

Lower Jurassic (Liassic) Invertebrates from Makhtesh Ramon (Negev, Southern Israel)

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Abstract

Described from the middle part of the Ardon Formation, in Makhtesh Ramon (southern Israel), are two fossils, *Nerinella janeti* Cossmann, known from the Hettangian of Deux-Sèvres (France), and *Pteroperna reticularis* sp. nov. *Gibbirhynchia gibbosa* Buckman is described from the overlying Inmar Formation. This suggests an Upper Liassic age. Accompanying specimens of *Nuculana*, *Coelopsis* and *Cardinia* are not sufficiently preserved for specific determination.

Introduction

The Triassic core in Makhtesh Ramon (Negev, southern Israel) is overlain unconformably by the flint clay of the Mishhor Formation, which in Makhtesh Ramon has a thickness of 20 m (Goldberg, 1970; Goldberg and Friedman, 1974). Above it, is the Ardon Formation which in Makhtesh Ramon attains a thickness of 45 m (Goldberg and Nevo, 1961).

An outstanding bed of brown dolomitic limestone (60 cm thick), in the middle part of the Ardon Formation, is built from shells of *Nerinella janeti* Cossmann (Nevo, 1955; Zak, 1957) and also contains fragments of *Pteroperna reticularis* nov. sp. *Nerinella janeti* from Deux-Sèvres (France) was regarded by Cossmann (1898) as being of Charmouthian age. Cossmann (1903) later altered this determination and placed the species, being derived from a lower series of Deux-Sèvres, in the Hettangian (Lower Liassic) age. Accordingly, *Nerinella janeti* of Makhtesh Ramon points to a Lower Liassic age for the Ardon Formation.

The overlying deltaic Inmar Formation, which in Makhtesh Ramon attains a thickness of 325 m, consists of sandstones with shale in its lower part and with numerous interbeds and lenses of clay in its upper part. An interbed of silty sandstone in sandy clay at the middle of the formation bears a marine fauna containing *Gibbirhynchia gibbosa* Buckman var., which suggests an Upper Liassic age for this part of the Inmar Formation. The uppermost part of this formation contains a flora, mainly Filicales and Bennettitales (Lorch, 1967), which may be compared with the Lower Estuarine of Yorkshire.

The following Middle and Upper Bajocian Mahmal Formation in Makhtesh Ramon attains a thickness of

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70 m. It is truncated above by the Arod Conglomerate, at the base of the Lower Cretaceous.

Paleontological Description

A. Fossils of the Ardon Formation

Family NERINEIDAE Zittel, 1873

Genus *Nerinella* Sharpe, 1850

Nerinella janeti Cossmann, 1898

Plate 1, Figures 1–17

1898 *Nerinella janeti* Cossmann, p. 40, pl. VII, fig. 21

1903 *N. janeti* Cossmann, p. 499

Material: Numerous specimens imbedded in brown dolomitic limestone, locally grey and black due to burning by a magmatic sill; Nahal Ardon, Makhtesh Ramon. M–523 and M–7716, coll. Bentor and Vroman; M–5490, coll. A. Nevo.

Description: A rubber cast of an impression in dark dolomitic limestone (Plate 1, 2) shows the dimorphism in the development of the shell. The first minute volutions are globular (see also Plate 1, 6 & 7, the lower specimen); the following adolescent volutions are inflated adapically and restricted anteriorly. Later, they become rhomboidal, excavated below the middle of the height of the shell. In the impression (Plate 1, 1) and in its rubber cast (Plate 1, 2) as well as in other specimens (Plate 1, 9 & 10), two fine bands are recognizable on both sides of the suture. One corresponds to the periphery of the base and the other, below it, corresponds to the posterior sinus. In the internal moulds, the anterior band is sometimes recognizable (Plate 1, 9–12), but the posterior band may become prominent (Plate 1, 13–15), suggesting a distinct variety.

The growth lines (recognizable on Plate 1, 2, 4, 5,

9, 15 & 17), slightly sigmoidal, convex posteriorly in the area of the posterior inflation of the volution, become almost straight in the middle part of the face down to the excavation, and then turn slightly anteriorly towards the base; the periphery of the base is angular; faint spiral threads are rarely preserved (Plate 1, 6 & 7, the upper specimen).

The aperture (Plate 1, 4, 5, 11, 12 & 16) is restricted by the excavation of the labrum, with the corresponding internal plica, and by the columellar plica. The lamellar columellar plica and the small parietal plica are recognizable in the natural section in brown limestone (Plate 1, 8).

Cossmann's specimens of *Nerinella janeti* are derived from the Hettangian (Lower Liassic) beds of Deux-Sèvres (Cossmann, 1903, p. 499). The stratigraphical position of the *Nerinella janeti* bed (60 cm thick) in Makhtesh Ramon, 42 m above the top of the Triassic (Upper Carnian) and more than 300 m below the Middle Jurassic (Bajocian) of the Mahmal Formation, suggests an age similar to that of the French *Nerinella janeti*. This conclusion is supported by the occurrence of *Gibbirhynchia gibbosa* Buckman var. in the overlying Inmar Formation (Fig. 1). A Lower Liassic age may thus be concluded for the *Nerinella* bed of the Ardon Formation in Nahal Ardon.

Family PTERIIDAE Gray, 1847

Genus *Pteroperna* Morris and Lycett, 1853

Pteroperna reticularis sp. nov.

Plate 1, Figures 18–23

Holotype: M–5490c, Plate 1, Figures 21–22.

Name: From reticulate ornamentation.

PLATE 1

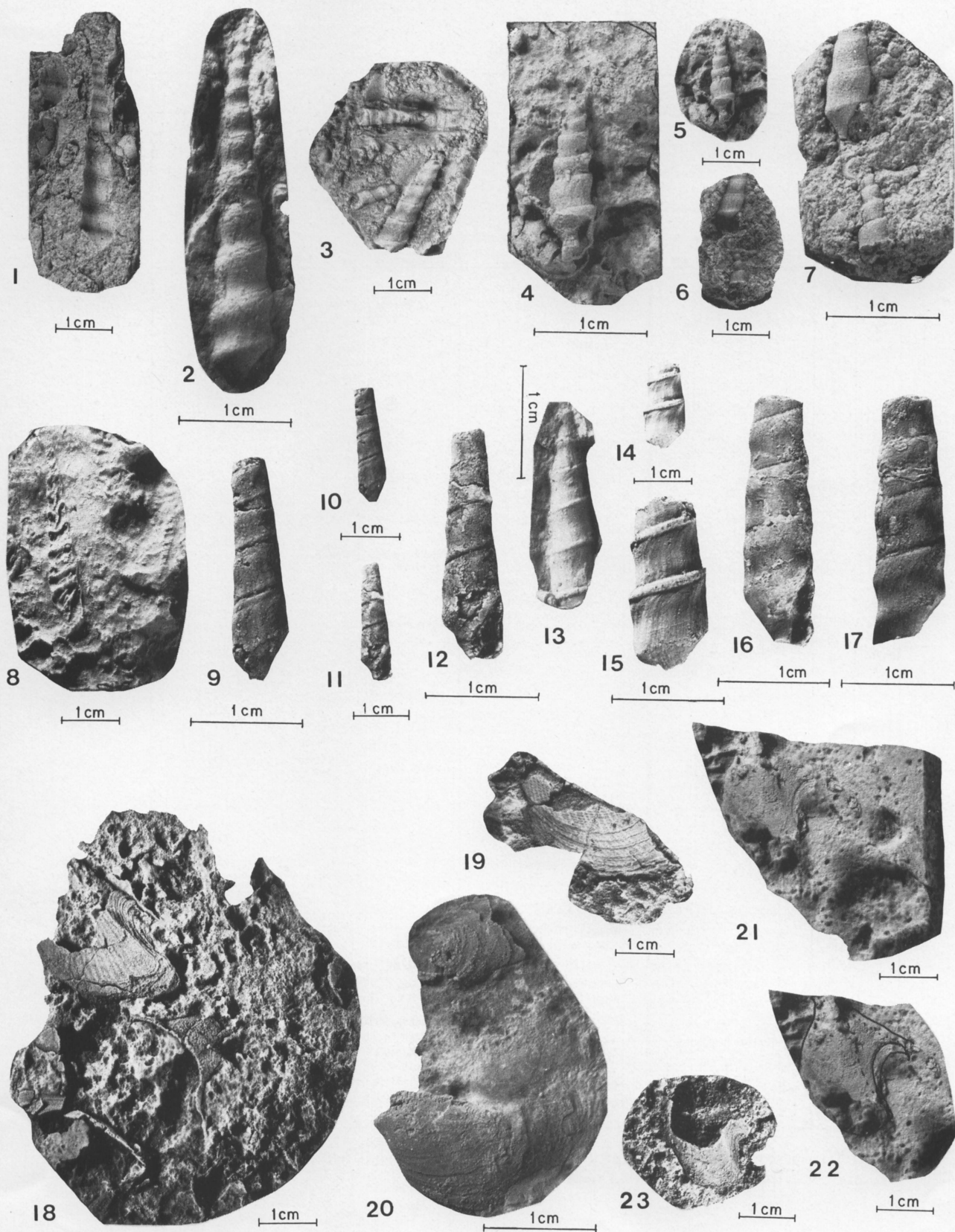
1–17. *Nerinella janeti* Cossmann, dolomitic limestone, Nahal Ardon, Makhtesh Ramon, Lower Liassic. **1–7.** Specimens in dark (burnt) limestone, M–523, (Coll. Bentor and Vroman). 1. Impression in dark rock. 2. Rubber cast of the above impression showing dimorphism. 3. Specimens imbedded in rock. 4 & 5. Specimen showing aperture. 6 & 7. Specimens imbedded in rock (Note faint spiral threads in the upper specimen.)

8. Natural section in brown limestone, M–7716 (Coll. Bentor and Vroman) (Note lamellar columellar plica.)

9–17. Specimens in dark limestone, M–523 (Coll. Bentor and Vroman). 9 & 10. Specimen with band above suture. 11 & 12. Specimen with aperture and with band above suture. 13. Rubber cast of fragment with band below suture. 14 & 15. Fragment with prominent band below suture. 16 & 17. Typical specimen without bands, both figs.

18–23. *Pteroperna reticularis* sp. nov., brown dolomitic limestone, Nahal Ardon, Makhtesh Ramon, Lower Liassic, M–5490, Coll. Goldberg and Nevo; left valves. 18. Rock built from crushed *Pteroperna*, a fragment on the bedding plane showing part of reticulate test and part of posterior auricle. 19. Fragment showing reticulate pattern. 20. Fragments showing lamellose tests. 21. Holotype, M–5490c, showing convex tests, parts of posterior auricle and traces of cardinal lines. 22. Same specimen, with traced outlines. 23. Fragment showing lower (adventral) part of posterior auricle.

All specimens are preserved in the collections of the Paleontological Division of the Geological Survey of Israel, Jerusalem.



AGE	FORMATION	GENERALIZED SECTION	LITHOLOGY	FOSSILS
LOWER CRETACEOUS			Variegated sandstone Arid conglomerate	Fossil wood
MIDDLE JURASSIC	BAJOCIAN - AALENIAN (?)	MAMAL	Pseudomorphose of pyrite Gray limestone	<i>Stomechinus bigranularis</i>
			Dolomite Ferruginous Oolites	<i>Caumontisphinctes (Infraparkinsonia) sp.</i>
			Ferruginous Oolites	
			Ferruginous Oolites	<i>Normannites sp. sp. Teloceras sp. sp.</i>
LOWER JURASSIC	UPPER LIAS	INMAR	Sandstone with intercalated clay	<i>Otozamites - Williamsonia sp.</i>
			Clay	PLANT REMAINS
			Clay	<i>Gibbirhynchia gibbosa var. Coelopsis sp.</i>
			Clay	<i>Cardinia sp.</i>
LOWER JURASSIC	LOWER LIAS	ARDON	Sandstone with intercalated shales	Fossil wood
			Dolomite (marly)	
			Limestone	<i>Nerinella janeti, Pteroperna reticularis</i>
			Dolomite Marl	
LOWER JURASSIC	MISHHOR		Flint clay	<i>Brachyphyllum sp. sp.</i> <i>Cupressinocladus ramonensis</i>
TRIASSIC	CARNIAN	MOHILA	Limestone	<i>Spiriferina cf. lipoldi</i> <i>Costatoria inaequicostata</i>
			Shales	
			Gypsum	

Fig. 1. Generalized columnar section of the Jurassic in Makhtesh Ramon (after: A. Nevo (1955, 1963), I. Zak (1957, 1964), A. Katz, (1968), M. Goldberg and G. M. Friedman (1974)).

Locality: Nahal Ardon, Makhtesh Ramon.

Level: Limestone of Ardon Formation with *Nerinea janeti*, Lower Lias.

Material: Four fragments of left valves and a fragment showing ornamentation; collected by Goldberg and Nevo, M-5490.

Diagnosis: Left valve convex, anterior margin almost straight, ventral margin arched, growth lamella curving in ventral region obliquely towards posterior auricle, postero-ventral extremity subacuminate, posterior auricle depressed, deeply excavated; surface with growth lamellae crossed by numerous radial threads, forming reticulate pattern.

Description: The convexity of the left valve is seen in Plate 1, 20 and 22 as is the almost straight antero-dorsal border; the growth lamellae curve sigmoidal on the depression of the posterior border, rise upwards and towards the hinge line (Plate 1, 18, 21 & 23); the lower (adventral) part of the posterior auricle is shown in figure 23 of Plate 1; the course of the hinge can be traced on the specimen (Plate 1, 21); the subacuminate postero-ventral edge, radial ornamentation and growth lamellae of the face are seen in Plate 1, figures 18-21; apex and anterior auricle are not preserved, but from the course of the borders near the dorsal region (Plate 1, 20 & 21), it is clear that the apex is small and narrow, and the anterior auricle probably very small. Right valve unknown.

Remarks: More or less distinct radial costae or riblets which cross the growth lines are present in species of *Pteroperna*, but none show such regular reticulate pattern as in the species of the Ardon Formation.

Remarks on the Deposit: In a relatively thin (60 cm) limestone bed, two fossils show two types of deposition. Different parts of the rock are built from one abundant and crowded single species, either *Nerinea* or *Pteroperna*. The thin tests of *Pteroperna* are crushed and the fragments are buried perpendicular or at an angle to the bedding plane; only exceptionally some larger fragment repose on the plane (Plate 1, 18). This shows that the tests were postmortally carried by breakers, crushed and thrown near shore.

The relatively heavier and thicker tests of the *Nerinea* underwent a more quiet transport, they resisted the impetus of the waves and were crowded unbroken in horizontal position on the bedding planes. The diagenesis, however, has more affected the tests of the *Nerinea* than the lamellar tests of the *Pteroperna*.

B. Fossils of the Inmar Formation

Family RHYNCHONELLIDAE Gray, 1848

Subfamily TETRARHYNCHIIDAE Ager, 1965

Genus *Gibbirhynchia* Buckman, 1917

Gibbirhynchia gibbosa Buckman var.

Plate 2, Figures 3-7

1962 *Gibbirhynchia gibbosa* S. S. Buckman, Ager, p. 92, pl. VIII, figs. 6 a-c, textfig. 53 (synonymy).

Material: An internal mould from a thin (20 cm) interbed of silty limestone in kaolinitic clay beds, S-5, at the middle part of the Inmar Formation in Makhtesh Ramon. M-7812, coll. G. Weinberger (Geology Department, Ben Gurion University of the Negev, Be'er Sheva).

Description: Shell biconvex, globose, brachial valve about twice as inflated as the pedicle valve; outline oval, longer than wide (1-7 mm; w-15 mm; th-15 mm); beak of pedicle valve gibbous, strongly incurved; small round foramen in contact with incurved umbo of brachial valve, beak ridges and interarea not preserved; subparallel, strong dental lamellae exposed; a fold recognizable from the middle of the brachial valve becomes rapidly prominent but slopes steeply towards the flanks and the convexity of the valve remains almost undisturbed; anterior commissure uniplicate, linguiform extension 5.4 mm high; thin dorsal septum seen on the mould extends from the umbo to 1/3 the length of the brachial valve.

Ornamentation consists of sharp, dense ribs, 7 on the fold, 6 in the sinus of the pedicle valve, 10 on each flank. The umbones are smooth, but this seems to be due to the state of preservation, as traces of the ribs continue to the umbones.

Remarks: Our specimen seems to be almost identical with *Gibbirhynchia gibbosa* Buckman, differing in oval outline, the length exceeding the width; this difference may be intraspecific or perhaps a distinct variety which derived directly from the typical *G. gibbosa*.

Family NUCULANIDAE Adams and Adams, 1858

Genus *Nuculana* Link, 1807

Nuculana sp. indet.

A cast and its imprint in kaolinitic clay show an elongated type of *Nuculana*. A fragment with dentition may belong to this species or perhaps to *Nucula*. The specimens are not suitable for illustration and determination.

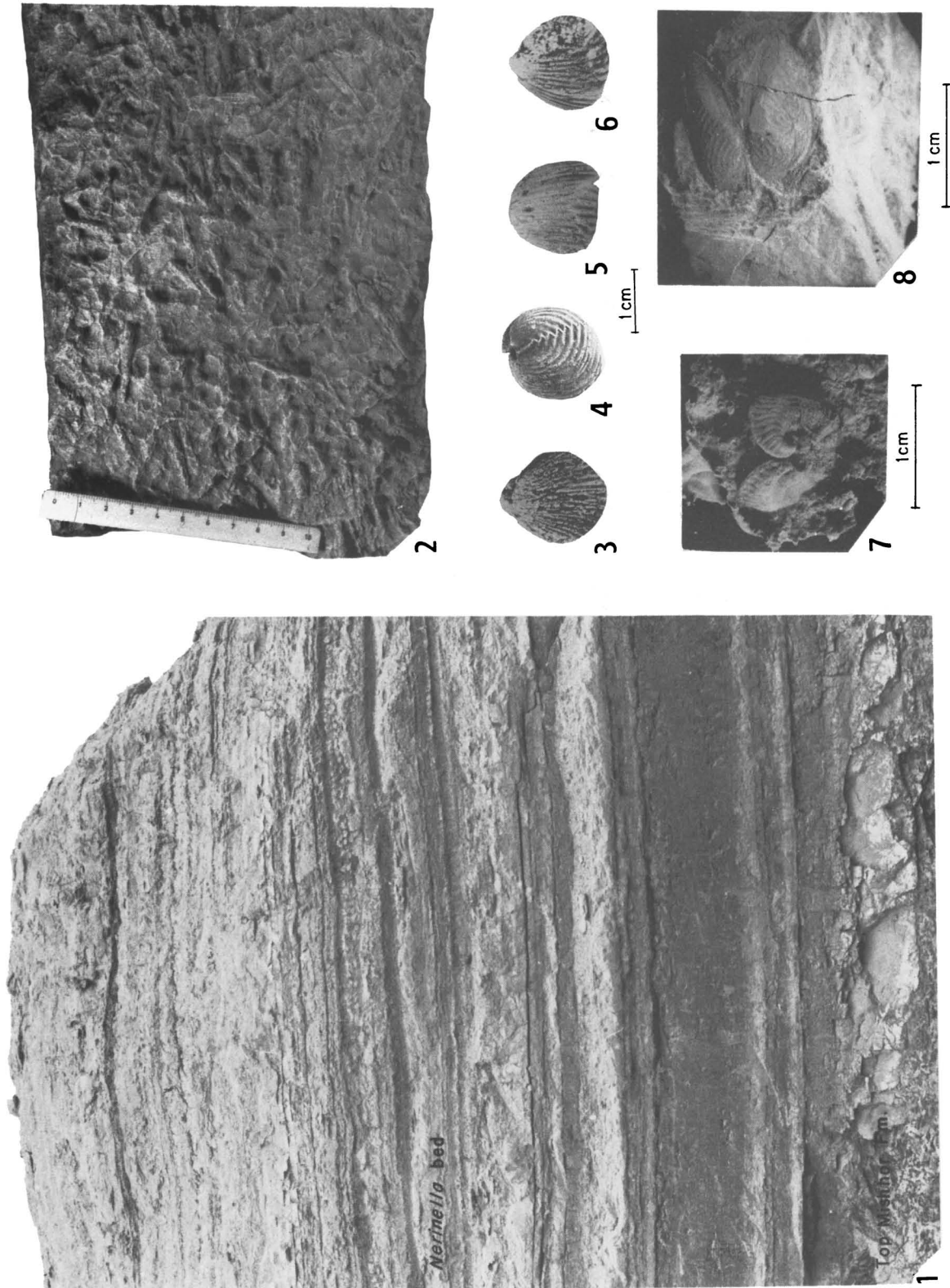


PLATE 2.

1. Almost complete natural section of the Ardon Formation with bed of *Nerinea janeti*, Nahal Ardon, Makhtesh Ramon (from Mazor, 1978). 2. Slab with *Nerinea janeti* Cossm., Nahal Ardon, coll. M. Goldberg. 3-6. *Gibbirhynchia gibbosa* Buckman, var., interbed of silty limestone in kaolinitic clay, Inmar Formation, Nahal Inmar, Makhtesh Ramon; M-7812, coll. G. Weinberger (Geol. Dept. Ben Gurion University, Be'er Sheva); dorsal side, anterior and ventral views. 7. *Coelopsis* sp., rubber cast of impression in silty limestone with *Gibbirhynchia gibbosa* Buckman, var.; M-7812, coll. G. Weinberger; anterior view. 8. *Cardinia* sp. natural cast of bivalve specimen in kaolinitic clay, Inmar Formation, western part of Makhtesh Ramon; M-4187, coll. Oil Div., Geol. Surv. Isr. ODP-2884.

Family ASTARTIDAE d'Orbigny, 1844

Subfamily OPINAE Chavan, 1952

Genus *Coelopsis* Fischer, 1887

Coelopsis sp.

Plate 2, Figure 7

Material: An imprint in silty limestone together with *Gibbirhynchia gibbosa* Buckman var. intercalated in kaolinitic clay with *Nuculana* indet., at the middle part of the Inmar Formation in Makhtesh Ramon. M-7812, coll. G. Weinberger (Geology Department Ben Gurion University of the Negev, Be'er Sheva).

Description: The rubber cast (Plate 2, 7) shows the lunular face and the side of a small shell, 7 mm high and about 6 mm thick; beaks prosogyrous, strongly involute, lunula deeply sunken, sharply bordered, cordiform; anterior face bordered by sharply rounded carina, side convex, narrow (2–3 mm) bordered posteriorly by a sharp carina; posterior part concealed; surface ornamented by fine, dense concentric riblets.

Remarks: The specimen is incomplete, not sufficiently preserved for specific determination.

Family CARDINIIDAE Zittel, 1881

Genus *Cardinia* Agassiz, 1841

Cardinia sp.

Plate 2, Figure 8

Material: Bivalve specimen, natural cast in kaolinitic clay of the Inmar Formation in Makhtesh Ramon. M-4187, coll. Oil Division of the Geological Survey of Israel, ODP-2884.

Description: Shell of moderate size, elongated, wedge-shaped, flatly convex; l – 25 mm, h – 10 mm; equivalve, strongly inequilateral, umbo at the anterior ¼ of the length, small, not prominent; short lunula and escutcheon well delimited by sharply rounded ridges, slope steeply inward; anterior margin circular, pallear margin widely arched, posterior edge acutely rounded; surface ornamented by thin, sharp concentric rugae, intervals regular, twice as wide as riblets.

Remarks: The specimen was collected at the base of the upper part of the Inmar Formation and is regarded as of Upper Liassic age (probably Domerian).

Conclusions

The analysis of this fauna assists in the division of the Jurassic sequence in Makhtesh Ramon into biostratigraphic units as summarized in the generalized columnar section of the Jurassic in Makhtesh Ramon (Fig. 1).

1) The Lower Liassic Ardon Formation with *Nerinella janeti* Cossmann.

2) The Upper Liassic middle part of the Inmar Formation with *G. gibbosa* Buckman var.

3) A supposed Aalenian-Bajocian age of the uppermost part of the Inmar Formation with flora similar to the Lower Estuarine flora of Yorkshire (*Otozamites*–*Williamsonia*).

4) The late Middle Bajocian of the basal beds of the Mahmal Formation with species of *Normannites* and *Teloceras*.

5) The Upper Bajocian of the higher parts of the Mahmal Formation supported by the occurrence of *Caumontisphinctes* (*Infraparkinsonia*) sp. (The biostratigraphy of the Mahmal Formation will be discussed elsewhere.)

Acknowledgements

The stratigraphic position of the Ardon Formation in the Jurassic sequence of Makhtesh Ramon was discussed with M. Goldberg and Z. Lewy (Geological Survey of Israel, Jerusalem). E. Mazor (Weizmann Institute of Science, Rehovot) has contributed valuable illustrations.

References

- Ager, D. V. 1962. A monograph of the British Liassic Rhynchonellidae. Part III. Paleontol. Soc. London 85-136.
- Bentor, J.K. and A. Vroman. 1951. Geological Map of the Negev, 1:100,000. Sheet 18, Ovdar. Tel-Aviv (Explanatory notes in Hebrew).
- Cossmann, M. 1898. Contribution à la Paléontologie Française des Terrains Jurassiques. Gastropodes: Nérinées. Mem. Soc. Géol. Fr. Paléontologie 19. 1-179.
- Cossmann, M. 1903. Note sur l'Infra Lias de la Vendée et des Deux-Sèvres. Bull. Soc. Géol. Fr. 497-536.
- Goldberg, M. 1970. The lithostratigraphy of Arad Group (Jurassic) in the Northern Negev. Geol. Surv. Isr. Rep. MM/3/70. 137 pp. (Hebrew, English summary).
- Goldberg, M. and G. M. Friedmann. 1974. Paleoenvironments and paleogeographic evolution of the Jurassic System in Southern Israel. Geol. Surv. Isr. Bull. No. 61: 1-44.
- Goldberg, M. and A. Nevo. 1961. Columnar section of the Marly and Red Cuestas in Makhtesh Ramon. Geol. Surv. Isr. Oil Dept. (in Hebrew).
- Lorch, J. 1967. A Jurassic flora of Makhtesh Ramon, Israel. Isr. J. Bot. 16: 131-165.
- Mazor, E. 1978. Field Geology, Makhtesh Ramon. The Weizmann Institute of Science, Dept. of Geoisotopes. (Hebrew). 20 p.
- Nevo, A. 1955. The Jurassic of Makhtesh Ramon. Geol. Surv. Isr. (internal report).
- Nevo, A. 1963. The Jurassic strata of Makhtesh Ramon, Summary of Lectures presented at Makhtesh Ramon Symposium. Isr. Geol. Soc. p. 11-12.
- Zak, I. 1957. The Triassic of Makhtesh Ramon. M.Sc. Thesis. Hebrew University of Jerusalem. 84 p. (Hebrew, English version in press).
- Zak, I. 1964. Columnar section of the Ardon Formation in Makhtesh Ramon. Geol. Surv. Isr. (revised edition in press).