

Geological Survey of the State of New York.

PALÆONTOLOGY:

VOL. VII.

Copy 2.

TEXT AND PLATES.

CONTAINING DESCRIPTIONS OF THE

TRILOBITES AND OTHER CRUSTACEA

OF THE

ORISKANY, UPPER HELDERBERG, HAMILTON, PORTAGE, CHEMUNG AND CATSKILL GROUPS.

BY

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ASSISTED BY

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1888.

STATE OF NEW YORK, }
ALBANY, *March*, 1888. }

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chapter 355 of the Laws of 1883.



DEDICATION.

To His Excellency

DAVID B. HILL,

Governor of the State of New York :

SIR :

I have the honor to present to your Excellency a new volume of the Natural History of the State, being a continuation of the work on the PALÆONTOLOGY OF THE STATE OF NEW YORK.

This volume is chiefly devoted to the description and illustration of the Trilobites and other fossil Crustacea of the Oriskany, Upper Helderberg, Hamilton, Portage, Chemung and Catskill groups of the New York Geological Series, and comprises about three hundred pages of text and forty-nine quarto plates of illustration with explanatory text.

Besides the principal subject of the volume there is included some matter supplementary to Volume V, part ii, embracing forty pages of descriptive text, with eighteen plates and explanations. These subjects together comprise the full amount of text and of plates which could be devoted to this volume under the law of 1883, while making a proportionate allowance for the Volume V, part ii, Lamellibranchiata, in two volumes, and Volume VI, already published, and for Volume VIII, upon the Brachiopoda, which is yet to be published.

The present volume is the seventh of the entire series, and the fourth in order which has been published under the provisions of Chapter 355 of the Laws of 1883, by which it was directed "that the entire work should not extend beyond five bound volumes in addition to those already issued."

The entire number of species of Crustacea described and illustrated in this volume is one hundred and forty-four, which are included under twenty-eight

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Genera. Of this number ninety-seven are Trilobites, which have perhaps a greater general interest than any other class of fossils.

The material furnishing these descriptions and illustrations is chiefly the result of field collections made within the State of New York; some of the specimens dating back as far as the year 1832; including also specimens from the collections of private individuals, and from the cabinets of institutions of learning, which have been placed at the disposal of the author for the purpose of enriching this volume.

While the work is far from reaching that degree of completeness which the author could desire, it must be regarded as the best which could be accomplished under existing circumstances; presenting, as it does, a systematic arrangement of the material at our disposal, it will furnish to students and teachers the means of study, and classification of their own collections, and in this view the author will hope that it may not prove unworthy of a place among the series of volumes intended to illustrate the NATURAL HISTORY OF THE STATE OF NEW YORK.

I have the honor to be,

With great respect,

Your obedient Servant,

JAMES HALL,

State Geologist and Palæontologist.

ALBANY, *March*, 1888.

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ERRATA.

- Page 1, line 9, read PLATE XXV, FIGS. 1, 2.
 Page 7, line 6, read PLATE II, FIGS. 1-12; PLATE IV, FIGS. 1-7; PLATE V, FIGS. 1-14.
 Page 19, line 15, for 55, read 65.
 Page 25, line 2, for *occitanus*, read *occitanicus*.
 Page 31, line 9, for 26, read 29.
 Page 32, line 4, for *spinifera*, read *spiniferus*.
 Page 32, line 18, for *Conrad*, read *Green*.
 Page 33, line 10, for XII, read XIII.
 Page 45, lines 31 and 32, for *species*, read *variety*.
 Page 49, line 5, for 1832, read 1835.
 Page 59, line 9, insert 9 between 3-6 and 10.
 Page 62, line 2, add PLATE X, FIG. 14.
 Page 62, line 21, read DALMANITES (CHASMOPS) ANCHIOPS, VAR. SOBRINUS, n. var.
 Page 63, line 5, for *Asaphus laticostatus*, read *Calymene anchiops*.
 Page 68, line 2, for XI B, read XI A.
 Page 75, line 22, for *there*, read *here*.
 Page 158, line 23, for CLAYPOLL, read CLAYPOLE.
 Page 160, line 16, for HALL, read WRIGHT.
 Page 223, line 12, for PHACOPIDÆ, read PHACOPIDÆ.
 Explanation of Plate xxxv, fig. 22, for *Goniatites sinuosus*, read *Goniatites complanatus*.

PREFACE.

THIS volume contains the descriptions and illustrations of the Trilobites and other Crustacea of the Oriskany, Upper Helderberg, Hamilton, Portage, Chemung and Catskill groups of the New York Geological Series, which essentially constitute the equivalent of the Devonian System of Europe. Some descriptive matter and illustrations, supplementary to Volume V, part ii, are also included.

The volume, as it will now go to the public, is very different in its scope and character from the original conception and plan of the author.

While still free to devise a scheme for the completion of the PALÆONTOLOGY OF NEW YORK, in what appeared to him the most satisfactory manner, he had contemplated a review and revision of all his previous work upon the PALÆOZOIC CRUSTACEA, the early part of which had been done with very incomplete and often unsatisfactory material and equally imperfect knowledge of the subject. With this end in view, an effort was made, in 1873, through private subscription of the citizens of Albany, to purchase from Mr. C. D. Walcott a collection of Trenton limestone fossils, mainly for the sake of the Trilobites which it contained. This plan failing, the collection went to the Museum of Comparative Zoölogy, in Cambridge. At a later period, a second similar collection was offered to the State Museum by Mr. Walcott, but its purchase was not effected. This collection like the preceding one was purchased by the Museum in Cambridge, which now possesses a series of New York Trenton limestone fossils far superior to any other in the country.

In the meantime the author had, at his own personal expense, sent an assistant into the field to make collections, especially of TRILOBITES, from the rocks

below the Trenton limestone, intending to extend the work of collecting to all the known localities of primordial fossils within, and adjacent to the State. The result of the first season's work proved so unsatisfactory and disappointing that this plan was abandoned with regret, and nothing farther was attempted in that direction.

From the time of the completion of Volume V, part ii, at the close of 1879, the failure to make appropriations for the publication of this work, left in the hands of the State Geologist a large amount of matter prepared, or partially ready for publication. Of this material were eighty plates of LAMELLIBRANCHIATA, which, with twelve additional plates, now constitute the illustrations of Volume V, part i, published in two volumes. A considerable number of the plates published in Volume VI had, at that time, already been lithographed; besides eight plates of CRUSTACEA for Volume VII. Of the BRACHIOPODA, which in the present arrangement are to constitute Volume VIII, twenty-seven plates had been lithographed when, in 1881, all progress in the PALÆONTOLOGY OF NEW YORK was suspended.

Upon resuming the work, under the limitations of the law of 1883, it became necessary for the author to content himself with a volume restricted to the description and illustration of the Devonian Crustacea, and in order to make this one of a size approximating the other volumes, it became necessary to include the supplementary material of Volume V, part ii, originally intended for a separate publication, and which here follows the principal matter giving title to the volume.

Under existing circumstances, it is not at all probable that the author will ever have the opportunity of reviewing and revising his earlier work upon the Trilobitic faunas of the older rocks, but he may hope that in the near future the scientific institutions of New York may feel it incumbent upon them to present to the public a work upon these fossils worthy of the subject and of the State whose position is so well established as the pioneer and munificent patron in the science of PALÆONTOLOGY. There is no longer any difficulty in finding willing and able hands to perform such a work, and the material, though scattered in the collections of different institutions, could readily be brought

together for such an important purpose as a monograph of the PALÆOZOIC CRUSTACEA.

In taking leave of a work which has in the past occupied his mind and prompted his earnest endeavors, he can only regret that the circumstances attending its final production have been less felicitous than he could have wished.

In the preparation of the matter for the press, and in the critical study of the material, the author acknowledges with great satisfaction the able and untiring efforts of his assistant, Mr. John M. Clarke.

The author acknowledges the liberality with which specimens have been placed at his disposal for study and comparison, and begs leave to express his obligations to the following-named gentlemen and institutions:

Dr. J. S. Newberry, -- -- -- -- --	New York, N. Y.
Mr. Louis Bevier, -- -- -- -- --	Marbletown, N. Y.
Mr. Cornelius Van Gaasbeck, -- -- -- -- --	Kingston, N. Y.
Prof. S. G. Williams, -- -- -- -- --	Ithaca, N. Y.
Prof. H. S. Williams, -- -- -- -- --	Ithaca, N. Y.
Prof. J. F. Whiteaves, Geological Survey of Canada,	Ottawa, Canada.
Mr. R. D. Lacoë, -- -- -- -- --	Pittston, Penna.
Prof. W. H. Barris, -- -- -- -- --	Davenport, Iowa.
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Mr. A. O. Osborne, -- -- -- -- --	Waterville, N. Y.
Mr. D. D. Luther, -- -- -- -- --	Naples, N. Y.
Dr. C. Rominger, -- -- -- -- --	Ann Arbor, Mich.
Sir William Dawson, -- -- -- -- --	Montreal, Canada.
Prof. B. K. Emerson, -- -- -- -- --	Amherst, Mass.
Mr. Charles E. Beecher, -- -- -- -- --	New Haven, Conn.
National Museum, -- -- -- -- --	Washington, D. C.
American Museum of Natural History, -- -- -- -- --	New York, N. Y.
Prof. J. P. Lesley, -- -- -- -- --	Philadelphia, Penna.
Prof. R. P. Whitfield, -- -- -- -- --	New York, N. Y.
Dr. J. Pohlman, -- -- -- -- --	Buffalo, N. Y.
Prof. George H. Cook, -- -- -- -- --	New Brunswick, N. J.
Prof. S. Calvin, -- -- -- -- --	Iowa City, Iowa.

All the later drawings have been made by Mr. E. Emmons. Many of the plates which bear the name of Mr. George B. Simpson, were drawn between 1870 and 1881, and have remained in the hands of the author awaiting publication.

The accuracy and completeness of the original drawings will be acknowledged both by the author and by the student in this department of PALÆONTOLOGY.

Much the larger proportion of the lithography has been done by Mr. Philip Ast, the completion of some of the plates bearing his name dating back to 1872. In the continuation of the work, since 1886, Mr. Paul Riemann has done a smaller number of the plates. In consequence of the pressure for the completion of the work within a specified time, the standard of quality originally established has not been maintained in this and the preceding volume, but the deterioration has principally come through the printing of the plates.

The typographical and mechanical execution of the work speaks for itself.

THE AUTHOR.

March, 1888.

INTRODUCTION.

THE CRUSTACEA discussed in this volume are, primarily, the species from the Devonian formations of the State of New York, and, incidentally, such species from other horizons as it has seemed important to introduce into the work either for purposes of comparison or for the furtherance of our knowledge in other respects. Since comparatively few species of the North American Devonian Crustacea have been found to occur exclusively outside the limits of the State of New York, these extra-limital species, for the sake of completeness, have been brought within the scope of the work. The volume may, therefore, for the present be regarded as a monograph of these Devonian Crustacea (not including the Ostracoda).

In the ensuing discussions of the species the order followed is taxonomic, although no single system of classification has been rigidly adhered to. The chronological arrangement of the species is therefore subordinated to the zoölogical order of the genera and families.

I. HISTORICAL.

The first published notice of the North American Devonian Trilobites was given by Alexandre Brongniart ("Crustacés Fossiles," 1822), who referred to his species *Calymene macrophthalma*, two American specimens, one of which is probably referable to the species *Phacops bufo* or *P. rana*, Green, and the other, a plaster cast of a specimen which subsequently served as the type of *Calymene* [*Dalmanites*] *anchiops*, Green. In 1824, Dr. James E. Dekay (Annals of the Lyceum of Natural History, New York), recognized the *Calymene macrophthalma* (= *Phacops rana*), "on the Helderberg Mountain near Albany, and at Coshung Creek, near the Seneca Lake." In 1832, Professor Amos Eaton (Geological Text-book), described the species *Nuttainia sparsa* (= *Homalonotus Dekayi*, Green); and *Asaphus* (= *Dalmanites*) *selenurus*. This work was followed, in the same year, by "A Monograph of the Trilobites of North America, with Colored

Models of the Species," by Jacob Green, M. D., accompanied by a Supplement in 1835. This Monograph included several of the best known and most characteristic of the Devonian species, namely :

<i>Calymene platys</i> .	<i>Asaphus</i> (= <i>Dalmanites</i>) <i>pleuroptyx</i> .
<i>Dipleura</i> (<i>Homalonotus</i>) <i>Dekayi</i> .	<i>A.</i> (= <i>D.</i>) <i>myrmecophorus</i> .
<i>Calymene</i> (= <i>Phacops</i>) <i>bufo</i> .	<i>Calymene</i> (= <i>D.</i>) <i>anchiops</i> .
<i>C. bufo</i> , var. <i>rana</i> = <i>Phacops rana</i> .	<i>Calymene?</i> <i>Odontocephala</i> = <i>D. selenurus</i> .

In the Annual Reports of the Palæontological Department of the New York State Geological Survey, for 1839, 1840 and 1841, Mr. T. A. Conrad described the species *Odontocephalus selenurus* (Eaton), *Asaphus* (= *Dalmanites*) *aspectans*, *Calymene marginalis* (= *Proëtus Rowi*, Green, 1838), *Asaphus?* *denticulatus* (= *Dalmanites aspectans*), and *Asaphus?* *acantholeurus* (= *Dalmanites myrmecophorus*, Green). From this date onward to the year 1861, brief notices of American Devonian Trilobites were published by various writers, viz. :

Burmeister,	Emmons,	Owen,	Vanuxem.
Castelnau,	Hall,	Shumard,	

In 1861, Professor James Hall published (Descriptions of New Species of Fossils from the Upper Helderberg, Hamilton and Chemung groups; in advance sheets of the Fifteenth Annual Report of the New York State Cabinet of Natural History) a brief revision of the previously described Devonian Trilobites from the State of New York, with the addition of several new species. The following species were discussed :

<i>Calymene platys</i> , GREEN.	<i>Dalmania</i> (= <i>Dalmanites</i>) <i>anchiops</i> , var. <i>armata</i> , HALL.
<i>Homalonotus Dekayi</i> , GREEN.	<i>Dalmania</i> (= <i>Dalmanites</i>) <i>Calypso</i> , HALL.
<i>Phacops cristata</i> , HALL.	<i>Dalmania</i> (= <i>Dalmanites</i>) <i>Erina</i> , HALL.
<i>Phacops bombifrons</i> , HALL (= <i>Ph. cristata</i> , partim).	<i>Dalmania</i> (= <i>Dalmanites</i>) <i>macrops</i> , HALL.
<i>Phacops rana</i> , GREEN.	<i>Lichas grandis</i> , HALL.
<i>Phacops bufo</i> , GREEN.	<i>Lichas armatus</i> , HALL (= <i>L. Eriopis</i> , HALL).
<i>Phacops Cacaponia</i> , HALL.	<i>Proëtus Conradi</i> , HALL.
<i>Phacops nupera</i> , HALL (1843).	<i>Proëtus angustifrons</i> , HALL.
<i>Dalmania Helena</i> , HALL (= <i>Dalmanites</i>) <i>aspectans</i> , CONRAD.	<i>Proëtus Hesione</i> , HALL.
<i>Dalmania</i> (= <i>Dalmanites</i>) <i>myrmecophorus</i> , GREEN.	<i>Proëtus crassimarginatus</i> , HALL.
<i>Dalmania</i> (= <i>Dalmanites</i>) <i>emarginata</i> , HALL.	<i>Proëtus clarus</i> , HALL.
<i>Dalmania</i> (= <i>Dalmanites</i>) <i>Pleione</i> , HALL.	<i>Proëtus canaliculatus</i> , HALL.
<i>Dalmania</i> (= <i>Dalmanites</i>) <i>Boothii</i> , GREEN.	<i>Proëtus Verneuili</i> , HALL.
<i>Dalmania</i> (= <i>Dalmanites</i>) <i>selenurus</i> , EATON.	<i>Proëtus Haldemani</i> , HALL.
<i>Dalmania</i> (= <i>Dalmanites</i>) <i>bifida</i> , HALL.	<i>Proëtus macrocephalus</i> , HALL.
<i>Dalmania</i> (= <i>Dalmanites</i>) <i>Ægeria</i> , HALL.	<i>Proëtus marginalis</i> , CONRAD.
<i>Dalmania</i> (= <i>Dalmanites</i>) <i>coronata</i> , HALL.	<i>Proëtus Rowii</i> , GREEN.
<i>Dalmania</i> (= <i>Dalmanites</i>) <i>anchiops</i> , GREEN.	<i>Proëtus longicaudus</i> , HALL.
	<i>Proëtus occidentis</i> , HALL.

These species were, at this date, mostly published without illustration, but figures of these and a few additional Devonian species were given in the *Illustrations of Devonian Fossils*, in 1876.

The following authors have published descriptions or notices of the American Devonian Trilobites, and full reference to their works will be found under the generic and specific synonymies:

Barris,	Conrad,	Meek,	Walcott,
Billings,	Eaton,	Nicholson,	Whitfield,
Brongniart,	Emmons,	Owen,	Williams, H. S.,
Burmeister,	Green,	Shumard,	Williams, S. G.,
Castelnau,	Hall,	Vanuxem,	Worthen.
Clarke,	Kayser,	*Vogdes,	

The other orders of the Crustacea have only more recently attracted the attention of American writers. The XIPHOSURA have been discussed by Williams and Packard; the EURYPTERIDA, by Hall and Claypole; the PHYLLOCARIDA, by Hall, Whitfield, Clarke, Packard, Beecher, Woodward and Jones; the DECAPODA, by Whitfield; the PHYLLOPODA, by Clarke, Packard and Jones; and the CIRRIPEIDIA, by Whitfield and Clarke.

II. CLASSIFICATION.

In the discussions of the species, it has not seemed advisable to accord a strict adherence to any given system of classification. The Trilobites, which include the larger and, for the geological student, the most important part of the work, stand first in order of treatment; the other orders of the sub-class to which they belong, being considered in the latter portion of the work. In the introductory discussion of the genera the same order is followed.

The classification which has been adopted, with modifications, for the purpose of the work, is the following:

* It is understood that a "Bibliography of the Palæozoic Crustacea," by Lieut. Vogdes, is ready for press at the present writing.

INTRODUCTION.

CLASS, CRUSTACEA.

Sub-Class A. Entomostraca.

ORDER I.—CIRRIPIEDIA.

FAMILY a. LEPADIDÆ.

Genus 1. *Strobilepis*.“ 2. *Turrilepas*.

FAMILY b. BALANIDÆ.

Genus 3. *Protobalanus*.

ORDER II.—PHYLLOPODA.

FAMILY a. LIMNADIADÆ.

Genus 4. *Estheria*.“ 5. *Schizodiscus*.

ORDER III.—TRILOBITA.

FAMILY a. CALYMENIDÆ.

Genus 6. *Calymene*.“ 7. *Homalonotus*.

FAMILY b. BRONTEIDÆ.

Genus 8. *Bronteus*.

FAMILY c. PHACOPIDÆ.

Genus 9. *Phacops*.“ 10. *Dalmanites*.Sub-genus 1. *Hausmannia*.“ 2. *Coronura*.“ 3. *Cryphæus*.“ 4. *Odontocephalus*.“ 5. *Chasmops*.

FAMILY d. ACIDASPIDÆ.

Genus 11. *Acidaspis*.

FAMILY e. LICHADÆ.

Genus 12. *Lichas*.Sub-genus 1. *Terataspis*.“ 2. *Conolichas*.“ 3. *Hoplolichas*.

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FAMILY e. LICHADÆ—Continued.

- Sub-genus 4. *Arges*.
- “ 5. *Ceratolichas*.
- “ 6. *Dicranogmus*.

FAMILY f. PROËTIDÆ.

- Genus 13. *Proëtus*.
- “ 14. *Phaëthonides*.
- “ 15. *Cyphaspis*.

Sub-Class B. Merostomata.

ORDER IV.—XIPHOSURA.

FAMILY a. LIMULIDÆ.

- Genus 16. *Protolimulus*.

ORDER V.—EURYPTERIDA.

FAMILY a. EURYPTERIDÆ.

- Genus 17. *Eurypterus*.
- “ 18. *Stylonurus*.

Sub-Class C. Malacostraca.

ORDER VI.—PHYLLOCARIDA.

FAMILY a. CERATIOCARIDÆ.

- Genus 19. *Ceratiocaris*.
- “ 20. *Echinocaris*.
- “ 21. *Elymocaris*.
- “ 22. *Tropidocaris*.

FAMILY b. PINACARIDÆ.

- Genus 23. *Mesothyra*.

FAMILY c. RHINOCARIDÆ.

- Genus 24. *Rhinocaris*.

FAMILY d. DISCINOCARIDÆ.

- Genus 25. *Spathiocaris*.
- “ 26. *Dipterocaris*.

ORDER VII.—DECAPODA.

FAMILY a. CARIDIDÆ.

- Genus 27. *Palæopalemon*.

III. CHRONOLOGICAL DISTRIBUTION.

Oriskany sandstone.

In the eastern outcrops of this formation but a single Crustacean species is known, the gigantic *Homalonotus major*, from Ulster county. In the western extension of these rocks into the Province of Ontario, are the species *Phacops cristata*, *Dalmanites* (*Hausmannia*) *pleuroptyx* and *Dalmanites* (*Chasmops*) *anchiops*, all of which occur in the overlying Upper Helderberg limestones, a fact which indicates the close alliance of the western Oriskany fauna to the true Devonian.

UPPER HELDERBERG GROUP.

Cauda-galli grit.

No Crustacea have been found in this formation.

Schoharie grit.

The rich Crustacean fauna of these rocks is exclusively trilobitic, and consists of eighteen species from the local development of the formation in eastern New York. These are:

<i>Calymene platys.</i>	<i>Lichas</i> (<i>Terataspis</i>) <i>grandis.</i>
<i>Phacops cristata.</i>	<i>Lichas</i> (<i>Conolichas</i>) <i>hispidus.</i>
<i>Dalmanites</i> (<i>Hausmannia</i>) <i>concinus.</i>	<i>Proetus</i> <i>Conradi.</i>
<i>Dalmanites</i> (<i>Coronura</i>) <i>emarginatus.</i>	<i>Proetus</i> <i>angustifrons.</i>
<i>Dalmanites</i> (<i>Corycephalus</i>) <i>regalis.</i>	<i>Proetus</i> <i>Hesione.</i>
<i>Dalmanites</i> (<i>Chasmops</i>) <i>anchiops.</i>	<i>Proetus</i> <i>crassimarginatus.</i>
<i>Dalmanites</i> (<i>Chasmops</i>) <i>anchiops</i> , var. <i>armatus.</i>	<i>Proetus</i> <i>sp.</i>
<i>Dalmanites</i> (<i>Chasmops</i>) <i>anchiops</i> , var. <i>sobrinus.</i>	<i>Phaceltonides</i> <i>arenicolus.</i>
<i>Acidaspis callicera.</i>	<i>Cyphasps</i> <i>minuscule.</i>

In addition to these are the species *Proetus curvimarginatus* and *Proetus latimarginatus*, from the sandstone beds at Pendleton, Indiana, which lie at the base of the Corniferous limestone, and contain a fauna closely allied to that of the Schoharie grit in the State of New York.

Corniferous limestone.

The greatest numerical development of the Devonian Crustacea, as a whole, is found in this extensive formation. The species are, however, mostly of Trilobites which here attain their specific and individual culmination, all other orders of Crustacea, excepting the CIRRIPIEDIA being unrepresented. The

condition of preservation of the fossils is often unsatisfactory, the specimens being generally in a disjointed or fragmentary condition; moreover the character of the matrix is such that it is often a matter of great difficulty to prepare the specimens in a proper manner for study. When the test of the animal has been silicified the matrix is usually in the same condition, and when preserved in the limestone, the substance of the test is usually softer and more friable than the matrix. The transported boulders of chert which are found abundantly in the drift accumulations south of the lines of outcrop of these rocks, and have become decomposed by the gradual removal of the calcic carbonate mixed with the silica, have proven a very fruitful source of instructive specimens. On account of the usually fragmentary condition of the specimens, a few of the species here described may eventually prove to be founded upon different parts of similar animals. The following fifty-two species at present constitute the Crustacean fauna of this formation:

TRILOBITA:

- Calymene platys.*
- Phacops cristata.*
- Phacops cristata*, var. *pipa*.
- [?] *Phacops rana.*
- Dalmanites (Hausmannia) pleuroptyx.*
- Dalmanites (Hausmannia) concinnus.*
- Dalmanites (Hausmannia) concinnus*, var. *serrula.*
- Dalmanites (Hausmannia) phacoptyx.*
- Dalmanites (Coronura) aspectans.*
- Dalmanites (Coronura) myrmecophorus.*
- Dalmanites (Cryphæus) comis.*
- [?] *Dalmanites (Cryphæus) Boothi.*
- Dalmanites (Odontocephalus) selenurus.*
- Dalmanites (Odontocephalus) bifidus.*
- Dalmanites (Odontocephalus) Ægeria.*
- Dalmanites (Odontocephalus) coronatus.*
- Dalmanites (Corycephalus) pygmaeus.*
- Dalmanites (Chasmops) anchiops.*
- Dalmanites (Chasmops) anchiops*, var. *armatus.*
- Dalmanites (Chasmops) Calypso.*
- Dalmanites (Chasmops?) Erina.*
- Dalmanites (Chasmops) macrops.*
- Acidaspis callicera.*
- Acidaspis sp.*
- Lichas (Terataspis) grandis.*
- Lichas (Conolichas) hispidus.*
- Lichas (Conolichas) Eriopsis.*

TRILOBITA:

- Lichas (Hoplolichas) hylæus.*
- Lichas (Arges) contusus.*
- Lichas (Ceratolichas) gryps.*
- Lichas (Ceratolichas) dracon.*
- Proëtus crassimarginatus.*
- Proëtus folliceus.*
- Proëtus clarus.*
- Proëtus canaliculatus.*
- Proëtus Vernenili.*
- Proëtus microgemma.*
- Proëtus stenopyge.*
- Proëtus ovifrons.*
- Proëtus delphinulus.*
- Proëtus (?) planimarginatus.*
- Proëtus tumidus.*
- Phaëthonides arenicolus.*
- Phaëthonides varicella.*
- Phaëthonides gemmaeus.*
- Cyphaspsis minuscula.*
- Cyphaspsis stephanophora.*
- Cyphaspsis diadema.*
- Cyphaspsis hybrida.*

CIRRIPEDIA:

- Palaeocrensia Devonica.*
- Turrilepas flexuosus.*
- Turrilepas cancellatus.*

Of these species *one* occurs in the Lower Helderberg group, viz.: *Dalmanites* (*Hausmannia*) *pleuroptyx*; three in the Oriskany sandstone, viz.: *Phacops cristata*, *Dalmanites* (*Hausmannia*) *pleuroptyx*, and *Dalmanites* (*Chasmops*) *anchiops*; and *eleven* in the Schoharie grit, viz.:

<i>Calymene platys.</i>	<i>Lichas</i> (<i>Terataspis</i>) <i>grandis.</i>
<i>Phacops cristata.</i>	<i>Lichas</i> (<i>Conolichas</i>) <i>hispidus.</i>
<i>Dalmanites</i> (<i>Hausmannia</i>) <i>concinuus.</i>	<i>Proetus crassimarginatus.</i>
<i>Dalmanites</i> (<i>Chasmops</i>) <i>anchiops.</i>	<i>Phaethonides arenicolus.</i>
<i>Dalmanites</i> (<i>Chasmops</i>) <i>anchiops</i> , var. <i>armatus.</i>	<i>Cyphasps minuscula.</i>
<i>Acidasps callicera.</i>	

But a single characteristic species of this fauna ranges upward into the Hamilton, viz.: *Phaethonides gemmæus*.

HAMILTON GROUP.

Marcellus shales.

The TRILOBITES found in these beds all pass upward into the Hamilton shales where they attain a more perfect development. These are:

<i>Homalonotus Dekayi.</i>	<i>Proetus Haldemani.</i>
<i>Phacops rana.</i>	<i>Proetus macrocephalus.</i>
<i>Dalmanites</i> (<i>Cryphaeus</i>) <i>Boothi.</i>	

The peculiar character of the sea which deposited these bituminous shales was not favorable to the existence of these animals, and it is only where the deposit becomes calcareous that trilobitic remains are found. In addition to these occurs the earliest known species of the Devonian PHYLLOCARIDA, *Mesothyra* (*Dithyrocaris*?) *Veneris*, and the interesting CIRRIPEDE, *Protobalanus Hamiltonensis*.

Hamilton shales.

In the rich fauna of these beds, the Crustacean element is much more varied than at any other Devonian horizon. The Trilobites have become much fewer in number since the close of the Upper Helderberg period, their place being taken by members of other Crustacean orders. The species occurring in the group are as follows:

<i>Homalonotus Dekayi.</i>	* <i>Dalmanites</i> (<i>Cryphaeus</i>) <i>Pleione.</i>
<i>Phacops rana.</i>	<i>Dalmanites</i> (<i>Cryphaeus</i>) <i>Boothi.</i>
* <i>Phacops bufo.</i>	<i>Dalmanites</i> (<i>Cryphaeus</i>) <i>Boothi</i> , var. <i>Callitels.</i>
* <i>Phacops Cacopona.</i>	* <i>Dalmanites</i> (<i>Cryphaeus</i>) <i>Barrisi.</i>
* <i>Dalmanites</i> (<i>Hausmannia</i> ?) <i>Meeki.</i>	* <i>Acidasps Romingeri.</i>

Proetus Haldemani.
Proetus macrocephalus.
Proetus Rowi.
Proetus jejunus.
 * *Proetus Phocion.*
 * *Proetus Prouti.*
 * *Proetus Nevadaæ.*

* *Proetus occidentens.*
 * *Proetus (?) longicaudus.*
Phaethonides gemmatus.
 * *Phaethonides (?) denticulatus.*
Cyphaspis ornata.
Cyphaspis ornata, var. *baccata.*
Cyphaspis craspedota.

Of this list those bearing a star (*) are from localities outside the State of New York, which may be regarded as of the age of the Hamilton group.

Of the PHYLLOCARIDA, are :

Echinocaris punctata.
Elymocaris capsella.
Tropidocaris Hamiltonia.
Mesothyra Neptuni.

Mesothyra spumata.
(Dithyrocaris) Belli.
Rhinocaris columbina.
Rhinocaris scaphoptera.

Of the PHYLLOPODA, the species :

Estheria pulcr.

Schizodiscus capsula.

Of the CIRRIPIEDIA :

Strobilepis spinigera.
Turrilepas Devonicus.
Turrilepas squama.

Turrilepas nitidulus.
Turrilepas foliatus.
Turrilepas tener.

Of these forty species, twenty-nine occur within the limits of this State.

Tully limestone.

Trilobitic remains only have been found in this formation, and these are, with one exception, the more common species of the underlying shales.

Bronteus Tullius.
Phacops rana.
Dalmanites (Cryphæus) Boothi.

Dalmanites (Cryphæus) Boothi, var. *Calliteles.*
Proetus Rowi.
Proetus macrocephalus.

Genesee shales.

These bituminous beds have produced but a single Crustacean, *Ceratiocaris longicauda*.

PORTAGE GROUP.

Under this designation, as used in this work, are included all the shales and sandstones lying between the Genesee shales below and the lowest sandstones bearing a typical Chemung fauna. These beds and their equivalents in other

States have produced no Trilobites, their Crustacean fossils being mostly PHYLLOCARIDA. They are :

<i>Stylonurus?</i> (<i>Echinocaris?</i>) <i>Wrightianus</i> .	<i>Echinocaris multinodosa</i> .
<i>Ceratiocaris Beecheri</i> .	<i>Mesothyra Oceani</i> .
<i>Ceratiocaris?</i> <i>simpler</i> .	<i>Spathiocaris Emersoni</i> .
<i>Echinocaris Whitfieldi</i> .	<i>Dipterocaris pennæ-Dædali</i> .
<i>Echinocaris sublaevis</i> .	<i>Dipterocaris pes-cervæ</i> .
<i>Echinocaris pustulosa</i> .	<i>Palæopalæmon Newberryi</i> .

CHEMUNG GROUP.

In the sandstones of this period the TRILOBITES are represented by two species, *Phacops nupera* (see page 27) and *Cyphaspis lævis*; the XIPHOSURA, by the species *Protolimulus Eriensis*; the EURYPTERIDA, by *Eurypterus Beecheri*; the PHYLLOCARIDA, by :

<i>Echinocaris condylepis</i> .	<i>Tropidocaris interrupta</i> .
<i>Echinocaris socialis</i> .	<i>Dipterocaris Procne</i> .
<i>Elymocaris siliqua</i> .	<i>Dipterocaris pes-cervæ</i> .
<i>Tropidocaris bicarinata</i> .	

The CIRRIPIEDIA are represented by *Turrilepas (?) Newberryi*; making a total of eleven species.

CATSKILL GROUP.

The sandstones of the town of Andes, Delaware county, and of Meshoppen, Wyoming county, Pennsylvania, have furnished specimens of the only known Crustacean from this formation, *Stylonurus excelsior*.

SYNOPSIS OF GENERA.

ORDER, TRILOBITA.

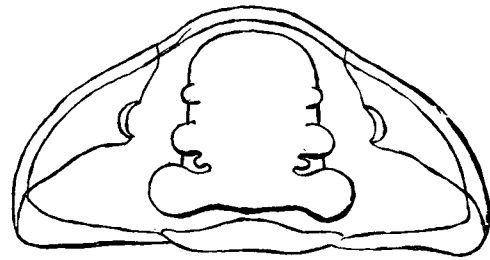
FAMILY, CALYMENIDÆ.

GENUS CALYMENE, BRONGNIART. 1822.

- 1759. *Entomolithus*, LINNE (*partim*). Act. Holm. 22.
- 1781. *Trilobus*, BRUENNICH. Kjöben. Selsk. Skrivt. Nye Saml. I.
- 1821. *Entomostracites*, WAHLENBERG. Nov. Act. Soc. Sci. Upsal., vol. viii.
- 1822. *Calymene*, BRONGNIART. Hist. Nat. Crust. Fossiles.
- 1826. *Calymene*, DALMAN. Ueber Palæaden.
- 1829. *Calymene*, HOLL. Handb. d. Petref.
- 1832. *Calymene*, GREEN. Monog. N. Am. Trilob.
- 1835. *Calymene*, BRONN. Lethæa Geognostica.
- 1837. *Calymene*, HISINGER. Lethæa Suecica.
- 1837. *Calymene*, BUCKLAND. Bridgewater Treat., vol. ii.
- 1837. *Calymene*, QUENSTEDT. Wiegmann. Archiv., vol. iv.
- 1839. *Calymene*, MURCHISON. Silurian System.
- 1839. *Calymene*, EMMRICH. De Trilobitis.
- 1839. *Calymene*, CONRAD. Second Ann. Rept. Pal. N. Y.
- 1840. *Calymene*, SEDGWICK and MURCHISON. Trans. Geol. Soc.
- 1840. *Calymene*, MILNE-EDWARDS. Hist. Nat. Crustacés.
- 1841. *Calymene*, CONRAD. Fifth Ann. Rept. Pal. N. Y.
- 1842. *Calymene*, EMMONS. Rept. Second Dist. N. Y.
- 1842. *Calymene*, VANUXEM. Rept. Third Dist. N. Y.
- 1843. *Calymene*, GOLDFUSS. Neues Jahrb. für Min., vol. v.
- 1843. *Calymene*, BURMEISTER. Organ. d. Trilobiten.
- 1843. *Calymene*, PORTLOCK. Geol. Rept. Londonderry.
- 1843. *Calymene*, HALL. Rept. Fourth Dist. N. Y.
- 1844. *Calymene*, D'ARCHIAC and DE VERNEUIL. Âlt. palæozoisch. Geb. im Nord. von Deutschl. und Belgien. (Leonhardt).
- 1845. *Calymene*, EMMRICH. Neues Jahrb. für Min.
- 1846. *Calymene*, GEINITZ. Grundr. d. Versteinerungen.
- 1846. *Calymene*, PICTET. Traité élém. d. Paléont., vol. iv.
- 1846. *Calymene*, BARRANDE. Notice Prélim. and Nouv. Trilob.
- 1846. *Calymene*, ROUAULT. Bull. Soc. géol. d. France, vol. iv.
- 1846. *Calymene*, MCCOY. Synop. Sil. Foss. Ireland.
- 1846. *Calymene*, BEYRICH. Untersuchungen üb. Trilob.
- 1847. *Calymene*, CORDA. Prodrum Monog. böhm. Trilobiten.
- 1847. *Calymene*, HALL. Pal. N. Y., vol. i.
- 1848. *Calymene*, SALTER. Mem. Geol. Surv. United Kingdom, vol. ii.

1849. *Calymene*, SALTER. Mem. Geol. Surv. United Kingdom, Decade ii.
 1850. *Calymene*, MCCOY. Ann. and Mag. Nat. Hist., vol. iv.
 1851. *Calymene*, MCCOY. Synop. Pal. Foss. Woodwardian Mus.
 1852. *Calymene*, BARRANDE. Syst. Sil. d. Bohême, vol. i.
 1852. *Calymene*, OWEN. Geol. Surv. Wis., Iowa and Minn.
 1855. *Calymene*, SHUMARD. Rept. Geol. Surv. Missouri.
 1855. *Calymene*, EMMONS. American Geology.
 1858. *Calymene*, BIGSBY. Quart. Jour. Geol. Soc.
 1860. *Calymene*, HALL. Thirteenth Rept. N. Y. State Cab. Nat. Hist.
 1861. *Calymene*, HALL. Geol. Rept. Wisconsin.
 1862. *Calymene*, MCCOY. Synop. Sil. Foss. Ireland.
 1862. *Calymene*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist.
 1864. *Calymene*, SALTER. Monog. Brit. Trilobites.
 1865. *Calymene*, SALTER. Mem. Geol. Survey United Kingdom.
 1867. *Calymene*, HALL. Twentieth Rept. N. Y. State Cab. Nat. Hist.
 1869. *Calymene*, LINNARSSON. Vestergöth. camb. och. silur. Aflag.
 1869. *Calymene*, HAIDENHAIN. Zeitschr. d. deutsch. geol. Gesellsch.
 1872. *Calymene*, BARRANDE. Syst. Sil. d. Bohême, vol. i, suppl.
 1873. *Calymene*, MEEK. Geol. Surv. Ohio, Palæontology, vol. i.
 1875. *Calymene*, MEEK. Geol. Surv. Ohio, Palæontology, vol. ii.
 1876. *Calymene*, HALL. Illustrations of Devonian Fossils.
 1876. *Calymene*, RÖEMER. Lethæa palæozoica.
 1878. *Calymene*, ANGELIN. Pal. Scandinavica, pt. i.
 1879. *Calymene*, ULRICH. Jour. Cin. Soc. Nat. Hist., vol. ii.
 1879. *Calymene*, NOVAK. Studien an Hypostomen, i.
 1880. *Calymene*, VOGDES. Proc. Acad. Nat. Sci. Phil.
 1881. *Calymene*, HALL. Eleventh Rept. Geol. Surv. Indiana.
 1881. *Calymene*, WALCOTT. Bull. Mus. Comp. Zoölogy, Harvard Coll.
 1883. *Calymene*, NOVAK. Zur Kenntn. böhmisch. Trilob.
 1884. *Calymene*, NOVAK. Studien an Hypostomen, ii.
 1885. *Calymene*, ZITTEL. Handb. d. Palæontologie.
 1885. *Calymene*, ŒHLERT. Bull. de la Soc. d'Etudes scientif. d'Angers.
 1887. *Calymene*, FOERSTE. Bulletin, Denison University.

DIAGNOSIS. Body oval. *Cephalon* semicircular, nearly three times as wide as long; rounded in front, genal angles blunt, rarely produced into spines. Anterior margin somewhat elevated; glabella strongly arched, sharply limited by deep dorsal furrows, and divided into three pairs of sub-spherical lobes, by the unequal, short lateral furrows, the posterior pair of which bifurcate near their proximal extremities. Cheeks convex, and with a distinct marginal border. Eyes situated somewhat anteriorly; visual surface small, homocorneal. The facial sutures begin at the genal angles, and pass in a sigmoid curve to the eyes, thence, parallel to the axis, to the anterior margin, where they are united by the



transverse frontal suture. Hypostoma small, elongate-sub-quadrate; sides gently concave; posterior edge emarginate.

Thorax composed of thirteen broad segments; axis tapering backward.

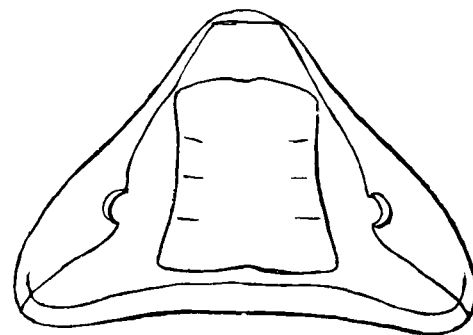
Pygidium bearing six to eleven distinct annulations; axis regularly tapering from the thorax.

GENUS HOMALONOTUS. KÆNIG. 1825.

- 1822. *Asaphus*, BRONGNIART. Hist. Nat. Crust. Fossiles.
- 1825. *Homalonotus*, KÆNIG. Icones foss. sectiles.
- 1825. *Asaphus*, DESLONGCHAMPS. Mem. Soc. Linn. du Calvados.
- 1828. *Asaphus*, DALMAN. Vet. Acad. Arsberätt.
- 1832. *Dipleura*, *Trimerus*, GREEN. Monog. Trilob. N. America.
- 1835. *Homalonotus*, BRONN. Lethæa Geognostica.
- 1837. *Trimerus*, GREEN. Amer. Jour. Science.
- 1839. *Homalonotus*, EMMRICH. De Trilob. Dissert.
- 1839. *Homalonotus*, MURCHISON. Silurian System.
- 1840. *Homalonotus*, MILNE-EDWARDS. Hist. Nat. Crustacés.
- 1840. *Homalonotus*, BRONN. Leonhardt's Jahrb. für Min.
- 1841. *Homalonotus*, PHILLIPS. Palæoz. Foss. Cornwall, Devon and Somerset.
- 1842. *Dipleura*, CONRAD. Jour. Acad. Nat. Sci.
- 1842. *Homalonotus*, D'ARCHIAC and DE VERNEUIL. Trans. Geol. Soc.
- 1842. *Dipleura*, VANUXEM. Rept. Third Dist. N. Y.
- 1843. *Homalonotus*, *Dipleura*, HALL. Rept. Fourth Dist. N. Y.
- 1843. *Dipleura*, *Homalonotus*, GOLDFUSS. Neues Jahrb. für Min.
- 1843. *Homalonotus*, CASTELNAU. Ess. sur le Syst. Sil. de l'Amer. Sept.
- 1843. *Homalonotus*, GOLDFUSS. Neues Jahrb. für Min.
- 1843. *Homalonotus*, F. A. RÆMER. Verstein. des Harzgeb.
- 1844. *Homalonotus*, SEDGWICK and MURCHISON. Ælt. palæoz. Geb. im Norden von Deutschl. und Belgien.
- 1844. *Homalonotus*, EICHWALD. Sil. Syst. in Esthland.
- 1846. *Homalonotus*, BURMEISTER. Organ. der Trilob.
- 1845. *Homalonotus*, EMMRICH. Neues Jahrbuch für Min.
- 1847. *Plæsiacomia*, CORDA. Prodr. Monog. böhm. Trilob.
- 1849. *Homalonotus*, ROUAULT. Bull. de la Soc. géol. de France.
- 1849. *Homalonotus*, SALTER. Ann. and Mag. Nat. Hist.
- 1850. *Homalonotus*, the Brothers SANDBERGER. Verst. Rhein Sch. Syst.
- 1850. *Homalonotus*, DE VERNEUIL. Bull. Soc. géol. de France.
- 1851. *Homalonotus*, MCCOY and SEDGWICK. Synopsis Brit. Pal. Foss.
- 1852. *Homalonotus*, HALL. Pal. N. Y., vol. ii.
- 1852. *Homalonotus*, BARRANDE. Syst. Sil. Bohême, vol. i.
- 1852. *Homalonotus*, F. A. RÆMER. Beitr. ii, zur Harzgeb.
- 1854. *Homalonotus*, WIRTGEN and ZEILER. Verhandl. d. Naturhist. Vereins.
- 1855. *Homalonotus*, F. A. RÆMER, Beitr. iii, zur Harzgeb.
- 1855. *Homalonotus*, ANGELIN. Palæontologia Scandinavica.
- 1858. *Homalonotus*, HOFFMANN. Trilob. Russlands.
- 1858. *Homalonotus*, BIGSBY. Quart. Jour. Geol. Soc., vol. xiv.
- 1859. *Homalonotus*, HALL. Pal. N. Y., vol. iii.
- 1860. *Homalonotus*, EICHWALD. Lethæa Rossica.
- 1860. *Homalonotus*, HALL. Canad. Nat. and Geol.
- 1862. *Homalonotus*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist.

1863. *Homalonotus*, F. A. RÖMER. Neues Jahrb. für Min.
 1864. *Brongniartia*, SALTER. Monog. Brit. Trilobites.
 1864. *Trimerus*, SALTER. Monog. Brit. Trilobites.
 1864. *Kœnigia*, SALTER. Monog. Brit. Trilobites.
 1864. *Dipleura*, SALTER. Monog. Brit. Trilobites.
 1864. *Burmeisteria*, SALTER. Monog. Brit. Trilobites.
 1864. *Homalonotus*, DE VERNEUIL. Bull. de la Soc. géol. de France.
 1864. *Homalonotus*, TCHIHATCHEFF. Le Bosphore et Constantinople.
 1864. *Homalonotus*, SALTER. Quart. Jour. Geol. Soc.
 1866. *Homalonotus*, D'ARCHIAC, FISCHER and DE VERNEUIL. In Tchihatcheff's Asie Mineure.
 1867. *Homalonotus*, DE VERNEUIL. Comptes rendus.
 1867. *Homalonotus*, ETHERIDGE. Quart. Jour. Geol. Soc.
 1868. *Homalonotus*, DEWALQUE. Prodr. d. descript. géol. de Belgique.
 1869. *Homalonotus*, SALTER and WOODWARD. Monog. Brit. Trilobites.
 1872. *Homalonotus*, BARRANDE. Syst. Sil. Bohême, vol. i, suppl.
 1873. *Homalonotus*, WASHBURN. Amer. Jour. Science.
 1875. *Homalonotus*, HARTT and RATHBUN. Ann. Lyc. Nat. Hist.
 1876. *Homalonotus*, HALL. Illustrations of Devonian Fossils.
 1876. *Homalonotus*, *Dipleura*, RÖMER. Lethæa palæozoica.
 1878. *Homalonotus*, ANGELIN. Palæontologia Scandinavica.
 1879. *Homalonotus*, HALL. Twenty-eighth Rept. N. Y. State Mus. Nat. Hist.
 1879. *Homalonotus*, GERSTÄCKER. Bronn's Class. u. Ordnung. der Thierr., vol. v.
 1881. *Homalonotus*, BEYRICH. Zeitschr. d. deut. geol. Gesellsch.
 1881. *Homalonotus*, HALL. Eleventh Rept. Geol. Surv. Indiana.
 1881. *Homalonotus*, WOODWARD. Geol. Mag., vol. viii.
 1882. *Homalonotus*, WOODWARD. Geol. Mag., vol. ix.
 1882. *Homalonotus*, BARROIS. Rech. sur les Terrains anc. des Asturies et de la Galice.
 1883. *Homalonotus*, KOCH. Monog. Homal. Art. Rhein. Unterdev.
 1883. *Homalonotus*, NOVAK. Zur Kenntn. böhm. Trilob.
 1884. *Homalonotus*, NOVAK. Studien an Hypost., ii.
 1884. *Homalonotus*, BEUSHAUSEN. Oberharz. Spirif. Sandstn.
 1885. *Homalonotus*, WHITFIELD. Bull. Am. Mus. Nat. Hist., No. 6.
 1885. *Homalonotus*, GOSSELET. Proc. Geol. Assoc. and Ann. de la Soc. géol. du Nord.
 1886. *Homalonotus*, MAURER. Fauna rechtsrhein. Unterdev.
 1886. *Homalonotus*, GOSSELET. Ann. de la Soc. géol. du Nord.
 1886. *Homalonotus*, BARROIS. Bull. de la Soc. géol. de France.
 1886. *Homalonotus*, LEBESCONTE. Bull. de la Soc. géol. de France.

DIAGNOSIS. Body usually large, produced, depressed above, with abruptly sloping sides. Axial furrows indistinct or obsolete. Surface smooth or spinose. *Cephalon* depressed-convex, wider than long; genal angles rounded; anterior margin somewhat produced; glabella sub-rectangular, smooth or with faint lateral furrows; eyes small, situated somewhat back of the middle of the shield; the facial sutures run from the genal angles over the eyes, converging toward the frontal margin, where they are connected by the transverse frontal



suture, thence they continue to the edge of the doublure, where they meet, thus inclosing a small, free, sub-triangular plate. *Thorax* composed of thirteen deeply sulcate segments. *Pygidium* smaller than the cephalon, elongate-triangular, posteriorly rounded or slightly produced. The axis bears usually from ten to fourteen annulations. Pleuræ smooth, or with posteriorly sloping ribs.

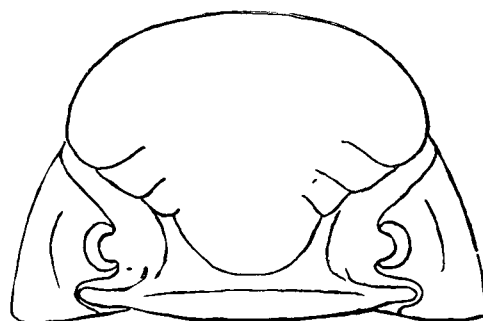
FAMILY, BRONTEIDÆ.

GENUS BRONTEUS, GOLDFUSS. 1843.

- 1821. *Entomostracites*, WAHLENBERG. Nov. Act. Soc. Sci. Upsala.
- 1822. *Asaphus*, BRONGNIART. Hist. Nat. Crust. foss.
- 1823. *Asaphus*, SCHLOTHEIM. Nacht. ii, zur Petrefakten.
- 1826. *Asaphus* (*Illænus*), DALMAN. Ueber Palæaden.
- 1831. *Asaphus*, STEININGER. Mém. Soc. géol. de France.
- 1832. *Olenus*, GOLDFUSS. Dechen's Handb. der Geognosie.
- 1839. *Asaphus* (*Olenus*), MURCHISON. Silurian System.
- 1839. *Asaphus*, EMMRICH. De Trilob. Dissert.
- 1839. *Brontes*, GOLDFUSS. Nov. Act. Acad. N. C.
- 1840. *Brontes*, MUENSTER. Beitr. iii, zur Petrefaktenkunde.
- 1840. *Brontes*, SEDGWICK and MURCHISON. Trans. Geological Society.
- 1841. *Goldius*, DE KONINCK. Nouv. Mém. de l'Acad. roy. de Bruxelles.
- 1841. *Brontes*, PHILLIPS. Pal. Foss. Cornwall Devon and Somerset.
- 1842. *Brontes*, D'ARCHIAC and DE VERNEUIL. Trans. Geological Society.
- 1842. *Brontes*, MUENSTER. Beitr. V, zur Petrefaktenkunde.
- 1843. *Brontes*, F. A. RÖMER. Verstein. des Harzgeb.
- 1843. *Bronteus* (*Brontes*), GOLDFUSS. Neues Jahrb. für Min.
- 1843. *Bronteus*, BURMEISTER. Organiz. d. Trilob.
- 1843. *Brontes*, PORTLOCK. Geol. Rept. Londonderry.
- 1844. *Brontes*, SEDGWICK and MURCHISON. Ält. Paläoz. Gebilde im Nord. von Deutschl. und Belgien (Leonhardt).
- 1845. *Bronteus*, EMMRICH. Neues Jahrb. für Min.
- 1845. *Bronteus*, MURCHISON, DE VERNEUIL and KEYSERLING. Russie et Oural.
- 1845. *Bronteus*, BEYRICH. Ueb. böhm. Trilob.
- 1846. *Bronteus*, MCCOY. Syn. Sil. Foss. Ireland.
- 1846. *Bronteus*, BARRANDE. Not. prélim. sur le Syst. Sil. Bohême.
- 1846. *Bronteus*, BEYRICH. Untersuchungen üb. Trilob. II.
- 1846. *Bronteus*, LOGAN. Rept. Geol. Surv. Canada.
- 1847. *Bronteus*, CORDA. Prodröm. Mon. böhmischen Trilobiten.
- 1850. *Bronteus*, MCCOY. Ann. and Mag. Nat. Hist.
- 1850. *Bronteus*, the BROTHERS SANDBERGER. Verst. d. Rhein. Sch. Syst.
- 1852. *Bronteus*, HALL. Pal. N. Y., vol. ii.
- 1852. *Bronteus*, BARRANDE. Syst. Sil. Bohême, vol. i.
- 1852. *Bronteus*, F. A. RÖMER. Beitr. ii, zur Harzgeb.
- 1855. *Bronteus*, F. A. RÖMER. Beitr. iii, zur Harzgeb.
- 1857. *Bronteus*, BILLINGS. Rept. Prog. Geol. Surv. Canada.
- 1858. *Bronteus*, GIEBEL. Silur. Fauna Unterharz.

1859. *Bronteus*, HALL. Pal. N. Y., vol. iii.
 1862. *Bronteus*, MCCOY. Synops. Sil. Foss. Ireland.
 1863. *Bronteus*, BILLINGS. Dev. and Silur. Foss., Square Lake, Maine.
 1866. *Bronteus*, BILLINGS. Cat. Silur. Foss. Anticosti.
 1866. *Bronteus*, F. A. RÖMER. Beitr. v zur Harzgeb.
 1867. *Bronteus*, HALL. Twentieth Rept. N. Y. State Cab. Nat. Hist.
 1870. *Bronteus*, BONNISSENT. Essai sur la géologie de la Manche.
 1872. *Bronteus*, BARRANDE. Syst. Sil. Bohême. vol. i, Suppl.
 1874. *Bronteus*, GOSSELET. Bull. de l'Acad. roy. de Belgique.
 1876. *Goldius*, TROMELIN and LEBESCONTE. Bull. Soc. géol. de France.
 1876. *Bronteus*, RÖMER. Lethæa palæozoica.
 1877. *Bronteus*, TROMELIN and GRASSET. Assoc. français Avanc. Sci.
 1878. *Bronteus*, WHITFIELD. Ann. Rept. Geol. Surv. Wisconsin.
 1878. *Goldius*, BAYLE. Expl. Carte géologique de France, Atlas.
 1878. *Bronteus*, KAYSER. Fauna ælt. Devon. Abl. d. Harzes.
 1879. *Bronteus*, KAYSER. Zeitschr. der deutsch. geol. Gesellschaft.
 1879. *Bronteus*, NOVAK. Studien an Hypostomen, i.
 1882. *Bronteus*, WHITFIELD. Geol. Wisconsin, vol. iv.
 1883. *Bronteus*, NOVAK. Zur Kenntn. böhm. Trilob.
 1884. *Bronteus*, CLARKE. Neues Jahrb. für Min.
 1884. *Bronteus*, NOVAK. Studien an Hypostomen, ii.
 1885. *Goldius*, OEHLERT. Bull. de la Soc. d'Etudes Scientif. d'Angers.
 1885. *Bronteus*, BARROIS. Ann. Soc. géol. du Nord.
 1885. *Bronteus*, MAURER. Kalke von Waldgirmes.
 1885. *Bronteus*, ZITTEL. Handb. d. Palæontologie.
 1886. *Bronteus*, BARROIS. Ann. Soc. géol. du Nord.
 1887. *Goldius*, TSCHERNYCHEW. Mém. Comité. géol.
 1888. *Brontes*, FRECH. Zeitschr. der deutsch. geol. Gesellschaft.
 1888. *Bronteus*, PENECKE. Zeitschr. der deutsch. geol. Gesellschaft.

DIAGNOSIS. Body broadly oval. *Cephalon* semi-circular, with sharp, often somewhat produced genal angles. Glabella closely appressed to the cheeks, broad anteriorly and extending to the frontal margin. Lateral furrows indistinct or obsolete. The facial sutures begin on the posterior margin, and in front of the eyes run nearly parallel to the margin of the glabella, being continuous on the frontal margin. Eyes lunate, homocorneal, and situated somewhat posteriorly. *Thorax* slightly larger than the cephalon, and composed of ten segments, which upon the pleuræ are simple and sharply pointed. *Pygidium* very large, depressed-convex, parabolic in outline, with a very short sub-triangular axis. The pleuræ each bear seven or eight simple ribs, arranged on each side of a larger median simple or compound rib.



GENUS PHACOPS, EMMRICH. 1839.

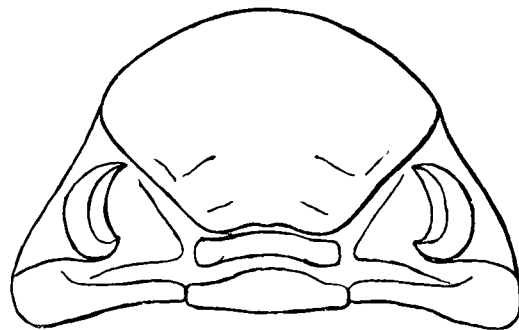
1770. *Echinites*, ZENO. Nene Physik. Belustig. vol. i.
 1822. *Calymene*, BRONGNIART. Hist. Nat. Crust. Foss.
 1823. *Trilobites*, SCHLOTHEIM. Nachtr. ii, zur Petref.
 1824. *Calymene*, HÖNINGHAUS. Nöggerrath's Rheinl. u. Westphal. and Isis.
 1825. *Calymene*, BRONN. Leonhardt's Zeitsch. Min.
 1825. *Trilobites*, STERNBERG. Verhand. d. Vaterl. Mus.
 1826. *Calymene*, DALMAN. Ueber Palæaden.
 1831. *Calymene*, STEININGER. Mém. Soc. géol. d. France.
 1832. *Calymene*, GOLDFUSS. Dechen's Handb. d. Geognosie.
 1832. *Calymene*, GREEN. Mon. Trilob. N. America.
 1835. *Calymene*, BRONN. Lethæa geognostica.
 1837. *Calymene*, BUCKLAND. Bridgewater Treatise.
 1837. *Trilobites*, QUENSTEDT. Wiegmann. Archiv.
 1838. *Trilobites*, SARS and BOECK. Gæa Norvegica.
 1839. *Calymene*, MURCHISON. Silurian System.
 1839. *Phacops*, EMMRICH. De Trilob. Dissert.
 1840. *Calymene*, SOWERBY. Trans. Geological Society.
 1840. *Calymene*, EICHWALD. Urwelt Russlands.
 1840. *Calymene*, MUENSTER. Beitr. iii, zur Petrefaktenkunde.
 1840. *Calymene*, MILNE-EDWARDS. Hist. Nat. Crust.
 1840. *Phacops*, VON BUCH. Beitr. zur Geol. Russlands.
 1841. *Calymene*, PHILLIPS. Pal. Foss. Cornwall, Devon. and Somerset.
 1842. *Calymene*, D'ARCHIAC and DE VERNEUIL. Trans. Geol. Soc. Lond.
 1842. *Calymene*, MUENSTER. Beitr. zur Petrefaktenkunde.
 1843. *Phacops*, GOLDFUSS. Neues Jahrb. für Min.
 1843. *Calymene*, ASAPHUS, F. A. RÖMER. Verst. des Harzgeb.
 1843. *Phacops*, BURMEISTER. Organiz. der Trilobiten.
 1843. *Phacops*, PORTLOCK. Rept. Geol. Londonderry.
 1843. *Calymene*, HALL. Rept. Fourth Dist. N. Y.
 1844. *Phacops*, C. F. RÖMER. Rhein. Uebergangsgeb.
 1844. *Calymene*, OWEN. Geol. Expl. Iowa, Wis., Ill.
 1845. *Phacops*, EMMRICH. Neues Jahrb. für Min.
 1845. *Phacops*, MURCHISON, DE VERNEUIL and KEYSERLING. Russie et Oural.
 1846. *Portlockia*, MCCOY. Silur. Foss. Ireland.
 1846. *Phacops*, GEINITZ. Grundr. der Versteinerungen.
 1846. *Phacops*, PICTET. Traité Elém. de Paléont.
 1846. *Phacops*, BARRANDE. Notice prélim. and Nouv. Trilob.
 1848. *Phacops*, SALTER. Mem. Geol. Survey United Kingdom.
 1849. *Phacops*, RICHTER. Pal. des Thüringerwaldes.
 1850. *Phacops*, the BROTHERS SANDBERGER. Verst. d. Rhein. Sch. Syst.
 1850. *Phacops*, *Portlockia*, MCCOY. Ann. and Mag. Nat. Hist.
 1850. *Phacops*, DE VERNEUIL. Bull. Soc. géol. de France.
 1850. *Phacops*, SALTER. Quart. Jour. Geol. Society.
 1850. *Phacops*, F. A. RÖMER. Beitr. i zur Harzgeb.
 1851. *Portlockia*, MCCOY. Synop. Pal. Foss. Woodwardian Mus.
 1851. *Phacops*, MCCOY. Synop. Pal. Foss. Woodwardian Mus.
 1852. *Phacops*, BARRANDE. Syst. Sil. d. Bohême, vol. i.
 1852. *Phacops*, F. A. RÖMER. Beitr. ii zur Harzgeb.
 1853. *Phacops*, GEINITZ. Grauwackenf. Sachsen.

1854. *Phacops* (*partim*), WIRTGEN and ZEILER. Verhandl. der Naturhist. Vereins.
 1854. *Calymene*, STEININGER. Mém. Soc. géol. de France.
 1855. *Phacops*, F. A. RÖMER. Beitr. ii zur Harzgeb.
 1856. *Phacops*, RICHTER. Beitr. zur Paläont. des Thüringerwaldes.
 1858. *Phacops*, GIEBEL. Silur. Fauna Unterharz.
 1859. *Phacops*, HALL. Pal. N. Y., vol. iii.
 1860. *Phacops*, STEIN. Zeitschr. d. deutsch. geol. Gesellschaft.
 1860. *Phacops*, BILLINGS. Canadian Naturalist and Geologist.
 1860. *Phacops*, EICHWALD. Lethæa Rossica.
 1861. *Phacops*, HALL. Descr. New Species Fossils.
 1862. *Phacops*, HELLMANN. Die Petrefacten Thüringens.
 1862. *Phacops*, GUÉMBEL. Neues Jahrb. für Min., etc.
 1862. *Phacops*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist.
 1863. *Phacops*, RICHTER. Zeitschr. der deutsch. geol. Gesellschaft.
 1863. *Phacops*, BILLINGS. Dev. and Silur. Fossils Square Lake, Maine.
 1864. *Phacops*, SALTER. Monog. Brit. Trilobites.
 1865. *Phacops*, RICHTER. Zeitschr. d. deutsch. geol. Gesellschaft.
 1866. *Phacops*, F. A. RÖMER. Beitr. v zur Harzgeb.
 1867. *Phacops*, ETHERIDGE. Quart. Jour. Geol. Soc.
 1867. *Phacops*, DE VERNEUIL. Comptes rendus.
 1868. *Phacops*, MEEK and WORTHEN. Geol. Surv. Ill., vol. iii.
 1868. *Phacops*, DEWALQUE. Prodr. d'une Descript. géol. de Belgique.
 1870. *Phacops*, TIETZE. Devon Schicht. Ebersdorf.
 1872. *Phacops*, KAYSER. Zeitschr. der deutsch. geol. Gesellschaft.
 1872. *Phacops*, BARRANDE. Syst. Sil. Bohême, vol. i, Suppl.
 1873(?) *Phacops*, ABDULLAH. Etudes géol. sur le Bosphore.
 1873. *Phacops*, NICHOLSON. Palæontol. Ontario.
 1874. *Phacops*, STEINHARDT. Die bis jetzt in preuss. Geschieb. gef. Trilob.
 1875. *Phacops*, MAURER. Neues Jahrb. für Min.
 1876. *Phacops*, HALL. Illustrations of Devonian Fossils.
 1876. *Phacops*, MAURER. Neues Jahrb. für Min.
 1876. *Phacops*, C. F. RÖMER. Lethæa palæozoica.
 1879. *Phacops*, NOVAK. Studien an Hypostomen, i.
 1880. *Phacops*, VON KÖENEN. Neues Jahrb. für Min.
 1881. *Phacops*, KAYSER. Jahrb. der Königl. preuss. Landesanst. und Bergakad.
 1881. *Phacops*, SCHMIDT. Rev. Ostbalt. Trilob., pt. i.
 1882. *Phacops*, WHITFIELD. Geol. Wisconsin, vol. iv.
 1882. *Phacops*, BARROIS. Rech. sur les Terrains anc. d. Asturies et de la Galice.
 1884. *Phacops*, WALCOTT. Pal. Eureka Dist.
 1884. *Phacops*, CLARKE. Iberger Kalk.
 1884. *Phacops*, NOVAK. Studien an Hypostomen, ii.
 1884. *Phacops*, KIESOW. Silur. und devon. Geschieb. Westpreuss.
 1885. *Phacops*, MAURER. Kalke von Waldgirmes.
 1885. *Phacops*, ZITTEL. Handb. d. Palæontologie.
 1885. *Phacops*, BARROIS. Ann. Soc. géol. du Nord.
 1885. *Phacops*, OEHLERT. Bull. de la Soc. d'Etudes Scientif. d'Angers.
 1885. *Phacops*, WALDSCHMIDT. Dev. Schicht. Gegend Wildungen.
 1885. *Phacops*, CLARKE. Geol. Succession in Ontario Co.
 1886. *Phacops*, BARROIS. Ann. Soc. géol. du Nord and Bull. Soc. géol. de France.
 1886. *Phacops*, MAURER. Fauna rechtsrh. Unterdev.
 1886. *Phacops*, MATUSCHKA. Dachschiefer von Berleburg.
 1887. *Phacops*, FÖRSTER. Bulletin Denison University.

1887. *Phacops*, OHLERT. Ann. de la Société géologique.

1888. *Phacops*, FRECH. Zeitschr. der deutsch. geol. Gesellschaft.

DIAGNOSIS. Body oval. *Cephalon* parabolic; genal angles obtuse, or produced into minute spines. Glabella tumid, prominent, widest anteriorly; the two anterior pairs of lateral furrows indistinct. Eyes very large, conspicuous, bearing numerous corneal lenses. *Thorax* sub-quadrate; segments eleven; pleuræ arched, and rounded at their extremities. *Pygidium* moderately large, composed of few annulations; margin entire and not prolonged into a terminal spine.



GENUS DALMANITES, BARRANDE. 1852.

- 1772. *Entomolithus*, BORN. Lithoph. Bornian.
- 1781. *Trilobus*, BRUENNICH. Kjöben. Sellsk. Skrifter. Nye Samml.
- 1794. *Entomolithus*, REUSS. Mayer's Samml. phys. Aufs.
- 1811. *Trilobites*, PARKINSON. Organic Remains.
- 1821. *Entomostracites (partim)*, WAHLENBERG. Nov. Act. Upsala.
- 1822. *Asaphus*, BRONGNIART. Hist. Nat. Crust. foss.
- 1823. *Trilobites*, SCHLOTHEIM. Nachtr. ii zur Petrefakt.
- 1825. *Trilobites*, STERNBERG. Verhandl. des Vaterl. Mus.
- 1826. *Asaphus*, DALMAN. Ueber Palæaden.
- 1829. *Asaphus*, HOLL. Handb. der Petrefacten.
- 1832. *Asaphus*, EATON. Geological Text-book.
- 1832. *Asaphus*, GOLDFUSS. Dechen's Handb. der Geognosie.
- 1832. *Asaphus*, GREEN. Monog. Trilob. N. America.
- 1835. *Asaphus*, GREEN. Suppl. Monog. N. Amer. Trilob.
- 1837. *Asaphus*, HISINGER. Lethæa Suecica.
- 1837. *Asaphus*, BUCKLAND. Bridgewater Treatise.
- 1837. *Asaphus*, QUENSTEDT. Wiegmann. Archiv.
- 1839. *Asaphus*, *Calymene*, MURCHISON. Silurian System.
- 1839. *Phacops partim*, EMMRICH. De Trilob. Dissert.
- 1840. *Asaphus*, MILNE-EDWARDS. Hist. Nat. Crust.
- 1840. *Phacops*, VON BUCH. Geb. Format. Russlands.
- 1841. *Asaphus*, *Aspidolites*, CONRAD. Fifth Ann. Rept. Pal. N. Y.
- 1843. *Asaphus*, HALL. Rept. Fourth. Dist. N. Y.
- 1843. *Asaphus*, GOLDFUSS. Neues Jahrb. für Min.
- 1843. *Phacops*, BURMEISTER. Organiz. d. Trilobiten.
- 1843. *Phacops*, PORTLOCK. Rept. Geol. Londonderry.
- 1845. *Dalmania*, EMMRICH. Neues Jahrb. für Min.
- 1845. *Phacops*, *Asaphus*, MURCHISON, DE VERNEUIL and KEYSERLING. Russie et Oural.
- 1846. *Phacops*, GEINITZ. Grundr. der Versteinerungen.
- 1846. *Phacops*, BARRANDE. Notice prélimin.
- 1846. *Phacops*, ROUAULT. Bull. Soc. géol. de France.
- 1847. *Odontochile*, CORDA. Prodrom Monog. böhm. Trilob.
- 1848. *Phacops*, HALL. Pal. N. Y., vol. i.

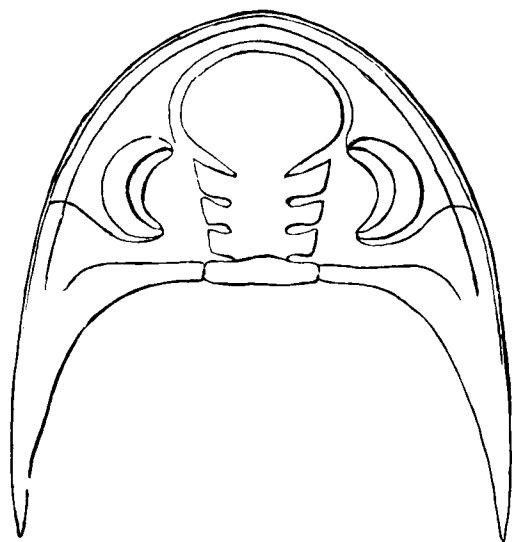
1849. *Phacops* (*partim*), SALTER. Mem. Geol. Surv. United Kingdom.
1849. *Phacops* (*partim*), MCCOY. Ann. Mag. Nat. Hist.
1849. *Dalmanina*, SALTER. Mem. Geol. Surv. United Kingdom.
1850. *Odontochile*, MCCOY. Ann. and Mag. Nat. Hist.
1850. *Phacops*, the BROTHERS SANDBERGER. Verst. d. Rhein. Sch. Syst.
1851. *Odontochile*, MCCOY. Synop. Pal. Foss. Woodwardian Mus.
1851. *Phacops*, HALL. Foster and Whitney's Rept. Geol. Lake Sup.
1852. *Dalmanina*, *Dalmanites*, BARRANDE. Syst. Sil. Bohême, vol. i.
1852. *Phacops*, ANGELIN. Palæontologia Suecica.
1852. *Dalmanina*, HALL. Pal. N. Y., vol. ii.
1852. *Phacops*, F. A. RÖMER. Beitr. ii zur Harzgeb.
1853. *Phacops*, SALTER. Mem. Geol. Survey, Decade vii.
1855. *Phacops*, F. A. RÖMER. Beitr. iii zur Harzgeb.
1855. *Dalmanina*, SHUMARD. Rept. Geol. Surv. Missouri.
1858. *Dalmanina*, GIEBEL. Silur. Fauna Unterharz.
1858. *Phacops*, *Asaphus*, BIGSBY. Quart. Jour. Geol. Soc., vol. xiv.
1859. *Dalmanina*, HALL. Pal. N. Y., vol. iii.
1860. *Dalmanina*, HALL. Canadian Naturalist and Geologist.
1860. *Dalmanina*, BILLINGS. Canadian Naturalist and Geologist.
1861. *Dalmanites*, HALL. Ann. Rept. Geol. Surv. Wisconsin.
1861. *Dalmanina*, HALL. Descr. New Species Fossils.
1862. *Dalmanina*, HELLMANN. Die Petrefacten Thüringens.
1862. *Dalmanina*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist.
1862. *Phacops* (*partim*), MCCOY. Synops. Silur. Foss. Ireland.
1863. *Dalmanina*, BILLINGS. Dev. and Silur. Foss. Square Lake, Maine.
1863. *Dalmanina*, HALL. Transactions Albany Institute.
1864. *Phacops* (*Odontochile*), SALTER. Monogr. Brit. Trilobites.
1865. *Dalmanina*, MEEK and WORTHEN. Proc. Acad. Nat. Sci. Phil.
1867. *Dalmanina*, HALL. Twentieth Rept. N. Y. State Cab. Nat. Hist.
1868. *Dalmanites*, DEWALQUE. Prodrôm. d'une Descrip. géolog de Belgique.
1868. *Dalmanites*, MEEK and WORTHEN. Geol. Surv. Ill., vol. iii.
1869. *Dalmanina*, HAIDENHAIN. Zeitschr. der deutsch. geol. Gesellschaft.
1869. *Phacops*, LINNARSSON. Vestergöth camb. och. silur. Aflag.
1871. *Dalmanites*, MEEK. Proc. Acad. Nat. Sci. Phil.
1872. *Dalmanites*, BARRANDE. Syst. Sil. Bohême, vol. i, Suppl.
1872. *Dalmanites*, MEEK. Am. Jour. Science.
1873. *Dalmanites*, MEEK. Geol. Surv. Ohio, Palæont. vol. i.
1874. *Phacops* (*partim*), STEINHARDT. Die bis jetzt in preuss. Geschieb. gef. Trilobiten.
1875. *Dalmanina*, HARTT and RATHBUN. Ann. Lyc. Nat. Hist.
1875. *Dalmanina*, HALL and WHITFIELD. Geol. Surv. Ohio, Palæont. vol. ii.
1876. *Dalmanina*, C. F. RÖMER. Lethæa palæozoica.
1876. *Dalmanites*, HALL. Twenty-eighth Rept. N. Y. State Mus. Nat. Hist.
1876. *Dalmanites*, HALL. Illustrations of Devonian Fossils.
1876. *Dalmanites*, BARRETT. Am. Journ. Science.
1877. *Dalmanites*, MEEK. Geol. Expl. Fortieth parallel.
1878. *Dalmanites*, KAYSER. Fauna d. ælt. Devon.-Ablag. Harz.
1878. *Phacops*, ANGELIN. Palæontol. Scandinav.
1879. *Dalmanites*, NOVAK. Studien an Hypostomen, i.
1879. *Dalmanites*, WALCOTT. Thirty-first Rept. N. Y. State Mus. Nat. Hist.
1880. *Dalmanites*, KAYSER. Zeitschr. d. deutsch. geol. Gesellschaft.
1881. *Dalmanites*, SCHMIDT. Revision Ostbalt. silur. Trilob.
1881. *Dalmanites*, MENEGHINI. Roy. Academia dei Lincei

1883. *Dalmanites*, NOVAK. Zur Kennt. böhm. Trilob.
 1884. *Dalmanites*, NOVAK. Studien an Hypostomen, ii.
 1884. *Dalmanites*, WALCOTT. Palæontol. Eureka Dist.
 1885. *Dalmanites*, CLARKE. Geol. Succession in Ontario Co.
 1885. *Dalmanites*, ŒHLERT. Bull. de la Soc. d'Etudes Scientif. d. Angers.
 1886. *Dalmanites*, BARROIS. Bull. de la Soc. géol. de France.
 1887. *Dalmanites*, FÖRSTER. Bull. Denison. Univ.

The species of the genus *Dalmanites* frequently exhibit a tendency to variation in many of their more important features. This variability may be either in the relative development of the lateral glabellar furrows, the coalescence of the glabellar lobes, or in the ornamentation of the margins of the cephalon and pygidium; the features of the glabella are of more distinctive importance, the ornamental characters undoubtedly being of a somewhat more fugitive value. By the unequal development and suppression of the glabellar lobes and furrows, there is an evident transition from the typical *Dalmanites* to the typical *Phacops*. Again, the gradual coalescence of the lateral glabellar lobes produces forms following the type of the genus *Chasmops*, in which the first two pairs are united, and of the genus *Monorakos*, in which the three lobes of each side are coalesced. The ornamental features are of importance in the establishment of subordinate groups of a provisional character. It is here proposed to group under the term *Hausmannia* the typical and unvaried forms of *Dalmanites* which follow the type of *D. caudatus*, (Brünnich) Emmrich, and *D. Hausmanni*, Brongniart.

SUB-GENUS HAUSMANNIA, N. S.-G.

DIAGNOSIS. Body elongate-ovate, depressed-convex. *Cephalon* lunate; genal angles produced into spines; glabella scarcely prominent; frontal lobe transverse or sub-rhomboidal; all the lateral lobes well developed. *Thorax* composed of eleven segments; pleuræ beveled, the posterior segments often produced. *Pygidium* large, bearing more than eleven annulations; margin entire, often produced into a caudal spine.

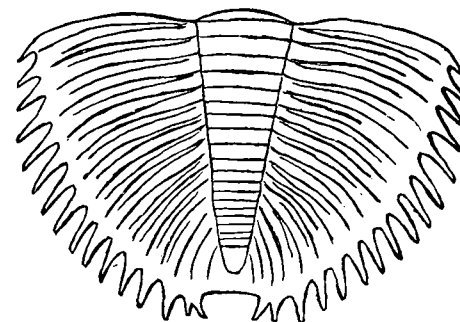


The Devonian species, which are referred to this group, are to some extent imperfectly known, and it may eventually

become necessary to place such as are now known only from pygidia in some other association.

SUB-GENUS CORONURA, N. S.-G.

DIAGNOSIS. *Pygidium* large, bearing along its lateral margins a row of long, cylindrical, acute and gently recurved spines. The posterior extremity is crescentic, its margin being smooth or furnished with a row of erect spines. Annulations numerous.

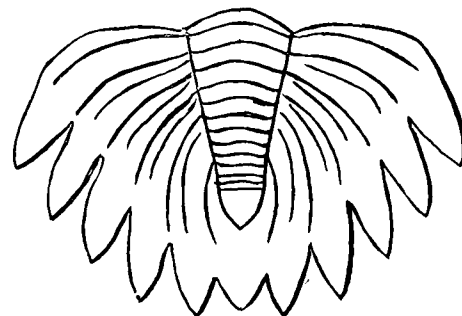


SUB-GENUS CRYPHÆUS, GREEN. 1837.

- 1832. *Asaphus*, GREEN. Monog. Trilob. N. America.
- 1833. *Olenus*, STEININGER. Mem. Soc. géol. de France.
- 1835. *Calymene*, HÆNINGHAUS. Litt. Lithograph.
- 1835. *Asaphus*, GOLDFUSS. Leonhardt's Jahrb. f. Min.
- 1837. *Cryphæus*, GREEN. Amer. Journ. Science.
- 1839. *Cryphæus*, CONRAD. Second Ann. Rept. Pal. N. Y.
- 1840. *Pleuracanthus*, MILNE-EDWARDS. Hist. Nat. Crust.
- 1842. *Olenus*, D'ARCHIAC and DE VERNEUIL. Trans. Geol. Soc.
- 1843. *Asaphus*, GOLDFUSS. Leonhardt's Jahrb. für Min.
- 1843. *Cryphæus*, HALL. Rept. Fourth Dist. N. Y.
- 1843. *Paradoxides*, F. A. RÖMER. Verstein. d. Harzgeb.
- 1844. *Olenus*, D'ARCHIAC and DE VERNEUIL. Aelt. palæoz. Gebilde im Nord. von Deutschl. und Belgien.
- 1844. *Pleuracanthus*, C. F. RÖMER. Rhein. Uebergangsgeb.
- 1846. *Cryphæus*, ROUAULT. Bull. soc. géol. de France.
- 1846. *Phacops*, BURMEISTER. Organ. d. Trilobiten.
- 1847. *Asteropyge*, *Metacanthus*, CORDA. Prodrum. Mon. böhm. Tril.
- 1849. *Cryphæus*, MCCOY, (*non Cryphæus*, GREEN). Ann. Mag. Nat. Hist.
- 1850. *Phacops*, *Cheirurus*, F. A. RÖMER. Beitr. i. zur Harzgeb.
- 1850. *Cryphæus*, DE VERNEUIL. Bull. Soc. géol. de France.
- 1850. *Phacops*, the BROTHERS SANDBERGER. Rhein. Schicht. Syst.
- 1850. *Cryphæus*, DE VERNEUIL. Bull. Soc. géol. de France.
- 1854. *Phacops*, WIRTGEN and ZEILER. Verhandl. des Naturhistor. Vereins.
- 1856. *Dalmania*, RICHTER. Beitr. zur Palæontol. des Thüringerwaldes.
- 1861. *Dalmania*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist.
- 1864. *Phacops* (*Cryphæus*), SALTER. Monog. Brit. Trilobites.
- 1866. *Cryphæus*, D'ARCHIAC, FISCHER and DE VERNEUIL. In Tchihatcheff's Asie Mineure.
- 1866. *Cryphæus*, F. A. RÖMER. Beitr. v. zur Harzgeb.
- 1867. *Cryphæus*, DE VERNEUIL. Comptes rendus.
- 1867. *Phacops*, ETHERIDGE. Quart. Jour. Geol. Soc.
- 1868. *Pleuracanthus*, DEWALQUE. Prodrum. d'une Descrip. géolog. de Belgique.
- 1873(?). *Cryphæus*, ABDULLAH. Etudes géol. sur le Bosphore.

1876. *Dalmanites*, HALL. Illustrations of Devonian Fossils.
 1876. *Cryphaeus*, C. F. RÖMER. Lethaea palæozoica.
 1878. *Cryphæus*, KAYSER. Abhandl. z. Specialkarte Pr. und d. Thür. St.
 1879. *Cryphaeus*, LOSSEN. Zeitschr. der deutsch. geol. Gesellschaft.
 1881. *Cryphaeus*, SCHLUETER. Sitzungsab. niederrh. Gesell. in Bonn.
 1883. *Cryphaeus*, KAYSER. Jahrb. der Königl. Preuss. geol. Landesanst. und Bergakad.
 1884. *Cryphaeus*, BEUSHAUSEN. Abhandl. z. Specialkarte Pr. und d. Thür. St.
 1885. *Cryphaeus*, ZITTEL. Handb. d. Palæontologie.
 1886. *Cryphæus*, MAURER. Fauna rechtsrhein. Unterdev.
 1886. *Cryphaeus*, MATUSCHKA. Dachschiefer von Berleburg.

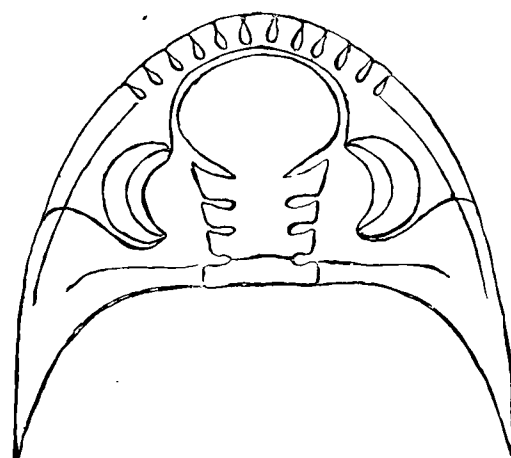
DIAGNOSIS. Genal angles produced into long, often laterally compressed and narrow spines. Posterior thoracic segments produced and acute. *Pygidium* with five annulations and five pairs of marginal lobes or spines. Terminal lobe more or less developed.



SUB-GENUS ODONTOCEPHALUS, CONRAD. 1840.

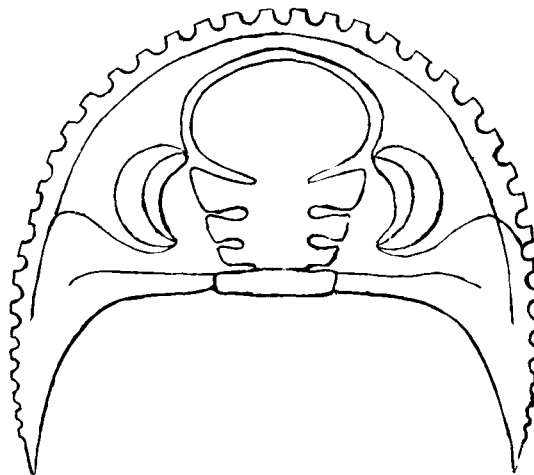
1832. *Asaphus*, EATON. Geological Text-book.
 1832. *Calymene*, GREEN. Mon. Trilob. N. America.
 1840. *Odontocephalus*, CONRAD. Third Ann. Rept. Pal. N. Y.
 1842. *Odontocephalus*, VANUXEM. Geol. Rept. Third Dist. N. Y.
 1843. *Odontocephalus*, HALL. Geol. Rept. Fourth Dist. N. Y.
 1845. *Odontocephalus*, EMNRICH. Leonhardt and Bronn's Neues Jahrb. für. Min.
 1861. *Dalmania*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist.
 1868. *Odontocephalus*, MEEK and WORTHEN. Geol. Surv. Illinois, vol. iii.
 1876. *Dalmanites*, HALL. Illustrations of Devonian Fossils.
 1885. *Odontocephalus*, ZITTEL. Handb. d. Palæontologie.

DIAGNOSIS. The frontal border of the cephalon bears a series of incisor-like denticulations, which lie in contact at their distal extremities. These are longest in front and become obsolete about half way from the anterior extremity to the tips of the genal spines. *Pygidium* usually with two more or less developed terminal spines.



SUB-GENUS CORYCEPHALUS, N. SUB-GEN.

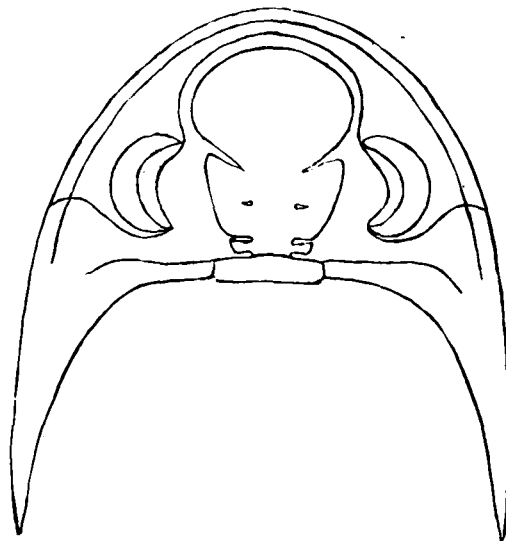
DIAGNOSIS. The entire frontal and lateral margins of the cephalon bear a single row of widely separated denticulations, which may be acute and triangular or broad and subquadrate.



SUB-GENUS CHASMOPS, McCoy. 1850.

- 1837. *Asaphus* (*partim*), MURCHISON. Silurian System.
- 1838. *Trilobites* (*partim*), SARS and BOECK. Gæa Norvegica.
- 1843. *Phacops* (*partim*), PORTLOCK. Geolog. Rept. Tyrone.
- 1845. *Phacops* (*partim*), EMMRICH. Neues Jahrb. für Min.
- 1846. *Phacops* (*partim*), BURMEISTER. Organiz. Trilobites.
- 1848. *Dalmania*, SALTER. Mem. Geol. Surv. United Kingdom.
- 1849. *Phacops* (*partim*), SALTER. Mem. Geol. Surv. United Kingdom.
- 1850. *Chasmops*, MCCOY. Ann. and Mag. Nat. Hist.
- 1851. *Chasmops*, *Odontochile*, MCCOY. Synops. Pal. Foss. Woodwardian Mus.
- 1852. *Chasmops*, ANGELIN. Palæontologica Suecica.
- 1853. *Phacops* (*Dalmania*), SALTER. Geol. Surv. Decade vii.
- 1864. *Chasmops*, SALTER. Monogr. Brit. Trilobites.
- 1869. *Phacops* (*partim*), LINNARSSON. Verstergötl. camb. och. silur. Aflag.
- 1874. *Phacops* (*partim*), STEINHARDT. In preuss. Geschieb. gef. Trilobit.
- 1876. *Dalmanites* (*partim*), HALL. Illustrations of Devonian Fossils.
- 1876. *Chasmops*, C. F. RÖMER. Lethæa palæozoica.
- 1878. *Phacops* (*partim*), ANGELIN. Palæontologia Scandinavica.
- 1885. *Chasmops*, ZITTEL. Handb. der Palæontologie.

DIAGNOSIS. Genal angles usually produced into spines. Frontal lobe of the glabella large, transverse and not intersected by the facial sutures. Lateral lobes unequal, the first and second pairs being coalesced and the third pair nearly obsolete. Pygidium large, sometimes with a terminal spine.



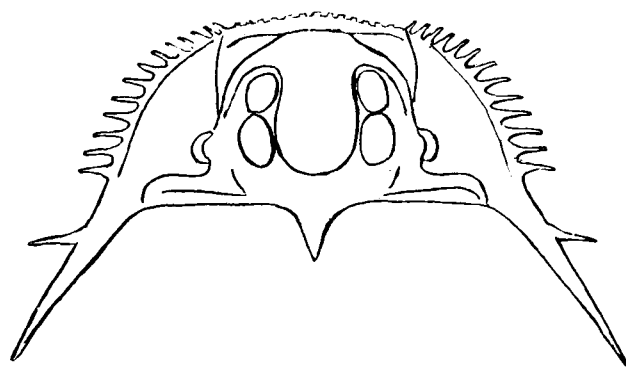
FAMILY, ACIDASPIDÆ.

GENUS ACIDASPIS, MURCHISON. 1839.

1838. *Ceratocephala*, WARDER. Amer. Jour. Science.
 1838. *Ceratocephala*, ANTHONY. Amer. Jour. Science.
 1839. *Acidaspis*, MURCHISON. Silurian System.
 1839. *Arges* (*partim*), GOLDFUSS. Nov. Act. Cæs. Leop. Cur.
 1839. *Odontopleura*, EMMRICH. De Trilob. Dissert.
 1840. *Trinuclæus*? MÜENSTER. Beitr. iii zur Petrefaktenkunde.
 1840. *Acidaspis*, MILNE-EDWARDS. Hist. Nat. Crust., vol. iii.
 1840. *Acidaspis*, *Acantholoma*, CONRAD. Third Ann. Rept. Pal. N. Y.
 1841. *Dicranurus*, CONRAD. Fifth Ann. Rept. Pal. N. Y.
 1843. *Ceraurus*, LOCKE. Amer. Jour. Science.
 1843. *Bronteus* (*partim*), F. A. RÖMER. Verstein. Harzgeb.
 1843. *Arges* (*partim*), *Odontopleura*, GOLDFUSS. Neues Jahrb. für Min.
 1843. *Odontopleura*, BURMEISTER. Organiz. d. Trilob.
 1844. *Odontopleura*, *Arges*, C. F. RÖMER. Rheinisch. Uebergangsgeb.
 1845. *Odontopleura*, EMMRICH. Neues Jahrb. für Min.
 1845. *Ceraurus*, LOVEN. Ofvers. of. Kongl. Vetensk. Akad. Forhandl.
 1846. *Acidaspis*, MCCOY. Synopsis Silur. Foss. Ireland.
 1846. *Odontopleura*, BARRANDE. Notice prélim. sur Syst. Sil. Bohême.
 1846. *Odontopleura*, GEINITZ. Grundriss d. Verstein.
 1846. *Odontopleura*, PICTET. Traité élément. de Paléont.
 1846. *Odontopleura*, BEYRICH. Untersuchungen ueber Trilob.
 1846. *Polyeres*, ROUAULT. Bull. Soc. géol. de France.
 1847. *Odontopleura*, *Selenopeltis*, *Trapelocera*, CORDA. Prodrom Monog. böhm. Trilob.
 1848. *Acidaspis*, HALL. Pal. N. Y., vol. i.
 1848. *Acidaspis*, PHILLIPS and SALTER. Mem. Geol. Surv. United Kingdom.
 1850. *Acidaspis*, MCCOY. Ann. and Mag. Nat. Hist.
 1850. *Odontopleura*, the Brothers SANDBERGER. Vestein. d. rhein. Schicht. Syst.
 1852. *Acidaspis*, BARRANDE. Syst. Sil. Bohême, vol. i.
 1852. *Acidaspis*, F. A. RÖMER. Beitr. ii zur Harzgeb.
 1855. *Acidaspis*, SHUMARD. Geol. Surv. Missouri.
 1855. *Acidaspis*, EMMONS. American Geology.
 1855. *Acidaspis*, F. A. RÖMER. Beitr. iii, Harzgeb.
 1857. *Acidaspis*, BILLINGS. Rept. Geol. Survey Canada.
 1858. *Acidaspis*, GIEBEL. Silur. Faun. Unterharz.
 1859. *Acidaspis*, BILLINGS. Rept. Prog. Canad. Geol. Surv.
 1859. *Acidaspis*, HALL. Pal. N. Y., vol. iii.
 1862. *Acidaspis*, MCCOY. Synops. Silur. Foss. Ireland.
 1862. *Acidaspis*, HELLMAN. Die Petrefacten Thüringens.
 1862. *Acidaspis*, HALL. Geol. Surv. Wisconsin.
 1863. *Acidaspis*, RICHTER. Zeitschr. der deutsch. geolog. Gesellschaft.
 1866. *Acidaspis*, F. A. RÖMER. Beitr. v, Harzgeb.
 1868. *Acidaspis*, MEEK and WORTHEN. Geol. Surv. Illinois, Pal., vol. iii.
 1869. *Acidaspis*, LINNARSON. Vestergötl. camb. och. silur. Aflag.
 1872. *Acidaspis*, BARRANDE. Syst. Sil. Bohême, vol. i, Suppl.
 1873. *Acidaspis*, MEEK. Geol. Ohio, Palæontology, vol. i.
 1875. *Acidaspis*, MILLER. Cincin. Quart. Jour. Science.
 1876. *Acidaspis*, C. F. RÖMER. Lethæa palæozoica.

1877. *Acidaspis*, WALCOTT. Twenty-ninth Rept. N. Y. State Mus. Nat. Hist.
 1878. *Acidaspis*, KAYSER. Fauna ælt. Devon. Ablag. des Harzes.
 1879. *Acidaspis*, HALL. Trans. Albany Inst., and Twenty-eighth Rept. N. Y. State Mus. Nat. Hist.
 1879. *Acidaspis*, WALCOTT. Thirty-first Rept. N. Y. State Mus. Nat. Hist.
 1879. *Acidaspis*, NOVAK. Studien an Hypostomen i.
 1881. *Acidaspis*, HALL. Eleventh Ann. Rept. Geol. Surv. Indiana.
 1883. *Acidaspis*, NOVAK. Zur Kennt. böhm. Trilob.
 1884. *Acidaspis*, NOVAK. Studien an Hypostomen ii.
 1885. *Acidaspis*, ZITTEL. Handb. d. Palæontologie.
 1885. *Acidaspis*, SCHMIDT. Revision d. Ostbalt. Silur. Trilob.
 1887. *Acidaspis*, FOERSTE. Bulletin Denison University.

DIAGNOSIS. Body depressed-convex. Surface ornamented with numerous spines. *Cephalon* indistinctly trilobate, with two longitudinal furrows crossing the glabella, produced by the union of the inner extremities of the three pairs of lateral furrows. Occipital ring conspicuous. *Thorax*



with from nine to ten segments, each one bearing a strong, nonsulcate ridge on the pleuræ, which is produced into a long, hollow spine. *Pygidium* short, small; axis bearing from one to three annulations, and the pleuræ usually but a single one. Margins spiniferous.

FAMILY, LICHADÆ.

GENUS LICHAS, DALMAN. 1826.

1821. *Entomostracites*, WAHLENBERG. Nova Acta Soc. Sci. Upsala.
 1822. *Trilobites*, SCHLOTHEIM. Nachtr. iii zur Petrefacktenkunde.
 1822. *Paradoxides*, BRONGNIART. Hist. Nat. Crust. Fossiles.
 1825. *Paradoxides*, BIGSBY. Jour. Acad. Nat. Science.
 1826. *Asaphus*, DALMAN. Ueber Palæaden.
 1826. *Lichas*, DALMAN. Ueber Palæaden.
 1828. *Ampyr*, DALMAN. Arsberätt.
 1829. *Lichas*, HOLL. Handbuch der Petrefacktenkunde.
 1833. *Paradoxides*, GREEN. Monograph of the Trilobites of North America.
 1835. *Lichas*, BRONN. Lethæa geognostica.
 1837. *Ampyr*, HISINGER. Lethæa Suecica.
 1838. *Platynotus*, CONRAD. Ann. Rept. Pal. N. Y.
 1839. *Arges*, GOLDFUSS. Nova Acta Acad. C. L., XIX.
 1840. *Paradoxides*, MILNE-EDWARDS. Hist. Nat. Crustacés.
 1842. *Asaphus*, CONRAD. Jour. Acad. Nat. Science.
 1842. *Arges*, D'ARCHIAC and DE VERNEUIL. Trans. Geol. Society.

1842. *Metopias*, EICHWALD. Urwelt Russlands.
1843. *Metopias*, EICHWALD. Beitr. zur Kenntn. d. Russ. Reichs.
1843. *Metopias*, LEUCHTENBERG. Thierrest. des Urwelts.
1843. *Paradoxides*, GOLDFUSS. Neues Jahrb. für. Min.
1843. *Arctinurus*, CASTELNAU. Essai sur le Syst. Sil. de l'Amerique Septentrionale.
1843. *Platymotus*, HALL. Geol. N. Y., Rept. Fourth District.
1843. *Lichas*, BURMEISTER. Organization der Trilobiten.
1843. *Nuttainia*, PORTLOCK. Geolog. Rept. Londonderry, etc.
1844. *Asaphus*, EICHWALD. Silursch. Esthlands.
1844. *Arges*, D'ARCHIAC and DE VERNEUIL. Die ælt. paläozoisch. Gebilde im Norden von Deutschl. u. Belgien.
1845. *Nuttainia*, EMMRICH. Neues Jahrbuch für Min.
1845. *Lichas*, LOVEN. Ofversigt af Kongl. Vetensk. Akad. Förhandl.
1845. *Lichas*, BEYRICH. Ueber böhm. Trilobiten.
1845. *Calymene*, MURCHISON. Quart. Jour. Geol. Soc.
1846. *Lichas*, BARRANDE. Notice prélim. sur le Syst. sil. Bohême.
1846. *Bronteus (partim)*, BARRANDE. Notice prélim. sur le Syst. sil. Bohême.
1846. *Trilobites (partim)*, BARRANDE. Notice prélim. sur le Syst. sil. Bohême.
1846. *Lichas*, BEYRICH. Untersuchungen ueber die Trilobiten.
1846. *Arges*, BEYRICH. Untersuchungen ueber die Trilobiten.
1847. *Calymene*, MCCOY. Silurian Foss. Ireland.
1847. *Corydocephalus*, CORDA. Prodrom Monog. böhmischen Trilobiten.
1847. *Dicranopeltis*, CORDA. Prodrom Monog. böhmischen Trilobiten.
1847. *Acanthopyge*, CORDA. Prodrom Monog. böhmischen Trilobiten.
1847. *Dicranognmus*, CORDA. Prodrom Monog. böhmischen Trilobiten.
1847. *Platymotus*, HALL. Palæontology N. Y., vol. i.
1848. *Lichas*, SALTER. Mem. Geol. Surv. United Kingdom.
1849. *Lichas*, MCCOY. Ann. Mag. Nat. Hist.
1850. *Lichas*, FLETCHER. Proc. Geol. Society.
1852. *Lichas*, BARRANDE. Syst. Silur. du Centre de la Pohême, vol. i.
1854. *Lichas*, ANGELIN. Palæontologia Scandinavica.
1854. *Lichas*, EICHWALD. Grauwacksch. Liv. und Esthlands.
1855. *Lichas*, EMMONS. American Geology.
1857. *Lichas*, EICHWALD. Beitr. zur geogr. Verbreit d. foss. Thiere Russlands.
1857. *Lichas*, NIESKOWSKI. Archiv. für Naturk. Liv, Esth und Kurlands.
1858. *Lichas*, HOFFMANN. Verhandl. der kaiserl. Mineral. Gesellsch.
1858. *Lichas*, SCHMIDT. Archiv. für Naturk. Liv, Esth und Kurlands.
1858. *Lichas*, DETHLEFF and BOLL. Archiv. d. Vereins d. Freund. d. Naturgesch. in Mecklenburg.
1859. *Lichas*, HALL. Palæontology N. Y., vol. iii.
1859. *Lichas*, NIESKOWSKI. Archiv. für Naturk. Liv, Esth und Kurlands.
1860. *Lichas*, EICHWALD. Lethæa rossica.
1861. *Lichas*, C. F. RÖMER. Foss. Fauna d. Silur. Diluvialgeschieb. von Sadowitz.
1862. *Lichas*, HALL. Sixteenth Rept. N. Y. State Cab. Nat. Hist.
1862. *Lichas*, HELLMANN. Die Petrefacten Thüringens.
1862. *Lichas*, MCCOY. Synopsis Silur. Foss. Ireland.
1863. *Lichas*, HALL. Transactions Albany Institute.
1865. *Lichas*, WINCHELL and MARCY. Mem. Boston Society Nat. Hist.
1865. *Lichas*, MEEK and WORTHEN. Proceed. Acad. Nat. Science.
1865. *Lichas*, BILLINGS. Palæozoic Fossils, vol. i.
1866. *Lichas*, BILLINGS. Cat. Silur. Foss. Anticosti.
1867. *Lichas*, HALL. Twentieth Rept. N. Y. State Cab. Nat. Hist.
1869. *Lichas*, KARSTENS. Beitr. zur Landeskarte von Schleswig-Holstein.

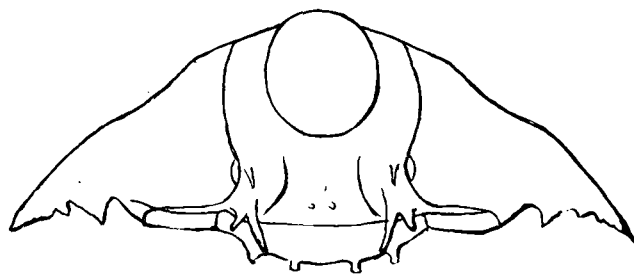
1872. *Lichas*, BARRANDE. Suppl. Syst. Silur. du Centre de la Bohême, vol. i.
 1872. *Lichas*, KAYSER. Zeitschrift der deutsch. geolog. Gesellschaft.
 1874. *Lichas*, STEINHARDT. In preussisch. Geschieb. gef. Trilobiten.
 1874. *Lichas*, BILLINGS. Canadian Naturalist and Geologist.
 1878. *Lichas*, MILLER. Jour. Cincinnati Soc. Nat. Hist.
 1879. *Lichas*, HALL. Twenty-eighth Rept. N. Y. State Mus. Nat. Hist.
 1880. *Lichas*, NOVAK. Sitzungsber. d. Königl. böhm. Gesellsch. d. Wissenschaften.
 1882. *Lichas*, BRÖGGER. Silur. étagen 2 und 3, im Kristianiageb. und auf Eker.
 1884. *Lichas*, TÖRNQUIST. Undersök. öfv. Siljanouräd. Trilobit fauna.
 1885. *Lichas*, SCHMIDT. Mem. de l'Acad. imp. de St. Petersburg.
 1886. *Lichas*, BARROIS. Ann. de la Société géol. du Nord.
 1887. *Lichas*, FOERSTE. Bulletin Denison University.
 1888. *Lichas*, FRECH. Zeitschr. der deutsch. geol. Gesellsch.

DIAGNOSIS. Body broadly oval. *Cephalon* transverse. Glabella convex and subdivided by two longitudinal furrows, which are produced by the union of the proximal extremities of the lateral furrows. Eyes situated somewhat posteriorly. Facial sutures beginning on the posterior margin, near the genal angles, passing forward from the eyes in sub-parallel lines to the anterior margin. *Hypostoma* sub-quadrate, with a deep reëntrant curve on the posterior margin. Centrum gently convex. *Thorax* composed of *eleven* segments. Pleuræ sulcate and produced into acute terminations. *Pygidium* sub-triangular, gently convex. Axis very short, with but two or three annulations. Pleuræ broad, sulcate. Margins lobate.

SUB-GENUS TERATASPIS, HALL. 1863.

1862. *Lichas*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist.
 1863. *Terataspis*, HALL. Sixteenth Rept. N. Y. State Cab. Nat. Hist.
 1876. *Acidaspis* (*Terataspis*), HALL. Illustrations of Devonian Fossils.

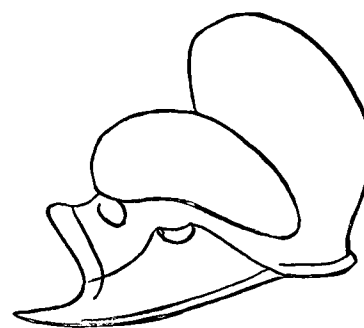
DIAGNOSIS. Frontal lobe of the glabella ellipsoidal, longitudinally and transversely bisymmetrical, strongly and equally constricted on all sides. First and second lateral lobes coalesced and strongly spinose at their summit; third lateral lobe obsolescent or extinct. Glabellar area between the anterior lobe and occipital ring much depressed. Occipital ring broad, bearing strong spines or baculate tubercles. *Pygidium* with one annulation upon the axis, two or three upon the pleuræ, and bearing eight long, recurved, simple or compound marginal spines.



SUB-GENUS CONOLICHAS, DAMES. 1877.

1859. *Lichas*, HALL. Pal. N. Y., vol. iii.
 1861. *Lichas*, HALL. Descr. New Species Fossils.
 1862. *Lichas*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist.
 1869. *Lichas*?, KARSTENS. Beitr. zur Landesg. herzog. Schleswig und Holstein.
 1874. *Lichas*, STEINHARDT. In preus. Gesch. gef. Trilob.
 1876. *Acidaspis* (*Terataspis*), HALL. Illustrations of Devonian Fossils.
 1877. *Conolichas*, DAMES. Zeitsch. der deutsch. geol. Gesellsch.
 1885. *Conolichas*, SCHMIDT. Revision Ostbalt. Silur. Trilob.
 1885. *Conolichas*, ZITTEL. Handb. d. palæontologie.

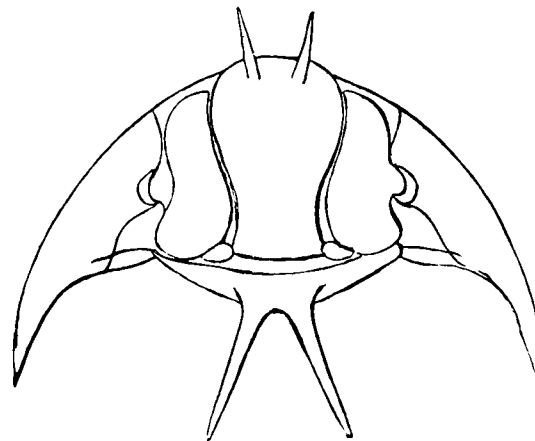
DIAGNOSIS. Glabella with only anterior and posterior lateral furrows. Lateral lobes well defined. Frontal lobe, and sometimes the lateral lobes, conically elevated, and often inclined backward.



SUB-GENUS HOPLOLICHAS, DAMES. 1877.

1842. *Asaphus*, CONRAD. Jour. Acad. Nat. Sci. Phila.
 1846. *Lichas*, BEYRICH. Untersuchungen üb. Trilob.
 1858. *Lichas*, DETHLEFF and BOLL. Trilobiten Mecklenburgs.
 1859. *Lichas*, NIESZKOWSKI. Monogr. Trilob. Ostseeprov.
 1867. *Metopias*, QUENSTEDT. Petrefaktenkunde.
 1869. *Lichas*, KARSTENS. Beitr. zur Landesg. herzog. Schleswig und Holstein.
 1874. *Lichas*, STEINHARDT. In preus. Gesch. gef. Trilob.
 1877. *Hoplolichas*, DAMES. Zeitsch. der deutsch. geol. Gesell.
 1885. *Hoplolichas*, SCHMIDT. Revision Ostbalt. Silur. Trilob.
 1885. *Hoplolichas*, ZITTEL. Handb. d. Palæontologie.

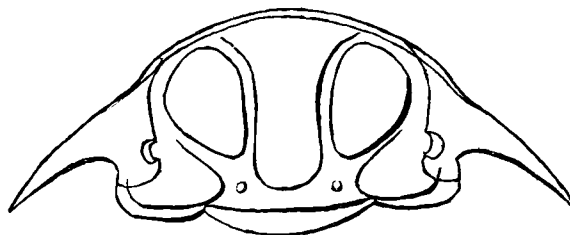
DIAGNOSIS. The frontal lobe of the glabella longitudinally arched, evenly convex, tubercled, spiniferous or with a single strong baculate process. Lateral furrows as in *Conolichas*. Occipital ring bearing a simple or compound spine.



SUB-GENUS ARGES, GOLDFUSS. 1839.

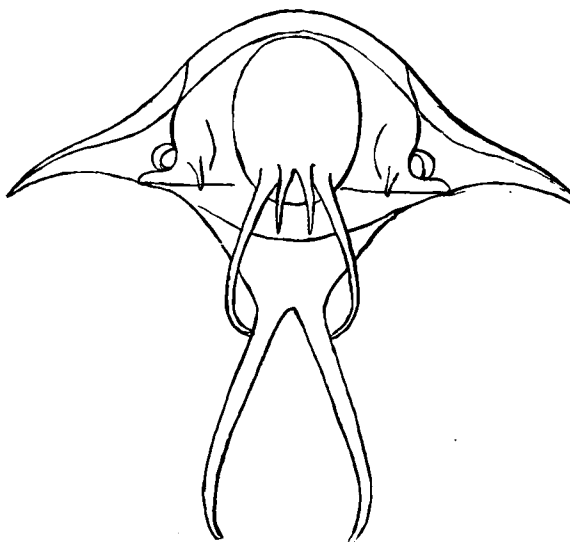
1837. *Calymene*, GREEN. Am. Jour. Science.
 1839. *Arges*, GOLDFUSS. Nov. Act. Acad. Caes. Leop. Car., vol. xix.
 1843. *Arges*, GOLDFUSS. Neues Jahrb. für Min.
 1846. *Lichas*, BARRANDE. Notice prélim. sur le Syst. sil. Bohême.
 1846. *Arges*, BEYRICH. Untersuchungen üb. Trilob.
 1847. *Corydocephalus*, *Acanthopyge*, *partim*, CORDA. Prodrum Monog. böhm. Trilob.
 1852. *Arges*, HALL. Pal. N. Y., vol. ii.
 1852. *Lichas*, BARRANDE. Syst. Sil. Bohême, vol. i.
 1857. *Lichas*, NIESZKOWSKI. Monog. Trilob. Ostseeprovinz.
 1858. *Lichas*, HOFFMANN. Trilobit. Russlands.
 1878. *Lichas*, ANGELIN. Palæontologia Scandinavica.
 1885. *Arges*, SCHMIDT. Revision Ostbalt. Silur. Trilob.

DIAGNOSIS. Middle lobe of the glabella sub-rectangular, longitudinally arched, often spiniferous. Second lateral lobes larger than the first; third lateral lobes inconspicuous or obsolete. Palpebral furrows indistinct.



SUB-GENUS CERATOLICHAS, N. SUB-GEN.

DIAGNOSIS. Frontal lobe ellipsoidal and strongly convex, faintly constricted on the abrupt and almost vertical posterior slope. The elevated posterior edge of this lobe bears two or four long recurved spines. The lateral lobes are very depressed and obsolescent, the first and second pairs coalesced, and the third pair either obsolete or represented by faint tubercles in the occipital furrow. Just within each palpebral lobe is a slender spine, and the occipital ring bears a long central recurved double spine.

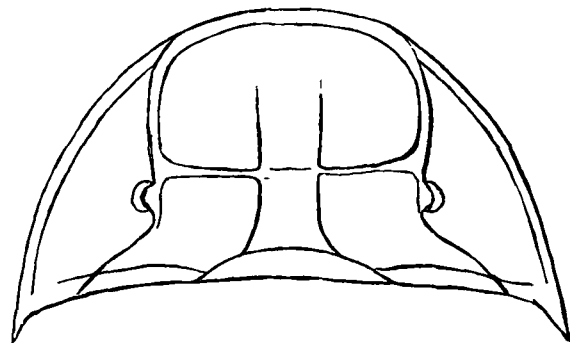


Ceratolichas differs from *Conolichas*, Dames, in the depressed and obsolete lateral lobes; from *Terataspis*, Hall, in the sub-quadrate, slightly constricted frontal lobe, and from *Arges*, Goldfuss, in having the frontal lobe shorter, more elevated, and abruptly sloping toward the posterior extremity.

SUB-GENUS DICRANOGMUS, CORDA. 1847.

1846. *Lichas* (*partim*), BARRANDE. Notice prélim. sur le Syst. sil. Bohême.
 1847. *Dicranognmus*, CORDA. Prodrom Monog. böhm. Trilob.
 1852. *Lichas* (*partim*), BARRANDE. Syst. Sil. Bohême, vol. i.
 1878. *Lichas* (*partim*), ANGELIN. Paleontologia Scandinavica.

DIAGNOSIS. Dorsal furrows of the glabella parallel, becoming obsolete toward the anterior margin. Second lateral furrows transverse; second lateral lobes smaller than the first; third lateral lobes inconspicuous or obsolete. Palpebral furrows not conspicuous.



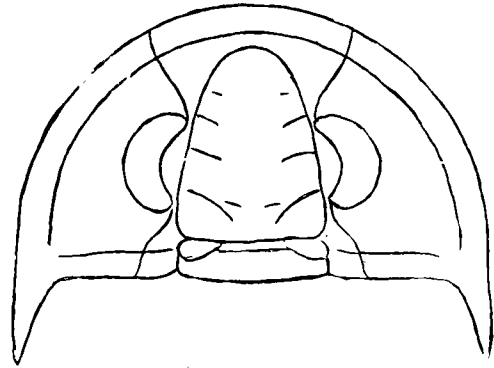
FAMILY, PROËTIDÆ.

GENUS PROËTUS, STEININGER. 1831.

1826. *Calymene*, DALMAN. Ueber Palaäden.
 1829. *Calymene*, HOLL. Handb. der Petrefakten.
 1831. *Proëtus*, STEININGER. Mem. Soc. géol. de France.
 1832. *Calymene*, GOLDFUSS. Dechen's Handb. d. Geognosie.
 1832. *Calymene*, GREEN. Mon. Trilob. North America.
 1837. *Calymene*, HISINGER. Lethæa Suecica.
 1837. *Calymene*, QUENSTEDT. Wiegmann Archiv.
 1838. *Calymene*, GREEN. Amer. Jour. Science.
 1839. *Calymene*, CONRAD. Second Ann. Rept. Pal. N. Y.
 1839. *Asaphus*, MURCHISON, Silurian System.
 1839. *Asaphus*, EMMRICH. De Trilob. Dissert.
 1840. *Calymene*, MILNE-EDWARDS. Hist. Nat. Crust. fossiles.
 1842. *Calymene*, D'ARCHIAC and DE VERNEUIL. Trans. Geol. Soc. London.
 1842. *Asaphus*, CONRAD. Jour. Acad. Nat. Sci.
 1843. *Gerastos*, GOLDFUSS. Leonhardt und Bronn's Neues Jahrb. für Min.
 1843. *Proëtus*, ÆONIA, BURMEISTER. Organiz. d. Trilob.
 1843. *Calymene*, HALL. Rept. Fourth Dist. N. Y.
 1844. *Gerastos*, C. F. RÆMER. Rhein. Uebergangsgeb.
 1845. *Gerastos*, EMMRICH. Neues Jahrb. für Min.
 1845. *Proëtus*, LOVEN. Ofversigt. af. Kongl. Vetensk Akad. Förhandl.
 1846. *Proëtus*, BARRANDE. Notice prélim. sur Syst. Sil. Bohême.
 1846. *Proëtus*, BEYRICH. Untersuchungen üb. Trilob.
 1846. *Forbesia*, MCCOY. Synopsis Sil. Foss. Ireland.
 1846. *Proëtus*, ROUAULT. Bull. Soc. géol. de France.
 1847. *Proëtus*, *Xiphogonium*, CORDA. Prodrom Mon. böhm. Trilob.
 1848. *Proëtus*, PHILLIPS and SALTER. Mem. Geol. Surv. United Kingdom.
 1850. *Trigonaspis*, *Cylindraspis*, the Brothers SANDBERGER. Verst. d. Rhein. Scht. Syst.
 1850. *Proëtus*, F. A. RÆMER. Beitr. i zur Harzgeb.
 1852. *Proëtus*, BARRANDE. Syst. Silur. böhm., vol. i.
 1852. *Proëtus*, HALL. Pal. N. Y., vol. ii.

1854. *Proetus*, WIRTGEN and ZEILER. Verhandl. d. Naturhist. Vereins.
1855. *Proetus*, SHUMARD. Geol. Surv. Missouri.
1856. *Cylindraspis*, RICHTER. Beitr. zur Paläontol. d. Thüringerwaldes.
1858. *Proetus*, BIGSBY. Quart. Jour. Geol. Soc.
1858. *Proetus*, F. A. RÖMER. Beitr. iv zur Harzgeb.
1858. *Proetus*, GIEBEL. Silur. Faun. Unterharz.
1859. *Proetus*, HALL. Pal. N. Y., vol. iii.
1860. *Proetus*, HALL. Thirteenth Rept. N. Y. State Cab. Nat. Hist.
1860. *Proetus*, BILLINGS. Canadian Naturalist and Geologist.
1861. *Proetus*, HALL. Descrip. New Species Fossils. Rept. N. Y. State Cab. Nat. Hist.
1862. *Proetus*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist.
1863. *Proetus*, SHUMARD. Trans. St. Louis Acad. Sci.
1863. *Proetus*, RICHTER. Zeitschr. der deutscher. geol. Gesellschaft.
1864. *Proetus*, RICHTER. Zeitschr. der deutscher. geol. Gesellschaft.
1865. *Proetus*, MEEK and WORTHEN. Proc. Acad. Nat. Science.
1865. *Proetus*, RICHTER. Zeitschr. der deutsch. geol. Gesellschaft.
1868. *Proetus*, MEEK and WORTHEN. Geol. Surv. Illinois, vol. iii.
1868. *Gerastos*, DEWALQUE. Prodrom. d'une Descr. géol. de Belgique.
1869. *Proetus*, LINNARSSON. Vestergötl. camb. och silur. Aflag.
1870. *Proetus*, TIETZE. Devon. Schicht. Ebersdorf.
1871. *Proetus*, MEEK. Proc. Acad. Nat. Science.
1872. *Proetus*, KAYSER. Zeitschr. der deutsch. geol. Gesellschaft.
1872. *Proetus*, MEEK. Amer. Jour. Science.
1872. *Proetus*, BARRANDE. Syst. Sil. Bohême. vol. i, Suppl.
1873. *Proetus*, MEEK. Geol. Surv. Ohio Palæontology, vol. i.
1874. *Proetus*, BILLINGS. Palæoz. Foss. Canada, vol. ii.
1875. *Proetus*, HALL and WHITFIELD. Geol. Surv. Ohio Palæontology, vol. ii.
1876. *Proetus*, C. F. RÖMER. Lethæa palæozoica.
1876. *Proetus*, HALL. Illustrations of Devonian Fossils.
1877. *Proetus*, HALL and WHITFIELD. U. S. Geol. Surv. Expl. Fortieth Parallel.
1877. *Proetus*, MEEK. U. S. Geol. Surv. Expl. Fortieth Parallel.
1878. *Proetus*, *Forbesia*, *Celmus*, ANGELIN. Palæontologia Scandinavica.
1879. *Proetus*, NOVAK. Studien an Hypostomen, i.
1879. *Proetus*, BARRIS. Proc. Davenport Acad. Science.
1880. *Dechenella*, KAYSER. Zeitsch. der deutsch. geol. Gesellschaft.
1881. *Proetus*, WILLIAMS. Amer. Jour. Science.
1881. *Proetus*, WETHERBY. Jour. Cincinnati Soc. Nat. Hist.
1883. *Proetus*, WOODWARD. Geological Magazine.
1884. *Proetus*, WALCOTT. Palæontol. Eureka Dist.
1884. *Proetus*, NOVAK. Studien an Hypostomen, ii.
1885. *Proetus*, *Dechenella*, CLARKE. Geol. Succession in Ontario Co.
1885. *Proetus*, ŒHLERT. Bull. de la Soc. d'Etudes Scientif. d'Angers.
1885. *Proetus*, MAURER. Kalke von Waldgirmes.
1885. *Proetus*, ZITTEL. Handb. d. Palæontologie.
1886. *Proetus*, MAURER. Fauna d. rechtsrhein. Unterdev.
1887. *Dechenella*, STAINER. Ann. de la. Soc. géol. de Bretagne.
1887. *Proetus*, *Phillipsia* (*partim*), HERRICK. Bulletin Denison University.
1887. *Proetus*, FOERSTE. Bulletin Denison University.
1887. *Dechenella*, TSCHERNYSCHEW. Mem. Comité géol., vol. iii.
1887. *Proetus*, ŒHLERT. Annales d. Société Géologique, vol. xix.
1887. *Proetus*, VOGDES. Ann. N. Y. Acad. Science.
1888. *Proetus*, *Dechenella*, FRECH. Zeitschr. der deutsch. geol. Gesellschaft.

DIAGNOSIS. Body generally small, elongate-ovate in outline. *Cephalon* semicircular, margin usually conspicuous and elevated; genal angles rounded or produced into spines. Glabella tapering anteriorly, scarcely reaching the frontal margin; lateral furrows conspicuous, faint or obsolete on the dorsal surface, distinct upon the internal surface. Eyes large, semilunate; lenses small, homocorneal. Facial sutures beginning on the posterior margin, just within the genal angles, and running from the eyes in nearly straight lines to the frontal margin, terminating on the edge of the doublure. *Hypostoma* elongate-rectangular, margins incurved and centrum very convex. *Thorax* longer than the cephalon, composed of from eight to ten segments, which are sulcate upon the pleuræ, sharply angled at the fulcrum, and rounded at their extremities. *Pygidium* sub-semicircular. Axis arched and bearing from four to thirteen annulations; pleuræ annulated; marginal area broad and entire.



The genus *Proëtus* possesses a greater specific representation in the Devonian formations of North America than any other group of *Trilobites*, and appears to have attained its culmination of development both in species and individuals in the waters which deposited the limestones of the Upper Helderberg group. But notwithstanding the abundance of specimens in these rocks, our knowledge of many of the species is imperfect on account of their usually fragmentary condition, and more complete material may eventually require the union of some of the forms described from detached parts of the animals, and which are now of necessity regarded as distinct species. In the higher Devonian formations the species are fewer, but the specimens are usually more complete and more satisfactory for purposes of description.

The material which has been at hand for the study of the twenty-six Devonian species here described is fairly representative, and in some instances comparatively abundant. All our observations point distinctly to the fact that the genus *Proëtus* includes a well-defined group of *Trilobites*, subject to but little variability in essential characters, and that the numerous subdivisions of the

genus erected by various authors have not been founded on the broadest conception of the value of slight variations.

With the single exception (*P. longicaudus*), all the American Devonian species possess *ten* thoracic segments; this one has but *nine*, and were this feature to be accorded generic significance, the species would fall under the subdivision *Xiphogonium*, Corda (Prodrom Monogr. böhm. Trilob., 1847). *Ten* however is the normal number of segments for the genus, and the possession of but nine (*P. sculptus*, Barrande), or even of eight (*P. Barrandii*, F. A. Roemer), is perhaps to be regarded as an embryological character retained in maturity. It has been customary to constitute subdivisions of this genus, and even distinct genera, upon the variations in the form of the glabella, and in the apparent number and length of the transverse glabellar furrows. Evidently the fact has frequently been overlooked that a glabella which evinces no trace of these furrows upon the external surface, will, under favorable weathering or upon a cast of the internal surface, show the normal number of four pairs and the posterior accessory pair of furrows. In occasional instances, where the ornamentation of the crust of the glabella has been preserved without defect, traces of all these furrows may be observed, but this is not true of species in which the glabella is normally smooth. The vertical compression of the crust, causing it to give way along the furrows, often develops them, or the slight detachment of the crust from its matrix makes them apparent by translucence. Thus the species *Proetus folliceus*, *P. crassimarginatus*, *P. Haldemani*, *P. Rowi*, in normal preservation, have a smooth, unfurrowed dorsal surface, but either in casts of the internal surface, or in cases of compression, show all the characteristic glabellar furrows. In the former condition of preservation *P. folliceus*, *P. crassimarginatus*, *P. clarus*, *P. Haldemani*, *P. Rowi* and *P. macrocephalus* would follow the type of *Gerastos*, Goldfuss; *P. canaliculatus* and *P. longicaudus* would belong to the genus *Æonia*, Burmeister. In other states of preservation *P. folliceus*, *P. Haldemani*, *P. Rowi* and *P. macrocephalus* would fall under the recently established genus *Dechenella*, Kayser. Therefore, and for the additional reason that even upon the internal surface of the glabella the furrows are subject to great variation in development (in *P. crassimarginatus* and

P. ovifrons being almost extinct), it becomes manifestly impossible to ascribe even a sub-generic value to such variations.

The sub-genus *Phaëton* was proposed by M. Barrande, in 1846, for forms of *Proëtus* in which the pygidium bears a marginal fimbria caused by the extension of the annulations.

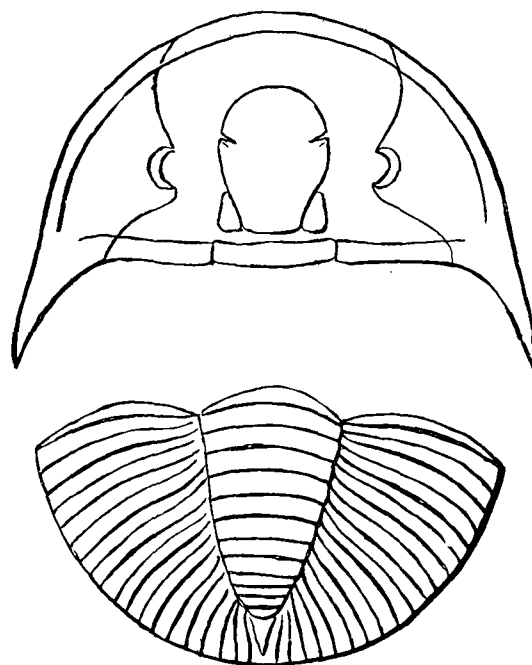
Forbesia, McCoy, 1846 (*Proëtus concinnus*, Dalman, type), is a *Proëtus* in which but two pairs of lateral furrows have been observed.

Celmus, Angelin, 1878 (*C. granulatus*, Ang., type), is founded upon an example in which there are twelve thoracic segments and but two pairs of lateral furrows. These last two genera are as yet imperfectly known, and may prove to include species showing a structure intermediate between that of the true *Proëtus* and of *Cyphaspis*.

GENUS PHAËTHONIDES, ANGELIN. 1878.

- 1835. *Asaphus* (*partim*), MURCHISON. Silurian System.
- 1845. *Proëtus* (*partim*), LOVEN. Ofversigt. af. Kongl. Vetensk. Akad. Förhandl.
- 1846. *Phaëton*, BARRANDE (?). Notice préliminaire sur les Syst. Sil. Bohême.
- 1847. *Prionopeltis*, CORDA (?). Prodrom Monog. böhm. Trilob.
- 1852. *Proëtus* (*Phaëton*), BARRANDE (?). Syst. Sil. Bohême, vol. i.
- 1863. *Proëtus* (*partim*), BILLINGS. Dev. and Silur. Foss. Square Lake, Me.
- 1877. *Proëtus* (*Phaëton*), MEEK. U. S. Geol. Surv. Expl. Fortieth Parallel.
- 1878. *Phaëthonides*, ANGELIN. Palæontologia Scandinavica.
- 1885. *Phaëton*, OEHLERT. Bull. de la Soc. d'Etudes Scientif. d'Angers.

DIAGNOSIS. *Cephalon* as in *Cyphaspis*, the frontal area, however, being more deeply concave, and the lateral glabellar furrows stronger and generally duplicate. *Thorax* composed of not less than seven narrow segments, and probably more. Axis wide. *Pygidium* Proëtoid, relatively large, bearing from eight to twelve annulations upon the axis, and eight or nine upon the pleuræ. These annulations extend to the margin, and are conspicuously duplicate their entire length. Surface tubercled or smooth.



The term *Phaëton* was used by M. Barrande in 1846 (Notice préliminaire sur le Système Silurien et les Trilobites de Bohême, p. 62), to include a certain series of Trilobites possessing Proëtoid characters, but differing from the normal *Proëtus* in having the annulations of the pygidium produced into a marginal fimbria. This term was at first given generic value, but subsequently reduced by its author (Syst. Sil. de Bohême, vol. i, p. 433, 1852), to the position of a sub-genus. The name *Phaëton* was long previously used by Linnæus for a genus of birds, and in 1847, Corda (Prodromeiner Monographie der Böhmischen Trilobiten) made use of the term *Prionopeltis* for the same group. In 1878, Angelin, in the posthumous edition of the *Palæontologia scandinavica* (part i, p. 21), referred to the group under the term *Phaëthonides*, ascribing the credit of the name to Barrande, giving it generic value and re-defining the genus in the following words:

“*Corpus* latiusculum, sub-ovate, distincte longitudinaliter trilobum, testa lævissima, aciculata tectum.

“*Caput* semilunare, undique marginatum canaliculoque lato, intramarginali præditum. Anguli capitis exteriores cornigeri. Frons ovata marginem apicalem haud attingens, utrinque lobo 1 distincto basali, lineisque 2 obsoletis abbreviatis impressis.

“*Oculi* sat magni, semi-circulares, approximati, sub-basales. Sutura facialis utrinque ab oculis extrorsum flexa, postice ad latera capitis anticeque ad marginem apicalem ducta.

“*Thorax* e segmentis 10, sulco pleurico instructis; rachi pleuris angustiore.

“*Abdomen* majusculum, semi-circulare, immarginatum, margine integerrimo aut dentato; rachis angusta, sub-cylindræa, aute scuti apicem evanescens; latera scuti sub-plana, costis dichotomis.”

As thus amended the group is made to include not only species with fimbriated pygidia, but also such as have the pygidial margin entire; cephalæ with a short, ovoid glabella, having distinct basal lobes and two pairs of faint, obsolescent lateral furrows in front of the lobes.

The type species under Angelin's diagnosis is *Asaphus* (*Proëtus*) *Stokesi*, Murchison, in which the pygidium has an entire margin, and the cephalon bears features which are more closely similar to those of the genus *Cyphaspis*

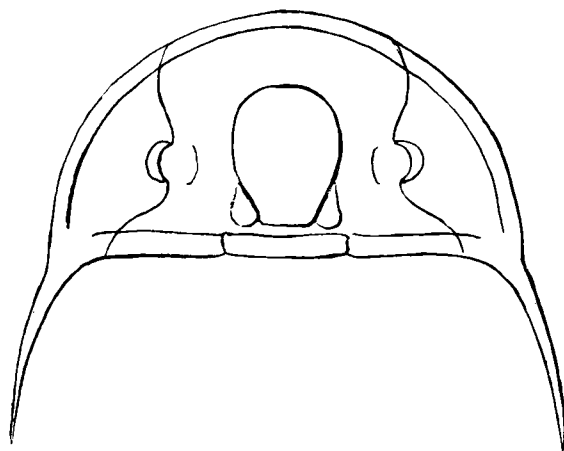
than of *Proëtus*, namely: the glabella is short and ovoid, with large, sub-pyri-form basal lobes distinctly separated from the body of the glabella, frontal area broad and conspicuous. In the type species of *Phaëton*, however (*Proëtus Archiaci* and *P. striatus*, Barrande), the glabella is sub-quadrate or broadly conate, the basal lobes not separated from the glabella by the third lateral furrows, while the two pairs of anterior furrows are clearly visible. Angelin's genus *Phaëthonides* includes a well-defined group of trilobites allied in certain features of the cephalon to *Cyphaspis*, and in certain features of the pygidium to *Proëtus*, but it appears very doubtful if this term can be used with propriety to cover the species recognized by Barrande under the name *Phaëton*. *Phaëthonides* is represented in the American formations by four species, two from the Lower Helderberg and two from the Devonian, and both cephalon and pygidium of all these are known. A doubtful species is known from the Devonian rocks of Nevada, which seems to be more closely allied to the *Phaëton* of Barrande than to the *Phaëthonides* of Angelin. Shall it eventually prove necessary to separate the species originally included under *Phaëton* as generically distinct from *Phaëthonides*, recognition should be accorded to the term *Prionopeltis*, Corda, 1847, which name was proposed for the same variations included under the term *Phaëton*, Barrande.

GENUS CYPHASPIS, BURMEISTER. 1843.

- 1843. *Cyphaspis*, BURMEISTER. Organ. der Trilobiten.
- 1843. *Calymene*, F. A. RÖMER. Verstein. des Harzgeb.
- 1843. *Gerastos*, GOLDFUSS. Leonhardt and Bronn's Neues Jahrb. für Min.
- 1844. *Phacops*, C. F. RÖMER. Verstein. d. Rhein. Uebergangsgeb.
- 1845. *Proëtus*, LOVEN. Ofversigt. af. Kongl. Vetensk. Akad. Förhandl.
- 1846. *Cyphaspis*, GEINITZ. Grundr. der Verstein.
- 1846. *Cyphaspis*, BARRANDE. Notice prélim. sur. Syst. Silur.
- 1847. *Cyphaspis*, *Conoparia*, *Goniopleura*, CORDA. Prodrom Monogr. böhm. Trilob.
- 1850. *Cyphaspis*, the Brothers SANDBERGER. Verstein. d. Rhein. Schichtensyst.
- 1852. *Cyphaspis*, BARRANDE. Syst. Sil. Bohême, vol. i.
- 1852. *Cyphaspis*, F. A. RÖMER. Beitr. ii zur Harzgeb.
- 1855. *Cyphaspis*, SHUMARD. Geol. Surv. Missouri.
- 1855. *Cyphaspis*, F. A. RÖMER. Beitr. iii zur Harzgeb.
- 1858. *Cyphaspis*, GIEBEL. Silur. Fauna Unterharz.
- 1862. *Cyphaspis*, HELLMANN. Die Petrefacten Thüringens.
- 1863. *Cyphaspis*, HALL. Trans. Albany Institute.
- 1869. *Cyphaspis*, HAIDENHAIN. Zeitschr. der deutsch. geol. Gesellsch.
- 1872. *Cyphaspis*, BARRANDE. Syst. Sil. Bohême, vol. i, suppl.

1874. *Cyphaspis*, STEINHARDT. Die bis jetzt in preuss. Geschieb. gef. Trilob.
 1875. *Cyphaspis*, MAURER. Neues Jahrb. für Min.
 1876. *Cyphaspis*, C. F. RÆMER. Lethæa palæozoica.
 1876. *Phillipsia*? (*Brachymetopus*?), HALL. Illustrations of Devonian Fossils.
 1878. *Cyphaspis*, KAYSER. Faun. aelt. Devon. Ablag. des. Harzes.
 1878. *Goniopleura*, ANGELIN. Palæontologia Scandinavica.
 1879. *Cyphaspis*, HALL. Twenty-eighth Rept. N. Y. State Mus. Nat. History.
 1881. *Cyphaspis*, HALL. Eleventh Ann. Rept. Geol. Surv. Indiana.
 1880. *Cyphaspis*, WHITE. Second Ann. Rept. Geol. Survey Indiana.
 1884. *Cyphaspis*, CLARKE. Neues Jahrb. für Min.
 1884. *Phillipsia*?, *Cyphaspis*, WALCOTT. Palæontol. Eureka District.
 1885. *Cyphaspis*, CLARKE. Geol. Succession in Ontario Co.
 1885. *Cyphaspis*, MAURER. Fauna der Kalke von Waldgirmes.
 1885. *Cyphaspis*, ZITTEL. Handbuch d. Palæontologie.
 1886. *Cyphaspis*, MAURER. Fauna d. rechtsrh. Unterdevon.
 1886. *Cyphaspis*, BARROIS. Ann. de la Soc. géol. du Nord.

DIAGNOSIS. *Cephalon* semicircular; genal angles produced into long spines. Glabella strongly arched, short and narrow, with two small pyriform basal lobes, bounded on all sides by deeply impressed furrows. Anterior lateral furrows obsolete. Cheeks broad, granulose; eyes small, semilunate. Facial sutures beginning near the genal angles, and in front of the eyes diverging to the frontal margin. *Thorax* composed of from ten to seventeen segments, which are rounded at their extremities. *Pygidium* semicircular, bearing from two to eight annulations upon the axis.



XIPHOSURA.

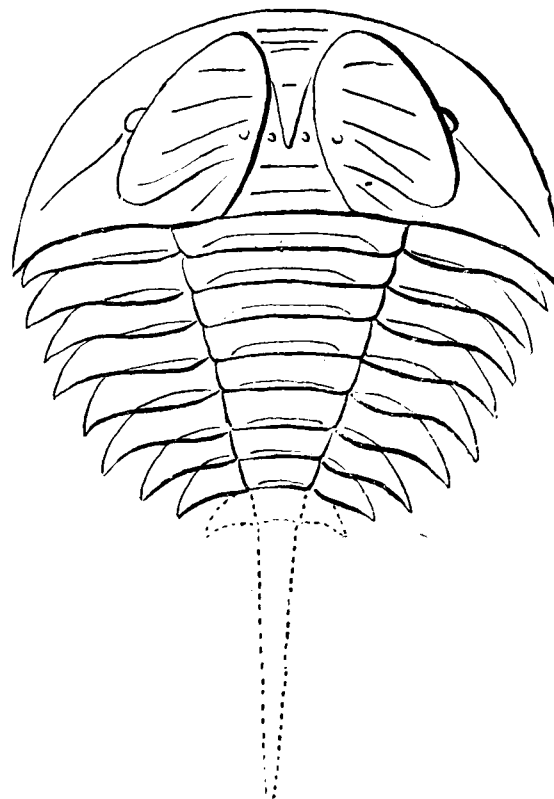
FAMILY, LIMULIDÆ.

GENUS PROTOLIMULUS, PACKARD. 1886.

1885. *Prestwichia*, H. S. WILLIAMS. Amer. Jour. Science.
 1886. *Protolimulus*, PACKARD. Mem. Nat. Acad. Sciences.

DIAGNOSIS. *Cephalothorax* relatively large, sub-semicircular, genal angles produced. Cephalic appendages small; terminal segments of the posterior members foliaceous. *Abdomen* composed of six (?) segments, including the large caudal spine.

This genus is represented by a single species which demonstrates the early appearance of the true limuloid crustacea. It is probable that its nearest known ally is the *Neolimulus falcatus*, Woodward, from the Upper Silurian of Lanarkshire. The latter fossil is regarded by Packard (Mem. Nat. Acad. Sci., p. 151, 1886), as not referable to the XIPHOSURA, and, together with the genera *Hemiaspis*, *Bunodes*, *Pseudoniscus* and others are made to constitute a distinct group (*suborder*, Packard), SYNZIPHOSURA. This separation is made principally on the ground that in all these forms the abdominal segments are free and not coalesced as in



Neolimulus falcatus, Woodward.

Limulus. It may be questioned whether the non-anchylosis of the segments has been satisfactorily demonstrated in *Neolimulus*, or if so, whether a division of so high value as a sub-order is wisely established upon a single larval character.

EURYPTERIDA.

FAMILY, EURYPTERIDÆ.

GENUS EURYPTERUS, DEKAY. 1825.

- 1825. *Eurypterus*, DEKAY. Ann. Lyceum Nat. Hist. New York.
- 1831. *Eidothea*, SCOULER. Edinburg Journ. Nat. and Geograph. Science.
- 1835. *Eurypterus*, HARLAN. Med. and Phys. Researches.
- 1835. *Eurypterus*, HARLAN. Trans. Geol. Society Penna.
- 1835. *Eurypterus*, BRONN. Lethæa geognostica.
- 1836. *Eurypterus*, HIBBERT. Trans. Roy. Soc. Edinburg.
- 1839. *Eurypterus*, FISCHER. Bull. de la Soc. Imp. des Naturalistes de Moscou.
- 1841. *Eurypterus*, CONRAD. Ann. Rept. Pal. New York.
- 1843. *Eurypterus*, VANUXEM. Geol. N. Y.; Rept. Third Dist.
- 1843. *Eurypterus*, BURMEISTR. Organ. der Trilobiten.
- 1848. *Eurypterus*, C. F. RÖMER. Palæontographica.
- 1850. *Eurypterus*, C. F. RÖMER. Lethæa geognostica.
- 1853. *Eurypterus*, DANA. Crust. U. S. Expl. Exped. Capt. Wilkes.
- 1854. *Eurypterus*, EICHWALD. Bull. de la Soc. Imp. des Naturalistes de Moscou.
- 1855. *Eurypterus*, MCCOY. British Palæoz. Fossils.
- 1855. *Lepidoderma*, REUSS. Denkschr. der Akad. Wissensch. Wien.
- 1856. *Eurypterus*, HUXLEY. Quart. Jour. Geol. Soc.

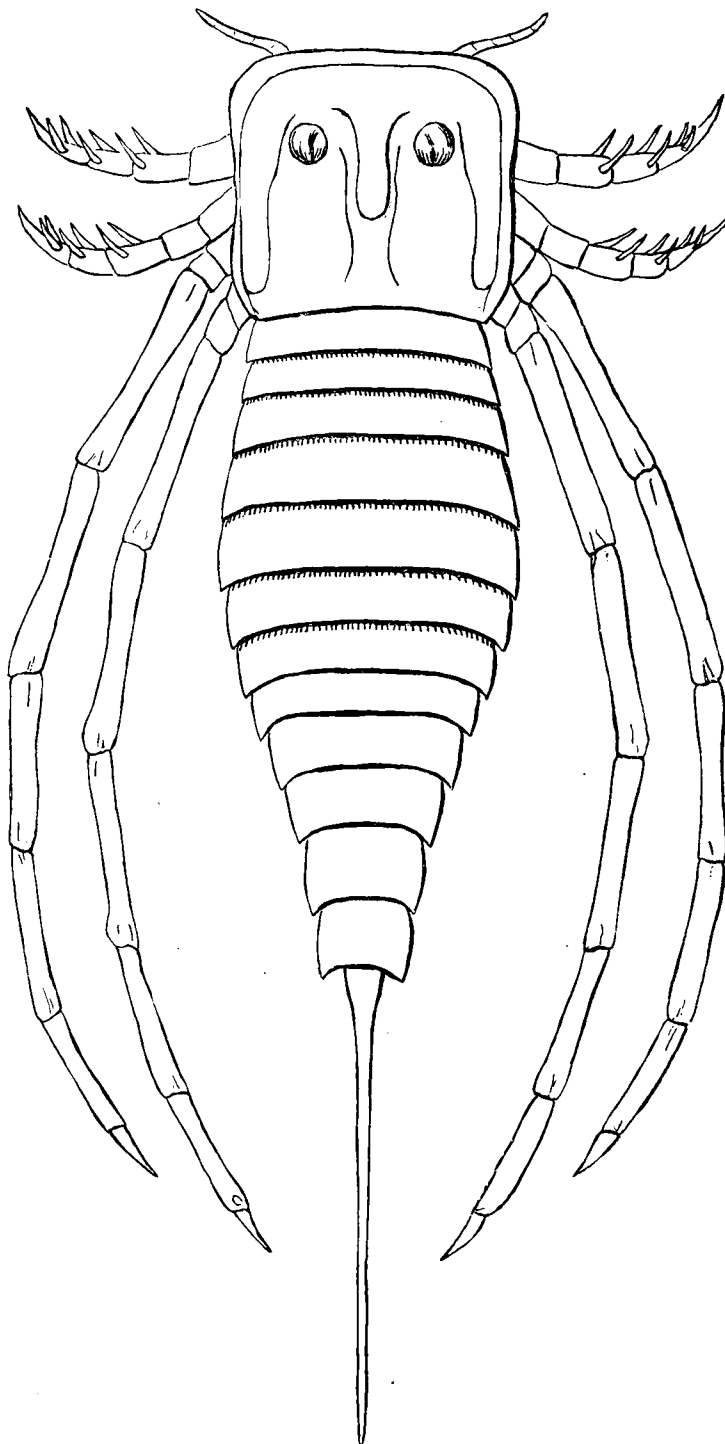
1856. *Lesmahago*, MURCHISON. Quart. Journ. Geol. Soc.
 1856. *Himantopterus*, SALTER. Quart. Jour. Geol. Soc.
 1856. *Eurypterus*, BANKS. Quart. Jour. Geol. Soc.
 1858. *Eurypterus*, SALTER. Quart. Jour. Geol. Soc.
 1859. *Eurypterus*, PAGE. Advanced Text-book of Geology.
 1859. *Eurypterus*, *Dolichopterus*, HALL. Palæontology N. Y., vol. iii.
 1859. *Eurypterus*, HUXLEY and SALTER. Mem. Geolog. Surv. United Kingdom.
 1859. *Eurypterus*, NIESZKOWSKI. Archiv. für Naturkunde Liv, Est und Kurlands.
 1863. *Eurypterus*, SALTER. Quarterly Journal. Geol. Soc.
 1864. *Eurypterus*, WOODWARD. British Assoc. Rept.
 1864. *Eurypterus*, WOODWARD. Geological Magazine.
 1868. *Eurypterus* (*Anthraconectes*), MEEK and WORTHEN. Amer. Jour. Science.
 1868. *Eurypterus* (*Anthraconectes*), MEEK and WORTHEN. Geol. Surv. Illinois, vol. iii.
 1868. *Eurypterus*, WOODWARD. Quart. Jour. Geol. Soc.
 1869. *Pterygotus*, BAILY. Brit. Assoc. Rept.
 1870. *Eurypterus*, WOODWARD. British Assoc. Rept.
 1871. *Eurypterus*, WOODWARD. Quart. Jour. Geol. Soc.
 1871. *Eurypterus*, WOODWARD. Trans. Woolhope Club.
 1872. *Eurypterus*, BARRANDE. Syst. Sil. du Centre de la Bohême. Suppl.
 1872. *Eurypterus*, WOODWARD. Monogr. Brit. Foss. Merostomata.
 1876. *Eurypterus*, C. F. RÖMER. Lethæa palæozoica.
 1877. *Eurypterus*, *Dolichopterus*, C. E. HALL. Trans. Amer. Philos. Soc.
 1882. *Eurypterus*, POHLMAN. Bull. Buffalo Soc. Nat. Sci.
 1882. *Eurypterus*, WHITFIELD. Descr. New Species Fossils from Ohio.
 1884. *Eurypterus*, HALL. Eurypteridæ Devon. and Carbonif. Format. Penna. Rept. P 3.
 1884. *Eurypterus*, WHITEAVES. Geol. and Nat. Hist. Surv. Canada. Palæoz. Fossils.
 1887. *Eurypterus*, WOODWARD. Geological Magazine.

DIAGNOSIS. Body elongate. *Cephalon* about one-fifth the length of the body, sub-quadrate in outline, gently convex. Eyes large, reniform, situated somewhat anteriorly, and within them lie two ocular punctæ or ocelli. Oral aperture surrounded by five pairs of cephalic appendages, in front of which is a pair of minute antennules. The first three pairs of appendages or gnathopods are of approximately the same length, the joints of the fourth pair being more elongate and the fifth pair being developed into powerful swimming appendages, the last two segments of which are very broad and flat. Behind the mouth lies an oval plate (*Metastoma*). *Abdomen* upon the dorsal side composed of six segments, the first of which corresponds to the *operculum* of *Limulus*. Upon the ventral surface there are but five segments apparent, all of which are divided by a median suture, the first two bearing median processes extending posteriorly. The first segment also bears a series of symmetrically arranged median plates, which may be connected with the genital apparatus. *Post-abdomen* composed of six tapering segments and a long slender caudal spine.

GENUS STYLONURUS, PAGE. 1856.

1856. *Stylonurus*, PAGE. Advanced Text-book of Geology.
 1857. *Eurypterus*, SALTER. Edinb. New Phil. Journ.
 1859. *Stylonurus*, PAGE. Advanced Text-book of Geology, 2d ed.
 1859. *Eurypterus* (*partim*), SALTER. Quart. Journ. Geol. Society.
 1859. *Eurypterus*, SALTER. In Murchison's Siluria, 3d ed.
 1864. *Stylonurus*, WOODWARD. British Assoc. Rept.
 1867. *Stylonurus*. Murchison's Siluria, 4th ed.
 1881. *Equisetides*, DAWSON. (?) Quart. Journ. Geol. Soc., vol. xxxvii.
 1882. *Stylonurus*, MARTIN. Trans. N. Y. Acad. of Sciences.
 1883. *Dolichocephala*, CLAYPOLE. Proc. Amer. Philos. Soc.
 1883. *Stylonurus*, HALL. Thirty-sixth Rept. N. Y. State Mus. Nat. Hist.

DIAGNOSIS. Body in general proportions similar to *Eurypterus*. *Cephalon* sub-quadrate or sub-pentagonal in outline. Eyes large, circular and approximate, sometimes surrounded by conspicuous orbital ridges. Ocelli situated at the posterior extremity of a median ridge, passing between the eyes. Surface coarsely squamose. Cephalic appendages in five (?) pairs, the last of which are produced nearly to the extremity of the telson. Segments of the *Abdomen* as far as known, similar to those in general features of *Eurypterus*. Those of the post-abdomen each bear a pair of lateral, detachable processes or *epimera*. Caudal spine long and slender or sub-clavate.



Restoration of *Stylonurus Logani*, according to Woodward.

SYNOPSIS OF GENERA.

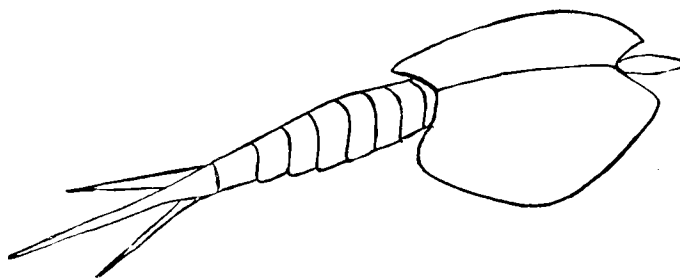
ORDER, PHYLLOCARIDA.

FAMILY, CERATIOCARIDÆ.

GENUS CERATIOCARIS, McCoy. 1849.

- 1839. *Onchus* (*partim*), AGASSIZ. Murchison's Silurian System.
- 1848. *Onchus* (*partim*), PHILLIPS. Mem. Geol. Surv. United Kingdom.
- 1849. *Pterygotus*, *Ceratiocaris*, McCoy. Ann. and Mag. Nat. Hist.
- 1851. *Leptocheles*, McCoy. Brit. Palæoz. Foss.
- 1851. *Pterygotus* (*Leptocheles*), BRONN. Lethæa geognostica.
- 1852. *Onchus*, HALL. Pal. N. Y., vol. ii.
- 1852. *Ceratiocaris*, BRONN. Lethæa geognostica.
- 1853. *Dithyrocaris*, GEINITZ. Verstein. Grauwacken. Sachsen.
- 1853. *Leptocheles*, McCoy. Quart. Jour. Geol. Soc.
- 1853. *Ceratiocaris* (*Leptocheles*), BARRANDE. Neues Jahrb. für Min.
- 1853. *Dithyrocaris*?, SHARPE. Quart. Journ. Geol. Soc.
- 1854. *Ceratiocaris*, *Leptocheles*, MURCHISON. Siluria.
- 1856. *Ceratiocaris*, SALTER. Quart. Journ. Geol. Soc.
- 1859. *Ceratiocaris*, HALL. Pal. N. Y., vol. iii.
- 1859. *Ceratiocaris*, SALTER. In Murchison's Siluria.
- 1860. *Ceratiocaris*, SALTER. Ann. and Mag. Nat. Hist.
- 1860. *Ceratiocaris*, ANGELIN. Palæontologia Scandinavica, suppl.
- 1865. *Ceratiocaris*, WOODWARD and SALTER. Chart Foss. Crustacea.
- 1865. *Ceratiocaris*, WOODWARD. Geol. Magazine.
- 1866. *Ceratiocaris*, WOODWARD. Geol. Magazine.
- 1866. *Ceratiocaris*, SALTER. Mem. Geol. Surv. United Kingdom.
- 1867. *Ceratiocaris*, SALTER. In Murchison's Siluria.
- 1868. *Ceratiocaris*?, MEEK and WORTHEN. Am. Jour. Sci. and Pal. Ill., vol. iii.
- 1871. *Ceratiocaris*, WOODWARD. Geol. Magazine.
- 1872. *Ceratiocaris*, WOODWARD. Geol. Magazine.
- 1872. *Ceratiocaris*, BARRANDE. Syst. Sil. Bohême, vol. i, suppl.
- 1872. *Ceratiocaris* (*Colpocaris*), MEEK. Proc. Acad. Nat. Sci. Phila.
- 1873. *Ceratiocaris*, ETHERIDGE. Mem. Geol. Surv. Scotland.
- 1874. *Ceratiocaris*, ETHERIDGE. Ann. and Mag. Nat. Hist.
- 1875. *Ceratiocaris* (*Colpocaris*), MEEK. Geol. Surv. Ohio Palæontology, vol. ii.
- 1876. *Ceratiocaris*, C. F. RÖEMER. Lethæa palæozoica.
- 1878. *Ceratiocaris*, YOUNG. Proc. Roy. Phys. Soc. Edinb.
- 1881. *Ceratiocaris*, POHLMAN. Bull. Buffalo Soc. Nat. Sci.
- 1882. *Ceratiocaris*, PEACH. Trans. Roy. Soc. Edinb.
- 1883. *Ceratiocaris*, PACKARD. Monog. North Amer. Phyllop. Crust.
- 1883. *Ceratiocaris*, ETHERIDGE, WOODWARD and JONES. Rept. Committee Fossil Phyllop.
- 1884. *Ceratiocaris*, BEECHER. Ceratiocaridæ Chemung and Waverly groups, Geol. Surv. Penna. Rept. P 3.
- 1885. *Ceratiocaris*, ZITTEL. Handb. d. Palæontologie.
- 1885. *Ceratiocaris*, NOVAK. Sitzungsab. böhm. Gesellsch. d. Wissensch.
- 1885. *Ceratiocaris*, CLARKE. Devon. Faunas Ontario Co.
- 1885. *Ceratiocaris*, CLARKE. Geol. Succession in Ontario Co.
- 1885. *Ceratiocaris*, JONES and WOODWARD. Geol. Magazine.
- 1886. *Ceratiocaris*, POHLMAN. Bull. Buffalo Soc. Nat. Sci.
- 1887. *Ceratiocaris*, ETHERIDGE, WOODWARD and JONES. Fifth Rept. Committee Fossil Phyllop. Palæoz. Rocks.
- 1888. *Ceratiocaris*, JONES and WOODWARD. Geological Magazine, March and April.

DIAGNOSIS. *Carapace* bivalved, probably with membranous attachment, no distinct hinge-joint observable; valves sub-ovate, semi-ovate, sub-quadrangle or trapezoidal; contracted in front, with the end sharp or rounded above the median line of the valve; more or less truncate. Rostrum a single lanceolate piece, the surface of which is chevron-marked. Antennæ (?) obscure. Dentate mandibles often apparent. *Abdomen* many-jointed, with fourteen or more segments, of which from four to seven extend beyond the carapace. Some or all of these segments bore small lamelli-form branchial appendages. *Post-abdomen* consisting of a long caudal plate which supports three caudal spines, namely: (1) a strong, tapering telson, thick at the proximal end, with its trifold articulating surface resembling that in the telson of *Limulus*, acute at the distal extremity and with the lateral margins ornamented with spinules or setæ; and (2) two shorter, simpler, lateral appendages. The entire dorsal surface has a lineate ornament, and the ventral margin of the carapace a thin raised rim. (Jones and Woodward, Geol. Mag., Decade iii, vol. ii, p. 385. 1885.)



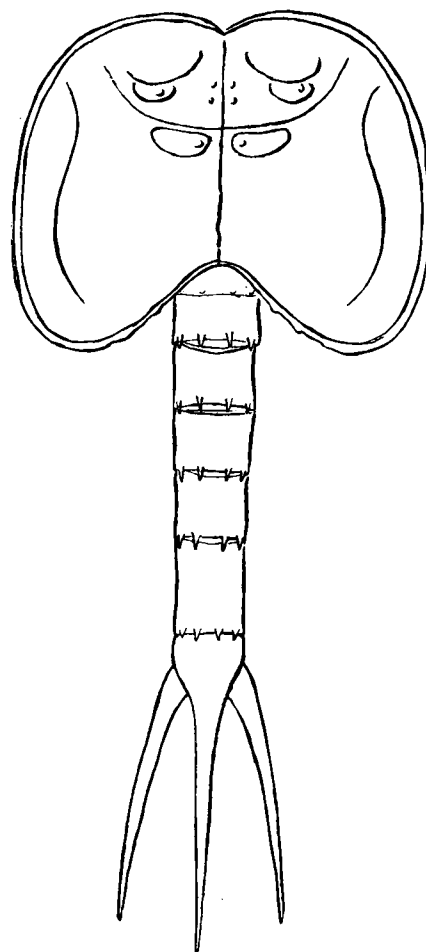
The species from the North American Devonian which are referred to this genus, are represented only by very incomplete specimens, which leave much to be desired for an accurate determination of their generic relations. The genus reached its culmination both in specific and individual development in the Upper Silurian and probably became extinct in this country with the close of the Devonian age.

GENUS ECHINOCARIS, WHITFIELD. 1880.

- 1863. *Ceratiocaris*, HALL. Sixteenth Rept. N. Y. State Cab. Nat. Hist.
- 1876. *Ceratiocaris* (*Aristozoe*), HALL. Illustrations of Devonian Fossils.
- 1880. *Echinocaris*, WHITFIELD. Amer. Journ. Science.
- 1881. *Equisetides*, DAWSON (?). Quart. Journ. Geol. Soc., vol. xxxvii.
- 1882. *Echinocaris*, PACKARD. American Naturalist.
- 1883. *Echinocaris*, PACKARD. Monog. N. Amer. Phyllop. Crustacea. [P 3.]
- 1884. *Echinocaris*, BEECHER. Ceratiocaridæ Chemung and Waverly groups, Geol. Surv. Penna. Rept.
- 1884. *Echinocaris*, JONES and WOODWARD. Geolog. Mag.
- 1885. *Echinocaris*, ETHERIDGE, WOODWARD and JONES. Third Rept. on Fossil Phyllopoda.
- 1885. *Echinocaris*, ZITTEL. Handb. d. Palæontologie.
- 1885. *Echinocaris*, NOVAK. Sitzungsber. d. böhm. Gesellsch d. Wissensch.
- 1885. *Echinocaris*, CLARKE. Devon. Faunas Ontario Co.
- 1886. *Echinocaris*, CLARKE. Geol. Succession in Ontario Co.

SYNOPSIS OF GENERA.

DIAGNOSIS. *Carapace* bivalvular, each valve obliquely sub-ovate in outline; hinge-line straight and shorter than the greatest length of the shield. Anterior extremities slightly gaping, posterior extremities somewhat produced, incurved or truncate. Rostrum absent or not observed. The cephalic and anterior portion of the thoracic area marked by various regularly and symmetrically arranged nodes, two of which bear the optic spots. Nuchal furrow more or less distinct. The thoracic portion of each valve bears one or two longitudinal, somewhat curving lateral ridges or carinæ. *Abdomen* naked, composed, so far as known, of six somites, which are furnished with short spinules or prickles on their dorsal surface. Caudal plate short and produced into a stout telson. Lateral spines or cercopods narrow and longer than the telson.



There are now known seven species referable to this genus in which the carapace has been observed, and while these are well-defined by differences in outline and the development of the nodes and ridges upon the surface, it appears that the nodes are constant in number and disposition in all the species. Of these nodes the *cephalic region* bears two, the anterior of which is large, irregularly defined and sometimes strongly tubercled upon its surface (*E. punctata*, *E. socialis*), the posterior small and situated close upon the hinge-line; the *thoracic region* also bears two, one at the hinge-line just behind the nuchal furrow, obliquely and anteriorly produced; the second originating near the ventral extremity of the first, transversely and posteriorly elongated and sometimes continuous with the lateral carina. (*E. sublevis*, *E. pustulosa*.)

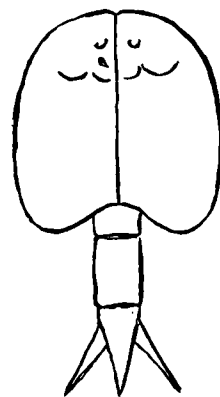
It is important to notice that certain species of the genus *Aristozoe*, Barrande, exhibit an arrangement of the cephalothoracic nodes very similar to that in *Echinocaris* (*A. memoranda*, *A. regina*, *A. bisulcata*), while other species included under that genus are widely dissimilar in this respect. None of the carapaces

in *Aristozoë* bear lateral carinae. It has recently been shown by Novák (Sitzungsber. d. Kl. böhm. Gesellsch. d. Wissensch. Jahrg. 1885,) that the species *Bactropus longipes*, Barrande, is probably the posterior abdominal somite of *Aristozoë regina*, and that the *Ceratiocaris debilis*, Barrande, may prove to be the telson spine of the same species. This spine is longitudinally ridged and bears a row of short prickles along each lateral margin. The genus *Ptychocaris*, Novák, 1885, from the same beds as *Aristozoë*, presents an intermediate group of forms in which the lateral carina is present, but in the arrangement of the anterior nodes it differs from both *Echinocaris* and *Aristozoë*. The points of similarity in *Aristozoë* and *Ptychocaris* with *Echinocaris* are of interest as the former genera antedate *Echinocaris* in palæozoic faunas, being characteristic of the Étage F, or Hercynian Fauna of Kayser and Novák, while the genus *Echinocaris* is limited to middle and upper Devonian formations, and as yet known is exclusively American in its distribution.

GENUS ELYMOCARIS, BEECHER. 1884.

1884. *Elymocaris*, BEECHER. Ceratiocaridæ Chemung and Waverly groups, Geol. Surv. Penna. Rept. P 3.
 1885. *Elymocaris*, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee Foss. Phyllop.
 1885. *Elymocaris*, ZITTEL. Handb. d. Palæontologie.

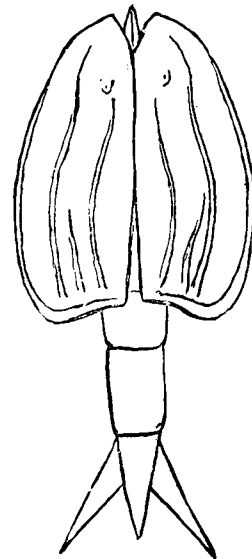
DIAGNOSIS. *Carapace* bivalvular, hinge-line straight and extending nearly the entire length of the valves. Outline elongate-subquadrangular or sub-ovate. Surface gently and evenly convex. Cephalic region smooth or marked by two low broad nodes; optic node usually distinct. Rostrum absent or not observed. *Abdomen* composed of two naked segments. *Post-abdomen* with a very short caudal plate to which are articulated a broad, convex and rapidly tapering telson and two short lateral spines which are crenulated along their inner margins for the attachment of the setæ.



GENUS TROPIDOCARIS, BEECHER. 1884.

1884. *Tropidocaris*, BEECHER. Ceratiocaridæ Chemung and Waverly groups, Geol. Surv. Penna. Rept. P 3.
 1884. *Tropidocaris*, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee Foss. Phyllop.
 1885. *Tropidocaris*, NOVÁK. Sitzungsber. böhm. Gesellsch. d. Wissensch.
 1885. *Tropidocaris*, ZITTEL. Handb. d. Palæontologie.

DIAGNOSIS. *Carapace* bivalvular, sub-quadrate or sub-ovate in outline, posterior margin transverse or incurved. Hinge-line straight, nearly equaling the length of the valves. Valves slightly gaping at the anterior extremity. Rostrum narrow and elongate, ornamented with longitudinal ridges. Cephalic region characterized by low, rounded, indistinct elevations. Optic node well defined. Surface with one or more strong longitudinal carinæ. *Abdomen*, as far as known, composed of two segments, which are sub-cylindrical and without nodes or spines.



FAMILY, PINACARIDÆ.

GENUS MESOTHYRA, NOV. GEN.

(See Plate xxxii.)

DIAGNOSIS. *Carapace* sub-quadrate in outline, composed of two valves which come into contact at the apices of two broad, sub-triangular extensions, situated on the dorsal line opposite the eye-nodes, forming a short and broad anterior, or rostral cleft and a long posterior cleft. Rostrum not observed. The posterior dorsal cleft was covered either by a single elongate plate, with each margin of which the valves were in symphysis, or, as is more probable, by a double plate, divided by a median suture. Test broadly infolded on the lower surface, thickened and produced into a conspicuous and acute posterior spine. Posterior margin incurved and produced into a short spine at the dorsal line. Surface with a single strong carina on each valve. *Abdomen* consisting of two somites of which the posterior is the longer. *Post-abdomen* with a broad caudal plate, which is produced into a relatively short telson. Lateral spines long and setaceous.

This genus is established to include certain species hitherto referred, on insufficient grounds, to the genus *Dithyrocaris*, Scouler. The peculiar structure of the hinge area separates it widely from *Dithyrocaris*, unless the type species of that genus has been inadequately described. There is, however, so close a similarity in these forms of *Mesothyra* with many of the described species of *Dithyrocaris*, in all respects except the feature noticed, as to give rise to a sus-

picion that a closer examination, of specimens of the various species described under the latter genus, may afford evidence of the structural features exhibited in *Mesothyra*. No simple bivalved carapace unquestionably referable to the genus *Dithyrocaris*, is known in the American Devonian; the species *Dithyrocaris Belli*, Woodward, from the Middle Devonian of Gaspé, being too imperfectly known to allow its generic relations to be determined. To facilitate a comparison of these two genera, the following index to the literature of the genus *Dithyrocaris* is given:

GENUS DITHYROCARIS, SCOULER. 1843.

- 1835. *Argas*, SCOULER. Records of Science.
- 1843. *Dithyrocaris*, PORTLOCK, Geol. Rept. Londonderry.
- 1844. *Dithyrocaris*, MCCOY. Syn. Carb. Foss. Ireland.
- 1849. *Dithyrocaris*, MCCOY. Ann. Mag. Nat. Hist.
- 1855. *Dithyrocaris*, MCCOY. Syn. Brit. Pal. Fossils.
- 1855. *Dithyrocaris*, F. A. RÖNER. Beitr. iii zur Harzgeb.
- 1863. *Dithyrocaris*, SALTER. Quart. Jour. Geol. Society.
- 1864. *Dithyrocaris*, LUDWIG. Palæontographica, vol. xi.
- 1865. *Dithyrocaris*, SALTER and WOODWARD. Chart of Fossil Crustacea.
- 1869. *Dithyrocaris*, MEEK and WORTHEN. Proc. Acad. Nat. Sci. Philadelphia.
- 1870. *Dithyrocaris*, WOODWARD. Rept. Brit. Association.
- 1871. *Dithyrocaris*, WOODWARD. Rept. Brit. Association.
- 1871. *Dithyrocaris*, WOODWARD. Geol. Magazine.
- 1873. *Dithyrocaris*, MEEK and WORTHEN. Geol. and Pal. Illinois, vol. v.
- 1873. *Dithyrocaris*, WOODWARD and ETHERIDGE. Mem. Geol. Surv. Scotland.
- 1873. *Dithyrocaris*, WOODWARD and ETHERIDGE. Geol. Magazine.
- 1874. *Dithyrocaris*, WOODWARD and ETHERIDGE. Geol. Magazine.
- 1878. *Dithyrocaris*, KAYSER. Ält. Devon. Ablag. Harz.
- 1878. *Rachura*, SCUDDER. Proc. Boston Soc. Nat. History.
- 1879. *Dithyrocaris*, ETHERIDGE. Quart. Jour. Geol. Society.
- 1882. *Dithyrocaris*, PACKARD. Amer. Naturalist.
- 1883. *Dithyrocaris*, PACKARD. Monog. N. Amer. Phyllop. Crustacea.
- 1884. *Dithyrocaris*, CLARKE. Neues Jahrb. für Min.
- 1884. *Dithyrocaris*, WHITE. Thirteenth Ann. Rept. Geol. Surv. Indiana.
- 1885. *Dithyrocaris*, NOVAK. Sitzungsab. böhm. Gesellsch. d. Wissenschaft.
- 1887. *Dithyrocaris*, ETHERIDGE, WOODWARD and JONES. Fifth Rept. Committee Foss. Phyllop.

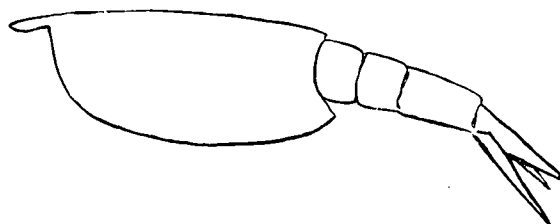
DIAGNOSIS. *Carapace* sub-quadrate in outline, bivalvular, the valves being connected by a simple, straight hinge-line, and gaping at the anterior extremity, forming the rostral cleft. Rostrum unknown. Each valve bears a single, gently curved carina. Optic nodes generally conspicuous. *Abdomen* composed of ? segments of which but one is naked. *Post-abdomen* consisting of caudal plate and three caudal spines.

SYNOPSIS OF GENERA.

FAMILY, RHINOCARIDÆ.

GENUS RHINOCARIS, NOV. GEN.

DIAGNOSIS. *Cephalothorax* univalvular, laterally appressed; outline as in *Ceratiocaris*. Anterior extremity produced into a narrow, vertically flattened *prora* continuous with substance of the carapace. The axial line of the carapace bears a low ridge along which it shows no inclination to separate when laterally compressed. Surface smooth or with one or more lateral carinæ, and ornamented by finely elevated lines, granules or tubercles. *Abdomen* composed of not less than four smooth sub-cylindrical somites. *Post-abdomen* bearing three spines, of which the telson is elongate and conical and the cercopods flattened.



This genus includes a series of forms which may tentatively be regarded as *Phyllocarida*, but which represent a type of crustacean structure hitherto unrecognized, taxonomically intermediate between the univalve PHYLLOCARIDA, *Hymenocaris* and *Dictyocaris*, and the Macrourous DECAPODA.

FAMILY, DISCINOCARIDÆ.

GENUS SPATHIOCARIS, CLARKE. 1882.

- 1882. *Spathiocaris*, CLARKE. Amer. Journ. Science.
- 1883. *Spathiocaris*, PACKARD. Monog. North Amer. Phyllop. Crustacea.
- 1883. *Spathiocaris*, ETHERIDGE, WOODWARD and JONES. Rept. Committee Foss. Phyllop.
- 1884. *Spathiocaris*, CLARKE. Neues Jahrb. für Min.
- 1884. *Spathiocaris*, DAMES. Neues Jahrb. für Min.
- 1884. *Spathiocaris*, VON KOENEN. Neues Jahrb. für Min.
- 1884. *Spathiocaris*, ETHERIDGE, WOODWARD and JONES. Second Rept. Committee Foss. Phyllop.
- 1884. *Spathiocaris*, JONES and WOODWARD. Geol. Magazine.
- 1885. *Spathiocaris*, CLARKE. Devon. Faunas Ontario county.
- 1885. *Spathiocaris*, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee Foss. Phyllop.
- 1885. *Spathiocaris*, DAMES. Neues Jahrb. für Min.
- 1885. *Spathiocaris*, ZITTEL. Handb. d. Palæontologie.
- 1886. *Spathiocaris*, CLARKE. Geol. Succession in Ontario Co.

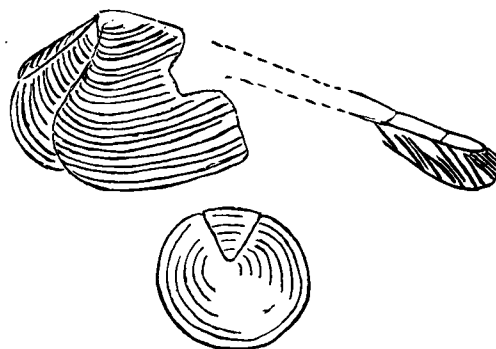
DIAGNOSIS. Carapace in one piece, elliptical, sub-conical and patelloid; apex situated at or near one focus of the ellipse. The cephalic cleft begins just in front of the apex and slowly widens to the anterior extremity. Surface ornamented with closely set concentric lines and usually with fine radii on the anterior and posterior portions.

GENUS DIPTEROCARIS, CLARKE. 1883.

1883. *Dipterocaris*, CLARKE. Amer. Jour. Science.
 1883. *Dipterocaris*, ETHERIDGE, WOODWARD and JONES. Rept. Committee Foss. Phyllop.
 1884. *Dipterocaris*, JONES and WOODWARD. Geol. Magazine.
 1884. *Dipterocaris*, ETHERIDGE, WOODWARD and JONES. Second Rept. Committee Foss. Phyllop.
 1885. *Dipterocaris*, CLARKE. Dev. Faunas Ontario county.
 1885. *Dipterocaris*, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee Foss. Phyllop.
 1885. *Dipterocaris*, ZITTEL. Handb. d. Palæontologie.
 1886. *Dipterocaris*, CLARKE. Geol. Succession in Ontario Co.

DIAGNOSIS. Carapace in one piece, ovate in general outline; normally with an elevated dorsum and sloping sides. Each extremity is strongly notched, dividing the carapace into two broad *alæ* connected by a narrow isthmus which shows no evidence of a dorsal suture or anchylosis. Surface ornamented by concentric elevated lines or wrinkles.

The true organic character of the bodies included under the genera *Spathiocaris* and *Dipterocaris* and allied forms, from the Devonian horizons of Great Britain and Europe, has been a subject of some debate among recent writers. A diversity of opinion has arisen from the fact that while some of the species included under the closely related genera *Peltocaris*, Salter, *Aptychopsis*, Barrande, *Discinocaris*, Woodward, *Aspidocaris*, Reuss, *Cardiocaris*, Woodward, *Ellipsocaris*, Woodward, and *Spathiocaris*, Clarke, have afforded indisputable evidence of a free rostral plate covering the anterior cleft, e. g., *Peltocaris aptychoides*, Salter; *Aptychopsis prima*, Barrande; *Cardiocaris Ræmeri*, Woodward; *Discinocaris Browniana*, Woodward; since the original description of the species as crustacea, others have been found in the body



Discinocaris Browniana, Woodward.

chamber of a single species of *Goniatites* (*G. intumescens*) (*Cardiocaris lata*, Woodward, *Spathiocaris Kæneni*, Clarke, both from the middle Devonian limestones at Bicken, Westphalia). From this fact, together with the similarity of these latter bodies in many respects to the aptychi of Mesozoic Cephalopoda, and their agreement in outline with the transverse section of the body chambers in which they have been found, there is no doubt that these two species at least have had some organic connection with the cephalopoda, serving a similar

function to the aptychi of the Ammonites. All the representatives of the genera mentioned show a degree of analogy in form and structure which, without accessory evidence, would naturally lead to their allocation to the same zoological position. The earliest of these genera established, viz., *Peltocaris*, *Discinocaris* and *Aptychopsis* are of undoubted crustacean nature, as they show evidence of a cephalic or rostral plate filling the anterior cleft, and moreover, they are found at Silurian horizons where *Goniatites* are unknown. Referring to the Devonian species, it must be taken into consideration that they occur at horizons which are usually prolific in *Goniatites*, but while some may be cephalopodous, as the two species mentioned, those described by Keyserling from the Domanik-schiefer of Petschora-land, by Woodward from the black shales of Büdesheim, and those from the State of New York occur in no intimate or suggestive association with these fossils. The species *Spathiocaris Emersoni* has proven an abundant fossil at certain localities in the lower shales of the Portage group, but it has not as yet been seen in intimate connection with *Goniatites*. On the other hand it is found at an horizon in which the Phyllocarid crustacea appear to have attained their maximum development in this country.

Of the bipennate species, or those with the univalvular shield cleft at both anterior and posterior extremities (*Dipterocaris*, *Pterocaris*), we have no means of positively determining the nature, either from analogy with the aptychi of cephalopods or from similarity to any undoubted crustacean, except as shown in the genus *Peltocaris*, etc. With our present knowledge their crustacean affinities appear the more decided; the anterior cleft for the rostral plate, the posterior cleft for the protrusion of the abdomen, and the sides normally sloping as in *Peltocaris*, *Rhinocaris*, etc.

On plate 35 of this volume is given a figure representing a minute bipennate body having the outline of *Dipterocaris*, lying within the body-whorl of a large individual of *Goniatites complanatus*. The body-whorl of the shell has a width of 37 mm., the diameter of the entire shell having been as great as 75 mm.; the length of the *Dipterocaris*-like body is 5 mm. The specimen is from the lower shales of the Portage group, in which *Goniatites complanatus* is the most

abundant cephalopod and furnishes the only instance observed, after the most careful examination of the rocks, of any such association of these bodies, and also the only example of the occurrence of a body resembling *Dipterocaris* in these beds. If this association is not purely accidental, and if there actually existed any organic connection between the Goniatite and the enclosed body, the latter has certainly not been similar in function to the aptychi.

While it is necessary to recognize the fact that of the bodies included under the genera *Spathiocaris*, *Cardiocaris*, *Discinocaris*, *Dipterocaris*, *Pterocaris* and *Pholadocaris* some are undoubtedly crustacean and others, with certainty, cephalopodous, with our present knowledge it is impossible to draw the dividing line between them.

ORDER, DECAPODA.

FAMILY, CARIDIDÆ.

GENUS PALÆOPALÆMON, WHITFIELD. 1880.

DIAGNOSIS. *Cephalothorax* not rostrate (?), keeled upon the dorsum and sides. Antennules not observed. Antennæ with very strong basal joints, exceeding in strength any of the thoracic appendages. Eye-peduncles probably short. Thoracic ambulatory appendages slender, not forcipate. *Abdomen* composed of six segments. *Telson* short, rapidly tapering and connected by a membranous expansion with the lateral caudal spines. In the midst of this caudal expansion lies a pair of thin lamellar spines articulated at their proximal extremities to both telson and lateral spines.

ORDER, PHYLLOPODA.

FAMILY, LIMNADIADÆ.

GENUS ESTHERIA, RÜPPEL.

(DEVONIAN SPECIES ONLY.)

1846. *Posidonomya*, EICHWALD. Geol. Russia.
 1849. *Asmusia*, PACT. Devon. Kalk in Livland.

1852. *Posidonomya*, PACHT. Ueb. Dimerocrinites.
 1852. *Posidonomya*, KUTORGA. Geogn. Karte Gouvern. Petersbourg.
 1855. *Estheria*, JONES. Quart. Journ. Geol. Society.
 1858.(?) *Posidonia*, VON HELMERSEN. Geogn. Untersuch. Mittl. Gouvern. Russl.
 1859. *Estheria*, JONES. Quart. Journ. Geol. Society.
 1860. *Asmusia*, PANDER. Monogr. der Saurodipterinen.
 1862. *Estheria*, JONES. Monogr. Foss. Estheriæ.
 1882. *Estheria*, CLARKE. Amer. Journ. Science.
 1883. *Estheria*, PACKARD. Monogr. North Amer. Phyllop. Crustacea.

DIAGNOSIS. *Carapace* bivalvular, the outline of each valve being sub-circular, obliquely oval or sub-quadrate. Beaks generally anterior, sometimes sub-central. Dorsal or hinge-line straight, shorter than the greatest length of the valves. Surface rarely smooth, usually with concentric lines of growth, the interstitial spaces being often ornamented with a fine punctate or reticulate sculpture. Test very thin.

GENUS SCHIZODISCUS, NOV. GEN.

DIAGNOSIS. *Carapace* bivalvular, the valves readily separable along the hinge. Outline circular or ovate, narrowing posteriorly. Surface convex or depressed, elevated at the beaks which are prominent, slightly incurved, and situated anteriorly. Hinge-line equaling in length the greatest diameter of the carapace; edges parallel and not gaping at either extremity. Surface ornamented by regularly concentric wrinkles.

ORDER, CIRRIPIEDIA.

FAMILY, BALANIDÆ.

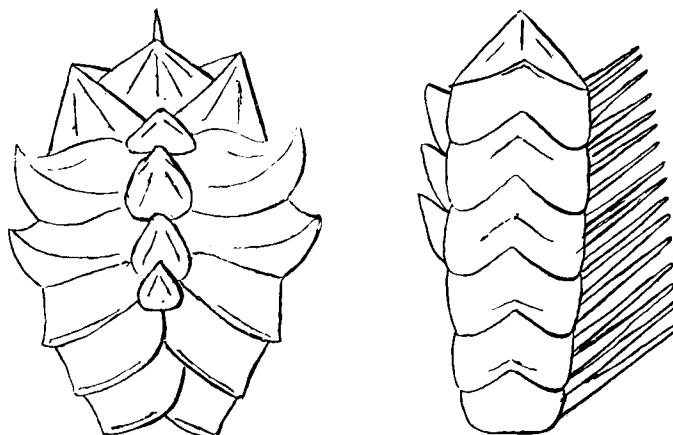
GENUS PROTOBALANUS, NOV. GEN.

DIAGNOSIS. Shell ovate about the basis; composed of twelve plates of which the carina is largest and most elevated. Rostrum small; lateralialia five on each side; radial areas between the lateralialia broad; scutum and tergum not known. General surface depressed convex.

FAMILY, LEPADIDÆ.

GENUS STROBILEPIS, NOV. GEN.

DIAGNOSIS. *Capitulum* composed of four vertical ranges of plates, having in general a trihedral form, but varying greatly in contour and size. Each plate is closely articulated to, and sometimes overlapping the next preceding. The anterior extremity is terminated by a relatively large, circular, conical plate, against the sides of which the first plate in each vertical range lies. In the type species, two of the four vertical ranges of plates are of about the same size, one consists of a few very small plates and the fourth is modified into a series of spines which appear to be articulated to one another at their bases and to lie opposite the range of small plates. Plates calcareous and relatively thick. Surface ornamented by fine concentric, often obsolete wrinkles of growth, and low radiating furrows and ridges, and entirely covered with minute punctæ.



GENUS TURRILEPAS, WOODWARD. 1865.

- 1865. *Turrilepas*, WOODWARD. Quart. Journ. Geol. Society.
- 1872. *Plumulites*, BARRANDE. Syst. Sil. Bohême, vol. i, suppl.
- 1875. *Plumulites*, HALL and WHITFIELD. Geol. Surv. Ohio, Palæontology, vol. ii.
- 1876. *Plumulites*, C. F. RÖMER. Lethæa palæozoica.
- 1882. *Plumulites*, CLARKE. Amer. Journ. Science.
- 1882. *Plumulites*, WHITFIELD. Ann. New York Acad. Sciences.
- 1884. *Plumulites*, ZITTEL. Sitzungsber. d. math.-phys. Classe d. k. bayer. Akad. d. Wiss.
- 1885. *Plumulites*, ZITTEL. Handb. d. Palæontologie.

DIAGNOSIS. Elongate cone-shaped bodies, composed of from four to six vertical ranges of scale-like plates, which are sub-triangular in general outline and are covered with strong, somewhat elevated concentric lines. The plates of the middle range are distinguished from those of the lateral ranges by their more convex surface and median carina.

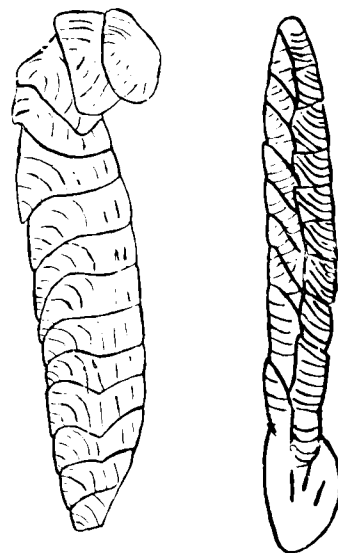
(ZITTEL.)

*Turrilepas Wrightianus*.

The structure and exact relations of these bodies still remains open to some question. As the separate plates are usually detached and isolated, it is impossible to determine how great a variation in form may have existed among them in any given species, and, therefore, it may be that some of the plates here described as different species on account of their diversity in form, will eventually have to be united, as being different parts of animals belonging to the same species. By Woodward and Zittel these fossils are regarded as representing the scaly peduncle of Lepadoid cirripedes similar to *Loricula* and *Archæolepas*, and by Barrande as an elementary type of capitulum. Figures are given by Barrande and Woodward which represent the different ranges of plates constituting these bodies in approximately their normal position, but in none of them is the character of the distal extremity of the scaly covering represented. The type specimen of the closely allied genus *Strobilepis* (*S. spinigera*) has a single conical terminal plate at the distal extremity, and the entire body is probably to be regarded as a capitulum, and from analogy it would appear that the view of Barrande in regard to the nature of *Turrilepas* may be correct.

The term *Turrilepas* was proposed by Woodward in 1865, the character of the fossils being analysed at some length and accompanied by satisfactory illustration. It has, however, been customary among authors to accord recognition to the term *Plumulites*, given by Barrande in 1872, with somewhat more extended description and illustration. There seems, however, to be no valid reason why Woodward's term should not be accorded acceptance.

The genus *Lepidocoleus*, Faber, (Journ. Cinti. Soc. Nat. Hist., 1886), founded upon a nearly entire specimen of the *Plumulites Jamesi*, Hall and Whitfield, appears to be composed of but two ranges of vertical plates of unequal size, interlocking along their basal edges for their entire length.



Lepidocoleus Jamesi.

CRUSTACEA

OF THE

UPPER HELDERBERG, HAMILTON, PORTAGE AND CHEMUNG GROUPS.

DESCRIPTIONS OF SPECIES.

TRILOBITA.

CALYMENIDÆ.

CALYMENE, BRONGNIART. 1822.

CALYMENE PLATYS.

PLATE I, FIGS. 1-9; AND PLATE XXV, FIG. 1.

Calymene platys, GREEN. Monogr. Trilob. of North America, p. 32. 1832.

Calymene platys, HALL. Descrip. New Species of Fossils, etc., p. 54. 1861.

Calymene platys, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 82. 1862.

Calymene platys, HALL. Illustrations of Devonian Fossils, pl. i, figs. 1-9. 1876.

GENERAL FORM AND PROPORTIONS. Body elongate-sub-ovate, widest anteriorly and tapering rapidly to the posterior extremity.

Surface convex, laterally deflected, sub-equally trilobate. Length to width as 1.7 to 1.

CEPHALON short and broad, outline crescentic; length to width as 1 to 2.5. Margin on the anterior extremity thickened, slightly produced, reflected and broadly infolded to the doublure. Epistomal surface narrow. Genal angles rounded, not produced. Frontal area narrow and obscured by the overarching glabella.

Facial sutures having their origin on the lateral margins just in front of the genal angles, passing inward with a slight curve nearly parallel to the posterior

margin, to the eye, thence forward at nearly right angles, to the frontal margin, where they pass over upon the doublure, gradually approximating, and terminating on the epistomal margin. These lateral branches are united by the transverse frontal suture just below the frontal margin, thus leaving a free median frontal plate.

Glabella large, trapezoidal or sub-quadrate in outline; widest posteriorly, where the width nearly equals the length of the cephalon; convex, tumid on the frontal lobe; dorsal and anterior furrows strong and deeply impressed; lateral furrows in three pairs, the first of which is faint and almost obsolete, the second short and broad, the third longer, curved slightly forward, bifurcating near its anterior extremity, the posterior branch having a retral bend. Frontal lobe sub-hemispherical, gibbous; second and fourth pair of lateral lobes transversely pyriform, the latter much the stronger and having a diameter equal to one-fourth the posterior width of the glabella; third pair inconspicuous, and seen only under favorable preservation.

Occipital furrow narrow on the axis, widening on the cheeks; occipital annulation broad, elevated, becoming flattened on the cheeks toward the genal angles.

Cheeks broadly sub-triangular, depressed convex; free portions triangular, small.

Eyes small, situated somewhat anteriorly; palpebral lobe depressed, broad, making the visual surface distant from the glabella; palpebral furrow deep and strong.

THORAX sub-equally trilobate, margins sloping posteriorly. Length and width equal.

Axis broadest at about the fifth segment, thence tapering evenly to the pygidium.

Pleurae deflected along the fulcrum at about one-third their width from the axial furrows.

The thirteen segments have a slight double curve upon the axis, bending backward at a short distance from the axial margins, thence forward again

along the axial line. Upon the pleuræ the segments are grooved, the anterior limb of each being small and becoming obsolete on the beveled planes of articulation.

PYGIDIUM spherically sub-triangular, truncate and strongly emarginate on the posterior border. Length to width as 1 to 1.3.

Axis broad, rapidly narrowing and ending abruptly in a blunt elevation within the posterior border; its terminal portion is flattened above, and from its apex a low ridge passes over the post-axial area. Axial annulations six.

Pleuræ broad, and abruptly deflected. Anterior margins strongly beveled by the articulating planes, and meeting the lateral margins at an angle of ninety degrees. Pleural annulations four, flattened near the margin and sometimes showing a tendency to bifurcate.

HYPOSTOMA sub-quadrate; lateral margins strongly incurved, posterior border emarginate. Anterior angles auriculate, margins thickened and slightly reflexed; centrum elevated, sharply carinate.

Surface Ornamentation. The cast of the external surface of a nearly entire individual, which served as Dr. Green's type of the species, shows faint tubercles over the glabella and free cheeks, but these appear to be obsolete upon the occipital annulation and the rest of the body.

Dimensions. The smallest individual of this species which has been observed is the type specimen. It affords the following measurements: Length 63 mm.; width 45 mm. The largest individual observed measures:

	Body.	Cephalon.	Thorax.	Pygidium.
Length -----	130 mm.	30 mm.	75 mm.	25 mm.
Width -----	75 mm.	75 mm.	70 mm.	30 mm.

Fragments of still larger individuals are sometimes found, a single pygidium from the Upper Helderberg limestone of the Falls of the Ohio measuring 45 mm. in length and 35 mm. in width, indicating an individual of quite

colossal size, which, judging from the proportions afforded by other specimens, must have measured upwards of 200 mm. in length.

Observations. There is a striking similarity in the specific details of *Calymene platys*, Green, and those of *Calymene Niagarensis*, Hall. Indeed upon the basis of any external feature, further than the great difference in size attained by the two species, it might be difficult to establish the specific limitations. Here, however, the notable diversity in the hypostomas proves of great importance. In *Calymene Niagarensis* the hypostoma is elongate, with the anterior margin entire, lateral margins broadly incurved and reflexed, sharply and deeply emarginate behind, centrum convex and rounded, bounded by a strong sulcus at its base, and bearing a conspicuous furrow on its posterior portion. In respect to size, the largest individuals of *Calymene Niagarensis* will not exceed 50 mm. in length, and the smallest observed of *Calymene platys* do not fall below 65 mm. in length, and as noticed, may have attained a length of 200 mm. Murchison has figured a large individual of *Calymene Blumenbachi*, Brongniart, which has a length of about 100 mm. (Silurian System, pl. vii, fig. 6), and Angelin one of *Calymene spectabilis*, Angelin, 125 mm. in length (Palæontol. Scandinavica, pl. xix, fig. 5). It is a noteworthy fact that the last known representative of this characteristic Silurian genus, *Calymene*, should have attained dimensions which surpass those of any of its known predecessors.

Distribution. Upper Helderberg group. In the Schoharie grit, at Schoharie, Schoharie county, and Knox, Albany county. In the Upper Helderberg limestone, at Falkirk and Clarence Hollow, Erie county, and Falls of the Ohio.

HOMALONOTUS, KÆNIG. 1825.

HOMALONOTUS MAJOR.

PLATE V A, FIG. 1.

Homalonotus major, WHITFIELD. Bulletin Amer. Mus. Nat. Hist., vol. i, No. 6, Art. xi, p. 193, pl. xxii. 1885.

The CEPHALON and anterior portion of the THORAX have not been observed.

The THORAX has the lateral margins sloping somewhat less rapidly than in *Homalonotus Dekayi*, and very much as in *H. delphinocephalus*. Surface flat,

abruptly deflected for nearly an inch at the margins, and very indistinctly trilobate.

Axis very broad, width more than two-thirds the width of the body. Segments broad and flattened, abruptly deflected at the anterior and posterior margins and separated by very narrow transverse furrows, which are scarcely distinguishable for their entire length, but are most noticeable at the margins of the axis, where lie the deep depressions to the leg-bases or visceral supports.

The deep transverse furrows along the middle of the segments are conspicuous and most distinct toward the lateral margins of the thorax and upon the broad beveled articulating planes. The same liability to error in regard to the anterior and posterior limits of the segments is noticeable in the lower surface of this species as mentioned in the description of *Homalonotus Dekayi*. The segments are evenly curved over the axis and posteriorly deflected toward the margins.

PYGIDIUM elongate-sub-triangular. Surface depressed-convex, sloping evenly to the margins.

Axis well defined and composed of ten annulations, the articulating ring being the posterior half of the *apparent* last thoracic segment. These annulations are broad, flat or slightly rounded, and are nearly transverse, with a slight forward bend over the axis.

The *pleuræ* bear seven or eight distinct annulations. Posterior margin slightly produced. In one specimen the posterior extremity is broken away, its extension being indicated by the slope of the lateral margins, and in the other it has been displaced and forced to one side.

Surface of the test characterized by tubules of comparatively small size, which have left their impressions on the cast of the lower surface.

Observations. Of this remarkable species of *Homalonotus* but two examples have been discovered. The smaller of these, and somewhat better preserved specimen, showing the pygidium and five thoracic segments, has served as the type of the original description, and the other which is here figured

in further illustration of the species, retains the pygidium and indications of ten segments. The former fragment has a length of 155 mm., and a width of 130 mm.; the latter a length of 220 mm., and a width of 150 mm. These specimens were obtained by Mr. Louis Bevier, of Marbletown, Ulster county. They are beyond doubt representatives of the largest known species of this genus, and were two of the largest known trilobites. Mr. Whitfield estimates the entire length of the specimen described by him, as restored from proportions furnished by other species, at fifteen and one-half inches. With the figure of the larger specimen here given is an outline restoration, the data for which have been derived from a careful summary of measurements of species in which the pygidium is strongly annulated. The result indicates an individual measuring 374 mm. or 14.95 inches in length, and 145 mm. or 5.8 inches across the base of the cephalon. This outline will help the student to realize, better than may be done from the figure of the fragment alone, the colossal size attained by this species.

Fragments of *Homalonoti* of large size have been described by other authors. Salter has referred (Palæontogr. Soc., vol. xvii, p. 109) to a large specimen of *Homalonotus rudis*, which he estimates may have been a foot in length when entire. Beushausen has figured a pygidium of *Homalonotus gigas*, F. A. Roemer, from the Spiriferen-sandstein of the Hartz Mountains (Beitr. zur Kenntn. Oberharz. Spirif. Sndst'ns, pl. i, fig. 1. 1884), which measures 94 mm. in length, and though proportionally narrower than the pygidium in *H. major*, represents an individual probably not much shorter than the one here illustrated. It is noteworthy that this large species, *Homalonotus gigas*, is from a lower Devonian formation, not widely differing in age from the horizon of *Homalonotus major*. In the distinctly annulated pygidium, *Homalonotus major* agrees with the majority, if not with all the species of *Homalonotus* known from Silurian and lower Devonian horizons, and in this regard differs from *Homalonotus Dekayi* of the Hamilton group, in which the annulations are faint or obsolete.

Distribution. The locality of these fossils as given by Mr. Bevier, for the specimen here figured, is "Lower Oriskany, bank of 4th Binnewater, Rosendale, Ulster county," and for the type specimen, "Upper Oriskany, Cranberry Dam, 5th

Binnewater, Ulster county." This reference is probably correct, as the matrix of the larger trilobite shows a well-defined specimen of *Spirifera arenosa*, an Oriskany species, and Mr. Whitfield has mentioned the occurrence of a young individual of *Strophodonta magnifica* upon the smaller specimen.

HOMALONOTUS DEKAYI.

PLATE II, FIGS. 1-11; PLATE III, FIGS. 1-5; PLATE IV, FIGS. 1-6; AND PLATE V, FIGS. 1-10.

Dipleura Dekayi, GREEN. Monog. Trilob. North America, p. 79. 1832.

Nuttainia sparsa, EATON. Geological Text Book, p. 34. 1832.

Dipleura Dekayi, VANUXEM. Geology of New York. Survey Third Geol. Dist., p. 150, fig. 1. 1842.

Dipleura Dekayi, HALL. Geology of New York. Survey Fourth Geol. Dist., p. 205, fig. 1. 1843.

Homalonotus Dekayi, EMMONS. Manual of Geology, pp. 146, 147, figs. 134, 135. 1860.

Homalonotus Dekayi, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 113. 1862.

Homalonotus Dekayi, HALL. Illustrations of Devonian Fossils, plates ii, iii, iv, v. 1876.

GENERAL FORM AND PROPORTIONS. Elongate, linguiform, anterior and posterior extremities produced and sub-angulate; lateral margins nearly straight and approximating posteriorly. Length to width about as 2 to 1.

Surface depressed-convex or flattened, obscurely trilobate, abruptly deflected along the lateral margins.

CEPHALON broadly sub-triangular in outline, posterior side the longest; angles rounded. In the usual condition of preservation the lateral margins approach each other at an angle of ninety degrees, making, at the basal margin, an angle of forty-five degrees. With the retention of normal convexity, the shield is nearly equilateral. Length to width as 1 to 1.9. The surface is normally depressed-convex or flattened, deflected beneath the ocular nodes; trilobate; frontal and lateral areas narrow, the former produced into a short prora.

The *facial sutures* take their origin on the lateral margins of the doublure in front of the genal angles and pass inward, parallel to the posterior margin of the cephalon, to the eye, thence forward with a broad curve inward to the anterior margin at the base of the prora, bending thence on to the epis-tomal doublure, meeting at its inferior margin. The branches of the facial suture are united on the upper surface of the prora by a straight transverse

frontal suture, thus leaving a free median plate upon the epistoma, which is elongate-sub-triangular in outline, attenuate at the apex, and recurved at the base which forms the anterior portion of the prora.

Glabella sub-quadrangular, broadest behind; lateral margins slightly incurving; angles rounded; length equal to three-fourths the length of the cephalon. Surface depressed-convex. Lateral furrows in three pairs, the first two of which are short, extending about one-fourth the distance across the glabella, and are perpendicular to the margin. The third pair near their proximal extremities are bent backward. The third or posterior lobes are the strongest, the anterior or frontal lobe having about the same strength as each of the first two pairs. Rarely in young individuals, and only under favorable preservation, are these furrows and lobes to be seen, since they become obsolete at an early stage of growth.

Cheeks. The movable portions are flattened, and when normally preserved are abruptly deflected. They have rarely been observed isolated, although the cephalic shield is not infrequently seen with these parts wanting.

Eyes situated at the summit of strong, elevated nodes, each of which occupies nearly one-third the entire surface of the cephalon. These nodes are bounded by low sulci separating them from the glabella, occipital ring and lateral area. Visual surface small, lunate, covered with minute homo-corneal lenses, of which about one thousand have been counted in each eye of a small individual. Palpebral lobe capping the visual surface, and sloping evenly and abruptly to the palpebral furrow.

THORAX broad; length equal to the width. Surface depressed-convex, scarcely trilobate; lateral portions abruptly deflected; margins approximating posteriorly.

Axis broad, making two-thirds the width of the body.

Pleuræ narrow, deflected along their median line.

Each of the segments is broadly rounded or flattened upon the axis, the posterior margin infolding over the articulating ring of the next succeeding segment. These articulating rings are exposed even where the

animal has been preserved in an extended condition. In casts of the under surface, the usual mode of preservation in the sandy shales of the central counties where individuals are most abundant, the transverse median groove upon the segments appears very broad and deep, and may be misleading in determining the true limits of the segments. In such specimens, along the low and indistinct longitudinal axial furrows, there are rows of double depressions or pits at the anterior and posterior margins of adjacent segments, which are suggestive of the depressions left by the visceral supports or basal joints of natatory appendages; but in position they are not homologous with those observed in *Phacops rana* and other species. The transverse groove is continued upon the pleuræ, passing over the broad beveled articulating planes, but becoming obsolete before reaching the margin. In specimens where the crust is retained, this furrow is visible only as a sharply impressed line.

PYGIDIUM. Outline sub-triangular; length and width equal. Anterior margin with a forward curve; lateral margins nearly straight, with an upward curve near the posterior extremity, which is produced into a sub-spatulate extension. Surface convex, faintly trilobate. The angle of convergence of the lateral margins is nearly ninety degrees and the anterior basal angles about forty-five degrees each. The articulating ring and furrow are conspicuous.

The *axis* tapers rapidly, becoming obsolete before reaching the posterior margin. Ten annulations may be counted upon it, and eight upon the *pleuræ*. These annulations are rarely visible upon the dorsal surface except in young individuals and become obsolete in mature animals, where traces of them can be seen only in casts of the under surface.

HYPOSTOMA sub-quadrate, auriculate at the anterior angles, emarginate on both anterior and posterior margins; centrum low, convex; posterior sulcus and posterior lateral pits conspicuous; margins thickened, not reflected. Surface pustulose.

Surface Ornamentation. The surface of the test on its more prominent portions is marked by the openings of large vertical tubulipores. On casts

of the lower surface impressions of the projecting edges of these tubules are also visible. Between these openings may be seen minute pittings which are the openings of smaller tubules.

Dimensions. An average example affords the following measurements:

	Body.	Cephalon.	Thorax.	Pygidium.
Length -----	156 mm.	40 mm.	73 mm.	43 mm.
Width -----	75 mm.	75 mm.	73 mm.	48 mm.

The largest entire individual observed has a length of 220 mm. and a width of 100 mm.; the smallest a length of 10 mm. and a width of 6 mm.

Observations. *Homalonotus Dekayi*, the latest and most prolific representative of the genus in America, differs from the *Homalonoti* of the earlier Devonian and the Silurian, both in this country and Europe, in the obsolescence of the annulations of the pygidium at maturity. It is an abundant fossil in the sandy shales of the Hamilton group of the central counties of the State where it is usually preserved in the form of casts. West of Cayuga county it is of much rarer occurrence and appears to be mostly confined to the shales above the *Encrinal limestone*. In Genesee and Erie counties it is very seldom met with, and in the eastern outcrops of this formation in Schoharie and Albany counties it is not abundant.

Distribution. Hamilton group. In the Marcellus shales on Flint Creek, Ontario county; in the Hamilton shales at Bear's Gulf, near Summit, Schoharie county; Cazenovia, Leonardville and Hamilton, Madison county; East Worcester and elsewhere, Otsego county; Pompey Centre, Pratt's Falls and Delphi, Onondaga county; Bellona, Yates county; Hopewell and West Bloomfield, Ontario county; Tichenor's and Menteth's* Points, Canandaigua Lake; Darien, Genesee county; Hamburg and Eighteen-mile Creek, Erie county.

* This name as used in the previous publications on the Palæontology of New York, and as spelled by the original owner of the property on Canandaigua Lake, was *Monteth*. It is now understood that its present owner has changed the spelling of the name to *Menteth*.

HOMALONOTUS VANUXEMI.

PLATE V B, FIGS. 1, 2.

Homalonotus Vanuxemi, HALL. Palæontology N. Y., vol. iii, p. 352, pl. lxxiii, figs. 9-14. 1859.

THIS species was described from very meager material consisting of detached pygidia and a fragment of the thorax. Although it has proven to be a fossil of rare occurrence, more complete specimens have since been obtained, which make the introduction of the species in this place important both for the purpose of extending the knowledge of its characters and of comparison with the Devonian *Homalonoti*. The very large fragment here figured consists of the pygidium and eleven segments of the thorax, the latter part being considerably weathered on the left side and over the dorsum. It was obtained from a quarry in the Lower Helderberg limestone at Kingston, Ulster county, and is so preserved as to retain its normal convexity. This specimen shows that the species approximates very closely *Homalonotus delphinocephalus*, Green, differing from the latter, however, in the features pointed out in the original description, namely, the greater number of annulations in the pygidium; the former having upon the axis eleven or twelve, including the articulating ring, the latter nine or ten; and upon the pleuræ the former ten and the latter eight. The pleural slopes of *H. Vanuxemi* appear also to have been considerably broader. The cephalon, which is restored in the figure from a fragment (the only example yet observed) taken from the limestone at Port Jervis, Orange county, is considerably produced at the anterior extremity, even more than in *H. delphinocephalus* or *H. Dekayi*. Just in front of the glabella is a gentle and broad depression, giving to the frontal prolongation a shovel-shaped surface. The glabella is generally smooth, and regularly convex, unlike that of the Niagara species, which often shows a lobate character. That the Lower Helderberg species attained very considerable size is shown by the restoration of the missing parts of the figured specimen, as given upon the plate, indicating that the animal reached a length of 275 mm., or eleven inches.

BRONTEIDÆ.

BRONTEUS, GOLDFUSS. 1843.

BRONTEUS TULLIUS, n. sp.

PLATE VIII A, FIGS. 34-36.

CEPHALON and THORAX unknown.

PYGIDIUM flabellate, comparatively small; outline semi-ovate, anterior margin rounded and incurved toward the axis. Length to width as 2 to 3. Surface depressed, gently elevated and convex about the axis, becoming concave toward the margin and slightly reflexed at the edge.

Axis short, about one-fourth the length of the shield; width about twice the length. Outline broadly trigonal. Articulating ring prominent, but not well preserved in the type specimen. No annulations visible.

Pleuræ very broad and bearing fifteen broadly flattened and simple annulations. Of these the widest lies in the axial line with seven on either side. These annulations are nearly straight, radiating evenly from the margins of the axis and separated by narrow, sharply impressed sulci. Both the annulations and sulci become obsolete before reaching the border, the posterior ones not extending so far as the anterior. The border is ornamented with a single row of minute spinules, numbering about twenty-five along the terminal margin of each annulation; these measure scarcely 1 mm. in length and are inclined slightly upward. Doublure very broad, extending fully half way across the pygidium.

Test extremely thin; the portions retained are strongly and regularly pustulose, the pustules on the ribs apparently extending to the margin. The doublure is marked by distant, sub-parallel, anastomosing, lamellose lines.

The type specimen has a length of 15 mm. and a width of 21 mm.

Another specimen of limestone from a different locality bears the epistomal doublure of some trilobite. This fragment is broadly convex and prominent over the central area and constricted toward the sides, and is quite unlike the frontal doublure of any associated species of crustacean, but has

the outline and contour usual in this part of *Bronteus*. It may, therefore, with propriety, be regarded as belonging to this species.

Observations. This species is represented only by the two fragments described, both of which were discovered by Professor S. G. Williams, of Cornell University, by whose kindness this notice appears. Unusual interest attaches to it as the first representative of the genus *Bronteus* discovered in the Devonian of America, although the genus is abundantly represented in the Devonian horizons of Europe. A close relationship is observable in the species *Bronteus Tullius* and *B. granulatus*, Goldfuss, from the middle Devonian of the Eifel and the lower upper-Devonian limestone of the Iberg-Winterberg terrane. This similarity consists in the number and contour of the ribs and the ornamentation of the dorsal surface and doublure. The fauna of the Iberg limestone is characterized by a very abundant development of the species *Rhynchonella cuboides*, Sowerby, of which species the American representative *R. venustula*, Hall, occurs only in the Tully limestone, the formation from which *Bronteus Tullius* has been derived. The row of minute spinules along the posterior margin of the pygidium of our species shows its relationship to the comparatively limited group of forms following the type of *Bronteus thysanopeltis*, Barrande. This group includes at present the following species, viz.: *B. thysanopeltis*, Barrande, *B. clementinus*, Barrande, *B. acanthopeltis*, Schnur, *B. Barrandii*, Hébert, *B. Waldschmidtii*, von Kœnen, *B. Raphaëli* and *B. Trutati*, Barrois, and *B. Tullius*. In *Bronteus Tullius* these spines are much more minute than in any other of the species mentioned. Kayser* has observed that this group of *Bronteus* stands in the same relation to the Silurian forms of the genus as the genus *Cryphæus* does to the normal forms of *Dalmanites*, i.e., those after the type of *D. Hausmanni*. So far as known, it is limited to Devonian faunas, and is appropriately designated by the term *Thysanopeltis*, applied to this variation by Corda (Prodrom. Monog. Trilob., 1847), and revived by Barrois (Ann. de la Soc. Géol. du Nord, p. 131, 1886), with sub-generic value.

Distribution. Hamilton group. In the Tully limestone, Kingsley's Hill, northeast of Otisco, and Borodino, Onondaga county.

* Älteste Devon-Ablag. des Harzes, p. 255. 1878.

PHACOPIDÆ.

PHACOPS, EMMRICH. 1839.

PHACOPS CRISTATA.

PLATE VI, FIGS. 1-13, 16-29; AND PLATE VIII A, FIGS. 1-4.

Phacops cristata, HALL. Descr. New Species of Fossils, etc., p. 67. 1861.*Phacops bombifrons*, HALL. Descr. New Species of Fossils, etc., p. 67. 1861.*Phacops cristata*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 95. 1862.*Phacops bombifrons*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 95. 1862.*Phacops cristata*, HALL. Illustrations of Devonian Fossils, pl. vi, figs. 1-13, 16, 17. 1876.*Phacops bombifrons*, HALL. Illustrations of Devonian Fossils, pl. vi, figs. 18-29. 1876.

GENERAL FORM AND PROPORTIONS. Outline elongate, sub-elliptical. Length to width as 1.7 to 1. Lateral margins sub-parallel.

Surface depressed-convex, echinate along the axis.

CEPHALON broadly ovate or nearly semi-circular in outline; length to width as 4 to 7. Frontal area obsolete, lateral area narrow, margins broadly thickened by doublure, and produced at the genal angles into short blunt spines, which are directed slightly upward and inward. Sub-marginal sulcus strong, extending to within a short distance of the genal extremities, bearing on the lateral margins, behind the epistoma, ten or eleven crenulations which diminish in size backward. Epistoma comparatively narrow.

Facial Sutures not observed.

Glabella broad, convex, sub-pentagonal, tumid (generally flattened in examples from the Schoharie grit), protuberant, extending for one-third its length beyond the frontal margin. In favorably preserved specimens, either of the external or internal surface, traces may be seen of the first and second pair of lateral furrows; third lateral furrows deeply impressed but undefined, making the third or basal lobes of the glabella very obscure. Antero-lateral furrows may sometimes be discerned in front of the first pair of lateral furrows, and parallel to the palpebral sulci.

Occipital furrow broad and deep; occipital ring elevated and conspicuous.

Cheeks depressed, sloping abruptly to the margins, broad and flat about the genal angles, echinate at the extremities.

Eyes large, scarcely reaching the height of the glabella. Visual surface lunate. Corneal lenses, in the normal individual, abundant and subject to considerable variation in number. Beginning at the posterior angle of the visual surface and following the rows diagonally, parallel to the lower posterior margin, the number of rows is generally *eight*, in no observed instance exceeding *nine* and rarely falling to *seven*. In *Phacops rana* the number of rows is usually *nine*, often ten, and rarely eleven or eight. In *Phacops cristata* the number of lenses averages about *sixty*, varying between the limits forty-seven and eighty-two, the higher numbers being reached only in examples from the Upper Helderberg limestone. Palpebrum scarcely prominent; strength of the palpebral lobe varying with the elevation of the eye.

THORAX. Margins sub-parallel, tapering slightly backward. Surface depressed-convex, and strongly trilobate. Length to width as 4 to 5.

Axis convex and evenly tapering.

Pleuræ flattened above and abruptly deflected at about one-third their width from the axial furrows. The segments show a slight retral curve on the axis near the margins, bending forward over the axial line; dichotomous on the pleuræ, the anterior limb becoming obsolete at the fulcrum by the development of the lateral articulating planes.

PYGIDIUM. Outline transversely semi-elliptical. Length to width as 1 to 2. Surface convex, depressed on the pleuræ.

Axis prominent, tapering to a broad, obtuse and obscurely defined termination within the posterior margin; in well-preserved specimens it bears five or six annulations, and behind these three or four pairs of tubercles or undeveloped annulations, which are separated by a low axial depression.

The *pleuræ* each bear five, and traces of six *dichotomous* annulations, all becoming obsolete before reaching the margin. In casts of the under surface, which is the usual condition of preservation in the Schoharie grit, and often

in the Upper Helderberg limestone, the bifurcate character of the pleural annulations is not always readily discernible.

HYPOSTOMA elongate-triangular. Length to width as 1 to 1.25. Antero-lateral angles strongly auriculate. Anterior margin with a gentle forward curve, lateral margins tapering evenly to the posterior extremity, which bears a short medial spine with a smaller spine on either side. Centrum convex; posterior sulcus conspicuous; postero-lateral depressions faint; a pair of circular depressions near the anterior angles.

Surface Ornamentation. The surface of the glabella is covered with low, closely set tubercles, traces of which seldom appear in the casts of the under surface. The other portions of the shield are smooth, except the genal angles which are faintly pustulose, each bearing a short, stout spine. At the center of the occipital ring is a similar, though considerably stronger spine, the first of a row of spines, twelve in number, extending along the axial line to the pygidium. In young individuals these spines are low and inconspicuous, and are usually accompanied by a few faint tuberculations upon the axis. The surface of the pygidium is nearly or quite free of ornament in the adult, and faintly pustulose in the young individual, the pustules being coarser upon the axis and finer upon the pleuræ, where they are arranged in single rows upon each ridge of the annulations.

Dimensions. Entire individuals referable to the type form of this species, are very rarely found, although fragments are of frequent occurrence. A single nearly entire example from the Schoharie grit has the following dimensions:

	Body.	Cephalon.	Thorax.	Pygidium.
Length	47 mm.	14 mm.	23 mm.	10 mm.
Width	26 mm.	26 mm.	20 mm.	20 mm.

An entire cast of the lower surface from the Corniferous limestone gives the following measurements:

	Body.	Cephalon.	Thorax.	Pygidium.
Length	75 mm.	19 mm.	43 mm.	13 mm.
Width	38 mm.	38 mm.	35 mm.	24 mm.

These dimensions may be regarded as those of normal full growth.

Observations. Specific Diagnosis. The diagnostic characters of this species are very clearly defined, and may be summarized as follows: (a) the axial row of spines extending as far as the pygidium, (b) the short, stout spines on the genal angles, (c) the strongly protuberant glabella, (d) the comparative absence of tuberculations, except on the glabellar surface, (e) the ten or eleven crenulations upon each side of the sub-marginal furrow of the cephalon, (f) the dichotomous annulations of the pygidium. In the summary of these features *Phacops cristata* differs from any species known outside of the State of New York, and therefore cannot be satisfactorily compared with any extra-limital forms in the United States. *Phacops fecundus*, Barrande, from the F, G and H étages of Bohemia, and the lower and middle Devonian of the Eifel, Westphalia and the Hartz, presents a striking similarity in outline, in the protuberant glabella and the grooved pygidial annulations. *Phacops Logani*, Hall, from the Lower Helderberg group, bears a pygidium with similarly bifurcate ribs and obtusely terminated axis, and a cephalon with minute spines on its genal angles, but it is distinguished from *Ph. cristata* by the conspicuous nodes along the margins of the axis of the thorax, the stronger tuberculation of the surface, and the absence of an axial row of spinules. *Phacops Trajanus*, Billings, also from the Lower Helderberg group, bears bifurcate annulations on the pygidium, but as this species is incompletely known, its further resemblances to *Ph. cristata* cannot be indicated. As described and limited in the original description (*loc. cit.*) *Phacops cristata* was made to include all the forms of this genus occurring in considerable abundance in the Schoharie grit, and these exclusively, with the exception of a single specimen from the Upper Helderberg limestone at the Indian quarries, Onondaga county. The species *Phacops bombifrons* was erected at the same time for certain cephalic shields and pygidia from the Upper Helderberg limestones, in which a degree of similarity to *Phacops cristata* was acknowledged, but in which a more prominent and protuberant glabella, wider occipital furrow, narrower palpebral sulcus and stronger palpebral lobe, were regarded as distinguishing characters. With due allowance made for differences in the mode of preservation in the sandstone and limestone of the Upper Helderberg, the specific identity of forms referred to

Phacops bombifrons with *Phacops cristata*, with the more abundant material now accessible, appears to be indisputable. There remains, however, a form of *Phacops*, abundant in nearly all the outcrops of the Corniferous limestone in the State, which it was not intended to include under the original diagnosis of *Phacops bombifrons*, and which has hitherto remained unnoticed in any published description, or has been tacitly referred to the species *Phacops rana*. A careful examination has proven that *Phacops rana* occurs with extreme rarity, if ever, in this formation, and that the specific affinities of these abundant individuals are much too close to *Phacops cristata* to justify their recognition as an independent species. They may be tentatively regarded as a prolific variety of *Phacops cristata*, under the following designation.

PHACOPS CRISTATA, var. PIPA, n. var.

PLATE VIII A, FIGS. 5-18.

The essential points of difference between this form and the normal *Phacops cristata*, are the following: (a) greatly inferior size, (b) absence of the axial row of spines, (c) smaller spines at the genal angles, (d) fewer annulations upon the pygidium, (e) smaller number of corneal lenses, varying, as ascertained from measurements of a large number of specimens, from twenty-three to forty-five for each eye. They agree with *Phacops cristata* in (a) general proportions, (b) gibbosity of the glabella, (c) presence of the genal spines, which though sometimes faint may always be detected, (d) crenulated sub-marginal sulcus, (e) obtuse termination of the axis of the pygidium, (f) dichotomous annulations on the pygidium, (g) similar surface ornamentation. A single pygidium of this variety from the decomposed Corniferous chert of Ontario county, is of exceptional interest as showing on a cast of the inferior surface seven pairs of muscular impressions just within the margins of the axis.

The dimensions of an average entire individual are; length 26 mm.; width 16 mm. The smallest observed has a length of 12 mm., and a width of 7 mm.

Distribution. *Phacops cristata*. Oriskany sandstone: Cayuga, Province of Ontario, associated with *Dalmanites anchiops*, Green, *Spirifera arrecta*, Hall, *Streptorhynchus* (*Orthis*) *hipparionyx*, Vanux., *Rensseleria ovoides*, Hall. Upper Helderberg group: in the Schoharie grit, near Clarksville, Albany county; Schoharie, Schoharie county.

In the Corniferous limestone at the Indian quarries, Onondaga county; Eastman's quarry, Waterville, Oneida county; Howell's quarry, Lime Rock, Genesee county. Variety *pipa*. In the Corniferous limestone everywhere; especially abundant in the central and western outcrops at Waterville, Oneida county; Phelps and Clifton Springs, Ontario county; LeRoy and Lime Rock, Genesee county; Clarence and Williamsville, Erie county, and in the boulders of decomposed chert in Ontario county; Falls of the Ohio. Also at Walpole and North Cayuga, Province of Ontario.

PHACOPS RANA.

PLATE VII, FIGS. 1-11; PLATE VIII, FIGS. 1-18; AND PLATE VIII A, FIGS. 21-33.

- Calymene bufo*, var. *rana*, GREEN. Monograph of the Trilobites of North America, p. 42. 1832.
Calymene bufo, HALL. Geology N. Y., Part. iv, p. 201. 1843.
Calymene bufo, OWEN. Geolog. Exploration of a part of Iowa, Wis. and Ill., p. 74, pl. xii, fig. 1. 1844.
Phacops bufo, EMMONS. Manual of Geology, p. 138, fig. 124 (6). 1860.
Phacops rana, HALL. Descriptions New Species of Fossils, etc., p. 55. 1861.
Phacops rana, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 93. 1862.
Phacops rana, MEEK and WORTHEN. Geol. Surv. Ill., vol. iii., p. 447, pl. xi, figs. 1a-e. 1868.
Phacops rana, NICHOLSON. Palæont. Province of Ontario, p. 123, figs. 5, 6a. 1873.
Phacops rana, HALL. Illustrations of Devonian Fossils, pl. vii, figs. 1-11; viii, figs. 1-17. 1876.
Phacops rana, WHITFIELD. Geology of Wisconsin, vol. iv, p. 339, pl. xxvi, figs. 17-19. 1882.
Compare *Phacops rana*, WALCOTT. Palæont. Eureka District: Monog. U.S. Geol. Surv., vol. viii, p. 207. 1884.

GENERAL FORM AND PROPORTIONS. Outline elongate sub-oval; greatest width (measured at the posterior margin of the cephalon) to axial length as 1 to 2. The cephalon, thorax and pygidium are to one another in length as 1.5 to 2 to 1. Thoracic margins straight, sub-parallel, gently converging posteriorly, connecting the curves of the cephalon and pygidium, which are approximately arcs of large and small circles respectively, the former with its center upon the occipital ring, the latter central upon the eighth thoracic segment.

CEPHALON arcuate, sub-semicircular, the regularity of the outline interrupted by the slight protrusion of the glabella and the genal extremities. Frontal margin obscure, concealed by the overhanging glabella; lateral edges faintly marginate and rounding to the obtuse genal angles; occipital margin nearly straight, bending backward on the axis. Occipital annulation strong, and equal in size to the segments of the thorax; occipital furrow narrow and becoming obsolete upon the cheeks.

Facial Sutures very rarely discernible. Occasional examples, in unusually perfect state of preservation and favorably weathered, or compressed in such manner as to slightly separate the cephalon along these lines, show that they take their origin on the lateral margins just in front of the genal angles, pass along the posterior edge of the visual area, thence forward along the margin of the palpebrum, following the frontal furrow of the glabella until they meet, thus taking the normal direction for the facial sutures in the *Phacopida*. It is probable that the separate parts of the cephalon, in all stages of growth, are virtually anchylosed along these lines, as the cheeks are rarely, if ever, found detached.

Glabella large, gibbous, filling all the space between the palpebral lobes, and separated from them by deep furrows. Outline sub-pentagonal; greatest width anteriorly. Transverse lateral furrows three on each side, of which the first two are obsolescent, often discernible only on casts of the under surface. In well-preserved specimens their existence is indicated by obscure depressions in the ornamentation of the surface. The third pair of transverse furrows is very strong, extending entirely across the posterior limb of the glabella, making a narrow annulation in front of the occipital ring. In favorably preserved specimens there are faint indications of short, longitudinal furrows parallel to the ocular sulci, and in front of the first pair of transverse glabellar furrows.

Cheeks abruptly sloping to the margin nearly in a plane with the visual area, narrowing anteriorly and reflected ventrally to form the doublure. This doublure or infolded margin is broad at the genal angles, narrowing somewhat beneath the eyes, thence forward, widening beneath the glabella to form the broad depressed epistoma. A strong sulcus passes along the doublure just below the margin, widening into a broad groove upon the epistoma, and toward the genal extremities its margins bear five or six crenulations which become finer as they approach the angles.

Eyes prominent, scarcely reaching the height of the glabella in uncompressed specimens. Palpebral lobe strong, scarcely as high as the palpebrum and extending to the occipital furrow. Palpebrum crescentic. Visual area

lunate, separated from the cheek by a strong, smooth sulcus; corneal lenses abundant, scleral cavities generally hexagonal; the number of lenses varying greatly with age. Counting from the lower posterior margin diagonally, the number of rows of lenses in normal, mature individuals is *ten*, in senile or in young individuals often *eight* or *nine*. The average number of lenses in normal adults, ascertained by enumeration upon several hundred eyes, is between *forty* and *fifty* for each eye. The variation in the number of lenses, as far as observed, is between *thirty* and *eighty-eight* for each eye; the former in a very young individual, 12 mm. in length; the latter in an adult of average size, measuring 34 mm. in length, and bearing *eleven* rows of lenses. Eyes showing more than sixty-five and less than forty lenses are unusual.

THORAX sub-quadrate, lateral margins slowly tapering. Surface strongly trilobate.

Axis flattened at the margins, evenly convex in the middle, slightly narrower than either lateral lobe, widest at the third or fourth segment, tapering very slowly to the ninth, and thence much more rapidly to the pygidium.

Pleuræ flat for about one-third their width from the axis and thence abruptly deflected to the margin. Each segment along the axis shows a slight retral bend from the margins to a point where, upon the under surface, the basal joints of the branchiæ, natatory appendages, or visceral supports were attached. Each segment of the pleuræ bears a furrow which becomes obsolete at the *fulcrum*; beyond this point the segment becomes attenuate, presenting scarcely more than a beveled surface of articulation.

PYGIDIUM relatively small; posterior margin the arc of a circle; anterior margin transverse in the middle, angulated toward the sides by the articulating planes.

Axis rapidly and evenly tapering from the last segment of the thorax, reaching an acute termination just within the posterior margin.

Pleuræ broad, depressed-convex, sloping evenly to the posterior margin. In well-preserved examples, nine simple, transverse annulations can be counted upon the axis, and seven upon the pleuræ; the latter being broadly

rounded and simple. The doublure is broad, extending about one-fourth the distance across the shield, and slightly thickened at the margin. The outline is truncate or slightly emarginate at the apex of the axis, a feature always exaggerated in flattened specimens.

Surface Ornamentation. In the average mature individual the surface of the test is ornamented with tubercles, which are largest and most closely set upon the glabella. Upon the cheeks, the axis and the pleural annulations of the pygidium, the tubercles are smaller and less distinct, and except in senile individuals, in which the entire surface is pustulose, certain portions of the test are comparatively smooth, namely, the palpebral lobes, the pleuræ, the marginal portions of the axis and pygidium. Upon the doublure and episstoma the surface is marked by sub-parallel lamellose lines.

VENTRAL ANATOMY.

Hypostoma. Notwithstanding the abundance of this species the hypostoma has rarely been observed. A well-preserved example belonging to a large individual, is elongate-triangular or sub-spatulate, very wide on the anterior margin and strongly auriculate, the antero-lateral extensions having a width equal to one-fourth the width of the plate. The width of the plate on the anterior margin is one-third greater than the axial length. The lateral margins are parallel for a short distance, thence approximating rapidly, and the posterior extremity bears three small spines, one situated in the axial line, and a shorter one on either side. The lateral margins and the antero-lateral processes are sharply inflected. The centrum is large and broadly convex, bounded behind by a distinct sulcus, and showing indications of two postero-lateral depressions. Low circular depressions are also noticeable near the antero-lateral angles. Surface covered with concentric striæ.

Carefully prepared sections of the test show, upon its inferior surface, a series of paired processes, which take their origin upon each segment of the axis, beginning with the third lobe of the glabella and extending to the pygidium. These processes are digitiform, hollow, flattened or faintly grooved

on the posterior face, continuous with the test, and formed by the deep deflection of the anterior margin of each segment and its reflection to the articulating ring. They originate just within the margins of the axis at points which are marked upon its dorsal surface by a slight posterior deflection of the segments, and as they pass downward converge toward the axial line where members of the same pair would nearly meet. Thirteen pairs of these processes are discernible, one for the third lobe of the glabella, one for the occipital annulation, and eleven for the segments of the thorax, the first two lobes of the glabella and the annulations of the pygidium being unrepresented. Similar processes have been observed in *Phacops latifrons* by von Koenen (Neues Jahrb. für Min., etc., 1880, vol. i, p. 430), and are regarded by him as the bases of support for the natatory appendages. The interpretation of the ventral anatomy of the trilobites as given by Walcott for certain species (*Calymene senaria*, *Ceraurus pleurexanthemus*), would regard such processes as enclosed within the "ventral membrane," and consider them functionally as supports for the axial viscera. Sections of other specimens of *Phacops rana* show evidence of the existence of such a ventral membrane, to the lower surface of which the natatory appendages were probably attached. The presence of this membrane does not, however, preclude a direct muscular connection across the visceral cavity, between the axial processes and the leg-bases.

Development. The members of this species assume very early in their life-history the essential features of maturity. Notwithstanding the abundant material in the collections of the State Museum, which afford great variations in size, no noteworthy deviation in form, proportions or details has been observed in the different stages of growth, except in the number of corneal lenses, as noticed above.

Dimensions. An average of several hundred measurements gives for the average individual a length of 32 mm., and a width of 19 mm. The largest entire individual observed measures as follows:

	Body.	Cephalon.	Thorax.	Pygidium.
Length -----	100 mm.	32 mm.	38 mm.	30 mm.
Width -----	53 mm.	53 mm.	51 mm.	47 mm.

The smallest entire specimen seen is 12 mm. long and 6 mm. wide. Fragments of both larger and smaller individuals have been observed.

Observations. Specific Diagnosis. The original of *Calymene bufo*, Green (Monograph of the Trilobites of North America, p. 41), was an imperfect individual accredited to an uncertain locality in the State of New Jersey, which may be regarded as of Devonian age. *Calymene bufo*, var. *rana*, Green (*loc. cit.*), is cited by the same author as occurring at Seneca, Ontario county, N. Y., which is a locality on the shales of the Hamilton group, and as this *Phacops* is the only representative of the genus known to occur in this formation in the State of New York, no doubt can remain of the correctness of the specific reference. *Phacops rana* is very generally disseminated throughout the different horizons of the Hamilton group, from the Marcellus shales to the top of the Tully limestone. It may also occur in extremely rare instances in the Upper Helderberg limestones, but the species of *Phacops* so abundant in the latter formation and usually referred to *Phacops rana*, has proved to be an entirely distinct form, *Phacops cristata*, var. *pipa*. (see description of that species, where the differences in the *Phacops* of the Hamilton and Upper Helderberg formations are summarized). *Phacops rana* finds closer allies in the Devonian species of Europe. With *Phacops latifrons*, Bronn, from the middle Devonian of the Eifel and elsewhere, it is closely similar in general proportions and most of its superficial details, both species having the pleural annulations of the pygidium simple and the termination of the axis acute (a noteworthy agreement). Points of difference may, however, be enumerated as follows: *Phacops latifrons* has (a) the cephalon more compressed laterally; (b) a narrower and more pentagonal glabella; (c) a more coarsely tubercled glabella and smoother cheeks; (d) more numerous corneal lenses, varying between seventy-seven and ninety for average adult individuals; a variety of this species having as many as one hundred and twenty.

A still more intimate agreement may be found in the form *Phacops latifrons*, var. *occitanus*, Tromelin and Grasset, as described by Barrois (Ann. de la Soc. Géol. du Nord, vol. xiii, p. 75, 1885), from the lower middle Devonian of the Hérault. This variety, with all the essential specific characters of *Ph. latifrons*, has the eyes less elevated, the basal glabellar annulation smaller and without the strong, central tubercle; the tuberculation of the glabella is finer, and the granules on the pleuræ of the pygidium less strongly marked. These different forms undoubtedly represent the same species in trans-oceanic faunas, and are only such variations as might be expected in descendants of the same ancestors subjected to different conditions of life. With *Phacops fecundus*, Barrois, of the later formations (Hercynian) of the Bohemian Basin, étages F, G and H, there is also a close agreement except in the occurrence of sulcate annulations upon the pygidial pleuræ in the latter species.

The specimens from the Eureka District and Lone Mountain, Nevada, identified by Walcott (*loc. cit.*) as *Phacops rana*, Green, present points both of similarity and difference with the typical forms of the species, at the same time showing distinct features allying them to the Upper Helderberg species *Phacops cristata*. They resemble the former species in (a) the absence of spines at the genal angles, (b) the apparently simple pleural annulations of the pygidium; they are similar to the Upper Helderberg form in (a) the inconspicuous palpebrum, (b) the strong palpebral lobe, (c) the deep and broad occipital furrow which bears no trace of the transverse ring behind the frontal lobe, (d) the elevated and narrow occipital ring, (e) the hypostoma with strong antero-lateral elevations enclosing shallow depressions, (f) the obtuse and flattened termination of the axis of the pygidium, (g) the interrupted terminal annulations of the axis. This western form, as observed by Mr. Walcott, thus appears to be a variety connecting the two species named and may eventually be regarded as of distinct specific value.

Distribution. Upper Helderberg group. The occurrence of *Phacops rana* in this formation is not yet established beyond question. A single specimen is labelled from the Corniferous limestone near LeRoy, Genesee county. Hamilton group: In the Marcellus shales rarely, at Chapinville, Ontario county: in

the limestone near the top of these shales abundant, at LeRoy and Stafford, Genesee county; Flint Creek, town of Seneca, Ontario county: in the Hamilton shales everywhere; the most prolific localities being in the western counties; Tichenor's and Menteth's Points, Canandaigua Lake; Centerfield, Hopewell and Flint Creek, Ontario county; shores of Seneca and Cayuga Lakes; Moscow and York, Livingston county; Darien and Pavilion, Genesee county; Hamburg and Eighteen-mile Creek, Erie county: in the Tully limestone at Moravia, Seneca county; Bellona, Yates county; near Borodino, Onondaga county. Also in the Hamilton formation at Charlestown, Indiana; "Bake-Oven," Jackson county, Illinois; Iowa City, Solon, Roberts' Ferry, Johnson county; Independence, Buchanan county, and New Buffalo, Scott county, Iowa;* Washington Street Bridge and Whitefish Bay, near Milwaukee, Wisconsin; Cumberland, Maryland; (?) Comb's Peak and Lone Mountain, Nevada; Widder and Arkona, Province of Ontario.

PHACOPS BUFO.

PLATE VIII, FIGS. 25, 26.

- Calymene bufo*, GREEN. Monogr. Trilob. North America, p. 41. 1832.
Phacops bufo, HALL. Descr. New Species of Fossils, etc., p. 65. 1861.
Phacops bufo, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 93. 1862.
Phacops bufo, HALL. Illustrations of Devonian Fossils, pl. viii, figs. 24, 25. 1876.

THE type specimen of Dr. Green's species is an imperfect cast of the lower surface, and is said to have been found in a dark grayish limestone in the State of New Jersey. Its geological horizon was not definitely stated by its author, but is undoubtedly of the age of the Upper Helderberg or Hamilton group. The original example of the species presents a general agreement with *Phacops rana* (*Calymene bufo*, var. *rana*, Green), of the Hamilton group, but appears to be somewhat more elongate, with a proportionally longer and more tumid glabella. Specimens from New York State agreeing with the type have not been observed.

* These localities in Iowa have been kindly communicated by Professor Samuel Calvin.

PHACOPS CACAPONA.

PLATE VIII, FIGS. 19-21. 3

Calymene bufo, CASTELNAU. Essai sur le Syst. Sil. de l'Amér. Sept., p. 21, pl. ii, figs. 1-4. 1843.*Phacops Cacapona*, HALL. Descr. New Species of Fossils, etc., p. 68. 1861.*Phacops Cacapona*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 96. 1862.*Phacops Cacapona*, HALL. Illustrations of Devonian Fossils, pl. viii, figs. 18-23. 1876.

THE two specimens from which this species was originally described are interior and somewhat imperfect casts of enrolled individuals, retaining very few of the features which are essential in determining the value of closely allied species of this genus. In general proportions they resemble *Phacops rana* as that fossil appears in the limestone layers of the Hamilton group, except that the glabella is more protuberant and the glabellar furrows more strongly marked, and in these features it approximates *Phacops cristata*. Whether the species belongs to either of these two, or is valid in itself, cannot be definitively determined without the acquisition of specimens retaining the test, the genal extremities and the pygidium. The specimens described and figured by Castelnau (*loc. cit.*) as *Calymene bufo*, Green, were from the same locality as the type specimens of *Phacops Cacapona*. This author's figures do not, however, assist in determining the specific value of his examples.

Distribution. Hamilton group. Mouth of the Cacapon River, near its junction with the Potomac, Virginia.

PHACOPS NUPERA.

PLATE VIII, FIG. 27.

Calymene nupera, HALL. Geology of N. Y. Survey Fourth Geol. Dist., p. 262, fig. 116. 1843.*Phacops nupera*, HALL. Illustrations of Devonian Fossils, pl. viii, fig. 26. 1876.

THE type specimen of this species was found during the progress of the geological survey of the State in a loose block of sandstone, apparently of the age of the Chemung sandstones, near the mouth of Chemung Creek, in Chemung county. No other specimen is known to have been found since, and this is not satisfactorily preserved for purposes of identification. In all apparent features it agrees with *Phacops rana* of the Hamilton group, but the critical characters for distinguishing the Devonian *Phacops*, viz.: the genal extremities, the cephalic doublure and the pygidium, are not retained, and it is consequently impossible to determine its specific value. The original designation is, therefore, retained, awaiting the acquisition of material which may serve either to establish or discard it.

Distribution. Chemung group. Chemung Creek, Chemung county.

DALMANITES, BARRANDE. 1852.

HAUSMANNIA, N. S.-G.

DALMANITES (HAUSMANNIA) PLEUROPTYX.

PLATE XI A, FIG. 1-3.

Asaphus pleuroptyx, GREEN. Monog. Trilob. North Amer., p. 55. 1832.

Dalmania pleuroptyx, HALL. Pal. N. Y., vol. iii, p. 356, pl. 74, figs. 5? 9? (not figs. 1-4, 6-8, 10-12); pl. 75, fig. 1? 1859.

THIS species, the most abundant of all the trilobites of the Lower Helderberg faunas, has been found in the Oriskany sandstone of Canada, associated with *Spirifera arrecta*, *Streptorhynchus* (*Orthis*) *hipparionyx*, *Phacops cristata* and *Dalmanites anchiops*, and also in two well-defined examples of the pygidium, in the Corniferous limestone of the State of New York. The species thus becomes the only member of the trilobitic fauna of the Lower Helderberg known to have continued its existence into the Upper Helderberg formations. Its occurrence in Devonian horizons affords the opportunity of suggesting some corrections of the previous identifications of the species. The two species, *D. pleuroptyx*, Green, and *D. micrurus*, Green, both of which were established upon pygidia, were recognized in the third volume of the Palæontology of New York, and the differences between them were there pointed out. It is nevertheless true, that while it is not difficult to select examples of such pygidia as appear to be specifically distinct, the differences seem to disappear with abundant material, so that upon the basis of the pygidia alone, the attempt to separate the two species is exceedingly unsatisfactory. The type specimen of *D. pleuroptyx* was from the Lower Helderberg of the Helderberg mountains, and extensive collections subsequently made from this prolific locality show that the abundant pygidia of this species are everywhere associated with cephalæ heretofore undescribed, a specimen of which is here figured (pl. xi A, fig. 1).

The outline of this cephalon is nearly crescentic, its length one-half its width, and the genal angles produced into conspicuous spines. The glabella agrees with that of *D. Hausmanni*, both in proportions and character of lobation. Its frontal lobe bears three circular depressions, one on the axial line and one near each of the lateral extremities; of these the former is largest and deepest. The eyes are large and elevated, the orbital sulcus unusually broad and conspicuous; the cheeks slope abruptly in front, and more evenly toward the genal angles, and their surface is marked by irregular, conspicuous wrinkles, except where it is crossed by the broad, smooth sulcus in which the facial suture lies. The border is a very characteristic feature, being moderately broad, smooth and concave on the sides, narrowing near the extremities of the frontal glabellar lobe and produced in front into a sub-nasute extension. Just below the lateral extremities of the glabella begins a series of marginal crenulations or alternate thickenings and thinings, which become more conspicuous anteriorly. The border thus has a character similar to that of *D. anchiops*, and is of especial interest as suggesting the inception of that peculiar frontal ornamentation which is more fully developed in *Odontocephalus*. There is no doubt that this is the cephalon of *D. pleuroptyx*, as in one well-defined example the parts have been found in conjunction. The cephalon which were referred to this species on plate lxxiv of the third volume of the Palæontology of New York, with the possible exception of figures 5 and 9, must therefore belong to another species. No similar heads have been found in the Helderberg mountains. The original pygidium of *D. micrurus*, Green, is known to have come from Schoharie, although the author regarded it as from Trenton Falls. At Schoharie the large pygidia which agree with the type of *D. micrurus* are not uncommon, and the cephalon with which they are there associated, and those in the western extension of the Lower Helderberg formation, in Herkimer county, should probably be regarded as belonging to this species. The cephalon described here as that of *D. pleuroptyx* appear to be of rare occurrence at Schoharie, and that species seems to have been most abundant in the Shaly Limestone, and *D. micrurus* in the Lower Pentamerus Limestone. The entire young individual figured on plate lxxiv (Pal. N. Y., vol. iii), may

be regarded as a specimen of the latter species. The fragmentary specimen represented on plate lxxv, fig. 1, is from a locality in Pennsylvania, and its coalesced glabellar lobes indicate a distinct species.

Distribution. Lower Helderberg group. Near Clarksville, Albany county; Schoharie, Schoharie county. Oriskany sandstone: Township of Walpole, Province of Ontario. Corniferous limestone: Clarence Hollow, Erie county; Lime Rock, Genesee county.

DALMANITES (HAUSMANNIA) CONCINNUS.

PLATE XI A, FIGS. 9-11.

Dalmanites concinnus, HALL. Illustrations of Devonian Fossils, pl. x, figs. 3-5. 1876.

PYGIDIUM only known. Outline sub-triangular, posteriorly acuminate. Surface convex, trilobate.

Axis relatively narrow, width less than one-third that of the shield, slightly elevated along the axial line, and tapering to an abrupt termination within the margin; bearing nine to ten flattened transverse annulations, which are thickened or faintly nodose on the axial line.

Pleuræ broad, deflected in an even curve to the margins and bearing seven or eight annulations which are broad, low and flat, and are separated by fine narrow sulci. The first five annulations are grooved by fine impressed lines, which extend to the margin. The anterior and posterior limbs thus formed are of equal strength. The margin is slightly thickened, becoming wider posteriorly and produced into a short and stout caudal spine. Surface smooth or minutely granulose.

Dimensions. The largest pygidium observed has a length of 16 mm., and a width of 18 mm.; the smallest a length of 9 mm., and a width of 10 mm.

Distribution. Upper Helderberg group. Schoharie grit, Schoharie, Schoharie county; near Clarksville, Albany county; Corniferous limestone, near Caledonia, Livingston county; Cayuga, Province of Ontario.

DALMANITES (HAUSMANNIA) CONCINNUS, var. SERRULA, n. var.

PLATE XI A, FIG. 12.

A SINGLE very small pygidium measuring 4 mm. in length and width bears all the characters of the normal pygidium, but has in addition to them a row

of short spinules upon the lateral margins. These spinules are five in number upon each side, the first being the largest, their size diminishing posteriorly so that the last is little more than a crenulation of the margin. They are short, stout, acute, and directed backward. The terminal spine of the pygidium also is relatively longer and more slender than in the normal form.

This specimen is from the decomposed chert of the Corniferous limestone at North Cayuga, Province of Ontario.

DALMANITES (HAUSMANNIA) PHACOPTYX, n. sp.

PLATE XI A, FIGS. 23-26.

FRAGMENTS of three large PYGIDIA show pleuræ which are broad on the anterior margin, but narrow rapidly backward and are abruptly deflected toward the posterior extremity. The margin is entire and the border quite narrow, widening at the posterior extremity, where it is laterally flattened and produced into a stout spine, having about one-fourth the length of the pygidium, and strongly bent upward.

The *axis* is composed of eleven or twelve moderately broad annulations, and towards its posterior extremity merges into the caudal ridge and spine.

The *pleuræ* bear twelve or thirteen ribs which are separated by wide, shallow sulci, and are strongly curved backward near their distal extremities. Each of these annulations is conspicuously sulcate. The surface is covered with spinules and acute tubercles which appear to be irregularly scattered over the annulations. On the axis they are sometimes in pairs or in single transverse rows, becoming crowded together near its margins; on the pleuræ they appear to lie exclusively upon the anterior limb of each annulation, although the larger spinules are often so broad at the base as to extend across the entire width of the annulation. The surface between the tubercles and spinules is covered with fine granulations.

Dimensions. The largest and most complete specimen observed has a length of 62 mm. to the tip of the caudal spine; its width across the anterior margin, when entire, would be about 85 mm.

Observations. This species, though imperfectly known, is of interest as presenting a continuation into the Devonian formation, of a type of *Dalmanites*

which attains its highest development in the Silurian. In outline and contour it shows an intimate relationship with an undescribed species of *Dalmanites* from the Lower Helderberg formation. It is, moreover, directly comparable with *Dalmanites spinifera*, Barrande, from the étage G, and *D. rhenanus*, Kayser, from the Wissenbach slates of the Lower Devonian.

Distribution. Upper Helderberg group. Cayuga, Province of Ontario.

DALMANITES (HAUSMANNIA) MEEKI.

PLATE XI A, FIGS. 28-30.

Dalmanites (undet. sp.), MEEK. Geol. Expl. Fortieth Parallel, vol. iv, p. 48, pl. i, figs. 11, 11a. 1877.

Dalmanites Meeki, WALCOTT. Monogr. U. S. Geol. Surv., vol. viii: Pal. Eureka Dist., p. 207, pl. xvii, figs. 5, 5a-b (not fig. 5c). 1884.

THE material representing this species consists of detached specimens of a glabella, a very large hypostoma and a quite perfect pygidium. The last-named part is very closely similar, probably identical with the pygidium of *Dalmanites anchiops*, but if the associated glabella belongs to the same species as the pygidium it will be necessary to regard these fragments as characterizing a distinct specific form.

CEPHALON. The *glabella* is very similar to that of *Dalmanites pleuroptyx*, Conrad. The frontal lobe is large and transversely sub-elliptical, depressed-convex above; the three pairs of lateral lobes are distinctly defined; the first two widest at their outer extremities, the last narrow, transverse and extending as an annulation across the glabella. The lateral furrows of the second pair appear to be nearly obsolete toward their distal extremities, causing a tendency to coalescence in the adjoining lobes. The occipital furrow is narrow and shallow, the occipital ring moderately broad and elevated, and without any central spine.

PYGIDIUM as in *Dalmanites anchiops*, although bearing two or three more pleural annulations than is usual in mature examples of that species.

HYPOSTOMA elongate-triangular, surface depressed-convex. Anterior margin slightly arched, antero-lateral extremities sub-auriculate. Centrum broadly

convex bearing a pair of short lateral furrows which terminate centrally in two conspicuous depressions or pits, bounded posteriorly by a low sulcus, beyond which is a linguiform extension bearing upon its margin five spinules, one of which lies on the axial line, with two on either side.

Distribution. "Lower horizon of the Devonian limestone, Comb's Peak, and on the divide at the head of the Reese and Berry Cañon, Eureka District, Nevada." (Walcott, *loc. cit.*)

CORONURA, N. S.-G.

DALMANITES (CORONURA) ASPECTANS.

PLATE XII, FIGS. 1-11, 13.

- Asaphus aspectans*, CONRAD. Fifth Ann. Rept. Pal. N. Y., p. 49, fig. 9. 1841.
Asaphus? denticulatus, CONRAD. Fifth Ann. Rept. Pal. N. Y., p. 48. 1841.
Dalmania adspectans (in error), HALL. Descr. New Species of Fossils, etc., p. 60. 1861.
Dalmania Helena, HALL. Descr. New Species of Fossils, etc., p. 61. 1861.
Dalmania adspectans (in error), HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 88. 1862.
Dalmania Helena, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 89. 1862.
Dalmanites Ohioensis, MEEK. Proc. Acad. Nat. Sci. Phil., p. 91. 1871.
Dalmanites Ohioensis, MEEK. Pal. Ohio, vol. 1, p. 234, pl. xxiii, fig. 1. 1873.
Dalmanites denticulatus, HALL. Illustrations of Devonian Fossils, pl. x, fig. 1. 1876.
Dalmanites aspectans, HALL. Illustrations of Devonian Fossils, pl. xiii, figs. 6-8. 1876.
Dalmanites Helena, HALL. Illustrations of Devonian Fossils, pl. xiii, figs. 11-14. 1876.

THIS species has been observed only in detached portions of the exoskeleton. The pygidia which have been described under the specific designations *Dalmanites Helena* and *D. Ohioensis* (*op. cit.*), are not uncommon in the Corniferous limestone of New York and Ohio, and associated with them are fragments of large cephalae, which presumptively can belong to no other species. Such a fragment of the cephalon, consisting of a free cheek retaining the visual surface of the eye, served as the original of the *Asaphus aspectans* of Conrad; more recently a larger fragment, also retaining the greater portion of the eye and agreeing in all particulars with Mr. Conrad's type, has been found in the Corniferous limestone at Columbus, Ohio, associated with the pygidium of *D. Helena*.* There is no other

* Through the kindness of Dr. J. S. Newberry this specimen has been made available for use in the revision of these species.

species known to us from this formation in Ohio, to which such fragments could be referred, and none in the Corniferous limestone of New York, except *D. myrmecophorus*, in which species the cephalon was undoubtedly similar in many respects to that of *D. Helena*, though of much larger dimensions than are indicated by these fragments. It seems necessary to establish Mr. Conrad's specific name, *aspectans*, upon a basis which will include the forms heretofore referred to *D. Helena* and *D. Ohioensis*.

The description of the original fragment is as follows: "A small portion of the buckler and one eye only is visible, but the eye is of an extraordinary height, the margins parallel, and the lenses arranged in parallel longitudinal lines, small and very numerous."

In this specimen the eye is remarkably elevated, sub-semi-cylindrical, reaching a height of 9 mm., with a width of 8 mm. across the base. The corneal lenses are numerous, and though the condition of preservation does not permit the enumeration of them, thirty rows are visible, some of them containing as many as thirty-four lenses each. It would therefore be safe to infer that the eye bore not less than 700 lenses. The attached portion of the cheek has a broad flattened border, and is covered with strong, closely crowded tubercles.

Additional details of the *Cephalon* are furnished by the Ohio specimen, as follows: the outline of the shield is semi-elliptical, the broad flat border slightly thickened toward its inner margin, the marginal sulcus deep and moderately broad, the genal angles produced into long sharp spines; the facial suture takes its origin at a point about half-way from the apex of the cheek-spine to the anterior extremity, passing abruptly forward over one-half the width of the border, thence straight across to the marginal sulcus, and inward to the inner angle of the visual surface; over the convex surface of the cheek it lies in a deep groove; the surface of the cheek beneath the eye is slightly flattened and the orbital ridge is well defined; occipital furrow and ring moderately strong.

Of the *thorax* nothing has been observed.

PYGIDIUM sub-ovate-triangular in outline, posteriorly truncate or broadly emarginate. Surface depressed-convex, with a general upward inflection posteriorly. Margin thickened, narrow, widening into the post-axial border.

Axis convex, width equal to one-fifth the width of the shield along a given annulation, regularly tapering to obsolescence upon the posterior margin; composed of sixteen to twenty transverse, somewhat flattened annulations, separated by moderately strong furrows.

Pleuræ wide, convex near the axis, thence regularly depressed toward the margin; composed of sixteen to eighteen broad, slightly flattened annulations, which become obsolete upon the margin. These are faintly sulcate, and are separated from one another by furrows, which are deepest and broadest near the margin. The border is ornamented by a fringe of conspicuous spines, one in continuation of each pleural annulation. Of these spines the anterior pair is the shortest, and their length increases backward to the ninth or tenth pair, thence becoming shorter to the terminal pair, in which the spines are broader and stouter than elsewhere, and distinctly curved upward and toward the axial line. These terminal spines are separated, at their bases, by a distance equal to the width of the axis on its anterior margin. The surface of the pygidium is covered with regularly arranged tubercles, of which the axis bears five longitudinal rows, one axial and four lateral (becoming two on the posterior annulations), each annulation bearing a single row of three or five tubercles. Each pleural annulation bears two rows, one for each anterior and posterior limb. Upon the lateral margins the tubercles become stronger and are more scattered, while the posterior border between the terminal spines is smooth. In the New York specimens the entire surface ornamentation, with the exception of the marginal spines, is frequently almost or quite obsolete.

Dimensions. An average pygidium from the Falls of the Ohio measures 60 mm. in length and 79 mm. in width; one from western New York, 46 mm. in length and 67 mm. in width. The largest specimen observed has a length of 67 mm. and a width of 100 mm.; the smallest a length of 35 mm. and a width of 51 mm.

Observations. The pygidium of this species, as already noticed, is subject to some variation in the matter of surface ornament. The type specimen of *Dalmanites Helena* is from the Corniferous limestone of the Falls of the Ohio, and all specimens from this locality have shown a regularly tubercled surface. In the limestones of the same age near LeRoy, N. Y., where the species is abundantly represented, the ornamentation has become nearly obsolete, and it is probable that a specimen in such condition was the original of the *Dalmanites Ohioensis*, described by Mr. Meek, from the Corniferous limestone of Marblehead, Ohio. In general form and outline, spinose margin and number of annulations, *D. aspectans* presents a close agreement with *D. myrmecophorus*. There are however persistent differences in the two species which may be enumerated as follows: in *D. aspectans* the posterior border between the marginal spines bears no tubercles, and is only slightly elevated; the tubercles of the surface are not nodiform, and are always regularly arranged, except upon the lateral margins; the terminal spines are short and not laterally flattened. The original of *Asaphus? denticulatus*, Conrad (Fifth Ann. Rept. Pal. N. Y., p. 68. 1841), was a fragment of a pygidium reported as from the Schoharie grit, at Schoharie, and a specimen from the Upper Helderberg limestone at Schoharie, exhibiting the same characters as those accredited to Mr. Conrad's type, was figured in the Illustrations of Devonian Fossils (pl. x, fig. 1). The original of Mr. Conrad's description is no longer accessible, but the specimen mentioned from the limestone shows a variation from the type of *Dalmanites Helena* in having the posterior spines broader, stouter and more flattened vertically, the posterior border bearing a few scattered tubercles; it retains, however, features characteristic of *D. Helena* (= *aspectans*) in the regular arrangement of the tubercles upon the annulations, and the absence of an elevated spinose border. It seems advisable to include this slight variation under the species *D. aspectans* rather than to establish varietal terms for all intermediate forms between the closely allied species *D. aspectans* and *D. myrmecophorus*. The specific name *denticulatus* has actual priority by a single page over the term *aspectans*; as, however, the fragment designated by the former name proves not to be in all respects a normal example of the species it represents, and as the description

of the latter species was accompanied by a figure, no violence is done to Mr Conrad's determinations by according recognition to the latter name.

Distribution. Upper Helderberg group. Corniferous limestone: near Clarksville, Albany county; Schoharie, Schoharie county; Caledonia, Monroe county; Lime Rock, near LeRoy, Genesee county; Clarence, Erie county; Falls of the Ohio, Columbus and Marblehead, Ohio.

DALMANITES (CORONURA) MYRMECOPHORUS.

PLATE XI A, FIG. 13; PLATE XIII, FIG. 12; PLATE XIV, FIGS. 1-6; AND PLATE XV, FIGS. 1-4.

- Asaphus myrmecophorus*, GREEN. Suppl. Monog. Trilob. North America, p. 16. 1835.
Asaphus? acanthopleurus (*acantholeurus*, in error), CONRAD. Fifth Ann. Rept. Pal. N. Y., p. 48. 1841.
Dalmania myrmecophorus, HALL. Descr. New Species of Fossils, etc., p. 60. 1861.
Dalmania myrmecophorus, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 88. 1862.
Asaphus? acantholeurus, (CONRAD) HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 113. 1862.
Dalmanites myrmecophorus, HALL. Illustrations of Devonian Fossils, pl. xiii, figs. 15, 16. 1876.
Dalmanites acantholeurus, HALL. Illustrations of Devonian Fossils, pl. xix, fig. 14. 1876.

The CEPHALON and THORAX of this species have been observed only in a condition so fragmentary as to be unsatisfactory for description or positive identification.

PYGIDIUM large, sub-ovate-triangular, broadly emarginate behind. Surface depressed-convex, scarcely flabellate, conspicuously trilobate. Posterior limbus with an upward curve, which begins at the posterior third of the shield and terminates in a vertical spiniferous border.

Axis relatively narrow, width about one-fifth the width of the shield upon the anterior margin; evenly tapering to a termination which becomes obsolete within the posterior border. Composed of sixteen to nineteen broad transverse annulations, separated by narrow, deep furrows.

Pleuræ broad, most convex at about one-third their width from the axial margins, thence rapidly sloping and becoming somewhat flattened near the edge; composed of fifteen to eighteen broad annulations, which widen toward their distal extremities, and in some instances show traces of a faint

groove upon the surface. Border narrow at the sides, produced at the postero-lateral angles into two broad, stout, incurving cornua, whose inner bases are continuous and form an elevated marginal collar at the posterior extremity. The articulating ring and each pleural annulation, at its termination upon the margin, bears a round, smooth terete, and gently incurved spine. These spines are shortest in front and increase in length toward the posterior cornua. The posterior collar has a width equal to that of the axis on its anterior margin, and bears a series of strong spines; one situated centrally, bifurcating at two-thirds its length, and, in a large individual, reaching a height of 10 mm., a short accessory pair of spines near the base of the foregoing (sometimes absent), a second and stronger pair at the beginning of the posterior curve, a third pair at the base of the broad terminal spines, and the incurved, elevated terminal spines or cornua, each of which bears an accessory spine near the apex. (See plate xv, figs. 1-3.) The height of the cornua in a large example is 12 mm.

The *Surface* of the pygidium is covered with strong, sub-spiniform, irregularly disposed nodes. Upon the axis each annulation bears but a single row, but no arrangement in longitudinal rows is discernible. Upon the pleuræ there is evidence of an irregular, double row of nodes, but at the lateral and posterior margins the nodes are more abundant and irregularly disposed. A single example having an irregularly nodose axis, and a central spine on the posterior collar, has the pleural nodes relatively small, abundant and arranged in two regular rows as in *Dalmanites aspectans*, affording evidence of the affinity of these two species in this respect. The characteristic ornamentation of *Dalmanites myrmecophorus* is however exhibited in pygidia varying widely in dimensions, the smallest individual noticed retaining this feature quite as strongly marked as the largest.

A single large *glabella* which differs from that of any known species of the Upper Helderberg group, may belong to this species. It has the general outline and contour of the glabella in typical *Dalmanites*, except that there is an apparent tendency to obsolescence in the second lateral furrows. The frontal lobe bears a pair of conspicuous nodes just behind its center, and a

pair of sharp tubercles in the median depression between the lateral lobes. The occipital furrow is narrow, and the occipital ring broad and rounded. The entire surface, except in the furrows, is sharply tubercled.

Dimensions. An average pygidium measures 50 mm. in axial length and 80 mm. in width; the largest observed is 115 mm. in length and 180 mm. in width; the smallest 6 mm. in length and 10 mm. in width. The glabella described has a length of 33 mm. and about an equal width.

Observations. The remarkable size attained by the pygidia of *Dalmanites myrmecophorus* show it to have been, at maturity, an animal of gigantic proportions. A careful restoration of the outline of an individual on the basis of the largest pygidium above referred to, has been made by comparison with the proportions of other species of this type of *Dalmanites*, and the result, which may be regarded as approximately correct, at all events not exaggerating the size, indicates that the animal when entire may have attained a length of 398 mm. or 16 inches, the largest form of *Dalmanites* yet observed, and one of the largest trilobites known. A similar restoration of the smallest pygidium gives an individual 21 mm. or .8 of an inch in length. Fragments of large cephalæ and thoracic segments have been occasionally observed in association with these pygidia, but our present knowledge of these parts is insufficient for satisfactory description. A few thoracic segments found in place with a pygidium indicate an irregularly nodose surface, and fragments of the head-shield show a wide and flat border, and a closely and strongly tubercled surface. The differences and similarities in *Dalmanites myrmecophorus* and *Dalmanites aspectans* are noticed under the description of the latter species. The *Asaphus? acanthopleurus* of Conrad (*loc. cit.*) was described from a fragment of the posterior portion of a very large pygidium of this species, in which the central spine is very strong, and the other marginal spines, as indicated by their bases, larger than have been observed in any other example. This specific term has been used in the various preliminary publications upon these fossils, as the nature of the posterior border in *Dalmanites myrmecophorus* had not at that time been observed. There now appears to be no doubt of the identity of the two species. The

original of *D. acanthopleurus* is from "near Schoharie, in limestone with *Odontocephalus* (Onondaga limestone)."

Distribution. Upper Helderberg group. In the Corniferous limestone, near Clarksville, Albany county; Schoharie, Schoharie county; Canandaigua, Ontario county; Lime Rock, near LeRoy, Genesee county.

DALMANITES (CORONURA ?) EMARGINATUS.

PLATE XI A, FIGS. 7, 8.

Dalmanites emarginatus, HALL. Illustrations of Devonian Fossils, pl. x, fig. 2. 1876.

OF this species fragments of the *pygidia* only, have been observed, which may be characterized as follows: Outline sub-triangular, broadly emarginate behind; apex of reëntrant angle sub-acute.

Axis narrow, tapering evenly to an apex near the posterior border and connected with the margin by a sharp, low ridge; it is composed of twenty to twenty-two transverse annulations.

Pleuræ broad, slightly produced upon the postero-lateral areas, and bearing seventeen to twenty broad and flattened annulations, which show a slight tendency to duplicature toward the posterior extremity. The border is narrow at the sides and widens a little posteriorly, where all the annulations become obsolete upon approaching it. Surface ornamented by pustules, each annulation bearing a single row upon the axis, and a double row upon the pleuræ. The axis bears five longitudinal rows, one in the axial line, and two on either side. Upon the margin of the pygidium the pustules are more irregularly scattered. The lateral margins bear no spines and the posterior border is covered only with granulations.

The dimensions of the shield are approximately 22 mm. in length, and 32 mm. in width.

Observations. This little known species presents points of similarity with *Dalmanites aspectans*, but differs in the following particulars, viz.: (a) the posterior margin is angulate and not transverse or crescentic, nor produced into

postero-lateral spines, (b) the lateral margin is not spinose, (c) the termination of the axis is connected by an angular ridge with the margin.

Distribution. Upper Helderberg group. Schoharie grit, Schoharie, Schoharie county.

[s.-g.] C R Y P H Æ U S, GREEN. 1837.

DALMANITES (CRYPHÆUS) COMIS, n. sp.

PLATE XVI A, FIG. 1.

A SMALL and somewhat incomplete pygidium indicates an undescribed species of this sub-genus. It is characterized by the narrow axis curving slightly inward on the margins, and bearing six annulations, four distinct and elevated, and the last two faintly defined. The pleuræ are moderately broad, sloping somewhat abruptly toward the margins, and bear five annulations, each of which terminates in a short, blunt spinule, with the apex directed backward. Whether or not there was a terminal spinule, as in the other American species, cannot be determined from this specimen. The pygidium has a length of 4 mm. and a width of 5 mm.

Distribution. In the decomposed chert of the Corniferous limestone, Walpole, Province of Ontario.

DALMANITES (CRYPHÆUS) PLEIONE.

PLATE XVI A, FIG. 2.

Dalmania Pleione, HALL. Descr. New Species of Fossils, etc., p. 62. 1861.

Dalmania Pleione, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 90. 1862.

Dalmanites Pleione, HALL. Illustrations of Devonian Fossils, pl. xvi, fig. 17. 1876.

Crypheus Pleione, KAYSER. Abhandl. z. Geol. Specialkarte von Preussen, etc., Band ii, Heft 4, p. 33. 1878

THE imperfect pygidium which served as the original of this species is closely similar in general proportions, number of annulations and marginal spines to that of *D. Boothi* var. *Calliteles*. The spines however are relatively longer, more slender, rounder and more distant than in the mature individuals of the variety mentioned, but have a striking similarity to the pygidia of the young of that form. Our knowledge of the species in America is at present limited to the

single type specimen, but Kayser has provisionally referred to this species a pygidium from the Lower Devonian at Daun in the Rhine-land.

Distribution. Hamilton group. Hydraulic limestone, Falls of the Ohio.

DALMANITES (CRYPHÆUS) BOOTHII.

PLATE XVI, FIGS. 1-4; AND PLATE XVII A, FIGS. 3-8.

- Cryphæus Boothii*, GREEN. Amer. Journ. Science, vol. xxxii, p. 343, figure. 1837.
Cryphæus Greenii, CONRAD. Second Ann. Rept. Palæont. Dept. N. Y. State Geol. Surv., p. 66. 1839.
Cryphæus calliteles, CONRAD. Second Ann. Rept. Palæont. Dept. N. Y. State Geol. Surv., p. 62. 1862.
Asaphus Hallii, CONRAD. Third Ann. Rept. Palæont. Dept. N. Y. State Geol. Surv., p. 204. 1840.
Cryphæus calliteles, HALL. Geology of N. Y., Pt. IV, p. 201. 1843.
[?] *Cryphæus calliteles*, DE VERNEUIL. Bull. Soc. Géol. de France, 2nd Ser., vol. vii, p. 164, pl. i, fig. 3. 1850.
Phacops pectinatus, F. A. ROEMER. Beitr. I, zur Kenntn. d. Harzgeb., p. 62, pl. ix, fig. 27. 1850.
Dalmania calliteles, EMMONS. Manual of Geology, p. 138, f. 124 (7). 1860.
Dalmania Boothii, HALL. Descr. New Species of Fossils, etc., p. 63. 1861.
Dalmania Boothii, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 91. 1862.
Dalmanites Boothii, HALL. Illustrations of Devonian Fossils, pl. xvi, figs. 1-6, 9-11, 13, 15, 16. 1876.
Cryphæus stellifer, KAYSER (partim). Abhandl. z. Geolog. Spezialkarte von Pr. und d. Thür. St., vol. ii, pt. 4, p. 33. 1878.
Cryphæus laciniatus, KAYSER (partim). Abhandl. z. Geolog. Spezialkarte von Pr. und d. Thür. St., vol. ii, pt. 4, p. 34. 1878.

GENERAL FORM AND PROPORTIONS. Body sub-ovate, laterally and posteriorly fimbriate; length about one-half greater than the width. Surface depressed-convex, distinctly trilobate. Axis prominent, elevated; pleuræ flattened.

CEPHALON relatively large; outline semi-elliptical, faintly produced on the frontal margin; length to width as 1 to 2. Frontal area narrow, lateral area broader but mostly occupied by the strong eye-lobes. Margin thickened by a broad doublure, which widens under the frontal limbus to form the epistoma, and is produced at the genal angles into spines which normally reach to the sixth thoracic segment, and are equal in length to the axial length of the glabella. These spines are broad, thin and blunt, and lie nearly in a vertical plane.

The *Facial Sutures* take their origin on the lateral margins at points about half-way between the frontal extremity and the apices of the cheek-spines, pass inward and downward to the lower margin of the ocular lobe, thence over the eye to the anterior edge of the frontal lobe of the glabella, meeting near the anterior extremity just within the margin.

Glabella elongate-sub-pentagonal; length and width equal, and nearly equal to the length of the cephalon. Frontal lobe large, transversely sub-elliptical in outline; the width equal to one-third that of the cephalon. The first pair of transverse furrows is long, directed obliquely backward; the second pair shorter and more transverse; the third pair still shorter and transverse. All these glabellar furrows are deeply impressed at their proximal extremities, as shown in casts of the inner surface. The first glabellar lobes are strong and sub-triangular; the second and third lobes shorter and more annular. Occipital furrow very narrow and sharply impressed; occipital ring strongly arched upon the axis, narrowing behind the ocular nodes, and widening again to the genal spines.

Eyes large, elevated, exceeding the height of the glabella. Visual surface lunate, corneal lenses numerous, an adult example showing fifteen rows, numbering diagonally from the lower posterior margin, and 206 lenses for each eye. Palpebrum inconspicuous, scarcely overlapping the visual surface. Palpebral lobe depressed, sloping evenly to the narrow palpebral sulcus.

THORAX. Length to width as 1 to 1.5.

Axis arched, widest at the fourth segment, tapering thence evenly to the pygidium.

Pleuræ flattened, gently deflected along the fulcrum. Segments narrow upon the axis, with a slight double curvature, bending forward along the axial margins and axial line; grooved upon the pleuræ, the anterior limb low and becoming obsolete along the fulcrum; the posterior limb slightly beveled, and considerably produced at the extremities.

PYGIDIUM sub-triangular, depressed-convex.

Axis tapering with slightly incurved margins, and ending abruptly just within the posterior border; bearing from ten to fourteen annulations in well-preserved specimens.

The *pleuræ* each bear five annulations which are sulcate, the posterior limb in each becoming obsolete near the margin, while the anterior limbs are flattened, thickened, slightly curved and produced beyond the margin

into spines having a length nearly equal to the length of the pleuræ themselves. A spine similar to these, but shorter and relatively broader, is produced in the axial line, thus making eleven spines in the pygidial fimbria. Some slight variation is noticeable in the form of these spines, but in typical examples, the ten lateral extensions of the fimbria are broad, short, flat and closely set, the apex pointed backward, the terminal lobe being shorter and linguiform.

HYPOSTOMA, elongate-sub-triangular; anterior angles auriculate, posterior extremity sub-linguiform. Centrum convex, bounded posteriorly by a conspicuous sulcus. The postero-lateral pits on the centrum are joined by a faint groove. Surface covered with venate lines and faintly granulose.

Surface Ornamentation. In the normal forms of this species the entire surface is covered with granulations which become quite strong on certain portions, viz., the axial region of the glabella and thorax, and the surface of the pygidial fimbria, where the granules become elongate and pustuliform, often crowded and more conspicuous than upon the surface of the shield itself. Upon the thoracic pleuræ are single rows of low and inconspicuous pustules, which, in somewhat weathered specimens from the shales, often appear as shallow punctæ. The occipital ring bears a strong central spiniform node, and the thoracic segments along the axial line, sometimes evenly rounded, are usually slightly angulated or nodose, the nodes becoming stronger toward the pygidium. The annulations of the pygidium are evenly rounded. The surface of the doublure is granulose.

Variations from the type of *Cryphæus Boothii*, Green, as diagnosed by its author, and as here described more at length, occur in a series of associated forms presenting a marked and persistent deviation in certain features. This is most noticeable in the character of the pygidial fimbria, but it appears that no variation has taken place in this feature without correlative variation in certain other respects. In many individuals of this sub-genus, particularly those occurring in the limestone layers in the Hamilton

shales, the lobes of the pygidial fimbria, instead of being flat, broad and contiguous, are more lanceolate, relatively narrow, elevated along the middle, with the apex nearly terminal. Upon careful comparison of these pygidia with Dr. Green's description of *Cryphæus Calliteles*, it appears beyond question that the species was founded upon a pygidium of this character. The original specimens of both *C. Calliteles* and *C. Boothii* were derived from the same locality, viz.: Huntingdon, Huntingdon county, Pennsylvania. The varietal feature of the pygidium with its associated characters is evidently a genetic difference, as it is apparent in the youngest individuals observed, and it therefore seems advisable to recognize in Green's species, *C. Calliteles*, at least a variety, with the following differential characters:

DALMANITES (CRYPHÆUS) BOOTHII, var. CALLITELES.*

PLATE XVI, FIGS. 5-22; AND PLATE XVI A, FIGS. 9-17.

Cryphæus Collitelus, GREEN. Amer. Journ. Science, vol. xxxii, p. 346. 1837.

Dalmanites Boothii, HALL. Illustrations of Devonian Fossils, pl. xvi, figs. 7, 8, 12, 14. 1876.

(?) *Cryphæus calliteles*, ? KAYSER. Abhandl. z. Geolog. Specialkarte von Pr. und d. Thür. St., vol. ii, part 4, p. 32, pl. iii, fig. 10. 1878.

GENAL spines long, flat, tapering to an acute extremity and reaching to the eighth thoracic segment; slightly depressed laterally and distinctly grooved by the occipital furrow for two-thirds their length. The occipital ring is unusually wide, and bears a stout spiniform node at its center. The first thoracic segment has a node or faint spine upon the axial line, and thence backward to the pygidium the spiniform nodes increase in size; the first annulation of the pygidium also bears a short spine. The lateral lobes of the pygidial fimbria are distant, narrow, lanceolate, elevated along the middle, having the apex terminal. The axial lobe is shorter than the rest, but more elongate than in *D. Boothii* and acutely angled. The surface of the test is mostly very faintly granulose, the glabella and pygidial lobes generally quite smooth, the posterior portion of the genal spines more strongly granulose than any other part of the surface, and the thoracic segments furnished with single rows of low pustules. Abundant material representing this species affords evidence

* The specific name of this species as originally published is *Collitelus*, probably a typographical error for the personal noun *Calliteles*.

of a considerable variation in size, from a length of 5 mm. to a length of 120 mm., as indicated by a large fragment, and this development in individual growth is accompanied, in the earlier stages, by considerable variation in the form of the pygidial lobes. A pygidium measuring 1 mm. in length and 3 mm. in width to the tips of the spines, has a very elevated axis, which is sub-spinose along the axial line, strongly incurved toward the extremity, and bears but six annulations. The marginal spines are unusually elongate and baccillate, the first pair being longest, the length decreasing backward, the two posterior pairs becoming strongly incurved toward the posterior extremity. The terminal lobe is very small and scarcely visible. With advancing growth the spines become relatively broader, and radiate regularly from the curve of the margin, assuming a sub-equal length, and the terminal lobe becomes gradually more conspicuous. Individuals occur occasionally in the shales of the Hamilton group, which indicate a slight inclination from the type of *Dalmanites* (C.) *Boothi* to that of the variety *D.* (C.) *Calliteles* to the extent of retaining the broad, short, vertically flattened cheek-spines of *D.* (C.) *Boothi*, and showing a tendency in the thoracic segments to become spinose on the axis, and in the pygidial spines to become narrow and acute. Such forms would naturally be expected in abundant material, but their rare occurrence, makes it inadvisable to recognize the usual variation as a distinct specific form.

Dimensions. A normal adult of *Dalmanites* (*Cryphæus*) *Boothi* affords the following measurements:

	Body.	Cephalon.	Thorax.	Pygidium.
Length	38 mm.	12 mm.	15 mm.	11 mm.
Width	24 mm.	24 mm.	22 mm.	18 mm.

Of *Dalmanites* (*Cryphæus*) *Boothi*, var. *Calliteles*, the following:

	Body.	Cephalon.	Thorax.	Pygidium.
Length	37 mm.	13 mm.	13 mm.	11 mm.
Width	26 mm.	26 mm.	19 mm.	21 mm.

Observations. It has been suggested by Professor Emanuel Kayser (Fauna d. æltst. Devon-Ablagerungen d. Harzes (*loc. cit.*), p. 33), that all the pygidia of *Dalmanites Boothi* represented in the Illustrations of Devonian Fossils (*loc. cit.*), do not belong to the same species, and he has consequently divided them in the following manner: Fig. 10 (pl. xvi), = *Cryphæus stellifer*, Burmeister; figs. 8, 11, 14, = *Cryphæus laciniatus*, C. F. Roemer; figs. 3, 6, 9, = *Cryphæus Calliteles* (*Boothi*), Green. Our observations do not sustain this sub-division. The type of *C. stellifer*, Burmeister (Organiz. der Trilobiten, pl. iv, fig. 8), shows a terminal spine upon the pygidium, exceeding in length any of the marginal spines: the same is true of *C. Calliteles*? Kayser (*loc. cit.*, pl. iii, fig. 10). This, however, is a feature which has not been observed in any specimen of the New York species. *C. laciniatus*, C. F. Roemer, bears a distinctly triangular caudal shield and a very broad terminal lobe, while the *C. laciniatus* of the Sandbergers (Versteinerungen d. Rhein. Schicht. Syst., pl. i, fig. 5c), referred by Kayser to *C. stellifer*, Burmeister, differs in this feature, and if correctly figured, might with propriety be regarded as identical with *C. Boothi*, var. *Calliteles*.

Distribution. Upper Helderberg group? *Dalmanites* (*Cryphæus*) *Boothi*. The pygidia of this species have been observed in the limestone lying beneath the Marcellus shales at the Indian Reservation, four miles south of Buffalo, Erie county, associated with *Chonetes lineata*, Vanux., and *Ch. laticosta*, Hall. Hamilton group. Marcellus shales: In the limestone near the top of these shales, on Flint Creek, Ontario county; LeRoy and Stafford, Genesee county. Hamilton shales: Rarely in the sandy shales of the eastern and central counties, at Bear's Gulf, near Summit, Schoharie county; East Worcester, and elsewhere, Otsego county; Cazenovia and Madison, Madison county; Pratt's Falls and Delphi, Onondaga county; abundant in many localities in the western counties; on the shores of Seneca and Cayuga Lakes; in the shales above the Encrinal limestone at Menteth's and Tichenor's Points, on Canandaigua Lake, and in the towns of Hopewell, Gorham, Canandaigua and East Bloomfield, Ontario county; Pavilion and Darien, Genesee county; Jaycox's Run, near Geneseo, and Moscow, Livingston county; Eighteen-mile Creek and Hamburg, Erie county. Also from Thunder Bay Run, Michigan. *Dalmanites* (*Cryphæus*) *Boothi*, var. *Calliteles*:

in the limestone near the base of the Hamilton shales, at Centerfield, and in the upper shales on Canandaigua Lake, Ontario county. In the Tully limestone at Tinker's Falls, Onondaga county; Goodwin's, Cayuga Lake, and near Lodi Landing, Seneca Lake.

DALMANITES (CRYPHÆUS) BARRISI, n. sp.

PLATE XVI A, FIG. 18.

SPECIMENS of PYGIDIA from the buff and drab Devonian limestones in the State of Iowa, present certain peculiarities which will not permit their union with either of the foregoing species. The general aspect of these caudal shields is quite similar to that presented by very young individuals of *Dalmanites Boothi*, var. *Calliteles*, with the exception that in the latter the axial spine is scarcely developed, while in the Iowa species it is conspicuous and broader than any of the lateral spines. The lateral spines are long, round, slender and terete, with a gentle backward curve; slightly thickened at the base, and not elevated along the middle as in the New York species. They are also relatively much larger than in any adult specimen of the variety *Calliteles* observed.

The *axis* of the pygidium tapers rapidly, and bears from six to eight annulations, which have a strong forward inclination in the middle.

All the specimens representing this species are small, but are of about the same size, and have undoubtedly attained their mature growth. The best preserved of the specimens has a length of 8 mm. to the extremity of the axial spine, a width of 9 mm. along the anterior margin to the bases of the lateral spines; the length of the anterior spines is 5 mm.

Distribution. Hamilton group. In the limestones usually referred to this horizon near New Buffalo, and at Searstown and Iowa City, Iowa.

[s.-g.] ODONTOCEPHALUS, CONRAD. 1840.

DALMANITES (ODONTOCEPHALUS) SELENURUS.

PLATE XI B, FIGS. 15-21; AND PLATE XII, FIGS. 1-13.

- Asaphus selenurus*, EATON. Geological Text Book, p. 31, pl. i, fig. 1. 1832.
Calymene? odontocephala, GREEN. Monog. Trilobites of North America, Suppl., p. 9. 1832.
Odontocephalus selenurus, CONRAD. Third Ann. Rept. Palæontological Dept. N. Y. Survey, p. 204. 1840.
Odontocephalus selenurus, VANUXEM. Geology of N. Y., Survey Third Geol. Dist., pp. 139, 140, fig. 1. 1842.
Odontocephalus selenurus, HALL. Geology of N. Y., Survey Fourth Geol. Dist., p. 175, fig. 1. 1843.
Dalmania selenurus, HALL. Twelfth Rept. N. Y. State Cab. Nat. Hist., p. 88. 1859.
Dalmania selenurus, HALL. Descr. New Species of Fossils, etc., p. 56. 1861.
Dalmania selenurus, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 84. 1862.
Odontocephalus ——— ? (*Dalmanites (Odontocephalus) arenarius*, MEEK and WORTHEN. Geol. Surv. Illinois, vol. iii, pp. 416, 417, pl. ix, fig. 10.
Dalmanites selenurus, HALL. Illustrations of Devonian Fossils, pl. xii, figs. 12-14. 1876.
Dalmanites Ægeria, HALL. Illustrations of Devonian Fossils, pl. xii, figs. 1, 2, 7. 1876.
Dalmanites coronatus, HALL. Illustrations of Devonian Fossils, pl. xii, figs. 15, 16. 1876.

GENERAL FORM AND PROPORTIONS. Outline elliptical or elongate-sub-ovate; anterior and posterior margins ornate. Length somewhat less than twice the width.

Surface depressed-convex above, lateral slopes abrupt. Cephalon, thorax and pygidium to one another in length as 1 to 1.3 to 1.

CEPHALON. Outline sub-semielliptical, somewhat produced in front; length about one-half the width. Surface convex, sloping abruptly in front and at the sides. Border moderately broad, horizontal in front and composed of nine conspicuous incisor-like processes, the strongest of which is central, with four on either side, which become regularly smaller as the margin narrows backwards, the terminal one standing just in front of the lateral extremities of the frontal lobe of the glabella. These tooth-like extensions are narrow and constricted at their bases, but widen rapidly so that they come in contact at the outer margin, though remaining entirely discrete. On the cheeks the border is broadly grooved and sloping, thickened along the outer and inner boundaries, and at the genal angles rounded or produced into a short, inconspicuous spinule.

The *facial sutures* take their origin at points on the lateral margins about one-third the distance from the angles of the cheeks to the anterior extremity, and are normal in their direction.

Glabella sub-clavate or elongate sub-pentagonal, extending to the frontal margin. Length and width nearly equal. Longitudinal furrows deep. Anterior lobe sub-rhomboidal, wider than long. Surface gently and evenly convex, sloping somewhat more rapidly anteriorly than laterally. First lateral furrows oblique and extending nearly across the glabella, second and third furrows transverse and short. First and second lateral lobes short and elevated, third lobes narrow and annular. The axial portion of the glabella behind the anterior lobe is rounded and depressed. Occipital furrow narrow and moderately deep, becoming more conspicuous upon the cheeks; occipital ring broad and elevated upon the axis, being very narrow upon the cheeks close to the axial furrows, but rapidly widening toward the genal extremities.

Cheeks moderately broad, flattened and strongly sulcate about the base of the eyes; abruptly deflected laterally.

Eyes prominent, elevated above any other portion of the head. Visual surface broad, lunate; lenses numerous. Palpebrum not prominent; palpebral lobe very depressed.

THORAX sub-quadrate, somewhat wider than long. Surface depressed-convex, deflected at the sides.

Axis narrow anteriorly, widening to the sixth segment, thence backward rounding and tapering rapidly to the pygidium. The segments are broad and flat or gently convex, with an anterior curve over the axial line.

Pleurae moderately broad, flat along the axial furrows for more than one-half their width, thence deflected more or less abruptly. Each annulation is conspicuously sulcate, the anterior limb being as broad at the fulcrum as the posterior limb at its widest point.

PYGIDIUM. General outline sub-triangular or sub-semielliptical. Surface depressed above, lateral slopes more or less abrupt. Border narrow; post-axial area flat, bending slightly upward and bearing two slender divergent

spines, giving the crescentic caudal extremity from which the specific name is derived.

Axis relatively narrow, having less than one-fourth the width of the shield on the anterior margin; margins approximating with a slight inward curve to the apex which is broad, smooth, somewhat elevated, and distant from the posterior margin. Annulations from nine to eleven with indications of others on the terminal portion, visible only on casts of the under surface

Pleura composed of eight flattened annulations and traces of a ninth, which are abruptly bent backward near the margin. When the crust is well-preserved the surface of each annulation bears a fine impressed line extending its whole length.

HYPOSTOMA elongate-sub-triangular or sub-linguiform. Anterior margin arcuate, antero-lateral angles auriculate. Centrum moderately convex, bearing posteriorly two pits connected by a faint groove, and separated from the posterior lingua by a conspicuous sulcus. The posterior margin appears to be smooth, but probably bears normally, one, three or five spinules. Lateral margins abruptly deflected dorsally.

Surface Ornamentation. The surface of the glabella, cheeks, margin and marginal denticulations is covered with faint obsolescent tuberculations. The entire test is very strongly punctate and the openings of the vertical tubules are visible everywhere upon the upper surface as well as upon casts of the under surface.

Dimensions. Fragments of this species show a wide variation in size. Entire individuals are however of comparatively rare occurrence, and of these one of average size measures as follows:

	Body.	Cephalon.	Thorax.	Pygidium.
Length-----	80 mm.	24 mm.	36 mm.	20 mm.
Width -----	46 mm.	46 mm.	44 mm.	37 mm.

The largest entire individual observed has a length of 95 mm., and the smallest a length of 50 mm.

Observations. This species was originally described by Professor Amos Eaton, from a caudal shield bearing elongate, divergent spines, giving the posterior margin a crescentiform outline; and at the time of publication this was the only part of the animal known. The original of *Culymene? odontocephala*, Green, was a detached head, and was regarded as a distinct species until Mr. Conrad, in 1840, described an entire individual from the limestone at Auburn, Cayuga county, under the name of *Odontocephalus selenurus* (*loc. cit.*). The species is abundant in many outcrops of the Corniferous limestone, and appears to be restricted to this formation. Entire individuals are, however, seldom met with unless in an enrolled condition. Although very closely allied in general features and in many details, with the associated species here referred to the same sub-generic group, *Dalmanites selenurus* is distinguished by the following persistent features: (a) the denticulations on the frontal margin number *nine*; (b) the extremities of the cheeks are obtuse or produced into minute spines; (c) the caudal spines are long, slender, divergent and bent upward, with their bases distant; (d) the number of pleural annulations on the pygidium is *eight*, with indications of a ninth. The peculiar frontal ornamentation in the species of *Odontocephalus* appears to have had its inception in the marginal crenulations or thickenings on the frontal limb of *Dalmanites pleuroptyx* of the Lower Helderberg, a feature reproduced in the species *D. anchiops* of the Schoharie grit. In both these species the crenulations are longest and most conspicuous in front and disappear opposite the lateral extremities of the anterior lobe of the glabella. In like manner, in the sub-genus *CORYCEPHALUS*, the Lower Helderberg species *D. dentatus* seems to be the forerunner of *D. regalis* of the Schoharie grit, and *D. pygmæus* of the Corniferous limestone, in all of which the dentate ornamentation extends around the entire cephalic margin.

Distribution. Upper Helderberg group. Corniferous limestone: Marbletown, Ulster county; near Clarksville, Albany county; Schoharie, Schoharie county; Eastman's and other quarries, Waterville, Oneida county; Cherry Valley, Otsego county; Manlius, Onondaga county; Auburn, Cayuga county; Canandaigua, Clifton Springs and Phelps, Ontario county; Lime Rock, near LeRoy, Genesee county; Clarence, Erie county.

DALMANITES (ODONTOCEPHALUS) BIFIDUS.

PLATE XI B, FIGS. 22-25.

Dalmania bifida, HALL. Descr. New Species of Fossils, etc., p. 63. 1861.*Dalmania bifida*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 91. 1862.Compare *Dalmanites (Odontocephalus) Ægeria*, HALL?, MEEK and WORTHEN. Geology of Illinois, vol. iii, p. 417, pl. x, fig. 4 a, b, c. 1868.

THE PYGIDIUM only of this species is known, and while presenting in general features a similarity with that of *Dalmanites selenurus* it is characterized by the following persistent points of difference, viz.: (a) the axis bears *eight* annulations; (b) the pleuræ show *seven* annulations with indications of an eighth; (c) the caudal extremity is narrow and considerably produced, making the post-axial area very conspicuous; (d) the caudal spines are close together, short, stout and parallel. The *Dalmanites Ægeria?* of Meek and Worthen (*loc. cit.*) appears to be more closely allied in the character of the terminal spines of the pygidium, to *D. bifidus*. The cephalon which is referred by these authors to the same species as the pygidia, is represented in their figure as having a frontal border with a row of elongate perforations which do not extend to the margin. If this character of the specimen is accurately shown, there can be no doubt that this form is widely different from any species of *Odontocephalus* known from formations in the State of New York.

Distribution. Upper Helderberg group. Corniferous limestone: Phelps, Ontario county; Lime Rock, Genesee county; Columbus, Ohio.

DALMANITES (ODONTOCEPHALUS) ÆGERIA.

PLATE XI B, FIGS. 1-11.

Dalmania Ægeria, HALL. Descr. New Species of Fossils, etc., p. 57. 1861.*Dalmania Ægeria*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 85. 1862.*Dalmanites Ægeria*, HALL. Illustrations of Devonian Fossils, pl. xii, figs. 3-6, 8-11. 1876.

THIS species in its general features and broader details is so closely similar to *D. selenurus*, that the description of that species will serve for this one except in the following particulars: in *D. Ægeria* (a) the body is rather more slender, tapering more rapidly backward; (b) the frontal denticulations are *eleven* in number, one central and five on either side, the terminal ones standing opposite the lateral extremities of the frontal lobe of the glabella; (c) the genal angles are

produced into slender spines which extend as far as the fourth or fifth thoracic segment; (d) the axis of the pygidium bears ten distinct annulations, and upon the cast of the under surface indications of five more; (e) the pleuræ of the pygidium each bear ten annulations, the last of which is often indistinct; (f) the caudal extremity is furnished with two short, obtuse, depressed, sub-spiniform processes; (g) the surface of the pygidium, in well-preserved examples, bears a double axial row of tubercles, with a fainter row on either side, and scattered tubercles of the same strength over the pleuræ. These characters appear to be persistent and indicate a well-defined specific variation from the type of *Dalmanites selenurus*.

Distribution. The range of this species appears to be restricted to the outcrops of the Upper Helderberg limestone in the western counties of the State, where *D. selenurus* is apparently of rare occurrence, viz., Schultz's Farm, near Clarence, and Williamsville, Erie county.

DALMANITES (ODONTOCEPHALUS ?) CORONATUS.

PLATE XI B, FIGS. 12-14.

Dalmania coronata, HALL. Descr. New Species of Fossils, etc., p. 58. 1861.

Dalmania coronata, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 86. 1862.

Dalmanites coronatus, HALL. Illustrations of Devonian Fossils, pl. xii, fig. 17. 1876.

A SINGLE example of this species has been observed, and this consists of the pygidium and a portion of the thorax, both of which are closely similar to the corresponding parts in *Dalmanites selenurus*, the pygidia of the two species having the same number of axial and pleural annulations. The single specimen however has a caudal extremity free of spines but broadly emarginate, evenly rounded and bent slightly upward. There is no evidence that spines have ever existed and have been accidentally lost during the life of the animal, but the posterior margin appears to have been preserved in a normal condition. If this varietal feature prove, upon more complete knowledge, to be accompanied by a variation in the details of the head from that of *D. selenurus*, the species will afford an interesting initial form for the differences exhibited in the caudal spines of the several species of the sub-genus *Odontocephalus*.

Distribution. Upper Helderberg group. Corniferous limestone: near Auburn, Cayuga county.

CORYCEPHALUS, N. S.-G.

DALMANITES (CORYCEPHALUS) REGALIS.

PLATE XI, FIGS. 1-4.

Dalmanites regalis, HALL. Illustrations of Devonian Fossils, pl. xi. 1876.

CEPHALON large, outline lunate or semi-ovate; length (axial) to width as 1 to 2. Border narrow and vertical in front, becoming broader on the sides, and produced at the genal angles into long incurving spines, which equal in length the axial length of the shield. The margin is ornamented by a series of quadrate denticulate processes, which are short in front of the glabella, but become broader and longer on the sides. These processes are somewhat constricted toward their bases, hollow and sub-cylindrical in front, flattened at the sides. On the anterior margin they slope outward with about the same inclination as the frontal area, but at the sides they stand almost at right angles with the nearly vertical genal area. Nineteen of these processes are visible upon one-half of the most perfect example, a portion of those on the other half being broken away; this would make thirty-eight around the entire margin of the head.

Facial Sutures apparently normal, lying in deep sulci in their course over the cheeks.

Glabella sub-hexagonal; surface convex in front, depressed behind; widest across the tips of the first pair of lobes; length and width about equal. Anterior lobe large, sub-pentagonal, transverse on the anterior margin; lateral margins short and nearly parallel to the axis; postero-lateral margins rapidly approximating. Surface convex, sloping almost vertically to the anterior margin, more gently to the sides, and is nearly horizontal posteriorly. The first lateral furrows are broad and shallow, inclined backward; the first lateral lobes are elevated and nearly transverse; the second lateral furrows are distinctly impressed at their inner extremities, becoming obsolescent outward, giving the first and second lobes the appearance of coalescing for the outer one-third of their length; third lateral furrows narrow and

deep; third lateral lobes well-defined, transverse. Occipital furrow narrow, becoming wide and deep upon the cheeks; occipital ring very wide upon the axial line, but narrowing to the axial furrows and upon the cheeks.

Cheeks elevated, very convex and protuberant at the sides, constricted at their bases by the broad marginal sulcus; posterior slope abrupt. The summit about the base of the eye is grooved by a deep orbital sulcus.

Eyes lunate, elevated, moderately large; palpebrum depressed; lenses abundant.

THORAX and PYGIDIUM unknown.

Surface covered with conspicuous, often sharp, spiniform tubercles, of which the strongest appear to be one in each angle of the occipital ring and marginal sulcus, and a single row about the bases of the marginal denticulations. Upon these processes the ornamentation consists of fine granules.

Dimensions. The more perfect example of the cephalon has an axial length of 45 mm.; a length to the extremity of the cheek spines of 92 mm., and a width of 88 mm.

Observations. All that is known of this remarkable species is from the two somewhat fragmentary cephalons which were collected in the year 1832. One of these is a cast of the dorsal surface and the other preserves nearly the whole of the crust. In the peculiar denticulate character of the border, distinct from that in the sub-genus *Odontocephalus*, the species finds an ally in the minute *Dalmanites pygmæus* of the Corniferous limestone.

Distribution. Upper Helderberg group. Schoharie grit, in the town of Knox, Albany county.

DALMANITES (CORYCEPHALUS) PYGMÆUS, n. sp.

PLATE XI, FIGS. 5-8.

CEPHALON minute, outline sub-semicircular or sub-elliptical. Surface convex, abruptly depressed at the sides. Margin narrow, thickened and produced at the genal angles into long slender spines which curve inward toward the extremity.

The *facial sutures* take their origin at points on the margins nearly one-half the distance from the genal angle to the anterior border, and follow a direction normal for the genus.

Glabella convex, scarcely elevated along the axial line. Width on the frontal lobe about one-third that of the cephalon, rapidly diminishing to the occipital ring. Frontal lobe transverse, sub-rhomboidal; first glabellar furrows extending backward, each somewhat less in length than one-third the width of the glabella; second and third furrows transverse, short, not encroaching upon the mesial elevation of the glabella; first pair of glabellar lobes sub-triangular, second and third pairs smaller, sub-quadrate. Occipital furrow shallow, widening on the cheeks, and uniting at the genal angles with the marginal sulcus. Occipital ring conspicuous.

Cheeks depressed at the margin, elevated toward the ocular lobes.

Eyes anterior, elevated and relatively large.

Surface finely pustulose except upon the border and occipital ring. The lateral margins and genal spines bear a series of denticulations or short spinules, which, in one specimen, appear to exist also upon the anterior border. The occipital ring bears a strong central tubercle.

Dimensions. The two specimens of this species which have been observed have about the same size, namely:

Length	1.7 mm.
Length to apex of spines.....	3 mm.
Width.....	2.5 mm.

Observations. This little species bears a striking resemblance in its proportions and outline, incurved cheek spines and denticulated border to *Dalmanites regalis* of the Schoharie grit; in the former, however, the eyes are placed further forward, the glabellar lobes are relatively much smaller and the marginal denticulations narrower and pointed. The minute size of the specimens may indicate that they are the young of some species of whose mature form we are still ignorant, but as the only examples yet seen have the same size, it is probable they are of mature growth.

Distribution. Upper Helderberg group. Corniferous limestone; in the decomposed chert boulders, Canandaigua, Ontario county.

DALMANITES (CORYCEPHALUS) DENTATUS.

PLATE XI A, FIGS. 4-6.

Dalmanites dentata, BARRETT. Amer. Jour. Science, vol. xi, 3d Ser., p. 200, plate. 1876.

Dalmanites dentata, BARRETT. Amer. Jour. Science, vol. xii, 3d Ser., p. 70. 1876.

THIS interesting Lower Helderberg species is the earliest known form of *Dalmanites* which presents a development of the ornamentation of the frontal border of the cephalon, a feature which becomes so characteristic of many species of this genus in the Upper Helderberg. This ornamentation consists of a single row of acute denticulations, about thirty-five in number, decreasing in size toward the genal extremities, and in their shape indicating the inception of the broader, incisor-like processes of *Dalmanites regalis*, *D. pygmæus* and the group represented by *D. selenurus*. In other respects however *Dalmanites dentatus* retains the distinctive characters of the Silurian representatives of this genus, that is, forms following the type of *Dalmanites Hausmanni*, Brongniart, and in respect to features, which are not of an ornamental character, is in harmony with its associates in the Lower Helderberg formations, viz., *D. nasutus*, *D. tridens*, *D. pleuroptyx*. The distinct lobation of the glabella, and the absence of any tendency in the first and second lateral lobes to coalesce, the frontal glabellar depression, the long, terete thoracic segments, and the narrow, triangular, caudate pygidium, are all features, which in their entirety, give a pre-Devonian aspect to the species. With the opening of the Devonian age some or all of these features appear with modifications so distinct as to require the recognition of sub-divisions in the genus. A notice of *Dalmanites dentatus* is introduced in this place for purposes of comparison with the Upper Helderberg species, and on account of its frontal ornament is referred with *D. regalis* and *D. pygmæus* to the group, *Corycephalus*.

Distribution. Lower Helderberg group. In the shaly limestone at Port Jervis, Orange county; Becraft's Mountain, near Hudson, Columbia county.

[s.-g.] CHASMOPS, MCCOY. 1840.

DALMANITES (CHASMOPS) ANCHIOPS.

PLATE IX, FIGS. 1-6, 10, 12, 13; AND PLATE X, FIGS. 1-14.

Calymene anchiops, GREEN. Monog. Trilob. North Amer., p. 35. 1832.

Asaphus laticostatus, GREEN. Monog. Trilob. North Amer., p. 45. 1832.

Phacops anchiops, BURMEISTER. Organ. d. Trilob., p. 90. 1846.

Dalmania anchiops, HALL. Descr. New Species of Fossils, etc., p. 55. 1861.

Dalmania anchiops, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 83. 1862.

Dalmanites anchiops, HALL. Illustrations of Devonian Fossils, pl. ix, figs. 1, 3-6, 10, 12, 13; pl. x, figs. 6-14. 1876.

GENERAL FORM AND PROPORTIONS. Body sub-elliptical in outline, more or less produced at the extremities.

Surface depressed-convex, distinctly trilobate; lateral margins deflected and sub-parallel. Length (including caudal spine), to width as 2 to 1.

CEPHALON relatively short, length about one-third the width; outline crescentic, slightly produced on the frontal margin. Surface evenly convex. Border narrow anteriorly, bearing in front of the glabella five to seven low crenulations or undulations, which become wider and thicker upon the cheeks, and produced at the genal angles into stout and rapidly tapering spines, which reach the third thoracic segment. Doublure wide and deep at the genal angles, narrowing at the lateral margins, and extending into a relatively narrow epistoma in front.

Facial Sutures normal.

Glabella elongate sub-pentagonal, widest anteriorly, depressed-convex; bounded on all sides by low sulci. Anterior lobe large, sub-rhomboidal; first pair of lateral furrows long, inclined backward; second pair obsolete, except at their proximal extremities, where they appear upon the cast as two deep pits; third pair transverse or inclined slightly forward, almost obsolete at their distal extremities; first and second glabellar lobes coalescent, forming a single pair of large convex lobes, whose elevation exceeds that of the frontal lobe; third glabellar lobes narrow, depressed and relatively inconspicuous. Occipital furrow narrow on the axis, becoming

broad and deeper on the cheeks, occipital ring prominent and bearing short and sharp central spine; narrowing to the axial furrows, thence rapidly widening to the genal spines.

Eyes lunate, large and elevated considerably above the summit of the glabella, and closely appressed against its coalescent first and second lobes. Visual surface with numerous corneal lenses, the single specimen (a young individual) in which they may be enumerated, showing eighteen rows, counting diagonally from the lower posterior margin, and one hundred and ninety-two lenses. Palpebrum scarcely prominent; palpebral lobe depressed and sloping abruptly to the narrow and elevated palpebral furrow.

Cheeks sloping abruptly from the ocular node to the thickened and somewhat flattened margin. A deep sinus, which is stronger in old individuals, bounds the ocular node and flattens the subjacent portion of the cheek.

THORAX sub-rectangular, length to width as 4 to 5. Surface depressed-convex.

Axis relatively narrow, widest at about the fifth segment, thence regularly tapering to the pygidium.

Pleuræ relatively broad, flat for about one-half their width and thence rounded to the lateral margins.

Each segment has a slight forward curve along the axial line, being sulcate on the pleuræ and having the anterior limb abbreviated by the beveled planes of articulation.

PYGIDIUM sub-triangular, depressed-convex or flattened. Posterior extremity produced into a stout, upwardly curved spine, usually short, but sometimes equaling the pygidium in length. Length, including the caudal spine, equal to the width.

Axis having less than one-third the width of the shield on the anterior extremity, regularly tapering to an obtuse, broadly rounded termination, and composed of from nine to fourteen broad, flat, transverse annulations.

Pleuræ broad and rounding more or less abruptly to the margins, bearing eight or nine wide, flattened annulations, which become obsolete just within the border. Wherever the crust is retained the annulations are seen to be

faintly grooved near their distal extremities, but in the usual condition of preservation as casts of the lower surface, the tendency to duplicature is not often apparent. Doublure narrow on the sides, rapidly widening toward the posterior spine, where it extends forward as far as the termination of the axis. The caudal spine is not infrequently broken away from the margin of the doublure, giving the caudal shield a semicircular outline.

Surface Ornamentation. The surface of the cephalon, within the border and the occipital ring, is covered by strong tubercles, which are closely disposed over the cheeks and more scattered on the glabella. In old individuals these tubercles extend to the margin, and the orbital ridge of the cheek becomes covered with fine granulations. The surface of the thorax and pygidium is smooth or finely granulose. Pygidia of young individuals show low nodes or tubercles upon the pleuræ, apparently arranged in three or four oblique rows with indications of similar ornamentation upon the axis.

Dimensions. The only specimen observed which retains the parts in conjunction affords the following dimensions, proper allowance being made for the caudal spine which is lost.

	Body.	Cephalon.	Thorax.	Pygidium.
Length -----	103 mm.	25 mm.	40 mm.	38 mm.
Width -----	49 mm.	49 mm.	50 mm.	39 mm.

The smallest head-shield observed has a length of 9 mm., and a width of 16 mm., and the largest, which can safely be referred to the normal form of the species, a length of 35 mm., and a width of 70 mm. Pygidia vary in size from a length and width of 15 mm., to a length and width of 110 mm.

VARIATIONS. Large cephalic shields associated with *Dalmanites anchiops* and bearing all the essential specific features of the normal form, afford some important varietal differences. One series of these variations has been already described under the first of the following designations.

DALMANITES (CHASMOPS) ANCHIOPS, var. ARMATUS.

PLATE IX, FIGS. 7-9.

Phacops anchiops, HALL. Foster and Whitney's Geol. Rept. Lake Superior, p. 124. 1851.*Dalmania anchiops*, var. *armata*, HALL. Descr. New Species of Fossils, etc., p. 56. 1861.*Dalmania anchiops*, var. *armata*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 84. 1862.*Dalmanites anchiops*, var. *armata*, HALL. Illustrations of Devonian Fossils, pl. ix, figs. 2, 7, 8. 1876.

THE points of variation in these specimens may be thus summarized: (a) the spine upon the occipital ring is very long, round and very stout toward the base. Its length is sometimes quite equal to the length of the glabella, while in the typical forms of the species the spine is not more than one-third or one-fourth of that length; (b) the genal spines are inconspicuous or obsolete; (c) the surface, as shown in casts of the exterior, is free from tubercles or other ornamentation; (d) the eyes appear to be less elevated and bear fewer corneal lenses.

As the cephalons of this character have not been found in conjunction with the other parts of the animal, it is impossible to determine whether the thoraces and pygidia belonging thereto, also varied from the type, since none of these parts have been seen which show any variation from the normal form. The largest cephalon observed has a length of 80 mm., and a width of 116 mm., indicating an animal upwards of 200 mm. in length when entire.

DALMANITES ANCHIOPS, var. SOBRINUS, n. var.

PLATE IX, FIG. 11.

Dalmanites, n. sp.? HALL. Illustrations of Devonian Fossils, pl. ix, fig. 11. 1876.

A SINGLE CEPHALON from the Schoharie grit has the general proportions of the species, but shows a variation from the foregoing in the following particulars, viz.: (a) the glabella is much more convex, and projects slightly beyond the frontal margin, (b) the genal angles appear to be without spines, (c) the occipital ring bears no spine, (d) the facial suture, where it crosses the summit of the cheek, lies in a much deeper sulcus. The original is a cast of the lower surface and is somewhat imperfect, but its features seem to be distinctly varietal.

Observations. The *Calymene macrophthalma* of Brongniart (Crustacés Fossiles, p. 15, pl. i, figs. 4, 5. 1822) embraced much heterogeneous material, and included a specimen which is now referred to *Dalmanites anchiops*. Two of the diverse forms mentioned by Brongniart were from unknown localities in America; one of these was a plaster cast made from the specimen which subsequently served as the type of *Asaphus laticostatus* of Green. Of the others, one form (*tab. cit.*, fig. 5), is the *Calymene macrophthalma* of Murchison, *Phacops Brongniartii* of Portlock, and the *Phacops latifrons* of Burmeister; the other is the *Phacops macrophthalmus* of Burmeister. The *Asaphus Wetherelli*, Green, which has been regarded by Burmeister (Organiz. der Trilob., p. 90) as probably a young individual of *Phacops anchiops*, was undoubtedly an imperfect specimen of *Dalmanites limulurus*, Green, from the Niagara group.

Dalmanites anchiops and its varieties show a divergence from typical forms of the genus *Dalmanites* (*D. Hausmanni*, *D. pleuroptyx*, etc.), in the coalescence of the first and second pairs of the glabellar lobes, a feature which places it under the group *Chasmops* of McCoy. In the typical species of *Chasmops* (*Phacops conicophthalmus*, Sars and Boeck; *Phacops macrurus*, Sjögren, these united lobes are large, and upon the dorsal surface give no apparent evidence of the obsolescent second glabellar furrows. *D. anchiops* in its usual condition of preservation as casts of the inner surface of the test, shows traces of these furrows, but when the crust is retained, or upon casts of the dorsal surface they are quite obsolete. The small basal or third glabellar lobes are usually quite distinctly separated from those in front, but occasionally show a tendency to coalesce with the others and form a single lobe on each side. In some species of *Dalmanites* (*Phacops Lopatini*, Schmidt, and *Phacops Sibericus*, Schmidt), this coalescence is complete, and for such variations the sub-generic term *Monorakos* has been recently proposed (Schmidt, Bull. de l'acad. imp. de sciences de St. Petersb., vol. xii, p. 417. 1886).

Distribution. *Dalmanites (Chasmops) anchiops*: Oriskany sandstone, Walpole, Province of Ontario, in association with *Phacops cristata*, var. *pipa*, *Streptorhynchus (Orthis) hipparionyx*, *Spirifera arrecta*, *Rensselæria ovoides*. Upper Helderberg group. Abundant in the Schoharie grit, in the town of Knox and vicinity

of Clarksville, Albany county; and at Schoharie, Schoharie county. In the Corniferous limestone, on Schultz's Farm, near Clarence, Erie county; Port Colborne, Province of Ontario; Falls of the Ohio. *Dalmanites* (*Chasmops*) *anchiops*, varieties *armatus* and *sobrinus*: Schoharie grit, Albany and Schoharie counties. The variety *armatus* has also been found in the Upper Helderberg limestones at Arched Rock, Mackinac, Michigan.

DALMANITES (CHASMOPS) CALYPSO.

PLATE XI A, FIGS. 19-22.

Dalmania Calypso, HALL. Descrip. New Species of Fossils, etc., p. 61. 1861.

Dalmania Calypso, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 89. 1862.

Dalmanites Calypso, HALL. Illustrations of Devonian Fossils, pl. xiii, figs. 1, 2. 1876.

GENERAL FORM AND PROPORTIONS. Outline elongate-elliptical, posteriorly sub-acuminate; length to width as 2 to 1.

Surface convex, axially elevated, sub-equally trilobate.

CEPHALON. Outline sub-semi-circular, length to width as 1 to 2. Border thin, moderately broad, flattened on the anterior limb, depressed at the sides, and produced at the genal angles into conspicuous spines. Surface convex, somewhat flattened axially.

Facial Sutures taking their origin on the lateral margins just in front of the genal spines, thence following a direction normal for this genus. Upon the free cheeks they lie in a broad, conspicuous sulcus, which unites with the sulcus at the base of the eye and becomes obsolete upon the margin.

Glabella elongate-sub-pentagonal, widest anteriorly; length and width equal. Surface gently rounded, depressed above. Anterior or frontal lobe large, transversely sub-elliptical or sub-rhomboidal; first pair of lateral furrows strong, inclined posteriorly and passing three-fourths the distance across the glabella; first and second glabellar lobes coalescing, reniform, elevated at their outer margins; second lateral furrows obsolete except at their proximal extremities, where they are represented by two deep depressions or pits; third glabellar lobes inconspicuous, transverse and separated from the coalesced first and second lobes by the faint third pair of lateral furrows.

The axial portion of the glabella between the lateral lobes is somewhat elevated, terminating in a narrow annulation formed by the coalescence of this part with the third pair of lobes. Occipital furrow narrow; occipital ring broad and strongly arched.

Cheeks grooved and slightly flattened beneath the orbital ridge, falling away thence somewhat abruptly to the margins. The regular convexity of their surface is interrupted only by the sutural grooves.

Eyes large, closely appressed to the glabella, and more elevated than any other portion of the cephalon. Visual surface lunate, lenses abundant. Palpebrum crescentic, narrow; palpebral lobe sloping rapidly from the coalesced first and second lobes of the glabella, from which it is separated by a sharp furrow.

THORAX. Outline sub-quadrate, lateral margins slowly approximating. Length and width equal. Surface conspicuously and sub-equally trilobate.

Axis strongly arched, relatively narrow on the anterior margin, widening to the fourth or fifth segment, thence narrowing to the pygidium; segments transverse, or with a slight double curve, posteriorly near the margins and anteriorly over the axial line.

Pleurae flattened above for one-half their width, and abruptly deflected at the sides. Each segment is strongly elevated near the axial furrow, and conspicuously sulcate, the anterior limb, at the fulcrum or line of geniculation, being as broad as the posterior limb. The former becomes obsolete upon the lateral slope where the planes of articulation are broad.

PYGIDIUM. Outline sub-triangular, sub-equilateral; width slightly greater than the length. Surface convex anteriorly, angulated on the axial line, and on the posterior portion sloping abruptly from this line to the margins.

Axis arched, equal in width to one-fourth the width of the shield, sides appressed and sharply angulated upon the median line; evenly tapering to a termination, beyond which an angulated ridge is continued to the margin; bearing twelve annulations which are low, somewhat flattened and transverse, each one with a short, laterally compressed spine or spiniform node.

The *pleuræ* are moderately broad and bear eleven or twelve low and flat annulations, which are grooved by fine impressed lines, and become obsolete upon the wide and slightly thickened border.

HYPOSTOMA. Elongate, sub-triangular; width on the anterior margin equal to the length. Antero-lateral angles broadly auriculate; lateral margins incurved and rapidly approximating. The posterior margin apparently bears five minute spines, one situated medially, and two on either side, but the only specimen observed is somewhat broken at this part, and its character cannot be satisfactorily determined. Margins thickened and sharply deflected. Centrum low, depressed-convex. Posterior sulcus conspicuous; postero-lateral pits moderately strong and elongate.

Surface Ornamentation. The glabella is covered with moderately strong and evenly disposed tubercles which become obscure or obsolete upon the cheeks and margin. The frontal lobe of the glabella bears a circular pit on the axial line just back of its centre. The segments of the thorax appear faintly pustulose upon the axis; otherwise the surface is smooth or minutely granulose.

Dimensions. The single entire individual known measures as follows.

	Body.	Cephalon.	Thorax.	Pygidium.	Hypostoma.
Length -----	80 mm.	23 mm.	32 mm.	25 mm.	18 mm.
Width -----	44 mm.	44 mm.	41 mm.	30 mm.	18 mm.

Observations. The pygidium of *Dalmanites Calypso* shows strong points of similarity with that of *D. Erina*. They differ, however, in these respects: (a) the type of *D. Erina* is faintly nodose along the axial line, but not angulate or spinose, (b) the shield is more depressed, (c) the outline is a broader curve, and (d) the border wider and usually somewhat unsymmetrical. It may eventually become necessary, with a more complete knowledge of the latter species, to unite the two under one designation, but with our present material it seems desirable to retain the species tentatively as distinct.

Distribution. Upper Helderberg group. Corniferous limestone: Sandusky, Ohio; Falls of the Ohio, Ky.; Schoharie, N. Y.

DALMANITES (CHASMOPS ?) ERINA.

PLATE XI A, FIGS. 16-18.

Dalmania Erina, HALL. DESC. New Species of Fossils, etc., p. 62. 1861.*Dalmania Erina*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 90. 1862.*Dalmanites Erina*, HALL. Illustrations of Devonian Fossils, pl. xiii, figs. 3, 4. 1876.

THE PYGIDIUM of this species only has been observed. Its outline is paraboloid. Surface depressed-convex.

Axis less in width than one-third the width of the shield, elevated or sub-angular along the median line, evenly tapering to a termination just within the margin; bearing twelve to fourteen transverse or retrally curved annulations which are thickened or sub-nodose on the axial line.

Pleuræ depressed in an even curve to the margins; composed of eleven or twelve broad, low annulations, separated by narrow sulci and becoming obsolete upon the broad border. Each annulation is grooved by a fine impressed line. In casts of the lower surface the lines upon the annulations, the sulci between them and the nodes upon the axial line appear much stronger than upon the test. Border broad, thickened, sometimes widening irregularly toward the posterior extremity. From the termination of the axis a low but sharply angled ridge extends to the posterior margin. Surface minutely granulose, the granulations being more conspicuous upon the border.

The differences between this species and *Dalmanites Calypso* are pointed out in the description of the latter species.

Dimensions. An average specimen measures 18 mm. in length and 28 mm. in width; the largest specimen observed attaining a length of 31 mm., and a width of 40 mm.

Distribution. Upper Helderberg group. Corniferous limestone: Eastman's quarry, Waterville, Oneida county; Canandaigua, Ontario county; LeRoy and Stafford, Genesee county; Williamsville and Clarence, Erie county.

DALMANITES (CHASMOPS) MACROPS.

PLATE XI B, FIGS. 14, 15.

Dalmania macrops, HALL. Descr. New Species of Fossils, etc., p. 59. 1861.*Dalmania macrops*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 87. 1862.

———, ———, ———. Illustration of Devonian Fossils, pl. xiii, figs. 9, 10. 1876.

(Not mentioned in the explanation of the plate).

A PORTION of the CEPHALON is the only part of this species known. It is lunate in outline, border narrow and thin.

Glabella long, equaling four-fifths the length of the shield. Frontal lobe sub-rhomboidal, one-third wider than long; first pair of lateral furrows long, inclined backward and nearly meeting; second lateral furrows obsolete except at their proximal extremities; third lateral furrows inconspicuous, inclined a little forward. The first and second glabellar lobes are coalesced and somewhat more elevated than the highest point of the frontal lobe. The third pair of lobes is inconspicuous and transverse. Occipital furrow narrow and shallow; occipital ring broad, rounded and strongly arched.

Eyes very large, elevated above any other portion of the cephalon. Visual surface measuring 9 mm. in height, and bearing about 500 lenses. Palpebrum scarcely prominent; palpebral lobe relatively small and closely appressed to the compound middle lobe of the glabella. Orbital sulcus distinct.

The *Cheeks* appear to have been relatively small and depressed or flattened near the margin.

Surface finely pustulose upon the glabella, smooth or granulose upon the cheeks and occipital ring.

The single specimen by which this species is represented has a length of 20 mm., and a width of 38 mm., and presents about the characters which, from comparison with the species *Dalmanites Calypso*, might be expected in the cephalon of *D. Erina*. Whether the latter species, which is now known only from its pygidia, should be united with *D. macrops* must be left to a more complete knowledge of these fossils.

Distribution. Upper Helderberg group. Corniferous limestone: Schoharie.

ACIDASPIDÆ.

ACIDASPIS, MURCHISON. 1839.

ACIDASPIS CALLICERA, n. sp.

PLATE XVI B, FIGS. 1-13.

GENERAL FORM AND OUTLINE. Body ovate; anterior margin slightly transverse; lateral margins evenly converging from the base of the cephalon.

Surface convex along the axis, depressed on the pleuræ. Length to width as 4 to 3.

CEPHALON transversely sub-rectangular, anterior and posterior margins sub-parallel, lateral margins divergent at the genal angles. Width equal to rather more than twice the length.

Facial Sutures beginning on the posterior margin, just within the genal angles, passing inward and forward over the eye-lobes, thence forward, converging slightly to the frontal margin.

Glabella sub-quadrate, frontal lobe elongate, convex, elevated, extending from the frontal margin to the occipital furrow; sides parallel. Lateral lobes in two pairs, pyriform, the posterior pair the larger, and both separated from the frontal lobe by elevated furrows. The lateral lobes are included by a ridge which extends from the anterior limb of the frontal lobe to the eye and thence to the axial furrows. Occipital furrow narrow, becoming rapidly obsolete upon the cheeks. Occipital ring broad, arched and bearing a short central spine.

Cheeks broad, slightly concave and sloping abruptly from the elevated eye-lobes. Border moderately thickened and produced at the genal angles into long, slightly incurved, diverging spines; above this the margin is fringed with short spines which are reduced to mere denticulations in front.

Eyes small, remarkably elevated. Visual surface lunate, sub-semi-cylindrical, homo-corneal.

THORAX convex, arched upon the axis, depressed and flattened upon the pleuræ. Composed of nine segments.

Axis having less than one-third the width of the body; margins sub-parallel.

Upon the *pleuræ* the elevated limb of each segment is produced into a long marginal spine, sometimes equaling the width of the thorax. In front of this spine, upon each segment, is a short, bifurcate marginal spine, which is visible only when the posterior spine is broken away.

PYGIDIUM short, lunate. Anterior margin straight.

Axis abruptly terminating just within the posterior margin in two nodes or tubercles. In addition to the strong articulating ring, it bears a single annulation which extends across the pleuræ and is produced at the margin into long spines. Anterior to this pair of spines are three pairs, of which the first is shortest, and belongs to the articulating ring. There is also a single pair on the terminal border, making in all ten marginal spines upon the pygidium.

Pleuræ flat.

Surface ornamented with tubercles, which are crowded upon the lobes of the glabella, and irregularly disposed upon the cheeks. The segments of the thorax each bear a single row of strong tubercles, there being from two to four longitudinal rows upon the axis, and two longitudinal rows upon the pleuræ. Upon the pygidium there are tubercles on the annulation, at the bases of the marginal spines, and at the termination of the axis.

Dimensions. The smallest individual observed has approximately a length of 10 mm., a width of 6.5 mm., and the largest a length of 21 mm. and a width of 14 mm.

Observations. There is a similarity in the more general features between this species and *Acidaspis tuberculatus*, Conrad, from the Lower Helderberg.

They may, however, be distinguished by the strong occipital spine, the stouter marginal spines, and the more depressed and broader glabella in the latter species.

Distribution. Upper Helderberg group. Schoharie grit: Near Clarksville, Albany county; Corniferous limestone: Camillus, Onondaga county; in the decomposed chert boulders, Canandaigua, Ontario county; Cayuga, Province of Ontario.

ACIDASPIS, sp.

PLATE XVI B, FIG. 14.

A SINGLE large PYGIDIUM from the decomposed chert at Port Colborne, Ontario, is shorter than in the foregoing species, the axis more arched, with a very strong articulating ring and a single annulation which becomes obsolete on the flat pleuræ, but the bases of two stout marginal spines represent its termination on the postero-lateral border. The rest of the margin appears to be fringed with small, irregularly disposed spines and spinose tubercles. The termination of the axis is less abrupt than in *A. callicera* and without the characteristic tubercles of that species. The specimen has a length of 9 mm., and a width of 21 mm.

ACIDASPIS ROMINGERI, n. sp.

PLATE XVI B, FIGS. 15-18.

PYGIDIUM comparatively large; surface very convex; anterior margin transverse.

Axis conspicuous, short, unsegmented, bullate; outline circular; articulating ring broken away, the transverse furrow behind this ring being shallow and narrow. The posterior portion of the axis is sub-spherical, slightly constricted about the base and flanked on the antero-lateral margins by two elongate nodes. The longitudinal furrows are conspicuous, being abruptly depressed near their anterior terminations. Border broad, depressed about the axis, flattened toward the margin, bearing twelve long spines. Of these, ten are marginal, the third spine on either side being very much longer than the others and attaining a length equal to more than five times the length of

the axis. The three pairs of lateral spines are curved regularly backward, while the four posterior spines appear to have been straight, and but slightly divergent. Within the margin, and just above the bases of the long third pair of spines, was another pair which, judging from the diameter of the broken base, must have had fully the length of the third pair. These spines were inclined at an angle of nearly forty-five degrees to the surface of the border. The actual length attained by all these spines is not indicated except for the third pair; judging, however, from their broken sections it is evident that they were of very considerable length. Across the posterior border the bases of the spines are continued as low ridges to the edge of the axis.

Surface Ornamentation. The bulbiform termination of the axis is covered with closely set pustules of uniform size. The anterior furrow and the border are minutely granulose, and the surface of the spines is marked by elevated, frequently interrupted striæ, which converge at an acute angle on the upper surface of the spine; towards the extremity of the spines these lines become stronger and much rounded, giving the surface a coarsely ridged appearance.

Dimensions. The single specimen observed has a width across the anterior margin of 9 mm., a length of 8.5 mm. to the posterior margin, and of 33 mm. axially, as far as the apex of the third pair of spines.

Observations. This extravagant form of *Acidaspis* is the only member of the genus as yet known in America from rocks younger than the Upper Helderberg limestone. The great length of the caudal spines is equaled by no other known species of the genus and is approximated only by *Acidaspis Dufresnoyi*, Barrande.*

Distribution. Hamilton group. Little Traverse Bay, Michigan.

* We are indebted to Dr. C. Rominger, of Ann Arbor, Michigan, for the discovery of this species, and through his favor the specimen has been made accessible for study and description.

LICHADÆ.

LICHAS, DALMAN. 1826.

[s.-g.] TERATASPIS, HALL. 1863.

LICHAS (TERATASPIS) GRANDIS.

PLATE XVII, FIGS. 1-6; PLATE XVIII, FIGS. 1, 2; PLATE XIX, FIGS. 1-7.

Lichas grandis, HALL. Descriptions New Species of Fossils, etc., p. 82. 1861.*Lichas grandis*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 110. 1862.*Lichas grandis*, sub-genus? *Terataspis*, HALL. Sixteenth Rept. N. Y. State Cab. Nat. Hist., p. 223. 1863.*Lichas superbus*, BILLINGS. Canadian Naturalist and Geologist, vol. vii, No. 4, p. 239. 1875.*Acidaspis (Terataspis) grandis*, HALL. Illustrations of Devonian Fossils, pls. xvii, xviii. 1876.

CEPHALON very prominent in front, abruptly depressed behind; length to width between the eyes as 5 to 4; to greatest width as 5 to 7. Frontal border broad, flat and sloping outward; margin not thickened.

The *facial sutures* begin on the posterior margin a short distance outside the axial furrows, and slope obliquely forward, curving abruptly and passing thence directly inward to the eye; thence directed outward in a broad curve to the anterior margin.

Glabella sub-quadrate in general outline; anterior lobe ovoid or ellipsoid, extremely prominent, tumid, evenly convex and strongly constricted about the base; length equal to five-eighths the length of the glabella; length to width as 6 to 5. Longitudinal furrows very broad and deep, merging at the posterior margin of the frontal lobe, and forming a broad, median depression, which narrows for a short distance and widens thence to the occipital ring. The two lateral lobes are broad, directed posteriorly, and at the summit each one is produced into a conspicuous compound spine, the inner branch of which is the longer, reaching beyond the height of the anterior lobe, and projecting over the occipital ring. These lateral lobes may be regarded as the coalesced first and second pairs, the third pair being obsolete or indicated only by a faint elevation of the crust near the occipital ring, crowned by a few strong

tubercles. There appears to have been also a strong spine near the ocular node just outside the lateral lobes. The occipital furrow is broad and shallow over the axis, deeper along the abruptly sloping sides of the cheeks; the occipital ring is very broad, depressed-convex, with a gentle anterior and an abrupt posterior slope, and narrows rapidly towards the axial furrows; on its posterior edge it bears a row of from six to eight strong clavate tubercles.

Cheeks separated from the lateral lobes by a faint furrow, which leaves the position of the eyes elevated, and gives to the fixed portions of the cheeks an abrupt anterior and posterior slope. The free portion, as far as can be judged from two fragments, was somewhat constricted or narrowed beyond the terminations of the facial sutures, and its posterior margin carried a series of more or less irregular, tubercled spines. The genal extremities were acute and attenuate, and the anterior margin regular.

The *surface* of the cephalon is covered with coarse tubercles which are largest on the posterior extremity of the anterior lobe, but are almost all absent on the median depression behind this lobe, and are obsolete on the constricting furrow about its base.

THORAX. The character of this part of the animal is known only from two impressions, one of a segment of a small individual, the other the axial arch of the segment of a large example. The segment shows a relatively wide and strongly arched axis and narrow pleuræ deflected at about the middle of their length. The axial arch bears two strong, straight, divergent spines, reaching a height equal to the width of the axis, and apparently directed posteriorly.

PYGIDIUM semi-circular in general outline, wider than long; strongly spinose on the lateral and posterior margins; anterior margin nearly transverse.

Axis relatively wide, being about one-third as wide as the shield on the anterior margin, and tapering rapidly to an elevated termination at a point about half way across the pygidium. It bears two annulations, behind which are situated a pair of conspicuous tubercles, and between this point

and the apex of the axis are three linear, transverse furrows. The apex appears to have borne a strong, probably spiniform, tubercle.

The *pleuræ* bear three broad, lobe-like annulations, which become obsolete before reaching the margin, and probably each one bears a conspicuous tubercle at its summit. They are strongly sulcate, the anterior limb being very narrow, and the posterior limb broad and inflated toward the margin. The post-axial area is elevated above the margin, though depressed below the *pleuræ* and axis. The border is broad and bears a row of eight marginal spines, one at the termination of each of the three annulations, and two on the posterior limb. These spines are very long, increasing in length posteriorly, incurved towards the tips, and covered on the upper surface and the margins with narrow, acute spinules. The entire surface of the pygidium was covered with strong pustules, the larger of which appear to have been acute at the apex. A very small pygidium, which is referred with some doubt to this species, bears narrow annulations which extend to the margin, rendering the border obscure or obsolete. This feature may eventually prove to be of specific importance. The pygidium is known only from imperfect specimens, the most complete example showing nearly the entire under surface of the shield and portions of several of the spines.

The type specimen of *Lichas superbus*, Billings, retains a large portion of the pygidium, and as this occurs in juxtaposition with a cephalon of *Lichas grandis*, little doubt can remain that the pygidia and cephala there described belonged to the same species.

Dimensions. A very large fragment of a cephalon has the following dimensions: length, 110 mm.; width between the eyes, 82 mm.; width along the occipital ring to the termination of the facial suture, 120 mm. Fragments of smaller individuals have also been found. A single small thoracic segment measures 51 mm. transversely, and the spines on its axis are 10 mm. in length. A large pygidium has a length of 119 mm. to the apex of the posterior spines, and probably had a width of 135 mm., to the tips of the first lateral spines. The smallest pygidium observed is 18 mm in length. That the individuals of this species sometimes reached colossal dimensions

is shown by the size of some of the fragments of the head, for in the genus *Lichas* the cephalon is usually very short in comparison with the length of the thorax and pygidium. An appearance of considerable length in this part is sometimes produced by a very protuberant and elevated glabella as in *Lichas celorhin* and others; but it is found on a careful comparison of the dimensions of the head, thorax and pygidium, in the rare instances of species in which the parts have been preserved in juxtaposition (*Lichas Boltoni*, *L. palmata*, *L. scabra*, *L. gibbus*), that their proportional length is as 1 to 1.6 to 1 (not inclusive of spines); and upon this basis a restoration of *Lichas grandis* from the very large fragment of a cephalon figured on plate xviii, indicates that the entire length of the animal to the extremity of the tail-spines would have been about 480 mm., or upwards of 19 inches. This estimate is in harmony with the relative proportions of the cephalon and pygidium furnished by the type specimen of *Lichas superbus*, Billings. In the description of *L. superbus* (Billings, *loc. cit.*), mention is made of a fragment of the cephalon in which the frontal lobe has a length of three inches. This would be one-third larger than the frontal lobe in the individual here restored, and if the increase in the size of this part was accompanied by the same relative increase in the length of the animal, this fragment belonged to an individual probably not less than two feet in length, a size unequaled by that of any other known trilobite.

Observations. The marked prominence of the anterior lobe and the somewhat suppressed lateral lobes of this species suggest a similarity to forms of the genus *Acidaspis*, and this feature, together with the striking spinose character of the pygidium, led to the temporary reference of the species to that genus in the Illustrations of Devonian Fossils (*loc. cit.*). The character of the subdivisions of the glabella appears, however, to be more in harmony with those of *Lichas*, and similar in general features to those of *L. Eriopis*, *L. hylæus*, *L. gryps* and *L. dracon*. The pygidium of *Lichas*, though usually with but three pairs of spines, occasionally has four (*L. Eriopis*, *L. ptyonurus*), while in *Acidaspis* the pygidium is very short, with two long postero-lateral spines and a fringe of shorter spines, and is not subject to much variation.

The type of *Lichas superbus*, Billings, is a specimen of average dimensions, preserving both cephalon and pygidium, and agrees in every essential feature with the type of *Lichas grandis*.

Distribution. Upper Helderberg group. Schoharie grit: Schoharie, Schoharie county; Thompson's Lake, Knox and near Clarksville, Albany county. Upper Helderberg limestone: Cayuga, Province of Ontario.

[s.-g.] CONOLICHAS, DAMES. 1877.

LICHAS (CONOLICHAS) HISPIDUS, n. sp.

PLATE XIX A, FIGS. 14, 17, 18.

Acidaspis (Terataspis) Eriopis, HALL. Illustrations of Devonian Fossils, pl. xix, figs. 8, 9. 1876.

THE PYGIDIUM, which is the only portion of the animal observed, presents in general proportions, a close similarity to pygidia referred to the species *Lichas Eriopis*. The marginal spines in *L. hispidus* are shorter and stouter, the terminal spine or lobe quite small but distinct, and the axial node elevated, but without a spine; the pleuræ are covered with rows of coarse and fine tubercles, without spines. In a single specimen the axis bears as many as four transverse rows of tubercles, representing annulations. The type specimen of this species is from the Schoharie grit, and in the Illustrations of Devonian Fossils (*loc. cit.*), was provisionally referred to *L. Eriopis*. The finding of pygidia in the Upper Helderberg limestone, similar in all the above particulars, seems to establish this form as a distinct variation, which may be tentatively accorded a specific value.

Dimensions. In two specimens the length is to the width as 9 to 16 mm. and as 18 to 30 mm.

Distribution. Upper Helderberg group. Schoharie grit: near Clarksville, Albany county; Corniferous limestone: LeRoy, Genesee county.

LICHAS (CONOLICHAS) ERIOPIS.

PLATE XIX A, FIGS. 2-13, 15, 16.

Lichas armatus, HALL. Descr. New Species of Fossils, etc., p. 81. 1861.*Lichas armatus*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 109. 1862.*Lichas Eriopis*, HALL. Sixteenth Rept. N. Y. State Cab. Nat. Hist., p. 226. 1863.*Acidaspis (Terataspis) Eriopis*, HALL. Illustrations of Devonian Fossils, pl. xix, figs. 4-7, 10, 11. 1876.*Acidaspis?* (*Terataspis*) sp. ?, HALL. Illustrations of Devonian Fossils, pl. xix, fig. 12. 1876.

CEPHALON one-half as long as wide; intra-sutural portion sub-quadrate.

Glabella as broad as long; frontal lobe elongate-pyriform, anterior half convex, tumid and sloping abruptly to the frontal margin, slightly constricted at one-half its length and abruptly depressed upon the posterior half to the occipital furrow. The first and second pairs of lateral lobes are coalesced by the obsolescence of the second pair of lateral furrows, forming a single pair of strong, elevated, elongate lobes, reaching from the margin to the occipital furrow, and most convex posteriorly. Third glabellar lobes obsolete. The longitudinal furrow formed by the union of the first and third pair of transverse furrows is broad and deep, the marginal and palpebral furrows less conspicuous. Occipital furrow relatively narrow; occipital ring broad, and showing evidence of having borne two strong central spines.

Facial sutures normal.

Cheeks abruptly deflected beneath the orbital lobe to the occipital ring; the free portions slender, narrowing rapidly to the genal angles and thence produced into long incurving spines.

Eyes prominent, crescentic; palpebrum relatively large; palpebral lobe inconspicuous.

THORAX not observed.

PYGIDIA found in association with the head above described, and bearing the following characters, are referred to this species: Outline nearly semicircular. Axis having a width, on the anterior margin, equal to one-third the width of the shield; convex, short, becoming rapidly obsolete beyond its most elevated point. It bears in addition to the well-marked articulating ring, one low annulation and traces of a second. Behind this is a strong, erect spine,

slightly curved backward toward the apex, and in a single specimen, having a length equal to one-half the greatest width of the pygidium. The pleuræ bear three double annulations, the anterior limb of each being small, the posterior broader and bearing on its most elevated portion a spine, similar in length and curvature to that upon the axis. The post-axial area is covered with scattered tubercles. Upon the margin, at the termination of each annulation, is a short, slender spine, making six on the sides, with two on the posterior limbus, and a very short inconspicuous lobe or spine at the termination of the axis.

Surface Ornamentation. Upon the cephalon the surface of the glabella is covered with tubercles, which are fine and thickly set on the anterior portion of the frontal lobe, scattered and stronger on its more elevated portion, and a single pair near the summit of the posterior slope may have been spiniform; toward the occipital furrow the tubercles become scattered and obsolete. The lateral lobes each bear a strong spiniform (?) tubercle near their most elevated point. Upon the cheeks the tubercles become acute and are arranged in rows parallel to the margins and the orbital node. The surface of these tubercles, of the genal spines, and of the cheek itself, between the spine-bases, is finely granulose. Upon the pygidium, besides the strong spines already described, are fine tubercles arranged regularly on the annulations and scattered without order over the post-axial area.

Dimensions. An average specimen measures:

	Cephalon.	Pygidium.
Length -----	19 mm.	13 mm.
Width -----	19 mm. (between the eyes.)	19 mm.

A pygidium measuring 13 mm. in width bears a central spine 6.5 mm. long.

Observations. The cephalon of this species, in the contour and elevation of the frontal and lateral lobes of the glabella, presents an agreement with the forms of *Lichas* referred by Dames (Zeitsch. d. deutsch. geol. Gesellsch, vol. xxix, p. 806. 1877), and Schmidt (Mem. de l'Acad. imp. d. Sciences d. St.

Petersb., 7th Ser., vol. xxxiii, No. 1, p. 42. 1885), to the sub-genus *Conolichas*, Dames, of which *L. triconica*, Dames, and *L. Schmidt*, Dames, are the types. In all the species enumerated by these authors, the third pair of lateral lobes is present in varying degrees of development. In *L. Eriopis*, however, it appears to be obsolete or represented only by a pair of tubercles; but as the general form of the head is the feature upon which the sub-genus is based, the obsolescence of these lobes will not vitiate the reference of the species to this group.

Distribution. Upper Helderberg group. Corniferous limestone: Schoharie, Schoharie county; in the boulders of decomposed chert, Canandaigua, Ontario county.

IN order to correct, and to a certain degree, to complete the original determinations of the species of *Lichas* occurring in the Lower Helderberg formations, a few observations are here introduced.

LICHAS (CONOLICHAS) PUSTULOSUS.

PLATE XIX, FIGS. 8, 10, 11.

Lichas pustulosus, HALL. Pal. N. Y., vol. iii, p. 366, pl. lxxvii, figs. 9, 10; pl. lxxviii, figs. 1-3. 1859.

LICHAS (CONOLICHAS) BIGSBYI. ?

PLATE XIX A, FIG. 1.

Lichas Bigsbyi, HALL. Pal. N. Y., vol. iii, p. 364, pl. lxxvii, figs. 1-7 (8 ?); pl. lxxviii, figs. 5, 6(?). 1859.

LICHAS (CONOLICHAS ?), sp. ?

PLATE XIX, FIG. 9.

Lichas pustulosus, HALL. Pal. N. Y., vol. iii, pl. lxxviii, fig. 7. 1859.

Recent careful investigations of the trilobitic layers of the shaly limestone in the vicinity of Clarksville, Albany county, have shown that the cephalae of *Lichas pustulosus* are found in close association with pygidia quite distinct from those originally ascribed to that species. These bear broad, sub-lanceolate, recurved spines on the lateral margins in two pairs only; the posterior extremity terminating in a single broadly rounded lobe. This form of pygidium, and

the cephalæ which agree in all respects with the originals of *Lichas pustulosus*, are the only parts of *Lichas* yet found at this locality. The pygidium represented on plate lxxviii, fig. 7, of the Third Volume of the Palæontology of New York, upon more careful scrutiny and removal of adhering rock, proves not to have the bilobed caudal margin as there illustrated, and its proper character is shown on plate xix, fig. 9; the margin bearing three pairs of lateral lobes, much narrower than in *L. pustulosus*, and terminating in a single, moderately broad posterior lobe. The single specimen showing this form of pygidium is from Schoharie, from which locality are also the large pygidia originally referred to *Lichas pustulosus*.

The cephalic portions of *Lichas Bigsbyi* are known only from the Lower Pentamerus limestone at localities in Schoharie county. It is impossible, however, to say which of the three different forms of pygidia represented on plate xix, fig. 9, plate lxxvii, fig. 8 (*op. cit.*), plate lxxviii, figs. 4, 5 (*op. cit.*), and plate xix A, fig. 1, is to be referred to this species. These cephalæ are not of uncommon occurrence, and by far the most abundant of the pygidia are those figured on the last two plates cited, the other two forms occurring, so far as known, only in single examples. It is therefore probable that the large pygidia bearing three pairs of lateral spines and a pair of posterior spines belong to the species *Lichas Bigsbyi*.

[s.-g.] HOPLOLICHAS, DAMES. 1877.

LICHAS (HOPLOLICHAS) HYLÆUS, n. sp.

PLATE XIX B, FIGS. 1, 2.

THE intra-sutural portion only of the CEPHALON has been observed. Outline semi-elliptical; surface strongly convex, tumid along the axial line, abruptly deflected to the margins.

Glabella large, sub-pentagonal. Frontal lobe elongate-pyriform or clavate, widest and most convex anteriorly, narrowing and becoming depressed medially, and abruptly widening again at the occipital furrow. The second pair of transverse furrows is obsolete, the first and second pairs of glabellar

lobes being coalesced, and the first and third pairs of furrows uniting to form a single pair of longitudinal furrows which extend in a broad curve from the anterior margin to the occipital furrow. Third glabellar lobes obsolete. Lateral lobes elongate, bounded on the sides by sigmoid curves, and separated from the frontal lobe, the eye-lobe and the margin by furrows of equal strength.

Facial Sutures normal. Eye-lobe slightly depressed. Fixed portions of the cheeks short, abruptly deflected to the occipital furrow. Free portions of the cheeks and the occipital ring not observed. Border narrow, thickened; marginal sulcus strong.

Surface evenly covered by fine closely crowded tubercles, which are strongest upon the posterior portion of the frontal lobe; not, however, becoming spiniform.

An HYPOSTOMA found in association with this head is sub-quadrate in outline, convex on the anterior margin, broadly emarginate behind, the postero-lateral areas being broad and rounded. The centrum is small, sub-hemispherical, distinctly defined in front and at the sides, merging behind into the elevated median area. The longitudinal furrows are broad and deep and from these two pairs of obscure, oblique sulci pass inward over the median area, leaving between them a pair of inconspicuous nodes just behind the centrum. The margins near the antero-lateral angles are strongly elevated. The surface of the centrum is covered with fine tubercles.

Dimensions. The single cephalon observed measures 16 mm. in length and 25 mm. in width at the occipital furrow. The length of the hypostoma is 9 mm.; its width 16 mm.

Observations. The sub-genus *Hoplolichas*, Dames, includes a series of Silurian species (*Lichas tricuspidatus*, Beyrich; *L. proboscideus*, Dames; *L. conico-tuberculatus*, Nieszkowski; *L. Plautini*, Schmidt; *L. longispina*, Schmidt; *L. furcifer*, Schmidt), with which this fossil agrees in the form and contour of the head, especially of the frontal lobe. This lobe is more clavate, never so elevated or

constricted at its base as in *Conolichas*. The third pair of lateral lobes which is usually present in typical species of *Hoplolichas*, is almost if not quite obsolete in *L. hylæus*, and the species bears the same relation to the Silurian forms of *Hoplolichas* as *L. Eriopis* does to the Silurian species of *Conolichas*. (See observations under the description of *L. Eriopis*.)

Distribution. Upper Helderberg group. In the limestone, Province of Ontario.

[s.-g.] A R G E S, GOLDFUSS. 1839.

LICHAS (ARGES) CONTUSUS, n. sp.

PLATE XIX B, FIGS. 3-6.

CEPHALON broadly semi-oval in outline. Surface sub-equally trilobate, evenly convex.

Glabella with an elongate frontal lobe, having a width equal to that of each of the lateral lobes, and bounded by furrows which are parallel for three-fourths their length, diverging near the frontal margin, thus greatly increasing the width of the lobe upon the anterior border. First and second pair of lateral lobes coalesced into a single pair of relatively short, obliquely pyri-form lobes, terminating posteriorly sooner than the frontal lobe. The third pair of lateral lobes are obsolete or represented only by tubercles in the occipital furrow.

The fixed portion of the *cheeks* is convex behind the eye-nodes, and abruptly deflected to the occipital furrow. Occipital furrow broad and deep upon the axial line at the posterior termination of the frontal lobe, narrowing upon the cheeks and bending forward to very near the ocular node; occipital ring axially convex, relatively narrow, making a marked anterior curve upon the sides as it turns toward the presumably very narrow and slender free cheeks. Frontal border narrow and thickened, with a strong marginal sulcus. Surface covered with closely set and evenly distributed tubercles. The remaining parts of the animal are unknown.

Dimensions. Two specimens of the intra-sutural portions of the cephalon have a length of 7 mm., and a width of 11 mm.

Observations. *Lichas* (*Arges*) *contusus*, in all known features bears a close similarity to *L. granulosus*, F. Roemer (Verstein d. Harzgebirges, Beitr. iii, pl. xx, fig. 9), and *L. Haueri*, Barrande (Syst. Sil., pl. xxviii, figs. 38–44), the former from the Stringocephalen Kalk (middle-lower Devonian) and the latter from Étage F of the Bohemian basin. These species are all representatives of the sub-genus *Arges*, Goldfuss, which is characterized by the elongate, sub-rectangular and evenly arched frontal or mesial lobe; relatively short, coalesced first and second lateral lobes; obsolete third lobes and convex fixed cheeks. The type of *Arges* (*A. armatus*, Goldfs.) bears a pair of strong spines upon the glabella, but this appears to be a variable feature in this group.

Distribution. Upper Helderberg group. Corniferous limestone: Near Clarksville, Albany county; Cherry Valley, Otsego county. In the boulders of decomposed chert, Canandaigua, Ontario county.

CERATOLICHAS, n. s.-g.

LICHAS (CERATOLICHAS) GRYPUS, n. sp.

PLATE XIX B, FIGS. 7–13.

Acidaspis, n. sp.? HALL. Illustrations of Devonian Fossils, pl. xix, fig. 1 (not figs. 2 and 3). 1876.

INTRA-SUTURAL portion of the CEPHALON only known. Outline sub-semicircular, slightly trilobate on the anterior margin. Surface convex, elevated, trilobate. Margin narrow, slightly thickened.

Glabella large, embracing nearly the entire cephalon. Frontal lobe ellipsoidal, convex or tumid, elevated behind, sloping abruptly to the sides and posterior margin, and becoming obsolete at or just behind the center of the shield. It bears at its summit two strong, diverging, recurved spines which nearly equal the glabella in length. Longitudinal furrows sub-parallel, diverging near the frontal margin. Lateral lobes depressed, becoming obsolete; the members of the first and second pairs have coalesced, and the third pair can be detected only as low, obsolescent nodes bearing a faint tubercle. Near the outer edge of the lateral lobes, and just within the eye-lobes, are slender, erect spines, usually represented only by their broken bases. The

anterior slope of the glabella is broad and nearly vertical, the occipital furrow narrow, and the occipital ring broad upon the axis, arched, and bearing at its center two long, divergent spines which are curved downward and slightly inward toward their tips. In the single specimen observed which retains one spine apparently entire, its length is nearly equal to the length of the cephalon.

Eye-lobes small, inconspicuous.

Surface bearing tubercles which are closely disposed over the frontal lobe, but are scattered or obsolescent on the lateral lobes. On the posterior slope of the frontal lobe these tubercles appear to be arranged in two longitudinal rows of three or four each. The spines of the head shield are covered with acute pustules and granules.

Dimensions. Two individuals afford the following measurements :

	(a)	(b)
Length	13 mm.	6 mm.
Width between the eyes	14 mm.	8 mm.
Height	10 mm.	6 mm.
Length of occipital spine	13 mm.	-----

Distribution. Upper Helderberg group. Corniferous limestone, Schoharie, Schoharie county; in the decomposed chert boulders, Canandaigua, Ontario county.

LICHAS (CERATOLICHAS) DRACON, n. sp.

PLATE XIX B, FIGS. 14-17.

Acidaspis, n. sp.? HALL. Illustrations of Devonian Fossils, pl. xix, figs. 2, 3 (not fig. 1). 1876.

Two fragmentary CEPHALA which agree in general features with the preceding species show some important variations, as follows: the frontal margin is more transverse, the marginal sulcus broader, the frontal lobe slightly more elevated and apparently bearing two pairs of strong spines on the posterior edge. Of these two pairs, the stronger have their bases wide apart near the margin of the lobe, and the other shorter pair is situated behind and within the former.

Above both these pairs of spines are the bases of two or three strong tubercles, which were probably spiniform. The principal pair of spines was evidently more divergent than the single pair in *Lichas gryps*. The lateral lobes are almost obsolete, each bearing a spine just within the orbital node. The posterior portion of the head-shield has not been observed.

Distribution. Upper Helderberg group. Corniferous limestone: Schoharie, Schoharie county; LeRoy, Genesee county.

[s.-g.] DICRANOGMUS, CORDA. 1847.

LICHAS (DICRANOGMUS) PTYONURUS, n. sp.

PLATE XIX B, FIGS. 19-21.

CEPHALON sub-semicircular in outline. Surface depressed-convex, flattened above and sloping gently in all directions to the margin; indistinctly trilobate. Border narrow, slightly thickened and produced into short spines at the genal angles.

Glabella large, sub-quadrate. Frontal lobe depressed, narrow, sub-rectangular; its width less than one-third that of the glabella; not differentiated from the lateral lobes on the anterior third of the shield; extending to the occipital furrow and constricted just behind the middle by a transverse depression, which is continuous with the second pair of lateral furrows. First lateral furrows longitudinal, parallel, shallow and becoming obsolete on the anterior one-third of the shield; second lateral furrows strong, transverse, at right angles with the first pair, and extending to the palpebral furrow with a slight forward curve; third lateral furrows beginning at the termination of the second pair, thence backward, parallel for a short distance and merging into the occipital furrow. First lateral lobes large, indistinctly defined on the antero-lateral margins, and coalesced with the frontal lobe anteriorly, forming a single conspicuous, semicircular subdivision, extending for more than one-half the length of the head; second lateral lobes smaller, sub-quadrate, and distinctly separated from the palpebral lobes by a sulcus; third lateral lobes obsolete. Occipital furrow narrow, deeply impressed

behind the ocular node, and widening toward the genal angles. Occipital ring strongly arched over the very narrow axis.

Cheeks, as far as known from a single fragment, relatively broad, evenly rounded upon the margin, and produced at the angles beyond the posterior margin of the shield.

THORAX. A single detached segment has been observed, which is strongly arched upon the axis and slopes rapidly upon the pleuræ to the lateral margins. It is very narrow and shows no articulating planes toward the extremities.

PYGIDIUM relatively large, flabellate, depressed-convex.

Axis less than one-third as wide as the shield upon the anterior margin, strongly arched upon the first two annulations, becoming depressed posteriorly, tapering to an obtuse termination just below the center of the pygidium and connected with the posterior margin by an elevated ridge. It bears three distinct annulations and seven transverse rows of pustules.

The *pleuræ* are broad, flattened above, and somewhat abruptly deflected near the margins; bearing two distant, elevated, narrow annulations, each of which terminates on the margin in a short spine directed posteriorly. There is no evidence of other annulations upon the pleuræ, but the postero-lateral margin bears two other pairs of spines, making in all eight spines in the marginal fimbria. Border thickened, narrow upon the sides, becoming wider at the posterior extremity.

Surface ornamented with pustules which, on the cephalon, are fine and crowded upon the frontal portions and coarser toward the occipital ring. Upon the thorax these pustules appear to be arranged in a single row for each segment. The annulations of the pygidium each bear a single row, and the postero-lateral area is covered with scattered tubercles and granules.

Dimensions. Average specimens afford the following measurements:

	Cephalon.	Pygidium.
Length	6 mm.	9 mm.
Width	6 mm. (between the eyes.)	11 mm.

Observations. The genus *Dicranogmus* was established by Corda (*loc. cit.*) for a form of *Lichas*, in which the longitudinal furrows of the glabella become obsolete before reaching the anterior margin. It is stated by Barrande (Syst. Sil. du centre de la Bohême, vol. i, pp. 43, 609), that the group was founded upon a single very fragmentary specimen, and it has not been accorded recognition by him for the reason that "le prolongement plus ou moins grand des sillons de la glabelle est un caractère très-variable dans divers types" (p. 609). It is nevertheless true that very few species of the genus *Lichas* bear longitudinal furrows which become anteriorly obsolete at so great a distance from the frontal margin as in the species *L. pustulatus*, Corda, which served as the type of *Dicranogmus*; and it may be questioned whether in any species of *Lichas*, except those following the type of *Dicranogmus*, the anterior longitudinal furrows become obsolete before reaching the margin. No evidence of this fact is shown in the species described by Barrande, Angelin, Dames and Schmidt, and none is found in any other American species of *Lichas*. The species *Lichas gibbus*, Angelin, *Lichas simplex*, Barrande (= *Dicranogmus pustulatus*, Corda), and *Lichas ptyonurus* have in common the characteristic obsolescence of the anterior longitudinal furrows and serve to form a distinct subdivision of the genus.

Distribution. Niagara group. Coralline limestone: Schoharie, Schoharie county.

PROËTIDÆ.

PROËTUS, STEININGER. 1831.

PROËTUS CONRADI.

PLATE XX, FIG. 9. PLATE XXI, FIGS. 27, 28; AND PLATE XXII, FIG. 4.

Proëtus Conradi, HALL. Descr. New Species of Fossils, etc., p. 69. 1861.*Proëtus Conradi*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 97. 1862.*Proëtus Conradi*, HALL. Illustrations of Devonian Fossils, pl. xx, fig. 6 (not figs. 5, 8, 9). 1876.*Proëtus marginalis*, HALL. Illustrations of Devonian Fossils, pl. xxi, figs. 27, 28. 1876.

GENERAL FORM AND PROPORTIONS. Outline elliptical or sub-ovate; length to width as 3 to 2.

Surface convex; depressed or flattened near the longitudinal furrows.

CEPHALON semi-elliptical; length to width as 1 to 2. Border very broad, gently convex toward its inner edge, sloping evenly outward and at the outer edge faintly reflexed; at the genal extremities produced into short, stout spines, extending as far as the fourth thoracic segment.

Facial Sutures normal, crossing the anterior border more directly than in *Proëtus angustifrons*.

Glabella short, slightly longer than wide; sub-ovoid; tangent at its anterior extremity to the inner margin of the border. Surface depressed-convex, slightly flattened above. Casts of the lower surface show well-defined basal lobes, and under favorable preservation the other glabellar lobes would probably be apparent. Occipital furrow deep; occipital ring moderately broad and elevated; occipital lobes inconspicuous on the dorsal surface, but quite large in the internal cast.

Cheeks narrow, broadly flattened about the eyes, and abruptly deflected to the marginal sulcus. The most elevated portion of the cheeks lies in the angle made by the marginal sulcus and occipital furrow.

Eyes proportionally large, reaching anteriorly almost to the marginal sulcus. Orbital ridge well developed, its base lying lower than the surface of the cheek. Visual surface elongate-lunate.

THORAX sub-quadrate, slightly wider than long.

Axis broadly arched, having somewhat more than one-third the width of the body. Segments transverse, narrow, with vertical sides.

Pleurae flattened near the longitudinal furrows for more than one-third their width, rounding thence to the margin; conspicuously sulcate.

PYGIDIUM sub-elliptical in outline, surface evenly sloping posteriorly; length slightly less than twice the width. Border broad, limited within by a low, faint sulcus; convex toward its inner edge, sloping regularly outward, sometimes slightly concave.

Axis depressed-convex, relatively narrow, having less than one-third the width of the shield on the anterior margin; tapering rapidly to a broad, scarcely elevated extremity just within the marginal sulcus, behind which, in the axial line, lies an obscure node-like elevation; composed of eight or ten broad and flat annulations, which are depressed just within the marginal furrows, and are gently recurved over the axial line.

Pleurae moderately broad and evenly convex. Annulations very indistinct, three or four of which and in rare instances a fifth may be counted on each side. These are all sulcate, the anterior and posterior limbs of the annulations having equal size. All the annulations become extinct at the marginal sulcus.

HYPOSTOMA sub-spatulate, very convex, abruptly depressed and broadly auriculate on the antero-lateral margins. Anterior margin slightly reflexed; posterior and postero-lateral margins narrow and flattened. Posterior sulcus conspicuous. The centrum also bears a low sulcus on its posterior portion.

Surface, on its more elevated portions, marked by scattered granules, which are most conspicuous upon the cephalon and the thoracic segments, but are faint or obsolete upon the pygidium.

Dimensions. Of this species but two individuals retaining the parts in juxtaposition have been observed, although detached portions of the body are not of uncommon occurrence. Both of the entire examples are more or less enrolled, the better preserved specimen having approximately the following dimensions:

	Body.	Cephalon.	Thorax.	Pygidium.
Length -----	36 mm.	10 mm.	18 mm.	8 mm.
Width -----	20 mm.	20 mm.	16 mm.	12 mm.

Observations. *Proëtus Conradi* is a well-defined species, approximating however some of its associates, but readily diagnosed by its short, ovoid glabella and sloping pygidium, characters which are persistent and which serve to distinguish it from its nearest ally, *Pr. angustifrons*.

Distribution. Upper Helderberg group: In the Schoharie grit at Schoharie, Schoharie county, and near Clarksville, Albany county.

PROËTUS ANGUSTIFRONS.

PLATE XX, FIGS. 1-5; AND PLATE XXII, FIGS. 1-3.

- Proëtus angustifrons*, HALL. Descr. New Species of Fossils, etc., p. 70. 1861.
Proëtus angustifrons, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 98. 1862.
Proëtus angustifrons, HALL. Illustrations of Devonian Fossils, pl. xx., figs. 1-4, 7. 1876.

OUR knowledge of this species is limited to portions of the cephalon and the pygidium.

THE CEPHALON appears to have been semicircular in outline, with a broad border slightly thickened near the marginal sulcus, and produced into short spines at the angles of the cheeks.

The *facial sutures* are normal in their direction, crossing the frontal border very obliquely.

Glabella elongate-sub-conate, tapering rapidly to a rounded, narrow anterior extremity, tangent to, but not encroaching upon the frontal margin. Length one-half greater than width. Surface depressed-convex, flattened above. Traces of three pairs of lateral furrows are faintly visible upon

the test of favorably preserved specimens, and more clearly seen upon casts of the lower surface. Occipital furrow shallow and narrow; occipital lobes transverse, inconspicuous; occipital ring broad and flat, becoming narrower upon the cheeks, and bearing a central tubercle.

Cheeks depressed or broadly flattened on the summit beneath the orbital ridge, thence rounding in all directions to the broad border.

Eyes moderately large, orbital ridge distinct; visual surface sub-crescentic.

Pygidium sub-semi-elliptical, slightly emarginate behind. Surface convex.

Axis elevated, arched, longitudinal furrows deep; width on the anterior margin about one-third the width of the shield; annulations seven or eight, slightly flattened and with a gentle retral curve over the axial line.

Pleurae sloping evenly to the margin, and bearing five or six sulcate annulations, which are separated by broad, shallow furrows, the anterior and posterior limb being of about equal size. The annulations become extinct at the broad, smooth, sloping border.

Surface of the test smooth, or covered with fine granules or obsolescent tubercles. Upon the glabella, cheeks and frontal border the ornamentation is faint; upon the pygidium it is more conspicuous. Each pleural annulation bearing two rows of sharp granules, one on each limb. The axis is covered with scattered granules.

Dimensions. A fragment of the cephalon, consisting of the intra-sutural portion, has a length of 11 mm., a width between the eyes of 7.5 mm. An average pygidium measures 11 mm. in length, and 18 mm. in width.

Observations. This species was erected upon detached fragments of cephalon and separate pygidia occurring in comparative abundance associated in the Schoharie grit. In many features these parts are closely allied to those of *Proetus Conradi*, also an abundant species and intimately associated with this. The differences in the two forms are as follows: In *Proetus angustifrons* (a) the glabella is longer, more rapidly tapering and less distinctly lobed; (b) the summit of the cheeks is rounded and the lateral slopes less abrupt; (c) the

pygidium is shorter, the axis being broader and more abruptly elevated, the lateral slopes less evenly convex, the pleural annulations more distinct and numerous, the posterior border emarginate. In *Proëtus Hesione* the pygidium is much longer and bears more annulations.

Distribution. Upper Helderberg group. Schoharie grit: Near Clarksville, Knox and elsewhere, Albany county; Schoharie, Schoharie county.

PROËTUS HESIONE.

PLATE XX, FIGS. 15, 16.

- Proëtus Hesione*, HALL. Descr. New Species of Fossils, etc., p. 70. 1861.
Proëtus Hesione, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist, p. 98. 1862.
Proëtus Hesione, HALL. Illustrations of Devonian Fossils, pl. xx, figs. 15, 16. 1876.

PYGIDIUM semi-elliptical, length to width as 2 to 3. Surface axially elevated, depressed-convex on the sides.

Axis relatively narrower than in the associated species of this genus, having a width slightly less than one-third the width of the shield on the anterior margin; longitudinally arched, margins tapering slowly to a rounded, scarcely elevated apex just within the posterior border; composed of ten or eleven annulations which have a retral curve over the axial line.

Pleurae depressed near the longitudinal furrows, and sloping evenly to the border; composed of eight annulations, each of which is distinctly sulcate for its entire length, and all terminate abruptly at the marginal sulcus. Border broad, evenly sloping, thickened on its inner edge and gently concave.

Surface faintly pustulose, the pustules being arranged in rows upon the annulations and scattered irregularly over the border. Length 15 mm., width 21 mm.

The single pygidium which has served as the type of this species, presents characters so unlike those of the associated species that it will be readily recognized as distinct. From *Proëtus angustifrons* and *P. Conradi* it differs in its longer pygidium and more numerous annulations, and is in some respects allied to *P. planimarginatus*, Meek, of the Upper Helderberg limestone of Sylvania, Ohio.

The latter species has the same number of annulations on both axis and pleuræ, and the same general outline; its axis however is more slender, the axial annulations transverse, and the border less conspicuous and more flattened.

Distribution. Upper Helderberg group. In the Schoharie grit, at Schoharie, Schoharie county.

PROËTUS, sp. ?

PLATE XXII, FIGS. 5, 6.

A SINGLE imperfect cephalon, and two pygidia from the Schoharie grit, differing from those of any species previously described from this horizon, indicate the existence of at least one additional species of *Proëtus*.

The *Cephalon* is semi-elliptical in outline, the glabella ovoid and very convex, its anterior extremity tangent upon the frontal border, and the surface without apparent traces of transverse furrows. The frontal border is very broad and sloping; eyes relatively small, orbital ridge unusually conspicuous, beneath which the surface of the cheek is grooved, somewhat flattened and thence abruptly deflected to the marginal sulcus; its extremities were evidently produced into short spines. The occipital furrow is narrow and sharp; the occipital ring broadly rounded. The specimen measures 12 mm. in length and 28 mm. in width.

The *Pygidia* exist in the form of casts, and there is no evidence that they belong to the species represented by the cephalon. They are much shorter than in *P. angustifrons* or *P. Conradi*, show but six annulations upon the axis and three or four upon the pleuræ.

Distribution. Upper Helderberg group. Schoharie grit: The cephalon is from Schoharie, Schoharie county; the pygidia from the towns of Knox and Clarksville, Albany county.

PROËTUS CURVIMARGINATUS, n. sp.

PLATE XXII, FIGS. 13-19.

GENERAL FORM AND PROPORTIONS. Body ovate or sub-elliptical.

Surface sub-equally trilobate, convex along the axial line, strongly deflected at the margins. Length to width as 2 to 1.

CEPHALON semi-elliptical in outline, slightly produced anteriorly; border broad, depressed by the wide marginal sulcus and strongly reflexed; produced at the genal angles into stout spines which extend as far as the fourth thoracic segment. Length to width as 1 to 2.

Facial Sutures normal; points of intersection with the frontal margin relatively distant.

Glabella sub-triangular or conate; convex, tumid anteriorly and elevated along the median line; abruptly depressed toward the frontal border. Length equal to five-sixths the length of the cephalon; width at the base more than one-third the width of the same. Lateral glabellar furrows in four pairs; first pair short, transverse, situated at one-third the length of the glabella from the anterior extremity; second pair longer, inclined slightly backward; third pair still longer and with a greater posterior inclination; fourth pair longest and deepest, each furrow curving to meet the occipital furrow at one-third the distance across the base of the glabella; accessory furrows conspicuous, oblique. The lobes of the glabella increase in size backward, the fourth pair being large and obliquely sub-triangular. They are followed behind by large, transverse, occipital lobes, which are distinctly circumscribed by the bifurcated occipital furrow. Occipital furrow shallow on the axis, increasing in width and depth upon the cheeks; occipital ring broad, flat, depressed below the glabella, and narrowing on the cheeks.

Cheeks convex about the orbital node, slightly flattened above, abruptly depressed to the broad marginal sulcus and recurved upon the margin. The marginal sulcus extends into the cheek-spines making them concave.

Eyes lunate, relatively small and very closely appressed to the glabella. Palpebral sulcus shallow and elevated.

THORAX sub-rectangular, lateral margins gently converging posteriorly; sub-equally trilobate.

Axis convex, prominent, widest at about the fourth segment, with margins slightly rounding thence to the pygidium. Segments transverse, flat and thin.

Pleuræ flat for one-half their width, thence abruptly deflected to the lateral margins. Each segment is grooved by a sharply impressed furrow which becomes obsolete at the articulating plane.

PYGIDIUM semi-elliptical, sometimes a little produced at the posterior extremity. Length to width as 4 to 5. Surface elevated, flattened above, deflected at the sides. Border broad, widening posteriorly and strongly curved upward.

Axis convex, tapering evenly to a blunt, somewhat elevated termination just within the margin, and bearing thirteen or fourteen annulations, which are marked by a faint, impressed longitudinal groove or line just above the axial furrows. Each annulation is obliquely flattened and makes a double curve in crossing the axis, sloping forward for about one-fourth the distance; being angulated at that point, just above the impressed line, and thence bending backward in a broad curve to the axial line, along which is a series of small nodes giving the axis the appearance of being medially angulated.

Pleuræ flattened or very gently convex for about one-third of their width, thence rounding to an almost vertical slope upon the sides. Upon the posterior area the slope is less abrupt. They bear twelve annulations, which are separated by moderately broad furrows, and each is distinctly grooved for its entire length by a fine impressed line, visible upon the cast as well as on the dorsal surface. The anterior annulations encroach for a short distance upon the border.

AN HYPOSTOMA found in association with abundant fragments of this species is sub-triangular, centrum elongate, regularly convex, anterior margin narrow and deflected; anterior angles broadly sub-auriculate; postero-lateral depressions long but not continuous; posterior sulcus prominent and posterior lingua short.

Surface Ornamentation. The cephalon is covered with fine tubercles and granules, which are most abundant upon the glabella, and are also faintly visible upon the segments of the thorax and the annulations of the pygidium. The inter-annular grooves of the pygidium appear to be punctate.

Dimensions. The only individuals observed in which the parts are not detached, measure as follows:

	a.	Body.	Cephalon.	Thorax.	Pygidium.
Length	-----	52 mm.	20 mm.	15 mm.	17 mm.
Width	-----	29 mm.	29 mm.	27 mm.	24 mm.
	b.				
Length	-----	38 mm.	14 mm.	12 mm.	12 mm.
Width	-----	25 mm.	25 mm.	21 mm.	18 mm.

Observations. In the form and furrows of its glabella, and in the contour of its pygidium, this species presents some points of similarity to *Proëtus macrocephalus*, of the Hamilton group. The rapidly tapering and deeply furrowed glabella makes its earliest appearance here and is not exemplified by any other species as yet known in the Upper Helderberg formations. *Proëtus Haldemani* is also a close congener, but in these forms specific differences will be found in relative proportions and the number and character of the pygidial annulations.

Distribution. In the sandstone at Pendleton, Indiana, associated with *Proëtus latimarginatus* and *Conocardium cuneus*, a horizon probably corresponding in age with the Schoharie grit of New York.

PROËTUS LATIMARGINATUS, n. sp.

PLATE XXII, FIGS. 7-12.

GENERAL FORM AND PROPORTIONS. Outline elliptical, length to width as 2 to 1.

Surface conspicuously trilobate, convex, deflected on the marginal area.

CEPHALON semi-elliptical in outline; border broad, flat, thickened by doublure and produced into stout spines at the angles of the cheeks. Length to width as 5 to 7.

Facial Sutures taking their origin close within the genal angles, passing forward very obliquely over the occipital ring to the eye-lobe, cutting the anterior margin at points relatively distant, and approximating upon the doublure.

Glabella depressed-convex, slightly flattened above and posteriorly elevated on the axial line; long, conate, extending to the frontal border. Width at the base greater than one-third the width of the shield. Lateral furrows obscure, but indications of three pairs may be observed. Occipital lobes comparatively large; occipital furrow narrow, bifurcating near the axial furrows to include the occipital lobes, and becoming very deep upon the cheeks; occipital ring broad and flat.

Cheeks convex, depressed about the base of the eyes, thence somewhat abruptly deflected to the marginal sulcus and occipital furrow.

Eyes comparatively small, approximate, attaining the elevation of the glabella. Palpebrum small; palpebral lobes depressed, obscure; palpebral sulcus shallow.

THORAX sub-quadrate, length to width as 2 to 3; margins nearly parallel; surface equally trilobate.

Axis evenly arched, widest at the fourth segment and tapering thence regularly backward. Segments flattened, transverse.

Pleuræ flat for one-half their width and thence deflected in a moderately sharp curve to the margin. Each segment is grooved for two-thirds its length, and beveled upon the outer third by the articulating plane.

PYGIDIUM parabolic in outline, length to width as 3 to 5; evenly convex; border broad, flat or slightly sloping.

Axis prominent and evenly tapering to an abrupt and somewhat elevated termination just within the posterior border, with which it is connected by a low ridge. Indications of seven or eight transverse annulations appear on the axis, exclusive of the articulating ring, which is more conspicuous than any of the others.

Pleuræ evenly sloping to the lateral and posterior margins. Articulating ring very conspicuous; annulations obscure, almost obsolete. Four are visible in favorably preserved specimens, and all are depressed above and faintly grooved.

Dimensions. An average individual affords the following measurements:

	Body.	Cephalon.	Thorax.	Pygidium.
Length -----	43 mm.	16 mm.	14 mm.	13 mm.
Width -----	23 mm.	23 mm.	23 mm.	21 mm.

The largest pygidium observed has a length of 22 mm. and a width of 35 mm., the smallest a length of 9 mm. and a width of 15 mm.

Distribution. In the sandstones at Pendleton, Indiana, associated with the preceding species.

PROËTUS CRASSIMARGINATUS.

PLATE XX, FIGS. 6-8, 20-31; PLATE XXII, FIGS. 20-26; AND PLATE XXV, FIG. 8.

Calymene crassimarginatus, HALL. Geology of N. Y., Survey of Fourth Geol. Dist., p. 172, fig. 5. 1843.

Proëtus crassimarginatus, HALL. Twelfth Rept. N. Y. State Cab. Nat. Hist., p. 88. 1859.

Phillipsia crassimarginata, BILLINGS. Canadian Journal, p. 362. 1861.

Proëtus crassimarginatus, HALL. Descr. New Species of Fossils, etc., p. 72. 1861.

Proëtus crassimarginatus, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 100. 1862.

Proëtus crassimarginatus, HALL. Illustrations of Devonian Fossils, pl. xx, figs. 20-31. 1876.

Proëtus Conradi, HALL. Illustrations of Devonian Fossils, pl. xx, figs. 5, 8, 9. 1876.

GENERAL FORM AND PROPORTIONS. Body regularly ovate, margins evenly tapering from the base of the cephalon to the narrow posterior extremity. Length to width at base of cephalon, as 2 to 1.

Surface convex and strongly trilobate.

CEPHALON semicircular in outline, border broad, strongly recurved in front, more depressed and flattened at the sides, and produced at the genal angles into a broad, flat spine. Length to width as 1 to 2.

Facial Sutures normal.

Glabella large, sub-quadrate, semi-ovoid, narrowing slightly toward the anterior extremity; length equal to five-sixths the length of the cephalon, and width more than one-third that of the cephalon. Surface very convex, slightly flattened above; sides rising abruptly from the shallow marginal furrows. External evidence of the lateral furrows wanting. A single specimen from which the test has been so far weathered as to leave only a thin film near the lower surface, shows four pairs and the accessory furrows, of the

same character and relative position as in *Proëtus folliceus*. These furrows would undoubtedly appear in well preserved casts of the lower surface. Occipital lobes well defined but relatively small, and somewhat concealed by the prominent basal margin of the glabella; occipital furrow narrow upon the axis and but slightly widening upon the cheeks; occipital ring broad upon the axis and narrowing upon the cheeks.

Cheeks depressed at the summit about the base of the orbital ridge, sloping for a short distance abruptly, and thence more gently to the broad marginal sulcus.

Eyes elevated, not large, approximate, probably attaining the height of the glabella.

THORAX trapezoidal, lateral margins approximating; very strongly arched upon the axis, flattened upon the pleuræ for about one-half their width and deflected toward the margins. Composed of ten segments which are transverse, somewhat flattened and grooved upon the pleuræ.

PYGIDIUM semi-ovate to semi-elliptical, convex and sloping evenly to the lateral and posterior margins; equally trilobate; border thickened, moderately wide, its width slightly increasing posteriorly. In specimens from the Corniferous limestone of Ohio the axis is strongly arched, both longitudinally and transversely, and tapers to an obtuse and somewhat elevated termination. While many of the New York specimens conform with this type, examples from Williamsville have the axis broader, more depressed, the margins tapering in a broad, outward curve to a low, blunt apex, in these respects affording a close resemblance to the pygidium of *Proëtus Conradi* of the Schoharie grit. Under favorable preservation as many as fourteen annulations may be counted upon the axis. These present the feature noticed in *Proëtus folliceus*, being slightly angulated at a short distance within the margin and bent backward over the median line. The pleuræ are marked by seven or eight annulations, the postero-lateral area being smooth. All the annulations with the exception of the articulating ring, become obsolete upon the border.

Dimensions. The only entire individual observed is an enrolled specimen from Sandusky, Ohio, having the following dimensions:

	Body.	Cephalon.	Thorax.	Pygidium.
Length -----	78 mm.	21 mm.	34 mm.	23 mm.
Width -----	38 mm.	38 mm.	34 mm.	28 mm.

Observations. *Proëtus crassimarginatus* is not of rare occurrence in detached fragments, in the Upper Helderberg limestone in the States of New York and Ohio, but these are usually pygidia, the other parts being seldom seen. Pygidia which are manifestly identical with the limestone species are of common occurrence in the Schoharie grit. Figures of such pygidia were erroneously referred to *Proëtus Conradi* in the Illustrations of Devonian Fossils (*loc. cit.*). A single glabella found in association with these caudal shields agrees with those of the Corniferous limestone specimens.

Distribution. Upper Helderberg group. Schoharie grit: Schoharie, Schoharie county; Knox and near Clarksville, Albany county. Corniferous limestone: Clarence and Williamsville, Erie county; Lime Rock, near LeRoy, and Stafford, Genesee county; Phelps and Canandaigua, Ontario county; Port Colborne and Cayuga, Province of Ontario; Sandusky, Ohio.

PROËTUS FOLLICEPS, n. sp.

PLATE XXIII, FIGS. 3-8.

GENERAL FORM AND PROPORTIONS. Body elongate, outline sub-elliptical, lateral margins nearly parallel. Length to width as 8 to 5.

Surface convex, anteriorly gibbous, conspicuously and sub-equally trilobate.

CEPHALON short, semicircular, border flat, moderately broad, horizontal anteriorly, becoming deflected toward the genal extremities, which are broadly rounded and not produced. Surface very convex, equally trilobate. Length to width as 1 to 2.

The *facial sutures* take their origin just within the genal angles, run very obliquely across the occipital ring to the outer angle of the occipital lobes, thence rise abruptly to the eye-lobes and pass, with slight divergence, down

the steep frontal slope, curving and approaching each other at the edge of the frontal border and uniting upon the doublure.

Glabella sub-pyriform, very convex, longitudinally arched, rising abruptly on all sides from the lateral furrows, which are not deeply impressed; gibbous on the anterior slope, slightly flattened at the summit. Length equal to four-fifths the length of the cephalon; width at the base more than one-third that of the cephalon. Four pairs of lateral furrows and one pair of accessory furrows are discernible upon the cast of the lower surface, but upon the crust only the stronger of them can be seen as faint lines interrupting the ornamentation. The first pair is situated at about one-third the length of the glabella from the anterior margin, and appear as faint elongate pits not distant from the marginal furrow. The other three pairs are longer and inclined backward, none except the fourth pair extending to the marginal furrow. The accessory furrows take their origin just in front of the proximal ends of the fourth furrows, and are strongly inclined backward. The occipital lobes are moderately strong in the cast but are inconspicuous where the crust is retained. Occipital furrow narrow, the anterior side nearly vertical and the posterior side almost horizontal, widening on the cheeks and continuous with the marginal sulcus. Occipital ring broad, flat, narrowing to the axial furrows and widening again to the genal angles, bearing a small pointed tubercle upon the axial line.

Cheeks grooved and depressed about the orbital lobe, thence abruptly deflected to the broad margin.

Eyes approximate, prominent, elevated to almost the height of the glabella; orbital ridge conspicuous; palpebral lobe small; palpebral furrow elevated and moderately deep.

THORAX sub-rectangular, margins nearly parallel. Length to width as 1 to 1.3.

Axis arched.

Pleuræ flattened above for one-half their width, and thence somewhat abruptly deflected. The segments are transverse, somewhat flattened, grooved upon the pleuræ and beveled for one-half their length.

Pygidium sub-semicircular, border broad, thickened and rounded. Surface convex, sloping more abruptly at the sides than posteriorly.

Axis having less than one-third the width of the shield, tapering to a broad and blunt termination considerably within the posterior margin. It bears seven or eight annulations, which bend forward for a short distance within the axial furrows, are there sharply angulated and cross the axial line in a broad curve.

Pleurae with seven or eight annulations, each of which is broad, low, often indistinct, and very faintly grooved, all becoming obsolete upon the border. Length to width as 1 to 1.8.

Dimensions. An average adult affords the following measurements:

	Body.	Cephalon.	Thorax.	Pygidium.
Length -----	43 mm.	12 mm.	18 mm.	13 mm.
Width -----	27 mm.	27 mm.	23 mm.	20 mm.

The smallest individual observed measures 24 mm. in length and 14 mm. in width.

Observations. This very characteristic and well-defined species is not of common occurrence but is well represented by two entire individuals from the Corniferous limestone near LeRoy, Genesee county. One of these specimens, from which the crust of the pygidium has been broken away, shows, upon the very fine-grained, compact matrix beneath the axis, a series of paired impressions which, as preserved in the cast, appear as elevations. Each transverse axial groove near the axial margins, bears a pair of narrow elongate impressions, which take their origin upon the edge of the annulation and are directed backward and inward into the axial groove. Within this pair and upon the upper surface of the axial groove is a pair of obliquely transverse, lamellate impressions, separated by a faint thickening of each annulation upon the axial line. Upon the second, fourth and sixth axial groove, along the axial line, is a faint tubercle, indicating a circular pit or depression in the under surface of the test. The upper surface of the crust shows no indications of these characters. These paired impressions seem to be areas of insertion for somitic muscles, the mar-

ginal pair probably connected with the natatory appendages, the axial pair possibly attached to the branchial apparatus, or to the viscera. The function of the median pits upon alternate grooves is not understood. Similar though not so distinctly preserved markings have been noticed upon pygidia of *Proëtus crassimarginatus*, and the paired marginal impressions are well exhibited in a pygidium of *Phacops cristata*, var. *pipa* (see description of this variety, page 18). Since the existence of a ventral membrane in certain species of trilobites has been demonstrated by Walcott, it may be assumed that the same structure has existed in this species also, and that the muscles, which are represented by these impressions, lay within this membrane. The specimens showing these features give no evidence of similar impressions upon the axial grooves of the thorax.

Distribution. Upper Helderberg group. Corniferous limestone: LeRoy, Genesee county; Schoharie, Schoharie county; Marbletown, Ulster county, In boulders of decomposed chert: Canandaigua, Ontario county; Ann Arbor, Michigan.

PROËTUS CLARUS.

PLATE XX, FIGS. 12-14; AND PLATE XXII, FIGS. 28-30.

Proëtus clarus, HALL. Descr. New Species of Fossils, etc., p. 71. 1861.

Proëtus clarus, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 99. 1862.

Proëtus clarus, HALL. Illustrations of Devonian Fossils, pl. xx, figs. 12-14. 1876.

GENERAL FORM AND PROPORTIONS. Outline elliptical or sub-ovate.

Surface convex, conspicuously and equally trilobate. Length to width as 7 to 5.

CEPHALON. Outline semi-elliptical, faintly produced on the frontal margin. Surface, in normally preserved specimens, very convex, depressed about the border, which is broad, rounded or sloping, thickened on the posterior portion, and generally bearing a broad and shallow groove in front; produced at the genal angles into short, acute spines, which reach to the fourth thoracic segment. The marginal sulcus, within the border, is deep and conspicuous.

Facial Sutures normal, rapidly approximating on the broad frontal border

Glabella broadly conate or sub-triangular, slightly constricted at the anterior angles of the eyes and rounded to the frontal extremity, which is closely appressed upon the marginal sulcus. Width at the base equal to one-third that of the shield. Length greater than the width. Surface convex, depressed above, and sloping in all directions to the cheeks. Lateral furrows obscure, obsolete upon the test, but under favorable preservation sometimes visible upon the cast of the lower surface. A single example shows three pairs and the accessory furrows or pits, the anterior of these pairs being numerically the second, the first pair being obsolete. They are all inclined posteriorly, and the last or fourth pair reach almost to the occipital furrow. Occipital lobes conspicuous; occipital furrow narrow, scarcely widening on the cheeks; occipital ring moderately broad and flat, narrowing slightly upon the cheeks.

Cheeks depressed on the summit about the orbital lobe, and sloping with a somewhat abrupt curve to the strong marginal sulcus.

Eyes relatively large, and closely appressed to the glabella. Palpebral lobe very small; palpebral furrow shallow and elevated.

THORAX sub-rectangular, lateral margins slowly approximating posteriorly. Length to width as 2 to 1.

Axis broad and strongly arched, width upon the anterior margin more than one-third the width of the thorax. Sides evenly approximating to the pygidium. The segments are flattened, transverse, or with a slight forward curve toward the axial line.

Pleuræ flattened near the axis, and at about one-third their width deflected in a more or less abrupt curve to the margins. Pleural annulations grooved, the anterior limb of each becoming rapidly obsolete beyond the fulcrum.

PYGIDIUM. Posterior outline the arc of a circle whose center is the middle point of the body; when slightly compressed it is distinctly emarginate at the posterior extremity; border broad, moderately thickened. Length about one-half the width.

Axis convex and slightly arched longitudinally, tapering to a broad, blunt termination just within the margin. Width equal to one-third the width of the shield. The sides are appressed just above the axial furrows, by a series of oblique impressions, one upon each annulation. From seven to eleven annulations may be counted upon the axis, the first five having an anterior inclination near the margins, and a posterior curve over the median region; the posterior annulations are transverse.

The *pleuræ* are depressed and curve evenly in all directions to the margins. They bear four annulations and traces of a fifth, and these are marked by fine impressed lines. All the annulations become obsolete upon the border, the articulating ring, however, encroaching upon it.

Surface smooth, sometimes granulose upon the glabella and segments.

Dimensions. An average individual affords the following measurements:

	Body.	Cephalon.	Thorax.	Pygidium.
Length	29 mm.	12 mm.	9 mm.	8 mm.
Width	20 mm.	20 mm.	18 mm.	15 mm.

Observations. *Proëtus clarus* appears to be the most abundant species of this genus occurring in the Upper Helderberg limestone, although entire examples are of extreme rarity. It shows many points of general and detailed similarity with the species *Proëtus Rowi* of the Hamilton group, and *Proëtus angustifrons* of the Schoharie grit. From the former it may be distinguished by its relatively larger cephalon, a glabella very faintly encroaching upon the frontal border, smaller eyes, and fewer annulations upon the pygidium. In *Proëtus angustifrons* the cephalon is shorter, the anterior extremity of the glabella tangential upon the border, the pygidium more convex, its axis broader anteriorly, more depressed and more rapidly tapering, and its ornamentation more conspicuous.

Distribution. Upper Helderberg group. Corniferous limestone: Stafford and Lime Rock Quarries, near LeRoy, Genesee county; Caledonia, Livingston county; Clarence, Erie county; Canandaigua, Ontario county; Cherry Valley, Otsego county; Schoharie, Schoharie county; Falls of the Ohio.

PROËTUS CANALICULATUS.

PLATE XX, FIGS. 10, 11; AND PLATE XXIII, FIGS. 10, 11.

Proëtus canaliculatus, HALL. Descr. New Species of Fossils, etc., p. 73. 1861.*Proëtus canaliculatus*, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 101. 1862.*Proëtus canaliculatus*, HALL. Illustrations of Devonian Fossils, pl. xx, figs. 10, 11. 1876.

THE original of this species is a fragment showing the intra-sutural portion of the CEPHALON, and more complete material has not been observed, with the exception of a few detached cheeks which may safely be regarded as belonging to this form.

The species is characterized by its violin-shaped glabella (genus *Æonia*, Burmeister), constricted at the anterior angle of the eye, and broadly rounded on the anterior extremity. Its length would be more than two-thirds the length of the cephalon, and its width apparently somewhat less than one-third that of the cephalon.

The transverse furrows are indistinct upon the crust, but appear to consist of three pairs and the accessory pair. A cast of the lower surface would probably show a small anterior pair. The first pair visible is transverse, and the posterior pairs are inclined backward. All the glabellar lobes are faint. The occipital lobes are conspicuous; the occipital furrow narrow and deep; the occipital ring moderately broad and flattened. The border is very broad and flat, and is grooved along the anterior limbus by two furrows, the anterior of which is narrow and close upon the edge, the other is broad and is separated from the frontal margin of the glabella by a rounded ridge. Upon the cheeks these grooves become shallower and reduced to two planes, the interior and broader one horizontal, the anterior narrower and beveling. At the genal angles the border is produced into moderately long and stout spines, which are ridged upon the surface and minutely incurved at the tip.

The eyes and palpebral lobes are comparatively large, the orbital ridge elevated, the cheeks flattened at their summit below this ridge, abruptly curving to the marginal and occipital furrows.

The surface is smooth upon the border, finely granulose upon the glabella, and pustulose upon the flattened summits of the cheeks.

The doublure is strongly rounded and incurved, somewhat excavate at the genal angles, sharply convex and ridged upon the genal spines. Its surface is marked by longitudinally parallel, lamellose lines.

Distribution. Upper Helderberg group. Corniferous limestone: Columbus, Ohio; Falls of the Ohio, Ky.

PROËTUS VERNEUILI.

PLATE XX, FIGS. 18, 19.

- Proëtus Verneული*, HALL. Descr. New Species of Fossils, etc., p. 73. 1861.
Proëtus Verueuili, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 101. 1862.
Proëtus Verneული, HALL. Illustrations of Devonian Fossils, pl. xx, figs. 18, 19. 1876.

THE CEPHALON and THORAX of this species have been observed only in a condition too incomplete for description.

PYGIDIUM short, nearly twice as wide as long; outline sub-elliptical; surface convex axially, laterally depressed.

Axis having one-third the width of the shield on the anterior margin, strongly convex, tapering rapidly to a blunt termination close upon the posterior border; bearing nine to eleven annulations, which have a retral bend over the axial line, where the first three or four are thickened and nodose.

The *pleurae* are flat for a short distance, thence abruptly deflected and bearing seven or eight annulations which are faintly grooved.

The border is broad, abruptly sloping for one-half its width, and near its inner edge bears a row of conspicuous nodes, which correspond in number and position to the annulations; outside of these the margin is smooth and concave.

The best preserved specimen of the pygidium has a length of 4 mm., and a width of 7.5 mm.

This species is well defined by the characteristic row of nodes upon the border, a feature which has been observed in many specimens and is undoubtedly persistent.

Distribution. Upper Helderberg group. Corniferous limestone: Williams-ville, Erie county; Phelps and Canandaigua, Ontario county; Schoharie county.

PROËTUS MICROGEMMA, n. sp.

PLATE XXII, FIGS. 33, 34.

SEVERAL detached PYGIDIA afford certain characteristic features in which they differ from described species.

The shield is small and transversely semi-elliptical in outline, convex, longitudinally arched, distinctly and equally trilobate.

The *axis* is elevated, tapering with slightly rounded margins to a blunt and somewhat elevated termination just within the border. It is somewhat ap-pressed at the sides just above the axial furrows, bears eleven annulations, which are angulated at the sides and posteriorly recurved over the median line. Upon the axial line each bears a strong tubercle.

The *pleuræ* are depressed below the axis, slightly flattened above and equally deflected to the lateral and posterior margins. Each bears seven or eight annulations which are grooved by fine impressed lines.

The border is thickened, moderately and equally broad throughout its extent; it is encroached upon by the articulating ring, and slightly by the first two or three annulations.

The *surface* is covered with minute and distinct tubercles, which are irregularly disposed upon the annulations of the axis, but are arranged in two or more rows on each annulation. A very young example, measuring 2 mm. in length and 3 mm. in width, shows nine annulations on the axis and ten on the pleuræ; the margin is less thickened than in the later stages of growth, all the pleural annulations encroaching upon it. The ornamentation is also more distinct than in larger specimens.

An average specimen measures 6 mm. in length and 9 mm. in width.

Distribution. Upper Helderberg group. Corniferous limestone: LeRoy, Genesee county; Canandaigua, Ontario county; Williamsville, Erie county; Falls of the Ohio, Ky.

PROËTUS STENOPYGE, n. sp.

PLATE XXII, FIG. 27.

PYGIDIUM small, short, transverse; anterior and posterior curves equal.

Axis wider than one-third the width of the shield, very convex and elevated, sloping to a blunt termination upon the border; composed of seven annulations, each of which, near the axial furrows, is broad, flat and impressed with a faint oblique line, and near the median line is slightly angulated.

Pleuræ depressed, nearly flat; composed of four broad annulations, each of which is grooved for its entire length, making the anterior and posterior limbs of the same strength. The annulations become obsolete upon the border, which is moderately broad, thick and rounded.

Surface smooth or minutely granulose. Length 3 mm., width 5 mm.

Specimens of this peculiar form of pygidium are not of common occurrence, but are of interest as representing a type of pygidium abundantly developed among the *Proëti* of Germany and Bohemia, as shown in such species as *Proëtus lævigatus*, Goldfuss; *P. complanatus*, *P. neglectus*, *P. Loveni*, Barrande., etc.

Distribution. Upper Helderberg group. Corniferous limestone: Flint Creek, township of Phelps, Ontario county; North Cayuga, Province of Ontario.

PROËTUS OVIFRONS, n. sp.

PLATE XXII, FIGS. 31, 32.

SEVERAL fragments of head-shields showing certain features in common serve to separate this form from any described species.

The *glabella* is broadly conate, convex, longitudinally arched and closely appressed against the narrow anterior margin. The first three pairs of lateral furrows are nearly obsolete, the second and third pairs being visible only near the marginal sulcus; the fourth pair is very strong and deep, each furrow beginning opposite the center of the palpebral lobe and extending obliquely backward to the occipital furrow, making the basal lobes very large, with a length equal to one-third the length of the glabella. The occip-

ital lobes are small and well defined; the occipital furrow sharp and narrow, and the occipital annulation broad and flat. The anterior border is narrow, thickened and curved upward.

Surface finely tubercled. Length of the cephalon 7 mm., width between the eyes, 5.5 mm.

Observations. The fragments of this species in their general outline, reflexed anterior border and strong basal glabellar lobes, are very similar to the same parts in *Proëtus macrocephalus*, of the Hamilton group, though in the latter the glabella is less convex, more elongate and conate than in *P. ovifrons*. The similarities which exist in the cephalon of these two species, and which are also observable in the pygidia of *P. microgemma* and *P. macrocephalus*, may, with a more complete knowledge of these Upper Helderberg forms, ultimately render it necessary to unite these detached parts under one specific designation.

Distribution. Upper Helderberg group. Corniferous limestone: In the decomposed chert, Canandaigua, Ontario county.

PROËTUS DELPHINULUS, n. sp.

PLATE XXIII, FIGS. 1, 2; AND PLATE XXV, FIG. 6.

A SINGLE small, somewhat imperfect CEPHALON shows the following characters: Outline semi-elliptical; border very broad, its width on the anterior limb, where it is slightly produced, equaling one-third the length of the cephalon; along the margin it is conspicuously thickened and gently reflexed; the marginal sulcus is broad and deep on the cheeks, becoming much wider on the frontal area, producing a general concavity in that part; this sulcus is bounded on its inner margin by a narrow ridge skirting the base of the cheeks. The genal angles are produced into slender, acute spines, longer than the glabella, and distinctly grooved on their upper surface by the continuation of the occipital furrow.

The *facial sutures* converge rapidly on the frontal area.

The *glabella* is sub-conate, and relatively small, tapering rapidly from the base to the anterior extremity, which lies just within the broad frontal

border. The specimen is somewhat crushed across the base of the glabella, but sufficient is retained to show evidence of strong basal lobes similar to those in *P. ovifrons*, and above these, indications of two pairs of lateral furrows.

The *eyes* are elongate, relatively narrow, and are closely appressed to the glabella.

The single example has an axial length of 5 mm., a length to the apex of the cheek-spines of 9 mm., and a width of 7.5 mm.

Distribution. Upper Helderberg group. In the decomposed Corniferous chert, at North Cayuga, Province of Ontario.

PROËTUS [?] PLANIMARGINATUS.

PLATE XXIII, FIG. 12

Proëtus planimarginatus, MEEK. Proc. Acad. Nat. Sci. Phila., p. 89. 1871.

Proëtus planimarginatus, MEEK. Palæontology of Ohio, vol. i, p. 233; pl. xxiii, figs 3 a, b. 1873.

PYGIDIUM semi-elliptical in outline; length to width as 3 to 5. Surface depressed-convex on the sides, elevated along the axis. Border moderately broad, flat and sulcate near the edge.

The *axis*, on the anterior margin, has about one-fourth the width of the shield, and tapers evenly to a blunt extremity considerably within the posterior margin. It bears ten distinct, and traces of two or three indistinct annulations; these are transverse over the median area, slightly angulated and inclined posteriorly toward the margins.

The *pleuræ* each bear nine low, narrow annulations, separated by broad, shallow sulci, and each annulation is sulcate upon its summit for its entire length. The annulations become obsolete toward the posterior extremity, leaving the post-axial area smooth.

The type specimen of the species is a smooth cast of the lower surface, and from Mr. Meek's observations upon other specimens, the dorsal surface appears to have been devoid of ornamentation.

Dimensions of the original: length 15 mm., width 25 mm.

Observations. The true generic position of this species must remain a matter of some doubt until more complete representatives have been obtained. The pygidium lacks the expression of the caudal shield in *Proëtus*, and is suggestive of that part in some species of *Dalmanites*, notably of *D. Calypso* with which it is associated. It is however tentatively left with the former genus awaiting more conclusive evidence of its character.

Distribution. Upper Helderberg group. Corniferous limestone: In the upper part of the formation, Sylvania, Lucas county, Ohio.

PROËTUS TUMIDUS, n. sp.

PLATE XXIII, FIG. 9.

A PROBABLY distinct species of *Proëtus* is indicated by fragments of the cephalon, which show a glabella having an outline somewhat as in *P. folliceus*, but narrower and much more conspicuous anteriorly. The surface is convex, slightly flattened above; the anterior and antero-lateral slopes abrupt, the posterior slope much less so; the occipital lobes are almost obsolete, the occipital furrows broad and elevated, the occipital ring narrow. The frontal border is broad and flat or gently sloping.

Distribution. Upper Helderberg group. In the limestones at Port Colborne and North Cayuga, Province of Ontario.

PROËTUS HALDEMANI.

PLATE XXI, FIGS. 7-9; AND PLATE XXIII, FIGS. 13-15.

Proëtus Haldemani, HALL. Descr. New Species of Fossils, etc., p. 74. 1861.

Proëtus Haldemani, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 102. 1862.

Proëtus Haldemani, HALL. Illustrations of Devonian Fossils, pl. xxi, fig. 7-9. 1876.

Dechenella Haldemani, KAYSER. Zeitschr. d. deutsch. geol. Gesellsch. Jahrg. 1880, p. 707, pl. xxvii, fig. 9.

Proëtus Haldemani, WALCOTT. Monog. U. S. Geol. Survey, vol. viii; Pal. Eureka Dist., p. 210. 1884.

? *Dechenella Haldemani*, TSCHERNYSCHEW. Mém. du Comité géol., vol. iii, No. 3, p. 14, pl. i, fig. 9. 1887.

GENERAL FORM AND PROPORTIONS. Outline sub-elliptical or elongate-ovate.

Surface convex, distinctly and equally trilobate. Length to width as 1.7
[to 1.

CEPHALON semicircular or semi-lunate in outline; border broad, flat and rounded at the edge; widest in front and narrowing toward the genal angles, where it is very faintly produced. Surface evenly convex.

Facial Sutures normal, rapidly approximating on the frontal margin.

Glabella broadly conate, constricted opposite the anterior angles of the eyes. Surface depressed-convex. Length and greatest width about equal; the anterior extremity scarcely reaching the marginal sulcus, the posterior margin ending abruptly at the occipital furrow. The anterior and lateral margins are bounded by shallow and inconspicuous furrows. Lateral furrows, as shown upon the cast of the lower surface, in four pairs, accompanied by the posterior accessory depressions. Of these furrows the first pair is very short and transverse, the other three pairs and the accessory pair inclined obliquely backward. The fourth pair is strong and reaches to the posterior margin, but does not open into the occipital furrow. Upon the surface of the test these lateral furrows would undoubtedly be less conspicuous, but no specimen has been observed in which the crust of the glabella is retained. Occipital lobes moderately strong; occipital furrow narrow, impressed and scarcely widening upon the cheeks; occipital ring moderately broad, somewhat flattened and of about the same width along the posterior margin.

Eyes relatively large and somewhat elevated above the surface of the glabella. Palpebral lobe prominent; palpebral furrow shallow and inconspicuous; orbital ridge well defined.

Cheeks slightly depressed on the summit about the base of the orbital ridge, and rounding over the very narrow lateral area to the broad and shallow marginal sulcus.

THORAX sub-rectangular, lateral margins nearly parallel, slightly approximating posteriorly; length to width as 1 to 1.5. Surface convex, sub-equally trilobate. Composed of ten segments.

Axis evenly arched and gently tapering to the pygidium. Segments rounded and somewhat flattened, transverse or with a slight anterior curve over the axial line.

Pleurae flattened near the axis for less than one-third their width, thence deflected, in a rather abrupt curve, to the lateral margins. Segments strongly sulcate over the fulcrum, the anterior limb being sharply angulated and becoming rapidly obsolete upon the beveled articulating surfaces.

PYGIDIUM rounded sub-triangular, slightly produced at the extremity; length to width as 1 to 1.5. Surface convex, sloping evenly to the lateral and posterior margins.

Axis narrow, its width on the anterior margin being about one-fourth the width of the shield; longitudinally arched and slightly angulated posteriorly along the median line; tapering evenly to an obsolete termination at the border. Composed of eleven or twelve flattened, transverse annulations.

Pleurae broad and evenly rounding to the margins; bearing from eight to eleven annulations, each being grooved by a faint impressed line, which is most distinct near the axis and toward the margins. The border is moderately broad and thickened, widening to the posterior extremity, the annulations, with the exception of the first three or four, becoming extinct upon reaching its inner margin.

Surface smooth or minutely granulose.

Dimensions. The only entire individual observed measures as follows:

	Body.	Cephalon.	Thorax.	Pygidium.
Length	20 mm.	7 mm.	7 mm.	6 mm.
Width	11 mm.	11 mm.	10 mm.	9 mm.

Observations. The specimen upon which this species was founded is a beautifully preserved example, which was obtained many years since from the late Professor S. S. Haldeman, of Columbia, Pa. Its locality is not known further than that it is from the south-western part of the State of Pennsylvania. It is preserved in a compact, fine-grained, chocolate-brown limestone, undoubtedly of the age of the Hamilton group of the State of New York, since isolated cephalons and pygidia of the same species have been found in the *Goniatite limestone* of the Marcellus epoch in this state. It is a very distinctly defined

species and cannot be confounded with any of the allied species of *Proëtus* in the adjoining formations. Pygidia considerably larger than those found in New York, but agreeing in essential details with that of the type of *P. Haldemani*, occur in the Hamilton limestone at Long River, Michigan.

The specimens of this species from the Eureka District of Nevada, described by Mr. Walcott (*op. cit.*), consist of two fragmentary cephalæ and two pygidia, which agree in every essential feature with the type, except in the character of the frontal border of the head, which in the typical form is flat, while in these specimens it is strongly reflexed. This feature may eventually prove of specific importance.

More recently certain pygidia from the west slope of the Ural Mountains have been referred to this species by Tschernyschew (*Die Fauna des mittl. und ober. Devon am West-abhange des Urals, loc. cit.*). So far as may be judged from the figures alone, these appear to be considerably shorter and more elliptical, with a relatively wider and stouter axis than in the type specimen.

Distribution. Hamilton group. In the Goniatite limestone of the Marcellus epoch: Cherry Valley, Otsego county; Manlius, Onondaga county. In the Hamilton limestones: Long River, Michigan. In the Devonian (Hamilton?) limestone in Pennsylvania, and in the Eureka District, Nevada.

PROËTUS MACROCEPHALUS.

PLATE XXI, FIGS. 10-21; AND PLATE XXIII, FIGS. 30, 31.

Proëtus macrocephalus, HALL. *Descr. New Species of Fossils, etc.*, p. 77. 1861.

Proëtus macrocephalus, HALL. *Fifteenth Rept. N. Y. State Cab. Nat. Hist.*, p. 105. 1862.

Proëtus macrocephalus, var. *a.*, HALL. *Fifteenth Rept. N. Y. State Cab. Nat. Hist.*, p. 107. 1862.

Proëtus macrocephalus, HALL. *Illustrations of Devonian Fossils*, pl. xxi, figs. 10-21. 1876.

GENERAL FORM AND PROPORTIONS. Outline elliptical.

Surface depressed-convex, distinctly and sub-equally trilobate. Length to width as 1.5 to 1.

CEPHALON sub-semicircular or lunate, margin slightly thickened and reflexed, produced at the genal angles into thin acute spines. Surface very convex in normally preserved specimens; depressed in the usual state of preservation. Length to width as 1 to 2.

Facial Sutures normal.

Glabella sub-conate, sides broadly tapering to the anterior extremity, where it is closely appressed upon the narrow, reflexed margin. Width three-fourths the length. Surface convex, anterior slope normally abrupt or vertical, curving posteriorly and becoming horizontal at the occipital furrow. Under normal preservation only a single pair of lateral furrows is visible. These are the fourth or basal furrows and are very strong and deep, taking their origin nearly opposite the anterior angle of the eye and extending to the occipital furrow, thus forming two strong conspicuous lobes. Upon casts of the lower surface, and in extremely rare instances upon the dorsal surface, there is evidence of the first, second and third pairs of furrows, with faint indications of the accessory furrows. Occipital lobes prominent; occipital furrow narrow, broadly bifurcating about the occipital lobes, and becoming deeply impressed and broadened upon the cheeks; occipital ring broad and posteriorly convex, narrowing upon the cheeks.

Eyes not large, lunate; palpebral lobe inconspicuous; palpebral sulcus narrow and deep.

Cheeks deeply grooved about the orbit of the eye, and abruptly depressed to the broad marginal sulcus.

THORAX sub-rectangular; surface convex and equally trilobate; length to width as 1 to 1.8; composed of ten segments which are arched upon the axis and considerably elevated above the pleuræ, obliquely flattened and transverse.

The *pleuræ* are flattened for less than one-half their width and abruptly deflected to the margin; segments sulcate, anterior and posterior limbs nearly equal, the former becoming abruptly obsolete at the fulcrum.

PYGIDIUM large, semi-elliptical, convex; length to width as 2 to 3.

Axis having less than one-third the width of the shield upon the anterior margin, and tapering to a blunt termination within the border. Annulations thirteen or fourteen, with an anterior bend near the margins, and a broad curve over the median line; in most individuals, the annulations are slightly

angulated along the axial line, each sometimes bearing a moderately strong tubercle.

Pleurae depressed in a more or less abrupt curve to the margin, bearing eleven or twelve flattened annulations, which are separated by moderately strong sulci. Each annulation is faintly grooved by a fine impressed line, which is sometimes almost or quite obsolete. Border broad, becoming excavate and slightly reflexed posteriorly; all the annulations except two becoming obsolete upon reaching it.

Doublure broad, reaching to the termination of the axis.

Surface Ornamentation. The cephalon is covered with low tubercles which become obsolete upon the anterior portion of the glabella and the depressed areas of the cheeks. Upon the thorax and pygidium each segment and annulation is ornamented with granules; these upon the latter sometimes appear to be arranged in two rows, one upon each limb of the pleural annulations. In rare examples a row of small tubercles is noticeable along the axial line on both thorax and pygidium, beginning with a faint tubercle upon the occipital ring, the next being at the third or fourth segment, thence backward becoming stronger toward the apex of the axis.

Dimensions. An average individual measures:

	Body.	Cephalon.	Thorax.	Pygidium.
Length-----	37 mm.	13 mm.	11 mm.	13 mm.
Width -----	24 mm.	24 mm.	22 mm.	21 mm.

The largest entire individual observed has a length of 60 mm. and a width of 40 mm.

Observations. Entire individuals of *Proëtus macrocephalus* are of rare occurrence, and the crust is so delicate and tenuous that when the parts are in juxtaposition, it is usually broken away. The symphysis along the facial sutures appears to have been very free, for the movable cheeks are usually detached, and of several hundred specimens of the species which have passed under observation but a single example retains all the parts.

The species occurs without variation except in the occasional presence of the axial row of tubercles, and this peculiarity was noticed in the original description of the species (Fifteenth Rept. N. Y. State Cab. Nat. Hist., *loc. cit.*), the variation being designated as *P. macrocephalus*, var. *a*. It appears, however, on closer examination, that this feature is not connected with variations in other respects, and individuals are found showing all intermediate stages between those with and those without tubercles. *P. macrocephalus* affords many points of close similarity to *P. curvimarginatus*, the general proportions of the two species and many of the details being quite identical. Differences, however, exist in the following respects: In the former the border is not so broad, so deeply excavate or so strongly reflected; the glabella is more broadly conate, and its lateral furrows much less conspicuous; the genal spines are shorter and stouter; the pygidium more elongate and more distinctly flattened upon the pleuræ.

Distribution. Hamilton group. In the limestone layer of the Marcellus shales: Orleans, Ontario county; in the Hamilton shales of the central and western counties; Canandaigua Lake, at Menteth's, Tichenor's and Foster's Points; Canandaigua, Bristol and Hopewell, Ontario county; Bellona, Yates county; Jaycox's Run, near Geneseo, and Moscow, Livingston county; Bethany, Genesee county; Eighteen-mile Creek, Erie county; in the Tully limestone, below Lodi Landing, Seneca Lake, and Borodino, Onondaga county.

PROËTUS ROWI.

PLATE XXI, FIGS. 2-6, 21-26; AND PLATE XXIII, FIGS. 20-29.

Calymene Rowii, GREEN. Amer. Journ. Science and Arts, vol. xxxiii, p. 406. 1838.

Proëtus Rowii, HALL. Descr. New Species of Fossils, etc., p. 75. 1861.

Proëtus Rowii, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 103. 1862.

Proëtus Rowii, HALL. Illustrations of Devonian Fossils, pl. xxi, figs. 2-6. 1876.

GENERAL FORM AND PROPORTIONS. Body ovate or elongate-elliptical in outline.

Surface depressed-convex, sub-equally trilobate. Axial length one-half greater than the width at the base of the cephalon.

CEPHALON semi-elliptical to semicircular in outline, width about twice the length. Border broad and flat; at the angles of the cheeks produced into

spines which reach as far as the fourth segment of the thorax. Posterior margin transverse. Surface moderately convex.

Facial Sutures normal, approximating on the frontal margin.

Glabella simple, elongate, sub-conate, sloping to a broadly rounded anterior extremity, which encroaches upon the frontal border. Length one-third greater than the width. Surface convex, longitudinally arched when normally preserved. There are usually no traces of lateral furrows, but a single individual in which the crust is slightly separated from the rock and has become translucent, shows evidence of three oblique lines, apparently the second, third and fourth lateral furrows; the first pair being obsolete, and the fourth extending only part way across the glabella. Occipital lobes conspicuous, transverse; occipital furrow narrow and sharply impressed, scarcely widening upon the cheeks; occipital ring broad, arched and somewhat flattened, narrowing slightly to the genal angles.

Eyes approximate, large, lunate, not elevated above the surface of the glabella; extending from the occipital lobes two-thirds the length of the glabella. Visual surface quite convex, particularly in young individuals. Palpebral lobe moderately large, sloping inward to the palpebral sulcus, which is sharply incised.

Cheeks relatively narrow on account of the size of the eyes. Conspicuously grooved or depressed about the orbital ridge, and rounding more or less abruptly to the margin. The border is unusually wide and carries two parallel grooves, the outer of which is narrow and marginal, producing a beveled edge; the inner broad and shallow, becoming flat in old individuals. On the posterior border the margin is also beveled, and the genal spines are strongly ridged by the meeting of these beveled edges.

THORAX transversely sub-rectangular, lateral margins slightly rounding and approximating posteriorly. Length to width as 2 to 3. Surface convex and strongly trilobate. Composed of ten segments.

Axis arched, having more than one-third the width of the thorax; widest at the third or fourth segment, and tapering with slightly rounding margins

to the pygidium. Segments flat, transverse, or with a gentle forward curve over the axial line.

Pleuræ flattened for one-half their width, and thence depressed in a more or less abrupt curve to the margins. Each segment is sulcate, the anterior limb being sharply angulated at the fulcrum and becoming rapidly obsolete upon the lateral slope.

PYGIDIUM sub-semicircular or sub-semi-elliptical in outline, faintly and broadly emarginate behind; length to width as 1 to 2; surface depressed-convex.

Axis broad on the anterior margin; width equal to one-third the width of the shield; arched and sloping to a termination within the posterior border, a low ridge connecting the apex of the axis with the margin; composed of nine or ten low, flattened annulations, which have a forward inclination for about one-fourth their width from the axial margins and pass over the median area in a gentle posterior curve.

Pleuræ gently depressed, bearing six annulations with indications of a seventh, which are low, flat and faintly sulcate, becoming obsolete at or near the margin. The border is conspicuously thickened and moderately broad.

HYPOSTOMA with a very convex centrum, sides abruptly depressed and margins flattened. Widest on the anterior margin; lateral margins incurved; posterior area extended; posterior sulcus deep; postero-lateral sulcus conspicuous, elevated. Length equal to the width on the anterior margin.

Surface Ornamentation. Upon the cephalon the surface of the glabella is covered with faint, obsolete pustules, and most individuals show indications of a large but indistinct tubercle in the axial line at the base of the glabella. The summit of the cheeks beneath the orbital ridges is covered with obscure, elongate or radiating tubercles, interspersed with simple pustules. Upon the thorax and pygidium the posterior edge of each segment and annulation bears a single row of sharply defined granulations; sometimes accompanied by finer and irregularly scattered granules. There are usually indications of a row of faint axial tubercles beginning at the occipital ring, omitting the first six thoracic segments, thence recurring and extending to the second or third

annulation of the pygidium. The surface of the hypostoma is punctate and covered with strong, concentric, lamellose markings.

Dimensions. An average individual affords the following measurement:

	Body.	Cephalon.	Thorax.	Pygidium.
Length -----	36 mm.	14 mm.	12 mm.	10 mm.
Width -----	22 mm.	22 mm.	20 mm.	18 mm.

The smallest entire specimen observed has a length of 12 mm., and a width of 9 mm., and the largest specimen, in which the parts are somewhat detached, was an individual measuring 62 mm. in length.

Observations. *Proëtus Rowi* is one of the rarer species of the Hamilton fauna. The fossil was first brought to public notice by Mr. Le Row, in the *Poughkeepsie Telegraph* of November 22, 1837, and was described by Green in the following year, as cited. The original was from the sandy shales of the group in Otsego county. In one locality only has it proven to be an abundant fossil in good preservation, namely, on Seaver's creek in the township of Canandaigua, Ontario county, in the shales and limestone immediately overlying the Marcellus shales.

Careful comparison of this species with *Proëtus clarus*, Hall, of the Upper Helderberg limestone, shows a very close similarity in the broader features and in the general expression of the animal. While the former may be regarded as the Hamilton representative or descendant of the latter, there are certain associated details which will serve to distinguish the species. *Proëtus Rowi* has larger eyes, flatter thoracic segments, a less abruptly tapering axis and a larger number of annulations upon the pygidium, and a peculiar ornamentation upon the cheeks, thorax and pygidium, which has not been noticed in *Proëtus clarus*.

Proëtus marginalis.

- Calymene marginalis*, CONRAD. Ann. Rept. Palæontology of N. Y., p. 66. 1839.
Proëtus marginalis (?), HALL. Descr. New Species of Fossils, etc., p. 76. 1861.
Proëtus marginalis (?), HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 104. 1862.
Proëtus marginalis (?), HALL. Illustrations of Devonian Fossils, pl. xxi, figs. 24-28. 1876.

The original of Mr. Conrad's *Calymene marginalis* was a cephalon described by him in the following terms (*loc. cit.*):

“*C. marginalis*, Buckler, with a broad margin; eyes large, semi-oval; middle lobe entire, convex, smooth abdomen.”

“*Locality*. Near Ithaca, in a boulder. This has a much less prominent front than the *Rowi*, a deeper groove between the eye and middle lobe, and the tubercle which nearly joins the lower angle of the eye is much smaller.”

It was subsequently ascertained that the boulder referred to by Mr. Conrad, was a mass of the Tully limestone, which had been transported many miles south of the outcrop of that formation. For this reason the species of *Proetus* which has been frequently found in the outcrops of this rock upon Seneca and Cayuga Lakes, in Onondaga county, and elsewhere, was regarded in the published descriptions of 1861 and 1862 (*vid. loc.*), as probably specifically identical with Mr. Conrad's original. This reference was without doubt correct, but the more complete material illustrating this fossil and its allies in adjoining formations, which has accumulated since the publication of these descriptions, has afforded conclusive evidence that *P. marginalis*, Conrad, is identical in every specific detail with *P. Rowi*, Green.

The points of difference in these forms, as stated in the description quoted above, depend solely upon the condition of preservation of the specimens. As the individuals of *P. marginalis* occurring in the State of New York are preserved in limestone, the surface has more nearly retained its normal rotundity, and the glabella is less extended anteriorly than in the usually somewhat flattened examples of *P. Rowi* from the Hamilton shales. The specimens from the Tully limestone show that the glabella encroaches slightly upon the frontal margin, as in normal examples of *P. Rowi*.

The depth of the groove between the eye and the glabella depends entirely upon the degree of flattening of the specimen; and the size of the occipital lobe varies with the absence or retention of the crust.

After a careful examination of all the representatives of *P. marginalis* at hand, it seems impossible to associate any characteristics by which it can be distinguished as even a variety of *P. Rowi*, and the foregoing description of the latter species will apply in every respect to Mr. Conrad's *P. marginalis*.

This fossil occurs in the Tully limestone, in intimate association with *Pha-*

cops rana and *Dalmanites Boothi*, var. *Calliteles*, as does also *P. Rowi*, in the basal layers of the Hamilton shales.

The name *Proëtus marginalis*, Conrad, as far as it has included the forms of *Proëtus* occurring in the Tully limestone, may therefore be regarded as synonymous with *P. Rowi*, Green.

Distribution. Hamilton group. In the Hamilton shales: On Seaver's Creek, Township of Canandaigua, Ontario county; York, Livingston county; Ham-burgh and Eighteen-mile creek, Erie county; Vly creek and elsewhere, Otsego county. In the sandy shales of Schoharie county. In the Tully limestone: Below Lodi Landing, Seneca lake; at Weston's quarry, near Spofford Corners, Split Rock, near Borodino, and Tully, Onondaga county; Moravia, Cayuga county, and Cuyler, Cortland county.

PROËTUS JEJUNUS, n. sp.

PLATE XXV, FIG. 7.

PYGIDIUM moderately large, the posterior outline being the arc of a circle.

Axis elevated, relatively narrow, having one-fourth the width of the shield on the anterior margin; tapering rapidly to an obtuse apex distant from the posterior extremity. The apex is slightly elevated, a low, depressed ridge connecting it with the posterior border. Ten annulations can be counted, all of which show a retral bend over the axial line, and each bears a conspicuous central node.

The *pleuræ* are relatively broad and slope with a gentle curve outward to the narrow border. There are eight annulations, exclusive of the articulating ring, and on the cast of the lower surface they appear to have been distinctly sulcate. Border smooth except near the antero-lateral angles, where it is encroached upon by the annulations.

Dimensions. Length 13 mm., width 21 mm.

Observations. This species is represented by a single pygidium from which the crust has been largely removed, but the specimen is sufficient to show that

it represents a definite specific variation from other forms included under this genus. Its distinctive characters are the broad, explanate pleuræ and the axial row of nodes.

The general proportions of the pygidium are similar to those of *Proëtus Rowi*, *P. clarus* and *P. Prouti*, but from all these it differs in its axial row of nodes and more conspicuously sulcate annulations. From *P. macrocephalus*, which often bears nodes upon the axis of the pygidium, it varies in the more numerous annulations and greater proportional length of the former.

Distribution. Hamilton group. In the sandy shales, Albany county.

PROËTUS PHOCION.

PLATE XXV, FIGS. 9, 10.

Proëtus Phocion, BILLINGS. Palæozoic Fossils of Canada. vol. ii, pl. 1, p. 63, fig. 31. 1874.

GENERAL FORM AND PROPORTIONS. One of the type specimens, which is a cast of the lower surface of an entire extended individual, indicates a body relatively broad and short, and more depressed upon the axis and pleuræ than *P. Rowi* or *P. Conradi*.

CEPHALON This part of the body is closely similar to that of *P. Rowi* and *P. angustifrons*. The border is moderately broad, slightly convex on its proximal edge, becoming gently concave outwardly as in *P. Rowi*, but produced into shorter cheek-spines. The cheek is elevated and distinctly ridged at about half the distance from the border to the base of the eye, and is broadly flattened on the upper surface.

The *glabella* has much the same proportions as in *P. angustifrons*, and shows indications of three pairs of lateral glabellar furrows. The occipital ring bears a central tubercle, which is situated on the upper surface as in *P. angustifrons*, and not on the posterior margin as in *P. Rowi*. The basal lobes in the occipital furrow are larger, but not so distinctly defined, and the eye is smaller than in *P. Rowi*.

The **THORAX** bears no feature of distinctive value except the general smoothness of the test, and the rounded posterior margins of the axial segments.

The PYGIDIUM is like that of *P. Rowi*, the *axis* bearing the same number of annulations, nine or ten, but scarcely so wide or so strongly arched as in that species; the *pleuræ* are more flattened, the ribs, of which four or five may be counted, being very faint, becoming obsolescent. The border is distinctly thickened.

Dimensions. The cast of the lower surface of the entire individual measures as follows:

	Body.	Cephalon.	Thorax.	Pygidium.
Length	35 mm.	12.5 mm.	13.5 mm.	9 mm.
Width	24 mm.	24 mm.	21 mm.	19 mm.

Observations. Of all the American *Proëti* which follow the type of structure exemplified in *P. Rowi*, Green, this species is much the broadest and stoutest, although it is closely allied in many details to several members of the group. It may be important to note that this broad form has been found only in the easternmost outcrops of the Devonian formations; while the narrowest and most slender member of the group is from the far west (Eureka District, Nevada).

Distribution. In the upper limestones and sandstones of Indian Cove, Gaspé, Province of Quebec.

PROËTUS PROUTI.

PLATE XXIII, FIGS. 16-18.

Proëtus Prouti, SHUMARD. Trans. St. Louis Acad. of Sci., vol. ii, No. 1, p. 110. 1863.

Proëtus Davenportensis, BARRIS. Proc. Davenport Acad. Nat. Sci., vol. ii, p. 287; pl. xi, fig. 8, and pl. xi revised, fig. 8. 1878.

GENERAL FORM AND PROPORTIONS. Body elliptical or sub-ovate in outline; length to width as 3 to 2.

Surface convex, scarcely elevated, and conspicuously trilobate.

CEPHALON sub-semicircular, faintly produced at the anterior extremity. Border broad and prominent, deeply grooved in front and recurved at the edge, becoming flatter at the sides, the sulcus more shallow and narrower and accompanied by a less conspicuous sulcus nearer the cheek. At the genal

angles the margin is produced into long, rounded spines which reach to the seventh segment of the thorax. Posterior margin nearly straight.

Facial Sutures normal, curving sharply forward on the anterior margin.

Glabella elongate-sub-conate, surface depressed-convex; length about one-fourth greater than the width. The narrow anterior extremity encroaches slightly upon the frontal border. Lateral furrows in four pairs, accompanied by the posterior accessory furrows. These furrows are all linear and in the specimens at hand are quite faint upon the surface, being made more conspicuous by the somewhat translucent test. Occipital lobes prominent, transversely sub-pyriform; occipital furrow narrow and sharply impressed; occipital ring broad, somewhat flattened above, and strongly arched.

Eyes moderately large, lunate; orbital ridge depressed and strongly sulcate at its base. Palpebral lobe large and closely appressed against the glabella; palpebral sulcus narrow and elevated.

Cheeks depressed at the summit and rounding more or less abruptly to the posterior and lateral margins.

THORAX sub-quadrate, about one-third longer than wide; lateral margins rounding to the pygidium. Surface sub-equally trilobate.

Axis convex and arched, having about one-third the width of the thorax, attaining its greatest width at the fourth segment, whence it tapers regularly to the pygidium. Segments narrow and somewhat flattened.

Pleuræ laterally depressed at about one-third their width from the axis. The segments are conspicuously sulcate, the anterior ridge becoming rapidly obsolete beyond the fulcrum.

PYGIDIUM sub-semicircular in outline, faintly emarginate at the posterior extremity; anterior margin with a slight forward curve; width equal to twice the length. The border is broad and conspicuous, flattened anteriorly, thickened and slightly sulcate behind.

Axis rather narrow, having less than one-third the width of the shield on the anterior margin, tapering rapidly to a blunt and elevated apex within the posterior border. It is composed of from eight to ten annulations which

have a forward bend near the axial furrows and a slightly retral curve over the median line.

Pleurae evenly convex and bearing from six to eight annulations, each of which is grooved by a finely impressed line. All the annulations become extinct upon reaching the border.

Surface Ornamentation. Upon the cephalon and thorax the test is covered with faint, nearly obsolete pustules or granulations, which seem to be wanting upon the pygidium, except at the posterior edges of the axial annulations. The last four or five segments of the thorax each bear a strong tubercle in the axial line, as in *Proëtus Rowi*. A faint axial tubercle is also visible upon the occipital ring.

Dimensions. An entire individual of normal proportions measures :

	Body.	Cephalon.	Thorax.	Pygidium.
Length -----	37 mm.	14 mm.	13 mm.	10 mm.
Width -----	26 mm.	26 mm.	20 mm.	19 mm.

Observations. The *Proëtus Davenportensis* of Barris, appears to be identical with Shumard's type, and the description here given is from Mr. Barris' original specimens, which he has kindly loaned for the purpose.

Proëtus Prouti may be regarded as a western representative of the type of *Proëtus*, exemplified by the New York species, *P. angustifrons*, *P. clarus* and *P. Rowi*. With the last named species it has many points of close similarity, both in general contour and in details. It will be found, however, to differ in the following particulars, which, taken together, prove of specific value: the cephalic border is broader and more conspicuously grooved; the genal spines very much longer; the axis, both upon the thorax and pygidium, narrower; the pygidium more evenly convex, and with a more conspicuous border.

Distribution. Hamilton group. In the fawn-colored limestone, near Davenport, Iowa.

PROËTUS NEVADÆ, n. sp.

PLATE XXIII, FIG. 19.

Proëtus marginalis, WALCOTT. Monogr. U. S. Geol. Surv., vol. viii : Pal. Eureka Dist., p. 210. 1884.

THE specimen identified by Mr. Walcott as *Proëtus marginalis*, Conrad, in the work above cited, is a well-preserved and nearly entire individual, which exhibits points both of relationship and difference with the various representatives of the group of *Proëtus* typified by *P. Rowi*, viz.: *P. angustifrons*, *clarus*, *marginalis* (= *Rowi*) and *Prouti*. All these species are established upon differences which are of themselves slight but which nevertheless appear persistent. To any of these species, as here described, it becomes impossible to admit the Nevada form, as it differs from each member of this group in as many respects as those species differ from one another. It therefore seems necessary to regard it as having a distinct specific value founded upon characters which may be best expressed by a comparison with each of the species above mentioned.

With *P. angustifrons* it agrees (a) in the character of the frontal border, which is convex near the marginal sulcus and slopes evenly to the edge, becoming faintly concave on the anterior limb; (b) in the relatively narrow glabella, tangential upon the frontal border (in the type specimen the glabella has been slightly compressed laterally and thus appears somewhat narrower and more convex than is normal); (c) in the number of annulations upon the pygidium. It differs from this species in (a) the narrower and more elongate body; (b) the much smaller eyes; (c) the broader, more elevated and convex cheeks; (d) the longer and more slender genal spines; (e) the narrower and more elevated pygidial axis.

With *P. clarus* it agrees in (a) the character of the frontal margin; (b) the length of the genal spines; (c) the form, contour and annulations of the pygidium. It differs from this species in (a) the much narrower and more regularly elliptical body; (b) the much narrower glabella; (c) the smaller eyes; (d) the narrower, more arched and more slowly tapering thoracic axis; (e) the narrower pygidial axis.

With *P. Rowi* (including *P. marginalis*, Conrad), it agrees in (a) the more elongate and slender form; (b) the character of the ornamentation of the cheeks; (c) the relatively narrow axis of the thorax; (d) the convex pygidial border. It differs from this species in (a) the narrow glabella not encroaching upon the frontal border; (b) the much smaller eyes; (c) the broader, more elevated cheeks; (d) the larger cheek-spines; (e) the convex frontal border; (f) the narrower pygidial axis; (g) the absence of the low elevation connecting the apex of the axis with the posterior border.

With *P. Prouti* it agrees in the general features common to all these species, but differs in (a) the character of the frontal border; (b) the shorter cheek-spines; (c) the tangential glabella; (d) the smaller eyes; (e) the narrower pygidium, with fewer annulations.

The ornamentation in *P. Nevada* consists of fine almost obsolete granulations. The crust of the thorax is broken in such a manner as not to show whether there existed an axial row of strong tubercles as in *P. Rowi* and *P. Prouti*.

These details of difference in all these species cannot be satisfactorily represented in life-size drawings. Dependence must therefore be placed upon the descriptions in establishing the limitations accurately.

Distribution. "Lower horizon of the Devonian limestone; Comb's Peak, Eureka District, Nevada." (Walcott, *op. cit.*)

PROËTUS OCCIDENS.

PLATE XXI, FIGS. 22, 23.

- Proëtus occidens*, HALL. Descriptions New Species of Fossils, etc., p. 80. 1861.
Proëtus occidens, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 108. 1862.
Proëtus occidens, HALL. Illustrations of Devonian Fossils, pl. xxi, figs. 22, 23. 1876.

THIS species, so far as known, is represented by only two somewhat imperfectly preserved PYGIDIA. Their outline is semi-elliptical; length to width as 3 to 4; surface depressed-convex. The axis has a little less than one-third the width of the shield on the anterior margin, is moderately convex and tapers evenly to an obtuse apex which lies just within the conspicuous marginal

border. It bears about twelve transverse annulations. The lateral slopes are gentle and bear nine or ten flattened annulations, each of which appears to be faintly sulcate. Surface minutely granulose. The larger of the two specimens measures 18 mm. in length and 23 mm. in width; the smaller 14 mm. in length and 18 mm. in width. This species has proportions similar to those of *Proetus macrocephalus*, but has fewer annulations and lacks the conspicuous ornamentation of that species. It is not closely comparable with any of the species here described.

Distribution. Hamilton group. New Buffalo, Iowa.

PROËTUS (?) LONGICAUDUS.

PLATE XX, FIGS. 32-34.

Proetus longicaudus, HALL. Fifteenth Rept N. Y. State Cab. Nat. Hist., p. 108, pl. x, figs. 7-9. 1862.

Proetus longicaudus, HALL. Illustrations of Devonian Fossils, pl. xx, figs. 32-34. 1876.

Proetus longicaudus, H. S. WILLIAMS. Amer. Journ. Science, vol. xxi, 3d Ser., p. 156. 1881.

GENERAL FORM AND PROPORTIONS. Body elongate-ovate, tapering, with margins rounding to the posterior extremity.

CEPHALON broadly semi-elliptical, transversely very convex. Border wide and thick, produced into short spines at the genal angles.

Glabella sub-ovoid, slightly constricted opposite the anterior angles of the eyes, and somewhat abruptly rounded in front. First lateral furrows faint and very short; second and third pairs gently curving backward, extending nearly two-thirds the distance across the glabella; fourth pair of furrows conspicuous, passing from near the middle of the palpebral lobe to the occipital furrow, and forming two large sub-pyriform basal lobes, each of which reaches about one-third the distance across the base of the glabella. Occipital lobes wanting; occipital ring broad and flattened above, becoming narrower on the cheeks.

Cheeks broadly marginate.

Eyes sub-reniform, moderately large and closely appressed upon the glabella.

THORAX composed of nine segments.

Axis very prominent, semi-cylindrical.

Pleuræ flat for about one-half their width, thence sloping gently to the margins.

PYGIDIUM very elongate-triangular, the length being equal to the width.

The *axis* tapers to an obtuse termination considerably within the scarcely thickened border; composed of twenty-two annulations, which are vertical on the sides, but have a gentle anterior curve toward their summit.

Pleuræ flat near the axis, thence curving somewhat abruptly outward and downward; bearing twelve annulations, which terminate in a broad, sloping border abruptly recurved at the edge.

Surface finely granulose.

Observations. There exists a great deal of doubt both as to the generic status and the geological age of this species. The original and type specimen was presented many years ago by the Rev. Mr. Nash, of Des Moines, Iowa, together with specimens of *Phacops rana*, and was said to have been found in association with the latter at some point to the north-east of that place. This was the only specimen of the species known until certain others were described by Mr. H. S. Williams (*loc. cit.*) from a blue limestone near Madison, Greenwood county, Kansas, and he has suggested that these may have been derived from rocks not older than the Carboniferous. Mr. Williams' specimens were obtained from Mr. Edwin Walters, of Hickman, formerly of Madison, Kansas, who, in response to inquiries, writes that he has found this species in association with *Phacops bufo* (*rana*). Admitting its association with this well-known and characteristic fossil, its geological age would appear to be that of the Hamilton group.

On the other hand the species, in many important structural features, is more closely related to the Carboniferous *Phillipsia* than to typical forms of *Proëtus*. The possession of but *nine* thoracic segments, which appears to be a normal feature of the species at maturity, is known in but *one* other species of *Proëtus*, viz., *P. sculptus*, Barrande, from the étage G. For the genus *Phillipsia* this is the normal number. Moreover, the oval, slightly constricted glabella,

the reniform eyes, the absence of occipital lobes, the great length of the pygidium and the number of its annulations are all Phillipsioid characters.

The species may ultimately prove to be a Carboniferous fossil, but any satisfactory determination of its age must await the acquisition of more complete material.

PROËTUS MISSOURIENSIS.

PLATE XXIII, FIG. 32.

Proëtus Missouriensis, SHUMARD. Geol. Rept. Missouri, p. 196, pl. B, fig. 13. 1855.

Proëtus auriculatus, HALL. Descr. New Species of Fossils, etc., p. 79. 1861.

Proëtus auriculatus, HALL. Fifteenth Rept. N. Y. State Cab. Nat. Hist., p. 107. 1862.

Phillipsia Shumardi, HERRICK. Bull. Sci. Lab. Denison Univ., vol. ii, pt. 1, pp. 58, 69, pl. vii, fig. 14. 1887.

THIS species is noticed here in order to call attention to its correct determination and its proper synonymy. The original of Mr. Shumard's *Proëtus Missouriensis*, described from the Lithographic limestone of Missouri, formerly regarded as of Upper Devonian age, is apparently identical with the detached cephalæ and pygidia from the Waverly sandstones of Licking county, Ohio, which were described in 1861 under the name *Proëtus auriculatus*, Hall. Recently an entire individual of the species from Licking county, Ohio, has been described by Herrick (*loc. cit.*), under the term *Phillipsia Shumardi*. The change of name proposed by this author arises from the consideration that if the fossil belongs to the genus *Phillipsia*, the designation *Phillipsia Missouriensis* would be inadmissible as this name had been used by Shumard for a species from the coal measures at Lexington, Missouri, described in 1858, (Transactions St. Louis Academy of Science). Without entering into a discussion upon the right of priority under these circumstances to the specific term *Missouriensis*, the evidence, afforded by the entire specimen of the species, points distinctly to the fact that the genus to which it belongs is *Proëtus* and not *Phillipsia*. The form of the glabella is in some respects similar to that of certain species of *Phillipsia*, being somewhat expanded anteriorly, the fourth lateral furrows strong and reaching to the occipital furrow, the third and second short and the first obsolete. Such variations frequently occur within the limits of the genus *Proëtus* (*P. canaliculatus*, *P. granulatus*, *P. crassimarginatus*). The occipital lobes,

which are well developed in this species, are either obsolete or obsolescent in *Phillipsia*. The ten thoracic segments, however, determine its generic relations and exclude it from the genus *Phillipsia*, while the relatively short pygidium is more strongly Proëtoid than Phillipsioid.

PHAËTHONIDES, ANGELIN. 1878.

PHAËTHONIDES ARENICOLUS, n. sp.

PLATE XXV, FIGS. 12, 13.

PYGIDIUM relatively short, broadly sub-elliptical in outline; length equal to one-half the width.

Axis elevated, comparatively narrow, having less than one-third the width of the shield on the anterior margin; tapering to a blunt extremity considerably within the margin. Characterized by transverse annulations, the number of which cannot be distinctly made out, apparently from five to seven.

Pleuræ broad, curving rapidly to the margins; bearing five annulations, with traces of a sixth, all of which are strongly sulcate, the posterior limb being much the wider, and the anterior ridge becoming extinct upon the lateral slope. Each annulation terminates upon the margin in a short, stout spinule, projecting horizontally, and the post-axial margin also bears two of these processes, making in all fourteen in the marginal fimbria. Close upon the margins of the lateral slopes are also bases of spinules equally stout, and there appears to have been a row of small tubercles further inward on the posterior limb of each annulation.

This pygidium appears to be constructed on the same plan as that of *Phaëthonides gemmæus*, of the Hamilton group, but the number of annulations is somewhat less, and the surface not so strongly tubercled.

The single specimen from the Schoharie grit has a length of 3 mm., and a width of 6 mm.

Distribution. Upper Helderberg group. Schoharie grit: Schoharie county. A specimen bearing similar characters has also been found in the decomposed Corniferous chert at North Cayuga, Province of Ontario.

PHAËTHONIDES VARICELLA, n. sp.

PLATE XXIV, FIGS. 29-31.

CEPHALON. Intra-sutural portion only observed. Outline sub-circular. Frontal area broad, concave, strongly recurved at the margin. Margin slightly thickened by doublure, elevated, reaching or exceeding the height of the glabella. Palpebral lobes conspicuous.

Facial Sutures normal.

Glabella elongate-ovate or pyriform, bounded by a low sulcus; convex, slightly flattened above. Basal lobes strong; baso-lateral furrows broad and deep; antero-lateral impressions duplicate, very faint upon the crust but apparent upon the lower surface.

THORAX not observed.

PYGIDIUM broad, the outline being the arc of a circle whose center is the middle of the first annulation.

Axis elevated, relatively narrow and longitudinally arched, abruptly terminating before reaching the posterior border; composed of eleven or twelve transverse annulations.

Pleuræ broad, depressed-convex, flattened at the margin, which is strongly thickened by doublure. Pleural annulations eight, six of which are sulcate and double. The cast of the lower surface, which serves the purposes of description, shows the last two annulations more distinctly than they would probably appear upon the upper surface of the test.

Surface of the cephalon ornamented by tubercles, which are scattered over the glabella, and are stronger upon the adjoining frontal and lateral areas. Upon the recurved marginal area the ornamentation changes to strong, abundant punctæ, which become finer toward the margin itself. On casts of the lower surface this punctate structure is to a large degree lost. The pygidium bears an axial row of bead-like tubercles with two less conspicuous rows on each side. The pleuræ show traces of three or four rows of tubercles, which become obsolete toward the posterior extremity.

Dimensions. An average cephalon measures 6 mm. in length and 6 mm. in width; the pygidium 8 mm. in length and 10 mm. in width.

Observations. In the outline and contour of the cephalon, *Phaëthonides varicella* approaches *Cyphaspis ornata*, of the Hamilton group. Its more elevated and sharply recurved frontal margin, and the absence of the peculiar marginal ornamentation of that species, will serve as distinguishing characters of the head. The species is thus far represented by three specimens, two imperfect cephalæ and a single pygidium. Of these, one head and the pygidium occur in juxtaposition, so that little doubt remains of their specific identity.

Distribution. Upper Helderberg group. Corniferous limestone: In the boulders of decomposed chert, Canandaigua, Ontario county.

PHAËTHONIDES GEMMÆUS, n. sp.

PLATE XXIV, FIGS. 32-36.

CEPHALON unknown. Two detached thoraces have been found, one in close association with a pygidium, and each of them shows seven segments. It is, however, probable that some of the segments have been lost.

THORAX sub-quadrate, margins nearly parallel.

Axis strongly arched and very broad, being nearly one-half the width of the body on the anterior margin; width increasing backward for a short distance and thence tapering rapidly toward the pygidium. Each segment is very narrow, elevated upon the anterior margin, grooved and depressed behind.

Pleuræ convex for about one-third their width, thence abruptly depressed to the margins; sulcate and strongly beveled for two-thirds their length.

The axis bears from three to five longitudinal rows of small pustules, one of which is in the axial line, and the pleuræ bear each three or four similar rows. The articulating grooves of the axis are punctate.

PYGIDIUM. Outline sub-semicircular, anterior margin curved backward at the antero-lateral angles. Surface sharply elevated along the median line, depressed-convex on the lateral portions.

Axis convex, elevated, evenly tapering to an abrupt termination distant from the posterior margin; width on the anterior margin about one-third the width of the shield; bearing from eight to twelve narrow annulations, which have a slight retral bend along the axial line and appear to be angulated by the five longitudinal rows of strong tubercles. Of these rows the middle one is much the strongest. Upon the elevated termination of the axis are a number of small, irregularly scattered pustules.

Pleuræ gently convex for about one-half their width, and depressed upon the broad, flattened border; bearing eight annulations, which are grooved for their entire length, making the anterior limb of each strong and the posterior limb inconspicuous. Each annulation bears upon the anterior limb four, five or six strong sub-spiniform tubercles, of which those upon the margin are much the strongest and are usually produced into short spines. Some specimens bear a terminal spiniform tubercle upon the margin between the last two annulations. The pleuræ and articulating grooves are punctate.

Doublure broad and flat.

Dimensions. A thorax from the Hamilton shales measures 6 mm. in length and 10 mm. in width; a pygidium from the same formation 6.5 mm. in length and 9 mm. in width; a small pygidium from the Upper Helderberg limestone 3 mm. in length and 5 mm. in width.

Distribution. Upper Helderberg group. Corniferous limestone: In the decomposed chert boulders, Canandaigua, Ontario county. Hamilton group: In the lower shales at Canandaigua and Fall Brook, Hopewell, Ontario county; Eighteen-Mile creek, Erie county.

PHAËTHONIDES CYCLURUS, n. sp.

PLATE XXIV, FIG. 26-28; AND PLATE XXV, FIG. 11.

CEPHALON. The intra-sutural portion, which is the only part known, indicates a semicircular outline for the head; frontal and lateral areas depressed and

concave; frontal margin elevated, rising to the height of the glabella, broad, thickened and rounded. Palpebral lobes conspicuous.

Glabella sub-pyriform, convex, slightly flattened above, bounded by a sulcus which is strong at the sides and obsolete in front. Baso-lateral lobes strong; antero-lateral impressions well marked.

Cheeks appressed and elevated along the lateral margins of the glabella.

THORAX not observed.

PYGIDIUM semicircular; length to width as 1 to 2.

Axis prominent, elevated and longitudinally arched; width less than one-third that of the shield, rapidly tapering to an apex just within the posterior border; composed of nine annulations which are transverse, rounded and separated by moderately broad sulci.

Pleuræ evenly rounding to the flattened border, and bearing seven annulations, which are strongly sulcate. Border broad, depressed or flat. All the pleural annulations pass over the border to its edge, where the anterior and posterior limbs are of equal strength. Doublure broad.

Surface Ornamentation. The cephalon shows traces of low pustules over the glabella, and upon the depressed frontal area, where they become elongate or lachrymate, sometimes anastomosing, leaving elongate depressions between them; the frontal border also bears an irregular row of conspicuous tubercles. The pygidium is marked by regularly arranged pustules; a median row upon the axis, bifurcating at the fifth or sixth annulation, thence backward continuing double until it becomes obsolete. Four rows of finer pustules are also visible on the axis, two on either side of the median row. The pleuræ bear three or four rows of small pustules, and the interspaces of the crust are minutely granulose, and punctate. The lower surface of the doublure is marked by faint radiating or venate striations.

Dimensions. The single fragment of the cephalon has a length of 7 mm.; the pygidium measures 6 mm. in length and 9 mm. in width.

Observations. This species does not widely differ from the *Proëtus Macrobius*, of Billings, from the Lower Helderberg of Square Lake, Maine. The latter species, however, is of considerably larger size, and also differs in the following particulars, viz.: the frontal area is not concave; the glabella is longer; the axis of the pygidium bears fewer annulations, and the surface of both cephalon and pygidium is smooth or minutely punctate.

This rare species is known in only a few specimens of the cephalon and pygidium. One example shows the two parts in juxtaposition, and from this fact, and from the analogy of other species of this genus, it is more than probable that they belong to the same species and the same individual.

Distribution. Lower Helderberg group. In the shaly limestone: Near Clarks-ville, Albany county.

PHAËTHONIDES (?) DENTICULATUS.

PLATE XXV, FIGS. 14, 15.

Proëtus (Phaëton) denticulatus, MEEK. U. S. Geol. Expl. Fortieth Parallel, part 1, Palæontology p. 49; pl i, figs. 10, 10 a, 10 b. 1877.

CERTAIN fragments, consisting of the pygidium, the glabella and detached thoracic segments, were described by Mr. Meek under the above name, and though the different parts may not have all belonged to the same species, the pygidium, which the author accepted as the type of his description, appears to represent a member of the genus *Phaëthonides*. The original specimens have not been accessible for examination and comparison, and we therefore reproduce the original description of the pygidium, accompanying it with figures copied from the work cited:

“PYGIDIUM transversely sub-elliptic, and nearly twice as wide as long, with a moderate convexity. Its mesial lobe is about as wide anteriorly as each lateral lobe (exclusive of their lateral spine-like projections), and more prominent than the latter, with three or four segments. The lateral lobes are rather depressed and show about four segments each; these segments are not well defined, but have each a distinct mesial furrow, extending out to the margin, where each segment terminates in a short spine directed backward; while there are two other smaller spine-like projections just behind the posterior end of the mesial

lobe; thus making ten of these projecting points to the whole of the free posterior and lateral margins. The surface shows a finely granular appearance under a magnifier."

This pygidium is different in many respects from the others here referred to the genus *Phaëthonides*, and is more nearly similar to the forms which it was the evident intention of M. Barrande to include under the term *Phaëton*. The glabella found in association with the pygidium, if correctly referred to the same species, is also different from those of the other American members of the genus, being distinctly proëtoid and conforming with that of *Phaëton planicauda* and *Ph. striatus*, Barrande. This species, when better known, may serve to establish the group designated by M. Barrande with the preoccupied term *Phaëton*, as generically distinct from *Phaëthonides*.

Distribution. From the west side of Steptoe Valley, Nevada: "Although not found associated with other fossils, they are believed to belong to the Devonian epoch." (Meek, *loc. cit.*)

CYPHASPIS, BURMEISTER, 1843.

CYPHASPIS MINUSCULA.

PLATE XX, FIG. 17; AND PLATE XXIV, FIGS. 7-12.

Phillipsia minuscula, HALL. Illustrations of Devonian Fossils, pl. xx, figs. 17. 1876.

GENERAL FORM AND PROPORTIONS. Outline ovate, posteriorly sub-attenuate.

Surface depressed-convex, sub-equally trilobate. Axis evenly tapering. Length to width as 3 to 2; axial length of cephalon, thorax and pygidium as 3 to 6 to 1.

CEPHALON semi-elliptical in outline, curvature slightly changing at the genal angles, which are produced into spines having an outward curve and reaching almost to the pygidium.

The *facial sutures* take their origin on the posterior margin near the genal angles, pass obliquely forward over the palpebral lobe, thence outward and forward, approximating toward the margin and terminating on the frontal doublure.

Glabella sub-pyriform, evenly convex, sometimes slightly elevated along the axial line; bounded by a strong sulcus, which is shallowest near the palpebral lobe. Basal lobes pyriform, conspicuous; baso-lateral furrows strong; antero-lateral impressions faint. Frontal area scarcely appressed against the glabella, evenly convex and depressed near the margin which is thickened and slightly reflexed.

Eyes elevated, conspicuous. Palpebral lobes relatively small.

Cheeks sloping more or less abruptly from the orbital area to the thickened margin.

THORAX elongate; axis and pleuræ evenly tapering, the latter at about one-third their width from the axis abruptly deflected to the lateral margins. Segments fifteen, each one of which is sulcate upon the pleuræ, the anterior limb being inconspicuous and becoming obsolete by the development of the beveled planes of articulation.

PYGIDIUM small; width greater than twice the length.

Axis strongly arched and bearing three annulations with traces of a fourth, beyond this point becoming obsolete just within the posterior margin.

Pleuræ with abrupt lateral slopes and showing two faint duplicate annulations. Doublure narrow.

Surface smooth, sometimes finely granulose or minutely papillose, and rarely tuberculate. The occipital ring of the cephalon occasionally bears a single short spine at its center.

HYPOSTOMA. A single imperfect example shows the hypostoma slightly displaced from its normal position. This organ is sub-quadrate, with the centrum evenly convex, and separated by a furrow from the flat marginal area. Anterior margin straight(?); lateral margins slightly incurved, widening posteriorly, posterior margin emarginate.

Dimensions. A representative individual affords the following measurement:

	Body.	Cephalon.	Thorax.	Pygidium.
Length	13 mm.	4.5 mm.	7 mm.	1.5 mm.
Width	8 mm.	8 mm.	7 mm.	3.5 mm.

Observations. *Cyphaspis minuscula* has usually been observed as casts of the lower surface. Fragments of the cephalon in this condition of preservation are far from uncommon in the decomposed chert of the Corniferous limestone. From *Cyphaspis craspedota*, of the Hamilton group, the species is distinguished by the more abrupt curvature of the frontal area of the cephalon, the longer genal spines, and the greater number of thoracic segments, none of which appear to bear any spines. It may be compared with *Cyphaspis Halli*, Barrande, from the Bohemian étage E, which it closely approximates in the characters of the cephalon. In that species, however, the glabella is more elongate, the basal lobes less conspicuous, the pygidium relatively larger and with more annulations than in *Cyphaspis minuscula*.

Distribution. Upper Helderberg group. Schoharie grit: Clarksville, Albany county. Corniferous limestone: Schoharie, Schoharie county; Phelps, Ontario county; LeRoy, Genesee county; Clarence, Erie county. In the decomposed chert boulders, Canandaigua and East Bloomfield, Ontario county; North Cayuga, Province of Ontario.

CYPHASPIS STEPHANOPHORA, n. sp.

PLATE XXIV, FIGS. 2-6.

CEPHALON. Outline transversely semi-elliptical; length to width as 1 to 1.7. Genal angles produced into recurved spines which are longer than the axial length of the cephalon. Border spinose and thickened by doublure. Frontal area narrow, convex and appressed about the glabella, anteriorly depressed by abrupt curvature to the thickened, slightly reflexed anterior margin.

Facial Sutures, normal for the genus, originating on the occipital annulation just within the genal angles, passing obliquely forward and inward to the eye-lobe, thence forward and outward to the anterior margin.

Glabella extending three-fourths the length of the cephalon, sub-pyriform, convex, bounded by a strong sulcus which becomes shallow over the ocular lobes. Basal lobes pyriform; baso-lateral furrows deep; antero-lateral impressions faintly discernible.

Cheeks elevated about the orbital node and sloping abruptly to the thickened margin. Palpebral lobes elevated; visual surface not observed.

The *Surface* of the cephalon is ornamented by strong, scattered pustules which become obsolete upon the border and the genal spines. Upon the occipital ring is a single, strong, spiniform tubercle, generally accompanied by a smaller one on either side. The anterior and lateral margins of the cephalon bear two rows of strong spines, one above the other; those of the upper row being the longer and having their bases upon the proximal surface of the marginal rim. The proximal surface of this rim lies vertically upon the margins of the cheeks, and hence the spines which stand perpendicular to its surface, lie in the horizontal plane; as it approaches the frontal margin this rim becomes turned upward and slightly reflexed, so that towards the anterior extremity the spines of the upper row stand at an angle of nearly forty-five degrees to the horizontal. The spines of the lower row are shorter, lying in the horizontal plane on the frontal margin, and deflected below the horizontal plane on the genal margins. Of these spines there are about eighteen in the upper and sixteen in the lower row.

A single fragment of a THORAX associated with a cephalon of this species, shows a very wide and gently arched axis, six narrow and flattened segments each bearing a number of strong pustules, of which there are two longitudinal rows upon the pleuræ, and for each segment of the axis five or six pustules which do not appear to be arranged in longitudinal rows. This appearance may, however, be due to the imperfection of the specimen.

Dimensions. Length of cephalon 4 mm.; width at the posterior margin 7 mm.; length to the extremity of the genal spines 8 mm.

Observations. The striking ornamentation of the cephalon of this species finds its analogue in *Cyphaspis Cerberus*, and *C. Davidsoni*, Barrande, from the étage F, and in *C. coronata*, Barrande, from the étage G. In these species there is but a single row of spines, which in *C. Cerberus* are short and numerous, in *C. Davidsoni* broad and stout, and in *C. coronata* more like the upper row of *C. stephanophora*, but fewer in number.

Distribution. Upper Helderberg group. From the decomposed chert boulders of the Corniferous limestone: Canandaigua and East Bloomfield, Ontario county.

CYPHASPIS DIADEMA, n. sp.

PLATE XXIV, FIG. 13.

A SINGLE example of this species showing only the intra-sutural portion of the cephalon has been observed.

CEPHALON minute; length and width equal; curve of the anterior margin an arc with its center at the middle of the occipital annulation; frontal area broad, gently convex and slightly appressed about the glabellar margins, depressed medially and reflexed upward to the marginal rim.

Facial Sutures normal.

Glabella one-half the length of the cephalon, elongate, sub-elliptical; basal lobes obscure; antero-lateral impressions discernible. Palpebral lobes prominent.

Surface minutely pustulose upon the glabella, the palpebral lobes and on the frontal area close to the glabella. About half way from the anterior extremity of the glabella to the frontal margin is a single row of minute but isolated and distinct tubercles, parallel to the frontal margin. This feature is characteristic and will serve to distinguish the species.

Dimensions. The single specimen has the following size: length 1.7 mm., width 2 mm.

Distribution. Upper Helderberg group. Corniferous limestone: From the boulders of decomposed chert, Canandaigua, Ontario county.

CYPHASPIS HYBRIDA, n. sp.

PLATE XXIV, FIG. 14.

INTRA-SUTURAL portion of the CEPHALON only observed. Outline regularly arcuate; length and width equal; frontal area concave, elevated at the margin to nearly the height of the glabella. Border broad, thickened.

Facial Sutures normal.

Glabella pyriform, convex; basal lobes conspicuous, sub-triangular; baso-lateral sutures strong; antero-lateral impressions inconspicuous.

Surface ornamented by punctæ, which are strongest on the frontal area near the margin. They are also noticeable over the entire surface of the glabella, basal nodes, occipital ring and frontal margin; moderately strong, scattered tubercles are visible on the glabella and over the fixed cheeks. The frontal border also shows faint indications of a single row of low tubercles.

The differences in this species and *Cyphaspis ornata* and *Phaëthonides varicella* are enumerated under the description of *C. ornata*.

Distribution. Upper Helderberg group. Corniferous limestone: In boulders of decomposed chert, Canandaigua, Ontario county.

CYPHASPIS ORNATA.

PLATE XXI, FIG. 1; AND PLATE XXIV, FIG. 21.

Phillipsia? (*Brachymetopus?*) *ornata*, HALL. Illustrations of Devonian Fossils, pl. xxi, fig. 1. 1876.

Phillipsia coronata, HALL. Miller's Cat. Am. Palæoz. Fossils, p. 221. 1877.

[?] *Phillipsia coronata?*, WALCOTT. Mon. U. S. Geol. Surv., vol. viii; Pal. Eureka Dist., p. 211. 1884.

THE original of this species consists of a fragment of the intra-sutural portion of the CEPHALON, and though additional specimens have come under observation the other parts of the animal are still unknown. This portion of the head-shield is small, greatest length and width equal. Anterior outline the arc of a circle, whose center is at the middle of the occipital ring. Frontal area broad, explanate, closely appressed and slightly elevated about the margins of the glabella, thence depressed for about one-half its width and reflexed at the frontal margin.

The *facial sutures* take their origin on the posterior margin near the genal angles, pass obliquely forward and inward over the ocular lobe, thence forward and outward to the anterior margin in the manner normal to the genus.

Glabella about one-half the length of the cephalon, sub-ovoid, a little elevated along the axial line, separated from the frontal area and the ocular

lobes by a low, narrow furrow. The baso-lateral furrows cut off two pyriform lobes, isolated by deep sulci on all sides. In front of these lobes the margin of the glabella shows two faint lateral indentations which are more conspicuous on the casts of the internal surface.

The *surface* of the cephalon is ornamented by a few faint, sometimes fine and crowded pustules upon the glabella, a single strong tubercle on each of the basal lobes, numerous sharp tubercles on the frontal area, and close upon the frontal edge sixteen to eighteen bead-like tubercles arranged in a single row about the border. A single example has the frontal area strongly pitted, a feature which gives it a similarity to *Phaëthonides varicella*, of the Upper Helderberg group.

Dimensions. Length 4 mm., width 4 mm.

Observations. The specimen figured in the Illustrations of Devonian Fossils (*loc. cit.*) is a fragment from the crystalline layers of the Hamilton group, at Eighteen-mile Creek, Erie county. As the species was described in the explanatory text accompanying the plate upon which the figure is given, under the name *Phillipsia? ornata*, and it being subsequently ascertained that this specific term was preoccupied by Portlock for a species of *Phillipsia*, Mr. S. A. Miller changed the specific name to *coronata* (Catalogue of American Palæozoic Fossils, p. 221). Since, however, the fossil proves to be a *Cyphaspis*, its original specific designation may be restored, especially as *Cyphaspis coronata* is a name already used by M. Barrande.

Examples of this species are not uncommon in the limestones at the base of the Hamilton shales, in Ontario county, and in association with them is a varietal form which may be designated:

CYPHASPIS ORNATA, var. BACCATA, n. var.

PLATE XXIV, FIGS. 22, 23.

This form differs from the type of the species in the following particulars, viz.: greater size (average dimensions, length 6 mm., width 5 mm.); frontal area bearing a few pustules near the glabella, but thence forward smooth and sometimes minutely pitted; tubercles on the margin fewer and larger; the

right free cheek shows the genal angle produced into a broad sub-acute spine; the lateral margin carries a row of tubercles which continue with diminishing size to the angle of the cheek; the lateral sub-orbital area bears a few strong tubercles, the interspaces of the surface being faintly pitted.

The *Phillipsia coronata* of Walcott (*loc. cit.*) is a somewhat distorted fragment of a cephalon from Newark Mountain, Eureka District, Nevada. The original specimen differs from the type of *Cyphaspis ornata* in its convex frontal area, and in this feature resembles *C. craspedota*, of the Hamilton group, but the ornamentation of the frontal and lateral areas and of the border is similar to that of the former species, and the specimen thus appears to represent a form intermediate between the two.

Distribution. Hamilton group. *Cyphaspis ornata*, and var. *baccata* occur associated with *Cyphaspis craspedota*, *Proëtus Rowi*, *Proëtus macrocephalus*, *Phacops rana*, and *Dalmanites Boothi*, var. *Calliteles*, in the limestones at the base of the Hamilton shales, near Centerfield, Ontario county. *C. ornata* is also known from the upper shales at Fall Brook, Hopewell, and Canandaigua Lake, Ontario county, and Eighteen-mile Creek, Erie county.

OUR knowledge of the species *Cyphaspis ornata*, *Cyphaspis hybrida*, and *Phaëthonides varicella*, is yet so imperfect that the details of structure here given may eventually prove only of varietal value. The points of difference upon which the species are now separated are as follows: *C. ornata* is usually very sharply pustulose and minutely punctate on the frontal area, a single example which retains the characteristic beaded border, being strongly pitted and affording a transitional form to the species *C. hybrida*, which is strongly punctate upon its entire surface bearing an elevated border upon which the tubercles are obsolescent. In *Ph. varicella* the surface is both tubercled and punctate, but not so strongly tubercled as in *C. ornata*, nor so strongly punctate as in *C. hybrida*, while the margin is thin and without tuberculations.

As it has been necessary to refer one of these species to the genus *Phaëthonides*, on account of its characteristic pygidium, it may be probable that the other

two species, of which only the cephalæ are known, may belong to the same genus, but in the absence of conclusive evidence they are allowed to remain under the genus *Cyphaspis*, with which they agree in the characters of the head-shield.

CYPHASPIS CRASPEDOTA, n. sp.

PLATE XXIV, FIGS. 15-20.

Compare *Phillipsia coronata*? WALCOTT. Monogr. U. S. Geol. Surv., vol. viii; Pal. Eureka Dist., p. 211. 1884.

GENERAL FORM AND PROPORTIONS. Outline regularly oval, interrupted only by the projection of the genal spines.

Surface convex, conspicuously and sub-equally trilobate. Axis prominent, elevated; pleuræ abruptly deflected on the lateral slopes. Length to width as 3 to 2.

CEPHALON. Outline nearly semicircular; length to width as 1 to 1.6. Border thickened, slightly reflexed, produced at the genal angles into spines which reach to the sixth thoracic segment. Doublure narrow, epistoma indistinguishable. Marginal sulcus broad; frontal area convex near the glabella, lateral areas depressed-convex, and abruptly sloping. Occipital furrow and ring distinct, the latter thickened at the center.

Facial Sutures normal.

Glabella ovate or sub-pyriform, evenly convex, slightly flattened above; bounded on all sides by a strong sulcus, which is shallowest near the palpebral lobes. Basal nodes conspicuous, pyriform or sub-triangular. Basolateral furrows strong; antero-lateral impressions faint, and discernible only in casts of the lower surface.

Cheeks depressed and sloping abruptly from the eye-lobe to the thickened border.

Eyes conspicuously elevated, attaining the height of the glabella; base sub-pedicellate, slightly constricted. Visual surface sub-lunate, smooth, when strongly magnified, showing numerous homo-corneal lenses. Palpebral lobe strong, not projecting, sloping abruptly to the palpebral sulcus.

THORAX elongate, length to width as 1.3 to 1. Margins tapering with a regular curvature. Composed of twelve segments of which the first, fourth and sixth are the stronger, the last two being spiniferous.

Axis broad and arched; width equal to one-third that of the thorax; widest at the third or fourth segment and tapering rapidly to the pygidium.

Pleuræ flattened near the axis for about one-third their width, and sharply deflected at the fulcra. Pleural sulci strong; anterior pleural limbs angulated by the articulating planes, not becoming obsolete on the lateral slopes as in most species of this genus. Posterior limbs of the pleural segments very strong.

PYGIDIUM minute; length to width as 1 to 2.

Axis broad, tapering rapidly to an obtuse termination within the posterior margin; bearing two strong annulations, with indications of a third.

Pleuræ deflected, each bearing three double annulations, which become obsolete within the slightly thickened margin.

Surface Ornamentation. Cephalon usually pustulose, the pustules being strongest upon the glabella and frontal area. The ornamentation upon these parts is often nearly obsolete, and the frontal margin generally quite smooth, sometimes with scattered obsolete pustules. The occipital ring, and the fourth and sixth segments of the thorax each bear a single slightly recurved spine, that upon the sixth segment being much the strongest. On the axis are four rows of minute granules, two on each side of the median line. The fulcra of the pleuræ each bear a single row of small bead-like pustules. These rows of pustules, upon the axis and pleuræ of the pygidium, approximate, and the posterior area is covered with scattered granulations.

Dimensions. An average entire individual measures:

	Body.	Cephalon.	Thorax.	Pygidium.
Length -----	12 mm.	3.5 mm.	7 mm.	1.5 mm.
Width -----	6.5 mm.	6.5 mm.	5.5 mm.	3 mm.

Fragments occasionally indicate slightly larger dimensions than the above.

Observations. *Cyphaspis craspedota* is not an uncommon species in the basal limestones of the Hamilton group in the township of Canandaigua, where a few entire individuals and parts of several hundred others have been found. Its occurrence in other localities of this formation has not been noticed. The species is closely allied to *Cyphaspis Burmeisteri*, Barrande (Sys. Sil., vol. i, p. 484, pl. xviii, figs. 61–71), from the étages D and E. This similarity is apparent in the general form and proportions, the position of the eyes, length of the genal spines and character of the surface ornamentation. Moreover the sixth thoracic segment in *C. Burmeisteri* bears a strong spine, as in our species, but the occipital ring and fourth segment in the former species, are without spines. Barrande has also shown that the number of thoracic segments for mature individuals of his species is fourteen; in immature examples varying from seven to thirteen. All the entire individuals of *C. craspedota* show but twelve segments. The pygidium of the Bohemian species is also larger and more strongly segmented. *C. craspedota* probably finds a congener in the *C. hydrocephala*, Maurer, of the German middle Devonian (Fauna der Kalke von Waldgirmes bei Giessen, pl. xi, figs. 20–22, not *C. hydrocephala*, A. Roemer, 1845; Barrande, 1852; Kayser, 1878).

Distribution. Hamilton group. In the shales and limestones directly overlying the Marcellus shales: Near Centerfield, township of Canandaigua, Ontario county.

CYPHASPIS LÆVIS.

PLATE XXI, FIG. 29.

Phillipsia lævis, HALL. Illustrations of Devonian Fossils, pl. xxi, fig. 29. 1876.

CEPHALON minute, outline semi-elliptical; surface convex; border conspicuous, elevated and rounded, produced at the genal angles into moderately long, slightly incurving spines; marginal sulcus deep; frontal area evenly convex.

Facial sutures normal, crossing the frontal area somewhat abruptly.

Glabella sub-ovoid, convex; basal lobes sub-pyriform, conspicuous; antero-lateral depression faint. Occipital ring not retained.

Cheeks broad, depressed about the base of the eyes and sloping with slight concavity to the margins. Occipital furrow narrow and deep; occipital ring rounded.

Eyes small, and elevated above any other portion of the head.

Surface smooth or minutely punctate.

The other parts of the animal have not been discovered.

Dimensions of the cephalon. The single specimen which has been observed measures 2 mm. in length and 3.8 mm. in width.

Observations. This species, in its general features, in the convexity of the frontal area and the smoothness of the test, appears to be closely similar to *Cyphaspis minuscula*. It differs from the latter in its more elevated and wider border and shorter cheek-spines, as well as in its smaller size, it being one of the most minute species of *Cyphaspis* yet observed in the Devonian rocks. Its occurrence in the beds of the Chemung group makes it the latest known representative of the genus, and with the exception of the somewhat doubtful species, *Phacops nupera*, is the only trilobite known from this formation.

Distribution. Chemung group. Chemung county.

CYPHASPIS CŒLEBS, n. sp.

PLATE XXIV, FIG. 1.

GENERAL FORM AND PROPORTIONS. Outline elliptical, lateral margins rapidly curving to the pygidium.

Surface depressed, distinctly trilobate. Axis broad, rapidly tapering posteriorly.

CEPHALON semi-elliptical in outline; marginal rim flattened, slightly reflexed; produced at the genal angles into spines, which extend to the pygidium. Frontal area convex, abruptly deflected from the glabella; lateral area depressed-convex.

Glabella ovoid; basal lobes distinct. Palpebral lobes high, distant; palpebral sulcus broad and deep.

THORAX elongate, rapidly narrowing. Composed of twelve segments.

Axis broader than either lateral lobe, broadest at the fourth or fifth segment and tapering rapidly to the pygidium.

Pleurae gently deflected at the fulcra, the segments being conspicuously sulcate.

PYGIDIUM imperfectly known, probably very small.

Surface smooth or minutely granulose.

Dimensions :

	Body.	Cephalon.	Thorax.	Pygidium.
Length	11 mm.	3.5 mm.	6.5 mm.	1 mm. ?
Width	7 mm.	7 mm.	6 mm.	2 mm. ?

Observations. This species approaches *Cyphaspis minuscula* in the contour and outline of the cephalon, but the much greater width of the axis, more rapidly tapering margins and longer cheek-spines, will serve as distinguishing characters.

A single imperfect individual retaining the parts in juxtaposition, and showing the lower surface of the test, and a fragment of the cephalon of another, are all the specimens known of this rare species, and constitute the only representative of the genus in this horizon.

Distribution. Lower Helderberg group. Near Clarksville, Albany county; Schoharie, Schoharie county.

XIPHOSURA.

LIMULIDÆ.

PROTOLIMULUS, PACKARD. 1886.

PROTOLIMULUS ERIENSIS.

PLATE XXVI, FIGS. 1, 2.

Prestwichia Eriensis, H. S. WILLIAMS. Amer. Jour. Science, vol. xxx, Third Series, p. 46, figs. 1-3. 1885.
Protolimulus Eriensis, PACKARD. Mem. Nat. Acad. Sciences, p. 150, figs. 11-13. 1886.

THE type specimen of this interesting species is an impression of the lower surface of the body, in very high relief, upon a block of fine-grained, compact, olive-gray sandstone. Its condition of preservation is such that the removal of the substance of the tenuous test, during the process of fossilization, and the infiltration of the sediments into the internal cavities of the telson, genal and abdominal spines, has left these parts standing out conspicuously, while over the central portion of the fossil there are various impressions which appear to be those of the appendages, and indicate something of the structure of the ventral surface of the animal. In the original description of the species, these characters have been carefully studied, and have undoubtedly been given their full importance, for the medium in which the fossil is preserved is not of such a character as to retain, with perfection, such delicate impressions as the appendages of this animal would have made, and it is possible that the appearances described may to a certain degree be fortuitous or mechanical, and without structural relation to the fossil itself; there is however a distinct symmetry in their arrangement, and it is important that the view of their mechanical origin be subordinated to that of their organic character.

The description of the fossil is as follows:

Outline of the BODY (cephalothorax and abdomen) sub-circular or slightly ovate, the genal spines scarcely protruding to interrupt the regularity of the outline.

CEPHALOTHORAX sub-semicircular in outline, genal spines produced as far as the tip of the first abdominal spines. The infolded frontal border is broad and convex anteriorly, narrowing to the base of the genal spines. In the axial line its edge, or a ridge upon its surface, appears to be connected with a bi-symmetrical, trifoliate plate, which lies in front of the probable position of the mouth and extends backward, its largest lobe lying in the axis. This has been regarded by Mr. Williams as possibly an hypostomal plate. It may be suggested, that if this body were continuous with the frontal border the apparent posterior margin of the doublure might be regarded as a sharp ridge upon the lower side, curved backward in the axial line, similar to that in *Limulus* and *Prestwichia*. Such an interpretation of this character is not unsupported by the appearance of the fossil and obviates the necessity of supposing the animal to have differed from the *Limulidæ* in the possession of an hypostomal plate, while agreeing in other respects. Behind the margin of the infolded test, lies a series of indistinct impressions of narrow appendages, of which three and possibly four pairs are discernible. They appear to be centered about a cavity close behind the apex of the doublure and to bend outward and upward in a broad curve. Near the genal spines on either side is a conspicuous, irregularly striated area, which Mr. Williams has suggested may be the impressions made by the foliaceous terminations of the last pair of limbs; they are certainly very suggestive of such an origin.

Behind these appendages and situated at about the center of the surface of the fossil is a transversely-elongate, triangular impression having the position of the *thoracic* or *opercular plate* in *Limulus* and the *Eurypterida*. The apex of this impression lies in the axial line, its lateral slopes are long and its length is less than one-half its width along the posterior margin. Two parallel longitudinal furrows divide it into median and lateral areas, and these

furrows appear to be carried for a considerable distance posteriorly over an area that may have been the continuation of this plate. Admitting that it was thus produced, there is evidence that it was divided by a transverse furrow or suture, making the analogy of its structure with that of the thoracic plate in *Limulus* very striking.

ABDOMEN. The posterior surface of the body bears a transverse row of eight, possibly ten longitudinal ridges, which may be the impressions of elevations on the surface of the abdominal area. These correspond in number with, and lie immediately in front of the stout spines fringing the postero-lateral margins, although the inner pair of spines lies so close against the base of the telson as to have left only very faint impressions.

TELSON very stout at its base, tapering to a blunt extremity, and having a length equal to nearly two-thirds that of the cephalothorax.

Dimensions. Axial length 100 mm.; width 58 mm. Length of telson 32 mm.

Observations. The affinities of this fossil, as far as it is possible to judge, are distinctly limuloid, as pointed out by Professor Packard (*loc. cit.*), who has proposed the generic term *Protolimulus* to include this form. Both Williams and Packard ascribe to the fossil seven abdominal segments, including the telson; we have, however, been able to find evidence of but *six*, though it may be reasonable to assume that the first or first two of these segments were concealed by the appendages of the animal. The character of the dorsal surface is a matter of conjecture, but as far as the specimen enables us to form a conception of it, it seems to be closely similar to that in the genus *Neolimulus*, of Woodward (*N. falcatus*, from the Lesmahagow deposits of Lanarkshire), in which the abdomen is composed of *nine* segments besides the telson, which are regarded by Woodward as unanchylosed; it is probable that this is likewise their condition in *Protolimulus*.

Distribution. Chemung group, LeBoeuf, Erie county, Pennsylvania.

EURYPTERIDA.

EURYPTERIDÆ.

EURYPTERUS, DEKAY. 1825.

EURYPTERUS BEECHERI.

PLATE XXVII, FIG. 5.

Eurypterus Beecheri, HALL. Second Geol. Surv. Pennsylvania, PPP, p. 30, pl. iii, fig. 1. 1884.

CEPHALON unknown.

BODY elongate, broadly convex along the dorsum, becoming more elevated posteriorly; composed of twelve somites, which gradually increase in breadth from the first to the fifth; thence backward rapidly decreasing in width and increasing in length, the eleventh having a length equal to one-half its width, while the fifth is nearly five times its length. The surface of the somites toward the lateral margins is depressed, the margins themselves being slightly produced at the postero-lateral angles into mucronate extensions. The posterior dorsal margin of each somite bears a single row of triangular scales or tubercles. The number of these scales varies with the width of the somite, there being six on the narrower and eight or more on the broader somites.

At the anterior portion of the specimen are preserved two joints of one of the great swimming feet, which are remarkable for their length and the three or more strong longitudinal ridges upon their surface. The distal joint has a length of more than three times its width, and the proximal joint a length of nearly five times its width. These joints are probably the fourth and fifth, the smaller joints near the base of attachment having disappeared.

TELSON and appendages unknown.

Dimensions. The single specimen from which this description is drawn is somewhat curved to the left toward the posterior extremity, and has a length along the axis of 97 mm. The body measures 39 mm. in width at the first somite, 41 mm. at the fifth, and 20 mm. at the eleventh. The fragment of the natatory appendage measures 50 mm. in length, of which the proximal joint measures 30 mm.

Observations. This specimen, although in an imperfect condition, is sufficiently well-preserved to allow of description and identification, and is of especial interest as the only representative of the genus known to occur in this geological formation.

Distribution. Chemung group. In the sandstones at Warren, Warren county, Pennsylvania.

EURYPTERUS PROMINENS.

PLATE XXVII, FIGS. 3, 4.

Eurypterus prominens, HALL. Proc. Amer. Assoc. Adv. Science, vol. xxxiii, p. 420. 1884.

CEPHALON sub-quadrate in general outline; anterior margin broadly circular, curving regularly to the lateral margins, which are parallel; posterior margin transverse, bending slightly forward. Surface convex, sloping more abruptly in front than laterally; flattened above over a triangular area, bounded by a faint transverse ridge joining the centers of the eyes and two oblique ridges passing from the posterior angles of the eyes to near the posterior margin, meeting in the axial line.

The eyes are large, lunate or obliquely fucate, distant, situated near the antero-lateral margins. The surface of the cephalon beneath their outer edges is depressed. The ocelli are represented by two minute pits lying near the axial line and in a transverse line joining the posterior extremities of the eyes. These are separated from each other by a distance of 2 mm. On the postero-lateral slopes are two oblique linear depressions having the lower extremities directed inward. These are each situated about half way

from the axial line to the margin, and may represent processes on the lower surface of the test designed for the attachment of the basal joints of the swimming feet or of the muscles moving those joints.

Dimensions. The specimen here described has a length of 28 mm., a width of 30 mm., and a height of 5 mm. The distance between the posterior extremities of the eyes is 16 mm.

Observations. This species is described from a specimen of the cephalon preserved in a block of sandstone and retaining the normal convexity of this part. Although only this fragment of the animal is known, it appears to be distinctly different from any species of *Eurypterus* heretofore described, and its specific validity rests upon the following features: (a) the convexity of the head-shield; (b) the anterior position of the eyes; (c) the ocelli, situated further back than is usual; (d) the flattened summit of the cephalon; (e) the oblique linear depressions on the postero-lateral area.

Distribution. Clinton group. In the greenish sandstones from the northern part of Cayuga county.

STYLONURUS, PAGE. 1856.

STYLONURUS EXCELSIOR.

PLATE XXVI.

Stylonurus excelsior (*Stylomurus* in error), HALL (MARTIN). Trans. N. Y. Acad. Sciences, vol. ii, p. 8. 1882.
Stylonurus excelsior, HALL. Thirty-sixth Ann. Rept. N. Y. State Mus. Nat. Hist., p. 77, pl. v, fig. 1. 1883.
Stylonurus excelsior, HALL. Proc. Amer. Assoc. Adv. Sciences, vol. xxxiii, p. 421. 1884.
 Compare *Dolichocephala Lacoana*, CLAYPOLL. Proc. Amer. Phil. Soc., vol. xxi, p. 236, plate. 1883.

CEPHALON elongate, semi-ovate; length to greatest width as 6 to 5. Basal margin transverse; baso-lateral angles truncate; lateral margins curving gently outward from the base, thence sloping more rapidly forward to the narrow anterior extremity. Surface depressed-convex.

Eyes large, circular, closely appressed, situated just in front of the greatest transverse diameter of the plate and separated by a prominent median ridge. Each eye is encircled on its outer edge by a conspicuous, sub-semicircular

orbital ridge. These ridges slope gradually outward, but more abruptly on their inner faces, their anterior extremities approximating the median ridge at its widest and most elevated portion. This median ridge is rounded and comparatively smooth as far backward as the posterior margin of the eyes, at which point it is interrupted, thence widening posteriorly into a broad, blunt, coarsely tubercled termination; toward the anterior extremity it becomes merged in the general convexity of the shield.

The *Surface* of the cephalon over the anterior region has a general and regular convexity toward the frontal margin, becoming a little more convex about the anterior extension of the orbital ridges. From near the posterior extremities of these orbital ridges runs an irregularly sigmoid depression, which widens and becomes obsolete just within the baso-lateral margins. The median area behind the eyes is depressed-convex or flattened, and is divided into three parts, a narrow central area, apparently a continuation of the longitudinal ridge passing between the eyes, and a broad, sub-semicircular area on either side. Behind this gently elevated region lies a broad, nearly smooth depression, followed by the elevated posterior border.

The ornamentation of the surface consists of conspicuous, squamiform tubercles, which are elongate and most elevated over the anterior portion of the shield, but become broader and more triangular posteriorly. They are arranged in lines concentric with the margin of the shield or with the most prominent features of its contour. Within the orbital ridges these scaly markings are comparatively fine, and over the depressed posterior area are quite obsolete.

Other parts of the animal are unknown.

Observations. The specimen from which the above description is drawn, consists of the intaglio and rilievo impressions of a single cephalon. These were found in a loose block of fine-grained, olive-gray sandstone, in the town of Andes, Delaware county, and are now in the possession of Rutgers College, New Brunswick, N. J. The mould of the dorsal surface retains all the details of structure and ornamentation in great distinctness and perfection, and the

drawing which accompanies this description has been made from a plaster impression of this natural mould.

The cephalon in *S. excelsior* is more elongate, the anterior extremity narrower and the orbital ridges very much more prominent than in any other known species. It has an axial length of 252 mm., and a width of 223 mm., or a length of about ten and a width of about nine inches. It undoubtedly represents one of the largest of palæozoic crustacea, probably the largest known with the exception of *Pterygotus anglicus*. By comparison with the other species of *Stylonurus*, *S. Logani*, and *S. Powriei*, Woodward, of which the length is known either from entire specimens or approximate restoration, it appears that *S. excelsior* would have measured, when entire, upward of fifty inches in length.

Distribution. Catskill group. Andes, Delaware county.

STYLONURUS(?) (ECHINOCARIS?) WRIGHTIANUS.

PLATE XXVII, FIGS. 7-9.

Equisetides Wrightiana, DAWSON. Quart. Jour. Geol. Soc., vol. xxxvii, p. 301, pl. xii, fig. 10; and pl. xiii, fig. 20. 1881.

Equisetides Wrightiana (DAWSON), HALL. Thirty-fifth Rept. N. Y. State Mus. Nat. Hist.: Expl. pl. xv. Note, and figs. 1 and 2, (Transmitted, 1882). 1884.

Echinocaris Wrightiana, JONES and WOODWARD. Geological Magazine, Dec. iii, vol. i, No. 9, p. 3, pl. xiii, figs. 1, a and b. 1884.

Echinocaris Wrightiana, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 35. 1885.

CEPHALOTHORAX unknown.

ABDOMEN. The original specimen consists of two somites, each being sub-cylindrical and flattened on the dorsal and ventral surfaces; the anterior somite somewhat the shorter and broader. The anterior margin of each somite is elevated into an articulating ridge, which is shown to the best advantage upon the posterior segment, as the overlapping edge of the preceding joint has been broken away in such a manner as to expose it. The dorsal and lateral surfaces of each segment bear a series of sharp longitudinal ridges which extend for nearly one-half the length of the segments. These ridges themselves do not appear to have extended far beyond the posterior margins of the segments, but they may have served as the bases of attachment of

spines of considerable strength. Impressions, which have apparently been left by the projecting spines of the anterior somite, are visible upon the anterior portion of the next one, caused by compression during the process of fossilization. There are eight spine bases upon the posterior somite, one of these being situated on the lateral margin, six upon the dorsal margin, and one on the ventro-lateral margin, the ventral margins bearing none.

The *surface* is covered with low, distant, scale-like pustules, undoubtedly less conspicuous and apparently more distant upon this internal cast than they were upon the external surface.

Dimensions. The length of the entire fragment is 90 mm. The anterior somite measures 43 mm. in length and 60 mm. in width; the posterior 44 mm. in length and 55 mm. in width.

Observations. This remarkable fragment, which was regarded by the author of the species as of vegetable nature and referred to the genus *Equisetides* (Dawson, *loc. cit.*), exhibits undoubted crustacean characters. Attention was called to this fact in the following note appended to the explanatory text of plate 15 of the Thirty-fifth Report on the New York State Museum of Natural History; this plate being made up of several of Dr. Dawson's figures of Devonian plants, and introduced in the report to illustrate an accompanying paper by Mr. Berlin H. Wright, on the geology of Yates county, N. Y.

“NOTE (Fig. 1).—The peculiar aspect and markings of this figure, as originally published in the *Quarterly Journal* of the London Geological Society, led the writer to suspect its relations to the crustacea. Through the kindness of Mr. Wright, who procured the loan of the specimen, I have had an opportunity of seeing the original, which is very correctly represented in the figure. The body is not cylindrical, but broadly elliptical or sub-ovate, enlarging above. The ridges occur only upon one side, having a symmetrical relation with the form of the body, while the other parts are free from them, and the joints are overlapping. The form of this body, together with the character of the ridges and the finer surface markings, suggest its crustacean origin. The lateral scars have probably been points of attachment for spiniform processes as in *Stylonurus*. The fragment represents two of the abdominal segments of a form not unlike *Stylonurus*, though comparatively longer than in the ordinary forms of that genus, and in this respect resembling *Slimonia*.”

After the recognition of its crustacean character, as expressed above, casts of the specimen and drawings of its finer markings were, at his request, sent to Dr. Henry Woodward, by whom, in association with Professor Jones (*loc. cit.*),

the fossil was referred to the genus *Echinocaris*. This reference was evidently based on the spinose character of the somites, but it is important to notice that no species of this genus, of which the abdominal parts are known, possess spines of similar character to those in this specimen. In *Echinocaris punctata*, *E. socialis*, etc., these spines project over the posterior margins, their bases not being conspicuously elongated. In this species, however, the longitudinal ridges, as noticed in the description, do not extend beyond the posterior margins, the spines being either produced by an internal thickening and a prolongation of the portions of the test between the ridges, or were movable, detachable bodies, having their bases articulated to the sides of the ridges, and directly comparable to the "epimeral" processes in the abdomen of species of *Stylonurus* (e. g. *S. Scoticus*, Woodward, Palæontographical Society, 1872, pl. xxiii), and the marginal abdominal spines in *Limulus*. In *Stylonurus* the dorsal surface of the abdominal segments is often strongly ridged at their posterior margins as in this species, but it does not appear to bear spines or the epimeral appendages. It may be added that while this fragment would indicate a size for the entire animal not great for a species of *Stylonurus*, it would be gigantic for *Echinocaris*, upward of twenty-five inches in length if restored according to the proportions of *E. punctata*.

The true generic position of this species must remain a matter of uncertainty until more light is thrown upon the question by the addition of new material.

Distribution. In the lower beds of the Portage sandstones, Italy, Yates county.

PHYLLOCARIDA.

CERATIOCARIDÆ.

CERATIOCARIS, MCCOY. 1849.

CERATIOCARIS LONGICAUDA.

PLATE XXXI, FIG. 1.

- Ceratiocaris longicaudus*, HALL. Sixteenth Rept. N. Y. State Cab. Nat. Hist., p. 73, pl. i, fig. 7 (not figs. 4, 5 and 6). 1863.
- Ceratiocaris longicaudus*, PACKARD. Twelfth Ann. Rept. U. S. Geol. Surv., Monog. N. Amer. Phyllopod Crust., p. 450. 1883.
- Ceratiocaris (?) longicaudus*, JONES and WOODWARD. Notes on Phyllopod. Crust., referable to the genus Echinocaris, etc., Geol. Mag., Dec. iii, vol. i, No. 9, p. 1. 1884.
- Ceratiocaris longicaudus*, ETHERIDGE, WOODWARD and JONES. Third Rept. Com. on Fossil Phyllopoda of the Palæozoic Rocks, p. 35. 1885.
- Not *Ceratiocaris longicaudus*, CLARKE. Bull. U. S. Geol. Surv., No. 16, Higher Devonian Faunas of Ontario county, N. Y., p. 20. 1885.

THE original of this species is a very tenuous impression of the last two abdominal somites and two caudal spines, one of which may be the telson. Of the somites the penultimate is broad and sub-quadrate, slightly longer than wide; the ultimate much narrower and more elongate, being twice as long as wide. The caudal plate is not distinguishable; of the two spines, one, which is unbroken, is as long as the two somites. The entire length of the fragment is 26 mm.; the first of the somites measures 5 mm. in length and 4.5 mm. in width; the second 7.5 mm. in length and 3.7 mm. in width, and the longer of the caudal spines has a length of 12.5 mm. The specimen has been so flattened in the shale that superficial markings are not discernible. But a single example of this species has been observed, and this is from the black slaty shale

of the Genesee epoch. The fossils originally illustrated in association with this species (Sixteenth Rept. N. Y. State Cab. Nat. Hist., figs. 4, 5 and 6, *loc. cit.*), and at the time of the publication of the description, regarded as detached caudal spines of larger individuals of the same species, prove to be specimens of the pteropod *Coleolus aciculum*, Hall. An undescribed species bearing very long and slender caudal spines is, however, known to occur in this formation, and it is probably distinct from *Ceratiocaris longicauda*. This undetermined species is the one referred by Clarke (*loc. cit.*) to *Ceratiocaris longicaudus*.

Distribution. Hamilton group. Genesee shales: Bristol, Ontario county.

CERATIOCARIS BEECHERI.

PLATE XXXI, FIG. 3.

Ceratiocaris Beecheri, CLARKE. Bull. U. S. Geol. Surv., No. 16, Higher Devonian Faunas of Ontario county, N. Y., p. 44, pl. ii, fig. 1. 1885.

THE original of this species consists of the two posterior *abdominal somites* and the *post-abdomen*, no additional examples having been observed. The specimen has been flattened in a soft shale, and its surface ornamentation not distinctly preserved. There appear to be no lateral or marginal spines upon the somites and the species is therefore referred to the genus *Ceratiocaris*.

Of the two abdominal somites the anterior is relatively short, with anterior and posterior margins slightly incurved. Its length is 3 mm., and its width 6.5 mm. The posterior somite is longer, measuring 8 mm. in length and 5 mm. in width. The caudal plate is sub-triangular on the dorsal surface; the telson rather stout, 10 mm. in length; the cercopods, of which a portion of one is wanting, a little longer. All these spines are carinate, the telson along the middle and the cercopods on their lateral margins.

Distribution. In the Cashaqua shales of the Portage group as originally limited ("Naples beds," of Clarke). Son Yea, Livingston county.

CERATIOCARIS (?) SIMPLEX.

PLATE XXXI, FIG. 2.

Ceratiocaris simplex, CLARKE. Bull. U. S. Geol. Surv., No. 16, Higher Devonian Faunas of Ontario county, N. Y., p. 43, pl. ii, fig. 2. 1885.

THE characters of this species are quite obscure, the type specimen being a cast of the internal surface of the *cephalothorax*. This appears to be bivalvular, oval in outline, the hinge-line gently curved. The anterior extremity is somewhat broken, but appears to have been obliquely truncate or slightly notched; the ventral margin has about the same degree of curvature as the dorsal line, and the posterior extremity is sub-acute. Surface convex, sloping gently to the ventral margin, but much more abruptly to the dorsal line. The margin is distinctly thickened on all sides and was probably somewhat elevated. No evidence of ornamentation is visible. The single valve measures 29 mm. in length by 12 mm. in width.

Distribution. In the lower shales of the Portage group as originally defined ("Naples beds," of Clarke). Parrish gully, Naples, Ontario county.

ECHINOCARIS, WHITFIELD. 1880.

ECHINOCARIS PUNCTATA.

PLATE XXVII, FIG. 10; PLATE XXVIII, FIGS. 1-7; AND PLATE XXIX, FIGS. 1-8.

- Ceratiocaris? punctatus*, HALL. Sixteenth Rept. N. Y. State Cab. Nat. Hist., p. 74, pl. i, fig. 8. 1863.
Ceratiocaris armatus, HALL. Sixteenth Rept. N. Y. State Cab. Nat. Hist., p. 72, pl. i, figs. 1-3. 1863.
Ceratiocaris armatus, HALL. Illustrations of Devonian Fossils, pl. xxiii, figs. 4, 5. 1876.
Ceratiocaris (Aristozoe) punctatus, HALL. Illustrations of Devonian Fossils, pl. xxiii, fig. 7. 1876.
Echinocaris punctatus, WHITFIELD. American Journal of Science, Third Series, vol. xix, p. 37. 1880.
Echinocaris punctatus, PACKARD. Palæozoic Allies of Nebalia. Amer. Naturalist, p. 952, fig. 12. 1882.
Echinocaris punctatus, PACKARD. Monog. North Amer. Phyllopod Crust. Twelfth Ann. Rept. U. S. Geol. Survey, p. 450, fig. 70. 1883.
Echinocaris armatus, PACKARD. Monog. North Amer. Phyllopod Crust. Twelfth Ann. Rept. U. S. Geol. Survey, p. 451. 1883.
Echinocaris punctata, BEECHER. Ceratiocaridæ from the Chemung and Waverly groups. Second Geol. Surv. Penna., vol. PPP, p. 6, pl. i, figs. 13-16. 1884.
Echinocaris armata, JONES and WOODWARD. Notes on Phyllopodiform Crustacea, referable to the genus *Echinocaris*. Geol. Magazine, Dec. iii, vol. i, No. 9, p. 2, pl. xiii, fig. 2. 1884.
Echinocaris armata, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 35. 1885.

CEPHALOTHORAX. Each valve obliquely sub-ovate, widest posteriorly. Surface gently and irregularly convex, most elevated in the postero-lateral region. Length to greatest width as 1.5 to 1. Hinge-line short, somewhat longer than one-half the length of the carapace, slightly thickened and elevated, and upon the posterior half bearing three or four low tubercles. The anterior margins of each valve are slightly reëntrant at the dorsal line, curving thence abruptly and rounding to the ventral edge in a constantly widening arc to the postero-lateral extremity; thence forward the margin is sharply curved for a short distance and slopes to the hinge in a nearly straight line. The posterior reëntrant angle thus formed between the valves is broad and deep. The entire margin is normally somewhat thickened and elevated into a sharp ridge; in specimens from the shales it is usually flattened. In well preserved examples, the posterior margin bears a few low tubercles, which in old individuals are elongated into stout spinules.

The *nuchal furrow* takes its origin upon the dorsal line just in front of the centre and passes obliquely forward to the antero-lateral margin, cutting off a sub-triangular area on each valve. This double area constitutes the

Cephalic region, which, upon the anterior portion of each valve, bears a broad, low node, a small elevated tubercle near the hinge, and a small node near the nuchal furrow, distant from the hinge. The last mentioned node upon each valve is usually slightly depressed at the summit, and occupies the position of the optic spot or eye.

Thoracic region large, anteriorly nodose, smooth and evenly convex behind. Just behind the nuchal furrow and close upon the hinge-line, there is a transversely elongate node, with its summit directed dorsally; below it an obliquely elongate node without apex. These two nodes are separated from the broad and evenly rounded postero-dorsal area by a conspicuous furrow. On the ventral area is a sharply elevated and conspicuous carina, beginning near the antero-lateral margin, and rounding in a broadly sigmoid curve to the posterior extremity of the carapace. The anterior curve of this ridge is dorsal, the posterior ventral, and the ridge itself is more strongly excavate upon its upper or dorsal slope. Under favorable preservation the area between the carina and the ventral margin shows a series of fine, undulating, elevated lines, radiating from the ventral edge of the carina.

Surface of the carapace over the cephalic region covered with low, faint pustules, which become more conspicuous upon the thoracic region. Upon the ventral face of the carina, and at the ventral margin, these pustules become elongated and much stronger. In specimens from the sandy shales of the central counties these markings appear as punctæ.

MANDIBLES. Two examples have been observed which retain these organs in their approximately normal position beneath the carapace. Of these one is a small individual measuring about 60 mm. in entire length, which has been described and figured by Mr. Beecher (*loc. cit.* fig. 16); the other a very large individual, measuring 185 mm. in entire length, in which the mandibles have been somewhat flattened but not much dislocated. These bodies are

sub-triangular in outline, with their apices posterior, very convex on their anterior surface and elevated along their longest axis. The masticating surfaces are parallel, approximate, moderately broad and bear four or five denticles of which the posterior is apical. Their substance is tenuous as in the carapace, except upon the crown, where it is sufficiently thick to retain the form without distortion. A very large carapace, 90 mm. in length, which belonged to the largest individual yet observed, shows a single mandible somewhat out of place, and compressed in such a manner as to conceal the masticating edge. It shows, however, a long process at the anterior extremity ("manubrium," Beecher), which has been broken off at the tip. Such a process is often noticed in detached mandibles, to which reference will presently be made, but of the two specimens referred to in which these organs are undisturbed in the rock, the mandibles of the smaller evidently lacked any such processes, and those of the latter are so preserved as not to show them had they existed. These mandibles are situated within the posterior half of the carapace, and are at least one-third as long as the carapace itself.

ABDOMEN long, slowly tapering to the *caudal plate*, and composed of six somites, which increase in length posteriorly, the ultimate joint being as long as the first two, and one-half longer than the penultimate. The anterior and posterior margins of each somite are slightly elevated and incurved on both dorsal and ventral sides; the dorsal surface is rounded and gently concave above, except upon the last somite. The posterior margin of each somite bears six short incurved spines, in three pairs. The strongest pair of these is upon the dorsal surface, a second and somewhat shorter pair upon the dorso-lateral surface, and a third pair (in young individuals often very faint) upon the lateral margins. Upon the anterior somites these spines are usually quite small or visible only as nodes. The ventral surface bears no spines. The articulating surfaces of the somites are broad, and when the abdomen is normally extended they come into actual contact only at the sides, leaving both the dorsal and ventral margins distant, a fact which indicates (as noted by Beecher) great freedom of motion in these parts.

POST-ABDOMEN. *Caudal plate* short, sub-quadrangular upon the ventral side, and sharply elevated on the anterior edge; sub-pentagonal on the dorsal side, elevated in the middle on the posterior half, and produced into a telson which is usually about twice as long as the last somite. Articulated to the caudal plate are two lateral spines or cercopods, each longer than the telson. Each of the three spines is elevated or carinated upon the dorsal surface, the telson grooved along the sides, and the cercopods grooved upon the ventral surface.

Surface of the abdomen and caudal spines smooth or finely granulose.

Dimensions. Although specimens of *Echinocaris punctata* are not uncommon at certain localities, the parts are usually disjointed and entire individuals are extremely rare. The most complete specimen observed (pl. xxviii, fig. 3), is of average dimensions and measures as follows:

	Body.	Cephalothorax.	Abdomen.	Post-abdomen.
Length -----	77 mm.	28 mm.	35 mm.	23 mm.
Width -----	40 mm.	20 mm.	6 mm.	-----

The somites of the abdomen in this specimen have the following lengths: First, 4 mm.; second, 4.5 mm.; third, 5 mm.; fourth, 6 mm.; fifth, 6.5 mm.; sixth, 9 mm. The largest individual observed in which the parts are in conjunction affords the following measurement:

	Body.	Cephalothorax.	Abdomen.	Post-abdomen.
Length -----	195 mm.	68 mm.	96 mm.	39 mm.
Width -----	88 mm.	44 mm.	-----	-----

A single very large carapace has a length of 90 mm., and the individual to which it belonged must have been about 244 mm. or nearly 10 inches in length when entire.

Observations. Specific Diagnosis. The specimen from which the original description of *Ceratiocaris? punctatus*, Hall (*loc. cit.*), was drawn, is a large carapace, represented both in the figure given in the Sixteenth Report of the State Museum, and also in the Illustrations of the Devonian Fossils, with a strong node at the posterior extremity of the dorsal line. This node proves

to be a portion of the matrix of the specimen, but otherwise it is a well characterized representative of the species. At the time of the preparation of this description the parts of the animal had not been found together, and a large abdomen and post-abdomen of another individual were taken as the type of the species *Ceratiocaris armatus*. Material which has come into the possession of the State Museum since that date, establishes beyond a doubt the identity of the two species. Both descriptions were published at the same time, and although that of the latter species precedes that of the former by two pages in the letterpress of the report referred to, it appears wiser to accord recognition to the specific name *punctatus*, as *C. punctatus* was founded upon the portion of the animal most characteristic and important for specific discrimination. *Echinocaris punctata* shows some points of general similarity with the species *E. sublævis*, *E. multinodosa*, Whitfield, and *E. socialis*, Beecher, but is readily distinguished from them by the size and disposition of the nodes, the curve of the lateral carinæ on the carapace, the length of the abdominal somites and the character of their spinous processes.

Distribution. Hamilton group. In the black shales at Pratt's Falls, near Pompey Center and at Delphi, and in the sandy shales, near Fabius, Onondaga county; in the higher shales at Menteth's Point and Tichenor's Glen, Canandaigua Lake, and near Norton's Landing, Cayuga Lake.

MANDIBLES OF PHYLLOCARIDA. Associated with *Echinocaris punctata*, in the locality which has produced the greatest number of specimens, viz., Pratt's Falls, and near Pompey Center, Onondaga county, large masticatory organs have been found quite abundantly, which, judging from a general similarity to the mandibles found *in situ* in this species, may be regarded as undoubtedly belonging to some species of the Phyllocarida. Beecher has described and illustrated these bodies (*loc. cit.*), and has indicated the fact that if bearing the same proportion to the carapace as do the mandibles in *E. punctata*, they must have belonged either to large individuals of this species or to some gigantic species yet unknown to us.

Barrande had earlier described and figured similar bodies (Syst. Silur. Bohème, vol. i, Suppl. p. 443, pl. xxi, figs. 41–44. 1872), from the *étage E.*, associated with *Ceratiocaris*, and regarded them as the masticatory organs of individuals of that genus. These mandibles are generally somewhat triangular in outline, with sometimes a straight but usually curved or lunate crown. This crown or masticating surface is broad, and bears five, six or seven cuspid denticles, of which those at the extremities are more pointed, simple and canine-like; those between having a surface strikingly similar to that of the human molar. The lower or basal portion of the mandible is broad and in many instances the surface of attachment is somewhat produced behind into the *manubrium*. The substance of this portion of the mandible is much thinner than that of the grinding surface, and on account of its being often crushed, the *manubrium* is frequently not apparent, and in young individuals it seems not to be developed. Judging from the relative proportions exhibited in the length of the mandibles, and of the entire animal in *E. punctata*, the largest of these bodies observed, which has a length of 38 mm., may have belonged to an animal 390 mm., or upwards of fifteen inches in length.

An individual of *Ceratiocaris papilio*, Salter, has been figured by Woodward (Geol. Mag., vol. ii, p. 501, pl. xi, figs. 1, 2), in which the mandibles are visible through the substance of the carapace. They appear to be of the same general character as those here described, but much smaller in proportion to the size of the carapace, and if represented in their normal position, situated much more anteriorly. Woodward's figure indicates that these bodies have undergone a vertical displacement, as both mandibles are equally distinct in a profile view of the specimen, and it is possible that a horizontal displacement has pushed them forward beyond their normal position. The figures of the mandibles of *Dithyrocaris*, upon the same plate, taken from a specimen described by Portlock (Geol. Rept. Londonderry, p. 315, pl. xii, fig. 6. 1843), show some minor differences in form and outline but apparently insufficient to be of value as generic features.

ECHINOCARIS WHITFIELDI.

PLATE XXIX, FIGS. 20, 21.

Echinocaris Whitfieldi, CLARKE. Bull. U. S. Geol. Surv., No. 16, Higher Devonian Faunas of Ontario County, N. Y., p. 45, pl. ii, figs. 3, 4. 1885.

CEPHALOTHORAX elongate, irregularly hemicordate; length of each valve somewhat less than twice the width, greatest width through the center; margin distinctly elevated. Hinge-line long, straight, scarcely equal to the greatest length of the carapace; curving gently outward toward the anterior extremity, whence the margin is abruptly deflected in a straight line for a short distance, and then sharply curved to the antero-lateral edge, which is also nearly straight, rounding to the ventral margin which is sub-parallel with the hinge, the posterior margin being truncate and slightly incurved.

Nuchal furrow indistinct on account of the flattening of the specimen.

Cephalic region relatively small, having less than one-third the width of the carapace; its surface is almost wholly occupied by a low node, well defined on its posterior margin, but becoming obsolete toward the hinge. The surface of this node bears a number of elongate pustules. Close upon the hinge are two small tubercles, the posterior of which probably represents the eye-node.

The *Thoracic region*, near the hinge-line and just behind the nuchal furrow, bears three parallel, elongate tubercles, one above the other; and behind them, situated more ventrally, an indistinct transversely elongate node. A short ridge or carina takes its origin at the base of the cephalic node, near the antero-lateral margin, and passes obliquely backward nearly parallel to this margin, becoming rapidly obsolete.

The *Surface* is marked by numerous low, scattered tubercles on the ventral and postero-dorsal areas. On the cephalic region the finer sculpture is minutely squamose, a feature not exhibited in other species of this genus.

ABDOMEN unknown.

POST-ABDOMEN. The same fragment of shale which contains the carapace also

bears a caudal plate, telson and one of the cercopods. The plate is sub-triangular, the telson moderately long but shorter than the cercopod; all are strongly carinate, and the surface covered with indications of strong tubercles.

Dimensions. The carapace of this species measures 28 mm. in length and 16 mm. in width across one valve. The telson is 28 mm. in length to the extremity of the spine, and the cercopod has about the same length.

Distribution. But a single individual of this species has been observed, and this has been so flattened that some of its surface-features may be obscured. The original is from the lower beds of the Portage group as originally defined (the "Naples beds" of Clarke). Hatch Hill, Naples, Ontario county.

ECHINOCARIS CONDYLEPIS, n. sp.

PLATE XXIX, FIGS. 14-17.

CEPHALOTHORAX small, sub-ovate in outline; length to width upon each valve as 3 to 2; greatest width centrally. Surface depressed. Hinge-line straight, two-thirds as long as the carapace. Anterior margin gaping for a short distance on the dorsal line, abruptly angled at the anterior extremity and rounding in a regular curve to the ventral margin and posterior extremity; at the latter point the margin is broadly angulated and passes thence obliquely forward in a nearly straight line to the hinge. The entire margin is moderately broad and thick and strongly elevated, especially upon the postero-dorsal edge.

Nuchal furrow obscure.

Cephalic region sub-triangular on each valve; occupied by an irregular node, which is distinctly limited on its anterior margin by a sulcus strongly impressed near the hinge-line. This node bears four tubercles, which are placed at the angles of a square, two close upon the hinge-line and two situated ventrally. Of these the posterior ventral tubercle holds the position of the optic node in *Echinocaris punctata*.

Thoracic region characterized by a strong transverse node just behind the nuchal furrow, acutely tubercled near the hinge-line, and beneath this an obscure node extending from this furrow obliquely backward. A lateral ridge or carina takes its origin near the anterior portion of the carapace and extends backward in a broad sigmoid curve, becoming obsolete near the posterior region. Above this carina the postero-dorsal area is gently rounded and smooth.

Surface smooth or minutely punctate.

ABDOMEN and TELSON unknown.

Dimensions. Three specimens of this species have been observed, and all are approximately of the same size, viz.: length 9 mm., width 5 mm.

Observations. *Echinocaris condylepis* appears in many respects almost a miniature of *Echinocaris punctata* of the Hamilton shales. The nodes are essentially the same in number and disposition, though less conspicuous; the lateral carina is much shorter, but has the same sigmoid curve; the ridge upon the postero-dorsal margin is, however, much more strongly elevated than in the latter species and is not tubercled or spinose. The general abbreviation of all the features in which it resembles *E. punctata* is a persistent character, and it will serve to distinguish the two species, while it may indicate their common genetic origin.

Distribution. Chemung group. In the soft greenish shales at Philipsburgh (now Belmont), Alleghany county.

ECHINOCARIS SOCIALIS.

PLATE XXX, FIGS. 1-12.

Echinocaris socialis, BEECHER. Ceratiocaridæ from the Chemung and Waverly groups. Second Geol. Surv. Penna., vol. PPP, p. 10, pl. i, figs. 1-12. 1884.

Echinocaris socialis, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 35. 1885.

CEPHALOTHORAX obliquely sub-ovate in outline, widest posteriorly. Length along the hinge-line to greatest width as 1 to 1.5; to greatest length as 1 to 1.8.

Hinge-line short, straight; anterior margin curving somewhat abruptly for a short distance, thence broadly rounding to the postero-ventral edge, there curving abruptly forward and passing in a nearly straight line to the posterior extremity of the hinge. Margins distinctly and sharply elevated on all except the dorsal side.

Nuchal furrow scarcely distinct, cutting off a sub-triangular area on each valve, similar in relative proportions to that in *E. punctata*.

The *Cephalic region* occupies about one-fourth the area of each valve, and its surface is mostly covered by a single large, elevated node, irregular in outline and when uncompressed, merging into one inconspicuous node lying near the dorso-lateral angle, another on the hinge-line at the nuchal furrow, and a third just opposite the nodiform termination of the lower thoracic carina.

The *Thoracic region* bears two conspicuous nodes, one near the hinge-line, apparently continuous with the sharply elevated dorso-lateral margin, the other situated medially, abutting closely upon and often apparently continuous with the lower carina. This carina lies at a little more than one-third the width of the valve from the ventral margin, takes its origin at or upon the median thoracic node and passes backward in a broad curve, becoming extinct considerably within the postero-lateral margin. At a little more than one-half the distance between this carina and the hinge-line, there is a short, straight, or dorsally curved carinate row of sharp pustules. The postero-dorsal margin is also sharply elevated and sub-carinate near the hinge.

The *Surface* of the carapace is covered with sharp, sub-spiniform pustules on its elevated portions, the depressed areas being smooth or minutely punctate.

ABDOMEN composed of six somites, which become more elongate in outline toward the caudal-plate. Somites sub-cylindrical, bearing three transverse rows of posteriorly directed spinules. The first row of these lies just within the anterior margin; the second about midway across the segment, and the third at the posterior margin. The spinules of the first row are often inconspicuous.

POST-ABDOMEN consisting of a short, triangular caudal plate, which is produced into a slender, carinate telson, having a length somewhat greater than that of the abdomen. The cercopods have about the same length.

Dimensions. A single specimen of average size retaining the parts in conjunction affords the following measurements:

	Body.	Cephalothorax.	Abdomen.	Post-abdomen.
Length-----	29 mm.	9 mm.	9 mm.	11 mm.
Width -----	-----	6 mm.	2 mm.	-----

This very distinctly defined Echinocarid finds no close ally among the known species. Some points of similarity in general form and outline are suggested by the species *E. pustulosa* and *E. sublevis*, Whitfield, but specific differences in the number and disposition of the carinæ and the shape of the nodes are readily apparent. Its comparative abundance, at the single locality where it is known to occur, is interesting and in consonance with the known gregarious habits of both fossil and recent forms of such crustaceans.

Distribution. Chemung group. "In the shales at the base of this group as exposed at Warren, Pa.; belonging to the upper strata of the series when considered in relation to the entire thickness of the group in New York and Pennsylvania." (Beecher, *loc. cit.*)

ECHINOCARIS SUBLÆVIS.

PLATE XXIX, FIGS. 11-13.

Echinocaris sublevis, WHITFIELD. New Forms of Fossil Crustacea, etc. Am. Jour. Science, 3d ser., vol. xix, No. 109, p. 36, pl. (unpublished), figs. 4, 5 and 6. 1880.

Echinocaris sublevis, PACKARD. Palæozoic Allies of Nebalia. Am. Naturalist, p. 952, fig. 11. Dec. 1882.

Echinocaris sublevis, PACKARD. Monog. N. Amer. Phyllopod Crustacea. Twelfth Rept. U. S. Geol. Surv., pp. 450, 451, fig. 71b. 1883.

Echinocaris sublevis, BEECHER. Ceratiocaridæ from the Chemung and Waverly groups, etc. Second Geol. Surv. Penna., vol. PPP, p. 5. 1884.

Echinocaris sublævis, JONES and WOODWARD. Notes on Phyllopodiform Crustaceans referable to the genus Echinocaris, etc. Geol. Mag. Dec. iii, vol. i, No. 9, p. 2. pl. xiii, figs. 3, 4 and 5. 1884.

Echinocaris sublævis, ETHERIDGE, WOODWARD and JONES. Third Rept. Com. on Fossil Phyllopoda of the Palæozoic Rocks, p. 35. 1885.

CEPHALOTHORAX. Outline obliquely sub-ovate, length to width as 3 to 2. Surface irregularly convex in front, evenly convex behind. Hinge-line

short, straight, extending from the anterior margin two-thirds the length of the carapace. Anterior extremities very slightly gaping, the margin sharply rounding in front, passing in a broad curve obliquely to the postero-lateral region, whence it passes in a gentle curve or a direct line to the hinge. The type specimen is so incomplete that the posterior outline can not be accurately determined. The entire margin is elevate and carinate.

Nuchal furrow distinct, taking its origin on the hinge at about one-third its length from the anterior extremity and passing obliquely forward.

Cephalic region small, sub-triangular on each valve and entirely occupied by a strong elevated node, the surface of which is covered with scattered tubercles, but it is impossible to determine which of them has served as the optic node.

Thoracic region just behind the nuchal furrow marked by a single, strong, obliquely elongate dorsal node, bearing a tubercle near the hinge-line. This node, at its inferior extremity, comes almost into contact with a nodiform ridge, directed obliquely backward and produced into a lateral carina, which is parallel to the ventral margin of the carapace. Postero-dorsal area smooth, broadly and evenly convex.

Surface obscurely punctate.

ABDOMEN. Portions of the last three somites are to be seen in one of the type specimens. Each of these is short, sub-cylindrical, the posterior segment being a little the longest. The anterior margin of each is elevated into an articulating ridge, and the posterior margin into a spiniferous ridge. Upon the dorsal surface the spines on each somite appear to have been very short and scarcely more than elevated tubercles, but on the lateral surface were quite strong. There appears also to have been a spine on the lateral surface of each somite between the anterior and posterior margins.

POST-ABDOMEN. The caudal plate on the dorsal side is sub-pentagonal, depressed on the postero-lateral areas. The telson begins as an elevated ridge near the anterior portion of the plate and is produced to a length probably equal-

ing the length of the last three somites of the abdomen. The cercopods are somewhat curved near the base of attachment, and have a slightly greater length than the telson.

Dimensions. The carapace of this species measures 17 mm. in length and 12 mm. in greatest width. The three somites of the abdomen and the telson have a length of 13 mm.; of this the first somite measures 1.5 mm. in length; the second 1.8 mm.; the third 2 mm.; the telson to the apex of the spine 7 mm.

Distribution. In the calcareous concretions of the Erie shales, a formation approximately equivalent to the lower Portage shales of New York. LeRoy, Lake county, Ohio.

ECHINOCARIS PUSTULOSA.

PLATE XXIX, FIGS. 9, 10.

Echinocaris pustulosa, WHITFIELD. Amer. Jour. Science, Third Series, vol. xix, No. 109, p. 38, pl. (unpublished), fig. 7. 1880.

Echinocaris pustulosa, PACKARD. Monog. N. Amer. Phyllopod Crustacea. Twelfth Ann. Rept. U. S. Geol. Surv., p. 451. 1883.

Echinocaris pustulosa, BEECHER. Ceratiocaridæ from the Chemung and Waverly groups, etc. Second Geol. Surv. Penna., vol. PPP, p. 5. 1884.

Echinocaris pustulosa, JONES and WOODWARD. Notes on Phyllopodiform Crustaceans referable to the genus *Echinocaris*, etc. Geol. Mag. Dec. iii, vol. i, No. 9, p. 2, pl. xiii, fig. 6. 1884.

Echinocaris pustulosa, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 35. 1885.

CEPHALOTHORAX small, longitudinally sub-ovate; length to width as 3 to 2. Surface irregularly convex. Hinge-line short, straight, length less than two-thirds the length of the carapace. The anterior extremity is broken off in the original specimen, but judging from the position of the nodes upon the thoracic portion of the carapace and the indications afforded by the broken edge, the anterior margin had probably about the same curvature as in the species *Echinocaris sublævis*, although in the original figure it is represented as strongly incurving near the hinge. The ventral margin is broadly curved at the posterior extremity, bending somewhat abruptly to

the postero-dorsal margin, which is nearly straight. The entire margin is elevated and is especially strong upon the posterior portion.

Nuchal furrow quite conspicuous, directed obliquely forward from the hinge-line.

Cephalic region apparently sub-triangular upon each valve and elevated into a conspicuous node, the surface of which is covered with sharp, scattered tubercles.

Thoracic region characterized by an arrangement of nodes similar to that observed in *Echinocaris sublævis*: a transverse dorsal node, just behind the nuchal furrow, directed slightly forward, followed below by a second transverse, elongated node, produced backward into a faintly curving ridge or carina, which becomes obsolete on the posterior area of the carapace. The postero-dorsal area is convex and relatively small. The surface of the thoracic nodes and of the postero-dorsal area is covered with conspicuous tubercles, while the remainder of the test appears to be minutely punctate or granulose. Length of the carapace 13 mm., width 9 mm.

ABDOMEN and POST-ABDOMEN not observed.

Observations. A single valve of the carapace of this species has been observed, and, in the disposition of the nodes and ridges upon the surface, it shows a close resemblance to its associate in the same formation, *Echinocaris sublævis*. *E. pustulosa*, however, differs from that species in the less oblique outline of the carapace, and the more centrally situated lateral carina. It resembles *E. socialis* in its strongly tubercled surface, but the differences in these two species are readily apparent.

Distribution. In the calcareous concretions of the Erie shales; LeRoy, Lake county, Ohio.

ECHINOCARIS MULTINODOSA.

PLATE XXIX, FIGS. 18, 19.

Echinocaris multinodosa, WHITFIELD. New Forms of Fossil Crustacea, etc. Amer. Jour. Science, Third Series, vol. xix, No. 109, p. 38, pl. (unpublished), fig. 8. 1880.

Echinocaris multinodosus, PACKARD. The Palæozoic Allies of Nebalia. Amer. Naturalist, p. 952, fig. 10, Dec. 1882.

Echinocaris multinodosus, PACKARD. Monog. N. Amer. Phyllopod Crust. Twelfth Ann. Rep. U. S. Geol. Surv., p. 451, fig. 71 a. 1883.

Echinocaris multinodosa, BEECHER. Ceratiocaridae from the Chemung and Waverly groups, etc. Second Geol. Surv. Penna., vol. PPP, p. 5. 1884.

Echinocaris multinodosa, ETHERIDGE, WOODWARD and JONES. Third Rept. Com. on Fossil Phyllopoda of the Palæozoic Rocks, p. 35. 1885.

CEPHALOTHORAX. In the two specimens of this species which have been observed the carapace has been somewhat compressed vertically, so that the outline of the valves can not be accurately determined. It was probably much like that in *Echinocaris pustulosa*, transversely sub-ovate, widest anteriorly. The margins are thick and strongly elevated. Hinge-line short, being one-half the length of the carapace. On the anterior extremity the margin bends strongly forward from the hinge, rounding to a broad curve upon the ventral border; from the posterior extremity to the hinge the margin is straight.

Nuchal furrow distinct, taking its origin just behind the second of the four nodes upon the hinge-line and passing obliquely forward, becoming obsolete at or near the anterior margin.

Cephalic region obliquely elliptical on each valve, the anterior portion occupied by a large, irregularly quadrate node, whose highest point is near the hinge. This is separated, by a deep furrow on its posterior margin, from a small but conspicuous node lying close upon the hinge. The optic spot can not be satisfactorily located.

Thoracic region characterized by a strong, obliquely elongate node situated upon the hinge-line and most elevated at its proximal extremity; terminating in a conspicuous depression which merges into the nuchal furrow. The node is sub-triangular in outline and has its apex directed ventrally. Below the apex of this node arises another, broad at its upper

extremity, transverse and produced backward into a lateral carina which is indistinctly preserved upon both the specimens in hand, but has evidently been similar in curvature to that in the species *E. sublævis* and *E. pustulosa*. At the posterior extremity of the dorsal margin and slightly distant from the hinge is a longitudinally elongate node curving gently inward and backward, and continued into a low ridge parallel with, and, toward its extremity, merging into the postero-dorsal margin. The dorso-lateral area of the carapace is broad and evenly convex, and is separated from the margins by a wide sulcus.

Surface of the carapace ornamented upon the nodes, ridges and dorso-lateral area with pustules, which appear as strong punctæ upon the cast of the ventral surface, as shown in one of the specimens.

The carapace, when in an uncompressed condition, has a length of 33 mm., and a width of about 20 mm. for each valve.

Distribution. In the calcareous concretions of the Erie shales on Paine's Creek. LeRoy, Lake county, Ohio.

ELYMOCARIS, BEECHER. 1884.

ELYMOCARIS CAPSELLA, n. sp.

PLATE XXXI, FIG. 4.

CEPHALOTHORAX small, siliquoid, each valve longitudinally semi-elliptical in outline, with a length equal to two and one-half times the width. Hinge-line straight, extending almost the entire length of the valves, and curving slightly downward or outward near the extremities. Anterior extremity rectangular, rounding rapidly to the broad curve of the ventral margin. Posterior extremity truncate and slightly incurved. Margin slightly thickened. Surface convex, elevated toward the dorsum, ventrally depressed. A faint node, which may indicate the position of the optic spot, is visible at about one-third the length of the carapace from the anterior extremity; its posi-

tion, however, is more posterior and ventral than the optic node in *Elymocaridus siliqua*.

The ornamentation consists of minute, elevated, anastomosing lines, most distinctly seen near the ventral margins.

The type specimen of this species has been folded and the valves slightly separated along the hinge, the right valve protruding somewhat beneath the ventral margin of the left. The left valve measures 13.5 mm. in length, and 5 mm. in width.

Abdominal and *caudal* parts unknown.

Distribution. Hamilton group. But a single specimen of this species has been noticed, and this is from the shales above the *Encrinural* limestone, at the second falls of Tichenor's Glen, Canandaigua Lake, associated with *Echinocaris punctata*, *Rhinocaris columbina*, *R. scaphoptera*, *Phacops rana*, *Proetus macrocephalus*, *Proetus Rowi*, *Dalmanites Boothi* and *Homalonotus Dekayi*.

ELYMOCARIS SILIQUA.

PLATE XXXI, FIGS. 5, 6.

Elymocaridus siliqua, BEECHER. Ceratiocaridæ from the Chemung and Waverly groups, etc. Second Geol. Surv. Penna., vol. PPP, p. 13, pl. ii, figs. 1 and 2. 1884.

Elymocaridus siliqua, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 35. 1885.

CEPHALOTHORAX elongate-sub-rhomboidal or siliquiform in outline; hinge-line straight, somewhat shorter than the greatest length of the valves; length equal to twice the width. Anterior extremity acutely angled, rounding rapidly to the ventral margin, which for a short distance is nearly parallel to the dorsal line. The postero-ventral extremity is broadly rounded, the margin curving thence forward, and at the hinge slightly backward again, making a sharp angle at that point. The margin is slightly thickened and elevated into a low, sharp carina on the anterior and ventral edges, becoming obsolete posteriorly. Surface evenly convex, sloping a little more abruptly toward the hinge than toward the ventral margin.

Nuchal furrow scarcely distinct, its position probably represented by the posterior margin of the cephalic nodes.

Cephalic region broadly sub-triangular on each valve, its length about one-third the greatest length of the valve. Near the hinge-line is a conspicuous optic node, just behind which lies a low, faintly defined sub-circular elevation, and below this a similar elevation, which is larger, more distinctly defined, oval or more transversely elongate.

Thoracic region without nodes. Surface ornamented with low tubercles over the cephalic nodes, and with irregularly scattered pustules or granules upon the thoracic area. Fine and elevated, obscurely anastomosing lines are visible near the ventral margin and upon the dorsum, and the postero-ventral margin is distinctly crenulate.

Abdomen short, composed, as far as known, of two somites, the anterior of which, in the only specimen observed, is partially concealed beneath the posterior area of the carapace. Each one is sub-cylindrical, slightly tapering and gently constricted at the margin, the latter being twice as long as wide.

POST-ABDOMEN. Caudal plate strongly elevated and wholly occupied by the base of the telson, which is short and stout and bears a conspicuous median ridge. The cercopods are flat, comparatively narrow and longer than the telson, and are minutely crenulated along their inner edges for the attachment of setæ.

The *surface* of the abdominal somites and post-abdomen is ornamented with granules and elevated lines.

Dimensions. The left valve measures 22 mm. in length and 10 mm. in width. The posterior somite of the abdomen measures 7 mm. in length, the telson 9 mm., and each lateral spine 10 mm. in length.

Distribution. Chemung group. Warren, Warren county, Pennsylvania.

TROPIDOCARIS, BEECHER. 1884.

TROPIDOCARIS BICARINATA.

PLATE XXXI, FIGS. 7-12.

Tropidocaris bicarinata, BEECHER. Ceratiocaridæ from the Chemung and Waverly groups, etc. Second Geol. Surv. Penna., vol. PPP, p. 16, pl. ii, figs. 3-5. 1884.

Tropidocaris bicarinata, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 35. 1885.

CEPHALOTHORAX elongate spatulate or semi-elliptical, truncate behind; length one and one-half times the width. Hinge-line straight, nearly as long as the greatest length of the shield. Toward the anterior extremity, just in front of the eye, it slopes gently outward to form the rostral cleft, which is quite narrow.

The *Rostrum* is a narrow, free strip or plate, tapering to an acute apex; longitudinally arched, bearing a strong axial ridge and two lateral ridges. This body has been observed in two instances in such a position and of such form as to leave little doubt of its function.

The anterior extremity of each valve is produced into a minute spine at the dorsal line; at its base the margin is transverse for a short distance, rounding in a broad curve to the ventral and posterior edges. The posterior extremity is broadly truncate, the margin rounding over the postero-ventral angles, curving inward toward the hinge-line, and outward at the hinge, making a minute posterior spine at that point. The margin on all sides is broadly thickened, and the marginal sulcus is conspicuous.

The *Cephalic region*, just within the principal lateral carina, bears a strong optic node, which usually shows a minute depression or pit at its summit. Two strong carinæ extend almost the entire length of each valve, the outer one the longer and more conspicuous, the inner usually terminating anteriorly near the dorsal line just opposite the eye, but sometimes produced to the anterior angle. A low ridge extends from the eye to the anterior extremity and a similar ridge is also visible in some specimens between the eye and the inner carina, extending for a short distance upon the thoracic portion of the carapace. On the exterior slope of the outer carina and

near the base of the cephalic region, a moderately large, semi-circular node is sometimes seen, which is more distinct in specimens where the carapace has been somewhat compressed.

The *Surface* is ornamented by elevated anastomosing lines, which are absent on the thoracic region within the outer carina. The hinge-line and the posterior margin are distinctly crenulated.

ABDOMEN. This part has not been found in conjunction with the carapace. A small abdomen, composed of two somites and bearing a portion of a cylindrical telson, which was found in the shales with these carapaces, was referred, in the original description, to this species, and it either belongs to this form or to some species as yet undescribed. These somites are sub-cylindrical, the first short, wider than long, and the second twice as long as wide, depressed at the anterior margins, slightly elevated and overlapping at the posterior margins, and ornamented with elevated lines similar to those upon the carapace. This specimen of the abdomen is small, and must have belonged to an individual smaller than indicated by any carapace yet observed.

Dimensions. The best preserved of the type specimens measures 39 mm. in length and 27 mm. in width. The two somites of the abdomen have a length of 11 mm. of which the first measures 4 mm. and the second 7 mm.

Distribution. Chemung group. In the shales associated with *Echinocaris socialis* and *Elymocaris siliqua*. Warren, Warren county, Pennsylvania.

TROPIDOCARIS INTERRUPTA.

PLATE XXXI, FIG. 13.

Tropidocaris interrupta, BEECHER. Ceratiocaridæ from the Chemung and Waverly groups, etc. Second Geol. Surv. Penna., vol. PPP, p. 18, pl. ii, fig. 6. 1884.

Tropidocaris interrupta, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 35. 1885.

CEPHALOTHORAX sub-oval in outline, reëtrantly truncate behind. The right valve is the only part yet observed, and this shows the hinge-line to be straight, shorter than the greatest length of the carapace; the anterior extremity acute, the margin rapidly rounding thence to the centre of the

ventral edge and passing posteriorly with the same curvature. The postero-ventral angle is broadly obtuse, the posterior margin slightly incurved to the hinge-line. The surface is evenly convex and is ornamented by a series of longitudinal carinæ, of which five, including the marginal ridge, extend the entire length of the valve, four of them being prominently exsert at their terminations upon the posterior margin. Intercalated between these carinæ is a series of shorter and less conspicuous ridges, beginning near the anterior extremity and mostly confined to the cephalic region; one or two extend for some distance upon the thorax. The number of ridges crossing the cephalic region is eleven, one of the shorter of these crossing the eye-node. The single valve has a length of 23 mm., and a width of 10 mm.

Distribution. Chemung group. In the shales near the summit of the formation, Warren, Warren county, Pennsylvania.

TROPIDOCARIS ALTERNATA.

PLATE XXXI, FIGS. 14, 15.

Tropidocaris alternata, BEECHER. Ceratiocaridæ from the Chemung and Waverly groups, etc. Second Geol. Surv. Penna., vol. PPP, p. 19, pl. ii, figs. 7 and 8. 1884.

Tropidocaris alternata, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee on Fossil Phyllopoda the of Palæozoic Rocks, p. 35. 1885.

THIS species is represented only by impressions of two somewhat fragmentary portions of left valves of the CEPHALOTHORAX. Their outline cannot be satisfactorily determined, but indications show that it does not widely differ from that of *Tropidocaris bicarinata*. These fragments are characterized by the numerous longitudinal ridges extending apparently the entire length of the valve, or somewhat interrupted and irregular in the cephalic region. These ridges or carinæ alternate in size, the best preserved specimen showing seven in all, of which the larger are finely crenulate, but no other ornamentation is apparent on the valve. The eye-node is distinct and is crossed by the fourth or middle carina.

Distribution. Waverly group. In the sandstones at Warren, Warren county, Pennsylvania.

PINACARIDÆ.

MESOTHYRA,* N. G.

MESOTHYRA OCEANI, n. sp.

PLATE XXXII, FIGS. 1-6; PLATE XXXIII, FIGS. 4-7; AND PLATE XXXIV, FIGS. 1-5.

Dithyrocaris Neptuni, HALL. Illustrations of Devonian Fossils, pl. xxii, figs. 1-5; pl. xxiii, figs. 1-3. 1876.
Dithyrocaris Neptuni, ETHERIDGE, WOODWARD and JONES. Fifth Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks. 1887.

CEPHALOTHORAX sub-quadrate or broadly spatulate; length to width as 2.5 to 1. Surface flattened along the axial region, slightly convex and normally somewhat deflected on the sides.

The dorsal line is nearly straight for three-fourths its length from the posterior extremity; thence bending inward and again curving outward it makes a broad, conspicuous angle opposite the eye-node; passing thence forward to the anterior extremity, forming the margin of the rostral cleft, and intersecting the anterior margin of the valve at an acute and slightly incurved angle. The angular extension upon the dorsal line is of the same length on both anterior and posterior slopes. On the anterior extremity of the carapace the margin is transverse for a short distance, rounding in a constantly widening curve along the ventral edge to very near the posterior extremity; thence backward it is slightly incurved, and at the postero-ventral angle is continued as the margin of a strong, sharp spine, which is directed inward. The posterior margin is transverse and nearly straight, terminating at the dorsal line in a short, sharp, posteriorly directed angle. On the anterior and

*The distinctive features upon which the type species of this genus (*D. Oceani*) is separated from the genus *Dithyrocaris* have not been noticed in any of the descriptions or illustrations of species of that genus given by English or American authors. The interpretation of the characters of the carapace, as here given, requires the removal of these forms from the family CERATIOCARIDÆ, and if the described species of *Dithyrocaris* shall, upon reëxamination, prove to possess similar features, they may all be united under the family name proposed above.

antero-lateral edges the margin is strongly thickened, on the postero-lateral edge being broadly infolded, and its thickened edge continuous with the posterior spine. This ridge on the doublure is distinctly marked upon the upper surface of the carapace when compressed.

The *Cephalic region* is gently convex and bears a strong, somewhat elongate eye-node, situated just in front of the extremity of the lateral carina, and toward the dorsal line. The summit of this optic node bears a deep pit or invagination, which may have held a lense or series of lenses, or it may be evidence of a more embryonic character in the visual organs. Upon the thoracic region is a strong, straight carina, extending its entire length. Its sides are broadly sloping, and well-preserved individuals show a finely incised longitudinal line about half way up each slope. On the inner slope, between this line and the summit of the ridge, there is a series of oblique crenulations.

The *Surface* is ornamented by a number of low tubercles in the inter-ocular region, and elsewhere over the cephalic area by fine, elevated, frequently anastomosing lines; upon the extra-carinal area these lines become longer and more continuous. Otherwise the surface is minutely punctate or granulose.

ABDOMEN composed of two somites of which the anterior was probably almost concealed beneath the carapace. This somite is short, one-half as long as wide, and slightly elevated at the margins into articulating ridges; the posterior somite is quadrate and somewhat longer than wide. The surface of both somites is ornamented by strong, elevated, venate lines, which, upon the anterior joint, radiate from the crenulated margins and are directed forward, and upon the posterior they also radiate from the margins but are directed inward and backward. In one specimen these lines are crossed by a series of fine, parallel wrinkles, which appear to be due to compression. The posterior somite bears a few low, broad tubercles.

POST-ABDOMEN. Caudal plate sub-triangular on the ventral surface, distinctly ridged on the anterior extremity for articulation with the last somite; sub-

pentagonal on the dorsal surface and produced into a relatively narrow telson, shorter than the lateral spines and strongly carinate along the axial line. The lateral spines are flat and long, with a low carina near the inner edge and a series of obscure, parallel ridges near the outer margin.

The surface is marked by elevated lines, parallel to the margins, and similar to those observed upon the abdomen, but more continuous. Strong tubercles are scattered irregularly over the surface of all the spines. A broad fimbria of setæ is visible upon the inner edges of the lateral spines, and the margin is distinctly crenulate for their insertion.

Dimensions. The largest carapace observed is represented by a right valve, which measures 140 mm. in length, inclusive of the posterior spine, and 60 mm. in greatest width. The smallest right valve has a length of 68 mm. and a width of 40 mm. The abdomen and post-abdomen of a large individual measure 105 mm. in length to the apex of the telson: the first somite, 16 mm.; the second, 22 mm.; the caudal plate and telson, 67 mm. The cercopods of the same specimen are 70 mm. in length.

Observations. The character of the articulation of the valves of the carapace in this species is widely different from that in typical species of the genus *Dithyrocaris*. If the valves came into contact only at the apices of the conspicuous angles upon the dorsal line a long posterior median cleft would be left between the valves with a width equal to that of the anterior or rostral cleft. Three right valves have been preserved showing this angle upon the hinge, but the only left valve observed has been broken at that point. If the process existed on both valves, as we must assume to be true in the bilaterally symmetrical carapaces, it is difficult to conceive how the articulation could have been effected by the mere apical contact of the valves at this point. Upon the right valve the angular extension is smooth near its apex, and the outer edge folded upward into a low ridge, so that it may have been slightly overlapped by and articulated to the valve at this point, but such articulation must have been quite insufficient to hold the two valves in place. With the exception of the surface about the apex, these extensions are quite

strongly tubercled and thus could not have been adapted to the purpose of articulation. It has been noticed in the description of the species *Mesothyra Veneris* that a short distance within the dorsal margin of the type specimen, and parallel to it, is an impressed line which merges into the hinge at a point corresponding in position to the angular process in this species. If this groove represents a suture or a line of symphysis, and the narrow strip of carapace between it and the dorsal line be removed, the outline of the dorsal margin of this species would be similar to that in *M. Oceani*. In two of the specimens at hand there is evidence, though not conclusive, of such a median strip in this species, detached from, and lying alongside the dorsal margin. It seems necessary to accept the presumptive evidence of the existence of this plate in order to explain the mode of articulation of the valves in this species. Such a plate may have been simple, articulated on each edge with the valves, or compound, with a suture or hinge in the axial line, as indicated in *M. Veneris*.

Although the existence of this plate has not yet been positively demonstrated, nor the necessity of its existence recognized in species heretofore referred to the genus *Dithyrocaris*, it must be born in mind that the rostral plate, which presumably filled the anterior cleft between the valves, so far as known, has not been seen in any species of the genus.

It will be readily conceived that a very slight degree of maceration would be sufficient to destroy the membrane holding these parts in place along the line of symphysis, and bodies so light as the rostrum and such a median plate, would be readily transported, even in quiet water, away from the heavier portions of the carapace, while members of the abdomen and post-abdomen, being held in place by stronger ligaments and by the overlapping slotted edges of the articulating surfaces, would naturally withstand a force sufficient to separate the parts of the carapace.

In the preliminary Illustrations of Devonian Fossils (*loc. cit.*) the specimens upon which this species is founded were referred to *Dithyrocaris Neptuni*, on account of the similarity apparent in many features of the post-abdominal parts, but a more careful comparison of these parts, in the Hamilton and Portage specimens leaves no doubt of their specific difference. This difference

consists of the following points: in *M. Oceani*, (a) the caudal plate is smaller, less robust, and is covered with low tubercles; (b) the telson is relatively much longer, though not as long as the cercopods (this feature is incorrectly represented on plate xxxiii, fig 7, where the telson is given about the same relative length as in *M. Neptuni*; at least a half-inch should be added to the length of the figure of this spine); (c) the carina on the telson is much narrower and more sharply angled; (d) both telson and cercopods are conspicuously tubercled, and (e) the linear ornamentation is less marked.

Distribution. This elegant species is represented by portions of four carapaces, four abdomens and post-abdomens and two post-abdomens without somites attached. All are from a single locality in the Portage group. In the sandy shales bearing *Plumalina Vanuxemi*, Dawson: Ithaca, Tompkins county.

MESOTHYRA NEPTUNI.

PLATE XXXII, FIG. 7; AND PLATE XXXIII, FIG. 1.

Dithyrocaris Neptuni, HALL. Sixteenth Rept. N. Y. State Cab. Nat. Hist., p. 75, pl. i, fig. 9. 1863.

Dithyrocaris Neptuni, HALL. Illustrations of Devonian Fossils, pl. xxiii, fig. 6. 1876; not pl. xxii, figs. 1-5; pl. xxiii, figs. 1-3.

Dithyrocaris Neptuni, PACKARD. Monog. N. Amer. Phyllopod Crustacea. Twelfth Ann. Rept. U. S. Geol. Surv., p. 452, fig. 73. 1883.

Dithyrocaris Neptuni, ETHERIDGE, WOODWARD and JONES. Fifth Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks. 1887.

CEPHALOTHORAX and ABDOMEN unknown.

POST-ABDOMEN. Caudal plate sub-quadrangular in outline on the dorsal side, strongly convex, and flattened above; produced into a broad, stout, relatively short telson. Along the axial line of this spine is a broad, low ridge, which runs to its apex and is most strongly elevated just behind the insertion of the spine upon the caudal plate. The cercopods are long, nearly one-half longer than the telson, flat and with a low ridge on their inner edges. To these ridges were attached the setaceous fimbriæ which are faintly visible on one of the lateral spines of the type specimen. The articulating edge of each cercopod is curved upward and forward into a smooth marginal ridge, which is overlapped by the adjacent edge of the caudal plate.

The surface is marked by strongly elevated, concentric, sometimes anas-

tomosing striæ, which are conspicuously angled over the median ridge of the caudal plate and pass thence backward over the lateral spines. They are absent upon the telson except near its base, and upon the cercopods are more abundant toward the outer edge, becoming obsolescent as they approach the extremities.

Dimensions. The caudal plate has a width of 27 mm.; the entire length of the caudal plate and telson is 81 mm. Each cercopod measures 110 mm. in length.

The individual represented by the post-abdomens must have been of great size when entire, making *Mesothyra Neptuni* probably the largest known species of the genus.

Observations. The specimen upon which the original description of this species was based is a very large caudal plate with the spines attached. It lies upon the surface of a slab of arenaceous shale, obtained in Otsego county, and is accompanied by more or less fragmentary impressions of four similar caudal parts and a fragment of the marginal portion of one valve of the carapace. Of the five impressions two are of the ventral and three of the dorsal surface, one of the latter being the type specimen and one a fragment of a considerably larger individual. The slab also bears a cephalon of a young *Homalotus Dekayi* and is thus beyond doubt from the Hamilton beds.

In the preliminary illustration of the New York Devonian Crustacea (Illustrations of Devonian Fossils, *loc. cit.*), a series of large carapaces and post-abdomens from the lower beds of the Portage group at Ithaca, Tompkins county, were provisionally referred to the same species; in the final revision of this material a careful comparison of the specimens from the two localities has shown that those from the Portage group present many well-marked and constant specific features distinguishing them from the type of *Dithyrocaris Neptuni*. This latter species must therefore be considered as limited to the Hamilton fauna, and our knowledge of it is thus far confined to the specimens from which the original description was drawn.

Distribution. Hamilton group. From a loose block in the town of Plainfield, Otsego county.

MESOTHYRA SPUMÆA, n. sp.

PLATE XXXII, FIGS. 8, 9; AND PLATE XXXIV, FIG. 2.

Two specimens, one displaying the ventral aspect of the caudal plate and the lateral spines, the other, a single long caudal spine, show the following points of difference from either of the species *Mesothyra Neptuni* or *M. Oceani*: the caudal plate is broader and its postero-lateral margins straight; the cercopods are broad and flat and taper very slowly, their outer margin being thickened or carinate, and the inner bearing an inconspicuous ridge; the surface of the test is smooth or very finely granulose, with a few pustules and elevated striæ on the spines near the lines of articulation. The cercopods are broader and stouter than in *M. Oceani* and very much smaller than in *M. Neptuni*. In surface ornament it differs from either.

Distribution. Hamilton group. From the dark shales at Pratt's Falls and Delphi, Onondaga county.

MESOTHYRA (DITHYROCARIS?) VENERIS, n. sp.

PLATE XXXIII, FIG. 3.

CEPHALOTHORAX. Right valve only known; this is longitudinally semi-ovate, widest anteriorly, and more than twice as long as wide.

Dorsal line straight along the median portion of the valve, bending gently outward toward the anterior extremity for the formation of the rostral cleft. Just within, and parallel to the dorsal line, is a finely impressed line, which runs from the posterior extremity of the carapace about two-thirds the length of the shield, to a point analogous in position to the strong angle observable on the hinge in the species *Mesothyra Oceani* (q. v.), where it merges into the dorsal line. Were this narrow strip along the dorsum, which is included between the hinge-line and this linear furrow, removed, the outline of the dorsal margin would be the same as in that species. This feature has an important bearing upon the interpretation of the character of the dorsal articulation in *M. Oceani*.

The anterior extremity appears to be produced at the dorsal line into a short spine continuous with the carapace. The specimen is slightly fractured

at this point so that only the outline of the spine can be detected. As it occupies the position of the rostral plate, there may be room for question whether this is not such a body, but with the present evidence, all indications are that it is a prorate spine coalesced with the carapace and thus necessarily existing on each valve. Below this spine the margin slopes rapidly backward to the ventral edge, along which, for a short distance, it is nearly parallel to the dorsal line. The valve narrows backward, and at the posterior extremity the margin is produced into an acute and slightly incurved spine, between which and the dorsal line the outline is strongly incurved. The margin is very slightly elevated and appears to be broadly infolded in the postero-ventral region, as in *M. Oceani*, the posterior spine being a prolongation of this infolded margin or doublure.

The *Surface* is smooth, slightly and evenly convex. The cephalic region bears an optic node distant from the dorsal line, and in its vicinity the carapace has apparently been somewhat compressed over some irregularity in the matrix. On the thoracic region is a faint longitudinal ridge, nearly parallel to the dorsal line, which becomes obsolete toward the posterior extremity.

Dimensions. The single valve measures 38 mm. in length, inclusive of the anterior and posterior spines, and 16 mm. in its greatest width.

Distribution. Hamilton group. In the Marcellus shales, on Mud Creek, East Bloomfield, Ontario county.

DITHYROCARIS BELLI.

Dithyrocaris Belli, WOODWARD. Geol. Magazine, p. 106, pl. iii, fig. 5. 1871.

Dithyrocaris Belli, ETHERIDGE, WOODWARD and JONES. Fifth Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 6. 1887.

THIS species was described from an extremely imperfect specimen in which the valves of the carapace apparently overlap along their inner margins, only their anterior portion being retained. The drawing shows two strong carinæ, but gives no indication of the hinge-line. The anterior extremity bears a short spinule similar to that in the species *Mesothyra* (*Dithyrocaris*?) *Veneris*, and the surface is ornamented by abundant striæ.

Distribution. Middle Devonian. Gaspé, Province of Quebec.

RHINOCARIDÆ.

RHINOCARIS, N. G. (J. M. C.).

RHINOCARIS COLUMBINA, n. sp.

PLATE XXXI, FIGS. 16-21.

CEPHALOTHORAX elongate-siliquiform. Surface normally arched or sub-cylindrical, and probably somewhat flattened toward the ventral margin. The anterior extremity is slightly depressed on the dorsum and produced into a *prora* or rostrum, which is vertically flattened and gently deflected toward the tip. On each side toward its base this *prora* bears a low ridge which is continued on the body of the carapace, accompanied by a faint ridge, which lies in the axial line. These ridges appear to extend the entire length of the carapace, though indistinctly seen on most examples on account of the lateral compression which has usually fractured the carapace irregularly along the dorsum. Below the *prora* the margin curves rapidly downward to the ventral edge, where it is nearly straight for a short distance, thence curving upward to the posterior margin, which is transverse and incurved over the axial line, the posterior extremity being thus truncate. The optic spot appears to be indicated by a faint tubercle in the cephalic region, close to the axial line. There is no evidence of a nuchal furrow, and the limits of the cephalic and thoracic areas are thus indistinguishable.

Surface free of nodes or tubercles, but ornamented with faint pits on the dorsal region and on the lateral areas with fine, raised, anastomosing lines, which are sub-parallel to the margin, and converge toward the anterior and posterior extremities. In all the specimens thus far obtained the carapace

has been somewhat distorted, and the test, which is extremely tenuous, broken by compression in the shales. A single individual shows the impression of the crown of a small *mandible* in the substance of the carapace. This organ, in every visible feature, is comparable to those already described under the species *Echinocaris punctata* (page 167). The crown is curved or lunate, and bears five denticles, of which the anterior is sharp and canine-like, the posterior broader and more closely resembling the grinding surface of a molar tooth. Its length is 5 mm.

ABDOMEN. In a single example the carapace is in close association with scattered somites of the abdomen, of which three are detached and the fourth is in articulation with the telson. One is quite broad, being twice as wide as long and somewhat elevated in the middle, the margins very slightly elevated and faintly produced in the axial line; another is relatively longer but quite imperfect; a third about one-half longer than wide, and the posterior somite twice as long as wide, and nearly cylindrical.

POST-ABDOMEN composed of a small caudal plate, whose entire dorsal surface is occupied by the base of the telson, and is strongly elevated, the spine itself being stout and sub-conical. The cercopods, in their normal condition, are laterally flattened and slightly longer than the telson.

The *Surface* of both abdomen and post-abdomen bears an ornamentation of elevated, anastomosing and slightly undulating lines, similar to those upon the carapace, but more conspicuous. These lines appear to be sharply angulated along the axis of each somite, and directed thence posteriorly over the lateral portions.

Dimensions. All the carapaces observed are of about the same size. A well-preserved individual measures 48 mm. in length including the *prora*, which is 6 mm. long. The greatest width of one-half the carapace, as compressed, is 16 mm. Of the abdomen one somite measures 5 mm. in length and 10 mm. in width; another, 7 mm. in length and 5 mm. in width, and the posterior somite 10 mm. in length and 5 mm. in width. The telson is 15 mm., and the cercopods each 17 mm. in length.

Distribution. This species is represented in the collection of the State Museum by fifteen specimens, most of which are in a very fragmentary condition, on account of the fragility of the test. In one locality, at the lower falls of Vinegar Brook Glen, near Norton's Landing, on Cayuga Lake, individuals have proven to be quite abundant in the shales, but are so massed together and macerated as to be unsatisfactory for purposes of description. Hamilton group. In the shales at Tichenor's Glen, Canandaigua Lake; near Norton's Landing, Cayuga Lake, and upon the shores of Owasco Lake.

RHINOCARIS SCAPHOPTERA, n. sp.

PLATE XXXI, FIGS. 22, 23.

CEPHALOTHORAX elongate, outline as in *Tropidocaris*. The *prora* at the anterior extremity is shorter than in the foregoing species, is vertically flattened and narrowly lanceolate, slightly broadened on its upper edge toward the base. The margin curves rapidly backward from the base of the *prora* to the ventral edge, thence slightly upward to the posterior margin, which is transverse and somewhat incurved over the dorsum. The single specimen of this species which has been observed, is folded unsymmetrically along the dorsum, and is laterally compressed. There are indications of a faint ridge in the axial line of the carapace, but this part has been broken along one side of that line. A strong lateral carina beginning near the anterior extremity is nearly parallel to the ventral margin, and becomes obsolete in the posterior region. Just above its anterior extremity on each side is a low elevation, which is probably an optic node.

The *Surface* is ornamented, on the lateral regions below the carina, with elevated lines parallel to the ventral margin, which are stronger and more frequently interrupted than in *Rhinocaris columbina*. The surface of the median area within the carinae, bears elongate linear nodes parallel to the axis, and several of these are visible over the surface of the optic spot. The intermediate space between the lines and nodes is minutely punctate. The

carapace measures 36 mm. in length, inclusive of the *prora*, and 25 mm. over the valve from one lateral margin to the other.

Observations. Were the slender *prora* of this specimen broken away, *Rhinocaris scaphoptera* might readily be taken for a species of *Dithyrocaris* or *Tropidocaris*, for, although there is no hinge in the carapace, the normal curvature of the shield would cause it to yield along the axial line whenever subjected to lateral compression.

Distribution. Hamilton group. In the upper shales of the group, associated with *Rhinocaris columbina*, *Echinocaris punctata* and *Elymocaris capsella*: Tichenor's Glen, Canandaigua Lake.

DISCINOCARIDÆ.

SPATHIOCARIS, CLARKE. 1882.

SPATHIOCARIS EMERSONI.

PLATE XXXV, FIGS. 12-18.

- Spathiocaris Emersonii*, CLARKE. Amer. Jour. Science, Third Series, vol. xxiii, p. 477, pl. O, figs. 1-3. 1882.
Spathiocaris Emersonii, PACKARD. Monog. N. Amer. Phyllopod Crustacea. Twelfth Ann. Rept. U. S. Geol. Surv., p. 451. 1883.
Spathiocaris Emersoni, CLARKE. Neues Jahrb. für Min., etc., p. 180. 1884.
Spathiocaris Emersonii, ETHERIDGE, WOODWARD and JONES. Second Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 7. 1884.
Spathiocaris Emersonii, JONES and WOODWARD. Geol. Mag., Dec. iii, vol. i, p. 348. 1884.
Spathiocaris Emersoni, CLARKE. Bull. U. S. Geol. Surv., No. 16. Higher Devonian Faunas, Ontario county, N. Y., p. 46. 1885.
Spathiocaris Emersonii, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 3. 1885.

CARAPACE ovate or elliptical in outline; surface elevated and sub-conical, somewhat flattened on the posterior slope, more abruptly depressed at the sides. The apex is situated somewhat anteriorly and connected by a low ridge with the inner angle of the cephalic cleft. This cephalic or rostral cleft takes its origin just in front of the apex of the shield and in uncompressed specimens widens slowly outward. In flattened individuals the inner angle and the width of this cleft are exaggerated. The surface of the shield is marked by regular, continuous, closely appressed concentric ridges, following the outline of the margin, becoming somewhat broader on the extremities and crowded on the lateral portions. At the posterior extremity the surface is cancellated by abundant radii, and similar radiating lines are visible in the anterior region along the margins of the cephalic notch. The outline of the carapace appears to vary with advancing growth, in mature individuals being nearly elliptical, but in younger specimens appearing broader at the

anterior extremity, so that in extremely small individuals the carapace is very short and cordate in outline. These variations in outline have been regarded by the Committee of the British Association on the Fossil Phyllopoda (Second and Third Repts., *loc. cit.*) as of specific value, but abundant material leaves no doubt that the difference is developmental and not specific. Specimens are not infrequently found folded symmetrically along the dorsum, although there is no evidence of any dorsal suture or anchylosis along that line. The substance of the test is chitinous and very thin.

Dimensions. The variation in size exhibited by specimens of this species is considerable. The average normal adult represented by the type specimen having a length of 28 mm., and a width of 16 mm.; the smallest individual observed is 2 mm. long and 3 mm. wide. A very large fragment indicates a shield upwards of 80 mm. in length.

Distribution. Widely distributed throughout the lower horizons of the Portage group as originally defined ("Naples beds," Clarke), in the towns of Bristol, Richmond and Naples, Ontario county; Sparta and Son Yea, Livingston county; and in the upper sandstones of the group at Naples and Canadice, Ontario county; Portageville, Wyoming county.

D I P T E R O C A R I S, CLARKE. 1882.

DIPTEROCARIS PENNÆ-DÆDALI.

PLATE XXXV, FIG. 24.

Dipterocaris pennæ-Dædali, CLARKE. Amer. Jour. Science, Third Series, vol. xxv, p. 122, fig. 1. 1883.

Dipterocaris pennæ-Dædali, JONES and WOODWARD. Geol. Mag., Dec. iii, vol. i, No. 8, p. 349. 1884.

Dipterocaris pennæ-Dædali, ETHERIDGE, WOODWARD and JONES. Second Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 11. 1884.

Dipterocaris pennæ-Dædali, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 3. 1885.

THE original of this species consists of but one-half or one *ala* of the CARAPACE, which is very elongate, with the lateral margin straight, the anterior angle nearly ninety degrees and the posterior angle acute. The area of union ("isthmus," Jones) is anterior, the cephalic cleft narrow, and the margin of the

abdominal cleft rapidly divergent. The surface is ornamented with concentric lines or ridges as in the associated species.

This species differs from *Dipterocaris Procne* in its more abrupt anterior marginal curvature, more anterior isthmus and the greater relative length of the abdominal cleft. The dimensions of the specimen are 50 mm. in length and 18 mm. in width to the axial line.

Distribution. Portage group. In the upper sandstones at Canadice, Ontario county.

DIPTEROCARIS PROCNE.

PLATE XXXV, FIGS. 25-27.

Dipterocaris Procne, CLARKE. Amer. Jour. Science, Third Series, vol. xxv, p. 122, figs. 2 and 3. 1883.

Dipterocaris Procne, JONES and WOODWARD. Geol. Mag., Dec. iii, vol. i, No. 8, p. 349. 1884.

Dipterocaris Procne, ETHERIDGE, WOODWARD and JONES. Second Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 11. 1884.

Dipterocaris Procne, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 3. 1885.

CARAPACE ovate or sub-quadrate in general outline. Surface normally elevated along the dorsum and broadly rounding to the sides. Cephalic cleft very broad and short, extending one-fourth the length of the shield; abdominal cleft narrower and longer. The isthmus or the area of the union of the *alæ* is situated somewhat anteriorly and has a length less than one-third the length of the carapace. The angles made by the margins of the anterior cleft and the periphery are large and obtuse, the posterior angles sharper.

Surface ornamented by regularly concentric lines or ridges which make a slight retral bend at the margins of the cleft. An uncompressed individual has a length of 25 mm., and a width of 19 mm.

Distribution. Portage group. In the upper portion of the formation in the township of Canadice, Ontario county, and in the sandstones of the Chemung group 1,000 feet higher at Haskinsville, Steuben county.

DIPTEROCARIS PES-CERVÆ.

PLATE XXXV, FIGS. 20, 21.

Dipterocaris pes-cervæ, CLARKE. Amer. Jour. Science, Third Series, vol. xxv, p. 123, figs. 4 and 5. 1883.*Dipterocaris pes-cervæ*, JONES and WOODWARD. Geol. Mag., Dec. iii, vol i, No. 8, p. 349. 1884.*Dipterocaris pes-cervæ*, ETHERIDGE, WOODWARD and JONES. Second Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 11. 1884.*Dipterocaris pes-cervæ*, ETHERIDGE, WOODWARD and JONES. Third Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 3. 1885.

CARAPACE small, elongate-lanceolate in outline; isthmus slightly anterior and one-fourth as long as the shield. Cephalic cleft short, margins rapidly diverging, and making obtuse and rounded angles on the periphery. Abdominal cleft long and narrow, its margins making sharp angles at the posterior extremity.

The *surface* is ornamented as in the preceding species.

Dimensions of the type specimen, length 11 mm., width 6 mm.

Distribution. Chemung group. In the lower shales of the group at Dansville, Livingston county.

DECAPODA.

CARIDIDÆ.

PALÆOPALÆMON, WHITFIELD. 1880.

PALÆOPALÆMON NEWBERRYI.

PLATE XXX, FIGS. 20-23.

Palæopalæmon Newberryi, WHITFIELD. Amer. Jour. Science, Third Series, vol. xix, No. 109, p. 41. 1880.
Unpublished plate, figs. 1-3; also Palæontology of Ohio, pl. viii, figs. 19-21 (unpublished).

CEPHALOTHORAX elongate and slender, tapering toward the anterior extremity; dorsum narrow; latera narrow in front, rapidly widening behind and sloping from the edges of the dorsum in nearly a vertical plane. Margin inflected on the ventral side, slightly thickened and finely sulcate just within the edge, on the postero-lateral area rounding in a broad forward curve to the posterior edge, which is conspicuously reëntrant. A sharp carina extends along the axis of the cephalothorax and, bifurcating near the anterior extremity, leaves a gently concave triangular area between its branches, which does not show satisfactory evidence of having been produced into a rostrum. Each branch of the axial carina connects with the anterior extremity of a dorso-lateral carina, and between this and the axial carina the surface is gently concave. The entire surface is ornamented by fine, elevated, venate, frequently anastomosing lines, which are more conspicuous on the latera than on the dorsum, and have a general direction upward and backward from the ventral margins. From the anterior extremity on each of the latera a fine,

elevated grooved line runs backward, bifurcating once and becoming extinct before reaching the middle of the shield.

The *eyes* are wanting, but the sockets of the ocular peduncles are plainly discerned. The antennules are absent, the antennæ being represented by two very long and large joints, which are flat on their lower surface, convex above and somewhat inflated in the middle; their inner extremities are concealed beneath the cephalothorax, but they are undoubtedly the distal peduncular joints of these appendages similar to those in some species of *Crangon* (*C. boreas*). A single joint of a *maxillary palpus* (?) is visible on the right side of the specimen, followed by portions of all the five pairs of *ambulatory appendages*. Of the first leg two joints are visible, the proximal being very broad where it disappears beneath the carapace, tapering to a narrow anterior extremity; the distal joint is also broad, but narrower than the former; the second leg is indistinctly represented by fragments of two joints, both of which appear to have been slender; the third leg shows two joints, the proximal broad and the distal more slender; the fourth is represented by a single slender inner joint, while the fifth shows three joints, all of which are very slender.

The ABDOMEN tapers rapidly toward the telson, the somites increasing in length as they grow narrower. The somites are strongly arched, the ventro-lateral portions being somewhat incurved and posteriorly inclined. The basal joint of the first two abdominal appendages on the right side, and of the second and third pair on the left side are visible. The surface of the somite, though indistinctly preserved, was evidently ornamented as in the cephalothorax.

The TELSON consists of a broad, rapidly tapering, convex spine, bearing a low axial ridge; articulated to its antero-lateral margins and to the posterior margin of the ultimate somite are the compound lateral spines, which are connected by a membranous expansion. The lateral caudal spines are composed of a short basal joint, sub-pentagonal in outline, the anterior margin of which is articulated to the ultimate somite, the outer posterior margin being

jointed to the spine itself, and the inner posterior margin articulating with a flat thin lamellar spine, which lies in the middle of the membranous expansion.

Dimensions. The single specimen of this species which has been observed has the following dimensions: Entire length of carapace (the caudal expansion being slightly infolded), 36 mm.; length of cephalothorax, 21 mm.; length of basal joints of antennæ, as far as visible, 9 mm.; width of caudal expansion 17 mm.

Distribution. In the Erie shales, at LeRoy, Lake county, Ohio.

PHYLLOPODA.

LIMNADIADÆ.

ESTHERIA, RÜPPELL. 1857.

ESTHERIA PULEX.

PLATE XXXV, FIGS. 10, 11.

Estheria pulex, CLARKE. Amer. Jour. Science, Third Series, vol. xxiii, p. 476, plate 0, fig. 4. 1882.

Estheria pulex, PACKARD. Monogr. North Amer. Phyllopod Crust., p. 355; Twelfth Ann. Rept. U. S. Geol. Surv. 1883.

Estheria pulex, ETHERIDGE, WOODWARD and JONES. Fifth Rept. Committee on Fossil Phyllopoda of the Palæozoic Rocks, p. 10. 1887.

CARAPACE minute; outline sub-circular; beaks slightly anterior, prominent and somewhat incurved. Surface evenly and strongly convex, the most elevated point being the center of the valve.

Hinge-line short and somewhat obscured by the anterior and posterior slope from the beak. The surface bears six or eight concentric ridges, which are broad and flattened above and separated by narrow furrows. The test is tenuous, and the very narrow, impressed interstitial furrows do not show any trace of the fine sculpturing often observed in other species of this genus.

Of this species six individuals have been observed, the average dimensions of which are $\frac{1}{2}$ mm. in length and $\frac{2}{3}$ mm. in width. Five of these occur together upon a small fragment of shale about 15 mm. square, upon which twenty individuals of *Entomis*, *Beyrichia* and *Leperditia* are crowded. The specimens are from a thin layer in the Hamilton shales, which is extremely

prolific in the remains of these gregarious creatures. Although examples of the *Estheria* have not proven abundant, its crustacean nature is sustained by its associations.

Observations. *Estheria pulex* is noteworthy as being the oldest described representative of the genus and the first found in America below the Trias. In outline and surface markings it bears a striking resemblance to *E. membranacea*, Pacht, from the Old Red of Caithness, while most of the species occurring in younger rocks have the beak more anterior and the outline more nearly sub-trigonal. It is known that none of the living species of *Estheria* are properly marine animals, and it has been suggested in the original description of this species that its presence in the shales of the Hamilton group may indicate the existence of pools of fresh or brackish water along the sea-shore of that period. The unusual abundance of ostracodous species in association with this *Estheria* furthers the probability of this supposition.

Distribution. Hamilton group. In the soft shales, Miles' gully, Hopewell, Ontario county.

SCHIZODISCUS, N. G. (J. M. C.).

SCHIZODISCUS CAPSA, n. sp.

PLATE XXXV, FIGS. 1-9.

CARAPACE sub-circular or broadly ovate in outline; greatest length along the hinge-line; greatest width just behind the beaks and slightly anterior to the center of the shield. When the valves are fully expanded the width nearly equals the length; normally, however, the valves appear to have been more or less folded along the hinge, and when closed were probably in actual contact with each other along the ventral margins. The majority of the specimens found have the valves in contact along the hinge-line, but expanded; a few show the valves to be laterally compressed.

Surface gently and regularly convex and elevated at the beaks, which are anterior, but distant from the extremity of the carapace by one-third its

length. Their apices scarcely reach the hinge-line and are gently incurved. Toward the hinge their slope is abrupt, leaving the hinge-line slightly depressed. The posterior slope sometimes shows a low sinus as in many species of lamellibranchiata.

Hinge-line long and straight, extending the entire length of the carapace and showing no articulating teeth or ridges.

The ventral margin is gently recurved and scarcely thickened.

Surface ornamented by continuous, concentric, sharp ridges, which are closely crowded near the apices and more distant on the posterior portions of the valves. Of these ridges, twenty-five may be counted in a full-grown individual.

Dimensions. Considerable variation in size is noticeable in the specimens at hand. A mature individual has a length of 15 mm., and a width of 13 mm.; the youngest example a length of 4.5 mm., and a width of 4 mm.

Observations. This unique species in outline and sculpture presents a striking similarity to species of the genus *Aptychopsis*. It lacks, however, any evidence of a rostral plate and of any anterior cleft for the reception of such a plate. Its affinities are evidently with the genus *Estheria* and *Leaia*, as is shown by its umbonate valves, but it differs from the former in its remarkably elongate hinge-line, absence of the characteristic surface ornamentation, and from the latter in outline, and in the absence of the posterior ridge. It may, therefore, be regarded as constituting a new generic type of Phyllopod crustacea.

Distribution. Hamilton group. A number of specimens of the species have been obtained, all from a single locality, in the limestone at the base of the Hamilton shales near Centerfield, Ontario county.

CIRRIPEDIA.

BALANIDÆ.

PROTOBALANUS, N. G. (R. P. WHITFIELD).

PROTOBALANUS HAMILTONENSIS, n. sp. (R. P. W.)

PLATE XXXVI, FIG. 23.

SHELL small, ovate in general outline, narrowing toward the carinal extremity; surface depressed-convex, most elevated at the apex of the carina; composed of twelve peripheral plates.

Carina sub-semicircular in peripheral outline, conspicuously elevated to an obtuse apex, which lies just within the proximal margin of the plate; regularly sloping on the anterior surface, but slightly incurving or concave upon the sides.

Rostrum short, posterior margin broadly curving, apex scarcely elevated.

The *lateralia*, which are regularly disposed in five pairs, are symmetrical, and of the same general elongate, triangular form and of nearly the same size, the anterior members being somewhat the larger. The apices of these plates, as far as preserved, are slightly elevated and elongated in a short ridge toward the axis of the shell. All these plates are marked by low, radiating ridges, which become obsolete before reaching the apex. Of these, twelve may be counted upon the *carina* and six or eight upon the *rostrum*; on the *lateralia* they vary in number from four to seven. The *radial areas* are conspicuous and, as far as can be discerned, smooth. A portion of the

type specimen has been broken away, removing the summits of the posterior plates and covering the spot where the *scutum* and *tergum* would normally lie.

The specimen, which retains the replaced substance of the original shell, shows an expanded margin about a portion of the periphery, and this probably represents a portion of the edge of the valves which has been flattened and creased by compression.

Dimensions. Length 4.5 mm., greatest width 3.5 mm.

Observations. This minute species is the only known representative of the Balanoid cirripeds in the Palæozoic rocks, with the exception of *Balanus carbonarius*, Petzhold, from the Carboniferous rocks near Dresden, Saxony (Neues Jahrb. für Min., etc., 1842). *Protobalanus*, however, differs essentially from other forms which are included in the order *Balanidæ* in its great number (twelve) of plates, the usual number being six, four or one. This fact is not without significance, as it may indicate a greater specialization and a higher degree of structural development than in the other fossil and recent species of this order.

Distribution. Hamilton group. In the Marcellus shales: Avon, Genesee county.

PALÆOCREUSIA, n. g. (J. M. C.).

PALÆOCREUSIA DEVONICA, n. sp.

PLATE XXXVI, FIGS. 24-26.

CAPITULUM ovate in outline, patelliform; length to greatest width as 5 to 4. Surface gently conical, slightly depressed on the posterior slope. The apex is truncated by a horizontal plane, forming a relatively large central aperture having approximately the outline of the shell itself, and a length equal to one-third that of the shell.

The substance of the shell is apparently thin; its surface marked by faint radiating striæ or elevated lines. There is no apparent evidence of the separate original plates, all having been coalesced into a single external

plate as is characteristic of the genus *Creusia*. A single conspicuous furrow, slightly within and concentric with the margin, may indicate the line of contact of the capitulum with the walls of the basis.

Basis tubuliform, sub-cylindrical or cup-shaped.

The specimen is attached to a colony of *Favosites hemisphericus* and has at some time been overgrown as far as the aperture by the multiplication of the cell tubes. A portion of the coral was subsequently removed by natural causes, exposing the capitulum, but leaving the tubular basis completely enveloped. The surface of the former still bears traces of the cell walls of the coral. By removal of a portion of the coral near the side of the specimen it is found that the internal cavity is partially filled with soft decomposed chert, the remainder of the cavity filling, the capitulum and the entire coral being silicified. The internal plates, *scutum* and *tergum*, are not preserved.

Dimensions. The capitulum has a length of 10 mm., and a width of 8.5 mm. The depth of the tubular basis can be measured through the aperture for 8 mm., but is probably somewhat greater.

Observations. This interesting species brings to our knowledge a representative, from Devonian rocks, of forms included under the recent genera *Pyrgoma* and *Creusia*, neither of them previously recognized in palæozoic formations, and the latter not heretofore known among fossils. Features of distinctively generic value in which this species differs from recent members of the genus *Creusia* are not readily apparent, and, therefore, the term *Palæocreusia* is used tentatively to express the probability that such differences will eventually be found.

Distribution. Corniferous limestone. LeRoy, Genesee county.

LEPADIDÆ.

STROBILEPIS, N. G. (J. M. C.).

STROBILEPIS SPINIGERA, n. sp.

PLATE XXXVI, FIGS. 20-22.

A SPECIMEN from the soft shales of the Hamilton group, in a fair state of preservation, presents features whose homologies are not at present well understood and do not permit a satisfactory interpretation of their taxonomic relations. The specimen itself is here described as it appears, and this description must serve temporarily as the diagnosis of the species:

The CAPITULUM consists of a conical terminal plate 5 mm. in height, having a nearly circular base, 10 mm. in diameter, against which lie the final plates of three vertical ranges, one at either side and one in the middle of the specimen. Of these three ranges, the plates composing those at the sides are of about the same size, while those on the central range are much smaller. All these plates have, however, about the same general trihedral form, but differ somewhat in details.

The first plate in the *left vertical range* is abruptly truncated on its anterior margin, from apex to base; from the apex backward sharply angulated and sub-carinate near the apex, becoming broader as it approaches the margin. This plate is quite unsymmetrical, its outer lateral slope being broad, equilateral, or gently concave; the inner slope convex, very narrow, angulated by three radiating ridges, the middle one of which is the strongest.

The second plate of this range is narrow and sellate, the antero-lateral slopes being concave, and the apex overarching. The posterior portion is angulated, without carina, and is broadly curved, making a moderately sharp angle with the antero-lateral faces. This plate is nearly bi-laterally symmet-

rical, the outer portion of the posterior slope being a little more convex than the inner.

In the third plate the form is much as in the preceding, but is broader, the apex more central and not so strongly incurved, the antero-lateral slopes more conspicuous and the posterior slope narrow and unsymmetrical.

The fourth plate is almost the reverse of the first in form; the posterior area is abbreviated, very narrow and slightly concave just beneath the elevated apex; the outer lateral slope is broad and flat. Whether the plate bears a median carina and differs as widely in the size of its lateral faces as in the first plate, cannot be determined, as it is largely covered by the preceding plate of the range.

The fifth plate is broken and its form cannot be satisfactorily determined.

In the *right vertical range* the plates were evidently symmetrical with those of the left, but have been somewhat displaced from their normal position. The first is in place; the second has been pushed out of its place and is not apparent, unless it is represented by the upturned lower surface of a plate visible near the lower portion of the specimen lying beneath the other plates; the third plate is pushed backward so as to show the strongly carinate anterior surface of the fourth plate projecting beyond its anterior edge; beneath this lies also the anterior edge of the fifth plate, showing that it also is carinate; and back of them all lies the sixth plate with a posterior apex, truncate behind, lateral slopes broad, the outer being the broader, and separated from the inner by a carina. Although this plate does not appear in the left range it may be represented by a fragment lying beneath the inner edge of the fourth plate of that range.

The *axial range* is composed of small plates having about one-third the diameter of those of the lateral ranges. These differ considerably in form, but appear to be bi-symmetrical. Three are to be seen in juxtaposition on the anterior portion of the specimen, and a fourth is displaced and lies behind the inner posterior edge of the fourth plate of left range.

In addition to these three ranges of plates is a *vertical row of spines*, which, whatever their normal position, lie in a more or less detached condi-

tion about the right and lower edges of the specimen. Sixteen of these spines may be counted, the first eleven lying regularly one below another along the edge of the terminal and first right lateral plates, and increasing in size downward. The remaining five are larger and detached, but still showing a degree of order in their arrangement, their bases all directed inward about the lower margins of the specimen. These spines are about four times as long as wide, the first ten deeply grooved on their exposed surface, the last six apparently turned over, showing a surface sharply carinate on the axial line and grooved within the margins. The position of this range of spines was in all probability opposite to the axial range of small plates, and the pressure, to which the specimen has been subjected in the shale, has displaced it by pushing it around to the right without scattering the spines to any great degree.

The plates and spines are calcareous, with a strongly punctate surface, and more or less distinct concentric growth-lines, which in the broader plates are crossed by low, radiating ridges and furrows. The basal edges of the plates are thick and crenulated on the under side.

The species thus appears to have been composed of four vertical ranges, three of plates and one of spines; of these the two larger rows of plates were in themselves asymmetrical, but were symmetrical in position, number and form; the third row was made up of bilaterally symmetrical plates, themselves symmetrical in position with the row of spines. All these ranges overlapped or were terminated by a conical plate.

Dimensions. The terminal plate has a diameter of 10 mm., and a height of 5 mm.; the elevation of the apex is slightly more than this in some of the other plates, and the width of the plates in the lateral ranges varies as pointed out in the description. The smaller plates have a diameter of 4 or 5 mm.; the spines a length of from 5 to 8 mm. The entire animal must have been between 25 and 30 mm. in length.

Observations. In the species of *Turrilepas* (*T. Wrightianus*), figured by H. Woodward (Quarterly Journal Geol. Soc., vol. xxi, 1865), and of *Plumulites* given by Barrande (Syst. Sil. de la Bohême, vol. i, suppl., 1872), the number of vertical

ranges of plates appears to be a matter of uncertainty and probably also of variation. *Turrilepas Wrightianus*, De Koninck, has four ranges and Barrande has expressed the impossibility of ascertaining from his specimens of *Plumulites* the exact number of these rows, regarding it as not less than four and rarely so few. In *Lepidocoleus*, Faber, there appear to be but two ranges of plates. In none of these genera has the character of the upper extremity of the animal been ascertained. *Strobilepis spinigera* may present a similarity to *Turrilepas* (*Plumulites*) in the numerical arrangement of its parts, but it presents an association of characters which separate it from either of those genera. In recognizing the cirriped character of this fossil, it is difficult to conceive how such a body, capped at the anterior extremity by a circular conical plate over which the adjacent plates are lapped, could have served as anything but the capitulum of the animal. There is no such difference in the character of the plates as would allow some of them to be regarded as peduncular and some as capitular, and no evidence that any scaly peduncle was attached beneath the plates. On the contrary the whole association of plates appears to represent a simple and uncomplicated primary type of lepadiform capitulum, less condensed and modified than in recent representatives, *Scalpellum*, *Lepas*, *Ibla*, etc.

Distribution. Hamilton group. In the upper shales near Menteth's Point, Canandaigua lake.

TURRILEPAS, WOODWARD. 1865.

TURRILEPAS FLEXUOSUS, n. sp.

PLATE XXXVI, FIG. 1.

A SINGLE minute plate is characterized by the following features: Outline obliquely lanceolate; nucleus apical; a longitudinal furrow, lying just behind the middle line of the valve, begins at one-third the distance from the apex to the basal margin, becoming broader and deeper as it proceeds, its slope on the anterior side being much stronger and more abrupt than on the posterior.

Surface ornamented by elevated lines, which are transverse and closely crowded near the apex, becoming strongly lamelliform and bent downwards over the longitudinal furrow, those toward the base not crossing this depression. Where thus interrupted the lines have multiplied more rapidly than on the anterior portion of the valve.

Length of the single plate 2.5 mm., width 1.5 mm.

Distribution. Upper Helderberg group. Corniferous limestone: In the boulders of decomposed chert, Canandaigua, Ontario county.

TURRILEPAS CANCELLATUS, n. sp.

PLATE XXXVI, FIG. 2.

A SINGLE plate is characterized by a few distant elevated concentric lines, crossed by fine, closely crowded, interrupted, radiating lines, which are more elevated and more conspicuous toward the posterior margin. The valve appears to be sinuous medially and is abruptly deflected to the left antero-lateral margin.

The specimen is small, measuring 2.5 mm. in height and 2 mm. in length.

Distribution. Upper Helderberg group. Corniferous limestone: In the decomposed chert, Canandaigua, Ontario county.

TURRILEPAS DEVONICUS.

PLATE XXXVI, FIG. 3.

Plumulites Devonicus, CLARKE. Amer. Jour. Science, Third Series, vol. xxiv, p. 55, figs. 1 and 2. 1882.

THE plates of this species appear to be of two forms; one elongate-sub-triangular and feather-like, the lateral margins curving to the nucleus, which is apical, basal margin terminal, surface flat except for a rounded median ridge extending from the apex to the base, which becomes wider and stronger with each increment of growth along the margins; concentric growth lines elevated, moderately distant, curving upward and closely appressed. The other form is broader and oblique, with sub-equal, convex margins, and sub-apical nucleus,

and without the median ridge. These different forms of plates have been found in close proximity leaving little doubt of their coherence in the same individual, probably being from separate vertical ranges in the composition of the capitulum. The elongate form finds a close parallel in some of the Bohemian species, as *Plumulites Bohemicus*, *Pl. fraternus*, *Pl. compar*, Barrande, although the latter attained a considerably greater size, and it appears probable that the broader plate here described is homologous with the plates termed by M. Barrande the *valve fenestrée*, found in association with the plumate plates in well-preserved specimens from the étage D. This plate was however regarded by Barrande not as a member of a range of similar plates but as isolated among the other plates composing the capitulum.

The scales of *Turrilepas Devonicus* are small, the elongate form measuring 3.5 mm. in length and 2.5 mm. across the base, the broader form 2.5 mm. in length and 2 mm. in width.

Distribution. Hamilton group. In the shales and limestones near the base of the Hamilton shales: Canandaigua and Centerfield, Ontario county.

TURRILEPAS SQUAMA, n. sp.

PLATE XXXVI, FIGS. 5-8.

A FEW scattered *plates* exceeding in size any belonging to the associated species appear to represent a distinct form. These are broadly sub-triangular, having a width nearly equal to the length. The best preserved examples are *valves fenestrées*, having the nucleus sub-apical. The earliest of the concentric striae are nearly circular, becoming sinuous, more transverse and more closely crowded near the basal margin. Along the posterior margin the striae present the appearance of being "gathered," but they become obsolete before reaching the anterior margin.

The surface is nearly flat, with indications of a low sinus near the middle of the valve and toward the posterior edge. The other plates referred to this species have the same general form, and the nucleus apical, one of them being abruptly deflected toward the anterior margin. They all agree in the character

of their sculpture, which consists of fine incised lines separated by broad, retrally sloping annulations. This ornamentation is noticeably coarser than in any of the associated species.

Their size varies from a length and width of 4 mm. to a length of 6 mm. and a width of 5 mm.

Distribution. Hamilton group Centerfield and Canandaigua, Ontario county.

TURRILEPAS NITIDULUS, n. sp.

PLATE XXXVI, FIG. 4.

A SINGLE plate wanting the nuclear portion is distinguished from the associated forms by its very fine and closely set concentric striæ, and its broad posterior area, which is covered with conspicuous pits or punctæ, apparently arranged also in concentric lines. The basal margin is gently sinuous, corresponding with the sinuous concentric lines, and a broad low sinus is apparent over the median portion of the valve.

The length of the specimen is 2.5 mm., and the height about 2 mm.

Distribution. Hamilton group. In the lower shales at Fall Brook, Hopewell, Ontario county.

TURRILEPAS FOLIATUS, n. sp.

PLATE XXXVI, FIG. 15.

A SINGLE plate has an elongate semi-lanceolate or semi-saggitate outline, and a length equal to three times the height. The nucleus is not distinctly seen in the specimen, and the concentric lines in its vicinity appear to be obsolete, but further downward are closely crowded and clearly defined. The posterior margin is long and straight, appears to have been slightly elevated or thickened and possibly folded. The anterior margin seems to have been abruptly curved across the plate, rounding backward to the straight basal margin.

The height of the plate is 2.5 mm., its length 7 mm., and the distance along the posterior margin 9 mm.

Distribution. Hamilton group. In the limestone layers at the base of the Hamilton shales: Canandaigua, Ontario county.

TURRILEPAS TENER, n. sp.

PLATE XXXVI, FIGS. 9-14.

To this species are referred certain plates which have the same general outline and surface features as in all the other specimens observed. One fragment of shale retains ten of these plates over the surface of a square inch. The outline is equilaterally triangular and the surface nearly flat; the nucleus apical; the anterior and posterior margins straight, diverging at an angle of seventy-five degrees; the basal margin is gently sinuous, curving upward toward the posterior, and downward toward the anterior margin. Along the posterior margin, the plate is abruptly deflected toward the opposite side, but this is only for a very short distance. When the plates are not flattened there appears to be an elevated fold or broad ridge, situated in front of the axial line of the plate, running from the apex to the basal margin. The concentric striæ are fine, elevated and crowded closely together, becoming obsolete just before reaching the anterior margin. As in other forms of this genus, these lines curve upward at or near the anterior and posterior margins.

All the specimens observed have about the same length and height, which is 3.5 mm.

Distribution. Hamilton group. In the lower shales at Centerfield, Ontario county.

TURRILEPAS (?) NEWBERRYI.

PLATE XXXVI, FIGS. 16-19.

Plumulites Newberryi, WHITFIELD. Annals New York Acad. Sciences, vol. ii, No. 8, p. 217. 1882.

Plumulites Newberryi, WHITFIELD. Pal. Ohio, vol. iii, pl. viii, figs. 6-11 (unpublished).

THE specimens referred to this species consist of detached plates, of large size, and generally obliquely sub-triangular outline. They are usually flattened in the shales and somewhat indistinctly preserved, but were evidently of sub-conical form. With a single exception, the nucleus is apical and inclined slightly to one side, the anterior margin gently incurved, the posterior convex, and the basal margin sinuous, a feature caused by a broad depression running from the apex obliquely backward. A single specimen preserved in a rolled con-

cretion retains two plates in juxtaposition, one of which indicates that the true form was sub-conical, appressed at the sides, with a broadly rounded, somewhat flattened dorsum. The anterior margins, from the apex to the base, appear to have been distant, leaving a broad cleft between them. Some of these characters are also shown upon the flattened specimens. There is but one exception exhibited to the general sub-triangular form of these plates, and that is afforded by a small example in which the apex is central and both anterior and posterior margins convex. The substance of the valves is chitinous, tenuous and reduced to a carbonaceous film; the surface is ornamented by concentric undulating ridges, which are closely crowded near the apex, and also near the basal margin in old specimens. The dorsum shows traces also of fine elevated radiating lines.

These plates vary in size from a length of 6 mm. and a height of 5 mm. to a length of 27 mm. and a height of 20 mm. Fragments also indicate a very much greater size.

Observations. The fossils which constitute this species vary widely in some features from those referred to *Plumulites* by M. Barrande, as well as from other species of this genus occurring in the rocks of New York State. All these are of very much smaller size, and are simple plates, never folded or rounded over the back or conical, and are usually characterized by a conspicuous ridge passing from the apex to near the basal margin. It is difficult to see how the combination of these sub-conical bodies in vertical ranges could produce such a scaly peduncle or capitulum as existed in *Turrilepas*. Should the anterior margins of these valves prove to be cleft from apex to base, they will resemble much more closely in form, contour and surface sculpture, the fossils which have been described under the genus *Spathiocaris* (page 199).

Distribution. In the black shales at Sheffield and Birmingham, Erie county, Ohio. In Mr. Whitfield's description the fossils were referred to the "Huron shale," equivalent to the Genesee shales and the lower portion of the Portage shales of New York; Dr. J. S. Newberry has however, in corrected labels upon the specimens, referred them to the "Cleveland shale," the uppermost Devonian strata of Ohio.

S U P P L E M E N T A R Y.

STYLONURUS EXCELSIOR.

(See page 158)

PLATE XXVI, AND PLATE XXVI A.

THROUGH the kindness of Mr. R. D. Lacoe, of Pittston, Pennsylvania, the type specimen of *Dolichocephala Lacoana*, Claypole (Proceedings Amer. Phil. Soc., vol. 21, p. 236), has been communicated for comparison with *S. excelsior*. This specimen is from the Catskill group, of Meshoppen, Wyoming county, Pennsylvania, and consists of the greater portion of a cephalon of slightly larger dimensions than the original of *S. excelsior*, and shows so close a similarity to the latter in outline and surface features that there can be no doubt of their specific identity.

The surface of Mr. Lacoe's specimen has been somewhat distorted by the compression of the carapace upon the underlying parts, and although this portion is not as well preserved as in the type specimen, it shows a single feature of great importance, not seen in the latter. The conspicuous and comparatively smooth ridge passing between the eyes, is divided at its rounded posterior extremity by a sharply incised longitudinal line, on each side of which lies a distinct *ocellus*. This feature has not before been noticed in specimens of *Stylonurus*, and it affords an additional point of alliance between this genus and the genera *Eurypterus* and *Pterygotus*.

The lower surface of the specimen as it came into our hands showed a few indications of the cephalic appendages; these traces have been followed up and the organs carefully worked out. These, as far as they remain, are quite perfectly preserved, and appear to lie in their normal position beneath the carapace.

The first or anterior pair of gnathopods is represented by the impression upon the upper left edge of the specimen, of two short joints, followed by a longer joint, which may have been chelate. This part is represented in the figure having been drawn from a cast in gutta-percha. Unless this appendage has been detached from its proper position it must have been somewhat longer than the members of the second pair. The right leg of the second pair is preserved nearly entire, a portion of its basal joint being deeply buried in the matrix beneath the next succeeding appendage. The portion exposed measures 40 mm. in length to the distal articular surface, and about 20 mm. in greatest width. The inner margin bears a broad mandibular flange, which is serrate upon the edge, and there is evidence of another such process partially concealed in the matrix. The remaining portion of this appendage is 90 mm. in length,

tapering rapidly, and was undoubtedly divided into several joints although the articulating surfaces cannot be detected. Along the lower margin of the appendage is a double series of strong spinous processes, each having a length of about 25 mm. Four of these and the bases of two others constitute the outer row, and portions of two members of the lower row are partially exposed. The terminal spine is incurved toward the tip, and all are characterized by the longitudinal elevated lines upon their surface. A fragment of the basal joint of the left leg of the same pair lies in its normal position, and a small portion of its mandibular process is exposed.

The carapace has been so forcibly compressed upon the basal joints of both these appendages as to produce conspicuous ridges upon the surface equidistant from the anterior prolongation of the median ridge of the cephalon.

Directly behind the base of the right member of this pair lies a single joint terminating in a chela, the whole measuring 60 mm. in length. The other joints of this appendage do not appear on the specimen, and it is impossible to determine positively whether this is, as it seems, the terminal portion of a third gnathopod, or is analogous to the chelate antennules of *Limulus*.

A portion of a very strong basal joint, belonging to the left member of the third pair of appendages, has a diameter of 30 mm., a length of 35 mm., and bears a double lamellate mandibular extension, which is sharply serrate along its oral edge. This joint is followed by a small portion of a fourth gnathopod, which has a diameter of 40 mm., and though quite imperfect represents a very large appendage. Behind this, and lying in its normal position is the basal joint of the last or fifth pair of appendages. This is very broad and flat, as in other members of the *Eurypteridæ*, has a length of 90 mm., a width of 60 mm., and a thickness of 20 mm. at its distal extremity. The oral margin of the joint bears a row of conspicuous denticulations.

According to the restoration of *Stylonurus Logani* given by Woodward (Mon. Brit. Foss. Merostomata, pt. iv, p. 131), the last two pairs of gnathopods were produced to a length nearly equaling that of the entire body. This may be true also of *Stylonurus excelsior*, and as the specimen under consideration bears the largest carapace of *Stylonurus* at present known to us, these appendages may have reached a length of upward of four feet.

The evidence from this specimen confirms in most particulars Woodward's restoration of the oral surface of *Stylonurus*, though there is reason to believe that the peculiar antennæ there ascribed to the animal represent the first pair of gnathopods, and that there were five instead of four pairs of these appendages as given by the author.

SYNOPTICAL TABLE OF THE GENERA AND SPECIES OF DEVONIAN CRUSTACEA DESCRIBED IN VOL. VII.

Serial Number.	Species Number.	NAME AND AUTHOR.	Oriskany.	Schoharie.	Corniferous.	Marcellus.	Hamilton.	Tully.	Genesee.	Portage.	Chemung.	Catskill.	Page.	Plate and Figure.
		TRILOBITA.												
		<i>CALYMENIDÆ.</i>												
1	1	Calymene , Brongniart. C. platys, Green, . . . . .	.	*	*	.	.	.	.	.	.	.	1	I, 1-9; XXV, 1, 2.
2	2	Homalonotus , Koenig. H. major, Whitfield, . . . . .	*	.	.	.	.	.	.	.	.	.	4	V A, 1.
3	2	H. Dekayi, Green, . . . . .	.	.	.	*	*	.	.	.	.	.	7	II, 1-12; III, 1-5; IV, 1-7; V, 1-14.
		<i>BRONTEIDÆ.</i>												
4	3	Bronteus , Goldfuss. B. Tullius, Hall,	1	.	.	1	1	.	.	.	.	.	12	VIII A, 34-36.
		<i>PHACOPIDIAE.</i>												
5	4	Phacops , Emmrich. P. cristata, Hall, . . . . .	.	.	.	.	.	.	1	.	.	.	14	VI, 1-13, 16-29; VIII A, 1-4.
6	2	P. cristata, var. pipa, Hall, . . . . .	*	*	*	.	.	.	.	.	.	.	18	VIII A, 5-18.
7	3	P. rana, Green, . . . . .	.	.	*?	*	*	*	.	.	.	.	19	VII, 1-11; VIII, 1-18; VIII A, 21-33.
8	4	P. bufo, Green, . . . . .	.	.	.	.	*	.	.	.	.	.	26	VIII, 25, 26.
9	5	P. Cacaponia, Hall, . . . . .	.	.	.	.	*	.	.	.	.	.	27	VIII, 19-24.
10	6	P. nupera, Hall, . . . . .	.	.	.	.	.	.	.	.	*?	.	27	VIII, 27.
		Dalmanites , Barrande.												
11	1	D. (Hausmannia) pleuroptyx, Green,	1	1	3	1	3	1	.	.	1	.	28	XI A, 1-3.
12	2	D. (Hausmannia) concinnus, Hall, . . . . .	*	.	*	.	.	.	.	.	.	.	30	XI A, 9-11.
13	3	D. (Hausmannia) concinnus, var. ser- rula, Hall, . . . . .	.	*	*	.	.	.	.	.	.	.	30	XI A, 12.
14	4	D. (Hausmannia) phacoptyx, Hall, . . . . .	.	.	*	.	.	.	.	.	.	.	31	XI A, 23-27.
15	5	D. (Hausmannia) Meeki, Walcott, . . . . .	.	.	.	.	*?	.	.	.	.	.	32	XI A, 28-30.
16	6	D. (Coronura) aspectans, Conrad, . . . . .	.	.	*	.	.	.	.	.	.	.	33	XIII, 1-11, 13.
17	7	D. (Coronura) myrmecophorus, Green, . . . . .	.	.	*	.	.	.	.	.	.	.	37	XI A, 13; XIII, 12; XIV, 1-6; XV, 1-4.
18	8	D. (Coronura?) emarginatus, Hall, . . . . .	.	*	.	.	.	.	.	.	.	.	40	XI A, 7, 8.
19	9	D. (Cryphæus) comis, Hall, . . . . .	.	.	*	.	.	.	.	.	.	.	41	XVI A, 1.
20	10	D. (Cryphæus) Pleione, Hall, . . . . .	.	.	.	.	*	.	.	.	.	.	41	XVI A, 2.
21	11	D. (Cryphæus) Boothi, Green, . . . . .	.	.	*?	*	*	.	.	.	.	.	42	XVI, 1-4; XVI A, 3-8.
22	12	D. (Cryphæus) Boothi, var. Calliteles, Green, . . . . .	.	.	.	.	*	*	.	.	.	.	45	XVI, 5-22; XVI A, 9-17.

SYNOPTICAL TABLE—Continued.

Serial Number.	Species Number.	NAME AND AUTHOR.	Oriskany.	Schoharie.	Corniferous.	Marcellus.	Hamilton.	Tully.	Genesee.	Portage.	Chemung.	Catskill.	Page.	Plate and Figure.
23	13	D. (Cryphæus) Barrisi, Hall, . . .	.	.	.	.	*	.	.	.	.	.	48	XVI A, 18.
24	14	D. (Odontocephalus) selenurus, Conrad, . . .	.	.	*	.	.	.	.	.	.	.	49	XI B, 15-21 ; XII, 1-13.
25	15	D. (Odontocephalus) bifidus, Hall, . . .	.	.	*	.	.	.	.	.	.	.	53	XI B, 22-25.
26	16	D. (Odontocephalus) Ægeria, Hall, . . .	.	.	*	.	.	.	.	.	.	.	53	XI B, 1-11.
27	17	D. (Odontocephalus?) coronatus, Hall, . . .	.	.	*	.	.	.	.	.	.	.	54	XI B, 12-14.
28	18	D. (Corycephalus) regalis, Hall, . . .	.	*	.	.	.	.	.	.	.	.	55	XI, 1-4.
29	19	D. (Corycephalus) pygmæus, Hall, . . .	.	.	*	.	.	.	.	.	.	.	56	XI, 5-8.
30	20	D. (Chasmops) anchiops, Green, . . .	*	*	*	.	.	.	.	.	.	.	59	IX, 1-6, 10, 12, 13 ; X, 1-13.
31	21	D. (Chasmops) anchiops, var. armatus, Hall, . . .	.	*	*	.	.	.	.	.	.	.	62	IX, 7-9 ; X, 14.
32	22	D. (Chasmops) anchiops, var. sobrinus, Hall, . . .	.	.	*	.	.	.	.	.	.	.	62	IX, 11.
33	23	D. (Chasmops) Calypso, Hall, . . .	.	.	.	.	.	.	.	.	.	.	64	XI A, 19-22.
34	24	D. (Chasmops?) Erina, Hall, . . .	.	.	*	.	.	.	.	.	.	.	67	XI A, 16-18.
35	25	D. (Chasmops) macrops, Hall, . . .	.	.	*	.	.	.	.	.	.	.	68	XI A, 14, 15.
<i>ACIDASPIDÆ.</i>			2	6	18	1	5	1						
	6	Acidaspis , Murchison.												
36	1	A. callicera, Hall, . . .	.	*	*	.	.	.	.	.	.	.	69	XVI B, 1-13.
37	2	A. sp., . . .	.	.	*	.	.	.	.	.	.	.	71	XVI B, 14.
38	3	A. Romingeri, Hall, . . .	.	.	.	.	*	.	.	.	.	.	71	XVI B, 15-18.
<i>LICHADÆ.</i>				1	2		1							
	7	Lichas , Dalman.												
39	1	L. (Terataspis) grandis, Hall, . . .	.	*	*	.	.	.	.	.	.	.	73	XVII, 1-6 ; XVIII, 1, 2 ; XIX, 1-7.
40	2	L. (Conolichas) hispidus, Hall, . . .	.	*	*	.	.	.	.	.	.	.	77	XIX A, 14, 17, 18.
41	3	L. (Conolichas) Eriopis, Hall, . . .	.	.	*	.	.	.	.	.	.	.	78	XIX A, 2-13, 15, 16.
42	4	L. (Hoplolichas) hylæus, Hall, . . .	.	.	*	.	.	.	.	.	.	.	81	XIX B, 1, 2.
43	5	L. (Arges) contusus, Hall, . . .	.	.	*	.	.	.	.	.	.	.	83	XIX B, 3-6.
44	6	L. (Ceratolichas) gryps, Hall, . . .	.	.	*	.	.	.	.	.	.	.	84	XIX B, 7-13.
45	7	L. (Ceratolichas) dracon, Hall, . . .	.	.	*	.	.	.	.	.	.	.	85	XIX B, 14-17.
<i>PROËTIDÆ.</i>				2	7									
	8	Proetus , Steininger.												
46	1	P. Conradi, Hall, . . .	.	*	.	.	.	.	.	.	.	.	89	XX, 9 ; XXI, 27, 28 ; XXII, 4.
47	2	P. angustifrons, Hall, . . .	.	*	.	.	.	.	.	.	.	.	91	XX, 1-5 ; XXII, 1-3.
48	3	P. Hesione, Hall, . . .	.	*	.	.	.	.	.	.	.	.	93	XX, 15, 16.
49	4	P. sp. ? . . .	.	*	.	.	.	.	.	.	.	.	94	XXII, 5, 6.
50	5	P. curvimarginatus, Hall, . . .	.	*	.	.	.	.	.	.	.	.	94	XXII, 13-19.
51	6	P. latimarginatus, Hall, . . .	.	*	.	.	.	.	.	.	.	.	97	XXII, 7-12.

SYNOPTICAL TABLE—Continued.

Serial Number.	Species Number.	NAME AND AUTHOR.	Oriskany.	Schoharie.	Corniferous.	Marcellus.	Hamilton.	Tully.	Genesee.	Portage.	Chemung.	Catskill.	Page.	Plate and Figure.
52	7	<i>P. crassimarginatus</i> , Hall, .	.	*	*	.	.	.	.	.	.	.	99	XX, 6-8, 20-31 ; XX, 20-26 ; XXV, 8.
53	8	<i>P. folliceus</i> , Hall, .	.	.	*	.	.	.	.	.	.	.	101	XXIII, 3-8.
54	9	<i>P. clarus</i> , Hall, .	.	.	*	.	.	.	.	.	.	.	104	XX, 12-14 ; XXIII, 28-30.
55	10	<i>P. canaliculatus</i> , Hall, .	.	.	*	.	.	.	.	.	.	.	107	XX, 10, 11 ; XXIII, 10, 11.
56	11	<i>P. Verneuili</i> , Hall, .	.	.	*	.	.	.	.	.	.	.	108	XX, 18, 19.
57	12	<i>P. microgemma</i> , Hall, .	.	.	*	.	.	.	.	.	.	.	109	XXII, 33, 34.
58	13	<i>P. stenopyge</i> , Hall, .	.	.	*	.	.	.	.	.	.	.	110	XXII, 27.
59	14	<i>P. ovifrons</i> , Hall, .	.	.	*	.	.	.	.	.	.	.	110	XXII, 31, 32.
60	15	<i>P. delphinulus</i> , Hall, .	.	.	*	.	.	.	.	.	.	.	111	XXIII, 1, 2 ; XXV, 6.
61	16	<i>P. (?) planimarginatus</i> , Meek,	.	.	*	.	.	.	.	.	.	.	112	XXIII, 12.
62	17	<i>P. tumidus</i> , Hall, .	.	.	*	.	.	.	.	.	.	.	113	XXIII, 9.
63	18	<i>P. Haldemani</i> , Hall, .	.	.	.	*	*	.	.	.	.	.	113	XXI, 7-9 ; XXIII, 13-15.
64	19	<i>P. macrocephalus</i> , Hall, .	.	.	.	*	*	*	.	.	.	.	116	XXI, 10-21 ; XXIII, 30, 31.
65	20	<i>P. Rowi</i> , Green, .	.	.	.	.	*	*	.	.	.	.	119	XXI, 2-6, 24-26 ; XXIII, 20-29.
66	21	<i>P. jejunus</i> , Hall, .	.	.	.	.	*	*	.	.	.	.	124	XXV, 7.
67	22	<i>P. Phocion</i> , Billings, .	.	.	.	.	*	*	.	.	.	.	125	XXV, 9, 10.
68	23	<i>P. Prouti</i> , Shumard, .	.	.	.	.	*	*	.	.	.	.	126	XXIII, 16-18.
69	24	<i>P. Nevadæ</i> , Hall, .	.	.	.	.	*?	.	.	.	.	.	129	XXIII, 19.
70	25	<i>P. occidentis</i> , Hall, .	.	.	.	.	*	*	.	.	.	.	130	XXI, 22, 23.
71	26	<i>P. (?) longicaudus</i>, .	.	.	.	.	*?	.	.	.	.	.	131	XX, 32-34.
9 Phaethonides , Angelin.				7	11	2	9	2						
72	1	<i>Ph. arenicolus</i> , Hall, .	.	*	*	.	.	.	.	.	.	.	134	XXV, 12, 13.
73	2	<i>Ph. varicella</i> , Hall, .	.	.	*	.	.	.	.	.	.	.	135	XXIV, 29-31.
74	3	<i>Ph. gemmæus</i> , Hall, .	.	.	*	.	*	.	.	.	.	.	136	XXIV, 32-36.
75	4	<i>Ph. (?) denticulatus</i> , Meek, .	.	.	.	.	*?	.	.	.	.	.	129	XXV, 14, 15.
10 Cyphaspis , Burmeister.				1	3		2							
76	1	<i>C. minuscula</i> , Hall, .	.	*	*	.	.	.	.	.	.	.	140	XX, 17 ; XXIV, 7-12.
77	2	<i>C. stephanophora</i> , Hall, .	.	.	*	.	.	.	.	.	.	.	142	XXIV, 2-6.
78	3	<i>C. diadema</i> , Hall, .	.	.	*	.	.	.	.	.	.	.	144	XXIV, 13.
79	4	<i>C. hybrida</i> , Hall, .	.	.	*	.	.	.	.	.	.	.	144	XXIV, 14.
80	5	<i>C. ornata</i> , Hall, .	.	.	.	.	*	.	.	.	.	.	145	XXI, 1 ; XXIV, 21.
81	6	<i>C. ornata</i> , var. <i>baccata</i> , Hall,	*	146	XXIV, 22, 23.
82	7	<i>C. craspedota</i> , Hall,	*	148	XXIV, 15-20.
83	8	<i>C. lævis</i> , Hall,	*	.	150	XXI, 29.
				1	4		3				1			

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SYNOPTICAL TABLE—Continued.

Serial Number.	Species Number.	NAME AND AUTHOR.	Oriskany.	Schoharie.	Corniferous.	Marcellus.	Hamilton.	Tully.	Genesee.	Portage.	Chemung.	Catskill.	Page.	Plate and Figure.
		XIPHOSURA. <i>LIMULIDÆ.</i>												
84	11 1	Protolimulus , Packard. P. Eriensis, Williams, . . . .	.	.	.	.	.	.	.	.	*	.	153	XXVII, 1, 2.
		EURYPTERIDA. <i>EURYPTERIDÆ.</i>									1			
85	12 1	Eurypterus , Dekay. E. Beecheri, Hall, . . . .	.	.	.	.	.	.	.	.	*	.	156	XXVII, 5.
86	13 1	Stylonurus , Page. S. excelsior, Hall, . . . .	.	.	.	.	.	.	.	.	1	*	{ 158	} XXVI, XXVI A, 1-3.
87	2	S. ? (Echinocaris ?) Wrightianus, Dawson, . . . .	.	.	.	.	.	.	.	*	.	.	221	
		PHYLLOCARIDA. <i>CERATIOCARIDÆ.</i>								1			160	XXVII, 7-9.
88	14 1	Ceratiocaris , McCoy. C. longicauda, Hall, . . . .	.	.	.	.	.	.	*	.	.	.	163	XXXI, 1.
89	2	C. Beecheri, Clarke, . . . .	.	.	.	.	.	.	.	*	.	.	164	XXXI, 3.
90	3	C. ? simplex, Clarke, . . . .	.	.	.	.	.	.	.	*	.	.	165	XXXI, 2.
91	15 1	Echinocaris , Whitfield. E. punctata, Hall, . . . .	.	.	.	.	*	.	1	2	.	.	166	XXVII, 10; XXVIII, 1-7; XXIX, 1-8. XXIX, 20, 21. XXIX, 14-17. XXX, 1-12. XXIX, 11-13. XXIX, 9, 10. XXIX, 18, 19.
92	2	E. Whitfieldi, Clarke, . . . .	.	.	.	.	.	.	.	*	.	.	172	
93	3	E. condylepis, Hall, . . . .	.	.	.	.	.	.	.	.	*	.	173	
94	4	E. socialis, Beecher, . . . .	.	.	.	.	.	.	.	.	*	.	174	
95	5	E. sublævis, Whitfield, . . . .	.	.	.	.	.	.	.	*	.	.	176	
96	6	E. pustulosa, Whitfield, . . . .	.	.	.	.	.	.	.	*	.	.	178	
97	7	E. multinodosa, Whitfield, . . . .	.	.	.	.	.	.	.	*	.	.	180	
		Elymocaris , Beecher.					1			4	2			
98	1	E. capsella, Hall, . . . .	.	.	.	.	*	.	.	.	.	.	181	XXXI, 4.
99	2	E. siliqua, Beecher, . . . .	.	.	.	.	.	.	.	.	*	.	182	XXXI, 5, 6.
							1				1			

SYNOPTICAL TABLE—Continued.

Serial Number.	Species Number.	NAME AND AUTHOR.	Oriskany.	Schoharie.	Corniferous.	Marcellus.	Hamilton.	Tully.	Genesee.	Portage.	Chemung.	Catskill.	Page.	Plate and Figure.
100	17	Tropidocaris , Beecher.												
101	1	T. Hamiltonensis, Hall, . . . .	.	.	.	.	*	.	.	.	.	.	Expl.	XXX, 24, 25.
102	2	T. bicarinata, Beecher, . . . .	.	.	.	.	.	.	.	.	*	.	184	XXXI, 7-12.
	3	T. interrupta, Beecher, . . . .	.	.	.	.	.	.	.	.	*	.	185	XXXI, 13.
		<i>PINACARIDÆ.</i>									2			
103	18	Mesothyra , Hall.												
104	1	M. Oceani, Hall, . . . . .	.	.	.	.	.	.	.	*	.	.	187	XXXII, 1-6; XXXIII, 4-7; XXXIV, 1-5.
105	2	M. Neptuni, Hall, . . . . .	.	.	.	.	*	.	.	.	.	.	191	XXXII, 7; XXXIII, 1.
106	3	M. spumæa, Hall, . . . . .	.	.	.	.	*	.	.	.	.	.	193	XXXII, 8, 9; XXXIV, 2.
107	4	M. (Dithyrocaris) Veneris, Hall, . . . .	.	.	.	*	.	.	.	.	.	.	193	XXXIII, 3.
	5	(Dithyrocaris Belli, Woodward), . . . .	.	.	.	.	*	.	.	.	.	.	194	
		<i>RHINOCARIDÆ.</i>				1	3			1				
108	19	Rhinocaris , Clarke.												
109	1	R. columbina, Clarke, . . . . .	.	.	.	.	*	.	.	.	.	.	195	XXXI, 16-21.
	2	R. scaphoptera, Clarke, . . . . .	.	.	.	.	*	.	.	.	.	.	197	XXXI, 22, 23.
		<i>DISCINOCARIDÆ.</i>					2							
110	20	Spathiocaris , Clarke.												
	1	S. Emersoni, Clarke, . . . . .	.	.	.	.	.	.	.	*	.	.	199	XXXV, 12-18.
111	21	Dipterocaris , Clarke.								1				
112	1	D. pennæ-Dædali, Clarke, . . . . .	.	.	.	.	.	.	.	*	.	.	200	XXXV, 24.
113	2	D. Progne, Clarke, . . . . .	.	.	.	.	.	.	.	*	*	.	201	XXXV, 25-27.
	3	D. pes-cervæ, Clarke, . . . . .	.	.	.	.	.	.	.	.	*	.	202	XXXV, 20, 21.
		DECAPODA.								2	2			
		<i>CARIDIDÆ.</i>												
114	22	Palæopalæmon , Whitfield.												
	1	P. Newberryi, Whitfield, . . . . .	.	.	.	.	.	.	.	*	.	.	203	XXX, 20-23.
		PHYLLOPODA.								1				
		<i>LIMNADIADÆ.</i>												
115	23	Estheria , Rüppell.												
	1	E. pulex, Clarke,	*	206	XXXV, 10, 11.
							1							

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SYNOPTICAL TABLE—Continued.

Serial Number.	Species Number.	NAME AND AUTHOR.	Oriskany.	Schoharie.	Corniferous.	Marcellus.	Hamilton.	Tully.	Genesee.	Portage.	Chemung.	Catskill.	Page.	Plate and Figure.
116	24 1	Schizodiscus , Clarke. S. capsa, Clarke, . . . .	.	.	.	.	*	.	.	.	.	.	207	XXXV, 1-9.
		CIRRIPIEDIA. <i>BALANIDÆ.</i>					1							
117	25 1	Protobalanus , Whitfield. P. Hamiltonensis, Whitfield, . .	.	.	.	*	.	.	.	.	.	.	209	XXXVI, 23.
						1								
118	26 1	Palæocreusia , Clarke. P. Devonicus, Clarke,. . . .	.	.	*	.	.	.	.	.	.	.	210	XXXVI, 24-26.
		<i>LEPADIDÆ.</i>			1									
119	27 1	Strobilepis , Clarke. S. spinigera, Clarke, . . . .	.	.	.	.	*	.	.	.	.	.	212	XXXVI, 20-22.
							1							
120	28 1	Turrilepas , Woodward. T. flexuosus, Hall, . . . .	.	.	*	.	.	.	.	.	.	.	215	XXXVI, 1.
121	2	T. cancellatus, Hall, . . . .	.	.	*	.	.	.	.	.	.	.	216	XXXVI, 2.
122	3	T. Devonicus, Clarke,. . . .	.	.	.	.	*	.	.	.	.	.	216	XXXVI, 3.
123	4	T. squama, Hall, . . . .	.	.	.	.	*	.	.	.	.	.	217	XXXVI, 5-8.
124	5	T. nitidulus, Hall,	*	218	XXXVI, 4.
125	6	T. foliatus, Hall,	*	218	XXXVI, 15.
126	7	T. tener, Hall,	*	219	XXXVI, 9-14.
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CRUSTACEA.

SUMMARY

OF THE NORTH AMERICAN DEVONIAN CRUSTACEA (EXCLUDING OSTRACODA).

	No. of Species.	NAME.	Oriskany.	Schoharie.	Corniferous.	Marcellus.	Hamilton.	Tully.	Genesee.	Portage.	Chemung.	Catskill.
I	1	Calymene, . . . . .	.	1	1	.	.	.	.	.	.	.
II	2	Homalonotus,	1	.	.	1	1	.	.	.	.	.
III	1	Bronteus, . . . . .	.	.	.	.	.	1	.	.	.	.
IV	6	Phacops,	1	1	3 ?	1	3	1	.	.	1	.
V	25	Dalmanites,	2	6	18 ?	1	5 ?	1	.	.	.	.
VI	5	D. (Hausmannia),	1	1	4	.	1 ?	.	.	.	.	.
VII	3	D. (Coronura), . . . . .	.	1	2	.	.	.	.	.	.	.
VIII	5	D. (Cryphæus), . . . . .	.	.	2 ?	1	4	1	.	.	.	.
IX	4	D. (Odontocephalus), . . . . .	.	.	4	.	.	.	.	.	.	.
X	2	D. (Corycephalus), . . . . .	.	1	1	.	.	.	.	.	.	.
XI	6	D. (Chasmops),	1	3	5	.	.	.	.	.	.	.
XII	3	Acidaspis, . . . . .	.	1	2	.	1	.	.	.	.	.
XIII	7	Lichas, . . . . .	.	2	7	.	.	.	.	.	.	.
XIV	1	L. (Terataspis), . . . . .	.	1	1	.	.	.	.	.	.	.
XV	2	L. (Conolichas), . . . . .	.	1	2	.	.	.	.	.	.	.
XVI	1	L. (Hoplolichas), . . . . .	.	.	1	.	.	.	.	.	.	.
XVII	1	L. (Arges), . . . . .	.	.	1	.	.	.	.	.	.	.
XVIII	2	L. (Ceratolichas), . . . . .	.	.	2	.	.	.	.	.	.	.
XIX	26	Proëtus, . . . . .	.	7	11	2	9 ?	2	.	.	.	.
XX	4	Phaëthonides, . . . . .	.	1	3	.	2 ?	.	.	.	.	.
XXI	8	Cyphaspis, . . . . .	.	1	4	.	3	.	.	.	1	.
	83	(Total Trilobita),	4	20	49	5	24	5	0	0	2	0
XXII	1	Protolimulus, . . . . .	.	.	.	.	.	.	.	.	1	.
XXIII	1	Eurypterus, . . . . .	.	.	.	.	.	.	.	.	1	.
XXIV	2	Stylonurus, . . . . .	.	.	.	.	.	.	.	1	.	1
XXV	3	Ceratiocaris, . . . . .	.	.	.	.	.	.	1	2	.	.
XXVI	7	Echinocaris, . . . . .	.	.	.	.	1	.	.	4	2	.
XXVII	2	Elymocaris, . . . . .	.	.	.	.	1	.	.	.	1	.
XXVIII	2	Tropidocaris, . . . . .	.	.	.	.	1	.	.	.	2	.
XXIX	4	Mesothyra, . . . . .	.	.	.	1	2	.	.	1	.	.
XXX	1	Dithyrocaris, . . . . .	.	.	.	.	1	.	.	.	.	.
XXXI	2	Rhinocaris, . . . . .	.	.	.	.	2	.	.	.	.	.
XXXII	1	Palæopalæmon, . . . . .	.	.	.	.	.	.	.	1	.	.
XXXIII	1	Spathiocaris, . . . . .	.	.	.	.	.	.	.	1	.	.
XXXIV	3	Dipterocaris, . . . . .	.	.	.	.	.	.	.	2	2	.
XXXV	1	Estheria, . . . . .	.	.	.	.	1	.	.	.	.	.
XXXVI	1	Schizodiscus, . . . . .	.	.	.	.	1	.	.	.	.	.
XXXVII	1	Protobalanus, . . . . .	.	.	.	1	.	.	.	.	.	.
XXXVIII	1	Palæocreusia,	1
XXXIX	1	Strobilepis,	1
XL	8	Turrilepas,	2	.	5	.	.	.	1	.
	126	Total,	4	20	52	7	40	5	1	12	12	1

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Geological Survey of the State of New York.

PALÆONTOLOGY:

VOL. V, PART II.

SUPPLEMENT,

CONTAINING DESCRIPTIONS AND ILLUSTRATIONS

OF

PTEROPODA, CEPHALOPODA AND ANNELIDA.

BY

JAMES HALL,

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1888.

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PREFATORY NOTE.

DURING the progress of Vol. V, part ii, some new material came into the hands of the author, as well as better specimens of some forms already described and illustrated. In order to render available the knowledge thus acquired, a few supplementary plates were lithographed, with the expectation of being permitted to publish them, with the necessary text, within a short time after the appearance of the volume at the end of 1879. Unforeseen obstacles in the way of any publication prevented these being made available, and this interruption finally prevented the completion of the Supplement upon the plan originally intended. The material thus prepared was laid aside, and the manuscript notes and observations, made at that time, preparatory for the printing, were mislaid or lost.

In 1883, after the passage of the law to limit and complete the PALÆONTOLOGY OF NEW YORK, provision was made for incorporating these plates, with the necessary descriptive matter, into the work, as a supplementary part of Volume VII, where they now appear. The plates are numbered in consecutive order from cxiv to cxxix inclusive, the last plate of Vol. V, part ii, being cxiii. A single plate is devoted to the more complete representation of the PTEROPODA, embracing figures in farther illustration of some species already described, together with others of new forms.

During the progress of Vol. V, part ii, the study of the PTEROPODA, especially of the genera TENTACULITES and STYLIOLA, had suggested the importance of a review of these genera and an inquiry into their relations with CORNULITES. It was not until the discussion of the genus TENTACULITES had been nearly completed, and the tabular arrangement of species in type, that the author became fully aware of the necessity of this revision and of a farther inquiry

into the nature of the species described as *TENTACULITES*. On pages 162–165, vol. v, pt. ii, some discussion of this subject has been introduced, and for the purpose of farther elucidation material from various sources was procured for the illustration of the Lower Silurian forms heretofore referred to the genus *TENTACULITES*, and to the more recent genera *CONCHICOLITES* and *ORTONIA*, proposed by Prof. Nicholson; there being already in hand, from the Waldron collections, sufficient material for illustration of the principal phases presented in the development of the Niagara species.

The acquisition of new material among the *PTEROPODA*, made it desirable to give some farther illustration of this class, and especially of the *TENTACULITES*, for a better means of comparison with described forms, and also to show their distinction from the elongate annulated forms of *CORNULITES* usually referred to the former genus.

I have, therefore, introduced in this connection, and following the illustration of *TENTACULITES* and other *PTEROPODA*, Plates cxv, cxvi, and cxvi A, for the purpose of showing the varying phases of development among certain forms belonging to the genus *CORNULITES*. These plates were introduced primarily, for the purpose of affording means of comparison with authentic forms of *TENTACULITES* since some of the species of the former genus, in their free condition, so closely resemble the latter that they have been mistaken for the same and described as *TENTACULITES*.

The plates cxvii to cxxix inclusive are given to the *CEPHALOPODA*, of which twenty species here described are not illustrated in Vol. V, part ii; together with a number of others already there described and figured, but which are important as presenting additional features to those already illustrated. All these plates have appeared as photo-lithographs, accompanied by explanations, in the Fifth Report of the State Geologist (1886).

THE AUTHOR.

March, 1888.

PTEROPODA

OF THE

NIAGARA, LOWER AND UPPER HELDERBERG, HAMILTON AND WAVERLY GROUPS.

TENTACULITES, SCHLOTHEIM. 1826.

(See Vol. v, part ii, pp. 155-165.)

THE following species of this genus are illustrated upon the supplementary plate cxiv :

TENTACULITES MINUTUS.

PLATE CXIV, FIGS. 1, 2.

Tentaculites minutus, HALL. Pal. N. Y., vol. 2, p. 183, plate A 41, fig. 8a-e. 1852.

Clinton group. Rochester, Monroe county.

TENTACULITES NIAGARENSIS (Hall), var. CUMBERLANDIÆ, n. var.

PLATE CXIV, FIGS. 3-6.

THIS variety differs from *T. Niagarensis*, Hall (Pal. N. Y., vol. ii, p. 352, pl. lxxxv, figs. 11, 12), in its more conspicuous interstitial annulations and more attenuate form.

Niagara group. Cumberland, Maryland.

TENTACULITES GYRACANTHUS.

PLATE CXIV, FIGS. 7-13.

Echinus gyracanthus, EATON. Geological Text-book. 1832.

Tentaculites irregularis, HALL. Pal. N. Y., vol. 3, p. 137, pl. vi, figs. 22, 23. 1859.

Tentaculites gyracanthus, EATON (HALL). Pal. N. Y., vol. 3. Expl. pl. vi.

THE *Tentaculites regularis* and *T. irregularis* of Castelnau (Essai sur le Syst. Sil. de l'Amer. Septentrionale, 1843), described as from the Trenton limestone, are probably from the Lower Helderberg group, and identical with this species. (See Pal. N. Y., vol. v, pt. ii, p. 156, foot-note.)

Lower Helderberg group (Tentaculite limestone). Clarksville, Albany county; Schoharie, Schoharie county, and Jerusalem Hill, Herkimer county.

TENTACULITES ELONGATUS.

PLATE CXIV, FIG. 14.

Tentaculites elongatus, HALL. Pal. N. Y., vol. 3, p. 136, pl. vi, figs. 16-21. 1859.

Lower Helderberg group. Schoharie, Schoharie county.

TENTACULITES ACULA, n. sp.

PLATE CXIV, FIGS. 15-17.

THIS species is distinguished by the regular, equidistant annuli and the few annulations on the intervals.

Lower Helderberg group. Port Jervis, Orange county.

TENTACULITES DEXITHEA, n. sp.

PLATE CXIV, FIGS. 18, 19.

Tentaculites scalariformis (partim), HALL. Pal. N. Y., vol. v, pt. ii, p. 167. 1879.

THIS species is distinguished from the *T. scalariformis* occurring in the Upper Helderberg limestone by its more elongate and slender form, and more sloping annuli.

Schoharie grit. Pendleton, Indiana.

TENTACULITES SCALARIFORMIS.

PLATE CXIV, FIG. 20.

Tentaculites scalariformis, HALL. Pal. N. Y., vol. v, pt. ii, p. 167, pl. xxxi, figs. 3-11. 1879.

Corniferous limestone. Delaware, Ohio.

HYOLITHES, EICHWALD, 1840.

(See Vol. v, part ii, pp. 191-202.)

HYOLITHES CENTENNIALIS.

PLATE CXIV, FIGS. 21-23.

Hyolithes centennialis, BARRETT. Ann. Lyceum Nat. Hist., vol. xi, p. 299. 1877.

Lower Helderberg group. Port Jervis, Orange county.

PTEROPODA.

7

HYOLITHES HEROS, n. sp.

PLATE CXIV, FIGS. 24-27.

THIS species is characterized by its large size, broadly crenulated lateral margins, and its finely and closely striated dorsal or convex surface.

Lower Helderberg group. Near Clarksville, Albany county.

STYLIOLA, LESUEUR. 1826.

(See Vol. v, part ii, pp. 175-182.)

STYLIOLA SPICA, n. sp.

PLATE CXIV, FIG. 28.

THIS species differs from *S. fissurella*, Hall, of the Hamilton and Portage groups, in its much greater size, more robust form, and in the absence of any indications of annulations or apical node.

Hamilton group. Hamburg, Erie county.

COLEOLUS, HALL. 1879.

(See Vol. v, part ii, pp. 184-190.)

COLEOLUS HERZERI, n. sp.

PLATE CXIV, FIG. 29.

THE shell of this species is of unusually large size, slightly incurved toward the apex, and the surface is marked by low, faint, obsolescent and somewhat irregular striations.

Waverly group. Medina county, Ohio.

PHARETRELLA, NOV. GEN.

SHELL large, elongate, *Hyolithes*-like in outline; apex acute, transverse section probably triangular; substance tenuous; ornamentation consisting of transverse, imbricating undulating striæ.

PHARETRELLA TENEBROSA, n. sp.

PLATE CXIV, FIGS. 30, 31.

Genesee slate. Genesee county.

TUBICOLAR ANNELIDA.

CORNULITES, SCHLOTHEIM. 1820.

For the discussion of the nature and biological relations of forms referred to this genus, see the following authors:

- 1820. SCHLOTHEIM, *Cornulites serpularius*. Petrefactenkunde, p. 378, pl. xxix, fig. 7.
- 1834. KLOEDEN, *Axis of Trilobites*. Verstein. der Mark Brandenb.
- 1839. J. SOWERBY, *Cornulites (incertæ sedis)*. Murchison's Silurian System.
- 1845. DE VERNEUIL and KEYSERLING, *Columns of Cystideans*. Russie et Oural.
- 1847. HALL, *Tentaculites?* Pal. N. Y., vol. i.
- 1848. CONRAD, *Cornulites (incertæ sedis)*. Jour. Acad. Nat. Sci.
- 1851. MCCOY, *Cornulites (incertæ sedis)*. ("Probably *Echinodermata* or *Annullata*.") British Pal. Fossils, p. 63.
- 1852. HALL, *Cornulites (incertæ sedis)*. Pal. N. Y., vol. ii.
- 1853. KEYSERLING, *Corals*. Bull. de la Soc. Géol.
- 1856. SHUMARD, *Tentaculites*. Geol. Report of Missouri.
- 1859. SALTER, refers *Tentaculites* and *Cornulites* to the *Annelida*. Siluria, 3d Edition, pp. 221 and 229.*
- 1864. LUDWIG, *Pteropods*. Palæontographica.
- 1865. MEEK and WORTHEN, *Tentaculites*. Proc. Acad. Nat. Sci. Phil.
- 1867. BARRANDE, *Cornulites (Annelida)*. Syst. Sil. de la Bohême.

* Under the head of Annelides of the Older Silurian Strata, Mr. Salter uses the following language in the text of Siluria, page 221, Third Edition. 1859:

"The Tentaculites and Cornulites of the early primeval strata must also be mentioned as remains of animals of this order. They were worms with shelly tubes like those of *Serpula*, but distinguished easily by their annulated form and cellular structure.†"

† These fossils, Tentaculites and Cornulites, have been assigned to various groups of animals, the notion that they were parts of crinoidal creatures being the most generally accepted. They were, however, shelly tubes, of a highly complex cellular structure, not jointed tentacles or stems; and could, by no means, be parts of such animals.—J. W. S."

1868. MEEK and WORTHEN, *Tentaculites*. Geol. Survey of Illinois. Geol. and Pal., vol. iii.
1872. NICHOLSON, *On the genera Cornulites and Tentaculites, and on a new genus Conchicolites*. Am. Jour. Sci., Third Series, vol. iii, p. 202.
1872. NICHOLSON, *On Ortonia, a new genus of Tubicolar Annelides, with Notes on the genus Tentaculites*. Geol. Mag., vol. ix, p. 446.
1873. NICHOLSON, *Description of two new species of Annelides, Conchicolites and Ortonia*. Geol. Mag., vol. x, p. 54, pl. iv.
1874. NICHOLSON, *Ortonia intermedia*. Geol. Mag., New Series, vol. i.
1874. S. A. MILLER, *Tentaculites*. Cin. Quart Jour. Sci.
1878. S. A. MILLER and C. B. DYER, *Spirorbis*. Jour. Cin. Soc. Nat. Hist.
1879. HALL, *Spirorbis* [?]. Twenty-eighth Rept. N. Y. State Mus. Nat. Hist.
1879. HALL, *Cornulites (Annelides)*. Twenty-eighth Rept. N. Y. State Mus. Nat. Hist.
1884. RINGUEBERG, *Cornulites*. Proc. Acad. Nat. Sci. Phila.

IN the study and description of the species illustrated in the PALÆONTOLOGY OF NEW YORK, Vol. V, pt. ii, under the generic names of TENTACULITES, STYLIOLA, COLEOPRION, COLEOLUS, HYOLITHES, etc., there appeared little difficulty in recognizing their relations to each other and their nearest affinities as with the PTEROPODA. The only question arose in considering certain species, which had originally been referred to the genus TENTACULITES, and of which, in the beginning, I had no knowledge from the actual examination of specimens.

In the tabular arrangement of the American species of this genus (p. 162, *loc. cit.*) I admitted into the list five forms which had been described as TENTACULITES, from the Hudson River horizon (Cincinnati group). Even before the pages had gone to press I began to doubt the generic identity of these forms with true TENTACULITES, and an examination of the species from the neighborhood of Cincinnati, brought confirmatory evidence of my suspicion as to their true affinities. At a later date, through the kindness of Mr. S. A. Miller and the late Mr. C. B. Dyer, I was enabled to study a collection of specimens which seemed to present a pretty complete life-history of those forms described as TENTACULITES from the Cincinnati region.

The forms described as *T. tenuistriatus*, *T. Oswegoensis*, *T. Sterlingensis*,* and *T. Richmondensis*,† are rarely if ever quite straight, and are usually considerably curved, a feature unknown among the most characteristic forms of the genus TENTACULITES. The *T. incurvus* of Shumard, now recognized as from the same horizon, is a curved form, as the name implies. We have at the outset, therefore, in all these species, to recognize a deviation from the acknowledged characteristics of TENTACULITES as described by the best authors and as known to us in American and European rocks. These forms in their intermediate stages are sharply annulated, and, in their advanced stage of growth, always longitudinally striated in a manner not observed among true TENTACULITES. Farther observation shows that in their young state they are parasitic, often occurring in groups, with their bases in contact and attached to some foreign body, as a shell or a fragment of a crinoid column; and that the extreme basal portion or initial point, in the young state, is always curved, often to a full volution; but this portion becomes absorbed, dissolved or worn off as the animal increases in size and the tube assumes a more or less direct manner of growth, continuing in a straight or slightly flexuous line and gradually enlarging toward the aperture. These tubes which in their beginning are apparently smooth, gradually become annulated and finally striated longitudinally. It usually and perhaps always happens, however, that during some stage of their growth, not always depending on the age, the walls become thickened and the annulations obsolescent. Occurring either singly or in groups, wherever the surface of attachment is broad enough to admit of it, they continue adherent until they have attained a considerable size—that is, a length of 20 to 35 mm., or even more. The apertures in nearly all examples are apparently incomplete, or with the margins broken.

The phases here described are illustrated in figures 1–11 of plate cxv.

Under other circumstances, where apparently the conditions have been unusually favorable, these colonies, adherent to some other body at their bases only, continue to increase in length and diameter; the lateral walls from being simply in contact become coalescent, and they continue this growth till the form

* See Proceedings of the Academy of Sciences, Philadelphia, and Report Geological Survey of Illinois, vol. iii.

† S. A. Miller, Cin. Quart. Jour. Sci. 1874.

of the tubes and of the apertures become angular, and they present the aspect of a colony of *FAVOSITES*. In other well-preserved groups, the cells, in a greater or less degree, retain their individuality, presenting a tubular appearance and circular or sub-circular apertures. These conditions are illustrated in figures 18–23.

As a general feature these tubes (in the Lower Silurian forms), whether singly or in larger or smaller groups, usually become more distinctly and extremely annulated as they recede from the initial point, while the longitudinal striæ become more distinct. It sometimes happens, however, that at an earlier stage of growth (figs. 12–14 of plate cxv), but often at a later period, the walls become thickened and the annulations are not developed, or they become obsolescent or even quite obsolete from this thickening of the tissue. In this condition they present an undulating surface with obscure or indistinct annulations, as in figure 27; plate cxv, which may be partially due to erosion. The condition of surface shown in figures 12–14 is seen in its more extreme degree in figure 15; a longitudinal section of which is shown in figure 16, plate cxv. We observe in this example the unequal development of the intermural cellular tissue which begins at a much earlier stage in some individuals than in others.

When these tubular bodies, in their advanced growth, are cut transversely or longitudinally the wall is usually found to consist not of a single lamina, or of cohering parallel laminæ, but being more or less of a vesicular tissue, which in some examples is scarcely, or even not at all developed, while in the majority of individuals this texture is a conspicuous feature. This tissue is rarely, if ever, observed in the extremely young state. It usually, but not always, increases with age, and upon its development depends the thickening of the walls. In some specimens, of apparently adult growth, the vesicular structure is not developed, and the inner and outer walls are in contact or separated from each other by simple uninterrupted space. The varying degrees of development in this intermural tissue are shown in the longitudinal sections, figures 32–39 of plate cxv; some of which are from single and separate individuals, and others from groups, like those represented in figures 7–13. Figures 15 and 16 illustrate

a specimen with abnormally thickened walls and great development of vesicular tissue.

With all the material here illustrated on plate cxv, and much more before me, I am unable to find any characters by which generic or specific distinction can be drawn between the forms represented in figures 1 and 2 and all those which follow up to figure 39. The names under which these and similar forms, as before mentioned, have been described are: *Spirorbis Cincinnatensis*, *Tentaculites incurvus*, *T. tenuistriatus*, *T. Oswegoensis*, *T. Sterlingensis* and *T. Richmondensis*.

Besides the species above enumerated, these organisms, in their different phases of development, have furnished the basis for the establishment of the genus ORTONIA (*O. minor* and *O. conica*), and a species described under CONCHICOLITES (*C. corrugatus*). The latter genus was founded upon a similar organism, occurring in the Caradoc shales of Westmoreland, England, the equivalent, in age, of the Hudson River group of America (American Journal of Science, Third Series, vol. iii, p. 202. 1872).

The manner of growth and development; the external form and internal structure of these bodies, seem to demonstrate very clearly that they should be all referred to the genus CORNULITES, as described and illustrated by the author of the genus and by subsequent authors whose opinions are entitled to respect. The description and illustrations of *Cornulites serpularius*, Murchison (Silurian System, p. 627, and plate xxvi, figures 5–9), present a most important study in this connection, and leave no doubt as to the nature of the organism under consideration.

In regard to the forms illustrated on plate cxv, figures 1–39, I do not propose to recognize any distinction of species, and I leave them without prejudice to be referred to such specific names as their authors may claim for the various phases here represented. Though referring certain of the illustrations to the names by which they are usually recognized, I have purposely confined myself to the discussion of the various phases of what appears to me a single form of this remarkable organism, all the specimens being from the same geological horizon.

Figure 40 represents the earlier stages of an irregular group growing upon the shell of an ORTHOCERAS, from the Utica slate of New York, and which pre-

sents all the phases of development from the convolute, spirorbiform condition to the nearly straight forms, and all have a very similar aspect to the specimen represented in figures 1 and 2 of the same plate. We know it only in its immature condition, in the single specimen illustrated.

In figure 41 the tubes are somewhat more slender and more flexuous than in specimens of the same degree of development from the region around Cincinnati, and this form will probably prove a distinct species. The figure is from the original specimen, described as *Tentaculites? flexuosus*, from the Trenton limestone (Pal. N. Y., vol i, p. 92, pl. xxix, figs. 6a-d). Want of material will prevent a complete comparison and final discussion of the relations of this species with any other, at the present time.

The forms illustrated on plate lxxii, figs. 2 a and b, Pal. N. Y., vol. i, p. 284, were referred to the species *Tentaculites [?] flexuosa*, the ? after the generic name being accidentally omitted. A comparison was also suggested with *Cornulites serpularius*, Schlotheim (Murchison's Sil. Syst., p. 627, pl. xxvi, figs. 5-8).

The specimens from the Hudson River group of New York are, however, more slender and are frequently regularly curved, not flexuous as in the typical form of *T.? flexuosus*, from the Trenton limestone. They are very similar to, and perhaps identical with those from the same horizon in the west, and their probable identity with the western forms was at that time recognized in citing the localities.

We come now to consider some forms of this genus known to us in the higher rocks, and more especially the single species occurring in the Niagara group at Waldron, Indiana. The material at hand is not so complete in some respects as that from the Hudson River group of the Cincinnati region, represented on plate cxv. In its entire aspect, however, it presents the same phases of development, and we have more complete material to illustrate the advanced stages of growth in this species. The earliest condition in which their specific relations usually are observed, is that of groups of slender, flexuous, or rarely almost straight tubes, attached on one side for nearly or quite their entire length to some other organisms, as the shell of a Brachiopod, a Gastropod, or the calyx of a Crinoid. In this condition the apertures are frequently turned outward.

Their bases are almost always more or less curved, sometimes making nearly an entire volution before diverging to the flexuous or straight line.

On carefully examining the surfaces of shells where these parasitic tubes occur, there are often found numerous circular specs attached to the shell-surface. Many of these, under the naked eye, or an ordinary magnifier, appear as simple circular discs of calcareous matter, while under a higher power a minute convolute tube is distinctly visible. These in their larger growth become spirorbiform, and are apparently identical with those described as *Spirorbis inornatus*, Hall (Twenty-eighth Annual Report of the State Museum of Natural History, page 181, pl. xxxi, figs. 14, 15).

The material in our possession is not sufficient to demonstrate a gradual and absolute transition from these minute convolute discs, through all the phases of development, to the recognized CORNULITES; but I believe they are identical, and that by careful examination of larger collections all intermediate stages of growth and development may be found.

The ordinary condition of the young of this species is that represented in figures 1-4, plate cxvi, where the tubes grow singly or in groups, with one side attached and the free portion sharply annulated. In this condition the apertures present an irregular margin, as if the continuation of the tube had been broken away, and much the greater proportion of the specimens are found in similar condition. In specimens represented in figures 5 and 6, the acute apex is preserved in its incurved condition. In figure 5 the annulations are less distinct than usual on the earlier portions of the tube, while in figure 6 this feature is strongly marked in the lower part of the specimen, becoming obsolete above, or merged into the thickening tissue as growth progresses. In figure 7 the apex is slightly incurved, the annulations distinct below, but becoming obsolete above. In figure 8 we have two individuals attached by their bases to the surface of *Platyostoma Niagarensis*. The apical portion is less distinctly annulated than in some other specimens, and the original initial point has probably been dissolved or eroded. In the progress of growth the regular annulations soon become obsolete in the thickened tissue above, which is finely striated longitudinally, and presents an irregular lamellose surface. In figure 9

the apex is much thickened, the initial point having been removed or absorbed; the annulations are obsolete and the surface lamellose. The specimen is attached for the greater part of its length to the calyx of an *Eucalyptocrinus crassus*. Figure 10 represents the largest specimen observed. The apex and the surface of adherence have been broken off, and only the free portion remains. This preserves the concentric lamellose-annulate character, and finely striated surface.

Figures 11 and 12 are interesting as showing an irregular lamellose growth, and the fracturing of the test, which has been subsequently healed during the life of the animal. In many instances, where the test has been broken and again restored, the continuity of the striæ is interrupted, as illustrated in the specimen, fig. 13.

As the individuals advance in growth, the inner and outer walls of the tube become separated, and the intermural space filled with vesicular tissue.

This separation of the walls and the development of the tissue is not always in proportion to the size of the individual, nor is it uniform on all parts of the circumference of the tube in the same specimen. It is rare that individual tubes, cut longitudinally through the center, show an equal development of this tissue on the two sides. In figure 14, a section of a small individual, the tissue on one side encroaches largely upon the visceral cavity, while on the other it is only incipiently developed. Figure 15 shows an unequal development of the tissue on the two sides; and figure 16, a section of one of the largest individuals known, shows but an incipient development of this tissue.

In figure 17 this vesicular structure is subequal on the two sides, while figure 18, a farther enlargement, shows the vesicles developed within the inner walls and encroaching upon the visceral cavity. This irregularity is especially shown in the transverse section, figure 19, where upon two sides there is no development of tissue, the walls being apparently quite solid as represented. In figure 20, however, we have a more distinct manifestation of this unequal development, where the upper or barren side, as shown in the figure, has probably been the attached surface. While there is a general similarity in this vesicular texture, there is no uniformity in size or form of the vesicles, as may be seen in any one of the sections, and especially in figures 18 and 21 of plate cxvi.

TO SUMMARIZE THE CHARACTERS:

THESE organisms, in their earliest recognizable conditions of existence, appear as a simple point or spec upon the surface of some other organism, becoming a slender enrolled tube where the volutions (so far as can be determined) may be in the same plane and having the form of SPIROBIS, under which designation they have sometimes been described. In its farther development the body becomes an elongate, straight or sinuous tube. In the earlier stages these organisms, either singly or in groups, remain attached to the surface of some organic or inorganic body, and the continuation of this parasitic condition depends upon the size of the body or extent of surface upon which they may continue to grow. Beyond the limits or extent of the surface affording means of attachment, they become free and continue their growth in a constantly expanding tubular form.

In their earlier stages the substance of the fossil consists of an inner and an outer wall, which are in contact; the exterior becoming annulated at an early period, and the inter-annular spaces, or the upper inner margin of these annular growths, produce sharp interior annulations, which often extend considerably within the visceral cavity, so that when the exterior becomes worn away, or the fossil is cut through on one side of the center, they often give the aspect of a septate tube.

In the first recognized stages of this organism, the tube is apparently smooth, but in the later conditions the annulations are conspicuous and again become gradually obsolete with the growth of the animal. The longitudinal striæ, which are at first obscure, become developed with the growth of the tube, and continue a conspicuous feature after the obsolescence of the annulations. The intermural vesicular tissue becomes developed only with the expansion of the tubular growth, and especially after the organism has assumed a free condition of growth.

In their earliest known condition these bodies are always parasitic, and they are not known to begin their existence as a free organism. Whenever, in their advanced state of growth, they occur in a free condition, it will be found that the initial point is wanting, having been broken off and the marks of the fracture still remaining, or the surface has become cicatrised.

The following forms are here regarded as representing various stages of development of what appears to be a single species of the genus CORNULITES. The figures to which names are here applied are those most nearly resembling the illustrations of the several species as given by the authors, and not as determined by the writer.

SPIRORBIS, LAMARCK. 1801.

Spirorbis Cincinnatensis.

PLATE CXV, FIGS. 1, 2.

? *Spirorbis Cincinnatensis*, MILLER and DYER. Jour. Cin. Soc. Nat. Hist., vol. i, p. 38, pl. i, fig. 13. 1878.

Hudson River group. Cincinnati, Ohio.

ORTONIA, NICHOLSON. 1872.

Ortonia minor.

PLATE CXV, FIG. 3; AND PLATE CXVI A, FIGS. 19, 20.

Ortonia minor, NICHOLSON. Geological Magazine, vol. x, p. 56, pl. iv, fig. 2a. 1873.

Hudson River group. Cincinnati, Ohio.

Ortonia conica.

PLATE CXV, FIG. 27; AND PLATE CXVI A, FIGS. 15, 16.

Ortonia conica, NICHOLSON. Geological Magazine, vol. ix, p. 447, fig. 1. 1872.

Hudson River group. Cincinnati, Ohio.

CONCHICOLITES, NICHOLSON. 1872.

Conchicolites corrugatus.

PLATE CXV, FIG. 27; AND PLATE CXVI A, FIGS. 17, 18.

Conchicolites corrugatus, NICHOLSON. Geological Magazine, vol. x, p. 55, pl. iv, fig. 3. 1873.

Hudson River group. Cincinnati, Ohio.

TENTACULITES, SCHLOTHEIM. 1820.

Tentaculites Sterlingensis.

PLATE CXV, FIGS. 5-7, 32.

Tentaculites Sterlingensis, MEEK and WORTHEN. Proc. Acad. Nat. Sci., p. 255. 1865.

Hudson River group. Cincinnati, Ohio.

Tentaculites Richmondensis.

PLATE CXV, FIGS. 28-30, 33-39.

Tentaculites Richmondensis, MILLER. Cin. Quart. Jour. Sci. 1874.Compare *T. tenuistriatus*, MEEK and WORTHEN. Proc. Acad. Nat. Sci., p. 254. 1865.

Hudson River group. Richmond, Indiana.

CORNULITES, SCHLOTHEIM. 1820.

CORNULITES FLEXUOSUS.

PLATE CXV, FIGS. 41, 42.

Tentaculites? flexuosa, HALL. Pal. N. Y., vol. i, p. 92, pl. xxix, figs. 6a-d; p. 284, pl. lxxviii, figs. 2a, b. 1847.Not *Cornulites flexuosus*, HALL. Pal. N. Y., vol. ii, p. 98, pl. xxviii, fig. 12.*Cornulites flexuosus*, HALL. Twenty-eighth Rept. N. Y. State Mus. Nat. Hist., p. 184. 1879.

Trenton limestone. Lowville, Lewis county.

CORNULITES IMMATURUS.

PLATE CXV, FIG. 40.

THIS species is known only in an early serpuloid stage of growth, and may eventually prove identical with the forms occurring in the Cincinnati group.

Utica slate. Holland Patent, Oneida county.

CORNULITES INCURVUS.

PLATE CXV, FIG. 31; AND PLATE CXVI, FIG. 31.

Tentaculites incurvus, SHUMARD. Geol. Rept. Missouri, part ii, p. 195, pl. B, figs. 6a, 6b. 1856.

IN the ultimate revision of these forms, the specific name "*incurvus*" will take precedence over all others in point of time.

Hudson River group. Cape Girardeau, Missouri.

CORNULITES DISTANS.

PLATE CXVI, FIG. 23.

Tentaculites distans, HALL. Pal. N. Y., vol. ii, p. 184, pl. A xli, fig. 9. 1852.

Clinton group. Rochester, Monroe county.

CORNULITES CLINTONI.

PLATE CXVI, FIG. 22.

Cornulites flexuosus, HALL. (Name preoccupied.) Pal. N. Y., vol. ii, p. 98, pl. xxviii, figs. 12a-e.*Cornulites Clintoni*, HALL. Twenty-eighth Rept. N. Y. State Mus. Nat. Hist., p. 184. 1879.Compare *Cornulites arcuatus*, CONRAD. Jour. Acad. Nat. Sci., vol. viii, p. 276, pl. xvii, fig. 8. 1848.

THIS species was originally described under the name *Cornulites flexuosus* (*loc. cit.*), but as the *Tentaculites? flexuosus* of Hall, which had been previously de-

scribed, was subsequently proved to be a *Cornulites*, the name of the former species was changed by its author to *Clintoni*. The *Cornulites arcuatus* of Conrad, from the Niagara limestone, in Orleans county, bears a close resemblance to specimens of *C. Clintoni*, and the type may represent a small individual which retains the substance of the tube. Mr. Conrad's specimen is not accessible, but in the event of the identity of the species being proved, the specific term *arcuatus* will take precedence.

CORNULITES, sp. ?

PLATE CXVI, FIGS. 24, 25.

THIS specimen has the distant, regular annuli of *C. distans*, but the evidence of vertical striation is very obscure and unsatisfactory. The specimen is in a crystalline condition, and on this account the small portion of the test remaining preserves only obscure indications of its original condition. When examined by transmitted light, there is evidence of a distinct transverse line upon the annulations, above which the ring is darker, and below more translucent, apparently indicating the line of articulation of the joints of the tube. The apparent transverse striæ on the figure are due to the texture of the surface, and are not organic markings.

Clinton group. Near Lockport, Niagara county.

CORNULITES ARCUATUS.

PLATE CXVI A, FIG. 9.

Cornulites arcuatus, CONRAD. Jour. Acad. Nat. Sci., vol. viii, p. 276, pl. xvii, fig. 8. 1842.

Niagara group. Albion, Orleans county.

CORNULITES PROPRIUS.

PLATE CXVI, FIGS. 1-21

Cornulites proprius, HALL. Twenty-eighth Rept. N. Y. State Mus. Nat. Hist., p. 182, pl. xxxi, figs. 1-13. 1879.

THE species referred to *Cornulites* ——— (= *C. bellastriata*) (Pal. N. Y., vol. ii, loc. cit.), is allied to *C. proprius* in its surface characters, although manifesting a tendency to greater regularity in the annuli, and having finer and less prominent longitudinal striations. It may, however, properly be regarded as the New York representative of the Waldron species. The species *C. contractus*, Ringueberg (Proc. Acad. Nat. Sci., p. 148, pl. iii, figs. 6, 6a, 6b, 1884), from the Niagara group

at Lockport, is suggestive of the same stage of development as that represented by figures 1-4 of *C. proprius*, and it may prove to have a similar relation to the larger individuals from this horizon in the State of New York. *C. nodosus*, Ringueberg (*loc. cit.*), p. 149, plate iii, fig. 7, is a very small form from the same formation, the surface of which is without annuli, but is covered with faint tubercles.

Niagara group. Waldron, Indiana.

CORNULITES BELLASTRIATUS.

PLATE CXVI A, FIGS. 12 and 13.

Cornulites ———, HALL. Pal. N. Y., vol. ii, p. 353, pl. lxxxv, figs. 12-17. 1852.

THE earliest conditions of this species have not been observed. In the most nearly entire individual known, the base is slender and somewhat rapidly attenuate. The annulations become subdued or obsolescent at a comparatively early period of growth, and in old specimens are often entirely obsolete. Fine longitudinal striæ are early developed and continue.

CORNULITES CHRYSALIS, n. sp.

PLATE CXVI, FIGS. 26-28.

THIS species is characterized by its regular and closely set annulations, which present the appearance of inverted, ensheathed, truncated cones.

Lower Helderberg group. Near Clarksville, Albany county.

CORNULITES CINGULATUS, n. sp.

PLATE CXVI, FIG. 29.

TUBE very flexuous, with regularly transverse but unequally distant, sharply angled or evenly rounded annulations.

Lower Helderberg group. Locality doubtful.

CORNULITES TRIBULIS, n. sp.

PLATE CXVI, FIG. 30.

TUBE characterized by its gently sinuous outline, low, irregular annulations, and fine but conspicuous longitudinal striæ.

Hamilton group. Hopewell, Ontario county.

A D D E N D A .

(See Plate CXVI A.)

THE following description and illustrations of CORNULITES are from Murchison's "Silurian System," published in 1839.

Under the head of "Fossil Shells of the Wenlock Limestone," J. De C. Sowerby describes *Cornulites serpularius*, as follows:

"*Cornulites serpularius*, Schlot., pl. xxvi, f. 5 (Schloth. Petr., t. xxix, f. 7). We can scarcely attempt a description of this anomalous fossil, of which at present but one species is known. So unlike is it to anything we have seen, that we are unable to assign it a place in the system of animals, or draw a comparison between it and any other creature. Its general form is a much elongated, hollow, more or less crooked cone, open at the base; in its early state it is parasitical, being attached by its side and often in pairs. The external crust is longitudinally striated, and marked with slightly raised rings, which indicate its passage over the margins of the series of truncated cones of which the fabric is constructed. These short cones are placed within each other, their widest edges being directed toward the apex of the general envelope, the smallest or most internal cone occupying the apex itself. Thus they form a pyramid of cups, or if viewed in a reverse position, a series of broad rings gradually increasing in size, and capping but not covering each other. Each cup or ring is thinnest at that part which is inclosed by the succeeding ring, where also its diameter is least; both surfaces are of a foliated structure, and the outer blends with and is lost in the external coat. Internally, each ring was apparently of a cellular structure, for it is composed of depressed, imbricating, and regularly arranged grains of calcareous spar. Some of the grains leave an impression upon the surface of each of the steps, which is formed upon the cast of the cavity of the cone by the thick edges of the rings.

"If the cells were the habitations of minute POLYPPES, they must have opened upon the edge of the cup, and each succeeding generation must have been located around the parent stock, and not upon or within the *Polyparium*, as in corals; but there is no appearance of stellæ or radiating laminæ. Upon the cast of the inner cavity may often be observed two, three, or more longitudinal impressions, each composed of two nearly approximating, fine, sunken lines, produced by elevations where probably there were joinings in the cups. The

cone of the larger specimens is generally rather straight, with the rings regular, and no appearance of having been attached to any other body; but the young specimens are irregularly curved, have more or less distorted rings, and are fixed upon corals or shells. With such only does Schlotheim appear to have been acquainted, and had not we been supplied with a complete series by Mr. B. Bright, we should have been induced to consider the full-grown specimen as another species of the same curious genus.”*

“*Locality.* Western slopes of the Malvern Hills; Dudley.”

In 1872 Prof. Nicholson (Am. Jour. Sci., *loc. cit.*) proposed the name CONCHICOLITES, in the following terms:

“CONCHICOLITES, Nich.—Animal social, inhabiting a calcareous (?) tube, attached in clustered masses to some solid body. The tube conical, slightly curved, attached by its smaller extremity. The wall of the tube thin, its external surface devoid of longitudinal striæ. The tube thin, composed of short imbricated rings, but apparently destitute of any cellular structure. Cast of the tube composed of short conical rings, its surface completely smooth, and destitute of striæ or furrows.

“*Conchicolites gregarius*, Nich.—Tubes closely in contact, attached by their smaller ends to dead shells. Tubes varying in length from a quarter to half an inch, and having a diameter at its mouth of about half a line.”

“The preceding species is found growing upon the shells of Orthocerata in the Lower Silurian of the North of England.

“The following described species are from the Lower Silurian in the neighborhood of Cincinnati.”

In the Geological Magazine, vol. ix, 1872, Prof. Nicholson published a paper on “ORTONIA, a New Genus of Fossil Tubicolar Annelides.”

“The following diagnosis gives the characters of the genus *Ortonia*, and of the single known species:

“ORTONIA, Nich.—Animal solitary inhabiting a calcareous tube, which is attached along the whole of one side to some foreign body. Tube slightly

* In the discussion of these forms in the Third Edition of *Siluria*, under the Wenlock series, page 259, Mr. Salter gives the following interesting facts:

“*Cornulites serpularius* (see pl. xvi, f. 3-10) is still, as in the Llandovery rocks, the principal annelide; and, though more frequent in the Wenlock limestone, is not rare in the Ludlow rocks. The finest specimens are from the Wenlock limestone of Ledbury; but at Dudley *Cornulites* are found attached to shells, in groups of three or four together, like *Serpulæ*, and they occur in profusion on the hard and seaworn surfaces of Ludlow rock at Marloes Bay, in Pembrokeshire, in masses a foot in diameter.”

flexuous, conical, in section cylindrical, or somewhat flattened laterally, and sub-triangular. Walls of the tube thick, cellular along the surface opposite to the attached portion, markedly annulated along the sides.

“*Ortonia conica*, Nich.—Tubes growing attached to the shell of some Mollusc; varying in length from a quarter to half an inch, with a diameter of about one-tenth of an inch at the mouth. Lateral annulations of the tube varying in number from thirty to thirty-five in the space of an inch. Surface smooth and completely destitute, so far as observed, of longitudinal striæ.

“The fossil from which the above description has been taken is an example of *Strophomena alternata*, to the dorsal valve of which are attached the remains of more than twenty individuals of *Ortonia conica*. In one case the tube of one crosses that of another individual; but it is quite clear that this is an accidental circumstance, so to speak, and that the tubes are truly solitary. The specimen is from the ‘Cincinnati group’ of South-western Ohio, a formation which belongs to the ‘Hudson River series,’ and which corresponds with the Caradoc or Bala division of the Lower Silurian.

“In conclusion, I may add that Mr. Orton has submitted to me a beautiful specimen, apparently of the *Tentaculites tenuistriata* of Messrs. Meek and Worthen, and also from the Cincinnati group of South-western Ohio. If this specimen be rightly determined, I cannot avoid the conclusion that it is truly referable to the genus *Cornulites* of Schlotheim, differing from the familiar *Cornulites serpularius* in its small size, and in some other minor characters. This conclusion, however, does not admit of complete verification except by the discovery of specimens absolutely attached to some foreign body.”

In the Geological Magazine, vol. x, 1873, the same author publishes “DESCRIPTIONS OF TWO NEW SPECIES OF FOSSIL TUBICULAR ANNELIDES.” He redescribes the genus CONCHICOLITES and the species *C. gregarius*, and describes the following new species—*Conchicolites corrugatus*, Nich., and *Ortonia minor*—in the following terms:

“*Conchicolites corrugatus*, Nich.—Tubes growing socially in clustered masses upon the shells of molluscs; calcareous; destitute of vesicular structure; conical, and gently curved. Attached by their smaller extremities, sometimes for the space of a line or more; and either partially free, or contiguous to one another throughout the remainder of their course. Length of the fully-grown tube one-half inch or a little more; diameter of tube at mouth one-tenth of

an inch. Tube composed of conical imbricating rings, about forty in the space of one inch (about four in the space of one-tenth of an inch), giving the tube a strongly annulated appearance.

“The specimen figured exhibits the tubes of more than thirty individuals of *Conchicolites corrugatus*, attached to the spire of *Cyclonema bilix*, Conrad.

“From *Conchicolites gregarius*, the present species is distinguished by its greater average length and much greater diameter, by its much less closely crowded habit, and by its much more strongly marked annulations.

“*Locality and formation.* Attached to the shell of *Cyclonema (Pleurotomaria) bilix*, Conrad, from the Hudson River group (Lower Silurian), of Cincinnati, Ohio.

“*Ortonia minor*, Nich.—*Spec. Char.* Tube calcareous, solitary attached by the whole of one side to some foreign object. Length of tube from one-tenth to three-twentieths of an inch; diameter at mouth from one-twentieth to one-twenty-fifth of an inch. Tube marked with transverse ridges or annulations, which are sometimes faintly marked on the side opposite to the attached surface, and the number of which is fifteen in one-tenth of an inch. Tube in general strongly curved toward its smaller extremity (pl. iv, fig. 3), (2).

“Though often occurring in great numbers together, the tubes of *Ortonia minor*, like those of *Ortonia conica*, are strictly speaking solitary; that is to say, they do not, like the tubes of *Serpula* or *Conchicolites*, interfere with one another or come into contact except accidentally. The tube is generally pretty nearly circular in section, though sometimes slightly trigonal, conical, and always more or less curved. Sometimes it is simply curved like a horn; sometimes it is curved like the letter S, and sometimes the smaller extremity is twisted into a flat spiral. I can detect no longitudinal striation, but the tube is covered with very numerous transverse ridges (at least 150 in the space of an inch), which are generally better marked on the sides than on the back of the tube. In very small, presumably young, specimens, I have been unable to determine the existence of these ridges, and even in fully-grown examples they are more strongly marked in some than in others. The tube is always attached along its whole length, and in no case is any portion free, as is the case in *Conchicolites*.

“*Locality and formation.* Common in the Hudson River group (Lower Silurian) of Cincinnati, Ohio, attached to the exterior of Brachiopods and Corals.”

CEPHALOPODA.

DESCRIPTIONS OF SPECIES.

NOTE.—The following descriptions and accompanying plates are supplementary to the fossil cephalopoda presented in Volume V, part II, of the Palæontology of New York. After the completion of that volume, there still remained in the possession of the author, some new or undescribed material, and a number of specimens which were important as illustrating additional features of some of the previously established forms. The descriptions of a number of the species presented on the supplementary plates, were prepared in time to be included in their proper place in the volume. Such species are here merely cited, and referred to volume v, part 2. It has been necessary to restrict the length of the descriptions here given, on account of the contract limitations for the present volume.

AT the close of Volume V, part ii, in 1879, the CEPHALOPODA were committed to the charge of Mr. C. E. BEECHER, who has furnished the following descriptions:

ORTHOCERAS, BREYNIUS. 1732.

ORTHOCERAS DURAMEN.

PLATE CXVII, FIG. 1.

Orthoceras duramen, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (117) 1, fig. 1. 1886.

SHELL straight, robust, rapidly enlarging to the chamber of habitation. Apical angle ten degrees. The specimen described is a compressed septate fragment, and the true form of the transverse section cannot be ascertained. Initial extremity unknown.

Air-chambers 15 to 20 mm. in depth.

Septa thin, deeply concave. Sutures straight, marked on the internal mould by narrow depressed zones, as in *O. cingulum* (Pal. N. Y., vol. v, pt. 2, p. 240).

Siphuncle and test not observed.

The fragment illustrated has portions of eight air-chambers and the base of the chamber of habitation, and measures nearly 160 mm. in length and 67 mm. in diameter at the last air-chamber.

This species somewhat resembles *O. Pelops* (Pal. N. Y., vol. v, pt. 2, p. 233), but may be distinguished by the comparatively deeper air-chambers and more rapidly enlarging tube.

Distribution. In the Schoharie grit, Clarksville, Albany county.

ORTHOCERAS SCEPTRUM.

PLATE CXVII, FIG. 2.

Orthoceras sceptrum, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (117) 1, fig. 2. 1886.

SHELL large, straight along the outer chamber and slightly curved in the septate portion, regularly and gradually expanding to the base of the chamber of habitation. Transverse section sub-circular. Apical angle nine degrees. Initial extremity unknown.

Chamber of habitation large, cylindrical, slightly contracting near the aperture; length about twice the diameter of the last septum. Air-chambers varying from 5 to 9 mm. in depth in the length of 140 mm., where the diameter of the tube is 40 and 55 mm. respectively.

Septa thin. Sutures straight or somewhat curved, the degree of curvature being dependent on the amount of the weathering of the fillings of the air-chambers. The appearance of the septa and air-chambers indicates that there was an organic deposit in the apical portion of the specimen, but no distinctive characters can be discerned.

Siphuncle sub-central.

Test unknown.

The individual described consists of the chamber of habitation and about thirty air-chambers, measuring 450 mm. in the entire length, of which 145 mm. pertain to the chamber of habitation. The diameter of the tube near the aperture is 90 mm. and about 30 mm. at the distal extremity of the specimen.

The only related species from the Upper Helderberg group, which also apparently has a slight normal curvature in the tube, is *O. Ohioense* (Pal. N. Y., vol. v, pt. 2, p. 236), from which the present form may be distinguished by its larger size and deeper air-chambers.

The specimen is a weathered and macerated internal mould, and many of the important specific features of test, ornaments and septa have not been preserved.

Distribution. In the Upper Helderberg limestone, at Cherry Valley, Otsego county.

ORTHOCERAS DIRECTUM.

PLATE CXVII, FIGS. 6, 7.

Orthoceras directum, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (117) 1, figs. 6, 7. 1886.

SHELL large, straight, gradually increasing in diameter to near the aperture.

Apical angle seven degrees. Initial extremity unknown.

Chamber of habitation large; length one and a half times the diameter of the tube at the last septum. Air-chambers varying from 8 to 12 mm. in depth in the distance of 100 mm. near the outer chamber.

Septa thin, moderately concave. Sutures direct.

Siphuncle and test not preserved in the specimen described.

Internal mould smooth.

The specimen consists of the chamber of habitation and twelve attached air-chambers, and has a length of about 250 mm., of which 115 mm. pertain to the chamber of habitation.

Figures 6 and 7 of plate cxvii, show in a very marked degree a condition frequently present in fossils of this class. Figure 6 shows the internal mould with the air-chambers well defined and the sutures depressed from the weathering of the septa, presenting every evidence of the preservation of the septa and siphuncle. A section of the specimen, represented in figure 7, shows that nearly the entire interior of the shell has been broken away, and that TENTACULITES and other shells were drifted in with the sediments filling the tube.

Distribution. In the Corniferous limestone, Delaware, Delaware county, Ohio.

ORTHOCERAS DAGON.

PLATE CXXIX, FIG. 1.

Orthoceras Dagon, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (129) 14, fig. 1. 1886.

THIS species is represented by a large septate fragment, preserving the base of the chamber of habitation with about two-thirds of the air-chambers attached. The entire length of the fragment is 223 mm. Although based on imperfect material, the distinguishing characters are so pronounced as to readily distinguish the species from any other form previously indicated from the same horizon.

The principal features are: The rapid enlargement of the tube, with the consequent large apical angle; and the broad retral curvature of the septal sutures on what is probably the ventral side.

Distribution. In the Upper Helderberg limestone, Columbus, Ohio.

ORTHOCERAS RUDENS.

PLATE CXVIII, FIG. 1.

Orthoceras rudens, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (118) 2, fig. 1. 1886.

THE species is represented in the collections by a compressed fragment of the chamber of habitation, having a length of a little more than 100 mm. The tube is marked by longitudinal striæ and ornamented by numerous regular annulations, of which there are three in the space of 10 mm., showing a well-defined retral curve on the ventral side.

This form differs conspicuously from *O. crotalum* (Pal. N. Y., vol. v, pt. 2, p. 296), and *O. calamen* (*id.*, p. 298), in its larger size and comparatively more frequent and depressed annulations. The surface characters more nearly approach those of *O. nuntium* (*id.*, p. 299), but the annulations are broader, less abrupt, and the strong retral curve in the ornamentation on the ventral side are not present in that species.

Distribution. The type specimen is from an argillaceous limestone, and is recorded as from the Hamilton group, in Livingston county.

ORTHOCERAS EXPOSITUM.

PLATE CXVIII, FIG. 2.

Orthoceras expositum, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (118) 2, fig. 2. 1886.

SHELL large, straight, gradually enlarging to the aperture; transverse section sub-circular. Apical angle five degrees. Initial extremity unknown.

Chamber of habitation long, regularly expanding to the aperture, length more than twice the diameter of the tube at the last septum. Air-chambers 7 mm. in depth where the tube has a diameter of 37 mm., becoming regularly shallower toward the apex of the tube.

Septa thin, concavity deeper than the depth of the air-chambers. The apical portion of the shell is partially filled with an irregularly vesiculose organic deposit.

Siphuncle moniliform, excentric.

Test not preserved. The impression of the shell in the rock shows that the surface was marked by lamellose concentric lines of growth.

The specimen illustrated has a length of about 300 mm., of which 125 mm. belong to the chamber of habitation.

Numerous fragments of this species are preserved in an iron-ore bed, from Bradford county, Pa. The specimens consist of internal moulds in a ferruginous sandstone, or of calcareous shells imbedded in the sandstone.

Distribution. In an iron-ore bed of the Chemung group. Canton, Bradford county, Pa.

ORTHOCERAS CONSORTALE.

PLATE CXVIII, FIGS. 3-5.

Orthoceras consortale, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (118) 2, figs. 3-5. 1886.

SHELL straight, rapidly expanding from the apex to near the aperture; transverse section broadly oval. Apical angle ten degrees. Initial extremity unknown.

Chamber of habitation not fully shown in the specimens observed, apparently short and constricted near the aperture. Air-chambers 5 mm. in

depth, where the tube measures 28 mm. in greatest diameter. But little variation in the depth of the air-chambers can be noticed in the tube for a length of 125 mm.

Septa thin, deeply concave. Sutures somewhat curved, not deeply impressed on the internal mould.

Siphuncle moniliform, excentric, distant more than one-third the diameter of the tube from the ventral side.

Test marked by irregular lamellose lines of growth, which make a distinct retral curve on the ventral side of the tube.

Internal mould smooth. The apical portions of the shell show an organic deposit partially filling the air-chambers; but on account of the preservation of the specimens in a sandstone, its minute characters cannot be described.

The specimen illustrated, has a length of 185 mm., with a diameter of 38 mm. near the aperture and 9 mm. at the distal extremity.

Individuals of this species are of frequent occurrence in a sandstone at Panama, N. Y., and are better preserved than is usual with other forms of this class from similar deposits in the Chemung group. The species may be distinguished by the rapid enlargement of the tube, the oval transverse section and the position and form of the siphuncle.

Distribution. In a sandstone of the Chemung group, at Panama, Chautauqua county.

ORTHOCERAS INDIANENSE.

PLATE CXVIII, FIGS. 6-10.

Orthoceras Indianensis, HALL. Thirteenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 107. 1860.

Orthoceras Dædalus, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (118) 2, figs. 6-11. 1886.

SHELL small, straight, slender; transverse section circular. Apical angle six degrees. Initial extremity unknown.

Chamber of habitation long, gradually enlarging from the last septum for two-thirds its length, and then contracted by a broad constriction, from which the tube enlarges to the aperture. Air-chambers regular, very gradually increasing in depth to the last septum, six in the length of 22 mm. where the tube measures respectively 9 and 12 mm. in diameter.

Septa thin, moderately concave. Sutures straight, not deeply impressed.

Siphuncle sub-central. The elements of the siphuncle have not been observed, except at its passage through the septa, where it is very small, having a diameter of not more than 1 mm. where the tube measures 15 mm. in diameter.

Test not preserved.

Internal mould smooth. Septa marked with an areola around the siphuncle and a concentrically marked, ovate, organic deposit extending from the siphuncle to the ventral walls of the air-chambers.

The chamber of habitation of a specimen has a length of 54 mm., and a diameter of 14.5 mm. at the last septum. A fragment containing nine air-chambers and the base of the outer chamber measures 29 mm. in the length of the septate portion, and is 9 mm. in diameter at the smaller extremity.

This species may be distinguished from *O. Icarus*, by its sub-central siphuncle, the comparatively deeper air-chambers, and the more marked constriction of the tube near the aperture.

Distribution. In the Goniatile limestone, at Rockford, Indiana.

ORTHOCERAS ICARUS.

PLATE CXVIII, FIGS. 11-15.

Orthoceras Icarus, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (118) 2, figs. 11-15. 1886.

THE specimens of this species bear so close a resemblance to those of *O. Indianensis*, that a statement of differences will be more satisfactory than a detailed description.

In this species the air-chambers are comparatively much shallower than in *O. Indianensis*, the siphuncle is excentric, and in the specimens observed there is a greater amount of organic deposit surrounding it. The internal mould of a small fragment shows a line of strong nodes along the ventral side of the tube.

A chamber of habitation has a length of 53 mm. with a diameter at the aperture of 23 mm., and of 18 mm. at the last septum.

Distribution. In the Goniatile limestone, Rockford, Indiana.

G O M P H O C E R A S, SOWERBY. 1839.

GOMPHOCERAS FAX.

PLATE CXXII, FIG. 5.

Gomphoceras fax, HALL. Pal. N. Y., vol. v, pt. 2, p. 321. 1879.

GOMPHOCERAS ILLÆNUS.

PLATE CXXII, FIG. 6.

Gomphoceras Illænus, HALL. Pal. N. Y., vol. v, pt. 2, p. 322. 1879.

GOMPHOCERAS ABSENS.

PLATE CXXII, FIGS. 1-3.

Gomphoceras absens, HALL. Pal. N. Y., vol. v, pt. 2, p. 324. 1879.

GOMPHOCERAS EXIMIUM.

PLATE CXX, FIGS. 1-3; AND PLATE CXXI, FIGS. 1, 2.

Gomphoceras eximium, HALL. Pal. N. Y., vol. v, pt. 2, p. 329. 1879.

GOMPHOCERAS MITRA.

PLATE CXIX, FIG. 1; AND PLATE CXXI, FIG. 3.

Gomphoceras mitra, HALL. Pal. N. Y., vol. v, pt. 2, p. 330. 1879.

GOMPHOCERAS IMPAR.

PLATE CXX, FIG. 4; AND PLATE CXXI A, FIG. 1.

Gomphoceras impar, HALL. Pal. N. Y., vol. v, pt. 2, p. 332. 1879.

GOMPHOCERAS CAMMARUS.

PLATE CXXII, FIG. 7.

Gomphoceras cammarus, HALL. Pal. N. Y., vol. v, pt. 2, p. 333. 1879.

GOMPHOCERAS GOMPHUS.

PLATE CXXIII, FIG. 1.

Gomphoceras gomphus, HALL. Pal. N. Y., vol. v, pt. 2, p. 334. 1879.

GOMPHOCERAS CRENATUM.

PLATE CXXI A, FIG. 2.

Gomphoceras crenatum, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (121 A) 6, fig. 2. 1886.

THIS species is based upon a specimen consisting of the chamber of habitation and a portion of ten attached air-chambers. The point of greatest transverse section is at about the second septum from the outer chamber.

Chamber of habitation a little longer than the transverse diameter, gradually contracting to the aperture. The base of this chamber is marked by a zone of strong elevated lines, distant from each other about 4 mm. and extending over the walls of the air-chambers. Air-chambers about 7 mm. in depth in the main body of the tube.

The specimen described has a length of 121 mm., of which 50 mm. pertain to the chamber of habitation. The greatest transverse diameter of the tube measures 56 mm.

Distribution. In the limestone of the Upper Helderberg group, Columbus, Ohio.

GOMPHOCERAS PLENUM.

PLATE CXXI A, FIGS. 3, 4.

Gomphoceras plenum, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (121 A) 6, figs. 3, 4. 1886.

SHELL large, stout, sub-fusiform. Transverse section circular; point of greatest gibbosity at about the tenth septum from the chamber of habitation. Axis nearly straight. Tube rapidly enlarging to the point of greatest transverse section, more gradually contracting to the outer third of the grand chamber, and abruptly constricted at the aperture.

Chamber of habitation as long as the diameter of the tube at the last septum. Aperture obscurely trilobate. Air-chambers from 6 to 7 mm. in depth over the larger portion of the shell; the last three being shallower. Sutures slightly curved.

Siphuncle situated near the ventral side of the tube; its elements in the interseptal spaces have not been observed.

Test not preserved Internal mould smooth.

The specimen described consists of the chamber of habitation and fifteen air-chambers, and measures 145 mm. in length and 64 mm. in greatest transverse diameter.

Distribution. In the Upper Helderberg limestone, near Columbus, Ohio.

GOMPHOCERAS MINUM.

PLATE CXXII, FIG. 4.

Gomphoceras minum, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (122) 7, fig. 4. 1885.

SHELL small, oviform; point of greatest transverse section on the anterior third of the tube.

Chamber of habitation comparatively large and gibbous. Aperture small, trilobate. Air-chambers 2 mm. in depth.

Test marked by lines of growth.

Length of specimen 30 mm., greatest diameter 22 mm.

The shell of the individual described is silicified and many of the features are obscure.

The species is distinguished by the small and ovoid shell.

Distribution. In the limestone of the Hamilton group, from the Falls of the Ohio River, near Louisville, Ky.

GOMPHOCERAS MANES.

PLATE CXXIII, FIG. 2.

Gomphoceras manes, HALL. Pal. N. Y., vol. v, pt. 2, p. 339. 1879.

GOMPHOCERAS NASUTUM.

PLATE CXX, FIGS. 5-7.

Gomphoceras nasutum, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (120) 4, figs. 5-7. 1886.

SHELL small, robust, nearly straight. Tube rapidly expanding to the middle of the chamber of habitation thence gradually contracting to the aperture.

Chamber of habitation shorter than the transverse diameter. Grand aperture large, oval, with a marked sinus on the ventral side, forming a small aperture. Crenulated zone narrow, marked by fine elevated transverse lines or nodes.

Air-chambers shallow, having a depth of 2.5 mm. near the outer chamber. Sutures straight, with the exception of a slight retral bend on the ventral side adjacent to the siphuncle.

Siphuncle small, ventral, situated close to the walls of the air-chambers.

Surface marked by irregular lamellose lines of growth which become aggregated into fascicles near the aperture.

Internal mould smooth.

A fragment preserving the chamber of habitation and four attached air-chambers has a length of 30 mm., and a greatest diameter of 28 mm.

Distribution. In the arenaceous shales of the Chemung group, at Belmont and Belvidere, Alleghany county.

GOMPHOCERAS POTENS.

PLATE CXXII, FIG. 8.

Gomphoceras potens, HALL. Pal. N. Y., vol. v, pt. 2, p. 351. 1879.

CYRTOCERAS, GOLDFUSS. 1832.

CRYPTOCERAS SUBCOMPRESSUM.

PLATE CXXIX, FIGS. 2, 3.

Cyrtoceras subcompressum, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (129) 14, figs. 2, 3. 1886.

SHELL large, robust, exogastric, curved, a mature individual making a quadrant of a circle. Transverse section broadly oval. Tube regularly enlarging from the apex to the aperture.

Chamber of habitation large. Air-chambers regular, about 7 mm. in depth.

Siphuncle nearly one-fourth the diameter of the tube, excentric, nummuloid, abruptly contracted at its passage through the septa.

Test and surface ornaments unknown.

A large specimen, preserving nearly the entire length of the tube, measures 245 mm. on the periphery, and 80 mm. in diameter at the last septum.

The specimens described are internal moulds preserved in a coarse limestone, and the external characters are not shown.

Distribution. In a limestone of the Clinton group, Piqua, Ohio.

CYRTOCERAS JASON.

PLATE CXXIV, FIG. 7.

Cyrtoceras Jason, HALL. Pal. N. Y., vol. v, pt. 2, p. 381. 1879.

CYRTOCERAS CITUM.

PLATE CXXIV, FIGS. 1-3.

Cyrtoceras citum, HALL. Pal. N. Y., vol. v, pt. 2, p. 372. 1879.

GYROCERAS, DE KONINCK. 1841.

GYROCERAS NEREUS.

PLATE CXXIV, FIG. 4.

Gyroceras Nereus, HALL. Pal. N. Y., vol. v, pt. 2, p. 373. 1879.

GYROCERAS LACINIOSUM.

PLATE CXXIV, FIGS. 5, 6.

Gyroceras lacinosum, HALL. Pal. N. Y., vol. v, pt. 2, p. 376. 1879.

GYROCERAS? STEBOS.

PLATE CXXVI, FIG. 7.

Gyroceras Stebos, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (126) 11, fig. 7. 1886.

SEVERAL specimens of this species have been obtained from the Waverly sandstones in Pennsylvania. The general form and appearance is that of a shell belonging to the genus GYROCERAS, although no traces of septa are preserved. The ventral or peripheral side shows a longitudinal groove, which may be of

siphuncular significance. In other characters it resembles some described species of gastropoda belonging to the genus PORCELLIA; but with the present material it is difficult to make a satisfactory determination.

The specimen illustrated shows three volutions and measures 100 mm. in greatest diameter.

Distribution. In the sandstones of the Waverly group, Warren county, Pa.

TROCHOCERAS ? (GONIOCERAS ?) PANDUM.

PLATE CXVII, FIGS. 3-5.

Trochoceras ? (Gonioceras ?) pandum, HALL. Pal. N. Y., vol. v, pt. 2, p. 403, pl. iii, fig. 4. 1879.

No additional specimens of this species have been obtained since the original publication in 1879, and its generic relations are still uncertain. In addition to its comparison with some associated forms of TROCHOCERAS from the Schoharie grit, as noticed in Pal. N. Y., vol. v, pt. 2, p. 403, it may also be compared with *Gomphoceras fax*, illustrated on plate cxxii.

NAUTILUS, BREYNIUS. 1732.

NAUTILUS ORIENS.

PLATE CXXVI, FIG. 2.

Nautilus oriens, HALL. Pal. N. Y., vol. v, pt. 2, p. 420. 1879.

NAUTILUS HYATTI.

PLATE CXXVI, FIG. 1.

Nautilus Hyatti, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (126) 11, fig. 1. 1886.

IN its general characters, this species is closely related to *N. bucinum* (Pal. N. Y., vol. v, pt. 2, p. 412). The shell is more rapidly expanded than in that species, especially toward the apex. The volutions are free. The transverse section is sub-circular in the apical portion of the shell, broadly oval through the chamber of habitation, and with no dorsal sinus produced by the contiguity of the volutions as in *N. bucinum*.

The specimen is an external mould preserved in an argillaceous concretion, and the form and surface characters of the shell are well preserved. The sur-

face ornaments do not differ materially from those in some varieties of *N. bucinum* and *N. liratus* (Pal. N. Y., vol. v, pt. 2, pp. 407, 412).

Distribution. In the shales of the Hamilton group, near Cumberland, Md.

NAUTILUS PARALLELUS.

PLATE CXXVI, FIGS. 3-5.

Nautilus parallelus, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (126) 11, figs. 3-5. 1886.

SHELL small, gradually enlarging to the aperture; volutions not embracing. Transverse section lenticular, with acute lateral angles.

Chamber of habitation nearly twice as long as the transverse diameter, very gradually expanding to near the aperture, which is constricted.

Siphuncle sub-central.

Surface marked by fine lines of growth and by elevated longitudinal lines or slender ridges, which are distant from 2 to 3 mm.

The chamber of habitation has a length of 60 mm. on the ventral side and a transverse diameter of 29 mm. at the last septum. The ventro-dorsal diameter at the same point is 16 mm.

The single imperfect specimen representing this species in the collection, was recorded as doubtfully from the Chemung group, at Salamanca, N. Y. The character of the rock and general appearance of the specimen do not agree with other fossils obtained from that locality, but closely resemble specimens from the coal measures of Ohio. It is probable that the specimen was misplaced in the collections and erroneously referred to the Chemung group of New York.

The species also represents a Carboniferous type of NAUTILUS, and is related to the genus TEMNOCHEILUS, Meek, and to species classed as GYROCERAS by De Koninck, obtained from the Carboniferous rocks of Belgium.

Distribution. Probably from the coal measures of Ohio.

NAUTILUS (DISCITES) AMMONIS.

PLATE CXXV, FIG. 1.

Nautilus (Discites) ammonis, HALL. Pal. N. Y., vol. v, pt. 2, p. 425. 1879.

NAUTILUS (DISCITES) MARCELLENSIS.

PLATE CXXVI, FIG. 6.

Nautilus (Discites) Marcellensis (VANUXEM), HALL. Pal. N. Y., vol. v, pt. 2, p. 428. 1879.

GONIATITES, DE HAAN. 1825.

GONIATITES VANUXEMI.

PLATE CXXVII, FIGS. 3-6.

Goniatites Vanuxemi, HALL. Pal. N. Y., vol. v, pt. 2, p. 434. 1879.

GONIATITES VANUXEMI, var. NODIFERUS.

PLATE XXVII, FIG. 7.

Goniatites Vanuxemi, var. *nodiferus*, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (127) 12, fig. 7. 1886.

SEVERAL specimens of GONIATITES have been obtained from the shales of the Hamilton group which agree in all essential features with the characteristic species of the Marcellus shales, *G. Vanuxemi* (Pal. N. Y., vol. v, pt. 2, p. 434). They are indicated as a variety on account of a row of distinct rounded nodes around the dorsal or inner third of the periphery of the volutions.

Distribution. In the shales of the Hamilton group, at Cherry Valley, Otsego county.

GONIATITES DISCOIDEUS.

PLATE CXXVII, FIGS. 11, 12.

Goniatites discoideus, HALL. Pal. N. Y., vol. v, pt. 2, p. 441. 1879.

GONIATITES UNIANGULARIS.

PLATE CXXVII, FIG. 10.

Goniatites uniangularis (CONRAD), HALL. Pal. N. Y., vol. v, pt. 2, p. 144. 1879.

GONIATITES AMPLEXUS.

PLATE CXXVII, FIG. 1.

Goniatites amplexus, HALL. Fifth Ann. Rept. State Geologist. Expl. pl. (127) 12, fig. 1. 1886.

SHELL small, discoid. Volutions slender, rounded, embracing to the depth of nearly one-half of their dorso-ventral diameter. Umbilicus large, open.

Chamber of habitation large, constituting nearly the whole of the outer volution. Sutures with two deep lobes and one saddle on each side of a volution, and a small acute saddle adjacent to the siphonal line.

Surface marked by regular lamellose concentric lines, curving forward from the umbilicus to the ventral side.

The specimen described has a greatest diameter across the disc of 18 mm. The lateral diameter of the tube at the last septum is 6.5 mm.

Distribution. In the Tully limestone, at Lodi Landing, Seneca Lake.

GONIATITES COMPLANATUS.

PLATE CXXVII, FIG. 2.

Goniatites complanatus, HALL. Pal. N. Y., vol. v, pt. 2, p. 455. 1879.

GONIATITES SINUOSUS.

PLATE CXXVIII, FIGS. 1, 2.

Goniatites sinuosus, HALL. Pal. N. Y., vol. v, pt. 2, p. 460. 1879.

GONIATITES PATERSONI.

PLATE CXXVII, FIGS. 8, 9.

Goniatites Patersoni, HALL. Pal. N. Y., vol. v, pt. 2, p. 464. 1879.

GONIATITES OWENI.

PLATE CXXVIII, FIGS. 4-7.

Goniatites Oweni, HALL. Pal. N. Y., vol. v, pt. 2, p. 470. 1879.

GONIATITES IXION.

PLATE CXXVIII, FIG. 3.

Goniatites Ixion, HALL. Pal. N. Y., vol. v, pt. 2, p. 474. 1879.

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