earnest scientific work which he had done and was doing was appreciated; and in 1876 he was elected a member of the National academy of sciences. He had long been a member of other learned societies, and was widely known and respected among scientific men.

In person, Gen. Warren was of medium height, and slightly built. His mind was intensely active. Nervous in temperament, and sometimes irritated at trifling annoyances, he became instantly cool and self-poised in times of real danger or difficulty. In close logical reasoning he had few superiors. His mental habits were those of an investigator, — never satisfied until he had studied the matter in hand in all its bearings; but in action he was impetuous, indomitable, and gallant in the extreme. His reading was extensive, both in science and literature, — due largely to his habit of seeking mental rest by working in a new direction. His sense of humor was keen, and his conversation was often brilliant as well as instructive. In disposition he was kindly and sympathetic, and he never failed to give others full credit for whatever good work they had done. He loved justice for its own sake; and the natural tendency of his mind was always to assist the weak, and to strive to redress wrongs wherever found. These traits of character endeared him to his friends; and his memory is cherished with mingled feelings of respect and regard, not easy to express.

HENRY L. ABBOT.

APPENDAGES OF THE TRILOBITE.

THROUGH the kindness of Mr. D. A. McCord, the owner of the trilobite described by Professor John Mickleborough (*Cinc. journ. nat. hist.*, vi. 200, 1883), I have had an opportunity to study the original specimen, and prepare a few notes upon it.

When received, the specimens — i.e., matrix and relief — were not free from the grease and dirt acquired in the process of taking casts and frequent handling. On giving them a thorough washing in a solution of potash, this was removed, and also a thin film of decomposed rock on the parts beneath the pygidium. Turning to the laboratory window, to have the sunlight strike across the specimens while still wet, much to my surprise, the appendages shown beneath the pygidium were seen to be of the same character as those beneath the thorax, a number showing in some instances two and three joints attached to the basal joint. On a more careful examination, numerous fine slender filaments were discovered, both beneath the thorax and pygidium, and also near the posterior end of the latter slender jointed appendages not half a millimetre in diameter. Having cut up over two thousand trilobites without discovering any 'branchigerous' appendages beneath the pygidium, other than the spiral and ribbon-like branchial filaments, — such as were attached to the basal joints of the thoracic legs, — naturalists can appreciate the feeling of satisfaction that the discovery of these jointed appendages, so much like those found in cutting sections of Ceraurus and Calymene, gave the writer.

The breaking-apart of the surfaces carrying the legs and their matrix left the legs beneath the thorax in relief; but beneath the pygidium the joints were broken longitudinally, and only a plain outline section is seen. It is probably owing to this that these were overlooked by Professor Mickleborough, and the space beneath the pygidium considered as showing leaf-like or foliaceous appendages. For the purpose of clearly indicating the actual relations of the portion of the Ohio trilobite showing the legs, to the entire dorsal shell of the same species, a figure of the under side of the shell was outlined; and then the Ohio specimen was carefully drawn as if resting in it, as shown in fig. 1. In the specimens, some of the appendages are shown more distinctly in the matrix, and others in the relief. In the drawing, the two are combined so as to give, without restoration, what is actually present in the specimens. Twenty-six pairs of appendages are clearly discernible. Of these, nine are situated beneath the thorax, one beneath the posterior margin of the head, and sixteen beneath the pygidium. From the character of the appendages beneath the thorax, none of them appear to have belonged to the manducatory apparatus; the ninth posterior pair having been crowded forward from beneath the pygidium. The anterior pair beneath the head is very imperfect; but sufficient remains to show that these appendages were intimately associated with the cavity of the head, which is now filled with calcite, and they probably represent a portion of the posterior pair of manducatory appendages. In Calymene senaria and Ceraurus pleurexanthemus, the posterior pair of manducatory appendages are always provided with a large basal joint, and undoubtedly the same was the case with other genera of trilobites. The appendages beneath the pygidium are, however, of the greatest interest. I have seen many trilobites, when cutting sections, that had the cephalic and thoracic legs clearly and distinctly defined; but, owing to the small size of the pygidium of Calymene

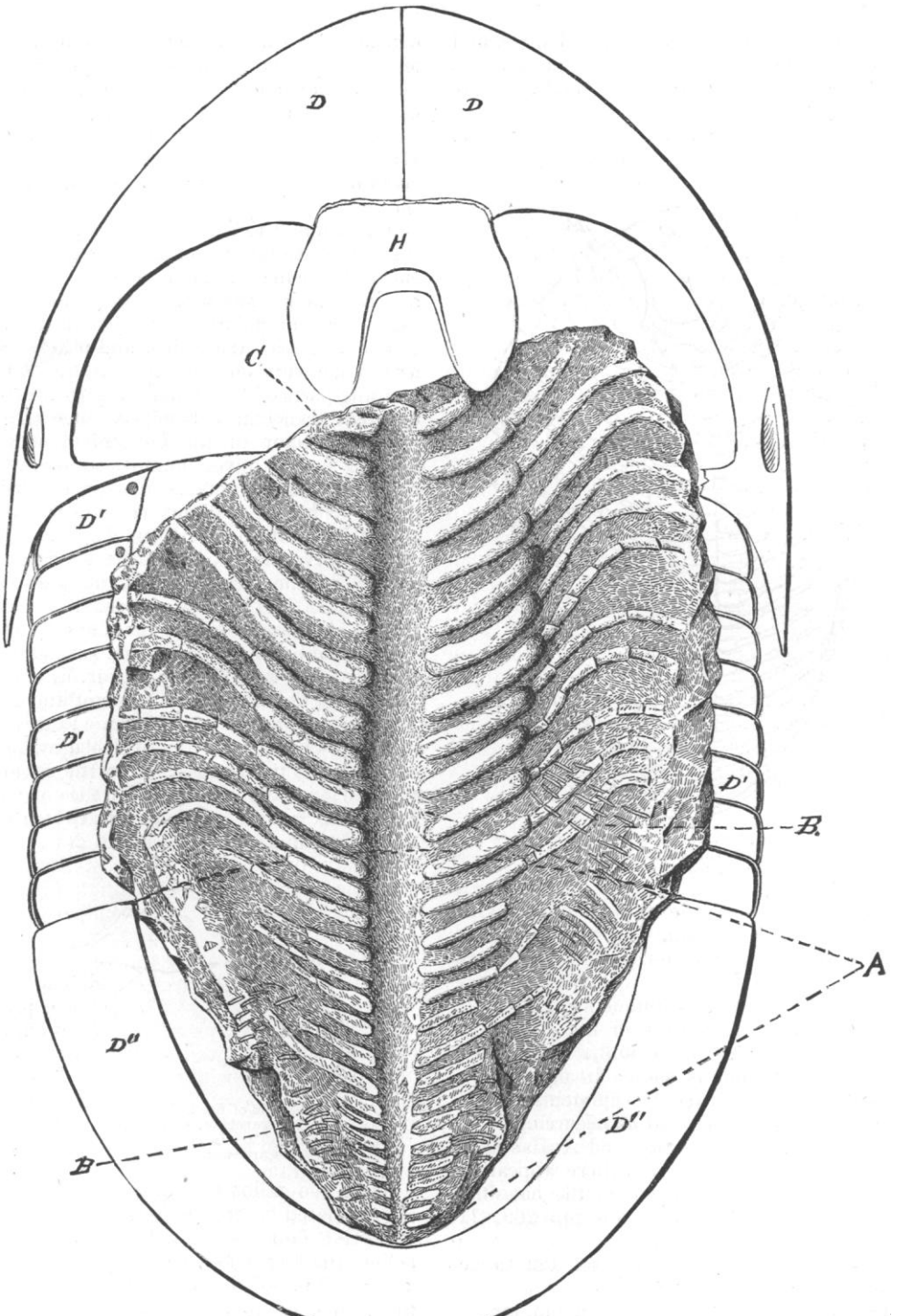

FIG. 1. — Outline of the under side of the dorsal shell of Asaphus megistos, with the fragment of the Ohio trilobite, showing the legs, resting in it. *H*, hypostoma; *D*, doublure or infolded margin of the dorsal shell; *D'*, same of the thoracic segments; *D''*, same of pygidium; *C*, portion of posterior pair of cephalic appendages; *A*, abdominal appendages; *B*, branchial filaments. The latter are enlarged to show their position.

and Ceraurus, there was always some doubt about the number of appendages that were to be assigned to the pygidium. That they were jointed and not foliaceous appendages, I had no doubt, and so stated it in the text,[1] and also in the restoration, of which fig. 2 is a copy.

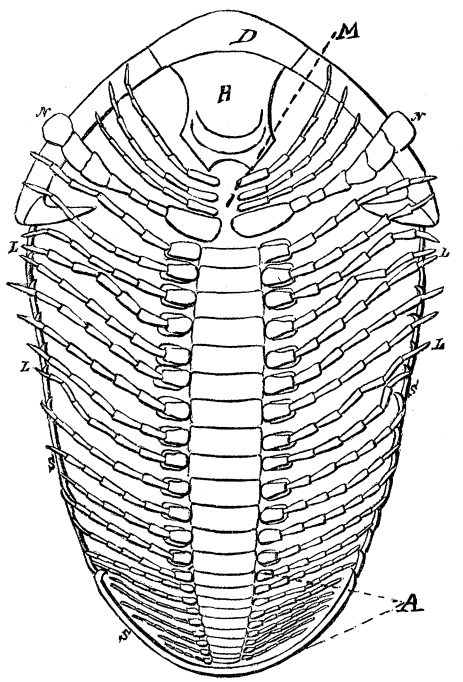

FIG. 2. — Under side of Calymene senaria as figured in *Bull. mus. comp. zoöl.*, vol. viii. pl. vi., 1881. *H*, hypostoma; *M*, mouth; *A*, abdominal appendages.

The leg beneath the thorax of the Ohio trilobite shows seven joints in two instances: the character of the terminal joint is unknown.

The discovery of this unique specimen fully establishes the correctness of the restoration made by the writer of the ambulatory appendages of Calymene, as shown in fig. 2. The few traces of the branchial filaments do not differ from those described as occurring in the genera Calymene, Ceraurus, and Acidaspis.

From the evidence given, there appears to be no necessity for a change in the classification of the trilobites given on pp. 209, 210 (*ibid.*) : —

Class, Poecilopoda; sub-class, Palaeadae; order, Trilobita.

Trilobita: ex., Asaphus, Calymene, etc.

1. Eyes sessile, compound. 2. Ocelli unknown. 3. Cephalic limbs serving as mouth-organs. 4. Thoracic segments bearing jointed legs and attached branchiae. 5. All segments bearing appendages. 6. Thoracic segments unanchylosed. 7. Abdominal segments anchylosed, and bearing jointed appendages. 8. Hypostoma large (metastoma unknown). To section 7 we now add '(similar to those of the thorax).'

[1] *Bull. mus. comp. zoöl.*, vol. viii. p. 204, 1861.

The attempt to locate the branchial apparatus of the trilobite beneath the pygidium is not surprising when a comparison with Limulus and Serolis is made with those trilobites having a large pygidium; but in such genera as Conocephalites, Arionellus, and others having a pygidium very small, as compared with the remaining parts of the animal, the necessity for a different branchial system is at once apparent.

The director of the Geological survey of Canada having given permission to have the original specimen of Asaphus platycephalus, described by Mr. Billings as showing ambulatory legs, sent to me, Prof. J. F. Whiteaves kindly forwarded it; and the specimen was placed by the side of the Ohio trilobite for comparison. A glance showed that Mr. Billings's interpretation was the correct one, and that, as far as the thoracic legs are considered, the Canadian trilobite has a pair for each segment. Of the abdominal legs nothing is seen. The only addition to our knowledge of the structure of the trilobite, furnished by the Ohio specimen, is the verification of the hypothesis that the legs were jointed beneath the pygidium, as shown in the sections of Ceraurus and Calymene, and expressed in fig. 2.

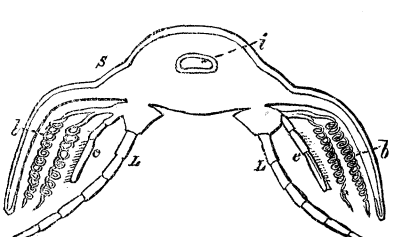

FIG. 3. — Cross-section of fig. 2. *s*, dorsal shell; *i*, alimentary canal; *B*, spiral branchiae; *e*, epipodite; *L*, leg. Taken from same plate as fig. 2. In some instances the branchial filaments or ribbons are straight and not spirally coiled.

That the trilobites and crustaceans were differentiated before the existence of the oldest Cambrian fauna we now know, is my present belief, the two classes coming down on two distinct lines of descent. In a paper now in the course of preparation, the entire subject will be reviewed, and illustrations given of the different orders of the class Poecilopoda.

CHARLES D. WALCOTT.