Annales Societatis Geologorum Poloniae (1989), vol. 59: 43–125
PL ISSN 0208-9068

AMMONITE BIOSTRATIGRAPHY OF THE TITHONIAN OF WESTERN CUBA

Ryszard Myczyński

Instytut Nauk Geologicznych Polskiej Akademii Nauk, Al. Żwirki i Wigury 93, 02-089 Warszawa, Poland

Myczyński, R., 1989 Ammonite biostratigraphy of the Tithonian of western Cuba *Ann. Soc. Geol. Polon.*, 59: 43–125.

Abstract: Ammonite fauna of the Tithonian of western Cuba, described in this paper, includes 42 species belonging to nine families. One species, *Simocosmoceras pszczolkowskii* n. sp., is new, and five others are probably new. Five ammonite zones have been distinguished in the Sierra de los Organos and four in the Sierra del Rosario, the two facies-structural units of the Cordillera de Guaniguanico where the fauna has been collected. The analysis of the paleobiogeographical relations of the Tithonian ammonites from western Cuba leads to the distiction of Caribbean Province in the Tithonian. This province existed probably also during the whole Late Jurassic and Early Cretaceous times. It is now represented in the sequences exposed in Cuba, Mexico and the southern part of the United States.

Key words: ammonites, biostratigraphy, paleobiogeography, Cuba, Caribbean area, Late Jurassic, Early Cretaceous.

Manuscript received November 13, 1987, revised accepted June 7, 1988

INTRODUCTION

Tithonian strata are exposed in western Cuba in the Cordillera de Guaniguanico which consists of two major facies-structural units – the Sierra de los Organos and Sierra del Rosario (Fig. 1). This paper presents a description of the Tithonian ammonites of the Cordillera de Guaniguanico, the ammonite biostratigraphy of the Tithonian strata, the reconstructions of the ammonite migration routes to the Caribbean region, and the reconstruction of paleobiogeographical relations between the ammonites from western Cuba and those from the adjacent Tethyan and Andean paleozoogeographical provinces.

The paper is based on author's studies realized in years 1971 – 1973 and 1981 – 1982. During the first period the author worked in the Sierra de los Organos, in the Polish-Cuban team preparing the *Geological Map of Pinar del Río Province 1 : 250,000*. During the second period the author studied the Tithonian strata exposed in the Sierra del Rosario, accompanied by J. Triff of the Institute of Geology and Paleontology, Cuban Academy of Sciences.

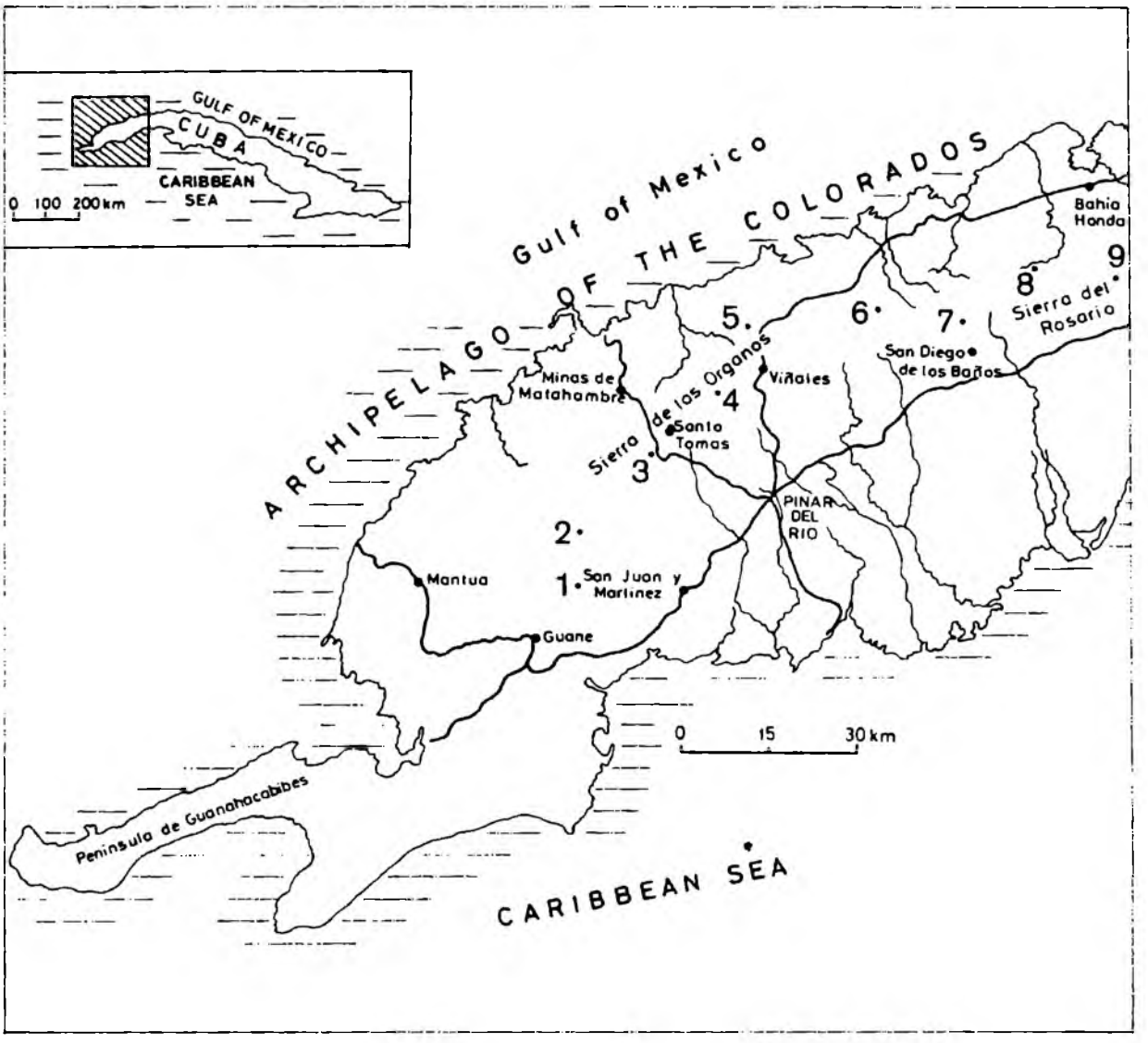


Fig. 1. Index map of the Tithonian sections studied in Pinar del Rio Province. *1* — Tumbadero (T); *2* — Mal Paso (SC); *3* — Sierra de Cabezas (SCb); *4* — Sierra del Infierno (ST); *5* — Valle del Ancón (VA); *6* — Hacienda El Americano (A-HA, B-HA, C-HA); *7* — La Catalina (LC); *8* — Cinco Pesos (MR-28) and Loma Ferretero (LF); *9* — Niceto Perez (MR-24)

Tithonian deposits have been hitherto recognized in four provinces of Cuba: Pinar de Rio, Villa Clara, Sancti Spiritus, and Camagüey (Imlay, 1942; Judoley & Furrazola-Bermúdez, 1965, 1968; Houša & Nuez, 1972, 1973; Houša, 1974; Millán & Myczyński, 1978, 1980). Ammonites in these strata and their stratigraphical significance were discussed in many papers. Imlay (1942) described the Tithonian ammonites from the provinces of Pinar del Río, Villa Clara, and Camagüey. His paper includes also the description and stratigraphic division of the Upper Jurassic strata of Cuba. He refers the Tithonian strata to the "Upper Portlandian" which would correspond to the Middle Tithonian in the tripartite division of this stage. Judoley & Furrazola-Bermúdez (1968) included the Upper Jurassic strata of Cuba to the Oxfordian, Kimmeridgian, and Tithonian stages, according to the Arkell's (1956) division of the Upper Jurassic. They estimated the thickness of the

Tithonian strata at 300–400 m, and referred the ammonites to the Lower and Middle Tithonian. Houša & Nuez (1972, 1973) were first to distinguish the zone with *Mazapilites*, *Protancyloceras* and *Pseudolissoceras* in the Tithonian of Cuba. Houša (1974) questioned the ammonite genera *Parodontoceras*, *Virgatosphinctes*, and *Hildoglochiceras* distinguished earlier by Imlay (1942) in the Tithonian of Cuba, and referred them to new taxa proposed by him. The last-named genus was earlier referred to a new genus *Salinites* by Cantú Chapa (1968).

Acknowledgements

The author expresses his cordial thanks to Docent A. Pszczólkowski of the Institute of Geological Sciences, Polish Academy of Sciences, for his aid during the field work and for the fruitful discussions on the connections and migration pathways of the Caribbean fauna in the Late Jurassic and Early Cretaceous times. Cordial thanks are also extended to Docent A. Wierzbowski of the University of Warsaw for his valuable comments on the taxonomy of the Tithonian fauna and for his generous supplying the literature, as well as to Professor J. Kutek of the same University, for his valuable comments during the work on this theme. The author thanks also Professor A. Zeiss of the Institute of Paleontology, University of Erlangen-Nürnberg, for helpful discussion on the Tithonian fauna and its stratigraphical significance, as well as to Professor G. Meléndez of the Paleontology Department, University of Saragossa, for his valuable comments on the paleobiogeographical relations between the Cuban, Chilean and Spanish Oxfordian ammonites.

This study was realized within the scientific cooperation program of the Institute of Geological Sciences, Polish Academy of Sciences and the Institute of Geology and Paleontology, Cuban Academy of Sciences (now affiliated with the Ministery of Basic Industry – MINBAS).

LITHOLOGY AND FAUNA OF THE TITHONIAN IN WESTERN CUBA

The Tithonian strata described in this paper form a part of the Upper Jurassic through Lower Cretaceous sedimentary sequences exposed in the Sierra de los Organos and Sierra del Rosario, two major facies-structural units forming together the orogenic structure exposed in the mountainous region of western Cuba, the Cordillera de Guaniguanico, and named after it. The lithostratigraphic division of the Upper Jurassic through Lower Cretaceous strata in the Cordillera de Guaniguanico is shown in Fig. 2.

TITHONIAN SECTIONS STUDIED IN THE SIERRA DE LOS ORGANOS

Tumbadero section (T) is situated near Tumbadero, 10 km northeast of Guane, on the road leading from Luis Lazo to Guane (Fig. 1), and in a small remnant hillock close to the road (coordinates 187, 300; 273, 400, Guane sheet, 1 : 50,000). The section is incomplete, cut at base by a fault plane.

EL Americano Member (?):

– ca. 3 m. Light-grey and grey micritic limestone in beds 10–20 cm thick, dipping 8°S, interlayered with dark-grey marly shale, up to 1.5 cm thick. No fauna occurs in the lower part; only at the top there are numerous recrystallized fragments of thick-shelled pelecypods and gastropods (*Nerinea ?*);

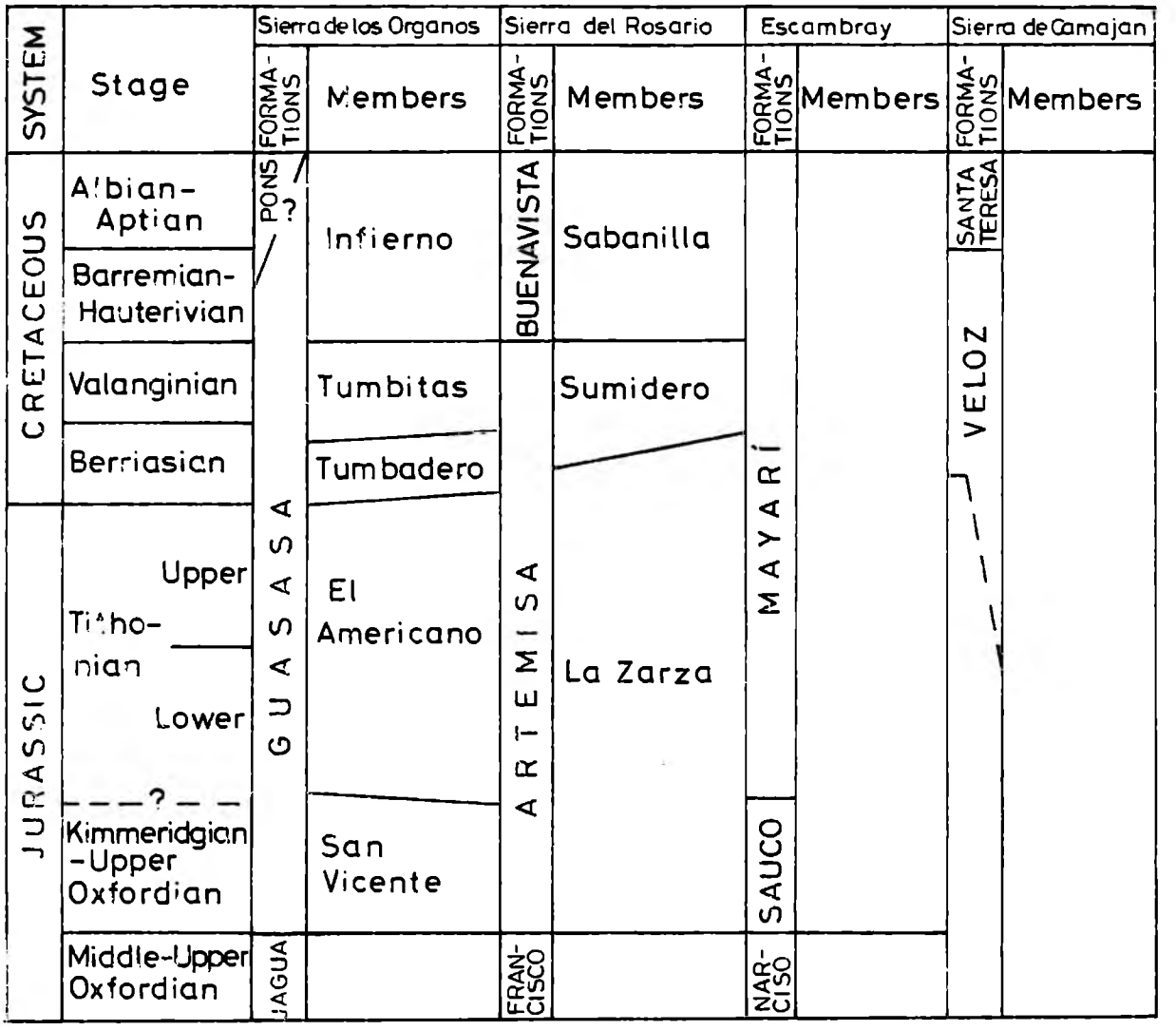


Fig. 2. Upper Jurassic and Lower Cretaceous lithostratigraphic units of western and a part of central Cuba. Partly after Pszczółkowski, 1978

– ca. 1.5 m. Grey and dark-grey detrital sparitic limestone with intercalations of arenaceous limestone and thin lenses of marly-arenaceous shale. Ammonites are numerous, they are strongly deformed, often streched. They are usually preserved as molds embedded in the marly-arenaceous lenses or on the outer surfaces of the limestone layers. The ammonites include *Nebrodites* (*Mesosimoceras*?) sp., *Pachysphinctes* (?) sp. (Pl. XII: 6), *Torquatisphinctes* sp. aff. *T. torquatus* Sowerby and *Aulacosphinctoides* sp.;
– ca. 3.5 m. Grey and dark-grey micritic, partly detritic, medium- and thin-bedded limestone. It includes thin intercalations of grey-brown and grey claycy-marly shale. Locally, there are traces of erosion in the shale. The shale intercalations contain fairly numerous *Hildoglochiceras* (*Salinites*), including *H.* (*S.*) cf. *grossicostatum* Imlay and *H.* (*Salinites*) spp. One specimen of *H.* (*S.*) *grossicostatum* was found at the top of this division;
– ca. 7 m. Dark-greyish-blue and dark-grey fine-grained, compact limestone in layers 10–20 cm thick, cut with numerous calcite veins. Thin layers of dark-grey shaly limestone and marly shale are interbedded with the limestone. No ammonites were found in this division. Strongly recrystallized radiolarian tests have been described in thin sections (Torre de la, 1978–1983).

The total thickness of the Tithonian strata in the Tumbadero section is about 15 m. The younger members are truncated by a fault.

Mal Paso section (SC) is situated on the road from Luis Lazo to Guane, beneath the bridge on a karst spring giving rise to a short, right-side affluent of the Cuyaguateje river in the valley known as Mal Paso, between the mogotes Sierra de San Carlos and Sierra del Pesquero (coordinates 190, 300; 286, 800, Dimas sheet 1 : 50,000). The section continues above the spring in the lowermost part of the slope of the Sierra del Pesquero. The Tithonian strata are cut at base by a W–E trending fault, followed now by the Cuyaguateje.

The El Americano Member (?) (see Myczyński in: Pszczółkowski *et al.*, 1975):

- along the fault, isolated blocks of dark-grey, micritic and detrital, partly dolomitized massive limestone are scattered in the river bed. The limestone (Upper Kimmeridgian?–Lower Tithonian) contains poorly preserved belemnites (Duvaliidae?) and tests of pelecypods of family Ptymatisidae Pcelincev, affined to the species *Ptygmatis bruntrutana* (Thurmann) and *P. pseudobruntrutana* (Gemmellaro);
- ca. 3 m. Dark-grey microcrystalline limestone, massive, locally thick-bedded, with thin intercalations of dark-grey and reddish (on weathered surface) clayey-marly shale. Irregular chert nodules, up to 10 cm in size, are numerous;
- ca. 2.8 m. Dark-grey, microcrystalline detrital limestone, medium-bedded (up to 30 cm), with thin intercalations of dark-grey clayey-marly shale, reddish when weathered, and with layers of dark-blue shaly limestone. The surfaces of layers are uneven, and the limestone is locally nodular. Poorly preserved ammonites are frequent on bedding planes. The nodular nature of the limestone and the strongly deformed fauna suggest correlation of this division with that containing deformed ammonites in section T, though the fauna in both sections is different. The perisphinctids at Mal Paso are poorly preserved (practically indeterminable), and have small diameters, while the ammonites of this group at Tumbadero are mostly large (up to 150 mm in diameter). At Mal Paso the same horizon includes also *Hildoglochiceras (Salinites) grossicostatum* (Imlay) and *H.* (*Salinites*) spp. This division includes four horizons of limestones with undulated layer boundaries. The most distinctive is the lowermost one, up to 15 cm thick.
- ca. 3.5 m. Dark-grey and dark-greyish-blue micritic limestone, medium- and thin-bedded, with strongly recrystallized ammonites, exposed in the lowermost part of the mogote slope. The limestone is intercalated with thin layers of dark-grey clayey-marly shale and shaly limestone. One ammonite, possibly a *Berriasella*, was found in this division. Microfauna is scarce and poorly preserved, it consists of recrystallized radiolarian tests and indeterminable benthic foraminifers found in bioclasts (Torre de la, 1978–1983).
- up to 1.5 m. Dark-blue, locally laminated, micritic limestone with shaly fissility. The limestone yielded: *H.* (*Salinites*) *gallardoi* (Chudoley et Furrazola), *H.* (*Salinites*) cf. *bicostatum* (Chudoley et Furrazola), and *Buchia*. sp.

The Tumbadero Member:

- up to 50 m. Dark and dark-grey-blue, locally lighter, medium-bedded laminated limestone with thin intercalations of shale and with numerous elongated dark-grey chert nodules. These strata build the lower part of the mogote slope. They yielded no macrofossils. Microfossils found in these strata indicate that their most part belongs to the Berriasian (Torre de la, 1972–1975; Pszczółkowski *et al.*, 1975).

The Tumbitas Member:

- c. 15 m. Light, partly spotted, thin- and medium-bedded micritic limestone with intercalations of grey limestone with shaly fissility. Scarce, poorly preserved indeterminated belemnites occur in the limestone.

The Infierno Member (Myczyński & Pszczółkowski in: Pszczółkowski *et al.*, 1975; Pons Formation according to *Lexico Estratigrafico de Cuba*, in preparation):

– Up to 25 m. It is strongly reduced in this section, and comprises grey and dark-grey limestone with shaly fissility, containing layers of light-colored chert. The age of this member is determined at the Hauterivian – Lower Turonian (Myczyński & Pszczółkowski in: Pszczółkowski *et al.*, 1975).

The Ancón Formation (Hatten, 1957; Herrera, 1961):

– thin-bedded pinkish limestone of Paleocene age (Pszczółkowski, 1978).

The Tithonian strata in the Mal Paso section are about 20 m thick.

Sierra de Cabezas section (SCb) is situated near the village of Pons in the mogote range of Sierra de Cabezas (coordinates 200, 500; 297, 700, Sumidero sheet 1 : 50,000).

The El Americano Member (?):

– ca. 4.5 m. Grey-blue limestone, medium- and thin-bedded with thin intercalations of dark-grey-blue clayey-marly shale. Ammonites of the genus *Aulacosphinctoides* were found in the lowermost part of this division;
– ca. 1.2 m. Dark-grey and dark-blue, well stratified micritic limestone in beds up to 25 cm thick, intercalated with mudstone. Ammonites found in this division include *Parodontoceras hatti* Imlay, *Hildoglochiceras* (*Salinites*) cf. *gallardoi* (Chudoley et Furrazola). *H.* (*Salinites*) *grossicostatum* Imlay.

The Tumbadero Member:

– 18 m. Dark, almost black, micritic, slightly silicified limestone, intercalated with dark-grey limestone with shaly fissility and with thin layers of dark, almost black chert. Locally the limestone is lighter and spotted. No fauna was found in the Tumbadero Member in this section.

The overlying Tumbitas and Infierno Members are 48 – 50 m thick. They are in tectonic contact with the greywackes of the Pica Pica Formation (Piotrowska, Pszczółkowski & Myczyński in: Pszczółkowski *et al.*, 1975). The Tithonian strata in the Sierra de Cabezas section are 23 – 26 m thick.

Sierra del Infierno section (ST; Fig. 3) is situated on the road from Viñales to Santo Tomas in the southern slope of the mogote range of Sierra del Infierno. It is exposed on the southern and northen side of the road, about 9 kilometres from Viñales (coordinates 212, 750; 310, 550, Minas de Matahambre sheet 1 : 50,000).

The San Vicente Member (?):

– ca. 8 m. Dark-grey, massive and indistinctly bedded dolomitic and siliceous limestone containing nodules of dark chert. The limestone is exposed on the southern side of the road. The contact with the El Americano Member is not exposed.

The El Americano Member:

– ca. 2.5 m. Dark-grey and black, medium- and thick-bedded micritic limestone, locally detrital, with thin (up to 7 cm) interbeds of black shaly limestone. There are numerous but poorly preserved ammonites, including *Aulacosphinctoides* (?) sp., *Corongoceras* cf. *cordobai*, and pelecypods *Buchia* sp.;

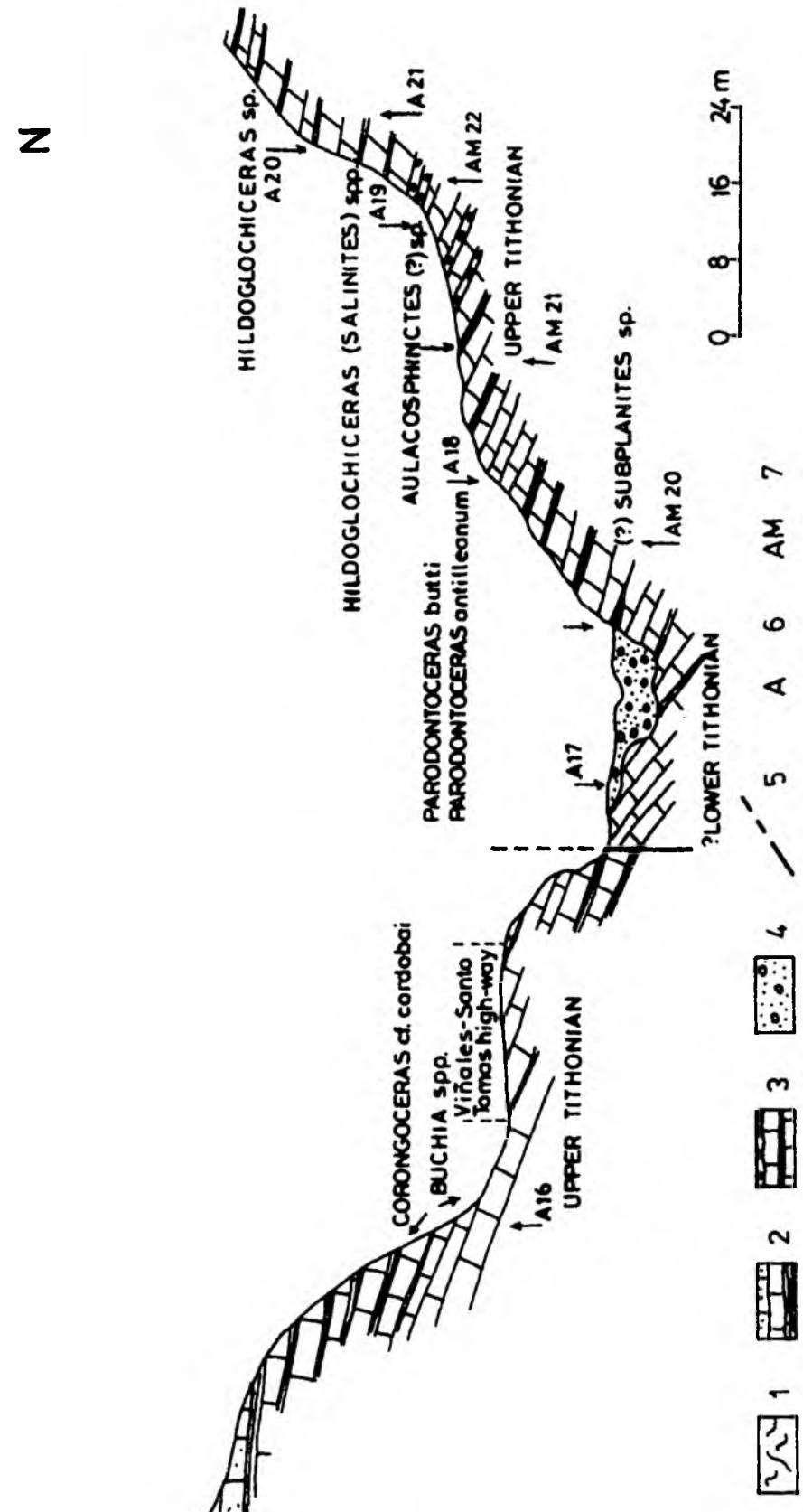


Fig. 3. Ammonite succession in Sierra del Infierno section (ST). *1* – massive limestone (San Vicente Member?); *2* – thick-bedded limestone with thin intercalations of shale; *3* – thin-bedded limestone with thin intercalations of shale and limestone with wavy boundaries; *4* – alluvium; *5* – faults; *6* – locations of macrofauna with specimen numbers; *7* – locations of samples for microfauna

– ca. 0.5 m. Micritic dark-grey-blue limestone in beds up to 10 cm thick. It contains *Hildoglochiceras* (*Salinites*) *gallardoi* (Chudoley et Furrazola);
– ca. 2.8 m. Dark-grey to black micritic limestone, strongly bituminous, thin- and medium-bedded, with intercalations of shaly limestone and dark marly shale. Fauna includes ammonites *H.* (*Salinites*) *grossicostatum* Imlay, *H.* (*S*) *gallardoi* (Chudoley et Furrazola), *H.* (*S*) *bicostatum* (Chudoley & Furrazola), and spordical pelecypods *Buchia*. Few specimens of *Hildoglochiceras* sp. have been found in the highest part of this division.

The Tumbadero Member:

– 25–30 m. Black, fine-grained, bituminous, locally dolomitized limestone with thin intercalations of dark-grey shale and dark chert. Tintinnids *Calpionellopsis simplex* (Colom), *Calpionellopsis oblonga* (Cadish) and *Tintinopsella oblonga* (Cadish), found in this division, indicate a Berriasian age (Torre de la, 1972–1975).

The Tumbitas Member:

– ca. 18 m. Light and dark-grey micritic, well bedded limestone, barren of fossils.

The Infierno Member (this section is its stratotype, see Myczyński & Pszczółkowski in: Pszczółkowski *et al.*, 1975; Pszczółkowski, 1978):

– ca. 50 m. Dark-grey micritic limestone interlayered with light limestone and dark chert.

The section is truncated tectonically at top and is in a fault contact with the younger Pica Pica Formation.

Valle del Ancón section (VA) is located in the wall of a mogote in the northern part of the Valle del Ancón (coordinates 218, 200; 317.00 Consolación del Sur sheet 1 : 50,000). The contact with the underlying limestones of the San Vicente Member is not exposed. The section begins at the base of slope.

The El Americano Member, lowermost part (?):

– ca. 1.8 m. Dark-grey, almost black, fine- and medium-grained micritic limestone: thick-bedded with thin intercalations (up to 1.5 cm) of dark-grey marly shale. The limestone is strongly dolomitized at places. Scarce ammonites are present in this limestone; they are heavily recrystallized and practically indeterminable. Most of them belongs to the family Perisphinctidae.

The El Americano Member (upper part):

– 3.5 m. Black, micritic limestone in beds 15–20 cm thick, with thin intercalations of dark shale. The limestone is slightly dolomitic and bituminous. It contains very scarce ammonites *Virgatosimoceras* (?) sp. (Pl. IV, Fig. 5) and *Pseudolissoceras* sp., as well as microfossils *Globochaete alpina* Lombard, *Chitinoidella boneti* Doben, and *Saccocoma* sp. (Torre de la, 1978–1983). According to Kreisel & Furrazola (1971), *Ch. boneti* indicates the upper part of the Lower Tithonian (*Chitinoidella* Zone);
– ca. 0.55 m. A bed of dark-grey coquinoid limestone, composed of broken ammonite shells in micritic matrix. The distribution of the ammonites is uneven, they are less numerous in the middle part of the bed. Most shells had been deposited in fragments, and were posteriorly broken by tectonic shear. The bed is bounded at top and bottom by grey-brown marly layers 4–6 cm thick which also include broken ammonites. The boundaries of the coquinoid limestone bed are wavy. The macrofauna in this bed comprise *Haploceras* (?) aff. *veracruzanum* Cantú Chapa, *Haploceras* (?) sp. nov., *Hildoglochiceras* (*Salinites*) *grossicostatum* Imlay, *H.* (*S.*) *gallardoi* (Chudoley et Furrazola), *H.* (*S.*) aff. *inflatum* Imlay, *H.*? (*S.*) aff. *ecarinatum* Imlay, *Durangites* sp. aff. *acanthicus* Burckhard, *Kossmatia* cf. *bifurcata* (Aguilera), and *Phanerostephanus* sp., one specimen of *Lamellaptychus* sp. and numerous *Buchia* aff. *B. okensis* (Pavlov).

Accompanying poorly preserved and indeterminable microfossils comprise molds of radiolarians and poorly preserved calpionellids. The ammonite assemblage found in this bed corresponds to the Upper Tithonian (cf. Cantú Chapa, 1968);

- ca. 4.5 m. Dark-grey-blue micritic limestone with thin intercalations of grey-brown marly shale. Macrofauna is absent. Thin sections revealed *Calpionella alpina* Lorenz, *Tintinopsella* sp., *Crassicolaria* sp. and numerous radiolarians indicating the Upper Tithonian or Berriasian (Torre de la, 1978–1983);
- ca. 5 m. Dark-grey, spotted dolomitic limestone with intercalatons of clayey-marly shale. The limestone contains common *Calpionella alpina* Lorenz, radiolarians and strongly recrystallized small ammonites;
- 4 m. Pseudoolitic, sparitic limestone, locally faintly laminated, with clayey-marly intercalations. The content of the pseudoolites locally exceeds 65 percent. Strongly recrystallized ammonites in this division are close to *Hildoglochiceras* (*Salinites*). The limestone probably still belongs to the Upper Tithonian.

The Tumbadero Member:

- ca. 4 m. Dark and dark-grey partly silicified limestone, with intercalations of shale and dark chert layers. Microfossils comprise *Tintinopsella carpatica* (Murgeanu et Filipescu), *Calpionella* sp., and numerous radiolarians, and it indicates the Berriasian age (Torre de la, 1978–1983);
- ca. 35 m. Grey, spotted, compact, thick- and medium-bedded micritic limestone, with intercalations of black, shaly, marly limestone with *Tintinopsella longa* (Colom), *Tintinopsella* sp., *Calpionellites darderi* (Colom), *Globochaete alpina* Lombard, and *Cadosina* sp. The age was determined by A. de la Torre (1978–1983) as the Lower Valanginian.

The Tumbitas Member:

- ca. 50 m. Light-grey, thin-bedded limestone with intercalations of grey, dark chert.

The Infierno Member is strongly tectonically reduced and it contacts directly with the pink limestones of the Ancón Formation (Myczyński in: Pszczółkowski *et al.*, 1975). The lowermost Tithonian is missing in this section, and the lowermost strata exposed are not older than the higher part of the Lower Tithonian.

Section A in Hacienda El Americano (**A-HA**; Fig. 4) is exposed ca. 18 km SE of the Valle del Ancón. Three sections (A, B, C) have been studied in this area. Section A-HA (coordinates 240, 100; 321,500, Consolación del Norte sheet 1 : 50,000) is exposed in SW–NE direction and its lower boundary is probably a fault (Fig. 3). The highest part of the San Vicente Member is not exposed.

The El Americano Member:

- 3.5 m. Dark-grey, micritic, medium-bedded limestone, with intercalations of greyish-brown marly limestone and dark-grey marly shale. The limestone layers have wavy boundaries. The limestone contains rare, poorly preserved ammonites, mostly molds, on the upper surfaces of layers. *Subplanites cubensis* Chudoley et Furrazola was described from this part of the section (Judoley & Furrazola-Bermúdez, 1968);
- 1.5 m. Lithology similar. Ammonites include *Parodontoceras butti* Imlay and small forms, probably *Hildoglochiceras* (*Salinites*). Microfossils are scarce. They include (Torre de la 1978–1983) *Calpionella alpina* (Lorenz) and abundant radiolarians. These strata belong to the Lower Tithonian. This means that the Lower Tithonian in this section is reduced tectonically, and is only about 5 m thick;
- 3 m. Dark micritic limestone, with thin intercalations of marly mudstone. The limestone

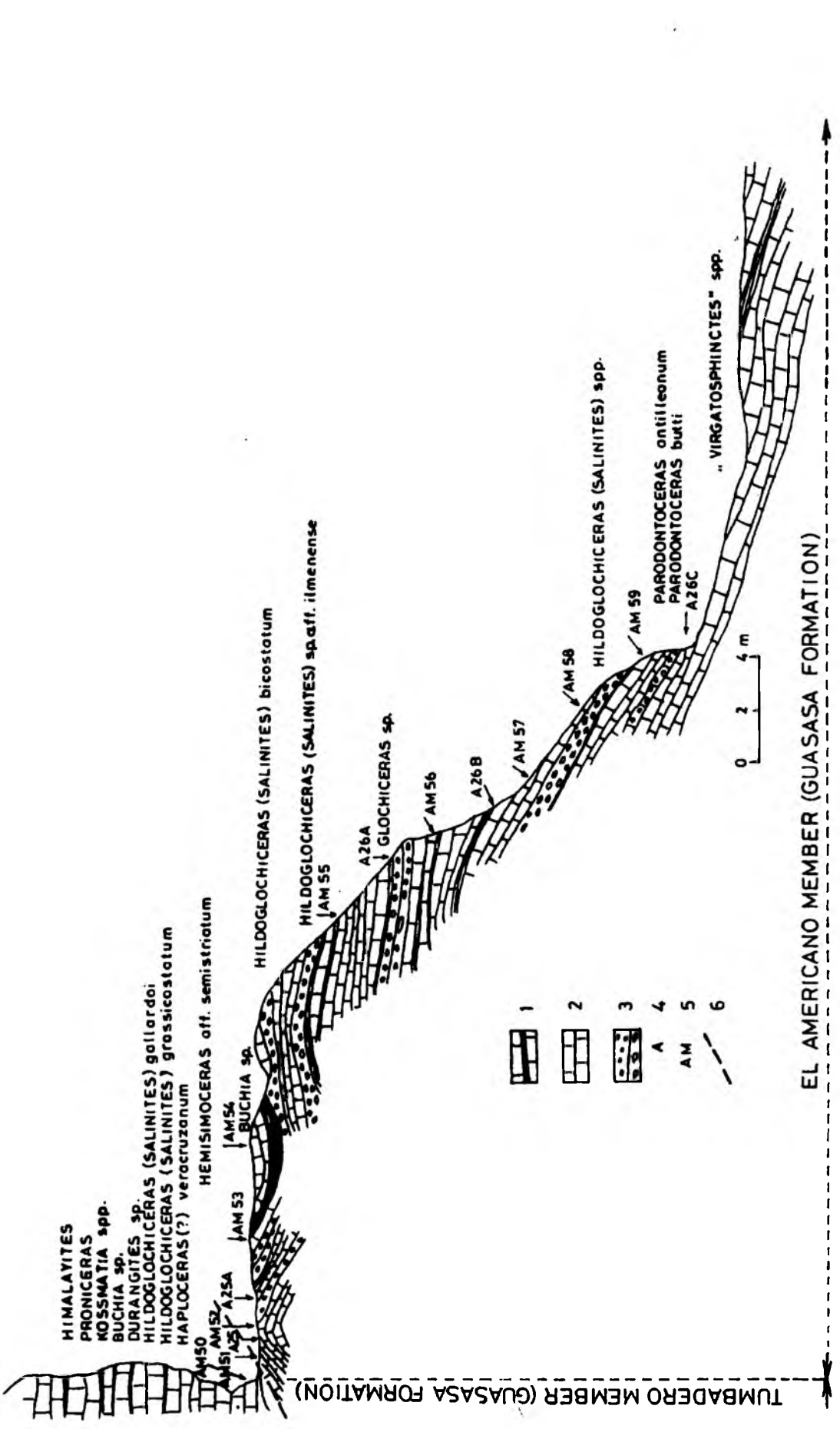


Fig. 4. Ammonite succession in section A-HA in Hacienda El Americano. *1* – thin- and medium-bedded micritic limestone with intercalations of shale and chert; *2* – thick-bedded limestone with thin intercalations of shale; *3* – nodular limestone and limestone with wavy layer boundaries; *4* – locations of macrofauna with specimen number; *5* – locations of samples for microfauna; *6* – faults

contains numerous ammonites *Hildoglochiceras* and poorly preserved microfossils, mainly radiolarians. The age is Upper Tithonian;

– 10 m. Dark, almost black, mainly micritic limestone, locally pseudoolithic, nodular, with marly-clayey intercalations. Fauna is extremely rare: it comprises *Glochiceras* (?) sp., *Hildoglochiceras* (*Salinites*), and *Hemisimoceras* (?) sp.;
– ca. 9 m. Dark-grey-blue micritic nodular limestone with marly-clayey intercalations, locally affected by boudinage. Rich fauna includes: *Haploceras* (?) spp., *Hildoglochiceras* (*Salinites*) *bicostatum* (Chudoley et Furrazola), *H.* (*S.*) *grossicostatum* Imlay, *H.* (*S.*) aff. *grossicostatum* Imlay, *H.* (*S.*) *gallardoi* (Chudoley et Furrazola), *H.* (*S.*) sp., *Kossmatia* sp. cf. *K. alamitosensis* (Aguilera), *Hemisimoceras* aff. *semistriatum* Spath, *Durangites* aff. *humbolti* Burckhardt, *Durangites* sp. aff. *acanthicus* Burckhardt, *Durangites* sp., *Proniceras* sp. cf. *P. subpronum* Burckhardt, and *Buchia* aff. *B. okensis* (Pavlow).

The Tumbadero Member (after a probable tectonic contact):

– 40 m. Dark micritic limestone with thin-bedded chert. It contains *Calpionellopsis simplex* (Colom), ?*Calpionellopsis oblonga* (Cadish), and *Tintinopsella carpathica* (Murgeanu et Filipescu), indicative of the Upper Berriasian–Lower Valanginian (Torre de la, 1978–1983).

Section B-HA in Hacienda El Americano begins in a karst depression (Fig. 5) marked with an altitude mark 177 (coordinates 240, 750; 321, 400, Consolación del Norte sheet; 1 : 50,000; cf. Houša, 1974). The dark-grey, massive limestones of the San Vicente Member are separated from the overlying limestone of the El Americano Member by a covered zone (fault?) 2.5 m long.

The El Americano Member (Houša & Nuez, 1972, 1973; Houša, 1974):

– 2.5–3 m. Dark-grey micritic limestone, medium- and thick-bedded, with intercalations of marly shale. There are no microfossils in this division; ammonites are few and poorly preserved
– *Protancyloceras* sp. aff. *gracile* (Oppel), *Mazapilites* sp., *Neochetoceras* sp., *Lithacoceras* (?) sp., and *Nebrodite* (*Mesosimoceras*) sp.;
– ca. 2.5 m. Grey- and dark-grey limestone with intercalations of clayey-marly shale. Fauna is poor and comprises *Aulacosphinctoides* sp. cf. *infundibulum* Uhlig, *Pseudoinvoluticeras* sp. cf. *P. mozambicum* Collignon, *Pseudoinvoluticeras* (?) sp., "*Virgatosphinctes*" *pinarensis* Chudoley et Furrazola, "*Virgatosphinctes*" sp. aff. *denseplicatus* (Waagen). The ammonites indicate a Lower Tithonian age;
– 3 m. Dark-grey dolomitic limestone with reddenings due to oxidation on tops of beds and with intercalations of dark shaly limestone. Microfossils are absent; scare macrofauna includes ?*Pachysphinctes* sp. and *Hildoglochiceras* (?*Salinites*) sp. About 1 m above the bottom of this division (9 m above the base of slope) a specimen of *Lytohoplites carribeanus* Imlay was found in similar dolomitic limestone;
– 8 m. Dark-grey-blue dolomitic limestone, thick-bedded, with shale intercalations. Fauna is very rare, only few fragments of ammonites *Parodontoceras butti* Imlay and *P. antilleanum* Imlay were found;
– 4 m. Light- and dark-grey micritic limestone, thick-bedded, with intercalations of marly limestone deformed by boudinage. The limestone includes numerous ammonites of the genus *Hildoglochiceras*: *H.* (*Salinites*) *grossicostatum* Imlay, *H.* (*S.*) *gallardoi* (Chudoley et Furrazola), *H.* (*S.*) *bicostatum* (Chudoley et Furrazola). Locally the limestone is ammonite coquina. This division is probably equivalent to the lower horizon with numerous ammonites in section A-HA;
– ca. 8 m. Dark-grey dolomitic limestone without fauna;
– ca. 5 m. Light-grey and grey-beige marly limestone, with poorly preserved microfossils and sporadic ammonites of the genus *Hildoglochiceras*;
– 0.5 m. Dark-grey dolomitic limestone, thin-bedded, intercalated with dark shaly limestone in

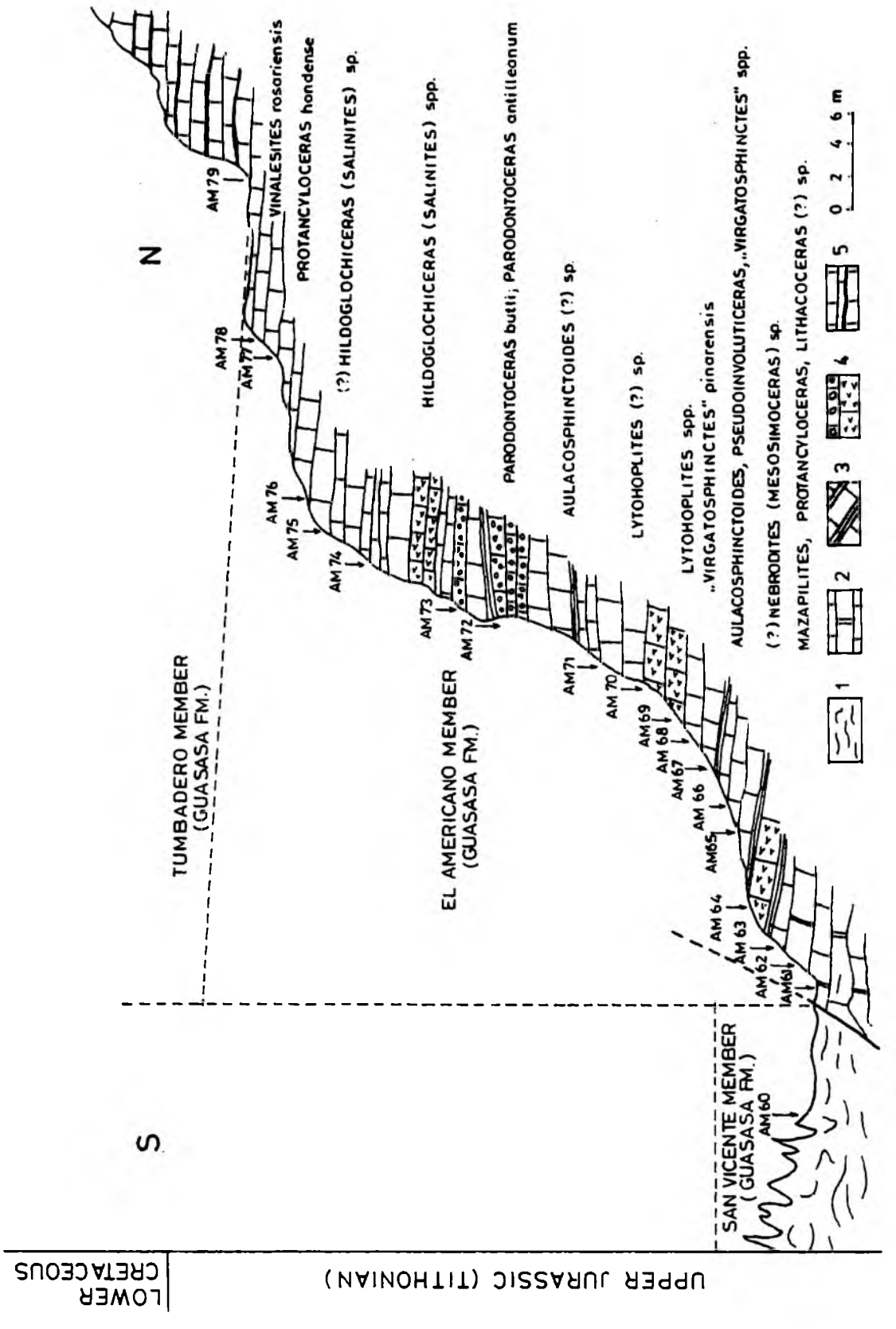


Fig. 5. Ammonite succession in section B-HA in Hacienda El Americano. *1* – massive limestone, San Vicente Member; *2* – thick- and medium-bedded limestone, partly dolomitic, lowest part of El Americano Member; *3* – micritic limestone with thin intercalations of shale; *4* – nodular limestone; *5* – micritic limestone with thin intercalations of dark chert, Tumbadero Member. Other explanations as in Fig. 2

layers 2–3 cm thick. The limestone contains indeterminable microfauna and small ammonites affined to the subgenus *Hildoglochiceras (Salinites)*;

- 1 m. Dark, almost black, medium-bedded laminated limestone, situated ca. 35 m above the base of slope. It contains abundant *Protancyloceras hondense*. Imlay and *P. catalinense* Imlay, and no *Hildoglochiceras* or *Vinalesites* Thieuloy, 1966. Microfossils are poorly preserved and include *Calpionella* spp. (Torre de la 1978–1983);
- ca. 2 m covered;
- 1.5 m. Dark-grey micritic and dolomitic limestone with small indeterminable, recrystallized ammonites;
- 1.5 m. Light-grey silicified limestone with thin mudstone intercalations. Rich microfossils in the limestone include (Torre de la. 1978–1983) *Calpionella alpina* Lorenz. *Calpionella* sp., *?Calpinellopsis* sp., and numerous radiolarians. These layers include also fairly numerous ammonites of the species *Vinalesites rosariensis* (Imlay). According to A. de la Torre (1978–1983) the microfauna in this division might indicate Berriasian–(?)Lower Valanginian.

The total thickness of the Tithonian strata in section B-HA is about 35–40 m. The highest part of the El Americano Member may thus belong already to the Berriasian. It is also noteworthy that the species *Protancyloceras hondense* (Imlay) and *P. catalinense* (Imlay) occur in a somewhat lower stratigraphic horizon than *Vinalesites rosariensis* (Imlay), unlike in section LC in the Sierra del Rosario where these ammonites are concurrent. Section B-HA continues upwards with the higher members of the Guasasa Formation and the Ancón Formation (see Houša, 1974).

Section C-HA in Hacienda El Americano (Fig. 6) begins at the opposite side of the same karstic depression as section B-HA (coordinates 240, 750; 231, 600, Consolación del Norte sheet 1 : 50,000). The lower part of the section has been labelled C-I, and the upper – C-II. The section extends at the azimuth 170°.

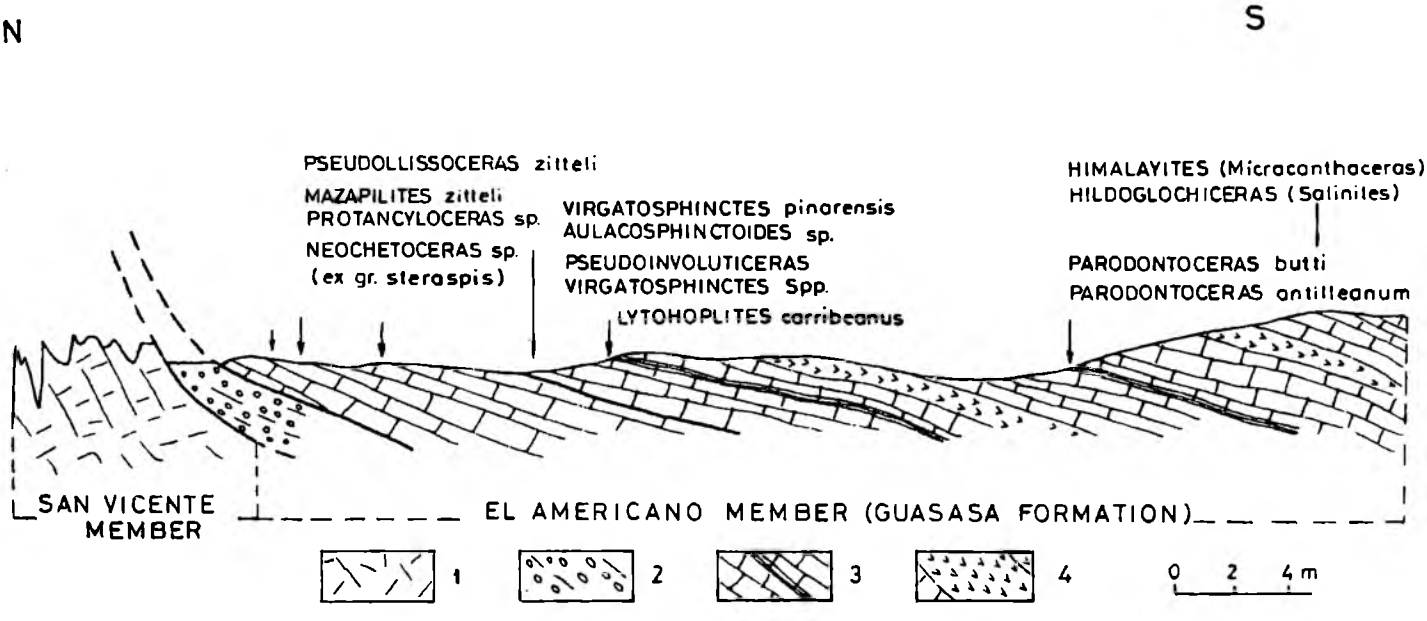


Fig. 6. Ammonite succession in section C-HA in Hacienda El Americano. *1* – massive limestone, San Vicente Member; *2* – tectonic breccia; *3* – thick-bedded limestone with intercalations of shale and with ammonites, El Americano Member; *4* – intercalations of nodular limestones

The San Vicente Member:

- 0.5 m. Dark-grey dolomitic limestone (Fig. 6);
- 2.5 m. Tectonic breccia consisting of limestones of the San Vicente and El Americano members.

The El Americano Member:

- 2 m. Dark-grey medium-bedded limestone with shale intercalations. The lowermost ammonites in this sequence — *Protancyloceras* sp. and *Neochetoceras* sp. — were found 0.75 m above its base. There occur also numerous pelecypods, brachiopods and gastropods;
- 6 m. Strongly recrystallized, dark-grey, to black thick-bedded, dolomitic limestone and dolomite, with intercalations of dark-grey, shaly and laminated limestone. The fauna in these strata includes *Holcophylloceras* cf. *zignodianum* (d'Orbigny), *Protancyloceras* sp. aff. *gracile* (Oppel), *Pseudolissoceras zitteli* (Burckhardt), *Neochetoceras* sp. aff. *N. steraspis* (Oppel), *Mazapilites zitteli* Burckhardt, *Mazapilites* sp.;
- 8 m. Dark-grey to black, thick-bedded, partly dolomitized, fine-grained limestone with shale intercalations up to 15 cm thick. Ammonites include: *Lytohoplites* sp., *L* (?) sp., *Haploceras* aff. *transatlanticum* Burckhardt, *Aulacosphinctoides* sp., *Pseudoinvoluticeras* sp. cf. *P. mozambicum* Collignon, "*Virgatosphinctes*" *pinarensis* Chudoley et Furrazola, "*Virgatosphinctes*" spp.;
- 10.1 m. Dark and grey limestone and dolomite, with thin intercalations of shaly and nodular

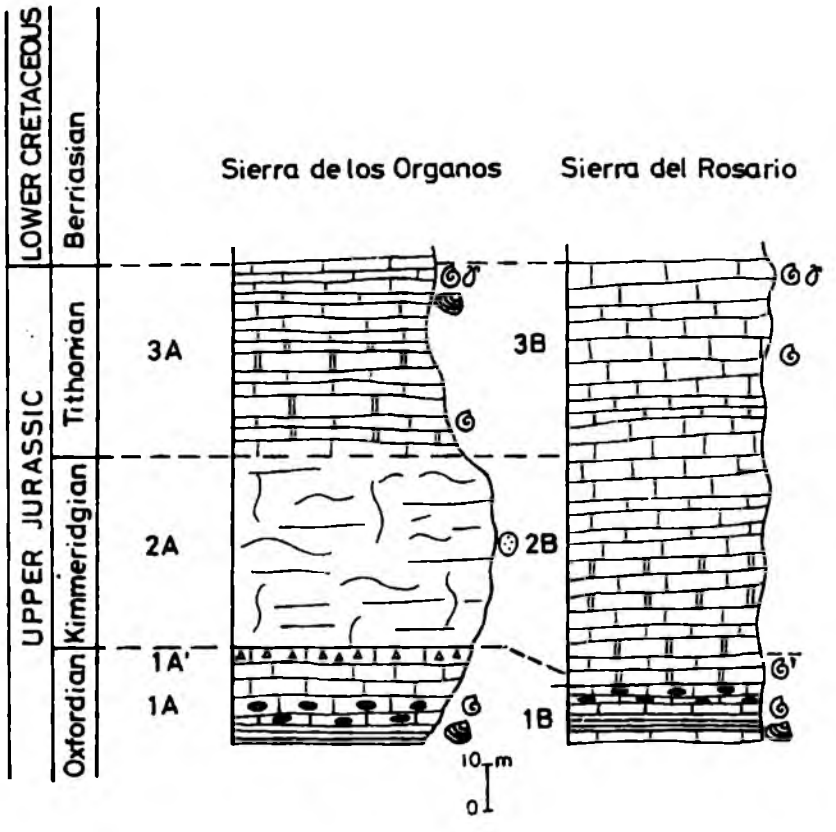


Fig. 7. General comparison of Upper Jurassic lithofacies and fossils in Sierra de los Organos and Sierra del Rosario. *1A* — shales and limestones with fossil-bearing carbonate concretions, Jagua Formation (pelecypods and ammonites); *1A'* — breccia at the top of Jagua Formation; *2A* — massive limestones of San Vicente Member, Guasasa Formation (*Favreina*); *3A* — bedded dolomitic limestones of El Americano Member, Guasasa Formation (pelecypods, belemnites, ammonites, calpionellids); *1B* — shales and limestones with fossil-bearing carbonate concretions, Francisco Formation (pelecypods and ammonites); *2B* — bedded micritic and dolomitic limestones, La Zarza Member, Artemisa Formation (ammonites and aptychi); *3B* — calcilutites and bioclastic limestones, the highest part of La Zarza Member (ammonites and calpionellids)

limestone. A horizon with *Parodontoceras butti* Imlay, *P. antilleanum* Imlay, and *Hildoglochiceras* occurs in the upper part of this division;

– 3.0 m. Dark-grey nodular limestone with numerous ammonites of the subgenus *Salinites*, including *Hildoglochiceras* (*S.*) *grossicostatum* Imlay, *H.* (*S.*) *gallardoi* (Chudoley et Furrazola), *H.* (*S.*) *bicostatum* (Chudoley et Furrazola). There occur also rare *Parodontoceras* (?) and poorly preserved tintinnids. Ammonites of the genera *Protancyloceras* and *Vinalesites* have been not found, probably because the section is tectonically truncated at the top.

The section terminates with a tectonic contact, on the southern side of a small hill. The thickness of the Tithonian strata in this section does not exceed 30 m.

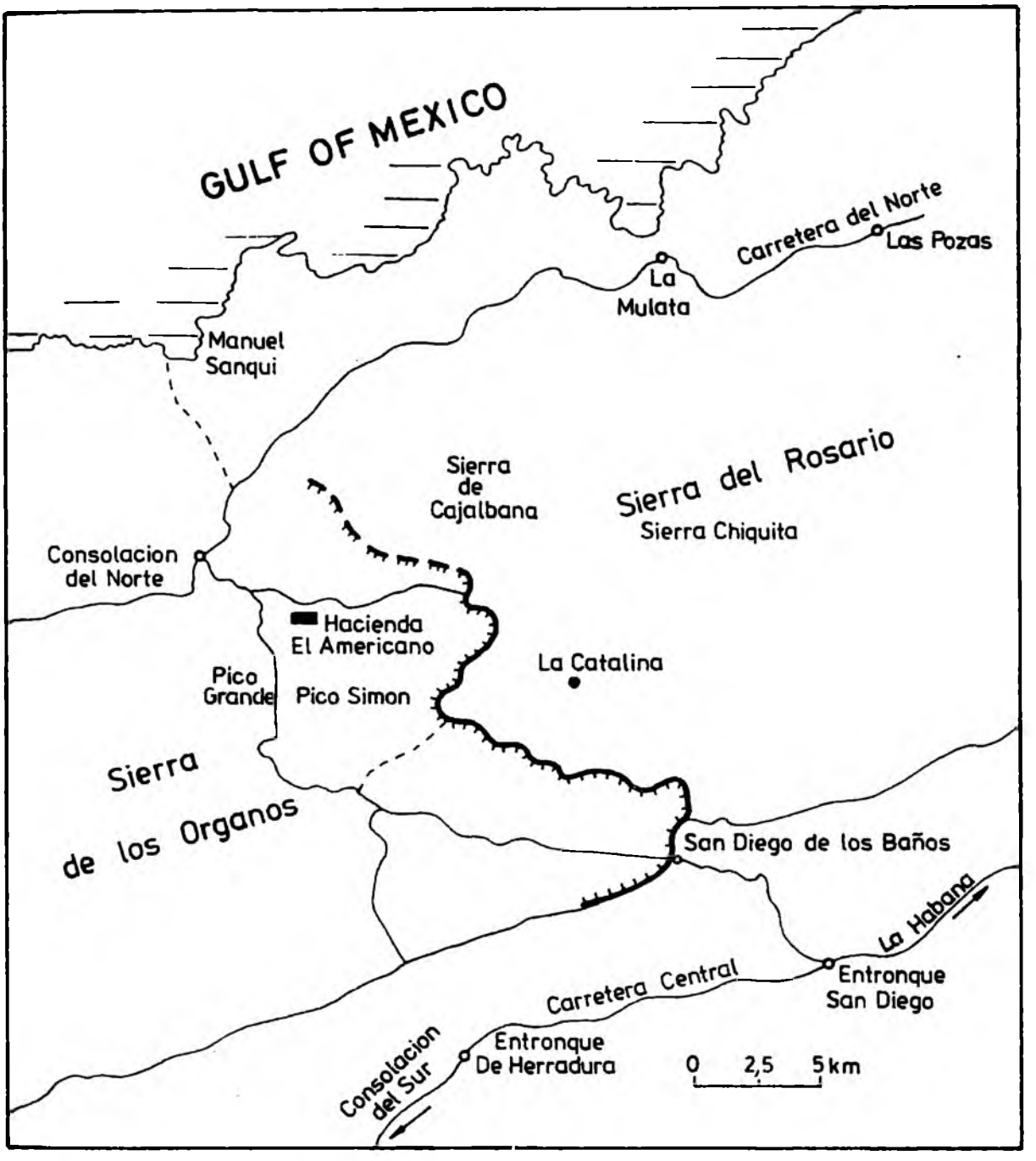


Fig. 8. Map showing the boundary between the tectonic-facies units of Sierra de los Organos and Sierra del Rosario

The area of Hacienda El Americano is the easternmost occurrence of the facies characteristic of the Sierra de los Organos (typified by massive limestones of the San Vicente Member). Farther to the east, the lithology of the Tithonian strata acquires the characteristics of the Artemisa Formation (redefined by Judoley & Furrazola-Bermúdez, 1968). In the next eastward section, La Catalina (LC), the Tithonian strata are already in the facies characteristic of the Sierra del Rosario (Fig. 7). The boundary of the facies regions runs near the town of San Diego de los Baños, 8 km SW of La Catalina (Fig. 8).

TITHONIAN SECTIONS STUDIED IN THE SIERRA DEL ROSARIO

The Tithonian strata in the Sierra del Rosario are represented by limestones and dolomitic limestones of the Artemisa Formation (Judoley & Furrazola-Bermúdez, 1968; Pszczółkowski in: Pszczółkowski *et al.*, 1975; Kutek *et al.*, 1976; Myczyński, 1977) including the La Zarza Member (Pszczółkowski, 1978). The ammonites in these strata were described by Imlay (1942) and Judoley & Furrazola-Bermúdez (1968).

La Catalina section (LC; Fig. 9) is exposed in three small hills in the SW part of the La Catalina valley (coordinates 249, 300; 320, 850, Pan de Guajaibon sheet 1 : 50,000). The lower boundary of the Tithonian is not well defined because of the lack of ammonites in the underlying strata, and their scarcity in the lower part of the Tithonian section.

- 3 m. Dark-grey, thick-bedded dolomitic limestone with intercalations of dark-grey shale, exposed in the southern part of the section (Fig. 8). One specimen of strongly recrystallized ammonite (Oppeliidae) was found in the upper part of these strata;
- 7.5 m. darker and strongly bituminous limestone. It includes *Protancyloceras hondense* (Imlay) and *P. catalinese* (Imlay);

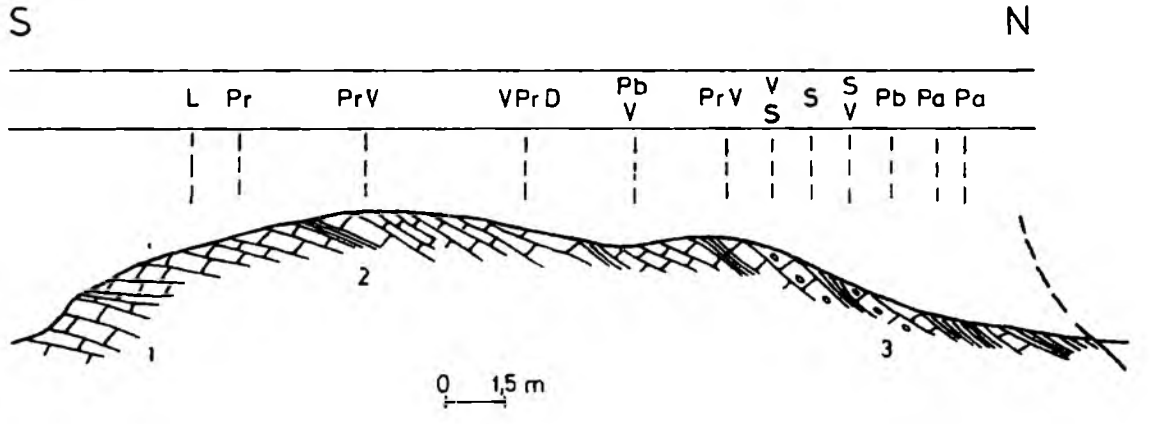


Fig. 9. Ammonite succession in La Catalina section (LC). *1* – dark, medium-bedded micritic limestone (?Lower Tithonian); *2* – medium-bedded limestone with shale intercalations (Upper Tithonian); *3* – intercalations of nodular limestone; *Pr* – *Protancyloceras hondense* (Imlay); *V* – *Vinalesites rosariensis* (Imlay); *Pb* – *Parodontoceras butti* Imlay; *Pa* – *Parodontoceras antilleanum* Imlay; *D* – *Dickersonia*; *S* – *Hildoglochiceras* (*Salinites*); *L* – *Lytohoplites*

- 1.5 m. The same type of limestone. *Vinalesites rosariensis* (Imlay) occurs together with *P. hondense* (Imlay) and *P. catalinense* (Imlay);
- 0.5 m (about 12 meters above the bottom of the section). Grey-blue and dark-grey micritic limestone with *Protancyloceras hondense* (Imlay), *P. catalinense* (Imlay), and *Vinalesites*;
- 6.5 m. Similar limestone, about 5 m above the bottom of this division yielded *Parodontoceras butti* (Imlay) and *Vinalesites rosariensis* (Imlay);
- 0.5 m. Light-colored and spotted limestone. Locally the layer surfaces are uneven. There are some intercalations of marly shale. *Protancyloceras*, *Vinalesites* and poorly preserved specimens of *Dickersonia* (see Imlay, 1942) occur in these strata;
- 0.5 m. Dark-grey, micritic limestone with layers of grey-brown clayey-marly shale with *Hildoglochiceras*, *Parodontoceras* and *Vinalesites* occur in this part of the section.

At the top the section is probably truncated by a fault on the south-east side. The thickness of the Tithonian strata with fauna is small in this section (probably about 20–25 m).

Loma Ferretero section (**LF**; Fig. 10) is situated about 1.5 km west of Cinco Pesos and is exposed in the southern slope of the Loma Ferretero hill (coordinates 280, 500; 329, 200, San Cristobal sheet 1 : 50,000). Dark-blue and dark-grey micritic limestone of the La Zarza Member of the Artemisa Formation overlies the Oxfordian limestone of the Francisco Formation. The ammonite sequence in the Tithonian part of this section is shown in Fig. 10.

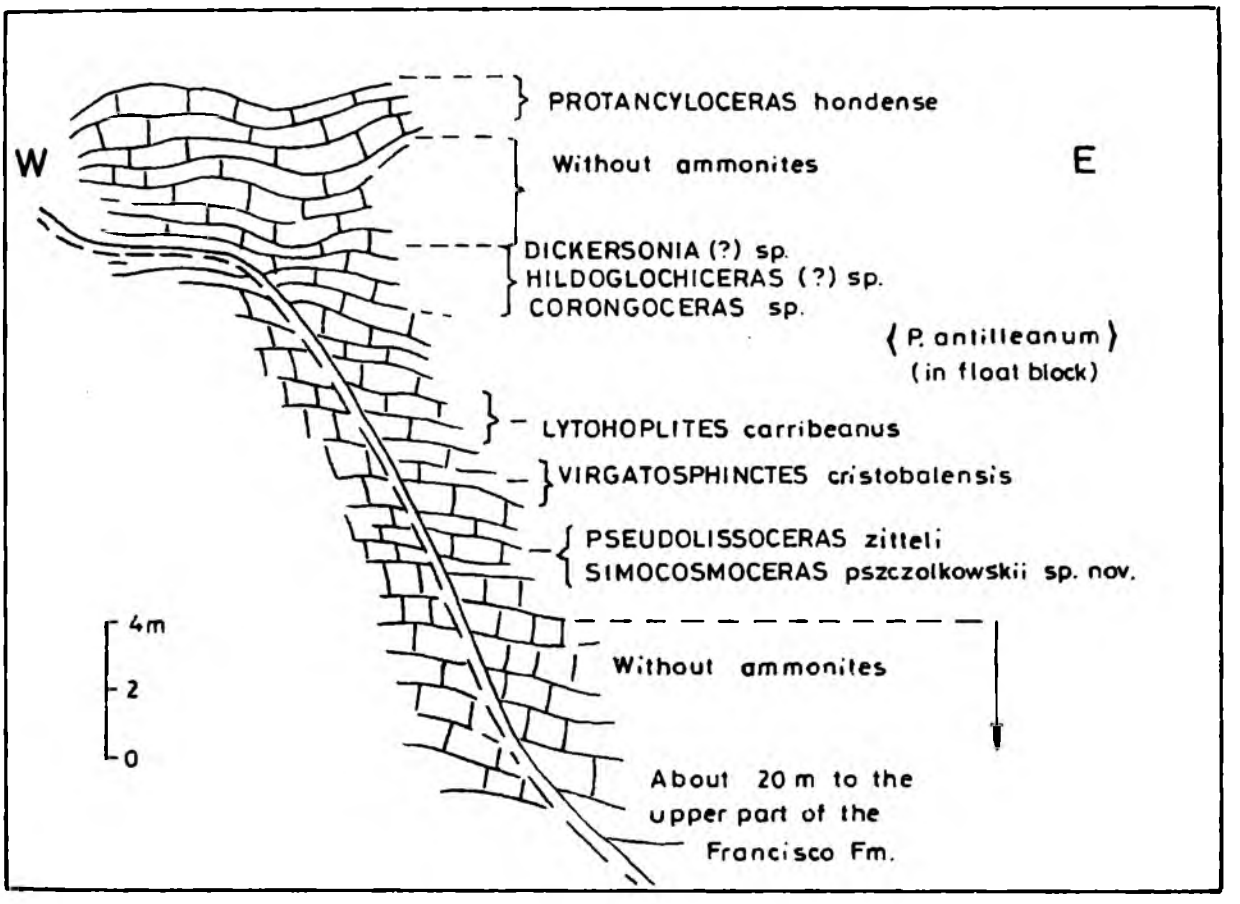


Fig. 10. Ammonite succession in Loma Ferretro section (LF). Exposure of limestone of Artemisa Formation along a path on hillslope

Cinco Pesos section (**MR – 28**; Fig. 11) is situated about 500 m NE of Hoyo del Rosario on the road from San Cristobal to Cinco Pesos (coordinates 283, 100; 327, 400, San Cristobal sheet 1 : 50,000). The lithology and ammonites of this section have been first described by Judoley & Furrazola-Bermúdez (1968, figs. 6, 7). The beginning of the section (Fig. 11) is in its southern part.

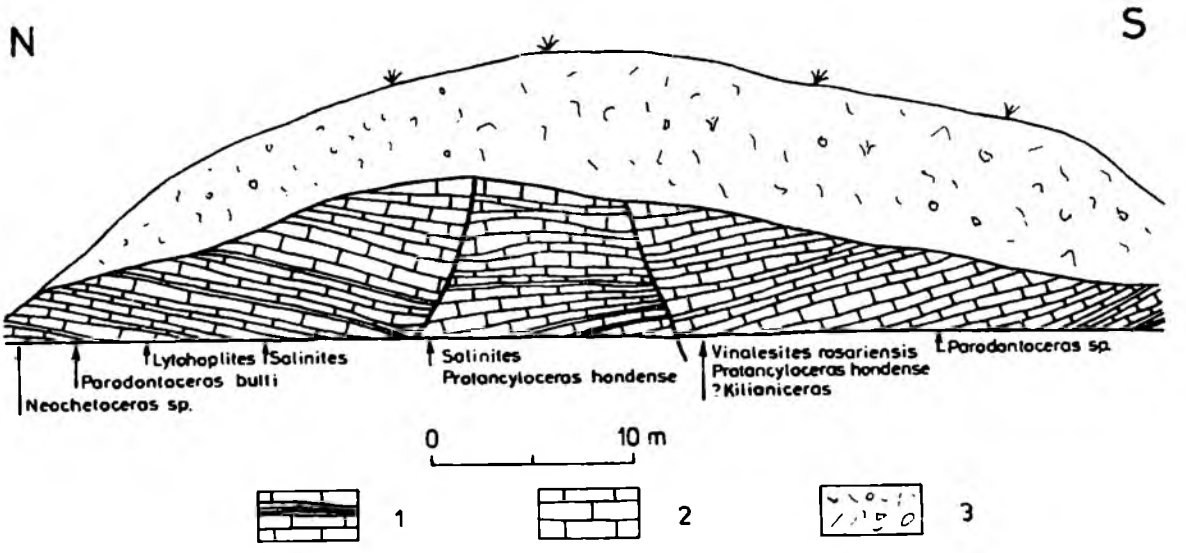


Fig. 11. Ammonite succession in section MR-28. *1* – thin-bedded limestone with shale intercalation, lower part of La Zarza Member of Artemisa Formation; 2 – medium-bedded limestone with scare intercalation of shale, upper part of La Zarza Formation; *3* – weathered cover

The La Zarza Member (Pszczółkowski, 1978):

- ca. 15 m. Dark-grey laminated limestone, with intercalations of marly shale, dipping 20 due north (section MR-28 in Fig. 11). One poorly preserved specimen of *Virgatosphinctes* sp. was found in the limestone;
- 8 m. Dark-blue, bituminous limestone appears in the section about 7 m farther north (23 m from the begining of the section). It includes *Parodontoceras antilleanum* Imlay;
- 2.5 m. Black micritic limestone with *Vinalesites rosariensis* (Imlay);
- 28 m. Dark-grey and black micritic limestone with interacalations of shales and with rich fauna: *Vinalesites rosariensis* (Imlay), *Protancyloceras* sp. and *Lamellaptychus* sp.

The described section (Fig. 10) is bounded on the north by a fault after which the same strata are repeated. The total thickness of the limestones in this section is about 53 m. According to Judoley & Furrazola-Bermúdez (1968) ammonites *Simoceras*? sp., *Berriasella*? sp., and *Corongoceras*? sp. are concurrent with the following microfossil assemblage: *Tintinopsella* sp., *T. longa*, *T. carpathica*, *T. cubensis*, *T. bermudezi*, *Calpionella* sp., *C. alpina*, *C. cristobalensis*, *Calpionellites darderi*, radiolarians, *Nannoconus steinmanni*, *Globochaete alpina*, *Lombardia* (= *Saccocoma*) sp. This assemblage is non-uniform in age, and some forms, e.g. *Calpionellites darderi*, are characteristic of strata younger than Tithonian (Lefeld, 1974; Pop, 1976).

Niceto Perez section (**MR-24**; Fig. 12) is exposed along the road from Niceto Perez (formerly Rancho Mundito) to El Mameyal (ca. 3.5 km NE of Niceto Perez, coordinates 262, 750; 326, 500, Pan de Guajaibon sheet 1 : 50,000) The Artemisa Formation is here in tectonic contact with the San Cayetano Formation.

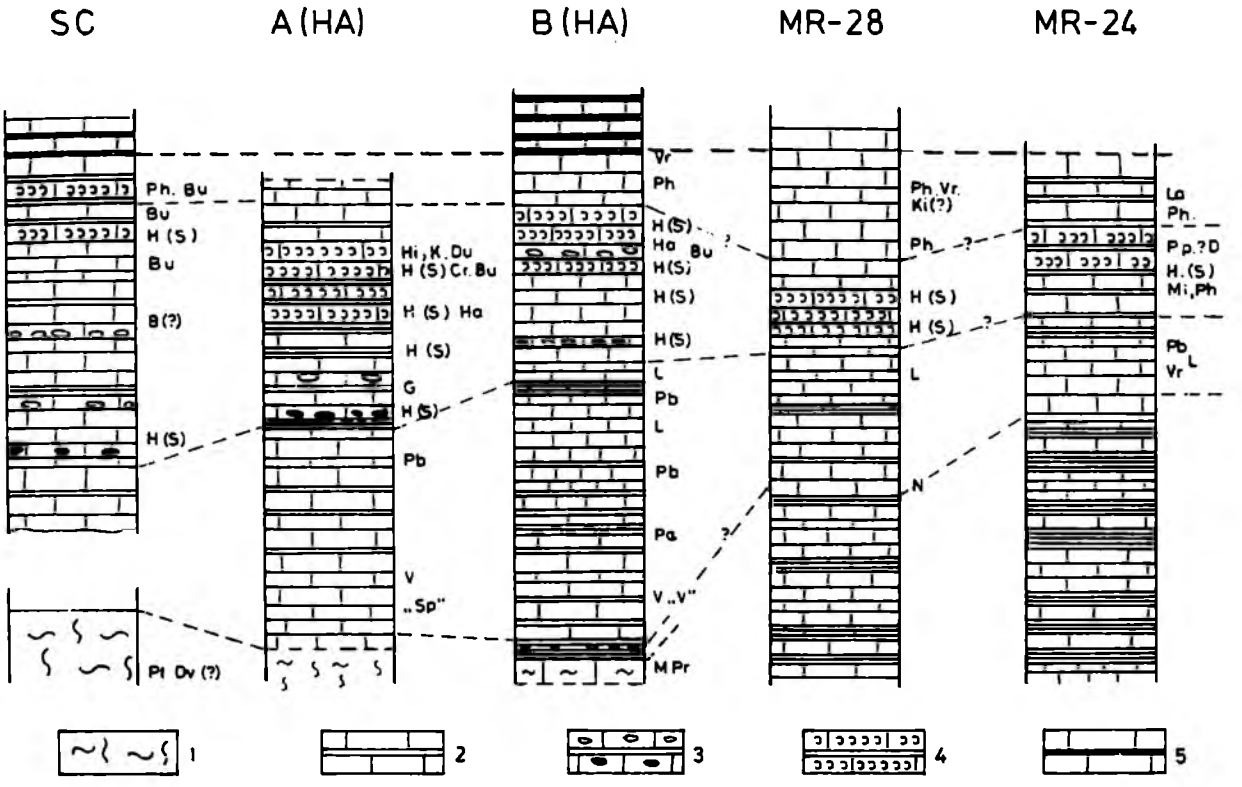


Fig. 12. Comparison of selected sections and ammonite successions in Tithonian of western Cuba. Section symbols explained in Fig. 1. *1* — massive limestones of San Vicente Member; *2* — bedded limestones of El Americano Member; *3—4* micritic limestones and nodular limestones with wavy layer boundaries; *5* — limestones with chert intercalations, Tumbadero Member; *B* — *Berriasella*; *Bu* — *Buchia*; *Cr* — *Corongoceras*; *D* — *Dickersonia*; *Du* — *Durangites*; *Dv* — *Duvalidae*; *G* — *Glochiceras*; *Hi* — *Hildoglochiceras*; *H (S)* — *Hildoglochiceras* (*Salinites*); *Ki* — *Kilianiceras*; *K* — *Kossmatia*; *M* — *Mazapilites*; *Mi* — *Micracanthoceras*; *La* — *Lamellaptychus*; *L* — *Lytohoplites*; *Pa* — *Parodontoceras antilleanum* Imlay; *Ph* — *Paradontoceras butti* Imlay; *Pp* — *Phylloceras*; *N* — *Neochetoceras*; *V* — "*V*" — *Virgatosphinctes*; *Vr* — *Vinalesites rosariensis* (Imlay); "*Sp*" — *Subplanites*; *Pt* — *Ptygmatidae*; *Pr* — *Protancyloceras*; *Ph* — *Protancyloceras hondense*

The La Zarza Member:

- about 37 m. Dark, medium- and thin-bedded limestone, intercalated with brown, reddish-weathering clayey shale. It contains only fish skeletons. Its age is Oxfordian, Kimmeridgian and possibly also Lower Tithonian;
- ca. 1.5 m. Covered;
- 0.8 m. Dark-grey, almost black, medium-bedded limestone with thin intercalations of shale. The limestone contains *Lytohoplites* sp., *Kossmatia* sp. and *Vinalesites rosariensis* (Imlay). Ammonites *Parodontoceras* and pelecypods *Buchia* sp. appear about 1.8 m above the first layer with ammonites;
- 11 m. Black and dark-grey, thick-bedded limestone with thin intercalations of shale. The

lowermost layers of this division furnished *Micracantoceras* sp. and *Protancyloceras hondense* (Imlay). The middle part contains several beds full of ammonites including *Phylloceras pinarense* Imlay, ?*Dickersonia* sp., *Haploceras* sp., *Hildoglochiceras* (*Salinites*) spp., ?*Pseudolissoceras* sp., *Protancyloceras hondense* (Imlay), *P. catalinense* (Imlay), and *Lamellaptychus* sp. The uppermost layers of this division are barren of ammonites.

The section is tectonically truncated at top. Its total thickness is about 50 m. The limestones contain poorly preserved tintinnids and radiolarians.

TITHONIAN STRATA IN OTHER PROVINCES OF WESTERN CUBA

Tithonian strata with ammonites do not occur in the area of City of Havana and Havana and Matanzas Provinces (Albear *et al.*, 1977; Albear & Iturralde-Vinent, 1985). The nearest eastward occurrence of the Tithonian is near the village of La Sierra in the western part of Villa Clara Province. Ammonites occur in the lowermost part of the Veloz Formation, in thin-bedded, grey and grey-yellow micritic and detrital limestone with intercalations of shale. The fauna comprises several specimens of *Pseudolissoceras*? sp. and *Hildoglochiceras* (*Salinites*) sp. (Myczyński in: Piotrowska *et al.*, 1981). Numerous ammonites from the provinces of Villa Clara (a part of former Las Villas Province) and Camagüey were described by Imlay (1942).

Tithonian ammonites in Camagüey Province occur in the Sierra de Camajan (Imlay, 1942; Iturralde-Vinent *et al.*, 1982). One section is situated on the Loma Yaguajay hill. The oldest strata in this section are of grey and beige micritic limestone with numerous aptychi. The limestone comprises *H.* (*Salinites*) *grossicostatum* Imlay and *H.* (*Salinites*) *gallardoi* (Chudoley et Furrazola). Higher in the section there occurs thin-bedded, beige, micritic limestone with thin intercalations of chert. No ammonites have been found in this limestone. The strata exposed in this section are included to the Veloz Formation.

The deposits of the Veloz Formation are also exposed on the northern side of the Sierra de Camajan. Ammonites occur there in the grey-brown and beige thin-bedded limestone with dark chert in the lower part of the Veloz Formation. They include *Vinalesites rosariensis* (Imlay), *Pseudolissoceras* (?) sp., ?*Haploceras* cf. *veracruzanum* Cantú Chapa and *Protancyloceras hondense* (Imlay). This assemblage occurs above the basalt exposed in a quarry at Nueva María (Iturralde-Vinent & Mari Morales, 1988). The section follows with light-beige and beige platy micritic limestone with chert and shale intercalations. Two specimens of ?*Protancyloceras* sp. and aptychi *Lamellaptychus excavatus* Trauth were found in these strata.

Tithonian strata occur also in the southern-central part of Cuba in the metamorphosed sequences of the Escambray Massif (Millán & Myczyński, 1978, 1980). The Escambray Massif is a mountainous area situated largely within the limits of Sancti Spiritus Province, built of metamorphic roks. There are two parametamorphic sequences in the Escambray Massif. A siliciclas-

tic-carbonate one, attributed to the ?Lower Jurassic–Middle Oxfordian, and the carbonate one attributed to the Kimmeridgian–Cretaceous. Ammonites were found in both sequences.

The strata which yielded the Tithonian ammonites are of dark-grey-blue and black crystalline limestone, thin- and medium-bedded, with thin intercalations of quartzitic slate. These strata are included into the Mayari Formation (Millán & Somin, 1981) which comprises the Tithonian through Lower Cretaceous sequences of the Escambray Massif. The thickness of the Tithonian limestone was established at about 45 m (Millán & Myczyński, 1978, 1980). In the oppinion of many authors the lithology of the strata included now in the Mayari Formation is similar to that of the Guasasa Formation in the Sierra de los Organos (Thiadens, 1973; Hill, 1959; Engel, 1962; Rigassi-Studer, 1963; Millán & Myczyński, 1978, 1980; Millán & Somin, 1981; Somin & Millán, 1981).

MAIN PROBLEMS OF AMMONITE BIOSTRATIGRAPHY OF THE TITHONIAN STRATA OF WESTERN CUBA

The Tithonian strata of Cuba were hitherto referred to the Portlandian (Imlay, 1942), Lower and Middle Tithonian (Judoley & Furrazola-Bermudez, 1968), and recently to the Lower, Middle and Upper Tithonian (Houša, 1974; Pszczółkowski, 1978).

According to Imlay (1980) in Cuba there are no ammonites indicative of uppermost Tithonian. This conclusion results from his acceptance of the division in which all the strata with ammonites of the genera *Substeueroceras* and *Berriasella* are included to the Tithonian. The same was the opinion of Jeletzky (1984, p. 99) who includes the strata with *Substeueroceras*, *Berriasella* and *Proniceras* to the Tithonian.

Another view is expressed by Zeiss (1984, 1986) who refers the strata with *Substeueroceras* and *Berriasella* to the Lower Cretaceous and correlates them with the *Jacobi-Grandis* Zones in the European division (Fig. 13). According to this approach, the Upper Tithonian includes the strata with *Kossmatia*, *Corongoceras*, *Virgatosphinctes*, and *Hildoglochiceras*. Such scheme is based on the occurrence of a calpionellid assemblage indicative of the Lower Berriasian (Zones B and C of Mediterranean Europe) in the strata with *Substeueroceras* in Mexico, as well as on the assumption that the strata with *Durangites* in southern Europe are of approximately the same age as the strata with *Kossmatia-Durangites* assemblage in Mexico (Zeiss, 1984, pp. 101, 102).

In the division proposed by Olóriz & Tavera (1981), the upper boundary of the Tithonian strata in Mexico is placed in the lower part of the strata with *Berriasella* and *Substeueroceras*, and above the strata with *Kossmatia*, *Durangites*, and *Corongoceras* assemblage which may be sporadically accompanied

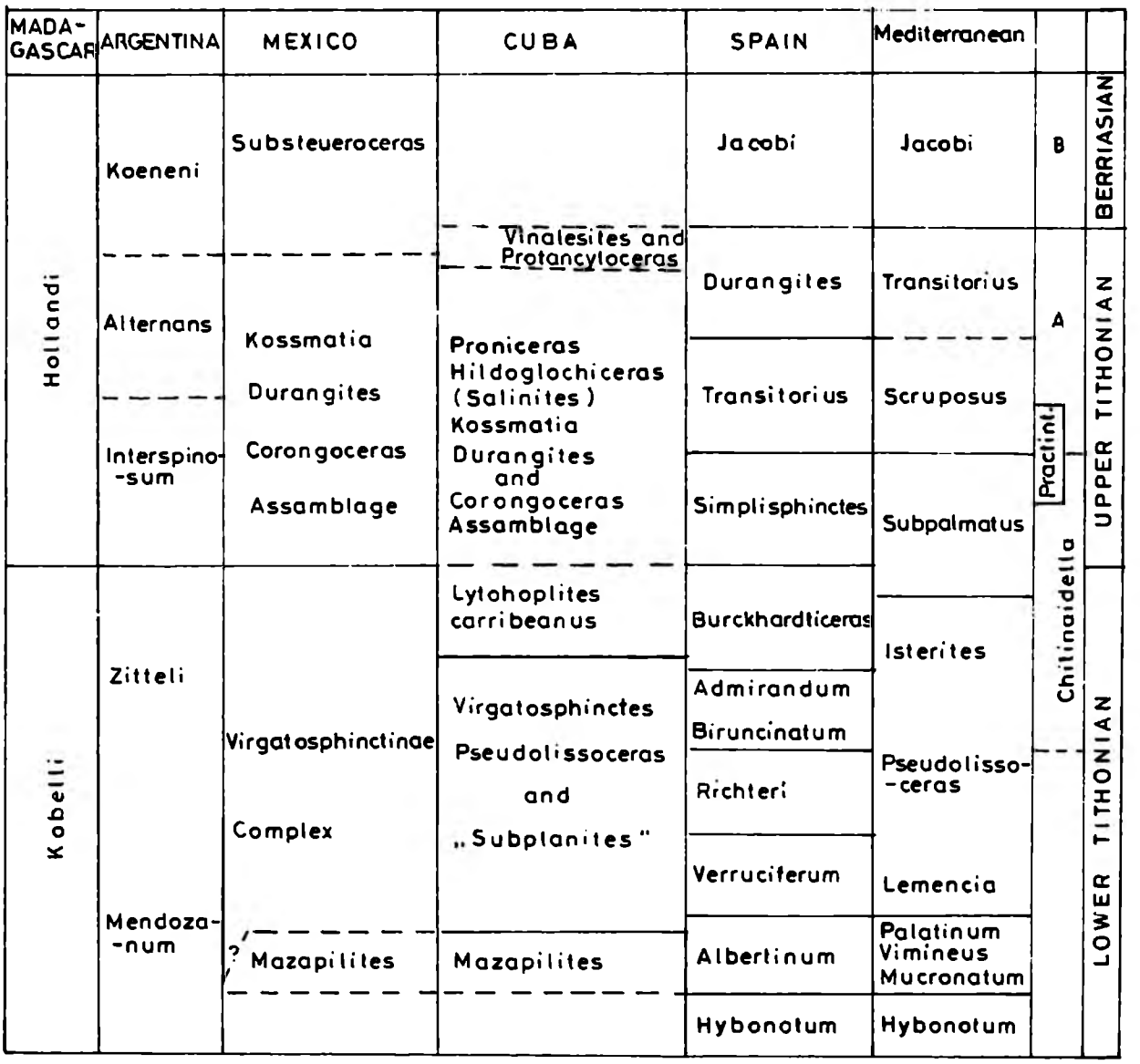


Fig. 13. Tentative correlation of Tithonian ammonite zones of western Cuba with ammonite zones of Madagascar, Argentina, Mexico, Spain and eastern part of Mediterranean area

by *Substeueroceras* (Verma & Westermann, 1973). The most part of the strata with *Berriasella* and *Substeueroceras* is included to the Barriasian. This division, which reflects the resolutions of the *Colloque...* (1973) and includes the opinions of other investigators (Enay & Geyssant, 1975; Olóriz, 1978; Olóriz & Tavera, 1981; Ogg *et al.*, 1984; Shulgina, 1985; Zeiss, 1983, 1984, 1986), was accepted in this paper.

The bipartite Tithonian comprises the Lower Tithonian with *Kobelli* Zone in Madagascar, *Mendozanum* and *Zitteli* Zones in Argentina, and the zones from *Hybonotum* to *Burckhardticeras* in the Spanish division, as well as the Upper Thitonian, equivalent to a part of the *Hollandi* Zone in Madagascar, to the *Interspinosum*, *Alternans*, and partly *Koeneni* Zones in Argentina, and to the *Simplisphinctes* through *Durangites* Zone in Spain (Fig. 13). The division accepted in this paper follows the tendency of using bipartite divisions of the Tithonian in non-European regions.

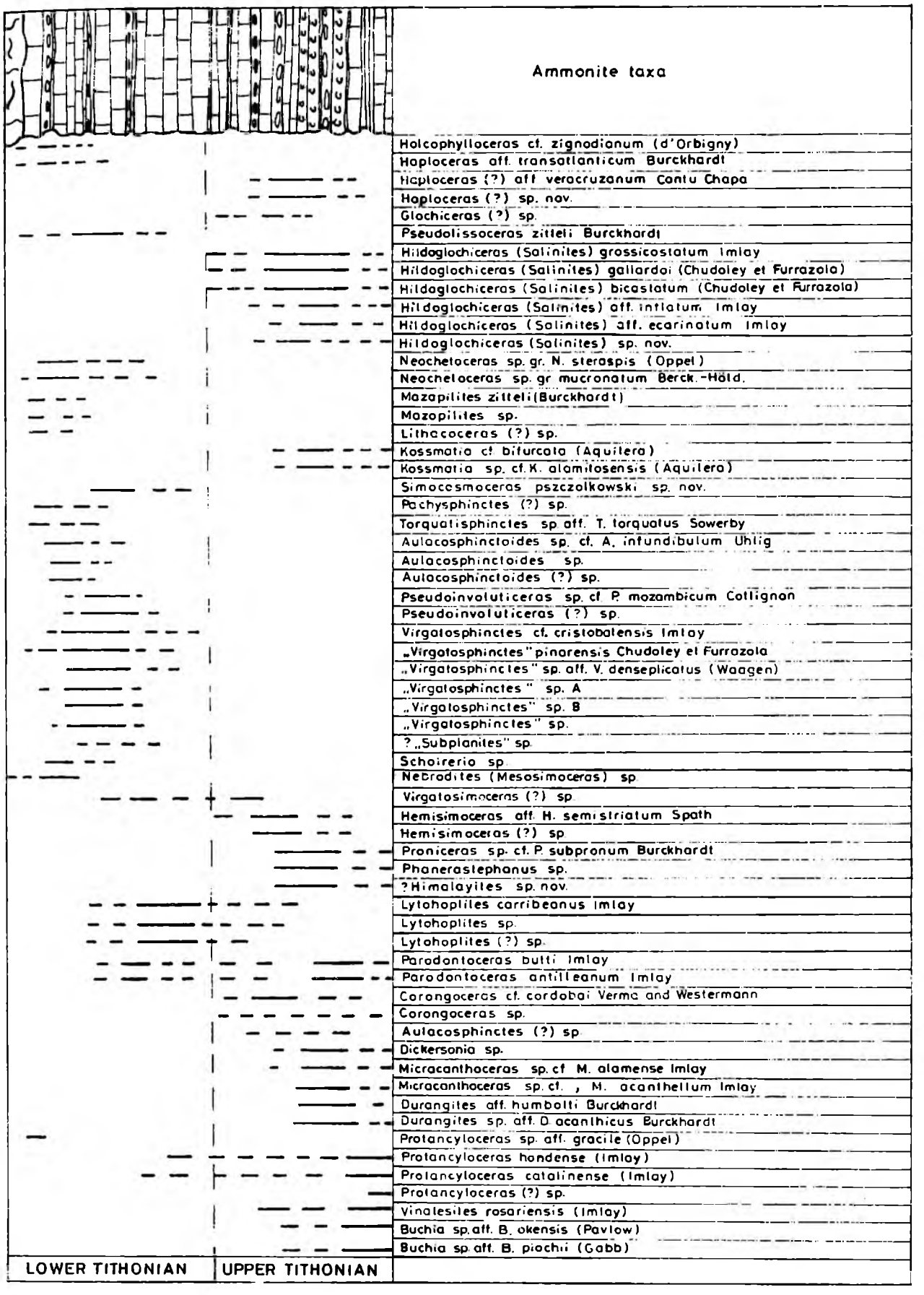


Fig. 14. Stratigraphical ranges of Tithonian ammonites and pelecypods of western Cuba. Lithology as in Fig. 11

The boundary between the Lower and Upper Tithonian was accepted at the disappearance of the genera *Virgatosphinctes*, *Pseudolissoceras*, "*Subplanites*", and *Lytohoplites*, and at the appearance of *Himalayites*, *Micracanthoceras*, *Corongoceras*, *Hildoglochiceras* (*Salinites*) – mass occurrence, *Kossmatia*, and *Durangites*.

The biostratigraphical division presented in this paper is partly simplified, due to difficulties in determining the stratigraphical ranges of individual taxa. Some taxa characteristic of the Upper Tithonian of Cuba have long ranges (Fig. 14). Similar situation occurs in Mexico where *Lytohoplites*, *Parodontoceras*, *Micracanthoceras*, *Proniceras* and *Hildoglochiceras* have long stratigraphic ranges (Jeletzky, 1984). This regards also *Durangites*, *Kossmatia*, and *Corongoceras* which though rarely but do occur even in the uppermost Tithonian (sensu Jeletzky, 1984).

Additional difficulties in the precise establishment of the ammonite succession result from the condensed nature of the Upper Tithonian strata in Cuba and from the presence of ammonite coquinas. As a result, it is difficult to precise the position of the upper boundary of the Tithonian in Cuba. The presence of the ammonites of the genus *Substeueroceras* in Cuba is not certain[1], and *Durangites*, *Kossmatia*, and *Proniceras* occur together.

Additionally, most sections of the Tithonian strata in Cuba terminate with strata which bear heteromorph ammonites *Protancyloceras* (type *P. hondense*) and *Vinalesites*, whose age has been not yet precisely established.

The acceptance of the upper boundary of the Tithonian in Cuba at the top of the strata with *Durangites*, *Kossmatia*, and *Corongoceras* agrees with the stratigraphical division proposed by Zeiss (1984). There is a difference consisting in the presence of *Proniceras* in this assemblage, which in the Zeiss's opinion belongs already to the Berriasian. This genus was, however, reported from Mexico from strata attributed by Jeletzky (1984) to the uppermost Tithonian (upper part of calpionellid Zone A). There are also informations on concurrence of *Parodontoceras* and *Spiticeras* in Mexico (Imlay & Jones, 1970; Jeletzky, 1984).

The above data and the results of micropaleontological studies (Torre de la, 1972–1975, 1978–1983) provided grounds for the acceptance of the upper boundary of the Tithonian at the top of the strata with *Protancyloceras* and *Vinalesites*. A possibility that at least a part of these strata might belong to the Berriasian can not be ruled out (Myczyński, 1977; Pszczółkowski, 1978).

An alternative solution would be the acceptance of the upper boundary of the Tithonian above the strata with *Durangites* and *Proniceras*, and below the strata with *Protancyloceras hondense* and *Vinalesites rosariensis*. This concept is contradicted, however, by some micropaleontological data and by the presence of the last two ammonite species in association with *Hildoglochiceras* and possibly with *Virgatosphinctes* and *Pseudolissoceras* (Imlay, 1942, pl. 12, fig. 1). This might

[1] There is one report on the presence of this genus in the Tithonian of Villa Clara Province (Shopov in: Kanchev *et. al.*, 1978; Shopov, 1975). However, the ammonites found by Shopov in this province have been not hitherto described and illustrated in a published report, and according to Kanchev *et al.* (1978) the Tithonian ammonites collected in central Cuba in years 1969–1975 are lost.

mean that they appear already in the Lower Tithonian, and only become very numerous in the Upper Tithonian. For this reason the *P. hondense – V. rosariensis* Zone is accepted here as an acme-zone and not a taxon-range zone.

In Mexico forms similar to the Cuban species *Protancyloceras hondense* (Imlay) and *Protancyloceras catalinense* (Imlay) occur in the strata with *Parodontoceras* and *Substeueroceras* (Imlay, 1980, p. 36). This would agree with the position of these forms in Cuba. In the Sierra del Rosario *Protancyloceras hondense* (Imlay) was found in the highest part of section LF and in the upper part of section MR-28. In section LF this species occurs about 2 m above the strata with *Corongoceras* sp., and in section MR-28 – in strata with *Hildoglochiceras* (*Salinites*). The position of *P. hondense* relative to the strata with *Proniceras*, *Durangites*, and *Kossmatia* is unclear. In sections VA and A-HA where these strata occur, *P. hondense* was not found. It occurs in section B-HA where, in turn, *Proniceras*, *Durangites*, and *Kossmatia* have been not found. The strata with these genera are probably somewhat lower stratigraphically than those with *P. hondense*, and the lack of *P. hondense* in section A-HA may be the result of the tectonic truncation of the upper part of this section.

Taking into account the presented data, the upper boundary of the Tithonian was accepted at the top of the strata with heteromorph ammonites. In some sections a part of these strata may already belong to the Berriasian, and there the boundary of the Tithonian is accepted al the top of the strata with *Proniceras*, *Kossmatia*, *Durangites*, and *Corongoceras*.

The division, based on the evolutionary changes of ammonites, in which the Berriasian is included to the Jurassic and constitutes the uppermost part of the Tithonian (Wiedmann, 1975, 1980), can not be applied for the Cuban sequences, because ammonites are scarce in the Berriasian and Valanginian, and some of them (the heteromorph ones) are endemic.

Equally difficult for precise determination is the lower boundary of the Tithonian strata in western Cuba. It is probably situated in the highest part of the massive limestones of the San Vicente Member (Pszczółkowski *et al.*, 1975; Pszczółkowski, 1978). No ammonites were found in this member. The lowermost bedded limestones overlying the massive limestones (locally in fault contact) yielded *Protancyloceras* and *Mazapilites* (Houša & Nuez, 1972, 1975; Houša, 1974). The age of these strata corresponds probably to the upper part of the Lower Tithonian. These strata belong to the El Americano Member and there are no ammonites which would indicate the lowermost part of the Lower Tithonian (*Hybonoticeras hybonotum* Zone in the European division – Olóriz & Tavera, 1981)[2].

---

[2] Although the occurrence of *Mazapilites* in association with *Hybonoticeras* was reported (Burckhardt, 1919–1921; Imlay, 1939, 1980) from Mexico (Symon and Durango), the genus *Mazapilites* in Cuba seems to represent a zone younger than the Mexican *Hybonoticeras* Zone, as it is concurrent in Cuba not with *Hybonoticeras*, but with *Protancyloceras*, whence *Pseudolissoceras* is present too.

It can not be exluded, however, that the San Vicente Member belongs only to the Kimmeridgian and does not pass to the Tithonian, and it is separated by a hiatus from the El Americano Member. Unfortunately, because of the lack of fossils precisely dating the upper part of the San Vicente Member, this hiatus can not be proven.

The lower part of the El Americano Member, with *Mazapilites* and *Protancyloceras*, can be correlated with the lowermost part of the so called "Virgatosphinctinae Beds" sensu Verma & Westermann (1973). The strata with *Mazapilites* and *Protancyloceras* in Cuba may be compared to the *Mazapilites* Zone in the division proposed by Imlay & Jones (1970) in which the *Mazapilites* Zone is situated above the *Hybonoticeras* Zone and below the *Pseudolissoceras* Zone.

AMMONITE ZONES OF THE TITHONIAN IN WESTERN CUBA

The oldest zone which can be distinguished in the Tithonian of western Cuba is the *Mazapilites* Range-Zone (Fig. 15). It contains the genera *Mazapilites*, *Protancyloceras*, *Nebrodites*, *Lithacoceras*? and rare *Pseudolis-*

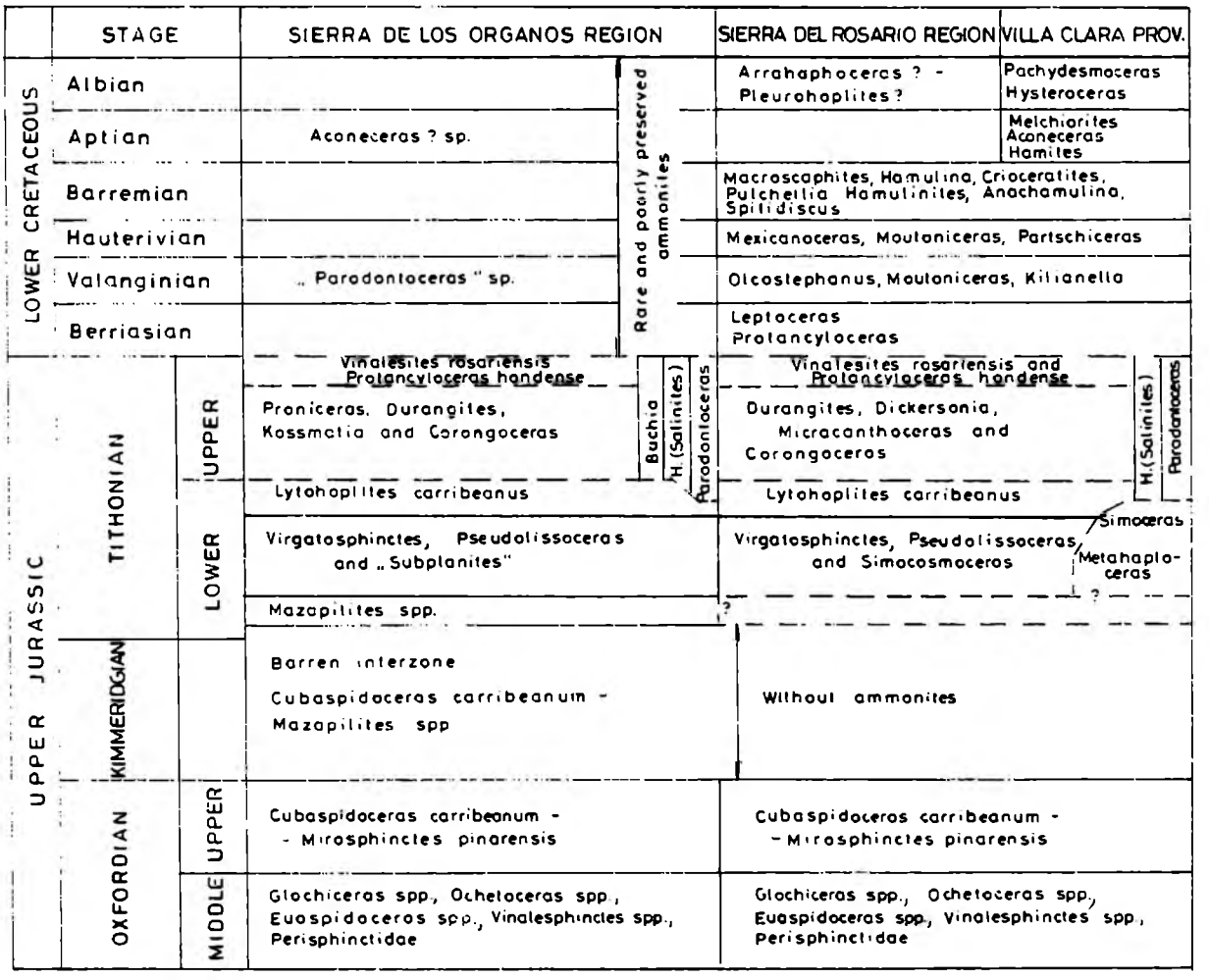


Fig. 15. Ammonite zones of Upper Jurassic and Lower Cretaceous in western Cuba with stratigraphical ranges of some genera

soceras, though the most important is *Mazapilites* Burckhardt, 1919, very numerous, and endemic for Mexico and Cuba. The zone is less than 1 m to 2 m thick, and its lower boundary is at the top of the massive limestones of the San Vicente Member. The upper boundary is marked by the *Virgatosphinctes*, *Pseudolissoceras*, and "*Subplanites*" Zone, and by the disappearance of *Mazapilites*. This zone is distinguished only in the Sierra de los Organos as *Mazapilites* does not occur in the Sierra del Rosario, and it was distinguished in sections B-HA and C-HA.

The *Virgatosphinctes*, *Pseudolissoceras*, and "*Subplanites*" Assemblage-Zone is distinguished in the Sierra de los Organos. Its equivalent in the Sierra del Rosario is the *Virgatosphinctes*, *Pseudolissoceras*, and *Simocosmoceras* Assemblage-Zone. The lower boundary of the Virgatosphinctes, *Pseudolissoceras*, and "*Subplanites*" Zone is placed at the disappearance of *Mazapilites* and appearance of *Virgatosphinctes*. *Pseudolissoceras* tend to occur in the lower part of this zone and they are absent in its higher part. "*Subplanites*" seem to occur only above *Pseudolissoceras*, but this is not well established. It is possible that in future this zone would be subdivided in two.

The assemblage of this zone includes also *Phylloceras*, *Lytoceras*, *Neochetoceras*, *Pseudoinvoluticeras* (group of *P. mozambicum* Collignon), *Pachysphinctes*, and in the lower part — *Protancyloceras* (Fig. 13). The upper boundary of this zone is indicated by the appearance of *Lytohoplites carribeanus* and the disappearance of *Virgatosphinctes*, *Pseudolissoceras*, and "*Subplanites*". The zone is about 2.5 m thick (10 m at maximum). The zone has been defined on the basis of the fauna collected in sections A-HA, B-HA, and C-HA.

A somewhat different assemblage is present in the equivalent zone in the Sierra del Rosario. It lacks "*Subplanites*", and includes *Simocosmoceras*, concurrent with *Pseudolissoceras* in the lower part of the zone. The thickness of the zone in the Sierra del Rosario could not be determined. The lower boundary is placed at the appearance of *Virgatosphinctes* and *Pseudolissoceras*.

The *Lytohoplites carribeanus* Range-Zone is defined by the presence of the index species *L. carribeanus* Imlay. The lower boundary is at the disappearance of the ammonites of the *Virgatosphinctes*, *Pseudolissoceras*, and "*Subplanites*" (and *Simocosmoceras* in the Sierra del Rosario) Zone. *Glochiceras*, *Hildoglochiceras* (*Salinites*), *Haploceras* and *Parodontoceras* appear in the upper part of this zone. The zone is usually about 80 cm thick, but it may attain up to 5 m. It was ascertained in both, the Sierra de los Organos and the Sierra del Rosario. This zone is included here to the upper part of the Lower Tithonian.

The next zone distinguished in the Sierra de los Organos is the *Corongoceras*, *Kossmatia*, *Durangites*, *Proniceras* Assemblage-Zone. It corresponds probably to the *Corongoceras*, *Micracanthoceras*, *Dickersonia*, *Durangites* Zone in the Sierra del Rosario. The zone was established as an assemblage-zone because no single, most distinctive taxon could be indicated. The limestones of this zone are usually thick-bedded ammonite coquinas. It is possible that the zone includes almost the whole Upper Tithonian. The thickness of the zone

varies from 1.5 to 13 m, exceptionally to 20 m (in some section it is thinned tectonically). Besides the mentioned genera, the zone includes *Haploceras*, *Hildoglochiceras*, *Hemisimoceras*, and *Himalayites*, as well numerous pelecypods *Buchia* (Fig. 14).

The strata with the heteromorph ammonites *Protancyloceras* and *Vinalesites* are separated as the youngest ammonite zone in the Sierra de los Organos. In section B-HA this zone is 1.5 thick and it is an acme-zone. In the Sierra del Rosario this zone is about 2 m thick and it is also an acme-zone.

CONDITIONS OF SEDIMENTATION OF THE TITHONIAN STRATA IN THE SIERRA DE LOS ORGANOS AND SIERRA DEL ROSARIO

The Sierra de los Organos and Sierra del Rosario, the two now adjacent units of the Cordillera de Guaniguanico, display marked differences in the facies and fauna of the Tithonian sediments. The Lower Tithonian strata of the Sierra de los Organos were laid down in a shallow, poorly ventillated sea (dark sediments, elevated bitumen content, and locally preserved lamination). Small amounts of terrigenous material were episodically supplied to the basin (e.g. the sandy material in the El Americano Member in section ST). The dominant group of fauna were ammonites, less common were gastropods, pelecypods, and brachiopods. The most distinctive microfacies of these sediments is one with *Saccocoma* (Houša, 1974; Pszczółkowski, 1978, 1981; also Pl. XV: 4, 6 in this paper). At the end of the Early Tithonian, the conditions of sedimentation in the Sierra de los Organos changed slightly, mainly due to a moderate deepening of the basin. This resulted in deposition of somewhat lighter-colored sediments, with *Chitinoidella* and *Crassicollaria* (Kreisel & Furrazola-Bermúdez, 1971; Pszczółkowski, 1981), as well as in accumulations of detrital material and traces of rolling fish vertebrae (section ST) which may indicate local current activity.

The Lower Tithonian sediments of the Sierra del Rosario were laid in somewhat deeper and calmer water, but also in a poorly ventillated basin (dark bituminous sediments). Turbidity currents and submarine slumps contributed to the sedimentation (Pszczółkowski, 1981).

The characteristic ammonite assemblage of the Lower Tithonian in the Sierra de los Organos consists of *Mazapilites*, *Protancyloceras* (type of *P. gracile*), *Neochetoceras*, *Nebrodites*, *Pseudoinvoluticeras*, and "*Subplanites*" (type of *S. cubensis* Chudoley et Furrazola). The characteristic assemblage of the Sierra del Rosario comprises *Simoceras*, *Metahaploceras* Imlay, 1942), and *Simocosmoceras*. The common genera for both areas are *Phylloceras*, *Pseudolissoceras*, *Virgatosphinctes*, and *Lytohoplites*.

In the Late Tithonian, the sedimentary conditions in the Sierra de los Organos changed only slightly. The basin was apparently shallower and the

energy of the environment increased. Ammonite coquinas and nodular limestones were formed. The pelletal-ooidal microfacies (Pl. XV: 1) is characteristic of these strata, and it indicates a shallow environment with a high dynamic gradient of sediment (K. Krajewski, personal information). The Upper Tithonian strata of the Sierra del Rosario were laid down in conditions of lower energy, but even there coquinas composed of ammonite shells or aptychi were locally accumulated.

The uppermost Tithonian sediments display features of deep-water sedimentation. Characteristic of them is the radiolarian-tintinnid microfacies (similar to the one illustrated by Borza, 1984).

The Upper Tithonian ammonite assemblage of both areas is comprised mainly of *Corongoceras*, *Micracanthoceras*, *Durangites*, *Parodontoceras*, *Kossmatia*, *Hildoglochiceras* (*Salinites*), *Protancyloceras* (type of *P. hondense*), and *Vinalesites*. *Dickersonia* is characteristic of the Sierra del Rosario, and *Proniceras*, *Hemisimoceras*, and *Phanerostephanus* are characteristic of the Upper Tithonian in the Sierra de los Organos.

The presented differences in the sedimentary features and fauna of both areas apparently reflect different positions of the respective sedimentary realms in the area of sedimentation. Their present juxtaposition is the result of later overthrusting. According to Pszczółkowski (1982), during the Early Cretaceous the Sierra del Rosario successions occupied a more northerly position with respect to the Sierra de los Organos, where the environment was one of deeper waters. The sedimentary features and fauna of the Tithonian strata in both sequences corroborate the extension of the same relations to the Tithonian times. The observed differences may be readily accounted for by the differences in the basin depth, without the need for both realms being situated far from one another. The sedimentary realms of the Sierra de los Organos and Sierra del Rosario were most likely situated in neighbouring areas of one basin.

PALEOBIOGEOGRAPHICAL RELATIONS OF THE TITHONIAN AMMONITES OF WESTERN CUBA WITH AMMONITES OF NEIGHBOURING ZOOGEOGRAPHICAL PROVINCES

Two Late Jurassic zoogeographical kingdoms are recognized by most authors dealing with the Jurassic paleobiogeography – the Boreal Kingdom in the northern areas of the Earth, and the Tethyan Kingdom embracing the other sedimentary basins of that time. The geographical differentiation of the Late Jurassic marine faunal communities was discussed by Uhlig (1911), Imlay (1961, 1980), Enay (1972, 1973, 1980), Cariou (1973), Gordon (1974, 1976), Pożaryska & Brochwicz (1975), Westermann & Ricardi (1976, 1984), Geyer (1979), Hallam (1981, 1983), Enay & Magnold (1982), Westermann (1981, 1984), Chong *et al.* (1984), Meléndez *et al.* (1985), Cariou *et al.* (1985). These

authors recognized also the necessity of distinguishing zoogeographic provinces and subprovinces within the Tethyan Kingdom, though they differ on the extents and nomenclature of the individual provinces.

The Mediterranean, Indopacific (Indian-West Pacific) (= Himalayan Province of Uhlig, 1911), and Andean provinces are commonly accepted for the Tithonian times (Enay, 1980). Caribbean Province has been recently proposed for the part of the Late Jurassic[3] (Westermann 1984; Figs. 16, 17). The existence of this province was postulated for the Middle Jurassic and a part of the Late Jurassic time only.

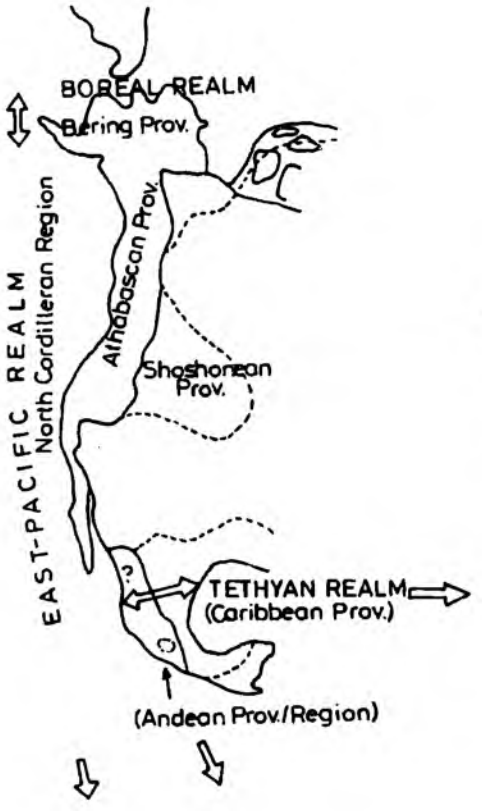


Fig. 16. Position of Jurassic Caribbean zoogeographic province after Westermann (1984)

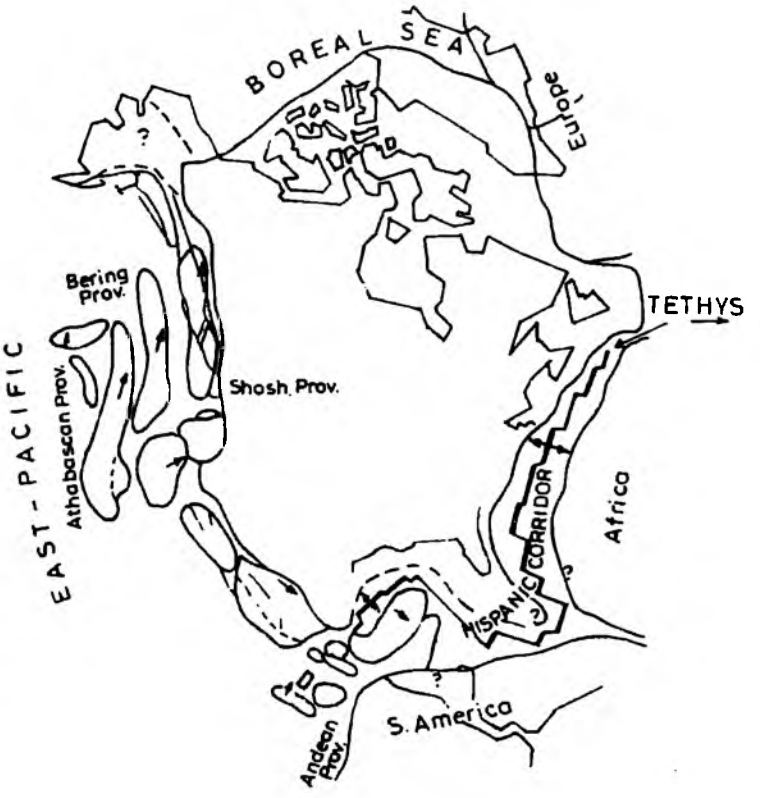


Fig. 17. Position of rift zone and "hispanic corridor" after Westermann (1984)

The present author used the published data on the Oxfordian of Cuba (Haczewski, 1976; Kutek et al., 1976; Myczyński, 1976a, 1976b; Myczyński & Pszczółkowski, 1973, 1976; Wierzbowski, 1976; Figs. 18, 19) as well as his own and published data on the Tithonian and Lower Cretaceous (Myczyński, 1977) ammonites of the Caribbean region and came to the conclusions that the Caribbean province existed through the whole Late Jurassic and early Cretaceous time. It included three sedimentary basins: Cuban, Mexican, and that of the southern United States.

---

[3] Scott (1986) suggests the existence of this province in the Aptian and Albian, on the basis of the distribution of pelecypods *Protocardia*.

Characteristic genera from Oxfordian of Cuba	L U	Mexico	Chile	Southern US	Western Tethys
Glochiceras	Jv; p; F	+	+	-	+
Ochetoceras	Jz,v; p; F	+	+	+	+
Cubaochetoceras	J; F; A	+	+	- ?	+ ?
Euaspidoceras	J; F	+	+	+	+
Cubaspidoceras	J; F; A	-	+	-	+ ?
Vinalesphinctes (Vinalesphinctes)	J; F	-	+	-	+ ?
Vinalesphinctes (Subvinalesphinctes)	J; F	-	+ ?	-	-
Vinalesphinctes (Roigites)	J; F	-	-	-	-
P. (Cubasphinctes)	J; F	- ?	-	- ?	-
„Discosphinctes"	J; F	+	+ ?	+	-
P. (Antilloceras)	J; F	+	-	-	-
Mirosphinctes	J; F; A	+ ?	+	-	+

Fig. 18. Characteristic genera of Cuba's Oxfordian and their presence in neighbouring provinces. *LU* – lithostratigraphic units; *J* – Jagua Formation; *Jz* – Zacarias Member of Jagua Formation; *v* – Jagua Vicja Member of Jagua Formation; *p* – Pimienta Member of Jagua Formation; *A* – Artemisa Formation; *F* – Francisco Formation

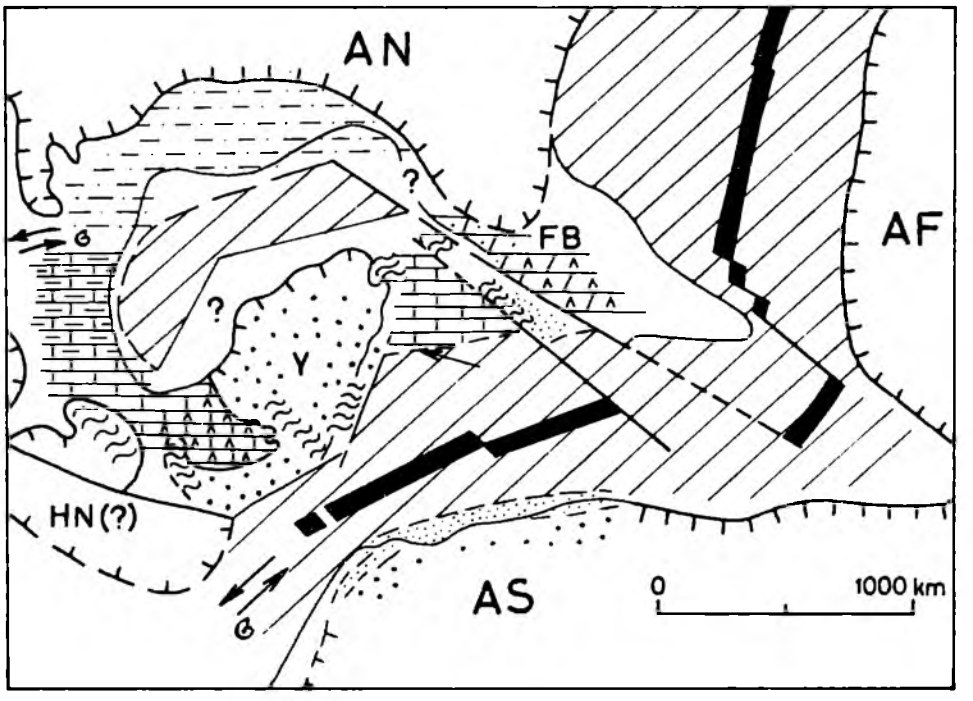


Fig. 19. Paleogeographical and paleotectonic position of western Cuba in Oxfordian (after Pszczółkowski, 1987) and hypothetical routes of ammonite migration. *AN* – North America; *AS* – South America; *AF* – Africa; *FB* – Florida-Bahama Platform; *Y* – Yucatan Platform; *HN* – Honduras-Nicaragua block; *SC* – area of deposition of San Cayetano Formation; *1* – continental clastic sediments; *2* – continental-marine clastic sediments; *3* – clayey sediments; *4* – clastic sediments and calcareous shales; *5* – evaporites; *6* – limestones and evaporites; *7* – dolomites and evaporites; *8* – dolomites; *9* – limestones; *10* – limestones and shales; *11* – marine sediments of continental shelf and slope of Africa and South America; *12* – oceanic zone; *13* – zones of metamorphism; *14* – rift zone; *15* – subduction zone; *16* – boundaries of continents; *17* – routes of ammonite migration to the Cuban Basin

The Early Tithonian deepening of the Cuban basin is marked by the presence of bedded limestones with ammonites. The presence of *Mazapilites* in these strata is a clear indication that the Cuban and Mexican basins were intercommunicated in that time. The communication did not extend, however, to Andean Province, as the occurrence of *Mazapilites* is limited to the Caribbean area (Burckhardt, 1906, 1919–1921; Imlay, 1939; Cantú Chapa, 1968, 1976).

The higher part of the Lower Tithonian contains ammonites of worldwide distribution (*Phylloceras*, *Lytoceras*, *Glochiceras*, *Haploceras*, and *Pseudolissoceras*) as well as the Mediterranean ones (*Neochetoceras*, *Simoceras*, and *Simocosmoceras*). The large proportion of both groups in the Lower Tithonian assemblage of Cuba seems to indicate an ingression of the Tethyan fauna into the area of Caribbean Province. The likely route of this ingression was the "Proto-Atlantic" route (= *hispanic corridor* of Westermann, 1984; Bartok *et al.*, 1985; Fig. 17), the more so, because there is no evidence of intercommunication between the Caribbean and Andean provinces at that time (Fig. 20). The typical ammonites for the Early Tithonian basin of the western Cuba, and perhaps the whole Caribbean Province include *Subplanites cubensis* Chudoley et Furrazola, *Parodontoceras butti* Imlay, *P. antilleanum* Imlay, and *Lytohoplites carribeanus* Imlay.

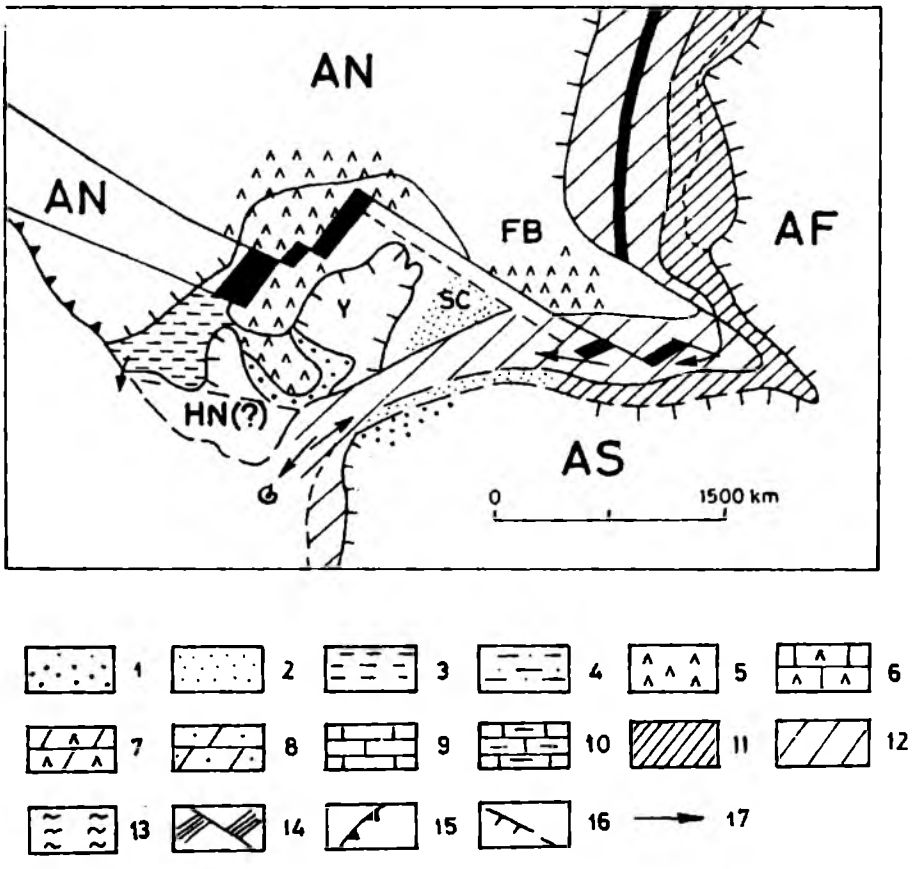


Fig. 20. Paleogeographical and paleotectonic position of western Cuba in Tithonian (after Pszczółkowski, 1987) and hypothetical routes of ammonite migration. Explanations as in Fig. 18

There was no marked change in the depth of the Cuban basin at the beginning of the Late Tithonian, but later it deepened again. An important change in the faunal assemblage has taken place at that time. Indo-Pacific and endemic ammonites became dominant, while those characteristic of the western Tethys were nearly absent. This seems to indicate the restriction of the role played by the "Proto-Atlantic" route of ammonite migration from the westernTethys to Caribbean Province. Apparently the migration from the Indo-Pacific area, around Antarctica and then along the shores of the East Pacific (through Andean Province), was more important at that time. The migration of the Tithonian fauna directly from the Pacific (Khudoley, 1974), seems less likely, but this possibility should be also taken into consideration.

An important argument in favour of the existence of Caribbean Province in the Late Tithonian is the large similarity of the Upper Tithonian ammonites in Cuba, Mexico, and the southern United States. Many genera and even species are common for these areas. This regards *Hildoglochiceras*, *Dickersonia*, *Parodontoceras*, *Corongoceras*, *Kossmatia*, *Micracanthoceras*, *Vinalesites*, and *Protancyloceras* (type of *P. hondense*), as well as pelecypods *Buchia*. A part of these taxa are unknown outside Caribbean Province, e.g *Hildoglochiceras* (*Salinites*), *Parodontoceras butti*, *P. antilleanum*, *Vinalesites*.

The frequency of ammonites decreases in the uppermost Tithonian of the western Cuba. Heteromorph ammonites (*Protancyloceras*, *Vinalesites*) dominate. *Substeueroceras* has been not hitherto found, though its presence was reported in the Tithonian of central Cuba (Shapov in Kanchev et al. 1978; Shopov, 1978). *Substeueroceras* is a distinctive genus of the Upper Tithonian and Lower Berriasian of Mexico (Verma & Westermann, 1933; Imlay, 1980). Heteromorph ammonites were found in the uppermost Tithonian strata of the southern United States. This suggests the possibility of the faunal exchange between the basins of Cuba, Mexico, and the southern United States, still in the latest Tithonian, and consequently the continuing existence of Caribbean Province in that time.

ANALYSIS OF THE TITHONIAN FAUNA

The studied fauna comprises 143 specimens belonging to nine families, 26 genera and 42 species (Figs. 14, 21). One species is new (*Simocosmoceras pszczolkowskii* n. sp.), and five others are probably new. Most specimens are preserved as internal or external casts. Their preservation is in some cases insufficient for specific or generic identification. Some specimens, especially those found in the lower part of the Lower Tithonian, are strongly deformed. In general, the ammonites from thick- and medium-bedded Upper Tithonian limestones, which locally are ammonite coquinas, are better preserved, though many of them are broken.

The percentages of individual families in the studied assemblage are as

Ammonite Genus	Eastern and Northern Mexico	Southern USA and California	Tethyan	Cosmopolitic	Indo-Pacific	Endemic
Phylloceras	+		o	+		
Holcophylloceras			o	+		
Haploceras	+		o	+		
Glochiceras	+		o	+		
Pseudolissoceras	+			+		
Hildoglochiceras	+				+	
Neochetoceras			o	+		
Mazapilites	+					+
Lithacoceras			o	+		
Kossmatia	+	+		+		
Simocosmoceras			o			
Pachysphinctes				+		
Torquatisphinctes				+		
Aulacosphinctoides	+				+	
Pseudoinvoluticeras	+				+	
Virgatosphinctes	+			+		
Phanerostephanus			o		+	
Schairerio	+			+		
Nebrodites (Mesosimoceras)	+		o			
Virgatosimoceras				+		
Hemisimoceras					+	
Proniceras	+	+		+		
Himalayites				+		
Lytohoplites						Argentina Cuba Algeria
Parodontoceras	+	+			+	
Corongoceras	+		o	+		
Aulacosphinctes				+		
Micracanthoceras				+		
Durangites	+			+		
Protancyloceras	+			+		
Vinalesites						Cuba
Dickersonia (Imlay, 1942)						+

Fig. 21. Characteristic genera of Tithonian in Cuba

follows: 42% – Haploceratidae, 20% – Perisphinctidae, 5% – Simoceratidae. The remaining 33% are Phylloceratidae, Oppellidae, Aspidoceratidae, Olcostephanidae, Berriasellidae, and Ancyloceratidae.

Family Phylloceratidae is represented by *Phylloceras pinarense* Imlay (Imlay, 1942) and a species affined to *Holcophylloceras zignodianum* (d'Orbigny).

The most numerous representatives of Haploceratidae are *Hildoglochiceras*, *Haploceras*, and *Pseudolissoceras*; *Glochiceras* is less numerous. These genera

are known from the Tithonian of South America, as well as from the Tethyan and Indopacific realms (Leanza, 1980). *Pseudolissoceras* is widely distributed and it was reported from the Tithonian of South America (Burckhardt, 1903; Leanza, 1980), Mexico (Burckhardt, 1906; Cantú Chapa, 1967, 1971, 1973, 1977; Verma & Westermann, 1973; Imlay, 1980), France (Donze & Enay, 1961), Spain (Olóriz, 1978), West Germany (Barthel, 1962), Czechoslovakia (Vašiček, 1982), Poland (Zittel, 1870; Kutek & Wierzbowski, 1979), Iraq (Spath, 1950), and Tunisia (Arnould-Saget, 1951). In Cuba this genus was found in the Tithonian strata of the Sierra de los Organos (Judoley & Furrazola-Bermúdez, 1968; Houša & Nuez, 1972, 1975), Sierra del Rosario (Imlay, 1942; Judoley & Furrazola-Bermúdez, 1968), and Santa Clara (formerly Las Villas) Province (Imlay, 1942). It is represented here mainly by *Pseudolissoceras zitteli* Burckhardt (Verma & Westermann, 1973) which occurs in the higher part of the Lower Tithonian.

The specimens of *Hildoglochiceras* referred here to the subgenus *Salinites* and the specimens tentatively attributed to the genus *Haploceras* are the dominant group in the Upper Tithonian assemblage of the Sierra de los Organos. *Hildoglochiceras* has worldwide distribution. It is known from the Lower Tithonian of Himalaya (Uhlig, 1903–1910), India (Spath, 1927–1933), Pakistan (Fatmi, 1972), Madagascar (Collignon, 1960), as well as from the Upper Tithonian of Mexico (Imlay, 1939; Cantú Chapa, 1968, 1969, 1976) and Cuba (Imlay, 1942, 1980). A new species of this genus has been recently described from Cerro Lotena (Argentina), from the *Pseudolissoceras zitteli* Zone (Leanza, 1980). However, ammonites of this genus seem to be scarce there (only one specimen was found).

Ammonites referred to the genus *Haploceras* comprise specimens found in two separate stratigraphical horizons. One is in the Lower Tithonian and it yielded forms affined to *Haploceras transatlanticum* Burckhardt, and the other is in the Upper Tithonian. *Haploceras* occurs in the Kimmeridgian and Tithonian strata (Arkell, 1956) of Europe (Zittel, 1870; Donze & Enay, 1961; Barthel, 1962), Africa (Arkell, 1956), India (Spath, 1927–1933), Madagascar (Collignon, 1960), Mexico (Burckhardt, 1906; Imlay, 1939; Cantú Chapa, 1976), and Cuba (Arkell, 1956; Judoley & Furrazola-Bermúdez, 1968.).

The genus *Glochiceras* Hyatt, 1900 is represented by one incomplete specimen. This genus is common in the Upper Jurassic of Europe (Družecic, 1958), Morocco (Renz *et al.* 1975), Mexico (Burckhardt, 1906; Imlay, 1939), Argentina (Leanza, 1980), Iraq (Spath, 1950), India (Spath, 1927–1933), USSR, Arabia, Somalia, Tanganika, Japan, and Cuba (Arkell, 1956).

Several specimens have been attributed to the genus *Neochetoceras* Spath, 1925, belonging to the subfamily Streblitinae Spath, 1925 and family *Oppeliidae* Bonarelli, 1894. These specimens have been referred to *N. sterapsis* (Oppel) and *N. mucronatum* Berckhemer-Hölder. *Neochetoceras* is known from the Upper Jurassic of Europe (Berckhemer & Hölder, 1959; Zeiss, 1968; Kutek & Zeiss, 1974; Olóriz, 1978; Vígh, 1984) as well as from Somalia (Arkell, 1956).

The family Mazapilitinae Spath, 1928 is represented by *Mazapilites* Burckhardt, 1919, known from the Lower Tithonian of Mexico (Burckhardt, 1906, 1919; Imlay, 1939; Cantú Chapa, 1963, 1971; Verma & Westermann, 1973; Imlay, 1980). It occurs in the eastern and northern part of Mexico above the strata with *Hybonoticeras* (Imlay, 1939, 1943), and below the strata with *Virgatosphinctes*. It is possible, however, that its vertical range is longer, as it was reported also from the eastern region of Mexico in stratigraphical position higher than the strata with *Virgatosphinctes mexicanus* (Cantú Chapa, 1963, 1971; Imlay, 1980). *Mazapilites* was reported from Cuba by Houša & Nuez (1972, 1975).

The most important representatives of the family Perisphinctidae Steinmann, 1890 in the Tithonian of western Cuba seem to be *Kossmatia*, *Simocosmoceras*, *Aulacosphinctoides*, *Pseudoinvoluticeras*, *Virgatosphinctes* (including ammonites tentatively attributed to this genus). *Kossmatia* Uhlig, 1907 is widely distributed in Europe, northern Africa—Syria, the Caucasus, the Himalayas, Indonesia, New Guinea, New Zealand, Australia, South America, Mexico, California and Texas (Arkell, 1956; Enay, 1973; Verma & Westermann, 1973). In all these areas, except of New Zealand, *Kossmatia* occurs in the Upper Tithonian (Verma & Westermann, 1973). In New Zealand it appears already in the Kimmeridgian. This exceptional occurrence is in conflict with the general correspondence of the Kimmeridgian faunas of Mexico and New Zealand (Verma & Westermann, 1973). The Cuban specimens of *Kossmatia* are affined to the Mexican species.

The genus *Simocosmoceras* Spath is reported from Cuba for the first time in this paper. Its representatives have been hitherto known only from the Lower Tithonian of central and southern Europe (the Carpathians, Romania, Italy, and Spain), and from Andean Province.

The genus *Aulacosphinctoides* is represented in western Cuba by forms affined to *Aulacosphinctoides infundibulum* Uhlig which was described from the Tithonian of the Himalayas (the Spiti Shales), as well as by other poorly preserved forms which could not be determined specifically. *Aulacosphinctoides* is widely distributed; it has been reported also from New Zealand, India, Somalia, Japan, Madagascar, Argentina and Mexico (Arkell, 1956; Collignon, 1960; Verma & Westermann, 1973; Leanza, 1980). It is characteristic of the Tithonian of Indo-Pacific Province.

The genus *Virgatosphinctes* Uhlig, 1910 is represented in Cuba by *V. cristobalensis* Imlay. Forms close to *V. pinarensis* Chudoley et Furrazola (= *V.* aff. *V. rutundidoma* Uhlig sensu Imlay, 1942) and *V. denseplicatus* Waagen have been only tentatively attributed to *Virgatosphinctes* until their systematic position would be precised on a more complete material. *Virgatosphinctes* is known from both, Europe and Indo-Pacific Province (northern Africa-Somalia, Ethiopia, Tanganica, Madagascar, India, the Himalayas, Pakistan, Australia, Argentina, Chile, Trinidad, Mexico, and Cuba; see Arkell, 1956; Imlay, 1942; Fatmi, 1972; Verma & Westermann, 1973; Leanza, 1980, 1981).

The genus *Pseudoinvoluticeras* Spath, 1925 is rather scarcely represented in the western Cuba. Few poorly preserved specimens have been attributed to it.This genus was reported from Somalia, Madagascar, Anatolia, Argentina, and Mexico (Douvillé, 1910; Arkell, 1956; Leanza, 1980).

The family Aspidoceratidae is represented in western Cuba by *Aspidoceras* (Imlay, 1942), *Physodoceras* (Imlay, 1942; Houša & Nuez, 1972, 1975), and *Schaireria*. All these genera have worldwide distribution.

The subfamily *Simoceratinae* Spath, 1924 is represented by *Simoceras* and *Virgatosimoceras* (Imlay, 1942). Moreover, the lower part of the Tithonian strata in western Cuba has yielded *Nebrodites* (?*Mesosimoceras*) and *Hemisimoceras*. *Nebrodites* and *Virgatosimoceras* are cosmopolitan genera. *Hemisimoceras* is typical of the Upper Tithonian of Madagascar (Collignon, 1960).

The most important subfamily of the family *Olcostephanidae* Haug, 1910 in the Tithonian of western Cuba are *Spiticeratinae* Spath, 1924, represented by *Proniceras* Burckhardt, 1919. This genus is known from Europe, India, northern Africa, Madagascar, and South America (Arkell, 1956; Collignon, 1960; Enay, 1964).

The family *Berriasellidae* Spath is represented by *Lytohoplites*, *Parodontoceras*, *Corongoceras*, *Aulacosphinctes*, *Himalayites*, and *Durangites*. *Lytohoplites* was reported also from Algeria, Madagascar, and Argentina (Arkell, 1956; Collignon, 1960; Enay, 1973).

The two species of *Parodontoceras* Spath, 1925 described from Cuba – *P. butti* Imlay and *P. antilleanum* Imlay (Imlay, 1942) – comprise forms of very distinctive ornamentation. Though their attribution to *Parodontoceras* has been questioned recently (Houša & Nuez, 1975; Verma & Westermann, 1973; Imlay, 1980) referres both species to this genus. *Parodontoceras* was described from Argentina, Peru, Mexico, Cuba, California, Kurdistan, and Somalia (Arkell, 1956; Verma & Westermann, 1973; Enay, 1973).

The genus *Corongoceras* Spath, 1925 is numerous in the Tithonian of western Cuba (Imlay, 1942). It is known also from Europe, South America and Madagascar (Collignon, 1960; Enay, 1964, 1972, 1973, 1980; Verma & Westermann, 1973; Biro-Bagoczky, 1978; Cecca, 1985).

Several poorly preserved specimens have been attributed to the genus *Aulacosphinctes* Uhlig, 1910. The presence of this genus in Cuba was already reported by Judoley & Furrazola-Bermúdez (1968), but the forms which they attributed to this genus are affined to *Aulacosphinctes symonensis* Burckhardt, a species which in Imlay's (1942) opinion may belong to the genus *Aulacosphinctoides* Spath, 1923 (Enay, 1973). *Aulacosphinctes* is known from the Caucasus, Algeria, Somalia, Madagascar, India, Pakistan, the Himalayas, Argentina, Chile, and California (Imlay, 1952; Arkell, 1956; Collignon, 1960; Leanza, 1980; Jeletzky, 1984).

The genus *Himalayites* Uhlig in Boehm, 1904, common in the Tithonian and Berriasian of India and Europe (Arkell, 1956; Le Hégarat, 1971), as well as *Micracanthoceras* Spath, 1925 are scarcely represented in Cuba. The Cuban

representatives of *Micracanthoceras* are affined to the species of this genus described from Mexico.

Also ammonites of the genus *Durangites* Burckhardt, 1912 are similar to the Mexican forms (Burckhardt, 1912; Cantú Chapa, 1977). This genus is also known from the Tethyan Europe (Enay, 1973; Tavera, 1985).

The family Ancyloceratidae Meek, 1876 is represented only by the genus *Protancyloceras* Spath, 1924. Its forms which appear in the Lower Tithonian of western Cuba have simple shells of *P. gracile* (Oppel) type; those which appear in the Upper Tithonian, near the Tithonian–Berriassian boundary, are of *P. hondense* (Imlay) type. Also the specimens found in the Veloz Formation (Tithonian–Barremian) in the Sierra de Camajan (Camagüey Province) have been attributed to *Protancyloceras*. These specimens have spirally coiled initial whorls and hook-like termination of the straightened part of shell. *Protancyloceras* is known from southern Europe, Crimea, northern Africa, Kurdistan, Mexico, Peru, and Cuba (Arkell, 1956).

Other Tithonian fauna of western Cuba includes pelecypods *Buchia* Rouillier, 1845. They are characteristic of the Upper Jurassic and Lower Cretaceous of Boreal Province and of the southern USA and Mexico (Imlay, 1952, 1961, 1980; Jeletzky, 1965, 1966; Zakharov, 1981).

CONCLUSIONS

1. Bipartite division of the Tithonian is accepted in this paper. The boundary between the Lower and Upper Tithonian is accepted at the appearance of the subfamily Himalayitinae and the mass occurrence of the subgenus *Hildoglochiceras* (*Salinites*), coupled with the disappearance of the genera *Virgatosphinctes*, "*Subplanites*" and the species *Lytohoplites carribeanus*. The upper boundary of the Tithonian is accepted at the disappearance of the heteromorph ammonites (*Protancyloceras*, *Vinalesites*).

2. Five ammonite zones have been distinguished in the Tithonian in the Sierra de los Organos (three in the Lower, and two in the Upper Tithonian), and four in the Sierra del Rosario (two in the Lower, and two in the Upper Tithonian).

3. The Lower Tithonian ammonite assemblage includes more forms of Western Tethyan affinities together with endemic forms. The Upper Tithonian assemblage is dominated by the Indo-Pacific forms, as well as endemic ones, unknown outside Cuba, Mexico, and the southern United States.

4. The sedimentary realms of the Upper Jurassic sequences of Cuba, Mexico, and the southern United States constituted a separate zoogeographical entity, termed here "Caribbean Province" after Westermann (1984).

5. The ammonite migration to the areas of western Cuba and the whole Cribbean Province during the Tithonian has taken place probably by the

"Proto-Atlantic" route (*hispanic corridor* of Westermann, 1984), and along the Pacific shores of South America. Also the western direction (through the Pacific), though less likely, should be taken into account.

SYSTEMATIC DESCRIPTIONS

All specimens described in this paper are stored at the Instituto de Geología y Paleontologia del MINBAS in Havana. Most specimens are internal molds. The systematic descriptions follow the order proposed by Arkell *et al.* (1957). Abbreviations employed in the systematic descriptions are the following:

D – maximum diameter at a given growth stage (in millimeters),
H – height of whorl (in millimeters),
E – maximum width of whorl (in millimeters).
O – diameter of umbilicus (in millimeters).
H/D – ratio of the height at a given growth stage to diameter,
E/D – ratio of the width at a given growth stage to diameter,
O/D – ratio of the umbilical diameter to diameter of the specimen.

Symbols used in descriptions of heteromorph ammonites are explained at respective descriptions. Specimen numbers begin with letter symbols of respective sections, followed by successive numbers of specimens found in each section. Letter symbols used for the sections are the following: T – Tumbadero; SC – Mal Paso; SCb – Sierra Cabezas; ST – Santo Tomás; VA – Valle del Ancón; A-HA, B-HA, C-HA (CI, CII) respective sections at Hacienda El Americano; MR-25 – upper part of section A-HA; LC – La Catalina; LF – Loma Ferretero; MR-24 – Niceto Perez; MR-28 – Cinco Pesos; CG – Veloz Formation in Camagüey Province.

Order AMMONOIDEA
Suborder PHYLLOCERATINA Arkell, 1950
Superfamily PHYLLOCERATACEAE Zittel, 1884
Family PHYLLOCERATIDAE Zittel, 1884
Subfamily PHYLLOCERATINAE Zittel, 1884
Genus *Holcophylloceras* Spath, 1927

Type species: *Phylloceras mediterraneum* Neumayr [= *Am. zignodianum* (d'Orbigny)]

***Holcophylloceras* cf. *zignodianum* (d'Orbigny, 1848)**
Pl. I: 1

1871 *Phylloceras Zignoanum* d'Orbigny sp.; Neumayr, p. 339, pl. XVII, 1
1971 *Holcophylloceras mediterraneum* (Neumayr); Sturani: p. 83; pl. 2: 7, 9, 10; pl. 16: 4.
1980 *Holcophylloceras zignodianum* (d'Orbigny); Galacz, p. 41; pl. V: 4, 5; pl. VI: 1; Pl. VII: 1; text-figs. 30–32.

Material. One fragment of whorl MR-CI/16 (H = 55).

Description. Incomplete specimen with high whorls, slightly flattened on sides. Ventral margin rounded, with rather strong, slightly prorsiradiate ribs. A deep constriction, characteristically bent, is visible on whorl side, especially near the ventral margin. It is accompanied by a small, lip-like forward extension.

Remarks. Despite the incomplete preservation, the morphological features of this specimen may be closely compared to those of *Holcophylloceras zignodianum* (d'Orbigny) illustrated in the papers listed in synonymy. The present specimen differs only by the constriction being slightly less distinct than at the typical specimens.

This species was subject of much controversy. Many authors considered it as a species distinct from *H. mediterranum* (Neumayr) (see e.g. Malinowska, 1963; Myczyński, 1973). Loczy (1915) was the first to suggest that *H. mediterranum* (Neumayr) is a younger synonym of *H. zignodianum* (d'Orbigny). Recently Galacz (1980) reviewed this problem and agreed with Loczy's suggestion. Both species are common in the Middle Jurassic geosynclinal sequences (Sturani, 1971). *H. zignodianum* is also frequently reported from younger, Upper Jurassic deposits (Książkiewicz, 1956; Collignon, 1960; Malinowska, 1963; Matyja, 1977; Galacz, 1980; Birkenmajer & Myczyński, 1984).

Occurrence. The basal part of section C-HA, together with *Protancyloceras* and *Pseudolissoceras*.

Superfamily HAPLOCERATACEA Zittel, 1884
Family HAPLOCERATIDAE Zittel, 1884, *sensu* Zigler, 1947
Subfamily HAPLOCERATINAE Zittel, 1884, *sensu* Zigler, 1947
Genus *Haploceras* Zittel, 1880
Type species: *Ammonites elimatus* Oppel, 1865

Haploceras aff. *transatlanticum* Burckhardt, 1906

Pl. I: 3; Pl. XII: 3b

1906 *Haploceras transatlanticum* Burckhardt, p. 83; pl. XXI: 1–8, 13–15.
1973 *Haploceras transatlanticum* Burckhardt?, Verma & Westermann, p. 165; pl. 26: 1, 2.

Material. One specimen (P-CII-1) and one whorl fragment (MR-B/6c).

Specimen	D	H	O	H/D	O/D
P-CII-1	30	15	5.5	0.50	0.18
MR-B/6c	–	–	–	–	–

Description. Coiling involute. Whorls fairly wide and slightly conex. Whorl sides slightly flattened. Shell is widest at the slightly diagonal umbilical margin. Umbilicus relatively wide and deep. Ornamentation on shell surface not preserved.

Remarks. The specimens closely resemble those of *H. transatlanticum* Burckhardt, described from the Lower Tithonian of Mexico and illustrated in the papers quoted in synonymy. They differ only by their smaller umbilical diameters and slightly greater flattening of whorl sides. The distinctive ornamentation characteristic of *Haploceras* from Mexico, visible on Burckhardt's specimens (Burckhardt, 1906, pl. XXI: 1–8, 13–15), is not preserved in the studied specimens, apparently due to the advanced corrosion of the shell surfaces.

Occurrence. Section C-HA (P-CII-1), and B-HA (MR-B/6c). *H. transatlanticum* Burckhardt was described from the Lower Tithonian of Mazapil area in Mexico (Burckhardt, 1906) and reported from the upper part of the Lower Tithonian of the Sierra Catorce (Verma & Westermann, 1963).

(?) *Haploceras* aff. *veracruzanum* Cantú Chapa, 1976

Pl. II: 6, 8,; Pl. III: 4, 10, 11, 13, 17; Pl. IV: 3, 4; Pl. XI: 8; Pl. XIV: 6, 7, 10

1976 *Haploceras veracruzanum* sp. nov. Cantú Chapa, p. 67; pl. 1: 2f, 3, 6 (?holotype); pl. 2: 7, 14.

The ammonites described below have been included to the genus *Haploceras* Zittel, 1880 only tentatively, because they have many morphological features in common with ammonites described in this paper as *Hildoglochiceras* (*Salinites*) from which they differ in the lack of keel and of distinct lateral groove. They differ from the European representatives of *Haploceras* in their slightly higher degree of involution and slightly stronger sculpture. Moreover, some ammonites of the group *Hildoglochiceras* (*Salinites*) have ornamentation similar to that of *Haploceras veracruzanum* Cantú Chapa while their lateral groove is weakly marked and keel is absent. These similarities may be due to a direct affinity of both ammonite groups, the more so because both groups occur in strata of the same age.

Material. Specimens of various preservation: AM-25/1, AM-25/2, AM-25/3, AM-25/4, AM-25/5, AM-25/6, AM-25/7, A-27c, VA-1, VA-2, VA-3, VA-4.

Specimen	D	H	E	O	H/D	E/D	O/D
AM-25/1	23.5	10.2	6.5	5.5	0.43	0.28	0.23
AM-25/2	20.5	9.2	–	5.4	0.44	–	0.26
AM-25/3	8.8	3.8	–	2.0	0.43	–	0.22
AM-25/4	–	8.3	–	5.0	–	–	–
AM-25/6	41.0	17.5	–	10.5	0.42	–	0.26
AM-25/7	15.0	7.0	–	3.5	0.46	–	0.23
A-27c	21.0	9.0	6.2	5.2	0.42	0.29	0.25
VA-1	50.0	22.0	16.0	11.0	0.44	0.32	0.22
VA-2	23.3	–	–	4.9	–	–	0.21
VA-3	25.2	11.1	–	6.6	0.44	–	0.26
VA-4	65.8	30.8	–	13.2	0.46	–	0.20
Holotype *H. veracruzanum* Cantú Chapa in Cantú Chapa, 1976, p. 67; pl. 1: 6					0.47	–	0.23

Description. Coiling involute. Whorl sides slightly flattened. Venter rounded, slightly acute in the middle. Umbilical margin slightly lowered. Umbilical wall vertical. Ornamentation on sides and venter consists of fine falcoid ribs which begin at the umbilical wall as curved forward, then sharply turn backwards in the middle of whorl. The ribs thicken on the ventral margin and turn again forward. They are passing venter uninterrupted. The ribs are few until the three quarters of the last whorl, then become more numerous and sharper near the ventral margin. Sides of whorls become progressively more flattened adorally. Also the middle part of the venter becomes sharper in the same direction, but keel does not appear. Peristome is preserved in fragments only.

Remarks. *Haploceras veracruzanum* Cantú Chapa, 1976 was described from a borehole in Mexico. According to Cantú Chapa (1976), this species is akin to *H. costatum* Burckhardt, 1906 described from Mazapil in Zacatecas (Burckhardt, 1906, p. 97, pl. 25: 3–10), from which it differs only in its stronger bending of the fine ribs.

The specimens described here are related more closely to *H. veracruzanum* Cantú Chapa than to *H. costatum* Burckhardt. They differ from the former only by their slightly lower whorls and more distinct ribs. It should be noted that three forms of shell growth may be distinguished in the assemblage of the Cuban ammonites described here as *?Haploceras* aff. *veracruzanum* Cantú Chapa: large (e.g. Pl. XIV: 10), medium-sized (Pl. XIV: 7), and small forms (Pl. III: 10, 11). According to Verma & Westermann (1973) the problem of the Mexican haploceratids is a complex one and it requires a detailed revision accounting for the dimorphic relations.

Occurrence. Section C-HA, the El Americano Member (AM-25/1, AM-25/2, AM-25/3); section

A-HA, same member (AM-25/4, AM-25/6, AM25/7); A-27c comes from this section also but from a loose block found somewhat lower; section VA, upper part of the El Americano Member (VA-1, VA-2, VA-3, VA-4). The Mexican species *Haploceras veracruzanum* Cantú Chapa and *H. costatum* Burckhardt were described from the Upper Tithonian of the Mazapil area (Burckhardt, 1906; Verma & Westermann, 1973).

?Haploceras n. sp.
Pl. II: 7, 9

Material. Two poorly preserved specimens (VA-5, VA-6).

Specimen	D	H	O	H/D	O/D
VA-5	44.2	22.0	5.1	0.49	0.11
VA-6	49	24.0	5.0	0.49	0.10

Description. Coiling involute, shell medium-sized. Whorl sides slightly flattened. Venter rounded, slightly sharpened in the middle part. Umbilicus medium-sized, not deep. Ornamentation consists of numerous fine, forward curved ribs beginning at the umbilical margin. Just below the whorl mid-hight the fine ribs shift backwards and then again towards the aperture. A faint, shallow groove is visible in the place of the shift. The ribs are thicker and sharper near the ventral margin.

Remarks. The ammonites described here are akin to *Haploceras costatum* Burckhardt, 1906 (Burckhardt, 1906, p. 97, pl. XXV: 3–10) from the Lower Tithonian of Mexico. They differ, however, from *H. costatum* by their higher whorls, less marked ornamentation, and the presence of a faint groove. Similarly, they differ from *H. ordonezi* Aguilera (see Burckhardt, 1906, p. 94), akin to *H. costatum* Burckhardt, by their less distinct ornamentation and the presence of the groove. The difference between the described specimens and *H. veracruzanum* Cantú Chapa (Cantú Chapa, 1976, p. 67, pl. 1: 2f, 3, 6; pl. 2: 7, 14) consists in their more dense sculpture, higher whorls and smaller umbilical diameter. They probably represent a new species, but their small number and rather poor preservation do not permit a formal distinction of the new species.

Occurrence. Section VA, the El Americano Member (Upper Tithonian), together with *Hildoglochiceras* (*Salinites*) spp. and *Kossmatia* aff. *purisima* Verma & Westermann. *H. costatum* Burckhardt, *H. ordonezi* Aguilera, and *H. veracruzanum* Cantú Chapa occur in the Tithonian of Mexico.

Genus *Glochiceras* Hyatt, 1900

Glochiceras (?) sp.
(Pl. I: 7)

Material. One specimen AM-25/8.

Description and remarks. Whorl section ovate. Whorl sides flattened. Umbilical margin slightly lowered. Umbilical wall nearly vertical, umbilicus wide and deep. Faint groove, situated below the middle of the side, and slightly undulated ribs are visible on whorl side. The ribs, bending at the groove, form a distinct loop-like trace. Some ribs pass the venter.

The present specimen is close to those described by Burckhardt (1906, p. 80, pl. XX: 7, 8–11, 13) as *Haploceras* aff. *fialar* (Oppel), especially to the specimen in Imlay's pl. XX: 11. Imlay's revision (1939) resulted in attributing these specimens to the genus *Glochiceras*. The incompletely preserved specimen described here can not be positively identified with any of the forms described by Burckhardt.

Occurrence. Section A-HA, middle part of the El Americano Member (upper part of the Lower Tithonian). The Mexican ammonites to which this specimen is affined come from the Kimmeridgian strata of the Mazapil area (Zacatecas).

Genus *Pseudolissoceras* Spath, 1925
Type species: *Neumaria zitteli* Burckhardt, 1903

***Pseudolissoceras zitteli* (Burckhardt, 1903)**
Pl. 1: 2; Pl. V: 8; Pl. IX: 10b; Pl. X: 4b

1903 *Nemayria zitteli* Burckhardt, p. 55; pl. X: 1–8.
1942 *Pseudolissoceras* cf. P. *zitteli* (Burckhardt), Imlay, p. 1443; pl. 4: 1–4, 7, 8, 11, 12.
1950 *Pseudolissoceras zitteli* (Burckhardt), Spath, p. 101; pl. 6: 8a–c.
1967 *Pseudolissoceras zitteli* (Burckhardt). Cantú Chapa, p. 4; pl. 1: 5; pl. 7: 9.
1973 *Pseudolissoceras zitteli* (Burckhardt), Verma & Westermann, p. 168; pl. 26: 3–5; text-figs 12, 13.
1978 *Pseudolissoceras zitteli* (Burckhardt), Olóriz, p. 34; pl. 2: 12; text-fig. 43.
1980 *Pseudolissoceras zitteli* (Burckhardt), Leanza, p. 17; pl. 1: 1a–b, 2a–b; text-figs. 2a, 3.
Material. Five specimens: MR-CI-4, MR-CII-8, B/4A, LF-5, LF-6.

Specimen	D	H	O	H/D	O/D
MR-CI-4	26.2	12.0	4.0	0.46	0.15
MR-CII-8	23.0	11.3	4.0	0.49	0.17
B/4A	22.0	11.0	–	0.48	–
LF-5	35.	16	5.5	0.50	0.16
LF-6	45.	23	6.0	0.51	0.14

Description. Small involute shell. Whorls higher than wide. Whorl sides slightly flattened, without ornamentation. Ventral margin rounded. Umbilicus medium-sized, not dep.
Remarks. The specimens conform Burckhardt's definition of the species and closely correspond to the descriptions and illustrations in the papers quoted in synonymy, especially to the specimens with more flattened sides (Burckhardt, 1903, pl. 10: 1–2; Imlay, 1942, pl. 4: 4). The studied specimens are molds and ornamentation on their sides is not preserved, as well as the suture can not be traced in detail.
Occurrence. Section B-HA (B/4A), section C-HA (MR-CI-4, MR-CII-8), about 7 m above the breccia separating the San Vicente and El Americano members, and slightly above the *Mazapilites* Zone; section LF (LF-5, LF-6).

Genus *Hildoglochiceras* Spath, 1924

Ammonites of the genus *Hildoglochiceras* Spath occurring in the Tithonian assemblage of Mexico were first described by Imlay (1939). He described four new species: *Hildoglochiceras grossicostatum*, *H. ecarinatum*, *H. inflatum*, *H. alamense*. The first two species were described from the strata with *Durangites*, and the other two from the strata with *Substeuroceras* (Imlay, 1939). Later the same author found forms affined to *H. grossicostatum* and *H. alamense* in the Tithonian of Cuba (Imlay, 1942).

Cantú Chapa (1968) questioned the attribution of these ammonites to *Hildoglochiceras* Spath. In his opinion they should be excluded from this genus because their features do not conform the definition of this genus and they differ essentially from the type species *Hecticoceras latistrigatum* Uhlig. According to Cantú Chapa (1968) the Mexican ammonites are almost involute, have a medio-lateral depression, and ribs or striae bending wavily, sometimes passing through the wide, keeled venter, and their whorls have rectangular cross-section. The Mexican forms differ also from typical *Hildog-*

lochiceras (see definition in Arkell, 1957). Cantú Chapa (1968) proposed distinguishing them as a new genus *Salinites*. According to him the Mexican ammonites have suture close to that of the family *Haploceratidae* and are at the same time morphologically similar to the genus *Aconeceras* (Lower Hauterivian).

Despite this objections Imlay (1980) maintains in the genus *Hildoglochiceras* Spath all the species earlier described by him an referred to this genus. Besides some differences, the ammonites from Mexico and Cuba have also features similar to some Indian species, as Imlay (1939, 1942) has pointed out. The closest Indian from is *Hildoglochiceras colei* Spath (Spath, 1927–1933; Imlay, 1942). Also *H. tennicostulatum* Collignon (Collignon, 1960) seems to be affined to the Mexican and Cuban forms. It is thus justified to maintain the Mexican and Cuban species within the broadly understood genus *Hildoglochiceras* Spath, but separating them in the subgenus *Salinites* Cantú Chapa, 1968, because of their morphological differences with respect to the typical forms of *Hildoglochiceras* from India.

Hildoglochiceras (*Salinites*) seems to have long stratigraphic range in the Sierra de los Organos. Its first representatives appear slightly above the strata with *Parodontoceras butti* Imlay and *P. antilleanum* Imlay; the latter occurs slightly below the strata with *Protancyloceras hondense* (Imlay).

Genus *Hildoglochiceras* Spath, 1924
Type species: *Hecticoceras latistrigatum*, Uhlig, 1903
Subgenus *Salinites* Cantú Chapa, 1968

***Hildoglochiceras (Salinites) grossicostatum* Imlay**

Pl. I: 4; Pl. II: 10–13; Pl. III: 1–3, 5, 8, 9, 12; Pl. IV: 1, 2, 10b, 11a, b

1939 *Hildoglochiceras grossicostatum* Imlay, n. sp., Imlay p. 27; pl. 2: 5–11, pl. 3: 1–7, 9–11.
1942 *Hildoglochiceras* cf. *H. grossicostatum* Imlay, Imlay, p. 1444; pl. 2: 3–5.
1968 *Haploceras cubensis* Chudoley et Furrazola; Judoley & Furrazola-Bermúdez, p. 55; pl. 3: 1–3.
1968 *Salinites grossicostatum* (Imlay), Cantú Chapa, p. 19; pl. 4: 1, 4, 7, 9; pl. 5: 3, 8, 10.
1976 *Salinites grossicostatum* (Imlay), Cantú Chapa, p. 67; pl. 1: 1a–d, 1f, 1g, 2g, 7a, 8e, 8f; pl. 2: 4a.

Material. 20 specimens of various preservation.

Specimen	D	H	E	O	H/D	E/D	O/D
VA	–	2.2	–	–	–	–	–
MR-25	–	–	–	–	–	–	–
VA-7	43.0	18.0	–	15.0	0.42	–	0.30
MR-25/8	56.0	31.2	–	–	0.57	–	–
MR-25/9	–	36.2	12.0	–	–	–	–
MR-25/9a	–	–	–	–	–	–	–
MR-25/10	–	43.0	–	–	–	–	–
MR-25/11	64.0	36.0	–	11.2	0.56	–	0.18
MR-B/15	46.0	20.0	–	8.0	0.43	–	0.17
MR-25/12	–	22.0	–	7.2	–	–	–
MR-25/13	–	22.5	–	–	–	–	–

VA-8	29.0	11.0	–	10.0	0.38	–	0.34
VA-9	41.4	20.0	–	11.3	0.48	–	0.27
VA-10	30.0	11.0	–	10.0	0.36	–	0.33
MR-25/14	–	39.0	–	–	–	–	–
MR-25/15	–	32.0	–	–	–	–	–
MR-25/16	–	42.0	–	–	–	–	–
MR-25/17	–	28.0	–	9.5	–	–	–
MR-25/18	–	16.0	–	–	–	–	–
MR-25/19	–	15.5	–	16.0	–	–	–

Description. The Cuban specimens have discoidal shell with ovate whorl section. Whorl sides slightly convex, becoming more flattened in adults. Shell is widest near the mid-hight. Venter at young forms rounded, at adults rather narrow, with a distinct, low keel. Umbilicus at young forms broad and shallow, it becomes narrower and deeper adorally. Umbilical margin slightly lowered. A spiral groove, rather narrow and shallow appears just above the whorl mid-hight. Whorl sides covered with fine, falcoid ribs, beginning at the umbilicus. The ribs are initially faint and curved forward. They turn sharply backwards at the groove, then turn again towards the aperture above the groove. This type of ornamentation is characteristic of larger forms (D – above 50 mm). Small forms (D – about 30 mm) have the falcoid ribs and the lateral groove rather strong, especially well visible on the molds. Keel is small or lacking at the small forms, neither the suture could be traced. Aperture is not preserved at any specimen.

Remarks. The described specimens conform the description and illustrations of *H. (Salinites) grossicostatum* Imlay in the papers listed in synonymy. *H. cubensis* Chudoley et Furrazola (Judoley & Furrazola-Bermúdez, 1968) was included to *H. (Salinites) grossicostatum* Imlay by Cantú Chapa (1976, p. 67). The Judoley & Furrazola-Bermúdez's (1968) specimens are small ones, keelless, with indistinct groove and dense ornamentation. They probably are microconches (m) *sensu* Makowski (1963) and Callomon (1963, 1969).

According to Imlay (1939), *H. (Salinites) grossicostatum* Imlay differs from the Indian specimen *H. propinquum* (Waagen) by its thicker ribs, more distinct keel and smaller umbilicus, from *H. dineri* Uhlig it differs by being less involute and having finer ribs, and from *H. colei* Spath, 1931 it differs in details of shell morphology and ornamentation. The suture observed by Imlay (1939) on one of the small Mexican specimens is simpler than in the Indian forms (Imlay, 1939, p. 27–28). This simplification may be due to the smaller size of Imlay's specimen (12.3 mm). The described species differs from *H. tenuicostulatum* Collignon (Collignon, 1960, pl. 155: figs. 568, 569) by its stronger groove and thicker ribs.

Occurence. The El Americano Member in sections A-HA, B-HA, VA, and other sections in the Sierra de los Organos; section ST – upper part, slightly above the strata with Berriasian-Valanginian microfauna (cf. Torre, de la, 1971–1973); section A–HA – in the highest part of the section (about 3 m below the tectonic contact with the Tumbadero Member) together with *Durangites*, *Kossmatia*, and *Himalayites*; sections B-HA and C-HA – beneath the strata with *Protancyloceras hondense* Imlay and *P. catalinese* Imlay. The Mexican specimens come from the Upper Tithonian (Imlay, 1939; Cantú Chapa, 1968, 1976). According to Cantú Chapa (1976) they occurred together with *Proniceras victoris* Burckhardt and *Corongoceras* sp.

Hildoglochiceras (Salinites) gallardoi (Chudoley et Furrazola, 1968)

Pl. VIII: 8

1968 *Haploceras gallardoi* Chudoley et Furrazola; Judoley & Furrazola-Bermúdez, p. 56; pl. 3: 4, 6; pl. 4: 2, 4, 5.

1976 *Salinites gallardoi* (Chudoley et Furrazola), Cantú Chapa, p. 67, 68.

Material. Three incomplete specimens VA-10 (H = 12 mm), MR-25/20 (H = 11 mm), and MR-25/21 (H = 13 mm).

Description. The specimens conform well the taxonomic features of the species, i.e. their whorl ornamentation is typical of this species. All three specimens have slightly flattened whorl sides,

ovate whorl section and characteristic, strongly undulated, biplicate ribs. Lateral groove poorly marked. All these features conform the description of the holotype.

Remarks. The specimens are closest to the forms of similar size illustrated by Judoley & Furrazola-Bermúdez (1968, pl. 3: 4a–c, pl. 4: 2). The correspondence with larger specimens is much less.

Occurrence. Sections VA, A-HA and ST, together with *?Haploceras* aff. *veracruzanum* Cantú Chapa, *?Haploceras* n. sp., bed with *Hildoglochiceras (Salinites)*, *Kossmatia*, and *Durangites*.

Hildoglochiceras (Salinites) bicostatum (Chudoley et Furrazola, 1968)

Pl. III: 7

1968 *Haploceras bicostatum* Chudoley et Furrazola; Judoley & Furrazola-Bermúdez, p. 57; pl. 4: 8.
1976 *Salinites bicostatum* (Chudoley et Furrazola), Cantú Chapa, p. 67.

Material. One whorl fragment MR-25/22 (H = 22 mm).

Description. Whorl fragment with ornamentation characteristic of the species. The ornamentation consists of rather fine ribs, beginning at the umbilical margin, initially bent forward. Slightly above the whorl mid-hight they turn backwards rather sharply. A shallow and rather narrow groove is situated at the turn. Above the groove the ribs divide into two secondaries and make a falcoidal bend. The secondaries are sharper and stronger than the primaries. Pairs of secondaries are loosely spaced.

Remarks. Ornamentation conforms the description and the illustration of *H. (Salinites) bicostatum* (Chudoley et Furrazola; Judoley & Furrazola-Bermúdez, 1968, pl. 4: 8). The type of ornamentation is affined to the ornamentation of large specimens of *H. (Salinites) grossicostatum* Imlay (see Pl. III: 1, 2 in this paper), but in the *grossicostatum* group the ribs are divided into more than two secondaries. A more detailed study of the relation between *H. (Salinites) grossicostatum* Imlay and the species *H. (S.) bicostatum* proposed by Judoley & Furrazola-Bermúdez (1968) is difficult because ornamentation in the specimen indicated by the authors as the holotype is strongly obliterated.

Occurrence. A-HA section, the El Americano Member, together with *Hildoglochiceras (Salinites) grossicostatum* Imlay. *H. (S.) bicostatum* was described from section VA (Judoley & Furrazola-Bermúdez, 1968, p. 58).

Hildoglochiceras (Salinites) sp. aff. *alamense* Imlay, 1939

Pl. III: 6; Pl. IV: 8b

1939 *Hildoglochiceras alamense* n. sp., Imlay p. 30; pl. 4: 6–9, 11, 12.
1942 *Hildoglochiceras* cf. *H. alamense* Imlay, Imlay, p. 1445; pl. 2: 1, 2, 6, 7.
1968 *Salinites alamense* (Imlay), Cantú Chapa, p. 20.

Material. One incomplete specimen MR-25/23 (H = 20 mm, 0 = 4 mm) and one incomplete fragment of ventral side MR-25/24.

Description. Small shell with high-ovate whorl section and flattened sides. Umbilical margin slightly lowered. Umbilicus narrow. Low keel on ventral side. Ornamentation consists of loosely spaced, falcate ribs, slightly stronger near the ventral margin. Lateral groove poorly developed.

Remarks. Shell form and ornamentation in MR-25/23 is close to *Hildoglochiceras (Salinites) alamense* Imlay, described from the Tithonian of Mexico. Some doubts arouse only from the stronger ornamentation and greater umbilical diameter of this specimen with respect to Imlay's specimens. This specimen seems closest to that in Imlay's (1939) pl. 4: 9. MR-25/24 has slightly wider whorls and more distinct keel than the specimens of *H. (S.) alamense* Imlay.

Occurrence. Section A-HA, together with other ammonites of the genus *Hildoglochiceras*. *H. (S.) alamense* Imlay was described from the Tithonian of Mexico, from the strata with *Substeueroceras* (Imlay, 1939).

Hildoglochiceras (*Salinites*) sp. aff. *inflatum* Imlay, 1939
Pl. XIV: 5

1939 *Hildoglochiceras inflatum* n. sp., Imlay p. 29; pl. 4: 1–5.
1968 *Salinites inflatum* (Imlay), Cantú Chapa, p. 20.
Material. One imperfectly preserved specimen VA-11 (D = 56 mm, H = 26 mm, 0 = 14 mm, H/D = 0.46, O/D = 0.25).
Description. Slightly involute shell with well marked sides and ovate whorl section. Venter rounded. Whorl sides convex. Sides are widest slightly below the whorl mid-hight. Umbilical margin strongly lowered. Umbilicus large and moderately deep. Ornamentation consists of dense, wavy riblets. At the beginning of the last whorl they are lossely spaced, thread-like and wavy, resembling the ribs of the specimens described here as ?*Haploceras* aff. *veracruzanum* Cantú Chapa. Groove wide and deep, occurs at the whorl mid-hight.
Remarks. Morphology and shell form closely resemble the specimens of *H.* (*S.*) *inflatum* Imlay illustrated by Imlay (1939). The main difference consists in the slightly larger umbilicus and the presence of the wavy, loosely spaced thread-like riblets at the beginning of the last whorl. This feature is absent in Imlay's (1939) specimens.
Occurrence. Section VA, upper part of the El Americano Member.

Hildoglochiceras (*Salinites*) sp. aff. *ecarinatum* Imlay, 1939
Pl. XIV: 4

1939 *Hildoglochiceras ecarinatum* n. sp., Imlay p. 28; pl. 5: 1–4.
1968 *Glochiceras ecarinatum* (Imlay), Cantú Chapa, p. 20.
1980 ?*Hildoglochiceras ecarinatum* Imlay, Imlay p. 34.
Material. One incomplete, poorly preserved specimen, VA-12, H = 11.6 mm, 0 = 7.0 mm.
Description. Small incomplete specimen. Whorl section high-ovate. Venter rounded. Whorl sides slightly convex. Groove indistinct. Umbilicus rather wide and shallow. Ornamentation consists of weak wavy riblets beginning at the umbilicus. The riblets thicken and become falcate (convex backwards) near the ventral margin.
Remarks. Despite of its poor preservation the specimen resembles closely *H. ecarinatum* Imlay, described from Mexico (Imlay, 1939). Practically, only the slightly stronger ribs near the ventral margin differ it from Imlay's specimens.

Imlay (1939) included this species to *Hildoglochiceras* Spath, 1924. Cantú Chapa (1968) suggested that this species should be referred to *Glochiceras* Hyatt, 1900, because of its morphological features. Imlay (1980) retained this species with *Hildoglochiceras*, but with an exception.
Occurrence. Section VA, bed of coquinoid limestone, yielding also other species of *Hildoglochiceras*.

Hildoglochiceras (*Salinites*) n. sp.
Pl. III: 15

Material. One incomplete specimen VA-13 (D = 66.6 mm, H = 36.6 mm, O = 11.3 mm, H/D = 0.55, O/D = 0.17).
Description. Large involute discoidal shell. Venter acute. Whorl sides strongly flattened. Umbilical margin slightly lowered. Umbilical wall almost vertical. Umbilicus wide and moderately deep. A broad flattened zone with centrally situated indistinct lateral groove occurs at the whorl mid-hight. Ornamentation consists of sharp falcate riblets, dividing in two secondaries slightly above the umbilical margin. In the initial part of the last whorl the riblets are divided, thread-like and sharply bent backwards in the whorl mid-hight. In the terminal part of the last whorl the ribs are denser and initially curved forward. They sharply turn backwards on the indistinct lateral groove. In the place where the strong flattening of sides terminates, the ribs turn again forward.

They are stengthened near the ventral margin and attain the ventral margin at an acute angle. Aperture not preserved. Suture could not be traced.

Remarks. Shell form and ornamentation resemble those of the other representatives of the subgenus *Hildoglochiceras* (*Salinites*), though some features depart from those hitherto observed in this group. One of these features is the double bending of ribs on the whorl sides. The other characteristic feature of this specimen is the occurrence of the broad flattened zone on whorl side. This feature, so strongly marked here, is absent in the other representatives of the *H.* (*Salinites*) group. The thread-like form of the riblets on inner whorls resembles to some degree the ornamentation of the specimens described here as *?Haploceras* aff. *veracruzanum* Cantú Chapa from which the present specimen differs, however, by the presence of the lateral groove. Despite the clear differences with respect to the other ammonites of the subgenus *H.* (*Salinites*), it was not erected to the status of a new species, because it is represented by only one and incomplete specimen.

Occurrence. Section VA, El Americano Member, together with other ammonites of the subgenus *H.* (*Salinites*).

Hildoglochiceras (*Salinites*) sp.

Pl. III: 14

Material. One specimen SC-1 (D = 30 mm, H = 15.5 mm, 0 = 4.5 mm, H/D = 0.52, O/D = 0.15).

Description and remarks. Small involute shell, with high-ovate whorl section. Sides flattened, venter rounded. Umbilicus narrow and moderately deep. Indistinct lateral groove present on whorl side. Strong arcuate ribs, convex backwards, occur above the groove.

This specimen is somewhat similar to *H.* (*Salinites*) *grossicostatum* Imlay, but its whorl sides are more flattened and the lateral groove is less distinct.

Occurrence. Section SC (Fig. 11) – the lowermost part, division of dark-grey limestone with intercalations of red-weathering shale. The limestone includes numerous, small, deformed ammonites (see Pl. VI: 2, 3).

Family OPPELIIDAE Bonarelli, 1894
Subfamily: STREBLITINAE Spath, 1925
Genus *Neochetoceras* Spath, 1925
Type species: *Ammonites steraspis* Oppel, 1863

Neochetoceras sp. aff. *N. steraspis* (Oppel)

Pl. I: 6, 8–10; Fig. 22.

1959 *Neochetoceras steraspis* Oppel, Berckhemer-Hölder, p. 103; pl. 20: 107; pl. 27: 145, 146.
1968 *Neochetoceras steraspis* (Oppel), Zeiss, p. 120–124.
1978 *Neochetoceras* sp. gr. *N. steraspis* (Oppel), Olóriz, p. 60; pl. 5: 2; text-figs. 58, 77.

Material. Seven specimens of various preservation, MR-CI-2, MR-CII-7, MR-CII-8, MR-CI-16, MR-CI-17, MR-CI-18, MR-CI-19.

Specimen	D	H	E	O	H/D	E/D	O/D
MR-CI-2	77.2	45.7	–	6.5	0.59	–	0.08
MR-CII-7	40.0	24.0	7.5	3.5	0.60	0.19	0.09
MR-CII-8	46.0	27.0	–	4.5	0.58	–	0.10
MR-CI-16	78.5	41.2	18.5	–	0.52	0.23	–
MR-CI-17	38.5	19.7	8.0	3.6	0.51	0.21	0.09
MR-CI-18	–	20.0	12.0	3.5	–	–	–
MR-CI-19	38.2	22.0	9.0	5.0	0.58	0.23	0.13

Description. Discoidal shell with narrow whorl section and involution varying from 0.08 to 0.13. Whorl sides slightly convex. Whorl thickness is greatest at their mid-hight. Venter very narrow, rounded. Umbilical margin slightly lowered. Ornamentation is preserved on inner whorls and it consists of weak, wavy riblets, well visible near the ventral margin (Pl. I: 8, 9). Some riblets bifurcate at the whorl mid-hight into two weak secondaries (MR-CI-2). Lateral groove absent on all specimens. Suture strongly developed, similar to that of *N. steraspis* (Oppel) (see Fig. 22).

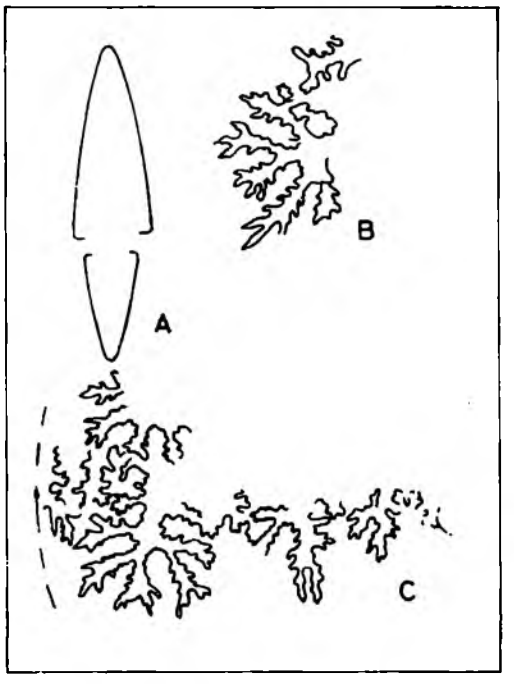


Fig. 22. Suture in *Neochetoceras* sp. cf. *N. steraspis* (Oppel)

Remarks. The described specimens are affined to specimens of the *N. steraspis* (Oppel) group. MR-CII-7 and MR-CII-8 are close to the form described by Olóriz (1978) as *Neochetoceras* sp. gr. *N. steraspis* (Oppel). MR-CI-2 (Pl. I: 6) resembles *N. praecursor* (Zeiss, 1968, p. 121, pl. 26: 6, text-fig. 5) in the nature of ribs, but differs from it in having a narrow keelless venter. Though the other specimens are poorly preserved, difficult for precise identification, their features do not depart from those of *N. steraspis* (Oppel) group, and they are referred to this group. The other species of *Neochetoceras* Spath, 1925 – *N. nodulosum* Berckhemer-Hölder, *N. praecursor* Zeiss, *N. mucronatum* Berckhemer-Hölder, *N. usselense* Zeiss, *N. griesbachiforme* (Donze & Enay), and *N. pseudodarwini* Olóriz – have morphological features different from the described specimens.

The present specimens show also some affinity to *Parastreblites* Donze and Enay, 1961, especially to the groups *Parastreblites circumnodosum* and *P. waageni* (Donze & Enay, 1961; Olóriz, 1978; Leanza, 1980). Nevertheless, the lack of marginal nodes even on inner whorls, indistinct ornamentation of these whorls, and exceptionally sharpened venter (especially in larger forms), all indicate that these specimens belong to *Neochetoceras* and not *Parastreblites*.

Occurrence. Section C-HA. The group *Neochetoceras steraspis* (Oppel) is known from the Lower Tithonian of Europe and Somalia (Zeiss, 1968). The Spanish specimen (Olóriz, 1978, p. 60) was described from the Lower Tithonian (Hybonotum–Richteri Zone).

Neochetoceras sp. aff. *N. mucronatum* Berckhemer-Hölder, 1959
Pl. I: 5.

1959 *Neochetoceras steraspis* (Oppel) n. subsp.? (*forma mucronata*), Berckhemer-Hölder, p. 106; pl. 27: 145, 146.

1968 *Neochetoceras mucronatum* Berckhemer-Hölder, Zeiss, p. 123; pl. 26: 3, 4

1978 *Neochetoceras* sp. gr. *N. mucronatum* Berckhemer-Hölder, Olóriz, p. 61–62; text-fig. in p. 58.
Material. One specimen MR-CI-1, D = 44.5 mm, H = 27.0 mm, O = 3.5 mm, H/D = 0.60, O/D = 0.08.
Description. Small, strongly involute discoidal shell. Whorl sides smooth, slightly convex. Shell is widest slightly above the umbilical margin. Keel with marginal edges seems to be present on the narrow venter. Suture not preserved.
Remarks. The specimen is very similar to the group *Neochetoceras mucronatum* Berckhemer-Hölder (see synonymy). Some doubts rouse from the lack of the wavy riblets characteristic of this group. Also the presence of the keel on the venter is not certain, due to the poor preservation of this part of the specimen. The marginal edges on the ventral side, characteristic of this group, are well visible.
Occurrence. Section C-HA, about 0.7 m above the strata with *Mazapilites* and *Protancyloceras*. Ammonites of the *N. mucronatum* group are known from the Lower Tithonian of West Germany (Zeiss, 1968) and from the Tithonian of Spain (Olóriz, 1978).

Subfamily MAZAPILITINAE Spath, 1928
Genus *Mazapilites* Burckhardt, 1919
Type species: *Mazapilites symonensis* Burckhardt, 1919 (SD Roman, 1938)

Mazapilites zitteli (Burckhardt, 1906)
Pl. II: 1–3, 5

1906 *Eurynoticeras zitteli* Burckhardt, p. 108; pl. 29: 1–17; pl. 30: 1–3, 5–7, 9.
1919–21 *Mazapilites zitteli* Burckhardt, Burckhardt, p. 6; pl. 2: 11–13.
1939 *Mazapilites zitteli* Burckhardt, Imlay, p. 5.
Material. One nearly complete specimen MR-CI-2 (D = 61.5 mm, H = 32 mm, O = 5.5 mm, H/D = 0.52, O/D = 0.09) and five fragmentarily preserved specimens: MR-B/2, MR-B/3, MR-CII/1, MR-CII/5, MR-C/15.
Description. Involute, discoidal shell, with strongly elongated whorl section and rounded venter. Whorl sides flattened. Umbilicus narrow and deep. Ornamentation consists of rather strong, biplicate, rarely triplicate ribs, beginning at the umbilical margin and initially inclined forward. At the whorl mid-hight the ribs turn sharply backwards, then slightly below the ventral margin they divide into two, rarely three, secondaries. Suture could not be traced.
Remarks. The specimens (especially MR-CI-2) conform the description and illustrations in Burckhardt (1906). The fragmentary specimens rouse some doubts, but the nature of the ribs and their form suggest that they also belong to the same species.
Occurrence. Sections B-HA (MR-B-2 and MR-B-3) and C-HA (MR-CI and MR-CII), the lower part of the El Americano Member, about 1.5 – 2 m above the top of the massive limestone of the San Vicente Member. They occur together with *Protancyloceras*. The species *Mazapilites zitteli* (Burckhardt) was created on the basis of the material collected in the Lower Tithonian of Mazapil area in the north-central Mexico (Burckhardt, 1906; Imlay, 1980).

Mazapilites sp. A
Pl. II: 4; Pl. V: 7

Material. Two nearly complete specimens MR-B/4 and MR-CII-6, and one whorl fragment MR-CII-19.

Specimen	D	H	O	H/D	O/D
MR-B/4	54.0	28.5	6.0	0.53	0.11
MR-CII-6	55.0	34	6.0	0.61	0.10
MR-CII-19	–	22.5	–	–	–

Description. Involute discoidal shell. Whorl sides flattened. Venter rounded. Umbilicus rather wide and moderately deep. Ornamentation consists of riblets, best pronounced near the ventral margin. The ribs are poorly visible in the middle part of the whorl hight.

Remarks. Ornamentation is indistinct, apparently obliterated. Near the ventral margin the ribs resemble those of *Mazapilites zitteli* (Burckhardt). The specimens differ from the other species of *Mazapilites* by having finer ornamentation.
Occurrence. Sections B-HA (MR-B/4) and C-HA (MR-CII/6 and MR-CII/16), the lowermost part of the El Americano Member, together with *Mazapilites zitteli* Burckhardt.

Family PERISPHINCTIDAE Steinmann, 1890
Subfamily ATAXIOCERATINAE Buckman, 1921
Genus *Lithacoceras* Hyatt, 1900
***Lithacoceras* (?) sp.**
Pl. V: 1; Pl. X: 1

Material. One incomplete specimen SCb-1 (D = 200 mm, H = 62 mm, O = 77.5 mm, H/D = 0.31, O/D = 0.38) and one fragment of whorl of large diameter (MR-B/7).
Description and remarks. Discoidal shell with ovate whorl section and rounded venter. Whorl sides slightly convex. Umbilical margin lowered. Ornamentation on inner whorls (in SCb-1) consists of dense, thin, slightly prosoclinal ribs. They divide at the whorl mid-hight into two weaker secondaries. Ribs are weakening in the lower part of the whorl, and thickening at the periphery. The type of ornamentation and the shell form conform those of *Lithacoceras* (*sensu lato*) (Donze & Enay, 1961; Zeiss, 1968; Olóriz, 1978; Sapunov, 1979). The poor preservation does not permit their positive generic identification. They might belong to one of the genera akin to *Lithoceras* Hyatt *sensu stricto*, e.g. *Sublithacoceras* Spath, 1925.
Occurrence. The lower part of section SCb (SCb-1), and section B-HA, the *Mazapilites* Zone (MR-B/7). *Lithococeras* Hyatt is known from the Upper Kimmeridgian and Lower Tithonian of Europe, north Africa, Madagascar, India, Japan, ?Spitsbergen, and ?Argentina (cf. Sapunov, 1979).

Genus *Kossmatia* Uhlig, 1907
Type species *Ammonites tenuistriatus* Gray in Uhlig, 1907
***Kossmatia* cf. *bifurcata* (Aguilera, 1895)**
Pl. XIV: 8

1973 *Kossmatia bifurcata* (Aguilera); Verma & Westermann, p. 215; pl. 40: 2–4; pl. 41: 1–2; pl. 42: 1–2; text-figs. 16B, 17B, 19, 20.

Material. One incomplete specimen VA-14 (D = c. 90 mm, H = 30 mm, O = 36 mm).
Description. Flattened evolute specimen with relatively narrow and shallow umbilicus. Inner whorls ornamented with numerous fine ribs. On the outer whorl, the ribs are more distant, stronger and biplicate (about 13 primary ribs per quarter whorl). Intercalatory ribs are also present. Constrictions are fairly common on the inner whorls.
Remarks. The form and ornamentation closely resemble *Kossmatia bifurcata* (Aguilera), especially the specimen shown in Verma & Westermann (1973, pl. 41: 1). The specimen is referred to this species with reservation because of its incomplete preservation.
Occurrence. The upper part of section VA, the bed with *Hildoglochiceras* (*Salinites*), *Kossmatia*, and *Durangites*. The specimens of *Kossmatia bifurcata* (Aguilera), illustrated by Verma & Westermann (1973), were found in the Upper Tithonian of the Sierra Catorce (Mexico).

Kossmatia* sp. cf. *K. alamitosensis (Aguilera, 1895)
Pl. XIII: 3

Material. One incomplete specimen MR-25/30 (D = c. 30 mm, H = 10 mm, O = c. 12 mm, H/D = c. 0.3, O/D = c. 0.4).
Description and remarks. Evolute specimen. Whorl section flattened-ovate. Umbilicus wide but moderately deep. Ribs irregularly distributed, rather strong, slightly curved forward at the ventral margin. They bifurcate in 2/3 of the whorl hight. There is about 13 primary ribs per quarter

whorl. The ribs turn forward on the venter. The strong ribs, flattened-ovate whorl section, and moderately deep umbilicus, resemble *Kossmatia alamitosensis* (Aguilera) (see Verma & Westermann, 1973, p. 211, pl. 39: 4–7; pl. 40: 1 text-figs. 16A, 17A, 18). In the other species of *Kossmatia*, the ornamentation on inner whorls is less distinct. Positive identification of this specimen as *Kossmatia alamitosensis* (Aguilera) was not possible because of its fragmentary preservation and more flattened whorl section.

Occurrence. Section A-HA, upper part, the bed with *Hildoglochiceras* (*Salinites*), *Kossmatia*, and *Durangites*. *Kossmatia alamitosensis* (Aguilera) was described from the Upper Tithonian of Mexico (El Verde Member of La Caja Formation in the Sierra Catorce; Verma & Westermann, 1973).

Subfamily AULACOSTEPHANINAE Spath, 1924
Genus *Simocosmoceras* Spath, 1925
Type species: *Cosmoceras adversum* Oppel in Zittel, 1870
***Simocosmoceras pszczolkowskii* n. sp.**
Pl. VIII: 4; Pl. X: 4a, 5

Holotype. Specimen LF-1, figured in Pl. VIII: 4, housed in the Instituto de Geologia y Paleontología del MINBAS in Havana.

Type horizon. La Zarza Member of the Artemisa Formation.

Type locality. Loma Ferretero (1.5 km to the west of the village of Cinco Pésos, see description of section LF in this paper).

Derivation of the name. In honor of Docent A. Pszczółkowski, the student of the Cuban Jurassic and Cretaceous.

Paratype. Specimen LF-2.

Diagnosis. *Simocosmoceras* with moderately strong ribs, sharply bent backwards above the whorl mid-hight, and with high, pointed ventrolateral nodes on wide bases.

Material. One complete specimen (LF-1) and one whorl fragment (LF-2).

Specimen	D	H	E	O	H/D	E/D	O/D
LF-1	21	6.5	c. 7	8.0	0.31	c. 0.33	0.38
LF-2	–	8.0	–	–	–	–	–

Description. Small, slightly evolute shell. Whorl section pentagonal, slightly approaching high-ovate. Venter with groove. Whorl sides slightly convex. Whorls are widest slightly above their mid-hight. Umbilical margin slightly lowered, umbilical wall almost vertical. Umbilicus wide and shallow. Fine ribs on umbilical margin become stronger adorally. The ribs are turned forward at the beginning, then curve sharply backwards slightly above the whorl mid-hight. Nodes occur at the bend. They are especially distinct in the middle part of the outer whorl. Two secondaries, inclined backwards, branch from the nodes. High nodes in form of spines on wide bases occur where the secondaries reach the ventral margin. Ventral groove is moderately deep. The ventrolateral nodes are distributed in this manner that nodes on one side correspond to the gaps between the nodes on the other side.

Remarks. Four species of *Simocosmoceras* Spath, 1925 have been hitherto distinguished: *S. simum* (Oppel), *S. catulloi* (Zittel), *S. adversum* (Oppel)[3], and *S. pampalonii* Cresta et Pallini. The new species described here is closest to *S. adversum* (Oppel) (see Zittel, 1870, p. 99, pl. 7: 9a–c, 10a–b; Arkell, 1957, p. 327–328, fig. 419: 9a, b; Birkenmajer, 1963, p. 70; Cresta & Pallini, 1982, p. 169, pl. 2: 1a–c, 3) in both, the shape and ornamentation. It differs, however, from this species and from the subspecies *S. adversum andinum* in details of the shell relief. These differences consist

[3] A new subspecies *S. adversum andinum* Leanza and Olóriz has been recently described from the Tithonian of the Andes (Leanza & Olóriz, in press).

in its weaker ribs and in their sharp backward curve. Moreover, the ventrolateral nodes are more distinct in the new species than in *S. adversum* (Oppel), and the ventral groove is deeper. The new species differs from *S. catulloi* (Zittel) (Zittel, 1870, p. 98, pl. 7: 7a–b) in its smaller lateral nodes, less numerous ribs, and higher ventrolateral nodes. *Simocosmoceras simum* (Oppel) (see Zittel, 1870, p. 98, pl. 7: 8a–c) has the ribs and nodes more numerous but weaker. In *Simocosmoceras pampalonii* Cresta and Pallini (see Cresta & Pallini, 1982, p. 171, pl. 1: 7a–c, pl. 2: 2) the ribs and lateral nodes are stronger, while the backward curve of the ribs, and the ventral groove are weaker. The Cuban specimens are morphologically close to the specimen described from Italy as *Simocosmoceras* sp. (Cecca *et al.*, 1986).

Occurrence. Section LF. *Simocosmoceras* is known from the Lower Tithonian of Rogoźnik in the Polish Carpathians (Zittel, 1870, Birkenmajer, 1963; Kutek & Wierzbowski, 1986), of Spain (Olóriz, 1978), Italy (Cresta & Pallini, 1982), and the Andes (Leanza & Olóriz, 1987). This genus occurs in the *Haploceras verruciferum* Zone (*sensu* Olóriz, 1978) and perhaps higher (Kutek & Wierzbowski, 1979; Cresta & Pallini, 1982), as well as in the *Semiformiceras fallauxi* Zone (*sensu* Enay & Geyssant, 1975).

Subfamily VIRGATOSPHINCTINAE Spath, 1925

Genus *Pachysphinctes* Dietrich, 1925

***Pachysphinctes* (?) sp.**

Pl. VII: 5; Pl. XII: 6

Material. Two poorly preserved specimens MR-T/2a (D = c.90 mm) and MR-T/3 (H = 30 mm).

Description and remarks. The specimens are very poorly preserved, so that their identification is difficult. Some features – thick, strong ribs and the presence of polygyritic ribs (*sensu* Zeiss, 1968; Olóriz, 1978) – indicate that they may belong to *Pachysphinctes* Dietrich, 1925. According to Olóriz (1978), the polygyritic ribs are an important feature of this genus.

Occurrence. Section T. *Pachysphinctes* is known from the Kimmeridgian and Lower Tithonian of Europe, East Africa, Madagascar, and India (Sapunov, 1977, 1979).

Genus *Subplanites* Spath, 1925

Type species: *Virgatosphinctes reisi* Schneid, 1914

"*Subplanites*" sp.

Pl. V: 6

Material. One whorl fragment ST-4 (H = c. 13 mm).

Description and remarks. Fragmentarily preserved specimen. It shows biplicate and simple ribs, with a tendency to join in pairs near the umbilical margin. The ribs make a wavy backward curve in whorl mid-hight. These features resemble *Subplanites* Spath, 1925 (Donze & Enay, 1961, p. 97–100). The specimen resembles also the ammonites described as "*Subplanites*" *cubensis* Chudoley et Furrazola, 1968 (Judoley & Furrazola-Bermúdez, 1968, p. 109, pl. 64: 1, pl. 67: 1, pl. 68: 1). Unfortunately, the poor preservation precludes its positive identification with *Subplanites*.

Occurrence. The lowermost part of section ST.

Genus *Torquatisphinctes* Spath, 1924

Type species: *Ammonites torquatus* Sowerby, 1840

***Torquatisphinctes* sp. aff. *torquatus* Sowerby, 1840**

Pl. V: 4

Material. One incomplete specimen MR-T/2 (D = c. 50 mm, H = 15 mm, 0 = 27 mm).

Description and remarks. Small evolute shell. Whorl sides flattened. Umbilical margin rounded. Umbilical wall vertical. Umbilicus wide and shallow. Sharp prosoclinal ribs, biplicate and rarely simple, begin at the umbilical margin. Some primaries join near the umbilical margin.

Bifurcation point situated high, in about 3/4 of the whorl height. Ribs distant. Narrow constrictions are present.

Due to its poor preservation the specimen can not be precisely identified. Its morphological features are close to *Torquatisphinctes* Spath, 1924, especially to the group *T. torquatus* Sowerby (cf. Spath, 1927–1933, p. 475, pl. 76: 4a–b). It resembles the specimen described from the Madagascar as *Torquatisphinctes torquatus belamboensis* Collignon (Collignon, 1960, pl. 118: 448), from which it differs by its more spaced ribs and the smaller number of ribs.

Occurrence. Section T. *Torquatisphinctes* is known from the Kimmeridgian of Somalia, Kenya, Madagascar, India, USSR, Mexico, Argentina (Arkell, 1957), as well as from the Lower Tithonian of the southern West Germany (Zeiss, 1968) and Spain (cf. Olóriz. 1978). *Torquatisphinctes torquatus belamboensis* Collignon was described from the Middle Kimmeridgian of the Madagascar (Collignon, 1960).

Genus *Aulacosphinctoides* Spath, 1923

Type species: *Aulacosphinctoides influndibulus* Uhlig, 1910

Aulacosphinctoides sp. cf. *infundibulum* Uhlig, 1910

Pl. XII: 3a, 3b

1957 *Aulacosphinctoides infundibulus* (Uhlig), Arkell (in Treatise), p. 329; fig. 426.

Material. Two specimens MR-B/5 and MR-B/6.

Specimen	D	H	E	O	H/D	E/D	O/D
MR-B/5	–	19	–	c. 29	–	–	–
	about 12 primary ribs per quarter whorl						
MR-B/6	33.4	8.5	–	17.3	0.25	–	0.52
	about 16 primary ribs per half whorl						

Description. Evolute shell with ovate whorl section. Whorl sides slightly convex. Venter slightly rounded. Whorls overlap one third of the preceding whorl. Umbilical wall slightly inclined. Umbilicus wide and deep. Ornamentation consists of fairly dense prorsiradiate primaries which divide into two or three near the ventral margin. On the ventral side, the ribs are sigmoidally curved towards the aperture. They are passing the venter without interruption. A weak siphonal groove is marked on the inner whorls (specimen MR-B/6). Wide constrictions are present. Suture is not preserved.

Remarks. The studied specimens resemble *A. infundibulum* Uhlig in their ornamentation and shell from, though their sculpture is slightly less distinct. The same holds true for their comparison with the forms described as *A.* cf. *infundibulum* Uhlig from the Madagascar (Collignon, 1960, pl. 150: 600, 601). The Cuban specimens differ markedly in their morphology from the other species of *Aulacosphinctoides* Spath, 1923.

Occurrence. Section B-HA, strata with *Pseudolissoceras* (*P. zitteli* Burckhardt) and *Protancyloceras*. *A. infundibulum* Uhlig was described from the Lower Tithonian of the Himalayas (Arkell *et al.*, 1957) and from strata attributed to the Lower Tithonian (*Hildoglochiceras kobelli* Zone) in Madagascar (Collignon, 1960).

Aulacosphinctoides sp.

Pl. XIII: 1

Material. One whorl fragment MR-CI/13 (H = 32 mm).

Description and remarks. The presence of strong, sharp, widely separated biplicate ribs, as well as the lack of simple and polygyritic ribs suggest the attribution to *Aulacosphinctoides* Spath, 1923. It is affined to *A.* aff. *sparsicosta* (Uhlig) described from the Tithonian of Antarctic

(Thompson, 1979, p. 22, pl. V: f, g), especially to the specimen in his pl. V: f.
Occurrence. Section C-HA. *Aulacosphinctoides* is known from the Upper Kimmeridgian and Lower Tithonian of Somalia, India, Himalayas, Japan, New Zealand, Argentina, and Mexico (Arkell *et al.*, 1957), Nepal (Herwart, 1969), and Antarctic (Thompson, 1979).

Aulacosphinctoides (?) sp.
Pl. VIII: 5

Material. One incomplete specimen LF-9 (D = c. 15 mm).
Description and remarks. The specimen is a fragment of inner whorl. Whorl sides convex. Whorls with constrictions, ovate in section. Ornamentation consists of numerous biplicate, rarely simple, rursiradiate ribs. The ribs are branching in the whorl mid-hight. There occur intercalary ribs. Whorl section and the style of ornamentation resemble those of *Aulocosphinctoides* (cf. Arkell, 1956; Verma & Westermann, 1973; Olóriz, 1978), but the small diameter of the specimen does not permit its positive identification with this genus.
Occurrence. Section LF.

Genus *Pseudoinvoluticeras* Spath, 1925

Pseudoinvoluticeras sp. cf. *P. mozambicum* Collignon, 1960
Pl. VII: 1; Pl. VIII: 3; Pl. IX: 5

1960 *Pseudoinvoluticeras mozambicum* Collignon, Collignon, pl. CLIX: 631.
1973 *Pseudoinvoluticeras* cf. *P. mozambicum* Collignon, Verma & Westermann, p. 182; pl. 29: 1.
Material. Three poorly preserved specimens: MR-C/5; MR-CIa, MR-B-14.
Description and remarks. Discoidal shell with slightly rounded whorl sides. Ribs rather weak, slightly bent, begin at the umbilical margin, then rapidly (in one third of the whorl hight) divide into two or three secondaries. The discoidal shell and the early dividing two- and triplicate ribs justify the attribution to *Pseudoinvoluticeras*. The specimens resemble *P. mozambicum* Collignon (Collignon, 1960), especially the form illustrated by Verma & Westermann (1973) as *Pseudoinvoluticeras* cf. *P. mozambicum*. The poor and incomplete preservation of the specimen preclude its positive identification as *P. mozambicum*.
Occurrence. Sections B-HA and C-HA, above the strata with *Mazapilites* and *Protancyloceras*. *Pseudoinvoluticeras mozambicum* was described from the Lower Tithonian of Madagascar (Collignon, 1960). The specimen illustrated by Verma & Westermann (1973) as *Pseudoinvoluticeras* cf. *P. mozambicum* was described from the upper part of the Lower Tithonian of the Sierra Catorce (Mexico).

Pseudoinvoluticeras (?) sp.
Pl. IX: 6

Incompletely preserved specimen (MR-B/9), discoidal, with low, biplicate division of ribs. Its poor preservation permits its attribution to *Pseudoinvoluticeras* with reservation only. Found in section B-HA.

Genus *Virgatosphinctes* Uhlig, 1910
Type species: *Perisphinctes (Virgatosphinctes) broilii* Uhlig, 1910

Two morphological types of ammonites attributed to *Virgatosphinctes* have been hitherto described in the Cuban literature. One is *V. cristobalensis* Imlay, 1942 (Imlay, 1942), the other — *V. pinarensis* (Chudoley et Furrazola, 1968) = *V.* aff *V. rotundidoma* Uhlig (Imlay, 1942). The features of *V. cristobalensis* conform the diagnosis of *Virgatosphinctes* (Arkell *et al.*, 1957)

which is not exactly the case of *V. pinarensis*. The latter has a significant proportion of simple ribs and biplicate ribs with branching point situated low on the whorl side (Imlay, 1942; Judoley & Furrazola, 1968). Ribs joining near the umbilical margin are rare. Virgatotome ribs are absent. This type of ribs resembles the ornamentation of *V. denseplicatus* (Waagen).

Houša (1974), taking into account the morphological differences between *V. pinarensis* and the typical forms of *Virgatosphinctes*, suggested the attribution of this species to a new genus. This proposal can not be formally accepted, because it is presented in an unpublished report. For this reason, and because of the poor preservation of the material available, the ammonites of the *V. pinarensis* morphological type are tentatively included to *Virgatosphinctes* by using the generic name in parentheses. The generic attribution of these ammonites requires further research on better material.

Virgatosphinctes cf. *cristobalensis* Imlay
Pl. VI: 3, 4

1942 *Virgatosphinctes cristobalensis* n. sp., Imlay, p. 1447; pl. 4: 13.
1968 *Virgatosphinctes cristobalensis* Imlay, Judoley & Furrazola-Bermúdez, p. 110.
Material. Two incomplete specimens LF-7, LF-8.
Description. Inner whorls of adult specimens. Whorl section ovate. Whorl sides convex. Umbilicus wide and moderately deep. Ornamentation consists mostly of bi- and triplicate ribs, branching early. Constrictions are fairly numerous, and bordered by swells.
Remarks. The specimens resemble *V. cristobalensis* Imlay, especially the inner whorls of the specimens described in the papers quoted in synonymy. Because of their poor preservation they can not be positively identified.
Occurrence. Section LF.

"*Virgatosphinctes*" *pinarensis* Chudoley et Furrazola, 1968
Pl. VII: 2; Pl. VIII: 6; Pl. X: 6; Pl. XI: 1

1942 *Virgatosphinctes* aff. *V. rotundidoma* Uhlig, Imlay, p. 1118; pl. 2: 14.
1968 *Virgatosphinctes pinarensis* sp. nov. Chudoley et Furrazola, Judoley & Furrazola-Bermúdez, p. 111; pl. LXIV: 3, 4; pl. LXV: 1–4; pl. LXVII: 2; pl. LXIX: 1, 2.
Material. Three incomplete specimens (MR-B/10, MR-B/12, MR-CI/4b), and two whorl fragments (MR-B/13, MR-B/14).

Specimen	D	H	E	O	H/D	E/D	O/D
MR-B/10	c. 80	24	–	40	–	–	–
MR-B/12	c. 93	34	–	54	–	–	–
MR-CI/4b	c. 110	29	–	56	c. 26	–	c. 50
MR-B/13	–	32	–	–	–	–	–
MR-B/14	–	28	–	–	–	–	–

Description. Evolute shell with slightly overlapping whorls. Involution index is about 0.50. The last whorl overlaps one fourth of the preceding whorl. Whorl sides slightly convex. Venter rounded. Umbilical wall almost vertical. Umbilicus wide and shallow. Ornamentation consists of numerous slightly prosoclinal ribs, dividing in two secondary ribs in the whorl mid-hight. There are also simple ribs. There is about 17 ribs per quarter whorl. Weak constrictions are visible. Suture could not be traced.

Remarks. The described specimens conform the description of the species (Judoley & Furrazola-Bermúdez, 1968, p. 111). The specimens illustrated in their paper include forms with various spacing of the ribs. The specimens with denser ribs include, besides the holotype, the specimen illustrated in Judoley & Furrazola-Bermúdez's pl. 65: 4. The other specimens pictured in their paper have more loosely spaced and stronger ribs. Among the specimens described here, MR-CI/4b has stronger and more loosely spaced ribs than the holotype, and the other specimens have finer and denser ribs.

Occurrence. Section B-HA and C-HA. The specimens described by Judoley & Furrazola-Bermúdez (1968) come from the same locality. The specimen described by Imlay (1942) as *Virgatosphinctes* aff. *V. rotundidoma* was found in section LC.

"*Virgatosphinctes*" sp. aff. *V. denseplicatus* (Waagen, 1875)
Pl. VIII: 1; Pl. XII: 5

1931 *Virgatosphinctes denseplicatus* (Waagen), Spath, p. 532; pl. 77: 3a–3c; pl. 90: 1; pl. 96: 3a, 3b; pl. 102: 4.

1972 *Virgatosphinctes denseplicatus* (Waagen), Fatmi, p. 346; pl. 8: 5a, 5b.

1979 *Virgatosphinctes denseplicatus* (Waagen), Thompson, p. 15; pl. 3: h.

Material. Two incomplete specimens MR-B/11 (H = 30 mm, E = 16 mm, O = c. 37 mm) and MR-CI/5 (H = c. 30 mm).

Description and remarks. Evolute shell with high-ovate whorl section and slightly convex whorl sides. Venter rounded. Umbilical margin rounded. Umbilical wall almost vertical. Umbilicus wide and shallow. Ribs on inner whorls are strong and slightly bent towards the aperture. The ribs are distant. On the outer whorl the ribs begin at the umbilical margin, turn towards the aperture, and then turn slightly backwards near the ventral margin, which makes them slightly wavy. The ribs bifurcate in the whorl mid-hight. Simple ribs are very rare. Weak constrictions are present. Suture is not preserved.

The specimens are affined to *V. denseplicatus*, especially to the specimen described as *V.* aff. *denseplicatus* by Thompson (1979, p. 16, pl. 3: k), from the Lower Tithonian of the Alexander Island. The specimens differ from the one described as *V.* cf. *denseplicatus* by Imlay (1939, p. 535, pl. 89: 1–4) from Mexico by their stronger and less numerous ribs and by the whorl section. The ornamentation of the Cuban specimens resemble that of "*V.*" *pinarensis*, but their poor preservation and uncertain generic attribution (see remarks on the genus *Virgatosphinctes* in Cuba) precludes their unequivocal attribution to *V. denseplicatus*.

Occurrence. Section B-HA (MR-B/11), section C-HA (MR-CI/5). *Virgatosphinctes denseplicatus* was described from the Tithonian of India (Spath, 1927–1933). The specimen described as *V.* aff. ?. *denseplicatus* by Thompson (1979) was found in the Tithonian of the Alexander Island. The specimen of *Virgatosphinctes* cf. *V. denseplicatus* described by Imlay (1939) comes from the Upper Jurassic of Mexico.

"*Virgatosphinctes*" sp. *A*
Pl. XII: 1

Material. One whorl fragment MR-CI/6 (D = c. 70 mm, H = 18 mm, E = 12 mm).

Description. Involute shell with high-ovate whorl section. Venter narrow and rounded. Whorl sides flattened. Ornamentation consists of moderately dense, somewhat irregular ribs, slightly prosoclinal. Most ribs are biplicate, but simple ribs are also common. The ribs begin at the ventral margin, are curved forward and pass the venter uninterrupted. Some ribs bifurcate in the whorl mid-hight, and the other bifurcate somewhat higher. The ribs turn towards the aperture on the ventral margin, then pass the venter. This bending makes them somewhat wavy. Weak constrictions are present.

Remarks. The described specimen resembles "*Virgatosphinctes*" *pinarensis* in the style of ornamentation. It differes, however by its whorl cross-section and more evolute coiling. The

specimen belongs probably to a new species which can not be formally established because of its poor and incomplete preservation.
Occurrence. Section C-HA.

"*Virgatosphinctes*" sp. *B*
Pl. VIII: 7

Material. One incomplete specimen MR-CI/7 (D = c. 86 mm, H = 25.5 mm, E = 10.3 mm, O = 39.4 mm, H/D = c. 0.3, E/D = c. 0.12, O/D = c. 0.46).
Description. Evolute shell with high-ovate whorl section. Whorl sides flattened. Venter narrow and rounded. Umbilical wall almost vertical. Umbilicus wide and shallow. Thin, thread-like ribs, slightly prosoclinal, begin at the umbilical margin. Most ribs bifurcate in the whorl mid-hight. Simple ribs are common. They are bent towards the aperture on the ventral margin, forming a loop-like bent on the ventral side. They are uninterrupted on the ventral side. There are about 33 primary ribs per half whorl. A simple rib occurs each two or three divided ribs. The ribs are very loosely spaced. There are about three shallow and wide constrictions per half whorl.
Remarks. The ornamentation of the specimen, though resembles that of "*Virgatosphinctes*" sp. *A*. is more regular and weaker. Both specimens differ also in their shell forms. The poor preservation of the present specimen does not permit its description as a new species.
Occurence. Section C-HA, stratigraphical position same as of "*Virgatosphinctes*" sp. *A*.

"*Virgatosphinctes*" sp.
Pl. V: 2; Pl. XII: 2, 4

Material. Three poorly preserved specimens MR-CI/8, MR-28/1, MR-24/1 and one whorl fragment MR-CI/8a

Specimen	D	H	E	O	H/D	E/D	O/D
MR-CI/8	c. 60	–	–	27.5	–	–	–
MR-CI/8a	–	21	–	–	–	–	–
MR-28/1	48	17	–	17	0.35	0.34	
MR-24/1	34	14.5	14.5	–	–		

Description and remarks. Incompletely preserved specimens. Ornamentation consists of simple and biplicate ribs, resembling those of "*Virgatosphinctes*" sp. *A* and "*Virgatosphinctes*" sp. *B*. The incomplete preservation precludes their more precise identification.
Occurrence. Sections C-HA (MR-CI/8, MR-CI/8a), MR-28 (MR-28/1), and MR-24 (MR-28/1).

Genus *Phanerostephanus* Spath, 1950
Type species: *Phanerostephanus subsenex* Spath, 1950

Phanerostephanus sp. aff. *Ph. antsalovensis* Collignon, 1960
Pl. XIV: 1a, 2, 3a

Material. One incomplete specimen VA-15 (E = 13 mm).
Description and remarks. Shell slightly flattened laterally, with triangular whorl section. Venter narrow, rounded at the top and slightly oblique near the ventral margin. Umbilical zone not preserved. Elongated bullae occur along the umbilical margin. Three or four ribs begin from them at the whorl mid-hight. The ribs turn gently towards the aperture near the ventral margin. The ribs are not preserved on the middle part of the ventral side. One oblique, deep constriction is visible on the inner whorl.

The features of this specimen correspond to those of *Phanerostephanus*. The numerous secondaries, the presence of deep constrictions, and the sub-triangular whorl section make this specimen affined to *P. antsalovensis* (cf. Collignon, 1960, pl. CLIX: 634). The specimen differs

from the representatives of this genus known from Kurdistan (Spath, 1950) and Europe (Donze & Enay, 1961). It differs from somewhat similar genera *Proniceras* Burckhardt, 1919 and *Spiticeras* Uhlig, 1903 by its virgatotome ribs, their prosoclinal bending and the marked elongation of the umbilical bullae.

Occurrence. Section VA, the bed of coquinoid limestone with *Hildoglochiceras* (*Salinites*), *Kossmatia*, and *Durnagites*. *Phanerostephanus* is known from the Tithonian of Europe (Donze & Enay, 1961), Kurdistan (Spath, 1950) and the Upper Tithonian of Madagascar (Collignon, 1960). It was not hitherto found in the Tithonian of America. *Ph. antsalovensis* was described from the Upper Tithonian of Madagascar (Collignon, 1960).

Family ASPIDOCERATIDAE Zittel, 1895
Subfamily ASPIDOCERATINAE Zittel, 1895
Genus *Schaireria* Checa, 1985
***Schaireria* sp.**
Pl. X: 3

Material. One small specimen MR-28/2 (D = 33 mm, H = 15 mm, E = 23 mm, O = 7.5 mm, H/D = 0.45, E/D = 0.7, O/D = 0.23).

Description and remarks. Small involute shell with flattened-ovate whorl section. Whorl sides convex. Whorls are widest at the umbilical margin. Venter rounded and broad. Umbilical margin rounded. Umbilical wall oblique. Umbilicus fairly narrow and deep. Oranmentation consists of small, scarcely visible, pointed umbilical tubercles (about five tubercles per half whorl) and narrow striae beginning from the tubercles.

The presence of the umbilical tubercles directed inwards, the lack of ornamentation and the shell form, all suggest the attribution of this specimen to *Physodoceras* (*Ph. altenense* group) or to *Schaireria*. The stratigraphical position at which the specimen was found (Tithonian) indicates that it should belong to *Schaireria* (see the diagnosis in Checa, 1985). The described specimen seems closest to *S. avellana* (Zittel, 1870) (Zittel, 1870, p. 86, pl. VII: 2a, 2b, 2c, 3a, 3b, 3c; Checa, 1985, p. 197, pl. 40: 1, 2; pl. 41: 11, text-figs. II.3.49, II.3.50, II.3.53), though it differs from this species by its less prominent umbilical tubercles and more evolute whorls. The presence of the umbilical tubercles differs it from *S. neoburgensis* (Oppel) (Checa, 1985, p. 199, pl. 40: 3–5, pl. 42: 1, text-figs. II.3.50, II.3.51, II.3.54).

Occurrence. Section MR-28. *Shaireria* occurs from the Midle Kimmeridgian to the Berriasian in the Mediterranean, Submediterranean, and Andean provinces (Checa, 1985). *S. avellana* is known from the Lower Tithonian of the Mediterranean and possibly Indo-Malagasy province (Checa, 1985).

Family SIMOCERATIDAE Spath, 1924
Subfamily SIMOCERATINAE Spath, 1924
Genus *Nebrodites*, Burckhardt, 1912
Subgenus *Mesosimoceras* Spath, 1925
***Nebrodites* (*Mesosimoceras* ?) sp.**
Pl. VII: 4; Pl. VIII: 2

Material. Two very badly preserved specimens MR-B/4 and T-2.

Specimen	D	H	E	O	H/D	E/D	O/D
MR-B/4	46	15	–	20.5	0.33	–	0.45
T-2	c. 64	(deformed specimen)					

Description and remarks. Evolute specimens with ovate whorl section, convex whorl sides and wide, moderately deep umbilicus. Ornamentation consists of strong, simple rectiradiate ribs.

Because of the poor preservation, the specimens can be precisely identified. The presence of strong simple ribs resembles the subgenus *Nebrodites* (*Mesosimoceras*) from the Kimmeridgian of Europe (Olóriz, 1978, p. 178; Sapunov, 1979, p. 118). The described specimens differ from the akin genus *Virgatosimoceras* by the lack of biplicate ribs.

Occurrence. Section B-HA, slightly above the strata with *Mazapilites* and *Protancyloceras* (specimen MR-B/4), and the lower part of section T. The subgenus *Nebrodites* (*Mesosimoceras*) is known from the Lower and Upper Kimmeridgian of Europe (Olóriz, 1978; Sapunov, 1979).

Genus *Virgatosimoceras* Spath, 1925

***Virgatosimoceras* (?) sp.**

Pl. IV: 5

Material. One whorl fragment VA-17.

Description and remarks. The incomplete preservation precludes more precise identification. The presence of deep constrictions and high collars suggests that it may be a *Virgatosimoceras* Spath (Arkell *et al.*, 1957), but this attribution is only tentative.

Occurrence. Section VA, the lowermost part, 1.15 m above the beginning of the section, and ca. 3.5 m below the bed with *Hildoglochiceras* (*Salinites*), *Kossmatia*, and *Durangites*. *Virgatosimoceras* is known from the Lower and Middle Tithonian of Germany, Somalia, Iran, and Cuba (Sapunov, 1979).

Genus *Hemisimoceras* Spath, 1925

***Hemisimoceras* aff. *semistriatum* Spath, 1925**

Pl. IV: 10a

1960 *Hemisimoceras semistriatum* Spath, Collignon, pl. CLX: 638, 639.

Material. Two whorl fragments MR-25/26 (E = c. 12 mm) and MR-25/27.

Description. Small specimens. Whorls nearly smooth. Nodes, passing to thick ribs on the ventral side, are situated on the ventrolateral margin. The nodes are distributed in this manner that nodes on one side correspond to the gaps between the nodes on the other side. Fine ribs passing the venter occur between the thick ribs. Constrictions are not visible.

Remarks. Despite poor preservation, the observable details of ornamentation and the shell form suggest affinity to *Hemisimoceras semistriatum*. The described specimens differ from that figured by Collignon (1960, pl. CLX: 638) in having thicker ribs on the ventral side. Shells of the other species of *Hemisimoceras* are smoother than those of the described specimens.

Occurrence. Section A-HA, the bed with *Hildoglochiceras* (*Salinites*), *Kossmatia*, and *Durangites*. *H. semistriatum* was described from the Upper Tithonian (*Aulacosphinctes hollandi* Zone *sensu* Collignon, 1960) of Madagascar (Collignon, 1960). In Spain, *Hemisimoceras* occurs in the Upper Tithonian *Simplicisphinctes* Zone (Tavera, 1985).

***Hemisimoceras* (?) sp.**

Pl. IV: 8a; Pl. V: 5

Material. Two whorl fragments MR-25/28 and MR-25/29.

Specimen	D	H	E	O	H/D	E/D	O/D
MR-25/28	37	9	–	20	0.24	–	0.54
MR-25/29	–	13	–	–	–	–	–

Description and remarks. Evolute shell with ovate whorl section. Whorl sides convex. Venter rounded. Ribs are weak and loosely spaced, in form of swellings. Numerous striae, parallel to the ribs, occur between them. Indistinct bullae or ubilical nodes occur at the umbilical margin. The nodes continue in stronger ribs. There are also lateral nodes (pointed nodes on the ventrolateral

margin). Constrictions typical of *Hemisimoceras* are absent on the preserved fragments. The details of ornamentation resemble those in forms described Imlay (1942, p. 1446, pl. 3: 8, 10) as *Virgatosimoceras* (?) sp. though those are fragments of much larger specimens. Both the described here and the Imlay's specimens seem close to *Hemisimoceras*, especially to *H. rati* Collignon (1960, p; CLXI: 640). The similarity to *Hemisimoceras* consists, among others, in the fine presence of the thread-like ribs (striae) between the thicker ribs, the presence of lateral and umbilical nodes and swellings, as well as the irregular nature of the thicker ribs. Despite these morphological differences the described specimens belong to *Hemisimoceras* rather than *Virgatosimoceras*.
Occurrence. Section A-HA, strata with *Hildoglochiceras*. Imlay's specimens were found in section LC.

Family OLCOSTEPHANIDAE Haug. 1910
Subfamily SPITICERATINAE Spath, 1924
Genus *Proniceras* Burckhardt, 1919
***Proniceras* sp. cf. *P. subpronum* Burckhardt, 1919**
Pl. VII: 3; Pl. XI: 5; Pl. XII: 9

Material. Three whorl fragments MR-25/33 (H = c. 20 mm), MR-25/34 (H = 16 mm), MR-25/35 (H = 18 mm).
Description and remarks. Fragmentarily preserved specimens. Numerous fine ribs begin in weak umbilical bullae. The ribs are mostly bi- and triplicate, turning towards the aperture near the ventral margin. Whorl section high-ovate. Fairly deep constrictions are numerous.

The poor preservation does not permit the positive specific identification, nevertheless the ornamentation is close to *P. subpronum* (Cantú Chapa, 1968, p. 24, pl.5: 6, 6a), and *P. subpronum* var. *saonjetensis* (Collignon, 1960, pl. 163: 656). The latter seems to have much wider whorls than the described specimens which differ also from *P. maupinense* (Imlay & Jones, 1970, p. B32, pl. 3: 8, 11–16) by their less pronounced ribbing in the umbilical zone.
Occurrence. Section A-HA, the bed with *Hildoglochiceras* (*Salinites*), *Kossmatia*, and *Durangites*. *P. subpronum* occurs in the Upper Tithonian of the Pimienta Formation in Mexico (Cantú Chapa, 1968). *P. maupinense* was described from the Upper Tithonian of California (Imlay & Jones, 1970).

Family BERRIASELLIDAE Spath, 1922
Subfamily BERRIASELLINAE Spath, 1922
Genus *Lytohoplites* Spath, 1925
Type species: *Lytohoplites carribeanus* Imlay, 1942
***Lytohoplites carribeanus* Imlay, 1942**
Pl. V: 3; Pl. IX: 1, 2, 7; Pl. X: 2

1942 *Lytohoplites caribbeanus* n. sp., Imlay, p. 1453; pl. 7: 1–9.
Material. One incomplete specimen MR-B/15 and two whorl fragments MR-CI/9 and LF-2.

Specimen	D	H	E	O	H/D	E/D	O/D
MR-B/15	c. 100	35	21	c. 36	–	–	0.54
			about 27 ribs per half whorl				
MR-CI/9	–	20	19	–	–	–	–
LF-2	–	25	–	–	–	–	–

Description. Evolute shell with high-ovate whorl section. Venter narrow and rounded on outer whorls, also rounded but wider on inner whorls. Whorl sides slightly convex. Umbilicus moderately wide. Ribs slightly prosoclinal, begin at the umbilical margin. They have pointed

terminations making them characteristically triangular (see description of the species by Imlay, 1942, p. 1453). The ribs on the inner whorls are interrupted on the venter by a weak ventral groove, and they are slightly thickening near the groove. On the outer whorls they are passing the venter with only slight weakening. The ribs are loosely spaced. Distinct constrictions were not observed. Suture not preserved. According to the rules of the ICZN the name of the *L. caribbeanus* change to the Latin name (*L. carribeanus*).

Remarks. The specimens conform Imlay's (1942) description of the species. Imlay (1942) compared this species to *Lytohoplites vetustoides* (Burckhardt) = *Hoplites vetustoides* Burckhardt, Burckhardt, 1903, p. 62, pl. 10: 23–25). Burckhardt's species differs, however, markedly by its shell form and sculpture. The ribs on Burckhardt's specimens are more distant and more wavy. A broad groove is present on the venter. Moreover, *L. vetustoides* is not coeval with *L. carribeanus* Imlay.

Occurrence. Sections B-HA (MR-B/15), and C-HA (MR-CI/9), below the strata with *Micracanthoceras* sp. *L. vetustoides* (Burckhardt) as well as the other species of *Lytohoplites* described by Burckhardt (1903) were found in the Jurassic/Cretaceous boundary strata, apparently younger than the strata in which the Cuban specimen was found.

Lytohoplites sp.
PL. IX: 11

Material. One incomplete, flattened specimen MR-CI/10 (H = 33 mm).

Description and remarks. Evolute specimen with high-ovate whorl section and slightly convex whorl sides. Ribs rectiradiate, moderately thick. Spaces between the ribs wide and rather shallow. Biplicate ribs seem to be present on the inner whorls. The coiling and ornamentation resemble some finely ribbed forms of the *Mesosimoceras risgoviensis – cavouri* group, known from the Kimmeridgian of Europe (cf. Olóriz, 1978). The ribs on the last preserved whorls are nearly identical to those on the specimens described in this paper as *Lytohoplites carribeanus*, but the specimen described here differs in having higher whorls and more flattened sides. This specimen is attributed to *Lytohoplites* because of its similarity to *L. carribeanus*, nevertheless its identity is not certain and its affinity to the Kimmeridgian genus *Nebrodites* (*Mesosimoceras*) can not be excluded. The same possibility regards also *L. carribeanus*. Unfortunately, the collected material is poorly preserved and it does not permit one to arrive at a firm conclusion. A somewhat similar form was described from Saxony (Berckhemer & Hölder, 1959, p. 60, pl. 14: 65).

Occurrence. Section C-HA.

Lytohoplites (?) sp.
Pl. IX: 3, 8

Material. Two whorl fragments MR-CI/11 (H = 20) and MR-CI/12 (H = c. 25 mm).

Description and remarks. Whorl sides flattened. Ribs rectiradiate, slightly prosoclinal, simple and, less frequently, biplicate. A shallow groove is probably present on the venter (specimen MR-CI/11). The ribs divide at the whorl mid-hight. The specimens resemble those atributed in this paper to the genus *Lytohoplites* in the large proportion of the simple ribs. They resemble the specimens described as "*Virgatosphinctes*" in the presence of biplicate ribs dividing in the whorl mid-hight. The incomplete preservation of the specimens does not permit their positive generic identification.

Occurrence. Section C-HA, strata with *Lytohoplites*, above the strata with *Pseudolissoceras zitteli*.

Subfamily HIMALAYITINAE Spath, 1923
Genus *Aulacosphinctes* Uhlig, 1910
Aulacosphinctes (?) sp.
Pl. XI: 7; Pl. XII 7b

Material. Two poorly preserved specimens ST-4 and LC-1.

Description and remarks. The poor preservation does not permit their positive generic identification. The coiling and preserved details of ornamentation suggest the genus *Aulacosphinc-*

tes. Specimens of this genus were described from Cuba by Judoley & Furrazola-Bermúdez (1968, p. 113, pl. LXX: 1–4; pl. IV: 6) as *A.* aff. *symonensis* Burckhardt (? *Aulacosphinctoides*, cf. Enay, 1973).

Occurrence. Section ST (ST-4) – higher part; section LC – together with *Vinalesites rosariensis* (Imlay). *Aulacosphinctes* is known from the Tithonian of India (Spath, 1931) and Mexico (Imlay, 1939).

Genus *Parodontoceras* Spath, 1923

Type species: *Hoplites callistoides* Behrendsen, 1891

Two species of *Parodontoceras* are known from the Tithonian of Cuba – *P. butti* Imlay and *P. antilleanum* Imlay (Imlay, 1942). Both species were described from the Sierra del Rosario (sections LC and MR-28) and *P. antilleanum* also from the area of Quemado de Guines in Villa Clara Province (Imlay, 1942, p. 1456). The latter was also reported from the Tithonian of the Sierra de los Organos by Judoley & Furrazola-Bermúdez (1968). The attribution of both species to *Parodontoceras* was questioned by Houša & Nuez (1973, 1975). They established *P.butti* as the type species of a new genus, "*Butticeras*". According to Verma & Westermann (1973) the genus *Parodontoceras* is close to *Substeueroceras* Spath, 1923. Despite these suggestions, Imlay (1980, p. 24, fig. 15) maintained *P. butti* and *P. antilleanum* with *Parodontoceras*. The additional difficulty in solving the problem of the generic attribution of both species is the poor preservation of the Cuban specimens. They are mostly strongly obliterated molds found on tops of limestone layers. The poorly preserved specimens of these species were found in sections SCb, ST, B-HA, and C-HA.

Subfamily HIMALAYITINAE Spath, 1923

Genus *Corongoceras* Spath, 1925[4]

Corongoceras cf. *cordobai* Verma and Westermann, 1973

Pl. XI: 2

Material. One incomplete specimen ST-6 (D = c. 80 mm, H = 20 mm, O = c. 40 mm).

Description. Evolute shell with wide and shallow umbilicus. Ornamentation consists of spaced, simple, slightly prosoclinal ribs with two rows of nodes (umbilical and ventrolateral).

Remarks. The specimen is similar to *Corongoceras cordobai*, whose distinctive features are simple, spaced ribs and the presence of the umbilical and ventrolateral nodes (cf. Verma & Westermann, 1973, p. 248, pl. 52: 4–5, pl. 53: 2–5, pl. 54: 1; text-fig. 28B). Incomplete preservation does not permit its positive identification. It differs from *Neocosmoceras sayni* (Simion), a species with somewhat similar ornamentation (cf. Mazanot, 1939, p. 182, pl. 28: 6, 7, 9a, 9b, 9c; pl. 29: 1a, 1b, 2a, 2b) in the nature of ribs, the higher position of the ventrolateral nodes and the lack of the ventral nodes.

---

[4] This genus has been recently regarded as a subgenus of *Micracanthoceras* and it is referred to the family Himalayitidae (Tavera, 1985, p. 135). According to this author, Himalayitidae include the following genera: *Himalayites*, *Aulacosphinctes*, *Djurjuriceras*, *Durangites*, *Micracanthoceras* (*Micracanthoceras*), *Micracanthoceras* (*Corongoceras*), *Protacanthodiscus*, *Simplisphinctes*, *Pseudosimplisphinctes*, and *Tithopeltoceras*.

Occurrence. The lower part of section ST. *C. cordobai* was described from the Upper Tithonian of Mexico (El Verde Member of the La Caja Formation in the Sierra Catorce; Verma & Westermann, 1973), *Corongoceras* is known from the Tithonian and Berriasian of Central and Southern Europe, Algeria, Mexico, Cuba, and Argentina (Verma & Westermann, 1973).

Corongoceras sp.
Pl. VI: 1

Material. One poorly preserved specimen MR-28/5 (D = c. 90 mm, O = 50 mm).
Description and remarks. Evolute, planispirally coiled shell. Whorl sides slightly convex. Umbilicus wide and shallow. Ornamentation consists of rectiradiate, simple ribs. Nodes are not visible. The poor preservation does not permit its positive identification. It resembles the genus *Corongoceras*, especially forms close to *C. cordobai* (Verma & Westermann, 1973, p. 248, pl. 52: 4–5, pl. 53: 2–5, pl. 54: 1; text-fig. 28B) in its fairly strong, simple ribs.
Occurrence. Section MR-28.

Genus *Himalayites* Uhlig in Böhm, 1904
Type species: *Himalayites treubi* Douvillé, 1912

Himalayites n. sp.
Pl. IV: 11c, 11d; Pl. XIII: 2, 4, 6, 10

Material. Two specimens MR-25/40 and MR-25/41 and one imprint of whorl MR-25/42.

Specimen	D	H	E	O	H/D	E/D	O/D
MR-25/40	20	8	15	9	0.40	0.75	0.45
MR-25/41	18	7	14	8.5	0.39	0.77	0.42
MR-25/42	–	–	15	–	–	–	–

Description. Small specimens, involute, coronate, and depressed. Venter rounded. Whorl sides very narrow. Umbilicus wide and very deep. Ribs bi-and triplicate beginning from ventrolateral spines. There are about ten spines per half whorl. The ribs are interrupted in the middle of the venter, forming a moderately wide, smooth groove. Deep constrictions are present, three in each whorl.
Remarks. The specimens display the distinctive features of the genus *Himalayites* – very depressed and coronate whorls, the presence of nodes and spines near the ventral margin, and the weak groove in the middle of the venter (cf. Mazanot, 1939; Arkell *et al.*, 1957; Drużczic, 1958, Collignon, 1960; Dimitrova, 1967; Fatmi, 1972; Sapunov, 1979). At the same time the fine ribs distinguish these specimens from those described in the papers quoted above. The described specimens seem closest to the specimen of *H. cortazari* Kilian figured by Collignon (1960, pl. CLXXIII: 744) from which they differ by their weaker sculpture and more distinct ventral groove. The described specimens differ from *H. concurrens* (Leanza, 1981, pl. III: 9–10) by their more flattened whorls and finer ribs. They differ from the somewhat affined genus *Spiticeras* in having the ventral groove and highly situated (much above the umbilical margin) nodes and spines (cf. the diagnosis of *Spiticeras* in Arkell *et al.*, 1957). Nevertheless they somewhat resemble *S. binodum* (Burckhardt, 1912, p. 176, pl. 42: 6–9, 11–31) from which they differ by their more flattened whorls and the presence of the ventral groove. They also display some resemblance to the specimens described in this paper as *Durangites* sp. (Pl. XII: 4, 6), and to the specimens described by Burckhardt as *D. vulgaris* (Burckhardt, 1912, p. 150, pl. 36: 18–21, 25) and *D. humboldti* (Burckhardt, 1912, p. 150, pl. 37: 1–35), that means to forms with finer ribs and a ventral groove. These forms, however, have no ventro-lateral spines and their whorls are higher. An obstacle in the more precise identification of the described specimens was the rock filling their umbilicus, and thus

precluding the closer study of the whorl sides. These specimens most likely belong to the genus *Himalayites*, as they bear the closest morphological resemblance to it, and probably they represent a new species. The new species is not formally established however, because the small specimens may be juvenils, and because of their insufficient number (two).

Occurrence. Section A-HA, the bed with *Hildoglochiceras* (*Salinites*), *Kossmatia*, and *Durangites*. *Himalayites* in known from the Upper Tithonian and Lower Berriasian of the Himalayas, Crimea, Caucasus, Spain, France, Bulgaria (Dimitrova, 1976; Sapunov, 1977, 1979; Krishna *et al.*, 1982; Tavera, 1985) and the uppermost Tithonian (Substeueroceras koeneni Zone) of Argentina (Leanza, 1981).

Genus *Micracanthoceras* Spath, 1925

Micracanthoceras sp. cf. *M. alamense* Imlay, 1939

Pl. IX: 4

1939 *Micracanthoceras alamense* n. sp., Imlay, p. 45; pl. 9: 3–12.

Material. One small specimen AM-25/24 (D = 11 mm, H = 4 mm E = c. 5 mm, O = 4.3 mm, H/D = 0.36, E/D = 0.45, O/D = 0.39).

Description. Small specimen with evolute shell. Whorl section acute, passing into a vertical umbilical wall. Venter wide and flattened. Umbilicus wide and deep. Ribs begin at the umbilicus, they are strongly prosoclinal, and they bifurcate near the ventral margin. Small but distinct nodes occur at the branching points. The secondaries turn backwards on the ventral side and pass the venter. Constrictions are present.

Remarks. The small dimensions of the specimen make difficult its positive identification. Nevertheless, some features are close to *Micracanthoceras alamenense*, namely: biplicate ribs, their high branching, the presence of distinct, though not very strong nodes at the branching points, and the wide and slightly flattened ventral side.

Occurrence. Section A-HA, the bed with *Hildoglochiceras* (*Salinites*), *Kossmatia*, and *Durangites*. *M. alamense* was described from the Tithonian of Mexico (Imlay, 1939).

Himalayites (*Micracanthoceras*) sp. cf. *H.* (*M.*) *acanthellum* Imlay, 1939

Pl. IX: 9; Pl. XI: 6

1939 *Micracanthoceras acanthellum* n. sp., Imlay, p. 43; pl. 16: 8–11.

1973 *Micracanthoceras acanthelium* Imlay, Verma & Westermann, p. 252; pl. 55: 1

Material. Two whorl fragments MR-CI/11 (H = 9 mm), P-CI/8a (D = c. 40 mm).

Description and remarks. Small specimens with evolute coiling and shell and slightly convex whorl sides. Ribs sharp, mostly biplicate, bifurcate slightly above the whorl mid-hight. A wide constriction is present. Ornamentation is close to *M. acanthellum*, but it differs by slightly weaker ribs. This difference and the incomplete preservation preclude the positive identification. The higher branching point and the presence of constrictions in these specimens differ them from *Parodontoceras antilleanum* Imlay = *Butticeras antilleanum* (Imlay) *sensu* Houša & Nuez (1975).

Occurrence. Section C-HA, above strata with "*Virgatosphinctes*" spp. *M. acanthellum* was described from the Tithonian strata of the La Casita Formation in Mexico (Imlay, 1939; Verma & Westermann, 1973).

Genus *Durangites* Burckhardt, 1912

Type species: *Durangites acanthicus* Burckhardt, 1912

Durangites aff. *humboldti* Burckhardt, 1912

Pl. XIII: 8, 9

Material. One whorl fragment MR-25/44 (H = 17 mm).

Description. Whorl section subrectangular. Whorl sides flattened. Venter flattened, with moderately deep groove. Numerous ribs, beginning at the umbilical margin are present on the whorl sides. They are rectiradial and thicken gradually towards the venter. Somewhat below the

whorl mid-hight some ribs divide into two, less commonly three, secondaries. Distinct nodes occur on the ventral margin each 4 to 5 ribs. Ventral groove interrupts the ribs. There are no constrictions in the preserved fragment.

Remarks. The specimen close to *D. humboldti* (Burckhardt, 1912, p. 152, pl. 36: 18–21, 25; Muñoz, 1964, p. 23, pl. 8: 3–4) from which it differs only by its slightly lower branching of the ribs, and the ribs being less distinct. These differences and the incomplete preservation of the specimen do not permit its positive identification.

Occurrence. Section A-HA, the bed with *Hildoglochiceras* (*Salinites*), *Kossmatia*, and *Durangites*. *D. humboldti* was described from the Tithonian strata of Mexico (Burckhardt, 1912).

Durangites sp. aff. *acanthicus* Burckhardt, 1912

Pl. XIV: 3b, 9

Material. Two incomplete specimens VA-15b and MR-25/45 (H = 10 mm).

Description and remarks. Whorl section subsquare. Venter flattened. Ribs strong, simple and biplicate. There are indistinct lateral nodes and a small ventral groove. The shell form and the ornamentation resemble those of early whorls of *Durangites acanthicus* (Burckhardt , 1912, p. 146, pl. 36: 7, 8, 10, 11, 15; Tavera, 1985, p. 156, pl. 18: 10–11; fig. 12/C), except for their somewhat less numerous ribs. The incomplete preservation does not permit the specific identification.

Occurrence. Section A-HA (MR-25/45), section VA (VA-15b), the bed with *Hildoglochiceras* (*Salinites*), *Kossmatia*, and *Durangites*. *D. acanthicus* was found in the Upper Tithonian of Mexico (Burckhardt, 1912; Imlay, 1939, 1942; Verma & Westermann, 1973).

Durangites n. sp.

Pl. IV: 6; Pl. XI: 3, 4; Pl. XIII: 5, 7

Material. Four whorl fragments MR-25/35 (H = 7 mm), MR-25/36 (H = 13 mm, E = 12 mm), MR-25/37 (H = 11 mm), MR-25/38 (H = 9 mm, E = 13 mm, O = 10 mm).

Description and remarks. The specimens are incompletely preserved. Whorls are wide and initially rather low. Whorl section is initially subsquare, then rectangular. Inner whorls are ornamented with simple and biplicate ribs, some of them with small pointed nodes at the branching points. The ribs are interrupted on the flattened venter, and a rather wide but shallow ventral groove is present. Bi- and triplicate ribs, branching at the whorl mid-hight dominate in the specimen MR-25/38. Adorally (in specimen MR-25/38) the nodes disappear, the whorls become higher, the whorl sides flattened, their section rectangular, and there are deep and wide constrictions. It is probable that both described fragments come from the same specimen.

The earliest whorls of the described specimens are close to *Proniceras* (cf. Cantú Chapa, 1968, pl. 2: 3, 12, 15) from which they differ by the presence of the small lateral nodes. Specimen MR-25/36 is considered more representative, and it is close to the specimen described and illustrated by Burckhardt (1912, p. 158, pl. 38: 18, 19) as *Durangites* sp. ind. The similarity consists in the whorl from and the loosely spaces ribs, characteristically bent backwards, while specimen MR-25/36 differs from the latter in its greater width of whorl, finer ribs, triplicate division of the ribs, and the presence of distinct lateral nodes at the branching points. Specimen MR-25/38 is similar to MR-25/36 (Pl. XIII: 5, 7) in the style of ornamentation and the sculpture of the venter. It is also somewhat similar to the specimen described by Imlay (1939, p. 55, pl. 18: 5, 6) as *Proniceras scorpionum* n. sp., but it differs from the latter in its shallow but wide ventral groove.

Occurrence. Section A-HA, the bed with *Hildoglochiceras* (*Salinites*), *Kossmatia*, and *Durangites*. The quoted Burckhardt's specimen (1912) was found in the Upper Tithonian of Mexico (area of Cerro de las Libres).

Family ANCYLOCERATIDAE Meek, 1876
Subfamily PROTANCYLOCERATINAE Breistroffer, 1947
Genus *Protancyloceras* Spath, 1924
***Protancyloceras* sp. aff. *P. gracile* (Oppel) in Zittel, 1870**
Pl. IV: 9; Pl. XII: 3d

Material. Three incomplete specimens MR-B/17, MR-B/18, MR-CI/10.
MR-B/17, width of shell = 8 mm, preserved lenght of shell = 30 mm,
MR-B/18, width of shell = 6 mm, preserved length of shell = 25 mm,
MR-CI/10, width of shell = 6 mm, preserved length of shell = 23 mm.

Description and remarks. All specimens are preserved in fragments only, hence their specific identification is impossible. Their elongated simple shells, slightly widening towards the aperture, and numerous oblique ribs resemble *Protancyloceras gümbeli* (Oppel) (Zittel, 1870, p. 115, pl. 12: 1–2; Drużczic, 1958, p. 106, pl. 49: 6a, 6b). The attribution to this species is, however, contradicted by the presence of numerous fine ribs and the simpler form of the shell. The described specimens are very similar to those described as *P.* sp. aff. *gracile* by Spath (1950, p. 122, pl. 6: 13, 14; pl. 8: 4, pl. 9: 6, 8), but they differ by having ribs more oblique to the axis of the shaft and more densely spaced, as well as by their shell being less curved. The studied specimens are closest to one of the Spath's specimens (1950, pl. 9: 6). The other specimens described by Spath as *P.* sp. aff. *gracile*, are, according to Barthel & Geyssant (1973, p. 25), comparable to *P. hondense*. The described specimens differ from *P. gracile* (Zittel, 1870, p. 115, pl. 12: 3) by simpler shell and stronger ribs. They differ from the specimen described as "*Aegocrioceras*" sp. (Imlay, 1939, p. 57, pl. 11: 1, 2) and coming from the strata with *Substeueroceras*, by the shell form and ornamentation. The specimens of *Protancyloceras* illustrated by Barthel & Geyssant (1973, p. 21: 2a–2f) have strongly coiled shells and thus they differ from *P. hondense* and *P. catalinense* known from the Upper Tithonian of Cuba (Imlay, 1942, 1980; Spath, 1950; Myczyński, 1977).

Occurrence. The lowermost part of section B-HA (MR-B/17 and MR-B/18), and the lower part of section C-HA (MR-CI/10). Spath's specimen (1950, pl. 9: 4) was found in the Tithonian strata of Kurdistan. *P. gracile* was described from the Tithonian strata of the Tethys (Zittel, 1870).

Protancyloceras*? sp. *A
Pl. XI: 9; Fig. 23

Material. Two specimens with obliterated ornamentation CG-1 and CG-2.

Specimen	S	O	P	F	R_d	R_s	L
CG-1	70	26	7	35	30	11	16
CG-2	55.2	17.5	6.3	22.8	–	–	14.2

Symbols used: S – total length of shell, O – diameter of spiral part, P – width of proversum in widest place, F – width of shell at the place of its bend (flexus), R_d – length of retroversum, R_s – width of retroversum, L – distance between arms.

Description. Shell ancyloceratoid in form, spirally coiled in the inner part, direct in the middle part, and bent hook-like at the end. Ornamentation strongly obliterated in both specimens. In the preserved fragments it consists of strong ribs transverse to the shell axis, simple and possibly biplicate.

Remarks. The shell form (Fig. 23) is similar to *Ancyloceras* d'Orbigny, 1840. The preserved fragments of ornamentation and the stratigraphic position of the described specimens suggest their affinity to *Protancyloceras*. The described specimens differ from *Vinalesites* Thieuloy, 1966 in the form of coiling of the initial whorls, resembling more the Cuban species *Protancyloceras hondense* (Imlay) = *Leptoceras*? *hondense* Imlay. However, the hook-like arms have been not hitherto

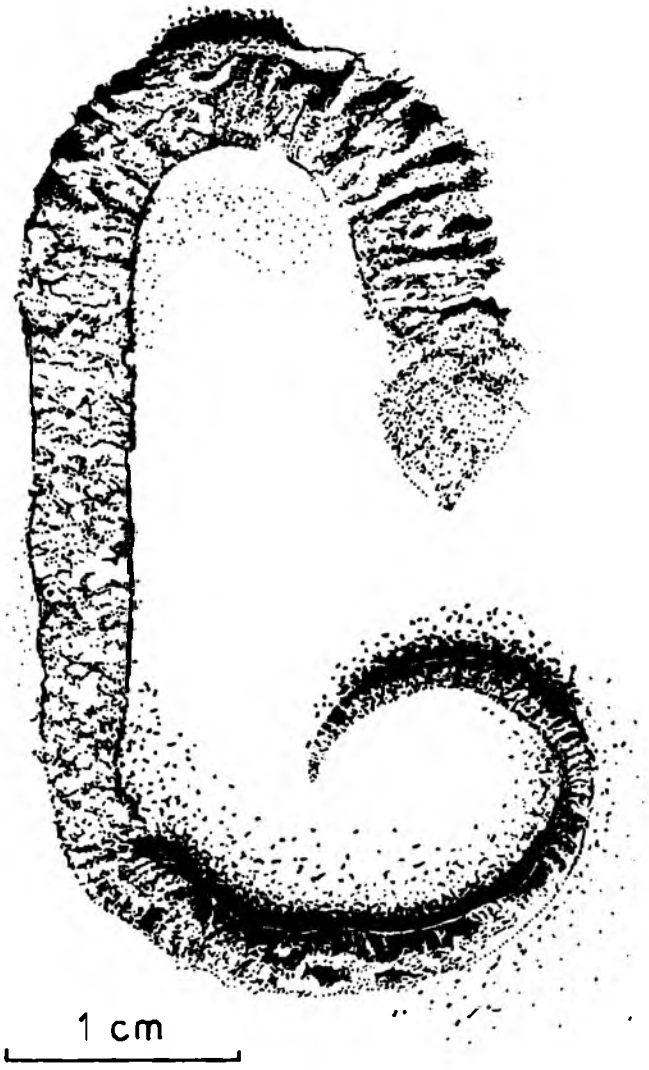


Fig. 23. ?*Protancyloceras* sp., A specimen CG-1, enlarged ca. ×3

observed in this species (cf. Imlay, 1942; Judoley & Furrazola-Bermúdez, 1968; Myczyński, 1977). The described specimens most probably belong to *Protancyloceras*, and represent a new species of this genus, though their preservation does not justify their formal erection to the rank of a new species.

Occurrence. The upper part of the section in the Sierra de Camajan, Camagüey Province.

Class PELECYPODA

Family BUCHIIDAE Cox, 1953 (= AUCELLIDAE Lahusen, 1897)

Genus *Buchia* Rouillier, 1845 (= *Aucella* Keyserling, 1846; Opinion 492 of Intern. Comm. Zool. Nomenclature, 1957)

Buchia* aff. *Buchia okensis* (Pavlow, 1907) *sensu lato

Pl. VII: 6; Pl. X: 7; Pl. XII: 8

Material. Three internal molds of left valves VA-17, MR-25/49, MR-25/50.

Specimen	Maximum length, mm	Maximum width, mm	Thickness mm	Beak's angle	Ribs per cm
VA-17	32	32	16	c. 80°	4
MR-25/49	52	72	26	88°	3
MR-25/50	c. 60	45	31	–	3

Description and remarks. Shell medium-sized. longer then wide (except for MR-25/49). Beak not pronounced, but pinched and sharp. The valve is thickest at the shell mid-length. The surface is covered by more or less regular, loosely concentric folds. The studied specimens are close to the Neocomian species *Buchia okensis* (Pavlow, 1907) *s. lato* (cf. Zakharov, 1981, p. 116, pl. XXXI: 1–3, pl. XXXII: 1–4, pl. XXXIII: 1–2, pl. XXXIV: 1–3, XXXV: 1–4, text-figs. 22, 24b; Jeletzky, 1965, pl. IV: 1, 3–4, 6, 18, pl. V: 2–6, 9, 10, pl. VI: 8, 9, pl. VII: 1–4, 7, 8, 10; pl. VIII: 1–9, pl. IX: 7, 8, pl. X: 2, 7), especially to the specimens with loose, concentric arrangements of folds, grouped in the subspecies *B. okensis* (Pavlow) *canadiana* Crickmay, 1950. The similarity is expressed in both the ornamentation and the shape of the shell. The Cuban specimens seem to have more distinct concentric folds, but this may be the result of our dealing with inner molds in this case. The preservation does not permit their positive subspecific, and even specific, identification, so they are referred to *B. okensis* (Pavlow) *sensu lato*. The forms described as *Inoceramus bassei* by F. L. Cantú (1967, p. 31, pl. 9: 1–6) from the Tithonian of Mexico, as well as the two specimens illustrated by Myczyński (1977, pl. 8: 6, 7), and found in section LC, seem to be close to this species.

Occurrence. The upper part of section VA (VA-17), and the uppermost part of section A-HA (ME-25/49, MR-25/50). *Buchia okensis* is known from the Berriasian of Canada (Jeletzky, 1965). The specimen described as *Buchia* aff. *B. okensis* is reported from the Upper Tithonian of California (Imlay, 1980).

Buchia aff. *B. piochii* (Gabb, 1864) *sensu lato*

Pl. IV: 7

Material. Internal mold of left valve MR-25/48.

Specimen	Maximum length, mm	Maximum width, mm	Thickness mm	Beak's angle	Ribs per cm
MR-25/48	38	33	14	87°	5

Description and remarks. Shell small-sized, moderately oblique, not considerably longer than wide. The surface covered with more or less regular to fairly irregular, loosely concentric folds. The described specimen is similar to the specimens described as *B. piochii* (Gabb, 1864) *sensu lato* by Jeletzky (1965, pl. I: 4, 5, 9, non Pl. I: 3, 6 = *B. russiensis* (Pavlow) cf. Zakharov, 1981, p. 89), and especially to the specimen described as *B. piochii* var. *mniovnikiensis* (Pavlow, 1907) by Jeletzky (1965, pl. I: 4). The described specimen differs from the specimens of *B. piochii sensu lato* by its somewhat less dense and slightly thicker concentric folds. Its preservation does not permit the positive identification as *B. piochii* because the internal details of the shell can not be observed. The specimen resembles also the specimens described above as *Buchia* aff. *B. okensis*, but differs from them by its weaker sculpture. This specimen differs from *B. mosquensis* (Buch, 1844) (Jeletzky, 1965, pl. I: 1), affined in sculpture, by its stronger concentric folds and more elongated shell.

Occurrence. Section A-HA, about 8.5 m above the strata with *Buchia* aff. *B. okensis*, together with *Hildoglochiceras* (*Salinites*) spp. *B. piochii* is known from the Upper Tithonian of Canada, northern Alaska, California, Oregon, and western part of Idaho (Frebold, 1964; Jeletzky, 1965, 1966; Imlay, 1952, 1961, 1980; Imlay & Jones, 1970; Zakharov, 1981).

REFERENCES

Albear, J. F., Iturralde-Vinent, M. A., Carassou, G., Mayo, N. D., Peñalver, L., 1977. *Memoria explicativa del mapa geologico de las provincias de la Habana, a escala 1: 250000.* (Unpublished). Inst. Geol. Paleont. ACC. La Habana.

Albear, J. F. de, & Iturralde-Vinent, M., 1985. Estratigrafia de las provincias de La Habana. In:

Contribución a la geologia de las provincias de La Habana. Inst. Geol. Paleont. ACC, La Habana, pp. 12–54.

Arkell, W. J., 1956. *Jurassic Geology of the World.* Edinburgh — London, 806 pp.

Arkell, W. J., Kummel, B. & Wright, C. W., 1957. Mesozoic *Ammonoidea.* In: Moore, R. C. (ed.), *Treatise on Invertebrate Paleontology*, part L (Mollusca 4, Cephalopoda, Ammonoidea). L80-L437.

Arnould-Saget, S., 1951. Les ammonites pyriteuses du Tithonique supérieur et du Berriasien du Tunisie centrale. *Ann. Min. Géol.*, 10 (4): 1–133.

Barthel, K. W., 1962. Zur Ammonitenfauna und Stratigraphie der Neuburger Bankkalke. *Bayer. Akad. Wissensch. N. F.*,: 1–30, München.

Barthel, K. W. & Geyssant, J. R., 1973. Additional Tethydian ammonites from the lower Neuburg formation (Middle Tithonian, Bavaria). *Neues Jb. Geol. Paläont. Mh.*, 1973: 1–60.

Bartok, P. E., Renz, O. & Westermann, G. E. G., 1985. The Siquisique ophiolites, Northern Lara State, Venezuela: A discussion on their Middle Jurassic ammonites and tectonic implications. *Geol. Soc. Am. Bull.*, 96: 1050–1055.

Berckhemer, F. & Hölder, H., 1959. Ammoniten aus dem Oberen Weissen Jura Süddeutschland. *Beih. Geol. Jh.*, 35: 1–135.

Birkenmajer, K., 1963. Stratigraphy and palaeogeography of the Czorsztyn Series (Pieniny Klippen Belt, Carpathians) in Poland. (In Polish, English summary). *Stud. Geol. Polon.*, 9: 1–380.

Birkenmajer, K. & Myczyński, R., 1984. Fauna and age of Jurassic Nodular Limestones near Niedzica and Jaworki (Pieniny Klippen Belt, Carpathians, Poland). *Stud. Geol. Polon.*, 83: 7–24.

Biro-Bagoczky, L., 1978. Algunos ammonites nuevos en la formacion Lo Valdes, Titoniano-Neocomiano, provincia de Santiago (33°50 lat. Sur) Chile. *Actas II Congr. Argentino de Paleont. y Bioestratigr. y I Congr. Latinoamericano de Paleontologia*, 1 (1980): 223–242.

Borza, K., 1984. Biostratigraphie Jurassischer und Unterkretazischer Kalke im Liegenden des Neogenes des Wiener Beckens. *Geol. Zbor. Geol. Carpat.*, 35 (5): 631–648, Bratislava.

Burckhardt, C., 1903. Beiträge zur Kenntnis der Jura und Kreide Formation der Cordillere. *Palaeontographica*, 50: 1–145.

Burckhardt, C., 1906. La Faune Jurassique de Mazapil avec un apendice sur les fossiles du Crétacique inferieur. *Bol. Inst. Geol. México*, 23: 1–216.

Burckhardt, C., 1912. Faunes Jurassiques et Crétaciques de San Pedro del Gallo. *Bol. Inst. Geol. México*, 29: 1–264.

Burckhardt, C., 1919–1921. Faunas Jurássicas de Symon (Zacatecas) y Faunas Cretácicas de Zupango del Rio (Guerrero). *Bol. Inst. Geol. México*, 33 (1): 1–135 (1919); (2): 30 pls. (1921).

Burckhardt, C., 1930: Étude synthétique sur le Mésozoique mexicain. *Mem. Soc. Paléont. Suisse*, 49: 1–123.

Callomon, J. H., 1963. Sexual dimorphism in Jurassic ammonites. *Trans. Leicester Lit. Phil. Soc.*, 57: 21–56.

Callomon, J. H., 1969. Dimorphism in Jurassic ammonites, some reflections. *Intern. Union Geol. Sci., Ser. A.*, 1: 111–125.

Cantú Chapa, A., 1963. Étude biostratigraphique des Ammonites du centre et de l'est du Mexique (Jurassiques supérieur et Crétacé). *Mém. Soc. Geol. France*, 99, NS, 42 (4): 1–102.

Cantú Chapa, A., 1967. El límite Jurásico-Cretácico en Mazatepec, Puebla. In: Estratigrafia del Jurásico de Mazatepec, Puebla (México). *Inst. Mexicano Petról. Tecnol. Explor. Secc. Geol., Monografia*, 1: 3–24.

Cantú Chapa, A., 1968. Sobre una asociacion Proniceras–Durangites–"Hildoglochiceras" del Noreste de México. *Inst. Mexicano Petról. Tecnol. Explor. Secc. Geol., Monografia*, 2: 19–26.

Cantú Chapa, A., 1969. Estratigrafia del Jurasico Medio–Superior del subsuelo de Poza Rica, Ver. (Area de Soledad-Miquetla). *Inst. Mexicano Petról. Rev.*, 1: 3–9.

Cantú Chapa, A., 1971. La serie Huasteca (Jurasico Medio–Superior) del centro este de México. *Inst. Mexicano Petról. Rev.*, 3 (2): 17–40.

Cantú Chapa, A., 1973. Huesteca Series (Middle and Upper Jurassic) and its relation with Poza Rica reservoir, México, (abs.). *Am. Ass. Petrol. Geol. Bull.*, 57: p. 772.

Cantú Chapa, A., 1976. El Contacto Jurásico—Cretácico, la Estratigrafía del Neocomiano, el Hiato Hauteriviano Superior—Eoceno Inferior y las Amonitas del Pozo Bejuco 6 (Centro—Este de México). *Bol. Soc. Geol. Mexic.*, 37: 60—63.

Cantú Chapa, A., 1977. Las amonitas del Jurásico Superior del Pozo Chac 1, Norte de Campeche (Golfo de México). *Inst. Mexicano Petról. Rev.* 9 (2): 38—39.

Cantú, F. L., 1967. *Inoceramus bassei* sp. nov. del Titoniano de Mazatepec, Puebla (México); *Inst. Mexicano Petról. Tecnol. Explor. Secc. Geol., Monografía*, 1: 31—32.

Cariou, E., 1973. Ammonites of the Callovian and Oxfordian. In: Hallam, A. (ed.), *Atlas of Palaeobiogeography*. Amsterdam, pp. 287—295.

Cariou, E., Contini, D., Dommergues, J. L., Enay, R., Geyssant, J. R., Mangold, Ch. & Thierry, J., 1985. Biogéographie des Ammonites et évolution structurale de la Téthys au cours du Jurassique. *Bull. Soc. Géol. France*, sér. 8, 1: 679—697.

Cecca, F., 1985. Alcone ammoniti provenienti dalla "Maiolica" dell' Appennino Centrale (Umbria, Marche a Sabina). *Biol. Serv. Geol. Ital.*, 103 (1982): 133—162.

Cecca, F., Cresta, S., Pallini, G. & Santantonio, M., 1986. Biostratigrafia ed ammoniti del Dogger—Malm di Coble Tordina (Monti della Rossa, Appennino marchigiano). *Bol. Serv. Geol. Ital.*, 194 (1983—84): 177—203.

Checa, A. 1985. Los Aspidoceratiformes en Europa (Ammonitina, Aspidoceratidae: subfamilias Aspidoceratinae y Physodoceratinae). *Tesis Univ. Granada*, 413: 1—42.

Chong, G., Brochwicz-Lewiński, W., Myczyński, R., Melendez, G. & Sequeiros, L., 1984. Stratigraphic value and paleobiogeographic implications of Oxfordian ammonite fauna of Chile. In: *International Symp. Jurassic Strat.*, 2: 416—427.

Collignon, M., 1960. *Atlas de fossiles caractéristiques de Madagascar*. Fasc. V (*Kimmeridgian*); Fasc. VI (*Tithonique*). Minist. Min. l'Energ. Rep. Malgache. Fasc. V, Pls. 96—133; Fasc. VI, Pls. 134—175.

Colloque..., 1975. Colloque sur la limite Jurassique-Crétacé, Lyon, Neuchâtel, Septembre 1973. *Mém. BRGM*, 86: 1—393.

Cresta, S. & Pallini, G., 1982. Revisione di *Simocosmoceras* Spath, *Perisphinctidae* del Titonico inferiore. *Bol. Serv. Geol. Ital.*, 103: 163—176.

Dimitrova, N., 1967. *Fossilite na Bulgarija*, IV, *Dolna Kreda, Glavonogi* (*Nautiloidea i Ammonoidea*). 236 pp. Sofia.

Donze, P. & Enay, R., 1961. Les céphalopodes du Tithonique inferieur de la Croix-De-Saint-Concors près Chambery (Savoie). *Trav. Lab. Géol. Lyon*, 7: 1—236.

Douvillé, R., 1910. Céphalopodes Argentins. *Mém. Soc. Géol. France, Paléont.*, 43: 1—22.

Drużczic, V. V., 1958. *Moluski*. In: *Osnovy Paleontologii*, 2: 9—144. Moskva.

Enay, R., 1964. L'Etage Tithonique. Coll. Juras. Luxembourg, 1962. *C. R. Mém. Inst. Gd. Duc., Sc. Nat. Phys. Maths.*, 355—379.

Enay, R., 1972. Paleobiogeographie des Ammonites du Jurassique terminal (Tithonique/Volgien/Portlandien s.l.) et mobilité continetale. *Geobios*, 5 (4): 355—407.

Enay, R., 1973. Upper Jurassic (Tithonian) Ammonites. In: Hallam, A. (ed.), *Atlas of Paleobiogeography*, Elsevier, Amsterdam, pp. 297—307.

Enay, R., 1976. Funes anatoliennes (Ammonitina, Jurassique) et domaines biogéographiques nord et sud téthysiens. *Bull. Soc. Géol. France*, sér. 7, 18: 535—541.

Enay, R., 1980. Paléobiogéographie et Ammonites jurassiques: "rythmes fauniques" et variations du nieveau marin; voies d'échenges, migrations et domaines biogéographiques. *Mém. h. sér. Soc. Géol. France*, 10: 261—281.

Enay, R. & Geyssant, J. R., 1975. Faunes tithoniques des chaînes bétiques (Espagne méridionale). Colloque Limite Jurassique—Crétacé, Lyon-Neuchâtel, Septembre 1973. *Mém. BRGM*, 86: 39—55.

Enay, R. & Mangold, Ch., 1982. Dynamique biogéographique et évolution des faunes d'Ammonites au Jurassique. *Bull. Soc. Géol. France*, sér. 7, 24: 1023—1046.

Engel, R. L., 1962. Geology and tectonics of Trinidad Mountains, Las Villas Province, Cuba (abs.). *Am. Assoc. Petrol. Geol. Bull.*, 46: 266.

Fatmi, A. N., 1972. Stratigraphy of the Jurassic and Lower Cretaceous rocks and Jurassic ammonites from northern areas of West Pakistan. *Bull. Brit. Mus. Nat. Hist.*, 20 (7): 297–390.

Frebold, H., 1964. Illustrations of Canadian fossils – Jurassic of western and Arctic Canada. *Can. Geol. Surv. Pap.*, 53–4: 1–106.

Galacz, A., 1980. Gyenespusztai Bajóci és Bath Ammonitesek (Bakony Hegység). Bajocian and Bathonian Ammonites of Gyenespuszta Bakony Mts., Hungary. *Geol. Hungar., Ser. Palaeont.*, 39: 1–227.

Geyer, O. F., 1979. Zur Paläogeographie mesozoischer Ingressionen und Transgressionen in Kolumbien (On the paleogeography of Mesozoic ingressions and transgressions in Colombia). *Neues Jb. Geol. Paläont. Mh.*, 1979: 349–368.

Gordon, W. A., 1974. Physical controls on marine biotic distribution in the Jurassic period. In: Ross, Ch. A. (ed.), Paleogeographic provinces and provinciality. *Soc. Econ. Paleont. Miner., Spec. Publ.*, 21: 136–147.

Gordon, W. A., 1976. Ammonoid provincialism in space and time. *J. Paleont.*, 50: 521–535.

Haczewski, G., 1976. Sedimentological reconnaissance of the San Cayetano Formation: an accumulative continental margin in the Jurassic of Western Cuba. *Acta Geol. Polon.*, 26: 331–353.

Hallam, A., 1981. A revised sea-level curve for the Early Jurassic. *J. Geol. Soc.*, 138: 735–743.

Hallam, A., 1983. Early and Mid-Jurassic Molluscan biogeography and establishment of the Central Atlantic Seaway. *Palaeogeogr., Palaeoclimatol., Palaeoecol.*, 43: 181–193.

Hatten, C. W., 1957. *Geological report on Sierra de los Organos.* (Unpublished report). Ministerio de Industrias, La Habana.

Herrera, N. M., 1961. Contribución a la estratigrafía de le Provincia de Pinar del Río. *Rev. Soc. Cubana Ing.*, 61 (1–2): 2–24.

Herwart, H., 1969. Eine Ammoniten-Fauna aus den Spiti-Schiefern von Muktinath in Nepal. *Zitteliana*, 1: 5–60.

Hill, P. A., 1959. Geology and structure of the northwest Trinidad Mountains, Las Villas Province, Cuba. *Bull. Geol. Soc. Am.*, 70: 1459–1578.

Houša, V., 1974. *Informe final sobre los trabajos de campo realizados para estudio bioestratigrafico y la recoleccion de los ammonites de Tithoniano y Cretacico Inferior en algunas localidades en la provincia de Pinar del Rio, Cuba.* (Unpublished). Inst. Geol. Paleont. ACC, La Habana.

Houša, V. & Nuez, M. de la, 1972. Hallazgo de ammonites del Kimmeridgiano en Hacienda el Americano (Pinar del Rio). *Actas ACC. Inst. Geol. Paleont.*, 2: 14–16. La Habana.

Houša, V. & Nuez, M. de la, 1973. Las faunas de ammonites del Tithoniano y del Infracretaceo de Cuba. *Actas ACC, Inst. Geol. Paleont.*, 3: 18–19.

Houša, V. & Nuez, M. de la, 1975. Ammonite fauna of the Tithonian and Lowermost Cretaceous of Cuba. *Mém. BRGM*, 86, 57. Paris.

Imlay, R. W., 1939. Jurassic ammonites from Mexico. *Bull. Geol. Soc. Am.*, 50:1–78.

Imlay, R. W., 1942. Late Jurassic fossils from Cuba and their economic significance. *Bull. Geol. Soc. Am.*, 53: 1417–1478.

Imlay, R. W., 1952. Correlation of the Jurassic formations of Norht America exclusive of Canada. *Bull. Geol. Soc. Am.*, 63: 953–992.

Imlay, R. W., 1961. Late Jurassic ammonites from the western Sierra Nevada, California. *U. S. Geol. Surv. Prof. Pap.*, 374-D: 1–30.

Imlay, R. W., 1980. Jurassic paleobiogeography of the conterminous United States in its continental setting. *U. S. Geol. Surv. Prof. Pap.*, 1062: 1–134.

Imlay, R. W., & Jones, D. L., 1970. Ammonites from the Buchia Zones in Northwestern California and Southwestern Oregon. *U. S. Geol. Surv. Prof. Pap.*, 647-B: 1–59.

Inturralde-Vinent, M. A. & Marí Morales, T., 1988. Toleitas del Tithoniano en la Sierra de Camajan, Camagüey. Possible datacion de la corteza oceanica. *Rev. Tecnologica*, 18 (1): 25–32.

Iturralde-Vinent, M. A., Tchounev, R. & Cabrera, R., 1982. *Resultados de las investigaciones cientificas y del levantamiento geologico a escala 1: 250 000 del territorio Ciego-Camagüey-Las Tunas.* (Unpublished). Inst. Geol. Paleont. ACC, La Habana.

Jeletzky, J. A., 1965. Late Upper Jurassic and Early Lower Cretaceous fossil zones of the Canadian Western Cordillera, British Columbia. *Geol. Surv. Can. Bull.*, 103: 1–70.

Jeletzky, J. A., 1966. Upper Volgian (Latest Jurassic) ammonites and Buchias of Arctic Canada. *Geol. Surv. Can. Bull.*, 128: 1–51.

Jeletzky, J. A., 1984. Jurasic–Cretaceous boundary of Western and Arctic Canada and the problem of correlation of Tethyan and Boreal facies of Tithonian and Berriasian stages. *Circum-Pacific Jurassic Research Group, Project 171*, Report 2. Hamilton, Ontario: 97–100.

Judoley, C. M. & Furrazola-Bermúdez, G., 1968. Estratigrafia y fauna del Jurassico de Cuba. *Publ. Especial ICRM*, La Habana, pp. 1–126.

Kanchev, J., Boyanov, J., Popov, N., Cabrera, R., Goranov, A., Jolkicev N., Kanazirski, M. & Stanchera, M., 1978. *Geologia de la provincia de Las Villas (resultados de las investigaciones geologicas y leventamiento geológico a escala 1: 250 000 realizados durante el periodo 1969–1975.* (Unpublished). Inst. Geol. Paleont. ACC. La Habana.

Khudoley, K. M., 1974. Circum-Pacific Mesozoic ammonoid distribution: relation to hypotheses of continental drift, polar wandering and Earth expansion. In: Kahle, C. F. (ed.), Plate tectonics – assessments and reassessments. *Am. Ass. Petrol. Geol. Mem.*, 23: 295–330.

Kreisel. K. & Furrazola-Bermúdez, G., 1971. Notas preliminares sobre la distribución de tintinidos en Cuba. *Publ. Especial ICRM*, 5: 1–24. La Habana.

Krishna, J., Kumar. S. & Singh, I. B., 1982. Ammonoid stratigraphy of the Spiti Shale (Upper Jurassic). Tethys Himalaya, India. *Neues Jb. Geol. Paläont. Mh.*, 1982: 580–592.

Książkiewicz, M., 1956. Jura i kreda Bachowic (The Jurassic and Cretaceous of Bachowice, Western Carpathians). *Rocz. Pol. Tow. Geol.*, 24:

Kutek, J. & Zeiss, A., 1974. Tithonian-Volgian ammonites from Brzostówka near Tomaszów Oxfordian ammonite faunule from the Artemisa Formation, Sierra del Rosario, western Cuba. *Acta Geol. Polon.*, 26: 299–319.

Kutek, J. & Wierzbowski, A., 1979. Lower to Middle Tithonian ammonite succession at Rogoźnik in the Pieniny Klippen Belt. *Acta Geol. Polon.*, 24: 195–205.

Kutek, J. & Wierzbowski, A., 1986. A new account on the Upper Jurassic stratigraphy and ammonites of the Czorsztyn succession, Pieniny Klippen Belt (Poland). *Acta. Geol. Polon.*, 36: 289–316.

Kutek, J. & Zeiss A., 1974. Tithonian-Volgian ammonites from Brzostówka near Tomaszów Mazowiecki, Central Poland. *Acta Geol. Polon.*, 24: 505–542.

Leanza, H. A., 1980. The Lower and Middle Tithonian ammonite fauna from Cerro Lotena, Province of Neuquen, Argentina. *Zitteliana*, 5: 3–49.

Leanza, H. A., 1981. Faunas de ammonites del Jurasico Superior y del Cretacico Inferior de America de Sur con especial consideracion de la Argentina. *Com. Sudamer. Jur. Cretac., Cuenc., Sed. Jur. Cret. Amer. Sur.*, 2: 559–597.

Leanza, H. A. & Olóriz, F. (in press). Presencia del genero *Simocosmoceras* Spath (Cephalopoda – Ammonoidea) en el Tithoniano Andino y su significado paleobiogeografico. *Ameghiniana.*

Lefeld, J., 1974. Middle-Upper Jurassic and Lower Cretaceous biostratigraphy and sedimentology of the sub-tatric succession in the Tatra Mts (Western Carpathians). *Acta Geol. Polon.*, 24: 277–364.

Le Hégarat, G., 1971. Le Berriasien du Sud-Est de la France. *Doc. Lab. Géol. Fac. Sci. Lyon*, 43 (1): 1–308.

Loczy, L., 1915. Monographie der Vallányer Calovien-Ammoniten. *Geol. Hung.*, 1 (3–4): 1–253.

Makowski, H., 1963. Problem of sexual dimorphism in ammonites. *Palaeont. Polon.*, 12: 1–92.

Malinowska, L., 1963. Stratygrafia oksfordu jury częstochowskiej na podstawie amonitów. (Stratigraphy of the Oxfordian of the Częstochowa Jurassic on the base of ammonites). *Pr. Inst. Geol.*, 36: 1–165.

Matyja, B. A., 1977. The Oxfordian in the south-western margin of the Holy Cross Mts. *Acta Geol. Polon.*, 27: 41–64.

Mazanot, G., 1939. Les palaehoplitidae tithoniques et berriasiens du Sud-Est de la France. *Mem. Soc. Géol. France*, 18, 41: 1–303.

Meléndez, G., 1983. La fauna de ammonites del Oxfordiense de la Cordillera Iberica y su posición paleogeografica. *X Congr. Nat. Sedim.* 6: 10–13.

Meléndez, G., Sequeiros, L. Brochwicz-Lewiński, W., Myczyński, R. & Chong, G., 1985. Paleobiogeographic relations between Oxfordian ammonite fauna from Mediterranean, Submediterranean and South American (Andean) provinces. *IInd Inter. Cephalopod Symp.,Cephalopods: Present and Past (O. H. Schindewolf Symp.)*.

Millán, G. & Myczyński, R., 1978. Fauna jurásica y consideraciones sobre la edad de las secuencias metamorficas del Escambray. *Inf. Cient.-Técn. ACC.*, 80: 1–14. La Habana.

Millán G. & Myczyński, R., 1980. Jurassic ammonite fauna and age of metamorphic sequences of Escambray. *Bull. Acad. Polon. Sc., Sér. Sci. Terre*, 27: 37–47.

Millán, G. & Somin, M. L., 1981. *Litologia, estratigrafia, tectonica y metamorfismo del macizo de Escambray*. Edit. ACC, La Habana, 104 pp.

Muñoz, M. J. P., 1964. Amonitas del Jurasico Superior y del Cretacico Inferior del Extremo Oriental del estado de Durango, Mexico. *Paleont. Mexic.* 20: 1–33.

Myczyński, R., 1973. Stratygrafia jury środkowej serii braniskiej okolic Czorsztyna (pieniński pas skałkowy). Middle Jurassic stratigraphy of the Branisko Succession in the vicinity of Czorsztyn (Pieniny Klippen Belt, Carpathians). *Stud. Geol. Polon.*, 42: 1–122.

Myczyński, R., 1976a. A new ammonite fauna from the Oxfordian of the Pinar del Rio province, western Cuba. *Acta Geol. Polon.*, 26: 262–297.

Myczyński, R., 1976b. *Organoceras* gen. n. (Ammonoidea) from the Oxfordian of Cuba. *Acta Palaeontol. Polon.*, 21: 391–394.

Myczyński, R., 1977. Lower Cretaceous ammonites from Sierra del Rosario (Western Cuba). *Acta. Paleont. Polon.*, 22: 139–173.

Myczyński, R. & Pszczółkowski, A., 1973. La fauna ammonoidea pretithoniana en la Sierra del Rosario, provincia de Pinar del Río. *Actas ACC, Inst. Geol. Paleont.*, 3: 31–34.

Myczyński, R. & Pszczółkowski, A., 1976. The ammonites and age of the San Cayetano Formation from the Sierra del Rosario, western Cuba. *Acta Geol. Polon.*, 26: 321–330.

Nikolov, T., 1982. *Les ammonites de la familie Berriasellidae Spath, 1922, Tithonique supérieur – Berriasien*. Acad. Bulg. Sci., Sofia 251 pp.

Nuez, M. L. de la, 1972. Sobre la edad de los esquistos arcillosos rojizos en los alrededores del mogote Zacarias, provincia de Pinar del Río. *Actas ACC, Inst. Geol.*, 1: 19–20.

Nuez, M. L. de la, 1974. Sobre la edad de los esquistos arcillosos rojizos en los alrededores del mogote Zacarias, provincia de Pinar del Rio. *Contribucion a la geologia de Cuba. Publ. Especial.*, 2: 141–156.

Ogg, J. G., Steiner, M. B., Olóriz, F. & Tavéra, J. M., 1984. Jurassic magnetostratigraphy, 1. Kimmeridgian – Tithonian of Sierra Gorda and Carcabuey, southern Spain. *Earth Planet. Sci. Lett.*, 71: 147–162.

Olóriz, F., 1978. Kimmeridgiense-Tithonico Inferior en el Sector Central de las Cordilleras Beticas (Zona Subbetica), paleontologia, bioestratigrafia. *Tesis Doctorales Univ. Granada*, 184: 1–785.

Olóriz, F. & Tavera, J. M., 1981. Correlation of the Tithonian in the central sector of the Betic Coridilleras (Spain) in the light of recent studies. *Bull. Acad. Polon. Sci., Sér. Sci. Terre*, 30: 146–156.

Piotrowska, K., Pszczółkowski, A., Piotrowski, J., Myczyński, R., Rudnicki, J., Kuźniarski, M. Franco, G., Peñalver, L. & Perez, N., 1981. *Texto explicativo al mapa geologico de la provincia de Matanzas, a escala 1 : 250 000*. (Unpublished). Archivo Inst. Geol. Paleont. ACC, La Habana.

Pop. G., 1976. Tithonian–Valanginian calpionellid zones from Cuba. Dări de Seamă *de Sedimt., sér. 3 Paleont.*, 62 (1974–75): 237–266.

Pożaryska, K. & Brochwicz-Lewiński, W., 1975. The nature and origin of Mesozoic marine faunal provinces (some reflections). *Mitt. Geol. Palāont. Inst. Univ. Hamburg*, 44: 207–216.

Pszczółkowski, A., 1978. Geosynclinal sequences of the Cordillera de Guanguanico in western Cuba; their lithostratigraphy, facies development and paleogeography. *Acta Geol. Pol.*, 28: 1–96.

Pszczółkowski, A., 1981. El banco carbonatado jurásico de la Sierra de los Organos, Provincia de Pinar del Río, su desarollo y situación paleotectónica. *Ciencias de la Tierra y del Espacio*, 3: 37–50.

Pszczółkowski, A. 1982. Cretaceous sediments and paleogeography in the western part of the Cuban miogeosyncline. *Acta Geol. Polon.*, 32: 135–161.

Pszczółkowski, A. 1987. Paleogeography and paleotectonic evolution of Cuba and adjoining areas during the Jurassic–Early Cretaceous. *Ann. Soc. Geol. Polon.*, 57: 127–142.

Pszczółkowski, A., Piotrowska, K., Myczyński, R., Piotrowski, J., Skupiński, A., Grodzicki, J., Danielewski, D. & Haczewski, G., 1975. *Texto explicativo al mapa geológico a escala 1 : 250 000 de la provincia Pinar del Río.* (Unpublished). Inst. Geol. Paleont. ACC, La Habana.

Renz, O., Imlay, R., Lancelot, Y. & Ryan, W. B. F., 1975. Ammonite-rich Oxfordian Limestones from the base of the continental slope off northwest Africa. *Eclogae Geol. Helv.*, 68: 431–448.

Rigassi-Studer, D., 1963. Sur la géologie de la Sierra de los Organos, Cuba. *Arch. Sci. Soc. Phys. Hist. Nat. Genève.*, 16 (2): 339–350.

Sapunov, I. G., 1977. Ammonite stratigraphy of the Upper Jurassic in Bulgaria. IV. Tithonian: substages, zones and subzones. *Geol. Balc.*, 7 (2): 43–64.

Sapunov, I. G., 1979. *Fossilite na Bulgaria. III Jura Gorna. Ammonoidea.* pp. 1–263.

Scott, R.. W., 1986, Paleobiology of Early Cretaceous protocardiis, Caribbean Province. *J. Paleontol.*, 60: 1186–1211.

Shopov, V., 1975. *Informe sobre los estudios de los Ammonites del Jurasico y Cretácico Inferior en la parte norte de la provincia de Las Villas, Cuba.* In: Informe de geologia de la provincia de Las Villas. II: 9. Inst. Geol. Paleont. (Unpublished).

Shulgina, N. I., 1985. Borealnye basejny na rubezhe yury i mela. *Tr. VNIIO*, 13: 1–162. Leningrad.

Somin, L. F. & Millán, G., 1981. *Geologia metamorficheskikh kompleksov Kuby.* Nauka, Moskva, 219 pp.

Spath, L. F., 1927–1933. Revision of the Jurassic Cephalopod fauna of Kachh (Cutch), I–IV. *Palaeont. Indica*, 9 (2): 1–945.

Spath, L. F., 1950. A new Tithonian ammonite fauna from Kurdistan, northern Iraq. *Bull. Brit. Mus Nat. Hist.* 1: 95–137.

Sturani, C., 1971. Ammonites and stratigraphy of the "*Posidonia alpina*" Beds of the Venetian Alps. *Mem. Inst. Geol. Miner. Univ. Padova*, 28: 1–190.

Tavera, I. M., 1985. Ammonites del Tithonico Superior–Berriasense de la Zona Subbetica. *Tesis Univ. Granada*, 381 pp., 49 pl.

Taylor, D. G., Callomon, J. H., Hall, R., Smith, P. L., Tipper, H. W. & Westermann, G. E. G., 1984. Jurassic ammonite biogeography of western North America; the tectonic implications. *Circum-Pacific Jurassic Research Group Project 171, Report 2.* Hamilton, Ontario: 113–116.

Thiadens, A. A., 1937. Geology of the southern part of the province Santa Clara (Las Villas), Cuba. *Geogr. Geol. Mededeel. Phys. Geol. Reeks.*, 12: 1–69.

Thompson, M. R. A., 1971. Ammonite faunas of south-eastern Alexander Island and their stratigraphic significance. In: Adie, R. J. (ed.), *Antarctic Geology and Geophysics.* Universitetsforlaget, Oslo, pp. 155–160.

Thompson, M. R. A., 1979. Upper Jurassic and Lower Cretaceous ammonite faunas of the Ablation Point area, Alexander Island. *Brit. Antarc. Surv. Sci. Rep.*, 97: 1–37.

Torre, A. de la, 1972–1975. *Informe de los estudios micropaleontologicos de la provincia de Pinar del Río.* (Unpublished). Inst. Geol. Paleont. ACC, La Habana.

Torre, A. de la, 1978–1983. *Informes de los estudios micropaleontologicos en las provincias de Pinar del Río y Matanzas.* (Unpublished). Inst. Geol. Paleont. ACC, La Habana.

Uhlig, V., 1903–1910. Hymalayan fossils. The fauna of the Spiti Shales. *Mem Geol. Surv. India, Palaeont. Indica*, 15, 4 (1–3), 511 pp.

Uhlig, V., 1911. Die marinen Reiche des Jura und der Unterkreide *Mitt. Geol. Ges. Wien*, 4 (3): 329–448.

Vašiček, Z., 1982. Hlavonožcová fauna z locality Rošt u Kroměříže (spodni Tithon). *Sbor. Věd. Prac. Vys. Škol. Baňske v Ostravě*, 28 (1): 91–110.

Verma, H. M. & Westermann, G. E. G., 1973. The Tithonian (Jurassic) Ammonite fauna and stratigraphy of Sierra Catorce, San Luis Potosi, Mexico. *Bull. Am. Paleont.*, 63: 107–314.

Vígh, G., 1984. Néhány Bankonyi (Titon) és Gerecsei (Titon–Berriázi) Lelőhely Ammonited-Faunájanak Biostretigráfiai Értékelése. *Ann. Inst. Geol. Publ. Hung.*, 67: 1–210.

Westermann, G. E. G., 1981. The Upper Bajocian and Lower Bathonian (Jurassic) ammonite faunas of Oaxaca and West-Tethyan affinities. *Paleont. Mexic.*, 46: 1–63.

Westermann, G. E. G., 1984. The Middle Jurassic Proto-Atlantic and Atlantic. *Circum-Pacific Jurassic Research Group Project 171, Report 2.* Hamilton, Ontario: 107 p.

Westermann, G. E. G. & Riccardi, A. C., 1976. Middle Jurassic ammonite distribution and affinities of the Andean fauna. *Congr. Geol. Chileno*, I (1), C23–39.

Westermann, G. E. G., & Riccardi, A. C., 1984. Middle Jurassic ammonite evolution in the Andean Province and emigration to Tethys. *A contribution to Project No 171. Circum-Pacific Jurassic*, Hamilton, Ontario: 6–34.

Wiedmann, J., 1975. The Jurassic-Cretaceous boundary as one of the Mesozoic system boundaries. In: Colloque sur la Limite Jurassique-Crétacé, Lyon, Neuchatel, Septembre 1973. *Mem. BRGM*, 86: 358–362.

Wiedmann, J., 1980. Paläogeographie und stratigraphie im Grenzbereich Jura/Kreide Südamerikas. *Münster. Forsch. Geol. Paläont.*, 51: 27–61.

Wierzbowski, A., 1976. Oxfordian Ammonites of Pinar del Río province (western Cuba): their revision and stratigraphical significance. *Acta Geol. Polon.*, 26: 137–260.

Zakharov, W. A., 1981. *Bukhidy i biostratigrafija borealnoj verkhnei yury i neokoma.* Nauka, Moskva, 270 pp.

Zeiss, A., 1968. Untersuchungen zur Paläontologie der Cephalopoden des Unter-Tithon der Südlichen Frankenalb. *Abh. Bayer. Akad. Wiss., Math. Naturw. KL., N. F.*, 132: 1–190.

Zeiss, A. 1983. Zur Frage der Äquivalenz der Stuffen Tithon/Berias/Portland in Eurasien und America. *Zitteliana*, 10: 427–438.

Zeiss, A., 1984. Upper Jurassic/Cretaceous boundary. In: Westermann, G. E. G. (ed.), Jurassic-Cretaceous Biochronology and Paleogeography of North America. *Geol. Ass. Can. Spec. Pap.*, 27: 101–103.

Zeiss, A., 1986. Comments on a tentative correlation chart for the most important marine provinces at the Jurassic/Cretaceous boundary. *Acta Geol. Hung.*, 29: 27–30.

Zittel, K. A., 1870. Die Fauna der älteren Cephalopoden-führenden Tithonbildungen. *Palaeontographica, Suppl.*, 2, 1: 1–192.

Resumen

BIOESTRATIGRAFÍA DEL TITHONIANO DE CUBA OCCIDENTAL EN LA BASE DE LOS AMMONITES

Ryszard Myczyński

La tarea principal de este trabajo es la elaboración bioestratigráfica de los sedimentos del Tithoniano de Cuba Occidental en la base de los ammonites, asi como también en la base de los resultados de las investigaciones microfaunisticas (Torre, de la, 1972–1975, 1978–1983). Los ammonites descritos en

este trabajo fueron recolectados en doce perfiles de los sedimentos del Tithoniano que afloran en la región de la Sierra de los Organos y la Sierra del Rosario en la provincia de Pinar del Río (Fig. 1–15).

En la región de la Sierra de los Organos los sedimentos del Tithoniano son representados por las calizas y esquistos del Miembro El Americano de la Formación Guasasa (Fig. 2), mientras que en la Sierra del Rosario estos pertenecen al Miembro La Zarza de la Formación Artemisa. Litológicamente los sedimentos de ambos miembros presentan alguna semejanza.

Los ammonitos encontrados en los sedimentos del Tithoniano de Cuba Occidental (Pl. I–XVII), a veces son mal preservados, pero tienen un gran valor estratigráfico como resultado de la poca presencia de la microfauna en estos sedimentos (Torre, de la, 1972–1975; 1978–1983). En total fueron estudiados 143 ejemplares pertenecientes a las 9 familias, 26 generos y 42 especies. Una de estas especies fué designada como nueva. Como más frecuentes ammonites del Tithoniano de Cuba Occidental son los representantes de las familias Haploceratidae (42,0%) y Perisphinctidae (20,0%). Menos frecuentes son los ammonites de las familias Simoceratidae, Phylloceratidae, Oppeliidae, Aspidoceratidae, Olcostephanidae, Berriasellidae y Ancyloceratidae.

En el Tithoniano Inferior de la Sierra de los Organos fueron distinguidos las siguientes zonas faunísticas: *Mazapilites* (*taxon-range-zone*); *Virgatosphinctes*, *Pseudolissoceras* e "*Subplanites*" (*assemblage-zone*), asi como la zona *Lytohoplites carribeanus* (*taxon-range-zone*) (Fig. 14. 15). En los sedimentos de la misma edad en la Sierra del Rosario fué posible distinguir solamente las zonas *Virgatosphinctes*, *Pseudolissoceras* e *Simocosmoceras* (*assemblage zone*) y *Lytohoplites carribeanus* (*taxon-range-zone*). En el Tithoniano Superior de la Sierra de los Organos han dividido una zona *Proniceras*, *Kossmatia*, *Durangites* e *Corongoceras* (*assemblage-zone*) y una zona llamada *Protancyloceras hondense – Vinalesites rosariensis* (*acme-zone*). En la Sierra del Rosario sus equivalentes son: la zona *Durangites*, *Dickersonia*, *Micracanthoceras* e *Corongoceras* (*assemblage-zone*) y también la zona *Protancyloceras hondense – Vinalesites rosariensis* (*acme-zone*).

En este trabajo fué utilizada la división del Tithoniano para el Tithoniano Inferior y el Tithoniano Superior como una división de este piso más adecuada para la América. Como límite inferior del Tithoniano Superior fué indicado el lugar donde por primera vez aparecen los ammonites de la subfamilia Himalayitinae junto con la massiva aparicion de los ammonites del subgénero *Hildoglochiceras* (*Salinites*). Límite superior del Tithoniano fué puesto en las capas que ya no llevan los ammonites de los géneros *Protancyloceras* y *Vinalesites* y todavia no aparece en ellas la microfauna del Berriassiano.

El análisis de la fauna del Tithoniano de Cuba Occidental y los datos de la literatura existente, sirvieron como la base para sugerir que esta fauna, en el Jurásico Tardío (y en el Cretácico Temprano) pertenecía a una provincia zoogeográfica llamada provincia caribeña (o del Caribe) (Westermann, 1984).

Esta provincia (Fig. 16–21) abarcaba Cuba, Mexico, y el Sur de los Estados Unidos. La migración de los ammonites hacia esta provincia, en el Jurásico Tardío (y en el Cretácico Temprano), provenía de la provincia andina y en algunos tiempos desde la Tethys Occidental. La migración desde la Tethys Occidental hacia la provincia andina, y a veces hacia la provincia caribeña, occurría por el corredor hispanico, una vía hipotética que podía existir en el Jurásico Tardío y en el Cretácico Temprano como la consecuencia de la deriva del Atlántico (Fig. 19–20). La comparación de los ammonites del Tithoniano de Cuba Occidental (Pl. I–XIV; Fig. 22, 23) con los de las provincias vecinas sugiere que esta vía podía ser más efectiva para la provincia caribeña en el Tithoniano Temprano cuando la migración hacia Cuba podía ocurrir en forma directa por la zone donde actualmente ubica la plataforma de las Florida-Bahamas.

Streszczenie

BIOSTRATYGRAFIA AMONITOWA TYTONU ZACHODNIEJ KUBY

Ryszard Myczyński

Praca przedstawia biostratygrafię tytonu zachodniej Kuby opracowaną na podstawie amonitów. Wykorzystano w niej także wyniki badań mikrofauny (Torre, de la, 1972–1975; 1978–1983). Opisane w pracy amonity zebrano w dwunastu profilach tytonu w prowincji Pinar del Rio (zachodnia Kuba) (Fig. 1–15). W prowincji tej znajdują się dwa regiony geologiczne: Sierra de los Organos i Sierra del Rosario należące do kordyliery Guaniguanico. Region Sierra de los Organos zajmuje zachodnią część kordyliery. Utwory tytońskie są w nim reprezentowane przez wapienie i łupki ogniwa El Americano formacji Guasasa (Fig. 2), podczas gdy w Sierra del Rosario stanowią je utwory ogniwa La Zarza formacji Artemisa o litologii zbliżonej do ogniwa El Americano (Houša, 1974; Pszczółkowski *et al.*, 1975; Pszczółkowski, 1978). Występująca w tych utworach fauna jest podobna i różni się tylko w szczegółach. Została ona odniesiona do tytonu dolnego i tytonu górnego w dwudzielnym podziale tego piętra.

Opracowane amonity (Pl. I–XIV) często są źle zachowane, mają jednak istotne znaczenie stratygraficzne, gdyż występujące w utworach tytońskich zachodniej i centralnej Kuby (Pl. XV–XVII) mikroskamieniałości są również często źle zachowane (Torre, de la, 1972–1975, 1978–1983). Opracowano 143 okazy amonitów należących do 9 rodzin, 26 rodzajów i 42 gatunków. Jeden gatunek (*Simocosmoceras pszczolkowskii* n. sp.) wskazano jako nowy. Najczęściej spotykanymi amonitami są przedstawiciele rodzin Haploceratidae (42,0%) i Perisphinctidae (20,0%), mniej licznie występują Simoceratidae, Phylloceratidae, Olcostephanidae, Berriasellidae, Aspidoceratidae, Oppeliidae i Ancyloceratidae.

W dolnym tytonie Sierra de los Organos wyróżniono następujące poziomy amonitowe: poziom zasięgu *Mazapilites* (najstarszy), poziom zespołowy *Vir-*

gatosphinctes, *Pseudolissoceras* i "*Subplanites*" oraz poziom zasięgu *Lytohoplites carribeanus* (najmłodszy) (Fig. 14, 15). W analizowanych utworach Sierra del Rosario nie stwierdzono poziomu *Mazapilites*, wyróżniono natomiast poziom zespołowy *Virgatosphinctes*, *Pseudolissoceras* i *Simocosmoceras* (starszy) oraz poziom zasięgu *Lytohoplites carribeanus* (młodszy). W utworach górnego tytonu Sierra de los Organos wyróżniono poziom zespołowy *Proniceras*, *Kossmatia*, *Durangites* i *Corongoceras* oraz poziom rozkwitu *Protancyloceras hondense* — *Vinalesites rosariensis*. Poziomom tym w Sierra del Rosario odpowiadają: poziom zespołowy *Durangites*, *Dickersonia*, *Micracanthoceras* i *Corongoceras* oraz poziom rozkwitu *Protancyloceras hondense* — *Vinalesites rosariensis*.

Jako granicę tytonu dolnego i górnego przyjęto miejsce pojawienia się amonitów z podrodziny Himalayitinae jak też pierwsze masowe wystąpienie amonitów z podrodzaju *Hildoglochiceras* (*Salinites*). Za górną granicę utworów tytońskich przyjęto warstwy, w których nie występują już amonity z rodzajów *Protancyloceras* i *Vinalesites*, przy jednoczesnym braku w nich kalpionellidów wskazujących na kredę dolną (berias). W niektórych profilach, zwłaszcza w Sierra del Rosario, amonity z rodzajów *Protancyloceras* i *Vinalesites* mogą przekraczać granicę tytonu (Myczyński, 1977; Pszczółkowski, 1978).

W wyniku przeprowadzonej analizy fauny tytońskiej zachodniej Kuby, jak też na podstawie danych z literatury dotyczących amonitów górnej jury i dolnej kredy tego regionu przyjęto, iż fauna ta należała do zoogeograficznej prowincji karaibskiej (Westermann, 1984). Prowincja ta (Fig. 16—21) obejmowała w późnej jurze (i wczesnej kredzie) obszar Kuby, Meksyku i południa Stanów Zjednoczonych.

Migracja fauny na obszar zachodniej Kuby w późnej jurze i wczesnej kredzie odbywała się z terenu prowincji andyjskiej poprzez obszar Meksyku (Imlay, 1980; Fig. 19—20). Z kierunku zachodniej Tetydy migracja na obszar prowincji andyjskiej, a także, być może, w pewnych okresach, na teren prowincji karaibskiej odbywała się drogą Protoatlantycką, czyli drogą morską powstałą w wyniku rozsuwania się Atlantyku (tzw. "hispanic corridor"). Porównanie amonitów tytonu zachodniej Kuby (Pl. I—XIV, Fig. 22, 23) z amonitami prowincji sąsiednich sugeruje, iż droga ta mogła być bardziej efektywna zwłaszcza we wczesnym tytonie, kiedy migracja amonitów mogła się odbywać bezpośrednio przez teren obecnie zajmowany przez platformę florydzko-bahamską.

EXPLANATIONS OF PLATES

In most figures taxon names are followed by specimen numbers, section symbols, age, and magnification.

Plate I

1 — *Holcophylloceras* cf. *zignodianum* (d'Orbigny), MR-CI/16, C-HA, Lower Tithonian, × 1
2 — *Pseudolissoceras zitteli* (Burckhardt), MR-CII-8, C-HA, Lower Tithonian, × 1
3 — *Haploceras* aff. *transatlanticum* Burckhardt, P-CII-1, C-HA, Lower Tithonian, × 1.5

4 – *Hildoglochiceras* (*Salinites*) *grossicostatum* Imlay, MR-25, A-HA, Upper Tithonian, ×1.5
5 – *Neochetoceras* sp. aff. *N. mucronatum* Berckhemer – Hölder, MR-CI-1, C-HA, Lower Tithonian, ×1.6
6 – *Neochetoceras* sp. aff. *N. steraspis* (Oppel), MR-CI-2, C-HA, Lower Tithonian, ×1.1
7 – *Glochiceras*(?) sp. AM-25/8, A-HA, Lower Tithonian, ×2.1
8–10 – *Neochetoceras* sp. aff. *N. steraspis* (Oppel). 8 – MR-CII-7, C-HA, Lower Tithonian, ×1.2; 9 – MR-CI-18, C-HA, Lower Tithonian, ×2; 10 – MR-CII-8, C-HA, Lower Tithonian, ×1.1

Plate II

1–3 – *Mazapilites zitteli* (Burckhardt). 1 – MR-B-2, B-HA, Lower Tithonian, ×1.5; 2 – MR-B-3, B-HA, Lower Tithonian, ×1.5; 3 – MR-CII-1, C-HA, Lower Tithonian, ×2
4 – *Mazapilites* sp. A, MR-B-4, B-HA, Lower Tithonian, ×0.7
5 – *Mazapilites zitteli* (Burckhardt), MR-CI-2, C-HA, Lower Tithonian, ×1
6 – *Haploceras*(?) aff. *H. veracruzanum* Cantú Chapa, AM-25/1, A-HA, Upper Tithonian, ×1.3
7 – *Haploceras*(?) n. sp., VA-5, VA Upper Tithonian, ×1.5
8 – *Haploceras*(?) aff. *H. veracruzanum* Cantú Chapa, AM-25/2, A-HA, Upper Tithonian, ×2
9 – *Haploceras*(?) n.sp., VA-6, VA, Upper Tithonian, ×1
10–13 – *Hildoglochiceras* (*Salinites*) *grossicostatum* Imlay, 10 – VA-7, VA, microcon., Upper Tithonian, ×1; 11 – MR-25-8, A-HA, macrocon., Upper Tithonian, ×1; 12 – MR-25-9, A-HA, macrocon., Upper Tithonian, ×1; 13 – MR-25-9a, A-HA, macrocon., Upper Tithonian, ×1

Plate III

1–3 – *Hildoglochiceras* (*Salinites*) *grossicostatum* Imlay. 1 – MR-25-10, A-HA, macrocon., Upper Tithonian, ×1; 2 – MR-25-11, A-HA, macrocon., Upper Tithonian, ×1; 3 – VA, macrocon., Upper Tithonian, ×1
4 – *Haploceras*(?) aff. *H. veracruzanum* Cantú Chapa, AM-25/4, A-HA, Upper Tithonian, ×1.8
5 – *Hildoglochiceras* (*Salinites*) *grossicostatum* Imlay, MR-B-15, B-HA, macrocon., Upper Tithonian, ×1
6 – *Hildoglochiceras* (*Salinites*) sp. aff. *H.* (*S*) *alamense* Imlay, MR-25-23, A-HA, Upper Tithonian, ×1
7 – *Hildoglochiceras* (*Salinites*) *bicostatum* (Chudoley et Furrazola), MR-25-22, A-HA, Upper Tithonian, ×1.1
8–9 – *Hildoglochiceras* (*Salinites*) *grossicostatum* Imlay. 8 – MR-25-18, A-HA, macrocon., Upper Tithonian, ×1.5; 9 – MR-25-13, A-HA, macrocon., Upper Tithonian, ×1
10–11 – *Haploceras*(?) aff. *Haploceras veracruzanum* Cantú Chapa. 10 – VA-2, VA, Upper Tithonian, ×1.5; 11 – VA-3, VA, Upper Tithonian, ×1.5
12 – *Hildoglochiceras* (*Salinites*) *grosicostatum* Imlay, MR-25-15, A-HA, Upper Tithonian, ×1.3
13 – *Haploceras*(?) aff. *H. veracruzanum* Cantú Chapa, AM-25-3, A-HA, Upper Tithonian, ×2
14 – *Hildoglochiceras* (*Salinites*) sp., SC-1, SC, Upper Tithonian(?), ×1
15 – *Hildoglochiceras* (*Salinites*) n. sp., VA-13, VA, Upper Tithonian, ×1.3
16 – *Hildoglochiceras* (*Salinites*) *grossicostatum*, VA-10, VA, microconch., Upper Tithonian, ×1
17 – *Haploceras*(?) aff. *H. veracruzanum* Cantú Chapa, A-27c, A-HA, Upper Tithonian, ×1.5

Plate IV

1–2 – *Hildoglochiceras* (*Salinites*) *grossicostatum*. 1 – VA-8, VA, microconch., Upper Tithonian, ×1; 2 – VA-9, VA, microconch., Upper Tithonian, ×1

3–4 – *Haploceras*(?) aff. *H. veracruzanum* Cantú Chapa. 3 – AM-25/4, A-HA, Upper Tithonian, ×2; 4 – AM-25/6, A-HA, Upper Tithonian, ×1
5 – *Virgatosimoceras*(?) sp. VA-17, VA, Upper Tithonian(?), ×1.3
6 – *Durangites* sp., MR-25-35, A-HA, Upper Tithonian, ×1.5
7 – *Buchia* aff. *B. piochii* (Gabb) *s. lato*, MR-25-48, A-HA, Upper Tithonian, ×1
8 – *Hemisimoceras*(?) sp. MR-25-29 (*a*), *Hildoglochiceras* (*Salinites*) sp. aff. *H.* (*S.*) *alamense* Imlay, MR-25-24 (*b*); A-HA, Upper Tithonian, ×1.5
9 – *Protancyloceras* sp. aff. *P. gracile* (Oppel), MR-B-17, B-HA, Lower Tithonian, ×1.3
10 – *Hemisimoceras* aff. *H. semistriatum* Spath, MR-25-26 (*a*), *Hildoglochiceras* (*Salinites*) grossicostatum, MR-25-9, macrocon. (*b*); A-HA, Upper Tithonian, ×1
11 – *Hildoglochiceras* (*Salinites*) *grossicostatum*, macrocon. (*a*, *b*): MR-25-17 (*a*), MR-25-8, (*b*): *Himalayites* n. sp., MR-25-42 (*c*, *d*); A-HA, Upper Tithonian, ×1

Plate V

1 – *Lithacoceras*(?) sp., MR-B-7, B-HA, Lower Tithonian, ×1
2 – "*Virgatosphinctes*" sp., MR-CI-8a, C-HA, Lower Tithonian, ×1.4
3 – *Lytohoplites carribeanus* Imlay, MR-B-15, B-HA, Lower Tithonian, ×1.2
4 – *Torquatisphinctes* sp. aff. *T. torquatus* Sowerby, MR-T-2, T, Lower Tithonian, ×1.2
5 – *Hemisimoceras*(?) sp., MR-25-28, A-HA, Upper Tithonian(?), ×1.2
6 – "*Subplanites*" sp., ST-4, ST, Lower Tithonian, ×1.2
7 – *Mazapilites* sp. A, MR-CII-6, C-HA, Lower Tithonian, ×1.1
8 – *Pseudolissoceras zitteli* Burckhardt, B-4a, B-HA, Lower Tithonian, ×1

Plate VI

1 – *Corongoceras* sp., MR-28-5, MR-28, Upper Tithonian, ×1.3
2 – *Pseudolissoceras zitteli* Burckhardt, LF-6, LF, Lower Tithonian, ×1.6
3–4 – *Virgatosphinctes* cf. *cristobalensis* Imlay, LF- 7 (3), LF-8 (4); LF, Lower Tithonian, ×1.4
5 – A fragment of nodular limestone with ammonites, section ŚC, Upper Tithonian(?), ×1.3

Plate VII

1 – *Pseudoinvoluticeras* sp. cf. *P. mozambicum* Collignon, MR-C-5, C-HA, Lower Tithonian, ×1.5
2 – "*Virgatosphinctes*" *pinarensis* Chudoley et Furrazola, MR-B-10, Lower Tithonian, ×1.5
3 – *Proniceras* sp. cf. *P. subpronum* Burckhardt, MR-25-33, A-HA, Upper Tithonian, ×1.3
4 – *Nebrodites* (*Mesosimoceras*?) sp., T-2, T, Lower Tithonian, ×0.8
5 – *Pachysphinctes*(?) sp., MR-T-2a, T, Lower Tithonian, ×1.3
6 – *Buchia* aff. *B. okensis* (Pavlow), *s. lato*, MR-25-50, A-HA, Upper Tithonian, ×1.3

Plate VIII

1 – "*Virgatosphinctes*" sp. aff. *V. denseplicatus* (Waagen), MR-B-11, B-HA, Lower Tithonian, ×1
2 – *Nebrodites* (*Mesosimoceras*) sp., MR-B-4, B-HA, Lower Tithonian, ×1.3
3 – *Pseudoinvoluticeras* sp. cf. *P. mozambicum* Collignon, MR-CIa, C-HA, Lower Tithonian, ×0.7
4 – *Simocosmoceras pszczolkowskii* n. sp., holotype, LF-1, LF, Lower Tithonian, ×2
5 – *Aulacosphinctoides*(?) sp., LF-9, LF, Lower Tithonian, ×2.3
6 – "*Virgatosphinctes*" *pinarensis* Chudoley et Furrazola, MR-B-13, B-HA, Lower Tithonian, ×1

7 – "*Virgatosphinctes*" sp. B, MR-CI-7, C-HA, Lower Tithonian, ×1.1
8 – *Hildoglochiceras* (*Salinites*) *gallardoi* (Chudoley et Furrazola), VA-10, VA, Upper Tithonian, ×1.3

Plate IX

1–2 – *Lytohoplites carribeanus* Imlay, MR-CI-9, C-HA, Lower Tithonian, ×1.5
3 – *Lytohoplites*(?) sp., MR-CI-11, C-HA, Lower Tithonian, ×1.2
4 – *Micracanthoceras* sp. cf. *M. alamense* Imlay, MR-25-24, A-HA, Upper Tithonian, ×2
5 – *Pseudoinvoluticeras* sp. cf. *P. mozambicum* Collignon, MR-B-14, B-HA, Lower Tithonian, ×1.5
6 – *Pseudoinvoluticeras*(?) sp. MR-B-9, B-HA, Lower Tithonian, ×1.1
7 – *Lytohoplites carribeanus* Imlay, LF-2, LF, Lower Tithonian, ×1
8 – *Lytohoplites*(?) sp. MR-CI-12, C-HA, Lower Tithonian, ×1
9 – *Micracanthoceras* sp. cf. *M. acanthellum* Imlay, MR-CI-11, C-HA, Upper Tithonian, ×0.9
10 – "*Virgatosphinctes*" *pinarensis* Chudoley et Furrazola, MR-CI-4b (*a*), *Pseudolissoceras zitteli* Burckhardt, MR-C-4a (*b*); C-HA, Lower Tithonian, ×0.4
11 – *Lytohoplites* sp., MR-CI-10, C-HA, Lower Tithonian, ×1.2

Plate X

1 – *Lithacoceras*(?) sp., SCb-1, SCb, Lower Tithonian, ×0.4
2 – *Lytohoplites carribeanus* Imlay, MR-B-15, B-HA, Lower Tithonian, ×1
3 – *Schaireria* sp., MR-28-2, MR-28, Lower Tithonian, ×0.55
4 – *Simocosmoceras pszczolkowskii* n. sp., cast of holotype, LF-7 (*a*), *Pseudolissoceras zitteli* Burckhardt (*b*); LF, Lower Tithonian, ×1.3
5 – *Simocosmoceras pszczolkowskii* n. sp., LF-2, LF, Lower Tithonian, ×1.3
6 – "*Virgatosphinctes*" *pinarensis* Chudoley et Furrazola, MR-B-14, B-HA, Lower Tithonian, ×1
7 – *Buchia* aff. *B. okensis* (Pavlow), MR-25-49, A-HA, Upper Tithonian, ×1

Plate XI

1 – "*Virgatosphinctes*" *pinarensis* Chudoley et Furrazola, MR-B-12, B-HA, Lower Tithonian, ×1.1
2 – *Corongoceras* cf. *cordobai* Verma and Westermann, ST-6, ST, Upper Tithonian, ×1.2
3–4 – *Durangites* sp., MR-25-37 (*3*), MR-25-38 (*4*); A-HA, Upper Tithonian, ×2
5 – *Proniceras* sp. cf. *P. subpronum* Burckhardt, MR-25-33, A-HA, Upper Tithonian, ×1.5
6 – *Micracanthoceras* sp. cf. *M. acanthellum* Imlay, P-CI-8a, C-HA, Upper Tithonian, ×0.4
7 – *Aulacosphinctes*(?) sp., ST-4, ST, Upper Tithonian, ×0.8
8 – *Haploceras*(?) aff. *H. veracruzanum* Cantú Chapa, A/27cd, A-HA, Upper Tithonian, ×1
9 – *Protancyloceras*(?) sp. A, CG-1, Upper Tithonian – ?Berriasian, ×1

Plate XII

1 – "*Virgatosphinctes*" sp. A, MR-CI-16, C-HA, Lower Tithonian, ×1.1
2 – "*Virgatosphinctes*" sp., MR-24-1, MR-24, Lower Tithonian, ×1
3 – *Aulacosphinctoides* sp. cf. *A. infundibulum* Uhlig, MR-B-6 (*a*), MR-B-5 (*b*); *Haploceras* aff. *transatlanticum* Burckhardt, MR-B/6c (*c*); *Protancyloceras* sp. aff. *P. gracile* (Oppel), MR-B-18 (*d*); B-HA, Lower Tithonian, ×1.2
4 – "*Virgatosphinctes*" sp., MR-28-1, MR-28, Lower Tithonian, ×1
5 – "*Virgatosphinctes*" sp. aff. *V. denseplicatus* (Waagen), MR-CI-5, C-HA, Lower Tithonian, ×1
6 – *Pachysphinctes*(?) sp., MR-T-2, T, Lower Tithonian, ×1
7 – *Vinalesites rosariensis* (Imlay) (*a*), *Aulacosphinctes*(?) sp., LC-1 (*b*); LC, Upper Tithonian, ×1.2

8 – *Buchia* aff *B. okensis* (Pavlow), VA-17, VA, Upper Tithonian, ×1
9 – *Proniceras* sp. cf. *P. subpronum* Burckhardt, MR-25-35, A-HA, Upper Tithonian, ×0.5

Plate XIII

1 – *Aulacosphinctoides* sp., MR-CI-13, C-HA, Lower Tithonian, ×0.9
2 – *Himalayites* n. sp., MR-25-40, A-HA, Upper Tithonian, ×1.3
3 – *Kossmatia* sp. cf. *K. alamitosensis* (Aguilera), MR-25-30, A-HA, Upper Tithonian, ×2
4 – *Himalayites* n. sp., MR-25-41, A-HA, Upper Tithonian, ×1.3
5 – *Durangites* n. sp., MR-25-38, A-HA, Upper Tithonian, ×2
6 – *Himalayites* n. sp., MR-25-40, A-HA, Upper Tithonian, ×2.5
7 – *Durangites* n. sp., MR-25-38, A-HA, Upper Tithonian, ×2
8–9 – *Durangites* aff. *D. humboldti* Burckhardt, MR-25-44, A-HA, Upper Tithonian, ×1.6
10 – *Himalayites* n. sp., MR-25-41, A-HA, Upper Tithonian, ×2.4
11 – Coquinoid limestone with ammonites, A-HA, Upper Tithonian, ×1.2

Plate XIV

1 – *Phanerostephanus* sp. aff. *antsalovensis* Collignon, VA-15 (*a*); *Hildoglochiceras* (Salinites) sp., VA-15c (*b*); VA, Upper Tithonian, ×1
2 – *Phanerostephanus* sp. aff. *antsalovensis* Collignon, VA-15 (ventral side), VA, Upper Tithonian, ×1
3 – *Phanerostephanus* sp. aff. *antsalovensis* Collignon, VA-15 (*a*); *Durangites* sp. aff. *acanthicus* Burckhardt, VA-15b (*b*); VA, Upper Tithonian, ×1.2
4 – *Hildoglochiceras*(?) (*Salinites*) aff. *H. ecarinatum* Imlay, VA-12, VA, Upper Tithonian, ×1.2
5 – *Hildoglochiceras* (*Salinites*) aff. *H. inflatum* Imlay, VA-11, VA, Upper Tithonian, ×1
6–7 – *Haploceras*(?) aff. *H. veracruzanum* Cantú Chapa, VA-1, VA, Upper Tithonian, ×1
8 – *Kossmatia* cf. *bifurcata* (Aquilera), VA-14, VA, Upper Tithonian, ×1
9 – *Durangites* sp. aff. *D. acanthicus* Burckhardt, MR-25-45, A-HA, Upper Tithonian, ×1
10 – *Haploceras*(?) aff. *H. veracruzanum* Cantú Chapa, VA-4, VA, Upper Tithonian, ×0.8

Plate XV

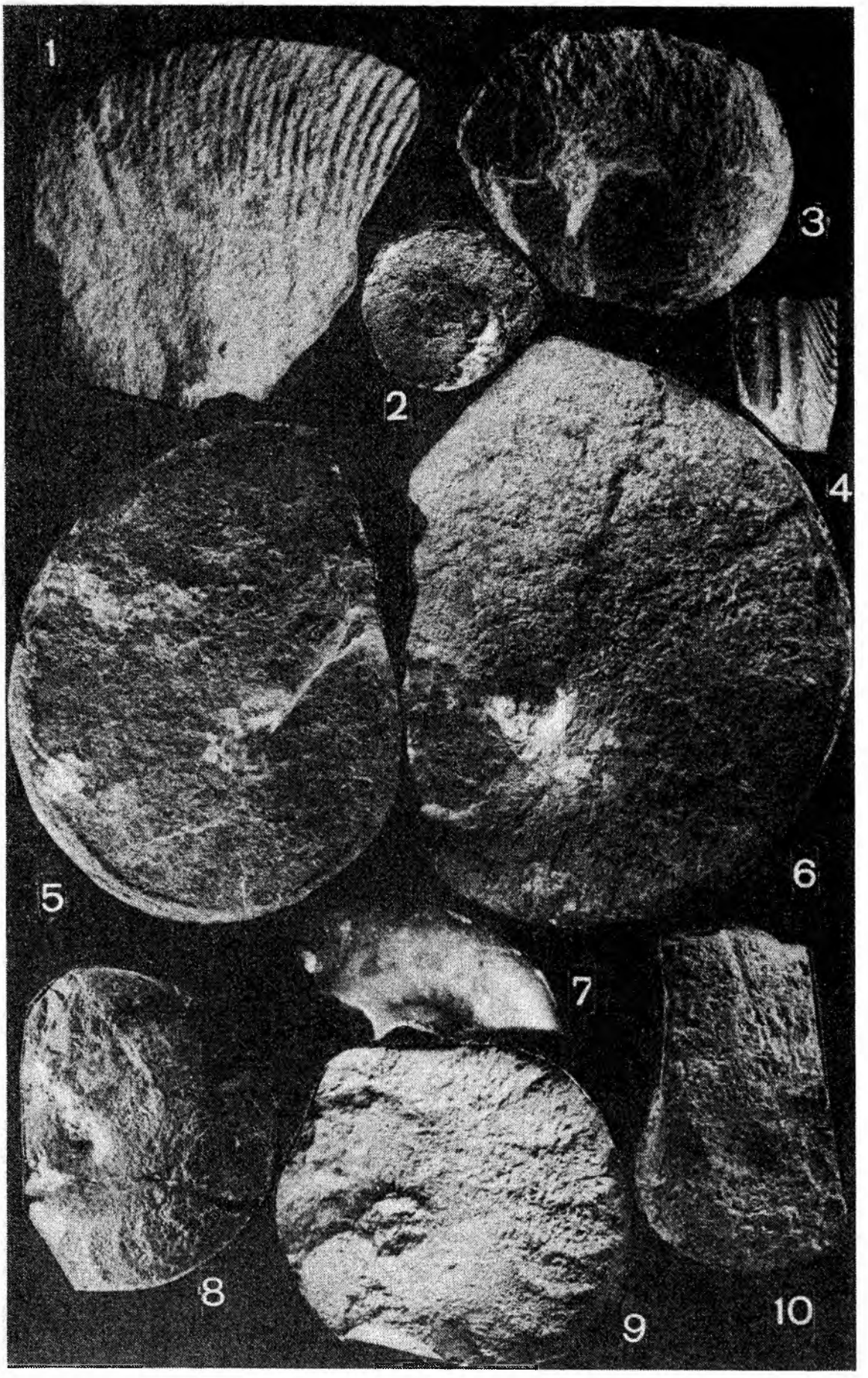
1 – Coquinoid limestone with juvenile ammonite shell in pelmicrite. The shell is filled with sparry calcite, micrite intraclasts, and peloids. Section VA, Upper Tithonian, ×16
2 – Pelsparite with ammonite shells and chlorite. Section VA, Upper Tithonian, ×16
3 – Micritic limestone with calpionellids and ammonite shell. Section SC, Upper Tithonian, ×16
4 – *Saccocoma* microfacies in micritic limestone. Section B-HA, Lower Tithonian, ×16
5 – Microcrystalline matrix and carbonate material in biomicritic limestone. Section B-HA, Lower Tithonian, *Mazapilites* spp. Zone, ×16
6 – Micritic limestone with *Saccocoma*. Section B-HA, Lower Tithonian, ×16

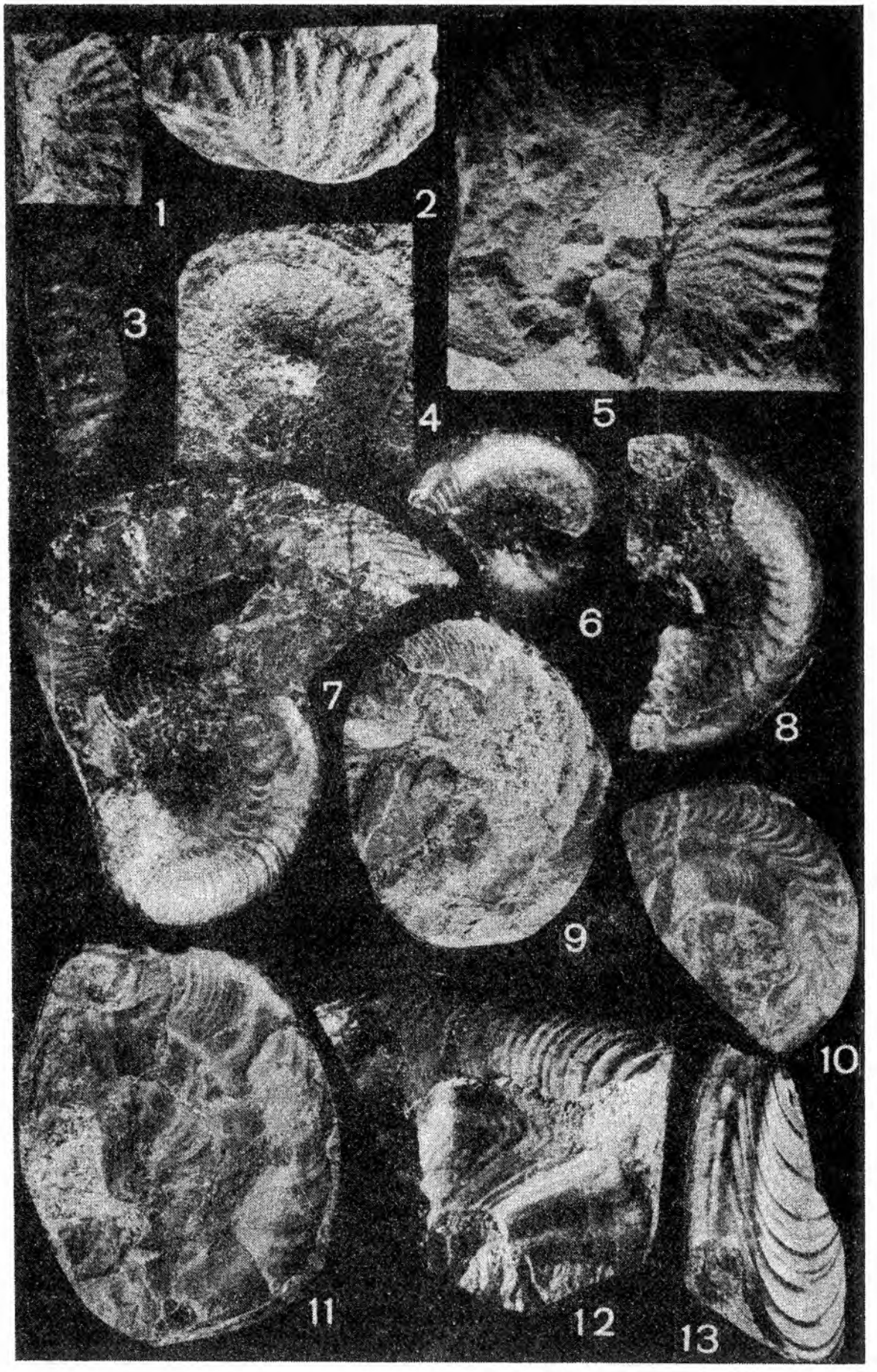
Plate XVI

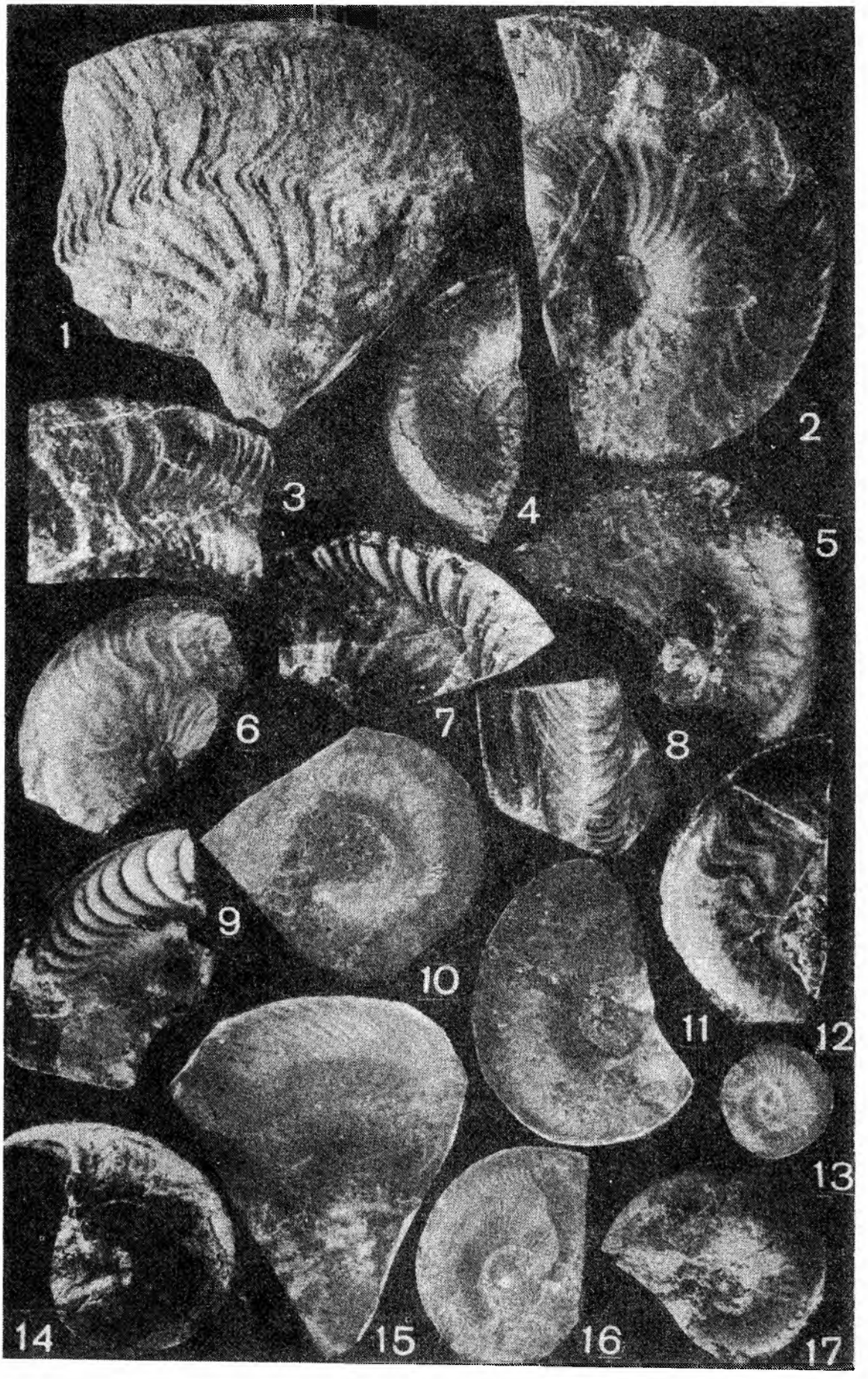
1 – Mogote range Sierra de Guasasa, Valle de Viñales, Sierra de los Organos. *J/Pm/* – Pimienta Member of Jagua Formation, *G/Sv/* – San Vicente Member of Guasasa Formation (Phot. M. Myczyńska)
2 – Micritic limestone intercalated with shale. Guasasa Formation, upper part of El Americano Member, Section A-HA, Upper Tithonian

Plate XVII

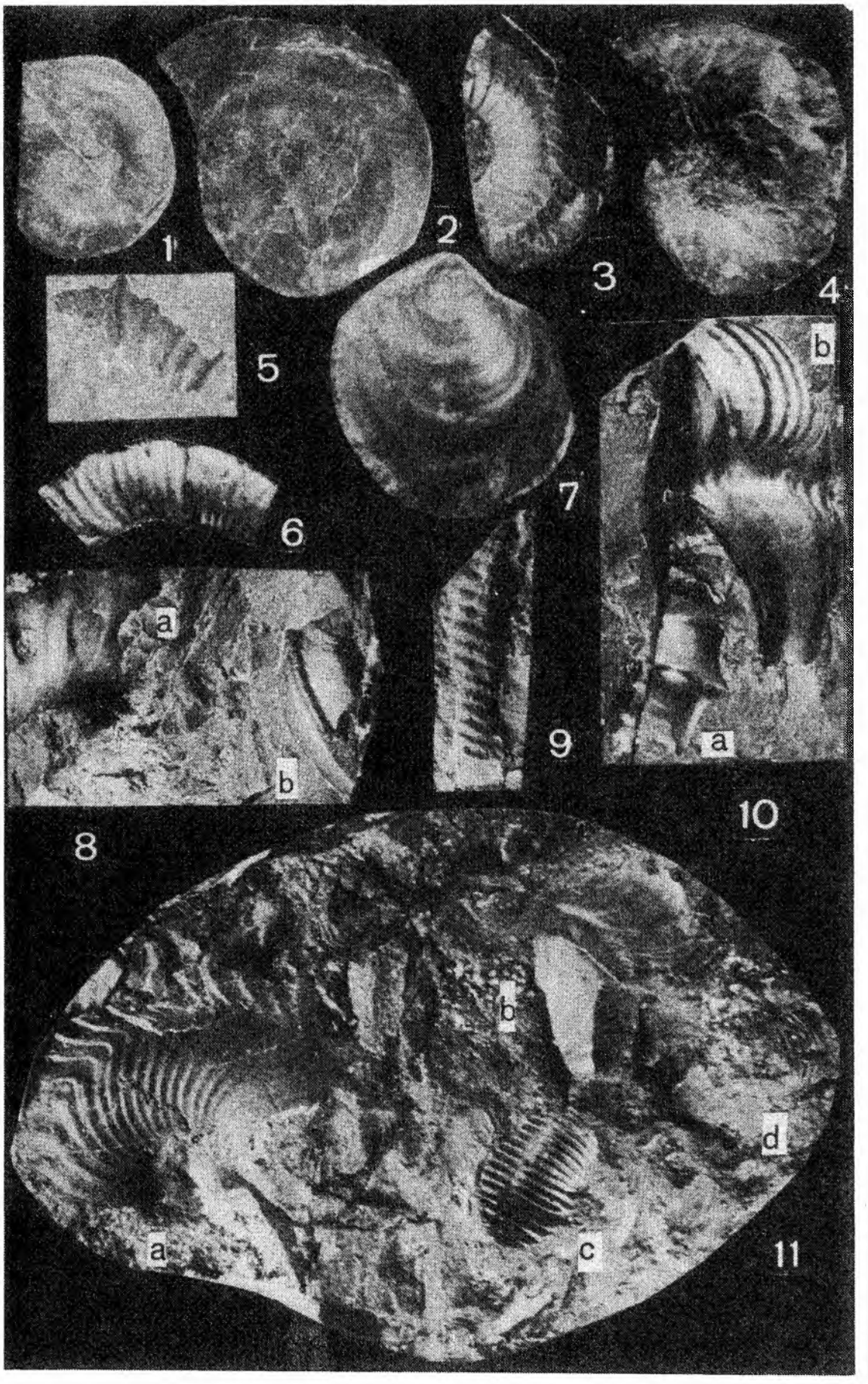
1–2 – Massive limestone of Sauco Fromation (sensu Millián & Somin, 1981), metamorphic sequences of Escambray Massif, Upper Oxfordian – Lower Tithonian (Phot. A. Pszczółkowski)

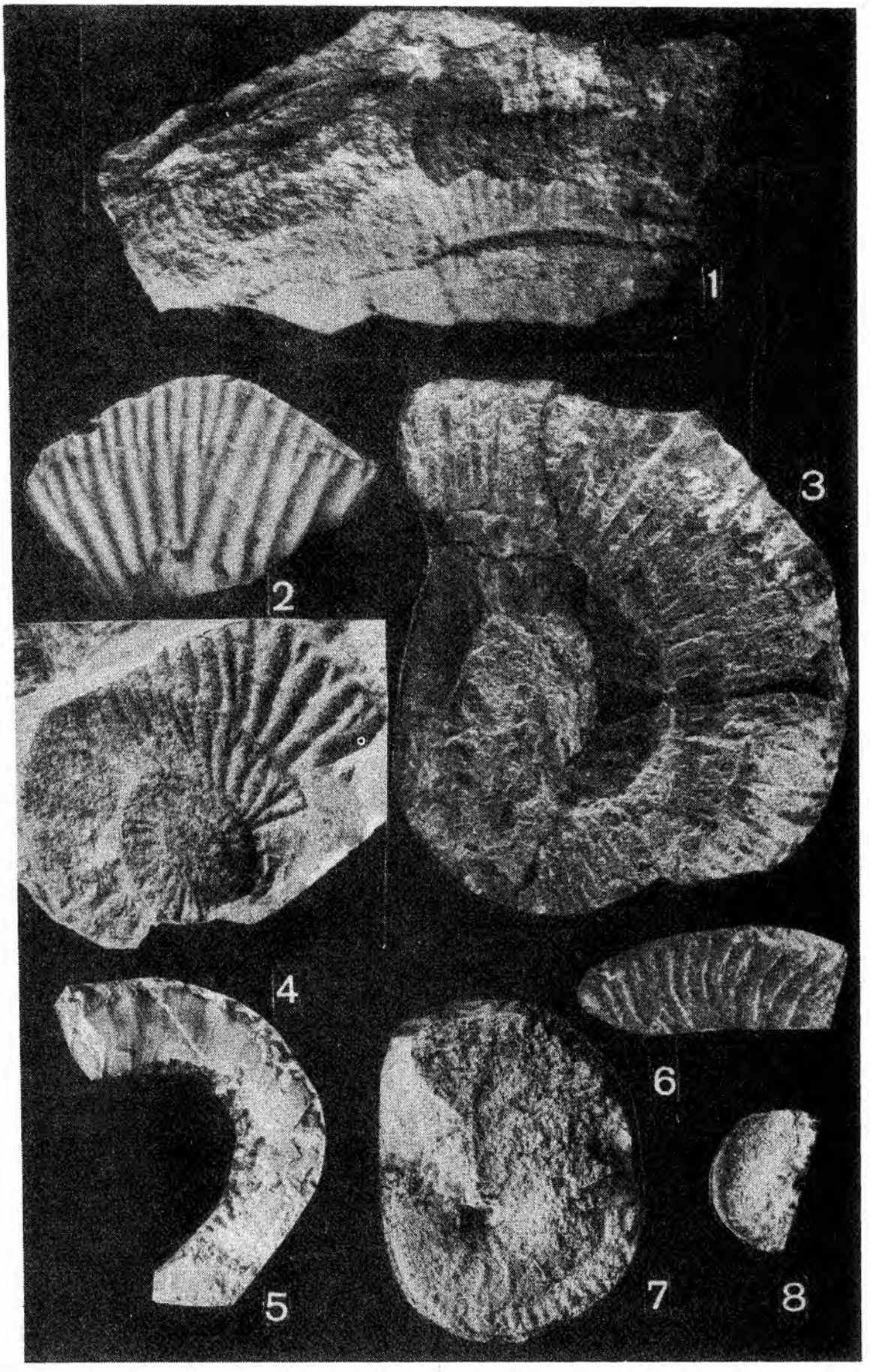

1
2
3
4
5
6
7
8
9
10

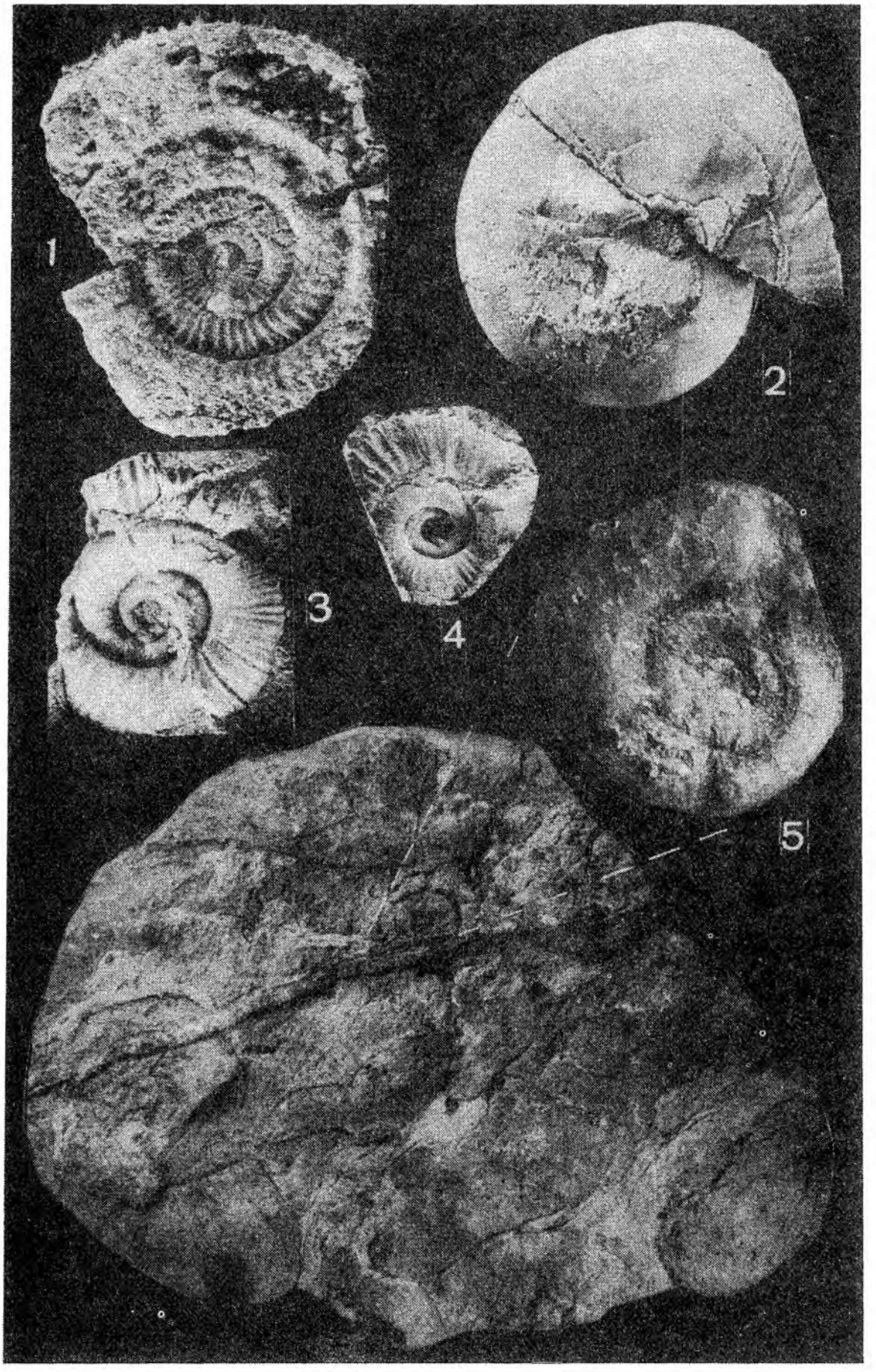

1
2
3
4
5
6
7
8
9
10
11
12
13



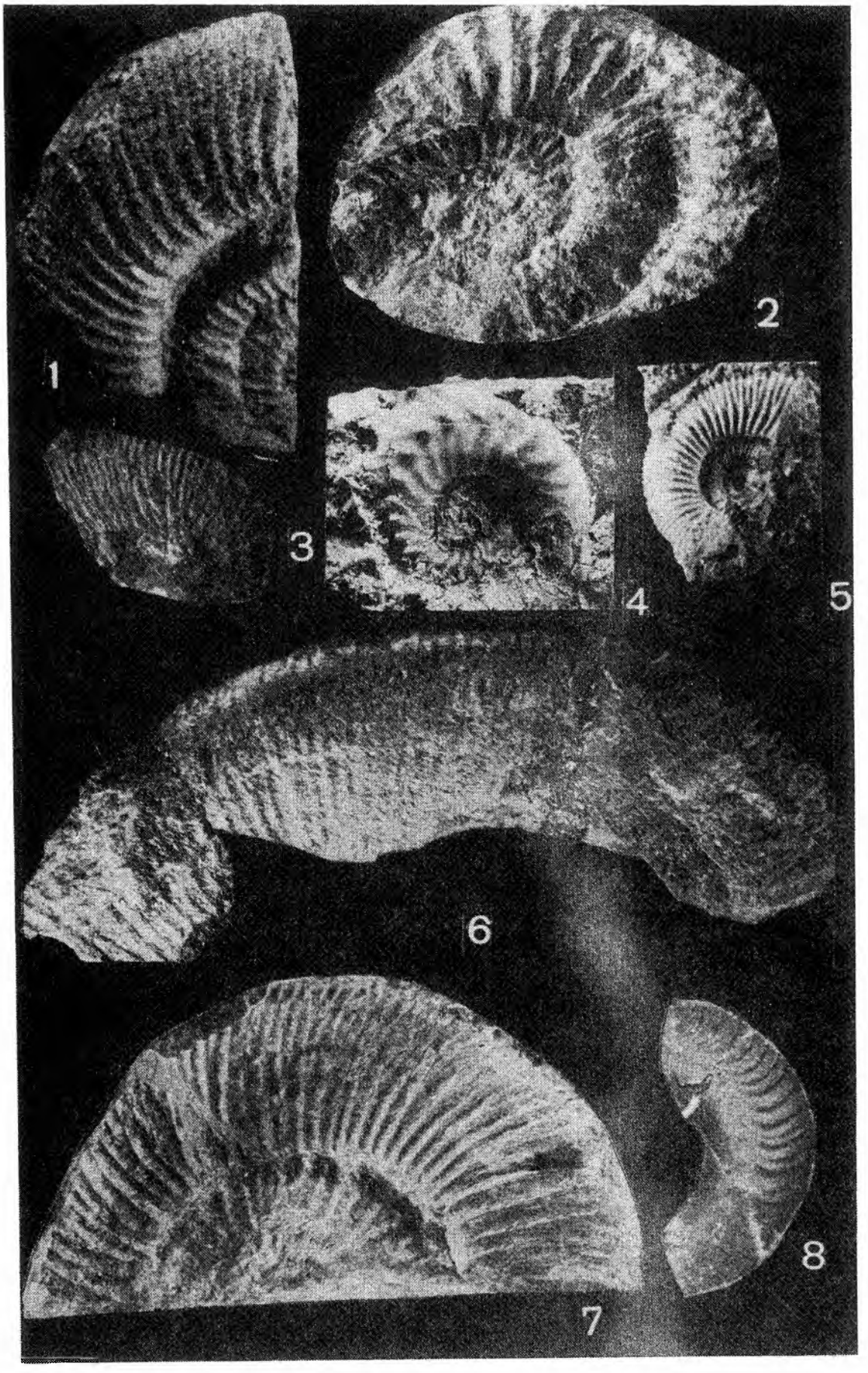
Ann. Soc. Geol. Poloniae vol. 59

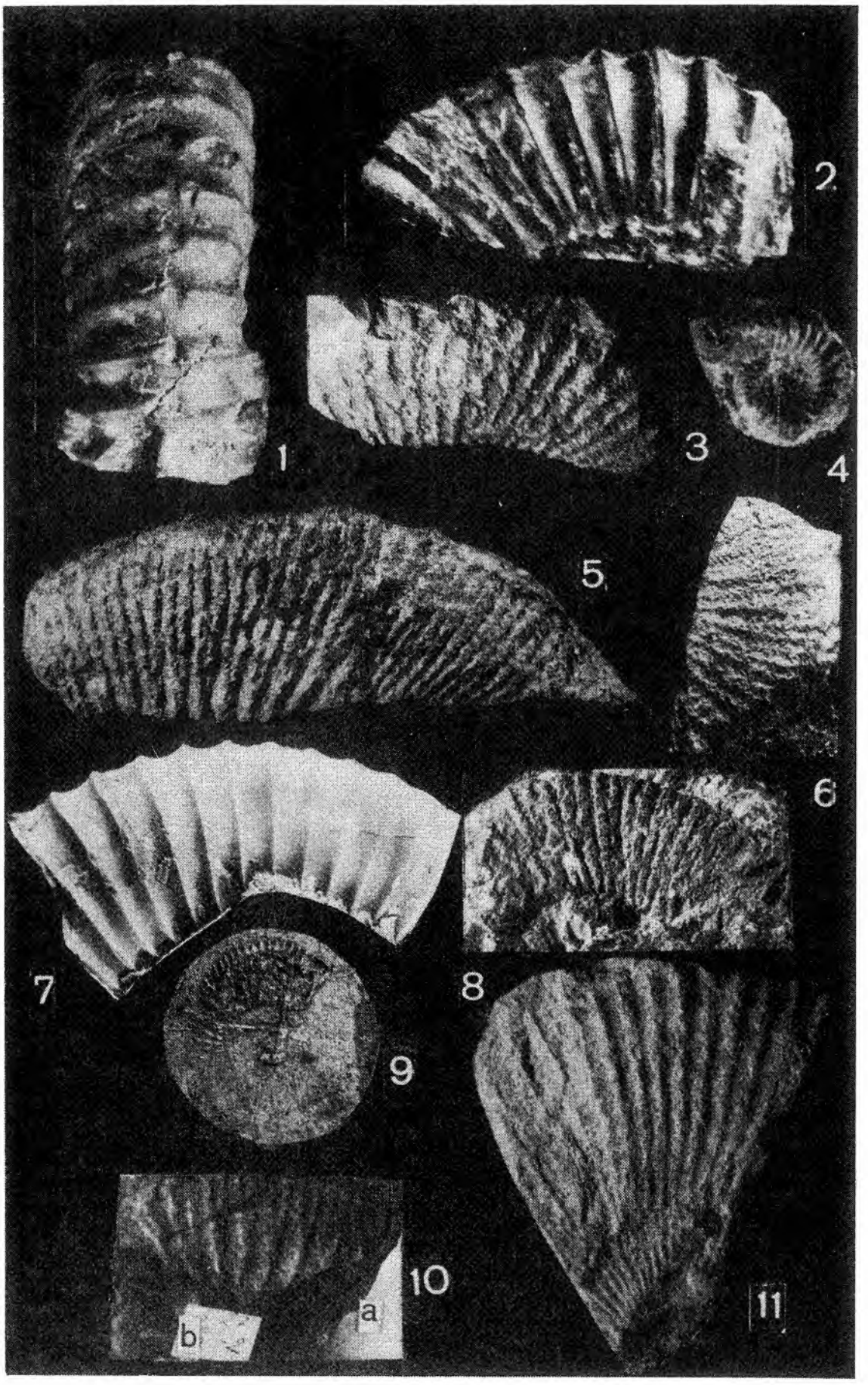

1
2
3
4
5
6
7
8
9
10
11
a
b
a
b
a
b
c
d

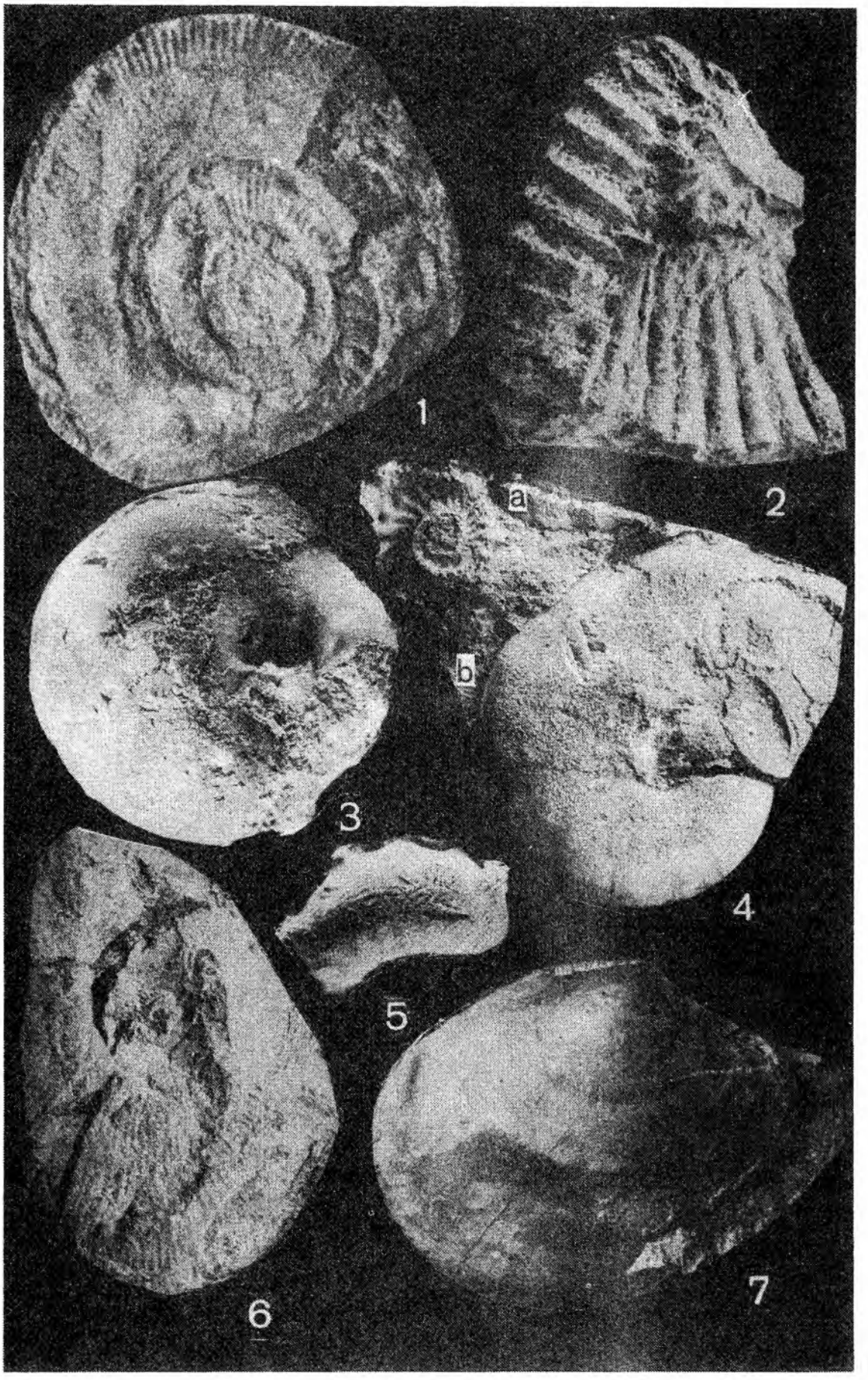

1
2
3
4
5
6
7
8

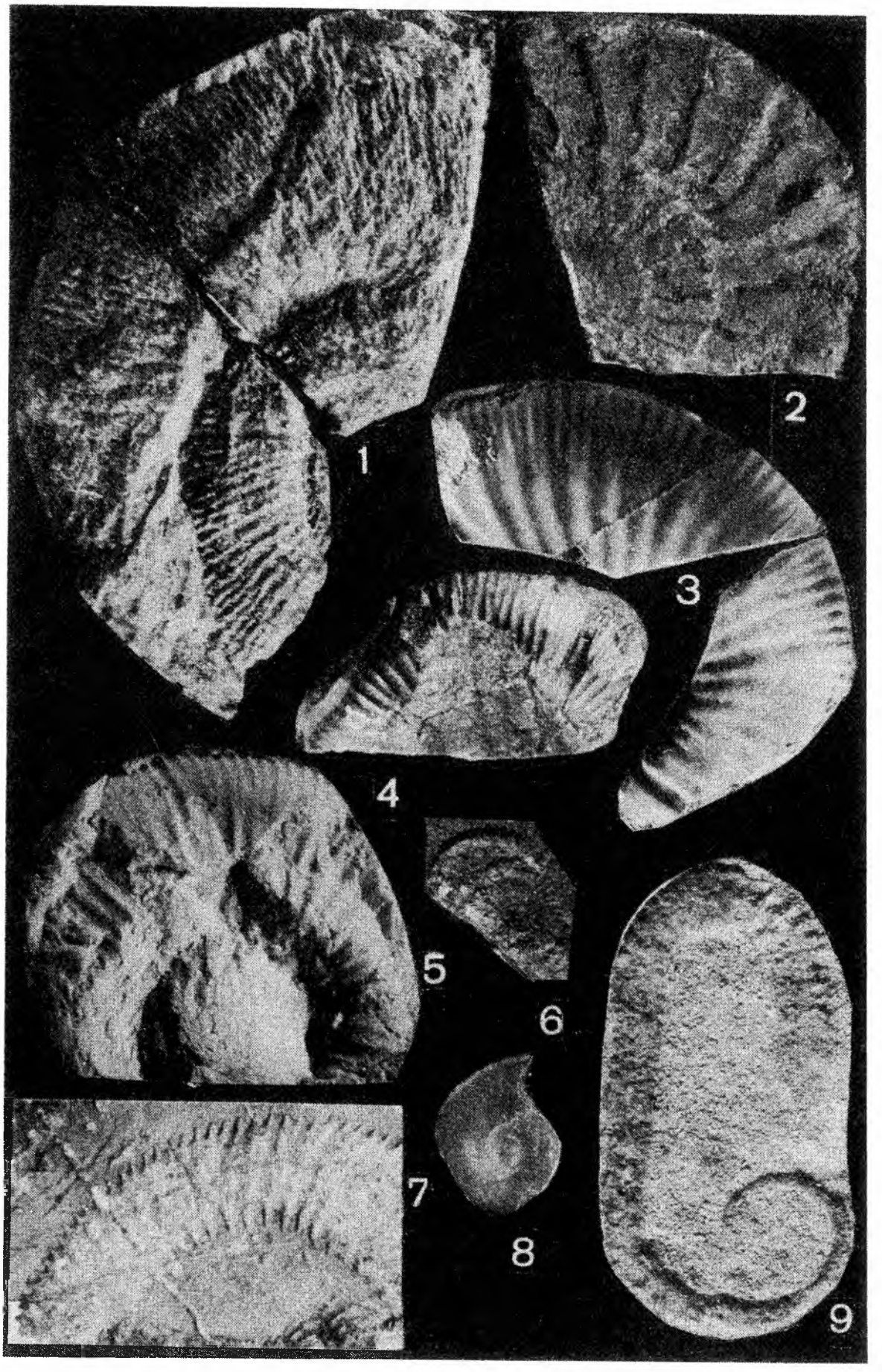

1
2
3
4
5

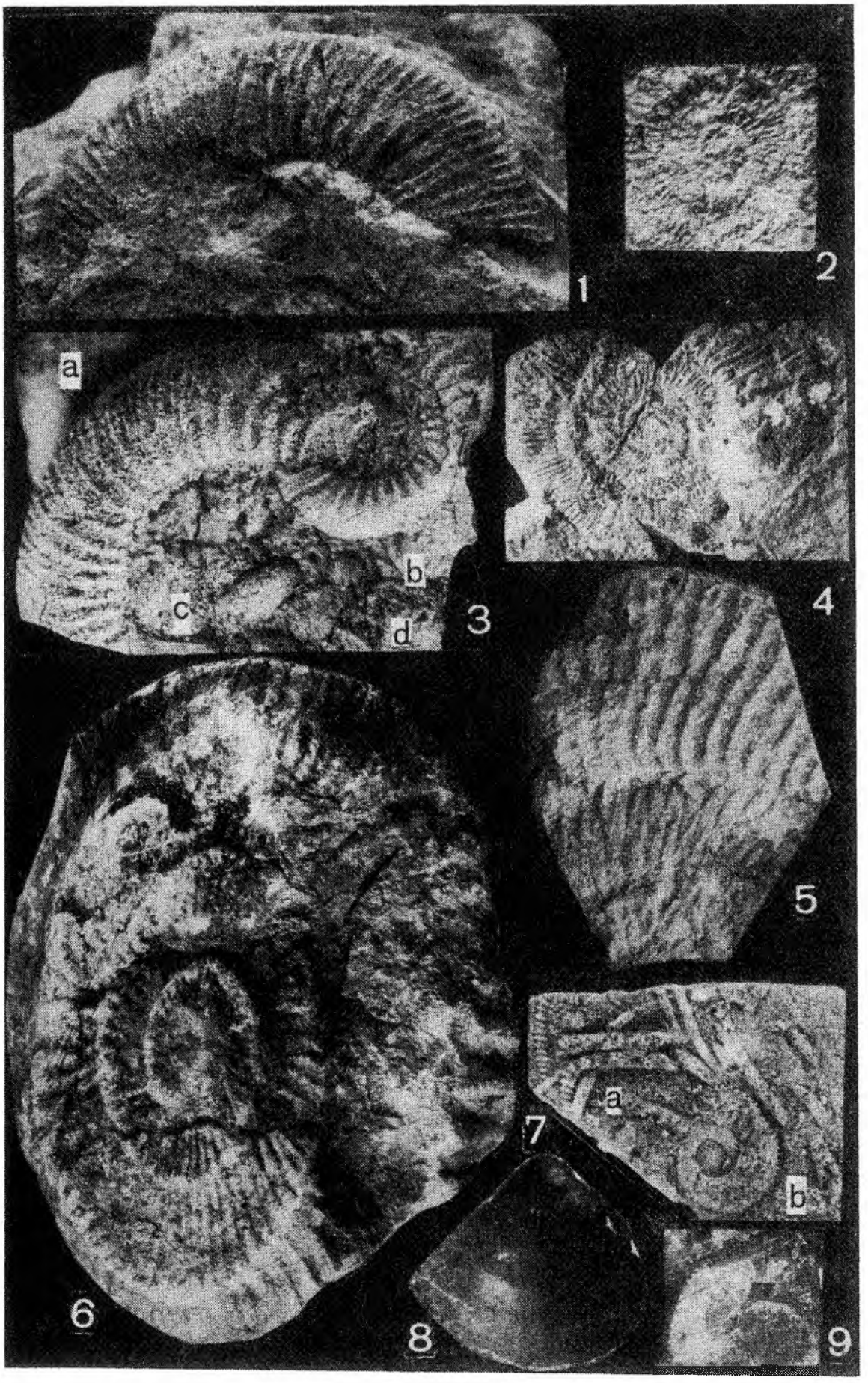

1
2
3
4
5
6

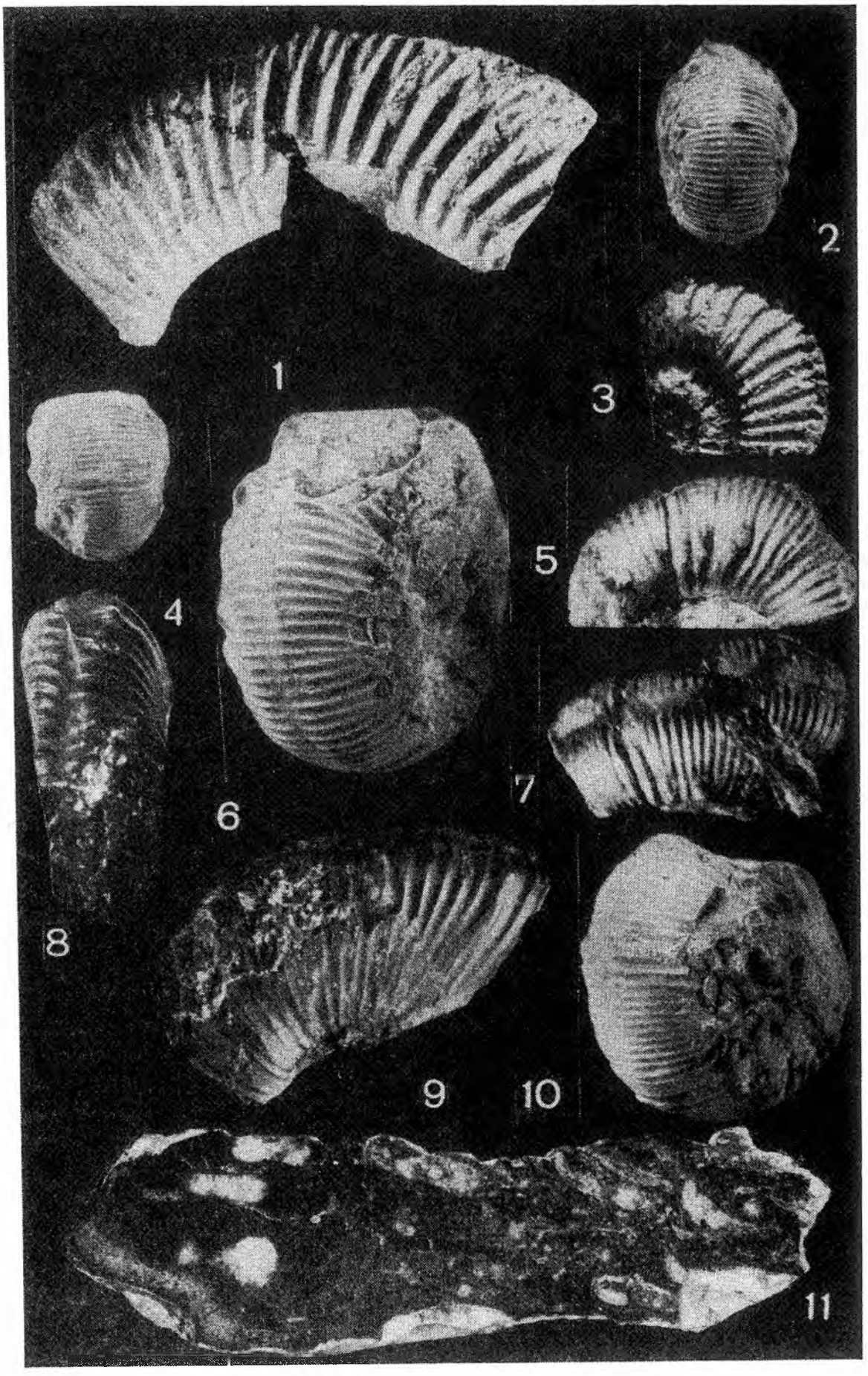

1
2
3
4
5
6
7
8

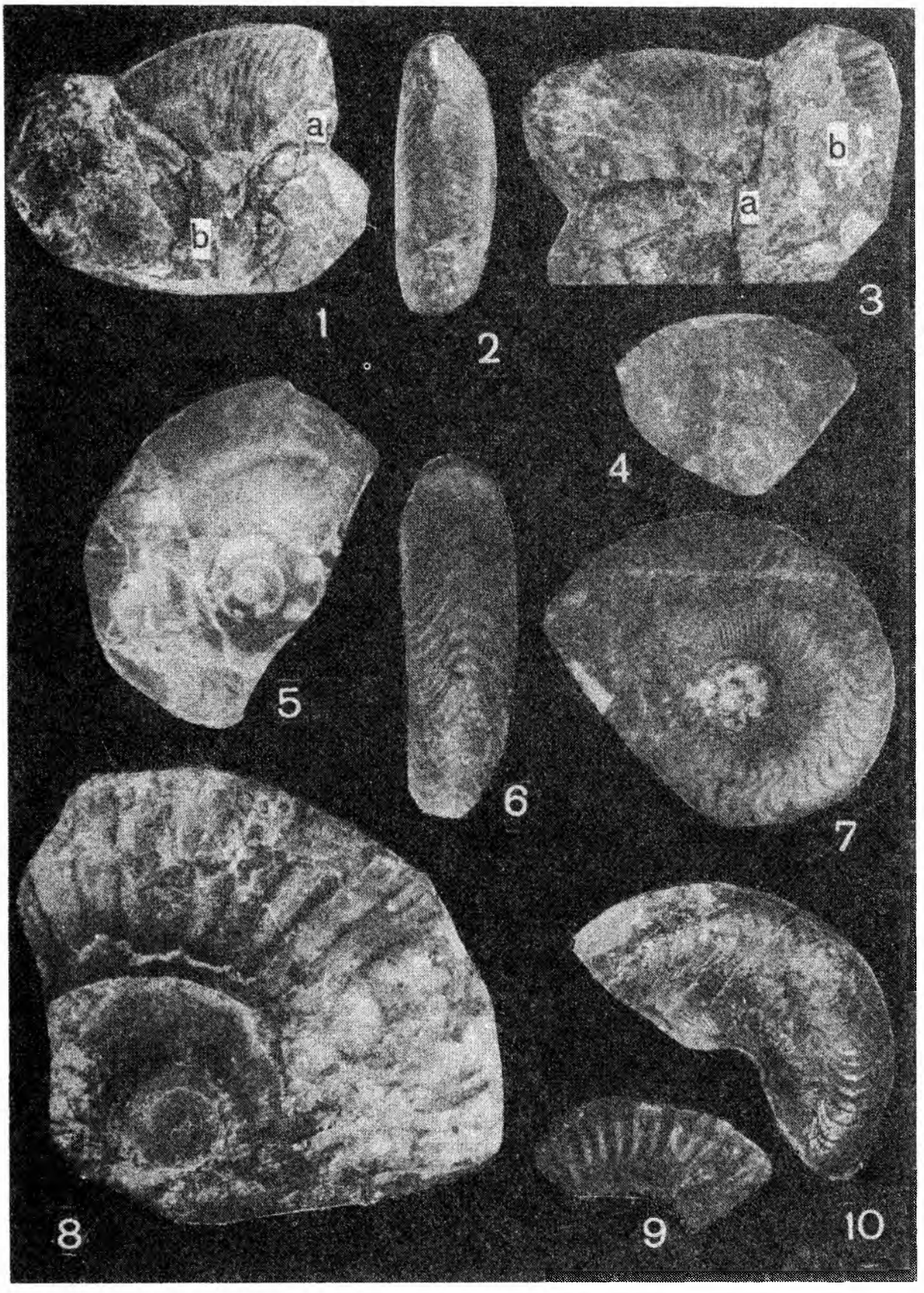

1
2
3
4
5
6
7
8
9
10
a
b
11

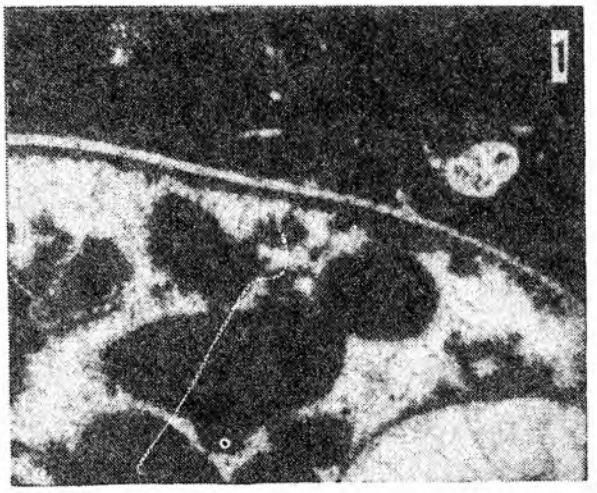

1
2
a
b
3
4
5
6
7

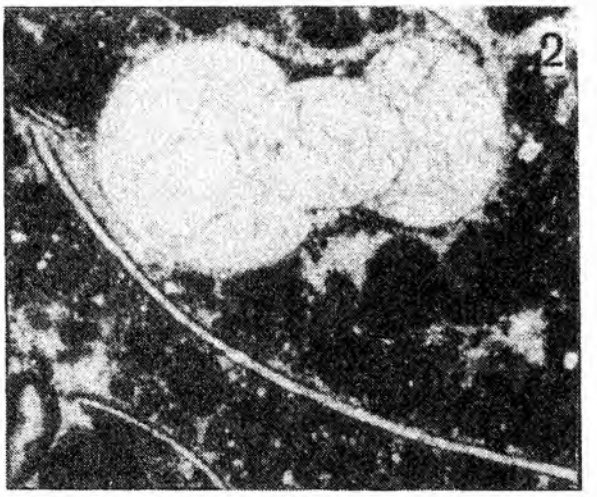

1
2
3
4
5
6
7
8
9

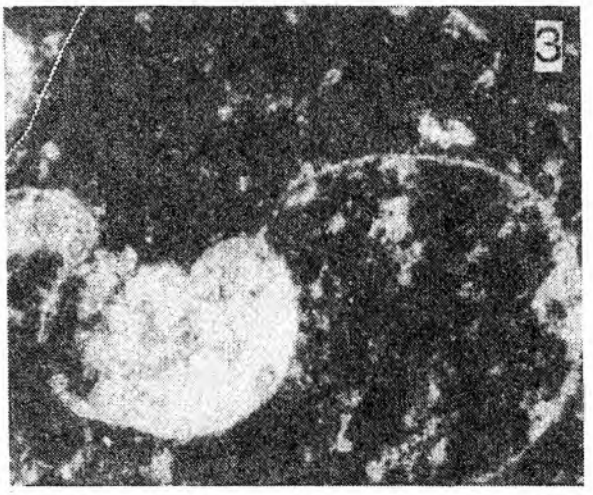

1
2
a
b
c
d
3
4
5
6
7
a
b
8
9

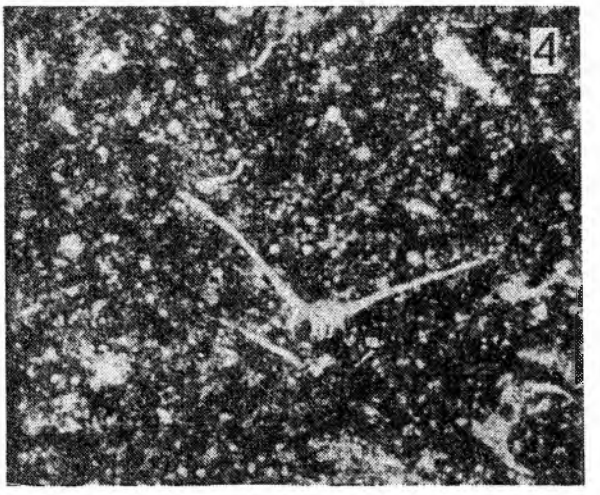

1
2
3
4
5
6
7
8
9
10
11

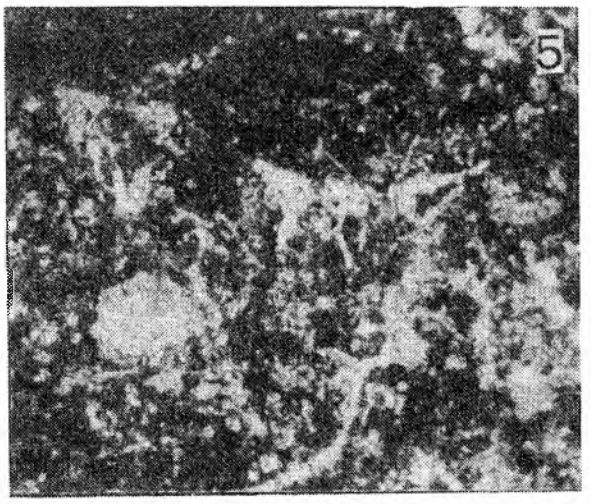

a
b
1
2
a
b
3
4
5
6
7
8
9
10

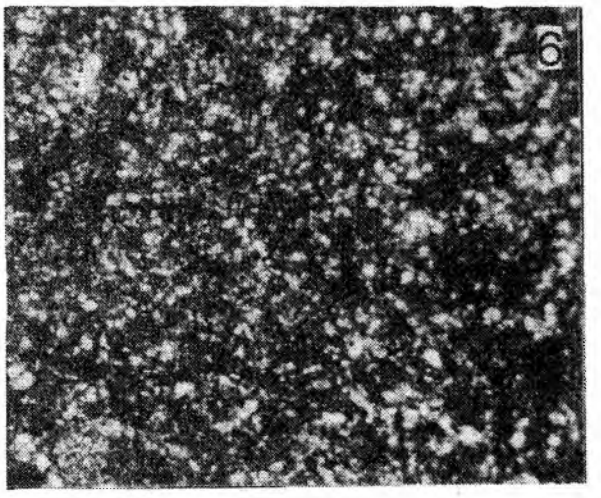

1

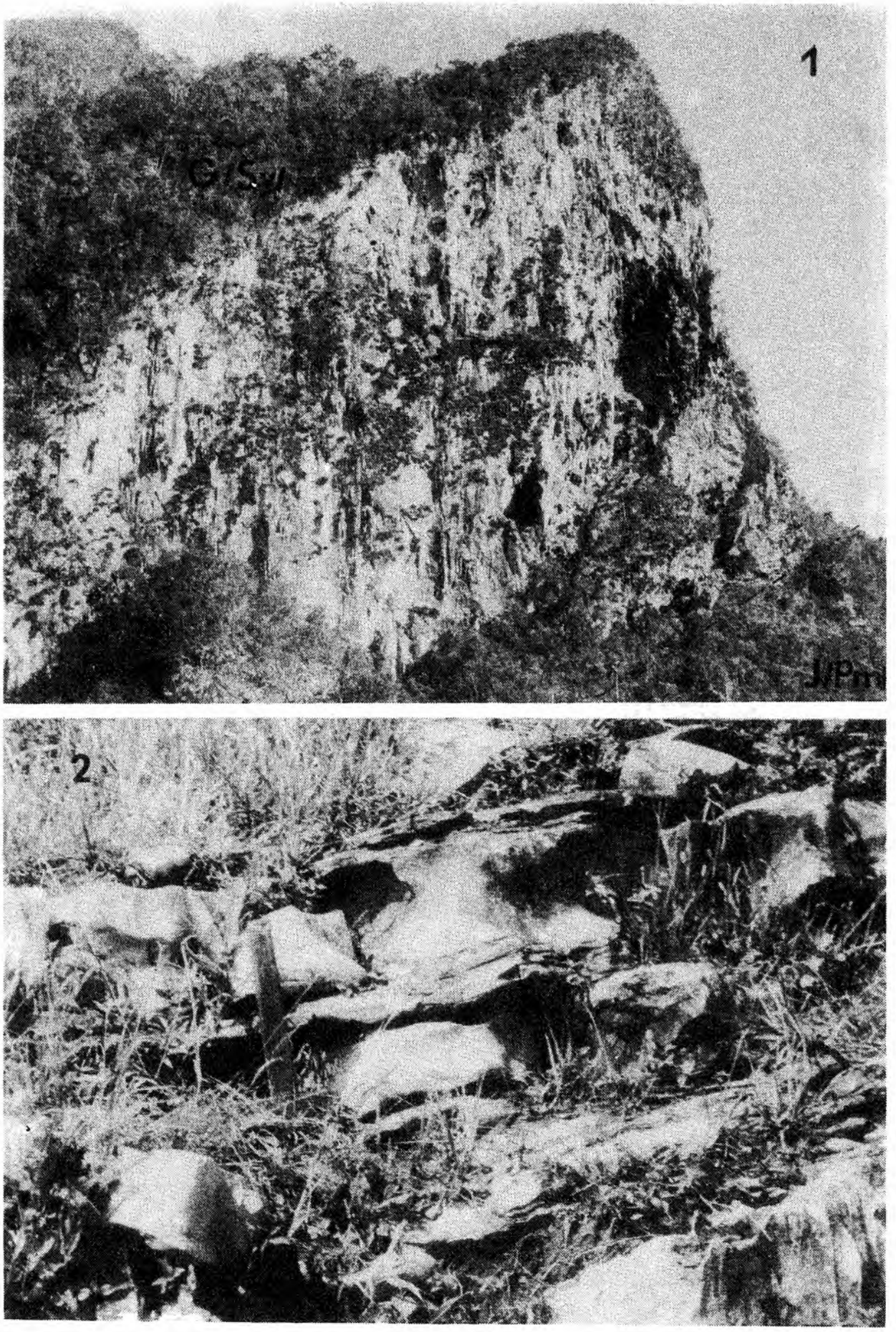

2

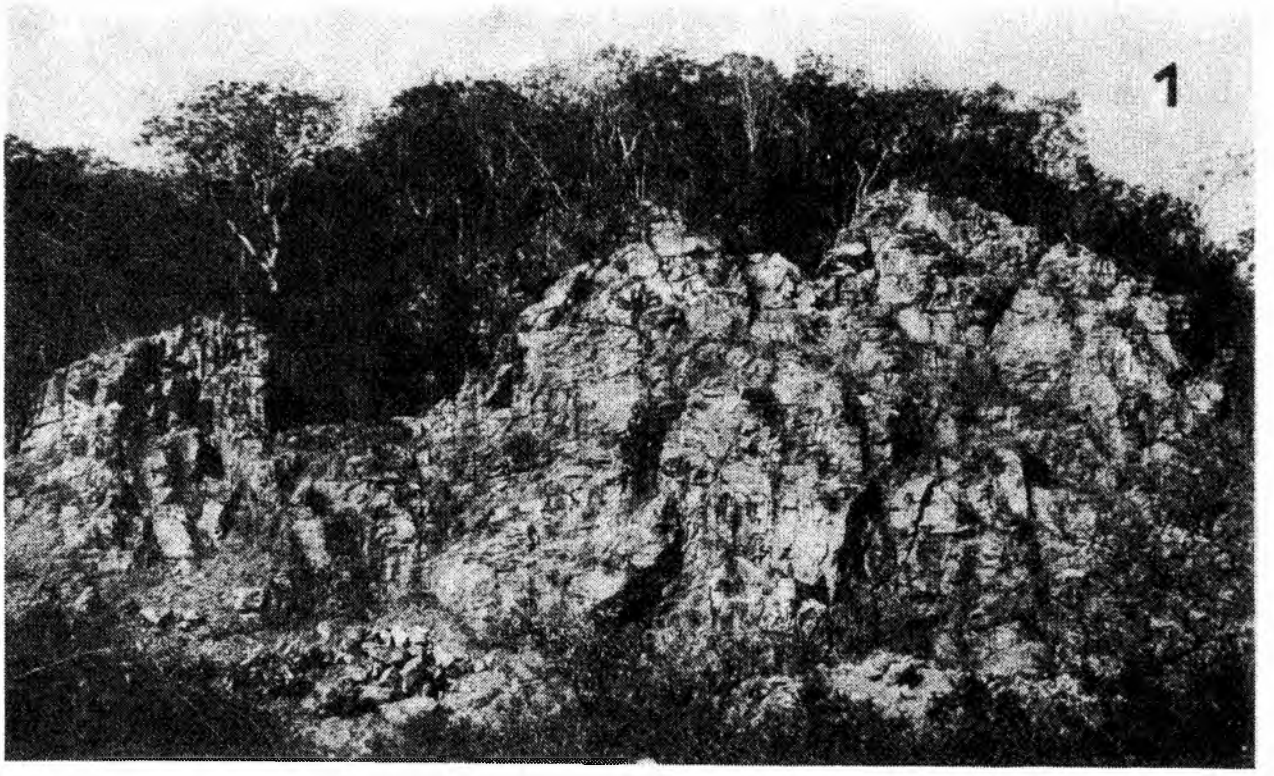

3

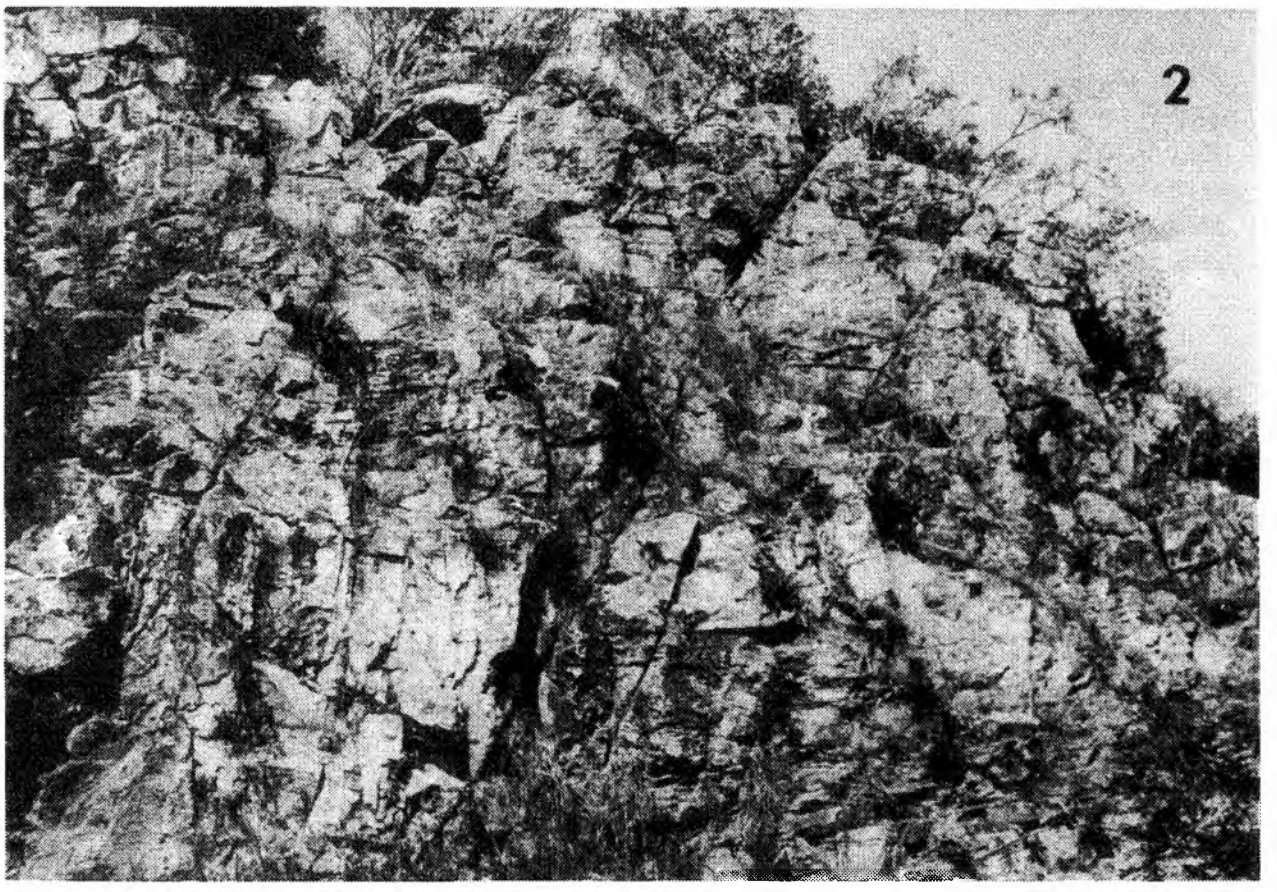

4


5


6


1
2


1


2