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LOWER TURONIAN AMMONITES FROM ISRAEL

BY

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CORRIGENDA

for *Special Paper Number 3*

p. 16, line 24. *For* Type specimens. Holotype USNM 157919, M39/0; paratype USNM 157919, M39/0 *read* Illustrated specimens. USNM 157919, M39/0

p. 18, line 20. *For* Firstly, by the *read* Firstly, the

p. 18, line 22. *For* secondly, by the *read* secondly, the

p. 70, line 11. For ?*L. regina* read *D. regina*

p. 75, line 5. *For* Holotype USNM 158013 *read* Holotype USNM 158011

p. 80, lines 28 and 29. For *in the Barbadoes chalk deposits* read *in the Barbados chalk deposit*

ABSTRACT. Sixty species and subspecies of twenty genera of Lower Turonian ammonites from the Middle East are described and figured. *Fagesia lenticularis* sp. nov., including three new subspecies (*lenticularis*, *asymmetrica*, and *elliptica*) and *Choffaticeras luciae trisellatum* subsp. nov. are defined. The genera *Pseudaspidoceras*, *Paramammites*, *Paravascoceras*, *Fagesia*, *Choffaticeras*, and *Protexanites* are revised and redefined. Seven biostratigraphic zones based on the ammonites studied are suggested. Some of these zones are correlatable with the Lower Turonian sequences of North and West Africa and of Western Europe.

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LOWER TURONIAN AMMONITES FROM ISRAEL

BY

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INTRODUCTION

LOWER TURONIAN ammonites have been collected in the Middle East since the second half of the last century. They were described and determined by Blanckenhorn (1890), Solger (1903), Fourtau (1904), Eck (1909, 1910, 1914), Douvillé (1912, 1928), Greco (1915), Taubenhaus (1920), and Basse (1937, 1940, 1954). Part of the material herewith studied was previously determined by Professor L. Picard, Professor M. Avnimelech, Dr. A. J. Vroman, and Dr. A. Parnes.

Many geologists noticed that the beds containing the Lower Turonian ammonites occur only in restricted areas (Douvillé 1910; Hume 1911; Blanckenhorn 1912, 1931; Blake 1936; Dubertret 1937, 1944; Wetzel and Morton 1959). It has subsequently been shown (Freund 1961, 1962) that the Lower Turonian beds were deposited in shallow synclinal basins formed during the Upper Cenomanian and the Turonian. Five such depositional basins which were mapped in Israel (text-fig. 1), extend to Transjordan in the east and to Sinai and Egypt in the south-west. Two other basins occur in Lebanon and Syria in the north.

In each basin a particular local formation was deposited. These formations show very rapid facies and thickness changes and disappear laterally towards the anticlinal areas of Early Turonian times. Columnar sections of the Lower Turonian formations are illustrated in text-fig. 2.

The Daliya Marl (Picard and Kashai 1958) on Mt. Carmel and the Yirka Formation (Freund 1959) in the Western Galilee are 0–80 m. thick, and consist of marl, chalk, and bioclastic rubbly limestone. They are underlain and overlain by hard bioclastic reef limestones.

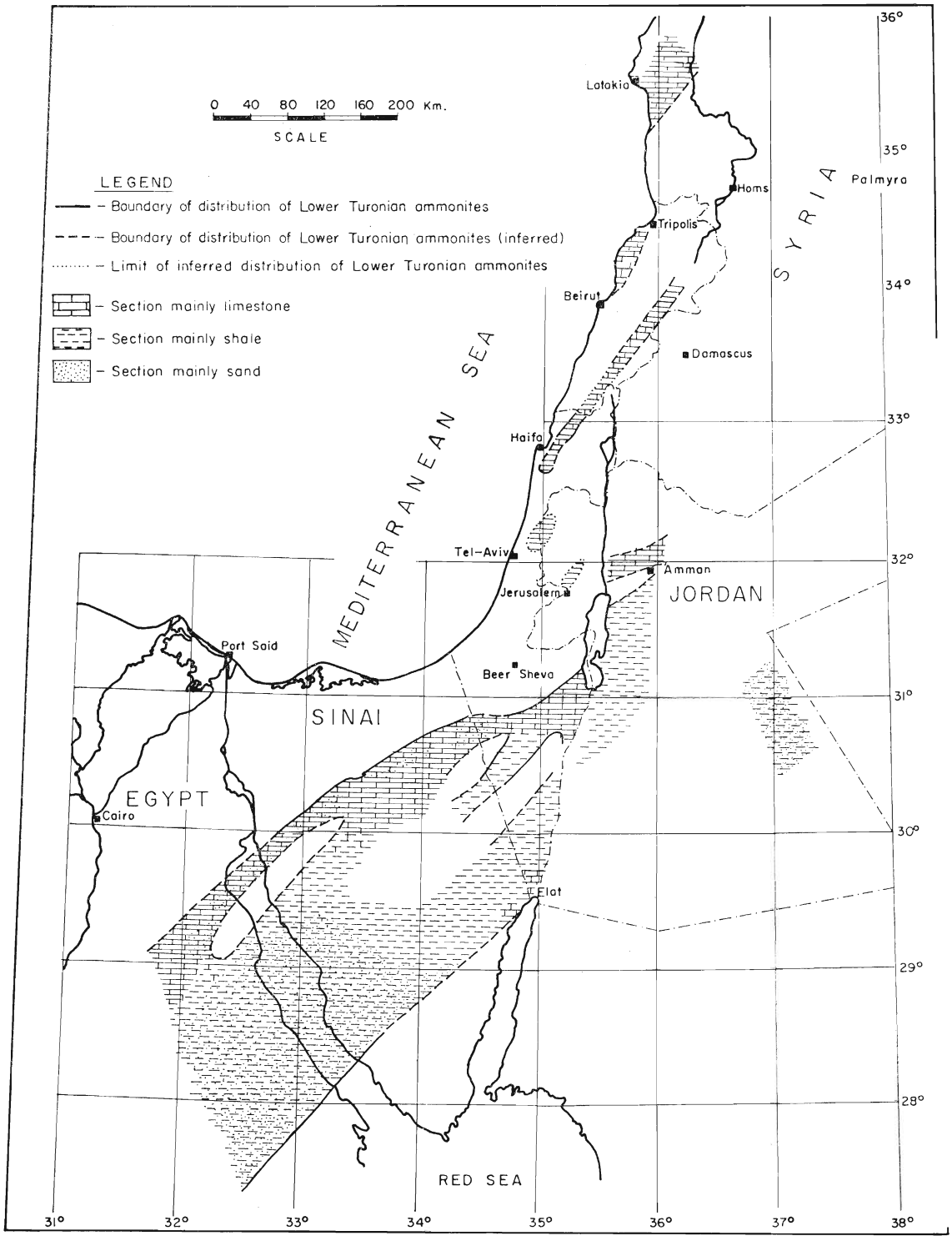
The Derorim Formation (Bentor and Vroman 1962) and Sub-Unit c6 (Bentor and Vroman 1954) in the Northern Negev are 0–25 m. thick, and consist of rubbly bioclastic limestone, yellow and red chalk, and some dolomite. They are underlain by well-bedded dolomite and covered by hard bioclastic reef limestone.

The Govay Shale (Freund 1962) in the Central Negev is 0–50 m. thick and consists mainly of green shale. Ammonites occur in this section only in rubbly bioclastic limestone at the lower part. This formation is underlain by dolomite and covered by hard limestone.

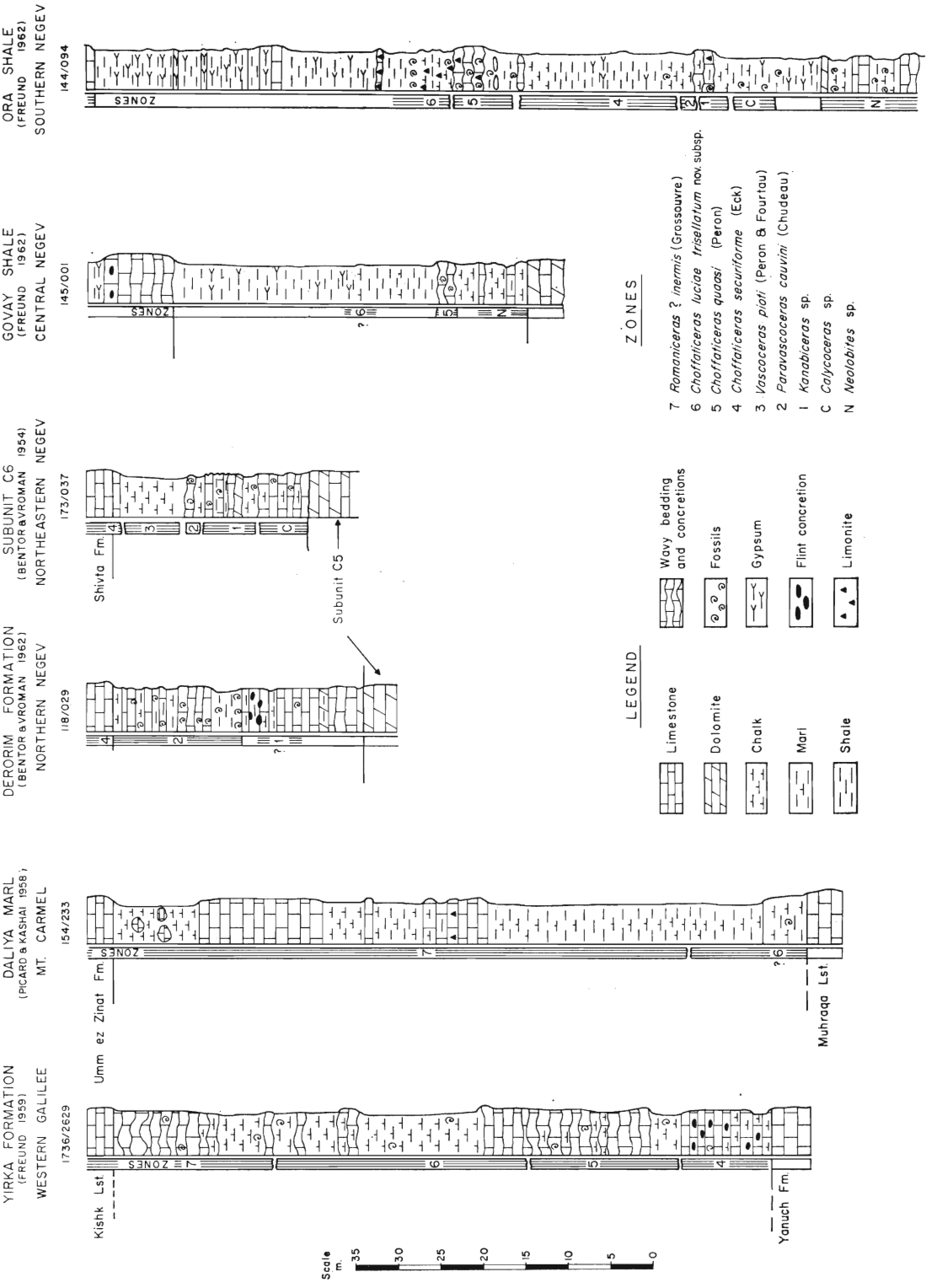
The Ora Shale (Freund 1962) in the Southern Negev is 80–120 m. thick, and consists mainly of green shale. The ammonites occur here in beds of rubbly bioclastic limestone and red marl. Well-bedded gypsum and few sandstone lenses occur at the upper part of this formation which is underlain by dolomite and covered by hard limestone.

More than 1,600 specimens of ammonites have been studied. Most of them were collected by the writers in about 70 measured columnar sections. The accurate stratigraphic position of most ammonites is thus well known. The provenance of the ammonites is shown on the location map (text-fig. 3).

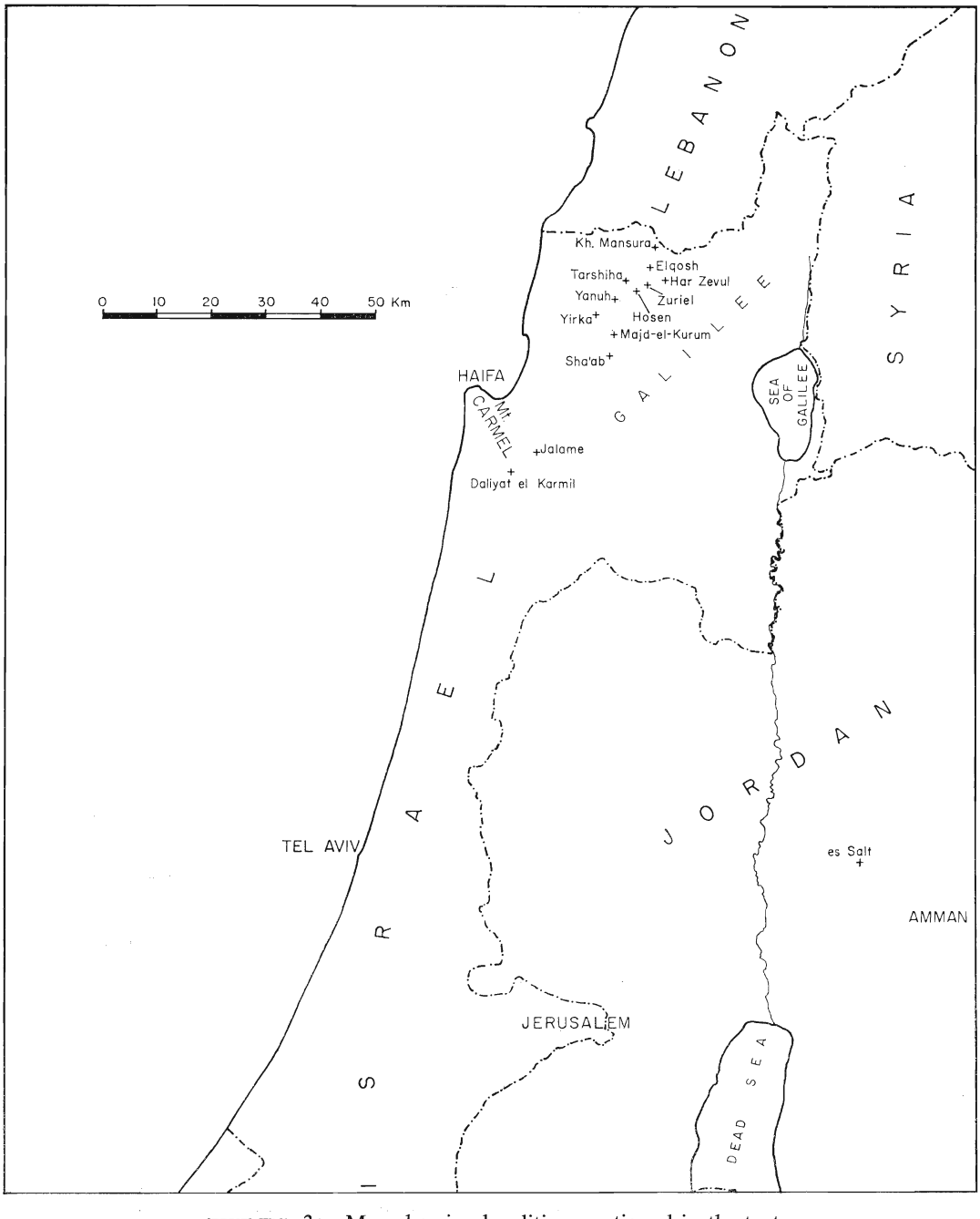
Apart from a few ammonites deposited in private collections (in which case the repository is specifically mentioned), all the ammonites are deposited either in the Department of Geology, the Hebrew University, (specimens designated by the initials HU, Le, P, and



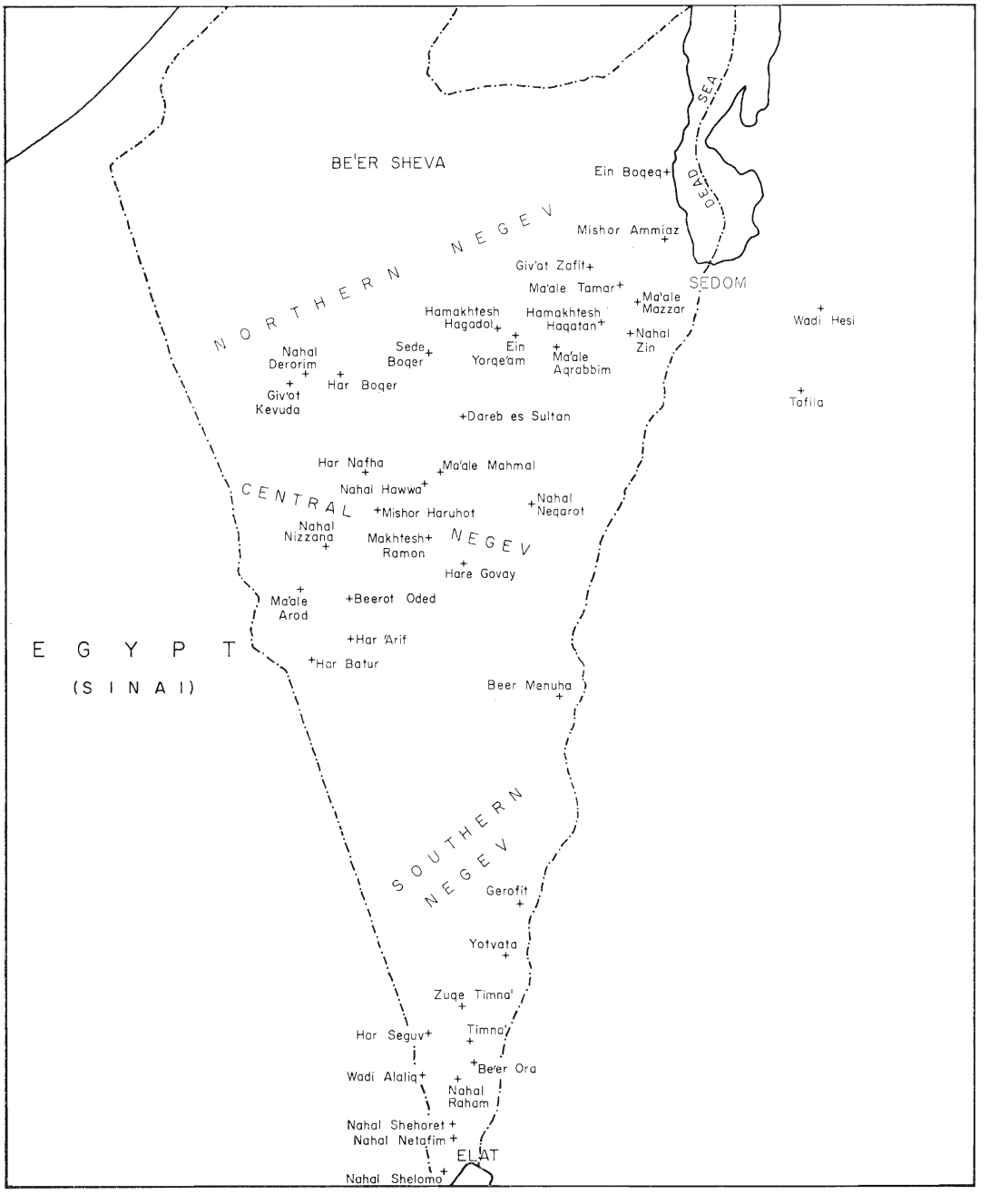
TEXT-FIG. 1. Lower Turonian basins in the Middle East.



TEXT-FIG. 2. Lower Turonian formations in Israel.



TEXT-FIG. 3A. Map showing localities mentioned in the text



TEXT-FIG. 3B. Map showing localities mentioned in the text

D) or in the Paleontology Division, Geological Survey of Israel (specimens designated by the initial M).

The terminology and taxonomy proposed in the *Treatise on Invertebrate Paleontology* (Moore 1957) is used in the present paper. Dimensions are given in millimeteres.

SYSTEMATIC DESCRIPTIONS

Superfamily DESMOCERATACEAE Zittel 1895
Family DESMOCERATIDAE Zittel 1895
Subfamily PUZOSIINAE Spath 1922
Genus PARAPUZOSIA (AUSTINICERAS) Spath 1922

Type species. Am. austeni Sharpe.

Parapuzosia (*Austiniceras*) sp.

Text-fig. 4*a*

Description. Fairly involute, high, and compressed. Section oval, walls slightly convex, converging ventrad. Venter narrowly rounded. Umbilicus fairly large. No ornament visible, perhaps as a result of the bad perservation or of the late stage.

Three high, triangular saddles with narrow bases, each divided by a deep accessory lobe occur on the sides, and 2–3 small ones on the umbilical wall. The lobes are trifid and asymmetric, the outer accessory saddle being larger than the inner one.

Dimensions

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	T/H
HU-23081	560	237	116	150(0·27)	0·5

Material. One badly preserved specimen from the southern exit of Makhtesh Ramon, zone 5; another specimen from the Daliya Marl, Mt. Carmel.

Superfamily ACANTHOCERATACEAE Hyatt 1900
Family ACANTHOCERATIDAE Hyatt 1900
Subfamily ACANTHOCERATINAE Hyatt 1900
Genus ROMANICERAS Spath 1923

Type species. Am. deverianus d'Orb. 1841.

Romaniceras deverianum (d'Orbigny)

1841 *Am. deverianus* d'Orbigny, p. 356, pl. 110.
cf. 1913 *Acanthoceras deverianum* (d'Orb.); Roman and Mazeran, p. 25, pl. 3, fig. 2.
1939 *Romaniceras deveriai* (d'Orb.); Collignon, p. 89, pl. 8, figs. 2–3; pl. 9. fig. 1.

Description. One complete and one fragmentary specimen both badly preserved. Evolute, whorl section square and wide, venter slightly rounded. Faint radial ribs cross the venter. Half of them reach the umbilical border, each ornamented by nine strong tubercles. The tubercles weaken toward the end of the living chamber.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	T/H
D-22	140	49(0·35)	60(0·43)	52(0·37)	1·2
D-26	—	56	58	—	1·04

Remarks. Since the holotype of this species is missing, different forms have been attributed to it. This problem is discussed in the remarks to *Romaniceras* (?) *inermis* (de Gross.).

Material. Two specimens collected from the Daliya Marl, Mt. Carmel (Daliyat el Karmil).

Romaniceras deverioide (de Grossouvre)

1889 *Ammonites deverioides* de Grossouvre, p. 524, pl. 12, figs. 1, 2.
1897 *Ammonites deverioides* Peron, p. 21, pl. 1, figs. 2–3.
1939 *Romaniceras deverioides* (Gross.); Collignon, p. 37.
1959 *Romaniceras deverioides* (Gross.); Matsumoto, p. 87, pl. 25, fig. 1; pl. 28, fig. 1; pl. 29, fig. 4; text-figs. 40–4h.

Description. Eight poorly preserved specimens, mainly living chambers. Evolute, umbilicus wide, whorl section wide and rounded. Coarse radial ribs, about thirty per whorl, cross the venter. Less than half of them reach the umbilicus. Eleven strong tubercles are regularly spaced on each of the main ribs.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*T/H*
Le-1546	130	41(0·31)	43(0·33)	43(0·33)	1·05
D-19	—	45	50	—	1·1

Remarks. Kossmat (1897, p. 16 (123), text-figs. 2–4) regarded *R. deverioide* a synonym of *R. ornatissimus* (Stoliczka 1865, p. 75, pl. 40). However, it seems that Matsumoto (1959*a*, p. 87) is right in separating them. *R.* (?) *inermis* (Gross.) bears also eleven rows of tubercles, but these occur irregularly and are subordinate to the ribs. The ammonites from California (Matsumoto 1959*a*) resemble ours but for the ventral tubercles, which are there clavate. The Nigerian *R.* aff. *deverioide* (Gross.) (Reyment 1955, p. 46, pl. 9, fig. 1; text-figs. 18–19) has different ventral tubercles.

Material. Eight fragments collected from the Daliya Marl, Mt. Carmel (Daliyat el Karmil).

Romaniceras (?) *inermis* (de Grossouvre)

Plate 1, figs. 1–2; text-fig. 4*b*

?1853 *Am. deverianus* d'Orb.; Sharpe, p. 43, pl. 19, fig. 5*a–b*.
1863 *Am. deverianus* d'Orb.; Pictet, p. 56, pl. 7, figs. 1–2.
1889 *Am. deverioides* var. *inermis* Grossouvre, p. 525.
1901 *Acanthoceras bizeti* Grossouvre, p. 780.
1924 *Acanthoceras shastense* Reagen, p. 179, pl. 18, fig. 1.
1937 *Acanthoceras* cf. *deverianum* d'Orb.; *Basse*, p. 180, pl. 8, figs. 1, 2; pl. 9, fig. 1.
1957 *Romaniceras deverianum* d'Orb.; Wright, p. L414, fig. 534, 3.
1959 *Eucalycoceras* (?) *shastense* (Reagan); Matsumoto, p. 94, pl. 23, fig. 1; pl. 24, figs. 2–3; text-figs. 47–50.

Description. Evolute, umbilicus medium sized. Section usually rounded at early stages, sides becoming flat and parallel at the end of the body chamber. However, the section of two small (60 and 85 mm.) specimens is squarish. Width exceeds height at young stages, the section becoming higher and narrower with growth. There are 30–50 fine, distinct ribs per whorl, increasing in number with growth. Less than half of the ribs reach the umbilical border. Secondary ribs are irregularly divided between the main ribs

(0, 1, 2), and do not branch from them. The ribs are usually radial on the sides and prorsiradiate on the venter, but in some specimens they are prorsiradiate on the sides, and in one specimen they are even rursiradiate (similarly to *Paracalycoceras*). Three rows of fairly strong clavi occur on the venter, and in one specimen the median row is slightly asymmetric. Two to three rows of weak lateral tubercles and a weak umbilical one occur sometimes. Thus every rib bears 9–11 tubercles, weakening with growth till their complete disappearance on the body chamber. The ribs remain the main element of ornament during all growth stages.

Suture badly preserved showing two wide, squarish bifid saddles and a bifid first lateral lobe.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*T/H*
HU-21119	*c.* 55	17	20	*c.*16	1·17
HU-23971	95	36(0·37)	39(0·41)	27(0·28)	1·1
HU-21087	136	43(0·32)	42(0·31)	49(0·35)	0·99
D-23	142	60(0·42)	45(0·33)	43(0·32)	0·75

Remarks. These ammonites resemble closely two specimens from d'Orbigny's collection, described and photographed by Basse (1937) as neotypes of *A. deverianus* d'Orb., the holotype of which was lost and the illustration being regarded as inaccurate. Wright (*in* Moore 1957), reproducing one of these photographs for the type of *Romaniceras deverianus*, apparently supports the proposal of Basse. This, however, disregards the repeated descriptions of ammonites from France and Madagascar (Roman and Mazeran 1913; Collignon 1939), which resemble closely the original illustration of d'Orbigny.

Collignon suggests therefore that the specimens described by Basse should belong to the group of *Romaniceras ornatissimum* (Stoliczka)—*R. deverioides* (de Grossouvre), characterized by eleven rows of strong tubercles. However, the ribs rather than the tubercles are the main element of the ornament of Basse's and of our specimens, where the tubercles are weak, uneven and variably spaced.

Following the description given by de Grossouvre together with the description and illustration by Pictet, these ammonites are identical with *A. deverioides* var. *inermis* de Gross., later renamed *A. bizeti* de Gross. According to Articles 12 and 25 of *I.C.Z.N.* (Stoll (Ed.) 1961, XVth International Congress of Zoology), *R. inermis* is the valid species name. *A. shastense* Reagan seems also to be identical with *R. inermis*.

The generic position of this species is dubious. Matsumoto places *A. shastense* in *Eucalycoceras* because the ribs are more pronounced than the tubercles. However, it seems preferable to place it in *Romaniceras*, the only acanthoceratid genus with nine or eleven rows of tubercles.

EXPLANATION OF PLATE 1

Figs. 1–2. *Romaniceras* (?) *inermis* (Gross.), zone 7, Jalame, HU-23971, $\times\frac{2}{3}$.

Figs. 3–6. *Kanabiceras* sp., zone 1, Nahal Zin; 3–4. HU-23475, $\times 1$; 5. HU-23484, $\times\frac{2}{3}$; 6. HU-23568, $\times\frac{2}{3}$.

Fig. 7. *Mammites nodosoides* (Schlotheim), zone 6, Yirka, HU-21197, $\times\frac{1}{2}$.

Figs. 8–9. *Mammites* (?) sp., Yanuh, M-3610, $\times 1$.

Figs. 10–11. *Pseudaspidoceras* cf. *P. pseudonodosoides* (Choffat), zone 2, Nahal Derorim, M-3450–4, $\times 1$.

The fine, dense ornament of *A. deverianus* d'Orb., described by Sharpe (1853) is much the same as of our specimens, but its section is high and rectangular, and moreover, Wright (1951, p. 29) remarks that the illustration is not accurate. The specimen from Syria described by Basse (1937) is unusually large (diameter 200 mm.) and is devoid of tubercles. Our larger specimens show the same obliteration of the tubercles with the growth.

Material. Fourteen specimens from the Daliya Marl, Mt. Carmel, and from the upper member of the Yirka Formation in the Western Galilee. This species is the index fossil of zone 7 and occurs solely in the northern part of the country. Two of the specimens are deposited in the Oranim Seminary.

Romaniceras (?) sp.

Text-fig. 4*c*

Description. One fragmentary specimen. Section rounded, wider (32 mm.) than high (30 mm.), maximum width at the umbilical shoulder. Ribs coarse, flat, prorsiradiate. Main ribs reach the umbilical border and are ornamented by eight strong, round, equidistant tubercles. No siphonal tubercles. Ventral tubercles slightly clavate. Secondary ribs do not reach the umbilicus and are ornamented by six tubercles only.

Large, squarish first saddle, equally divided by a deep accessory lobe. Lobes narrow, bifid; the ventral lobe is the deepest.

Remarks. Matsumoto (1959*a*, p. 89, pl. 29, fig. 4; text-fig. 44) describes among other specimens of *R. deverioide*, an ammonite (No. UC 33831) ornamented by ten rows of tubercles, lacking the siphonal row. He interprets this ornament as an asymmetric-abnormal condition. Moreover, he believes that such a form was erroneously determined by Anderson as a species of *Mantelliceras* (*M. conquistador*, 1958, p. 245, pl. 14, fig. 2; pl. 15, fig. 2). The genus *Sharpeiceras* Hyatt (1903, p. 111) is also ornamented by eight rows of tubercles.

Material. One fragment collected in Western Galilee (Yanuh).

Genus KANABICERAS Reeside and Weymouth 1931

Type species. Acanthoceras (?) *kanabense* Stanton 1893.

Kanabiceras sp.

Plate 1, figs. 3–6; text-fig. 4*d–f*

Description. Small ammonites, maximum diameter 100 mm. Evolute to slightly involute, the strong inner ventro-lateral tubercles touch the umbilical wall of the following whorl. Umbilicus large, growing with the diameter. Whorl section rounded-quadrangular, wider than high; walls straight and venter rounded. Young stages ornamented by numerous (40–50 per whorl) prorsiradiate ribs. The ribs bend sometimes backwards at the ventral margin, where they are accentuated by a tubercle. They continue obliquely forwards on the venter, being accentuated there by an elongated tubercle, and disappear before reaching the mid-venter. The mid-venter is ornamented by round siphonal tubercles matching the ribs. At a diameter larger than 20–30 mm. strong inner-ventro-ateral tubercles develop on every sixth or seventh rib (about 7 per whorl), each


a
b
c
d
e
f
g
h
i
j
k
l
m
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o

connected to an equally strong umbilical tubercle by a more or less pronounced rib. These accentuated ornament elements enumerate with growth to about 12–14 per whorl at a diameter of 100 mm. The inner ventro-lateral tubercle is connected with two, generally weaker, outer ventro-lateral tubercles. The row of siphonal tubercles unites into a continuous, somewhat wavy keel.

The suture comprises two simple, low, round saddles, a deep ventral lobe, and a wide shallow first lateral lobe. The lateral lobe is divided by a large central accessory saddle, and a somewhat smaller one, ventrad to the latter. A third small saddle appears on the umbilical wall; the second and third lobes are small.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*T/H*
HU-23325	10	4(0·4)	5(0·5)	3(0·3)	1·2
HU-23475	34	14(0·41)	14(0·41)	10(0·3)	1·0
HU-23569	44	18(0·41)	—	12(0·3)	—
HU-23568	62	27(0·43)	22(0·34)	19(0·3)	0·85
HU-18581	72	26(0·37)	31(0·43)	27(0·37)	1·2
HU-23484	75	28(0·37)	32(0·43)	29(0·39)	1·1
HU-23519	98	31(0·32)	30(0·31)	41(0·42)	1·0

Remarks. Matsumoto (1959*a*, p. 99, pl. 24, fig. 1; text-figs. 52–3) unites the species *K. kanabense* (Stanton) (1893, p. 181, pl. 36, figs. 6–8), *K. septemseriatum* (Cragin) (1893, p. 240), and *Lyelliceras stanislauense* Anderson (1958, p. 247, pl. 8, fig. 5), noting that it is a very variable species, viz. the ventro-lateral tubercles are not always directed obliquely forwards (although this is regarded as a diagnostic feature of the genus according to Wright 1957, p. L414), and sometimes the keel is absent. According to Matsumoto the retaining of the ventral tubercles and the small size are the diagnostic features of *Kanabiceras* which distinguish it from *Euomphaloceras*.

The Israeli specimens are larger (100 mm. *v.* 65 mm.) and narrower (T/H 1·0–1·2 *v.* 1·3–1·5) than the American ones and bear less main ribs. Although the first saddle in Stanton's illustration is rather high, and the accessory saddle of the first lobe in Matsumoto's illustration (text-fig. 53) is small, the suture lines are similar. *Calycoceras* (*Lotzetites*) *lotzei* Wiedmann (1959, p. 732, pl. 2, figs. 1–2, text-fig. 1) resembles *Kanabiceras*, differing by the strength of the ribs which are uninterrupted on the venter.

Material. More than thirty fragmentary and well-preserved specimens, collected in the Northern Negev (Sedom), in the Southern Negev, and at Jabel Shaira in Sinai. *Kanabiceras* is the index fossil of the Lower Turonian zone 1.

Subfamily METOICOCERATINAE Hyatt 1903

Genus METOICOCERAS Hyatt 1903

Type species. Am. swallowi Shumard 1859.

TEXT-FIG. 4. *a*, *Parapuzosia* (*Austiniceras*) sp., zone 7, Daliyat el Karmil, HU-23980. *b*, *Romaniceras* (?) *inermis* (Gross.), zone 7, Mt. Carmel, HU-23971. *c*, *Romaniceras* (?) sp., Yirka Fm., Yanuh, M-3638–1. *d–f*, *Kanabiceras* sp., zone 1; *d*, Nahal Zin, HU-23484; *e*, Nahal Zin, HU-23475; *f*, Gebel Shaira, Egypt, HU-18589. *g–i*, *Mammites nodosoides* (Schlotheim), zone 6, Yirka; *g*, HU-21111; *h*, HU-21109; *i*, HU-21111. *j–k*, *Pseudaspidoceras* cf. *P. pseudonodosoides* (Choffat), zone 2, Nahal Derorim, M-3455–2. *l*, *Pseudaspidoceras* cf. *P. paganum* Reyment, zone 2, Nahal Derorim, HU-23445. *m–n*, *Paramammites* sp., zone 2, Dareb es Sultan; *m*, HU-23595; *n*, M-3570. *o*, *Nigericeras* sp., zone 1, Ma'ale Mazzar, M-4010.

Metoicoceras cf. M. whitei Hyatt

1903 *Metoicoceras whitei* Hyatt, p. 122, pl. 13, figs. 3–5; pl. 14, figs. 1–10, 15.

Remarks. One small (diameter 42 mm.), poorly preserved specimen which resembles closely *M. whitei* at the same size.

Material. One specimen, M-963-1, collected in the Northern Negev (Giv'at Zafit).

Subfamily MAMMITINAE Hyatt 1900
Genus MAMMITES Laube and Bruder 1886

Type species. Am. nodosoides Schlotheim *in* von Buch 1829.

Mammites nodosoides (Schlotheim)

Plate 1, fig. 7; text-fig. 4*g–i*

1829 *Am. nodosoides* Schlotheim *in* von Buch.
1887 *M. nodosoides* (Schlot.); Laube and Bruder, p. 229, pl. 25, fig. 1.
1903 *M. nodosoides* (Schlot.); Pervinquière, pp. 97–101.
1907 *M. nodosoides* (Schlot.); Pervinquière, p. 309, pl. 18, figs. 1–3.
1935 *M.* cf. *nodosoides* (Schlot.); Karrenberg, p. 136, pl. 31, fig. 10.
1940 *M. tischeri* Laube and Bruder; Basse, p. 458, pl. 7, fig. 3.
1955 *M.* cf. *afer* Perv.; Reyment, p. 53, pl. 9, fig. 3.
?1957 *M. nodosoides afer* Perv.; Benavides-Càceres, p. 468, pl. 55, figs. 5–8.
1959 *M. nodosoides* (Schlot.); Freund, p. 45.
1961 *M. nodosoides afer* Perv.; Freund, Table I.
1966 *M. nodosoides* (Schlot.) and var. *afra* Perv.; Collignon, p. 39, pl. 20, figs. 11–13.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*T/H*
HU-21109	—	26	27	20	1·04
HU-21111	181	85(0·45)	56(0·31)	56(0·31)	0·66
HU-23309	182	74(0·41)	63(0·35)	59(0·32)	0·85

Remarks. The specimens studied resemble closely those described by Pervinquière from Tunisia. There are, however, many slight differences. The ventral tubercles in our small specimen are oblique and form a chevron on the venter, whereas they are spirally directed in a Tunisian small one. Pervinquière's var. *afra* differs from the type by both the bullate umbilical tubercles and the rapid growth in height. In our material these two features occur independently one from the other, and the shape of the umbilical tubercles even changes during the development of the same specimen, from round to bullate. This makes Pervinquière's subspecies indiscernable. Other significant differences from the Tunisian ammonites are the ventral clavate carina and the asymmetrically inclined ventral area (Plate 1, fig. 7).

M. nodosoides spinosa (Basse) (1940, p. 458, pl. 7, fig. 2; pl. 9, fig. 2) has a very wide and low whorl section, whereas the poorly preserved specimen determined as *M. tischeri* (Basse 1940) seems to be within the range of *M. nodosoides*.

Material. Thirteen fragmentary and complete specimens collected in the Western Galilee (Yirka, Yanuh, Majd-el-Kurum) and in Central Negev (Makhtesh Ramon) from zone 6.

Mammites (?) sp.

Plate 1, figs. 8–9

Description. Shell thin, rather involute; umbilicus fairly large. Section narrow, height almost three times the width. Venter concave, bordered by two rows of clavi up to the last third of the living chamber, becoming there keeled, with a rounded passage to the sides. Five weak, forwardly convex, periumbilical bullae per half a whorl. Ribs almost indistinct. Rounded tubercles, about ten per half a whorl occur on the sides, at three-quarters of the height. Anteriorly to each of the latter tubercles, the ventro-lateral margins are ornamented by clavi. The clavi disappear completely and the lateral as well as the umbilical tubercles become denser and weaker on the last one-third volution of the living chamber, where dense, prorsiradiate growth-lines appear.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
M-3610	79	35(0·44)	13(0·16)	19(0·24)

Remarks. The ornament (except that on the end of the living chamber) resembles that of various *Mammites*, although at a much larger size (150–200 mm.). The dimensions of the shells are comparable with those of *Metoicoceras*, nevertheless any relationship between them seems quite improbable.

Material. One specimen from Western Galilee (Yanuh).

Genus PSEUDASPIDOCERAS Hyatt 1903

Type species. Am. footeanum Stoliczka 1865.

Diagnosis. Evolute, whorls only touching, with a large umbilicus. Section wide and squarish; venter wide, fairly flat, and walls straight. Radial, weak, widely spaced ribs, cross the venter uninterruptedly, ornamented by weak umbilical tubercles, strong ventro-lateral ones and tubercles on both sides of the sipho. The latter tubercles disappear at late stages. A few secondary ribs bear no umbilical tubercles. Suture comprises two bifid saddles, with apices inclined obliquely towards the first lateral lobe, which is very wide and divided by a large accessory saddle.

Remarks. Hyatt (1903) included within *Pseudaspidoceras* dissimilar species such as *Am. conciliatum* Stoliczka, *Am. cunliffi* Stoliczka, *Am. euomphalus* Sharpe, and *Am. rotomagensis* d'Orbigny together with the type species, *Am. footeanum* Stoliczka, thus rendering a vague realm to the genus. Pervinquière (1907, p. 308) considered *Pseudaspidoceras* a subgenus of *Mammites* and included in it also *Am. salmuriensis* Courtiller, regarding the squarish whorl section, the wide umbilicus and the simple, distant ribs with six rows of tubercles as diagnostic features. He ignored the involute coiling of *Mammites nodosoides*, the median keel of *Am. salmuriensis* and the differences in suture lines between the various species. Several authors (Petrascheck 1902; Boule, Lemoine and Thévenin 1907; Basse 1937) accepted Pervinquière's opinion, but others (Karrenberg 1935; Roman 1938; Reyment 1955; Wright 1957) followed de Grossouvre (1894) in separating *Mammites* from *Pseudaspidoceras*. The present writers share the latter opinion and consider the suture line with narrow saddles and wide first lateral lobe a distinctive feature of *Pseudaspidoceras*. De Grossouvre indicated as well (1912, p. 14)

that the systematic position of *Am. salmuriensis* is not within either of the above genera, but close to the Upper Cretaceous '*Mortoniceras*' which is included at present in the texanitids. This subject is further discussed under the remarks to *Protexanites salmuriensis*.

Pseudaspidoceras footeanum (Stoliczka)

1865 *Ammonites footeanus* Stoliczka, p. 101, pl. 52, fig. 1 (non 2).

Remarks. Several fragments resemble closely the adult stage of this Indian species by the evolute coiling, the square whorl section, the simple, distant radial ribs bearing six tubercles and by the suture line comprising two narrow saddles and a very wide first lateral lobe. Other two fragments with a trapezoidal whorl section, a concave venter resemble the early stages of *Pseudaspidoceras*. However, they retain this 'young' shape until a late stage (whorl height and thickness of over 80 mm.).

Material. Six fragments collected in the Northern Negev (Nahal Derorim, Hamakhtesh Hagadol) and Southern Negev (Nahal Shelomo) in zone 2.

Pseudaspidoceras cf. *P. pseudonodosoides* (Choffat)

Plate 1, figs. 10–11; text-fig. 4*j–k*

1898 *Acanthoceras* (?) *pseudonodosoides* Choffat, p. 65, pl. 16, figs. 5–8; pl. 22, figs. 32–3.
1915 *Mammites* (*Pseudaspidoceras*) *footeanus* (?) (Stol.); Greco, p. 208 (20), pl. 17 (1), fig. 5.

Description. Evolute, only the venter being covered by the following whorl. Umbilicus wide, ranging from 30 per cent at a diameter of 75 mm. to 40 per cent at a 150-mm. one. The growth of the section is rapid, about twice per whorl. Section squarish, the width slightly exceeding the height. Later (over 150 mm.) the height increases and the section narrows (T/H = 0·85). Walls flat and parallel, venter slightly convex, separated from the sides by distinct shoulders. Umbilical walls almost vertical, separated by a rounded angle from the sides. The umbilical border is ornamented by 7–9 round tubercles, or sometimes by radial bullae. Weak, commonly obliterated, radial ribs originate from each umbilical tubercle. Each rib is ornamented by a ventro-lateral tubercle, of the same size as the umbilical ones. There are 2–3 more ventro-lateral tubercles per whorl than umbilical ones. Up to a diameter of 90 mm., the ribs continue obliquely forward across the venter, and are ornamented by a weak tubercle on both sides of the sipho. At a diameter of 120 mm. the ornament on the venter disappears, the umbilical tubercles weaken, but the ventro-lateral ones remain of the same size. The number of ornament units per whorl varies between 5 and 13. Few specimens show slightly flexuous ribs, originating from the radially elongated umbilical tubercles, and intercalatory, non-tuberculate ribs.

In spite of the variability of this species a certain group (group 2 in the 'dimensions') is discernable. In the second group the section height exceeds the width at earlier stages (75 mm.), the umbilicus is wider at all stages, the rate of growth is slow (about 1·5 times per one whorl), the ornament units are more numerous (about 20–24 per whorl), the ventral tubercles still persist in a late stage, and the umbilical ones are always weak. Moreover, the body chamber is slightly involute, and its section slightly rounded.

The suture comprises two saddles, the first one on the venter, and the second—a higher one—on the side. The saddles' apices are obliquely inclined towards the first

lateral lobe which is the widest, and is divided medially by an accessory saddle into two branches of which the outermost is deeper. The ventral lobe is deeper than the lateral one at early stages, becoming shallower during growth.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*T/H*	*Remarks*
M-3484–1	76	31(0·4)	33(0·43)	23(0·3)	1·06	Group 1
M-3450–5	96	39(0·4)	41(0·43)	34(0·35)	1·05	„ „
M-3450–31	114	42(0·36)	51(0·44)	44(0·38)	1·22	„ „
M-3455–1	155	60(0·39)	62(0·4)	64(0·4)	1·03	„ „
HU-23459	204	85(0·42)	70(0·34)	72(0·35)	0·85	„ „
M-3487	360	104(0·29)	88(0·25)	—	0·84	„ „
HU-23441	96	34(0·35)	27(0·28)	40(0·4)	0·8	Group 2
HU-23008	160	56(0·35)	52(0·32)	64(0·4)	0·92	„ „

Remarks. This species is allied to *P. footeanum* (Stoliczka) (1865, p. 101, pl. 52, fig. 1) showing, however, several differences. In the Indian species, the growth is rapid (about three times per one whorl), its venter is concave at some stages, it has more intercalatory ribs, and the ventral tubercles, persisting until a late stage, lag behind the ventro-lateral ones. Another specimen of *P. footeanum* (loc. cit., fig. 2), with a round section has been related to a Portuguese specimen described under the same name by Choffat (1898, p. 66, pl. 16, figs. 9–10; pl. 22, fig. 34). In that Portuguese specimen the ventral tubercles precede the ventro-lateral ones (as already noted by Woods 1911, p. 284).

Our specimens resemble *A.* (?) *pseudonodosoides* Choffat in form, section, ornament, rate of growth and suture, but it is neither mentioned there (Choffat, loc. cit.) nor does the figure show whether the ventral tubercles precede the ventro-lateral ones. Furthermore, it is noted that the ventral tubercles disappear earlier (60 mm.). Our specimens are ornamented by a few more units or ornament per whorl (12–16) than the Portuguese ones (10–14), which have sometimes a wider section, and a somewhat higher rate of growth (about 2·5 times per whorl). These differences seem to be rather small for separating the two groups. Barber (1957, p. 33) suggests including the Portuguese species within *Paramammites*, but although certain features of our 'group 2' support this suggestion, the evolute coiling and the wide first lateral lobe are still typical of *Pseudaspidoceras*.

The specimen from Egypt described by Greco (1915) as *Mammites* (*Pseudaspidoceras*) *footeanum* (?) (Stol.) is identical with our material. *Mammites hourqui* Collignon (1939, p. 82, pl. 7, figs. 1–2; text-fig. F) resembles also our material, differing only by its very wide section (T/H = 1·65), and it should be included within *Pseudaspidoceras*. The large specimens (height of section over 100 mm.) closely resemble the specimens of *Prionocycloceras dubertreti* (Basse) of the same size, described below. They differ only in the early stages (height of up to 50–70 mm. or a diameter of 150–200 mm.).

Material. Sixty complete and fragmentary specimens, most of them collected in the Northern Negev (Nahal Derorim, Hamakhtesh Haqatan, Sede Boqer, Hamakhtesh Hagadol, Ein Yorqe'am, Dareb es Sultan) and some in the Southern Negev (Nahal Netafim) all from zone 2.

Pseudaspidoceras cf. *P. paganum* Reyment

Text–fig. 4*l*

?1911 *Mammites* (*Pseudaspidoceras*) sp. Woods, in Falconer, p. 283, pl. 23, figs. 1–2.
?1954*b* *Pseudaspidoceras paganum* Reyment, p. 253, pl. 4, fig. 1, text-figs. 3*h*, 4.

?1956 *Pseudaspidoceras paganum* Reyment, p. 68.
1957 *Pseudaspidoceras paganum* Reyment; Barber, p. 9, pl. 1, figs. 1–2; pl. 25, figs. 5–7.

Description. Very evolute, section narrow (T = 46 mm.) and relatively high (H = 65 mm.). Venter flat, separated by acute angles from the slightly convex sides. Maximum thickness at the umbilical margin. Umbilical wall vertical. A few spirally elongated ventro-lateral tubercles are connected by weak radial ribs with weak umbilical tubercles. Growth lines flexuous on the side, and prorsiradiate on the venter.

The apices of the two narrow squarish saddles are inclined towards the wide first lateral lobe, which is medially divided by a large accessory saddle.

Remarks. This fragment differs only slightly from the specimen described by Barber. The Nigerian specimen is somewhat wider and its venter is slightly convex and not flat. These differences seem to be small in comparison with those existing between Reyment's holotype and the other Nigerian specimens.

Material. One fragment from Hamakhtesh Hagadol, Northern Negev, zone 2.

Family VASCOCERATIDAE Spath 1925
Genus PARAMAMMITES Furon 1935

Type species. Vascoceras polymorphum Pervinquière 1907.

Remarks. Vascoceratids from Portugal ornamented by six rows of tubercles were named *V. subconciliatum* Choffat (1898, p. 64, pl. 15, figs. 1–3; pl. 16, fig. 4; pl. 22, figs. 28–31), and were included in the group of 'formes multituberculées'. The ribs are of secondary importance in the ornament of this species, and the umbilical tubercles persist later than other elements of the ornament. Choffat noted that the dimensions and the ornament of this species are very variable. The ornament of the type species *Vascoceras polymorphum* Pervinquière from Tunisia is also variable. *V. polymorphum* is more evolute than *V. subconciliatum* and its tubercles are coarser.

Karrenberg (1935, p. 134) included *V. polymorphum* within the genus *Mammites*, but his opinion was not followed. In the same year Furon (p. 58) suggested including both species in *Paramammites*, a new subgenus of *Vascoceras*. Reyment (1954, p. 255) attributed generic rank to *Paramammites*, suggesting *V. polymorphum* as its type species.

Nigericeras Schneegans (1943, p. 118) is characterized by seven rows of tubercles which disappear completely with growth. The umbilical tubercles are here again the last to disappear. This group like the former ones is very variable, and was divided into several species.

Barber (1957) described many species from Nigeria, characterized by seven rows of tubercles at early stages, in which the ornament weakens with growth. He included in the genus *Nigericeras* all those in which the ornament disappears at later stages, whereas those (three species) which retain six rows of tubercles at later stages were included within *Paramammites*. This is the first description of the earlier stages of ammonites included in this genus, but this description does not necessarily apply to the young stages of the Portuguese and Tunisian ammonites. Many Nigerian specimens belonging to both genera, show at late stages ventro-lateral ribs which become stronger with growth.

This ornament which occurs also in our specimens attributed to this genus, is a typical feature of *Paravascoceras*.

Several species of vascoceratids from the United States with six rows of tubercles at early stages were described by Jones (1938, p. 123, pl. 9, figs. 1–3, 7–8), and were included by Kummel and Decker (1954, p. 311, pl. 30–31), together with other species, in the genus *Spathites*. The ornament of this genus disappears completely at adult stages, and the section becomes rectangular with flat venter.

Wiedmann (1959), redescribing the fauna of the Iberian Peninsula, divided *V. subconciliatum* Choffat into two species which were included in a new genus, *Fallotites*. This genus is defined by the disappearance of ornament at the end of the living chamber. A subgenus of this genus—*Ingridella*—was defined by a very early disappearance of all ornament except of the umbilical tubercles which persist to relatively late stages. The type species of this subgenus is *V. malladae* Fallot (1931, p. 749), which is homeomorphic with *Vascoceras* in its outer whorls. Within the genus *Paramammites*, Wiedmann left two new species that retain the ornament during growth (*P. saenzi*, *P. postsaenzi*), noting that he 'did not see any traces of siphonal tubercles', but it is not explicitly written whether he succeeded in examining inner whorls. The presence or absence of siphonal tubercles is regarded by Wiedmann as a principal feature, which justifies the division of the family into two subfamilies viz: Fallotitinae, which lacks siphonal tubercles, originating from Mammitinae, and Vascoceratinae provided with siphonal tubercles, allied to Acanthoceratinae.

The multituberculate vascoceratids studied herein are also very variable, but they differ from all the above-mentioned groups by the following features: 1. The ornament becomes stronger on the body chamber. 2. The ribs are more pronounced than the superimposed tubercles. 3. Among the 6–7 rows of tubercles the umbilical ones are the weakest and do not remain the last persisting element of ornament. The first feature seems to exist inconspicuously also in the Nigerian fauna.

It might be summarized that the variability within the groups of 'multituberculate' vascoceratids is always wide, but that the difference between the various geographic groups is larger. The 'multituberculate' vascoceratids studied herewith do not fit within the narrow realm of any of the existing genera. Since it seems preferable not to erect an additional genus, our specimens are included in *Paramammites* which has priority over the others.

In addition to the groups discussed above, vascoceratids ornamented by four rows of tubercles at young stages, were included in *Paramammites* (Faraud 1940, p. 17, pl. 7, fig. 4; pl. 9, fig. 4 and photographs p. 23). It appears accepted (Wiedmann, Barber, op. cit.) to include these ammonites and those described by Böse (1918) and by Reeside (1923), in the genus *Plesiovascoceras* Spath.

Paramammites cf. *P. polymorphum* (Pervinquière)

1907 *Vascoceras polymorphum* Pervinquière, p. 336, pl. 21, figs. 2–6.

Remarks. Three poorly preserved fragments resembling the adult specimen from Tunisia (pl. 21, fig. 3). Section round-squarish, wide and low. Strong ribs, pronounced at the ventro-lateral angle and interrupted in the middle of the venter. Wiedmann (1959, p. 752)

doubts whether the above-mentioned adult Tunisian specimen belongs to this species at all.

Material. Three fragments collected in the Western Galilee (Har Zevul) and Mt. Carmel (Daliyat el Karmil) from zone 7.

Paramammites sp.

Plate 2, figs. 2–4; text-fig. 4*m–n*

Description. The specimens at our disposal have a diameter of at least 100 mm., comprising mostly only body chambers. Compressed and fairly evolute. Width of section equals more or less its height. Straight parallel walls, gradually passing to a rounded venter. A fairly large umbilicus ($\frac{1}{4}$–$\frac{1}{3}$ of the diameter). Ornament consists of eight main radial ribs and two intercalatory ribs per half a whorl. Each main rib originates from a small bulge at the umbilical border. Another bulge, somewhat stronger and radially elongated, appears at the ventro-lateral angle. Three, very weak tubercles, exist on the venter. The ribs reach only the ventro-lateral tubercles, and do not cross the venter. Very weak ribs, devoid of tubercles, appear in addition to the intercalatory ones. The siphonal tubercles are erased on most specimens. The most conspicuous and persistent element of ornament are the tubercle-like bulges on the ventro-lateral border, which are sometimes inclined forward. The ornament becomes considerably stronger on the anterior half of the body chamber, and in numerous specimens the posterior half of the body chamber is completely smooth, and the ornament appears only on the anterior-most quarter of the whorl.

The suture is simple comprising three saddles, of which the third is located on the umbilical border; the first lateral lobe is bifid.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*T/H*
M-3570	95	44(0·46)	40(0·42)	25(0·26)	0·9
HU-23595	120	48(0·4)	52(0·43)	34(0·28)	1·1

Remarks. In the remarks to the genus it has been noted that this species does not belong to any of the 'multituberculate' vascoceratids, and occupies a position intermediate between them and *Paravascoceras*.

Pseudaspidoceras pseudonodosoides (Collignon 1957, p. 9, pl. 2, fig. 1; non Choffat) resembles closely the specimens described here.

Material. Eighteen complete and fragmentary specimens, collected in the Northern Negev (Dareb es Sultan and Har Boqer) from zone 2.

Genus NIGERICERAS Schneegans 1943

Type species. Acanthoceras gadeni Chudeau, 1909.

EXPLANATION OF PLATE 2

Fig. 1. *Nigericeras* sp., zone 1, Ma'ale Mazzar, M-4010–18, ×1.

Figs. 2–4. *Paramammites* sp., zone 2; 2–3. Har Boqer, M-3642, ×$\frac{2}{3}$; 4. Dareb es Sultan, HU-23565, ×$\frac{2}{3}$.

Figs. 5–7. *Paravascoceras* cf. *P. evolutum* Schneegans, zone 1, Nahal Zin; 5. HU-23503, ×1; 6–7. HU-23582, ×1.

Fig. 8. *Paravascoceras obessum* (Taubenhaus), zone 2, Ein Yorqe'am, HU-23422, ×1.

Fig. 9. *Paravascoceras tavense* (Faraud), zone 2, Ma'ale Aqrabbim, HU-23091, ×1.

Nigericeras sp.

Plate 2, fig. 1; text-fig. 4*o*

Description. Only one specimen consisting of half a whorl of the living chamber is at our disposal. Small, compressed conch, sides flat and parallel, venter round. Umbilicus of medium size, umbilical walls round. Ornament is absent at this stage. Two bifid square saddles of the last suture-line are visible.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
M-4010–18	61	28	14(0·23)	13(0·21)

Remarks. The thin conch, the flat sides, the shallow umbilicus, the lack of ornament and the acanthoceratid shape of the suture-line relates this specimen to *Nigericeras jacqueti* Schneegans (1943, p. 125, pl. 6, fig. 8; pl. 7, fig. 1, text-fig. 7).

Material. One specimen collected in the Northern Negev (Ma'ale Mazzar), at the bottom of zone 1.

Genus PARAVASCOCERAS Furon 1935

Type species. Vascoceras cauvini Chudeau 1909.

1935 *Pachyvascoceras* Furon, p. 58.
1935 *Paracanthoceras* Furon, p. 59.
1935 *Paravascoceras* Furon, p. 60.
1956 *Broggiiceras* Benavides-Càceres, p. 409.
1957 *Discovascoceras* Collignon, p. 11.

Diagnosis. Vascoceratids lacking umbilical tubercles. Compressed and involute at early stages; less involute later. During growth, there is either a short or a very long stage without any ornament. Lateral or marginal bulges sometimes appear; prorsiradiate ribs, uninterruptedly crossing the venter, usually appear at a late stage. They rarely attain the umbilical border. The suture is simple and typical for the family.

Remarks. Furon established two new subgenera *Paravascoceras* and *Paracanthoceras*, on the basis of highly involute, uninflated adult forms, showing strong ornament of ribs without tubercles, and differing from each other by the suture-line, which is nearer to the acanthoceratid type in the second. Schneegans (1943, p. 127) revised this classification on the basis of a detailed study of the development of form and ornament, from early stages onwards. He showed that the suture is very variable, even in the same specimen and considered the second subgenus a synonym of the first one. Reyment (1954*b*, p. 256) attributed to it a rank of a genus, using the name *Paracanthoceras* according to the 'Law of page priority' but returned to use the name *Paravascoceras* (1955, p. 63) according to the 'Law of first revision'. Schneegans, followed by Barber (1957, p. 34), included in this genus also the genus *Pachyvascoceras* Furon, which differs from the previous ones only by the thickness of the conch, regarding this feature as non diagnostic. For the same reason it seems justified to include in *Paravascoceras* also the genus *Discovascoceras* Collignon (1957, p. 11). The genus *Broggiiceras* Benavides-Càceres, based on two Peruvian species, is identical with *Paravascoceras*.

The definitions of this genus by Schneegans, Barber, Reyment, and Wright vary according to the differences between the specimens at their disposal. Although Barber's

definition is the most comprehensive and the least rigid one, it is still not wide enough to include all the species at our disposal. The present writers suggest to stress the importance of the absence of umbilical tubercles at early stages (on the contrary to all other genera of the vascoceratids excluding *Neoptychites*) and to include within this genus also the forms which are entirely devoid of ornament throughout their development.

Paravascoceras cauvini (Chudeau)

Plate 3, figs. 1–3; text-fig. 5*a–b*

1909 *Vascoceras cauvini* Chudeau, p. 67, pls. 1–3.
?1915 *Acanthoceras mantelli* (?) Sow.; Greco, p. 207, pl. 18, figs. 1–2.
1921 *Thomasites cauvini* (Chudeau); Chudeau, p. 463, fig. 1.
1933 *Vascoceras cauvini* Chudeau; Furon, p. 268, pl. 9, fig. 17.
1935 *Vascoceras* (*Paravascoceras*) *cauvini* Chudeau; Furon, p. 60, pl. 5, fig. 1.
1943 *Paravascoceras cauvini* (Chudeau); Schneegans, p. 128, pl. 5, fig. 2.
1956 *Broggiiceras humboldti* Benavides-Càceres; p. 471, pl. 56, figs. 3–6.
?1957 *Paravascoceras* aff. *cauvini* (Chudeau); Barber, p. 37, pl. 14, figs. 2–3; pl. 32, figs. 8–9.

Description. Compressed and fairly involute. Round section, usually slightly wider than high, maximum width at one-third of the height from the umbilical border. Umbilicus of medium size (23–27 per cent of the diameter) with round borders and vertical walls. Early stages examined only in one rather small specimen (M-3602—see Pl. 3, fig. 3) in which the ornament development resembles that described by Schneegans (1943, p. 127). Five strong, oval, lateral bulges cover half a whorl up to a diameter of 55 mm. They disappear on the outer half of the same whorl which bears in their stead wavy, prorsiradiate ribs which cross the venter and do not reach the umbilicus. The unornamented stage between diameters of 20–55 mm. mentioned in the original description does not exist in this specimen. Furthermore, this specimen differs from the typical *P. cauvini* by its thin section (34 per cent of D) and thus, can be related to *V.* (*P.*) *chudeaui* Furon (1935, p. 61, pl. 4, fig. 2), whereas its wide umbilicus (27 per cent of D) relates it to *P. cauvini* var. *evoluta* Schneegans (1943, p. 130, pl. 8, fig. 2). The adult ornament appearing usually at a diameter of 50–60 mm. includes prorsiradiate ribs which cross the venter uninterruptedly. Usually there are 27, but sometimes up to 36 ribs per whorl. The ribs are usually slightly more pronounced at the ventro-lateral margin where sometimes even a tubercle occurs, but in several specimens they are stronger on the mid-venter. The ribs disappear on the sides, not reaching the umbilicus. On one specimen (M-3450-29), the ribs disappear on the middle of the body chamber, reappearing as shallow waves at its end, resembling the ornament of *V.* (*P.*) *cauvini* (Chudeau) var. *semiglabra* Furon (1935, p. 61, pl. 4, fig. 3). The specimens with narrow section and straight converging walls resemble *V.* (*P.*) *chudeaui*, except in their sparser, finer, and more radial ribs.

The suture-line is preserved only on a single specimen and can be hardly followed. First saddle large and wide, second lateral lobe much smaller than the asymmetrically bifid first lateral lobe.

EXPLANATION OF PLATE 3

Figs. 1–3. *Paravascoceras cauvini* (Chudeau), zone 2; 1–2. Nahal Derorim, M-3453–16, $\times\frac{2}{3}$; 3. Nahal Alaliq, M-3602, $\times 1$.
Figs. 4–5. *Paravascoceras rumeaui* Collignon, zone 2, Nahal Derorim, M-3453–34, $\times 1$.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
M-3602	70	33	24(0·34)	19(0·27)
M-3453–3	81	35	38(0·47)	19(0·23)
HU-23437	113	50	36(0·31)	27(0·24)
M-3453–7	118	39	44(0·37)	31(0·26)
M-3450–29	130	48	49(0·37)	39(0·3)

Remarks. The Central African ammonites have few more (34–45) ribs. The dimensions and the ornament of this species are rather variable rendering some doubt on the erection of so many species and subspecies by Furon. *V. globosum compressum* Barber (1957, p. 25, pl. 7, fig. 4; pl. 9, fig. 1; pl. 21, figs. 10–12) resembles this species, being only slightly thicker and having more spaced ribs. Even its umbilical tubercles, which are typical for the genus *Vascoceras*, disappear at a smaller diameter. It is noteworthy in this connection that periumbilical tubercles have been mentioned already in the original description (Chudeau 1909). This is an important feature which has somehow been neglected in later descriptions of the species and of the genus. *Broggiiceras humboldti* Benavides-Càceres and our material are identical and both bear less ribs than the African type. *B. olssoni* Benavides-Càceres (1956, p. 470, pl. 55, figs. 1–4) has wide section and umbilicus, and its ribs are almost radial. Several species of *Thomasites* (e.g. *Thomasites meslei* Perv.) and *Vascoceras* (especially *V. durandi* Th. and Per.) have also ventral ribs as late ornament.

Material. Seventy-five complete and fragmentary specimens collected in the Northern Negev (Hamakhtesh Hagadol, Hamakhtesh Haqatan, Nahal Derorim, Sede Boqer, Dareb es Sultan, Ein Yorq'eam) and in the Southern Negev (Wadi Alaliq, Nahal Raham, Nahal Netafim, Timna). This is the index fossil of Lower Turonian zone 2.

Paravascoceras rumeaui Collignon

Plate 3, figs. 4–5; text-fig. 5*c–d*

1943 *Paravascoceras cauvini* (Chudeau) var. *inflata* Schneegans, p. 131.
1957 *Paravascoceras rumeaui* Collignon, p. 10, pl. 1, fig. 2.

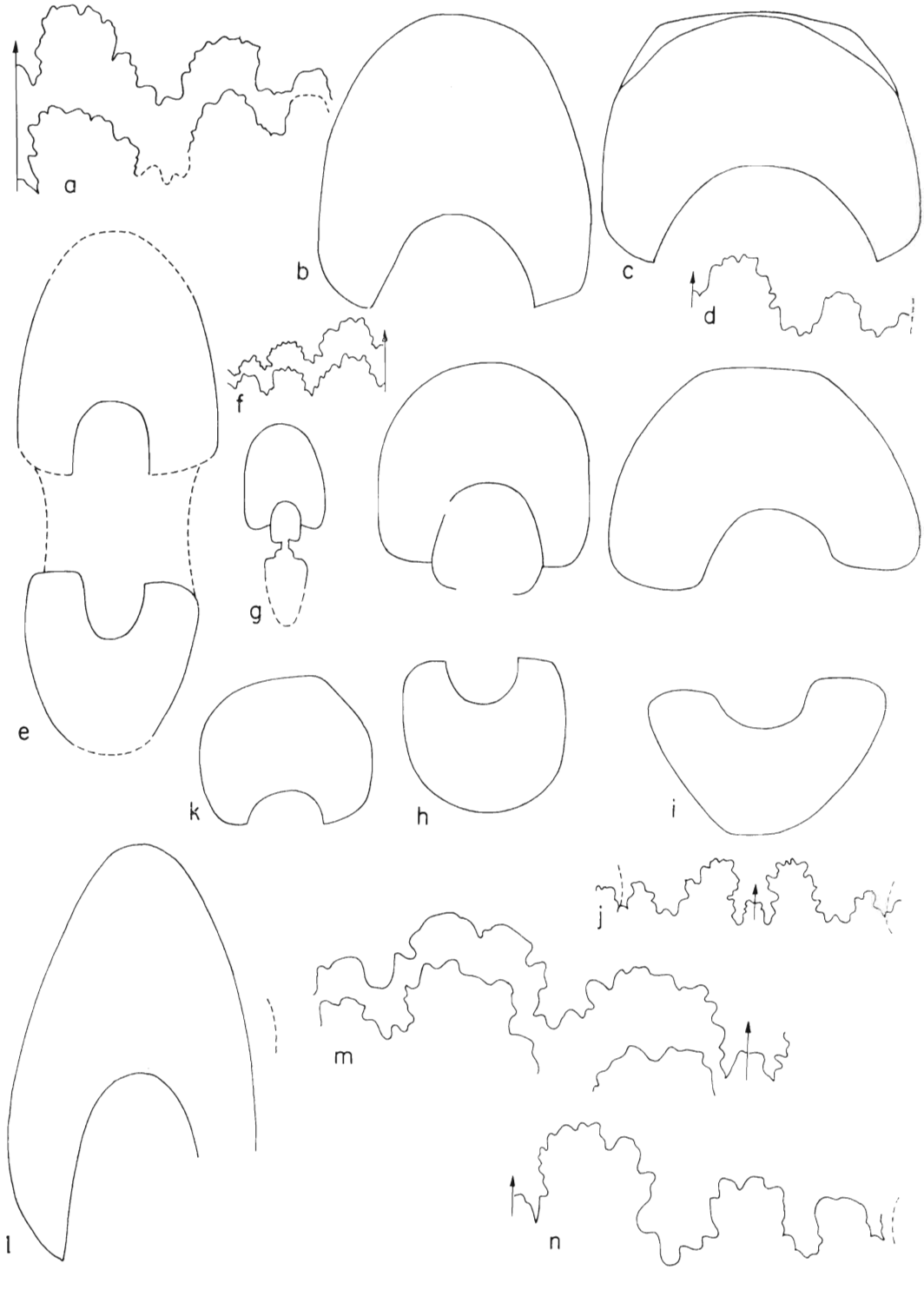
Description. Fairly involute, inflated shells. Section round, much wider than high (T/H–1·6). Umbilicus of medium to large size with round borders and vertical walls. The anterior half of the body chamber is ornamented by prorsiradiate ribs, crossing the venter. The posterior half is usually smooth. It was not possible to examine the inner whorls.

Two groups are discernable. One, represented by the first three measurements, is characterized by a wider section and is ornamented by about 25 narrow, densely spaced ribs per whorl. The other one, represented by the fourth measurement, is characterized by large and rather thin shells, less numerous (about 18 per whorl) and shallower ribs, which are less prorsiradiate and attain the umbilical border. In several specimens the ribs are pronounced at the ventro-lateral region.

The suture shows three simple, round, and fairly high saddles (the third one is on the umbilical border); the lobes are round, showing rudimentary bifidity.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
HU-23020	89	32	53(0·57)	32(0·36)
M-3453–19	92	37	56(0·61)	24(0·26)
M-3453–8	95	36	54(0·56)	27(0·28)
M-3453–18	147	58	73(0·5)	46(0·31)


a
b
c
d
e
f
g
h
i
j
k
l
m
n

Remarks. These ammonites, especially the first group, differ from *P. cauvini* only by the wider section and they agree perfectly with the description and the photographs of *P. rumeaui* Collignon from Lybia. This species differs only slightly from *P. crassus* (Furon 1935, p. 58, pl. 3, fig. 2), but the latter species has weaker ribs. The ribs of *P. crassus bullata* Schneegans (1943, p. 131, pl. 8, figs. 3–4) are radial and not prorsiradiate. *P. costatum* Reyment (1955, p. 65, pl. 14, figs. 1–2) shows very weak ribs. The adult stages of *V. globosum compressum* Barber (1957, p. 25, pl. 7, figs. 4*a*, *b*; pl. 9, figs. 1*a*, *b*; pl. 28, figs. 10, 11), resemble our specimens, but as mentioned above, it is impossible to compare the young stages. The second group, which includes less inflated forms with coarser ribs, resemble specimens of *Paramammites*, and thus the generic position of the second group is somewhat doubtful.

Material. Fifteen fragmentary and complete specimens collected in the Northern Negev (Naha Derorim, Hamakhtesh Hagadol) from zone 2.

Paravascoceras tavense (Faraud)

Plate 2, fig. 9; text-fig. 5*e–g*

1940 *Vascoceras tavense* Faraud, p. 6, pl. 1, fig. 1; pl. 5, fig. 1; pl. 8, fig. 2.

Description. Compressed and involute. Section oval, higher than wide, its maximum width at about one-third of the height. Venter narrowly rounded, continuous with the round flanks. Umbilicus small, with distinct borders and straight, vertical to overhanging walls at early stages. During growth the umbilicus widens from 15 to 25 per cent of the diameter, its borders become indistinct and the walls inclined. Meanwhile, the thickness of the shell decreases from 43 to 30 per cent of the diameter. The shell is smooth at all stages from a diameter of 30 mm. onward, except for very shallow and wide waves, which seldom appear on the ventral region at a diameter of about 70 mm.

The suture comprises three shallow, round saddles and narrow lobes. One accessory lobe, deeper than the usual notching of the saddle, occurs in the first saddle, near the first lateral lobe.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
HU-23091	40	20	17(0·43)	6(0·15)
HU-23082	68	34	27(0·4)	10(0·15)
M-3595–3	100	44	—	21(0·21)
Holotype (France)	105	49	43(0·4)	21(0·21)*
M-3457–3	124	58	46(0·37)	31(0·25)
M-3462–1	139	63	50(0·3)	33(0·24)

* Measurements of Faraud's illustrations.

Remarks. There is no difference between our ammonites and that from France described by Faraud. It should, however, be noted that this species is based only on a single adult

TEXT-FIG. 5. *a–b*, *Paravascoceras cauvini* (Chudeau), zone 2, Nahal Derorim; *a*, M-3450–29; *b*, M-3450–32. *c–d*, *Paravascoceras rumeaui* Collignon, zone 2, Nahal Derorim, M-3453. *e–g*, *Paravascoceras tavense* (Faraud), zone 2; *e*, Nahal Derorim, M-3453–36; *f*, Ma'ale Aqrabbim, HU-23082; *g*, Ma'ale Aqrabbim, HU-23091. *h–i*, *Paravascoceras crassum* (Furon), zone 2; *h*, Ma'ale Aqrabbim, HU-23551; *i*, Nahal Derorim, M-3453–13. *j–k*, *Paravascoceras* cf. *P. evolutum* Schneegans, zone 1, Nahal Zin; *j*, HU-23372; *k*, HU-23374. *l–m*, *Paravascoceras* (?) sp., zone 3; *l*, Ma'ale Mazzar, HU-23413; *m*, Sede Boqer, HU-23339. *n*, *Gombeoceras* cf. *G. gongilense* (Woods), zone 2, Nahal Derorim, M-3450–6.

specimen, the inner whorls of which have not been examined (personal letter, Faraud 1961). The suture of the French specimen is erased, not allowing any comparison. *Gombeoceras subtenue* Reyment (1954*b*, p. 261, pl. 4, fig. 4; text-fig. 3*f*), closely resembles our ammonites but its section is wider and the ornament of periumbilical tubercles persist up to a diameter of 55 mm. (*vide* Barber 1957, p. 43). The differences between our specimens and *Nigericeras jacqueti* Schneegans (1943, p. 125, pl. 4, fig. 8; pl. 7, fig. 1; text-fig. 7), are even smaller; the latter species is somewhat thinner (34 per cent of a diameter of 50–80 mm.), its umbilicus is slightly larger (22–28 per cent of the same diameter) and the shells are completely smooth during all growth stages. Also *N. lamberti* Schneegans (1943, p. 123, pl. 6, fig. 7) looses the ornament typical for the genus, at a diameter of 17 mm., which is a smaller diameter than the smallest one here examined. Unlike *P. tavense*, the species of *Nigericeras* are characterized by a more square acanthoceratid suture. The form and the suture relates the present species to *P. cauvini*, differing only by the ornament.

Material. More than 220 specimens, most of which are in a poor state of preservation, collected in the Northern Negev (Har Boqer, Hamakhtesh Hagadol, Nahal Yorqe'am, Ma'ale Aqrabbim, Hamakhtesh Haqatan, and Sedom.) They abound in zone 2.

Paravascoceras crassum (Furon)

Text-fig. 5*h–i*

1935 *Vascoceras* (*Pachyvascoceras*) *crassus* Furon, p. 58, pl. 3, fig. 2; text-fig. 17.
1943 *Paravascoceras crassus* (Furon); Schneegans, p. 127.

Description. Moderately thick shells (55 to 80 per cent of the diameter). Umbilicus small with vertical walls. Shell inflated and round, lacking any ornament at all the examined stages, from a diameter of about 15 mm. Medium-sized specimens show weak waves on the ventral region.

The suture comprises 2 to 3 round and simple saddles on the sides. The first lateral lobe is sometimes bifid.

Dimensions

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
HU-23551	52	25	27(0·54)	11(0·21)
HU-23088	89	40	54(0·6)	23(0·24)
M-3453–13	74	34	54(0·73)	20(0·26)
M-3453–6	75	30	62(0·83)	22(0·28)

Remarks. This species is based on a poorly described single specimen from Sahara, whose dimensions agree well with the mean dimensions of our material (width 68 per cent and umbilicus 26 per cent of the diameter). Apart from its thickness this species is identical with *Paravascoceras tavense* (Faraud). The Nigerian species *V. nigeriensis* Woods (1911, p. 281, pl. 21, fig. 6; pl. 22, figs. 2–3) is of similar dimensions but differs from our material by the periumbilical tubercles. Other species of similar dimensions are *V. polygonum* Barber (1957, p. 17, pl. 5, fig. 2; pl. 29, figs. 1–3), *V. robustum* Barber (1957, p. 15, pl. 5, fig. 1; pl. 26, figs. 5–6), both of which have umbilical tubercles and *P. costatum* Reyment (1954, p. 257, pl. 3, fig. 6; pl. 4, fig. 3; pl. 5, fig. 2; text-figs. 3, 5), which is included by Barber within the genus *Paravascoceras* because it lacks umbilical

tubercles. The most inflated shells have a width near to that of *V. kossmati* Choffat (1897, p. 63, pl. 13, figs. 8–9; pl. 14, figs. 1–2; pl. 21, figs. 26–7).

Material. Twenty-one complete and fragmentary specimens, collected in the Northern Negev (Har Boqer, Ma'ale Mazzar, Hamakhtesh Hagadol, and Ma'ale Aqrabbim). One specimen was found at Tafila, Transjordan.

Paravascoceras obessum (Taubenhaus)

Plate 2, fig. 8; text-fig. 7*c–e*

1920 *Pseudotissotia segnis* Solger var. *obesa* Taubenhaus, p. 43, pl. 7, fig. 4.
1940 *Vascoceras* (*Pachyvascoceras*) *triangulare* Faraud, p. 9, pl. 3, fig. 2; pl. 4; pl. 8, fig. 3.
1957 *Discovascoceras tesselitense* Collignon, p. 13, pl. 1, fig. 1.
1957 *Discovascoceras defrennei* Collignon, p. 13, pl. 2, fig. 3.
1961 *Vascoceras triangulare* Faraud; Freund, p. 81, Table I.

Description. Inflated shells with a triangular, sharp-ventered section. Side convex, maximum width near umbilical border. Two groups are discernable: one with thick shells (50–60 per cent of the diameter), large umbilici (25–35 per cent), and a less acute venter in the inner whorls (text-fig. 7*e*). The second group comprises narrower shells (40–50 per cent) with smaller umbilici (15–20 per cent of the diameter), and the venter is sharp throughout (text-fig. 7*d*). The umbilical walls are vertical or slightly inclined. No ornament exists from a diameter of 25 mm. onward. The suture is simple, with two or three low, round saddles.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
HU-23446	31	14	20(0·65)	10(0·32)
HU-23417	87	48	49(0·57)	20(0·24)
HU-23422	93	39	55(0·6)	24(0·26)
HU-23006	102	32	57(0·56)	37(0·36)
HU-23464	100	45	39(0·39)	15(0·15)
HU-2211	—	43	53	28 Holotype

Remarks. The holotype described by Taubenhaus as *P. segnis* Solger var. *obesa*, which is at our disposal, comprises only the living chamber and does not show the suture line. It certainly does not belong either to the genus or to the species to which it was attributed, as the venter of the outer whorl is acute, and that of the inner whorl is round, whereas the reverse is true both for *Pseudotissotia* and for *Choffaticeras* to which *segnis* is now attributed (see p. 54). Moreover, it is much thicker than any *Choffaticeras*. *V. triangulare* Faraud also resembles our material; its width ranges between 50 and 60 per cent of the diameter, similar to the range of 40–60 per cent in our material. It is not known whether it has umbilical tubercles at early stages. Barber (1957, p. 17, pl. 4, fig. 1; pl. 6, fig. 4; pl. 26, figs. 3, 4, 7–11), notes that *V. ellipticum* is probably identical with the former species, but as the Nigerian material is well preserved, allowing a more accurate definition, he prefers to use a new name. It has umbilical tubercles at early stages and thus differs definitely from our material. *Paravascoceras costatum tectiforme* Barber (1957, p. 37, pl. 14, fig. 4; pl. 15, figs. 1, 3; pl. 16, fig. 2; pl. 32, figs. 4–7) differs from the former Nigerian species and resembles ours by the lack of umbilical tubercles. *P.c. tectiforme* is, however, ornamented by weak ribs at advanced stages and its venter is narrow but not acute. Collignon (1957) proposed a new genus, named *Discovascoceras*, for vascoceratids with a sharp venter and lacking any ornament. It is difficult to accept

this suggestion, especially because it is based on poorly preserved specimens, of which only the last whorl can be examined. These specimens resemble closely our material.

Material. Twelve specimens collected in the Northern Negev (Hamakhtesh Hagadol, Ein Yorqe'am, Ein Boqeq, Giv'at Zafit, Har Boqer), and in the Southern Negev (Nahal Rehav'am) from zone 2.

Paravascoceras cf. *P. evolutum* Schneegans

Plate 2, figs. 5–7; text-fig. 5*j–k*

1943 *Paravascoceras cauvini* (Chudeau), var. *evoluta* Schneegans, p. 130, pl. 8, fig. 2; text-figs. 10–11.

Description. Rather small, comparatively evolute conch. Whorl section round, its height equals its thickness. The umbilical walls, the sides, and the venter form one continuous, uninterrupted surface. Prorsiradiate ribs occur on the venter but do not reach the umbilicus. The ribs are sometimes of unequal size, and are slightly pronounced on the mid-venter and in the ventro-lateral region. There are about 30–35 ribs per whorl at the early stages; later they become wider, shallower, and fewer.

The suture-line has the usual simple vascoceratid shape. Two saddles occur on the sides and the first lateral lobe is equally divided by a small accessory saddle.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
HU-23582	35	15(0·43)	14(0·42)	11(0·32)
HU-23373	62	25(0·42)	25(0·42)	21(0·34)
HU-23502	87	38(0·43)	36(0·42)	30(0·34)

Remarks. These ammonites are rather evolute for *Paravascoceras*. They resemble in shape *P. cauvini* var. *evoluta* and *Paravascoceras* cf. *baroicensis* (Choffat) from Nigér (Schneegans 1943, p. 134, pl. 8, fig. 1; text-fig. 15). The second one, however, lacks any ornament.

Material. Twenty-five well-preserved and 25 poorly preserved specimens collected in the Northern Negev (Nahal Zin) and in the Southern Negev (Be'er Ora, Nahal Netafim) from zone 1.

Paravascoceras (?) sp.

Text-fig. 5*l–m*

Description. Large (restored diameter 170–250 mm.), discoidal, narrow, and involute shells. Section oval, high (80 mm.) and narrow (55 per cent of the height). Venter narrowly rounded. Slightly convex walls converge ventrad, passing gradually, without a definite border into a small umbilicus (17 per cent of diameter). The specimens consisting almost only of living chambers are not ornamented. One specimen with preserved shell, shows dense, prorsiradiate growth-lines. The suture is composed of two broad and round saddles and a third smaller one. It seems that the second saddle is much higher than the first one. The first lateral lobe is asymmetrically divided by a small accessory saddle, and is less deep than the ventral lobe.

Remarks. These specimens resemble *Neoptychites cephalotus* (Court.) in size and section, differing by a larger umbilicus, by an uninflated body chamber and by the simple suture-line.

Material. Five fragmentary specimens, collected in the Northern Negev (Hamakhtesh Hagadol, Sede Boqer, Giv'ot Kevuda and Ma'ale Mazzar) from zone 3.

Genus GOMBEOCERAS Reyment, 1954

Type species. Vascoceras gongilensis Woods, 1911.

Gombeoceras cf. *G. gongilense* (Woods)

Plate 6, figs. 1–2; text-figs. 5*n*, 6*a*

1911 *Vascoceras gongilensis* Woods; in Falconer, p. 282, pl. 21, fig. 7; pl. 22, fig. 1.
?1928 *Vascoceras niloticum* Douvillé, p. 14, pl. 3, fig. 1.
?1928 *Mammites* sp. Douvillé, p. 12, pl. 2, fig. 1.
1954 *Gombeoceras gongilense* (Woods); Reyment, p. 151, pl. 3, fig. 6; pl. 2, fig. 1; text-fig. 1.
1955 *Gombeoceras gongilense* (Woods); Reyment, p. 63, pl. 14, fig. 5; pl. 21, fig. 4.
1956 *Gombeoceras gongilense* (Woods); Reyment, p. 70.
?1957 *Gombeoceras gongilense gongilense* (Woods); Barber, p. 39, pl. 17, fig. 3; pl. 33, figs. 1–3.
?1957 *Gombeoceras gongilense lautum* Barber; p. 39, pl. 17, figs. 2, 5, 6; pl. 33, figs. 11–12.
1961 '*Vascoceras*' *niloticum* Douvillé; Freund, p. 81, Table I.

Description. Compressed and fairly involute. High, rectangular whorl section. Slightly convex, converging walls, separated from a flat or slightly convex venter by a distinct ventro-lateral border. Medium-sized umbilicus increasing rapidly with the diameter. Umbilical wall vertical, with well-defined border. At a large diameter (above 120 mm.), the wall and the venter become rounded and the boundary between them diminishes. Round ventro-lateral tubercles, about 34 per whorl, compose the only ornament. In one specimen these tubercles are connected by weak prorsiradiate ribs across the venter. One specimen shows very weak umbilical tubercles. Sometimes the ornament disappears on the body chamber. One specimen shows a very weak mid-ventral ridge. The suture comprises three fairly high, squarish saddles.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
M-3450–41	27	14	12(0·44)	5(0·18)
M-3470–6	101	43	36(0·36)	25(0·25)
M-3570	103	49	40(0·38)	25(0·24)
M-3450–6	149	58	53(0·36)	45(0·3)

Remarks. Woods noted the existence of distinct periumbilical tubercles. On the other hand, Reyment (1954) defining the genus, attributed less importance to these tubercles, noting that they disappear early. It is noteworthy to mention the close resemblance of the young stages of the present genus to those of *Thomasites*, the latter being distinguished only by its strong umbilical tubercles. Only one specimen of our material shows rudimentary umbilical tubercles. *G. gongilense lautum* Barber, has a smaller umbilicus (15 per cent of D) and a more lenticular section. The small specimen described by Douvillé (1928) as *V. niloticum*, closely resembles our material and is, in the present authors' opinion, a young specimen of the discussed species. It is ornamented by weak but distinct umbilical tubercles. The specimen described by Douvillé as *Mammites* sp., resembles our specimens, but it has a smaller umbilicus with fairly distinct umbilical tubercles.

Material. Six specimens collected in the Northern Negev (Nahal Derorim, Har Boqer) from zone 2.

Genus VASCOCERAS Choffat 1898

Type species. V. gamai Choffat 1898.

Vascoceras cf. *V. depressum* Barber

Plate 5, figs. 2–3; text-fig. 6*b–c*

1957 *Vascoceras depressum* Barber, p. 19, pl. 6, fig. 5; pl. 27, figs. 7–9.

Description. Small, fairly involute shells. Umbilicus medium to large; umbilical walls vertical, rounded. Section rectangular somewhat higher than wide. Sides flat, slightly converging towards the venter which is flat or slightly rounded. Ornament consists of large, shallow, round umbilical tubercles, about 9 per one whorl on small specimens and up to 13 per whorl on larger ones. Very weak ribs, which do not attain the ventro-lateral margin, originate sometimes from the umbilical tubercles. Two simple round saddles, the first one larger than the second one.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
HU-23523	43	21(0·5)	19(0·43)	12(0·28)
M-3442–1	57	25(0·44)	25(0·44)	14(0·24)
HU-23521	67	29(0·43)	24(0·36)	24(0·36)

Remarks. The umbilical tubercles are preserved on our specimens to a larger diameter than on the Nigerian ones. Otherwise, there is a close resemblance between them, but the poor material at our disposal does not allow an accurate comparison.

Material. Five specimens collected in the Northern Negev (Nahal Zin, Nahal Derorim) from zone 1.

Vascoceras pioti (Peron and Fourtau)

Plate 4, figs. 1–9; text-fig. 6*d–g*

1904 *Ammonites pioti* Peron and Fourtau; Fourtau, p. 275, pl. 1, figs. 4–5.
1920 *Thomasites rollandi* (Thomas and Peron); Taubenhaus, p. 44 (pars).
?1959 *Neoptychites* (*Spathitoides*) *sulcatus* Wiedmann; p. 754, pl. 7, figs. 7–8; text-figs. 11–12.
1966 *Neoptychites hottingeri* Collignon, p. 44, pl. 25, fig. 1.

Description. Very involute, umbilicus small with well-defined borders and vertical walls. Whorl height generally equals the width. Maximum width near umbilicus and walls converging ventrad. Venter flat or slightly convex, clearly separated from the sides. The trapezoidal section exists throughout the whole septate part of the shell, up to a diameter of 90 mm., becoming more oval in the body chamber. The body chamber occupies almost a whole whorl; it is somewhat inflated and the aperture is constricted. Its maximum width is at one-third of the height. The body chamber resembles closely that of *Thomasites rollandi*. The width of the section is variable to a certain degree. Thus, whereas in most specimens the width varies between 42 and 49 per cent of the diameter there are few very thin specimens (35 per cent of D) and a wider one (75 per cent).

EXPLANATION OF PLATE 4

Figs. 1–9. *Vascoceras pioti* (Peron and Fourtau), zone 3, Ma'ale Mazzar; 1. HU-23356, ×⅔; 2. M-970, ×⅔; 3–5, M-4059, ×1; 6–7. HU-23382, ×1; 8–9. M-4054, ×1.

From a diameter of 18 mm. (the smallest one measured), the shell is ornamented by weak, slightly prorsiradiate ribs which cross the venter. There are up to 25 ribs per whorl. Sometimes, they occur on the venter and on the outer fifth of the flanks only, and sometimes they originate from umbilical tubercles. The ornament often disappears at an early stage, but sometimes persists as weak waves on the body chamber. Dense (about 15 per quarter of a whorl) and very weak ribs appear sometimes at the end of the body chamber.

Suture comprises four broad and shallow saddles, the fourth one is situated on the umbilical border. The first lateral lobe is unequally divided by an accessory saddle, which is situated on its outer side. The second lobe is much less deep than the first one.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
HU-23392	24	12(0·5)	11(0·46)	3(0·12)
HU-23396	31	16(0·51)	13(0·42)	3(0·1)
HU-23382	71	35(0·49)	35(0·49)	10(0·14)
HU-23356	126	56(0·44)	55(0·43)	17(0·13)
M-960	143	66(0·45)	65(0·45)	21(0·15)
P-795	66	32(0·49)	50(0·75)	11(0·17)

Remarks. The dimensions and the ornament of *Ammonites pioti* Peron and Fourtau are identical with those of our specimens of the same size. Four specimens from the vicinity of es Salt (Transjordan), described among others by Taubenhaus, were re-examined by the present authors, and it seems that their identification as *Th. rollandi* was a result of the close similarity of the body chambers of both species. The genus *Spathites* Kummel and Decker (1954, p. 311) has also a trapezoidal section and a flat venter, but the ornament of the young specimens of that genus comprises six rows of tubercles. A mid-ventral ridge on the body chamber, such as illustrated in plate 30, fig. 2 (Kummel and Decker) exists also in a large specimen from our material (Pl. 4, fig. 2). Barber (1957) described many involute and flat-ventered ammonites from Nigeria; the one closest to our material is *Gombeoceras gongilense lautum* Barber (loc. cit.), differing only by the ventro-lateral tubercles at early stages. *Pseudotissotia* (*Bauchioceras*) *nigeriensis tabulata* Barber (1957, p. 51, pl. 21, fig. 1; pl. 34, figs. 1, 11) differs from our material only by its narrow section (55 per cent of the diameter which occurs rarely in our material). This species is also unornamented so that by itself it is inseparable from our narrow specimens. Its definition depends on considerations regarding it as a transition form of the above-mentioned genus and species. *Neoptychites* (*Spathitoides*) *sulcatus* Wiedmann, resembles our material, except for the concave venter, and the much more developed suture. It seems that the specimen named *Neoptychites hottingeri* Collignon (loc. cit.), is very near, if not identical with *V. pioti.*

Material. Forty-six complete and fragmentary specimens, some very well preserved, from Transjordan (es Salt) and from the Northern Negev (Ma'ale Aqrabbim, Nahal Zin, and Ma'ale Mazzar). This is the index fossil of zone 3.

Vascoceras durandi (Thomas and Peron)

Text-fig. 6*h–i*

1889 *Pachydiscus durandi* Thomas and Peron, p. 27, pl. 18, figs. 5–8.
1896 *Pachydiscus durandi* Thomas and Peron; Peron, p. 44, pl. 4, fig. 1; pl. 5, fig. 1; pl. 17, fig. 5.
1897 *Vascoceras douvillei* Choffat, p. 59, pl. 10, figs. 3, 6; pl. 11, figs. 2–5; pl. 21, figs. 13–16.

TEXT-FIG. 6. *a*, *Gombeoceras* cf. *G. gongilense* (Woods), zone 2, Nahal Derorim, M-3450–6. *b–c*, *Vascoceras* cf. *V. depressum* Barber, zone 1, Nahal Zin; *b*, HU-23521; *c*, HU-23524. *d–g*, *Vascoceras pioti* (Peron and Fourtau), zone 3, Ma'ale Mazzar; *d*, HU-23370; *e–f*, HU-23356; *g*, P-795. *h–i*, *Vascoceras durandi* (Thomas and Peron), zone 5, Ma'ale Mahmal; *h*, HU-23131; *i*, P-788. *j*, *Vascoceras harttiforme* Choffat, zone 5, Ma'ale Mahmal, M-3578, *k–l*, *Vascoceras* cf. *V. amieirense* Choffat, zone 5, Timna, P-846.

1907 *Vascoceras durandi* (Thomas and Peron); Pervinquière, p. 332, pl. 21, fig. 1; text-fig. 125.
1928 *Vascoceras* sp. Douvillé, p. 15, pl. 1, fig. 6.

Description. Thick, round, and involute. Umbilicus large and deep, with distinct borders and inclined walls. Section wide, semilunar, uniformly high from umbilical border to mid-venter. At the last half-whorl of the body chamber the section becomes triangular and narrow, so that the penultimate whorl is slightly exposed. The body chamber is very long, up to one and a half whorls. Several specimens show a more rounded umbilical border and their section does not become triangular at the end of the body chamber (text-fig. 6*i*). These specimens resemble *V. douvillei* Choffat, which otherwise differs so slightly from *V. durandi*, that it is preferable to accept Pervinquière's suggestion to consider them as one single species. A few specimens are wider and have wider umbilici and a lower depressed section. They probably approach var. *crassa* of Pervinquière. Up to a diameter of 60 mm. these ammonites are ornamented by small and round peri-umbilical tubercles, about nine per whorl. The well-preserved typical specimens show on the anterior part of the body chamber dense, slightly prorsiradiate, and irregularly arranged ribs. The suture is poorly preserved, as the inner whorls are highly calcified and the outer one comprises only the body chamber.

Three simple, low, and indented saddles are discernible, the third one on the umbilical border; the siphonal lobe is deeper than the two lateral ones.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
HU-23131	129	47	73(0·57)	57(0·44)
HU-23278	123	45	80(0·64)	55(0·45)
HU-23061	121	44	90(0·72)	60(0·48)
M-3388–1	99	38	63(0·63)	32(0·32)

Remarks. Several well-preserved specimens are identical with the Tunisian ones described by Pervinquière. He regarded the numerous species from Portugal described by Choffat as superfluously divided and tended to unite them. Faraud (1940) tried to clarify the classification of these inflated forms, and to retain the various names. A more recent opinion, indicated by Barber (1957, p. 15) in the discussion on *V. nigeriensis* Woods, is that the differences between the various inflated forms are small. However, since these inflated shells abound in our region, it was preferred in the present work to use several names to express the variability ranges. It seems that the specimen described as *Fagesia pervinquierei* Böse (1918, p. 212, pl. 14, fig. 3) is almost identical with this species.

Material. Eighteen specimens collected in the Southern Negev (Be'er Ora, Timna) and the Central Negev (Ma'ale Mahmal) from zone 5. One doubtfully determined specimen was collected in the Northern Negev (Ein Yorqe'am) from zone 3.

Vascoceras harttiforme Choffat

Text-fig. 6*j*

1897 *Vascoceras harttiformis* Choffat, p. 61, pl. 12, fig. 3; pl. 13, figs. 3–6; pl. 21, figs. 22–24.

Description. Shell globular, inflated. Umbilicus fairly large. Section low, embracing. All specimens are poorly preserved, with neither suture nor ornament visible.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
HU-23155	100	39	73(0·73)	44(0·44)
HU-23152	101	42	74(0·73)	39(0·39)
HU-23156	106	37	74(0·70)	43(0·41)

Remarks. As indicated in the remarks to *V. durandi*, the latter species differs from *V. harttiforme* only by the dimensions. The Brasilian ammonite *V. harttii* Hyatt (White 1887, p. 226, pl. 19, figs. 1–2; pl. 20, fig. 3) closely resembles our ammonites in dimensions and in shape. The first saddle of *V. harttii* is very high, similar to that of several species of *Plesiovascoceras* from Montana (Reeside 1923, fig. xx, 2).

Material. Eight specimens collected in the Central Negev (north of Makhtesh Ramon and at Ma'ale Aqrabbim) from zone 5.

Vascoceras cf. *V. amieirense* Choffat

Text-fig. 6*k–l*

1897 *Vascoceras amieirensis* Choffat, p. 61, pl. 12, figs. 1–2; pl. 13, figs. 1–2; pl. 21, figs. 17–21.
?1914 *Vascoceras* sp. cf. *amieirensis* Choffat; Eck, p. 201.
?1915 *Vascoceras durandi* (Thomas and Peron); Greco, p. 202, pl. 18, figs. 2–3.

Description. Inflated with a fairly wide umbilicus. Section and umbilical border round. No ornament visible. Several specimens are asymmetrically distorted. The suture, which probably comprised three saddles, shows clearly only the first one, which is fairly high and irregularly incised.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
P-786	100	38	54(0·54)	40(0·40)
P-785	110	43	55(0·50)	35(0·32)
M-3579	100	36	53(0·53)	40(0·40)

Remarks. The form is very close to *Vascoceras durandi*, differing only by its thinner section. The specimens at our disposal seem somewhat wider (53 per cent of the diameter) than the value given by Choffat (p. 61) for the Portuguese holotype (45 per cent). This low value seems to be due to the distortion of the holotype at the end of the living chamber. Pervinquière (1907) includes specimens with a width of 45–57 per cent of the diameter in *V. durandi*, regarding them as transition forms to *V. amieirense*. Collignon (1957, p. 13) included this species within a new subgenus *Discovascoceras* which is discussed in the remarks to *Paravascoceras obessum* (Taubenhaus).

Material. Nine specimens collected in Transjordan (Tafila and Wadi Bagat) in the Southern Negev (Timna, Yotvata, Be'er Ora), and in the Central Negev (Makhtesh Ramon). All are probably from zone 5.

Vascoceras cf. *V. adonense* Choffat

Plate 5, fig. 1; text-fig. 7*a–b*

?1897 *Vascoceras adonensis* Choffat, p. 59, pl. 9, fig. 3; pl. 21, figs. 12*a–b*.
?1918 *Vascoceras* n. sp. aff. *adonensis* Choffat; Böse, p. 214, pl. 14, fig. 4.

Description. Large, asymmetrically distorted ammonites. Umbilicus large. Section round, semilunar, and flat. Umbilical walls flat and inclined, umbilical border distinct. Eight

to nine small round tubercles surround the umbilical margin up to a diameter of 60 mm. Body chamber slightly exceeding one whorl.

Suture badly preserved, comprises two round saddles and a part of a third one on the umbilical border.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
HU-23072	215	74(0·34)	114(0·53)	94(0·43)
HU-23045	208	76(0·37)	91(0·44)	98(0·47)

Remarks. Our specimens have similar dimensions to those of the Portuguese holotype, but the section of the latter is round and its umbilical tubercles are coarser. No significant difference can be seen between our material and the Mexican one, but the latter is so badly preserved that any comparison would be uncertain. It is noteworthy that the asymmetric shape of our specimens is an original feature and cannot be a result of any deformation. These ammonites were found in places far away from each other, always together with many other undeformed ammonites. The large umbilicus and the depressed section of this group suggests an allience to the genus *Plesiovascoceras*, although evidently, they have not the strong umbilical tubercles which are preserved in the latter genus until late stages.

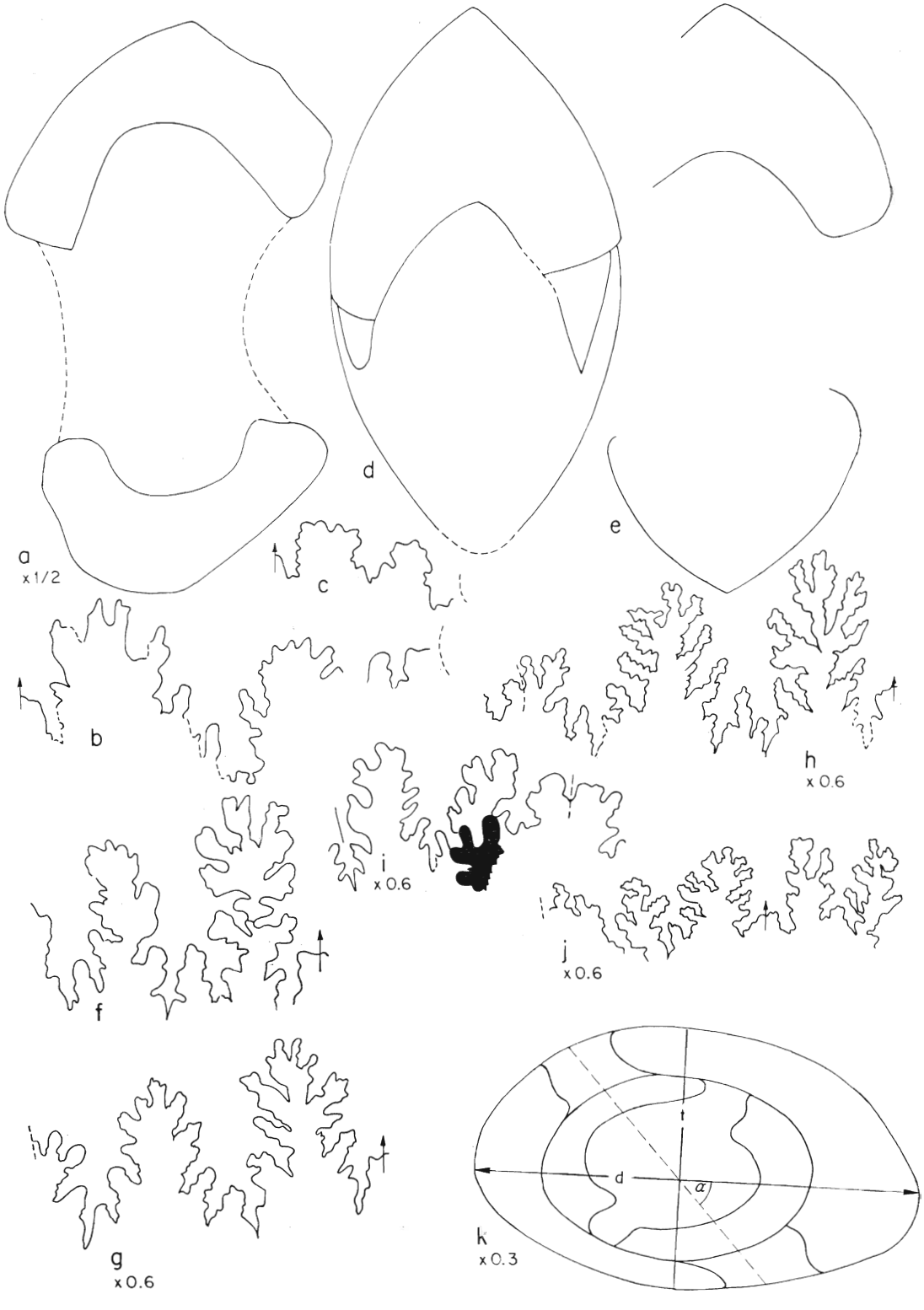
Material. Ten specimens collected in the Central Negev (Makhtesh Ramon) and one in the Southern Negev (Nahal Raham) from zone 5. One specimen was collected in the Northern Negev (Ein Yorqe'am) from the uppermost part of zone 4.

Genus FAGESIA Pervinquière 1907

Type species. Olcostephanus superstes Kossmat 1897.

Diagnosis. Inflated cadicones with large umbilicus. Two to three strong prorsiradiate ribs which cross the venter uninterruptedly, split from each strong umbilical tubercle. Ornament preserved until a late stage. In most species the ribs disappear before the tubercles, and in others, the reverse is true. Outermost whorls usually smooth. Suture deeply incised and rather complicated relative to the common one of the family. Three or four high saddles, the first and second often divided into three branches; lobes narrow, deep, and bifid.

Remarks. The deeply incised suture-line as well as the inflated form are regarded as diagnostic features of *Fagesia* by Pervinquière (1907). Barber (1957, p. 13), on the other hand, emphasized the importance of the shape of the shell and of the ornament. Following the recent tendency to minimize the importance of the suture-line in the taxonomy of Cretaceous ammonites he noted (p. 23) that 'The suture line of *Fagesia bomba* figured by Eck (1909, p. 181, fig. 3) is almost identical with that of the Nigerian species *Vascoceras globosum* Reyment . . .'. The present authors do not share this opinion, since the saddles of the latter species are rather shallow and not divided into three branches, and the lobes are wide, asymmetrically bifid, rather than narrow and deep. Barber's conclusion (p. 13) that 'Comparison of the diagnoses of *Vascoceras* s.s., *Fagesia* and *Plesiovascoceras* reveal that the differences are of degree rather than of kind . . .' seems difficult to accept. The species from India, Middle East, Spain, and North Africa, included originally in this genus, viz. *F. superstes*, *F. thevestensis*, *F. rudra*,


a
x 1/2
b
c
d
e
f
g
x 0.6
h
x 0.6
i
x 0.6
j
x 0.6
k
x 0.3
t
d
α

F. peroni, and *F. bomba* form a well-defined group, which is very different from any *Vascoceras*. It should, however, be admitted that the numerous species of very wide distribution (New Caledonia, Japan, Madagascar, Nigeria, France, England, Southern and Western United States, and perhaps South America), included later in this genus, differ considerably from those mentioned above so that in several cases the generic position is uncertain.

Fagesia cf. *F. superstes* (Kossmat)

Text-fig. 7*f*

1897 *Olcostephanus superstes* Kossmat, p. 26 (133), pl. 4 (17), fig. 1.
1903 *Pachyceras superstes* (Kossmat); Pervinquière, pp. 96, 99, 101.
1907 *Fagesia superstes* (Kossmat); Pervinquière, p. 322, pl. 20, figs. 1–4; text-fig. 122.
1940 *Fagesia superstes* (Kossmat); Basse, p. 459.

Description. A single, fairly large (diameter 129 mm.), badly preserved specimen. Very inflated (thickness 84 per cent of the diameter) with large umbilicus (33 per cent of the diameter). Section wide, semilunar, and depressed. Absence of ornament may be partly due to the obliteration of the inner whorls and to the broken umbilical margins.

The suture is composed of three high, deeply incised saddles and a deep, bifid, first lateral lobe.

Remarks. The specimen agrees well in size and shape with the Tunisian and Indian specimens.

Material. One specimen (HU-23619) collected at Dareb es Sultan from zone 5.

Fagesia thevestensis (Peron)

Text-fig. 7*g*

1896 *Mammites* (?) *thevestensis*, Peron, p. 23, pl. 7, figs. 2–3.
1907 *Fagesia thevestensis* (Peron); Pervinquière, p. 325, pl. 20, figs. 5–6; text-figs. 123–124.
1961 *Fagesia thevestensis* (Peron); Freund, Table I.

Description. Inflated shells, usually slightly asymmetrical. Umbilicus large, with vertical or steep walls. The size of the umbilicus varies between 25 and 37 per cent of the diameter. Fourteen rounded and weak periumbilical tubercles persist until a diameter of 160 mm. At this stage the ribs are very faint.

The suture is the typical one of the genus, comprising three high and deeply incised saddles, the first and the second ones divided into three branches. The lobes are narrow, deep, and bifidic.

TEXT-FIG. 7. *a–b*, *Vascoceras* cf. *V. adonense* Choffat, zone 5; *a*, Makhtesh Ramon, HU-23068, ×½; *b*, Nahal Raham, HU-23663. *c–e*, *Paravascoceras obessum* (Taubenhaus), zone 2. *c–d*, Hamakhtesh Hagadol, HU-23417; *e*, Ein Yorqe'am, HU-23422. *f*, *Fagesia* cf. *F. superstes* (Kossmat), zone 5, Dareb es Sultan, HU-23619. *g*, *Fagesia thevestensis* (Peron), Yirka, HU-21195, ×0·6. *h*, *Fagesia lenticularis elliptica* sp. and subsp. nov., zone 6, Yanuh, holotype, HU-21083, ×0·6. *i–k*, *Fagesia lenticularis asymmetrica* sp. and subsp. nov., zone 6; *i*, dorsal suture line, Har 'Arif, HU-23641, ×0·6; *j*, compressed right side of suture line, Yanuh, HU-21078, ×0·6; *k*, reconstructed section after Plate 6, fig. 7; letters *d*, *t*, and α explained in the 'dimensions', holotype, HU-21085, ×0·3.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
HU-21195	189	68	125(0·64)	65(0·33)
HU-21165	168	58	98(0·57)	64(0·37)

Remarks. One well-preserved specimen (HU-21195), resembles closely the Tunisian specimen of the same size. The section of another specimen is fairly narrow, and its umbilicus is rather small.

Material. Five specimens collected in the Western Galilee (Tarshiha, Elqosh, Yirka and Kh. Mansura) from zone 6. One specimen collected on Mt. Carmel (Jalame) is deposited at Oranim Seminary.

Fagesia lenticularis elliptica sp. and subsp. nov.

Plate 7, figs. 1–2; text-figs. 7*h*, 8*a–c*

Diagnosis. Large, fusiform, lenticular elliptically coiled cadicones. Suture typical for the genus.

Derivation of name. The lenticular form and the elliptical coiling.

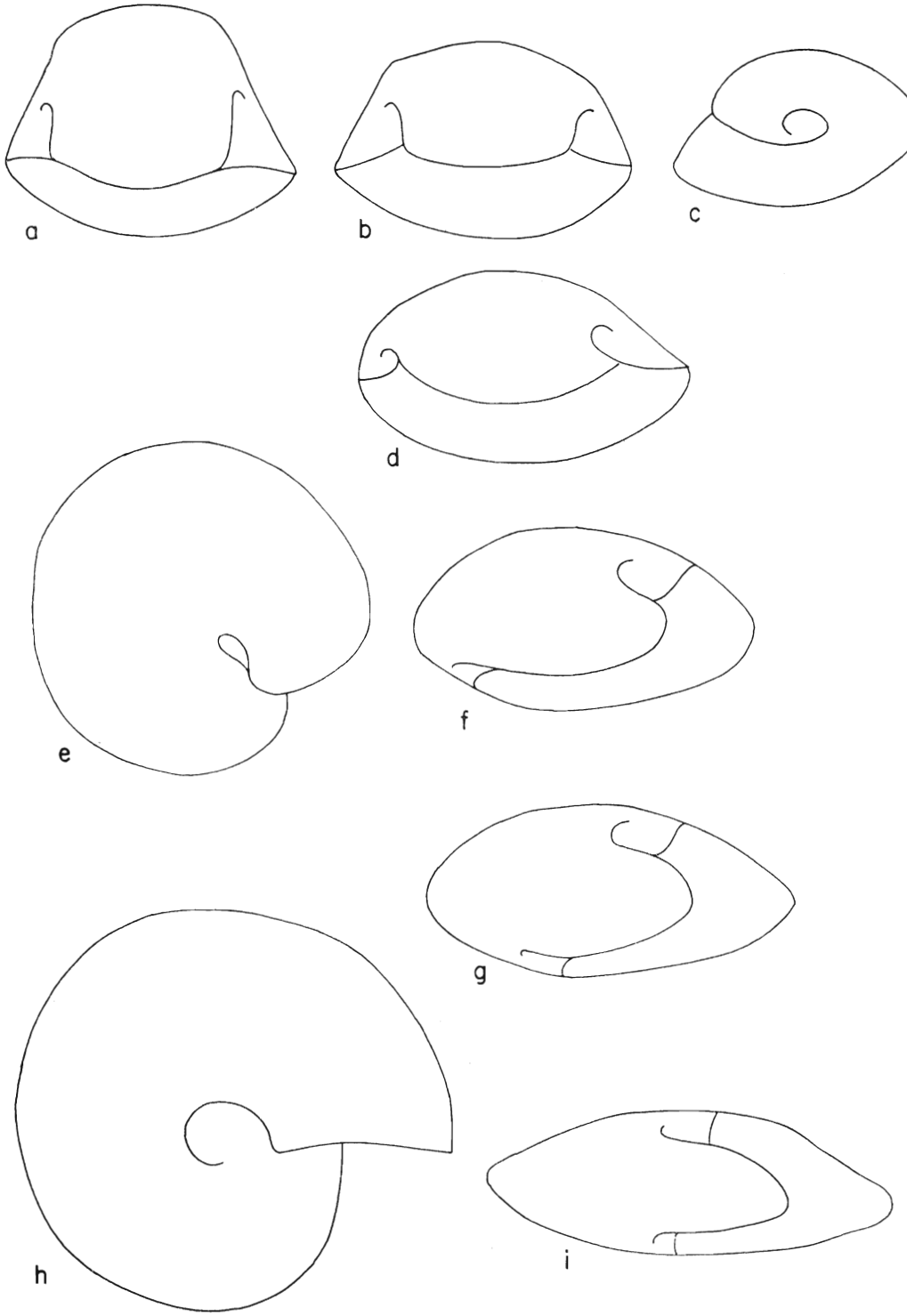
Holotype. No. HU-21083, Yanuh.

Description. Large, fusiform, elliptically coiled lens-shaped cadicones. The elliptical, lens-shaped conch is determined by three axes: the thickness and two diameters of unequal size. At early stages (up to diameters of about 100 and 150 mm.), the whorl thickness is smaller than the larger diameter, and the difference between the two diameters is small. Later the section widens rapidly and the diameters become unequal, forming thus the lenticular fusiform shape. At late stages the width exceeds both diameters, the longer one by about 5–20 per cent and the shorter one by about 30–90 per cent. The elliptical umbilicus is fairly wide, about one-third of the respective diameter. The umbilical walls are vertical to overhanging with well-defined umbilical border. Whorl section semilunar, depressed, and very wide. Body chamber occupies a whole whorl. An impair, asymmetrical, smooth mould of an anaptychus-like hield appears at the end of the body chamber of the holotype. Young stages (D = 75 mm.) are ornamented by ten round umbilical tubercles per whorl. A pair of prorsiradiate ribs which cross the venter originate from each umbilical tubercle. Large specimens are completely smooth.

Suture comprises three high saddles on the sides, the first and second are divided into three branches; sometimes one notch is slightly deeper, and thus the saddles appear bifid. Lobes are deep and slightly asymmetrically bifidic. Ventral lobe sometimes deeper and sometimes shallower than the lateral ones.

EXPLANATION OF PLATE 5

Fig. 1. *Vascoceras* cf. *V. adonense* Choffat, zone 5, Makhtesh Ramon, HU-23079, $\times\frac{1}{2}$.
Figs. 2–3. *Vascoceras* cf. *V. depressum* Barber, zone 1, Nahal Zin, HU-23499, $\times 1$.
Figs. 4–6. *Protexanites salmuriensis* (Courtiller); 4. Zone 7, Yirka, HU-21090, $\times\frac{1}{2}$; 5–6. Zone 6, Yanuh, M-2805, $\times\frac{1}{3}$.



TEXT-FIG. 8. Stages in the development of *Fagesia lenticularis* sp. nov. *a–c*, *Fagesia lenticularis elliptica* sp. and subsp. nov. *d–g*, *Fagesia lenticularis asymmetrica* sp. and subsp. nov. *h–i*, *Fagesia lenticularis lenticularis* sp. and subsp. nov. *a*, *e*, *h*: wider side of the conch. *b*, *d*, *f*, *g*, *i*: oral view, *c*: side view.

Dimensions.

	Diameter		*Height*			*Umbilicus*	
No.	*large*	*small*	*large*	*small*	*Thickness*	*large*	*small*
HU-21181	75	—	—	28	54(0·72)	30(0·4)	20(0·27)
HU-21083	225	170	82	47	230(1·05–1·35)	85(0·38)	55(0·32)
HU-23260	238	122	115	—	281(1·2–2·3)	—	55

Remarks. Several specimens of *Fagesia superstes sphaeroidalis* Pervinquière (1907, p. 322, pl. 20, figs. 3–4) and of *Vascoceras globosum carteri* Barber (1957, p. 25, pl. 8, fig. 2; pl. 28, figs. 8–9), are fusiform, but their coiling is not elliptical. Specimens of *Fagesia peroni* Pervinquière (1907, p. 329, pl. 20, figs. 7–8) have an elliptical coiling, but are not fusiform. All three species retain the umbilical tubercles much later than the ribs. *V. globosum carteri* has the simple suture typical for its genus. The difference between the present subspecies and the following two are discussed below, in the remarks to the third one.

Material. Three complete and fragmentary specimens, including the holotype, collected in the Western Galilee (Yanuh, Yirka, and Elqosh) from zone 6. Five specimens were collected in the Central Negev (north and south of Makhtesh Ramon) from zone 6.

Fagesia lenticularis asymmetrica sp. and subsp. nov.

Plate 6, figs. 3–7; text-figs. 7*i–k*, 8*d–g*, 9*a*

Diagnosis. Large cadicones with a lenticular shape and an asymmetric coiling. Umbilici of variable sizes, virguliform. Umbilical tubercles disappear earlier than ribs. Suture typical for the genus.

Derivation of name. The lenticular shape and the asymmetric coiling.

Holotype. No. HU-21085, Yanuh.

Dimensions. Due to the asymmetric coiling, the common measurements of diameter, height and width are not useful. Therefore, the following parameters were measured (see text-fig. 7*k*):

d: largest parameter of the shell.
t: smallest parameter of the shell, perpendicular to the largest parameter.
α: angle between the line connecting the umbilici and the largest parameter (*d*).
u: largest diameter of the umbilicus.

No.	*d*	*t*	α	*u*	*t/d*	*u/d*
M-3551	74	59	70°	24	0·8	0·3
HU-21156	86	52	70°	28	0·6	0·32
HU-21081	143	120	55°	48	0·48	0·34
HU-21085	280	160	60°	63	0·65	0·23
HU-23258	190	135	60°	55	0·71	0·28

Description. Thick, lenticular, asymmetrically coiled, very wide cadicones. As a result of the asymmetric coiling, the umbilicus is partly or completely covered by the following whorl. The body chamber covers sometimes even both umbilici (see Pl. 6, fig. 6). By this

EXPLANATION OF PLATE 6

Figs. 1–2. *Gombeoceras* cf. *G. gongilense* (Woods), zone 2, Nahal Derorim, M-3450–6, ×½.
Figs. 3–7. *Fagesia lenticularis asymmetrica* sp. and subsp. nov., zone 6, Yanuh; 3–5. Paratype, HU-21165, ×½; 6. Holotype, HU-21085, oral view, ×⅓; 7. Idem, half body chamber removed.

covering, the position of the umbilici is changed from one whorl to the other (text-fig. 7*k*). The asymmetry of the coiling can be expressed by the angle α which is measured between the largest parameter and the line connecting the umbilici. Thus, $\alpha = 90°$ indicates a normal symmetric shell, $\alpha = 0°$ indicates a symmetric, fusiform shell, such as *F. lenticularis elliptica*, and $\alpha = 45°$ indicates the most asymmetric form (text-fig. 8). *F. lenticularis asymmetrica* arbitrarily includes forms in which α ranges between 15° and 75° (text-figs. 8*d–g*). Smaller specimens seem to be less asymmetric than larger ones, but since it is impossible to recover the inner whorls of the large specimens, it is uncertain whether this difference is an ontogenetic or an individual character. Whorl section depressed, very wide and asymmetrically semilunar. Umbilicus of medium size, drop-shaped (pl. 6, fig. 7). The umbilical wall nearer to the edge of the conch is high and vertical and the opposite wall is low and round (text-fig. 7*k*). The body chamber occupies a whole whorl in the large specimens, and about $\frac{2}{3}$ of a whorl in the smaller ones.

Up to a diameter of 75 mm. the ammonites are ornamented by 7–9 round strong periumbilical tubercles, from which prorsiradiate ribs originate in pairs and cross the venter. At a diameter of 100–150 mm. the tubercles disappear and the shallow and broad ribs remain the single element of ornament. Larger shells are smooth.

Four high and well-notched saddles exist on the external side of the shell, the fourth is on the umbilical border, the two external saddles are divided into three branches; sometimes one notch is deeper. The lobes are deep and bifidic. Three saddles appear in the dorsal suture. The saddles are high and asymmetrically divided into two branches. The dorsal lobe is not clearly defined but seems to be deep and bifidic. The other two lobes are asymmetrically bifidic. The suture corresponds usually to the asymmetry of the shell, and it is much extended or compressed on one side whereas it has the ordinary shape on the other side of the shell (text-figs. 7*j*, 9*a*).

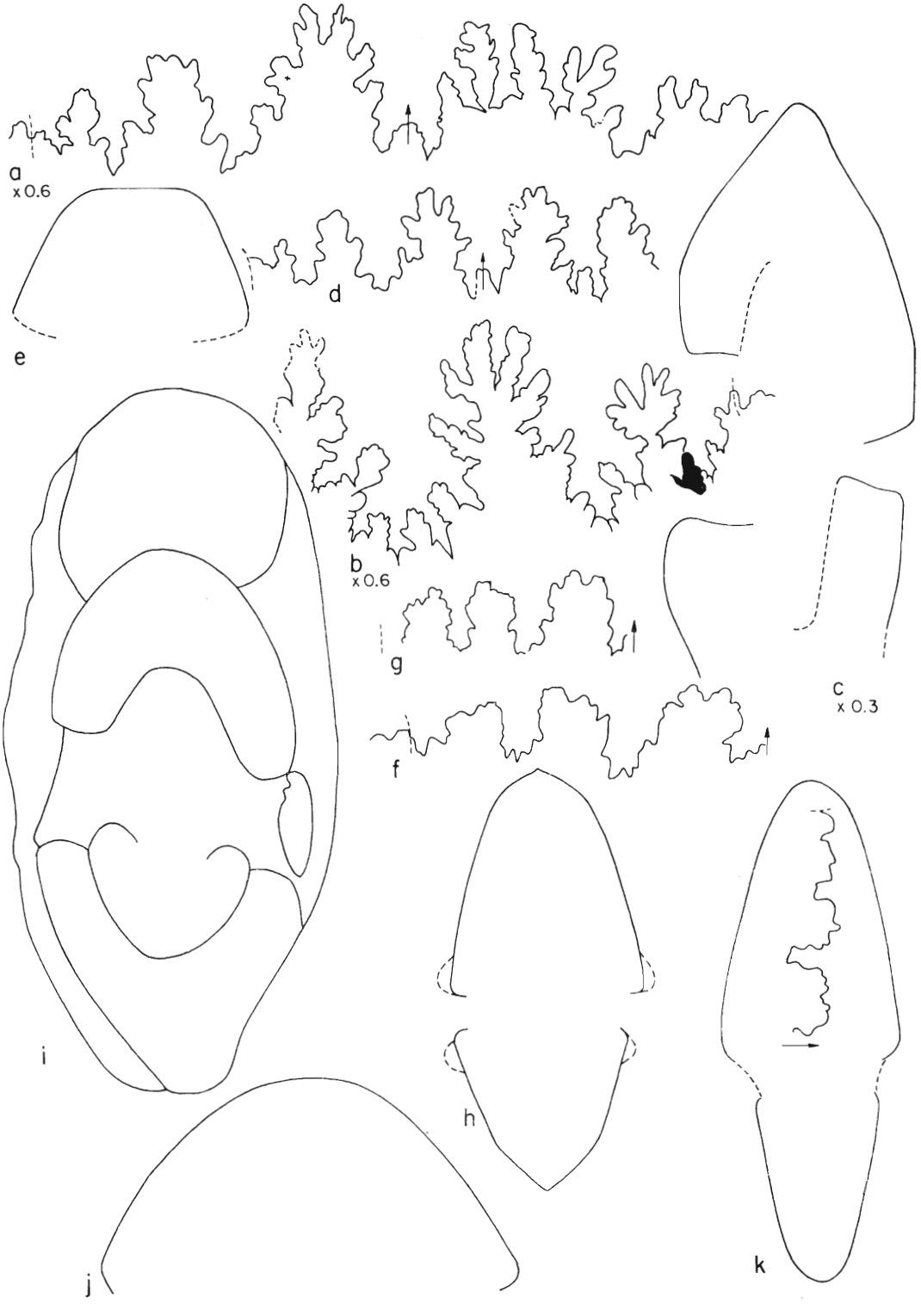
Remarks. It has been suggested that the asymmetric form of *Fagesia lenticularis asymmetrica* resulted from diagenetic processes (depositional, tectonic, or sedimentary deformation), and therefore has no systematic significance. These suggestions seem improbable for the following reasons. The covering of the umbilicus by the following whorl, as well as the asymmetry of the suture, can hardly be explained by diagenetic processes. The specimens of this subspecies were found together with many other ammonites, including inflated forms, which do not show any sign of deformation. This subspecies was found in two distant regions (Western Galilee and Makhtesh Ramon) and in both cases the same asymmetry exists. Gradual transition forms connect this subspecies with the previous and the following subspecies.

Material. Fourteen specimens collected in the Western Galilee (Yirka, Yanuh, Elqosh, Majd-el-Kurum) from zone 6. Fourteen specimens collected in the Central Negev (Makhtesh Ramon, Nahal Nizzana, Be'erot O'ded, Har Batur) from zone 6.

Fagesia lenticularis lenticularis sp. and subsp. nov.

Plate 7, fig. 3; Plate 8, figs. 1–2; text-figs. 8*h–i*, 9*b–c*

Diagnosis. Very large, lenticular, compressed, and involute shells; coiling slightly asymmetrical. Section high oval, becoming triangular at large diameters. Umbilici medium-sized to small, unequal on the two sides. Suture typical of the genus.


a
x 0.6
d
e
b
x 0.6
g
c
x 0.3
f
i
h
k
j

Derivation of name. The lenticular shape.

Holotype. No. HU-21064, Yirka.

Description. Very large lenticular shells, compressed and involute. Section high, oval, one side always shorter than the other. Section becomes triangular with round venter and with somewhat concave sides at later stages. Umbilici of medium to small size. The umbilicus of one side differs in size from that of the other. The angle α between the line connecting the umbilici and the diameter exceeds 75°. Umbilical wall vertical, flat to concave. One small specimen (diameter 183 mm.) is partly ornamented solely by prorsiradiate broad ribs, which cross the venter. All the larger specimens are smooth.

The suture comprises four high and notched saddles on the side, the fourth one is located on the umbilical border. The first and second saddles are divided into three branches and the third one into two branches. In many cases the division into three branches is not clear. The first lateral lobe is deep and bifidic, the second one is less deep and asymmetric-bifidic. The suture details are very variable, but the main features are always preserved.

Dimensions.

				Umbilicus	
No.	*Diameter*	*Height*	*Thickness*	*left*	*right*
HU-21076	183	58	66(0·36)	33(0·17)	—
HU-23252	239	96	113(0·47)	55(0·23)	—
HU-21064	380	118	115(0·31)	95(0·25)	51(0·14)
HU-21063	450	163	159(0·35)	51(0·11)	83(0·18)
HU-23253	450	180	—	—	140(0·31)

Remarks. Specimens of this subspecies are approximately twice as large as the largest hitherto described vascoceratid, and three to four times larger than the common ones. The high section which is sometimes triangular, and the umbilicus resemble those of some species of *Choffaticeras*, abundant in the same horizon. It has been suggested that there is a certain resemblance to *Neoptychites*. Yet, the latter has a narrow venter, a very small umbilicus and an inflated body chamber. In spite of the unusual shape, these ammonites seem to be true *Fagesia*, as indicated by the round venter of the inner whorls, by the ornament of ribs on the venter, by the relatively large umbilicus and by the suture-line. Moreover, the relationship of this subspecies with the previous two, through gradational transition forms, makes the connection to *Fagesia* rather certain.

It seems to the present writers that the group of *Fagesia lenticularis* is allied to *Fagesia rudra* (Stoliczka) (1865, p. 122, pl. 60) which also loses the umbilical tubercles before the ribs. It is suggested that the range of the group of *F. lenticularis* from *elliptica* through *asymmetrica* to *lenticularis* is a result of the continuous change of three variables, viz. the degree of depression, the 'migration' of the umbilici and the absolute size. Thus, the 'simplest' forms are those of *F. lenticularis elliptica* in which the depression results

TEXT-FIG. 9. *a*, *Fagesia lenticularis asymmetrica* sp. and subsp. nov., note the asymmetry of suture, Yanuh, HU-21081, ×0·6. *b–c*, *Fagesia lenticularis lenticularis* sp. and subsp. nov., zone 6, Yirka; *b*, holotype, HU-21065, ×0·3; *c*, HU-21064, ×0·6. *d–e*, *Fagesia* sp., zone 5, Nahal Hawwa, HU-23304. *f–i*, *Thomasites rollandi rollandi* (Thomas and Peron); *f*, Yanuh, HU-21039; *g*, Yirka, HU-21031; *h*, Yanuh, HU-21059; *i*, Yirka, HU-21022. *j*, *Thomasites rollandi globosus* Pervinquière, zone 6, Yanuh, HU-21036. *k*, *Thomasites rollandi complanatus* Pervinquière, Zuriel, HU-21169.

from the elliptical coiling, there is only a slight shift of the umbilici ($\alpha = 0$–$15°$) and the maximum size (282 mm.) is not much more than that of other species of *Fagesia* (180 mm.). In the more 'advanced' forms of *F. lenticularis asymmetrica* the shell is more depressed, the shift of the umbilici is very considerable ($\alpha = 15$–$75°$), and the maximum size is greater (302 mm.). The other extremity of this line is *F. lenticularis lenticularis* which attains the largest size (450 mm.), and is the most depressed form. However, since the umbilici are shifted to the largest extent ($\alpha = 75$–$90°$), this highly depressed shell appears as a compressed shell. This trend is not necessarily an evolutionary one, since the three subspecies, and the continuous transitional forms between them, occur in the same horizon.

Material. Fourteen specimens were collected in the Western Galilee (Yanuh, Yirka), Mt. Carmel, and in the Central Negev (Makhtesh Ramon) from zone 6.

Fagesia sp.

Plate 7, fig. 4; text-fig. 9*d–e*

Description. One small specimen (diameter 86 mm.) fairly wide (thickness 42 mm., 62 per cent of diameter), with a rather small umbilicus (16 mm.). Section trapezoidal, venter flat, well differentiated from the straight sides. Three ribs originate from each of the nine periumbilical tubercles. The ribs are accentuated at the ventro-lateral region and cross the venter forwardly. Suture-line corroded but shows the typical generic elements.

Remarks. The narrow umbilicus and the trapezoidal section of this species distinguishes it from any other *Fagesia.*

Material. One specimen (HU-23304) collected in the Central Negev (Makhtesh Ramon) from zone 5.

Genus THOMASITES Pervinquière 1907

Type species. Pachydiscus rollandi Thomas and Peron 1889.

Remarks. Ammonites of this genus are very abundant in the Lower Turonian of Tunisia and of the Middle East (Egypt, Jordan, Israel, Lebanon, and Syria), but were seldom recorded from elsewhere, and in these few cases, the specimens are very poor (Adkins 1931; Wiedmann 1959; Faraud 1934; Karrenberg 1935). These ammonites, included previously in *Neoptychites*, were separated by Pervinquière because of the 4–5 rows of tubercles at the early stages, absent in *Neoptychites*. Furthermore, the apertural constriction of *Thomasites* is less pronounced than that of *Neoptychites* and the suture-line is much simpler. Reyment (1954*b*, p. 150) erected another genus *Gombeoceras*, for vascoceratids with 4–5 rows of tubercles. The type species of this genus is *Vascoceras gongilesis* Woods (loc. cit.) which has been regarded by Basse (1940, p. 457) as a synonym of *Thomasites jordani* Perv. Reyment states that *Gombeoceras* differs from

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EXPLANATION OF PLATE 7

Figs. 1–2. *Fagesia lenticularis elliptica* sp. and subsp, nov., zone 6, Yanuh, Holotype, HU-21083, $\times\frac{1}{3}$.
Fig. 3. *Fagesia lenticularis lenticularis* sp. and subsp. nov., zone 6, Yirka, Holotype, HU-21064, $\times\frac{1}{3}$.
Fig. 4. *Fagesia* sp., zone 5, Makhtesh Ramon, HU-23304, $\times\frac{1}{2}$.

Thomasites by the weak and irregular ornament, the large umbilicus and the simple suture-line. In addition he states that there is not apertural constriction in *Gombeoceras*. It is, however, noteworthy that in the descriptions and illustrations of various *Gombeoceras* (Woods 1911; Reyment 1954*b*, 1955; Barber 1957), no living chamber has been shown. Is it possible that the differentiation between the two genera is due to the fact that the preserved part of most specimens of *Thomasites* from North Africa and from the Middle East is the body chamber, whereas this part is absent in the specimens of the West African *Gombeoceras*? The variability of dimensions and ornament within both genera seems to be in favour of this proposal.

Pervinquière distinguished three species and seven varieties of *Thomasites*. They differ from each other by the thickness (ranging from 30 to 90 per cent of the diameter), by the occurrence or absence of a siphonal row of tubercles, by the stage at which the ornament disappears, and by slight changes in the suture-line. Unfortunately only the thickness can be observed in the majority of the specimens from the Middle East, which consist only of the body chambers, whereas the inner whorls are obliterated. At this stage it is difficult to distinguish between the various varieties.

Douvillé (1928, pp. 16–18, pl. 2, figs. 3–6) described two new species (*T. egyptiacus* and *T. lefevrei*), but neither did he mention the differences between them and *T. rollandi*, nor can such differences be derived from his illustrations and descriptions. The same applies also to his new 'race' (*sinaitica*) of *T. jordani*. *T. fischeri* Benavides-Càceres (1956, p. 471, pl. 56, figs. 1–2; pl. 57, figs. 1–3) seems to be very close to *Gombeoceras gongilense* (Woods).

Thomasites rollandi rollandi (Thomas and Peron)

Text-fig. 9*f–i*

1889 *Pachydiscus rollandi* Thomas and Peron, p. 25, pl. 17, figs. 1–3.
1896 *Pachydiscus rollandi* Thomas and Peron; Peron, p. 47, pl. 7, figs. 6–7.
1895–8 *Neoptychites rollandi* (Thomas and Peron); Kossmat, p. 190.
1903 *Neoptychites rollandi* (Thomas and Peron); Pervinquière, pp. 95–101.
1907 *Thomasites rollandi* (Thomas and Peron); and var. *tuberculata* and var. *bifidata*, Pervinquière, p. 341, pl. 22, figs. 2, 6; text-figs. 127–130.
1928 *Thomasites egyptiacus* Douvillé, p. 16, pl. 2, fig. 3.
1928 *Thomasites lefevrei* Douvillé, p. 16, pl. 2, fig. 4.
?1937 *Thomasites rollandi* (Thomas and Peron); Basse, p. 185, pl. 10, fig. 5; pl. 11, fig. 6; text-fig. 54.
1940 *Thomasites rollandi* (Thomas and Peron); Basse, p. 456.
1959 *Thomasites rollandi* (Thomas and Peron); Freund, p. 45.
1961 *Thomasites rollandi* (Thomas and Peron); Freund, pp. 80–81.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
M-3617	56	29	30(0·53)	6(0·11)
HU-21059	65	38	30(0·44)	8(0·11)
HU-21034	108	54	59(0·54)	16(0·14)
HU-21035	133	53	81(0·60)	23(0·17)

Remarks. Most of our specimens agree well with Pervinquière's description. The variations *tuberculata* and *bifidata* are here included in the subspecies *rollandi* since they differ from one another only by features which can be observed on the inner whorls

(such as the late stage of disappearance of tubercles and the bifid first saddle). Few specimens from Ramat Kevuda have less inflated sides, a more triangular whorl section, and lack the shallow undulations on the last whorl. The four specimens attributed by Taubenhaus (1920, p. 44) to *T. rollandi* have been shown (p. 29) to belong to *Vascoceras pioti* (Peron and Fourtau), which also has a constricted aperture. The specimen shown in an illustration by Basse (1937, pl. 10, fig. 5) has a wide umbilicus and lacks the constricted aperture; it seems to be related to *Paravascoceras crassum* (Furon).

Material. This is one of the most abundant ammonites in the Lower Turonian of Israel. One hundred and fifty specimens were collected in the Western Galilee, in the Northern, Central, and Southern Negev, in Sinai and in Transjordan. Only on Mt. Carmel it has not been found. It occurs from zone 3 to zone 6.

Thomasites rollandi globosus Pervinquière

Text-fig. 9*j*

1907 *Thomasites rollandi* (Thomas and Peron), var. *globosa* and var. *globosotuberculata* Pervinquière, p. 344, pl. 22, figs. 3, 4, 7.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
P-793	63	30	55(0·87)	12(0·18)
HU-23629	59	29	41(0·69)	10(0·16)
HU-21032	90	46	80(0·89)	12(0·13)
HU-21036	106	55	79(0·74)	15(0·13)
HU-21031	109	50	67(0·63)	12(0·11)

Remarks. This subspecies includes the thick specimens (T/D $>$ 0·6). Similarly to the former subspecies the ornament of the inner whorls cannot be examined, and therefore the two varieties of Pervinquière are not treated separately. Furthermore, several adult specimens included here may probably belong to *T. jordani*, which is also rather thick, but is characterized by a siphonal row of tubercles at young stages.

Material. This subspecies is much less abundant than the previous one. Twenty specimens were collected in the Western Galilee and in the Central and Southern Negev from zone 6.

Thomasites rollandi complanatus Pervinquière

Text-fig. 9*k*

1907 *Thomasites rollandi* (Thomas and Peron), var. *complanata*; Pervinquière, p. 344, pl. 22, fig. 5.
1907 *Thomasites meslei* Pervinquière, p. 345, pl. 22, figs. 8–9.
?1915 *Thomasites meslei* Perv.; Greco, p. 212, pl. 18, fig. 4.
1935 *Thomasites meslei* Perv.; Karrenberg, p. 141, pl. 33, fig. 12.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
M-3617–2	38	18	15(0·39)	4(0·10)
HU-21169	90	48	26(0·29)	4(0·05)

Remarks. This subspecies includes the thin specimens (T/D $<$ 0·4). Pervinquière distinguished between two forms. The first one is *T. rollandi* var. *complanata* with a slightly thicker section, slightly larger umbilicus, three saddles on the sides and sides converging towards the venter. The second form is *T. meslei* with a thinner section, four

saddles, and almost parallel sides. We failed to apply this classification to our material and thus share Basse's opinion (1937, p. 185) that '*T. meslei* Perv. . . . se rattachant intimement . . . à la variété *complanata* de *T. rollandi* . . .'. Although the name *T. meslei* is used more frequently in the literature, *T. rollandi complanatus* has page priority. Furthermore, it indicates that this form is very close to *T. rollandi* and a separation as a full species does not seem justified. *T. meslei* Perv. in Chudeau (1921, p. 465) has a much larger umbilicus and was subsequently placed by Furon (1935, p. 60) in *Paravascoceras*.

Material. This subspecies is less abundant than *T. rollandi rollandi* but much more than *T. rollandi globosus*. Fifty-nine specimens collected in the Western Galilee and in the Negev from zones 5 and 6.

Thomasites jordani jordani Pervinquière

Text-fig. 10*a*

1907 *Thomasites jordani* Pervinquière, p. 347, pl. 22, figs. 10–11.
1928 *Thomasites jordani* Perv., race *sinaitica* Douvillé, p. 17, pl. 2, figs. 5–6.
1940 *Thomasites jordani* Perv.; Basse, p. 457.
1959 *Thomasites jordani* Perv.; Freund, p. 45.
1961 *Thomasites jordani* Perv.; Freund, Table I.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
HU-21060	67	35	47(0·70)	9(0·13)
HU-21164	66	33	41(0·62)	13(0·19)

Remarks. These ammonites resemble closely the material described by Pervinquière from Tunisia. A slight asymmetry occurs in few of them. As already mentioned above, it is possible that several adult specimens included in *T. rollandi globosus* are actually adults of this species.

Material. Six specimens collected in the Western Galilee (Yanuh, Elqosh), Central Negev (Mishor Hawwa, Har Batur), and in Sinai (Jebel Thelemet) from zone 6.

Thomasites jordani laevis Pervinquière

Text-fig. 10*b–c*

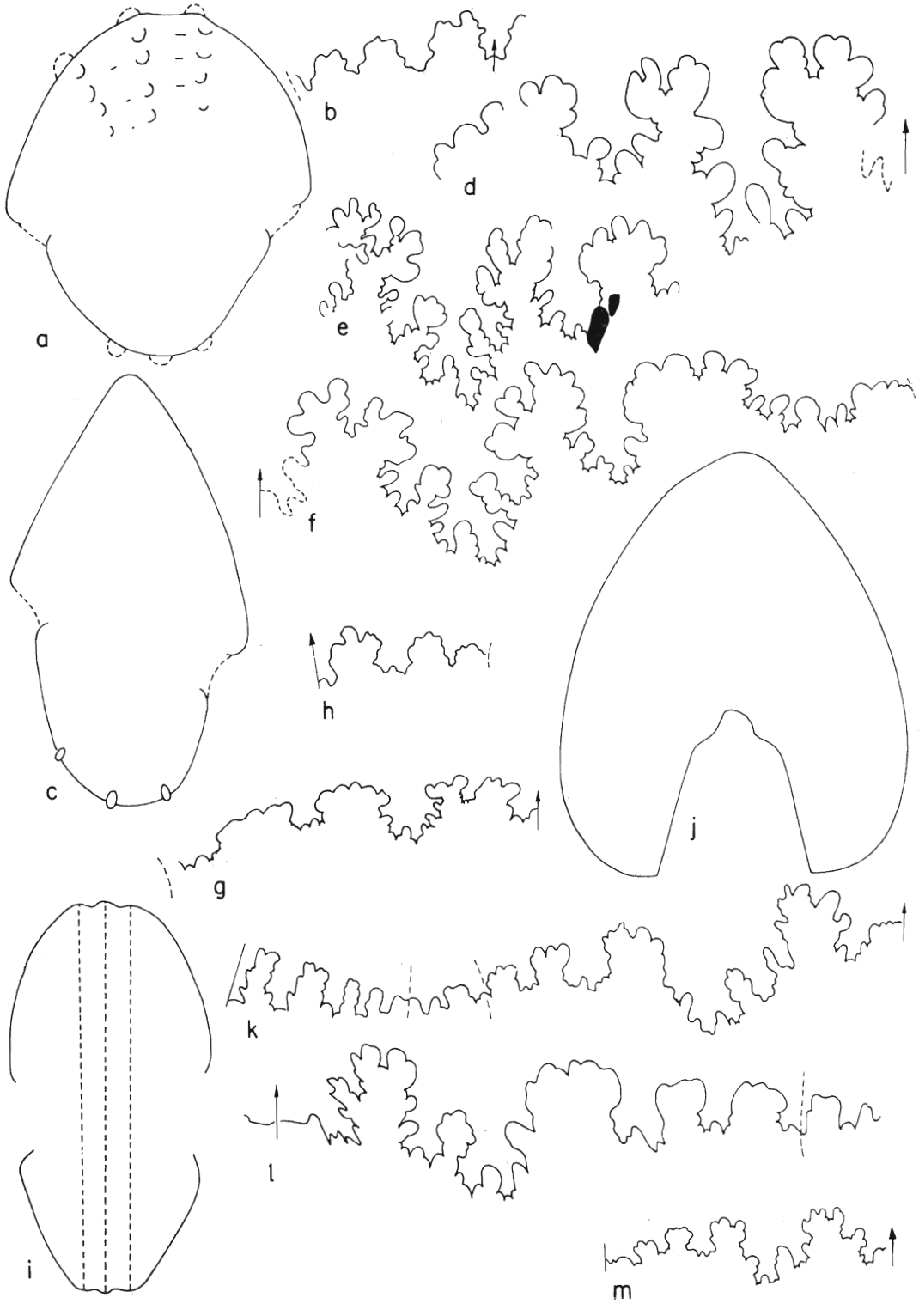
1907 *Thomasites jordani* Pervinquière, var. *laevis* Pervinquière, p. 348, pl. 22, fig. 13.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
M-2040	75	26	30(0·37)	4(0·05)

Remarks. These specimens resemble closely the material described by Pervinquière. Although the siphonal row of tubercles appears both in *T. jordani* and in this subspecies, they should be kept separate, because unlike other *Thomasites* the umbilical tubercles are very weak, the ventro-lateral tubercles are spirally pinched, the sides are much less inflated, and the thickening is very rapid.

Material. Five specimens collected in the Western Galilee (Yanuh, Elqosh) and in the Central Negev (Makhtesh Ramon) from zone 6.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Genus NEOPTYCHITES Kossmat 1895

Type species. Am. telinga Stoliczka 1865 (? = *Am. cephalotus* Courtiller 1860).

Remarks. Neoptychites occupies an isolated position within the Vascoceratidae, since unlike other genera of this family, this genus has no transition forms to any other genus.

Adult *Neoptychites* are rather similar to adult *Thomasites*, nevertheless, the differences in the suture-line and in the ornament are considerable. Several authors (Pervinquière 1907; Diener 1925; Basse 1931) placed therefore *Neoptychites* far from the vascoceratids. Although *Neoptychites* is a well-defined genus, it is rather difficult to distinguish between its various species. Nine species and six subspecies (including variations) have been erected and rearranged by de Grossouvre (1889), Solger (1904), Pervinquière (1907), and Karrenberg (1935). The various species differ from each other by their thickness, by the details of the suture, by the shape and density of the ribs, and by the stage at which the ribs disappear. Only the thickness can be examined in adult specimens. The inner whorls of large specimens from Cameroon (Solger 1904) could be studied, whereas the study of young stages of our and of the Tunisian material (Pervinquière 1907) was possible in separate specimens only. Since the material at our disposal is not sufficient for a revision of the taxonomy of species of *Neoptychites*, Solger's approach of distinguishing many species is here followed, although this practice is avoided in other genera.

Neoptychites is the most widely distributed among Turonian ammonites (India, Madagascar, Middle East, North Africa, Spain, and Western Africa). The American forms described by Böse (1918) and by Kummel and Decker (1954) are less typical than the others. This genus occurs usually at the upper part of the Lower Turonian.

Neoptychites sp. juv.

Plate 8, figs. 3–6

Description. The section of the smaller specimen is round, the height equals the width, and the umbilicus is rather large. Forwardly concave constrictions, bordered posteriorly by a weak rib, occur at each quarter of a whorl. The section of the larger specimen is oval, its maximum width is near to the umbilical border, and the umbilicus is small. The latter specimen bears only constrictions (three per whorl) up to a diameter of 25 mm. The constrictions are confined to the ventral region and to the external half of the sides, and they are bordered anteriorly and posteriorly by bulges. Prorsiradiate ribs, which cross the venter, thirteen per half a whorl, appear at a diameter of 25 mm. They also occupy only the external half of the side. Among them there is one constriction. The suture is not visible.

TEXT-FIG. 10. *a*, *Thomasites jordani jordani* Pervinquière, Yanuh, HU-21060. *b–c*, *Thomasites jordani laevis* Pervinquière, Yanuh, M-183. *d*, *Neoptychites* cf. *N. xetra* (Stoliczka), Jalame, HU-23969. *e–f*, *Neoptychites* sp. 1, Yirka, HU-21226; *e*, radius 64 mm.; *f*, radius 95 mm. *g*, *Neoptychites* sp. 2, Timna, M-14, *h*, *Pseudotissotia* (*Bauchioceras*) *tricarinata* Reyment, zone 3, Ma'ale Mazzar, M-4058. *i*, *Choffaticeras meslei* (Peron), zone 2, Nahal Derorim, M-3453–7. *j–l*, *Choffaticeras segne* (Solger), zone 5, Southern Negev; *j*, M-3594–1; *k*, M-3609; *l*, HU-23473. *m*, *Choffaticeras quaasi* (Peron), zone 5, Gebel Shaira, Sinai, HU-18586.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
HU-23978	16	*c.*5	5(0·31)	5(0·31)
HU-23620	35	18	16(0·46)	4(0·11)

Remarks. The specimens described by Solger (1904, p. 110) show a high section at an earlier stage, but the ribs appear at a similar radius. The ribs of the Tunisian material described by Pervinquière (1907, p. 394) appear at a somewhat larger radius.

Material. The smaller specimen was collected in Western Galilee (Yirka) and the larger one in Central Negev (Dareb es Sultan) from zone 2.

Neoptychites cephalotus (Courtiller)

1860 *Am. cephalotus* Courtiller, p. 248, pl. 2, figs. 1–4.
1867 *Am. cephalotus* Courtiller, p. 3, pl. 1, figs. 1–3; pl. 2, figs. 1–2.
1903 *Am. cephalotus* Courtiller, Palaeontologia Universalis fiche 5.
1907 *Neoptychites cephalotus* (Courtiller); Pervinquière, p. 393, pl. 27, figs. 1–4; text-fig. 152.
1931 *Neoptychites cephalotus* (Courtiller); Basse, p. 34, pl. 4, fig. 9; pl. 11, fig. 5.
1959 *Neoptychites cephalotus* (Courtiller); Freund, p. 45.
1961 *Neoptychites cephalotus* (Courtiller); Freund, pp. 80, 81; Table I.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*Aperture width*	*Body chamber inflation*
HU-21028	191	82(0·43)	56(0·29)	11(0·06)	23(0·12)	88(0·46)
HU-23623	242	122(0·50)	58(0·24)	12(0·05)	34(0·14)	72(0·30)

Remarks. The specimens at our disposal agree well with the descriptions of *N. cephalotus*. Nevertheless, being gerontic, they resemble as well the same stage of *N. telinga* (Stoliczka) (1865, p. 125, pl. 62) and of *N. telingaeformis* Solger (1904, p. 108, pl. 3, figs. 2–4; text-figs. 7–17). Since the differences distinguishing between these species appear at earlier stages only, which could not be examined in our specimens, it is possible that they belong to any of these three species. The name *N. cephalotus* is preferred because the gerontic suture of our specimens most resembles that species.

Material. Fifteen specimens collected in the Western Galilee (Sha'ab, Majd-el-Kurum, Yirka, Yanuh, Tarshiha) and on Mt. Carmel (Jalame, Daliyat el Karmil) from zones 6–7, in the Central Negev (Makhtesh Ramon) and in the Southern Negev (Timna) from zone 6.

Neoptychites xetriformis Pervinquière

1907 *Neoptychites xetriformis* Pervinquière, p. 398, pl. 27, figs. 6–7; text-fig. 153.

Remarks. One specimen which agrees well with Pervinquière's written description who noted 15 ribs per whorl, but not to his photographs which show 24 ribs per whorl. This specimen resembles also *N. cephalotus* but is somewhat smaller (D = 127 mm.) and the inflation of the body chamber is weaker.

Material. One specimen (HU-21023) collected in the Western Galilee (Yirka) from zone 6.

EXPLANATION OF PLATE 8

Figs. 1–2. *Fagesia lenticularis lenticularis* sp. and subsp. nov., zone 6, Yirka, Holotype, HU-21064, ×⅓.
Figs. 3–6. *Neoptychites* sp. juv.; 3. Yirka, HU-23978, ×1; 4–6. Zone 2, Dareb es Sultan, HU-23620, ×1.
Figs. 7–8. *Pseudotissotia* (*Bauchioceras*) *tricarinata* Reyment, zone 3, Ma'ale Mazzar, M-4058, ×1.

Neoptychites cf. *N. xetra* (Stoliczka)

Text-fig. 10*d*

?1865 *Ammonites xetra* Stoliczka, p. 122, pl. 60.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*Aperture width*	*Body chamber inflation*
HU-23970	220	108(0·39)	85(0·39)	20(0·09)	47(0·21)	127(0·58)

Remarks. The inflated shape of these ammonites relates them to *N. xetra* and to *N. crassus* Solger (1904, p. 119, pl. 3, fig. 5; text-figs. 18–19). The shells are about 10 per cent wider than those of *N. cephalotus*. The suture is gerontic and corroded in most specimens. One fragment that seems to belong to this species (No. HU-23969) has a well-preserved suture (text-fig. 10*d*) with bifid, almost symmetric lobes and saddles. This suture is not identical with any of the suture-lines recorded in the literature but the differences from that of *N. xetriformis* (loc. cit.) are rather small. However, a diagnostic feature of the latter species, viz. the ribs on the body chamber, is absent in our specimens.

Material. Five specimens collected on Mt. Carmel (Daliyat el Karmıl, Jalame) and in the Western Galilee (Majd el Kurum) from zones 6–7.

Neoptychites sp. 1

Text-fig. 10*e–f*

Description. One complete, and two fragmentary well-preserved specimens without body chambers. Section higher and thinner than that of the specimens included in *N. cephalotus*. Umbilicus small. Venter narrowly rounded. One specimen shows a sharpened venter. Very weak radial waves, about ten per whorl, appear on the outer two-thirds of the sides.

Suture well preserved, shows a rapid decrease in the height of the saddles and in the depth of the lobes. The three saddles are equally high and the two exterior ones are converging. The first saddle is divided into two branches and the second one into three. First lateral lobe is very deep, divided into four branches by three main accessory saddles, the largest of which is the external one and the smallest is the innermost. The second lobe is less deep, divided by four equal accessory saddles into five branches. The third saddle is wider and shallower than the former ones and is divided by an accessory lobe into two unequal branches. Two large phylloid and three small accessory saddles divide the flat and shallow third lateral lobe. The fourth saddle is simple, small, and quadrangular, situated at the umbilical border.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
HU-21226	187	103(0·55)	56(0·3)	11(0·07)

Remarks. N. telinga (Stol.) described by Kossmat (1895, p. 167, pl. 21) has a similar, although much more delicately notched suture. Our ammonites are as narrow as *N. gourgeuchoni* Pervinquière (1907, p. 400, pl. 27, figs. 8–9) but the latter has a very delicately indented suture and its shape is slightly different.

Material. The three specimens were collected in the Western Galilee (Yirka, Yanuh, Elqosh) from zone 6.

Neoptychites sp. 2.

Text-fig. 10*g*

Description. One thin specimen of medium size. Body chamber weakly inflated, occupying half a whorl. Apertural constriction not pronounced. No ornament. The gerontic suture shows flat-topped saddles. First saddle bifid, second one almost entire. Lobes simple, the first lateral one with five weak accessory saddles, the second one with four of them.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Body chamber inflation*	*Umbilicus*
M-14	150	72	42(0·28)	51(0·34)	14(0·09)

Remarks. Flat-topped saddles were recorded only in *N. xetriformis*, which is relatively thicker and ornamented by ribs.

Material. One specimen collected in the Southern Negev (Timna) from zone 5.

Family TISSOTIIDAE Hyatt 1900
Subfamily PSEUDOTISSOTIINAE Hyatt 1903
Genus PSEUDOTISSOTIA Peron 1896

Type species. Ammonites gallienei d'Orbigny 1847.

Subgenus BAUCHIOCERAS Reyment 1954

Type species. Hoplitoides nigeriensis Woods 1911.

Pseudotissotia (*Bauchioceras*) *tricarinata* Reyment

Plate 8, figs. 7–8; text-fig. 10*h*

1954a *Bauchioceras tricarinatum* Reyment, p. 158, pl. 3, fig. 5; text-fig. 4*a*.
1955 *Pseudotissotia* (*Bauchioceras*) *tricarinata* Reyment, pp. 71, 72, 77, 98.
1956 *Pseudotissotia* (*Bauchioceras*) *tricarinata* Reyment, p. 73.
1957 *Pseudotissotia* (*Bauchioceras*) *nigeriensis tricarinata* (Reyment); Barber, p. 47, pl. 20, figs. 1*a*, *b*; pl. 21, figs. 4*a*, *b*; pl. 34, figs. 6, 14.

Remarks. One well-preserved specimen and a fragmentary one resembling closely the original material from Nigeria. The sides are slightly less inflated and the section is slightly thinner. The ribs and the umbilical tubercles disappear already at a radius of 13 mm.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
M-4058	47	25(0·56)	18(0·38)	7(0·15)

Material. One specimen and one fragment collected in the Northern Negev (Ma'ale Mazzar) from zone 3.

Genus CHOFFATICERAS Hyatt 1903

Type species. Pseudotissotia meslei Peron 1897.

1903 *Choffaticeras* Hyatt, p. 37.
1907 *Pseudotissotia* (*Choffaticeras*) Pervinquière, p. 349.
1912 *Leoniceras* Douvillé, p. 312.

1928 *Leoniceras* Douvillé, p. 20.
1938 *Pseudotissotia* (*Choffaticeras*) and *Leoniceras* Roman, pp. 475, 483.
1952 *Choffaticeras* and *Leoniceras* Basse, in Piveteau, p. 667.
1955 *Choffaticeras* (*Choffaticeras* and *Leoniceras*) Reyment, pp. 72–5.
1957 *Choffaticeras* (*Choffaticeras* and *Leoniceras*) Wright, in Moore, pp. L423–4.

Diagnosis. Large, involute ammonites. Section cordate. Venter acute, with or without lateral carinae which are weaker than the median one. Sometimes rows of tubercles occur instead of lateral carinae. Ornament of ribs, ventro-lateral and umbilical tubercles, exist generally only at small diameters, disappearing at different growth stages.

First lateral lobe considerably wide, divided into two unequal parts by a large accessory saddle on its external side. The first saddle is large and divided. The other lobes and saddles considerably simpler, resembling one another.

Remarks. The genus *Pseudotissotia* was erected by Peron in 1897 for the three species *A. gallienei* d'Orb., *P. meslei* Peron, and *P. douvillei* Peron. Its diagnostic features were one or three keels, and a general resemblance to certain species of *Tissotia* differing by the uneven saddles. This name is retained today for species in which the ventro-lateral keels are of the same size or larger than the median one, whereas for the forms having a larger median keel or a single keel only, Hyatt (1903) proposed the generic name *Choffaticeras*, whose type species is *C. meslei.* Additional characteristic features of this genus are a smaller umbilicus and a more compressed section than that of *Pseudotissotia.* Pervinquière (1907) regarded *Choffaticeras* as a subgenus of *Pseudotissotia* and divided it into two groups: one with one keel and a second with three keels. In 1911 Douvillé proposed the name *Leoniceras* for ammonites having an asymmetrically divided first lateral lobe, formerly included in the above-mentioned genera, with the intention to show the alliance of the group to the Coilopoceratidae. The type species of this genus is *L. luciae* (Perv.). Douvillé did not note in that publication (1911) which of the species of the former genera were included in *Leoniceras.* In 1928, however, he included within *Leoniceras* most of these species admitting that not all of them have the diagnostic asymmetry of the first lateral lobe. *C. meslei*, remains, according to this taxonomy, the single species of *Choffaticeras.* Nevertheless, later authors continued to use both names, applying various new meanings to them and including the various species at times in one genus and in others in the other one. Roman (1938) followed Douvillé, placing *Leoniceras* far from *Pseudotissotia* (*Choffaticeras*), although for no apparent reason he included within *Choffaticeras* the species *barjonai* Choffat, which is generally regarded to be rather close to the type species (*luciae*) of *Leoniceras.* Later authors did not regard the suture as a discriminating feature between the two genera. Basse (1952) regarded the two as full genera, noting only the width of the umbilicus (wide in *Leoniceras*) as a discriminating feature between them. Reyment (1955) and Wright (1957) distinguished between them according to the number of the keels (three in *Choffaticeras* and only one in *Leoniceras*) regarding them as subgenera.

Each of these criteria, viz. the asymmetry of the first lateral lobe, the size of the umbilicus, and the number of the keels, can be used independently to divide the group into two generic taxa, but the three ways of division do not coincide. Thus, each taxon includes other species, according to the criterion used. It is suggested, therefore, to include the whole group in a single genus, and according to its priority the name *Choffaticeras* is retained.

Choffaticeras occurs mainly in the circum-Mediterranean region. The West African species, *C. philippii* (Solger), *C. koeneni* Riedel, and *C. spathi* Reyment, which have a wide and shallow first saddle and an almost symmetric first lateral lobe, form a separate group both morphologically and geographically. All the other species are known only from the circum-Mediterranean region (except for *C. pavillieri*, which occurs also in Madagascar (Basse 1931) and in Gabon (Lombard 1930)).

Extensive collections of *Choffaticeras* have been described from the Middle East (Egypt, Israel, Jordan, Syria, and Lebanon), North Africa (Tunisia, Algeria), and the Iberian Peninsula (Spain, Portugal). The material described from France is rather poor. The inner whorls of most specimens are not preserved, and the various growth-stages have been studied from series of different specimens. It has been found in this study that these series comprise specimens collected at different stratigraphic levels, the larger ones (100–400 mm.) occurring usually higher than the smaller ones. It is therefore probable, that the series represent phylogenetic rather than ontogenetic relationships.

The innermost whorls are described in detail by Solger (1904) and by Eck (1914). At this stage the section is round, the umbilicus is rather large and there is no ornament. Ornament composed of ribs (20–60 per whorl) with ventro-lateral and umbilical tubercles begins to appear at a radius of 10 mm. Not all the elements do necessarily appear, and their strength, shape and stage of appearance are variable, but at least within the height of 5–15 mm. no *Choffaticeras* have been recorded to be completely devoid of ornament. The median keel appears immediately after the appearance of the ornament.

There are five different types of ornament at diameters of 10–50 mm.:

(*a*) Wide, shallow, and radial ribs, 20–25 per whorl, with ventro-lateral tubercles. Half of the ribs reach the umbilical border, where they are produced into strong, round, umbilical tubercles. The section is thick and the umbilicus is relatively large. This is the form described as the inner whorls of *P. segnis* Solger, but it was not noted whether it is an inner volution of the large holotype or merely another small specimen. This form has never been redescribed and was not found within the material studied herewith. Strong umbilical tubercles have not been recorded in any other *Choffaticeras*, whereas, as previously noted by Pervinquière (1907, p. 351), this ornament is characteristic of certain young *Thomasites*.

(*b*) A form narrower than the former one, with a smaller umbilicus, ornamented by distinct, prorsiradiate ribs, 40 per whorl. The ribs are pronounced on the umbilical and on the ventral margins. This form, named *Schloenbachia quaasi* Peron (1904), is very abundant in our region, and Eck (1910, 1914) described a series connecting it with the adult *C. segne*. The variability in width of *C. segne* (from the thick holotype to the thin var. *discoidalis* Perv.) occurs already from early stages, and therefore, Eck cancelled the name *quaasi* as a synonym of *segne*. Douvillé (1928) revived *C. quaasi*, noting that only young specimens with strong umbilical tubercles as that described by Solger should be regarded as *C. segne*. He included within *C. quaasi* also forms with many ribs (60 per whorl) being unaware that they were already named *C. pavillieri* Pervinquière (1907).

(*c*) A narrower form than the former ones, characterized by 50–60 slightly flexuous ribs. The ribs are not pronounced at the umbilical and ventro-lateral margins. Pervinquière (1907) described only the stage where the ornament disappears. He noted that the species *C. pavillieri* is narrower and has a smaller umbilicus than *C. segne* var. *discoidalis*, but even his own measurements do not confirm definitely this conclusion.

Moreover, the so-called *P. macrodiscus* Schweinfurth (Taubenhaus 1920, pl. 4, fig. 4) which is fairly inflated with a fairly large umbilicus, has the same number and shape of ribs as *C. pavillieri*.

(*d*) Greco (1915, pl. 19, figs. 2–3) shows two narrow and sharp specimens, ornamented by 30–40, weak, round, ventro-lateral tubercles per whorl and by ribs which do not reach the umbilicus. He regards this form as the inner whorls of *C. segne discoidalis* Perv. Taubenhaus (1920, pl. 4, figs. 1–2), shows a similar form, naming it *P. segnis* var. indet.

(*e*) A form with few (16–18 per whorl), wide, shallow, and flexuous ribs, is described by Basse (1937, p. 186) as the inner whorls of *L. alaouitense*.

In conclusion, it seems that form (*a*) is a young *Thomasites*. *C. segne* includes the thick specimens of form (*b*), whereas the narrow ones are included in *C. quaasi* which has priority to *C. segne discoidalis*. Form (*c*) is *C. pavillieri* and form (*d*) is *C. sinaiticum*. Form (*e*) is the early stage of *C. securiforme* which has priority to *C. alaouitense*.

The ornament disappears at various diameters, and the last to disappear is usually that on the ventro-lateral region. At large diameters the species are distinguished by their width, by the number of the keels, and by the dimensions and the shape of the umbilicus. Usually the species with thick shells have also a wide umbilicus, and the thin ones, narrow umbilicus. However, *C. mokattanicum* Greco (? = *C. luciaeformis* (Faraud)) has a wide, acute section and a small umbilicus and *C. massipianum* Perv. and *C. securiforme* (Eck) (= *C. alaouitense* (Basse)), have a narrow section and a large umbilicus with distinct walls.

Among the narrow species we include *C. quaasi* (= *C. discoidalis*), in which the lateral carinae disappear rather late whereafter the venter becomes rounded; *C. pavillieri* (? = *C. carinifer* (Douv.)), in which the median keel is preserved even on the body chamber; *C. sinaiticum* (? = *C. luciae stricta* Perv. and *C. destefanii* Greco), in which the lateral keels disappear at a very early stage and the section is sharp from a stage of 60 mm. onward. In each of these species, the umbilicus grows slowly at large diameters (150 mm. and further), but distinct umbilical walls are never formed. Among the thick and wide umbilicate species, the monocarinate *C. luciae* Perv. and *C. barjonai* (Choffat) and the tricarinate *C. segne* and *C. meslei* (Choffat), should be counted. The latter species preserves the three keels up to the end of the body chamber and is probably identical with *L. kenehense* Douvillé. *C. segne* looses its three keels on the body chamber and its venter becomes round. *C. schweinfurthi* (Eck) belongs probably to this species. The suture is very variable and hence it has only a limited systematic significance. The diagnostic features of the genus are: a wide and deep first lateral lobe with a large accessory saddle on its external side. The other elements are small and simple, usually more numerous on thin specimens than on thicker ones. In a few ammonites the first lateral lobe is not divided but indented only. These ammonites were related by several authors (Peron, Douvillé, Eck) to the genus *Hemitissotia*.

Choffaticeras meslei (Peron)

Plate 9, fig. 2; text-fig. 10*i*

1897 *Pseudotissotia meslei* Peron, p. 33, pl. 1, fig. 1; pl. 2, figs. 1–2; pl. 3, fig. 2; pl. 17, fig. 1.
?1928 *Leoniceras kenehense* Douvillé, p. 27, pl. 4, fig. 5; text-fig. 18.

Description. Fairly inflated, small, and involute ammonites. Width of specimens very variable. Section oval, relatively high. Umbilicus of medium size with round steep walls.

Three, almost equal carinae on the venter, the median one slightly more pronounced. Other ornament and suture are not observed.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
M-3453–7	62	30(0·48)	35(0·56)	15(0·24)
HU-23058	56	25(0·44)	20(0·36)	13(0·23)

Remarks. Our specimens resemble closely those of equal size from Algeria. The Algerian material includes, however, much larger specimens with a triangular section and straight, vertical umbilical walls. At this late stage they are ornamented by ribs. The single difference between *C. meslei* and *L. kenehense* is the smaller umbilicus of the latter, which does not seem to be a significant feature. The variability of the thickness of the Algerian specimens is comparable with that of our material. This group seems to be more primitive than the other species of *Choffaticeras* and in our region they occur lower than the others in the stratigraphic section. The resemblance to species of the genus *Bauchioceras* Reyment, which have three equal keels is noteworthy.

Material. Three specimens collected in the Northern Negev (Nahal Derorim, Hamakhtesh Hagadol) from zone 2.

Choffaticeras segne (Solger)

Text-fig. 10*j–l*

1903 *Pseudotissotia* Indet. Pervinquière, p. 99.
1903 *Pseudotissotia segnis* Solger, p. 77, pl. 4, figs. 1–2; text-figs. 16–21.
1907 *Pseudotissotia* (*Choffaticeras*) *segnis* Solger; Pervinquière, p. 351, pl. 23, figs. 1–3.
?1909 *Tissotia schweinfurthi* Eck, p. 184, figs. 6–8.
1910 *Pseudotissotia segnis* Solger; Eck, p. 383.
1911 *Leoniceras segne* (Solger); Douvillé, p. 313, text-fig. 49.
?1914 *Pseudotissotia segnis* Solger; Eck, p. 204, pl. 15, fig. 3; pl. 16, figs. 1–3; text-figs. 10–20.
1915 *Pseudotissotia* (*Choffaticeras*) *segnis* Solger; Greco, p. 213, pl. 18, fig. 5; pl. 19, fig. 1; text-fig. 4.
1920 *Pseudotissotia segnis* Solger; Taubenhaus, p. 41, pl. 4, figs. 3, 5; pl. 6, fig. 4.
1937 *Pseudotissotia* (*Leoniceras*) *segne* Solger; Basse, p. 187.
1940 *Leoniceras segne* (Solger); Basse, p. 460, pl. 9, fig. 1.
1961 *Choffaticeras segne* (Solger); Freund, p. 81, Table I.

Descriptions. Section oval up to a diameter of 6–8 mm., where a median keel appears on the round venter. At this stage the umbilicus is small. The ornament, consisting of 25–40 radial or slightly prorsiradiate ribs per whorl appear at a diameter of about 10 mm. The ribs are pronounced at the ventro-lateral margin, forming thus the ventro-lateral

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EXPLANATION OF PLATE 9

Fig. 1. *Choffaticeras securiforme* (Eck), zone 4, Yanuh, HU-21010, ×½.
Fig. 2. *Choffaticeras meslei* (Peron), zone 2, Nahal Derorim, M-3453–7, ×1.
Figs. 3–4. *Choffaticeras pavillieri* Pervinquière, zone 5; 3. Wadi Abu Had, Egypt, HU-18586a, ×1; 4. Zones 3–4, Beer Menuha, M-772–1, ×1.
Figs. 5–6. *Choffaticeras quaasi* (Peron), Wadi Tarfa, Egypt, HU-18568a, ×1.
Figs. 7–8. *Choffaticeras luciae trisellatum* subsp. nov., zone 6, Wadi Hesi, Jordan, Holotype, HU-15087, ×½.

shoulders, whereas only one-third to half of them reach the umbilical border where they are superimposed by weak tubercles. This ornament is maintained up to a diameter of 100 mm. At this stage the section is trapezoidal, wide (thickness more than $\frac{2}{3}$ of height), and tricarinate. The umbilicus becomes larger with growth, its walls become vertical and the round borders become more distinct. At about the diameter of 100 mm. the ornament, the ventro-lateral shoulders, and in most cases also the median keel disappear. The ventro-lateral tubercles are the last element to disappear. From this diameter onwards the venter is round, with the few exceptions where the median keel is maintained throughout, and the umbilicus is fairly large (20–30 per cent of the diameter).

The details of the suture-line are very variable. Its external part comprises four saddles of which the first one is high and generally notched into three unequal branches. The other three saddles are squarish with a slightly narrow base. The ventral lobe is broad and shallow. The first lateral lobe is broad and divided by a large accessory saddle on its external side, and by several additional accessory saddles. Two saddles are situated on the umbilical wall and four, high, narrow, and bifid saddles on the internal part.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*T/H*
P-722–6	8·0	4·0(0·5)	2·8(0·35)	1·3(0·16)	0·7
P-722–1	19	8·5(0·45)	6·5(0·34)	3·9(0·21)	0·65
HU-18568	42	21(0·5)	15(0·36)	8(0·19)	0·71
HU-18566	105	54(0·51)	37(0·35)	17(0·16)	0·68
HU-2210*	200	95(0·48)	74(0·37)	42(0·21)	0·76
HU-21149	390	185(0·48)	120(0·31)	80(0·24)	0·65

* Described by Taubenhaus.

Remarks. Solger (1903) described a specimen of a small diameter, ornamented by a few coarse ribs and by strong umbilical and ventro-lateral tubercles, without noting whether it was an inner whorl of the larger holotype or another specimen. Pervinquière (1907) noted the close similarity of that specimen to the corresponding stage of *Thomasites* and described in addition young *C. segne* with much weaker ribs. Our material includes only one specimen with coarse, broad ribs, but without strong umbilical tubercles, whereas all the others have dense and fine ribs.

Pervinquière, Eck, and Taubenhaus noted the wide range of the dimensions. The holotype is thick, with small umbilicus, convex flanks, and round venter. The umbilicus of many specimens is larger than that of the holotype, and the venter is often acute. It seems that the specimens which develop concave flanks during different growth stages (e.g. those described by Roman and Mazeran (1913, p. 28, pl. 3, fig. 3), Eck (1914, pl. 16, figs. 1–2), and Douvillé (1928, pl. 5)) are related through the transition form *C. schweinfurthi* (Eck), to *C. securiforme* (Eck) (see below). On the other hand, there is a continuous transition to thinner forms (T = 40–65 per cent of H) with small umbilicus, named var. *discoidalis* by several authors (Pervinquière, Eck, Greco, and others). This form is here regarded as a synonym of *C. quaasi* (Peron). *C. mokattanicum* Greco is more involute and has a smaller umbilicus than *C. senge*. In conclusion, the boundaries between the species are arbitrary, since all the features change continuously.

Material. The species is not very common in our region. Twenty-four large specimens collected from the lower part of the Yirka Fm., zones 5–6 in the Western Galilee, from zone 6 at the Central Negev (Ramon-Arif region), the Southern Negev (Beer Menuha, Elat) and in Transjordan (Tafila, es Salt).

Four tiny specimens were found lower in the section (zones 3–4) at Beer Menuha and at Nahal Zin. Forms of medium size, were collected in Sinai and in Egypt.

Choffaticeras quaasi (Peron)

Plate 9, figs. 5–6; text-figs. 10*m*, 11*a*

1904 *Schloenbachia quaasi* Peron; Fourtau, p. 255, pl. 1, figs. 1–3.
1907 *Pseudotissotia* (*Choffaticeras*) *segnis* Solger, var. *discoidalis* Pervinquière; p. 352, pl. 23, fig. 3.
1914 *Pseudotissotia segnis* Solger, var. *discoidalis* Pervinquière; Eck, p. 207, pl. 14, fig. 7; pl. 15, fig. 1; text-figs. 7–9.
1914 *Schloenbachia quaasi* Fourtau; Eck, p. 212, pl. 13, figs. 3–7; pl. 14, figs. 2–5, 8.
1915 *Schloenbachia quaasi* Peron; Greco, p. 209, pl. 17, fig. 6.
1915 *Pseudotissotia* (*Choffaticeras*) *segnis* Solger; var. *discoidalis* Pervinquière; Greco, p. 214, pl. 19, fig. 4.
1920 *Pseudotissotia segnis* Solger; Taubenhaus, p. 41, pl. 4, figs. 1–2.
1928 *Leoniceras quaasi* (Peron); Douvillé, p. 21, pl. 3, fig. 3.
1959 *Leoniceras quaasi* (Peron); Freund, p. 45.
1961 *Choffaticeras quaasi* (Peron); Freund, p. 81.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*T/H*
P-722–5	14·7	7·0(0·48)	4·2(0·28)	3·0(0·2)	0·6
HU-18566*a*	58	30(0·52)	19(0·33)	9(0·16)	0·61
HU-23284	320	142(0·44)	75(0·23)	60(0·18)	0·53

Remarks. This species differs from the former one only by its thinner section (thickness less than $\frac{2}{3}$ of height) and by its smaller umbilicus. At small diameters it is ornamented similarly to the former species and the ornament is variable as well. The ornament of *C. quaasi* usually disappears somewhat later (diameter of 80–90 mm.) than that of the allied species. This species is slightly wider than both *C. pavillieri* Perv. and *C. sinaiticum* (Douvillé), which also have a smaller umbilicus and retain the acute venter throughout, whereas the venter of *C. quaasi* is frequently round at late stages.

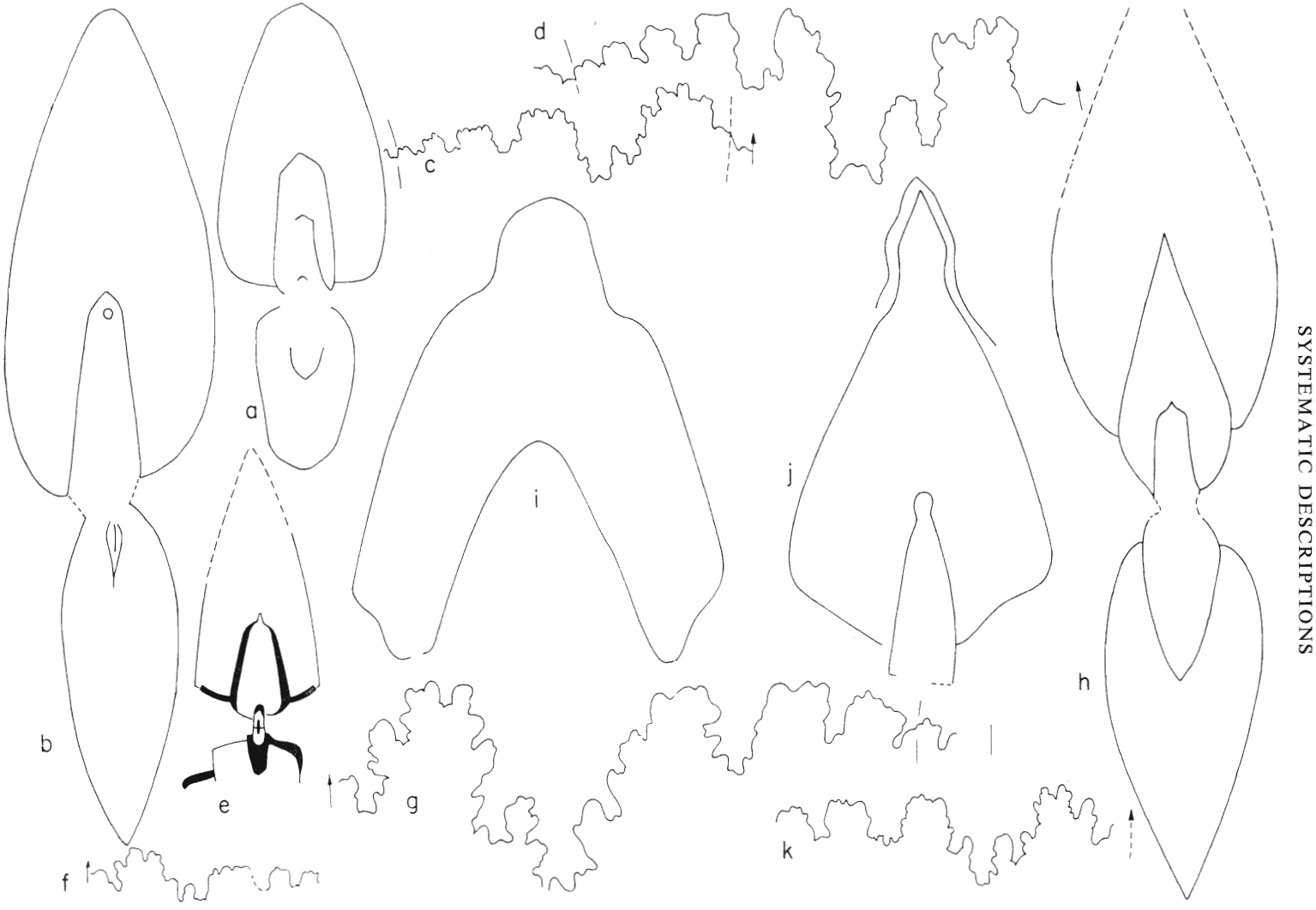
Material. The large specimens of *C. quaasi* are more abundant than any other species of *Choffaticeras* in zone 5 in the Central and Southern Negev. Ninety-four specimens were collected. The small specimens (up to 50 mm.) are very common in the horizons of the dwarfed fauna (zones 3–4) at Beer Menuha and at Nahal Zin. It occurs with the former species in the lower part of the Yirka Formation in Western Galilee (zone 5). Several uncertainly identified specimens occur at the base of the Daliya Marl on Mt. Carmel (Dalyiat el Karmil, Jalame). Other specimens were collected in Transjordan (Tafila, Wadi Hesi) and in Sinai. This species also occurs rarely in zone 6.

Choffaticeras pavillieri Pervinquière

Plate 9, figs. 3–4; text-fig. 11*b–d*

1907 *Pseudotissotia* (*Choffaticeras*) *pavillieri* Pervinquière, p. 353, pl. 23, figs. 1–3; text-fig. 134.
1920 *Pseudotissotia macrodiscus* Schweinfurth; Taubenhaus, p. 42, pl. 4, fig. 4.
1928 *Leoniceras quaasi* (Peron); Douvillé, p. 21, pl. 3, figs. 3–5.
?1928 *Leoniceras carinifer* Douvillé, p. 25, pl. 4, fig. 3.
1930 *Pseudotissotia* (*Choffaticeras*) *pavillieri* Pervinquière; Lombard, p. 289.
1931 *Pseudotissotia pavillieri* Pervinquière; Basse, p. 40, pl. 9, fig. 23; pl. 13, fig. 2.
1961 *Choffaticeras pavillieri* Pervinquière; Freund, p. 81, Table I.

Description. The small specimens are flat with an acute keel. Ornament appears at a diameter of 5–6 mm. and is composed of 50–60 delicate, slightly sinusoidal, and



TEXT-FIG. 11. *a*, *Choffaticeras quaasi* (Peron), zone 5, Gebel Shaira, Sinai, HU-18586. *b–d*, *Choffaticeras pavillieri* Pervinquière, zone 5, Yanuh; *b–c* HU-21014; *d*, HU-21017. *e–h*, *Choffaticeras sinaiticum* (Douvillé); *e–f*, Wadi Alaliq, M-3600; *g*, Majd el Kurum, HU-21146; *h*, Yanuh, HU-21018. *i–k*, *Choffaticeras securiforme* (Eck), zone 4; *i*, Beer Menuha, Le-1555; *j*, Yanuh, HU-21010; *k*, Yanuh, HU-21007.

strongly prorsiradiate ribs. The ribs reach almost the median keel, without any considerable swellings at the ventro-lateral margins. One-third of the ribs reach the umbilical border, but they do not bear umbilical tubercles. At a diameter of 30–50 mm. the ribs disappear, remaining only as forwardly inclined projections at the ventro-lateral margins. Both lateral keels disappear at a diameter of 50–100 mm., whereas the median keel remains acute throughout. The umbilicus is small between diameters of 25–150 mm. (about 15 per cent of D). At smaller diameters the umbilicus is larger, and at late stages it is growing somewhat scaphitoidally, its walls become fairly distinct and inclined. The suture comprises 5–7 saddles, forming a slight bow, forwardly convex (text-fig. 11*d*). The first saddle is squarish, and not divided into branches. The asymmetry of the first lateral lobe is not always strongly accentuated (text-fig. 11*c*).

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*T/H*
M-3618	14·5	7·0	3·4(0·23)	3·0(0·2)	0·48
HU-18566–2	42	23	12(0·28)	4·0(0·09)	0·51
HU-21014	165	80	35(0·21)	30(0·17)	0·44
HU-21044	325	147	60(0·18)	58(0·18)	0·41

Remarks. This species is closely related to the preceding (*C. quaasi*) and to the following species (C. *sinaiticum*). It differs from the former species by a narrower section, by a smaller umbilicus, by finer and denser ornament, and by the more numerous lobes and saddles. The latter species (*C. sinaiticum*) is ornamented at early stages by only a few ventro-lateral tubercles, it loses very early the lateral keels, the median keel remains sharp throughout and the suture comprises only four saddles. Many transitional forms exist between these three species. *C. pavillieri* resembles *Coilopoceras* in the narrow section, the small umbilicus, and forwardly convex suture. The early, ornamented stages of *C. pavillieri* are clearly distinct from the smooth *Coilopoceras*, whereas later stages differ only by the wide first lateral lobe of *Coilopoceras*. *C. pavillieri* is the only species of *Choffaticeras* described outside the Mediterranean basin, excluding the three West African species (Lombard (1930) from Gabon and Basse (1931) from Madagascar). The descriptions in both references are rather poor, neither allowing acceptance or rejection of the determination.

Material. Five specimens collected in the Western Galilee (Yanuh, Kisra) from the lower part of the Yirka Fm. One specimen was collected from zone 5 at Dareb es Sultan and one in Sinai (Wad Abu Had). Five small specimens were collected at Beer Menuha.

Choffaticeras sinaiticum (Douvillé)

Text-fig. 11*e–h*

?1907 *Pseudotissotia* (*Choffaticeras*) *luciae* var. *stricta* Pervinquière, p. 355.
?1915 *Pseudotissotia* (*Choffaticeras*) *de-stefanii* Greco, p. 217, pl. 20; text-fig. 6.
1915 *Pseudotissotia* (*Choffaticeras*) *segnis* Solger, var. *discoidalis* Perv.; Greco, pl. 19, figs. 2–3.
1928 *Leoniceras sinaiticum* Douvillé, p. 25, pl. 4, fig. 4; text-fig. 15.
1961 *Choffaticeras sinaiticum* (Douvillé); Freund, p. 81, Table I.

Description. Shell discoidal, fairly narrow. Section high, triangular in whorls of medium size, its maximum width is near the umbilicus, and the slightly convex flanks meet at a sharp keel. The widest part of the section moves later from the umbilical border to one-third of the height. Three keels exist up to a diameter of 30 mm., where the ventro-

lateral ones disappear. The umbilicus is small, with well distinct, almost vertical walls, up to a diameter of 50–80 mm. Later the umbilicus grows rapidly losing its distinct borders. Small specimens (15–20 mm.), have on the outer part of the flank about 35 delicate ribs per whorl. Earlier and later stages are not ornamented.

The variable suture comprises four saddles on the flank. Unlike the other species of *Choffaticeras* the second saddle is also developed relatively to the simple third and fourth ones, and the second lateral lobe is sometimes wide relatively to the third one.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*T/H*
M-3600	93	51	34(0·35)	13(0·14)	0·66
HU-21146	355	140	61(0·17)	110(0·3)	0·43

Remarks. These ammonites are attributed to *C. sinaiticum* (Douvillé) because of the early disappearance of the lateral keels and the similarity of the suture line and the whorl section. *C. luciae stricta* Perv. seems to be identical with *C. sinaiticum*, but its poor description and the lack of illustration does not permit an exact comparison. It is suspected that what seems as a flat venter, ornamented by tubercles of *Pseudotissotia* (*Choffaticeras*) *destefanii* Greco, which was erected on the basis of a single specimen, is due to the fracturing of the shell in the ventral region. Otherwise, it resembles closely *C. sinaiticum*. The small specimens recorded by Greco (1915, pl. 19, figs. 2–3) as *C. segne discoidalis* are similar to our young *C. sinaiticum*. As mentioned above the differences between *C. pavillieri* and *C. sinaiticum* are slight and there are transitional forms between them.

Material. Ten small specimens collected from zone 3 in Nahal Zin. Twenty-nine specimens of medium and large sizes collected in the Southern Negev (Wadi Alaliq, Be'er Ora), Transjordan (Wadi Hesi), and in the Central Negev (Makhtesh Ramon and surroundings), from zones 5–6. In the Western Galilee (Majd el Kurum) they were collected from the lower part of the Yirka Fm.

Choffaticeras luciae trisellatum subsp. nov.

Plate 9, figs. 7–8; text-figs. 12*i–q*, 13*a–h*

1959 *Leoniceras luciae* (Pervinquière); Freund, p. 45.
1961 *Choffaticeras luciae* Pervinquière; Freund, pp. 80, 81, 87; Table I.

Diagnosis. Thick, monocarinate *Choffaticeras*, with a wide umbilicus, vertical umbilical walls and with three to four saddles.

Derivation of name. The three saddles on the side.

Holotype. No. HU-15087, Wadi Hesi, Transjordan.

Description. Section thick (60–80 per cent of height), triangular, maximum thickness near the umbilicus. Walls slightly convex, meeting at the keeled venter. Umbilicus wide (about 30 per cent of D) with distinct walls. The umbilical border is acute from a diameter of 80–90 mm. onward, but sometimes becoming round again. The umbilical walls are usually vertical and sometimes oblique. At a radius of 70 mm. (diameter of 150–180 mm.) the external part of the flank becomes sometimes concave forming a wide spiral notch and the venter is narrowly rounded. The body chamber occupies half to three-quarters of a whorl, tending to be narrower and higher than the septate part of the shell. Distinct, round, and fairly well-spaced ventro-lateral tubercles, about 25 per

whorl, occur at a diameter of 8 mm. They do not form a lateral keel. At a diameter of 15 mm. the tubercles disappear. Two well-preserved specimens (one retaining the original shell) show on the external part of the flanks sporadic bunches of very dense, prorsiradiate growth lines.

The variable suture comprises $2\frac{1}{2}$–4 saddles on the flank. Ventral lobe broad and sometimes very broad, shallow, with a branch penetrating obliquely under the first saddle. First saddle simple, indented at a radius of 8 mm., later, up to a diameter of 100 mm. it is high and narrow, divided by a deep accessory lobe at its external side. At a larger radius, the first saddle is usually unequally divided into three branches. The first lateral lobe is always the deepest, in most cases with a large and oblique accessory saddle in its external side, and frequently also with a median accessory saddle. In several specimens the external accessory saddle is not developed, and the narrower lobe has a more symmetric appearance. The other lobes are in most cases narrow and shallow. In the external side of the second saddle there is an accentuated accessory lobe. Sometimes the second saddle has a flat top with several equal notches. The third saddle has frequently the same shape. The fourth and fifth saddles occur on the umbilical wall.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*T/H*	
HU-17751a	68	32	25(0·37)	20(0·29)	0·79	
HU-23177	81	33	25(0·31)	32(0·39)	0·78	
HU-15087	247	106	79(0·32)	85(0·35)	0·75	holotype
HU-21123	340	149	104(0·31)	105(0·31)	0·7	
HU-21038	440	150	103(0·23)	116(0·26)	0·7	

Remarks. C. luciae trisellatum is an intermediate form between *C. luciae* Pervinquière (1907, p. 354, pl. 24, figs. 1–2; text-figs. 135–7) and *C. barjonai* (Choffat) (1898, p. 73, pl. 3; pl. 8, fig. 3; pl. 22, figs. 40–2). The section is thicker than that of the former and thinner than that of the latter species. The details of the suture are similar to those of the former, but there are $3\frac{1}{2}$ elements in comparison with 4–5 in *C. luciae*, whereas it has the same number of elements as *C. barjonai*, but the shape is different. The body chamber of *C. barjonai* is ornamented by less but coarser ribs. Pervinquière notes that *C. luciae* is unornamented throughout, but Basse (1940, p. 459) remarks that several specimens of the original material are distinctly striated. Basse (loc. cit.) records a similar striation on a specimen from Syria. The umbilical walls of *C. luciae* are flat and vertical and those of *C. barjonai* are concave and overhanging. Pervinquière did not note ventrolateral tubercles at early stages. The adult *C. luciae trisellatum* resembles inflated *C. securiforme*, but the latter has three distinct keels at early stages.

Material. Sixty-two specimens collected in Western Galilee, in the Negev, in Sinai and in Transjordan. *Choffaticeras luciae trisellatum* is the index-fossil of zone 6.

Choffaticeras securiforme (Eck)

Plate 9, fig. 1; text-fig. 11*i–k*

1909 *Tissotia securiformis* Eck, p. 187, figs. 9–13.
?1913 *Leoniceras* groupe de *senge* Solger; Roman and Mazeran, p. 28, pl. 3, fig. 3.
1914 *Tissotia securiformis* Eck, p. 216, pl. 19, fig. 3.
?1914 *Pseudotissotia segnis* Solger; Eck, pl. 16, figs. 1–2.
?1928 *Leoniceras segne* (Solger); Douvillé, p. 27, pl. 5.

1937 *Pseudotissotia* (*Leoniceras*) *alaouitense* Basse, p. 186, pl. 10, fig. 1.
1940 *Leoniceras* cf. *alaouitense* Basse, p. 459.
1959 *Leoniceras luciae* (Pervinquière); Freund, p. 45 (pro part.).

Description. At early stages the shell is narrow, the umbilicus is small with round walls and without a clear border. Flanks converge towards the venter, from which they are separated by round shoulders. Venter narrow with a median, obtuse keel. The ornament at this stage is composed of weak, prorsiradiate ribs, starting at the middle of the flank and terminating in a weak tubercle on the ventro-lateral shoulder. The ornament does not reach the umbilicus and is preserved up to a diameter of 65 mm. The number of the tubercles ranges between 15 and 25 per whorl.

At a diameter of about 65 mm. in thin specimens and later on in thicker ones, a deep spiral groove appears near the venter, forming distinct shoulders below it and sometimes a widening of the section above. Simultaneously, there is a considerable growth of the umbilicus (up to 25–40 per cent of the diameter), the border of which becomes distinct although round, and its walls oblique and concave. The thickness ranges between 45 and 80 per cent of the height, but there is a tendency of thickening with growth. Adult stages lack any ornament except for distinct, slightly uneven growth lines, which are rursiradiate on the umbilical wall, prorsiradiate on the flank, bend backwards in the spiral groove and again forwards crossing the rounded keel. These growth lines are very strong and their impressions are seen even on badly corroded internal moulds.

The suture comprises four saddles. The first one is tripartite, divided by shallow accessory lobes, the other saddles are simple. The first lateral lobe is deeper than the ventral lobe and is divided by an accessory saddle into two unequal parts. Sometimes there is a second accessory saddle on the side of the second saddle.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*T/H*
M-3571–6	69	37	15(0·22)	9(0·13)	0·4
HU-21010	150	61	30(0·2)	50(0·33)	0·5
M-3583	193	70	59(0·31)	68(0·35)	0·84
HU-21128	—	277	145	—	0·53

Remarks. It seems that *Tissotia securiformis* Eck does not belong to the genus *Tissotia* as its umbilicus is too large and its saddles are not entire. This species and *Tissotia schweinfurthi* Eck should be included in *Choffaticeras*.

Leoniceras alaouitense Basse is almost identical with *C. securiforme*. The early section of both is tricarinate and the adult monocarinate, the ornament of the young stages is delicate, and both have the same spiral notch and the same suture line. Although *alaouitense* has faint periumbilical tubercles which are absent in our material, it seems preferable to include both in the same species.

Roman and Mazeran (1913), Eck (1914), and Douvillé (1928) describe several ammonites named *C. segne* which resemble closely *C. securiforme*. Although adult *C. luciae* are rather similar to adult *C. securiforme*, the single keel, the shallow spiral groove, and the flat umbilical walls of *C. luciae* distinguish it from *C. securiforme*. The combination of a narrow section and a wide umbilicus, which is rather unusual in this genus, exists also in the Tunisian species *C. massipianum* Perv. (1907, p. 357, pl. 24, fig. 3; text-fig. 138), which differs from *C. securiforme* by the lack of lateral keels and by its entire saddles.

TEXT-FIG. 12. *a–b*, *Choffaticeras* cf. *C. mokattanicum* Greco, zone 6, Be'er Ora, Le-1549. *c–h*, *Choffaticeras* sp.; *c–d*, Wadi Hesi, Transjordan, M-3596; *e–f*, Southern Negev, M-3580–1; *g*, Nahal Neqarot, HU-23036; *h*, Har Seguv, HU-23685. *i–q*, *Choffaticeras luciae trisellatum* subsp. nov., zone 6; *i*, Ramat Kevuda, M-3545; *j*, Nahal Hawwa, HU-23177; *k–l*, Nahal Hawwa, HU-23248; *m*, Hosen, HU-21153; *n–o*, Yanuh,

Material. Forty-nine specimens collected in the Southern Negev (Wadi Alaliq, Timna), in the Northern Negev (Hamakhtesh Hagadol, Ma'ale Aqrabbim, Ma'ale Mazzar), and in the Galilee (Sha'ab, Yanuh, Hosen, Elqosh). This species is the index fossil of zone 4.

Choffaticeras cf. *C. mokattanicum* Greco

Text-fig. 12*a–b*

1915 *Pseudotissotia* (*Choffaticeras*) *mokattanica* Greco, p. 215, pl. 19, fig. 5; text-fig. 5.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*T/H*
Le-1549	141	69	51(0·35)	20(0·15)	0·72
M-297–2	143	74	50(0·34)	27(0·19)	0·68

Remarks. These ammonites differ from *C. luciae* by their small and shallow umbilicus. They are similar to the Egyptian specimen named *P.* (*C.*) *mokattanica* which shows a simple and symmetric first lateral lobe (without an accessory saddle), although it seems that the suture is partly corroded. The shape and the simple suture of *C. mokattanicum* resemble those of *Hemitissotia morreni praecipua* Peron (1897, p. 77, pl. 15, figs. 1–2; pl. 18, fig. 11). *Leoniceras luciaeformis* Faraud (1951, p. 152, pl. 5, figs. 2–4; text-fig. 3) has also a wide, acute section with a small umbilicus (rather rare in the genus), but the description is too poor for comparison.

Material. Two specimens and one fragment collected in the Southern Negev (Be'er Ora, Beer Menuha) from zone 6.

Choffaticeras sp.

Text-fig. 12*c–h*

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
M-3580–1	71	39	23(0·32)	6(0·08)
M-3596	157	76	41(0·26)	22(0·14)
HU-23636	159	78	43(0·26)	27(0·18)

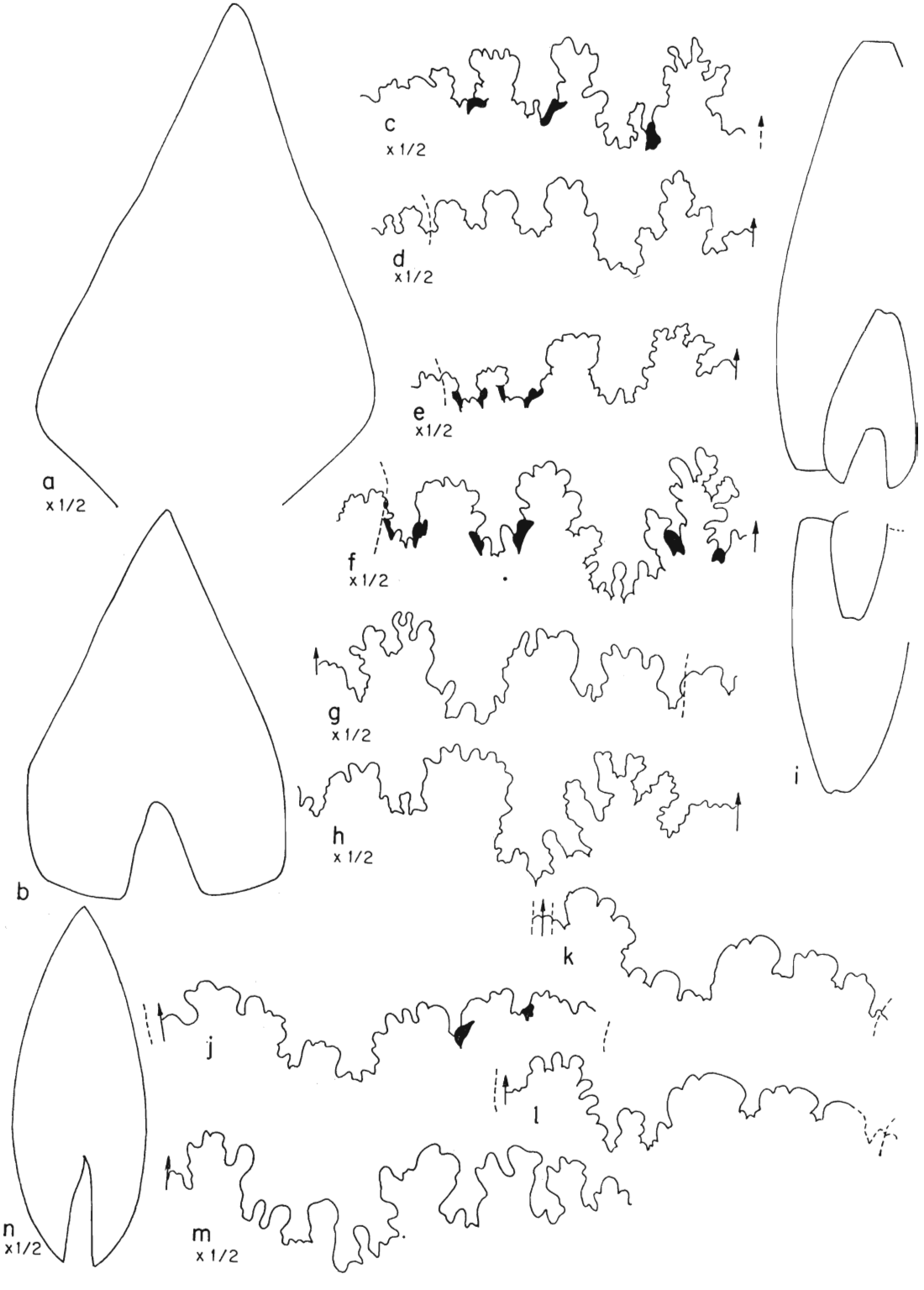
Remarks. The main difference between this group and *C. sinaiticum* is the absence of the large accessory saddle in the outer part of the first lateral lobe. One of our specimens has this accessory saddle on one side and lacks it on the other side. *Hemitissotia cazini* Peron of Douvillé (1928, p. 19, pl. 4, fig. 1; text-fig. 7) and *Hemitissotia* sp., of Eck (1914, p. 216, pl. 13, fig. 1; pl. 17, figs. 3–4) seem to be identical with our material. Differing from the above mentioned, *H. cazini* Peron (1897, p. 74, pl. 14, figs. 1–5; pl. 18, figs. 9–10) has five saddles and no ventro-lateral shoulders. Our material is rather similar to *Hemitissotia galeppei* Pervinquière (1907, p. 359, pl. 25, fig. 1; text-fig. 139) the suture line of which is, however, closer to that of the genus *Tissotia*. *H. cazini*, and *H. galeppei* are of Early Senonian age. The accessory saddle of the first lateral lobe is missing also in *C. meslei* (Peron), in several specimens of *C. luciae trisellatum* and in *C. mokattanicum*.

Material. Six specimens collected in Transjordan (Wadi Hesi), in the Southern Negev (Be'er Ora, Nahal Raham), and in the Central Negev (Beerot Oded) from zones 5–6.

Family COILOPOCERATIDAE Hyatt 1903

Genus HOPLITOIDES von Koenen 1897

Type species. H. latesselatus von Koenen 1897.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Hoplitoides cf. *H. mirabilis* Pervinquière

Plate 10, figs. 1–2; text-fig. 13*i–l*

1907 *Hoplitoides mirabilis* Pervinquière, p. 218, pl. 10, fig. 3; text-fig. 84.
1928 *Hoplitoides ingens costatus* Solger; Douvillé, p. 29, text-fig. 19.
1928 *Hoplitoides ingens nodifer* Solger; Douvillé, p. 30, pl. 6, fig. 2; text-fig. 20.

Description. Thin, discoidal, involute conchs. Section high, its widest part slightly above the umbilical border, thence tapering towards the flat or concave venter. The width of the ventral area enlarges from 2 mm. at a diameter of 40 mm. to 6 mm. at 120 mm. Thereafter the venter narrows again and becomes round. The umbilicus is very small. The specimens at our disposal, which range between the diameters of 15–150 mm., are not ornamented except for very faint radial waves occurring sometimes on the sides. Living chambers were not found.

Four to five saddles occur on the sides. The first one is low, wide, and inclined towards the first lateral lobe. The others are simple and are arranged on a forwardly bent arch. The first lateral lobe is very wide and deeper than the ventral lobe. A median accessory lobe divides it into two equal parts, and two smaller ones occur on both sides. The other lobes are very small.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
HU-23316	41	24	11(0·27)	4(0·10)
M-3622	123	73	43(0·35)	9(0·07)

Remarks. The Egyptian specimens described by Douvillé are similar to ours, and the slight differences in the suture-line do not justify their separation. The specimens described by Eck (1914, pp. 194–196, pl. 13, fig. 2; text-figs. 3–5) are too poor for comparison. *Hoplitoides mirabilis* Pervinquière differs from our ammonites only by its frilled suture, which nevertheless has the same general shape. *H. ingens* (von Koenen) from Tunisia (Pervinquière 1907, p. 221, text-figs. 86–89) is also rather similar to our material. All these ammonites (as well as *H. inca* Benavides-Càceres 1956, p. 475, pl. 63, figs. 6–11; text-fig. 54) retain the bicarinate venter up to a late stage (about 70 mm. radius) whereas all the West African ones of Senonian age (von Koenen 1897; Solger 1903; Riedel 1932; Reyment 1955, p. 81) lose the bicarinate venter at a radius of 20 mm. Reyment (1954*a*, p. 159) proposed therefore to include the Tunisian species in his new subgenus *Wrightoceras* of the Pseudotissotiinae. It seems, however, that the shape of the suture-line of *H. mirabilis* and of our specimens, which is very similar to that of other ammonites of the coilopoceratid family does not conform with Reyment's proposal. It might, however, be reasonable to include *H. munieri* Perv. (1907, p. 217, pl. 10, figs. 1–2; text-fig. 83) and *H. inca*, the suture-lines of which lack the characteristics of the coilopoceratids, in *Wrightoceras* together with the Nigerian *Pseudotissotia* (*Wrightoceras*) *wallsi*

TEXT-FIG. 13. *a–h*, *Choffaticeras luciae trisellatum* subsp. nov., zone 6; *a–g*, Yanuh, ×½; *a*, HU-21008; *b–c*, HU-21006; *d*, HU-21005; *e*, HU-21001; *f*, M-474; *g*, HU-21019; *h*, Tarshiha, HU-21161, ×½. *i–l*, *Hoplitoides* cf. *H. mirabilis* Pervinquière, zone 6; *i–j*, Southern Negev, M-3622; *k*, Beer Menuha, HU-23329; *l*, Ramat Kevuda, Le-1556. *m–n*, *Coilopoceras* sp.; *m*, Yanuh, P-774, ×½; *n*, Jalame, (Oranim Seminary, 1252) ×½.

Reyment (1955, p. 72, fig. 32) and with the Iberian *P.* (*W.*) *llarenai* (Karrenberg) (1935, pl. 33, fig. 14).

Material. Fifteen specimens and fragments collected in the Southern Negev (Beer Menuha, Beer Ora, Nahal Raham) and in the Central Negev (Nahal Nizzana, Kevuda) from zone 6.

Genus COILOPOCERAS Hyatt 1903

Tyhe species. Coilopoceras colleti Hyatt 1903.

Coilopoceras sp.

Text-fig. 13*m–n*

Description. Large, involute, very thin oxycones. High, well-embracing whorls, the widest part of which occurs at one-third of the height. The sides taper towards the sharp venter. Umbilicus very small and not deep. The conchs reach a large size and become thinner with the growth. The living chamber occupies at least half a volution. No ornament is visible on our badly worn specimens. The suture-line comprises five saddles at a radius of 70 mm. and seven saddles at 200 mm. All saddles but the first one are arranged in a forward bent arch. The first saddle is quite large and is inclined towards the first lateral lobe. The very wide first lateral lobe is divided by a large accessory saddle into two sub-equal parts, the inner one is deeper than the outer one. There are two to three additional small accessory saddles.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*
P-775	120	68	34(0·28)	7(0·06)
HU-21011	490	200	63(0·13)	35(0·07)

Remarks. The suture-line, the thin whorl section, and the small umbilicus are typical of the family. The absence of a bicarinate stage places these specimens outside *Hoplitoides*. *Coilopoceras* of an equivalent size are known from Texas (e.g. *C. springeri* Hyatt, 1903, p. 96, pl. 12, figs. 1–3; *C. eaglefordense* Adkins; *C. chispaense* Adkins; and *C. austinense* Adkins, 1931, pp. 46–51, pl. 4–5), but the fine details of ornament and the suture-line which characterize these species could not be observed on our poorly preserved specimens. Parnes (personal communication) compares these specimens with *Coilopoceras zihoricum* Parnes (1964, p. 5, pl. 1, figs. 8–11; text-figs. 2*a*, *b*, *d*, *e–i*, 3) from the Coniacian of Israel.

Material. Five specimens collected in the Western Galilee (Majd el Kurum), on Mt. Carmel (Jalame), and in the Central Negev (Makhtesh Ramon) much higher than zone 6. One specimen is deposited in Oranim Seminary.

Family COLLIGNONICERATIDAE Wright and Wright, 1951
Subfamily PERONICERATINAE Hyatt 1900
Genus PRIONOCYCLOCERAS Spath 1925

Type species. Am. guayabanus Steinmann 1881.

EXPLANATION OF PLATE 10

Figs. 1–2. *Hoplitoides* cf. *H. mirabilis* Pervinquière, zone 6, Nahal Raham, HU-23662, $\times\frac{2}{3}$.
Fig. 3. *Prionocycloceras* (?) *dubertreti* (Basse), Yanuh, M-2809, $\times\frac{1}{3}$, stereo pair.

Prionocycloceras (?) *dubertreti* (Basse)

Plate 10, fig. 3; text-fig. 14*a–b*

1952 *Donjuaniceras* (?) *dubertreti* Basse, p. 199, pl. 5, fig. 1; text-fig. 2–3 (2).
?1952 *Donjuaniceras* (?) *madagascariensis* Basse, p. 201, pl. 5, fig. 2; text-fig. 2–3(1).

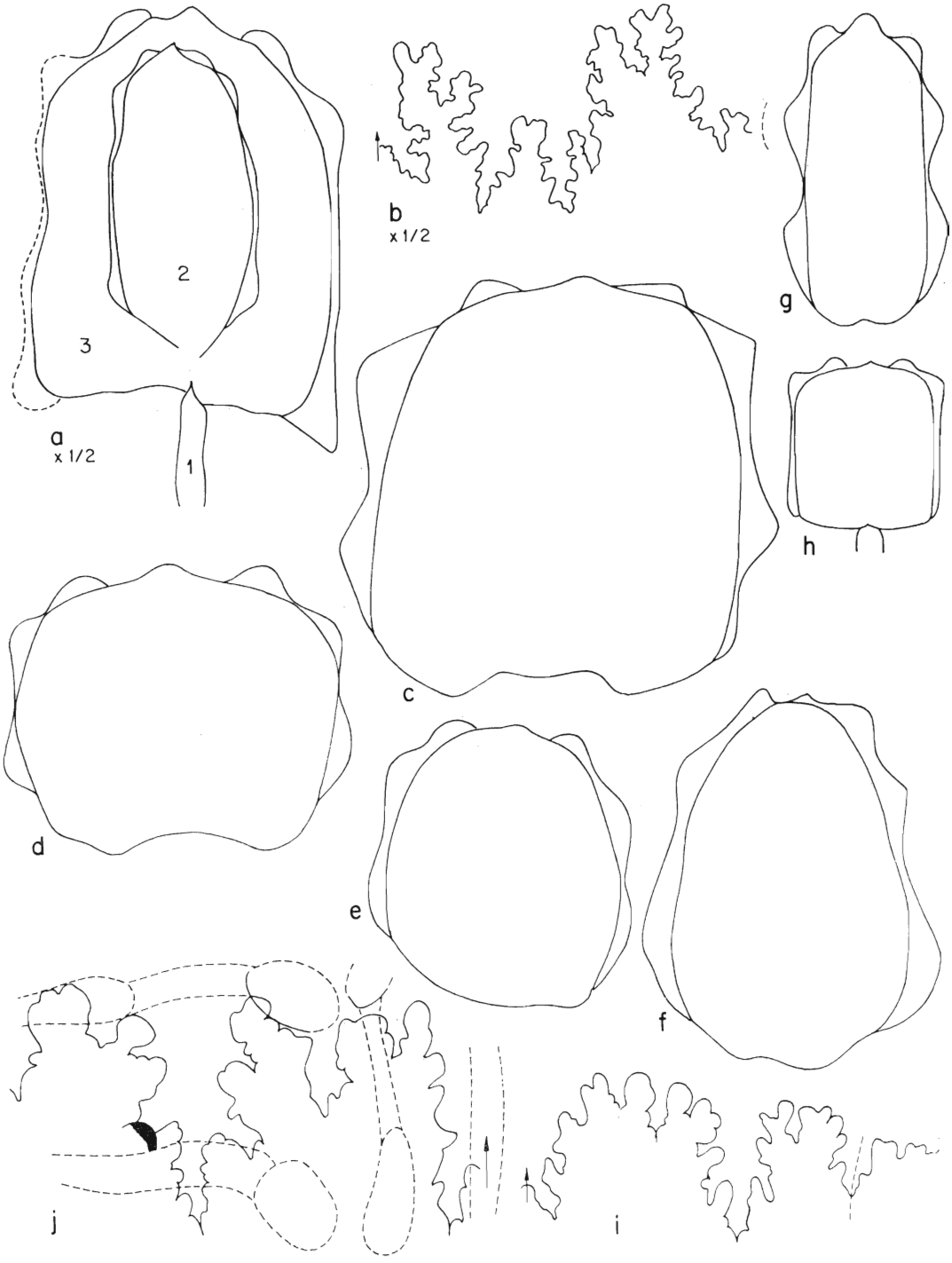
Description. Large, evolute conchs. As a result of the very high rate of growth (three times in height and seven times in thickness per whorl), the deep umbilicus remains comparatively small in spite of the evolute coiling. At early stages the whorl section is thin (T/H = 0·33) with a sharp venter. Later it becomes thick (T/H up to 0·8) and rectangular, with vertical umbilical walls and a round venter. A serrate keel exists at early stages and disappears with growth, leaving on the outer whorl only slight bulges preceding the ventro-lateral tubercles. The ornament is both complex and variable, composed of flexuous ribs, umbilical tubercles, and double ventro-lateral ones. The good preservation of several shells allows a detailed description of various types of ornament. One large specimen (M-2809) has seven strong, flexuous, main ribs per half a whorl. These extend from a long umbilical spine to an obliquely pinched ventro-lateral tubercle. The inner ventro-lateral tubercle which is not connected with the rib, is missing on the first two ribs of this whorl, and like all other tubercles enlarges with growth. Seven intercalatory ribs occur between the main ones. They are less pronounced, their umbilical tubercles are smaller, the outer ventro-lateral ones are weaker, longer, and bent obliquely backwards. There are no inner ventro-lateral tubercles on the intercalatories. In addition there are few smaller ribs on the outer part of the side, carrying the outer ventro-lateral tubercles only. Dense and fine growth-lines follow the ribs from the umbilicus to the outer ventro-lateral tubercles. There they bend sharply backwards on a feeble spiral crest. On the middle of the venter they form a rounded, forwardly directed arch. In the penultimate whorl of the same specimen the ribs are weaker and less flexuous. A second specimen (HU-21100), of about the same size as the former one, has the same growth-lines and umbilical tubercles but the ribs are much weaker and the inner ventro-lateral tubercles are absent. In a third small specimen (HU-21201), of about the same size as the inner whorl of the first specimen, the ribs are flexuous, the umbilical tubercles are weak, and a pair of ventro-lateral clavi is situated on a common bulge. This specimen has a serrate keel. A fourth specimen (M-427), of intermediate size, has in addition to the ribs and tubercles, three to four weak bulges on each rib. It retains the serrate keel on a rectangular whorl section.

The suture-line is well preserved. The two large saddles are asymmetrically bifid, the lower branch of both occurs near the first lateral lobe. The second saddle is larger and higher than the first one. The first lateral lobe is deeper than the ventral lobe and is rather wide. A large accessory saddle occurs in the middle of the first lateral lobe and a smaller one near the second saddle.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*T/H*
M-2809	340	147	96(0·29)	115(0·3)	0·6
HU-21100	—	115	85	—	0·8
HU-21201	—	30	10	—	0·33

Remarks. The holotype from Lebanon has only one ventro-lateral tubercle; the ribs are radial and the suture is frilled. The specimen from Malgasy has also only one ventro-lateral



TEXT-FIG. 14. *a–b*, *Prionocycloceras* (?) *dubertreti* (Basse), Yanuh, $\times\frac{1}{2}$; *a*, M-2809, whorl section 2 is halfway between whorl sections 1 and 3; *b*, HU-21100. *c–j*, *Protexanites salmuriensis* (Courtiller), zones 6–7; *c*, Elqosh, HU-21168; *d*, Yirka, HU-21213; *e–f*, Yirka, HU-21112; *e*, posterior part of living chamber; *f*, anterior part of living chamber; *g*, Yanuh, HU-21094; h, Majd el Kurum, M-3607; *i*, Yirka, HU-23979; *j*, Yanuh, M-2805.

tubercle, its ribs are flexuous, but very fine. However, taking the variability of the ornament and its rapid change during the growth into consideration, it seems justified to include the Lebanese, Malgasian, and Israeli specimens in one species. Wright (1951) regards the genus *Donjuaniceras* Basse (1950, p. 245) as a synonym of *Prionocycloceras* Spath. The species of these two Conianian genera from Columbia resemble our material, but they have single and not double ventro-lateral tubercles. Basse (1952, p. 203, footnote) disagrees with Wright, but does not explain her opinion. It might be noteworthy that the suture-line resembles that of *Pseudaspidoceras pseudonodosoides* (Choffat).

Material. Eight specimens and fragments collected in the Western Galilee (Yanuh, Hosen) and on Mt. Carmel (Jalame, Daliyat el Karmil).

Subfamily TEXANITINAE Collignon 1948
Genus PROTEXANITES Matsumoto 1955

Type species. Mortoniceras bourgeoisi de Grossouvre 1894.

Protexanites salmuriensis (Courtiller)

Plate 5, figs. 4–6; text-fig. 14*c–j*

1867 *Am. salmuriensis* Courtiller, p. 6, pl. 6, figs. 1–4.
1903 *Am. salmuriensis* Courtiller, Palaeontologia Universalis, fiche no. 6.
1903 *Mortoniceras* cf. *salmuriensis* (Courtiller); Pervinquière, pp. 96–7.
1907 *Mammites* (*Pseudaspidoceras*) *salmuriensis* (Court.) var. *zerhalmensis* and var. *byzacenica* Pervinquière, p. 314, pl. 19, figs. 1, A; text-fig. 120.
1907 *Mammites* (*Pseudaspidoceras*) *armatus* Pervinquière, p. 317, pl. 19, figs. 2–3; text-fig. 121.
1912 *Mortoniceras salmuriensis* (Courtiller); de Grossouvre, p. 14.
?1931 *Mammites* (*Pseudaspidoceras*) *armatus* Pervinquière; Basse, p. 37.
1937 *Mammites* (*Pseudaspidoceras*) cf. *salmuriensis* (Courtiller); Basse, p. 182.
1951 *Pseudaspidoceras* aff. *salmuriensis* (Courtiller); Wright and Wright, p. 27.
1959 *Pseudaspidoceras salmuriensis* (Courtiller); Freund, p. 45.
1961 *Pseudaspidoceras salmuriensis* (Court.) and *P. salmuriensis zerhalmensis* Perv.; Freund, pp. 80, 81; Table I.

Description. Evolute, whorls only touching. Whorl section rectangular-oval to squarish-round, becomes high and thin with growth. Sometimes it becomes trapezoidal. Umbilicus large. Umbilical shoulders round. Ribs simple, straight, and radial, extend from the umbilicus to the venter but do not cross it. At late stages they may become flexuous, and faint intercalatory ribs may occur. Six tubercles occur on each rib. The umbilical bullae are situated on the sides at one-third of the height, they are rarely round and strong. The inner ventro-lateral tubercles are usually obliquely pinched and sometimes even clavate. They are sometimes connected by feeble carina, which, together with the median keel form a tricarinate venter. The median keel is sometimes serrate, and it does not change from the septate part of the conch to the living chamber.

The first saddle is large, square, and divided into two equal parts by a deep accessory lobe. The second saddle is narrower and unequally divided. The third small saddle occurs on the umbilical border. The ventral lobe is very deep, sometimes deeper than the first lateral lobe. The first lateral lobe is narrow and deep, divided into three or four branches—a pseudo-trifid shape is common. The second lateral lobe is much less

deep, about the size of the accessory lobe of the first saddle, and it is frequently pointed. The third lateral lobe is wide, low, and flat.

Dimensions.

No.	*Diameter*	*Height*	*Thickness*	*Umbilicus*	*T/H*
HU-21090	114	39(0·34)	33(0·29)	46(0·41)	0·85
HU-21117	115	41(0·36)	32(0·28)	46(0·40)	0·79
HU-21182	143	59(0·41)	41(0·28)	49(0·34)	0·7
HU-21113	184	65(0·36)	62(0·34)	69(0·37)	0·9
HU-21094	192	67(0·38)	33(0·17)	80(0·41)	0·5
HU-21168	200	75(0·37)	75(0·37)	72(0·36)	1·0
M-2805	273	100(0·34)	57(0·21)	112(0·41)	0·57

Remarks. This variable species has only been described until now from France and Tunisia. It was recorded, but not described, from Syria and Malgasy. Pervinquière erected one new species and three new varieties in material comprising four complete specimens and a few fragments only. All the characteristic features of the new taxa were found also in our material but in different combinations. Since the application of Pervinquière's criteria would have lead to the erection of many new taxa among our material, it is preferred to unite all of them under the first species.

The holotype and paratypes from France have usually 25 and rarely 20 ribs per whorl. The Tunisian specimens have 20 ribs, most of ours carry 17–18 ribs during all stages, but one has only 15 ribs. *P. salmuriensis byzacenica* is distinguished by the disappearance of the ribs between the umbilical and the ventro-lateral tubercles at a late stage. This feature which is not uncommon in several of our specimens relates this species, according to Pervinquière, to *Pseudaspidoceras footeanum* (Stoliczka).

In *P. armatus* the inner ventro-lateral tubercles sometimes become large spines. This occurs also in two of our specimens, but without the relatively small umbilicus which is typical for this species. On the other hand, in one of these two specimens a new feature appears. The two inner ventro-lateral rows of tubercles approach each other on a part of the living chamber, where the median keel temporarily disappears. Again, there are other specimens with the small umbilicus typical of *P. armatus* but with different ornament and suture-line. Furthermore, all the specimens become higher with the growth, but while in the French material the height exceeds the thickness at a diameter of 150 mm., this occurs usually earlier (at 100 mm.) in our material, and several specimens become twice as high as thick. On the other hand, there are others which remain thick up to large diameters. The variations in the shape of the inner ventro-lateral tubercles, which are rarely round, sometimes obliquely pinched, and sometimes clavate and connected by a feeble carina, occur in our as well as the French and Tunisian materials. The variations in the suture-line have already been mentioned above.

This species has been placed by de Grossouvre (1912) within the genus *Mortoniceras*, whereas Pervinquière (1907) has included it in *Mammites* (*Pseudaspidoceras*). Basse (1937) refers again to this controversy. The definite median keel, which is sometimes accompanied by two lateral ones, prevents the connection of this species with either *Pseudaspidoceras* or *Mammites*. The species is very close to *Mortoniceras bourgeoisi* de Grossouvre (1894, p. 73, pl. 13, fig. 2; pl. 14, figs. 2–5) from the Coniacian of France, now considered as the type species of the genus *Protexanites* Matsumoto 1955 (p. 38). The ribs of *P. bourgeoisi* are prorsiradiate whereas those of *P. salmuriensis* are radial.

P. bourgeoisi has intercalatory ribs at early stages, but these stages were not examined in *P. salmuriensis*. The Santonian genus *Texanites* has radial ribs, but carries four rows of tubercles on each side.

Protexanites salmuriensis occurs from the Lower Turonian onwards, whereas all the other species of *Protexanites* make their first appearance in the Coniacian.

Material. About fifty specimens and fragments, mostly well preserved, were collected in the Western Galilee (Yirka, Yanuh, Elqosh, Kh. Mansura) from the middle part of the Yirka Fm. up to the Kishk Fm., and several from the Central Negev (Givót Kevuda, Nahal Nizzana). They are common in zone 6, but occur also above it.

BIOSTRATIGRAPHY

Ten ammonite zones from the Uppermost Cenomanian to the Upper Turonian are recognizable. Two of these belong to the Upper Cenomanian, seven to the Lower Turonian and one to the Upper Turonian. Only the seven Lower Turonian zones (indexed 1–7 for convenience in the following discussion) may be regarded as true zones (or more properly, as teilzones). The two Upper Cenomanian zones are only the highest epiboles of their genera, which also occur lower. Similarly, the Upper Turonian *Coilopoceras* zone is only the lowest occurrence of this genus extending up to the Coniacian (Parnes 1964). For this reason, and also because these three zones do not abound with ammonites, they were not studied thoroughly. The problem of whether zone 7 belongs to the Lower or to the Upper Turonian is still a matter of argument and is discussed below.

The distribution of the ammonites species in the seven Lower Turonian zones is given in Table 1. The range of most species is only one zone, ten species occur in two zones, three in three zones, and only one occurs in four zones. The ammonites assemblages change abruptly from one zone to the other, without any transitional forms. Although frequent alternations of shale, limestone, and marl do occur in the Lower Turonian sequence (text-fig. 2) they could not be correlated with these abrupt faunal changes. Furthermore, even the species which occur through a considerable stratigraphic sequence in one or more zones do not show any significant gradual change.

Table 1 also shows the distribution of the ammonites species in the various local stratigraphic sections and the correlations between the formations and the ammonite zones. Nowhere have all the zones been found in one sequence. The assemblages of several zones differ slightly from one location to the other. Some zones are widely distributed whereas others occur in a restricted area. Nevertheless, with a very few exceptions, the zones keep fairly well their sequential order and their place in the stratigraphic sections throughout Israel and apparently also in the whole Middle East. This order is retained in spite of the fact that the rocks in which the ammonites are embedded vary from shale to marl, chalk, rubbly bioclastic limestone, and dense lithographic limestone.

No recognizable Turonian fossil occurs in the zones of *Neolobites* sp. and *Calycoceras* sp., which are regarded everywhere (Southern Europe, North Africa, South and North America) to be of Upper Cenomanian age. Both zones occur in the Southern Negev and are followed there by Lower Turonian zone 1. In the Central Negev zone 5 or 6 overlie directly the *Neolobites* zone. The *Neolobites* zone is absent in the Northern Negev, and the *Calycoceras* zone is followed by zones 1, 2, 3, and 4. Apart from the occurrence

TABLE 1. Distribution chart of Lower Turonian ammonites in Israel.

of *Neolobites* sp. in the Deir Yasini limestone of Jerusalem, these two zones were not encountered in Northern Israel.

One specimen of *Nigericeras* sp. is the lowermost Turonian ammonite found. It has still an acanthoceratid suture-line but has lost all the ornament. It was found a few metres below the first *Kanabiceras*. The three species found in zone 1, *Kanabiceras* sp., *Paravascoceras* cf. *P. evolutum* Schneegans, and *Vascoceras depressum* Barber, are already typical Lower Turonian ammonites, although *Kanabiceras* has been reported to occur also in the Upper Cenomanian. *Kanabiceras* is known from England, United States, and Japan, the other three from West Africa: they do not determine any specific zone in these places. Zone 1 occurs in the Southern and North-eastern Negev.

Many species of *Paravascoceras*, *Paramammites*, *Gombeoceras*, and *Pseudaspidoceras* occur in zone 2 of *Paravascoceras cauvini* (Chudeau). Similar fossils occur in India, Lybia (Fezzan), Central Sahara (Damergou), Nigér, Nigeria, and Peru. Zone 2 is well developed in the Northern Negev, and with slightly different faunal assemblage, in the Southern Negev, e.g. *Pseudaspidoceras footeanum* (Stoliczka) occurs instead of *P. pseudonodosoides* (Choffat).

Vascoceras pioti (Peron and Fourtau), the index fossil of zone 3, was found only in the North-eastern Negev and at es Salt in Transjordan. At these localities its position between zone 2 and zone 4 is well established. Also *Neoptychites hottingeri* Collignon, which seems to be identical with *V. pioti*, occurs in Morocco in the Lower Turonian. The assignment of this fossil to the Cenomanian (Fourtau 1904) seems therefore doubtful. *Thomasites rollandi* (Thomas and Peron) makes its first appearance in this zone. It is noteworthy that one specimen of *Vascoceras harttiforme* Choffat and one specimen of *V. adonense* Choffat, the common place of which is in the middle of zone 5, were found in zone 3.

All the species of *Paravascoceras* disappear in zone 4 of *Choffaticeras securiforme* (Eck), where the species of *Choffaticeras* take over. This zone occurs everywhere in the Lower Turonian of Israel, except on Mt. Carmel and in the Central Negev. It occurs in several horizons between zone 2 and zone 5 in the Southern Negev. In the Northern Negev it is the highest zone encountered, and in the Galilee it is the lowest one.

Swarms of dwarf ammonites (3–30 mm. in diameter) occur in the vicinity of zones 3–4 at Beer Menuha, Nahal Neqarot, and Nahal Zin, which are near the Dead Sea rift. These ammonites, which are regarded as young stages of various *Choffaticeras*, *Vascoceras*, and *Neoptychites*, are never accompanied by larger ammonites, and are embedded in platy limestone alternating with red chalk. Few dwarf ammonites occur also in other places (Western Galilee, Northern Negev).

Zone 5 abounds with many specimens of *Choffaticeras* and *Thomasites*. The thick *Vascoceras* species occur usually in a separate bed in the middle of this zone. This is the highest occurrence of *Vascoceras* in the section. The fauna of zone 6 has many elements in common with that of zone 5, but several species of *Choffaticeras* and *Thomasites* and almost all the *Fagesia* and *Mammites* are restricted to this zone. *Neoptychites*, *Protexanites*, and *Hoplitoides* make their first appearance in this zone. These two zones occur everywhere in the Lower Turonian of Israel, but show slight local variations. The thick *Vascoceras* were not found in zone 5 in Northern Israel. Several species of *Fagesia* and *Mammites* occur in zone 6 of Northern Israel and the Central Negev, where

Hoplitoides is very rare. In the Northern Negev (Kevuda) and Southern Negev *Hoplitoides* is common and the other two are missing.

The *Neoptychites* and *Protexanites* continue in zone 7, which is determined by several species of *Romaniceras*. This zone occurs only in Northern Israel—on Mt. Carmel and in the Western Galilee. Zone 7 seems to be equivalent to zone *d* of Pervinquière (1903). According to the *Neoptychites*, our zone 7 and the Tunisian zone *d* should be assigned to the Lower Turonian but according to the *Romaniceras*, to the Upper Turonian.

Few specimens of *Coilopoceras* were found some 20–40 m. above the last Lower Turonian zone in Northern Israel and in the Central Negev. These ammonites belong definitely to the Upper Turonian.

BIOSTRATIGRAPHIC CORRELATIONS

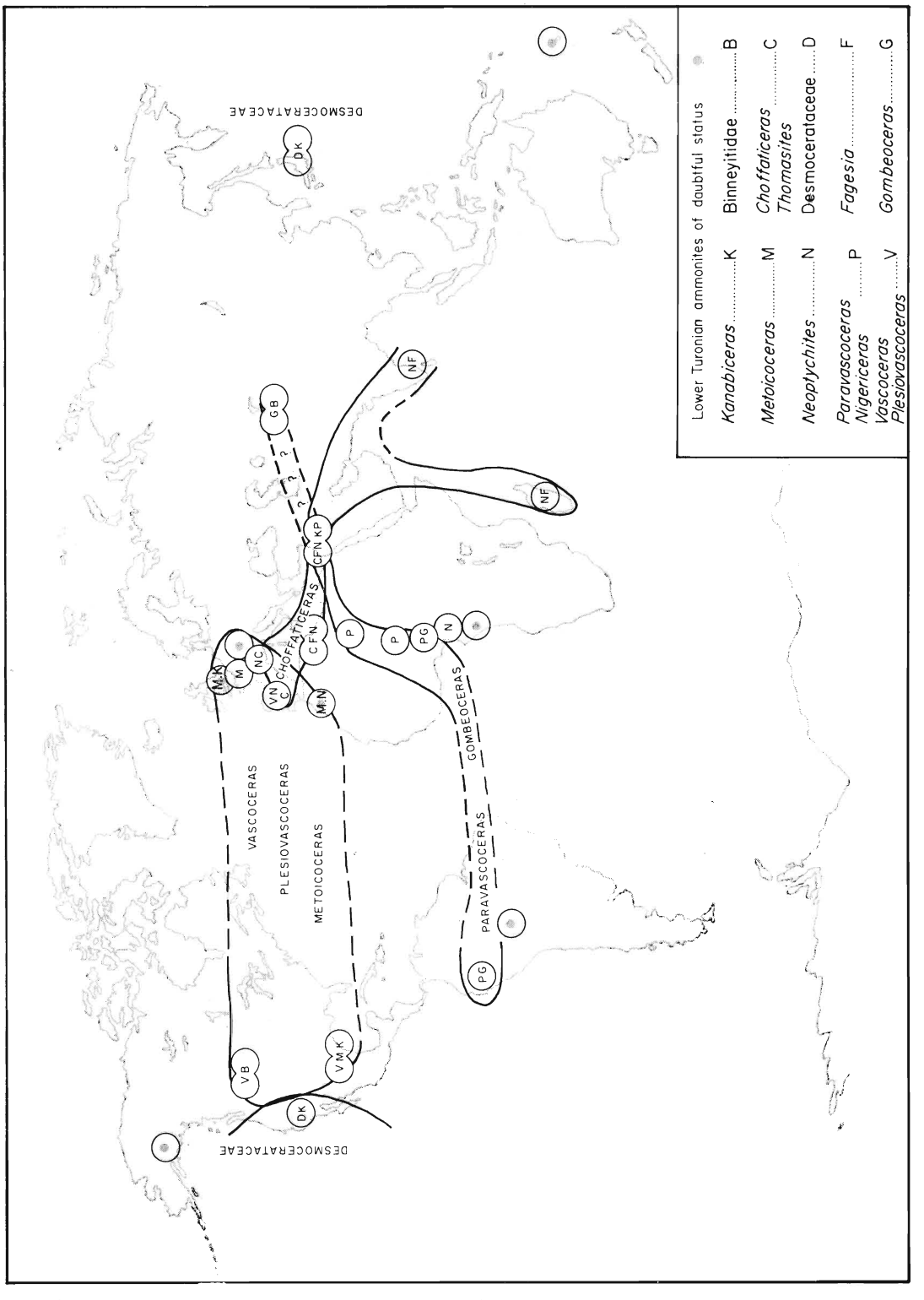
The world-wide distribution of the main groups of the Lower Turonian ammonites found in Israel is given in text-fig. 15.

Lower Turonian ammonites were not found in geosynclinal, but only on the shelf regions. A desmoceratid fauna prevailed around the Pacific whereas in the Tethys the Vascoceratidae and Tissotiidae branched from the acanthoceratid stock. In the Early Turonian a 'paravascoceratid' fauna—vascoceratids with a tendency to develop ribs at late stages—prevailed in the southern shelf seas of the Tethys: Middle East, Algeria, Nigér, Nigeria, and Peru. The 'vascoceratid' fauna—ammonites retaining their umbilical tubercles to a late stage—prevailed simultaneously in the northern shelf seas of the Tethys: France, Spain, Texas, and Mexico. Later there followed a *Choffaticeras* fauna which was restricted to the Mediterranean basin. Few elements of a much wider distribution, such as *Neoptychites* and *Fagesia* occurred with this fauna.

The tendency to develop prorsiradiate ribs on the venter at late stages provides a significant correlation line from Israel through Western Libya (Collignon 1957), Nigér (Chudeau 1909, 1921; Furon 1935; Schneegans 1943), and Nigeria (Woods 1911; Reyment 1954, 1956; Barber 1957) to Peru (Benavides-Càceres 1956), although there are only a few species in common in all these places. This ornament is typical for the genus *Paravascoceras* and occurs also in several *Nigericeras*, *Paramammites*, and *Gombeoceras*. These 'paravascoceratid' faunas have some other features in common, such as the narrow umbilicus of inflated conchs and certain details of the suture-line. In the Lower Turonian faunas elsewhere this ornament is uncommon, one exception being *Vascoceras durandi* (Thomas and Peron) from North Africa.

The fauna from the Tinghert Plateau near the Algerian–Libyan border (Collignon 1957) is closest to ours both geographically and palaeontologically. *Paravascoceras rumeaui* Collignon occurs in both places, one of Collignon's '*Discovascoceras*' seems to be identical with *Paravascoceras obessum* (Taubenhaus), and his *Mammites* cf. *pseudonodosoides* resembles closely our *Paramammites* sp. All these ammonites occur in our zone 2 of *Paravascoceras cauvini* (Chudeau).

The Lower Turonian section of Damergou in Nigér (Chudeau, Furon, loc. cit.) consists of 10 m. of gypsiferous green-white shale with limestone beds at the top, overlying red sandstones with lumachelles and *Neolobites*, and covered by laterites. Several species of *Exogyra* including *E. olisiponensis* are found with the Turonian ammonites. It seems reasonable to correlate the fauna from Nigér with our zone 2 by



TEXT-FIG. 15. World-wide distribution of Lower Turonian ammonites.

Paravascoceras and *Nigericeras* although the ornament of the Nigerian *Paravascoceras* is more dense and fine than that of ours, and *Nigericeras* is common in Nigér whereas it is rare in the Middle East. Furon (1935) suggests that the shallow Turonian seas surrounded the Ahaggar from both sides and extended northward to Tunisia and southward to Nigeria.

Although Damergou is not far from North-eastern Nigeria, the number of species in common is small, and the correlation depends again on general features of the fauna rather than on specific identity. The section at Pidinga consists of 80 m. of shale with thin beds of concretional limestone in which the ammonites occur. Reyment (1956) defines three Turonian zones, the lower one of which is divided by Barber (1957) into three zones. *Vascoceras depressum* Barber occurs both in Barber's first Turonian zone of *Vascoceras bulbosum* (Reyment) and in our zone 1 of *Kanabiceras* sp., but there are no other identical species. The ammonites of the Nigerian second zone of *Paravascoceras costatum* (Reyment) have several features in common with ammonites of our zone 2 of *Paravascoceras cauvini* (Chudeau), so that the correlation seems to be good in spite of the rarity of the identical species. *Gombeoceras gongilensis lautum* Barber, which resembles *Vascoceras pioti* (Peron and Fourtau), the index fossil of our zone 3, occurs in the Nigerian second zone and thus the distinction between our zones 2 and 3 cannot be maintained there. The third Nigerian zone of *Pseudotissotia* (*Bauchioceras*) *nigeriensis* (Woods) contains ammonites which are unknown in our region. Barber (1957) calls these three zones Salmurian, although they have little in common with the French type, which contains ammonites (*Neoptychites*, *Protexanites*) occurring in our section much higher.

The fourth Nigerian zone of *Kamerunoceras eschii* (Solger) occurs in the limestone section at the mouth of the Mungo River in Cameroon. Its fauna (von Koenen 1897; Solger 1904; Riedel 1932; Reyment 1955) comprises many genera in common with our zones 5–7, such as *Choffaticeras*, *Mammites*, *Neoptychites*, *Hoplitoides*, and *Romaniceras*. A closer examination shows that only the species of *Neoptychites* resemble our species. The species of all the other genera are different from ours, and therefore anything more than a very general correlation is not justified. The absence of rudists and echinids in the Cretaceous of Nigeria (Reyment 1956) is another significant difference from the Cretaceous of the Middle East. The lack of illustrations and the short description of *Fagesia* and *Choffaticeras pavillieri* Perv. from Gabon (Lombard 1930) makes any correlation uncertain.

The resemblance of the Turonian ammonites of Peru (Benavides-Càceres 1956) to those of West Africa is remarkable, especially regarding the rapid faunal changes in Africa. The green shale, marl, and thin limestone beds of the Quilquinan group are divided into the lower 50 m. of Romiron Fm., with Cenomanian fossils and the upper 90 m. of Conor Fm., with Turonian fossils. Several species of *Neolobites* together with *Exogyra olisiponensis* and other fossils provide a good correlation with the highest Cenomanian zones of Nigér, Tunisia, and the Middle East. The two species of *Broggiiceras* (a synonym of *Paravascoceras*) together with *Thomasites fischeri* Benavides-Càceres (apparently a synonym of *Gombeoceras gongilense*), which occur in the Tembaladera section, 50 m. above *E. olisiponensis* may be correlated with the Nigerian and with our second zones. *Coilopoceras jenkesi* (the index fossil of a zone including the whole Turonian section) and *Pseudaspidoceras reesidei* which occur 70 m. higher do not resemble any of our ammonites.

Mammites nodosoides afer and *Hoplitoides inca* (rather similar to several specimens of our *Hoplitoides*), which occur at the top of this zone can be vaguely correlated with our zone 6. The Conor Fm., is followed by *c.* 100 m. of the Cajamarca Fm., containing *Coilopoceras newelli* Benavides-Càceres which resembles the West African *Choffaticeras*.

Other Lower Turonian ammonites from South America support the suggestion of a connection with West Africa. Reyment (1955) and Barber (1957) regard Lisson's (1908) Peruvian *Vascoceras amieirensis* Choffat, as *V. costatum* Reyment.

According to Reyment and Barber (loc. cit.) the fauna from Turkestan (*Gombeoceras kaulabicum* (Kler)) resembles that of Nigeria. In that case the 'paravascoceratid-belt' extends from Turkestan through the Middle East, North, Central, and West Africa to Peru (see text-fig. 15).

A second line of correlation leads through the circum-Mediterranean countries: Tunisia, Algeria, Spain, Portugal, and France. Pervinquière (1903) divides the Turonian of Central Tunisia into six horizons, marked *a* to *f*. *Neolobites* and *E. olisiponensis* occur below horizon *a* and define the end of the Cenomanian, just as they do in Peru, Nigér, and Israel. Only one unidentified ammonite specimen has been found in the 20 m. marl of which horizon *a* consists at Bou el Hanèche. There is no equivalent fauna to that of our lower zones. Horizons *b* and *c* consist of 30–50 m. of blue marly shale (*b*) which changes gradually upwards into concretional limestone (*c*). The ammonites are very abundant in horizon *c* but occur also in horizon *b*. The ammonite fauna of these horizons is nearly identical with that of our zones 5 and 6. There are only minor differences between the various corresponding *Thomasites*, *Choffaticeras*, *Fagesia*, *Neoptychites*, *Protexanites*, *Hoplitoides*, *Mammites* and thick *Vascoceras*. Horizons *d–f* consist of hard limestone with *Hippurites*. Rare *Neoptychites* (Gebel Bireno) and *Romaniceras* (Kef Si Abd el Kader) occur in horizon *d*, which may thus be compared with our zone 7. Pervinquière compared his horizons *a–c* with the French Salmurian and *d–f* with the Angoumian.

The ammonite-bearing facies is absent over wide areas in Tunisia and Algeria. (e.g. Solignac 1929) and it occurs only in isolated restricted areas west of Central Tunisia. The fauna of the Tebessa region in Central Algeria (Peron 1896) is not as close to our fauna as the Tunisian. The Lower Turonian shale and marl at Aurès (Laffitte 1939) are 800 m. thick but contain only a few ammonites. The western localities along this belt are Gebel Amour (Peron 1883) and Ksours Mts. (Laffitte 1939) near the town of Laghouat. The Turonian ammonites from Morocco (Rolland 1924; Collignon 1966) seem to belong to another province which is discussed below.

The rich faunas of the Iberian Peninsula (Choffat 1897–8; Karrenberg 1935; Wiedmann 1959) contain in the higher Turonian horizons various species of *Choffaticeras*. Wiedmann distinguished seven ammonite zones in the 70-m. section of shale and marl of the Lower Turonian. The first *Choffaticeras* appears in his zone IV with ammonites which are unknown in the Middle East. *C. luciae* which is related to the index of our zone 6 occurs in his zone V together with *Vascoceras durandi* which occurs in our zone 5. The Iberian zones VI–VII contain many ammonites of our zone 6, such as *Fagesia*, *Hoplitoides*, *Neoptychites*, *Protexanites salmuriensis*, and *Mammites nodosoides* but all the species of *Choffaticeras* of our zone 6 and of the Tunisian *c* are already absent. Another difference is the rarity of *Thomasites*, which is one of the most common ammonites both in Tunisia and in the Middle East. The ammonite-bearing facies occurs only in restricted areas, similar to the situation in North Africa and in the Middle East.

The Spanish zones VI–VII may be correlated also with the French Salmurian (in the original sense of Grossouvre (1901)), which contains *Protexanites salmuriensis* and *Neoptychites cephalotus*, but does not contain any *Choffaticeras* or *Vascoceras*. The application of the term Salmurian to the whole Lower Turonian (e.g. Pervinquière 1907; Barber 1957) renders this name a vague meaning. The name Salmurian should be restricted to the upper zones of the Lower Turonian only. The correlation of Wright's (1957) zone of *Mammites nodosoides* with our zone 6 and with the Iberian zones VI–VII is doubtful, because this index fossil occurs in Morocco (Collignon 1966) and Texas (Powell 1965) in a lower position, together with fossils occurring in the lower Spanish zones.

Sandstone and limestone beds of the Upper Utatur in India (Stoliczka 1865; Kossmat 1895–7) and similar beds in Madagascar (Basse 1931) contain *Neoptychites* and *Fagesia* which are related to those of our zone 6 and of the Tunisian *c. Pseudaspidoceras footeanum* (Stoliczka) which occurs together with them in India, is found in our zone 2.

Wiedmann's three lower zones of the Iberian Lower Turonian contain ammonites which are unknown in our region, but they are related to the faunas of Western Europe, Southern United States, Morocco, and West Africa. Several species of *Metoicoceras* are abundant in both Wiedmann's Cenomanian zone VI and Turonian zone I. As well *Metoicoceras* is the index fossil of Wright's (1957) first Turonian zone in Western Europe, Collignon's (1966) first Turonian horizon in Morocco, and it is common in Texas and Mexico (Hyatt 1903) in Powell's (1965) first Turonian zone of *Kanabiceras septemseriatum* (Cragin). The latter species is in turn closely allied to the index of our zone 1, but in the Middle East *Metoicoceras* is very rare and occurs higher, in our zone 4.

Various *Vascoceras*, *Plesiovascoceras*, and *Fallotites* abound in Wiedmann's zones II–III. This 'vascoceratid' fauna, which retains the umbilical tubercles to a late stage, is common in Texas–New Mexico (e.g. Böse 1918; Adkins 1931; Jones 1938; Kummel and Decker 1954; Powell 1964, 1965) and Montana (Reeside 1923), and occurs also in West Africa and in the Ligerian of Southern France (Faraud 1934, 1940), but is rare in our region. Wiedmann's zones II–III may be correlated with Powell's second Turonian zone of *Pseudaspidoceras flexuosum* Powell and perhaps also with his third zone of *Spathites chispaensis* Kummel and Decker. Several forms such as *Gombeoceras gongilense* (Woods), *Vascoceras triangulare* Faraud (which is rather close to *Paravascoceras obessum* (Taubenhaus)) and several species of *Pseudaspidoceras* relate our zone 2 and Barber's second zone to Wiedmann's zones II–III and to Powell's second zone. It seems, therefore, that the 'paravascoceratid fauna' of the southern side of the Tethys is contemporaneous with the 'vascoceratid fauna' on its northern side.

The Ligerian of Gard contains in a 20-m. section of sandy limestone several *Fagesia*, *Choffaticeras*, *Mammites*, *Neoptychites*, *Vascoceras*, and *Coilopoceras* (Faraud 1934, 1940, 1951). The stratigraphically undifferentiated fauna seems to represent a condensed section including most of Wiedmann's zones, from II–VII.

Several species of *Romaniceras* are widespread in the higher zones of the Turonian: e.g. the Angoumian of France (Grossouvre 1901), Wiedmann's zone VIII in Spain, Pervinquière's horizon *d* in Tunisia, Reyment's zone of *Romaniceras uchauxiense* Collignon in West Africa, Powell's zone of *Romaniceras cumminsi* Adkins, our zone 7 of *Romaniceras* (?) *inermis* (Grossouvre) and this genus extends also to California and Japan (Matsumoto 1959*a*, *b*). A correlation between the *Romaniceras*-bearing beds is

not certain because our zone 7 and Pervinquière's *d* contain *Neoptychites* which does not occur in the French Angoumian, and, on the other hand, the Angoumian of the Uchaux Basin (Roman and Mazeran 1913) contains certain *Choffaticeras* which resemble *C. securiforme*, the index fossil of our zone 4, together with *Romaniceras* and *Coilopoceras*.

Coilopoceras is another widespread Upper Turonian ammonite (France, Middle East, Texas, West Africa, Morocco, Peru), but it occurs also lower in the Turonian (Benavides-Càceres 1956) and extends far higher into the Coniacian (e.g. Parnes 1964). *Collignoniceras* which is also an important genus of the Upper Turonian is not represented in Israel.

There is little in common between our Turonian fauna and those of the Pacific coast of North America (e.g. Anderson 1931, 1958; Matsumoto 1959*a*; Cobban 1961) and of Japan, where the desmoceratid, rather than the acanthoceratid stock seems to be dominant. Still, the occurrence of *Kanabiceras* in the lowest horizons and of *Romaniceras* in the higher ones both in Japan and California is a remarkable correlation with our Turonian section.

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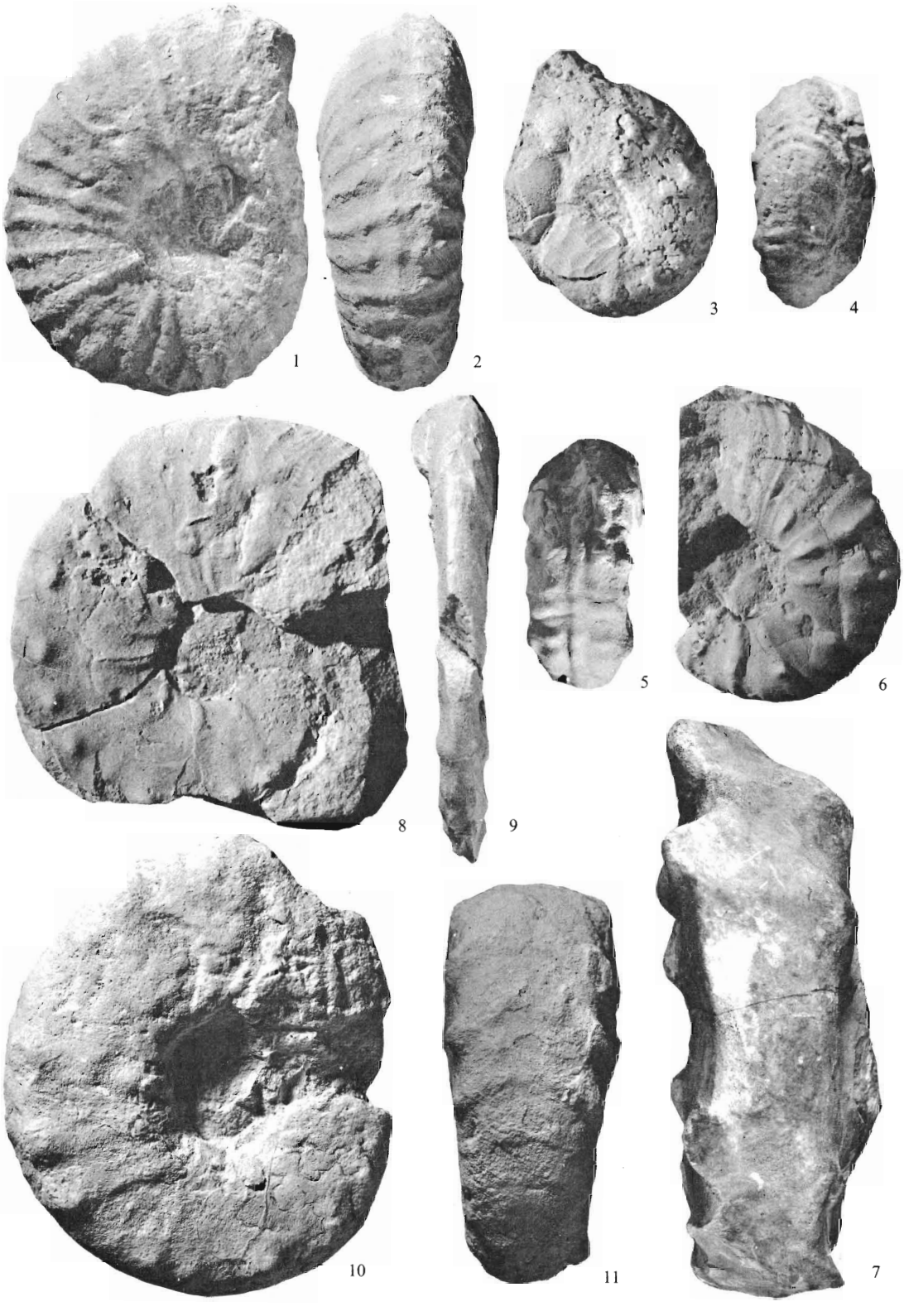

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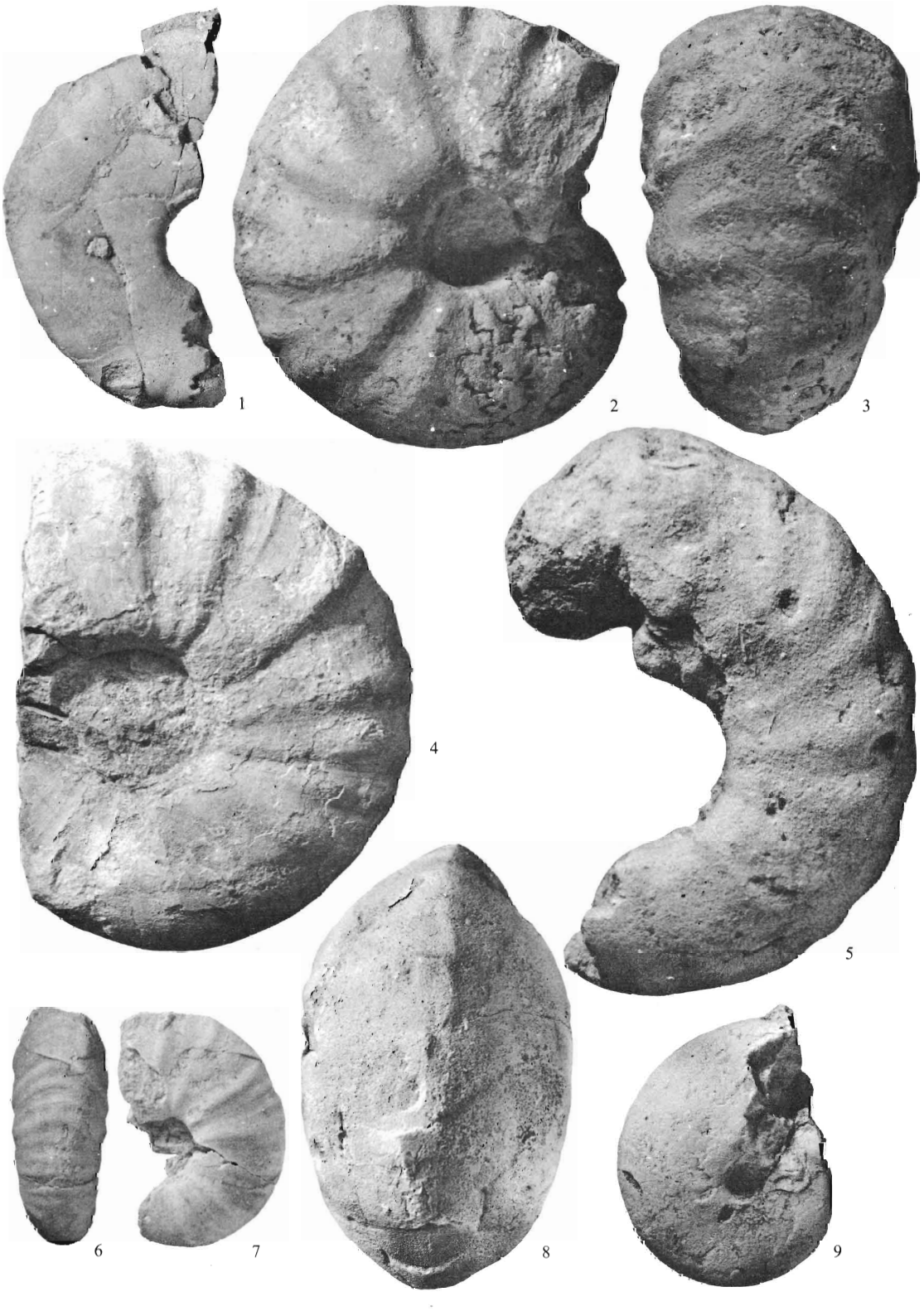

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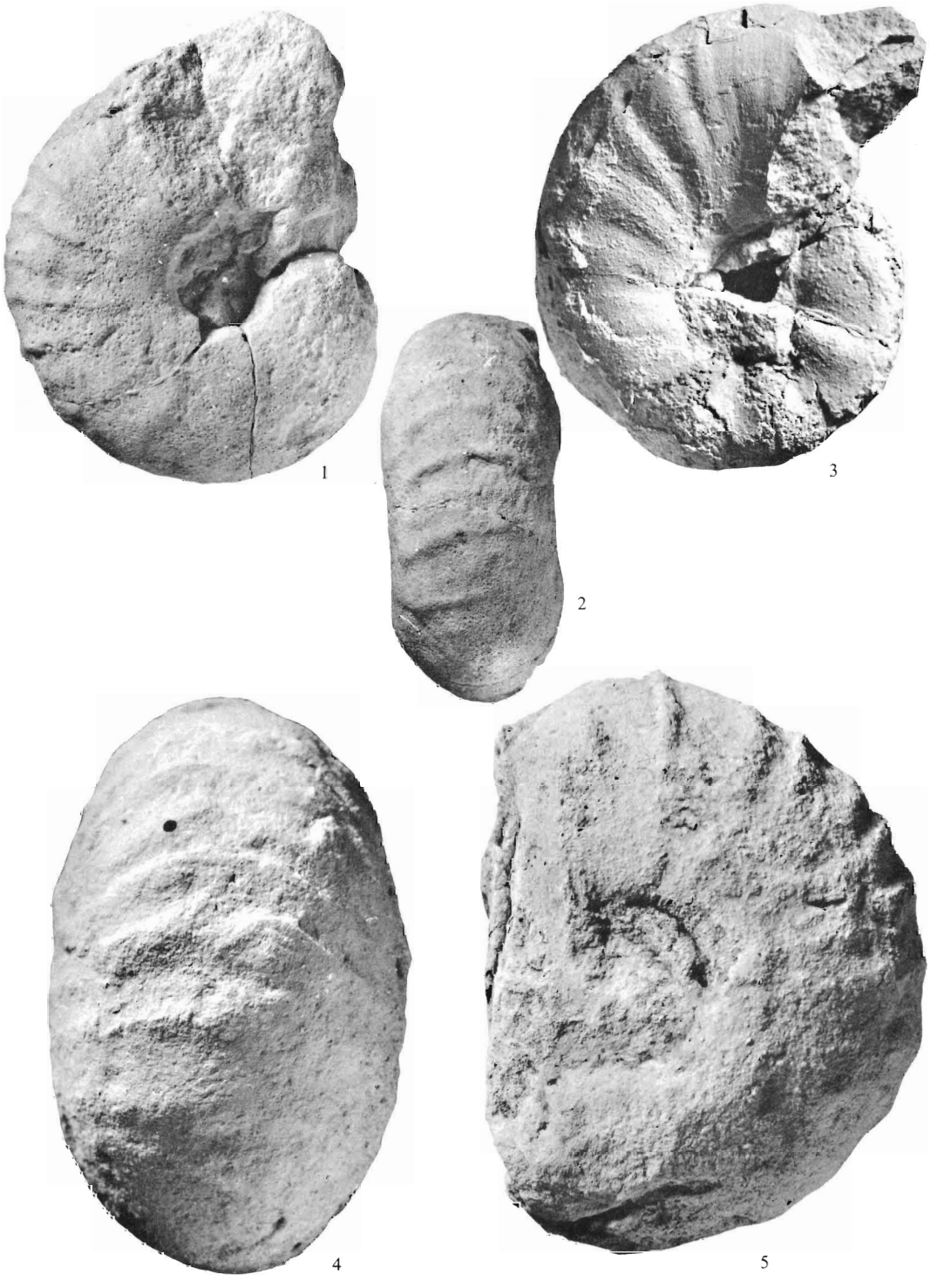

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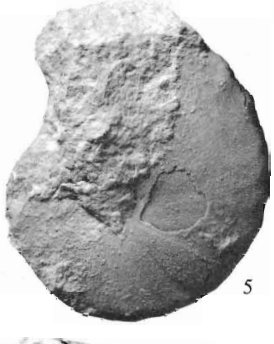
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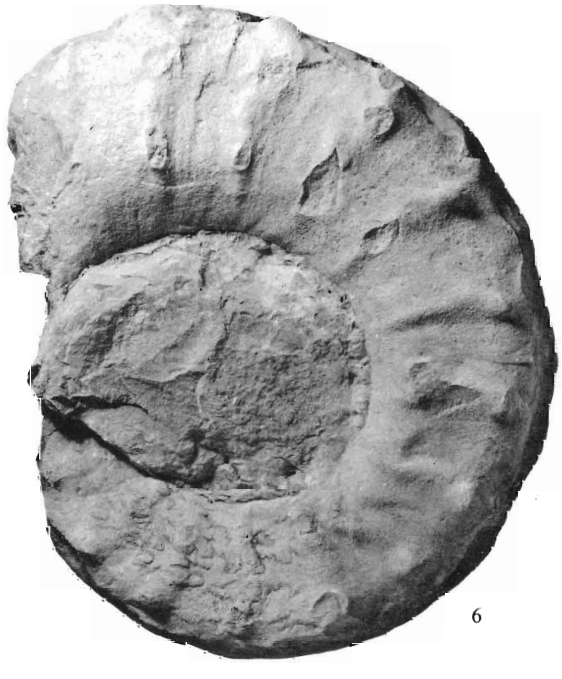
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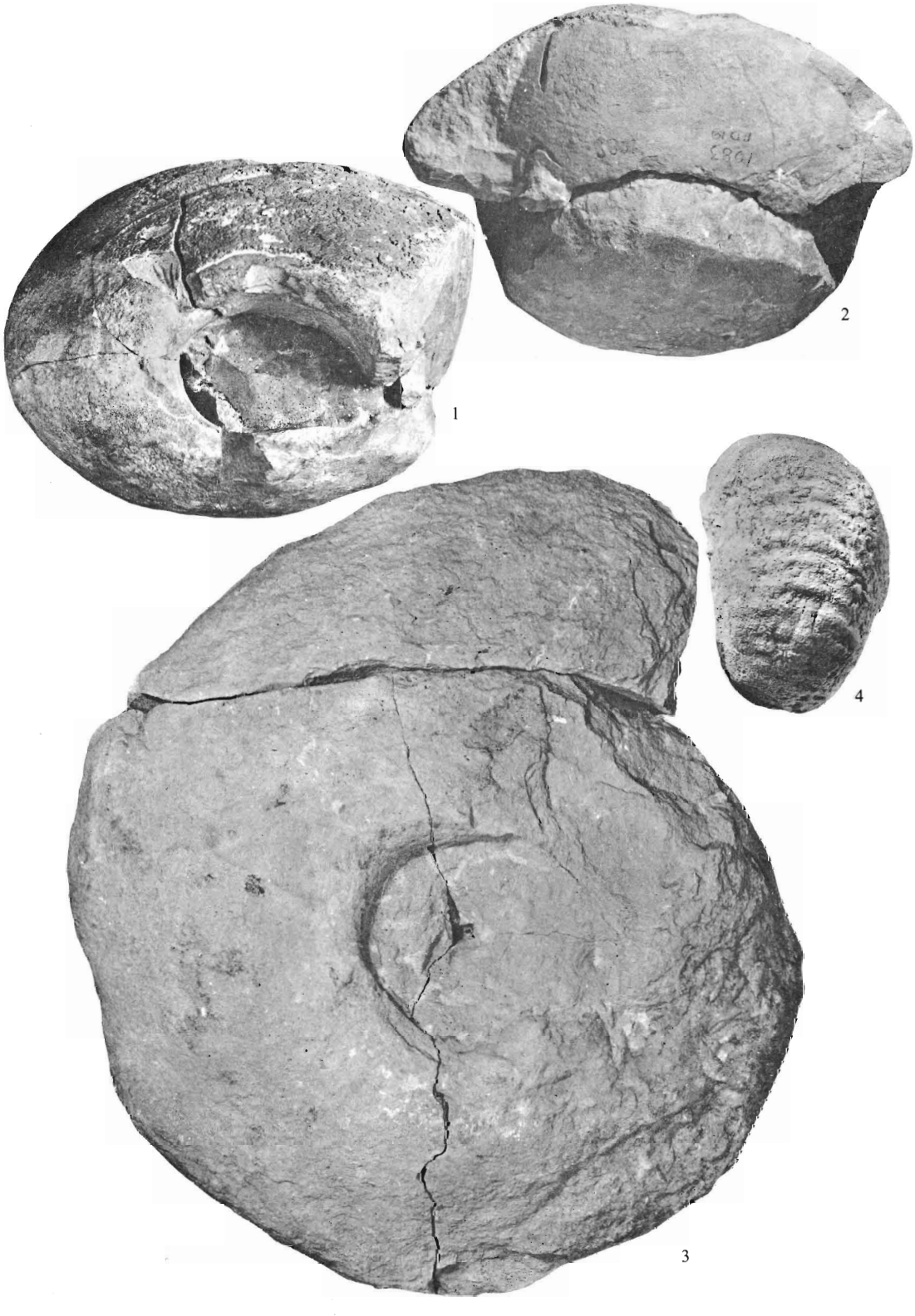

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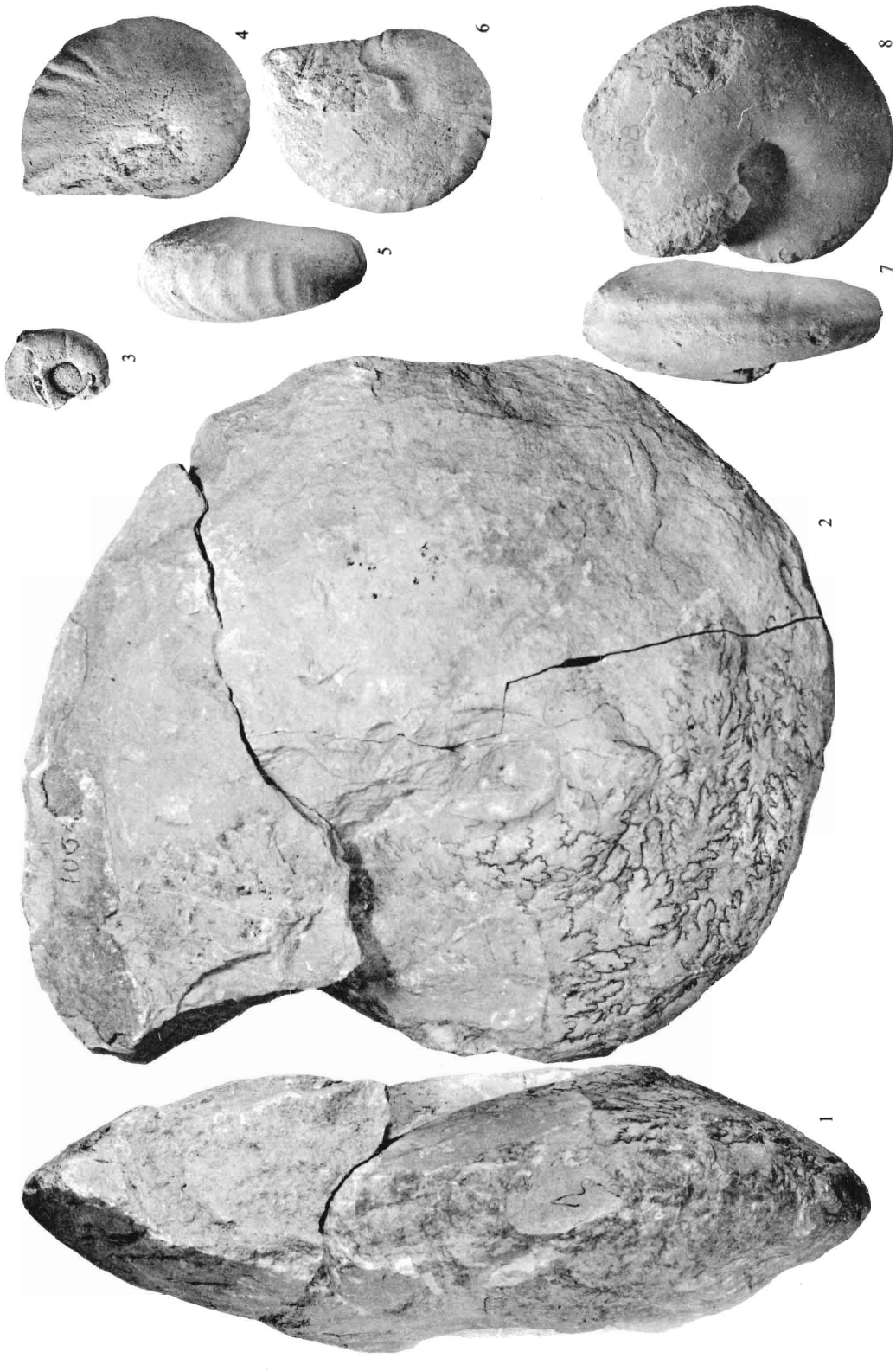

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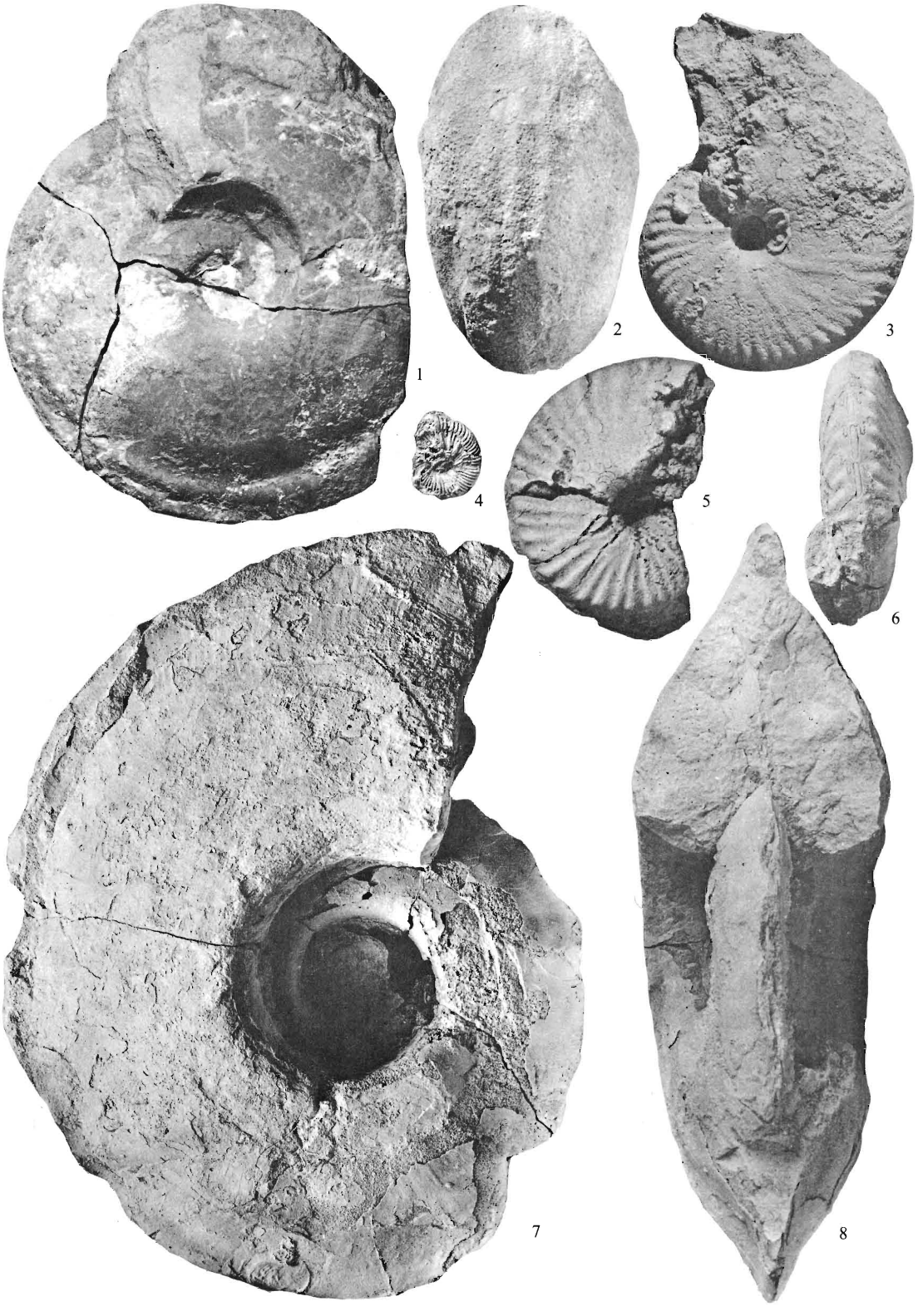

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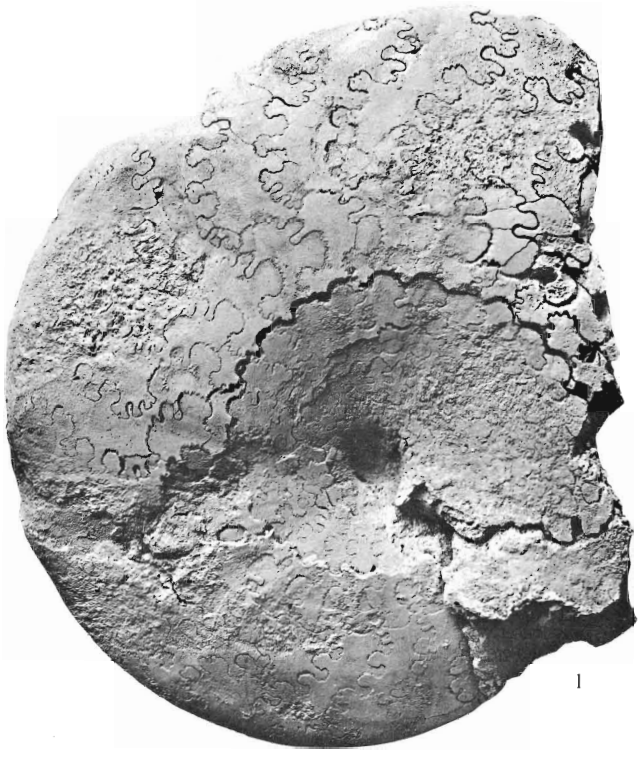

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