

MUSSEL DISTRIBUTION IN RELATION TO FORMER STREAM CONFLUENCE
IN NORTHERN MICHIGAN, U. S. A.

by

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ABSTRACT

It has been shown previously that certain Mississippi River naiades have invaded the St. Lawrence drainage system in the region of the Fox River and Green Bay on the western shore of Lake Michigan, Wisconsin, in post-glacial times when the Fox River was still joined to the Wisconsin River, a tributary of the Mississippi. The fluvial species *Alasmidonta marginata* and *Actinonaias carinata*, for instance, now occur in 3 streams flowing into Green Bay, but not in the impounded waters of the Lake itself. The present discontinuous distribution of these mussels was explained by a former enlarged Fox River system with a dendritic river pattern that comprized these rivers during a low water stage of Lake Michigan.

The southern species *Alasmidonta marginata*, *Elliptio dilatatus* and *Lasmigona costata* have been found in 3 northern Michigan rivers: the Millecoquin, in the eastern part of the Upper Peninsula, and the Carp and Ocqueoc, in the northern part of the Lower Peninsula. Again we have a discontinuous pattern of distribution. Particularly *A. marginata* is strictly fluvial and the 2 other species also do not occur in Lake Michigan. Such an extension of their range from the northwest can be accounted for best by geomorphological evidence. Glacial geologists have indicated that a former Mackinac River occupied the bed of northern Lake Michigan during a post-glacial low water stage in Chippewa-Stanley times, approximately 8500 years ago. The rivers concerned, now tributaries of Lake Michigan and Lake Huron, must have been connected with the now submerged Mackinac River system before the higher lake levels separated them.

An Atlantic species, *Elliptio complanatus*, has reached northern Michigan through other post-glacial confluences, for the east. It has also been found in the Ocqueoc River, although it is known to be absent from the Lower Peninsula, and in the Millecoquin of the Upper peninsula.

The relations of the distribution of fresh-water mussels to geomorphology have been discussed in several earlier accounts. Although this subject has been somewhat controversial, facts to indicate that mussel distribution does serve as a means for determining post-glacial stream confluence have been demonstrated in several regions. For the Great Lake region of the Northern United States of America, which was formerly glaciated, the sequence of events that occurred in post-glacial history, as revealed by glacial geologists such as Leverett and Taylor (1915), Stanley (1938), Hough (1955, 1958) and others, can best explain certain features of present naiad distribution.

Broadly speaking, it is apparent that some species typical for the Mississippi drainage, a system draining southwards

since glacial times, are also present in the upper reaches of the more recent Great Lakes - St. Lawrence hydrographical system, which drains to the east and which has captured some of the headwaters of the Mississippi system. The present divides lie in northeastern Wisconsin and in northern Illinois and Indiana and the whole of Michigan belongs to the St. Lawrence watershed.

Particulars on naiad distribution in this area and on its correlation with glacial history are found in the literature. Goodrich and van der Schalie (1939: 40) have shown that certain Mississippi naiades entered rivers tributary to the Green Bay of Lake Michigan, Wisconsin, at a low water stage of the Lake during which there existed an enlarged Fox River System with a dendritic river pattern. Since these

species are, in part, strictly fluviatile, or at least do not inhabit Lake Michigan, such a formerly connected river system appears to be an essential factor in accounting for the present occurrence of these species in streams that are now discontinuous due to the present higher water level in Green Bay. Further pertinent data are given, for northeastern Wisconsin and northwestern Michigan, by Walker (1913), H. B. Baker (1922), Morrison (1932) and van der Schalie (1939, 1945); for southwestern Michigan, by van der Schalie (1941, 1945) and, for southeastern Michigan, by Walker (1913), Ortmann (1924) and van der Schalie (1939). In central New York, Clarke and Berg (1959) have more recently correlated mussel distribution with geologic history.

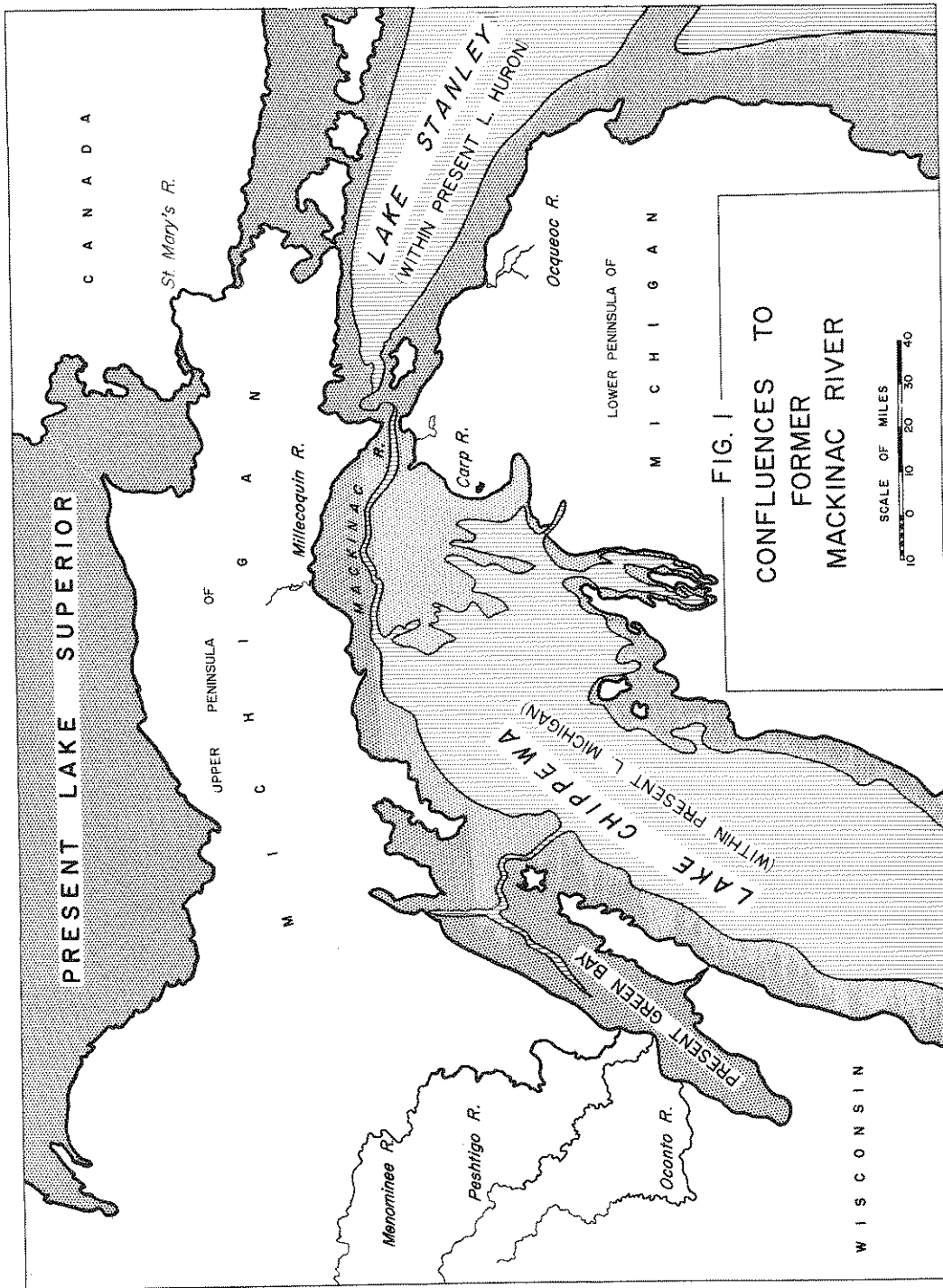
With additional information now available, it is possible to show that the influx of the southern Mississippi mussel fauna into the Northern Peninsula of Michigan extended a considerable distance north-eastward beyond the Green Bay area than previously known, as far east as, and even beyond the Mackinac Straits between Lakes Michigan and Huron. The studies on the rivers of the Great Lakes, as published by Stanley (1938) and Hough (1958) are here shown to account for this influx.

In view of past misunderstanding as to the value of mussel distribution as an aid in determining stream confluence, it must again be emphasized that fresh-water mussels are an especially useful group for relating their patterns of distribution to both the present and the past history of the streams in which they now live. The controversial aspects of the subject have been discussed by Ortmann (1913) and van der Schalie (1939, 1945). Passive means of distribution, other than fishes on which the animals are normally parasites, do not serve to account for the patterns in distribution now observed. Most attempts to explain mussel dispersion by birds as passive agents are based on untenable biological conditions and do not serve either to explain the definite inter-relation of mussels with their environmental conditions or the intricate relations necessary

for the successful completion of the life histories that mussels must have with their fish hosts.

Knowledge of the mussel fauna in the streams of the Upper Peninsula of Michigan is all too incomplete. There are several reasons for a lack of such data. The area is still a rather extensive wasteland, with very few roads providing access to its streams. Many of the rivers are not favorable for mussels throughout their entire course because the bottom often tends to be too sandy; mussels do not maintain themselves on shoals with shifting sands. It thus becomes very difficult to determine which species live in a particular drainage system, since an accessible stretch of a stream bottom may be unproductive while not far away in the same stream mussels thrive on a firm bottom. With these conditions in mind, it is obvious that one cannot be certain that the information available is anything but fragmentary. However, the few reliable data available, already do enable one to postulate the conditions that must have existed during the late Pleistocene, when lakes and rivers were connected in such a way as to permit the patterns of distributions now observed among some of the mussels in northern Michigan. It should be stressed that information of this kind ought to be obtained before the rivers are subjected to detrimental human influences that may eradicate the original fauna.

While 8 species are involved in showing stream confluence in northern Michigan and Wisconsin, the distribution patterns of 2 river-inhabiting species, *Actinonaias carinata* Barnes and *Alasmidonta marginata* Say, have already been stressed by Goodrich and van der Schalie (1939: 41-44, Map 2). They occur in northeastern Wisconsin, in the Oconto, Peshtigo and Menominee rivers (Fig. 1), but are unable to maintain themselves in impounded waters such as Green Bay and Lake Michigan itself. These species, now, occurring in 3 separate streams, clearly have a discontinuous distribution pattern. For a previous continuous river pattern that would explain this distribution, a



low-water stage must have existed in Green Bay and Lake Michigan in former times. In fact, during the post-Algonquin period, the streams in Wisconsin and northwestern Michigan, now draining into the lake, connected with the enlarged Fox River, then flowing through the bed of Green Bay, to form a continuous dendritic pattern. These former confluences have been indicated in that previous account.

The Mackinac River drainage. Recent studies by Hough (1955, 1958) using radio-carbon dating techniques confirm this low-water stage in post-Algonquin and pre-Nipissing time; Hough places the water level as much as 350 feet below the present lake surface. More recently Hough (1963) clearly summarizes the glacial lake levels as they occurred in succession in the Lake Huron basin. His Fig. 7 shows the time sequences of the several lake stages in relation to sea level. He indicates that the Algonquin stage, with an age of 11,000 B.P. (Before Present) and at an altitude of 605 feet above sea level, was followed by a large drop in level (about 370 feet) in the Stanley stage to a low level of 190 feet above sea level. This was followed by a gradual rise so that about 4500 years later the Nipissing stage was attained (about 4500 B.P.) when the water level was again 605 feet above sea level. In earlier accounts the low level of lake water was simply referred to as the "Algonquin-Nipissing" stage. These newer data provide a useful tool for studies of stream confluence.

Hough's studies and those by Stanley (1938) also show that a submerged Mackinac River channel (Fig. 1.) existed in northern Lake Michigan. Three additional river connections in that area can now be indicated to account for the presence in recent time of 3 Mississippi naiades, the river-inhabiting species, *Alasmidonta marginata* Say, and 2 other species not found in Lake Michigan, *Elliptio dilatatus* (Rafinesque) and *Lasmigona costata* (Rafinesque). The 3 rivers in which this southern, Mississippi River faunal group has been found are the Millecoquin River in the Upper Peninsula of Michigan and

the Carp and Ocqueoc Rivers in the Lower Peninsula (Fig. 1). Another, Atlantic species, *Elliptio complanatus* (Dillwyn), was also found in 2 of these streams. Former confluences must have existed to account for the presence of such faunal elements in the northern Michigan streams, which evidently once were part of a Mackinac River drainage. It is with the evidence of these confluences that we can now understand how the southern mussels could be established farther north and east than hitherto suspected. Each of the 3 drainages will be considered separately.

The Millecoquin River. On August 23, 1941, Dr. Carl L. Hubbs collected three species of fresh-water mussels from that River. Among the eight specimens collected were three *Alasmidonta marginata* Say, an location even farther to the northeast than the Wisconsin-Michigan border and also far from its normal southern range in the Lower Peninsula of Michigan. Because this discovery was so unusual the Millecoquin River was re-visited on October 4 of the same year. During this survey the following species were collected:

Unioninae:

- Elliptio complanatus* (Dillwyn)
- **Elliptio dilatatus* (Rafinesque)

Anodontinae:

- Anodonta grandis* Say
- Anodontoides ferussacianus* (Lea)
- **Lasmigona costata* (Rafinesque)
- **Alasmidonta marginata* Say

Lampsilinae:

- Lampsilis siliquoidea* (Barnes)
- Lampsilis ventricosa* (Barnes)

The three species marked with asterisks in the above list are characteristically among the Mississippi fauna (van der Schalie, 1939: 39-45), and they indicate former conditions not now present in the Great Lakes. While *Elliptio dilatatus* and *Lasmigona costata* have not been reported (Goodrich and van der Schalie, 1932) from

Lake Michigan, both species are known to be able to live in a lake environment (van der Schalie, 1938), particularly if the lake has a stream influence as brought about by a strong inlet or outlet, or both. Since Lake Michigan does not support a rich mussel fauna, both species actually have a discontinuous pattern; they probably reached the Millecoquin with *Alasmidonta marginata* during a period of stream confluence.

The presence of *Elliptio complanatus* (Dillwyn) in the Upper Peninsula clearly indicates an invasion through confluence from the east, since this species belongs to the North Atlantic (St. Lawrence River) mussel assemblage (van der Schalie, 1950: 449-450). The species probably traveled westward as glochidia attached to fish, from Quebec through the Trent and Nipissing outlets into Georgian Bay, from there to spread, according to Walker (1913: 45), "along the north shore of Georgian Bay [of Lake Huron] into the St. Mary's [River], and from thence into the eastern Lake Superior, without getting either into Lake Erie, Lake St. Clair, or the lower part of Lake Huron". With regard to the period of this spread, Clarke and Berg (1959) indicated that the Trent Outlet stage was more likely than the Nipissing outlet stage (which is the present valley of the Ottawa River).

Carp River. This stream in the upper part of the Lower Peninsula flows northwards into northern Lake Michigan (Fig. 1), and there is one authentic record in the collections of the Museum of Zoology, University of Michigan, to establish that *Alasmidonta marginata* has been found in this stream. Royal Brunson collected this species on July 20, 1945, at the mouth of Carp River, Emmet County (UMMZ 197969). The predominantly southern distribution of *Alasmidonta marginata* in Michigan has been recognized for more than half a century and is thus indicated by Bryant Walker (1898: 6) when he stated "*Margaritina marginata* Say [now known as *Alasmidonta marginata*] is apparently of general distribution through the southern part of the state [Michigan] and has been

found as far north as Houghton Lake, Roscommon county, the source of the Muskegon river". This location is about 170 miles up Michigan's Lower Peninsula, a region accessible to Mississippi mussels from the south, through the Des Plaines-Illinois and the Maumee routes, which were formerly connected with the Mississippi drainage.

The Ocqueoc River drainage. This lower Peninsula stream also flows to the north and drains into Lake Huron at Hammond Bay (Fig. 1). The following mussels, collected in 1948 by Harold W. Harry and me, represent the recent mussel fauna in Ocqueoc River:

Unioninae:

**Elliptio complanatus* (Dillwyn)

Anodontinae:

Anodonta grandis Say

Alasmidonta calecolus (Lea)

**Alasmidonta marginata* Say

Lasmigona compressa (Lea)

**Lasmigona costata* (Rafinesque)

Strophitus rugosus (Swainson)

Lampilinae:

Lampsilis siliquoidea (Barnes)

The species marked with an asterisk are of special interest in that they would not be anticipated as a part of the fauna of the river in this area while the 5 other species are normally found in northern rivers such as the Ocqueoc. These species have used two separate avenues of invasion, the *Elliptio complanatus* reaching the Ocqueoc from the east, while *Alasmidonta marginata* and *Lasmigona costata* definitely came from the northwest.

The mussels of the Ocqueoc drainage have long been known to represent an unusual assemblage in which northern and southern elements are found intermingling with remarkable discontinuity among several faunal elements. The disparity can now be explained best in terms of the submerged Mackinac River channel, backed by means of additional evidence adduced by Stanley (1938) and by Hough

(1955, 1958), which shows that there was a low-water stage known as "Lake Stanley" in the Huron basin. Hough (1955: 967) stated: "Detailed study of the present lake-bottom topography should reveal many more effects of low stages of the lake. Captain Vernon Seaman of the research vessel Cisco reports (Personal communication, 1951) that fishermen have brought up in their nets, from a depth of 85 feet, off Hammond Bay, Lake Huron, whole trees complete with their roots and bearing no man-made scars. These trees, perhaps from a flooded forest, were identified as Tamaracks". This information tends to strengthen the belief that a level sufficiently low must have existed to permit the river confluence necessary for the introduction of the river species *Alasmidonta marginata* into the Ocqueoc drainage from the northwest; this low level could account for the interesting pattern observed in the distribution of *Elliptio complanatus*. The time when this low-water stage occurred has been established as 7850 ± 350 , according to radiocarbon dates assigned by Crane and Griffin (1960: 31) for vegetable matter from Grand Traverse Bay; the radiocarbon age of wood from two stumps *in situ* in Thompson's Harbor in Lake Huron was 7250 ± 300 years (1961: 106). Farrand (unpublished thesis, 1960) places the beginning of the Chippewa-Stanley period at 8500 years ago which is some 2000 years earlier than the date estimated by Hough (1958).

The occurrence of *Elliptio complanatus* in the Ocqueoc drainage has been known for many years. Why it lived nowhere else in the southern peninsula has been a matter open to conjecture. The records (Walker, 1898: 11; Matteson, 1948: 14) for its occurrence in Macomb, Lenawee and Monroe counties are dubious and unconfirmed, since many years of collecting have shown that this species is not a normal inhabitant in the southern regions. Its prevalence in the Ocqueoc and its absence as a regular element in the fauna of all streams in the remainder of the lower Michigan Peninsula have been well authenticated and can be adequately sub-

stantiated by the hundreds of distribution records available in the Museum of Zoology at the University of Michigan. Matteson (1948: 13, Fig. 1) used those records to show distribution in Michigan; his map clearly indicates its isolated occurrence in the Ocqueoc region. Ortmann (1924: 116) suggested that the few scattered outlying records of *Elliptio complanatus* indicated that it might be expanding its range southward at the present time. However, this extension has not been observed to have taken place.

The faunal list for the Ocqueoc River does not include *Elliptio dilatatus* (Rafinesque) although the Museum of Zoology collections record it from some of the other rivers in the northern part of the southern Peninsula such as: the Devil River and Thunder Bay River in Alpena County; the Rifle River in Ogemaw County; Sylvan and Crystal lakes in Leelanau County; Platte River, Benzie County; and Betsie Creek, Grand Traverse County. It would be interesting to discern the reasons for its absence in the Ocqueoc and its presence in the Carp and Millecoquin rivers.

Alasmidonta marginata and *Lasmigona costata* are both well established in the Ocqueoc drainage. While the former has not been recorded farther east along this northern route, there is evidence that *Lasmigona costata*, clearly a Mississippi species, did travel far to the east with records for the Erie Canal in New York (Clarke and Berg, 1959: 8-9) and the Rideau River at Ottawa, Ontario (LaRocque and Oughton, 1937: 152-53). This species seems to have migrated both through the southern Greater Maumee system (in the basin of present Lake Erie) and the former Mackinac River, in the north, to establish itself far in the St. Lawrence drainage system.

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¹Obtainable through University Microfilms Inc., Ann Arbor, Mich.

ZUSAMMENFASSUNG

DER EINFLUSS EHEMALIGER FLUSSVERBINDUNGEN AUF DIE
VERBREITUNG EINIGER MUSCHELN IM NÖRDLICHEN MICHIGAN, V. S. A.

Ich habe schon früher darauf hingewiesen, dass gewisse Naiaden des Mississippi-flusses das St. Lorenz Entwässerungsbecken nach der Eiszeit in der Nähe des Foxflusses und der Green-Bucht, am westlichen Ufer des Michigansees, in Wisconsin, besiedelt haben, zu einer Zeit als der Foxfluss noch mit dem Wisconsinfluss, einem Nebenfluss des Mississippi, in Verbindung stand. Z.B. kommen die Flussmuscheln *Actinonaias carinata* und *Alasmidonta marginata* jetzt in 3 verschiedenen Nebenflüssen der "Green Bay", nicht aber in den Stauwässern des Sees selbst vor. Die gegenwärtige diskontinuierliche Verbreitung dieser Arten habe ich im Zusammenhang damit erklärt, dass der Foxfluss während einer Tiefwasserperiode des Michigansees ein ausgedehnteres, verzweigtes System bildete, dem diese Flüsse angehörten.

Die südlichen Muscheln *Alasmidonta marginata*, *Elliptio dilatatus* und *Lasmigona costata* wurden nun auch in 3 Flüssen des nördlichen Michigan gefunden: im Millecoquin, der im östlichen Teil der Oberen Halbinsel gelegen ist, und in den Carp und Ocqueoc Flüssen, die im nördlichen Teil der Unteren Halbinsel liegen, wobei zu beachten ist, dass insbesondere *A. marginata* eine ausgesprochen fluviatile Art ist und die beiden anderen Arten zumindest im See nicht angetroffen werden. Diese Funde zeigen, dass es den Mississippiarten gelungen ist, vom Nordwesten her bedeutend weiter in das St. Lorenz Abzugsbecken einzudringen als bisher angenommen wurde. Wieder sehen wir ein zersplittertes Verbreitungsbild, das am besten durch die inzwischen bekannt gewordene geologische Vorgeschichte der Gegend erklärt werden kann. Während einer post-glazialen Tiefwasserperiode in der Chippewa-Stanley Zeit, vor ungefähr 8500 Jahren, durchströmte ein ehemaliger Mackinacfluss das Bett des nördlichen Michigansees. Die erwähnten Flüsse, welche sich jetzt in die Michigan- und Huronseen ergießen, gehörten zweifelsohne dem Mackinacsystem an, bevor die höheren Wasserspiegel in den Seen ihre Verbindung unterbrachen.

Andererseits gelangte eine atlantische Art, *Elliptio complanatus*, vom Osten her durch andere ehemalige Flussverbindungen ins nördliche Michigan. Diese Art wurde ebenfalls im Ocqueocfluss gefunden, obwohl sie bekanntermassen sonst in der südlichen Halbinsel fehlt, und auch im Millecoquin der nördlichen Halbinsel.

RÉSUMÉ

L'INFLUENCE DE JONCTIONS FLUVIATILES DU PASSÉ, SUR LA DISTRIBUTION DE
CERTAINES NAIADES DANS LE NORD DU MICHIGAN, E. U. A.

Nous avons déjà montré que certaines espèces naiades fluviatiles du Mississippi ont envahi le bassin du St. Laurent dans la région du fleuve Fox et de la "Green Bay" sur la rive occidentale du lac Michigan, au Wisconsin, après la glaciation, pendant que le Fox était encore uni au fleuve Wisconsin, un affluent du Mississippi. Par exemple, on trouve à présent les espèces *Actinonaias carinata* et *Alasmidonta marginata* dans 3 rivières tributaires de la baie Green mais pas dans les eaux du lac même. La présente discontinuité dans la distribution de ces bivalves a été expliquée par l'existence d'un système Fox plus important autrefois qu'aujourd'hui et à disposition dendritique, qui englobait les 3 rivières actuelles pendant une période d'eaux basses du Lac Michigan.

Les espèces méridionales *Alasmidonta marginata*, *Elliptio dilatatus* et *Lasmigona costata* ont été trouvées dans 3 rivières du nord du Michigan: le Millecoquin, situé dans l'est de la Péninsule Supérieure, et le Carp et l'Ocqueoc, situés dans le nord de la Péninsule Inférieure. Nous avons donc là aussi une distribution discontinue. Notons que l'espèce *A. marginata* en particulier est strictement fluviatile et que les 2 autres espèces aussi font défaut dans le lac Michigan. La grande extension qui n'est ainsi produite à partir du nord-ouest trouve sa meilleure explication dans l'histoire géomorphologique de la région. Les géologues du glaciaire ont indiqué récemment divulgué. Qu'une ancienne rivière Mackinac occupait le lit du lac Michigan du nord pendant une période post-glaciaire d'eaux basses, au temps du Chippewa-Stanley, il y a environ 8500 années. Sans doute les rivières en question, maintenant tributaires des lacs Michigan et Huron, faisaient-elles partie de l'ancien système Mackinac et étaient-elles alors en communication, avant que les niveaux plus élevés des lacs les séparent.

D'autre part une espèce atlantique, *Elliptio complanatus*, venant de l'est, a pénétré jusqu'au nord du Michigan par d'autres confluences du passé. L'espèce, dont on connaît l'absence de la Péninsule Inférieure en général, n'y a été trouvée que dans l'Ocquéoc; et, dans la Péninsule Supérieure, elle a été trouvée dans le Millecoquin.

RESUMEN

DISTRIBUCION DE ALMEJAS EN RELACION CON ANTIGUAS CONFLUENCIAS DE CORRIENTES EN EL NORTE DE MICHIGAN, U. S. A.

Ha sido demostrado previamente que ciertas almejas del río Mississippi invadieron el sistema de drenaje del San Lorenzo en la región del río Fox y Bahía Green en la costa oeste del lago Michigan, Wisconsin, en tiempos post-glaciales, cuando el río Fox todavía estaba unido al Wisconsin, tributario del Mississippi. Las especies fluviales *Alasmidonta marginata* y *Actinonaias carinata*, por ejemplo, aparecen ahora en tres cursos que desembocan en Bahía Green, pero no en las aguas embalsadas del lago mismo. La presente distribución discontinua de estas almejas fué explicada por un antiguo sistema más amplio y de configuración dendrítica del río Fox, que englobaba esos ríos, durante un periodo de aguas bajas del lago Michigan.

Las especies meridionales *Alasmidonta marginata*, *Elliptio dilatatus* y *Lasmigona costata* se encontraron en 3 ríos del norte de Michigan: el Millecoquin en la parte este de la Alta Península, y en los ríos Carp y Ocqueoc en la parte norte de la Baja Península. Aquí, otra vez, tenemos un tipo de distribución discontinua. Particularmente *A. marginata* es estrictamente fluvial y las otras dos especies tampoco se encuentran en el lago Michigan. Tal extensión de sus áreas desde el noroeste puede estimarse mejor por evidencias geomorfológicas. Los glaciólogos han indicado que un antiguo río Mackinac ocupaba el lecho del norte del lago Michigan durante una fase post-glacial de aguas bajas en la época Chippewa-Stanley, hace aproximadamente 8.500 años. Los ríos en cuestión, hoy tributarios de los lagos Michigan y Huron, deben haber estado conectados con el sistema del río Mackinac, sumergido al presente, antes que el alto nivel de las aguas lacustres los separaran.

Una especie del drenaje atlántico, *Elliptio complanatus*, alcanzó el norte de Michigan desde el este, a través de otras confluencias post-glaciales. Ha sido encontrada también en el río Ocqueoc, aunque se sabe que está ausente en la Baja Península, y en el Millecoquin de la Alta Península.

АБСТРАКТ

РАСПРОСТРАНЕНИЕ ЖЕМЧУЖНИЦ В СВЯЗИ С ПРЕЖНИМ СЛИЯНИЕМ ПРИТОКОВ НА СЕВЕРЕ ОЗЕРА МИЧИГАН, С.Ш.А.

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Ранее было показано, что некоторые виды наяд реки Миссисиппи вторглись в бассейн реки Сэйнт Лорэнс в районе реки Фокс и Грин Бэй с западной стороны озера Мичиган, в штате Висконсин, в послеледниковое время, когда река Фокс была еще соединена с рекой Висконсин, притоком реки Миссисиппи. Речные виды *Alasmidonta marginata* и *Actinonaias carinata*, например, сегодня живут в трех ручьях, впадающих в Грин Бэй, но не в водах самого озера. Настоящая оторванность ареала этих моллюсков объясняется прежним расширением бассейна реки Фокс с ее разветвлениями, которые образуют три реки во время половодья в озере Мичиган.

Южные виды *Alasmidonta marginata*, *Elliptio dilatatus* и *Lasmigona costata* в трех северных реках штата Мичиган: в Миллексин, в восточной части Верхнего Полуострова и в Карп и Оквэок, в северной части Нижнего Полуострова. Тут снова мы находим перерыв в ареале распространения. В частности, *A. marginata* - строго речной моллюск и два других вида также не живут в озере Мичиган. Такое удлинение их ареала от северозапада может служить лучшим геоморфологическим показателем. Геологи-ледниковеды указывали на тот факт, что прежняя река Макинак занимала ложе северной части озера Мичиган в пост-ледниковый период межковдья в эпоху Чиппива-Станлей, приблизительно 8500 лет тому назад. Реки, о которых идет речь, в настоящее время служащие притоками озера Мичиган и озера Хурон, должны были быть соединенными с, ныне погруженным бассейном реки Макинак, прежде чем более

высокие уровни озер разъединили их.

Атлантический вид *Elliptio complanatus* достиг северного Мичигана через другие пост-ледниковые слияния с востока. Он был также найден в реке Окавск, хотя он и неизвестен в Нижнем Полуострове и в Миллэкокине Верхнего Полуострова.