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ON THE ABDOMINAL SEGMENTATION IN THE ADULT FEMALE OF ARMOURED SCALE INSECTS OF THE ODONASPIDINI AND ANTAKASPIDINI (DIASPIDIDAE)*,**

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ABSTRACT

The number of and the distinction between abdominal segments in adult females of the Diaspididae is not clearly discernible in all tribes of this family, using external examination of the cuticle in slide-mounted specimens. In adult females of the Odonaspidini and Antakaspidini, abdominal segmentation is very distinct because of presence of several features. From observations on slide-mounted female specimens of all available species of these two tribes, it appears that their abdominal segmentation exhibits a pattern previously not recorded in the Diaspididae. Each of the three anterior segments is constructed of its separate tergite and sternite. The fourth and fifth segments each possess a separate tergite and ventrally a separate parasternal area. Whereas the ventral median and submedian areas (i.e. between parasternal areas) of both segments became fused, and they appear as a joint area bordered anteriorly and posteriorly by intersegmental sutures.

The distinction between head, thorax and abdomen in the adult female scale insect, and the separation between segments of these body parts, are extensively employed in the systematics of this group. These landmarks in the morphology of scale insects serve as significant and reliable criteria for separation between taxa at various levels. Segmentation of the head and thorax in the female is indistinct because of their close fusion. Abdominal segmentation, on the other hand, is quite clear in some of the families of scale insects, for example in Pseudococcidae, Lecanodiaspididae, Coccidae, Diaspididae, and it was used by earlier workers for suggesting evolutionary changes in

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abdominal segmentation of female scale insect (Balachowsky, 1937; Ferris, 1942, 1950).

For several years I have been studying, on a world-wide basis, the morphology and systematics of the Odonaspidini, one of the five major groups of the Diaspididae, with special reference to the adult female. The species of this tribe infest almost exclusively Gramineous host plants. They are characterized by some features which make the abdominal segmentation remarkably well-defined and more conspicuous for accurate observation, as compared to the adult females of some other tribes. My observations on the distribution of these morphological structures enable me to establish that abdominal segmentation in females of the Odonaspidini exhibit a pattern which was not hitherto reported or noticed, in any of the tribes of Diaspididae.

These structures are:

1) *Intersegmental sutures.* These sutures occur on the ventral and dorsal surfaces of the abdomen from the first to the fourth and fifth segments. Under a scanning electron microscope they appear as narrow grooves set transversely on the derm between segments (Fig. 1). In each suture or groove there are short folds of the cuticle, always arranged longitudinally, in a pattern that is conspicuously different from the pattern of reticulation of the segment surface. In stained, slide-mounted specimens these sutures will be observed (Fig. 2) as transverse lines of spots, elongate oval or circular in shape, heavily stained by Fuchsin in comparison to the surrounding areas of the cuticle. These spots, named "spicules" in the literature, are arranged on each suture in a regular pattern which consists of a median and a submedian part on each half of the body.

2) *Intersegmental emarginations.* In the females of all Odonaspidini the margin of the abdomen (along which the tergites and sternites join) is marked by emarginations or notches (Fig. 2), very conspicuous in some species but less defined in others. These emarginations occur from the first to the sixth segment. Each notch marks a clear division between adjacent segments, and it clearly continues to the sternal and tergal intersegmental sutures.

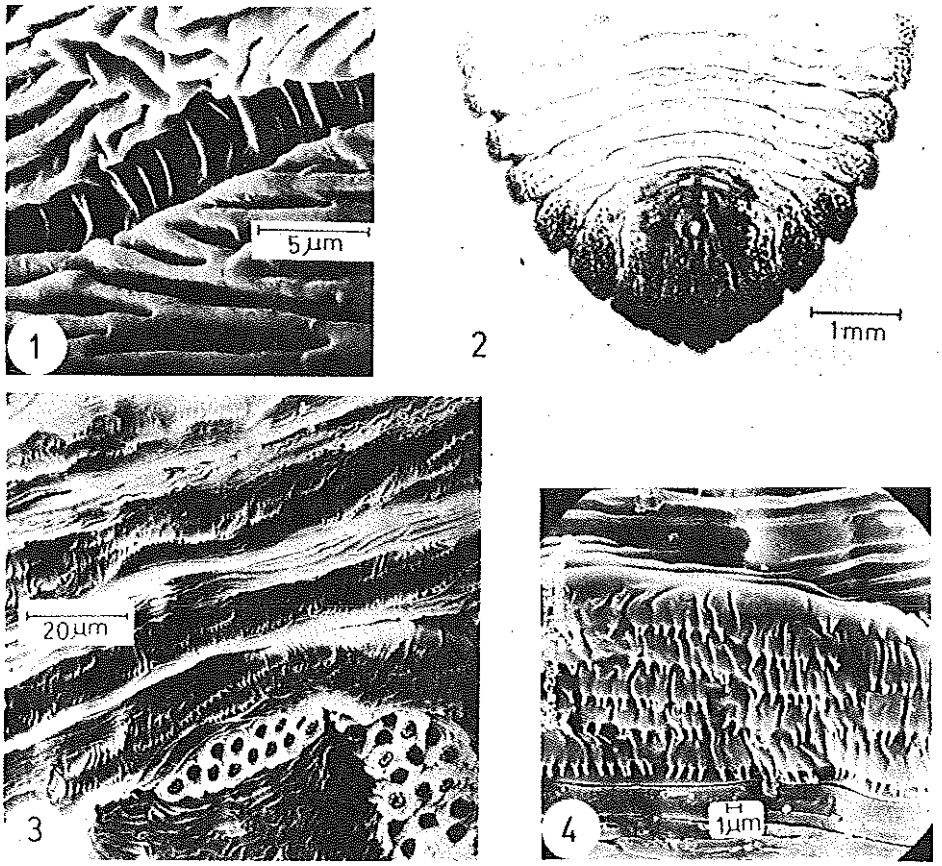
3) *Crenulae.* This term refers to scale-like projections (Figs. 3, 4) of the derm which are present on the thoracic and abdominal sternites. These structures are not typical to the Odonaspidini being common in numerous species of other tribes. In Odonaspidine species they occur only on the sternites, close to the mouth parts, sometimes on the thorax, and always in transverse bands, arranged segmentally on the abdominal sternites as far as the vulva. Each crenula is roughly rectangular, about 4-8 μ long, and its posterior margin is deeply serrated.

4) *Segmental clusters of ducts.* The glandular ducts on the abdomen in the Odonaspidine female are arranged in well-defined segmental clusters on the marginal and submarginal areas of the segments (Figs. 2, 5, 6). Dorsally the ducts are placed in clusters on the paratergal areas. These areas are usually sclerotized and become heavily stained by Fuchsin. The paratergal clusters join to clusters of ducts on parasternal areas. Each segmental cluster, ventral as well as dorsal, is clearly bordered anteriorly and posteriorly by an intersegmental suture.

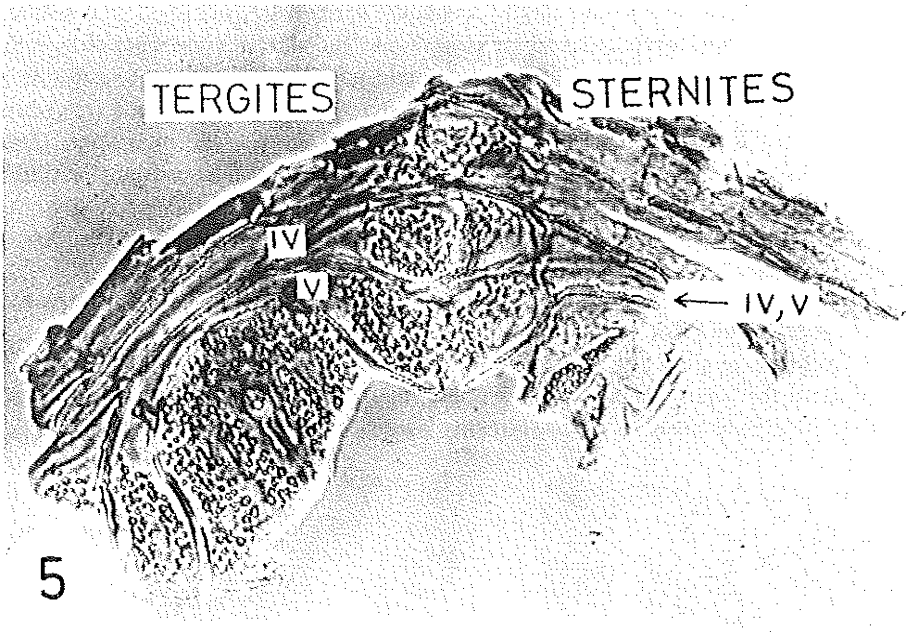
My observations on the abdominal segmentation on Odonaspidine adult females, show that it exhibits the following pattern (Figs. 7, 8). Each of the three anterior segments is composed of a sternite and its respective tergite. The fourth and fifth

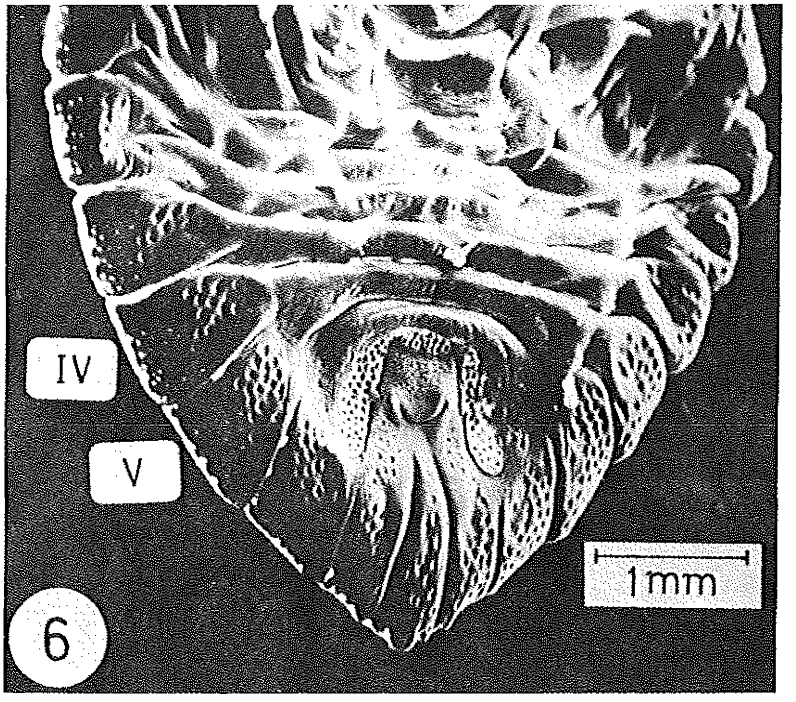
segments each have a separate tergite distinctly defined by intersegmental sutures, paratergal areas, and intersegmental emarginations. The sternites corresponding to the fourth and fifth tergites are recognized separately only by their respective parasternal areas. The median areas of the fourth and fifth sternites are fused into one area which is defined anteriorly and posteriorly by intersegmental sutures, and by a single transverse band of crenulae. In order to elucidate this pattern of separate fourth and fifth tergites with their fused respective sternites, these segments were plotted (Fig. 8) in a schematic drawing showing the ventral surface with its margin placed next to that of the dorsal one.

To elucidate this interpretation, I prepared a slide of these abdominal segments in *Odonaspis ruthae* Kotinsky (Fig. 5). In this preparation the sternites were mounted apart from the tergites but retained joined to each other along the margin. On the dorsal derm the itnersegmental sutures bordering the fourth and fifth tergites, and the separate paratergal areas of these segments may be observed. On the ventral surface



Figs. 1-4. *Odonaspis* spp. Adult females. 1. Micrograph of intersegmental suture with spicules. 2. Photograph of abdominal segments in slide-mounted specimen. 3-4. Micrographs of ventral crenulae.

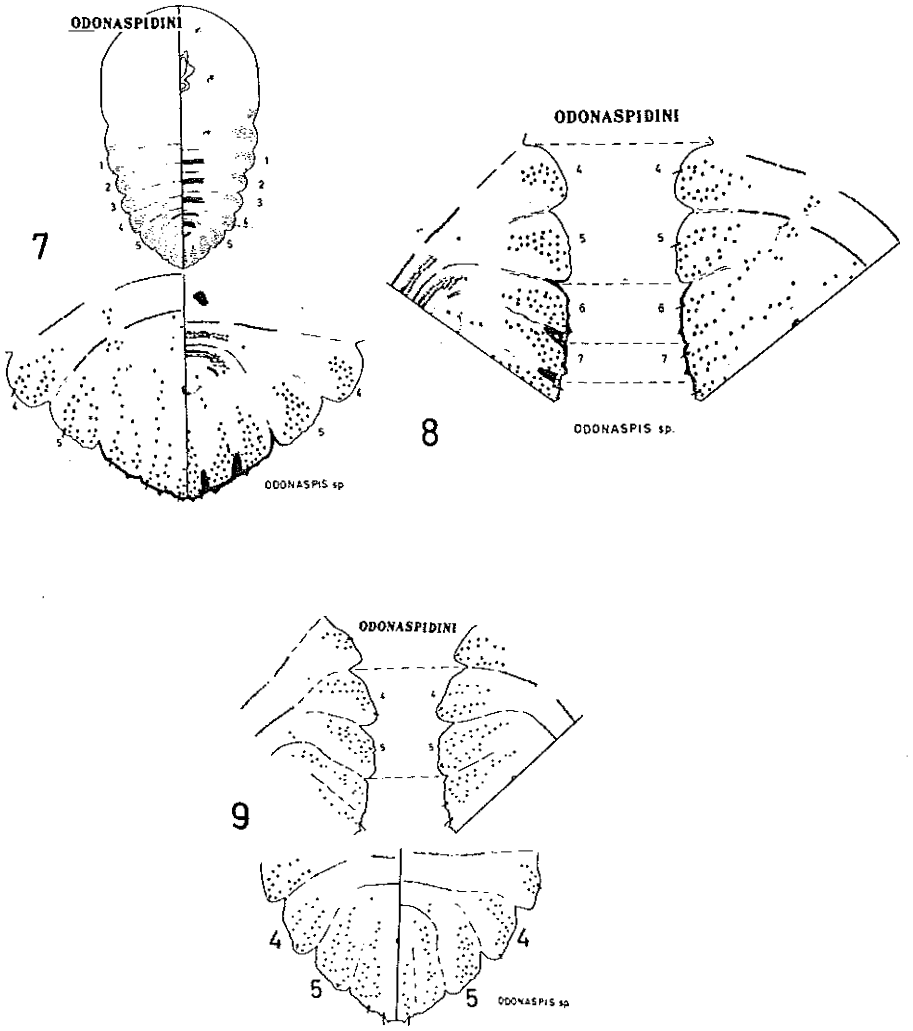




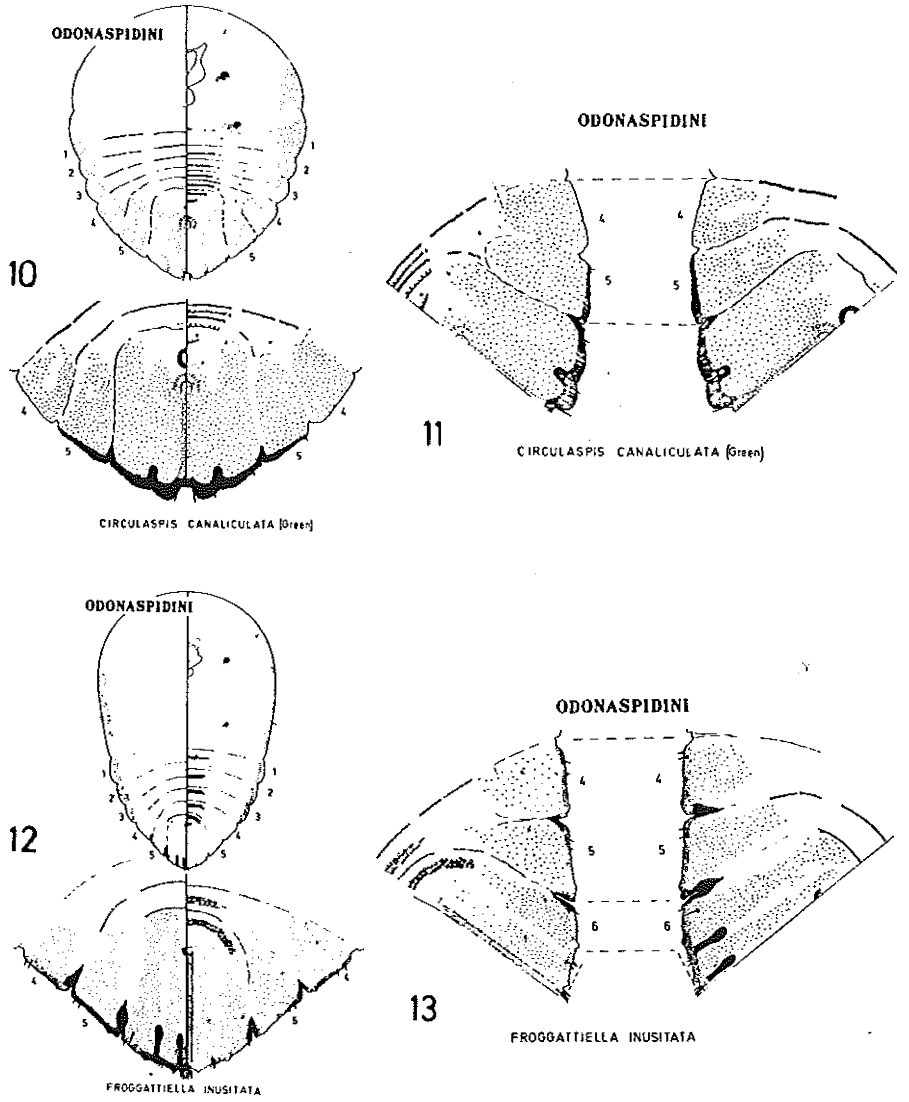
Figs. 5-6. *Odonaspis ruthae* Kotinsky, adult female. 5. Photograph of tergites and sternites of fourth and fifth abdominal segments (Intersegmental sutures slightly retouched). 6. Micrograph of ventral aspect of abdominal segments.

one may notice separate parasternal areas (divided by distinct sutures), each connected to its respective paratergal area. However, medially to the parasternal areas, the median areas of sternites four and five are fused into a single area, bordered anteriorly and posteriorly by intersegmental rows of spicules, and provided with a single band of crenulae. The same pattern will be observed also in Fig. 6 which shows a micrograph of the ventral aspect of *Odonaspis ruthae*.

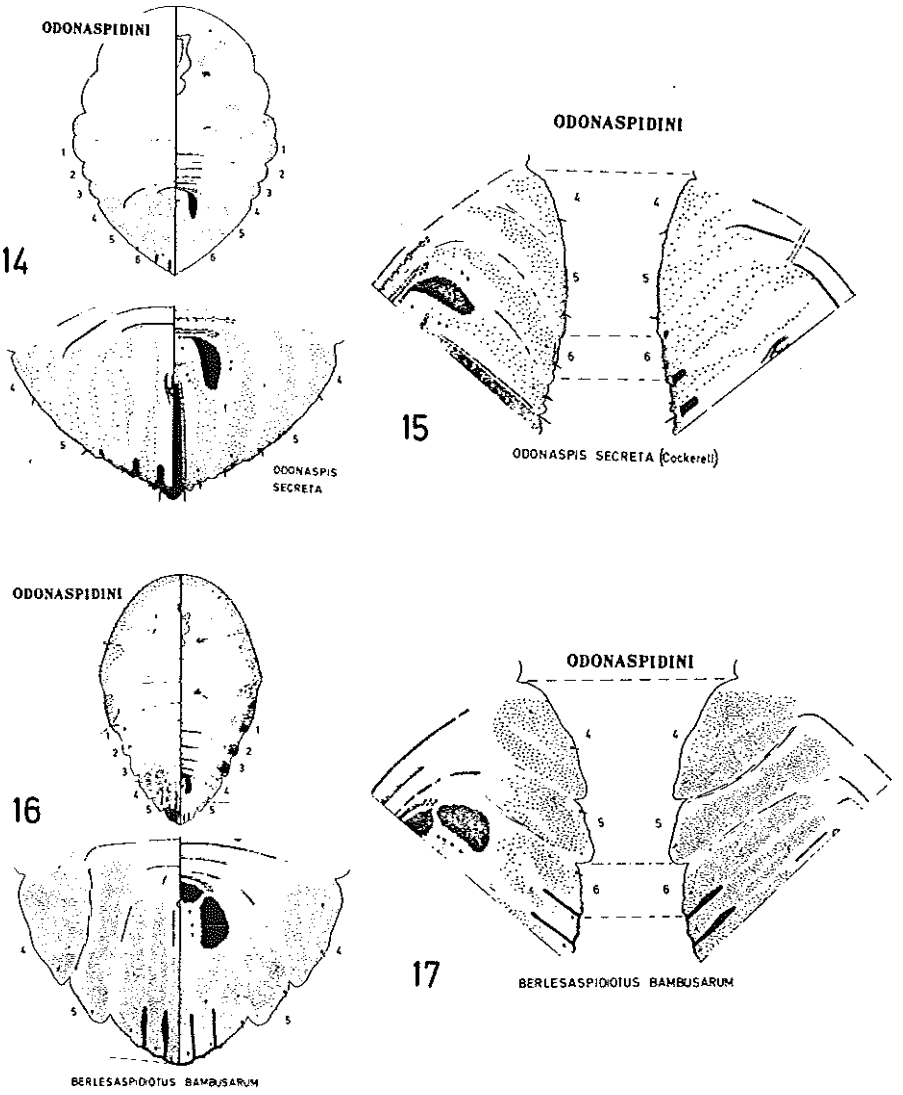
My observations on all described and undescribed species of the Odonaspidini which were available to me, show this pattern to be consistently present. To substan-



Figs. 7-9. *Odonaspis* sp. Schematic drawings of ventral and dorsal aspects. 7-8. Adult female. 9. Female second instar.



Figs. 10-13. Odonaspidini spp. Schematic drawings of ventral and dorsal aspects. 10-11. *Circulaspis canaliculata* (Green), adult female. 12-13. *Froggattiella inusitata* (Green), adult female.



Figs. 14-17. Odonaspidini spp. Schematic drawings of ventral and dorsal aspects. 14-15. *Odonaspis secreta* (Cockerell), adult female. 16-17. *Berlesaspidiotus bambusarum* (Cockerell), adult female.

tiate my interpretation I present drawings of the dorsal and ventral aspects of the adult female of the nominal type-species of four valid genera in the Odonaspidini:

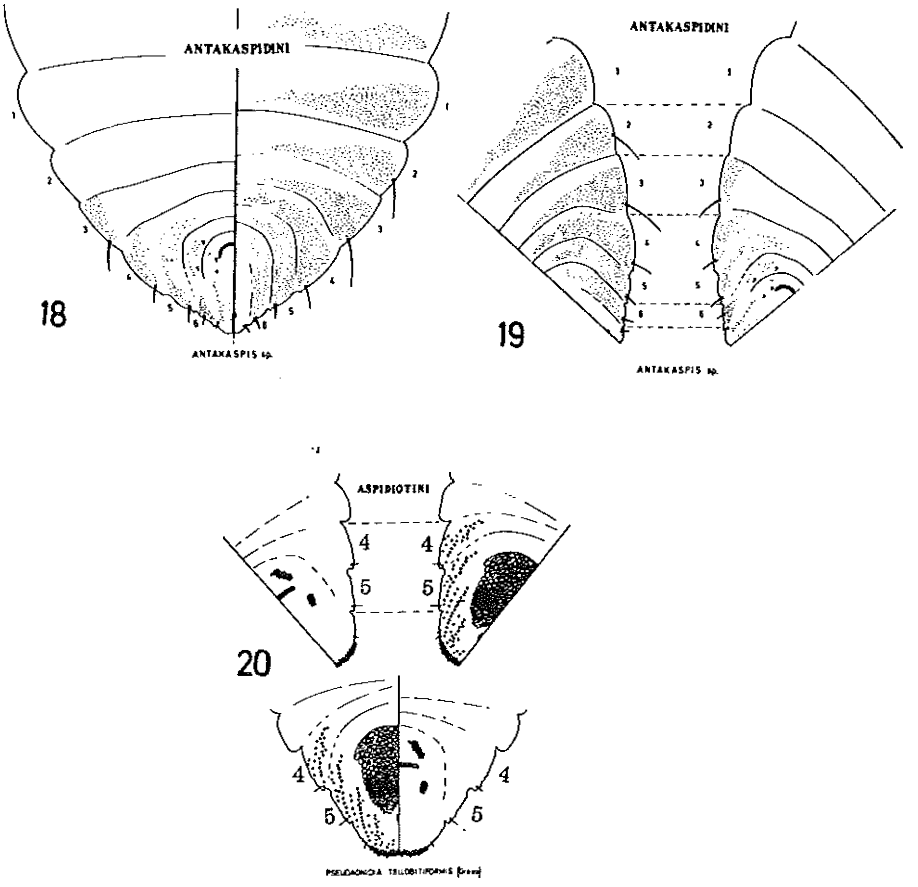
Odonaspis secreta Cockerell (Figs. 14, 15)

Berlesaspidiotus bambusarum (Cockerell) (Figs. 16, 17)

Circulaspis canaliculata (Green) (Figs. 10, 11)

Froggattiella inusitata (Green) (Figs. 12, 13)

The morphological structures mentioned above, are also present in the second instar females of the Odonaspidini. Abdominal segmentation could therefore be studied also in this instar. This pattern of "separate tergites – fused sternites" exists in the female second instar of the above-mentioned undescribed species of *Odonaspis* (Fig. 9). No more material of this instar was available for other species of the Odonaspidini, therefore it could not be established whether this pattern of segmentation is a characteristic common to all female second instar of the tribe.



Figs. 18-19. Antakaspis sp. Schematic drawings of ventral and dorsal aspects of adult female. Fig. 20. *Pseudaonidia trilobitiformis* (Green), Schematic drawings of ventral and dorsal aspects of adult female.

It would also be pertinent to study the comparative morphology of this pattern of segmentation in other tribes or subfamilies of the Diaspididae. This comparative study could not be accomplished, therefore I selected one of the smallest tribes – the Antakaspidini. This unique tribe is known to include but one species, *Antakaspis terminaliae* Mamet which occurs in Madagascar. A good reason for studying this species was the fact that abdominal segmentation in the adult female is very well-defined in slide mounted specimens, as conspicuous sclerotized sutures or intersegmental lines. It appears that the pattern of "separate tergites – fused sternites" exists also in the Antakaspidini, as shown in Figs. 18, 19.

One Aspidiotine species, namely *Pseudaonidia trilobitiformis* (Green), was also studied because the itnersegmental sutures in the abdomen of its adult female are comparatively well-defined. As shown in Fig. 20 the pattern of "separate tergites – fused sternites" exists also in this Aspidiotine species.

Although the observations presented here refer only to two tribes of the Diaspididae, it is hoped that they will contribute to an improvement in our interpretation of the evolutionary sequence which resulted in the development of the pygidium in this family. It is generally accepted that the pygidium evolved through processes in which abdominal segments four and/or five and the succeeding ones, have been bent posteriorly together with fusion and loss of segments (Ferris, 1942). Assuming that in the adult diaspidine female the anal opening represents the eleventh segment, that the genital opening occurs on the eight, and that the pygidial median lobes also belong to the eighth segment, I propose that the processes of fusion and loss in the pygidial region developed asymmetrically on the tergites and on sternites. The pattern, outlined above, of "separate tergites – fused sternites" further demonstrates the asymmetric development during the evolution of the pygidium.

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