



## LATE CAMPANIAN PSEUDOCERATITES FROM ISRAEL AND JORDAN

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### ABSTRACT

Late Campanian strata in Central and Southern Israel contain rich ammonite assemblages among which occur the pseudoceratite genera: *Libycoceras* and *Coahuilites*.

The tests of *Libycoceras* show infra-specific variations which seem to be caused by the different living conditions in their partly isolated habitats. Variations in the sutures of *Libycoceras* occur too, affecting mainly the bifid first lateral saddle ( $S_1$ ). One or both branches of  $S_1$  may be notched on both or one side of the test only.

The probable Maastrichtian age of single *Sphenodiscus* found in Jordan is discussed.

The material from Israel is described, illustrated and compared to specimens from Jordan.

### INTRODUCTION

The Mishash Formation (Shaw, 1947; emended Bentor and Vroman, 1960) consists mainly of chert and porcellanite layers alternating with some chalk and phosphorite (or silicified phosphorite) ones. The chert complex is overlain by a layer of phosphorite ranging in thickness from a few centimeters to over ten meters. This unit comprises the economic phosphorites, well known from the Negev, (Israel; Bentor, 1953), Ruscifa mines near Amman in Jordan, several localities in Egypt (e.g. Kosseir, Safaga, Qift and Qene; Figure 1) and Northern Africa. These phosphorites in Israel and in the region of the Nile Valley, Egypt (Sibaiya Phosphates; El-Naggar, 1966) were dated by foraminifera as of Late Campanian age, the biostratigraphic equivalent of the *Bostrychoceras polyplacum* Zone (Reiss, 1962; El-Naggar, 1966). The phosphorites in Israel are overlain by the marly chalk of the Ghareb Formation (P. D. P. geologists, in: Shaw, 1947; emended Bentor and Vroman, 1960) attributed by foraminifera to the Maastrichtian whereas its very lower part may be of Latest Campanian age (Reiss, 1962). The Sibaiya Phosphate in Eastern Egypt is overlain by the Sharawna Shale (El-Naggar, 1966), the lithostratigraphic equivalent of the Dakhla Formation (=Dakhla Shales; Said, 1961).

Several ammonites were found in the Sharawna Formation in Eastern Egypt (El-Naggar, 1966). At the base occurs *Libycoceras* cf. *L. ismaele* (Zittel) and at the top

*L. berisense* (Awad and Naim) (although Awad *et al.*, 1964, are not quite sure of the stratigraphic sequence of the *Libycoceras* species they describe). In the phosphates of the Duwi Formation (Youssef, 1957) biostratigraphic equivalent of the Sharawna Formation; Issawi, 1972) in the Qene region, Egypt, occur *Bostrychoceras polyplacum*, *Libycoceras phosphaticus*, *Coahuilites* sp. and *Baculites* sp. (Issawi, 1972). *L. phosphaticus* occurs also in Central Sinai (SW of Gebel E-Tih) and in the phosphates of Safaga and Kosseir area (Figure 1)(Awad *et al.*, 1964).

The genus *Libycoceras* was assigned to the Maastrichtian on the basis of Zittel's (1883) stratigraphic descriptions. Although his section from Gasser in the Dakhel (Dakhla) Oasis, the Western Desert of Egypt (Zittel, 1883, p. 63-65) does not contain *Libycoceras*, it is the best and most detailed stratigraphic description. 22 m above the *Exogyra overwegi* beds (which are associated with *L. ismaele* east of Dakhel Oasis: "Ammonitenberge", in Zittel, 1883, p. 74) there occurs *Scaphites kambysis* (Zittel). 76 m above this bed occurs *Aturia danica*. This Tertiary nautilid is overlain by 83 m of clay, followed by 54 m of lithified chalk containing *Pycnodonte vesicularis*, *Spondylus dutempleanus* and Porifera of Late Cretaceous age. [This chalk is included within the Owaina Shale (El-Naggar, 1966) and assigned to the Paleocene; El-Naggar, 1966.] *Aturia schweinfurthi* was recorded from the *E. overwegi* beds at the foot of Mount Omm E-Renneien (Quaas, 1902, p. 301). There is no doubt that this inaccurate sampling of bio-

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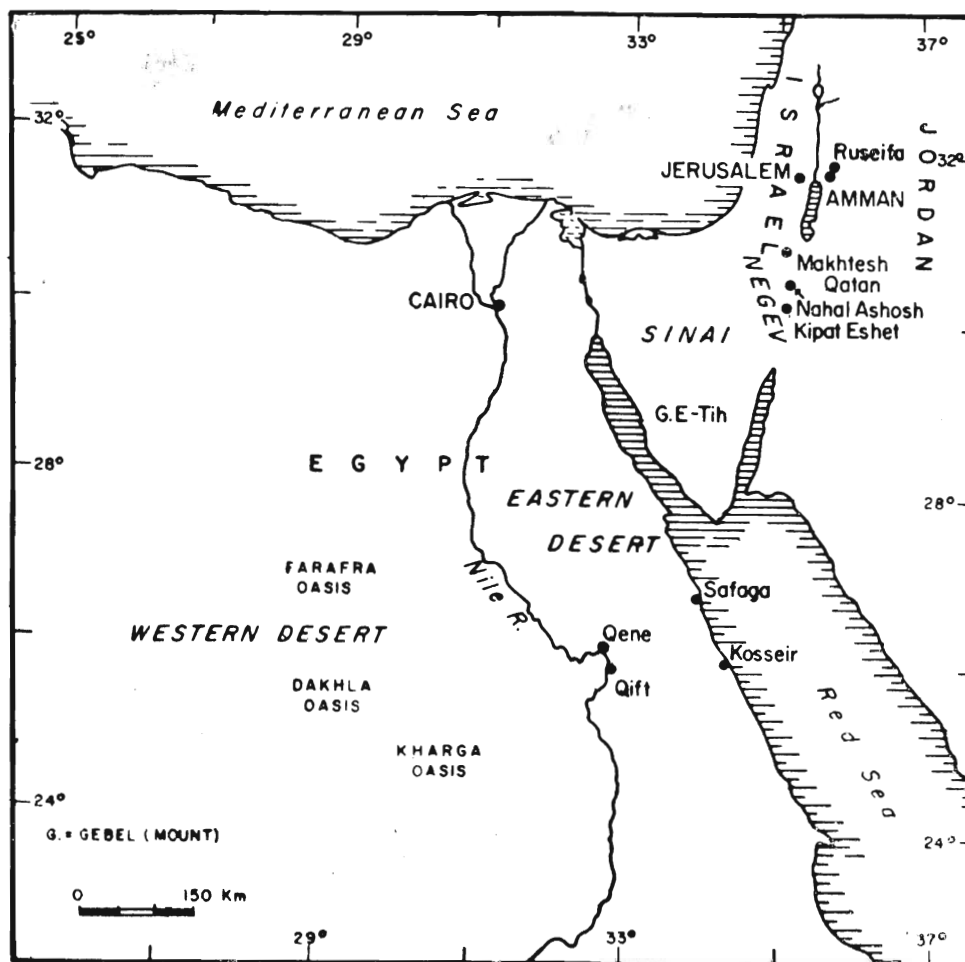


Fig. 1 Location Map

stratigraphically significant faunas has caused the great confusion concerning the age of the *E. overwegi* beds and thus of *Libycoceras*. This problem seems yet unclear although El-Naggar (1966) dated the *overwegi* beds as Lower Maastrichtian on the basis of foraminiferids. This may give some *Libycoceras* species a wide living range. Further precise biostratigraphic study is required.

#### SYSTEMATIC DESCRIPTION

- Family Sphenodiscidae Hyatt, 1900  
Genus *Libycoceras* Hyatt, 1900

This is one of several Late Cretaceous pseudoceratite genera in which the first lateral saddle is divided into two branches by an adventitious lobe. Thereby they differ from *Sphenodiscus* in which  $S_1$  is trifid.

*Libycoceras* usually has entire saddles, but the bifid first lateral saddle may be irregularly indented. This may occur in one or both branches, on one or both sides of the conch (Fig. 3 I, J, K). *Manambolites* shows similar variations in the indentation of the first lateral bifid saddle (Howarth, 1965, p. 395) as well as *Coahuilites* and

perhaps *Indoceras*. *Sphenodiscus acutodorsatus* Noetling (Noetling, 1897, pl. 21, Fig. 3) is no real *Sphenodiscus*. It has a bifid first lateral saddle in which the external branch is notched. Thus this specimen may be regarded as an *Indoceras* or a *Libycoceras* species.

*Sphenodiscus? spathi* Picard, 1929, is a *Libycoceras* sp. in which both branches of  $S_1$  are indented (as in *L. chargense*, Fig. 3 I). *Sphenodiscus* sp. n. aff. *S. stantoni* Hyatt from Transjordan (Picard, 1929; kindly shown to me by Dr. M. K. Howarth, the British Museum, Natural History, London) is a real *Sphenodiscus*. In its living chamber occurs a *Libycoceras ismaeli* (Picard, 1929, P. 452) identical to the Late Campanian ones from Israel. In case *Sphenodiscus* is exclusively of Maastrichtian age a revision of the macro- and microfaunal assemblage of the *Bostrychoceras polyplacum* Zone is required due to this association (*Libycoceras-Sphenodiscus*).

All known Late Cretaceous pseudoceratites have a narrow, discoidal conch in their early ontogenetic stage, with a lanceolate whorl section. Different species of *Libycoceras* may be distinguished at this stage by their ornament only. The whorl section of most species

changes with growth affecting mainly the venter. While *L. chargense* remains lanceolate throughout ontogeny, *L. ismaele* forms a ventro-lateral shoulder and a high, fastigate venter.

In *L. afikpoense* the whorl section becomes rectangular and platycone with a broad venter. The fastigate venter of the young stage lowers with growth towards an almost flat venter (in between the ventro-lateral tubercles) on the gerontic body-chamber.

Regarding all the *Libycoceras* forms which exhibit the characteristic ontogenetic development of *L. afikpoense* as a single species, we have to assume that they were strongly affected by local environmental conditions. The tests of each population of this form have a similar pattern of morphological development which varies between the assemblages of the different sites. The specimens from Ruseifa (Jordan) attain a flat venter (maturity?) at diameters (D) of 50-60 mm; the ones from Nahal Ashosh (Eastern Negev, Israel) at D=70-90 mm, and those from Kipat Eshet (Eastern Negev) at D > 110 mm.

The breadth of the conch and the position of the medio-lateral tubercle in tests of a similar diameter varies between different assemblages (different sites) but is quite constant in the same population (same site). The ratios between the distances of the medio-lateral tubercle to the umbilical seam (MU) and to the ventro-lateral shoulder (MV) of different *Libycoceras* species are presented in Figure 2. There occurs quite a clear separation between the following assemblages:

- L. ismaele* from the Northern Negev, Israel.
- L. afikpoense*, Northern Negev and Nigeria (Reyment, 1955), and *L. ismaele* (Quaas, 1902).
- L. afikpoense* from Ruseifa (Jordan).

Most *L. afikpoense* assemblages (including the Nigerian material) show almost the same relative position of the medio-lateral tubercle, similar to that of *L. ismaele* from the Western Desert, Egypt (Quaas, 1902). *L. afikpoense* from Ruseifa (Jordan) differs from the other *L. afikpoense* in its rapid morphological development and the relative position of the medio-lateral tubercle. The question rises whether the libycoceratids from Ruseifa should be separated from *afikpoense* as a new (endemic?) species, or whether it is a local variation of *afikpoense*. Similar intra-specific morphological variations occur in the sutures, whorl section and intensity of ornament in other species of *Libycoceras* such as *ismaele* (e.g. Figure 3 A, B, C).

The libycoceratids from Israel and Jordan lived in the Late Campanian times, in partly isolated marine basins of abnormal bottom conditions (Reiss, 1962) and perhaps also abnormal surface water. Thus different local living conditions may be assumed to prevail in each of these basins which apparently affected the biota; therefore, the precise correlation of these basins is hitherto unknown.

For the time being all the forms which show the same pattern of morphological development are regarded as a single species, some of which show a broad range of variations.

The below described material is deposited in the collections of the Department of Geology, The Hebrew University of Jerusalem (marked HU) and the Geological Survey of Israel (marked M). Thereby I thank M. Raab, head of the Paleontology Division in the Geological Survey of Israel, for the material he has lent me.

*Libycoceras chargense* Blanckenhorn, 1900  
(Fig. 3 H, I)

- 1900 *Libycoceras chargense* Blanckenhorn, p. 45.  
1928 *Libycoceras chargense* Blackenhorn, Douvillé, p. 33, pl. 7.

*Description*: Discoidal, involute, quite large conchs, attaining diameters of more than 25 cm. The whorl section is lanceolate with its maximum thickness at the dorsal third of its height. The flanks converge gradually, forming a sharp keel without any ventro-lateral shoulders.

Young specimens have low, weak ribs or rather low bullae on the ventral third of the flanks, which weaken toward the umbilicus. They are slightly curved parallel to the growth-lines. These ribs may occur on some large specimens in the form of very low and broad lateral undulations. Their spacing changes with growth from 30° in small specimens (D=35 mm) to 15° in larger ones (D=210 mm).

The saddles of the pseudoceratitic suture tend to become smaller from the venter to the umbilicus (Fig. 3H).

*Discussion*: This species differs from all other ones by its lanceolate whorl section without ventro-lateral shoulders throughout ontogeny. Only the young stages of most libycoceratids and even other sphenodiscid genera such as *Coahuilites*, *Indoceras* and *Manambolites* have a similar lanceolate whorl section. Most of these forms may be distinguished from young *L. chargense* by their sharp medio-lateral tubercles or the ventro-lateral carina-like shoulder and the different pattern of the sutures.

*Occurrence*: *L. chargense* occurs in Southern Israel (throughout the whole Negev) at the top of the Mishash Formation in the uppermost flint layers and the phosphorite beds above. Late Campanian.

*Libycoceras ismaele* (Zittel), (1883) 1885  
(Plate I—9-12, Fig. 3A—C, F, G, J, K)

- 1883 *Ammonites ismaelis* Zittel, p. 74  
1881-5 *Sphenodiscus ismaelis* Zittel, p. 451, fig. 631  
1900 *Libycoceras ismaeli* Zittel, Hyatt (in Zittel), p. 585  
1902 *Libycoceras ismaeli* Zittel, Quaas, p. 302, pl. 29, figs. 3-7; pl. 30  
1915 *Sphenodiscus ismaelis* Zittel, Eck, p. 185, pl. 10  
1915 *Libycoceras ismaeli* Zittel, Greco, p. 227, pl. 22, fig. 4, Text-fig. 4.

- 1931 *Libycoceras ismaeli* Zittel, Pérébaskine, p. 130, pl. 11, figs. 3a, b  
 1931 *Libycoceras ismaeli soudanense* Pérébaskine, p. 130, pl. 11, figs. 1a, b  
 1959 *Libycoceras* sp. ex gr. *ismaeli* Zittel, Sornay, p. 221, pl. 7, figs. 1a, b; ?2

*Remarks* : This species was described and figured by Quaas (1902). It is characterized by its sharp and high keel throughout ontogeny, thus differing from *L. afikpoense* which has a quite similar ornament and suture.

The young stage of *ismaele* has prorsiradiate umbilico-lateral ribs which split into low ventro-lateral ones almost in the middle of the flanks (Plate I—11). With growth ( $D > 55$ -65 mm) the umbilico-lateral ribs weaken and disappear, but at their former splitting point a medio-lateral spinose tubercle develops (Plate 1—10). Specimens of *L. ismaele* exhibit variations in the breadth of the whorl section and the shape of the ventro-lateral shoulders (Fig. 3A—C).

The ratio of the distances of the medio-lateral tubercle from the ventro-lateral shoulder (MV) to that from the umbilical seam (MU) is given in Figure 2.

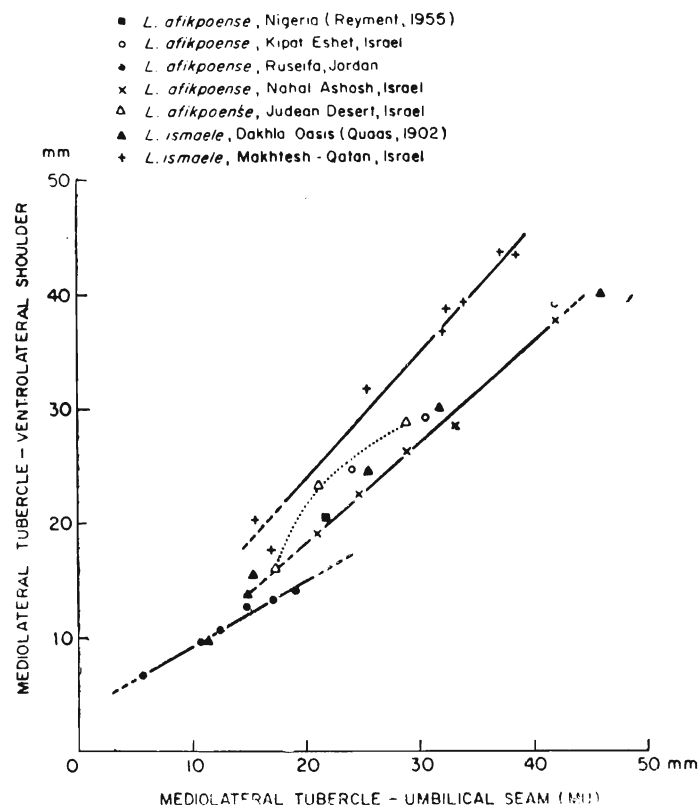


Fig. 2. The ratio of the distances between the medio-lateral tubercle to the umbilical seam MU to its distance from the ventro-lateral shoulder MV.

The two branches of the first lateral saddle are smaller than the second lateral one (as in *afikpoense*). This is in contrast to the pattern in *L. charginense* which may be mistaken with corroded or weakly ornamented *ismaele*.

*L. ismaele* was recorded from Jordan by Sornay (1959) and Bender (1974; determined by F. Schmid, Hannover) and Sudan (Pérébaskine, 1930). The Sudanese material is poorly preserved and may therefore lack the medio-lateral tubercles by which it is claimed to differ from the typical *ismaele*. Awad and Naim (and Abdou, 1964) described two new *Libycoceras* species from Egypt and Sinai: *L. berisense* and *L. phosphaticus*, which generally resemble *L. ismaele*. *L. berisense* is claimed to lose its ornament at a diameter of 7 cm. The adventitious lobe of the first lateral saddle is bifid. A similar bifid adventitious lobe in  $S_1$  occurs in *L. ismaele* (Quaas, 1902, pl. 29, Fig. 6). *L. phosphaticus* differs from *ismaele* mainly by the position of the medio-lateral tubercles, which tend to be closer to the umbilicus. It seems that *L. berisense* and *phosphaticus* do not differ considerably from *ismaele* (it should be pointed out that the description of the Egyptian material by Awad and Naim, 1964, is insufficient and the precise stratigraphic position of these two species is unknown to them. Therefore, they were not included in the present synonymy of *L. ismaele*).

*Material and occurrence* : *Libycoceras ismaele* occurs mainly at the base of the economic phosphorites in the Eastern Central Negev (SE Makhtesh Qatan), HU 29960, 29962, 29957 (2), 29978 (12). A few specimens were collected from the layer of *Baculites palestinensis* Picard (SE Makhtesh Qatan), HU 35009 (2) and 29961 (4). Late Campanian.

#### *Libycoceras afikpoense* Reyment, 1955

(Plate 1—1-6; Figs. 3 D, E)

1955 *Libycoceras afikpoense* Reyment, p. 89, pl. 21, fig. 2a, b; pl. 22, fig. 6a, b; text-figs. 45a-d. ?pl. 21, fig. 1.

1959 *Libycoceras* sp. ex gr. *ismaeli* Zittel, Sornay, p. 221, pl. 7, figs. 1a, b; non 2a, b.

*Remarks* : This species is characterized by its rectangular whorl section at the adult stage due to the broadening and flattening of the venter. The young stage is discoidal, with a lanceolate whorl section similar to that of all other *Libycoceras* species. Therefore, only mature specimens can be undoubtedly defined as *afikpoense*. There may occur variations in the diameter in which the venter of the conch becomes rounded or flattened (maturity?). The specimens from Ruseifa (Jordan) (Plate 1—3, 4) lose their keel at a diameter of 55 mm whereas those from Kipat Eshet (Eastern Central Negev) attain a flat venter at a diameter of 12 cm.

The specimens described by Picard (1929) as *L. ismaeli* (the Judean Desert, Israel; associated with *Baculites palestinensis* Picard) are relatively young stages with one side of the conch corroded. Their venter seems to lower and broaden with growth and thus may represent a narrowly conched variation of *L. afikpoense*. Similar narrow and weakly ornamented specimens (unfortunately

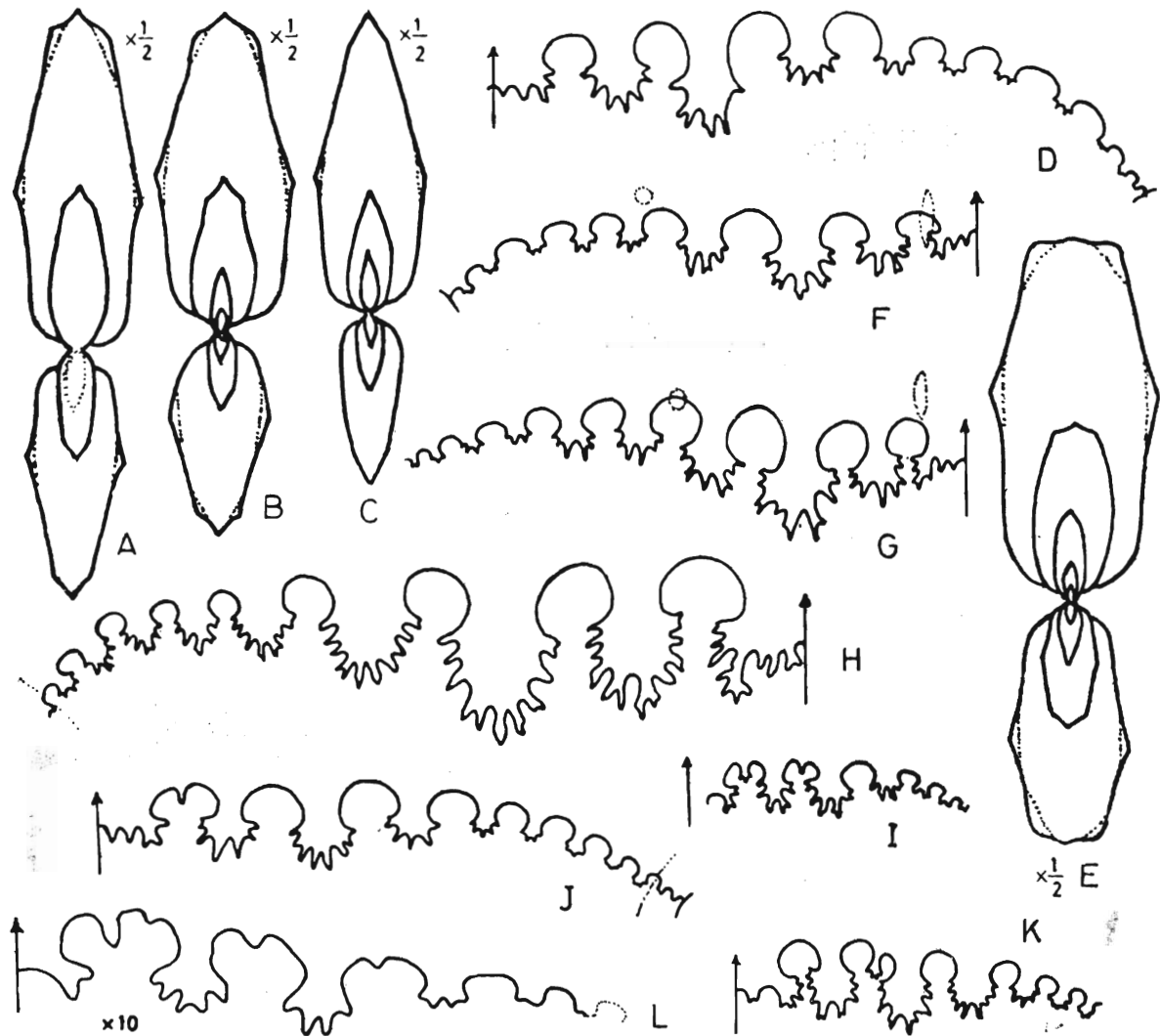


Fig. 3. A-C, F, G, J, *Libycoceras ismaele* (Zittel), Northern Negev, Israel; A-C) cross-sections,  $\times \frac{1}{2}$ , A, B) HU-29962, C) HU-29978. F, G) HU-29978, note the increase in dimensions of the saddles from the venter to the second lateral saddle. J) HU-29960, notched external branch of left side bifid  $S_1$ . D, E) *Libycoceras afikpoense* Reymont, M-5749, Mahal Ashosh, Israel. E)  $\times \frac{1}{2}$ . H, I, K), *Libycoceras chargense* Blanckenhorn; H) HU-29958, SE Makhtesh Qatan; note the reduction in the dimensions of the saddles from the venter to the umbilicus. I) M-2776, both branches of the bifid first lateral saddle are notched, Central Negev, Israel. K) HU-30934, internal branch of  $S_1$  notched, Northern Negev, Israel.

poorly preserved) which resemble *afikpoense* were found in the Negev (SE Makhtesh Qatan). Better preserved specimens from this layer are required to decide whether the specimens of Picard (1929) and those from the Negev belong to *afikpoense* or are an independent species.

The ratio of the distances of the medio-lateral tubercle from the ventro-lateral shoulder (MV) to that from the umbilical seam (MU) is similar in the Israeli and Nigerian material but differs from that from Ruseifa (Jordan) (Figure 2). The specimens from Jordan differ from other *afikpoense* by losing their keel at small diameters (approx. 5.5 mm) (see the discussion on *Libycoceras*). In

spite of those differences the specimens from Jordan are included within *L. afikpoense* as a local variation until their stratigraphic position is clarified.

*Material and occurrences*: *L. afikpoense* was found associated with *Baculites palestinensis* in the upper part of the Mishash Formation SE of Makhtesh Qatan, HU 29965 (3), 35009; and the Judean Desert HU 14441 (coll Picard). This species is most common at the lower part of the phosphorite layer at Nahal Ashosh M5406, 5749 (2), Kipat Eshet HU 35008 (8) all from the Eastern Central Negev, Israel, and HU17917 (6) from Ruseifa, Jordan. Late Campanian.

Genus *Coahuilites* Böse, 1927  
*Coahuilites* sp.

(Plate 1—7-8 ; Fig. 3L)

*Description* : Involute, discoidal conch at the young stage (D=20 mm), whorl section lanceolate with a weak ventro-lateral carina-like shoulder and a sharp keel. The flanks are ornamented with low sigmoidal ribs parallel to the growth lines.

With growth these ribs develop medio-lateral bullae and ventro-lateral crescent tubercles pointing forward (Plate 1—8). The umbilico-lateral part of the flanks becomes quite smooth whereas low, broad ribs connect the medio-lateral bullae with the ventro-lateral tubercles (Plate 1—8). The whorl section becomes subangular with growth forming a broad venter which is fastigate at a diameter of 30 mm (Plate 1—7) and rounded to almost tabulate at diameters over 45 mm.

The sutures of the small specimen (D=20 mm) are well preserved (Fig. 3L) whereas only relicts of the last septum of the larger specimen are present. All saddles are broad and the lobes are bifid. Both parts of the bifid first lateral saddle are weakly indented. The second lateral one has a small notch too.

*Remarks* : The examined specimens have the morphology of *Coahuilites* throughout ontogeny as described by Böse (1927). The sutures of all adult *Coahuilites* species from Texas (Böse, 1927) have phylliform elements with narrow necks and many indentations (like *Sphenodiscus*).

In the material from Israel only the suture of the young stage is well preserved (Fig. 3L). Therefore it is difficult to compare the Israeli material to any of the Texan ones, although *Coahuilites cavinsi* Böse may be at the most similar one.

Issawi (1972) recorded *Coahuilites* from Qene in the Eastern Desert of Egypt together with *Bostrychoceras polyplacum*, *Libyoceras phosphaticus* and *Baculites* sp.

*Material and occurrence* : Two small phragmocones and a living chamber, HU 35317 (3) were found in the upper part of the Mishash Formation (*B. paestinensis* bed) in the Judean Desert, East of Jerusalem. Late Campanian.

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## EXPLANATION OF PLATE

## PLATE 1

(All figures 2/3 the natural size)

- 1-6 *Libycoceras afikpoense* Reymont ; 1-2) M-5749 from Nahal Ashosh ; 3-4) HU-17917, the economic phosphorite layer at Ruseifa, Jordan ;  
5 M-5406, Mahal Ashosh (Israel) from the phosphorite layer ; 6) HU-35008, Kipat Eshet (Israel) base phosphorite layer.  
7-8 *Coahuilites* sp. Judean Desert (east of Jerusalem), upper part of the Mishash Fm. (*B. palestinensis* bed).  
9-12 *Libycoceras ismaele* (Zittel), SE flanks of Makhtesh Qatan, base economic phosphorite layer. 9,12) HU-29962 ; 10,11) HU-29978.

