREAS

Devonian sediments are widespread throughout western Europe and northwestern Africa. Regrettably comparisons are hampered by the uneven knowledge of the trilobites in the various areas. For correlation the Asteropyginae are the most suitable group, because its species have a short time-range and are less rare than most other trilobite groups. During the last years trilobites from nearby areas such as the Celtiberian Chain (Aragón) and the Armorican Massif have been described in detail.

The Devonian succession of the Celtiberian Chain has been extensively studied by Carls (1965) and Carls & Gandl (1968, 1969). The uninterrupted succession of Silurian to Upper Emsian deposits is, besides in formations, subdivided accurately in smaller lithostratigraphic units (Fig. 10, left column) and dated with conodonts and brachiopods. Moreover its Acastavinae and Asteropyginae have been well described by Gandl (1972). Unfortunately the Middle and Upper Devonian deposits in this area are badly known. In general the trilobite fauna shows affinity to that of the Cantabrian Mountains. In the Gedinnian and Siegenian the Homalonotidae, Acastavinae and Asteropyginae dominate. In the Emsian *Phacops* together with *Otarion*, *Leonaspis* and some Proetidae species appear. This Emsian fauna, however, yields fewer species than the Cantabrian Mountains and deeper water elements as those occurring in the Palentian Basin (*Odontochile*, *Cheirurus (Pilletopeltis)*, *Lobopyge* and *Eremiproetus*) have not been found. The Givetian-Frasnian trilobites resemble those of the Asturo-Leonese area (Asteropyginae).

In the Armorican Massif a continuous succession from Silurian to Devonian is found in the "Synclinorium médian" which extends from the Rade de Brest in the west, via Bénez-Belair to the Laval Basin in the east. The Lower Devonian is complete throughout the whole synclinorium; the Middle Devonian is well developed in the west, but reduced in the east; the Upper Devonian is only known in the western part. Trilobites from the "Synclinorium médian" were described by Morzadec (1969, 1971, 1976a, b, c, 1980, 1981) and Pillet (1973). South of it in the "Synclinorium d'Angers-St. Julien de Vouvantes" and the "Synclinorium d'Ancénis" Lower Siegenian and Middle Siegenian deposits respectively transgressively overly Lower Palaeozoic. The trilobites of these two synclinoria were described by Pillet (1973). In general the trilobite fauna of the "Synclinorium médian" shows affinity to that of the Cantabrian Mountains. In the Gedinnian and Siegenian the Homalonotidae, Acastavinae and Asteropyginae dominate; in the Emsian a resemblance with the fauna of the Abadía Fm. has been found. The Eifelian deposits have species in common with the Huergas Fm. and the Frasnian deposits yield Asteropyginae which have affinity to those of the Asturo-Leonese Basin. The deposits of the "Synclinorium d'Ancénis" do not yield Asteropyginae and seem to be deposited in deeper water. Its Upper Emsian fauna is very varied and shows affinity to that of the shales and marls of the Abadía Fm.

Correlation with the well studied Devonian succession of central Bohemia (Barrandium) is obstructed by the absence of Homalonotidae, Acastavinae and Asteropyginae in the Lower Devonian in that area, which may be due to environmental conditions. During Silurian to Lower Devonian uninterruptedly carbonates have been deposited in a deeper environment with minimal supply of terrigenous material.

The Lower Devonian trilobites of Bithynia (Turkey) have been extensively described by Haas (1968). The Asteropyginae are dominating and the faunal composition at generic level is quite similar to that of the Ibero-Armorican region. Haas, however, interpreted the faunas as much younger than those in the Ibero-Armorican region. The species *Pilletina incisa* (Haas, 1968) together with *Treveropyge cathamma* (Haas, 1968) have been dated as Upper Emsian, but resemble the Middle-Upper Siegenian species *Pilletina aequisulcata* and *Treveropyge lebanzaensis*. The species *Pilletina acinacifera* (Haas, 1968), *Kayserops asteriferus* (Haas, 1968) and *Pelitlina goltzi* Haas, 1968, which also are dated as Upper Emsian, resemble respectively *Pilletina aulnensis*, *Kayserops ogivalis* and *Paracryphaeus caboi* from the Requejada Member (Lower Emsian).

Correlation with northwestern Africa is obstructed by lack of sufficient knowledge of its Asteropyginae. On account of publications of R. & E. Richter (1943), G. & H. Termier (1950), LeMaître (1952) and Pillet (1961) one may expect that a detailed study of the Asteropyginae will provide many new data.

Correlation of the Palentian Basin with other areas

In the Gedinnian and Siegenian deposits of the Palentian Basin trilobites, belonging to the Homalonotidae, Acastavinae and Asteropyginae predominate and correlation is possible with areas with detrital deposits, such as the Rhenish Mountains, the Armorican Massif and Aragón. In the Emsian deposits Asteropyginae dominate in the limestone members, trilobites which indicate a deeper environment (*Reedops*, *Xiphogonium*, *Astycoryphe*) occur in the shaly and marly deposits. In the deposits dating from Eifelian to Famennian Asteropyginae are absent and deeper water elements such as phacopids with reduced eyes (*Eocryphops*) or even without eyes (*Trimerocephalus*) occur.

Boundary between Carazo Fm. and Lebanza Fm. - (For a survey of the trilobite fauna the reader is referred to Pl. 18 figs. 1-10, Pl. 19 figs. 1-3; locs. P1-3). In the upper part of the Carazo Fm., which Binnekamp (1965) with brachiopods dated as Lower Gedinnian, the following trilobites occur: *Acastella tiro*, *Treveropyge? ebbae* and *Digonus aff. roemeri*. This fauna confirms the dating with brachiopods. In the basal limestone beds of the overlying Lebanza Fm. *Warburgella rugulosa* ssp. was found, which occurs in Aragón in the uppermost Lower Gedinnian (Gandl, pers. comm.). On account of these data the age of the boundary between the Carazo Fm. and Lebanza Fm. is accurately established. The trilobite fauna can be correlated with the fauna of many areas throughout Europe and northwestern Africa. Both *Acastella tiro*, which mainly occurs in siliciclastic deposits, and *Warburgella rugulosa*, which prefers organodetritic limestones, should be considered as good guide fossils. *A. tiro* occurs in the upper part of the Luesma Fm. (d1cγ) and in combination with *W. rugulosa* ssp. at the base of the overlying Nogueras Fm. (d2aα) in Aragón, which means that the transition of the siliciclastic to the calcareous sedimentation in the Palentian Basin (Carazo Fm.→Lebanza Fm.) was contemporaneous to the same transition in Aragón (Luesma Fm.→ Nogueras Fm.). *A. tiro* also occurs on the transition of the Alcolea Fm.→ Cercadillo Fm. (Gandl, 1972) in the Guadarrama. In northern Europe

A. tiro together with *T.? ebbae, D. roemeri* and *W. rugulosa rhenana* Alberti, 1962 occurs in the Hüinghausen Beds and the Bredeneck Beds of the Rhenish Mountains (R. & E. Richter, 1954; Timm, 1981), while the combination *A. tiro* and *W. rugulosa rugulosa* (Alth, 1874) occurs both in the Bostow Fm. in the Holy Cross Mountains (Poland) and in the Borszczow Fm. in Podolia (USSR). Furthermore *D. roemeri* occurs in the "Schistes de Mondrepuits" in the Ardennes. In central Europe *W. rugulosa* has been found, however, without *A. tiro*, in eastern Thuringia (Upper Graptolite Shales) and in central Bohemia (Radotin & Kotýs Fm.) at the base of the Lochkovian. In northwestern Africa *A. tiro* together with *T.? ebbae* and *W. rugulosa maura* G. Alberti, 1963 has been found near the top of the Ain Deliouine Fm. (Anti-Atlas), in the Tindouf Basin and in the Ougarta Chain (Algeria). Finally *Warburgella rugulosa* even has been found in northern Canada.

Upper part of the Lebanza Fm. - (Pl. 19 figs. 4-11; locs. P4-7). The trilobite fauna, which for the larger part consists of Asteropyginae, has *Paracryphaeus jonesi* and *Pilletina aequisulcata matutina* in common with the fauna of the upper part of the Nogueras Fm.(d2cβ) in Aragón. Moreover in this part of the Nogueras Fm. the first representatives of *Treveropyge procerospinosa*, which are quite similar to *Treveropyge lebanzaensis* (Lebanza Fm.) occur. This indicates a contemporaneous end (Middle-Upper Siegenian) of the calcareous Nogueras Fm. and Lebanza Fm. The presence of *Paracryphaeus jonesi, Pseudocryphaeus oehlerti, Pseudocryphaeus michelini, Kayserops? champagnensis* and *Parahomalonotus gervillei* in the Lebanza Fm. allows a good correlation with the *Athyris undata* brachiopod zone (upper Middle Siegenian) in the Armorican Massif. This zone occurs throughout the "Synclinorium médian" (upper part of l'Armorique Fm., upper part of St. Céneré Fm. and Calc. de Mayenne) as well as in the "Synclinorium d'Angers-Julien de Vouvantes" (Calc. de Vern à *A. undata*). On account of the occurrence of a.o. *Treveropyge wallacei* G. & H. Termier, 1950 (quite similar to *T. lebanzaensis*) and *Parahomalonotus gervillei* in the "Assise d'Assa" (Anti-Atlas) the Lebanza Fm. can be correlated with Morroccan deposits.

The appearance of *Phacops* in deposits just below the Requejada Member (Abadía Fm.) seems to be contemporaneous to the first occurrence of *Phacops potieri* Bayle, 1878 in the Armorican Massif at the transition Siegenian-Emsian.

Requejada Member and overlying siltstones of the Abadía Fm. - (Pl. 20 figs. 1-8, Pl. 21 figs. 1-13, Pl. 22 figs. 1,2; locs. P8-P14). The abundant trilobite fauna of the Requejada Member and of some overlying siltstones is strikingly similar to the fauna of the upper part of the Faou Fm. and the base of the Reun ar C'Hrank Fm. of the Rade de Brest (Armorican Massif), which is referred to by Le Menn et al. (1976) as an "Incursion hercynienne dans les faunes rhenanes..". The Armorican trilobites have been described by Morzadec (1976b). The upper part of the Faou Fm. and the Requejada Member have the following species in common: *Pilletina aulnensis, Kayserops ogivalis Scutellum* sp., *Proetus* (n.sg.) n.sp., *Phacops saberensis, Otarion* sp., *Odontochile seillouensis, Leonaspis* sp. and *Trimerus (Dipleura)* sp. (which in neither areas occurs together with *O. seillouensis*). *Acastava* n.sp., *Trimerus (Dipleura)* sp., *Phacops saberensis* and *Otarion* sp. are found both at the base of the Reun ar C'Hrank Fm. and in the siltstones (loc. P14) which overly the Requejada Member. Moreover the other faunal elements, of which pleurodictyoform tabulates and dacryoconarids are abundant, and the lithologic features of the deposits (argillaceous decalcified siltstones) are quite similar. On account of tentaculites as well as dacryoconarids and brachiopods the fauna near the top of the Faou Fm. is dated as Lower Zlichovian or Lower Emsian, which corresponds to the age of the Requejada Member (*praecursor* tentaculite zone, Goeyenbier, pers. comm.). The base of the Reun ar C'Hrank Fm. is dated as Lower Zlichovian or upper Lower Emsian (on account of a.o. *Kayserops obsoletus*), which corresponds to the age of loc. P14. The siltstones of loc. P14 may also be correlated with the lower part of the Mariposas Fm. (d4aβ, upper Lower Emsian) in Aragón on account of *Acastava* n.sp. and *C. (Cornuproetus)* n.sp. *aff. chouberti*.

Green-yellow marls between the Requejada and Polentinos Member of the Abadía Fm. - (Pl. 22 figs. 3-13, Pl. 23 figs. 1-15, Pl. 24 figs. 6-12; locs. P16-18). These deposits have a varied trilobite fauna, the Asteropyginae are of minor importance and elements indicating a deep environment dominate. In general the fauna is quite similar to that of the "Calc. de la Grange" (synclinorium of Ancénsis, Armorican Massif), which, however, completely lacks Asteropyginae. Further *Reedops cf. modestus, Xiphogonium trautensteinensis* ssp., *Cheirurus (Pilletopeltis) aff. sternbergi* and *Scabriscutellum (Cavetia) cf. furciferum* indicate affinity to the faunas of the Zorgensis Limestone (Lower Harz Mts.), Zlichov Limestone (central Bohemia) and to deposits in southeastern Morocco (Tafilalt), which are all of Upper Emsian (or upper Zlichovian) age. On account of Asteropyginae (*Kayserops brevispinosus* and *Rhenops*) this part of the Abadía Fm. can be correlated with the upper part of the Mariposas Fm. (d4bβ-γ) in Aragón and with the Marettes Fm. ("Syncl. médian", Armorican Massif).

Polentinos Member of the Abadía Fm. - (Pl. 24 figs. 6-12, Pl. 25 figs. 1-6; locs. P19-24). In these limestones with shaly intercalations Asteropyginae are again dominant. *Comura defensor* indicates an affinity to the fauna of the Heisdorf Beds (Rhenish Mountains), which are of uppermost Emsian age. *Treveropyge henryi, G. (Greenops) chaconae, G. (Neometacanthus) perforatus* and *Phacops oehlerti* indicate affinity to faunas of the "Synclinorium médian" in the Armorican Massif (a.o. "Sch. à nodules calcaires de l'Eifelien inférieur"; Morzadec, 1969).

Green-yellow shales of the lower part of the Gustalapiedra Fm. - (Pl. 25 figs. 7-12; loc. P25). These deposits yield iron-coated specimens of *Eocryphops aff. cyclophthalmus* together with *Harpes aff. radians*. *Eocryphops*, which is characteristic for a relatively quiet environment with a muddy bottom in deeper water (Chlupač, 1977), is an important guide fossil of the Lower Eifelian (*Struveaspis micromma* zone). It has been found in the Rhenish Mts., Harz Mts., Thuringia, central Bohemia and Morocco (Hercynian Massif of Central Morocco). *E. cyclophthalmus* together with a.o. *H. radians* has been found in the Tentaculites Shales (also green-yellow with iron-coated fossils) in Vogtland (Thuringia), which can be correlated with the Daleje Shales and lower part of the Trebotov Limestone (central Bohemia).

Black shales of the middle part of the Gustalapiedra Fm. - (Pl. 26 figs. 1-8; loc. P26). These shales with an abundant fauna of dacryoconarids and pelecypods yield an impoverished trilobite fauna with *Paraaulacopleura aff. beyrichi* and *Leonaspis aff. pigra*. The first species indicates affinity to the fauna of the Lower Harz Mts. and the Eifel (Gunterod Limestone); the latter species occurs in the Upper Eifelian of central Bohemia (Choteč Limestone), Eifel, Lahn area (Gunterod Limestone), Lower Harz Mts., Moravian Karst and Morocco (Tafilalt).

Green shales and nodular limestones at the base of the Vidrieros Fm. - (Pl. 26 figs. 9-16; loc. P28). These deposits yield blind phacopid trilobites belonging to the genus *Trimerocephalus*. This genus, which has a widespread distribution throughout Europe, Asia Minor, western Asia and northern Africa, indicates relatively deeper water conditions. Some specimens from the Vidrieros Fm. can be identified as *T. aff. caecus* which occurs in Germany (Harz Mts., Rhenish Mts., Thuringia, Frankenwald), Poland (Holy Cross Mountains), Ural Mountains and northern Africa. It indicates a Lower Famennian age (main distribution in to IIβ: upper *Cheiloceras* goniatite zone) which corresponds to the dating with conodonts: *marginifera*-Zone (Raven, pers. comm.)

Correlation of the Asturo-Leonese Basin with other areas

In the Lower Devonian the general composition of the trilobite fauna looks quite similar to that of the Palentian Basin, with the exception the Emsian deposits of the Asturo-Leonese Basin lack trilobites which indicate a deeper water environment (*Odontochile, Cheirurus (Pilletopeltis), Reedops* and *Astycoryphe*). In the Eifelian to Frasnian the Asteropyginae dominate, accompanied by phacopids with large eyes ("reefal" facies).

Upper part of the San Pedro Fm. - (loc. L1). Ferruginous sandstones of the upper part of the San Pedro Fm. near Grandoso (Esla-Porma region) yield, besides brachiopods, *Acastella* sp. and *Digonus aff. roemeri*, which indicate a Lower Gedinnian age.

Base of the La Vid Fm. near Lumajo. - (Pl. 34 figs. 1-4; loc. X1). The La Vid Fm. near Lumajo commences with a dark argillaceous limestone unit (Abelgas unit), which is overlain by dolomites. From this fossiliferous limestone *Acastella cf. crenulata* and *Acastella cf. latimarginata* were collected, which can be correlated with the fauna of the Guadarrama and the Armorican Massif. In the Guadarrama Gandl (1972) has described *A. latimarginata* from dark marly limestones of the lower part of the Cercadillo Fm. (MS6 ≈ d2aβ), which are of uppermost Lower Gedinnian (just above the *A. tiro* zone). In the Armorican Massif *A. latimarginata* together with *A. crenulata* occur in the lower part of the St. Céneré Fm., which is also dated as uppermost Lower Gedinnian on account of its fauna and flora (Babin et al., 1976).

Lower part of the limestone member of the La Vid Fm. west of the Pardomino High. - (Pl. 34 figs. 5-17; locs. X2,3). The limestones just above the dolomites yield an abundant trilobite fauna, in which the genus *Phacops* is not represented. This fauna has in common with the fauna of the upper part of the St. Céneré Fm. in the Armorican Massif: the Asteropyginae *Paracryphaeus izensis* and *Pseudocryphaeus cossensis*, which indicate a Siegenian age (*A. undata* zone), and with the fauna of the middle and upper part of the Santa Cruz Fm. (d3bγ-δ) in Aragón: the (sub)species *Pilletina lips mozoensis, Pilletina triangularis* and *Pseudocryphaeus astrictus*, which indicate lowermost Emsian. Besides these Asteropyginae, *P. (Coniproetus) finitimus* n.ssp. and *C. (Cornuproetus) aff. haentzscheli* occur. *P. (C.) finitimus* occurs in the Upper Koneprusy Limestone (central Bohemia) and at the base of the "princeps" Limestone (northwestern Morocco), *C. (C.) haentzscheli* is found in the upper part of the "Assise d'Assa" (Tindouf Basin, Morocco), which both indicate a Pragian age. On account of the complete trilobite fauna the age of these limestones should be considered as Upper Siegenian-lowermost Emsian.

Lower part of the limestone member of the La Vid Fm. in the Esla-Porma region. - (Pl. 27 figs. 3-8; locs. L2-5). In the limestones just above the dolomites in this area, we find, besides species which indicate the same age as the above mentioned level (locs. X2,3), some younger elements (*Phacops saberensis, Pilletina collensis* and *Trimerus (Dipleura)* sp.) which suggest Lower Emsian.

Upper part of the limestone member of the La Vid Fm. in the Esla-Porma region. - (Pl. 27 figs. 9-13, Pl. 28 figs. 1-14, Pl. 29 figs. 1-10, Pl. 30 figs. 1-12, Pl. 31 figs. 1-17; locs. L6,7). In the argillaceous limestones of this level an abundant trilobite fauna is found. Most specimens have been collected at loc. L6 near Colle. The Asteropyginae *Treveropyge iberica, Treveropyge? acrifrons* and *Kayserops obsoletus* together with *Acastava* n.sp. and *C. (Cornuproetus)* n.sp. *aff. chouberti* both occur in this level and in the lower part of the Mariposas Fm. (d4aβ) in Aragón. They indicate an upper Lower Emsian age. *K. obsoletus* and *Acastava* n.sp. have also been found at the base of the Reun ar C'Hrank Fm. (Rade de Brest, Armorican Massif). Furthermore *Leonaspis aff. maura* and *C. (Cornuproetus)* n.sp. *aff. chouberti* indicate a relation to the fauna of the Aïn Targa Beds (western Morocco) for which a lowermost Upper Emsian age is designed (G. Alberti, 1969).

The shale member of the La Vid Fm. - In these deposits *Kayserops brevispinosus* is found. It also occurs in the upper part of the Mariposas Fm. (d4bβ) in Aragón and near the transition La Foulerie Fm.-Marettes Fm. in the Armorican Massif and indicates a lower Upper Emsian age. The species *C. (Cornuproetus) aff. corrugatus* and *Otarion aff. druida* indicate affinity to the fauna of the Zorgensis Lst. (Lower Harz Mts.).

The trilobite fauna of the Santa Lucía Fm. is too poor to allow a correlation with other areas, moreover the dominating Malladaiinae are only known from the Cantabrian Mountains.

Lower part of the Huergas Fm. - (Pl. 32 figs. 8-16; locs. L14-17, X9,10). The Asteropyginae *G. (Neometacanthus) perforatus* and *Bradocryphaeus? cantarmoricus* occur both in the lower part of the Huergas Fm. and in the Armorican Massif. The first species has been found in the "niveau schisto-grauwackeux à *Euryspirifer* sp. groupe *intermedius*" (Morzadec, 1969), the latter one occurs in the St. Fiacre Fm.; both indicate Lower Eifelian. The Proetidae *P. (Proetus) cf. orbitatus, P. (Proetus) aff. granulosus* and *C. (Diademaproetus) holzapfeli* ssp. indicate affinity to the fauna of the Suchomasty Lst. (central Bohemia), the Greifenstein Lst. and the Gunterod Lst. (Germany). *Lobopyge cf. peneaui* from the lower part of the San Martin Fm. (≈Huergas Fm.; Pl. 27 figs. 1,2; loc. V1) indicates affinity to the fauna of the upper part of the "Calcaire d'Erbray" in the Armorican Massif.

A fossiliferous sandstone bed in the upper part of the Huergas Fm. - (locs. L19,20). This bed yields *Neocalmonia cantabrica* n.sp., which only has affinity to species described from Afghanistan. Because this species is the oldest one of the genus, an European origin of *Neocalmonia* is probable. This reinforces the probability of a direct migration route along the southern border of the Palaeotethys during the Middle Devonian (cf. Fig. 12).

The limestones of the Portilla Fm. - The trilobite fauna of these deposits is characteristic of a "reef" facies, which occurs in many areas in Europe. Besides Asteropyginae (*G. (Greenops), Heliopyge* and *Bradocryphaeus*) the following (sub)genera have been found: *Phacops, Otarion, P. (Proetus)* and *Scutellum*. The representatives of *Phacops* belong to *Phacops rana*, which has been originally described from North America. Burton & Eldredge (1974) described two subspecies from the Middle Devonian of northwestern Africa (Tindouf Basin), at present three subspecies are known from the Cantabrian Mountains. This makes it probable that *Phacops rana* originated in Europe. The same is true for *G. (Greenops) boothi*, which both occurs in Europe (Asturias, León, Aragón), northwestern Africa and northeastern North America. This suggests a direct migration from Spain, via northwestern Africa to northeastern North America in the Middle Devonian (Fig. 9).

In the lower part of the Portilla Fm. (Veneros Member; Reijers, 1972) a subspecies of *Phacops rana* closely related to the North African *P. rana africanus* is found.

In the middle member of the Portilla Fm. (Pl. 35 figs. 4-11; locs. X12-15) a subspecies quite similar to the North American *P. rana crassituberculata* occurs together with a.o. *Scutellum costatum cf. lummatonensis* which indicates affinity to the fauna of the Torquay Lst. (England). Conodonts of the middle member indicate Upper *varcus* Zone - *hermanni-cristatus* Zone (Raven, pers. comm.).

In the upper member of the Portilla Fm. (Pl. 33 figs. 1-13; loc. L22) a subspecies related to the North American *P. rana rana* occurs together with *Otarion aff. ellipsocephalum* which indicates affinity to the Lower Frasnian trilobite fauna of the Dorp Lst. (Bergisch Land, F.R.G.) and the Iberg Lst. (Upper Harz Mts.). The conodont fauna also indicates a Lower Frasnian age (Raven, pers. comm.).

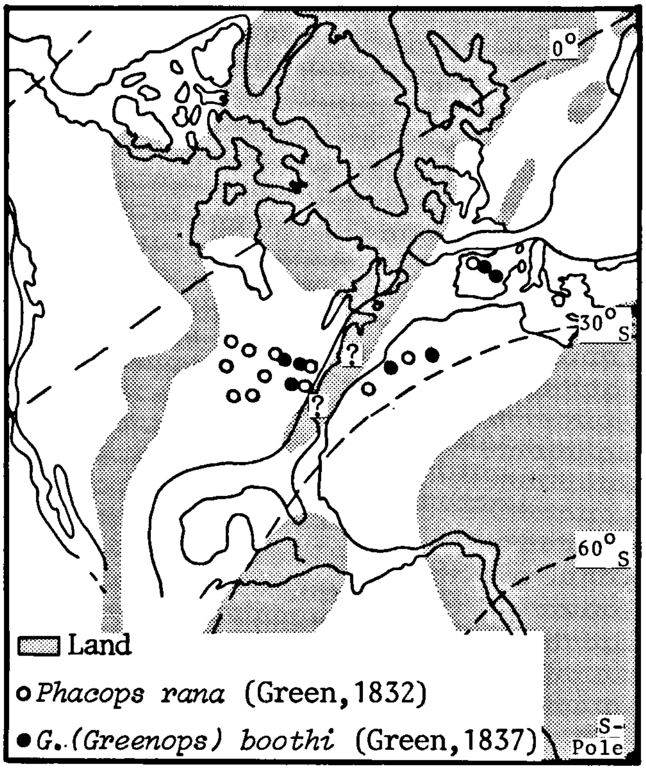
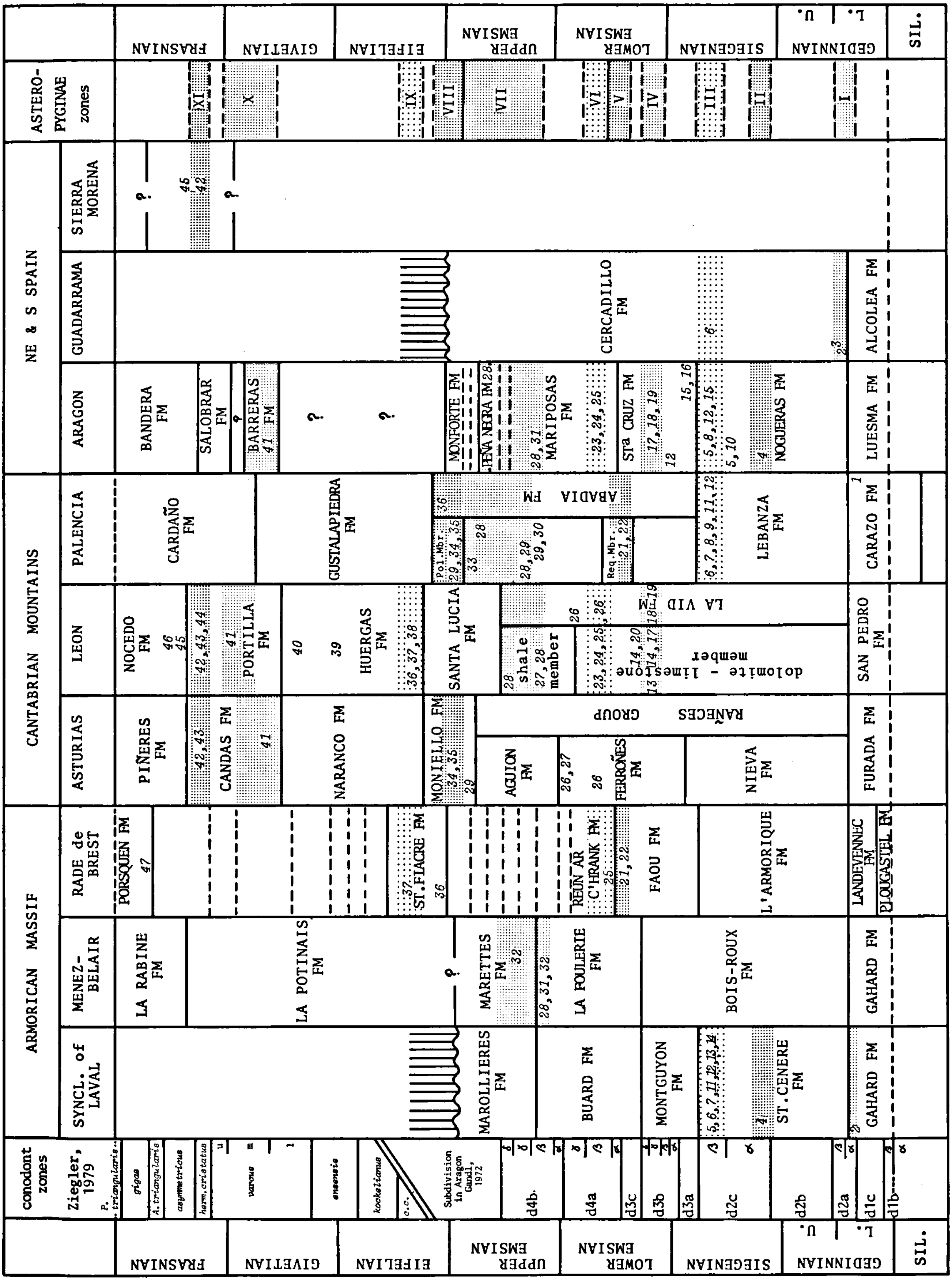


Fig. 9. Givetian-Frasnian palaeogeography with the distribution of *G. (Greenops) boothi* and *Phacops rana*. Base map modified after Oliver (1977, fig. 13).

ZONATION BY MEANS OF ASTEROPYGINAE

As now the Asteropyginae from the southern Cantabrian Mountains have been described, this group is fairly well known throughout the Ibero-Armorican region. As geographic barriers seem to have been absent migration of species was possible. Only environmental conditions sometimes seem to have been an obstruction for the distribution of Asteropyginae throughout the region. In a time-stratigraphic table (Fig. 10) the distribution of the species, which are important for correlation, has been plotted. The correlations between the Cantabrian Mountains and other areas were discussed in the preceding sections of this chapter. Further on account of *Protacanthina velillae* subspecies the transition of the Gahard Fm. - St. Céneré Fm. in the Armorican Massif should be correlated with the transition of the Alcolea Fm. - Cercadillo Fm. in the Guadarrama (upper Lower Gedinnian) and on account of *Paracryphaeus praejonesi* Gandl, 1972 the middle part of the St. Céneré Fm. can be correlated with the middle part of the Nogueras Fm. in Aragón (Lower Siegenian).

On the ground of these correlations and the stratigraphic distribution of the most important species of the Asteropyginae a provisional biozonation of the Devonian has been designed (Fig. 11). In the Gedinnian and Lower Siegenian the Asteropyginae were so scarce that only two



SIL.
GEDINNIAN
L.
U.
SIEGENIAN
LOWER EMSIAN
UPPER EMSIAN
EIFELIAN
GIVETIAN
FRASNIAN
ASTERO-PYGINAE zones
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
NE & S SPAIN
SIERRA MORENA
GUADARRAMA
ARAGON
CANTABRIAN MOUNTAINS
PALENCIA
LEON
ASTURIAS
ARMORICAN MASSIF
RADE de BREST
MENEZ-BELAIR
SYNCL. of LAVAL
conodont zones
Ziegler, 1979
Subdivision in Aragon Gandl, 1972
ALCOLEA FM
CERCADILLO FM
LUESMA FM
NOGUERAS FM
Sta CRUZ FM
MARIPOSAS FM
PEÑA NEGRA FM
MONFORTE FM
BARRERAS FM
SALOBRAR FM
BANDERA FM
CARAZO FM
LEBANZA FM
Req.Mbr.
ABADIA FM
Pol.Mbr.
GUSTALAPIEDRA FM
CARDAÑO FM
SAN PEDRO FM
dolomite - limestone member
LA VID FM
shale member
SANTA LUCIA FM
HUERGAS FM
PORTILLA FM
NOCEDO FM
FURADA FM
NIEVA FM
FERROÑES FM
AGUION FM
RAÑECES GROUP
MONIELLO FM
NARANCO FM
CANDAS FM
PIÑERES FM
PLOUGASTEL FM
LANDEVENNEC FM
L'ARMORIQUE FM
FAOU FM
REUN AR C'HRANK FM
ST.FIACRE FM
PORSQUEN FM
GAHARD FM
BOIS-ROUX FM
LA FOULERIE FM
MARETTES FM
LA POTINAIS FM
LA RABINE FM
ST.CENERE FM
MONTGUYON FM
BUARD FM
MAROLLIERES FM
d1b
d1c
d2a
d2b
d2c
d3a
d3b
d3c
d4a
d4b
P. triangularis
gigas
A. triangularis
asymmetricus
herm. cristatus
varcus
ensensis
kockelianus
c.c.

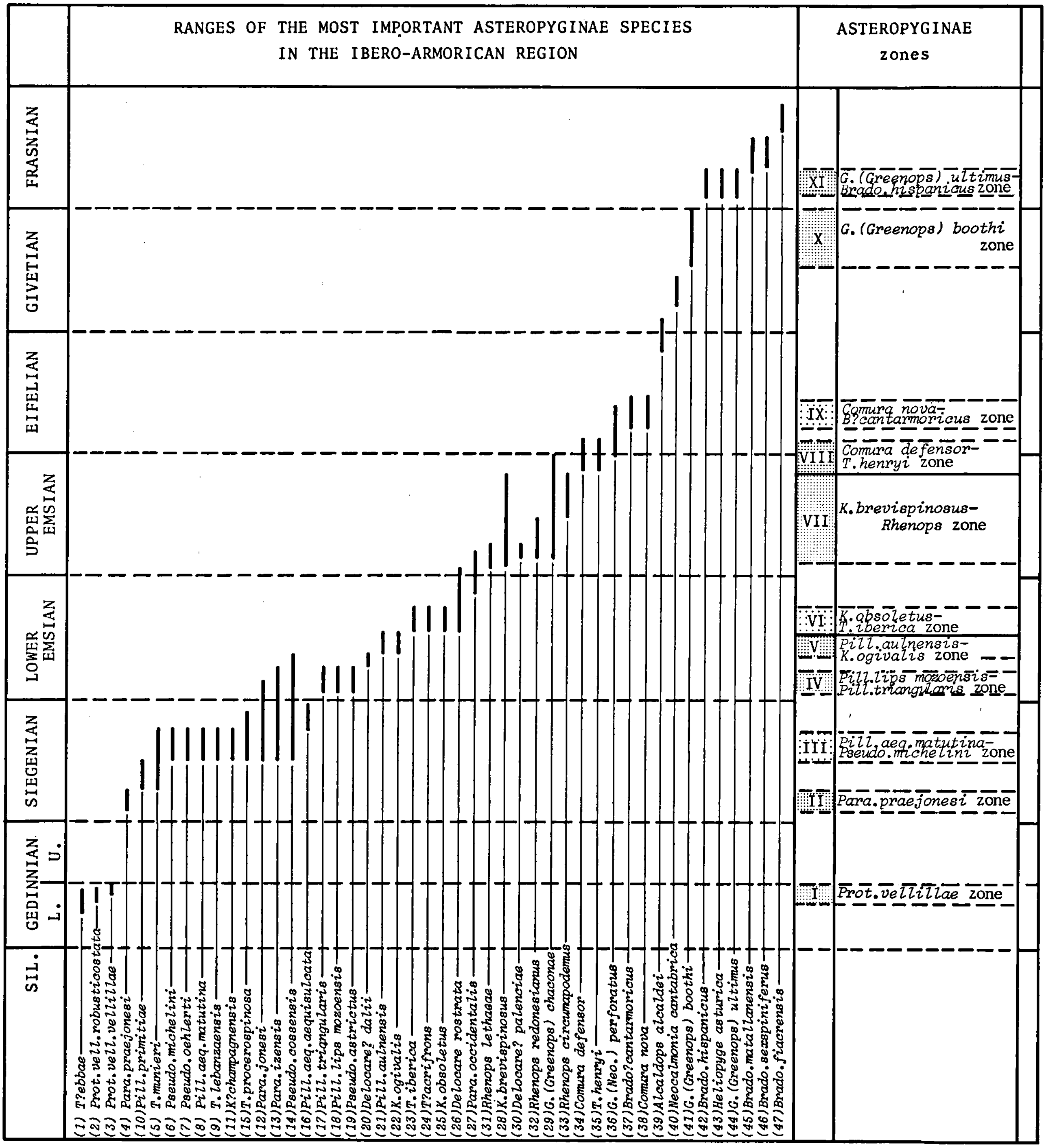


Fig. 11. Zonation by means of Asteropyginae. The left part shows the vertical distribution of the most important species within the Ibero-Armorican region. The right column shows the provisional zonation, which corresponds to the right column of Fig. 10.

Fig. 10. Time-stratigraphic table of Devonian formations throughout the Ibero-Armorican region after Racheboeuf (1982) for the Armorican Massif, Brouwer (1968) for the Cantabrian Mountains, and Carls & Gandl (1968) and Carls et al. (1972) for the Celtiberian Chain (Aragón) and the Guadarrama. In the upper left the conodont zonation according to Ziegler (1979) is related to the Middle and Upper Devonian. In the lower left the lithostratigraphic subdivision of the Lower Devonian succession in Aragón according to Gandl (1972) is given. The most important Asteropyginae data are plotted as numbers, which refer to the species of Fig. 11. A provisional zonation on account of these Asteropyginae species is given in the right column.

range zones could be established. From Middle Siegenian to Lower Eifelian Asteropyginae were more common and it was possible to design seven Oppel zones as well as overlap zones which cover most of this time interval. Due to the scarcity of Asteropyginae no biozonation is possible in the Upper Eifelian - Lower Givetian interval. For the Upper Givetian and Lower Frasnian a range zone and an Oppel zone could be established.

I. The *Protacanthina velillae* range zone, which is based on the occurrence of subspecies of *P. velillae* Gandl, 1972. Up to now they have only been found in the Guadarrama and the Armorican Massif (uppermost Lower Gedinnian).

II. The *Paracryphaeus praejonesi* range zone, is based on the occurrence of *P. praejonesi* Gandl, 1972 which has been found in Aragón and the Armorican Massif (Lower Siegenian).

III. The *Pilletina aequisulcata matutina - Pseudocryphaeus michelini* Oppel zone is based on the occurrence of some species of the group *Pilletina aequisulcata matutina, Pseudocryphaeus michelini, Pseudocryphaeus oehlerti, Treveropyge lebanzaensis, Treveropyge munieri, Treveropyge procerospinosa* and *Kayserops? champagnensis*. This zone, which may be correspond for the major part to the *Athyris undata* brachiopod zone, has been found in the Armorican Massif, Palencia, Aragón and probably in the Guadarrama, Portugal, northern Africa and Turkey and indicates a Middle-Upper Siegenian age.

IV. The *Pilletina lips mozoensis - Pilletina triangularis* Oppel zone, which is based on the occurrence of some species of the group *P. lips mozoensis, P. triangularis, Pseudocryphaeus astrictus* and eventual *Pseudocryphaeus cossensis* or *Paracryphaeus izensis* has been found in the Leonese Basin, in Aragón and probably also in northern Africa (lowermost Emsian).

V. The *Pilletina aulnensis - Kayserops ogivalis* overlap zone is based on the occurrence of these species simultaneous. This zone has been found in the Armorican Massif, Palencia and probably also in Turkey and indicates a Lower Emsian age.

VI. The *Kayserops obsoletus - Treveropyge iberica* Oppel zone, which is based on the occurrence of some species of the group *K. obsoletus, T. iberica, Treveropyge? acrifrons* and *Delocare rostrata* has been found in the Leonese Basin, Aragón and probably in the Armorican Massif (uppermost Lower Emsian).

VII. The *Kayserops brevispinosus - Rhenops* overlap zone is based on the occurrence of *K. brevispinosus* together with one of the species of the *Rhenops lethaeae* group (*Rh. lethaeae, Rh. redonesianus* or *Rh. circumapodemus*). These species may be accompanied by *G. (Greenops) chaconae*. It is not impossible that this zone is only valid for deeper water environments. The zone has been found in Aragón, Palencia and the Armorican Massif and indicates an Upper Emsian age.

VIII. The *Comura defensor - Treveropyge henryi* overlap zone, or possibly Oppel zone if *G. (Neometacanthus) perforatus* or *G. (Greenops) chaconae* also occur, has been found both in the Asturo-Leonese and the Palentian Basins (uppermost Emsian - lowermost Eifelian).

IX. The *Comura nova - Bradocryphaeus? cantarmoricus* overlap zone is based on the occurrence of these species together. This zone has been found in the Leonese Basin and in the Armorican Massif and indicates a Lower Eifelian age.

X. The *G. (Greenops) boothi* range zone up to now has been found in the Asturo-Leonese Basin, Aragón, northern Africa and North America and indicates a Middle to Upper Givetian age.

XI. The *G. (Greenops) ultimus - Bradocryphaeus hispanicus* Oppel zone is based on the occurrence of some species of the group *G. (G.) ultimus, B. hispanicus* and *Heliopyge asturica*. This zone has been found in the Asturo-Leonese Basin and probably in the Sierra Morena and indicates a Lower Frasnian age.

This zonal scheme is provisional, but sketches what may be expected for biostratigraphic purposes from the Asteropyginae in future. Moreover this zonation may be a key for studying the Asteropyginae from northwestern Africa or dating the Lower Devonian succession in Turkey.

GEOGRAPHIC DISTRIBUTION OF THE ASTEROPYGINAE

The geographic distribution of Asteropyginae is restricted (Fig. 12). Since in the Lower Devonian they are only known to occur in Europe and northwestern Africa, Spain may be considered as the center of distribution. In the Middle Devonian they spread to northeastern North America in the west and Persia, Afghanistan and Burma in the east. Europe has genera in common with both areas, northeastern North America and Asia have no genera in common.

When plotted on the palaeogeographic map for the Middle Devonian of Oliver (1977) the localities show a regular distribution pattern between the equator and 30° S with one discrepancy: on that map Burma is situated far in the north. As there are no palaeomagnetic data the position of the Burma-Malaysia block, however, is quite speculative. On account of the distribution of carbonates and related lithic palaeoclimatic indicators Heckel & Witzke (1979) concluded that the Burma-Malaysia block was situated in the southern hemisphere. According to Colbert (1973) it probably was part of Gondwana. This is also suggested by (1) the fact all other localities where Asteropyginae are found were situated in the southern hemisphere, (2) the migration of the Asteropyginae seems to have taken place along the southern border of the Palaeotethys from Spain via Persia to Afghanistan and (3) Burma has the genus *Bradocryphaeus* in common with Afghanistan.

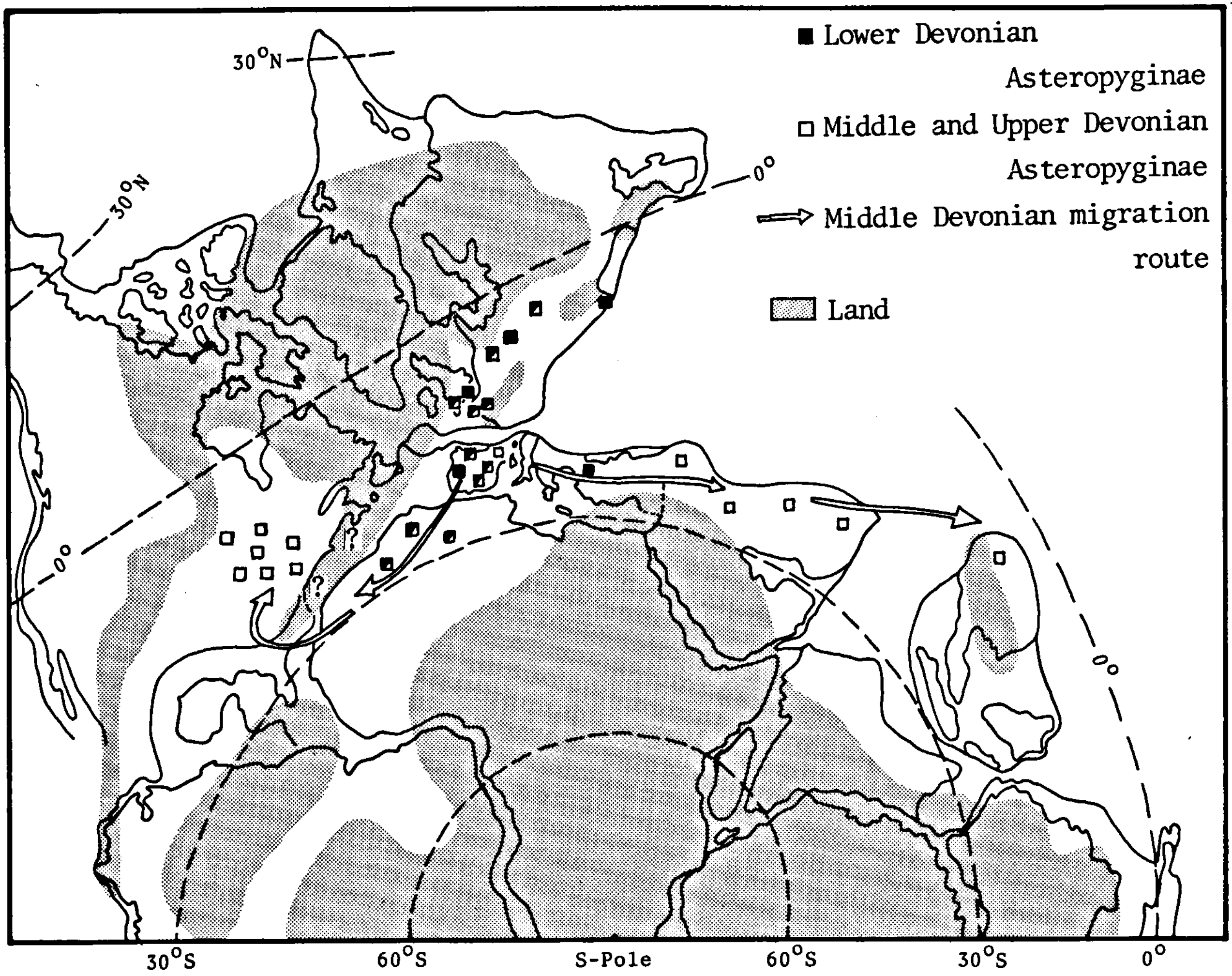


Fig. 12. Geographic distribution of the Asteropyginae. Data are plotted on the palaeogeographic map for the Middle Devonian from Oliver (1977, fig. 13), which is modified by shifting the Burma-Malaysia block to the southern hemisphere.

CHAPTER V

LOCALITIES WITH THEIR TRILOBITE FAUNA

The trilobites have been obtained from a total of 70 localities in the Palentian Basin and the Leonese part (except the Valsurvio region) of the Asturo-Leonese Basin, throughout the entire Devonian from Lower Gedinnian to Famennian.

In the Palentian Basin from twenty-nine localities (P1-28, M1) trilobites have been collected, which represent thirteen stratigraphic levels ranging in age from Lower Gedinnian to Lower Famennian. In the Ventanilla region of the Leonese Basin trilobites have been obtained from three localities (V1-3), which represent as many stratigraphic levels ranging in age from Eifelian to Frasnian. In the Esla-Porma region trilobites have been obtained from twenty-two localities (L1-22) representing eleven stratigraphic levels, which range in age from Lower Gedinnian to Lower Frasnian. Finally in the western part of the Leonese Basin trilobites have been collected from eighteen localities (X1-18) belonging to thirteen stratigraphic levels ranging in age from Lower Gedinnian to Middle Frasnian.

In this chapter for each locality a description of the sediments, its stratigraphic level, its geographic position and coordinates with regard to Madrid, its trilobite fauna and age is given. The geographic position of the localities is further indicated on the locality maps, Figs. 15-22. Moreover the trilobites of the most important stratigraphic levels are depicted on Plates 18-35.

Abbreviation. - (t.l.) = type locality.

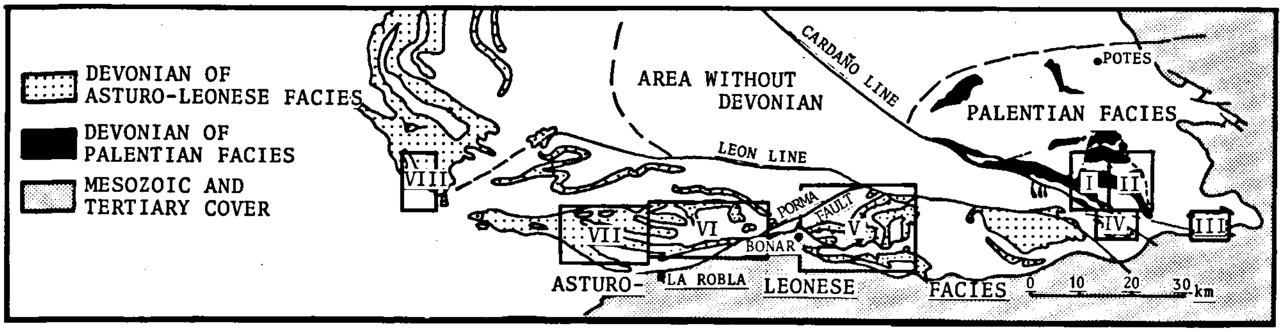


Fig. 13. Index-map of the southern Cantabrian Mountains showing the locations of the investigated regions: I. Arauz-Carrion region; II. Polentinos-Lebanza region; III. Mudá-San Julian region; IV. Ventanilla region; V. Esla-Porma region; VI. Curueño-Torio-Bernesga region; VII. Bernesga-Luna region; VIII. Luna-Sil region.

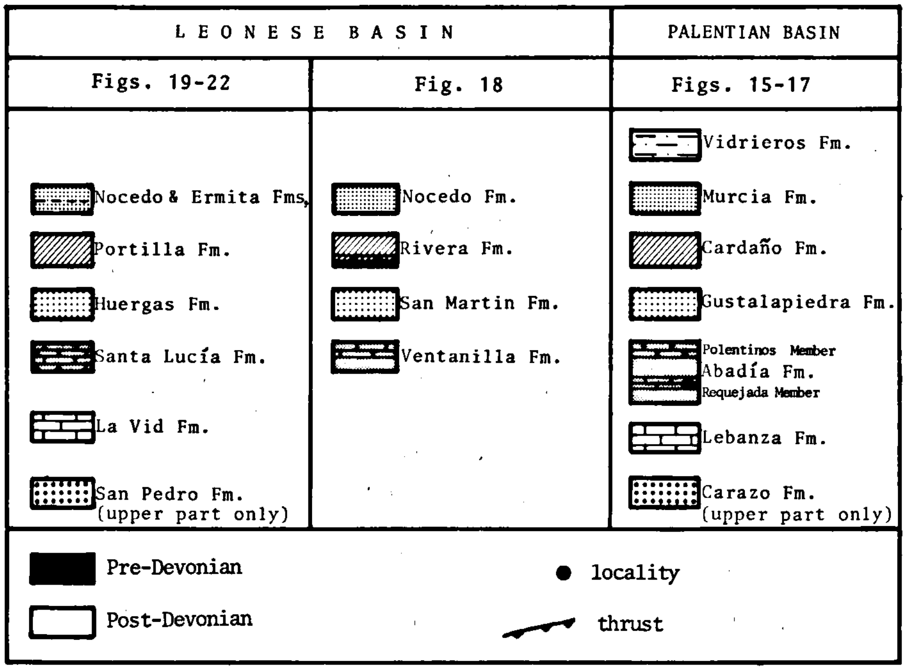


Fig. 14. Legend to the locality maps of Figs. 15-22.

PALENTIAN BASIN

Polentinos - Carrion Region (Figs. 15,16)

Carazo Fm.

P1. Argillaceous sandstones with some limestone intercalations at the top of the Carazo Fm. near the Peña Carazo 4.5 km WSW of Lores. Coord.: 0°53'39" / 42°58'49". *Acastella tiro* R. & E. Richter, 1954, *Digonus aff. roemeri* (de Koninck, 1876). Age: Lower Gedinnian (*tiro* zone).

P2. Calcareous sandstones from the upper part of the Carazo Fm. at the south side of the Arauz syncline along the Arroyo Arauz 5.5 km W of Lores. Coord. 0°54'40"/42°59'52". *Treveropyge? cf. ebbae* (R. & E. Richter, 1954) together with *Acastella tiro* R. & E. Richter, 1954 and *Digonus aff. roemeri* (de Koninck, 1876). Age: Lower Gedinnian (*tiro* zone).

Lebanza Fm.

P3. Argillaceous limestones at the base of the Lebanza Fm. at the south side of the Arauz-syncline along the Arroyo Arauz 5.5 km W of Lores. Coord.: 0°54'40"/42°59'52". *Warburgella rugulosa* ssp., *Parahomalonotus* sp. Age: upper Lower Gedinnian.

P4. Argillaceous limestones from the upper part of the Lebanza Fm. (E-member: see Krans, Guit & van Ofwegen, 1982) 400 m SW of Lebanza. Coord.: 0°50'35"/42°58'02". *Paracryphaeus?* sp., *Pseudocryphaeus* sp., *Treveropyge lebanzaensis* n.sp. (t.l.), *Kayserops? champagnensis* (Morzadec, 1971), *Protacanthina* n.sp. together with *Parahomalonotus gervillei* (de Verneuil, 1850). Age: Middle-Upper Siegenian.

P5. Stratigraphic level like P4, in the quarry along the southern border of the Requejada Lake 2750 m NNE of Arbejal. Coord.: 0°49'08"/42°54'41". *Paracryphaeus cf. jonesi* (Oehlert, 1877), *Pseudocryphaeus cf. michelini* (Rouault, 1851), *Pseudocryphaeus cf. oehlerti* Morzadec, 1971, *Pilletina aequisulcata cf. matutina* (Gandl, 1972) together with *P. (Coniproetus) aff. foucauldi* G. Alberti, 1967, *Parahomalonotus gervillei* (de Verneuil, 1850), "*Scutellum*" sp. Age: Middle-Upper Siegenian.

P6. Stratigraphic level like P4, along the northern border of the Requejada Lake 2500 m SSE of Polentinos. Coord.: 0°49'32"/42°54'58". *Paracryphaeus cf. jonesi* (Oehlert, 1877), *Pseudocryphaeus cf. oehlerti* Morzadec, 1971, *Treveropyge lebanzaensis* n.sp. together with *Parahomalonotus gervillei* (de Verneuil, 1850). Age: Middle-Upper Siegenian.

P7. Stratigraphic level like P4, 2 km W of Lores. Coord.: 0°52'20"/42°59'45". *Paracryphaeus cf. jonesi* (Oehlert, 1877), *Treveropyge lebanzaensis* n.sp. together with *Parahomalonotus gervillei* (de Verneuil, 1850). Age: Middle-Upper Siegenian.

Abadía Fm.

P8. Yellow decalcified siltstones of the Requejada Member 100 m W of Lebanza. Coord.: 0°50'26"/42°58'07". *Paracryphaeus caboi* n.sp. (t.l.); *Pilletina aulnensis* Morzadec, 1976, *Kayserops ogivalis* (Morzadec, 1976) together with *Otarion aff. druida* Erben, 1952, *Cheir. (Pilletopeltis) aff. maurus* (G. Alberti, 1966), *Trimerus (Dipleura)* sp., *Phacops saberensis* Morzadec, 1970, *Leonaspis cf. hoernesi* (Barrande, 1846), "*Scutellum*" sp. Age: lowermost Lower Emsian.

P9. Stratigraphic level like P8, along the road 200 m NNE of the Abadía of Lebanza. Coord.: 0°51'52"/42°57'50". *Pilletina aulnensis* Morzadec, 1976 together with *Trimerus (Dipleura)* sp., *Odontochile aff. spinifera* Barrande, 1852. Age: lowermost Lower Emsian.

P10. Stratigraphic level like P8, 900 m SE of Polentinos. Coord.: 0°49'48"/42°55'56". *Paracryphaeus caboi* n.sp., *Pilletina aulnensis* Morzadec, 1976 together with *Proetus* (n.sg.) n.sp., *Trimerus*

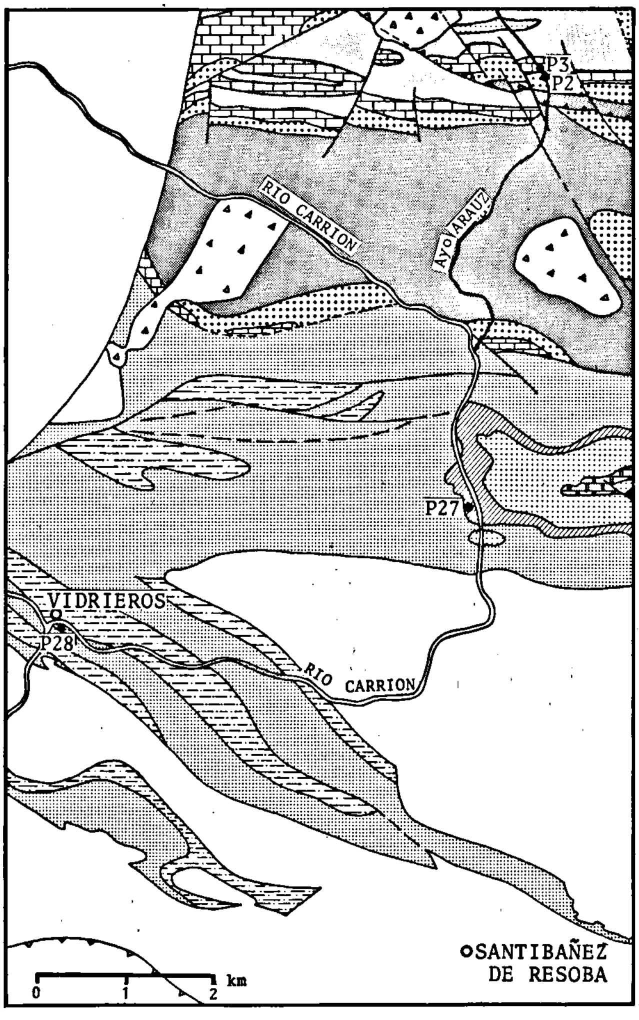


Fig. 15. Locality map of the Arauz-Carrion region (Palentian Basin). Modified after the sheet of Savage (1977).

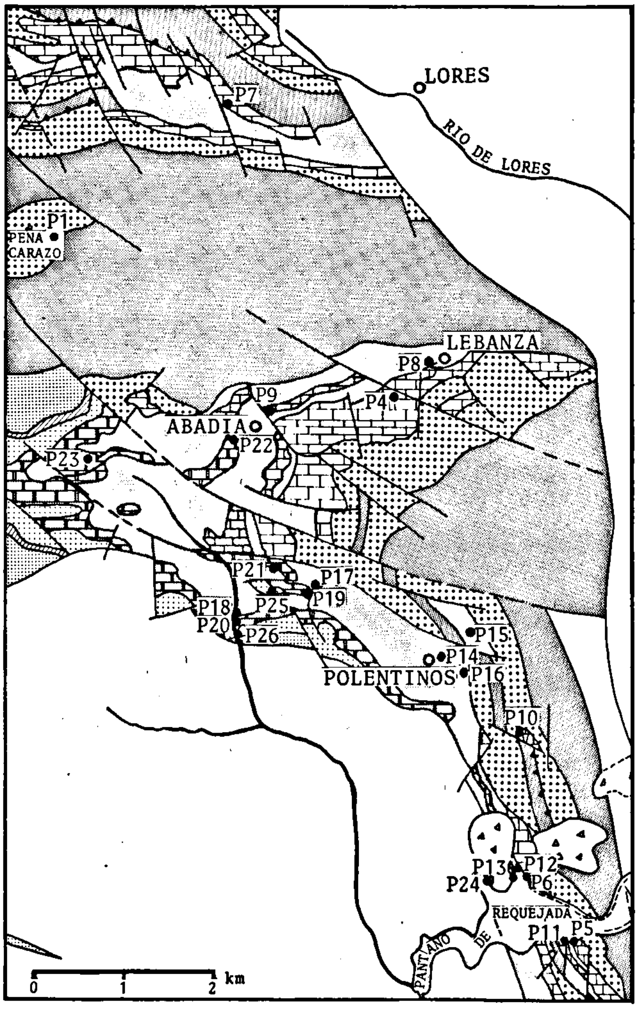


Fig. 16. Locality map of the Polentinos-Lebanza region (Palentian Basin). Modified after the sheet of Savage (1977).

(Dipleura) sp., *Phacops saberensis* Morzadec, 1970, *Odontochile aff. spinifera* Barrande, 1852, *Leonaspis cf. hoernesi* (Barrande, 1846). Age: lowermost Lower Emsian.

P11. Grey calcareous siltstones (stratigraphic level like P8) near the quarry along the southern border of the Requejada Lake 2750 m NNE of Arbejal. Coord.: 0°49'11"/42°54'39". *Paracryphaeus caboi* n.sp., *Pilletina aulnensis* Morzadec, 1976 together with *Cheir. (Pilletopeltis) aff. maurus* (G. Alberti, 1966), *Trimerus (Dipleura)* sp., *Phacops saberensis* Morzadec, 1970, *Odontochile aff. spinifera* Barrande, 1852. Age: lowermost Lower Emsian.

P12. Grey calcareous siltstones (stratigraphic level like P8) along the northern border of the Requejada Lake 2500 m SSE of Polentinos. Coord. 0°49'44"/42°55'04". *Paracryphaeus caboi* n.sp., *Pilletina aulnensis* Morzadec, 1976 together with *Cheir. (Pilletopeltis) aff. maurus* (G. Alberti, 1966), *Trimerus (Dipleura)* sp., *Burmeisteria pradoana* (de Verneuil, 1850), *Phacops saberensis* Morzadec, 1970, *Reedops cf. sternbergi* (Corda, 1847). Age: lowermost Lower Emsian.

P13. Limestones at the top of the Requejada Member along the northern border of the Requejada Lake 2.5 km SSE of Polentinos. Coord.: 0°49'44"/42°55'04". *Kayserops ogivalis* (Morzadec, 1976) together with *Phacops saberensis* Morzadec, 1970, *Reedops cf. sternbergi* (Corda, 1847), *Odontochile seillouensis* Morzadec, 1976. Age: Lower Emsian.

P14. Yellow decalcified siltstones from the transition Requejada Member to overlying shales near the wash-house in the village Polentinos. Coord.: 0°50'16"/42°56'19". *Paracryphaeus caboi* n.sp. *Pilletina aulnensis* Morzadec, 1976, *Kayserops ogivalis* (Morzadec, 1976) together with *Proetus* (n.sg.) n.sp., *C. (Cornuproetus) aff. chouberti* G. Alberti, 1964, *Otarion aff. druida* Erben, 1952, *Trimerus (Dipleura)* sp., *Phacops saberensis* Morzadec, 1970, *Acastava* n.sp., *Leonaspis aff. maura* G. Alberti, 1969, *Platyscutellum aff. viator* (Barrande, 1852). Age: Lower Emsian.

P15. Green shales between Requejada and Polentinos Member 400 m NE of Polentinos. Coord.: 0°49'59 42°56'24". *G. (Greenops) chaconae* Arbizu, 1979, *Delocare? palenciae* n.sp. (t.l.) together with *Cheir. (Pilletopeltis)* sp. Age: (lower?) Upper Emsian.

P16. Green-yellow marls between Requejada and Polentinos Member 150 m SE of Polentinos. Coord.: 0°50'08"/42°50'15". *Kayserops brevispinosus* Gandl, 1972, *G. (Greenops) chaconae* Arbizu, 1979 together with *Cornuproetus* sp., *Eremiproetus* sp., *Xiphogonium trautensteinensis* ssp., *Astycoryphe* sp., *Otarion* sp., *Cheir. (Pilletopeltis) aff. sternbergi* (Boeck, 1827), *Lioharpes aff. venulosus* (Corda, 1847), *Phacops* sp.1, *Phacops* sp.2, *Reedops cf. modestus* (Barrande, 1872), *Lobopyge (Nitidulopyge) sexlobata* (A. Roemer, 1855), *Leonaspis* n.sp., *Koneprusia* sp., "*Scutellum*" sp. Age: (lower?) Upper Emsian.

P17. Green-yellow marls just below the Polentinos Member 1.5 km WNW of Polentinos. Coord.: 0°51'26"/42°56'45". *Kayserops brevispinosus* Gandl, 1972, *Rhenops circumapodemus* n.sp. together with *P. (Proetus) aff. granulosus* (Goldfuss, 1843), *C. (Diademaproetus) holzapfeli* ssp., *Phacops* sp.2. Age: Upper Emsian.

P18. Stratigraphic level like P17, 2 km W of Polentinos along the north-south streaming Arroyo de la Vega. Coord.: 0°52'00"/42°56'35". *Rhenops circumapodemus* n.sp. (t.l.) together with *Phacops* sp.2, *Leonaspis* sp., *Scabriscutellum (Cavetia) cf. furciferum* (Corda, 1847). Age: Upper Emsian.

P19. Limestones of the Polentinos Member 1.5 km WNW of Polentinos. Coord.: 0°51'26"/42°56'45". *G. (Greenops) chaconae* Arbizu, 1979, *G. (Neometacanthus) perforatus* (Morzadec, 1969), *Treveropyge henryi* Arbizu, 1979, *Comura defensor* (R. & E. Richter, 1952) together with *P. (Proetus) aff. granulosus* (Goldfuss, 1843), *C. (Diademaproetus) holzapfeli* ssp., *Phacops* sp.3. Age: Upper Emsian-Eifelian transition.

P20. Stratigraphic level like P19, 2 km W of Polentinos along the north-south streaming Arroyo de la Vega. Coord.: 0°52'00"/42°56'35". *G. (Greenops) chaconae* Arbizu, 1979, *Treveropyge henryi* Arbizu, 1979 together with *P. (Proetus) aff. granulosus* (Goldfuss, 1843), *C. (Diademaproetus) holzapfeli* ssp., *Phacops oehlerti* Morzadec, 1970, *Phacops* sp.3, *Phacops* sp.4. Age: Upper Emsian-Eifelian transition.

P21. Stratigraphic level like P19, 2 km WNW of Polentinos. Coord.: 0°51'22"/42°56'54". *G. (Greenops) chaconae* Arbizu, 1979, *Treveropyge henryi* Arbizu, 1979 together with *P. (Proetus) aff. granulosus* (Goldfuss, 1843), *C. (Diademaproetus) holzapfeli* ssp., *Otarion* sp., *Phacops oehlerti* Morzadec, 1970. Age: Upper Emsian-Eifelian transition.

P22. Stratigraphic level like P19, 250 m WSW of the Abadía of Lebanza. Coord.: 0°52'04"/42°57'42". *G. (Greenops) chaconae* Arbizu, 1979, *Treveropyge henryi* Arbizu, 1979 together with *P. (Proetus) aff. granulosus* (Goldfuss, 1843), *Phacops oehlerti* Morzadec, 1970, *Phacops* sp.3, *Phacops* sp.4. Age: Upper Emsian-Eifelian transition.

P23. Stratigraphic level like P19, 2 km WSW of the Abadía of Lebanza. Coord.: 0°53'17"/42°57'22". *Treveropyge henryi* Arbizu, 1979 together with *C. (Diademaproetus) holzapfeli* ssp., *Phacops* sp.3, *Leonaspis* sp. Age: Upper Emsian-Eifelian transition.

P24. Stratigraphic level like P19, along the northern border of the Requejada Lake 2.5 km S of Polentinos. Coord.: 0°50'03"/42°55'06". *G. (Neometacanthus) perforatus* (Morzadec, 1969), *Treveropyge henryi* Arbizu, 1979 together with *Phacops oehlerti* Morzadec, 1970, *Phacops* sp.3. Age: Upper Emsian-Eifelian transition.

Gustalapiedra Fm.

P25. Green-yellow shales of the lower part of the Gustalapiedra Fm. 2 km WNW of Polentinos. Coord.: 0°51'46"/42°56'45". *Eocryphops aff. cyclophthalmus* (Walther, 1907), *Harpes aff. ra-*

dians Reinh. Richter, 1863. Age: Lower Eifelian.

P26. Black shales of the middle part of the Gustalapiedra Fm. along the north-south streaming Arroyo de la Vega 2 km W of Polentinos. Coord.: 0°52'00"/42°56'29". *Paraaulacopleura aff. beyrichi* (Novak, 1890), *Leonaspis aff. pigra* (Barrande, 1872). Age: Upper Eifelian.

Cardaño Fm.

P27. Grey nodular limestones along the river Carrion 6.5 km WNW of Polentinos. Coord.: 0°55'18"/ 42°57'19". *Phacops?* sp. Age: ?Frasnian.

Vidrieros Fm.

P28. Green shales at the base of the Vidrieros Fm. 200 m S of Vidrieros. Coord.: 0°58'42"/ 42°56'24". *Trimerocephalus aff. caecus* (Gürich, 1896), *Cyrtosymbole (?)* sp. Age: Lower Famennian (*marginifera* conodont Zone or upper *Cheiloceras*-lower *Prolobites* goniatite Zone).

Mudá - San Julian Region (Fig. 17)

'Abadía' Fm.

M1. Red nodular limestones 250 m E of Mudá. Coord.: 0°42'09"/42°52'31". *Metacanthina cf. barrandei* (Oehlert, 1889), *Kayserops* sp. together with *Cornuproetus* sp., *Cheir. (Pilletopeltis)* sp., *Phacops* sp., *Reedops cf. modestus* (Barrande, 1872). Age: Upper Emsian.

LEONESE BASIN

Ventanilla Region (Fig. 18)

San Martin Fm.

V1. Grey-brown shales from the lower part of the San Martin Fm. 1 km SW of Ventanilla (prov. Palencia). Coord.: 0°52'33"/42°52'28". *Greenops (Neometacanthus)* sp. together with *Phacops* sp., *Lobopyge cf. peneaui* Pillet, 1972. Age: Eifelian.

Rivera Fm.

V2. Grey shales from the upper part of the Rivera Fm. 600 m SSW of Ventanilla. Coord.: 0°52'41"/42°52'29". *Heliopyge* sp. together with *Phacops rana* ssp. Age: Givetian-Frasnian transition.

V3. Yellow decalcified siltstones from the upper part of the Rivera Fm. 350 m SSW of Ventanilla. Coord.: 0°53'06"/42°52'36". *G. (Greenops)* sp. together with *Phacops rana* ssp. Age: Givetian-Frasnian transition.

Esla-Porma Region (Fig. 19)

San Pedro Fm.

L1. Shales and ferruginous sandstones at the top of the San Pedro Fm. 1 km N of Grandoso. Coord.: 1°35'03"/42°51'32". *Acastella* sp., *Digonus aff. roemeri* (de Koninck, 1876). Age: Lower Gedinnian.

La Vid Fm.

L2. Lower part of the limestone member of the La Vid Fm. 750 NNE of Grandoso. Coord.: 1°35'07"/42°51'24". *Pseudocryphaeus cossensis* Morzadec, 1971, *Pseudocryphaeus? demoulini* n.sp. (t.l.), *Pilletina collensis* Arbizu, 1979 together with *P. (Coniproetus) finitimus*

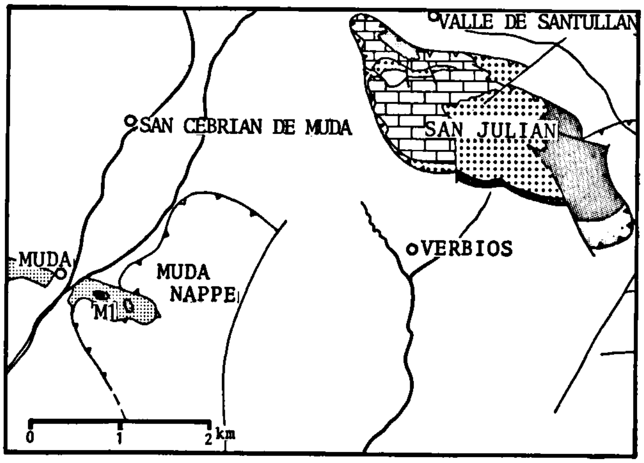


Fig. 17. Locality map of the Mudá-San Julian region (Palentian Basin). Modified after de Sitter & Boschma (1966) and Wagner (1971).

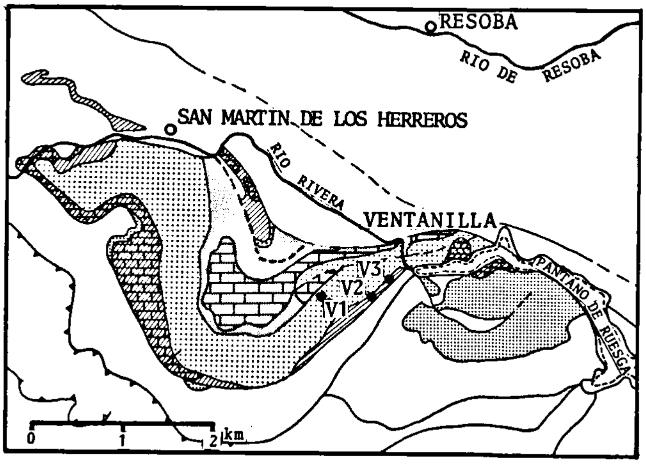


Fig. 18. Locality map of the Ventanilla region (Leonese Basin). Modified after the sheet of Savage (1977).

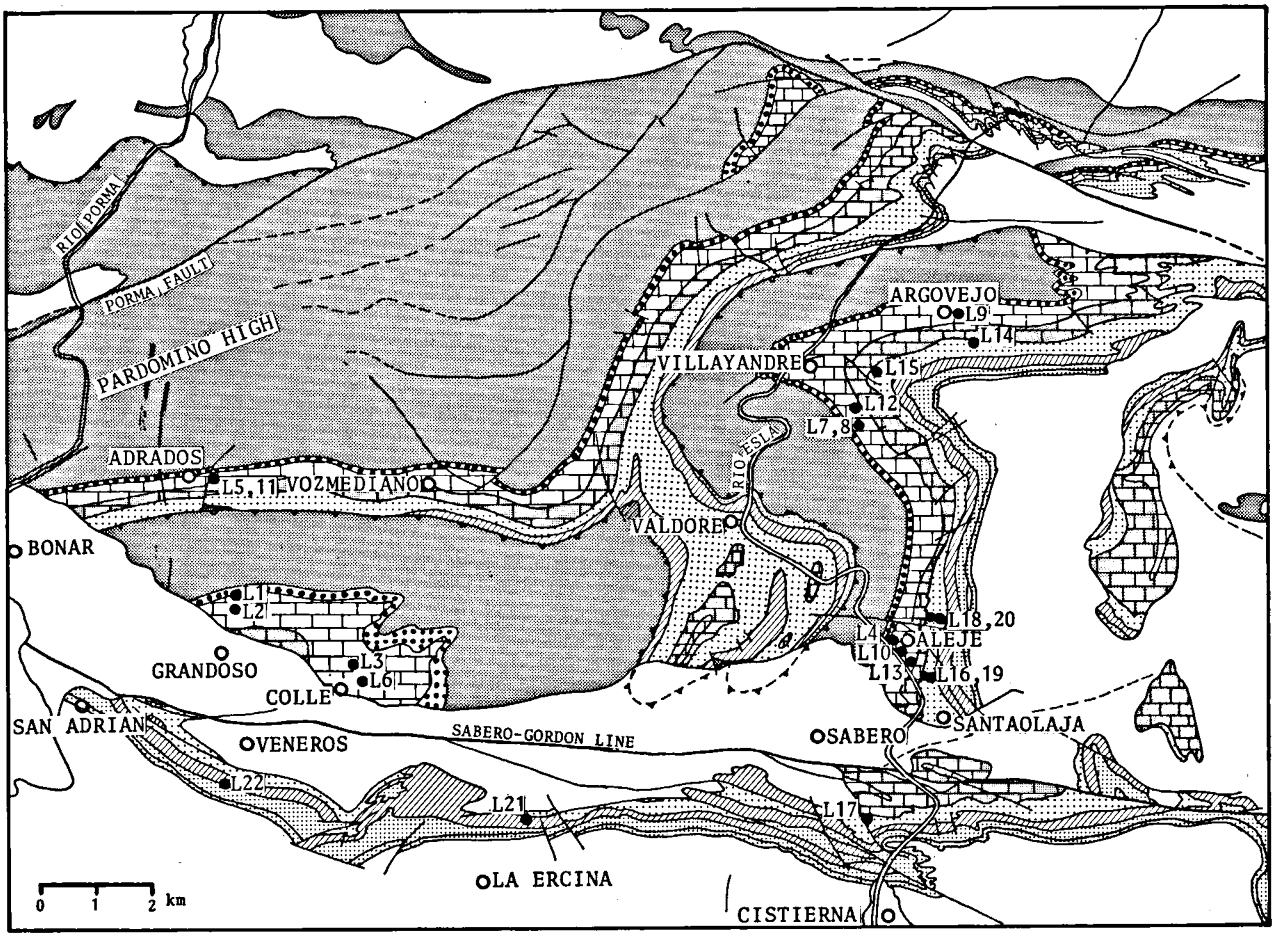


Fig. 19. Locality map of the Esla-Porma region (Leonese Basin east of the Pardomino High) Modified after the sheet of Rupke & Helmig (1964).

n.ssp., *C. (Cornuproetus) aff. haentzscheli* G. Alberti, 1967, *Trimerus (Dipleura)* sp., *Phacops saberensis* Morzadec, 1970. Age: Lower Emsian.

L3. Stratigraphic level like L2, along the old road Colle-Vozmediano (loc. 32 of Arbizu, 1979) 600 m NNE of the crossing in Colle. Coord.: 1°33'30"/42°50'54". *Pilletina collensis* Arbizu, 1979 (t.l.) together with *Trimerus (Dipleura)* sp., *Phacops saberensis* Morzadec, 1970. Age: Lower Emsian.

L4. Stratigraphic level like L2, 200 m W of Aleje. Coord.: 1°26'27"/42°50'58". *Pilletina collensis* Arbizu, 1979 together with *Proetus* (n.sg.) n.sp., *Trimerus (Dipleura)* sp., *Phacops saberensis* Morzadec, 1970. Age: Lower Emsian.

L5. Stratigraphic level like L2, 250 m E of Adrados. Coord.: 1°35'26"/42°52'41". *Pilletina collensis* Arbizu, 1979 together with *P. (Coniproetus) finitimus* n.ssp., *Phacops saberensis* Morzadec, 1970. Age: Lower Emsian.

L6. Upper part of the limestone member of the La Vid Fm. 650 m NE of the crossing in Colle (loc. 31 of Arbizu, 1979). Coord.: 1°33'23"/42°50'44". *Treveropyge iberica* Gandl, 1972, *Treveropyge? acrifrons* Gandl, 1972, *Kayserops obsoletus* Gandl, 1972, *Delocare rostrata* Arbizu, 1979 together with *Proetus* (n.sg.) n.sp., *P. (Longiproetus)* sp., *C. (Cornuproetus) chouberti* n.ssp., *Otarion aff. druida* Erben, 1952, *Harpes* sp., *Trimerus (Dipleura)* sp., *Burmeisteria pradoana* (de Verneuil, 1850) (t.l.), *Phacops saberensis* Morzadec, 1970 (t.l.), *Acastava* n.sp., *Leonaspis aff. maura* G. Alberti, 1969, *Radiaspis* sp., *Platyscutellum* sp., *Kolihapeltis* sp., *"Scutellum"* sp.1. Age: upper Lower Emsian.

L7. Stratigraphic level like L6, 1300 m SE of Villayandre. Coord.: 1°26'56"/42°53'07". *Kayserops obsoletus* Gandl, 1972, *Delocare rostrata* Arbizu, 1979 together with *Proetus* (n.sg.) n.sp., *C. (Cornuproetus) chouberti* n.ssp., *Otarion aff. druida* Erben, 1952, *Trimerus (Dipleura)* sp., *Phacops saberensis* Morzadec, 1970, *Acastava* n.sp., *Leonaspis aff. maura* G. Alberti, 1969. Age: upper Lower Emsian.

L8. Transition limestone-shale member of the La Vid Fm. 1300 m SE of Villayandre. Coord.: 1°26'56"/42°53'07". *Delocare rostrata* Arbizu, 1979 together with *C. (Cornuproetus) aff.*

corrugatus (Erben, 1952), *Phacops saberensis* Morzadec, 1970. Age: Lower-Upper Emsian transition.

L9. Transition limestone-shale member of the La Vid Fm. in the eastern part of the village of Argovejo. Coord.: 1°25'33"/42°54'06". *C. (Cornuproetus) aff. corrugatus* (Erben, 1952), *Phacops saberensis* Morzadec, 1970, *Cryphina?* sp., "*Scutellum*" sp.2. Age: Lower-Upper Emsian transition.

L10. Stratigraphic level like L8 and L9, 200 m SW of Aleje. Coord.: 1°26'22"/42°50'53". *Delocare rostrata* Arbizu, 1979. Age: Lower-Upper Emsian transition.

L11. Marls from the shale member of the La Vid Fm. 200 m E of Adrados. Coord.: 1°35'26"/ 42°52'41". *Paracryphaeus occidentalis* (Haas, 1970), *Kayserops brevispinosus* Gandl, 1972 together with *Phacops saberensis* Morzadec, 1970. Age: Lower-Upper Emsian transition.

L12. Limestone intercalation in the shale member, 40 m below the Santa Lucía Fm, 1 km SE of Villayandre. Coord.: 1°26'56"/42°53'17". *Proetus* (n.sg.) n.sp., *Leonaspis aff. maura* G. Alberti, 1969, *Isoprusia (Mauraspis) aff. cyrius* G. Alberti, 1967. Age: (lower?) U. Emsian.

L13. Limestone at the top of the La Vid Fm., just below the Santa Lucía Fm. 250 m SE of Aleje. Coord.: 1°26'09"/42°50'52". *Kayserops brevispinosus* Gandl, 1972 together with *Otarion* sp. Age: lower Upper Emsian.

Huergas Fm.

L14. A decalcified ferruginous sandstone bed of the Huergas Fm. (15 m above the Santa Lucía Fm.) 700 m SE of Argovejo. Coord.: 1°25'16"/42°53'54". *G. (Neometacanthus) perforatus* (Morzadec, 1969), *Alcaldops? argovejensis* n.sp. (t.l.) together with *Phacops* sp.5, *Leonaspis cf. pigra* (Barrande, 1872). Age: Lower Eifelian.

L15. Ferruginous sandstone beds of the Huergas Fm. (10 m above the Santa Lucía Fm.) 1200 m E of Villayandre. Coord.: 1°26'35"/42°53'41". *Bradocryphaeus? cantarmoricus* (Morzadec & Arbizu, 1978) together with *Phacops* sp.5. Age: Eifelian.

L16. Ferruginous sandstone at the base of the Huergas Fm. 600 m SE of Aleje. Coord.: 1°25'52"/ 42°51'12". *P. (Proetus) aff. granulosus* (Goldfuss, 1843), *P. (Proetus) aff. orbitatus* (Barrande, 1846), *C. (Diademaproetus) holzapfeli* ssp., *Otarion* sp., *Phacops* sp.5. Age: Eifelian.

L17. Decalcified sandstone from the lower part of the Huergas Fm. 1.5 km SE of Sabero. Coord.: 1°26'51"/42°49'18". *Bradocryphaeus? cantarmoricus* (Morzadec & Arbizu, 1978) together with *Phacops* sp.5. Age: Eifelian.

L18. Sandstones and shales of the middle part (180 m above the base, 100 m below the top) of the Huergas Fm. 600 m NE of Aleje. Coord.: 1°25'52"/42°51'12". *Alcaldops alcaldei* Arbizu, 1979 together with *Phacops* sp. Age: Upper Eifelian-?Lower Givetian?

L19. A fossiliferous sandstone bed in the top of the Huergas Fm. (60 m below the Portilla Fm.) 600 m SE of Aleje. Coord.: 1°26'00"/42°50'37". *Neocalmonia cantabrica* n.sp. (t.l.). Age: Lower Givetian.

L20. Stratigraphic level like L19, 600 m NE of Aleje. Coord.: 1°25'52"/42°51'12". *Neocalmonia cantabrica* n.sp. Age: Lower Givetian.

Portilla Fm.

L21. Limestone of the Portilla Fm. (top Veneros Member; see Reijers 1972) 15 m above the Huergas Fm. 1200 m NE of La Ercina. Coord.: 1°31'14"/42°49'19". *Bradocryphaeus? cf. quadratispinosus* (Gandl, 1972). Age: probably Givetian.

L22. Argillaceous limestones in the top of the Portilla Fm. (10 m below the Nocedo Fm.) 750 m S of Veneros. Coord.: 1°35'10"/42°49'37". *Bradocryphaeus hispanicus* (R. & E. Richter, 1926), *Heliopyge asturica* Haas, 1970, *G. (Greenops) ultimus* n.sp. (t.l.) together with *Proetus?* sp., *Otarion aff. ellipsocephalum* (Trenkner, 1867), *Phacops rana aff. rana* (Green, 1832), *Scutellum costatum cf. lummatonensis* Selwood, 1966. Age: Lower Frasnian.

Leonese Basin west of the Pardomino High (Figs. 20-22)

La Vid Fm.

X1. Limestones 15 m above the San Pedro Fm. 2 km NNW of Lumajo. Coord.: 2°35'04"/43°00'05". *Acastella cf. crenulata* Morzadec, 1976, *Acastella cf. latimarginata* Gandl, 1972. Age: uppermost Lower Gedinnian.

X2. Lower part of the limestone member of the La Vid Fm. 1200 m NNE of Aviados. Coord.: 1°45'00"/42°52'15". *Paracryphaeus izensis* (Morzadec, 1971), *Pseudocryphaeus cossensis* Morzadec, 1971, *Pilletina* sp. together with *P. (Coniproetus) finitimus* n.ssp., *C. (Cornuproetus) aff. haentzscheli* G. Alberti, 1967. Age: Upper Siegenian.

X3. Lowermost part of the limestone member of the La Vid Fm. 1 km E of La Vid along the road to Vegacervera. Coord.: 1°56'13"/42°53'47". *Paracryphaeus izensis* (Morzadec, 1971), *Pseudocryphaeus cossensis* Morzadec, 1971, *Pseudocryphaeus astrictus* Gandl, 1972, *Pilletina lips mozoensis* (Gandl, 1972), *Pilletina cf. triangularis* (Gandl, 1972), *Metacanthina lavidensis* n.sp. (t.l.) together with *P. (Coniproetus) aff. foucauldi* G. Alberti, 1967. Age: Upper Siegenian-lowermost Lower Emsian.

X4. Lower part of the limestone member of the La Vid Fm. 1 km E of La Vid. Coord.: 1°56'13"/

42°53'47". *Pseudocryphaeus cossensis* Morzadec, 1971, *Treveropyge?* sp., *Delocare? dalii* n.sp. (t.l.) together with *P. (Coniproetus) aff. foucauldi* G. Alberti, 1967. Age: Upper Siegenian-lowermost Lower Emsian.

X5. Lower part of the limestone member of the La Vid Fm. 1.5 km E of Aralla. Coord.: 2°07'56"/42°54'18". *Pilletina cf. triangularis* (Gandl, 1972). Age: Upper Siegenian-lowermost Lower Emsian.

X6. Marls at the top of the La Vid Fm. (2 m below the Santa Lucía Fm.) along the Lake 1350 m N of Barrios de Luna. Coord.: 2°10'24"/42°51'24". *Kayserops brevispinosus* Gandl, 1972, *Delocare cf. boopis* (Rud. Richter, 1909) together with *Proetus* (n.sg.) n.sp., *Trimerus (Dipleura)* sp., *Phacops* sp. Age: probably lower Upper Emsian.

Santa Lucía Fm.

X7. Limestones of the middle part of the Santa Lucía Fm. 700 m NW of Beberino along the road

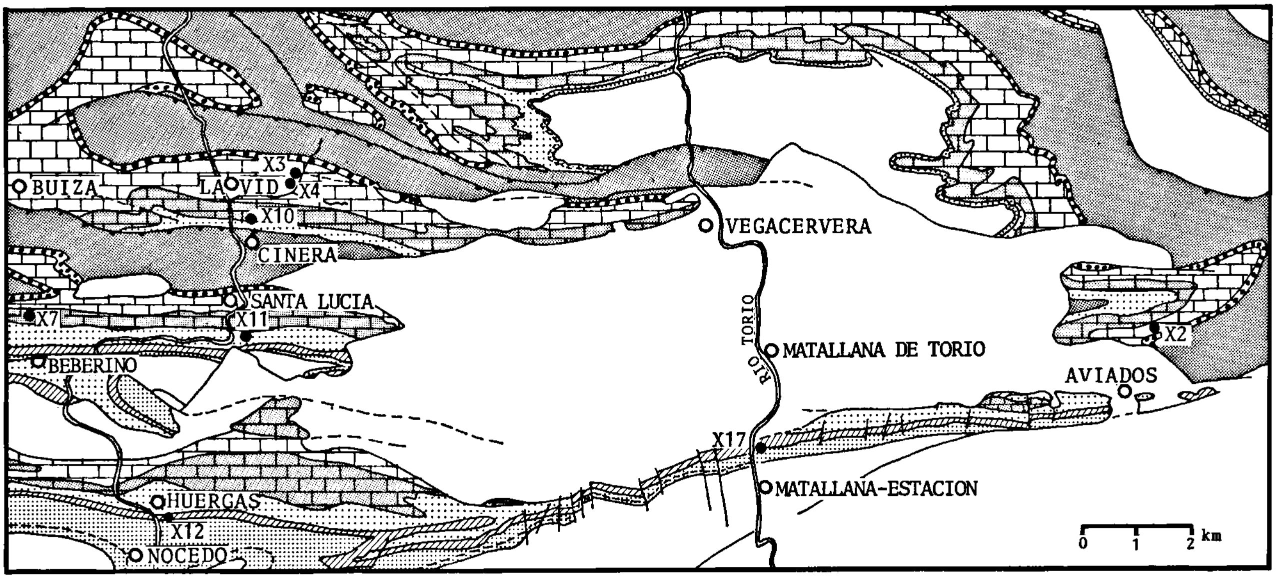


Fig. 20. Locality map of the Curueño-Torio-Bernesga region (Leonese Basin west of the Pardomino High). Modified after Evers (1967) and van Staalduinen (1973).

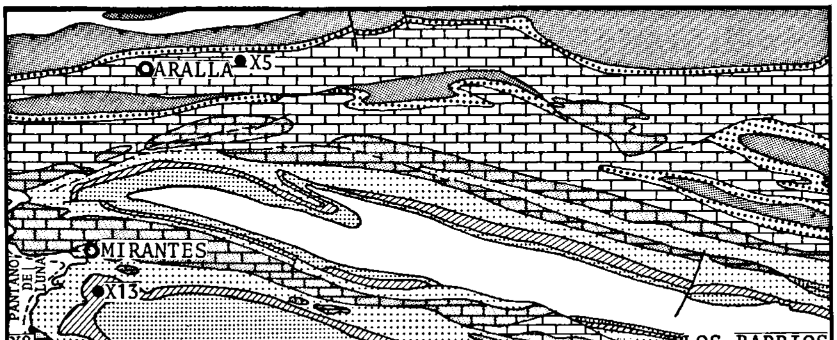


Fig. 21. Locality map of the Bernesga-Luna region (Leonese Basin west of the Pardomino High). Modified after van Staalduinen (1973) and van den Bosch (1969).

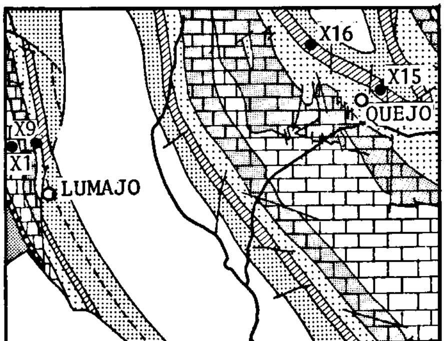


Fig. 22. Locality map of the Luna-Sil region (Leonese Basin west of the Pardomino High). Modified after van den Bosch (1969).

to Buiza. Coord.: 1°59'51"/42°52'19". *Malladaia luciae* Oehlert & Oehlert, 1896. Age: Upper Emsian-Lower Eifelian.

X8. Dark argillaceous limestones at the top of the Santa Lucía Fm. 1.5 km N of Los Barrios de Luna. Coord.: 2°10'23"/42°51'28". *Phacops* sp.7. Age: Lower Eifelian.

Huergas Fm.

X9. Sandstone at the base of the Huergas Fm. 800 m N of Lumajo. Coord.: 2°34'14"/42°59'27". *G. (Neometacanthus) perforatus* (Morzadec, 1969) together with *P. (Proetus) cf. orbitatus* (Barrande, 1846), *C. (Diademaproetus) holzapfeli* ssp., *Phacops* sp.5. Age: Lower Eifelian.

X10. Shales at the base of the Huergas Fm. 250 m N of Ciñera. Coord.: 1°57'06"/42°53'16". *Phacops* sp.5, *Phacops* sp.6. Age: Lower Eifelian.

X11. Sandstones and shales from the middle part of the Huergas Fm. 600 m SE of Santa Lucía. Coord.: 1°56'49"/42°52'06". *Alcaldops alcaldei* Arbizu, 1979 together with *P. (Proetus) cf. orbitatus* (Barrande, 1846). Age: Upper Eifelian-?Lower Givetian?

Portilla Fm.

X12. Argillaceous limestones from the middle member of the Portilla Fm. along the road 350 m S of Huergas de Gordón. Coord.: 1°57'56"/42°50'25". *Heliopyge* sp. together with *P. (Proetus)* sp., *Phacops rana* ssp. Age: lowermost Frasnian (Upper *varcus* Zone-*hermanni-cristatus* Zone).

X13. Argillaceous limestones from the middle member of the Portilla Fm. 500 m S of Mirantes. Coord.: 2°09'51"/42°52'19". *Heliopyge* sp.2 *aff. asturica* Haas, 1970 together with *Phacops rana aff. crassituberculata* Stumm, 1953, *Scutellum costatum cf. lummatonensis* Selwood, 1966. Age: lowermost Frasnian.

X14. Stratigraphic level like X13, 500 m S of Barrios de Gordón. Coord.: 2°00'36"/42°50'37". ?*Heliopyge* sp.2 *aff. asturica* Haas, 1970? together with *Phacops rana aff. crassituberculata* Stumm, 1953. Age: lowermost Frasnian.

X15. Argillaceous limestones from the middle part of the Portilla Fm. 200 m NE of Quejo along the road to La Cueta. Coord.: 2°29'46"/42°59'56". *Heliopyge* sp.1 *aff. asturica* Haas, 1970 together with *P. (Proetus)* n.sp., *Phacops rana aff. crassituberculata* Stumm, 1953. Age: lowermost Frasnian.

X16. Argillaceous limestones from the upper part of the Portilla Fm. (base D-member, 35 m below the Nocedo Fm.) 1.5 km NW of Quejo. Coord.: 2°30'46"/43°00'21". *G. (Greenops)* sp. Gandl, 1972 *cf. boothi* (Green, 1837). Age: lowermost Frasnian.

Nocedo Fm.

X17. Cross-bedded limestone at the base of the Nocedo Fm. just N of the village Matallana-Estación. Coord.: 1°50'04"/42°51'06". *Bradocryphaeus matallanensis* n.sp. (t.l.) together with *Phacops* sp. Age: Middle Frasnian (Middle *asymmetricus* conodont Zone).

X18. Limestone lens at the top of the A-member of the Nocedo Fm. (170 m above the Portilla Fm.) 750 m NW of Portilla de Luna. Coord.: 2°07'28"/42°50'28". *Bradocryphaeus sexspiniferus* n.sp. (t.l.). Age: Middle Frasnian (Lower-Middle *asymmetricus* conodont Zone).

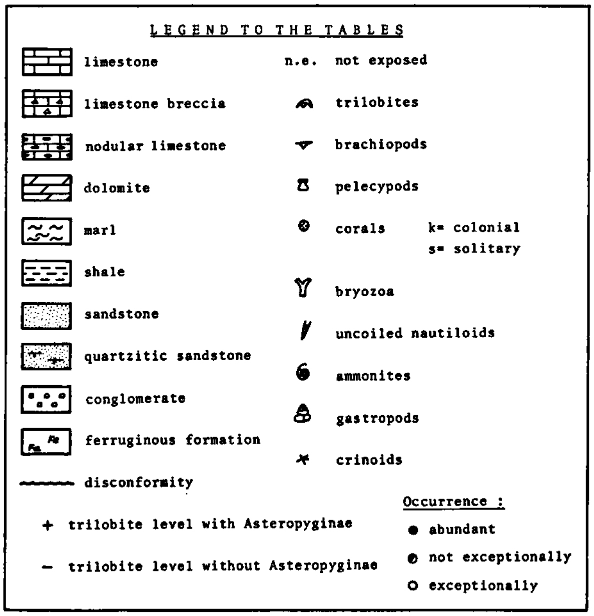


Fig. 23. Legend to the tables of Figs. 24-26.

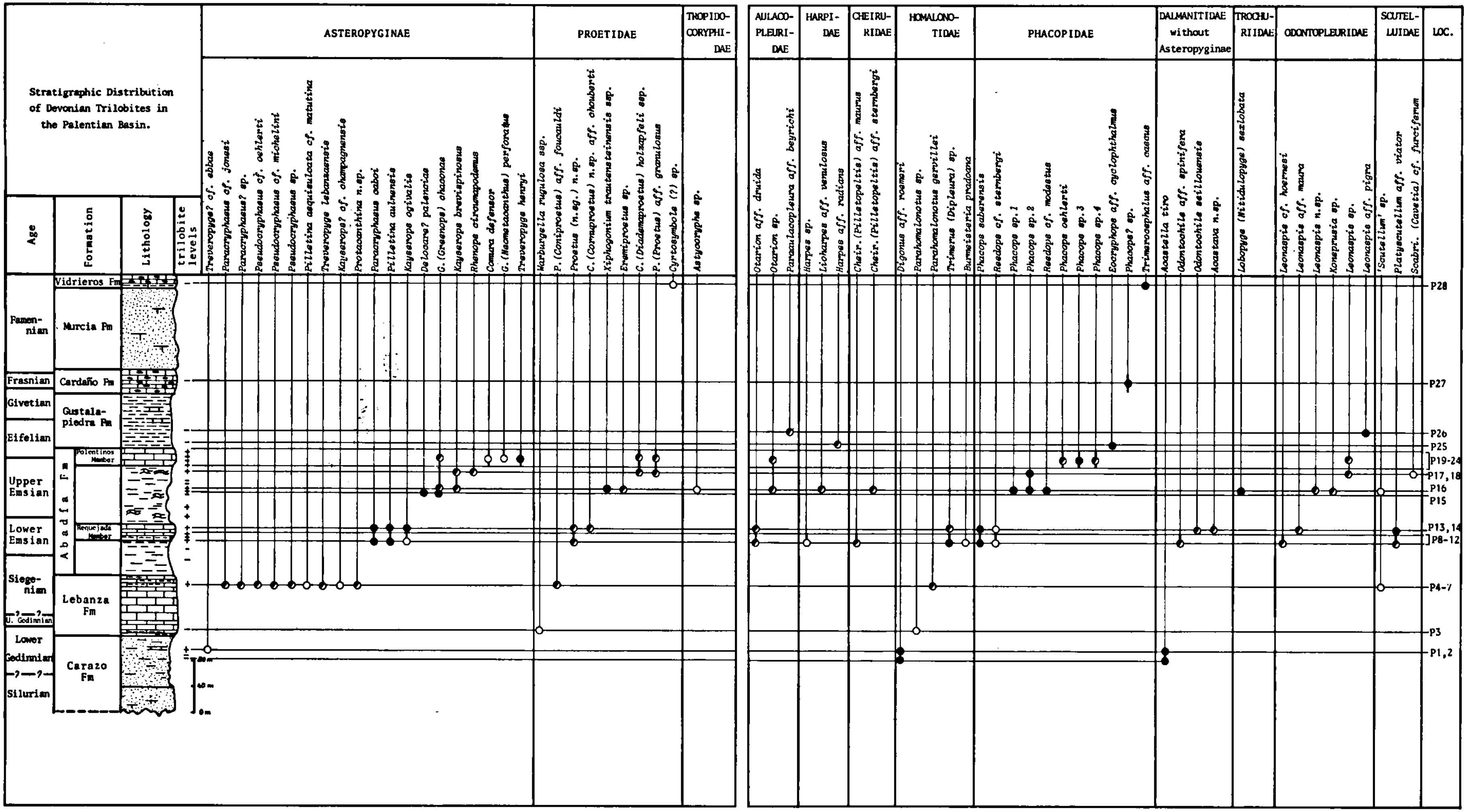


Fig. 24. Stratigraphic distribution of Devonian trilobites in the Palentian Basin.

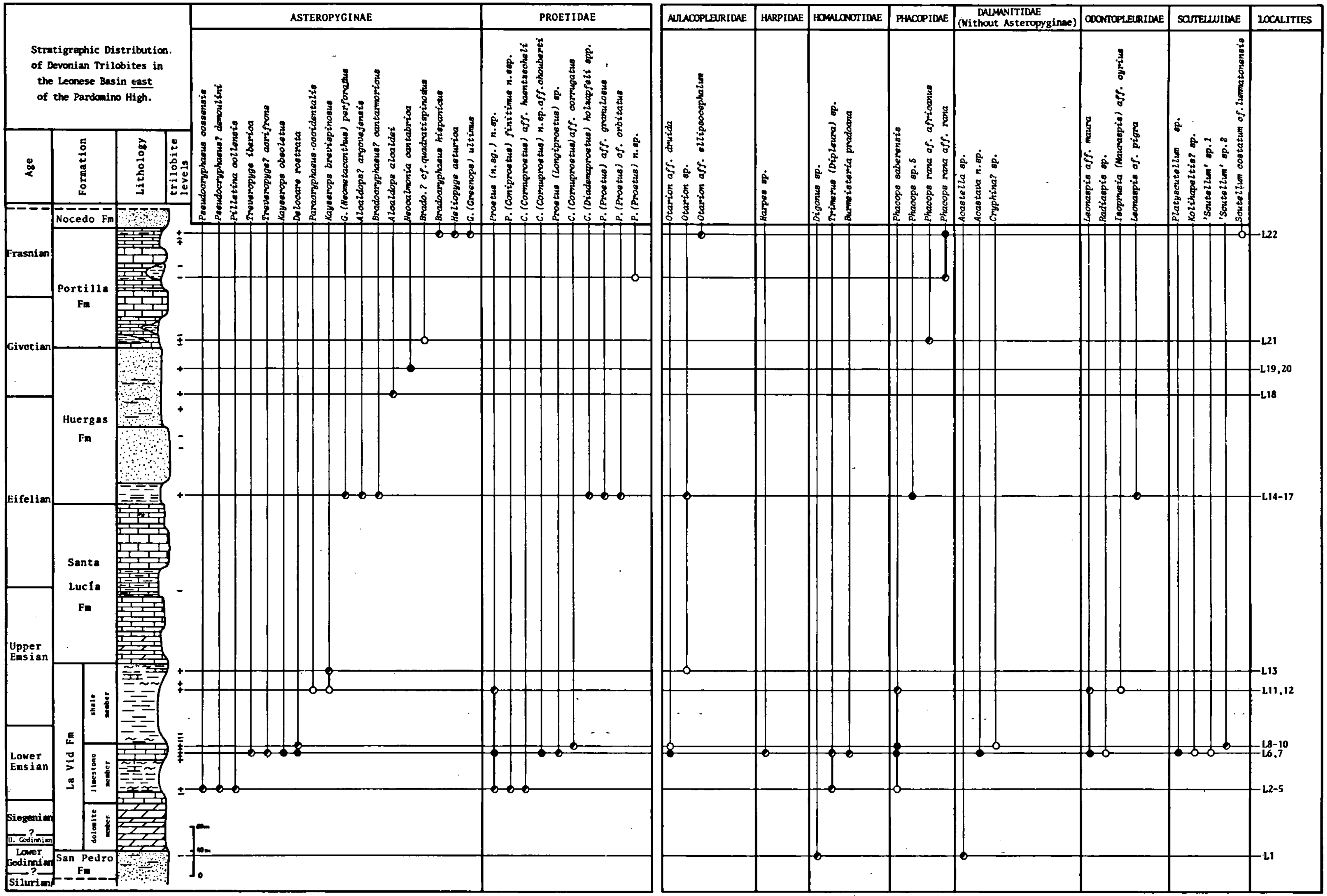


Fig. 25. Stratigraphic distribution of Devonian trilobites in the Leonese Basin east of the Pardomino High.

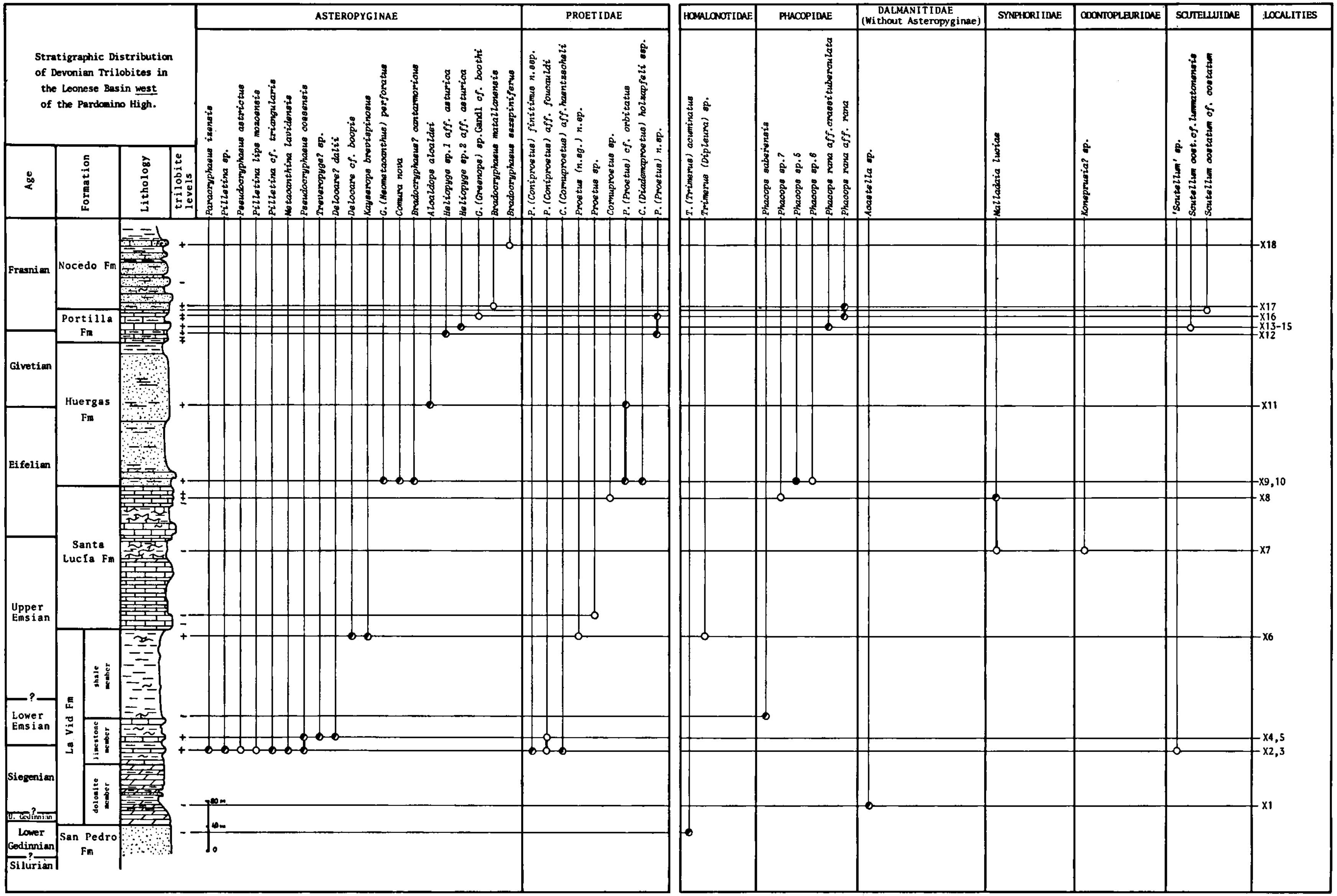


Fig. 26. Stratigraphic distribution of Devonian trilobites in the Leonese Basin west of the Pardomino High

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P L A T E S

PLATES 1-17. Systematics of the Asteropyginae.

PLATES 18-35. Trilobite faunas of some stratigraphic levels in the Palentian and Leonese basins (the Asteropyginae which have been extensively pictured in the preceding part, will be illustrated summarily).

Specimens are whitened with MgO, except the ones for the SEM-photographs: Pl. 3 fig. 3c, Pl. 8 fig. 11, Pl. 12 figs. 9a, 11, Pl. 32 figs. 6a, b and Pl. 33 fig. 1.

PLATE 1

Figs. 1-3. *Paracryphaeus cf. jonesi* (Oehlert, 1877)
Top of the Lebanza Fm; Middle - Upper Siegenian.
1. Pygidium RGM 339000, partly internal mould, x 2.3, loc. P5.
2. Incomplete pygidium RGM 339001, external mould, x 2.7, loc. P5.
3. Incomplete pygidium RGM 339002, x 3.7, a. external mould of rubber; b. internal mould, loc. P6.

Fig. 4. *Paracryphaeus*? sp.
Top of the Lebanza Fm; Middle - Upper Siegenian.
4. Pygidium RGM 339004, external mould, x 2.2, loc. P4.

Figs. 5-11. *Paracryphaeus izensis* (Morzadec, 1971)
Lower part of the limestone member of the La Vid Fm; Upper Siegenian - lowermost Emsian.
5. Incomplete juvenile cephalon RGM 339007, external mould, x 5, a. dorsal view, b. frontal view, loc. X2.
6. Cephalon RGM 339008, external mould, x 2.7, a. frontal view; b. lateral view, loc. X2.
7. Cephalon RGM 339009, glabella internal mould, x 1.8, a. lateral view; b. frontal view, loc. X2.
8. Pygidium RGM 339011, ventral view of external mould, x 4, loc. X2.
9. Pygidium RGM 339018, chiefly external mould, x 7.3, loc. X3.
10. Pygidium RGM 339019, external mould, x 6.7, loc. X3.
11. Pygidium RGM 339020, external mould, granulation eroded, x 4.3, loc. X3.

Figs. 12-15. *Paracryphaeus caboi* n.sp.
Requejada Member of the Abadía Fm; lowermost Emsian.
12. *Holotypus*: cephalothorax RGM 339026, x 2.3, a. external mould of rubber; b. internal mould with glabella pulled down to show the hypostome, loc. P8.
13. Deformed cephalon RGM 339030, external mould or rubber, x 1.8, loc. P8.
14. Hypostome RGM 339029, ventral view of external mould of rubber, x 7, loc. P8.
15. Pygidium RGM 339046, external mould of rubber, x 3.5, a. dorsal view; b. lateral view, loc. P10.

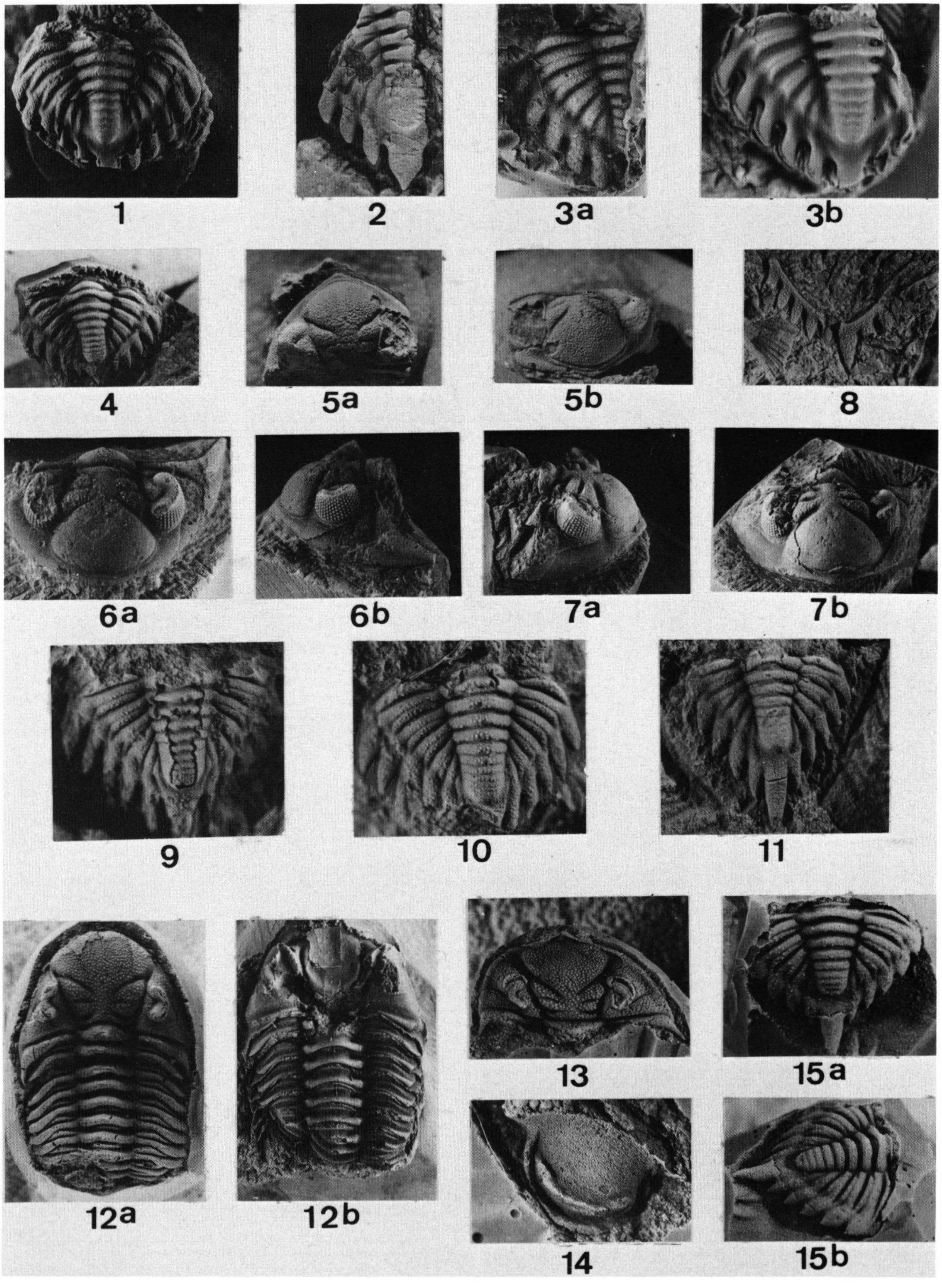
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PLATE 2

Figs. 1-5. *Paracryphaeus caboi* n.sp.
Requejada Member of the Abadía Fm; lowermost Emsian.
1. Cephalon RGM 339044, external mould of rubber, x 3.1, a. lateral view; b. dorsal view, loc. P10.
2. Deformed cephalon RGM 339031, external mould of rubber, x 4, loc. P8.
3. Pygidium RGM 339038, external mould of rubber, x 6, loc. P8.
4. Pygidium RGM 339039, external mould of rubber, x 3.7, loc. P8.
5. Pygidium RGM 339040, internal mould, x 6, loc. P8.

Fig. 6. *Paracryphaeus occidentalis* (Haas, 1970)
Shale member of the La Vid Fm; transition Lower - Upper Emsian.
6. Pygidium RGM 339049, external mould of rubber, x 4.2, loc.L11.

Figs. 7,8. *Pseudocryphaeus cf. michelini* (Rouault, 1851)
Top of the Lebanza Fm; Middle - Upper Siegenian.
7. Pygidium RGM 339050, external mould, x 3, a. dorsal view; b. caudal view; c. lateral view, loc. P5.
8. Incomplete pygidium RGM 339051, ventral view of external mould, x 3, loc. P5.

Figs. 9,10. *Pseudocryphaeus cf. oehlerti* Morzadec, 1971
Top of the Lebanza Fm; Middle - Upper Siegenian.
9. Pygidium RGM 339053, external mould, x 4.3, loc. P5.
10. Pygidium RGM 339055, external mould, x 2.8, loc. P6.

Figs. 11,12. *Pseudocryphaeus* sp.
Top of the Lebanza Fm; Middle - Upper Siegenian.
11. Pygidium RGM 339057, external mould, x 2.5, loc. P4.
12. Pygidium RGM 339058, partly external, partly internal mould, x 2.4, loc. P4.

Figs. 13,14. *Pseudocryphaeus cossensis* Morzadec, 1971
Lower part of the limestone member of the La Vid Fm; transition Upper Siegenian - Lower Emsian.
13. Pygidium RGM 339068, external mould, x 2.5, a. dorsal view; b. caudal view, loc. X4.
14. Complete specimen RGM 339062, lateral view of external mould, x 2.2, loc. X3.


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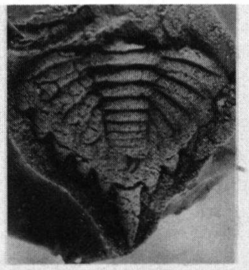
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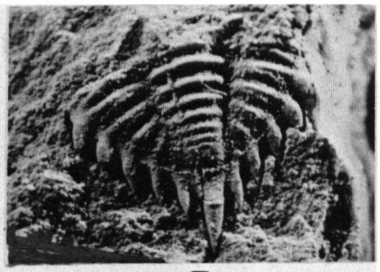
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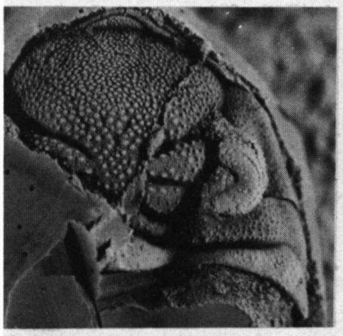
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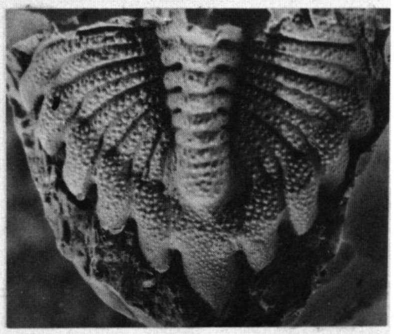
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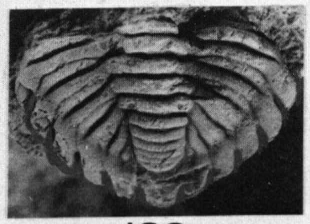
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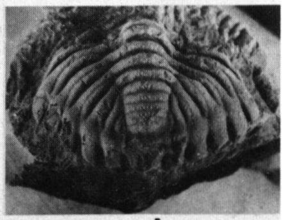
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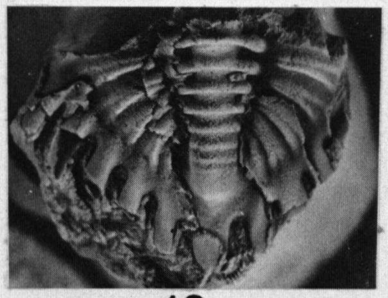
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PLATE 3

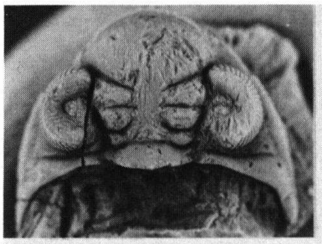
Figs. 1,2. *Pseudocryphaeus cossensis* Morzadec, 1971
Lower part of the limestone member of the La Vid Fm; Upper Siegenian - Lower Emsian.
1. Cephalon RGM 339063, external mould, x 3, a. dorsal view; b. lateral view, loc. X3.
2. Cephalon from enrolled specimen RGM 339060, eroded external mould, x 2.2, a. dorsal view; b. frontal view, loc. L2.

Fig. 3. *Pseudocryphaeus astrictus* Gandl, 1972
Lower part of the limestone member of the La Vid Fm; lowermost Emsian.
3. Pygidium RGM 339070, external mould, a. lateral view, x 5; b. dorsal view, x 5; c. SEM photograph of fine granulation, x 25, loc. X3.

Fig. 4. *Pseudocryphaeus*? *demoulini* n.sp.
Lower part of the limestone member of the La Vid Fm; Lower Emsian.
4. *Holotypus*: complete specimen RGM 339071, a. lateral view of chiefly internal mould, x 3; b. dorsal view of chiefly internal mould, x 3; c. dorsal view of external mould of rubber, x 3; d. dorsal view of external mould, x 2.6; e. caudal view of external mould, x 4; f. lateral view of external mould, x 4, loc. L2.

Fig. 5. *Pilletina aequisulcata cf. matutina* (Gandl, 1972)
Top of the Lebanza Fm; Middle - Upper Siegenian.
5. Incomplete pygidium RGM 339074, external mould, x 1.4, loc. P5.

Fig. 6. *Pilletina lips mozoensis* (Gandl, 1972)
Lower part of the limestone member of the La Vid Fm; lowermost Lower Emsian.
6. Pygidium RGM 339083, external mould, x 1.5, loc. X3.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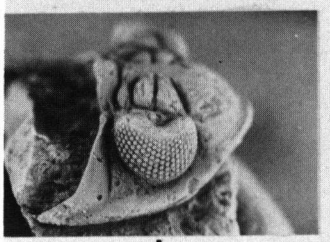
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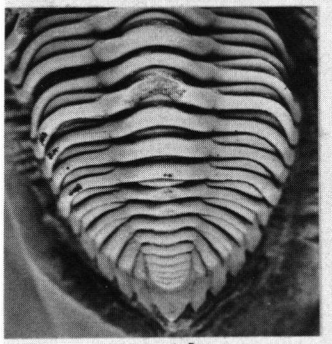
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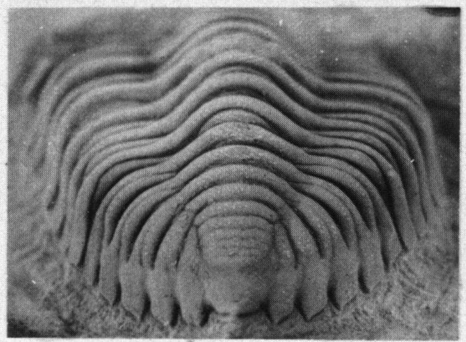
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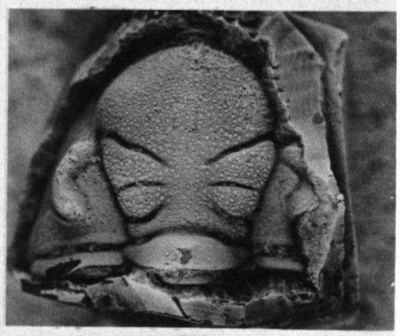
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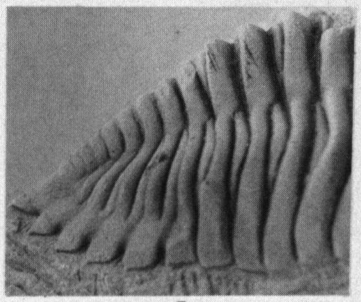
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PLATE 4

Figs. 1-6. *Pilletina* sp.
Lower part of the limestone member of the La Vid Fm; transition Siegenian - Lower Emsian.

1. Cephalon RGM 339075, chiefly external mould, x 1.6, a. dorsal view; b. lateral view, loc. X2.
2. Cranidium RGM 339076, internal mould, x 2.6, loc. X2.
3. Pygidium fragment RGM 339078, internal mould of rubber, x 2.6, loc. X2.
4. Pygidium fragment RGM 339079, external mould of rubber, x 3.5, loc. X2.
5. Incomplete pygidium RGM 339080, internal mould, x 4.4, loc. X2.
6. Incomplete pygidium RGM 339081, external mould of rubber, x 3, loc. X2.

Figs. 7-9. *Pilletina cf. triangularis* (Gandl, 1972)
Lower part of the limestone member of the La Vid Fm; transition Siegenian - Lower Emsian.

7. Pygidium fragment RGM 339085, external mould, x 4.1, loc. X3.
8. Pygidium fragment RGM 339086, external mould, x 3, loc. X3
9. Incomplete pygidium RGM 339087, external mould, x 5.6, loc. X3.

Figs. 10-16. *Pilletina aulnensis* Morzadec, 1976
Requejada Member of the Abadía Fm; Lower Emsian.

10. Flattened cephalon RGM 339113, external mould of rubber, x 2.4, loc. P11.
11. Flattened cephalon RGM 339094, external mould of rubber, x 3,3, loc. P8.
12. Flattened cephalon RGM 339095, external mould of rubber, x 1.3, loc. P8.
13. Enrolled specimen RGM 339093, external mould of rubber, x 1.9, loc. P8.
14. Cephalon RGM 339096, external mould of rubber, x 1.7, loc. P8.
15. 2 Complete specimens RGM 339091-092, flattened, internal moulds, x 1.5, loc. P8.
16. Complete specimen RGM 339116, external mould of rubber, distinctly showing the blunted occipital and axial nodes, x 2.1, loc. P14.

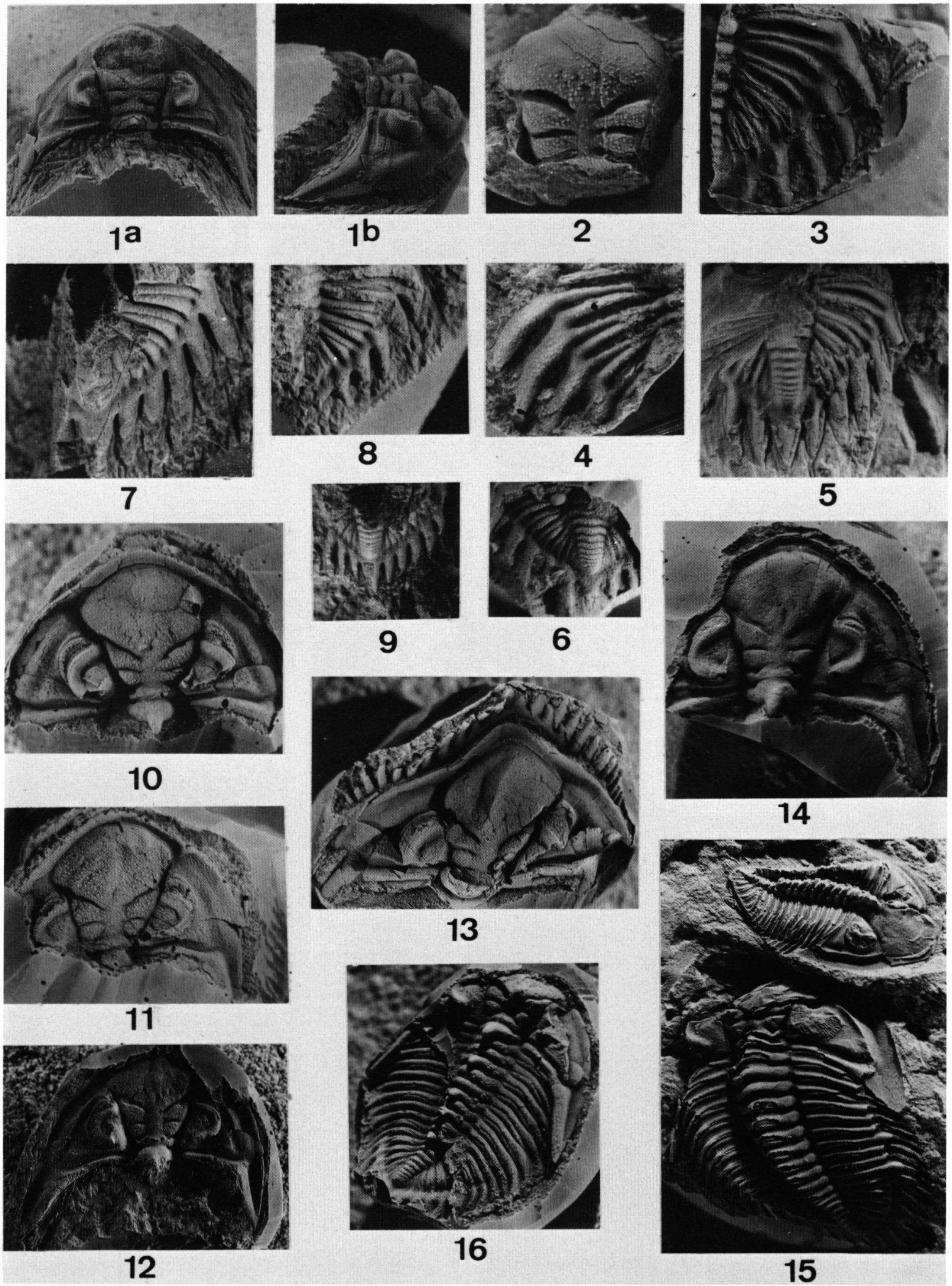
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PLATE 5

Figs. 1-6. *Pilletina aulnensis* Morzadec, 1976
Requejada Member of the Abadía Fm; Lower Emsian.
1. Pygidium RGM 339101, deformed, x 3, a. external mould of rubber; b. internal mould, loc. P8.
2. Pygidium RGM 339102, flattened, internal mould, x 4, loc. P8.
3. Pygidium RGM 339103, external mould of rubber, x 2.4, loc. P8.
4. Pygidium RGM 339104, flattened, internal mould, x 6.3, loc. P8.
5. Pygidium RGM 339109, ventral view of external mould of rubber, x 2.5, loc. P12.
6. Pygidium RGM 339110, flattened, external mould, x 2, a. dorsal view; b. caudal view, loc. P12.

Figs. 7-11. *Pilletina collensis* Arbizu, 1979
Lower part of the limestone member of the La Vid Fm; Lower Emsian.
7. Pygidium RGM 339122, external mould, x 3.3, a. dorsal view; b. caudal view; c. lateral view, loc. L2.
8. Pygidium RGM 339123, external mould, x 2.8, a. dorsal view; b. caudal view, loc. L2.
9. Incomplete pygidium RGM 339125, external mould, x 1.4, loc. L3.
10. Complete specimen RGM 339117, lateral view of external mould, x 1.4, loc. L2.
11. Cranidium RGM 339119, external mould, x 2.9, loc. L2.

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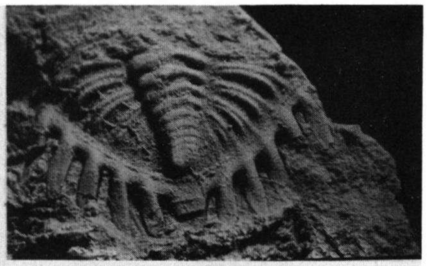

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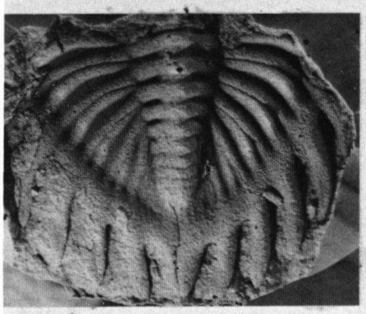

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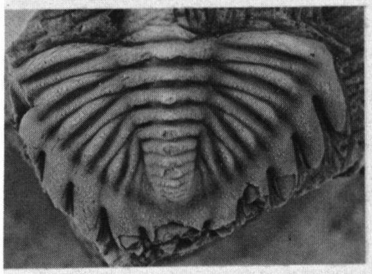

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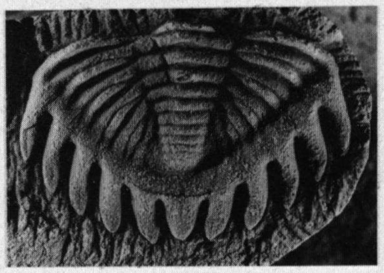

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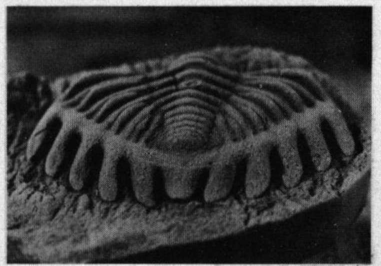

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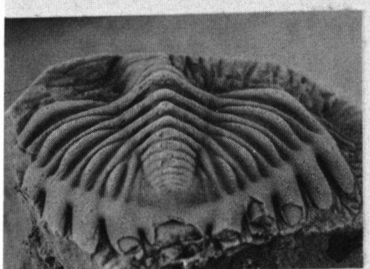

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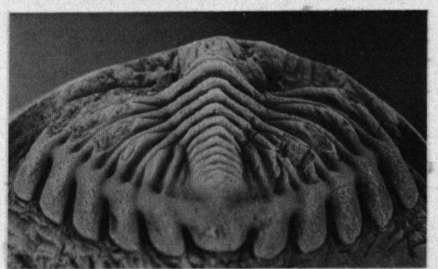

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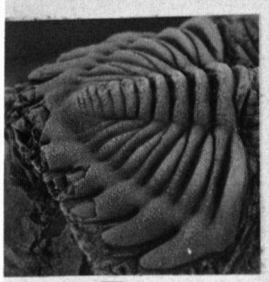

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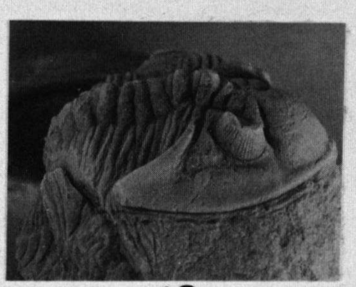

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PLATE 6

Figs. 1-4. *Treveropyge lebanzaensis* n.sp.
Top of the Lebanza Fm; Middle - Upper Siegenian.

1. *Holotypus*: cephalon RGM 339130, x 2.4, a. dorsal view on external mould of rubber; b. dorsal view on internal mould; c. lateral view on external mould of rubber; d. frontal view on internal mould; e. frontal view on external mould of rubber, loc. P4.
2. Pygidium RGM 339132, internal mould, x 3.7; a. dorsal view; b. lateral view, loc. P4.
3. Incomplete pygidium RGM 339134, x 3.3, a. internal mould; b. external mould of rubber, loc. P6.
4. Pygidium RGM 339135, internal mould, x 3.3, loc. P6.

Figs. 5,6. *Treveropyge*? sp.
Lower part of the limestone member of the La Vid Fm; transition Siegenian - Lower Emsian.

5. Incomplete pygidium RGM 339136, internal mould, x 4.5, loc. X4.
6. Pygidium RGM 339137, partly external mould, x 5.7, loc. X4.

Figs. 7-9. *Treveropyge iberica* Gandl, 1972
Upper part of the limestone member of the La Vid Fm; upper Lower Emsian.

7. Pygidium RGM 339142, external mould, x 3, loc. L6.
8. Pygidium RGM 339143, x 2.8, a. external mould of rubber; b. external mould, loc. L6.
9. Incomplete pygidium RGM 339144, external mould with well-preserved posterior lappet, x 4.2, loc. L6.

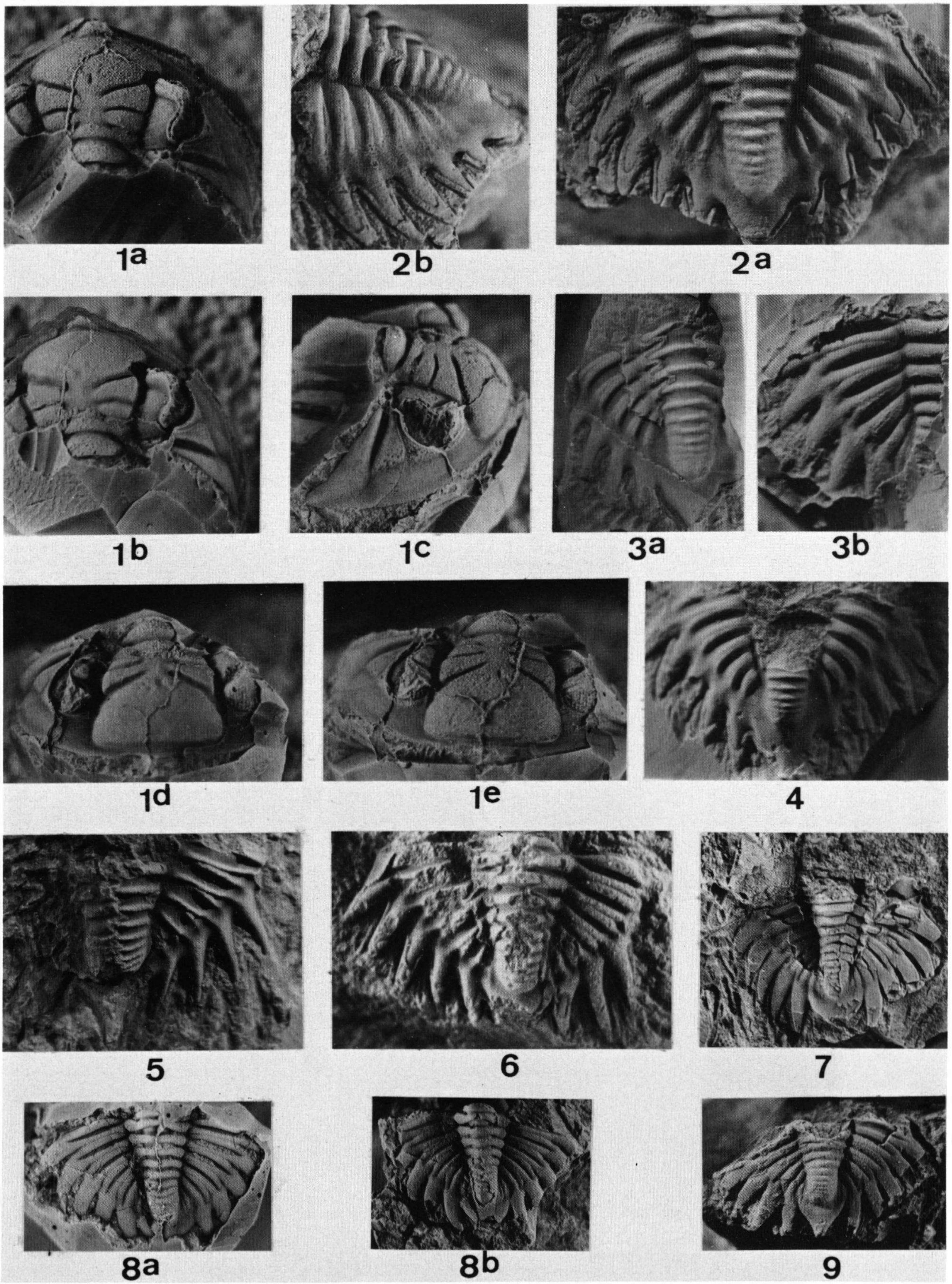
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PLATE 7

Figs. 1,2. *Treveropyge iberica* Gandl, 1972
Upper part of the limestone member of the La Vid Fm; upper Lower Emsian.
1. Enrolled specimen RGM 339138, a. deformed internal mould of the cephalon, x 2.3; b. chiefly external mould of the pygidium, x 2.9; c. detail of the cephalon with ornamentation of fine granules and pits on an external mould of rubber, x 5.6, loc. L6.
2. Cephalon fragment RGM 339139, internal mould, x 3.8, loc. L6.

Fig. 3. *Treveropyge? acrifrons* Gandl, 1972
Upper part of the limestone member of the La Vid Fm; upper Lower Emsian.
3. Cephalon RGM 339148, internal mould, x 3.4, a. dorsal view; b. lateral view, loc. L6.

Figs. 4-7. *Treveropyge henryi* Arbizu, 1979
Polentinos Member of the Abadía Fm; transition Upper Emsian - Eifelian.
4. Cephalon RGM 339154, chiefly internal mould, x 2.1, a. dorsal view; b. lateral view, loc. P24.
5. Eroded incomplete cephalon RGM 339155, external mould, x 1.9, loc. P24.
6. Incomplete pygidium RGM 339152, external mould, x 1.7, loc. P19.
7. Pygidium fragment RGM 339153, external mould of rubber, x 2.2 loc. P19.

Fig. 8. *Metacanthina lavidensis* n.sp.
Lower part of the limestone member of the La Vid Fm; transition Upper Siegenian - Lower Emsian.
8. *Holotypus*: pygidium RGM 339163, partly internal, partly external mould, x 1.4, a. dorsal view; b. lateral view, loc. X3

Fig. 9. *Kayserops? cf. champagnensis* (Morzadec, 1971)
Top of the Lebanza Fm; Middle - Upper Siegenian.
9. Incomplete pygidium RGM 339167, external mould, x 3, loc. P4.

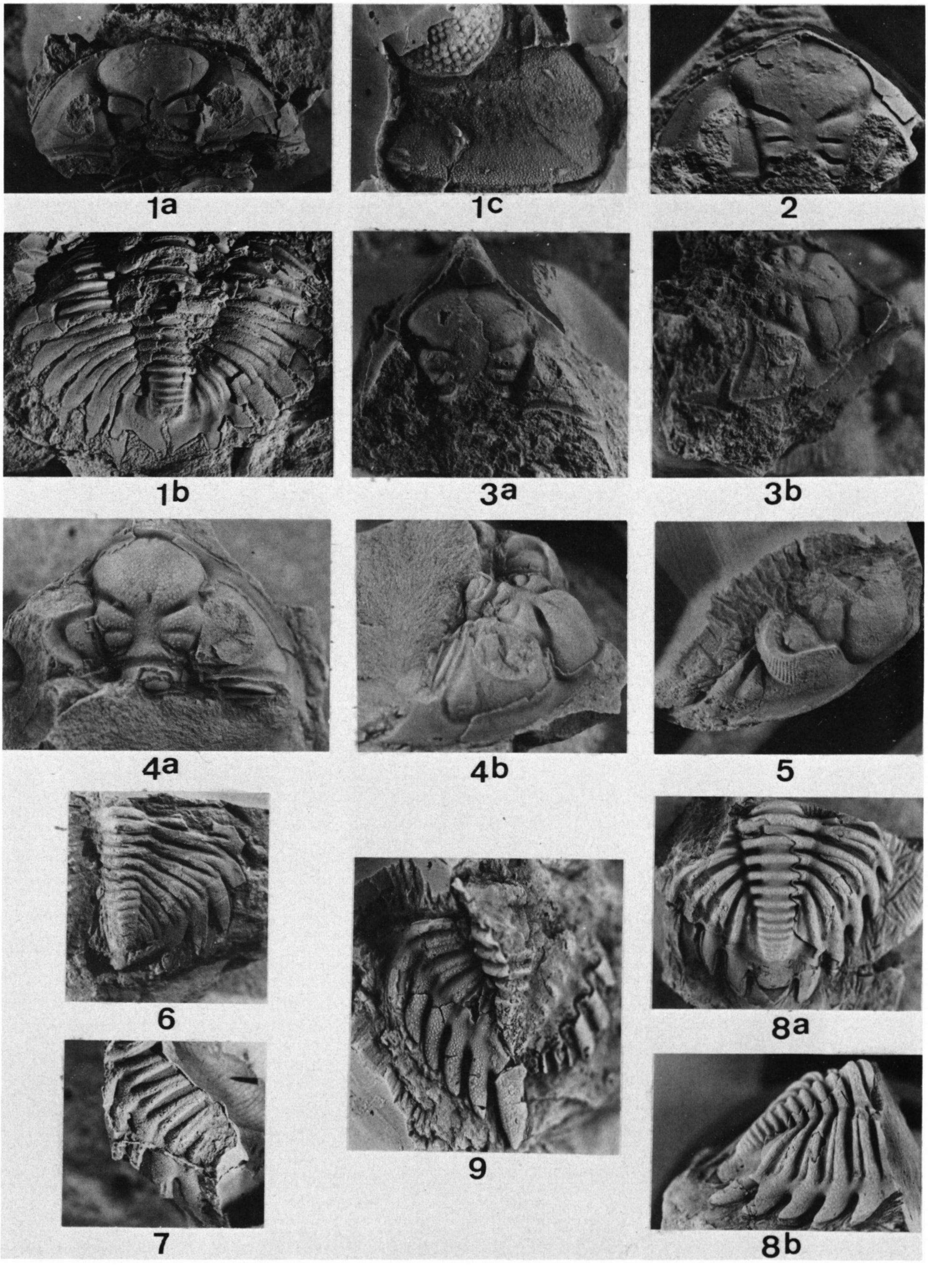
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PLATE 8

Figs. 1-6. *Kayserops ogivalis* (Morzadec, 1976)
Upper part of the Requejada Member (Abadía Fm); Lower Emsian.
1. Cephalon RGM 339173, internal mould, x 3,8, loc. P14.
2. Thorax-pygidium RGM 339178, external mould of rubber, x 3.4, loc. P14.
3. Incomplete cephalon RGM 339174, flattened, external mould of rubber, x 2.4, loc. P14.
4. Thorax-pygidium RGM 339179, deformed, external mould of rubber, x 1.9, loc. P14.
5. Cephalon RGM 339175, external mould of rubber, x 3, loc. P14.
6. Thorax fragment RGM 339169, lateral view on external mould, x 2.1, loc. P13.

Figs. 7-12. *Kayserops obsoletus* Gandl, 1972
Upper part of the limestone member of the La Vid Fm; upper Lower Emsian.
7. Incomplete cephalon RGM 339185, external mould, x 2.4, loc. L6.
8. Cephalon RGM 339186, x 2.2, a. dorsal view on chiefly internal mould; b. lateral view on chiefly internal mould; c. lateral view on external mould of rubber, loc. L6.
9. Pygidium fragment RGM 339195, external mould, x 8, loc. L6.
10. Pygidium RGM 339196, external mould, x 7.4, loc. L6.
11. Pygidium RGM 339197, SEM photograph on external mould, caudal-lateral view, x 8.2, loc. L6.
12. Cephalon RGM 339208, chiefly internal mould, x 2.1, a. lateral view; b. dorsal view, loc. L7.

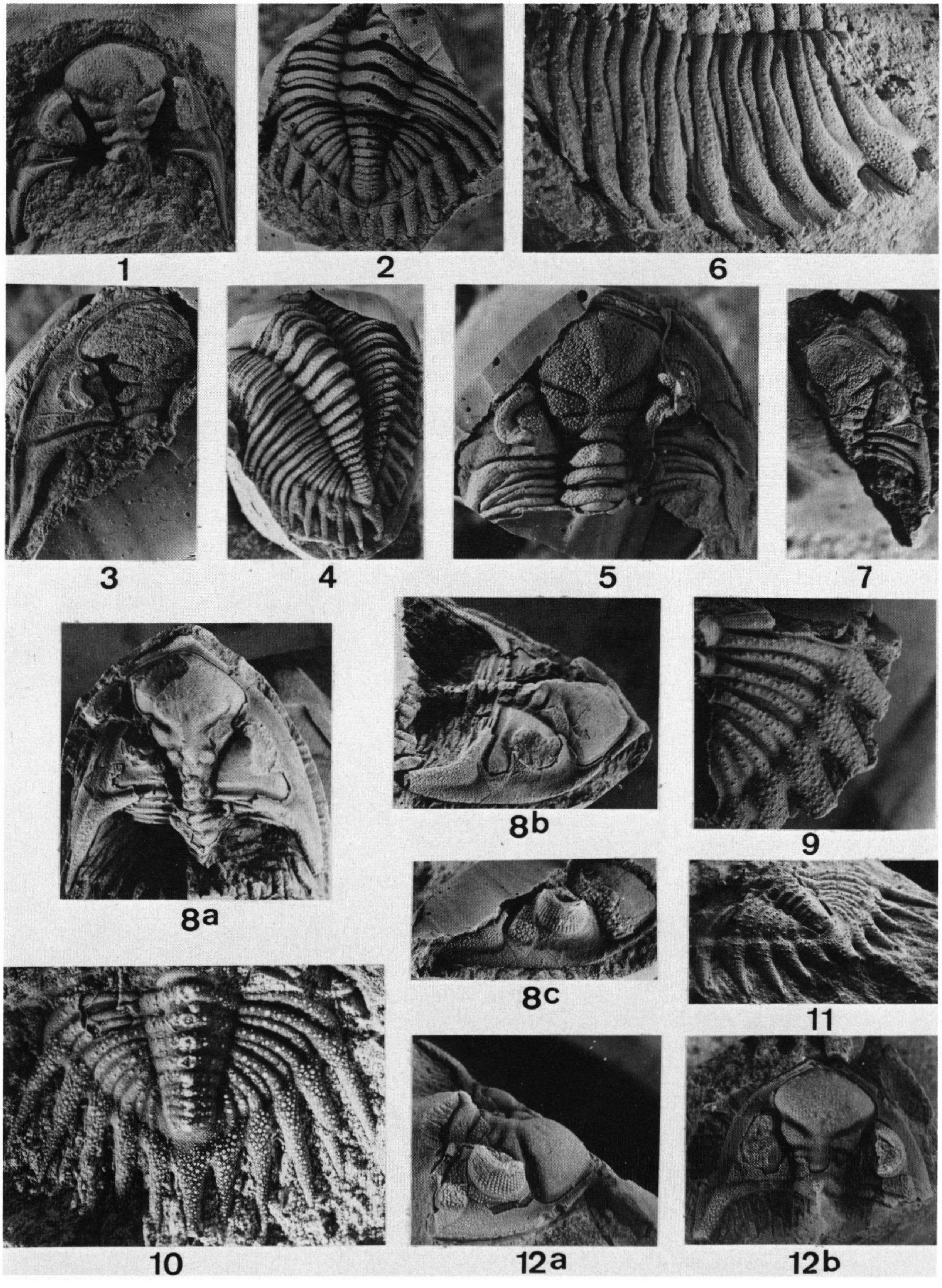
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PLATE 9

Figs. 1-5. *Kayserops brevispinosus* Gandl, 1972
Marls just below the Polentinos Member (Abadía Fm); lower Upper Emsian.

1. Cephalon RGM 339225, x 3, a. external mould of rubber; b. internal mould, loc. P16.
2. Thorax-pygidium RGM 339235, x 5, internal mould, loc. P17.
3. Cephalo-thorax RGM 339233, x 3, internal mould, loc. P17.

Shale member of the La Vid Fm; lower Upper Emsian.

4. Pygidium RGM 339238, x 4.3, chiefly external mould, loc. L 13.
5. Cranidium RGM 339241, x 2.5, a. internal mould; b. external mould of rubber, loc. X6.

Figs. 6-8. *Rhenops circumapodemus* n.sp.
Marls just below the Polentinos Member (Abadía Fm); Upper Emsian.

6. Cephalon RGM 339244, chiefly internal mould, x 1.8, a. dorsal view; b. lateral view; c. frontal view, loc. P17.
7. Incomplete pygidium RGM 339248, eroded external mould, x 4 loc. P17.
8. *Holotypus*: complete specimen RGM 339243, partly internal, partly external mould, a. lateral view cephalon, x 1.1; b. lateral view specimen, x 0.9; c. dorsal view cephalon, x 1.3; d. dorsal view pygidium, x 1.3, loc. P18.

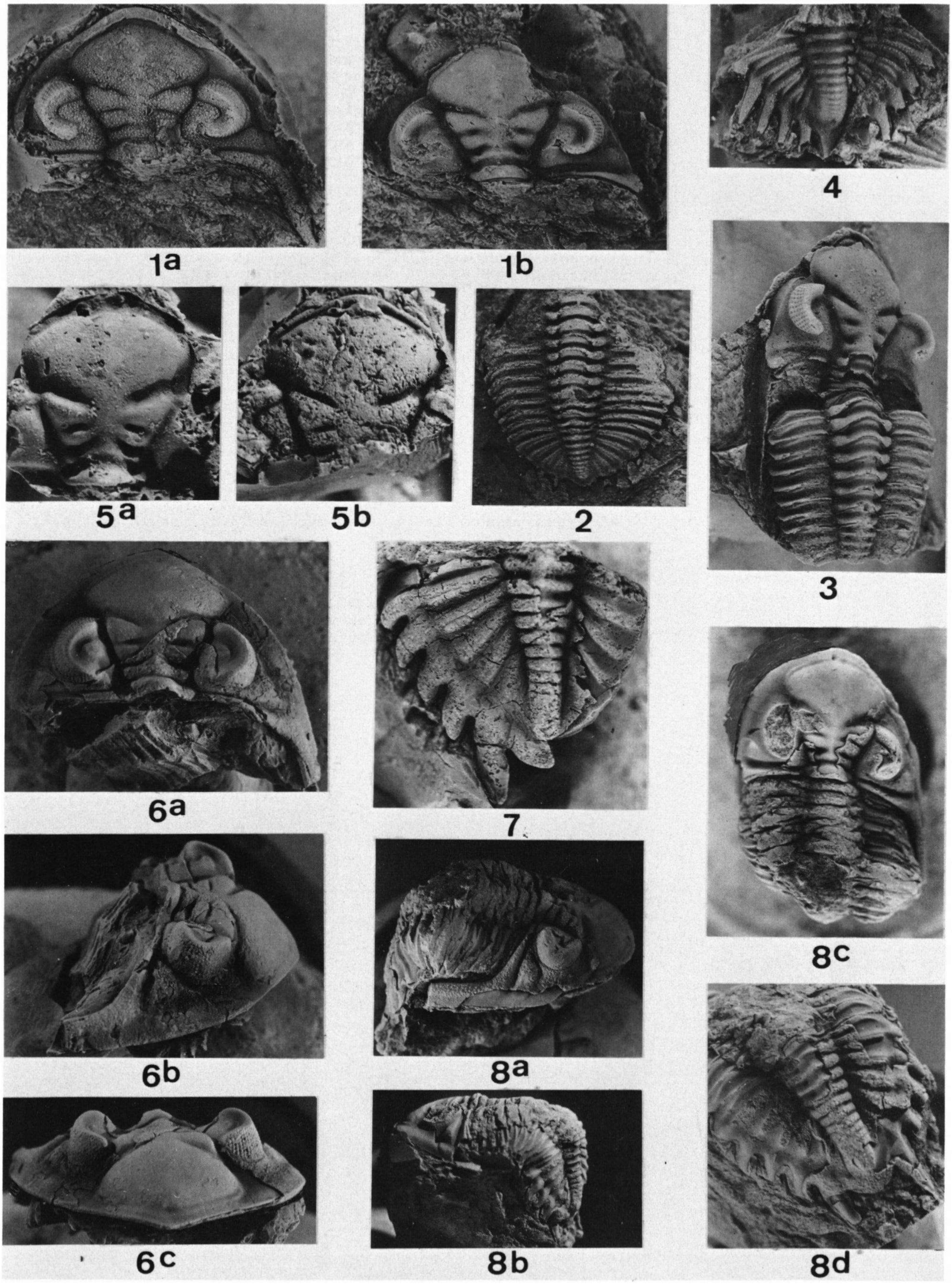
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PLATE 10

Figs. 1-8. *Greenops (Greenops) chaconae* Arbizu, 1979
Shales and marls between Requejada Member and Polentinos Member (Abadía Fm); Upper Emsian.
1. Cephalon RGM 339250, external mould of rubber, x 2.5, a. dorsal view; b. lateral view, loc. P15.
2. Cephalon RGM 339251, external mould of rubber, x 3.4, a. dorsal view; b. lateral view, loc. P15.
3. Cephalon RGM 339252, a. external mould of rubber, x 2.3; b. internal mould, x 2.3; c. lateral view on external mould of rubber, x 3.3, loc. P15.
4. Pygidium RGM 339259, x 3.6, a. external mould of rubber; b. external mould of rubber showing the backwards widening doublure; c. internal mould, loc. P15.
5. Pygidium RGM 339260, internal mould, x 4.7, loc. P15.
6. Pygidium RGM 339261, external mould of rubber, lateral view, x 5.3, loc. P15.
7. Cranidium RGM 339263, external mould of rubber, x 3.5, loc. P16.

Polentinos Member of the Abadía Fm.; Upper Emsian-lowermost Eifelian.

8. Enrolled specimen RGM 339266, eroded external mould, x 3, a. lateral view cephalon; b. dorsal view cephalon, loc. P19.

Figs. 9,10. *Greenops (Greenops)* sp.
Yellow shales of the Rivera Fm. (Leonese Basin); probably Upper Givetian.
9. Pygidium RGM 339273, flattened, external mould of rubber, x 5, loc. V3.
10. Pygidium RGM 339274, flattened, external mould of rubber, x 3, loc. V3.

Fig. 11. *Greenops (Greenops)* sp. Gandl, 1972, *cf. boothi* (Green, 1837).
Upper part of the Portilla Fm; probably Upper Givetian.
11. Cephalon RGM 339275, x 4.2, a. dorsal view on internal mould; b. dorsal view on external mould of rubber; c. lateral view on internal mould, loc. X16.

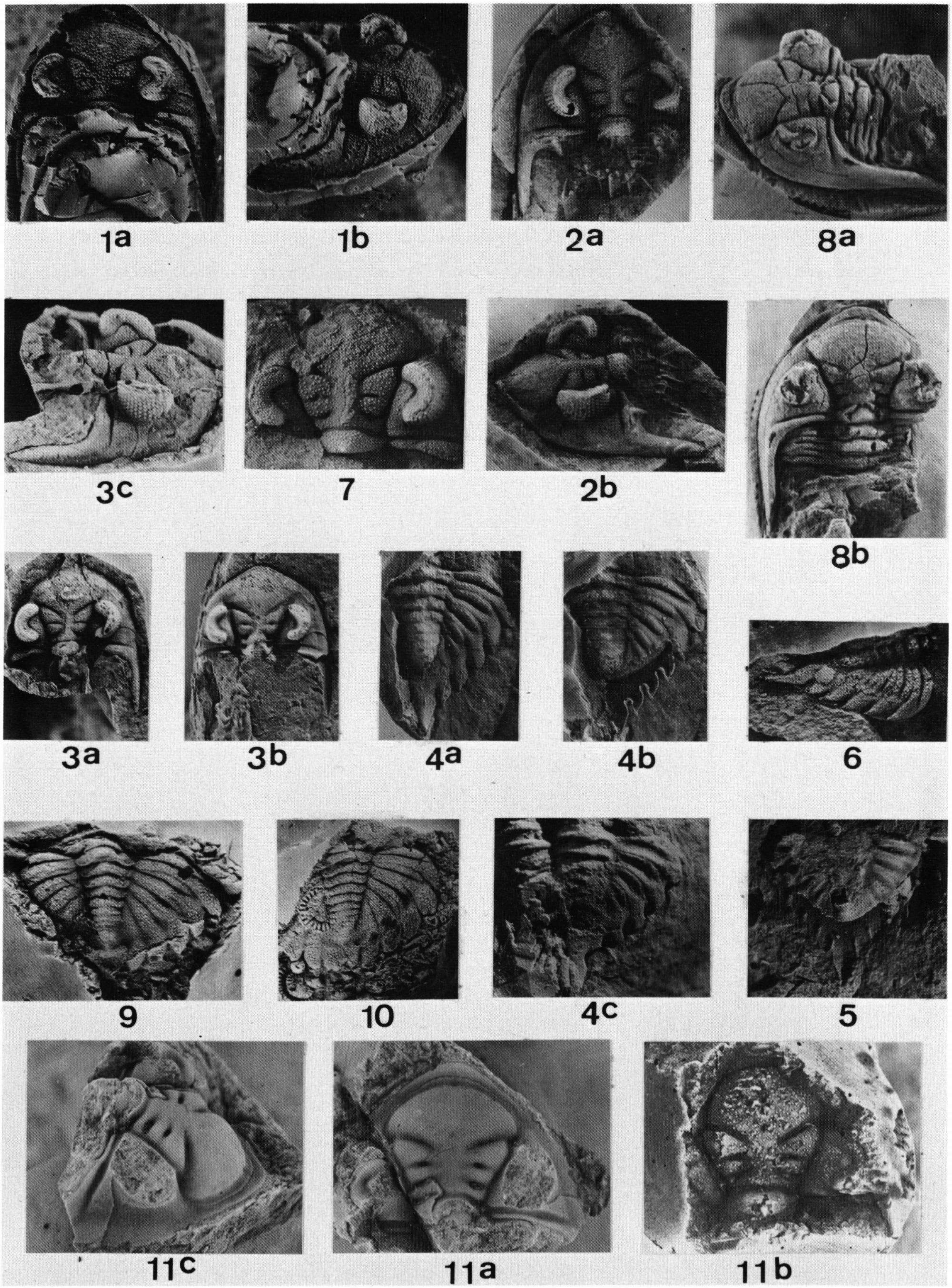
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PLATE 11

Figs. 1-6. *Greenops (Greenops) ultimus* n.sp.
Top of the Portilla Fm; Lower Frasnian.
1. Cephalon RGM 339277, external mould, x 2.5, a. dorsal view; b. lateral view; c. frontal view; d. lateral view, loc. L22.
2. Cranidium RGM 339279, x 2.8, a. external mould of rubber; b. internal mould, loc. L22.
3. Cranidium RGM 339280, internal mould of rubber, x 3.2, loc. L22.
4. *Holotypus*: pygidium RGM 339276, chiefly external mould, x 3.2, a. dorsal view; b. lateral view; c. caudal view, loc. L22.
5. Pygidium fragment RGM 339281, internal mould of rubber, x 3.5, loc. L22.
6. Pygidium fragment RGM 339282, internal mould of rubber, x 4.4, loc. L22.

Figs. 7,8. *Greenops (Neometacanthus) perforatus* (Morzadec, 1969)
Base of the Huergas Fm; Lower Eifelian.
7. Enrolled specimen RGM 339283, x 1.9, a. internal mould of the cephalon; b. internal mould of thorax-pygidium; c. external mould of rubber with numerous little pores on the pleural bands, loc. L14.
8. Enrolled specimen RGM 339284, x 2.4, a. internal mould; b. internal mould; c. ventral view on external mould of rubber, loc. L14.

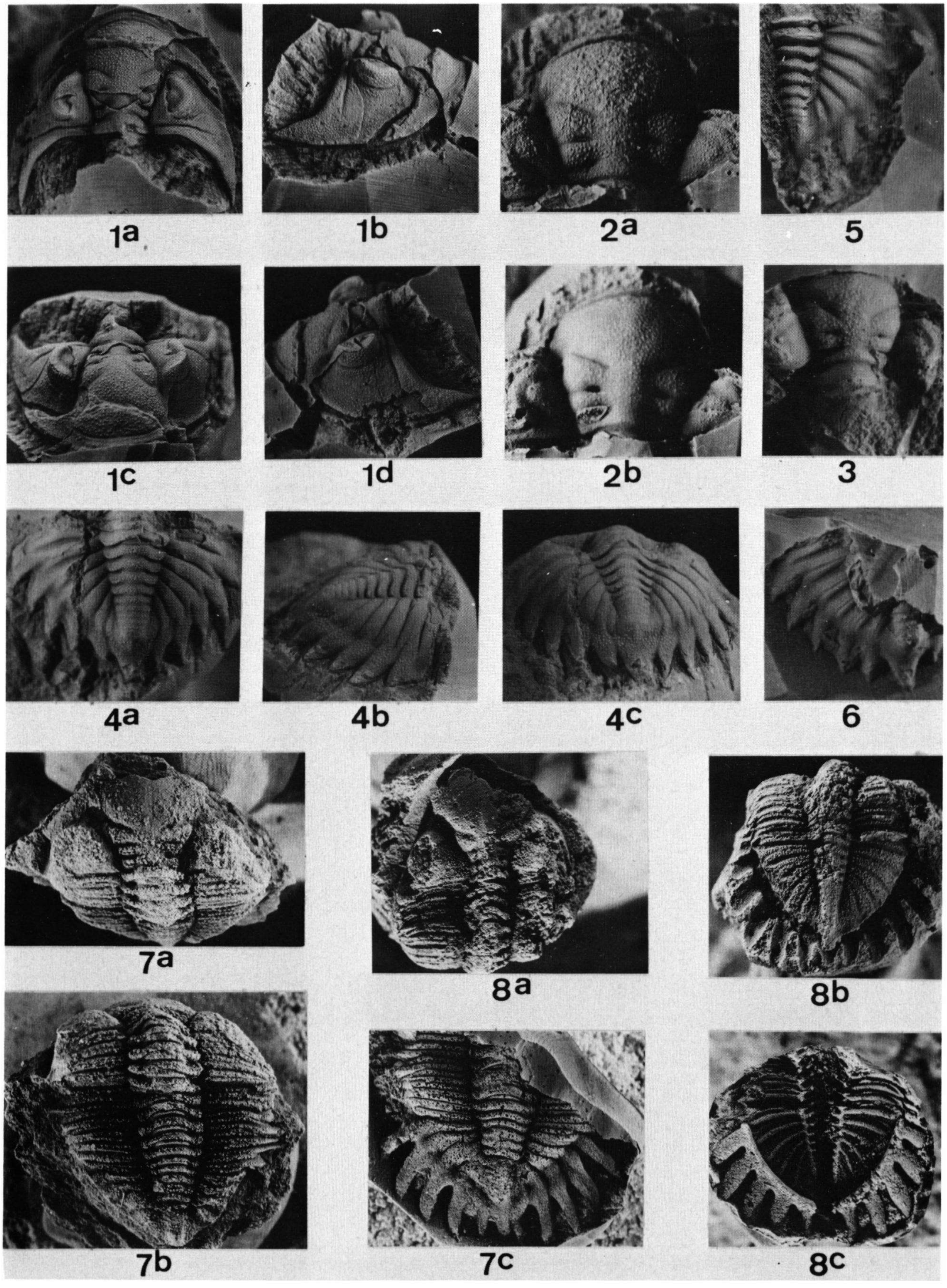
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PLATE 12

Figs. 1-7. *Delocare? dalii* n.sp.
Lower part of the limestone member of the La Vid Fm; transition Upper Siegenian - Lower Emsian.

1. Incomplete cephalon RGM 339291, partly internal, partly external mould, x 5, a. dorsal view; b. lateral view, loc. X4.
2. Incomplete cephalon RGM 339292, partly external, partly internal mould, x 4, loc. X4.
3. Cranidium RGM 339293, internal mould of rubber, x 5, loc. X4.
4. *Holotypus*: Pygidium RGM 339290, external mould, x 5, a. dorsal view; b. lateral view, loc. X4.
5. Pygidium RGM 339298, chiefly internal mould, x 5, a. dorsal view; b. lateral view, loc. X4.
6. Pygidium RGM 339299, internal mould, x 3.7, loc. X4.
7. Pygidium fragment RGM 339300, external mould of rubber, x 4.5, loc. X4.

Figs. 8-12. *Delocare rostrata* Arbizu, 1979
Upper part of the limestone member of the La Vid Fm; upper Lower Emsian.

8. Pygidium fragment RGM 339319, external mould, x 3.3, loc. L6
9. Pygidium RGM 339320, external mould, a. SEM photograph shows caudal view, x 8; b. dorsal view, x 6, loc. L6.
10. Genal spine RGM 339318, external mould, a. dorsal view, x 4; b. lateral view shows smooth furrow along the border, x 6, loc. L6.
11. Pygidium RGM 339321, SEM photograph of external mould, lateral view, x 5, loc. L6.
12. Cephalon RGM 339307, partly external, partly internal mould, x 4.8, a. dorsal view; b. lateral view, loc. L6.

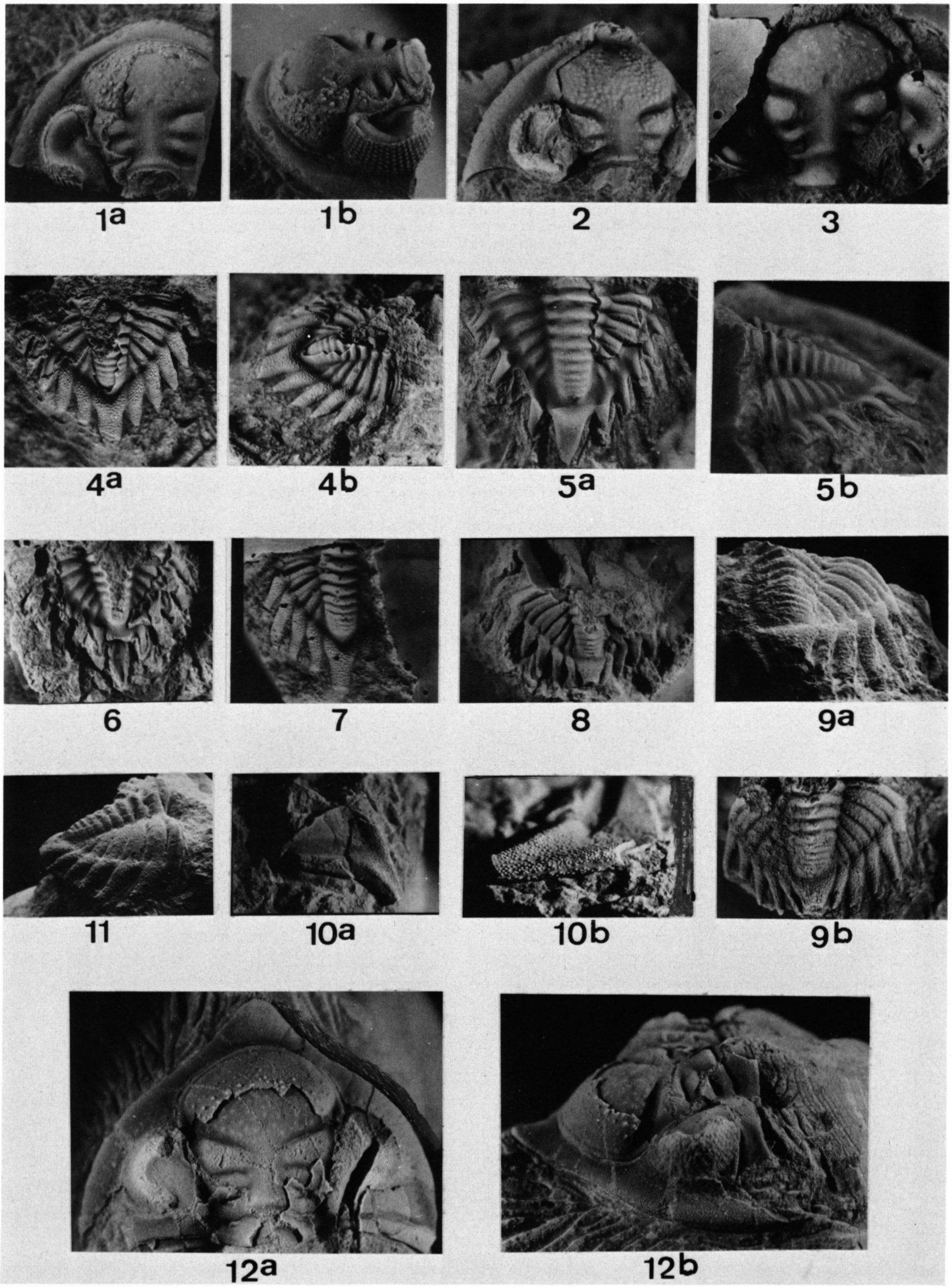
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PLATE 13

Figs. 1-7. *Delocare rostrata* Arbizu, 1979
Upper part of the limestone member of the La Vid Fm; upper Lower Emsian.
1. Cephalon fragment RGM 339308, external mould of rubber, x 4.6, a. dorsal view; b. lateral view, loc. L6.
2. Cranidium RGM 339309, external mould, x 6, loc. L6.
3. Cephalon RGM 339310, partly internal, partly external mould, x 4, loc. L6.
4. Pygidium RGM 339322, external mould, x 9, loc. L6.
5. Pygidium RGM 339323, external mould, x 9, loc. L6.
6. Pygidium RGM 339324, a. external mould, x 8.3; b. external mould of rubber, x 5.7, loc. L6.

Transition limestone-shale member of the La Vid Fm; transition Lower - Upper Emsian.

7. Pygidium RGM 339334, x 9, chiefly external mould showing features of *D? palenciae* n.sp., loc. L10.

Figs. 8,9. *Delocare cf. boopis* (Rud. Richter, 1909)
Top of the shale member of the La Vid Fm; Upper Emsian.

8. Pygidium fragment RGM 339336, external mould of rubber, x 2.8, a. dorsal view; b. lateral view, loc. X6.
9. Cranidium RGM 339335, x 1.7, a. internal mould; b. external mould of rubber, loc. X6.

Figs. 10-12. *Delocare? palenciae* n.sp.
Shales between Requejada and Polentinos Member (Abadía Fm); Upper Emsian.

10. Pygidium RGM 339346, external mould of rubber, x 6.2, loc. P15.
11. Pygidium RGM 339347, external mould of rubber, x 4.6, loc. P15.
12. Pygidium RGM 339348, external mould of rubber, x 6.5, loc. P15.

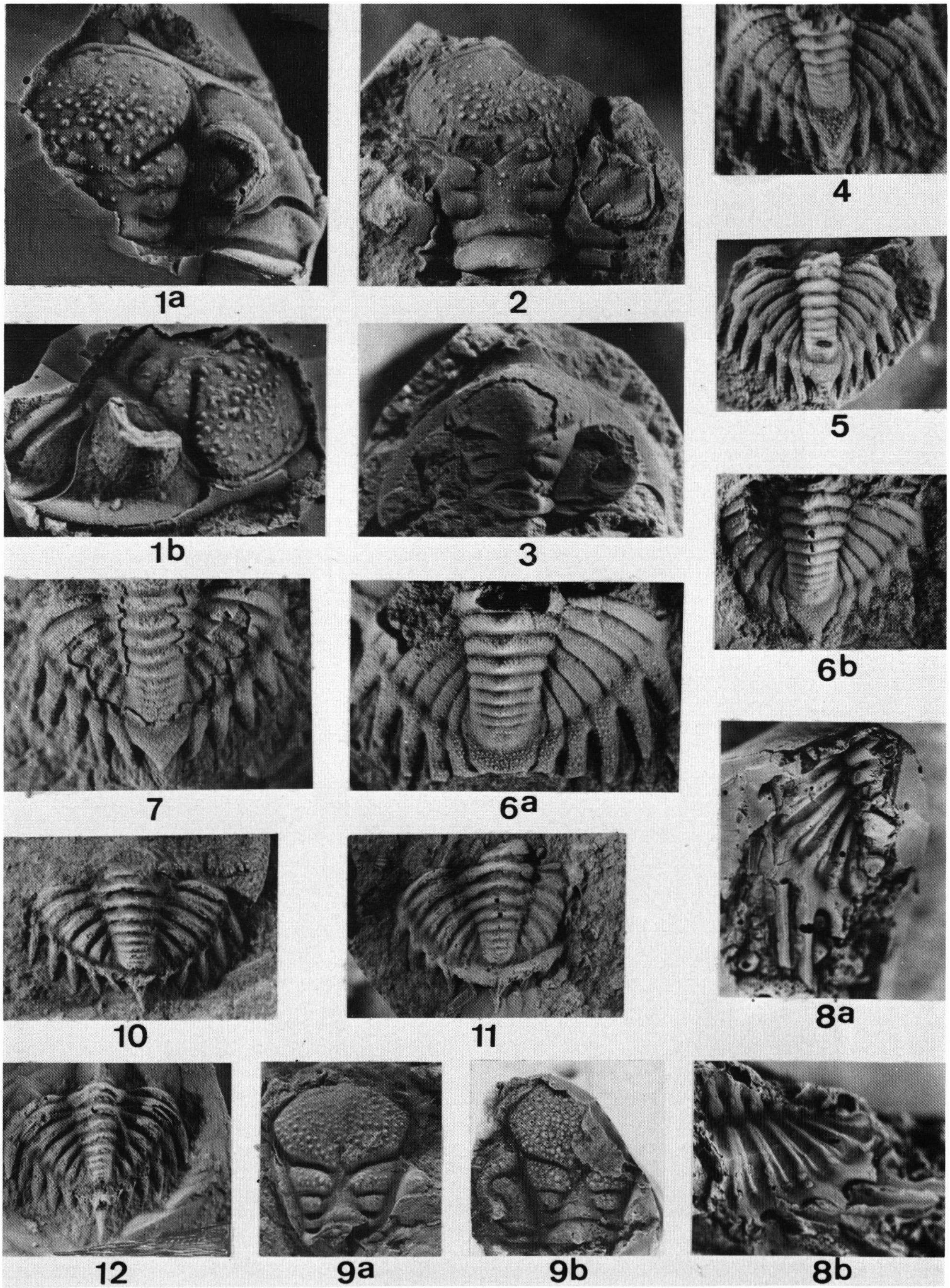
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PLATE 14

Figs. 1-3. *Delocare? palenciae* n.sp.
Shales between Requejada and Polentinos Member; Upper Emsian.
1. *Holotypus*: complete specimen RGM 339338, external mould of rubber, x 3.8, loc. P15.
2. Cephalon RGM 339339, external mould of rubber, x 4, a. dor sal view; b. frontal view, loc. P15.
3. Cephalon RGM 339340, external mould of rubber, x 3.4, loc. P15.

Fig. 4. *Comura defensor* (R. & E. Richter, 1952)
Polentinos Member of the Abadía Fm; Upper Emsian - Eifelian transition.
4. Incomplete specimen RGM 339350, x 1.4, internal mould of rubber, posterior border of cephalon shows a metafixigenal spine, loc. P19.

Figs. 5,6. *Alcaldops? argovejensis* n.sp.
Lower part of the Huergas Fm; Lower Eifelian.
5. *Holotypus*: complete specimen RGM 339351, x 1.8, a. lateral view on external mould of rubber; b. dorsal view on external mould of rubber; c. internal mould; d. external mould of rubber of pygidium; e. ventral view on external mould of rubber, loc. L14.
6. Pygidium fragment RGM 339352, external mould of rubber, x 1.8, loc. L14.

Figs. 7,8. *Alcaldops alcaldei* Arbizu, 1979.
Middle part of the Huergas Fm; Upper Eifelian - Lower Givetian
7. Pygidium RGM 339354, external mould of rubber, x 1.6, loc. X11.
8. Pygidium RGM 339353, external mould of rubber, x 1.7, loc. L18.

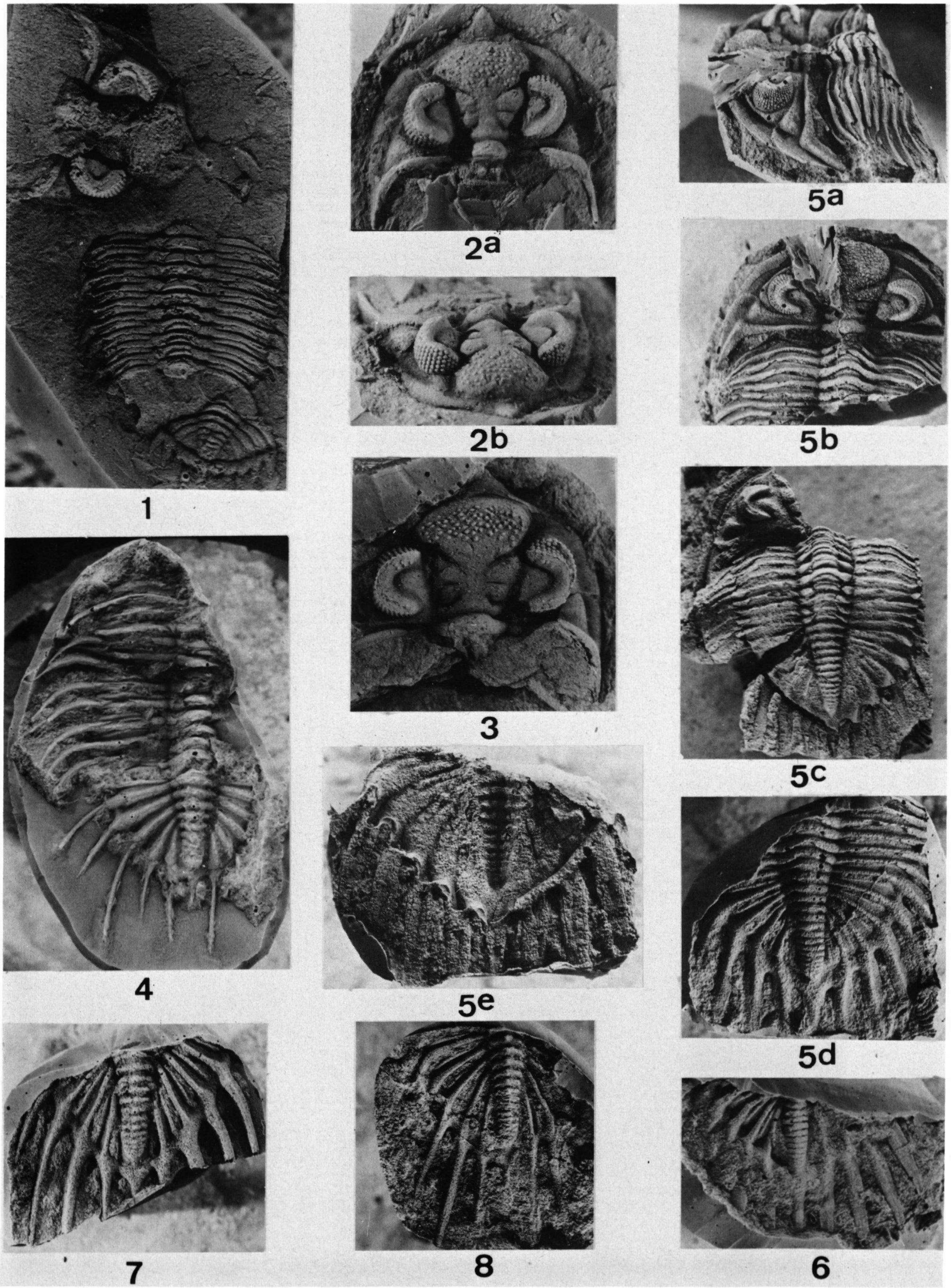

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PLATE 15

Figs. 1,2. *Heliopyge* sp.1 aff. *asturica* Haas, 1970
Middle part of the Portilla Fm; Givetian - Frasnian transition.
1. Incomplete pygidium RGM 339356, external mould, x 3, loc. X15.
2. Pygidium fragment RGM 339357, external mould of rubber, x 3, loc. X15.

Fig. 3. *Heliopyge* sp.2 aff. *asturica* Haas, 1970
Middle part of the Portilla Fm; Givetian - Frasnian transition.
3. Pygidium RGM 339359, a. internal mould of rubber, x 4.5; b. external mould of rubber, x 3.5, loc. X13.

Fig. 4. ?*Heliopyge* sp.2 aff. *asturica* Haas 1970?
Middle part of the Portilla Fm; Givetian - Frasnian transition.
4. Cephalon RGM 339361, antero-lateral view on external mould, x 2.3, loc. X14.

Figs. 5-10. *Heliopyge asturica* Haas, 1970
Top of the Portilla Fm; Lower Frasnian.
5. Pygidium RGM 339364, internal mould, x 3, a. dorsal view; b. lateral view, loc. L22.
6. Incomplete pygidium RGM 339365, external mould of rubber, x 3, loc. L22.
7. Incomplete pygidium RGM 339366, internal mould, x 2.3, loc L22.
8. Pygidium RGM 339367, internal mould, x 3, loc. L22.
9. Cranidium RGM 339362, internal mould, x 1.6, loc. L22.
10. Librigenum RGM 339363, internal mould, x 3, loc. L22.

Figs. 11-14. *Bradocryphaeus*? *cantarmoricus* (Morzadec & Arbizu, 1978)
Lower part of the Huergas Fm; Eifelian.
11. Cephalon RGM 339368, internal mould, x 2.3, a. dorsal view; b. lateral view, loc. L17.
12. Cephalon RGM 339369, a. ventral view on external mould of rubber, x 1.5; b. lateral view on external mould of rubber, loc. L17.
13. Pygidium RGM 339371, external mould of rubber, x 2, loc. L17.
14. Incomplete pygidium RGM 339372, internal mould, x 2.4, loc. L17.

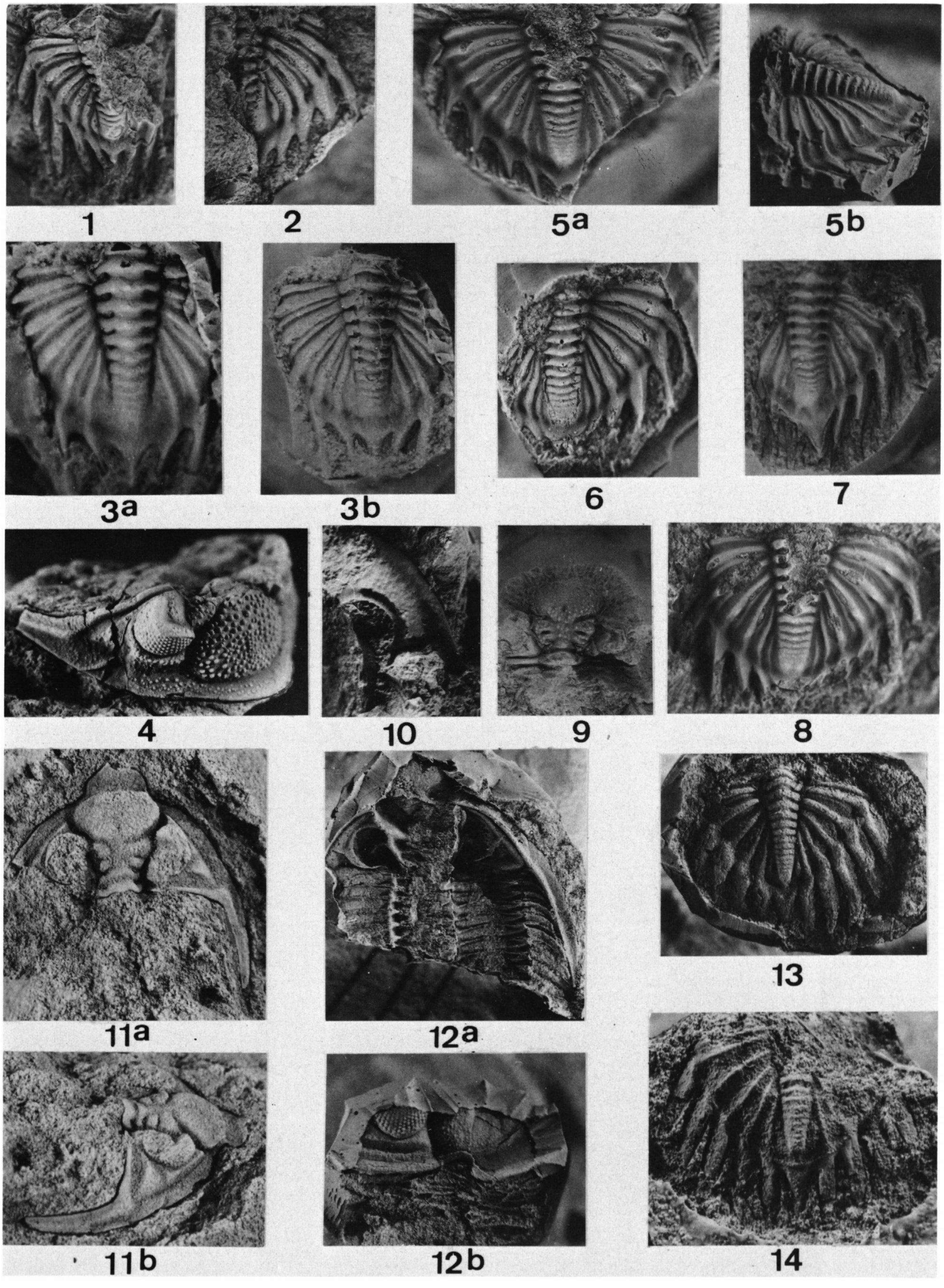

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PLATE 16

Figs. 1,2. *Bradocryphaeus? cantarmoricus* (Morzadec & Arbizu, 1978)
Lower part of the Huergas Fm; Eifelian.
1. Pygidium fragment RGM 339373, external mould of rubber, x 2.3, loc. L17.
2. Pygidium-thorax fragment RGM 339376, ventral view on external mould, x 2.5, loc. L15.

Fig. 3. *Bradocryphaeus? cf. quadratispinosus* (Gandl, 1972)
Base of the Portilla Fm; probably Givetian.
3. Pygidium RGM 339377, x 3, a. chiefly internal mould; b. external mould of rubber, loc. L21.

Figs. 4-11. *Bradocryphaeus hispanicus* (R. & E. Richter, 1926)
Top of the Portilla Fm; Frasnian.
4. Cephalon RGM 339378, x 2.5, a. dorsal view on chiefly internal mould; b. dorsal view on external mould of rubber; c. frontal view on partly internal, partly external mould; d. lateral view, loc. L22.
5. Cephalon RGM 339379, lateral view on chiefly external mould showing a metafixigenal spine, x 2, loc. L22.
6. Genal spine RGM 339382, external mould of rubber, x 2, loc. L22.
7. Eye RGM 339380, external mould of rubber, x 2.5, loc. L22.
8. Cranidium RGM 339381, external mould of rubber, x 2.4, loc. L22.
9. Pygidium RGM 339384, x 3, a. external mould of rubber; b. chiefly internal mould, loc. L22.
10. Pygidium RGM 339385, internal mould, x 2, loc. L22.
11. Pygidium fragment RGM 339386, external mould of rubber, x 2.5, loc. L22.

Figs. 12,13. *Protacanthina* n.sp.
Top of the Lebanza Fm; Middle - Upper Siegenian.
12. Pygidium RGM 339390, chiefly internal mould, x 2.4, a. dorsal view; b. lateral view, loc. P4.
13. Pygidium fragment RGM 339391, external mould of rubber, x 3, loc. P4.

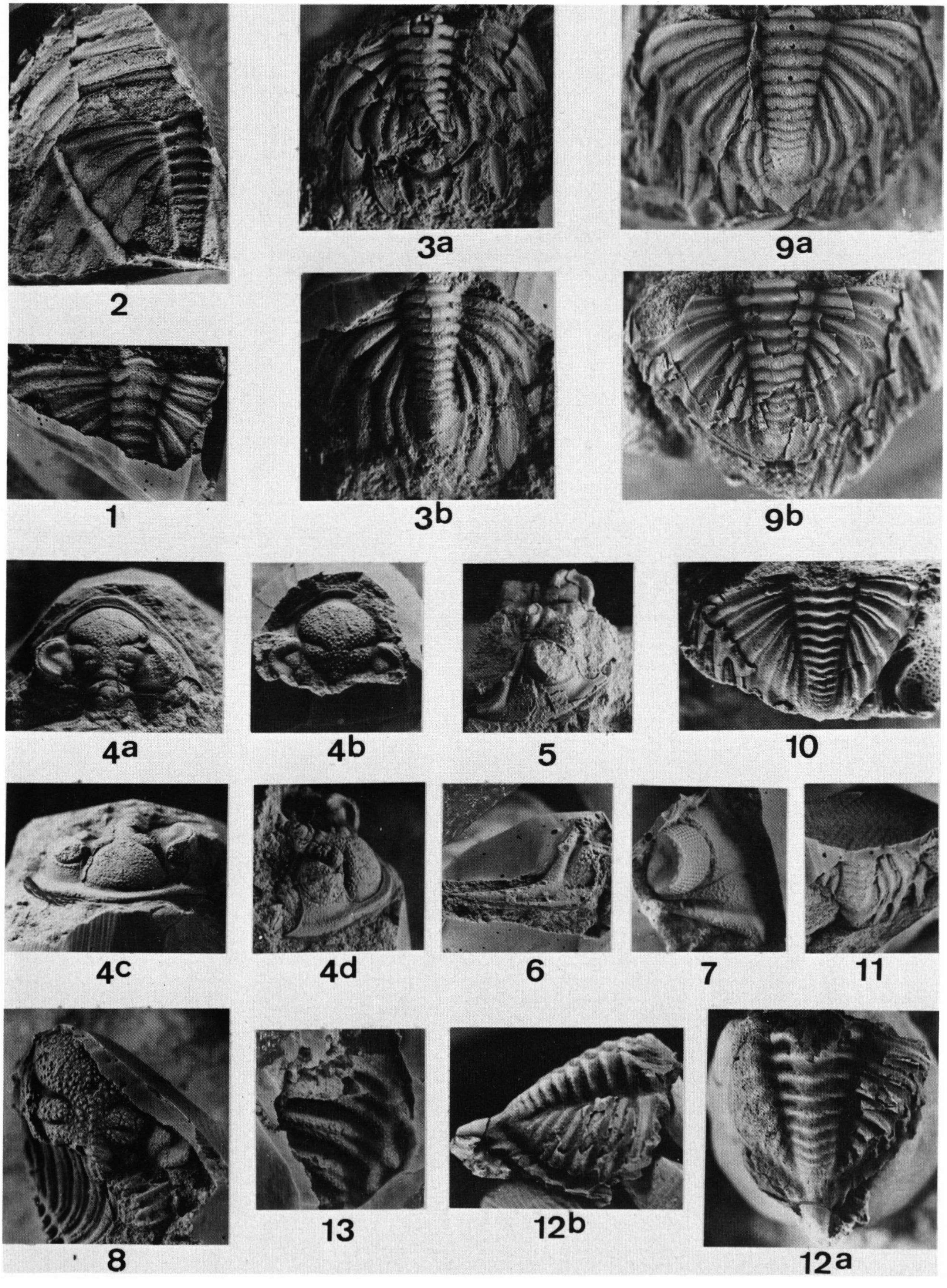

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PLATE 17

Fig. 1. *Bradocryphaeus matallanensis* n.sp.
Base of the Nocedo Fm; Middle Frasnian.
1. *Holotypus*: pygidium RGM 339388, external mould, x 6, a. dorsal view; b. caudal view, loc. X17.

Fig. 2. *Bradocryphaeus sexspiniferus* n.sp.
Calcareous bed at the top of the A-member of the Nocedo Fm; Middle Frasnian.
2. *Holotypus*: pygidium RGM 339389, external mould, x 7, a. lateral view; b. dorsal view, loc. X18.

Figs. 3-11. *Neocalmonia cantabrica* n.sp.
Upper part of the Huergas Fm; Lower Givetian.
3. *Holotypus*: pygidium RGM 339393, external mould of rubber, x 4, loc. L19.
4. Pygidium RGM 339401, internal mould, x 4, loc. L19.
5. Pygidium RGM 339402, x 4, a. external mould of rubber; b. internal mould, loc. L19.
6. Pygidium RGM 339403, external mould of rubber, x 4, loc. L19.
7. Pygidium RGM 339404, internal mould, x 4, loc. L19.
8. Cephalon RGM 339394, x 3, a. dorsal view on internal mould; b. dorsal view on external mould of rubber; c. lateral view on internal mould; d. lateral view on external mould of rubber, loc. L19.
9. Cranidium RGM 339395, x 3, a. internal mould; b. external mould of rubber, loc. L19.
10. Cranidium RGM 339396, x 3, external mould of rubber, loc. L19.
11. Cranidium RGM 339397, x 3.7, external mould of rubber, loc. L19.

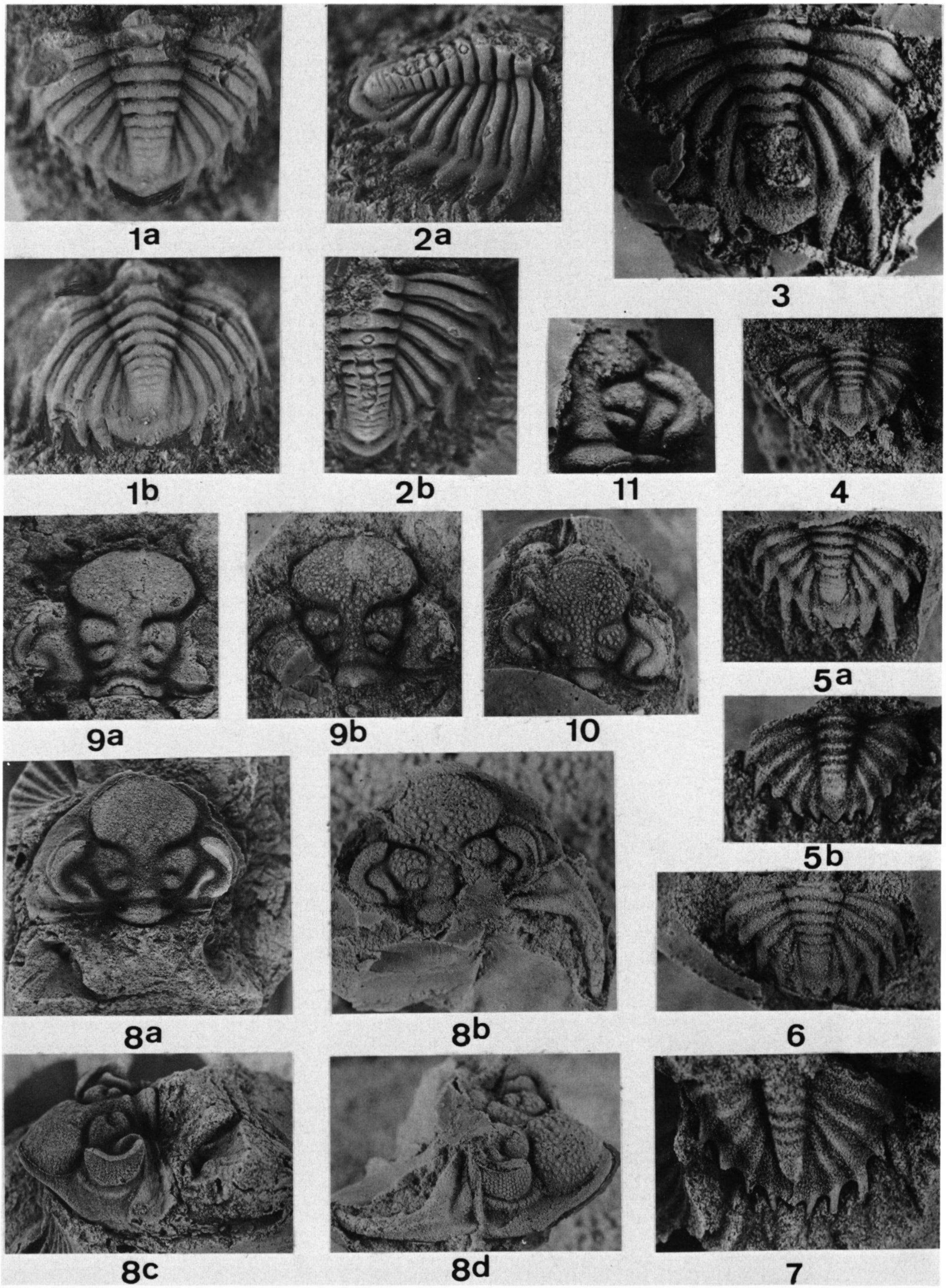
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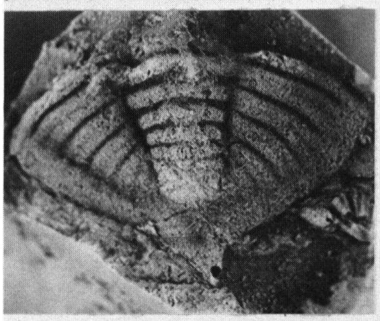
PLATE 18

PALENTIAN BASIN

Argillaceous sandstones with some limestone intercalations at the top of the Carazo Fm. Age: Lower Gedinnian (tiro zone); locs. P1, P2.

Figs. 1-5. *Acastella tiro* R. & E. Richter, 1954
1. Pygidium RGM 339410, external mould of rubber, x 5, loc. P1
2. Pygidium RGM 339411, internal mould, x 8, loc. P1.
3. Cephalon RGM 339412, internal mould, x 3, loc. P1.
4. Cephalon RGM 339413, external mould of rubber, x 2.3, loc. P1.
5. Pygidium RGM 339414, external mould of rubber, x 5.5, loc. P1.

Figs. 6-10. *Digonus aff. roemeri* (de Koninck, 1876)
6. Cranidium RGM 339415, internal mould, x 3.2, loc. P1.
7. Cephalon RGM 339416, internal mould, x 2, loc. P1.
8. Pygidium RGM 339417, external mould of rubber, x 2.8, loc. P1.
9. Cephalon with pygidium RGM 339418, external mould of rubber, x 2.5, loc. P2.
10. Pygidium RGM 339419, chiefly internal mould, x 2.5, a caudal view; b. lateral view, loc. P1.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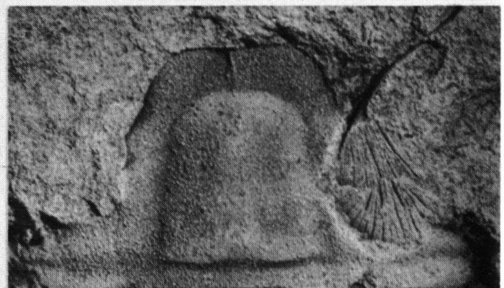
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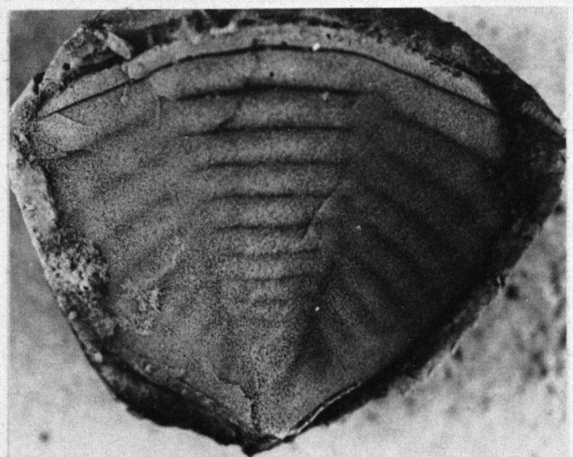
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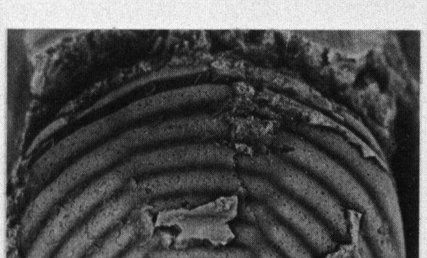
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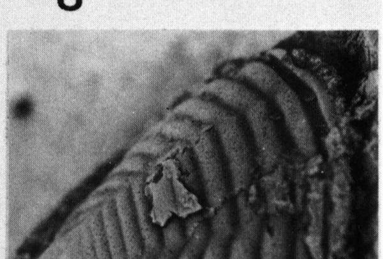
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PLATE 19

Argillaceous limestones at the base of the Lebanza Fm. Age: upper Lower Gedinnian; loc. P3.

Figs. 1,2. *Parahomalonotus* sp.
1. Pygidium RGM 339420, partly internal, partly external mould, a. dorsal view, x 1.6; b. detail border, x 3.8, loc. P3.
2. Cranidium RGM 339421, external mould, x 1.8, loc. P3.

Fig. 3. *Warburgella rugulosa* ssp.
3. Pygidium RGM 339422, internal mould, x 4.6, loc. P3.

Argillaceous limestones of the upper part of the Lebanza Fm (E-Member). Age: Middle - Upper Siegenian; locs. P4-P7.

Fig. 4. *Treveropyge lebanzaensis* n.sp.
4. Pygidium RGM 339134, external mould of rubber, x 3.3, loc. P6.

Fig. 5. *Protacanthina* n.sp.
5. Pygidium RGM 339392, external mould of rubber, x 5, loc. P4.

Fig. 6. *Pilletina aequisulcata cf. matutina* (Gandl, 1972)
6. Pygidium RGM 339074, external mould, x 1.5, loc. P5.

Fig. 7. *Pseudocryphaeus cf. michelini* (Rouault, 1851)
7. Pygidium RGM 339050, external mould, x 3, loc. P5

Fig. 8. "*Scutellum*" sp. (together with *Pilletina aequisulcata cf. matutina*)
8. Pygidium RGM 339423, external mould of rubber, x 2, loc. P5.

Fig. 9,10. *Parahomalonotus gervillei* (de Verneuil, 1850)
9. Pygidium RGM 339424, external mould of rubber, lateral view, x 2.5, loc. P5.
10. Cranidium of young specimen showing the glabellar segmentation, RGM 339425, external mould, x 10, loc. P6.

Fig. 11. *Proetus (Coniproetus) aff. foucauldi* G. Alberti, 1967
11. Pygidium RGM 339426, external mould, x 6, loc. P5, a. dorsal view; b. caudal view.

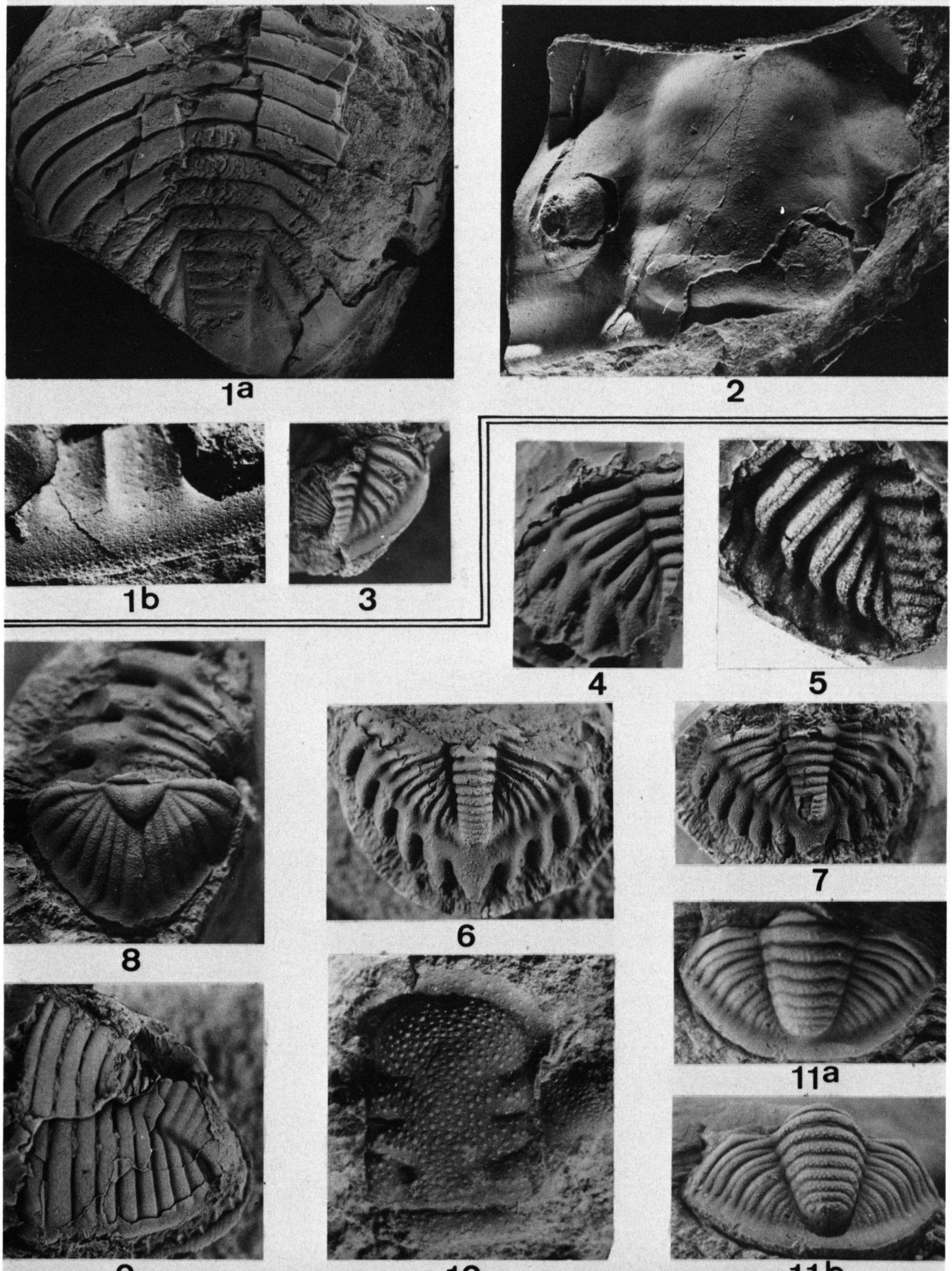
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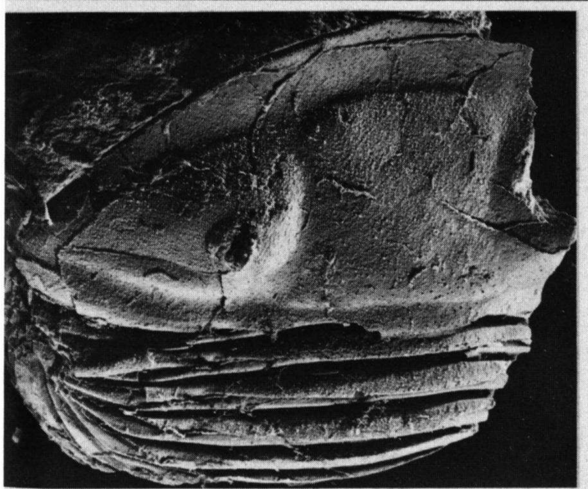
PLATE 20

Decalcified siltstones of the Requejada Member (Abadía Fm). Age: lowermost Lower Emsian; locs. P8-P12.

Figs. 1-5. *Trimerus (Dipleura)* sp.
1. Complete specimen RGM 339427, internal mould, a. cephalon, x 2.9; b. pygidium, x 1.7, loc. P8.
2. Doublure with rostral plate RGM 339428, external mould of rubber, x 2.3, loc. P11.
3. Cephalon RGM 339429, external mould of rubber, x 1.3, loc. P11.
4. Pygidium RGM 339430, external mould of rubber, x 2.5, loc. P10.
5. Hypostome RGM 339431, external mould of rubber, x 2.5, loc. P10.

Fig. 6. *Reedops cf. sternbergi* (Corda, 1847)
6. Cephalon RGM 339432, weathered external mould, x 2.5, a. lateral view; b. dorsal view, loc. P12.

Figs. 7,8. *Cheirurus (Pilletopeltis) aff. maurus* (G. Alberti, 1966)
7. Pygidium RGM 339433, external mould of rubber, x 2.5, loc. P8.
8. Pygidium RGM 339434, internal mould, x 1.9, loc. P8.



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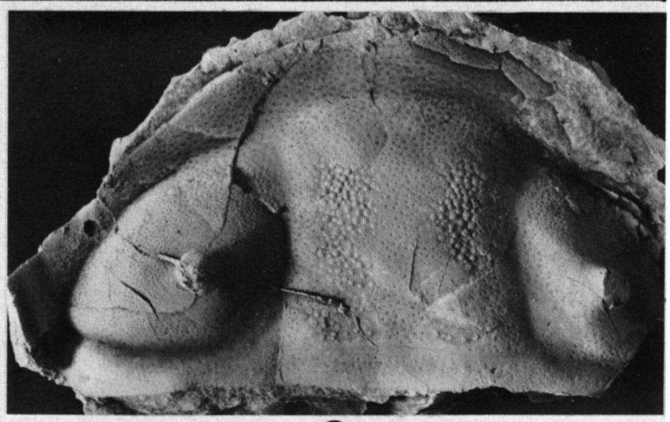

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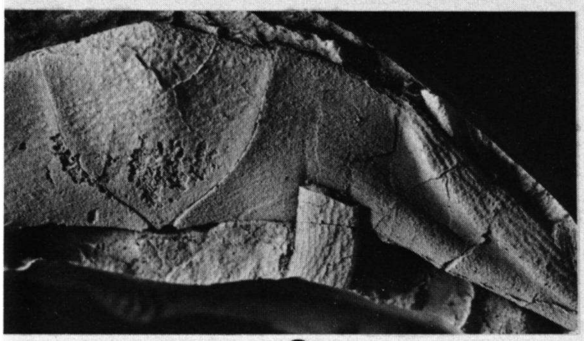

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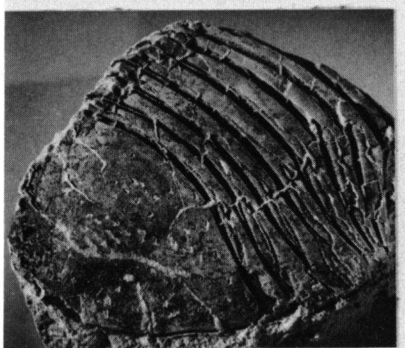

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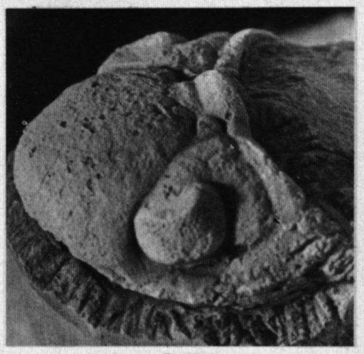

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PLATE 21

(Continuation:) Decalcified siltstones of the Requejada Member.

Figs. 1-3. *Leonaspis cf. hoernesi* (Barrande, 1846)
1. Complete specimen RGM 339435, internal mould, x 3.5, loc. P8
2. Complete specimen RGM 339436, external mould of rubber, x 2.5, loc. P8.
3. Pygidium RGM 339437, internal mould, x 7.7, loc. P8.

Fig. 4. *Otarion aff. druida* Erben, 1952
4. Cephalon RGM 339438, external mould of rubber, x 3.4, loc. P8.

Fig. 5. *Phacops saberensis* Morzadec, 1970
5. Pygidium RGM 339439, external mould of rubber, x 2.3, loc P8.

Figs. 6,7. *Paracryphaeus caboi* n.sp.
6. Cephalon RGM 339032, external mould of rubber, x 3.5, loc P8.
7. Pygidium RGM 339046, external mould of rubber, x 3.5, loc P10.

Fig. 8. *Pilletina aulnensis* Morzadec, 1976
8. Pygidium RGM 339110, external mould, x 2, loc. P12.

Figs. 9,10. *Odontochile aff. spinifera* Barrande, 1852
9. Pygidium RGM 339440, external mould of rubber, x 2.2, loc P10.
10. Pygidium fragment RGM 339441, external mould of rubber, x 2.5, loc. P9.

Transition of limestones of the Requejada Member to overlying siltstones (Abadía Fm). Age: Lower Emsian; locs. P13, P14.

Fig. 11. *Odontochile seillouensis* Morzadec, 1976
11. Pygidium RGM 339442, external mould, teratological pygidium missing the right fifth rib, x 1.4, a. dorsal view; b. lateral view, loc. P13.

Fig. 12. *Kayserops ogivalis* (Morzadec, 1976)
12. Thorax-pygidium RGM 339179, external mould of rubber, x 1.9, loc. P14.

Fig. 13. *Pilletina aulnensis* Morzadec, 1976
13. Complete specimen RGM 339116, external mould of rubber, x 2.1, loc. P14.

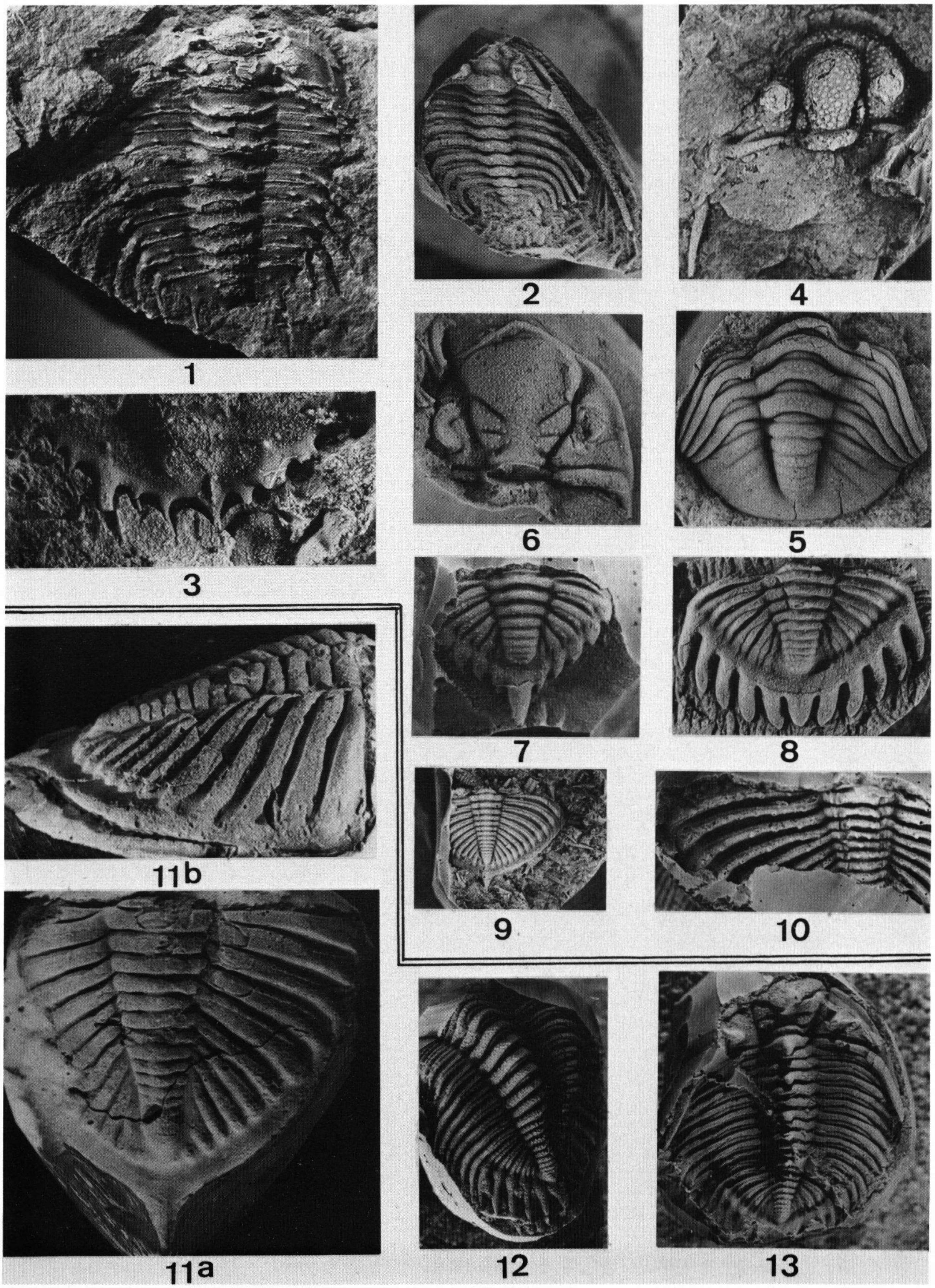
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PLATE 22

(Continuation) Transition limestones of the Requejada Member to overlying siltstones (Abadía Fm).

Fig. 1. *Phacops saberensis* Morzadec, 1970
1. Pygidium RGM 339443, external mould, x 2.2, loc. P13.

Fig. 2. *Platyscutellum aff. viator* (Barrande, 1852)
2. Pygidium RGM 339444, internal mould, x 1.8, loc. P14.

Green-yellow marls between Requejada and Polentinos Member (Abadía Fm). Age: (lower?) Upper Emsian; loc. P16.

Figs. 3,4. *Kayserops brevispinosus* Gandl, 1972
3. Meraspid pygidium RGM 339227, internal mould, x 18
4. Cephalon RGM 339225, external mould of rubber, x 3

Fig. 5. *Reedops cf. modestus* (Barrande, 1872)
5. Cephalon RGM 339445, internal mould, x 2.3, a. frontal view; b. dorsal view; c. lateral view.

Figs. 6,7. *Phacops* sp.1.
6. Cephalon RGM 339446, external mould of rubber, x 2.3
7. Cephalon RGM 339447, internal mould of rubber, x 2.2 a. dorsal view; b. lateral view.

Figs. 8,9. *Koneprusia* sp.
8. Cephalon RGM 339448, internal mould, x 5.
9. Pygidium RGM 339449, internal mould, x 6.5.

Figs. 10,11. *Leonaspis* n.sp.
10. Complete specimen RGM 339450, internal mould, x 3.5.
11. Pygidium RGM 339451, external mould of rubber, x 4.

Figs. 12,13. *Lioharpes aff. venulosus* (Corda, 1847)
12. Cephalon fragment RGM 339452, external mould of rubber, x 2.
13. Cephalon RGM 339453, external mould of rubber, a. lateral view, x 2.2; b. detail of fringe, x 7.

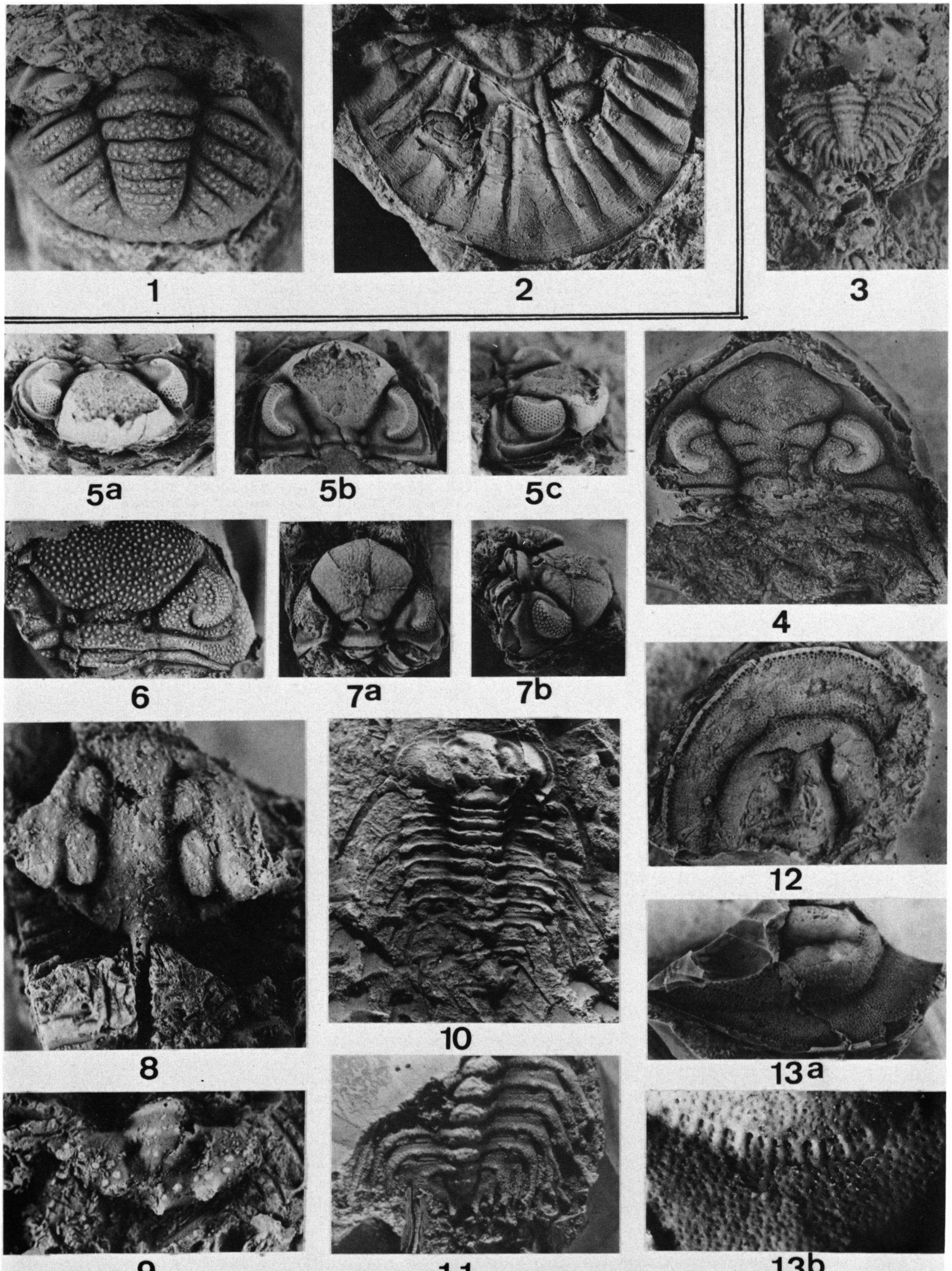
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PLATE 23

(Continuation) Green-yellow marls between Requejada and Polentinos Member (Abadía Fm); loc. P16.

Figs. 1-3. *Cheirurus (Pilletopeltis) aff. sternbergi* (Boeck, 1827)
1. Cranidium RGM 339454, external mould of rubber, x 2.4.
2. Cephalon RGM 339455, internal mould, x 2.2.
3. Pygidium fragment RGM 339456, external mould of rubber, x 2.5.

Figs. 4-7. *Xiphogonium trautensteinensis* ssp.
4. Cephalon RGM 339457, external mould of rubber, x 2.5.
5. Cephalon RGM 339458, external mould of rubber, x 2.5.
6. Pygidium-thorax RGM 339459, external mould of rubber, x 2.4.
7. Pygidium-thorax RGM 339460, external mould of rubber, x 4.

Fig. 8 *Astycoryphe* sp.
8. Cranidium RGM 339461, external mould of rubber, x 3,7, a. dorsal view; b. lateral view.

Figs. 9,10. *Eremiproetus* sp.
9. Pygidium RGM 339462, external mould of rubber, x 6.
10. Pygidium RGM 339463, external mould of rubber, x 12.

Figs. 11-15. *Lobopyge (Nitidulopyge) sexlobata* (A. Roemer, 1855)
11. Pygidium RGM 339464, external mould of rubber, x 18.
12. Cephalon RGM 339465, external mould of rubber, x 8.
13. Cephalon RGM 339466, external mould of rubber, x 10.
14. Pygidium RGM 339467, external mould of rubber, x 16.
15. Cephalon RGM 339468, internal mould, x 8.

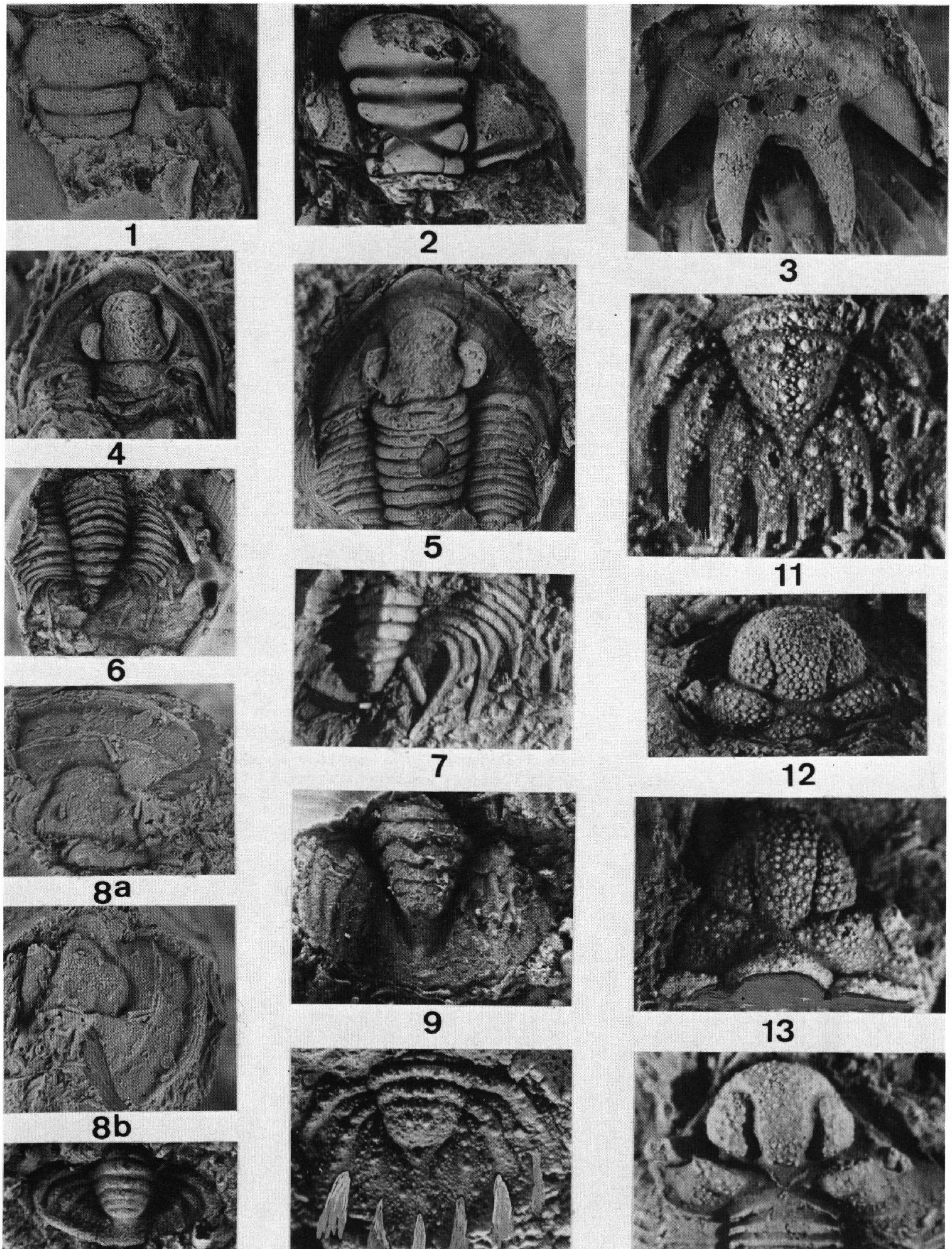
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PLATE 24

Green-yellow marls just below the Polentinos Member (Abadía Fm). Age: Upper Emsian; locs. P17, P18.

Fig. 1. *Proetus (Proetus) aff. granulosus* (Goldfuss, 1843)
1. Complete specimen RGM 339469, internal mould, x 3.5, loc. P17.

Fig. 2. *Scabriscutellum (Cavetia) cf. furciferum* (Corda, 1847)
2. Pygidium fragment RGM 339470, external mould of rubber, x 2.4, loc. P18.

Fig. 3. *Phacops* sp.2
3. Cephalon RGM 339471, partly external mould, x 1.8, a. dorsal view; b. lateral view, loc. P17.

Fig. 4. *Rhenops circumapodemus* n.sp.
4. Pygidium RGM 339243, partly external mould, x 1, loc. P18.

Fig. 5. *Kayserops brevispinosus* Gandl, 1972
5. Cephalo-thorax RGM 339233, internal mould, x 3, loc. P17.

Limestones of the Polentinos Member (Abadía Fm). Age: Upper Emsian - Lower Eifelian transition; locs. P19 - P24.

Figs. 6,7. *Phacops oehlerti* Morzadec, 1970
6. Cephalon RGM 339472, chiefly external mould, x 3, a. dorsal view; b. lateral view, loc. P21.
7. Cephalon RGM 339473, external mould, lateral view, x 2.5, loc. P22.

Fig. 8. *Phacops* sp.4
8. Complete specimen RGM 339474, lateral view on external mould, x 2.5, loc. P22.

Figs. 9-12. *Phacops* sp.3
9. Cephalon RGM 339475, external mould, x 1.8, a. dorsal view; b. lateral view, loc. P24.
10. Pygidium RGM 339476, external mould, x 2.7, loc. P19.
11. Complete specimen RGM 339477, lateral view on external mould, x 1.9, loc. P24.
12. Cephalon RGM 339478, chiefly external mould, x 2, a. dorsal view; b. lateral view; c. frontal view, loc. P24.

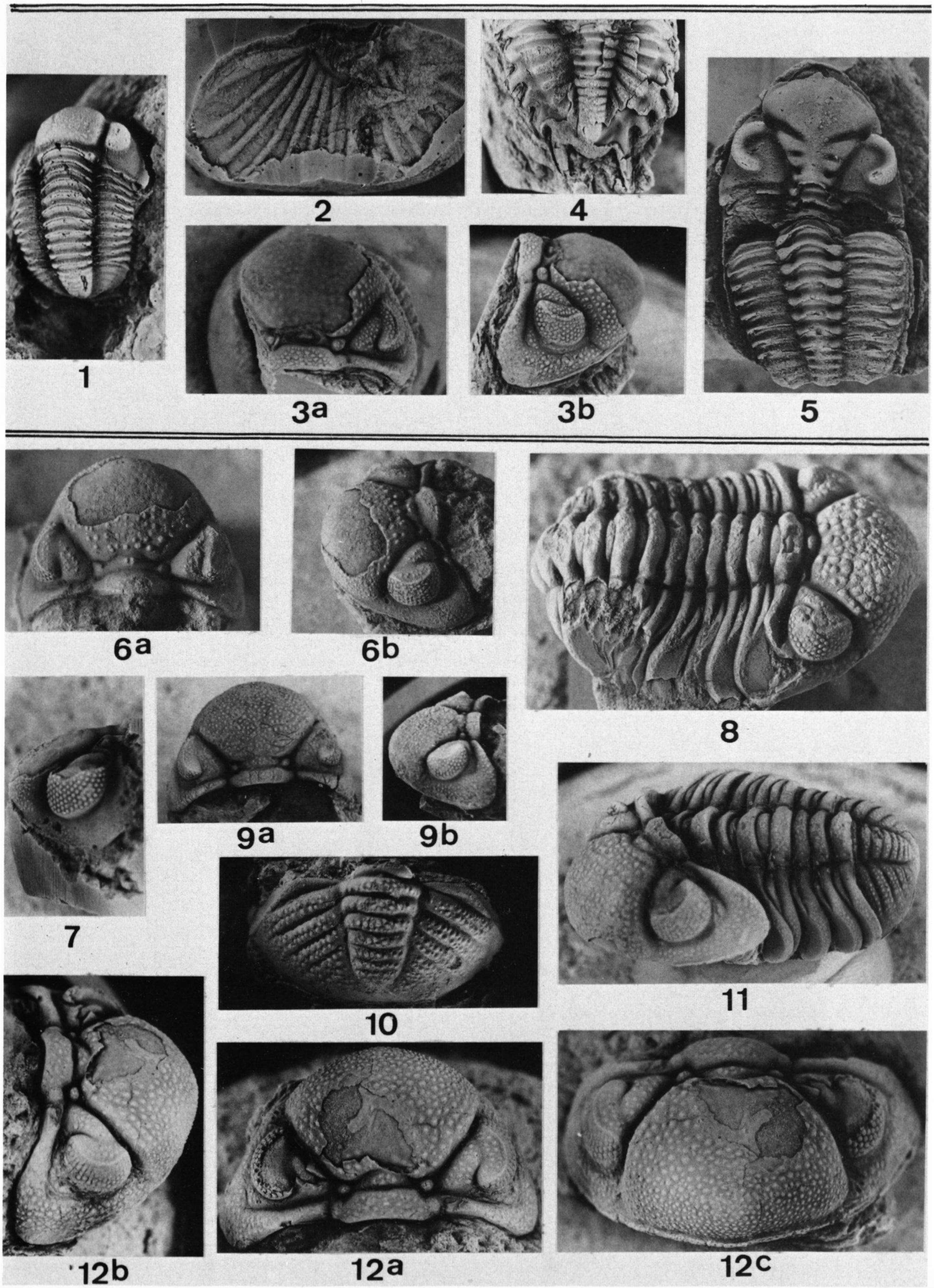
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PLATE 25

(Continuation) Limestones of the Polentinos Member (Abadía Fm); locs. P19-P24.

Figs. 1,2. *Proetus (Proetus) aff. granulosus* (Goldfuss, 1843)
1. Complete specimen RGM 339479, external mould, lateral view, x 3.6, loc. P22.
2. Cephalon RGM 339480, external mould, lateral view, x 3.5, loc. P22.

Fig. 3. *Cornuproetus (Diademaproetus) holzapfeli* ssp.
3. Pygidium RGM 339481, external mould, x 2.5, loc. P23

Fig. 4. *Treveropyge henryi* Arbizu, 1979
4. Pygidium RGM 339152, external mould, x 1.7, loc. P19.

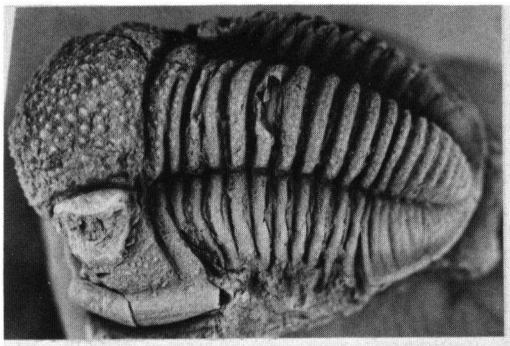
Fig. 5. *Greenops (Greenops) chaconae* Arbizu, 1979
5. Cephalon RGM 339267, external mould, x 3, loc. P19

Fig. 6. *Comura defensor* (R. & E. Richter, 1952)
6. Thorax-pygidium RGM 339350, chiefly internal mould of rubber, x 1.4, loc. P19.

Green-yellow shales of the lower part of the Gustalapiedra Fm. Age: Lower Eifelian; loc. P25.

Fig. 7. *Harpes aff. radians* Reinh. Richter, 1863
7. Cephalon RGM 339482, a. internal mould, x 1.8; b. external mould of rubber, x 1.7; c. detail of fringe, x 2.1.

Figs. 8-12. *Eocryphops aff. cyclophthalmus* (Walther, 1907)
8. Cephalon RGM 339483, internal mould, x 2.5.
9. Cephalon RGM 339484, external mould of rubber, x 5, a. lateral view; b. dorsal view.
10. Cephalon with vincular furrow RGM 339485, internal mould, x 2.3.
11. Pygidium RGM 339486, external mould of rubber, x 2.5.
12. Cephalon RGM 339487, external mould of rubber, x 5, a. dorsal view; b. frontal view.



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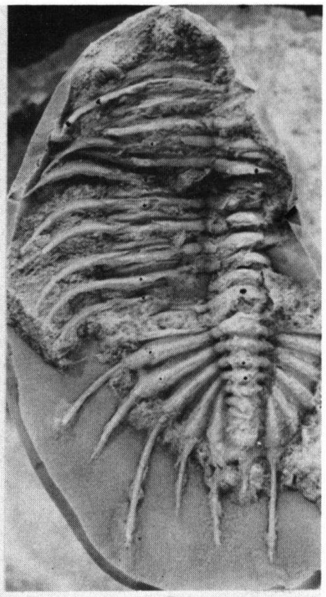

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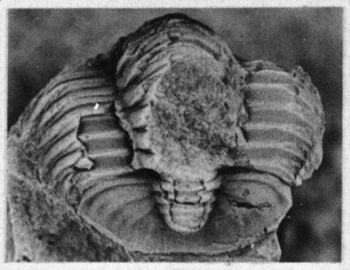

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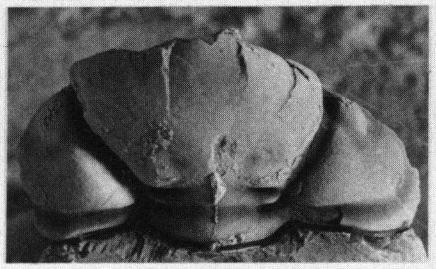

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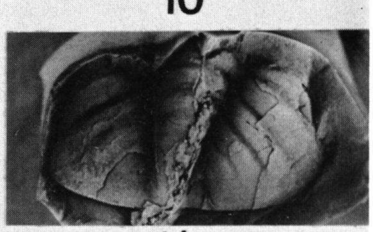

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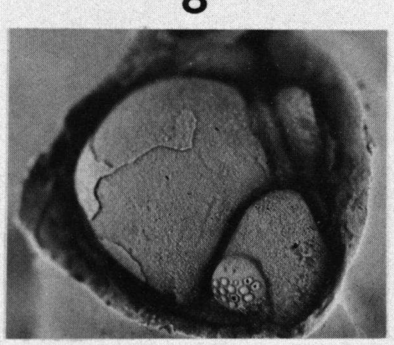

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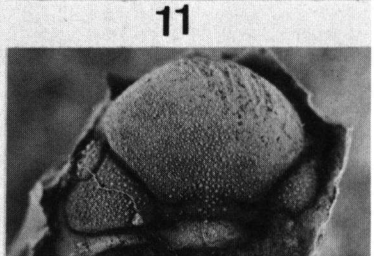

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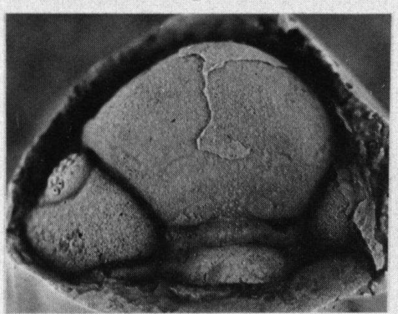

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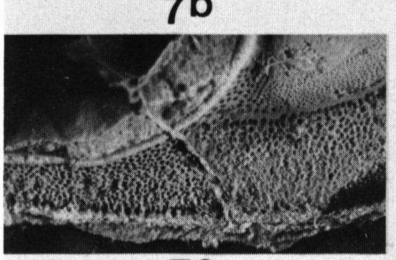

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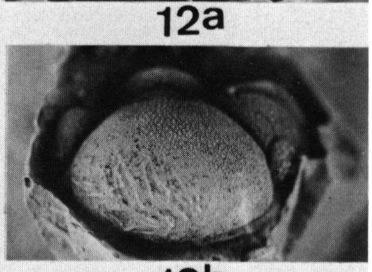

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PLATE 26

Black shales of the middle part of the Gustalapiedra Fm. Age: Upper Eifelian; loc. P26.

Figs. 1-5. *Leonaspis aff. pigra* (Barrande, 1872)
1. Complete specimen RGM 339488, internal mould, x 2.8.
2. Pygidium RGM 339489, internal mould, x 9.
3. Cranidium RGM 339490, external mould of rubber, x 3.8.
4. Librigenum RGM 339491, internal mould, x 3.5.
5. Pygidium RGM 339492, external mould of rubber, x 3.5.

Figs. 6-8. *Paraaulacopleura aff. beyrichi* (Novak, 1890)
6. Complete specimen RGM 339493, external mould, x 6.8.
7. Cranidium RGM 339494, internal mould, x 6.
8. Cranidium RGM 339495, internal mould, x 10.

Green shales at the base of the Vidrieros Fm. Age: Famennian *(marginifera* conodont Zone); loc. P28.

Figs. 9-16. *Trimerocephalus aff. caecus* (Gürich, 1896)
9. Cephalo-thorax RGM 339496, external mould of rubber, x 2.
10. Cephalo-thorax RGM 339497, external mould of rubber, x 2.1.
11. Cephalon RGM 339498, external mould of rubber, x 6.3.
12. Pygidium RGM 339499, internal mould, x 3.5.
13. Cephalon RGM 339500, lateral view on external mould of rubber, x 5.
14. Cephalon RGM 339501, internal mould, x 2.7.
15. Cephalon RGM 339502, internal mould, x 3.5.
16. Cephalon with frontal doublure RGM 339503, internal mould, x 3.

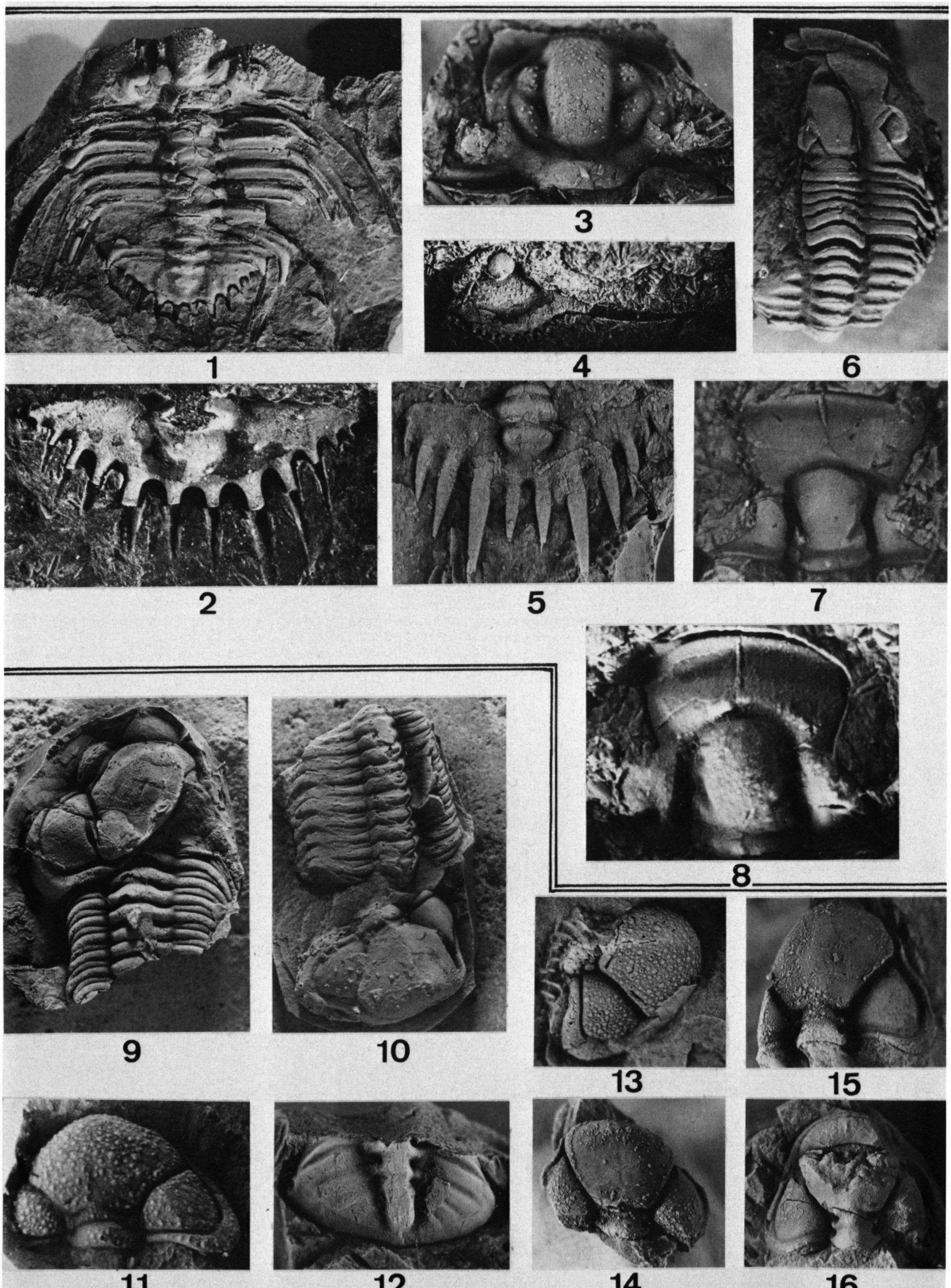

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PLATE 27

L E O N E S E   B A S I N

Ventanilla Region:

Green-brown shales of the lower part of the San Martin Fm. Age: Eifelian; loc. V1.

Fig. 1. *Lobopyge cf. peneaui* Pillet, 1972
1. Cephalon RGM 339504, internal mould, x 3.5.

Fig. 2. *Greenops (Neometacanthus)* sp.
2. Pygidium RGM 339505, internal mould, x 3

Esla-Porma Region:

Lower part of the limestone member of the La Vid Fm, just above the dolomites. Age: Lower Emsian; locs. L2-L5.

Fig. 3. *Pilletina collensis* Arbizu, 1979
3. Pygidium RGM 339123, external mould, x 2.5, loc. L2.

Fig. 4. *Phacops saberensis* Morzadec, 1970
4. Cephalon RGM 339506, external mould of rubber, x 2.5, loc. L2.

Fig. 5. *Pseudocryphaeus? demoulini* n.sp.
5. Thorax-pygidium RGM 339071, external mould, x 3, loc. L2

Fig. 6. *Proetus (Coniproetus) finitimus* n.ssp.
6. Cranidium RGM 339507, external mould, x 3.6, loc. L2.

Figs. 7,8. *Cornuproetus (Cornuproetus) aff. haentzscheli* G. Alberti, 1967
7. Cranidium RGM 339508, external mould, x 6.5, loc. L2.
8. Pygidium RGM 339509, external mould, x 6.3, loc. L2.

Upper part of the limestone member of the La Vid Fm. Age: upper Lower Emsian; locs. L6, L7.

Fig. 9. *Harpes* sp.
9. Cephalon RGM 339510, external mould, a. dorsal view, x 2.6; b. lateral view, x 5.7; c. of rubber, with eye, x 2.6; d. lateral view, x 2.6, loc. L6.

Figs. 10-13. *Otarion aff. druida* Erben, 1952
10. Cephalon RGM 339511, external mould of rubber, x 3.3, loc. L7.
11. Cephalon RGM 339512, external mould of rubber, x 3.3, loc. L6.
12. Pygidium RGM 339513, external mould, x 8, loc. L7.
13. Complete specimen RGM 339514, chiefly external mould, x 3.3, a. lateral view; b. caudal view, loc. L7.

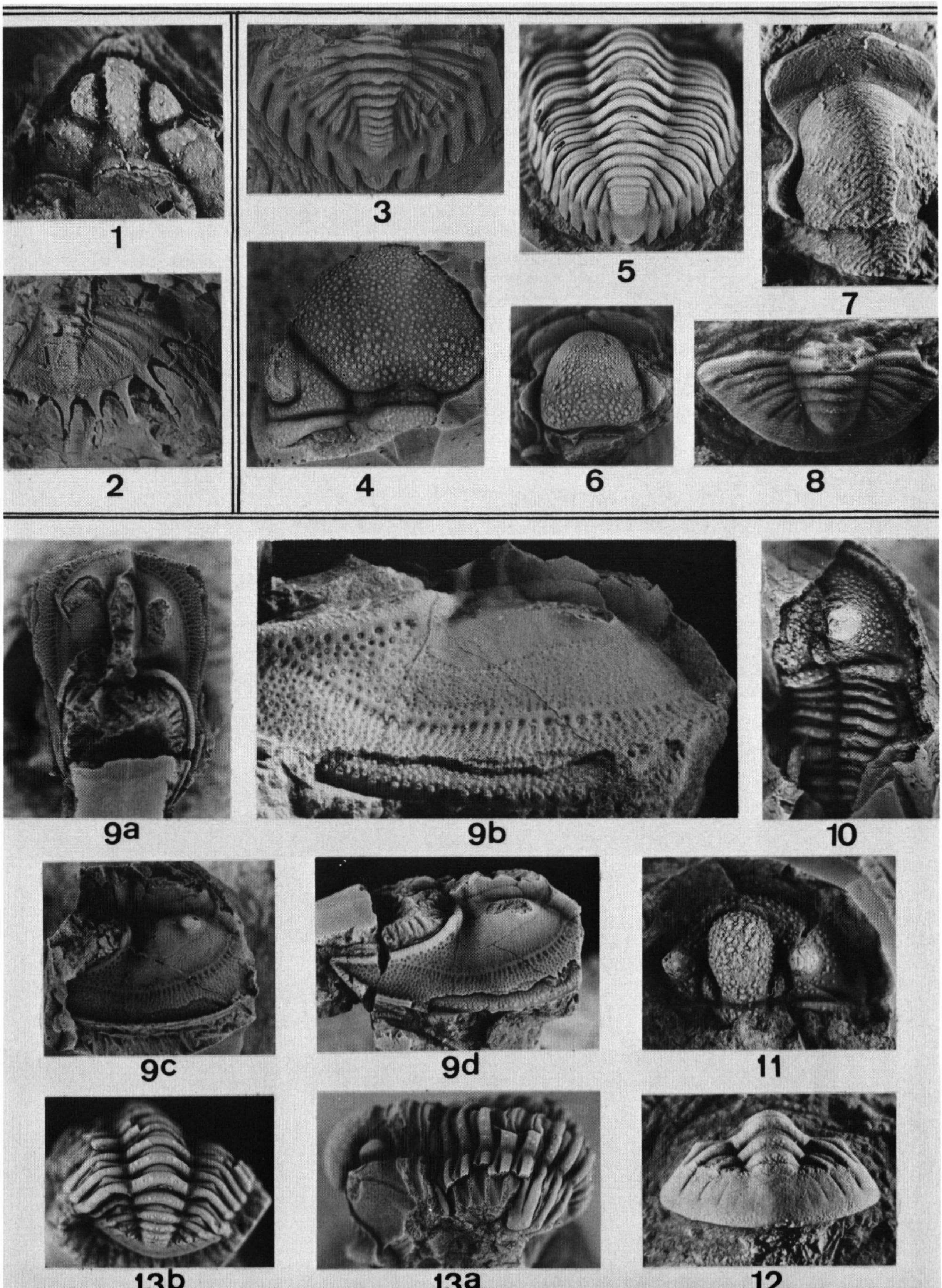
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PLATE 28

(Continuation) Upper part of the limestone member of the La Vid Fm; locs L6, L7.

Figs. 1-6. *Acastava* n.sp.
1. Cephalon RGM 339515, external mould, x 4.3, a. lateral view; b. dorsal view, loc. L6.
2. Pygidium RGM 339516, external mould, x 7, loc. L6.
3. Pygidium RGM 339517, external mould, x 4.5, loc. L6.
4. Pygidium RGM 339518, external mould, x 5, loc. L7.
5. Cephalon RGM 339519, external mould, x 5.2, loc. L6.
6. Cranidium RGM 339520, external mould, x 5.7, loc. L7.

Fig. 7. *Treveropyge iberica* Gandl, 1972
7. Complete specimen RGM 339138, a. cephalon, internal mould, x 2.7; b. external mould of rubber of pygidium, x 2.2, loc. L6.

Fig. 8. *Treveropyge? acrifrons* Gandl, 1972
8. Cephalon RGM 339148, chiefly internal mould, x 3, loc L6.

Figs. 9,10. *Delocare rostrata* Arbizu, 1979
9. Cephalon RGM 339307, chiefly external mould, x 4.5, loc. L6.
10. Pygidium RGM 339324, external mould, x 7, loc. L6.

Fig. 11. *Kayserops obsoletus* Gandl, 1972
11. Pygidium RGM 339196, external mould, x 5.5, loc. L6

Fig. 12. *Platyscutellum* sp.
12. Cranidium RGM 339521, external mould of rubber, x 1.6, loc. L6.

Fig. 13. "*Scutellum*" sp.1
13. Pygidium RGM 339522, external mould of rubber, x 2.8 loc. L6.

Fig. 14. *Kolihapeltis* sp.
14. Cranidium RGM 339523, external mould, x 3, loc. L6.

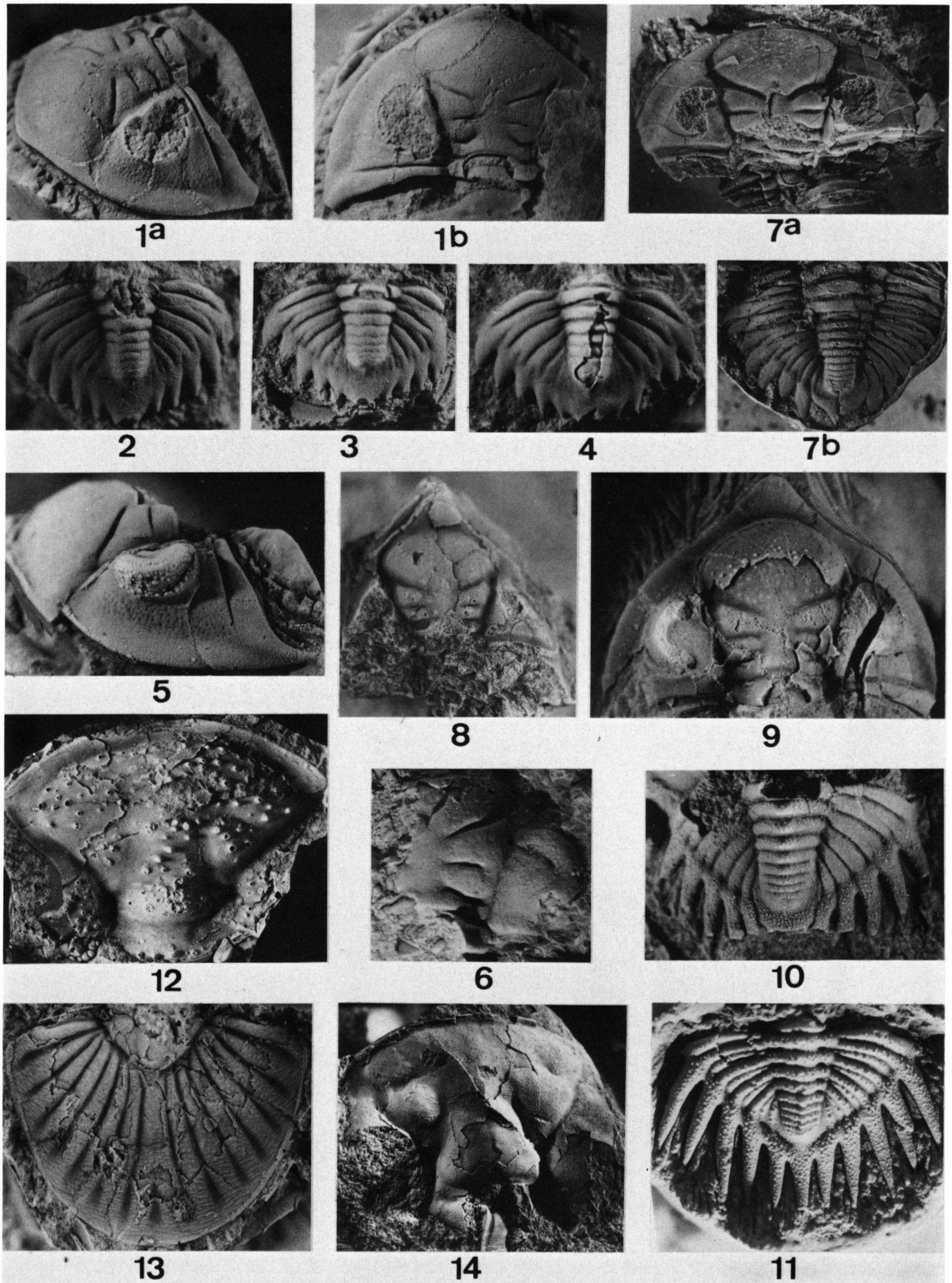
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PLATE 29

(Continuation) Upper part of the limestone member of the La Vid Fm; locs. L6, L7.

Figs. 1-6. *Platyscutellum* sp.
1. Librigenum RGM 339524, external mould, x 2.1, loc. L6.
2. Cranidium RGM 339525, external mould of rubber, x 1.7, loc. L6.
3. Librigenum RGM 339526, external mould, x 2.7, loc. L6.
4. Pygidium RGM 339527, x 1.9, a. external mould of rubber; b. partly internal mould, loc. L6.
5. Pygidium fragment RGM 339528, external mould with ornamentation, x 7, loc. L6.
6. *Teratological* pygidium RGM 339529, external mould of rubber x 2.6, loc. L6.

Fig. 7. *Trimerus (Dipleura)* sp.
7. Pygidium RGM 339530, chiefly internal mould, caudal view, x 2.3, loc. L6.

Figs. 8-10. *Burmeisteria pradoana* (de Verneuil, 1850)
8. Pygidium RGM 339531, external mould, x 1.2, loc. L6.
9. Pygidium RGM 339532, external mould, x 1.2, loc. L6.
10. Thoracic segment RGM 339533, external mould, x 3.8, loc. L6.

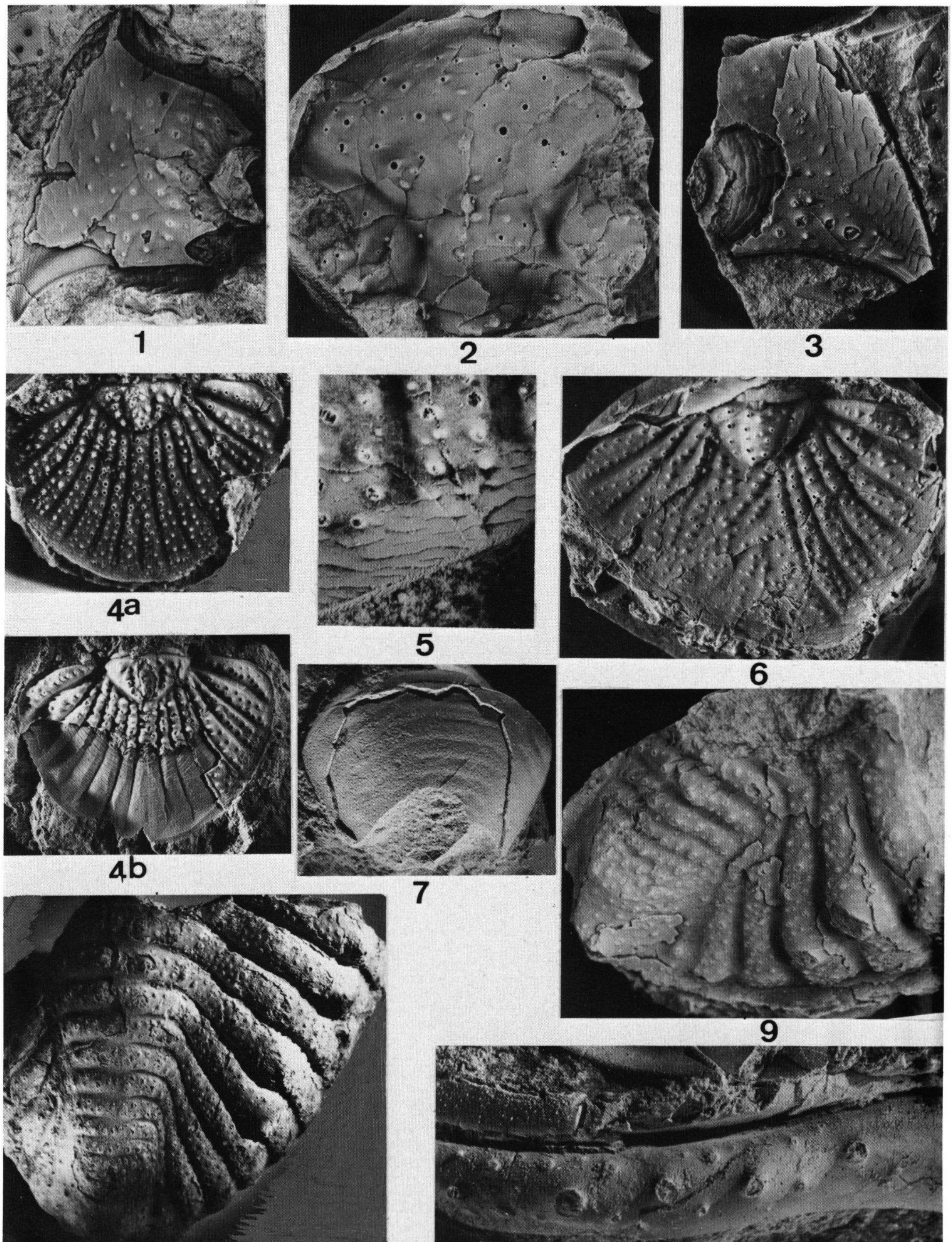
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PLATE 30

(Continuation) Upper part of the limestone member of the La Vid Fm; locs. L6, L7.

Figs. 1-6. *Phacops saberensis* Morzadec, 1970
1. Thorax-pygidium RGM 339534, external mould, x 2.3, loc. L6.
2. Cephalon RGM 339535, chiefly external mould, x 2, loc. L6.
3. Cephalon RGM 339536, lateral view on external mould, x 4.5, loc. L6.
4. Hypostome RGM 339537, chiefly external mould, x 3.5, loc. L6.
5. Cephalon RGM 339538, external mould, x 2.3, a. lateral view; b. dorsal view, loc. L6.
6. Cephalon RGM 339539, external mould, x 5.5, a. lateral view; b. dorsal view, loc. L6.

Figs. 7-12. *Leonaspis aff. maura* G. Alberti, 1969
7. Pygidium RGM 339540, external mould, x 5.5, loc. L6.
8. Pygidium RGM 339541, external mould, x 7.7, loc. L6.
9. Cranidium RGM 339542, chiefly external mould, x 3.5, loc. L6
10. Cranidium RGM 339543, partly external mould, x 6.4, loc. L6.
11. Librigenum RGM 339544, external mould, x 3.6, loc. L6.
12. Cranidium RGM 339545, chiefly internal mould, x 7, loc. L6.

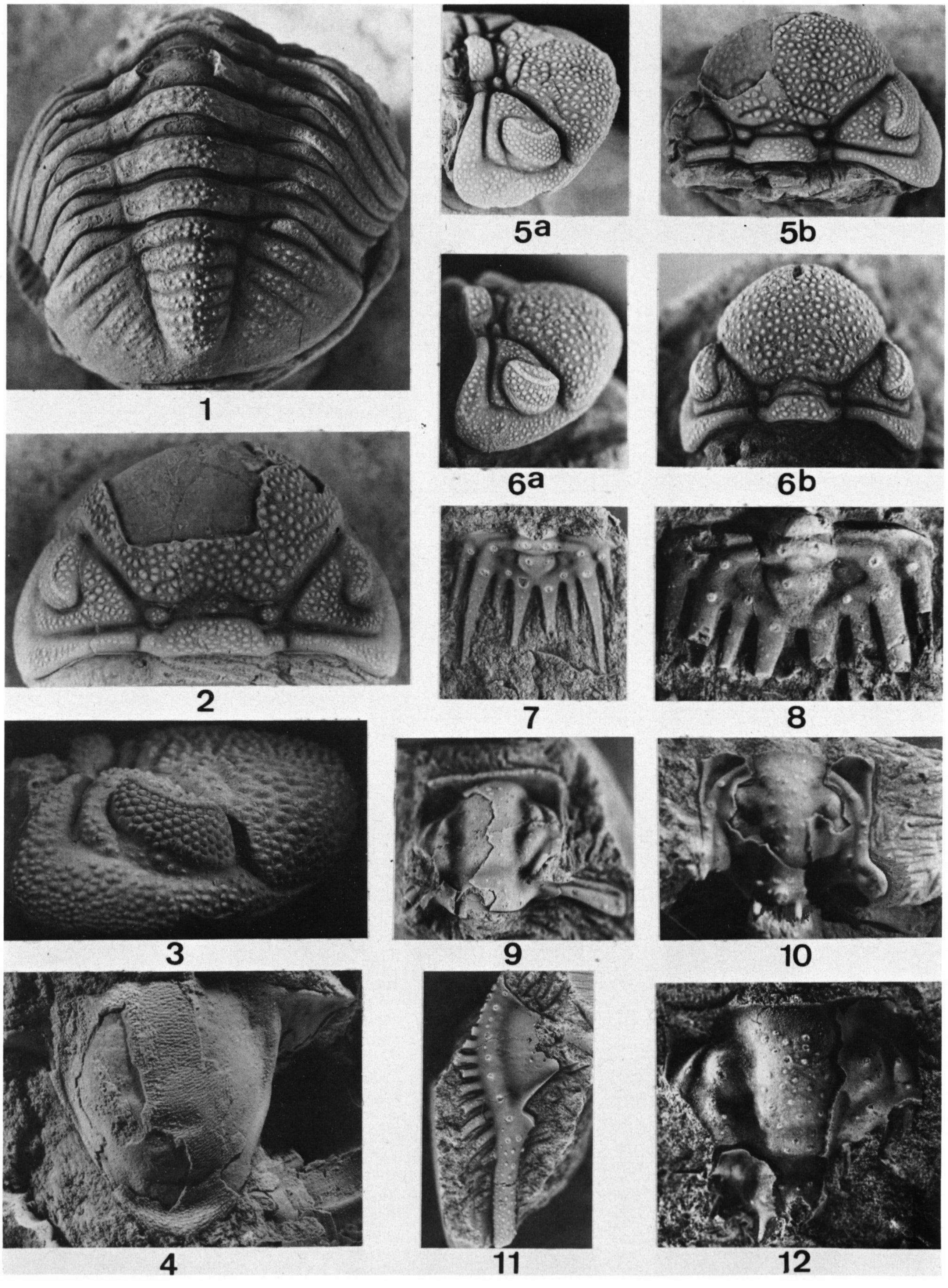
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PLATE 31

(Continuation) Upper part of the limestone member of the La Vid Fm; locs L6, L7.

Figs. 1-9. *Proetus* (n.sg.) n.sp.
1. Cranidium RGM 339546, external mould, x 10, loc. L6.
2. Cranidium RGM 339547, external mould, x 9.5, loc. L6.
3. Cranidium RGM 339548, external mould, x 6, loc. L6.
4. 2 Cranidia RGM 339549, external mould, x 2.5, loc. L6.
5. Pygidium RGM 339550, external mould, x 7, loc. L6.
6. Pygidium RGM 339551, external mould, lateral view, x 4.5, loc. L6.
7. Pygidium RGM 339552, external mould, x 7.5, loc. L7.
8. Pygidium RGM 339553, external mould, x 2.5, a. dorsal view; b. caudal view, loc. L6.
9. Cranidium RGM 339554, external mould, x 6.5, a. frontal view; b. lateral view; c. dorsal view, loc. L6.

Fig. 10. *Proetus (Longiproetus)* sp.
10. Cranidium RGM 339555, external mould, x 6, loc. L6.

Figs. 11-16. *Cornuproetus (Cornuproetus) chouberti* n.ssp.
11. Cranidium RGM 339556, external mould, x 8, loc. L6.
12. Cephalon RGM 339557, external mould of rubber, x 7, loc. L6.
13. Librigenum RGM 339558, external mould, x 9, loc. L6.
14. Pygidium RGM 339559, partly external mould, x 7, loc. L6.
15. Pygidium RGM 339560, external mould, x 10, loc. L6.
16. Librigenum RGM 339561, external mould, x 11, loc. L6.

Fig. 17. *Proetus*? sp.
17. Hypostome RGM 339562, external mould, ventral view, x 10, loc. L7.

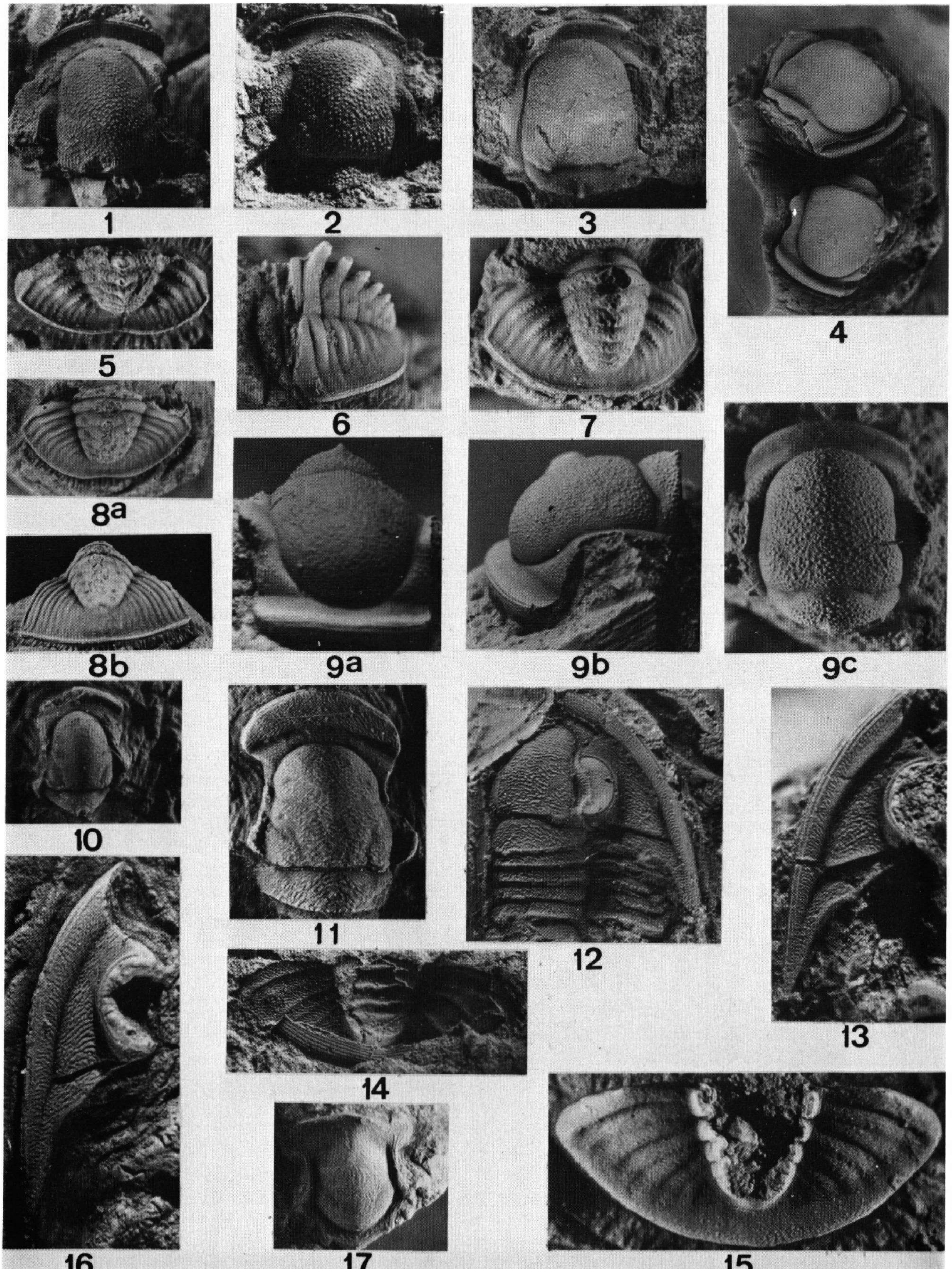
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PLATE 32

Transition limestone-shale member of the La Vid Fm. Age: Lower - Upper Emsian transition; locs. L8-L10.

Fig. 1. *Delocare rostrata* Arbizu, 1979
1. Pygidium RGM 339334, chiefly external mould, with tendency to *Delocare palenciae* n.sp., x 7, loc. L10.

Figs. 2,3. "*Scutellum*" sp.2
2. Cranidium RGM 339563, external mould, x 3.6, loc. L9.
3. Pygidium RGM 339564, external mould, x 3.5, loc. L9.

Fig. 4. *Cornuproetus (Cornuproetus) aff. corrugatus* (Erben, 1952)
4. Cranidium RGM 339565, external mould, x 5.7, loc. L9.

Fig. 5. *Cryphina*? sp.
5. Pygidium RGM 339566, external mould, x 6, loc. L9.

Limestone intercalation in the shale member of the La Vid Fm, 40 m below the Santa Lucía Fm. Age: (lower?) Upper Emsian; loc. L12.

Fig. 6. *Isoprusia (Mauraspis) aff. cyrius* G. Alberti, 1969
6. Cranidium RGM 339567, external mould, x 12.5, a. dorsal view; b. frontal view, SEM-photographs, loc. L12.

Fig. 7. *Proetus* (n.sg.) n.sp.
7. Cranidium RGM 339568, external mould, x 7, loc. L12.

Ferruginous sandstone bed at the base of the Huergas Fm, both east and west of the Pardomino High. Age: (Lower) Eifelian; locs. L14-L17, X9, X10.

Fig. 8. *Proetus (Proetus) orbitatus* (Barrande, 1846)
8. Cephalon RGM 339569, external mould of rubber, lateral view, x 3.2, loc. X9.

Figs. 9,10. *Leonaspis cf. pigra* (Barrande, 1872)
9. Cephalon RGM 339570, internal mould, x 2.3, loc. L14.
10. Pygidium RGM 339571, external mould of rubber, x 2.3, loc. L14.

Fig. 11. *Bradocryphaeus? cantarmoricus* (Morzadec & Arbizu, 1978)
11. Pygidium RGM 339371, external mould of rubber, x 2, loc. L17.

Fig. 12. *Alcaldops? argovejensis* n.sp.
12. Pygidium RGM 339351, external mould of rubber, x 1.8, loc. L14.

Fig. 13. *Greenops (Neometacanthus) perforatus* Morzadec, 1969
13. Pygidium RGM 339283, external mould of rubber, x 2, loc. L14.

Fig. 14. *Otarion* sp.
14. Cephalon RGM 339572, internal mould, x 3.3, loc. L16.

Fig. 15. *Phacops* sp.5
15. Complete specimen RGM 339573, external mould of rubber, x 2, loc. L14.

Fig. 16. *Phacops* sp.6
16. Cephalon RGM 339574, internal mould, x 3, a. dorsal view; b. lateral view, loc. X10.

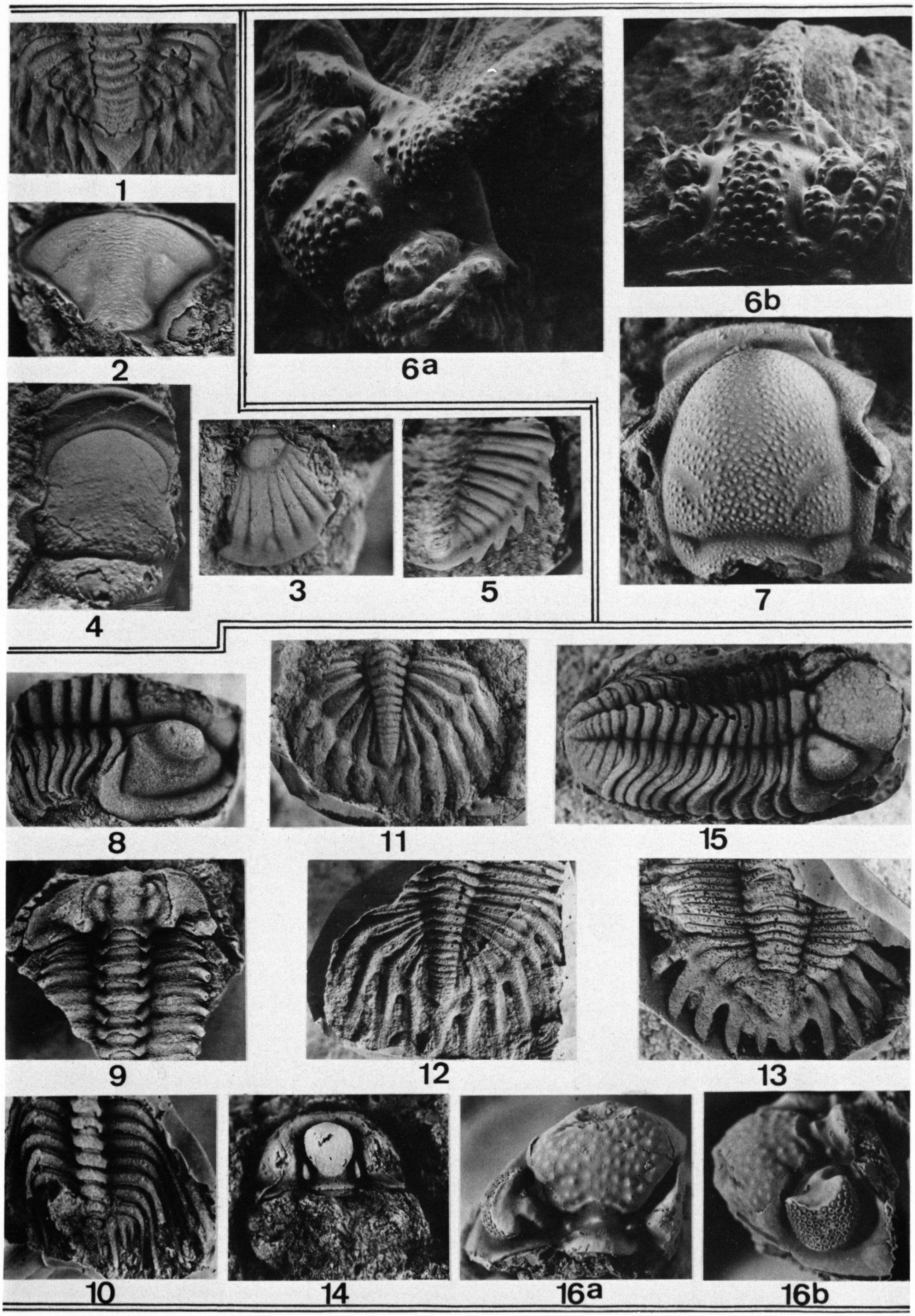
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PLATE 33

Argillaceous limestones at the top of the Portilla Fm, 10 m below the Nocedo Fm. Age: Lower Frasnian; all loc. L22.

Figs. 1-7. *Phacops rana aff. rana* (Green, 1832)

1. Young cephalon RGM 339575, SEM-photograph of external mould x 12.5.
2. Cephalon RGM 339576, external mould, a. dorsal view, x 3.3; b. lateral view, x 3.3; c. frontal view, x 2.3.
3. Cephalon RGM 339577, external mould, x 2.7.
4. Pygidium RGM 339578, external mould of rubber, x 2.5.
5. Thoracic segments RGM 339579, external mould, x 2.
6. Cephalon RGM 339580, external mould, a. dorsal view, x 1.6; b. lateral view, x 2.
7. Hypostome RGM 339581, external mould, x 3.7.

Figs. 8-10. *Otarion aff. ellipsocephalum* (Trenkner, 1867)

8. Librigenum RGM 339582, external mould of rubber, x 5.
9. Pygidium RGM 339583, chiefly external mould, caudal view, x 10.
10. Cranidium RGM 339584, chiefly external mould, x 5, a. frontal view; b. dorsal view.

Fig. 11. *Greenops (Greenops) ultimus* n.sp.

11. Pygidium RGM 339276, chiefly external mould, x 3.2.

Fig. 12. *Bradocryphaeus hispanicus* (R. & E. Richter, 1926)

12. Pygidium RGM 339384, external mould of rubber, x 2.4.

Fig. 13. *Heliopyge asturica* Haas, 1970

13. Pygidium RGM 339364, internal mould of rubber, x 3.

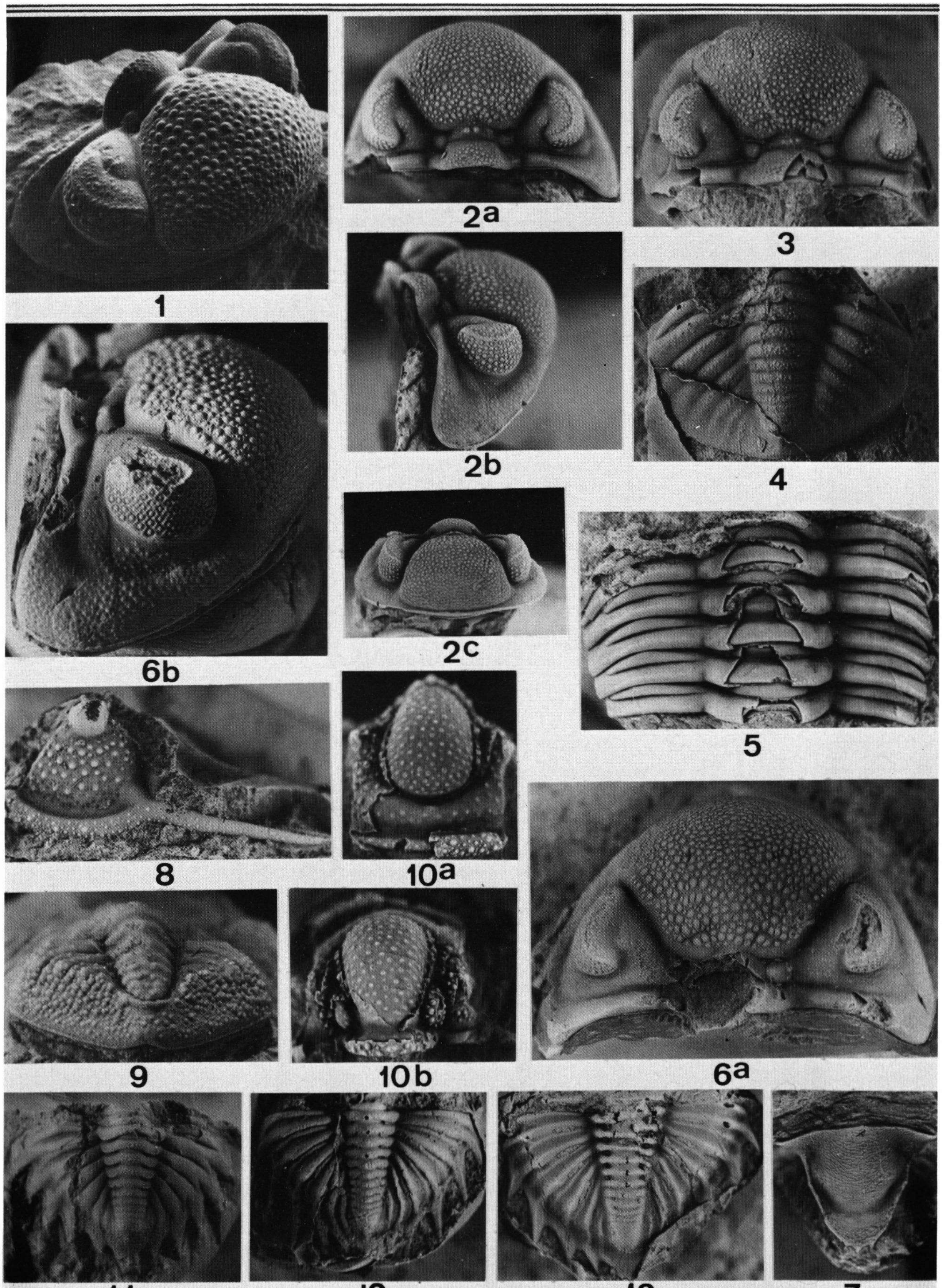
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PLATE 34

Leonese Basin west of the Pardomino High:

Limestone bed at the base of the La Vid Fm; just below the dolomites, near Lumajo. Age: upper Lower Gedinnian; loc. X1.

Figs. 1,2. *Acastella* sp.
1. Cephalon RGM 339585, internal mould, x 2.5.
2. Cephalon RGM 339586, internal mould, x 2.5.

Fig. 3. *Acastella cf. crenulata* Morzadec, 1976
3. Pygidium RGM 339587, chiefly external mould, x 5.

Fig. 4. *Acastella cf. latimarginata* Gandl, 1972
4. Pygidium RGM 339588, external mould, x 8.

Lower part of the limestone member of the La Vid Fm, just above the dolomites, near Aviados and La Vid. Age: Upper Siegenian - Lower Emsian; locs. X2, X3.

Fig. 5. *Cornuproetus (Cornuproetus) aff. haentzscheli* G. Alberti, 1967
5. Cranidium RGM 339589, external mould, x 7, loc. X2.

Figs. 6,7. *Proetus (Coniproetus) finitimus* n.ssp.
6. Complete specimen RGM 339590, external mould, a. cephalon, x 3; b. lateral view, x 3; c. lateral view, x 4.3; d. pygidium, x 4.3, loc. X2.
7. Pygidium RGM 339591, external mould, x 5.4, loc. X2.

Fig. 8. *Pilletina lips mozoensis* Gandl, 1972
8. Pygidium RGM 339083, external mould, x 1.7, loc. X3.

Fig. 9. *Metacanthina lavidensis* n.sp.
9. Pygidium RGM 339163, external mould, x 1.4, loc. X3.

Figs. 10,11. *Pilletina* sp.
10. Cephalon RGM 339075, chiefly external mould, x 1.6, loc. X2.
11. Pygidium fragment RGM 339079, external mould of rubber, x 3.5, loc. X2.

Fig. 12. *Pseudocryphaeus astrictus* Gandl, 1972
12. Pygidium RGM 339070, external mould, x 5, loc. X3.

Fig. 13. *Pilletina cf. triangularis* Gandl, 1972
13. Pygidium fragment RGM 339086, chiefly external mould, x 3, loc. X3.

Figs. 14,15. *Pseudocryphaeus cossensis* Morzadec, 1971
14. Cephalon RGM 339063, external mould, lateral view, x 3, loc. X3.
15. Pygidium RGM 339068, external mould, x 2.8, loc. X3.

Figs. 16,17. *Paracryphaeus izensis* (Morzadec, 1971)
16. Cephalon RGM 339008, external mould, lateral view, x 3.2, loc. X2.
17. Pygidium RGM 339020, external mould, x 3.6, loc. X3.

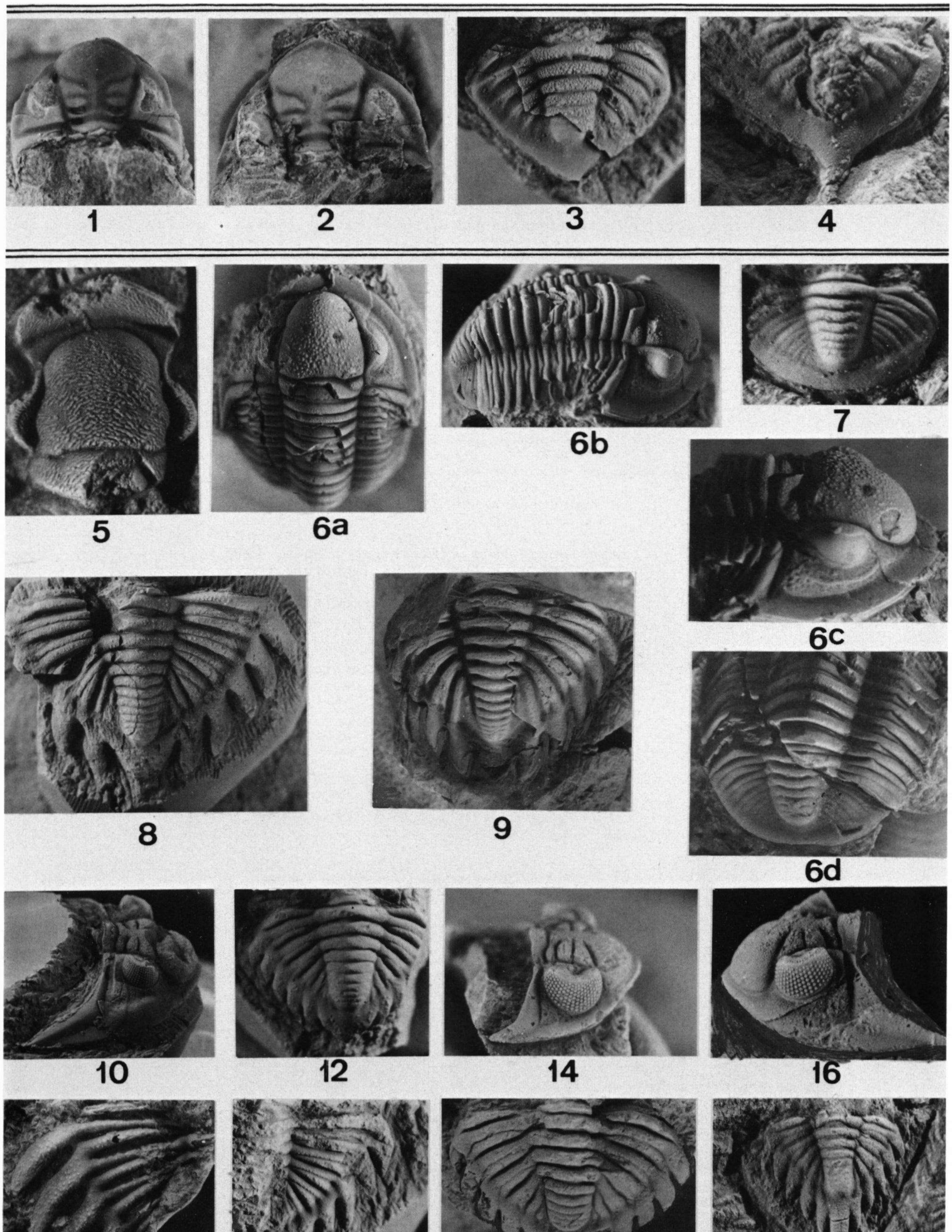
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PLATE 35

Argillaceous limestones of the middle and upper part of the Santa Lucía Fm.
Age: Upper Emsian - Lower Eifelian transition; locs. X7, X8.

Figs. 1,2. *Malladaia luciae* Oehlert & Oehlert, 1896
1. Cephalon RGM 339592, external mould, x 1.9, loc. X7.
2. Pygidium RGM 339593, chiefly external mould, x 2.4, a. lateral view; b. dorsal view, loc. X7.

Fig. 3. *Phacops* sp.7
3. Cephalon RGM 339594, partly external mould, x 5, a. frontal view; b. dorsal view; c. lateral view, loc. X8.

Argillaceous limestones of the middle member of the Portilla Fm. Age: Givetian - Frasnian transition; locs. X12-X15.

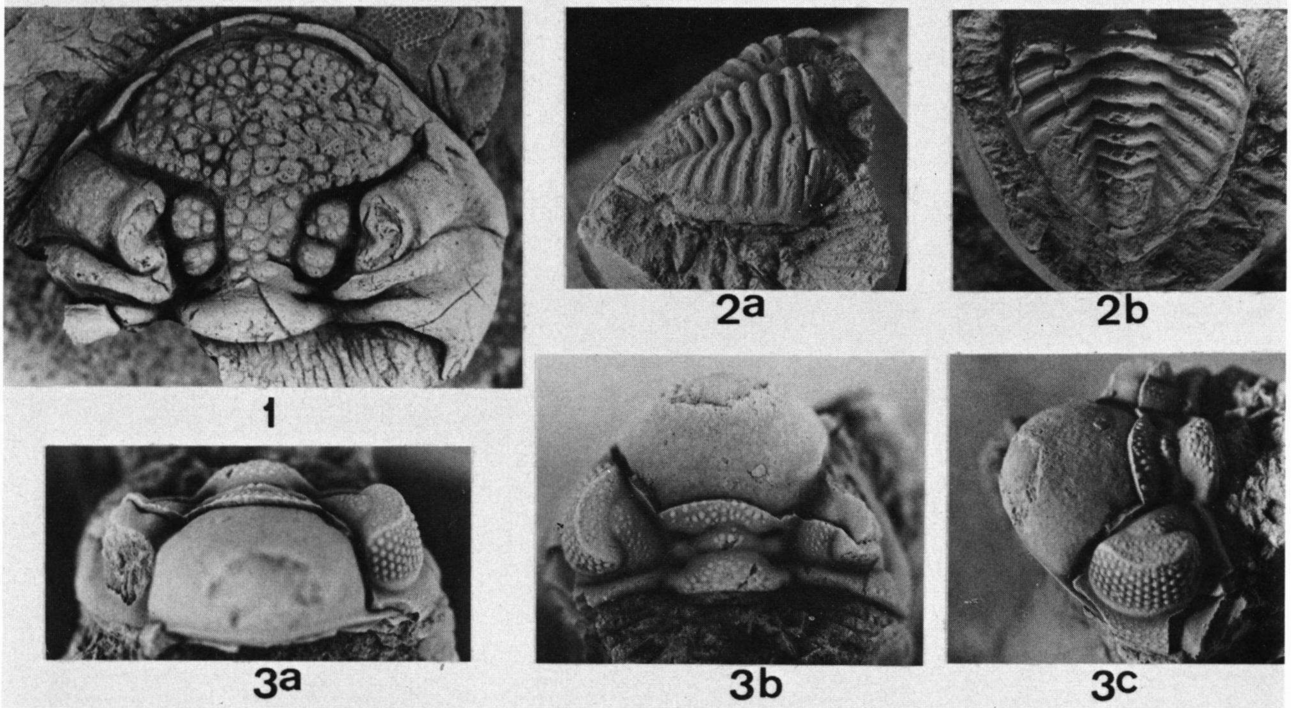
Figs. 4,5. *Proetus (Proetus)* sp.
4. Cranidium RGM 339595a, external mould, x 5, loc. X15.
5. Pygidium RGM 339595b, external mould, x 4, loc. X15.

Figs. 6-8. *Phacops rana aff. crassituberculata* Stumm, 1953
6. Cephalon RGM 339596, external mould, x 2.4, a. dorsal view; b. frontal view; c. lateral view, loc. X15.
7. Cephalon RGM 339597, chiefly external mould, x 3, a. lateral view; b. dorsal view, loc. X15.
8. Pygidium RGM 339598, external mould, x 2.5, caudal view, loc. X12.

Fig. 9. *Heliopyge* sp.1 *aff. asturica* Haas, 1970
9. Pygidium RGM 339356, external mould, x 3.8, loc. X15.

Fig. 10. *Heliopyge* sp.2 *aff. asturica* Haas, 1970
10. Pygidium RGM 339359, external mould of rubber, x 3, loc. X13.

Fig. 11. *Scutellum costatum cf. lummatonensis* Selwood, 1966
11. Pygidium RGM 339599, weathered external mould, x 1.6, loc. X13.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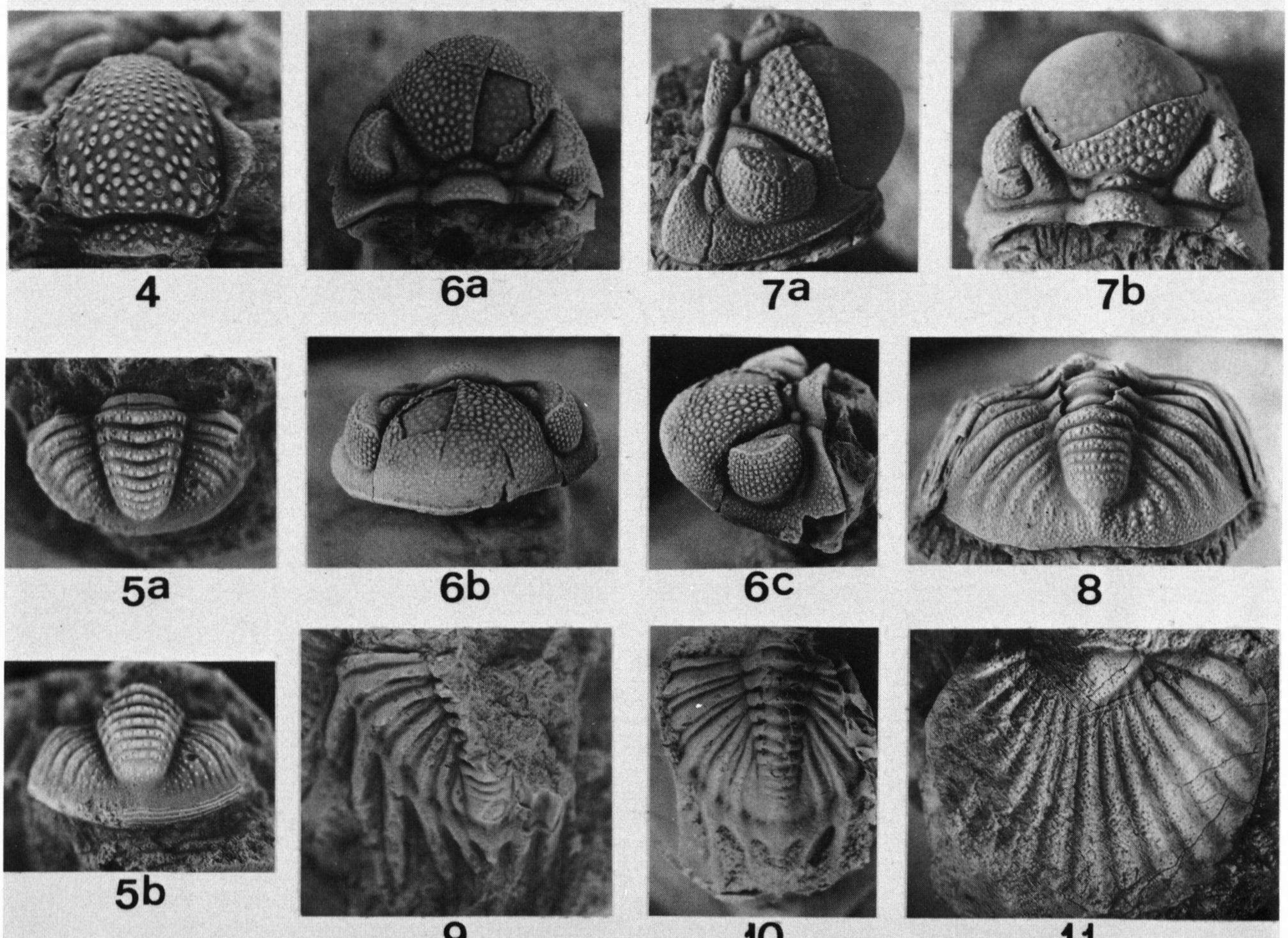
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