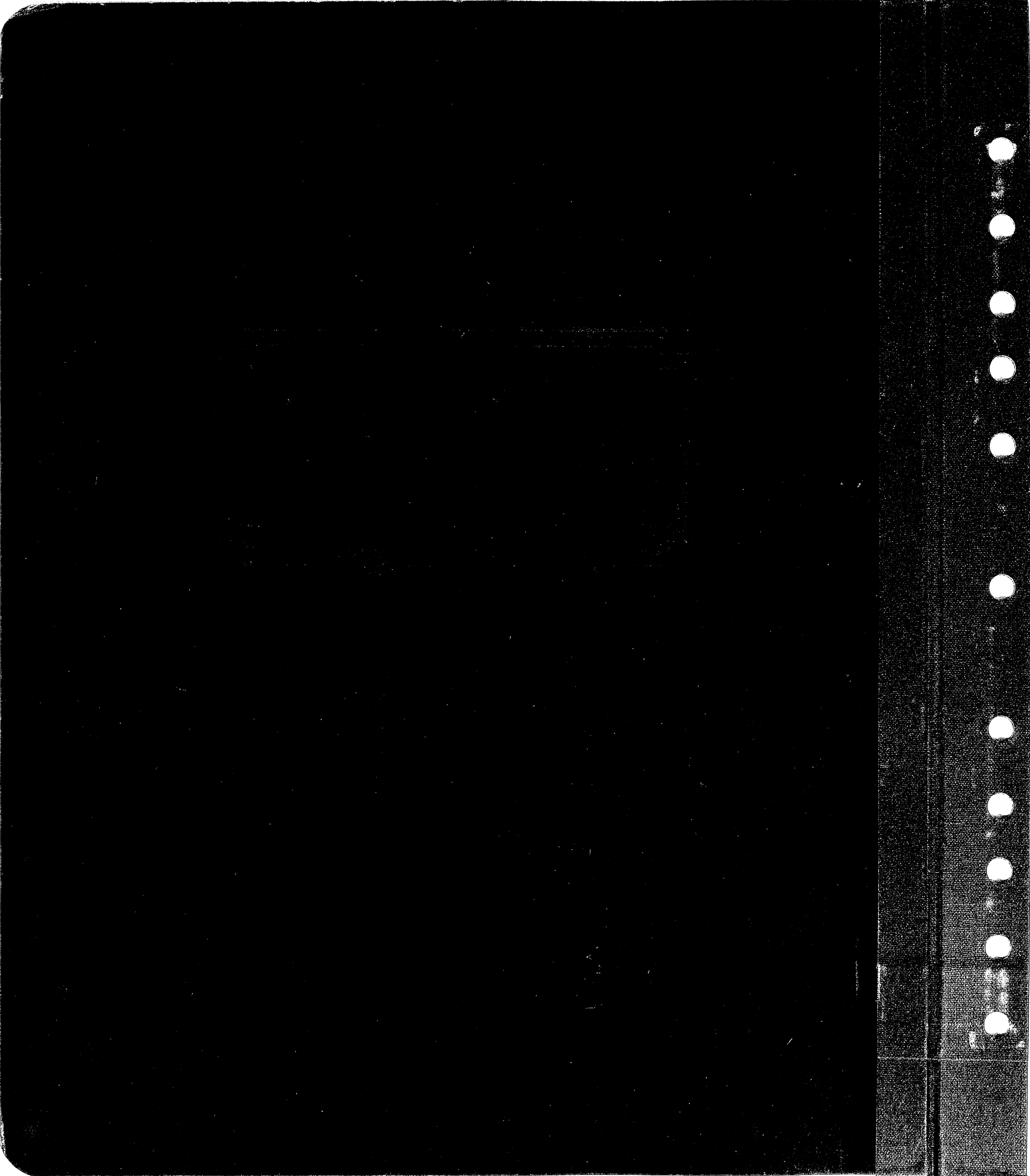


NEW GENERA AND SPECIES OF MOLLUSCA

FROM THE MIDDLE DEVONIAN OF

MICHIGAN AND MANITOBA

A. La Rocque





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DEVONIAN OF MICHIGAN AND MANITOBA

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## INTRODUCTION

The Mollusca studied in this paper are from the Middle Devonian Rogers City limestone of Michigan. Two of the species originally were described as Modiomorpha attenuata and Hyolithes alatus by J. F. Whiteaves (1891, p. 96; 1892, pp. 342—343) from the Middle Devonian strata of Lake Winnipegosis, Manitoba. The fragmentary character of Whiteaves' material prevented him from recognizing the correct generic position of these species. Better preserved specimens from the Rogers City limestone show that Whiteaves' species belong to undescribed genera. In this paper Modiomorpha attenuata Whiteaves is assigned to a new genus Liromytilus and Hyolithes alatus Whiteaves to a new genus Mastigospira. Two new species of Mastigospira, M. intermedia and M. ingens are also described.

The writer is indebted to Dr. G. M. Ehlers, Museum of Paleontology, University of Michigan, for suggesting the study to him and for much valuable information and criticism and to Dr. Alice E. Wilson, Geological Survey of Canada, for photographs of Whiteaves' types, bibliographic references to the species and the loan of the types of Hyolithes alatus Whiteaves. He is also indebted to Dr. Henry van der Schalie, Division of Mollusks, Museum of Zoology, University of Michigan and to Dr. Ralph Hile, U. S. Fish and Wildlife Service, for many helpful suggestions and critical examination of the manuscript.

## DESCRIPTIONS OF GENERA AND SPECIES

## CLASS PELECYPODA

## Family Mytilidae

Liromytilus gen. nov.

Description.-- Shell large, elongate, compressed, expanded posteriorly. Surface with strong concentric ridges of unequal thickness, with intercalated finer, more numerous lirae. Hinge line two thirds of length, rounding gently into the posterior margin, more abruptly into the anterior margin. Umbones anterior, but not terminal, situated in the anterior one-sixth of the shell; small, blunt, and inconspicuous. Anterior margin evenly rounded; ventral margin sinuate; posterior margin elliptical. Ligament not preserved.

Interior with a small anterior adductor scar and a large posterior one, the latter occupying more than one-half the posterior portion of the shell. A raised ridge from the dorsal margin to the anterior border of the posterior muscle scar, flanked by a parallel sulcus on the anterior side. Umbonal cavities very shallow. Two small, pyramidal cardinal teeth just in front of the umbo in the right valve; dentition of the left valve unknown. Lateral teeth not seen. Pallial line faint; above it is a series of small, shallow, elongated

pits arranged perpendicularly to the ventral margin.

Genotype.-- Modiomorpha attenuata Whiteaves.

Remarks.-- Liromytilus differs from Modiolopsis Hall in possessing well-developed teeth; from Modiomorpha Hall in lacking a well-developed callosity on the hinge line; from Eurymyella Williams in having two cardinal teeth in the right valve. It cannot well be placed in the family Modiolopsidae if one accepts Dall's diagnosis of the family (1913, p. 462) because the adductor scars can scarcely be described as "sub-equal." The Paleozoic Mytilacea are greatly in need of revision, but that problem is beyond the scope of this paper. At present it seems better to place this genus in the Mytilidae as understood by Dall. Within this family it has affinities with Modiolus Lamarck from which it differs in the more posterior position of the umbones, the great disparity in size between the adductor scars, and in the presence of cardinal teeth. Hall (1884, pp. 267--268) describes a few species of Modiolus from the Devonian, but they are all small and their outline is quite different from that of Liromytilus. From Mytilus, Liromytilus is easily distinguished by the position of the beaks.

Liromytilus differs from Solenopsis M'Coy in possessing cardinal teeth, in the peculiar ornamentation of the exterior of the valves, and in the absence of a posterior ridge. Beushausen's reference of Modiomorpha attenuata Whiteaves to Solenopsis is discussed below.



Liromytilus attenuatus (Whiteaves)

(Pls. I--IV)

Modiomorpha attenuata Whiteaves, Trans. Roy. Soc. Canada for 1890, sec. IV, p. 96, pl. V, figs. 1 and 1a, 1891.  
 --- Contr. to Canadian Palaeontology vol. 1, pt. IV, no. 6, pp. 295--296, 1892. --- Tyrrell, Ann. Rept. Geol. Surv. Canada, vol. V, pt. E, p. 174, 1893.

Solenopsis attenuata Beushausen, Abhandl. der K. preuss. Geol. Landes-Anstalt, N. F., Heft 17, pp. 220--221, taf. XVIII, fig. 8, 1895.

Description.-- Shell large, very elongate, three times as long as high, thickness uniform, approximately half the height of the shell; anterior portion narrower than the posterior portion; surface with strong concentric ridges, individual ridges varying in thickness, with numerous lirae intercalated between them. Hinge line two-thirds of the length, rounding gently into the posterior margin, more abruptly into the anterior one. Umbones anterior, but not terminal, situated in the anterior sixth of the shell; small, blunt, inconspicuous, with fine concentric growth lines. Ventral margin sinuate; anterior margin evenly rounded, posterior margin elliptical. Ligament not preserved, but the hinge region, on the outside of the shell is excavated, apparently for its reception,

giving a sharply serrate appearance to the dorsal edge of the valve. Valves thin, thickest in the umbonal region and gradually thinning toward the ventral margin. No evidence of a byssal notch or of a gap in the shell for the protrusion of a byssus.

Interior of the shell with a small anterior adductor muscle scar and a large posterior one, the latter occupying more than one-half the posterior portion of the shell. Anterior muscle scar ovate-pyramidal; posterior scar pear-shaped, with the smaller portion pointing antero-dorsally. Both muscle scars with low concentric ridges. A low ridge or lira starts just behind the umbo and extends along the anterior and ventral margins of the posterior adductor muscle scar. Lira flanked anteriorly by a slightly wider depression which follows it closely throughout its length. Both lira and depression sigmoid in outline.

Hinge narrow, with two low but distinct cardinal teeth just in front of the umbo in the right valve; dentition of the left valve unknown, but probably consisting of one cardinal tooth and two sockets on each side of it for the reception of the cardinals of the right valve.

Umbonal cavity shallow, scarcely perceptible in casts of the interior of the shell. Pallial line faint; above it is a series of small, shallow, elongated pits with longer axes arranged perpendicularly to the ventral margin.

Types.-- The holotype is in the collection of the Geological Survey of Canada, No. 4144. A cast of this specimen has been deposited in the Museum of Paleontology, University of Michigan, under No. 23923.

The type locality is on the south-east side of Dawson Bay, Lake Winnipegosis, four or five miles north of Shoal River, Manitoba, approximately in latitude  $52^{\circ} 50'$  and longitude  $100^{\circ} 40'$  west of Greenwich. This locality is referred to as "Whiteaves Point" by Tyrrell (1893, pp. 173--174).

The specimens in Whiteaves' possession consisted of "one nearly perfect, and three very imperfect casts of the interior of the shell." Only the specimen figured by him and later labelled as the type is now in the collection of the Geological Survey. A search through the Survey material from the Manitoba Devonian failed to produce the "three very imperfect casts" mentioned by Whiteaves. The holotype is refigured (see Pl. I) from photographs supplied by the Geological Survey of Canada. The dimensions of the holotype are as follows: Length 172 millimeters, height 57 millimeters, thickness 27 millimeters. Both the maximum height and thickness are in the posterior region, near the anterior third of the posterior muscle scar.

The Michigan material examined consists of the following hypotypes:

Hypotype No. 23918 (Pl. II, Fig. 1) is a right

valve, much exfoliated, but showing an almost continuous band of shell in the vicinity of the hinge and the anterior end of the valve. It also shows the depressions formerly occupied by the cardinal teeth (Pl. II, Fig. 2).

Measurements: Length 120 millimeters, height 46 millimeters. This hypotype was collected by R. E. Radabaugh from the upper part of the Rogers City limestone along the shore of Lake Huron near the west line of the SW  $\frac{1}{4}$  sec. 31, T. 33 N., R. 9 E., about one-half mile north of the boundary between Alpena and Presque Isle Counties, Michigan.

Hypotype No. 23919 (Pl. III, Fig. 1) is an almost complete mold of the exterior of a right valve, showing the surface sculpture, the outline of the shell and the location of the umbo. A natural mold of the same specimen (Plastotype No. 23919B) shows the posterior two-thirds of both valves and also some of the detail of the hinge region; the mold indicates that the left valve was badly crushed. Measurements (right valve): Length 123 millimeters, height 51 millimeters. This hypotype was collected by R. E. Radabaugh from the same locality and stratum as hypotype No. 23918.

Hypotype No. 23920 (Pl. II, Fig. 3) consists of an incomplete mold of the interior showing the posterior two-thirds of both valves; the hinge region is poorly preserved; the posterior muscle scar is indistinct. An external mold of the same specimen shows the sculpture on the posterior

third of the right valve. Measurements: Length (actually preserved) 95 millimeters; (estimated) 100 millimeters; height 41 millimeters; thickness 19 millimeters. This hypotype was collected by R. E. Radabaugh from a loose block of limestone in the quarry of the Michigan Limestone and Chemical Company at Rogers City, Presque Isle County, Michigan. With little doubt the block came from the upper part of the Rogers City limestone exposed in the walls of the quarry.

Hypotype No. 23921 (Pl. III, Fig. 2) is an incomplete mold of the interior of a specimen with closed valves which lacks part of the postero-dorsal margin and the anterior end of both valves but shows good detail of the posterior muscle scar, the median sulcus and the grooves on the ventral margins. Length (actually preserved) 116 millimeters, (estimated) 135 millimeters; height 64 millimeters; thickness 26 millimeters. This hypotype was collected either by Alexander Winchell or Carl Rominger from Crawford's quarry near Rogers City, Michigan. Crawford's quarry was taken over by the Michigan Limestone and Chemical Company; the quarry has been obliterated by the very extensive workings of this company. The specimen without doubt was derived from the Rogers City limestone.

Hypotype No. (United States National Museum) is an interior mold of a fragmentary specimen showing part of the posterior two-thirds of an individual with

closed valves and the somewhat distorted hinge line in the same region. The external mold of the left valve of the same specimen shows the sculpture in the region of the hinge line from just behind the umbo almost to the posterior dorsal margin. The specimen is too fragmentary for accurate measurements. The specimen was collected by G. Arthur Cooper from the Rogers City limestone of the Michigan Limestone and Chemical Company quarry at Rogers City.

Remarks.-- Whiteaves' description of Modiomorpha attenuata is exact insofar as his specimens permitted. His material did not show the exterior nor the hinge teeth and this led him to remark that the species was placed doubtfully in Modiomorpha. Whiteaves' statement that the posterior muscle scar is unknown seems strange at first glance. This scar is clearly marked on the type specimen which he had before him, and its outline is indicated, though not very clearly, in Whiteaves' figure. A reasonable explanation may be that Whiteaves had in mind the comparatively smaller scar of a Modiomorpha and refused to interpret as such the large scar which was shown in his specimen. Had he seen the Michigan specimens, which also show this feature clearly, he probably would have interpreted it correctly as a posterior muscle scar, enormous as it may seem for a Modiomorpha, though not remarkably so for a mytilid.

There is a slight discrepancy between my measurements of the length of the holotype, 172 millimeters, and Whiteaves', 176 millimeters. This difference may be due either to chipping away of part of the specimen during the intervening years, or to Whiteaves' measuring the maximum length rather than taking the conventional measurement parallel to the hinge.

Beushausen (1895, p. 220) correctly interpreted the posterior muscle scar, but he did not have specimens showing the dentition. His reference of the species to Solenopsis M'Coy cannot be accepted. M'Coy definitely stated that the hinge in his genus lacked teeth, and Beushausen, in emending M'Coy's genus, seems to have thought that this applied to Whiteaves' species as well, for he states "Schlossrand lang, zahnlos" which he could not have done had his specimen shown the dentition. The presence of teeth on the hinge line is sufficient in itself to exclude Liromytilus attenuatus from the genus Solenopsis, but this is supported also by the peculiar ornamentation of the surface of the valves, the much greater size of Whiteaves' species and the characters shown on the interior of the valves.

Beushausen (1895, p. 221) is also inclined to believe that Orthonota corrugata Whiteaves is only "ein beschaltes Exemplar unserer Art." The writer has examined

the holotype of O. corrugata, No. 4145, in the collections of the Geological Survey of Canada, and he is satisfied that it is not only specifically, but generically distinct from Liromytilus attenuatus (Whiteaves).

As may be seen in Table I, the Manitoba specimen is longer and proportionately narrower than the Michigan ones, but all specimens studied have the following characters in common: 1, position of the umbones in the anterior third of the valve; 2, proportionate size of the muscle scars; 3, shape of the hinge line; 4, presence and position of the lira and sulcus anterior to the posterior muscle scar; 5, lightly incised but characteristic grooves on the posterior portion; 6, mytiloid outline. It seems logical to consider these forms as being conspecific and to interpret as individual variations their relative differences of size and proportion. One must take into account the fact that the percentages of height to length and thickness to length are based partially on estimates in hypotypes 23920 and (U. S. N. M.) and on measured length in hypotypes 23918 and 23919 only. It is possible that further collecting in the Dawson Bay area of Manitoba will yield material showing the external features which may afford characters useful in establishing the exact relationship between the Manitoba and Michigan forms. For the present it seems better to place them in the same species on the evidence of the agreement of internal features.



Table 1.-- Comparison of Manitoba and  
Michigan specimens of Liromytilus attenuatus.

	Length milli- meters	Height milli- meters	Height as percentage of length	Thickness milli- meters	Thickness as per- centage of length
Holotype No. 4144	172	57	32.5	27	15.7
Hypotype No. 23918	120	46	38.3	--	----
Hypotype No. 23919	123	51	41.5	--	----
Hypotype No. 23920 <sup>1</sup>	100	41 <sup>2</sup>	41.0	19 <sup>2</sup>	19.0
Hypotype No. <sup>1</sup>	135	64	47.3	26 <sup>2</sup>	12.0

1. Measurement estimated from incomplete specimen.

2. Percentage estimated, see note 1.

In order to illustrate graphically the shell characters of Liromytilus attenuatus restorations of both the exterior (Pl. IV, Fig. 1) and interior (Pl. IV, Fig. 2) of the shell have been made. The restoration of the interior was obtained by making a cast of the right valve of hypotype No. 23921 and modelling thereon the cardinal teeth according to the dimensions shown by hypotype No. 23918. The restoration of the exterior was made from a cast of a right valve, hypotype No. 23919. The ornamentation has been retouched in the few places where it had been eroded away in the original, using as a guide the

specimens in which it was well preserved. Both restorations have been deposited in the Museum of Paleontology, University of Michigan, under numbers 23921A (interior) and 23919A (exterior).

Occurrence.-- In addition to the Devonian beds of the type locality, this species has been found in the Rogers City limestone of Michigan whose fauna is similar to that of the rocks at the type locality (Ehlers & Radabaugh, p. 441). It also occurs in the Eifelian of Gerolstein, Germany.

The fauna associated with Liromytilus attenuatus at the type locality is listed by Tyrrell (1893, p. 174). It should be noted that the type specimen was found in an exposure of "white, compact, uncrystalline dolomite" twenty-one feet thick, and that it has not been recorded elsewhere in the Middle Devonian of Manitoba. These facts may be significant in establishing its exact stratigraphic position when further collecting and more exact zoning can be done in these rocks. In Michigan the species is found in some, but not all, of the exposures of the Rogers City limestone (see discussion of types, pages 6--9). It seems to be limited to the upper part of the formation. In Germany only two specimens have been recorded by Beushausen, the first simply from "Gerolstein," the other "im Universitätsmuseum zu Bonn." It may also occur at "Lustheide bei Refrath" if Beushausen is correct in his statement that the specimen figured by Roemer might belong to this species.

## CLASS GASTROPODA

## Family Euomphalidae

Mastigospira gen. nov.

Description.-- Shell large, 96 millimeters or more long, tusk-shaped, uncoiled, gently and irregularly curved, triangular in cross-section, with three more or less developed, unequally spaced wing-like processes, two of them basal, the other apical, the latter less pronounced than the former; interior circular in cross-section. Shell thick, especially at the bases of the processes. Aperture flaring at the two basal angles, much less so at the apical one. Sculpture of fine growth-lines curving backward along the base and forward from the apical angle. Nuclear whorls not preserved. Apical portion terminating abruptly in a convex surface which suggests that the earliest part of the shell had been broken off at a point marked by a septum or plug.

Genotype.-- Hyolithes alatus Whiteaves.

Remarks.-- The reasons for removing Hyolithes alatus from the Pteropoda and for considering it an uncoiled gastropod will be recognized from the following comparison of the structures of Hyolithes and Mastigospira:

Hyolithes Eichwald

Shell a triangular pyramid,  
either straight or some-  
what curved.

Edges of the pyramid rounded;  
the sides slightly arched  
outward.

Interior and exterior cross-  
sections both triangular.

Aperture not expanded or very  
slightly so, oblique to the  
longitudinal axis of the  
shell, base without notch.

Shell thin (0.5 millimeter or  
less).

Mastigospira gen. nov.

Shell a triangular pyramid,  
somewhat curved, the  
edges of the pyramid pro-  
longed into wing-like  
processes.<sup>1</sup>

Edges acute; sides of py-  
ramid curving either out-  
ward or inward.

Exterior cross-section tri-  
angular, interior circular.

Aperture greatly expanded,  
not oblique to the longi-  
tudinal axis of the shell,  
deeply notched on the base.

Shell thick (1 millimeter  
or more).

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1. Diagnostic characters are italicized.

The structures whose characters are used as criteria for differentiation, i.e. apex, spire, and umbilicus, are lacking in gastropods of this type; consequently the method used by Knight (1941, p. 209) has been followed as much as possible, that is, the face of the whorl bearing two carinae is considered as the outer face of the whorl and the other parts of the shell are oriented as they would be in a dextral gastropod.

Among the Gastropoda, loose coiling of the spire is not particularly rare. Occasional scalariform examples are met with in genera whose whorls are usually tightly coiled. In certain Paleozoic genera such as Eccyliopterus, Loxoplocus, Lytospira, Ecculiomphalus, Serpulospira, Tubina, Orthonychia, and Leptozyga, loose coiling is the rule rather than the exception. In the Mesozoic, Tertiary and Recent Vermetidae, the spire is at first coiled but soon loses all semblance of regular coiling and becomes an irregularly curved tube. Continued development of the uncoiling of the shell would eventually produce a long, slightly curved cone, a stage which seems to have been reached in Mastigospira.

The walling-off of the earlier whorls is not uncommon in some marine gastropods whose shell has many whorls (e.g. Turritella); in some modern land snails (Rumina, Coelocentrum and others) the earlier whorls are broken off and the opening sealed by a calcareous plug.

The only Paleozoic genus which is comparable to Mastigospira, as far as degree of uncoiling is concerned, seems to be Odontomaria C. F. Roemer (Wenz, 1938, p. 159, and Knight, 1931, p. 208). It is a rather remarkable coincidence that Odontomaria should be found in the Middle Devonian of Gerolstein which yielded Liromytilus attenuatus and other Mollusca present also in the Middle Devonian of Michigan and Manitoba. Nevertheless, Mastigospira is easily distinguished from Odontomaria: Mastigospira has a triangular cross-section and lacks a selenizone whereas Odontomaria has a quadrangular cross-section and a well-defined selenizone.

Mastigospira is placed in the family Euomphalidae for the following reasons: the uncoiling of the shell, the tendency to form septa to wall off the earlier part of the shell, the presence of a notch giving rise to nodes in at least one species, the triangular section of the shell, the characters of the aperture, and the absence of a true selenizone.

In the Euomphalidae it resembles two genera, Lytopira and Ecculiomphalus, which have loosely coiled shells. The uncoiling in these genera has not been carried as far as it has in Mastigospira. The cross-section of the whorl and the nodes on the upper part of the shell of Mastigospira are similar to those of many Pennsylvanian Euomphalids

figured by Knight (1934, pls. 20 and 22). The formation of septa in the earlier part of the shell has been previously noted. M. ingens described in this paper, shows especially well the nodes on the upper angle of the whorl. These nodes seem to have developed from blunt spines whose concave anterior surface formed a notch in the aperture.

Mastigospira alata (Whiteaves)

(Pl. V, Figs. 1, 3, 4)

Hyolithes alatus Whiteaves, Contr. to Can. Pal. vol. 1, pt. IV, No. 6, pp. 342--343, pl. 46, figs. 2--4, 1892.

Hyolithes alatus Tyrrell, Ann. Rept. Geol. Surv. Canada, vol. 5, pt. E, p. 174 (1890--1891) 1893.

Hyolithes alatus Sinclair, Journ. Pal. 20: 73, 1946.

Description.-- Shell tusk-shaped, irregularly but only slightly curved, outer cross-section triangular, inner wall of shell conical. The three sides of the pyramidal exterior of the shell prolonged into thin, lamellar processes about 20 millimeters wide; areas between the wings gently concave. Lip flaring widely at the base, less so at the upper angle; base of lip with a deep but gently rounded notch. Basal wings prolonged forward into spine-like processes; upper

wing ending just above the beginning of the basal notch. Ornamentation of close, fine, crowded lines prolonged on the wings, where they curve forward near the base of the wing and backward near its outer edge. Apical portion of shell terminated abruptly in a convex surface suggesting the presence of a septum or plug.

Types.-- Three syntypes, Nos. 4099, 4099a, and 4099b, are in the Geological Survey of Canada collection, Ottawa, Canada. The type locality is on the north side of Manitou Island, Lake Winnipegosis, Manitoba, Canada. Hypotype No. 4100, Geological Survey of Canada collection, is from Dawson Bay, Lake Winnipegosis, Manitoba.

Remarks.-- The most complete syntype, (Geological Survey of Canada No. 4099a, Pl. V, Fig. 4) is a partly exfoliated specimen showing the two basal wings, a mold of the interior of the shell, and its irregular curvature. The beginning of the flaring aperture is partially shown; the apical portion of the shell is not preserved. This is the specimen figured by Whiteaves (1892, plate 46, figure 2). Its dimensions are as follows: Length 110 millimeters, width of aperture 26 millimeters, width of right wing 18 millimeters.

The second syntype (Geological Survey of Canada No. 4099) is an incomplete specimen showing the underside of the left basal wing and an indication of the notch in the



base of the lip. It is figured by Whiteaves (1892, plate 46, Fig. 3). Dimensions: Length of preserved shell 62 millimeters, width of aperture 28 millimeters.

The third syntype (Geological Survey of Canada No. 4099b) is a small portion of the shell showing an oblique cross-section which indicates the position and thickness of the wings. It is not figured by Whiteaves.

A hypotype (Geological Survey of Canada No. 4100), collected by J. B. Tyrrell in 1889, is from Station 815, Dawson Bay, Lake Winnipegosis. It shows a mold of the interior and portions of the exterior. This may be the specimen from which Whiteaves' figure 4 (1892, pl. 46) was prepared. Dimensions: Length 78 millimeters, width of aperture 20 millimeters, width from tip to tip of basal wings about 32 millimeters. Another hypotype (Geological Survey of Canada No. 6364) is part of a mold of the interior of another specimen from the north bank of the Red Deer River, Manitoba, at Limestone knoll one mile below Long Rapids. This specimen was collected by E. M. Kindle on September 1, 1912. Length 44 millimeters.

One other hypotype in the collection of the Geological Survey of Canada No. 6365 is a mold of the interior from Dawson Bay, Lake Winnipegosis, Manitoba. This specimen is 111 millimeters in length and shows the impression of the apical septum or plug.

Remarks.-- Mastigospira alata differs from M. intermedia and M. ingens, described on pages 21 and 23 of this paper, in the much greater width of its wing-like processes which are very wide even in the earliest part of the shell preserved in the type, No. 4099a, Geological Survey of Canada. The wing-like processes are difficult to reconcile with the conventional idea of a gastropod shell, but other characters of the shell and especially the type of ornamentation in Mastigospira intermedia and M. ingens indicate that Mastigospira is indeed a gastropod.

Occurrence.-- Middle Devonian of Manitoba: Lake Winnipegosis; Lake Manitoba; Red Deer River (Whiteaves, 1892, p. 343).

Mastigospira intermedia sp. nov.

(Pl. VI, Figs. 1--4)

Description.-- Shell tusk-shaped, uncoiled, gently curved, triangular in cross-section on the outside, the three apices of the triangle gently rounded, with blunt wing-like processes. Lip flaring widely at the base, less so at the upper angle. Base of lip with a deep but gently rounded notch producing two spine-like processes at the base of the aperture. Upper angle of lip less produced than the two basal ones.

Ornamentation of fine, crowded growth lines directed forward from the upper angle of the shell and curved backward on its basal face. Angles of the shell bluntly rounded, obscurely nodulose, the lower ones smooth except where crossed by the growth lines. Apical portion of shell terminating abruptly in a convex surface which suggests that the earliest part of the shell had been broken off at a point marked by a septum or plug.

Types.-- The holotype, No. 23926, Museum of Paleontology, University of Michigan, is poorly preserved but shows the outer surface of the shell. The aperture is lacking. The shell is broken 81 millimeters from the apical septum or plug, disclosing the cylindrical inner wall and the triangular outline of the outer wall. Length 160 millimeters, greatest width 16 millimeters, height 13 millimeters.

A paratype, No. 23925, Museum of Paleontology, University of Michigan, is a mold of the interior of the shell in which part of the aperture is preserved. The aperture flares strongly at the base, less so at the upper angle, as in M. alata. Length 129 millimeters, greatest width of aperture 25 millimeters, height 13.5 millimeters. This specimen shows characters of the apical region which are lacking in the holotype.

Both specimens are from the upper part of the Rogers City limestone along the shore of Lake Huron near the west

line of the SW  $\frac{1}{4}$  sec. 31, T. 33 N., R. 9 E., about one-half mile north of the boundary between Alpena and Presque Isle Counties, Michigan.

Remarks.-- This species is easily distinguished from M. alata by the reduction of the wings which are so conspicuous in that species. The internal molds of the two species are so similar in cross-section that identification from these alone is impossible.

Occurrence.-- At present this species is known only from the type locality.

Mastigospira ingens sp. nov.

(Pl. VII, Figs. 1--5)

Description.-- Shell large, at least twice the size of the two preceding species, uncoiled, outer cross-section triangular, inner circular, angles acute and pinched out, but wings not as wide as in the type species. Lower and inner sides of the shell concave, the outer convex and bearing two strong carinae, the upper carina 14 millimeters from the upper angle of the whorl and the lower carina 7 millimeters below the upper one. Lip not preserved except on the lower surface of the whorl where it shows a distinct

basal notch. Ornamentation of fine, crowded growth lines directed forward from the upper angle of the whorl on the inner surface; on the outer surface they are first directed forward as far as the upper carina, then they bend sharply backward toward the outer basal angle of the whorl. On the lower surface the growth lines bend backward sharply, following the outline of the notch in the aperture. Upper angle of whorl distinctly nodose, the nodes unevenly spaced and of unequal size. Outer basal angle bearing smaller nodes, the inner basal angle sharp and not nodose.

Type.-- The holotype, No. 23924, Museum of Paleontology, University of Michigan, is incomplete, both the apical and apertural portions of the shell missing. As preserved, its dimensions are as follows: Length 107 millimeters, width 33 millimeters, height 21 millimeters. The type locality is along the shore of Lake Huron near the west line of the SW  $\frac{1}{4}$  sec. 31, T. 33 N., R. 9 E., about one-half mile north of the boundary between Alpena and Presque Isle Counties, Michigan.

Remarks.-- The much greater size of this species readily separates it from both the preceding ones. The pinching-in of the inner basal angle suggests relationship with M. alata, the wingless, nodose upper carina suggests relationship with M. intermedia.

## SUMMARY

1. The occurrence of Liromytilus attenuatus (Whiteaves) is reported for the first time from the Middle Devonian Rogers City limestone of Michigan.
2. Its exterior features and hinge teeth are described from new material found in this formation.
3. A new genus, Liromytilus, is erected for the reception of this species and its characters are defined.
4. Liromytilus is assigned to the family Mytilidae on the basis of the new features shown.
5. Liromytilus attenuatus (Whiteaves) is redescribed.
6. Restorations of both the interior and exterior of this species are figured.
7. The occurrence of Liromytilus attenuatus in both the Devonian rocks of Manitoba and the Rogers City limestone of Michigan confirms the conclusions of Ehlers and Radabaugh (1938, p. 445) in regard to the correlation of these strata with the Eifelian deposits of Germany.
8. Four key specimens of L. attenuatus and two restorations are figured.
9. Hyolithes alatus Whiteaves is transferred from the Pteropoda to the Gastropoda.
10. A new genus Mastigospira is proposed to include this species and its characters defined.

11. Two new species of Mastigospira are described from the Rogers City formation of Michigan.

Ann Arbor, Michigan,

26th. June, 1946.

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## PLATE I

PAGE

Fig. 1. Liromytilus attenuatus (Whiteaves) . . 4

Dorsal view of the holotype, a mold  
of the interior.

Holotype No. 4144, Geological Survey  
of Canada.

Middle Devonian, South-east side of  
Dawson Bay, Lake Winnipegosis,  
four or five miles north of  
Shoal River, Manitoba, Canada.

Fig. 2. Liromytilus attenuatus (Whiteaves) . . 4

Side view of holotype showing a mold  
of the interior of the right  
valve.

Holotype No. 4144, Geological Survey  
of Canada.

Middle Devonian, South-east side of  
Dawson Bay, Lake Winnipegosis,  
four or five miles north of  
Shoal River, Manitoba, Canada.

PLATE I



## PLATE II

PAGE

Fig. 1. Liromytilus attenuatus (Whiteaves) . . 4

Largely exfoliated right valve showing ornamentation along dorsal and anterior margins and molds of two teeth in dark area in front of umbo.

Hypotype No. 23918, U. M.

Middle Devonian, Rogers City limestone, along the shore of Lake Huron near the west line of the SW  $\frac{1}{4}$  sec. 31, T. 33 N., R. 9 E., about one-half mile north of the boundary between Alpena and Presque Isle Counties, Michigan.

Fig. 2. Liromytilus attenuatus (Whiteaves) . . 4

Cast of part of the hinge of the same specimen as Figure 1, showing teeth.

Hypotype No. 23918, U. M.

Same formation and locality as Figure 1.

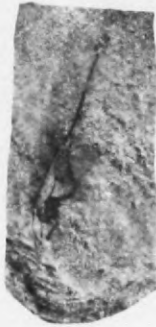
Fig. 3. Liromytilus attenuatus (Whiteaves) . . 4

Mold of the interior of a left valve.

Hypotype No. 23920, U. M.

Middle Devonian, Rogers City limestone, quarry of the Michigan Limestone and Chemical Company at Rogers City, Presque Isle County, Michigan.

PLATE II



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## PLATE III

PAGE

Fig. 1. Liromytilus attenuatus (Whiteaves) . . . 4

Plaster cast of the exterior of a right valve, showing prominent ridges of shell.

Plastotype No. 23919B, U. M., made from hypotype No. 23919, U. M., a natural mold of the exterior of a right valve.

Middle Devonian, Rogers City limestone, along the shore of Lake Huron near the west line of the SW  $\frac{1}{4}$  sec. 31, T. 33 N., R. 9 E., about one-half mile north of the boundary between Alepna and Presque Isle Counties, Michigan.

Fig. 2. Liromytilus attenuatus (Whiteaves) . . . 4

Mold of the interior of a right valve.

Hypotype No. 23921, U. M.

Middle Devonian, Rogers City limestone, Crawford's quarry, near Rogers City, Michigan.

PLATE III



## PLATE IV

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|--|------|
| Fig. 1. <u>Liromytilus attenuatus</u> (Whiteaves) . . .  | 4    |
| Restoration of the exterior of a right valve, based chiefly on hypotype No. 23919, U. M.<br>Plastotype No. 23919A, U. M.     |      |
| Fig. 2. <u>Liromytilus attenuatus</u> (Whiteaves) . . .  | 4    |
| Restoration of the interior of a right valve, based on hypotypes Nos. 23921 and 23918, U. M.<br>Plastotype No. 23921A, U. M. |      |



PLATE IV



## PLATE V

PAGE

Fig. 1. Mastigospira alata (Whiteaves) . . . . . 18

Apical portion of hypotype No. 6365,  
Geological Survey of Canada, X 2.  
Note convex termination at smaller  
end, indicating the presence of a  
septum or plug.

Middle Devonian, Dawson Bay, Lake Win-  
nipegosis, Manitoba, Canada.

Fig. 2. Mastigospira intermedia sp. nov. . . . . 21

Apical portion of hypotype No. 23925,  
U. M., X 2. Note convex termi-  
nation, as in Fig. 1.

Middle Devonian, Rogers City limestone,  
along the shore of Lake Huron near  
the west line of the SW  $\frac{1}{4}$  sec. 31,  
T. 33 N., R. 9 E., about one-half  
mile north of the boundary between  
Alpena and Presque Isle Counties,  
Michigan.

Fig. 3. Mastigospira alata (Whiteaves) . . . . . 18

Specimen showing basal notch and spines.  
Hypotype No. 4100, Geological Survey of  
Canada.

Middle Devonian, Station 815, Dawson Bay,  
Lake Winnipegosis, Manitoba, Canada.

Fig. 4. Mastigospira alata (Whiteaves) . . . . . 18

Dorsal view of the best preserved syn-  
type, showing portions of the two  
basal processes.

Syntype No. 4099a, Geological Survey  
of Canada.

Middle Devonian, North side of Manitou  
Island, Lake Winnipegosis, Mani-  
toba, Canada.

PLATE V



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## PLATE VI

- |   | PAGE |
|---|------|
| Fig. 1. <u>Mastigospira intermedia</u> sp. nov. . . .   | 21   |
| <p style="margin-left: 40px;">Ventral view of a mold of the interior,<br/> showing basal notch and spines.<br/> Paratype No. 23925, U. M.<br/> Middle Devonian, Rogers City limestone,<br/> along the shore of Lake Huron near<br/> the west line of the SW <math>\frac{1}{4}</math> sec. 31,<br/> T. 33 N., R. 9 E., about one-half<br/> mile north of the boundary between<br/> Alpena and Presque Isle Counties,<br/> Michigan.</p>  |      |
| Fig. 2. <u>Mastigospira intermedia</u> sp. nov. . . .   | 21   |
| <p style="margin-left: 40px;">Cross-section of the same specimen<br/> as Figure 1.</p>  |      |
| Fig. 3. <u>Mastigospira intermedia</u> sp. nov. . . .   | 21   |
| <p style="margin-left: 40px;">Cross-section of the same specimen<br/> as Figure 4.</p>  |      |
| Fig. 4. <u>Mastigospira intermedia</u> sp. nov. . . .   | 21   |
| <p style="margin-left: 40px;">Dorsal view of holotype, No. 23926,<br/> U. M. The smoother areas not<br/> showing growth lines are plaster.<br/> Middle Devonian, Rogers City limestone,<br/> along the shore of Lake Huron near<br/> the west line of the SW <math>\frac{1}{4}</math> sec. 31,<br/> T. 33 N., R. 9 E., about one-half<br/> mile north of the boundary between<br/> Alpena and Presque Isle Counties,<br/> Michigan.</p> |      |

PLATE VI



## PLATE VII

- |   | PAGE |
|---|------|
| Fig. 1. <u>Mastigospira ingens</u> sp. nov. . . . .   | 23   |
| Cross-section of the holotype just<br>behind the basal notch.   |      |
| Fig. 2. <u>Mastigospira ingens</u> sp. nov. . . . .   | 23   |
| Cross-section of the holotype 41 mm.<br>behind the cross-section in<br>Figure 1.  |      |
| Fig. 3. <u>Mastigospira ingens</u> sp. nov. . . . .   | 23   |
| Side view showing carinae on the outer<br>wall of the shell.  |      |
| Holotype No. 23924, U. M.<br>Middle Devonian, Rogers City limestone,<br>along the shore of Lake Huron near<br>the west line of the SW $\frac{1}{4}$ sec. 31,<br>T. 33 N., R. 9 E., about one-half<br>mile north of the boundary between<br>Alpena and Presque Isle Counties,<br>Michigan. |      |
| Fig. 4. <u>Mastigospira ingens</u> sp. nov. . . . .   | 23   |
| Dorsal view, showing inner wall of the<br>shell and the character of the<br>nodes.  |      |
| Holotype No. 23924, U. M.<br>Formation and locality as for Figure 3.  |      |
| Fig. 5. <u>Mastigospira ingens</u> sp. nov. . . . .   | 23   |
| Ventral view, showing basal notch and<br>ornamentation. Note obscure en-<br>crusting bryozoan ( <u>Hederella</u> ?)<br>on the surface of the shell.   |      |
| Holotype No. 23924, U. M.<br>Formation and locality as for Figure 3.  |      |

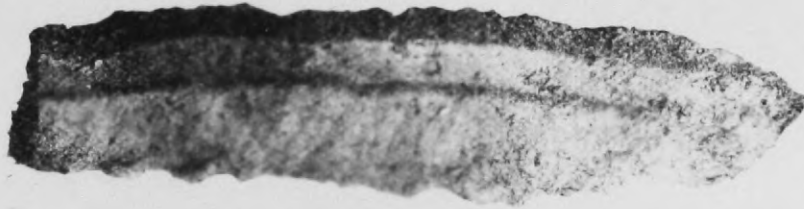
PLATE VII



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