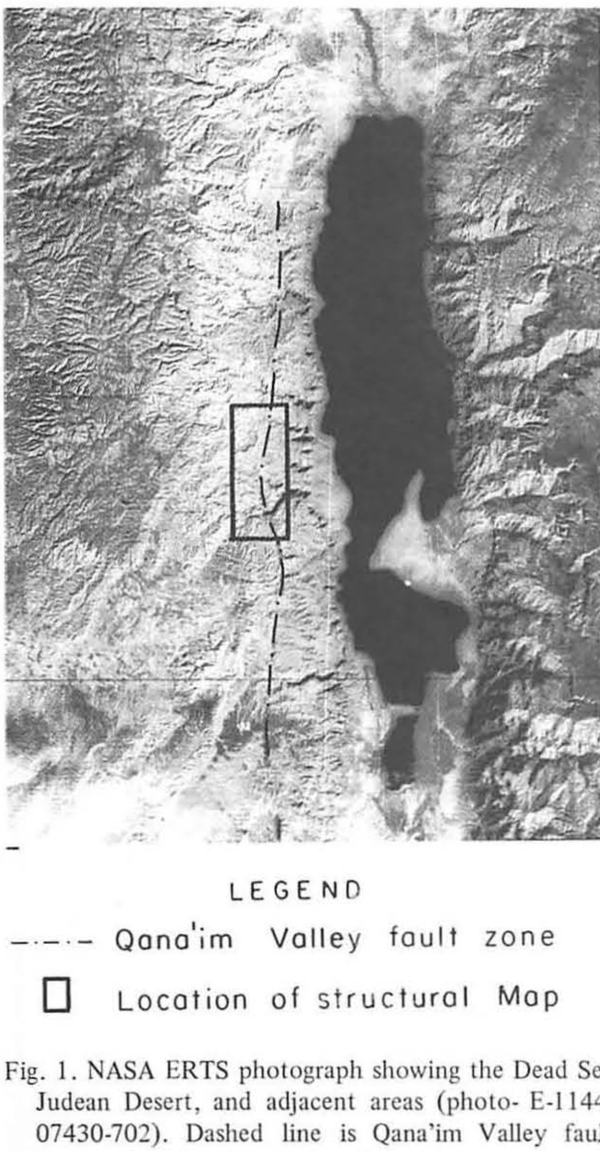
THE POLYPHASE HISTORY OF THE QANA'IM VALLEY FAULT ZONE

Aryeh Gilat and Avraham Honigstein

STRUCTURAL FRAMEWORK

The Judean Desert is a structural terrace bounded by the Judean Mountains anticlinorium to the west and by the Dead Sea Rift Valley to the east. It is complicated by Senonian to Miocene flexures with NE-SW to NNE-SSW trends, younger flexures with N-S trends and by various types of fissures. The Qana'im Valley fault zone is developed subparallel to the Dead Sea Rift Valley, 8-10 km to the west, and can be recognized on satellite images as a more than 100 km long lineament (Fig. 1).



LEGEND

—·—·— Qana'im Valley fault zone

□ Location of structural Map

Fig. 1. NASA ERTS photograph showing the Dead Sea Judean Desert, and adjacent areas (photo- E-1144-07430-702). Dashed line is Qana'im Valley fault zone, and outline is location of structural map.

The faults of this zone were examined in the southern part of the Judean Desert during geological mapping at a 1:50,000 scale (Gilat, in prep.). The zone is a part of the Dead Sea Rift complex structure and has a similar polyphase history from normal faulting in the Early Senonian to sinistral strike-slip in the Miocene-Pleistocene.

The Qana'im Valley fault zone has a main N-S trend with NNW-SSE branch faults. The latter total 3-15 km in length, and cross the entire Judean Desert (Fig. 2). These faults are in places normal, and in places change their throw direction. They form flexures and V-shaped synclines, and may produce one fault plane or a polyplaned shear zone. Vertical displacements of up to 0.3 km and sinistral offsets of 0.1–1.3 km were observed. On many segments they formed on pre-existing structures (Fig. 3). Between the Qana'im zone and the main Dead Sea cliff there are at least three more strike-slip faults of more than 20 km length with the same N-S trend (Fig. 2; see also Gilat and Agnon, 1981).

Two of the pre-existing structures of the main Qana-'im Valley fault zone were examined in detail; in both sections the faults appeared to represent pre-Senonian movements. In the Adasha Valley section (Fig. 4) the Senonian rock sequence is thinner above the hanging wall and the younger fault occurs in this zone of weakness, passing into it at a distance of about 100 m from the Early Senonian fault.

The fault complex in the Mt. Holed vicinity is more complicated, forming a long and narrow graben (Fig. 2) above which the Senonian sequence is much thinner (Fig. 5). The oldest fault plane, exposed up to a height of 10 m, was eroded during Late Turonian-Coniacian times, and slightly rounded pebbles of silicified Turonian limestone of the B'ina Formation were deposited in the escarpment (base of the Menuha chalk).

OSTRACODE DISTRIBUTION

An attempt was made to study the faulting and the sedimentation process with the help of ostracode distribution. In Israel, three ostracode assemblage zones of Santonian age (S-1, S-2, S-3) and two assemblage zones of Lower Campanian age (S-4, S-5) have been established on the basis of 62 ostracode species and subspecies (30

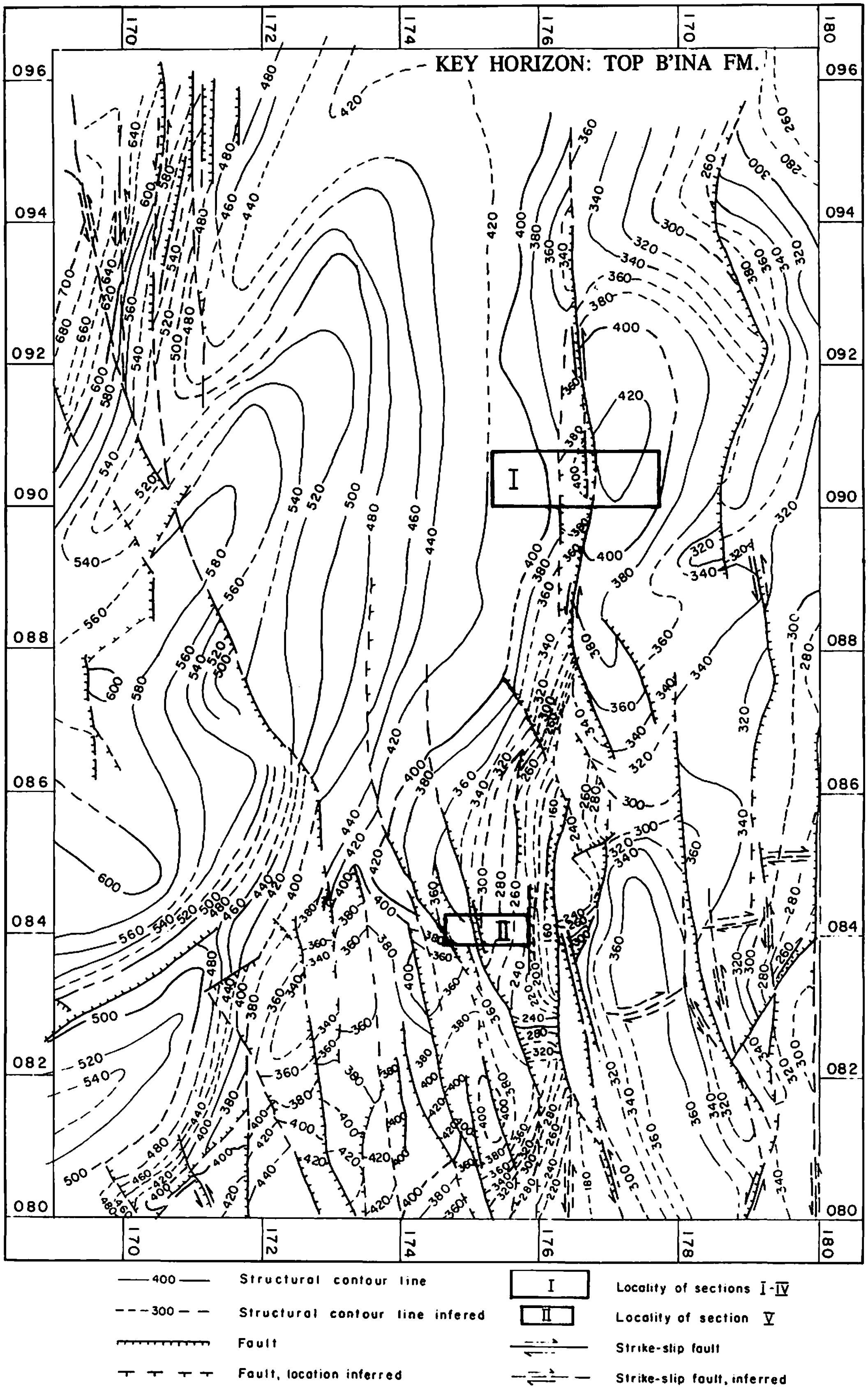


Fig. 2. Preliminary structural map of the Qana'im Valley fault zone.

of which are new; Honigstein, in prep.). These assemblage zones enable the dating and correlation of the sections given in Figures 4 and 5. Out of 92 samples, 84 showed a relatively rich ostracode fauna. The distribution of age diagnostic ostracode species and the assemblage zones are listed and illustrated in Figure 6.

The examination showed that in all sections, the base of the S-1 assemblage zone (Coniacian-lowermost Santonian) is missing. In the Adasha Valley section (in the rock sequence above the hanging wall of the fault), assemblage zones S-1/2a and S-2 are absent. Assemblage zones S-3 and S-4 are normally deposited in equal thickness on both sides of the fault. The base of the Mishash Formation is defined by the first occurrence of chert above the B'ina-Menuha contact (Bentor, 1959). The lowermost chert layer appears about 25 m above the Santonian/Campanian boundary. The Senonian section below consists of white chalk intensively dolomitized in the fault vicinity. The part comprising Santonian sediments is 22-24 m thick.

Rock sequences in all four sections examined in the Mt. Holed vicinity start with the S-1/2a assemblage zone and all the following zones are also present. The thickness of each in the graben part of the structure is about half of that of the equivalent zone above the upthrown blocks.

The Turonian-Senonian rocks near the pre-Santonian fault are not dolomitized; however, near the Plio-Pleistocene fault they are intensively dolomitized.

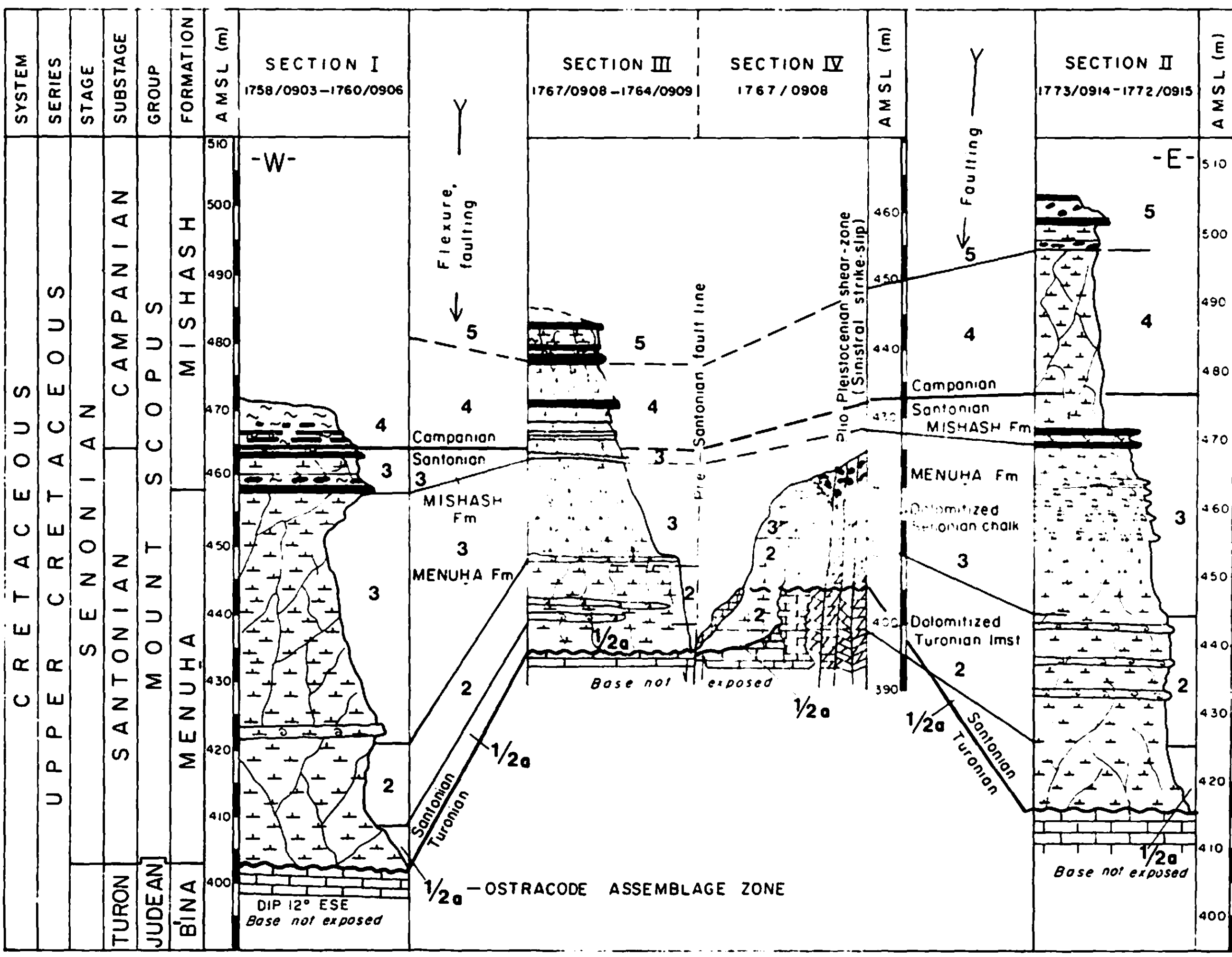


Fig. 3. Qana'im Valley fault zone, Mt. Holed vicinity.

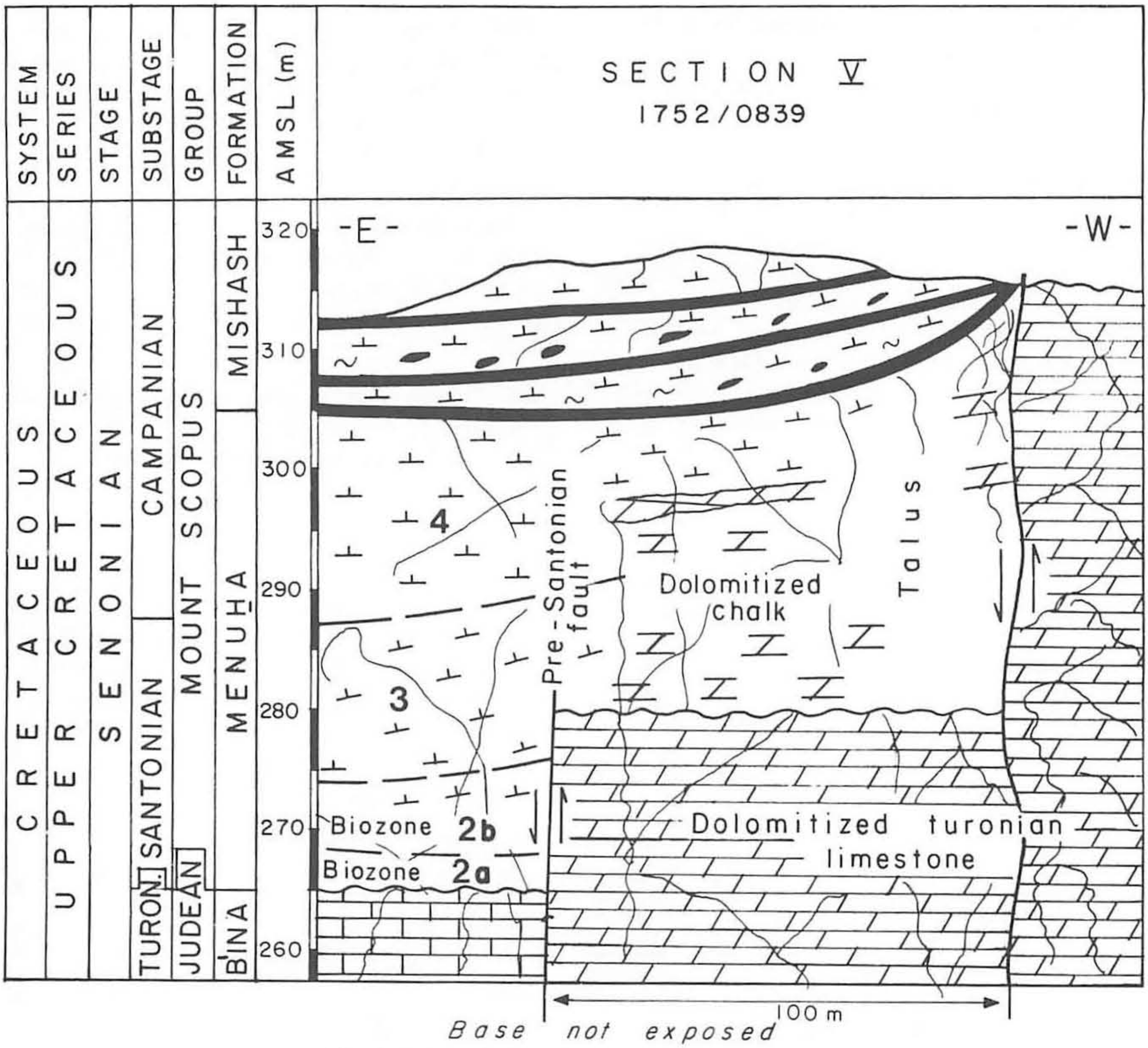


Fig. 4. Section of Senonian sequence, Adasha Valley.

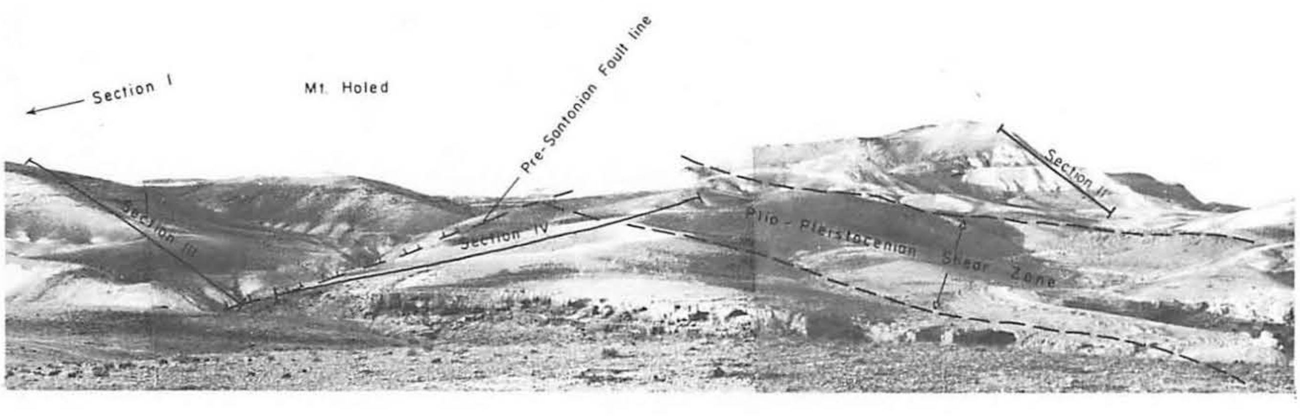


Fig. 5. Sections of Senonian sequence, Mt. Holed.

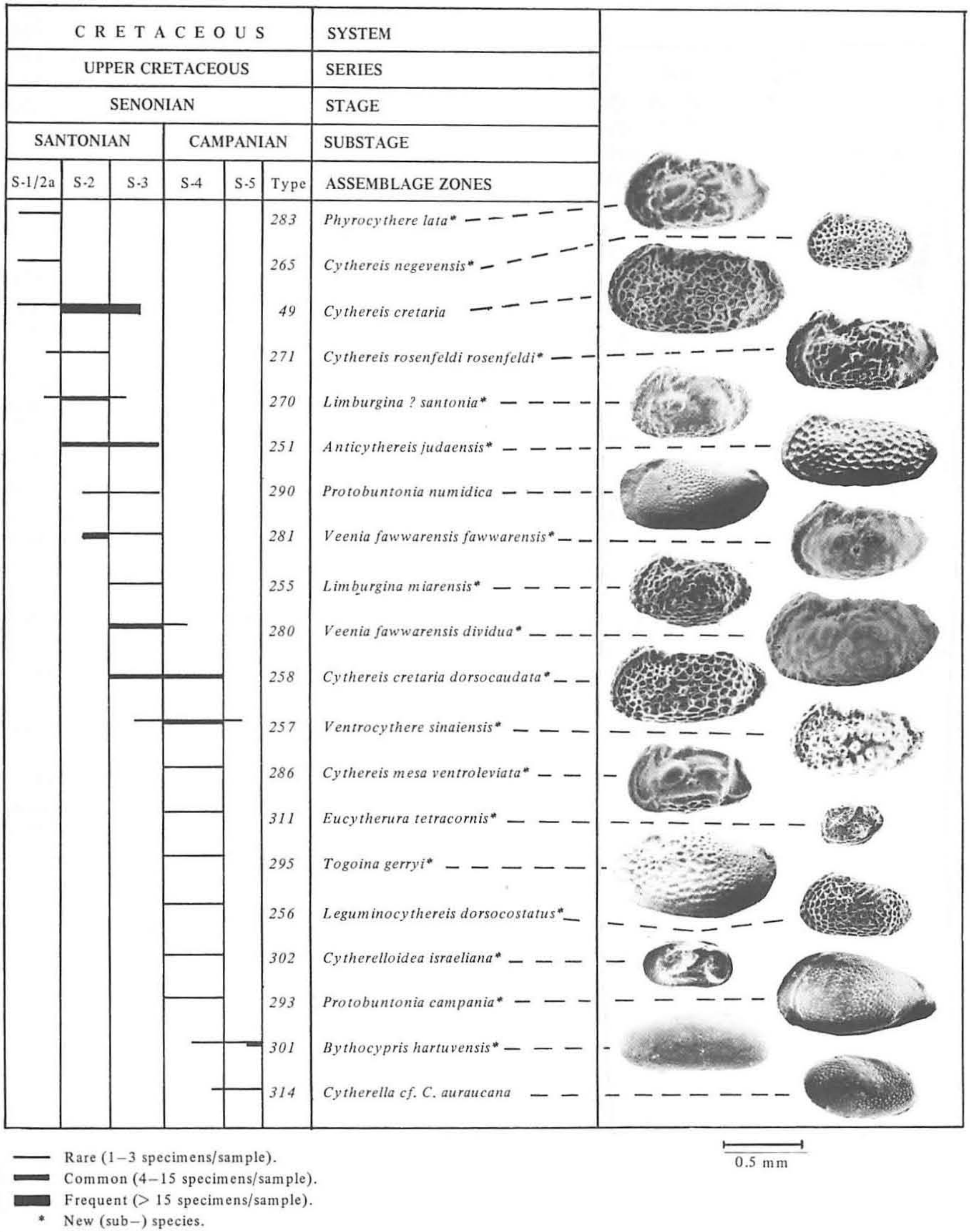


Fig. 6. Selected species of ostracodes and their biostratigraphical distribution in the Mt. Holed and Adasha Valley sections.

CONCLUSIONS

Ostracode biostratigraphy proved the pre-Santonian age of the older faults in the main Qana'im Valley fault zone (Mt. Holed) and its Adasha Valley branch. The thickness and facies changes in the Senonian rock sequences indicate that intensive tectonic movements took place at that time and small anticlinal structures and probably flexures were formed. The present graben in the Mt. Holed vicinity was once a part of the dome which developed continuously during Santonian-Campanian times. This correlates well with the structures of the northern Negev, which are described as a part of the Syrian Arc and whose folding started in the Senonian stage. Bartov (1974) and Steinitz (1974, Fig. 4) showed some Senonian structures in the Judean Desert, including a graben in the Qana'im Valley, about 10 km south of Mt. Holed.

A younger post-Senonian strike-slip phase developed in two stages: one of post-Miocene-Pliocene age (which also caused massive dolomitization of the limestones near the faults), and the second, of Pleistocene age. The youngest stage of movement resulted in a temporary closing of the pre-existing Hever, Harduf, Shafan, Arnav, Badar, Adasha and Ze'elim valleys, in the development of thick accumulative terraces in the areas bordering faults, and caused stream captures. The evidence for lateral displacement are horizontal slickensides and offsets which were measured by the displacement of the older flexures and river beds.

It has been noted (Zak and Freund, 1981) that nearly the entire motion of the great transform along its Dead Sea segment occurred within the Rift Valley, close to the eastern shore of the Dead Sea. New evidence on sinistral strike-slip movements in the Judean Desert will help in understanding their influence in central Israel and the possible implications for development of construction projects.

REFERENCES

Bartov, Y., 1974. A structural and paleogeographical study of the central Sinai faults and domes. Unpubl. Ph.D. thesis, Hebrew Univ., Jerusalem, 143 p. (in Hebrew).

Begin, Z.B., 1974. The Geological Map of Israel (1: 50,000): Sheet 9-III: Jericho, explanatory notes, Isr. Geol. Surv., Jerusalem, 11 p.

Bentor, Y.K. (ed.), 1959. Lexique Stratigraphique International, vol. 3, Asie, Fasc. 10 c 2, Israel. Centre Nat. Rech. Sci., Paris.

Gilat, A. and Agnon, A., 1981. The Geological Map of the 'En-Boqeq-Mezada area (1:10,000). Isr. Geol. Surv., Rep. MM/2/81.

Roth, I., 1970. The Geological Map of Israel (1:50,000), Sheet 12-I: Wadi El-Qilt. Isr. Geol. Surv.

Steinitz, G., 1974. The deformational structures in the Senonian bedded cherts of Israel. Unpubl. Ph. D. thesis, Hebrew Univ., Jerusalem, 126 p. (in Hebrew).

Zak, I. and Freund, R., 1981. A symmetry and basin migration in the Dead Sea Rift. In: R. Freund and Z. Garfunkel (eds.), The Dead Sea Rift, Tectonophysics, vol. 80, pp. 27-38.

* * *