ART. X.—*The Silurian Arisaig Series of Arisaig, Nova Scotia*;^{*} by F. H. McLEARN.*Introduction.*

The Silurian section of Arisaig has more than one claim to importance and is responsible for the reputation of this place in geological literature. As the most continuous and longest ranging of its age in eastern Canada it serves well as a type exposure, by comparison with which the more fragmentary occurrences of less favoured localities may be integrated and assigned to their true position in the stratigraphic column. It is interesting because of the resemblance of its faunas to those of Great Britain and for the light it sheds on the paleogeographic relations of the North Atlantic to the interior seas of America. The unusual faunal associations, and in particular the rich development of bivalves, also attract attention.

Previous studies.—The section possesses considerable historic interest and has been studied by the geologists and paleontologists of three generations. Among them may be mentioned Abraham Gesner, J. William Dawson, James Hall, Rev. David Honeyman, E. Billings, Hugh Fletcher, Henry M. Ami, Charles Schuchert, W. H. Twenhofel, and M. Y. Williams. Briefly the work already done at Arisaig may be stated as follows: The general geological problems, igneous, structural and physiographic, and the correlation of the Ordovician have been treated at length by M. Y. Williams (1914)¹. In Silurian stratigraphy, the section has been finally divided into five formations whose delimitations and thicknesses have been determined by Twenhofel (1909). These have been correlated with interior North America and Kristiania, Norway, by Schuchert and Twenhofel (1909) and with Anticosti by Twenhofel (1913). The important and necessary direct comparison with the British succession has been almost entirely neglected. There has also been no correlation with the neighboring section of Eastport, Maine. The identifications and zonal

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¹ Since a complete bibliography will be given in the final monograph, only the year of publication of the works cited is thought necessary here.

range of the species as given by Schuchert and Twenhofel were only intended to be preliminary and deal chiefly with well-known American forms. The peculiar faunal content and its relation to the muddy seas of Arisaig has been briefly noted by Schuchert and Twenhofel (1909, 1913), but the details of response to the silt factor and the evidence for its operation have not been considered. In paleogeography the transatlantic affinities of the fauna have been recognized since the time of Honeyman (1859). The overlying Knoydart formation has been referred to the Lower Devonian by Ami (1901).

Scope of present investigation.—The present investigation differs from that of all previous workers by dealing primarily with the purely paleontological problems of the Silurian. In spite of all that has been done at Arisaig, the whole fauna is now assembled and systematically studied for the first time. That this is necessary is shown by the fact that eight new genera, forty-nine new species and twenty-seven new varieties have been erected, and many species not previously recognized in this fauna have been identified. With the taxonomic work as a basis, the problem is expanded to include the zonal range of all the species, the evolution of the fauna, the biological associations and their causes, correlation with Great Britain and Maine, and finally the paleogeographic relations. While the age of the overlying Knoydart formation and its relation to the Arisaig series are not solved, the whole problem is restated and a Silurian age suggested.

The entire work, including the description and illustration of all the species, and the bibliography, is to be published by the Geological Survey of Canada. For this reason, only a summary of the main results, together with a preliminary description of the new genera and a few new species, is given below. The complete taxonomic treatment of the fauna, its evolution and zonal arrangement, full faunal lists, etc., are reserved for the final report.

Acknowledgments.—The whole investigation has been carried out under the constant supervision of Professor Charles Schuchert of Yale University and has thus benefited by the long experience of that research worker in Paleozoic stratigraphy. The author is under obligations to other members of the Department of Geological

Sciences at Yale University, and in particular to Professors Joseph Barrell and R. S. Lull. He is also indebted in many ways to the officials of the Geological Survey of Canada. More detailed acknowledgment will be made in the final publication.

Location.—The Silurian rocks of Arisaig occupy a small area in northern Antigonish County, Nova Scotia, on the shore of Northumberland Strait. The best sections are in the sea cliffs along the shore, and an almost continuous exposure of the whole Arisaig series extends from the small fishing village of Arisaig westward to the vicinity of McCara's Brook.

Stratigraphy.

Arisaig series.—The name of Arisaig series has been given by M. Y. Williams to the entire marine Silurian column as developed at Arisaig. It has a total thickness of about 3800 feet. The sediments are prevailingly argillaceous and consist of shales, sandstones and impure limestone bands. Limestone, properly speaking, is entirely absent. It has been divided by the cumulative efforts of previous workers into five formations. In ascending order, these are Beechhill, Ross Brook, McAdam, Moydart and Stonehouse. Locally it is underlain by a flow of aporhyolite of Ordovician age, but Williams (1914) and others have shown that the relation to the sediments of the Ordovician is that of an angular unconformity. The Arisaig series is followed by the subaërial strata of the Knoydart formation.

Beechhill formation.—The Beechhill, the basal member of the Arisaig series, has a thickness of about 200 feet and is made up of sandstone and arenaceous shale with a few local lenses of arenaceous limestone. The fauna is a poorly developed one and only fourteen species are recognized. The guide fossils are: *Heliophrentis bilateralis* var. *beechhillensis*, n. var., *Rhipidomella arisaigensis*, n. sp., *Camarotoechia bimesiornata*, n. sp., *Whitfieldella?* *crassa* var. *beechhillensis*, n. var., and *Cyclonema parvimedius*, n. sp.

Ross Brook formation.—The Ross Brook consists of about 830 feet of black, gray and greenish gray shales and gray, somewhat lenticular, finely cross-bedded sandstones. The fauna consists of forty-three species of

which twenty-three are confined to this formation. Among the guide fossils are: *Retiolites geinitzianus* mut. *venosus* (Hall), *Monograptus clintonensis* (Hall), *Camarotæchia llandoveriana* var. *rossbrookensis*, n. var., *C. (Pectorhyncha) humiliplicata*, n. sp., *Plagiorhyncha decemplicata* (Sowerby), *P. glassii* (Davidson), *P. plastica*, n. sp., *Cælospira hemispherica* (Sowerby) and *Dalmanites weaveri* (Salter). *Chonetes tenuistriatus* Hall appears here for the first time.

McAdam formation.—The McAdam is made up of 1120 feet of gray and black shales and sandstones with a little argillaceous limestone. Near the base is a three-foot bed of iron-ore. The fauna totals forty-seven species, of which twenty are restricted. The bivalves, for which this locality is so noteworthy, now appear in abundance for the first time and make up sixteen species of the fauna. The guide fossils are: *Dalmanella abdidimacula*, n. sp., *D. elegantula* var. *transversomedia*, n. var., *Camarotæchia (Pectorhyncha) obtusiplicata* (Hall), *Delthyris crispa* (Hisinger), *Honeymania planimarginata*, n. sp., and its variety *elongimarginata*, n. var., *Arisaigia postornata*, n. sp., *Orthonota arisaigensis*, n. sp., *O. pressiorinata*, n. sp., and *Modiolopsis postunisulcata*, n. sp. *Chonetes tenuistriatus* Hall makes its last appearance here.

Moydart formation.—This formation has a total thickness of 380 feet. Impure limestone now becomes common and the lithology consists of thin-bedded, flaggy and ripple-marked greenish shales and arenaceous and argillaceous limestones. The fauna numbers thirty-four species of which nine are restricted. The principal guide fossils are: *Eatonoides lamellornatus*, n. sp., *Wilsonia wilsoni* var. *saffordi* (Hall), *Delthyris crispa* mut. *moydartensis*, n. mut., *Seelya moydartensis*, n. sp. The following are among those forms that appear here for the first time and continue into the Stonehouse: *Orbiculoida novascotica* Ami, *Chonetes novascoticus* Hall, *Goniostropha aciculata* (Hall), *Calymene intermedia* var. *antigonishensis*, n. var., and *Dalmanitina logani* var. *conservatrix*, n. var.

The top 32 feet consist of massive red shale, without fossils, and are thought to indicate a subaërial stage of unknown duration.

Stonehouse formation.—This, the terminal member of the Arisaig series, has a thickness of 1275 feet and consists of gray, green and red thin-bedded, ripple-marked shales, sandstones and impure limestones. Two hundred feet of strata on Stonehouse Brook are now recognized for the first time and added to the top of the section. The fauna numbers ninety-four species, of which fifty-six are restricted. The principal guide fossils are: *Lingula minima* (Sowerby), *Dalmanella lunata* (Sowerby), *Brachyprion gilpini* (Dawson), *Camarotachia glomerosa*, n. sp., *Delthyris rugicosta* (Hall), *D. rugicosta* var. *subsulcata* (Hall), *Grammysia triangulata* (Salter), *G. obliqua* (McCoy), *Palaeoneilo attenuata* (Hall), *Nuculites concentricus* var. *subequilatus*, n. var., *Arisaigia placida* Billings, *A. placida* var. *socialis* (Billings), *Tropinuculites carinatus* (Hall), *Pterinea honeymani* (Hall), *Palaeopecten danbyi* (McCoy), *Goniophora* (*Cosmogoniophora*) *bellula* (Billings), *Modiolopsis exilis* Billings, *M. rhomboidea* (Hall), *Orthonota angulifera* (McCoy), *O. incerta* Billings, *Orthoceras antigonischene*, n. sp., *Dawsonoceras elegantulum* (Dawson), *Homalonotus dawsoni* Hall, *Dalmanitina logani* (Hall), and *Leperditia sinuata* Hall. Other common forms, but not restricted to this formation, are: *Chonetes novascoticus* Hall, *Calymene intermedia* var. *antigonishensis*, n. var., *Nuculites concentricus* (Hall), *N. concentricus* var. *subovatus* (Hall), *N. cawdori* (Sowerby), *N. cawdori* var. *elongatus* (Hall), *N. cawdori* var. *erectus* (Hall) and *Kionoceras angulatum* (Wahlenberg).

Physical conditions.

Two dominant bottom conditions are recorded by the lithology. One is a mud habitat, the life of which is now enclosed in shale. The other is a shelly bottom, mixed with mud or sand and now recorded by the impure shelly limestone layers. The absence of pure limestone shows that clear waters never existed for any length of time. The series was probably laid down in a shallow marginal, but normally marine, sea, into which flowed silt-laden rivers from an elevated landmass.

Biological associations.

The faunal associations are somewhat unusual and merit consideration. One notes the absence of many

familiar groups of Silurian life. The almost entire absence of corals claims first attention, while the lack of Stromatoporidæ and the impoverishment in Crinoidea and Bryozoa do not escape notice. The Brachiopoda, outside of some common species of *Dalmanella*, *Chonetes* and *Camarotæchia* and a few other genera, are poorly represented. Many ubiquitous species and with few exceptions all the higher and more specialized families, in particular the Pentameridæ and the spire-bearers, are missing. As if to atone for this, the bivalve families Grammysiidæ, Nuculacea and Modiolopsidæ have a rich development and make a strong impress on the total assemblage of the fauna. The Aviculidæ have about the normal development, but the bivalve Cardiolidæ, Conocardiidæ and Megalomidæ are conspicuously absent. The remaining phyla, the Gastropoda, Pteropoda, Cephalopoda, Trilobita and Ostracoda, make a very modest showing. Compared with the majority of Silurian faunas, the differences lie chiefly in a falling off in many groups and the only new and unfamiliar elements introduced are to be found among certain families of bivalves.

While it is natural to turn to the prevailing muddy bottoms as the cause of this faunal association, it must be remembered that there are other factors of marine environment. These must be considered and the evidence for the control of the mud factor must be examined. Curiously enough, some of these other factors tend to produce somewhat similar biological associations. A reduction in salinity would early be marked by an elimination of corals and then by a falling off within the other phyla, including the bivalves. Finally, it would result in a bivalve fauna largely, with some gastropods and crustaceans, including contributions from the fresh-water realm. But the molluscs would be poor in variety of development and in species. It would by no means explain the rich bivalve development of this fauna, for such diversification is only possible in the normal marine realm. Moreover, water bodies of decreased salinity are evanescent in geological time, as recently pointed out by Miss O'Connell (1916), whereas the factor or factors that controlled the biological associations of this fauna endured without relaxation throughout nearly a whole period. Reduced temperature also would finally result in the elimination of corals and in a depreciation in all

groups of organisms, since the variety of life declines in the cold waters. But this factor would not bring about the profound modification of this fauna and certainly would not result in a diversity of bivalves. Moreover, the climates of the Silurian seem to have been uniformly distributed. They were warm rather than cold, and in the earlier Silurian, reef corals flourished not far away in the Anticosti sea. No ecological factor related to depth could be called upon to explain this faunal association and the geological test of constancy throughout a whole period could not be met.

Among the known and larger factors, this leaves, by elimination, the control of the mud bottoms and turbid waters. The proof of their potency, however, need not be left to rest on negative evidence alone, for there is much of a positive kind in their favor. Criteria of a positive nature may be sought in the local distribution of the fauna. This may be called the internal evidence. It is found that the bivalves which are, in particular, characteristic of this locality, are confined to the shale beds, i. e., they were mud-dwellers and avoided the harder shelly bottoms. It is not a far step, therefore, to seek in the prevalence of mud bottoms the cause of this rich bivalve development. That the depauperation in other groups is related to the muddy conditions is suggested by their better, although still restricted, development in the impure limestone lenses as compared with shale. This can be well tested in the Stonehouse, the fauna of which embraces two distinct animal communities, one a mud faunule chiefly of bivalves, and the other a shell-bottom faunule, with few bivalves and richer in all other forms of life.

We can also examine the external evidence. It may be recalled that there is no true limestone in the Arisaig series. It is found that the forms of Silurian life absent from Arisaig are elsewhere most common in limestone or calcareous shale with pure limestone layers. This means that the absent forms are inhabitants of clear waters and suggests that it was the muddy bottoms and silt-laden waters of the Arisaig sea that prevented their entrance there.

Therefore, both the internal and external evidence support the conclusion that it was the silt factor that controlled the biological associations of this fauna, while a

study of the salinity, temperature and depth factors indicates that they cannot even be considered as contributory. It is well to note in passing that all shales do not record the same environmental conditions. Thus many calcareous shales must have accumulated quite slowly, for at times it was possible for thin layers of pure limestone to form within them. Such shales have faunal associations more closely related to those of pure limestone. Biological associations similar to those of Arisaig are found in the late Silurian (Upper Ludlow) of Great Britain, where similar groups of bivalves are related to similar mud bottoms, i. e., to those of marginal but normally marine seas receiving the silt-laden waters of inflowing rivers from a high landmass. The adaptation may not be to mud alone, but also to food supply associated with the incoming silt.

So the Arisaig fauna becomes an index of response to such a marine environment and the faunal associations described on a preceding page record the relative adaptability of various groups of organisms to it. The degree of adaptation varies considerably, some forms being restricted to one or another environment while others are more "indifferent." With the exception of a few species scattered through various phyla, it is only within the bivalve families Grammysiidae, Nuculacea and Modiolopsidae that a preference is prevailingly shown for the mud-bottom environment. Within them many of the genera and a preponderance of the species of the remaining genera are restricted to the shale beds. These then are primarily *the mud-dwellers of the Silurian seas*. The representation in this environment of all other families and phyla seems to depend on the resistance of some hardy forms to these, for them, unfavorable conditions. These include the "indifferent" organisms which have a wide environmental range and also the few species actually adapted and restricted to this mud habitat.

Correlation.

Owing to the peculiar biological associations of this fauna, it has fewer species than usual in common with other faunas. This makes the correlation difficult.

Great Britain.—The best comparisons can be made with the British Silurian. These are very important, for

it was in western England and in Wales that the Silurian was first studied and the Silurian system was established. The Beechhill is correlated with the Lower Llandovery of Wales, the Haverford stage of Haverfordwest in southwest Wales and the Mulloch Hill and Saugh Hill groups of Girvan in south Scotland. This is based in part on negative evidence, in the absence of such characteristic Upper Llandovery species as *Plagiorhyncha decemplicata* (Sowerby), *Calospira hemispherica* (Sowerby), and *Dalmanites weaveri* (Salter). More positive evidence is found in the presence of a variety of the typical Lower Llandovery, *Whitfieldella?* *crassa* (Sowerby). Accumulative evidence is sought in the presence of a single specimen of *W.?* *angustifrons* (McCoy) and the close resemblance of the Beechhill *Rhipidomella* (*Schizophorella*) *arisaigensis*, n. sp., to the Mulloch Hill *R. (S.) mullochensis* (Davidson). The resemblance of the Mulloch Hill *Calospira scotica* to *C. planocconvexa* (Hall), of which at best it is likely not more than a variety, suggests that the British equivalent of the American Cataract is to be found in the Mulloch Hill and probably also the Saugh Hill group of Girvan.

The Ross Brook correlates with the remainder of the Valentian, i. e., the Upper Llandovery and Taranon of Wales and also the Mullin and Rosemarket stages of Haverfordwest and the Camregan and Penkill groups of Girvan. This is based chiefly on the highly diagnostic species: *Plagiorhyncha decemplicata* (Sowerby), *Calospira hemispherica* (Sowerby), and *Dalmanites weaveri* (Salter). For the first time the Taranon is recognized in intercontinental correlation and indeed in any correlation founded on fossils other than graptolites. This is based on the writer's interpretation of the recent work of F. R. C. Reed (1917). The Taranon has heretofore been recognized only by its characteristic graptolite faunas, other phyla being too poorly represented to have any significance. In the Penkill group of Girvan both graptolite and brachiopod phases are closely associated and the former establishes its Taranon age. Reed's list of brachiopods includes such characteristic Llandovery species as *C. hemispherica*, *Clorinda undata* and *Pentamerus oblongus*, the first of which does not range below the Upper Llandovery. When correlating with brachiopods, therefore, the Taranon is best combined

with the Upper Llandovery to form a single correlative unit. This unit, then, compares not only with the Arisaig Ross Brook, but also with the American Clinton (not including the Irondequoit).

The McAdam and Moydart are together correlated with the Salopian without regard at present to its component divisions. The Stonehouse compares very well with the marine zones of the Downtonian, i. e., with the Aymestry, Upper Ludlow and also the lower part of the Downton sandstone. This is based on the following: *Lingula minima* Sowerby, *Dalmanella lunata* (Sowerby), *Brachyprion gilpini* (Dawson) cf. *B. ornatella* (Salter), *Grammysia triangulata* (Salter), *G. obliqua* (McCoy) and *Orthonota angulifera* (McCoy).

Eastport, Maine.—Comparison with Eastport, Maine, indicates that the Edmunds fauna is intermediate in development between the Arisaig Moydart and Stonehouse faunas. Its duration may in large part be equivalent to the time represented at Arisaig by the "red bed" sub-aërial stage. The Eastport Pembroke formation correlates with the Stonehouse while the earlier Quoddy and Dennys compare with parts at least of the McAdam and Moydart.

Interior America, etc.—Comparisons with interior North America, Anticosti, and Kristiania, Norway, practically follow those of Schuchert and Twenhofel (1909). The same difficulty is met with in correlating with the later Silurian of interior North America, but this is shown to be the result of the paleogeographic relations that prevailed in post-McAdam-Rochester time.

The Knoydart problem.—The age of the Knoydart and its relation to the Arisaig series will be discussed in detail in the final report. It may be said that the faunal evidence is non-committal and the structural evidence obscure. The topographic conditions of the late Silurian, however, were more favourable for the building out of deltas into the sea than were those of the Lower Devonian. The evidence of the geologic setting, therefore, favors a Silurian age.

Paleogeographic relations.

While the affinities of this fauna are chiefly trans-Atlantic and with Great Britain, it also shows relation-

ship with interior North America in the early Silurian. Since the Beechhill fauna is not definitely correlated with the American succession, its paleogeographical relations can not be discussed with certainty. Its affinities are chiefly with Great Britain. It shows some relation to the Cataract sea, but the evidence is not conclusive.

Ross Brook-McAdam time.—In both Ross Brook and McAdam time, relationship is shown not only with Great Britain, but also with eastern and western New York and southward in the Cumberland trough. No relation, however, is exhibited with the Mississippi sea of Indiana, Ohio, etc. This is based in part on a number of forms which are confined to Arisaig and northwest Europe, of which *Dalmanites weaveri* (Salter) and the short-headed *Homalonotus*, *H. knightii* Koenig, are examples. Other forms are known only from Arisaig and southward in New York, etc., of which *Camarotæchia* (*Pectorhyncha*) *obtusiplicata* (Hall) and *Monograptus clintonensis* (Hall) are examples. Others are common to northwest Europe, Arisaig and southward in New York and the Cumberland trough. Among these are: *Plagiorhyncha decemplicata* (Sowerby) and *Camarotæchia* of the *C. llandoveriana* (Davidson) type.

Moydart-Stonehouse time.—At the end of McAdam-Rochester time important paleogeographic changes took place on the North American continent (1910). The seas were withdrawn from the Cumberland trough and a great invasion from the north spread down over the interior. At this time all further communication of the Arisaig sea with interior America was broken off and thereafter relationship with northwest Europe only is exhibited. This endured to the end of the Silurian and the seas which again appeared in the Cumberland trough in the late Silurian no longer display Arisaig or North Atlantic affinity. Outside of a few ubiquitous species there is nothing in common between the Arisaig and interior seas. This is based on brachiopod, gastropod, cephalopod and trilobite evidence alone. The bivalves indicate open seaways to northwest Europe but can not be used as evidence of paleogeographic relation with interior America of this time. For here the ecological factor also enters. The prevailing clear waters and hard shelly bottoms of the interior seas would prevent their development there anyway. Restriction of

the interpretation to evidence based on the other groups is for the purpose of eliminating, as far as possible, this ecological factor.

New genera and subgenera.

It is proposed below to present a brief description of the new genera and subgenera. Where the genotypes are new species, they are also described. The final report will include the taxonomy of the entire fauna of 169 species and varieties.

Class Brachiopoda Duméril.

Family Rhynchonellidæ Gray.

Genus *Camarotæchia* Hall and Clarke.

Pectorhyncha, new subgenus.

(Πηκτός, fixed.)

Obtusely plicated *Camarotæchia* in which the teeth are not supported freely by dental plates extending into the valves, but are cemented to the lateral walls of the ventral valve. Resembles *Plethorhyncha* Hall and Clarke in the prominently elevated and posteriorly thickened dorsal median septum and the thickened hinge-plate and crura. Lacks the fine median sulcus on the anterior part of the plications which is present in *Wilsonia*, *Plethorhyncha* and *Uncinulus*. Divided hinge-plate and crural cavity as in *Camarotæchia*.

Genotype: Atrypa obtusiplicata Hall.

Genus *Eatonia* Hall.

Pareatonia, new subgenus.

1857 *Eatonia* Hall (partim), 10th Rept. N. Y. State Cab. Nat. Hist., p. 90.

This subgenus is erected to embrace the plicate *Eatonia* stock of *E. medialis* (Vanuxem), *E. sinuata* Hall, etc. *Eatonia* is restricted to those forms which are finely striate but not plicate. They may be crenulate at the margins, however, "as if by the extremities of the rounded plications" (Hall and Clarke 1894, p. 206).

Genotype: Eatonia medialis (Vanuxem).

Eatonioides, new genus.

(*Eatonia* + εἶδος, form.)

The exterior of these forms is similar to that of the plicate or *Pareatonia* species of *Eatonia*. The broad,

rounded, flabellate and excavated ventral muscle scar and the short dorsal median septum are similar to *Eatonia*. But certain *Eatonia* characters are not developed. These are the radiating fine striæ, the cardinal process of crural origin and the ventral median septum. Probably ancestral to the *Pareatonia* forms of *Eatonia* at least, but the later of the two Arisaig species referred to this genus has developed concentric lamellæ and hence is off the main ancestral line.

Genotype: *Eatonioides lamellornatus*, n. sp.

Eatonioides lamellornatus, new species.

The form of this species closely resembles that of *Eatonia* (*Pareatonia*) *medialis* (Vanuxem). The dorsal valve is more convex and the surface is ornamented, not by radiating striæ, but by concentric lamellæ. The generic characters have already been described.

Width 25 mm., length 22 mm.

Horizon and locality: Common in the Moydart formation, coast section, Arisaig, N. S.

Plagiorhyncha, new genus.

(Πλάγιο lateral, referring to position of plate bearing the teeth.)

Dorsal interior as in *Camarotæchia* Hall and Clarke, but the teeth are not supported by a dental plate produced forward from the walls of the rostral cavity, but are borne on a short plate arising from the lateral walls of the ventral valve. Outline plicated biconvex, out of which arise independently nearly smooth and also striated species with shallow and marginally deflected ventral valve. The following are referred to the new genus: *Rhynchonella glassii* Davidson, *Plagiorhyncha plastica*, n. sp., and *Terebratula decemplicata* Sowerby.

Genotype: *Rhynchonella glassii* Davidson = *Atrypa depressa* Sowerby.

Class Pelecypoda Goldfuss.

Superfamily Nuculacea.

Honeymania, new genus.

The flattened post-cardinal border resembles some of the Limopsidæ Dall and also some of the Lunulicardiidæ

Fischer. The size is much smaller than the latter and there is no radial sculpture. The dentition consists of two transverse teeth posterior to the beak and two rows of numerous and much smaller transverse teeth anterior to it. The hinge below the beak is not known. The contrast in the dentition anterior and posterior to the beak recalls the Triassic to Recent Limopsidæ. But there does not appear to be any amphidetic area of the Arcacea type. This genus is named after Rev. David Honeyman, whose name will always be associated with this locality.

Genotype: Honeymania planimarginata, n. sp.

Honeymania planimarginata, new species.

Outline somewhat mytiliform, with the post-cardinal slope abruptly deflected and descending to a flattened and straight post-cardinal border. The margin is also slightly flattened anterior to the beak. Both adductors well impressed, equal in size, and small. Pallial line not preserved. A longer expression of this form is named var. *elongimarginata*, n. var.

Length 10 mm., height 12 mm.

Horizon and locality: Rare in the McAdam formation, McAdam Brook and coast sections, Arisaig, N. S.

Arisaigia, new genus.

Nuculacea with the dentition of *Nuculites* Conrad and the clavicle variably developed. Differs in particular from that genus by having radiating striæ on the post-umbonal slope. Escutcheon, better defined in later forms, also present. In later Silurian develops scarp or carina, extending from the umbo to the postero-basal angle. The following species are referred to the new genus: *Arisaigia postornata*, n. sp., *Nucula sinuosa* Simpson, and *Cytherodon? placida* Billings.

Genotype: Arisaigia postornata, n. sp.

Arisaigia postornata, new species.

This species differs chiefly from *Arisaigia sinuosa* (Simpson) in form. It is longer and only slightly convergent posteriorly, the post-cardinal margin being almost parallel to the basal margin. The Arisaig form

has a second low fold and often a second shallow sinus on the post-umbonal slope.

Length 20-37 mm., width 9.5-17 mm.

Horizon and locality: Common in the McAdam formation, coast section, Arisaig, N. S.

Tropinuculites, new genus.

(Τρόπις, carina or keel + *Nuculites*.)

Nuculacea with the dentition and clavicle of *Nuculites* Conrad, but differing from that genus in the presence of a carina from the umbo to the postero-basal angle. In the single species referred to this genus the surface in front of the carina is covered by concentric prominent ornamental striæ, while posterior to it are fine growth-lines only.

Genotype: *Nuculites* (*Orthonota*) *carinata* Hall.

Family Modiolopsidæ Fischer.

Genus *Goniophora* Phillips.

Cosmogoniophora, new subgenus.

(Κόσμος, ornament.)

This subgenus is erected to include those forms of *Goniophora* Phillips with radiating striæ. They are very common in the Devonian, but in the Silurian are confined to the Arisaig Stonehouse fauna.

Genotype: *Goniophora bellula* Billings.