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THE DISTRIBUTION OF *MARGARITANA MARGARITIFERA* (LINN.) IN NORTH AMERICA.

By Bryant Walker.

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PLATE II.

This common and well-known species has the most extensive range of any of the Unionidæ. As stated by Simpson (1900, p. 677), it inhabits "all Europe, except the southernmost portion; northern Asia; Japan; northern North America; Iceland. Its southern limit seems to be about north latitude 40°. It appears to be entirely circumboreal, except that, so far as is known, it is missing in the central part of the North American continent".

Wetherby (1881, p. 7) was apparently the first to call attention to the peculiar distribution of the species on this continent, and his suggestion that its absence in central North America was due to its extinction in that region during the Glacial Epoch, and that for some reason it had not, like its associated species, been able to regain its former range upon the retreat of the glacier, has been approved by Simpson (1893, p. 594, and 1896, p. 339), and tentatively, perhaps, by Call (1882, p. 402) and Dall (1905, p. 132).

A recent study of the known distribution of *M. margaritifera* in North America, and the possible causes for its anomalous character, has raised a question as to the sufficiency of Wetherby's supposition, and has suggested that possibly the explanation is to be sought for along an entirely different line of argument.

But before pursuing that subject, it may be well to consider the exact distribution of the species on this continent, so far as it has been made known. The accompanying map (Plate II) shows with substantial accuracy the present range of *M. margaritifera* in North America. The detailed list of the exact localities, from which it has been compiled, will be found at the conclusion of the paper.

On the Pacific coast, it may be said, in general terms, to range, west of the Rocky and Wasatch Mountains, from southern Alaska south to Santa Cruz and Merced Counties, Cal., northern Nevada and Utah, and possibly into Arizona. The most northern locality recorded is that of Dall, at Naha Bay, Alaska, lat. 50° 35′ N. The most southern authentic records are the Stanislaus River and Merced Co., Cal. The records from Idaho and Utah are both very considerably north of these Californian localities. It apparently does not occur anywhere in the Colorado basin, unless Call's very doubtful citation be verified. East of the Rocky Mountains, it has only been recorded from the head-waters of the Missouri above the falls (Cooper), and the Gallatin River (Call) in Montana.

This western race of *margaritifera* is peculiar in having the nacre usually of a dull purple colour, and has twice been described as a distinct species, first by Gould in 1850 as *Alasmodon falcata*, and

again by Trask in 1855 as *A. Yubaensis*. Dr. Dall has recently (1905) considered the western form worthy of varietal recognition under Gould's name. The deep purple nacre, however, is not invariably present, and specimens not infrequently occur with the nacre quite as light-coloured as in the typical form. Individual specimens from the eastern states are occasionally quite deeply tinted with purple and salmon colour.

On the Atlantic coast, the most northern record is from Labrador (Packard), but this is questioned by Whiteaves. It is found in Newfoundland (Johnson and Marshall); Anticosti (Johnson); New Brunswick (Matthew and Walker); Nova Scotia (Jones); in the northerly tributaries of the St. Lawrence west to the St. Charles River at Quebec (Latchford); in Maine (Lermond); Vermont (Adams, Davis, and Walker); Massachusetts (Call, Davis, and Walker); Connecticut (Davis and Walker); Rhode Island (Carpenter); Eastern New York (Lewis, De Kay, Marshall, and Walker); and in Chester Co. (Latham and Minehner), Delaware Co. (Lea), and Schuylkill Co., Pennsylvania (Connor and Ortmann).

The Delaware Co., Pa., locality is the most southern yet recorded on the Atlantic coast. It has not been listed from New Jersey or Delaware so far as I have been able to ascertain.

In New York, where it attains its extreme eastern range, it is recorded from Oneida Co. (De Kay and Marshall), and Fox Creek, Lewis Co., a tributary of Oneida Lake (Walker).

In general, therefore, it may be said that on the Pacific coast its range is limited on the east by the Rocky Mountains, and on the Atlantic coast it is confined to the region east of the Appalachian Mountains. In both instances, however, it has, in occasional instances, secured a foothold in the interior beyond the mountains, but in such cases its range is extremely limited. In the United States, there is no authentic record of its occurrence between Lewis and Oneida Counties, N.Y., and the Falls of the Missouri in Montana. In British North America, with a single exception, it has not been recorded at all from the great region extending from the Rocky Mountains east to Quebec. The single exception above mentioned from Central British America is that of Dall (1905), who records the typical (eastern) form from the valley of Saskatchewan near Lake Winnipeg.

In considering the possible causes of this peculiar distribution of the species, it is necessary to take into consideration not only its present distribution at the present time, but also the geologic changes, which in past ages have affected the configuration of the continents as they now exist, and which may have played an important part in promoting or preventing the migration of the species in different directions from the primitive place of origination. In the first place, the genus *Margaritana*, as limited by Simpson, is evidently a very ancient one. This is shown not only by the enormous range of the present species (*margaritifera*), but also by the equally remarkable discontinuity of the ranges of the six species included in the genus.

As already stated, *M. margaritifera* is circumpolar, with the single exception of the central region of British North America.

M. crassa is restricted to South Europe, where it apparently replaces *margaritifera* and extends "possibly into Asia Minor, and southwest Siberia" (Simpson, 1900). *M. Laosensis* is known only from Cambodia and Burmah. *M. Hembeli* is confined to the gulf drainage of southern Louisiana and Alabama. *M. monodonta* is found only in the central United States, where it inhabits the Ohio, Tennessee, and Cumberland river systems and ranges west to Illinois, eastern Iowa, and possibly Nebraska (Simpson, 1900). The type and only known specimen of *M. decumbens* came from Alabama, but the exact locality is unknown. It must be very rare, as the exhaustive collections made in that state during the last five years by Mr. H. H. Smith have failed to rediscover it. The recorded ranges of the several American species are indicated on the map (Plate II).

M. Hembeli is the most aberrant member of the group, and differs from all the other species by the plicate dorsal area. Too little is known of *M. decumbens* to base an opinion on. Dr. Lea compares it with one of the many forms of *Unio complanatus*, Dill., and if it came from the Atlantic faunal area of Alabama the comparision is, perhaps, suggestive. If, however, it came from the Alabama drainage system it is possible that it may prove to be an offshoot from the *monodonta* stock of the Tennessee drainage, modified specifically in the same way that so many of the species of that system have been since it was separated from its ancient connexion with the Tennessee. It is possible, however, that both these species are of an entirely different line of descent, and a more extended knowledge of their anatomy may necessitate their removal from the genus.

The remaining four species are essentially homogeneous. *Margaritifera* and *crassa* are closely related, and *Laosensis* and *monodonta* stand in about the same relation to *margaritifera*. The range of the two latter species is of interest in connexion with the range of the *margaritifera* and not without importance.

Margaritifera itself is a very ancient species, which, through an enormous extent of time, during which it has wandered nearly, if not quite, around the globe, has preserved its peculiar characters and specific identity to a remarkable degree. The essential similarity of the species as it exists at the present time on the different continents is very remarkable, and indicates that its persistent specific characters were well established before its long migration was begun. As North America has been permanently separated from Asia and Europe since the close of the Tertiary period, and the progress of the species in its long journey must have necessarily been slow, there would seem to be no doubt but that the evolution of the species must have long antedated that period, and quite possibly may go back even to Cretaceous times.

Where the species did originate is by no means clear. It must have been either in Europe, Asia, or North America. That it is an immigrant into Europe is generally conceded. Dr. Scharff, in his recent work on European Animals (1907, p. 34), expresses the opinion that it reached Europe via Greenland and Iceland. If so the inference would be that it originated in North America, and from

there spread east into Europe and west into Asia. But there are several objections to that theory.

There is no doubt but that the characteristic Unione fauna of North America is descended from the Upper Cretaceous species, which then lived "in the region now included in the states of Colorado, Utah, Wyoming, South Dakota, and Montana, and in the Canadian territories of Alberta, Assiniboia, and Saskatchewan" (see White, 1905, p. 86). If *M. margaritifera* originated in central North America during the extraordinary development which took place in the Unionidæ of that time, it must have travelled nearly around the globe, across Europe and Asia, and over the Behring bridge in order to have attained its present foothold on the Pacific coast, *because it could not have reached there in any other way.*

During the Upper Cretaceous period, this portion of North America was separated from the present Pacific region by an arm of the sea which extended from the Gulf of Mexico to the Arctic Ocean. This insurmountable barrier was at the end of the Cretaceous and in the beginning of the Tertiary replaced by another, owing to the elevation of the Rocky Mountains. And as Ortmann well states (1902, p. 354), this barrier was probably emphasized by the development of desert conditions, in and at the foot of this mountain range." This barrier was sufficient to prevent the crayfish, which reached the Pacific coast from Asia during this period, from passing into eastern North America (Ortmann, 1902, p. 356), and according to Pilsbry (1904, p. xliii) greatly restricted the range of the Asiatic Helicidæ, which came in at the same time. So too with the Unionidæ, this barrier, first of sea and later of mountain, has unquestionably been an absolute one to the extension of the fauna, either to the east or to the west.

The relations of the present Unione faunas east and west of the Rocky Mountains at the present time are very significant in this connexion. West of the mountains the fauna, meagre in species, is represented by only three genera—*Margaritana*, *Anodonta*, and *Gonidea*. The latter is endemic and is confined to that area. The single species of *Margaritana* is the one under discussion. The Anodontas are all of a common type, evidently of Asiatic derivation, and, in some of its forms, so similar to the common European species, *A. cygnea*, that an eminent conchologist in this country has questioned their specific distinction from that species (see Stearns, 1882, p. 17).

As in the Helicidæ, so in the Unionidæ, the relations of the Pacific fauna are wholly with the Old World, and are no doubt the results of early immigrations from Asia (see Pilsbry, 1904, p. xliii). The Anodontas have never succeeded in passing the mountains. And the only known instance of the *Margaritana* doing so is the occurrence in the head-waters of the Missouri in Montana. (The Saskatchewan colony may, perhaps, be another instance.) That this is, probably, a comparatively recent date, is shown by the fact that it has not as yet extended its range any further east. This colony "may have been captured with streams by orographic changes or transported as the glochidium stage attached to fishes" (Dall, 1905). The *Margaritana*, moreover, preferably inhabits rapidly running water,

and on both the east and west coasts is found high up in mountain streams, while the Anodontas, on the contrary, are essentially inhabitants of lakes and the deeper waters of slow-moving rivers, a fact which may explain the 'capture' of the Margaritanas of the Missouri, in which the Anodontas were not involved. On the other hand, not a single one of the several hundred species of the Unionid fauna of the Mississippi and eastern North America, which no doubt are descended from the Cretaceous Unionidæ of the western states has ever succeeded in passing over or around the mountains and obtaining a foothold on the Pacific coast or in Asia.

If it were true that the Margaritanas of the Pacific coast of North America and Asia were the descendants of an early migration to the north-west from central North America, it is certainly very remarkable that the species was not accompanied by any of the species which must have been associated with it in Cretaceous or early Tertiary times. But there is not the slightest evidence of anything of the kind. And in view of this fact, as well as the acknowledged relations of the Pacific coast fauna with that of north eastern Asia, it would seem to be certain that no such migration ever did occur, and that the present Margaritanas of the Pacific coast are derived from Asiatic sources.

If this be conceded, then, if *Margaritana* originated in North America, its occurrence in the Old World must be accounted for by a north-easterly migration from central North America across the Greenland bridge into Europe, and from there entirely across Europe and Asia and, via the Behring bridge, into California. The first part of the hypothesis would accord with Dr. Scharff's theory, but not the necessary extension of the route to account for the occurrence of the species in eastern Asia and western North America. This he would apparently attribute to a north-western migration from North America. But this we have shown is untenable.

There is apparently little doubt but that, following the manifold mutations of the Unionidæ in the Upper Cretaceous, as Simpson (1895, pp. 336–7) has already pointed out, there was an extensive dispersal of the Unionidæ in two directions—eastward through British America and the northern United States (in the early Tertiary, the Gulf of Mexico extended north above the present junction of the Ohio and Mississippi Rivers) and south into Mexico. It was with the northern migration, if at all, that the original Margaritanas reached the Atlantic coast and Greenland from the region of the Mississippi. It seems to be clear that the migration did extend to the Atlantic coast from the close relationship that exists between many of the existing species of the Atlantic drainage with those of the Mississippi system.

The exact relation, as to specific identity, between the pre-Glacial fauna of eastern North America and that which now exists is not known. Except as scattering fragments may have survived in favourable localities along the coast, it was entirely exterminated north of the Ohio by the ice of the Glacial Epoch. From that time the Atlantic and Mississippi faunas as a whole have been entirely

separated and have developed in different, though in many cases along analogous, lines.

There is reason to believe that the pre-Glacial northern migration consisted of comparatively few specific types, and that the peculiar genera characteristic of the Mississippi fauna, many of which have the head-waters of the Tennessee system as their centre of distribution, originated from another migration along an entirely different route. But be that as it may, it is significant that nearly every species of the comparatively small northern Atlantic fauna has its analogous species of general distribution in the present fauna of the northern states west of the Appalachian mountains, viz.—

Atlantic.	Mississippi.
Lampsilis radiata.	*Lampsilis luteola.*
L. carinata.	*L. ventricosa.*
L. nasuta.	*L. subrostrata.*
Unio complanatus.	*Unio gibbosus.*
Alasmodonta heterodon.	*Alasmodonta calceola.*
Strophitus undulatus.	*Strophitus edentulus.*

It may perhaps be claimed that *M. margaritifera* and *M. monodonta* should be included in the above list, but the latter is not a species of general distribution in the north central states as the others are, and its occurrence in the Ohio and Tennessee systems can apparently be better explained in another way. Putting that species aside temporarily, it is certainly remarkable that if *M. margaritifera* existed in central North America in pre-Glacial times, and took part in the pre-Glacial migration above indicated, it did not leave any traces of its former existence in the Mississippi Valley. As already remarked, wherever it did originate it has extended nearly all round the world, including all the enormous period required for that dispersal and under all the varied conditions of environment to which it has been subjected, it has always and everywhere maintained its specific identity, or varied within comparatively narrow limits. In view of these unquestionable facts, it would seem improbable that it could ever have been a member of the pre-Glacial Mississippi fauna, and yet nowhere in the Mississippi Valley have left any remnant to preserve a record of its former occurrence in that region. The theory of the post-Mississippian origin and subsequent extermination by the ice-cap involves the necessity of its complete emigration from the entire Mississippi region south of the glaciated area, before the beginning of the Glacial Period, a most violent assumption in view of the fact that it is not true of any other species belonging to the pre-Glacial fauna.

Taking into consideration, therefore, the apparent impossibility that there could have been any extension of the species to the west or north-west, and the improbability that a pre-Glacial migration from the Mississippi states to the north-east could have taken place without leaving some trace somewhere in the vast extent of territory covered, as apparently all the other specific types involved in that migration have done, and realizing that such a hypothesis involves migration eastward around nearly the entire globe from central

North America to California, it would certainly seem highly improbable, and any other theory which offers a reasonable explanation for the present distribution of the species would be preferable.

If, then, the American origin of the *Margaritana* is improbable there only remains the possibility that it originated in Asia. If such an origin can be assumed, it certainly gives a much more reasonable theory for the dispersal of the species than that of an American centre of distribution. It is practically certain the Pacific coast race of the species was derived from an Asiatic immigration. So that portion of the problem is satisfactorily disposed of. An Asiatic centre of distribution with a western migration into Europe would be quite in accord with the recognized theories in regard to a very large part of the present European fauna. In this connexion it is to be noted that both Simpson (1900) and Dall (1905) give a much more extensive range toward the west in northern Asia than is shown by Scharff in his map in 1907 (loc. cit., p. 35). This is probably due to the inclusion in the synonymy of *margaritifera* of several North Asian forms which have been described as distinct species. This granted a western extension from European land across the Greenland bridge into eastern North America would be quite as feasible as a corresponding migration at the same time in the other direction. There is, then, no insurmountable objection to such a theory. It must be confessed, however, that the direct evidence in favour of an Asiatic origin of *Margaritana* is not as satisfactory as it perhaps might be, if we knew more of the palæontological history of the Unionidæ in this country and of the exact distribution of the present fauna.

Simpson (1896, pp. 334-6) has called attention to the remarkable similarity in many respects existing between the Unione fauna of North America, and the present fauna of south-eastern Asia and the Tertiary fauna of both Europe and Asia, and thus states his conclusion: "Whether the Naiades originated in North America or in the Old World is not known. At any rate, I do not think that any careful student can examine a good series of species from the Oriental region without being convinced that the Unione fauna of that area is somewhat closely related to that of the Laramie beds and the Mississippi Valley, and a conclusion seems reasonable that a migration took place perhaps during or shortly after the Laramie epoch over an old, now submerged, land-way either from Asia to North America, or *vice versa*. It is, I believe, more probable that this fauna developed in the western continent than the eastern, for as we have seen, a few prophetic types of it appeared in the North American Jurassic, while the earliest recorded existence in the Old World of species, which seem intimately related to it, is in the later Cretaceous or earlier Tertiary. While some eight or ten groups of Unios and Anodontas, now living in the Oriental region, bear such a strong resemblance to similar assemblages in the United States that at first sight, they seem to be the same, I believe every one of them to be distinct, and it seems probable, when it is taken into consideration how slowly the Naiades change and the fact that the forms of the Laramie groups have scarcely altered specifically in our own

country, that if such migration and separation took place it occurred a long time ago."

In this connexion, it is to be noted, as Simpson has already pointed out, that the southern migration of the Cretaceous fauna into Mexico and Central America has resulted in the evolution of several distinct groups in that region, which are not represented in the present Mississippi fauna, and as he states, "These older Central American faunal groups bore about the same relation to those of the Mississippi Valley as do many of those of the Oriental region." This would suggest the possibility that if the Asiatic fauna was derived from the Cretaceous fauna of North America, it was a migration from the ancient fauna of Mexico and Central America rather than from that portion of the Cretaceous fauna that remained in the north, to become the progenitors of the present Mississippi fauna. In view of the fact that the way was open, from the Upper Cretaceous to the later Tertiary, for the Astacine crayfish and Helices to pass down the Pacific coast into Mexico, it would seem possible at least for the ancient Unionidæ of Mexico to find their way into Asia by the same route. This would supply the necessary link between the two faunas, and would not in the least militate against the argument already advanced as to the improbability of any migration from central North America into Asia. In this connexion the following extract from a recent letter from Mr. Harold Hannibal, of Stanford University, Cal., is of interest: "I have been working on the vertical distribution of the species myself, and can give the following, which you are welcome to use: *Unio* (*Margaritana*) *margaritifera* immigrated from Asia in the earliest Quaternary. It first appears on the west coast in the Upper Bonneville, which should be correlated with the first glacial epoch. A very closely related species occurs in the Tesla formation (Eocene) at Tesla, Cal. There are practically no distinguishing characters, except the latter is a survivor of the occurrence of this sub-genus, *Quadrula* and a number of other genera in the Cretaceous and Laramie, while the former is an immigrant. Whether this species migrated to Europe during the Eocene, survived there and migrated back in the Quaternary, is possible, but to avoid confusion I will name it something else."

The difficulties suggested by this latter theory might be avoided by the assumption that this Eocene *Margaritana* was a remnant of the earliest invasion of this continent by this species from Asia. The association of *Quadrula* with it is of great interest, and may indicate which hypothesis is correct. It is to be noted, however, that the theory that this Eocene *Margaritana* was of American origin involves the assumption that the species or its prototype originated on this continent, and had practically attained its specific characters before it passed over into Asia. There is, as yet, no evidence except this of that fact, and while its occurrence in the beds with *Quadrula* would seem to argue in favour of the Mexican–Asiatic migration above suggested, on the other hand the fact that neither it nor any congeneric form is found in the present fauna

of Mexico and Central America, would seem to be an argume against that view. But however that may be, in the absence a any direct evidence on the subject, it might be said that it quite as possible that the genus sprang from the series of mutatio involved in the evolutionary history of the later Creta Unione fauna of Europe and Asia, which from some cause beca extinct in Europe, but which, under more favourable condition environment, survived in Asia and gave rise to the present fau of that country, as that it originated in the Cretaceous mutations the North American fauna. The existence of a similar spec of the genus (*M. Laosensis*) at the present time in Siam an Burmah, would also seem to be of considerable significance bearing on the probability of an Asiatic origin of the gen In view of the remarkable tenacity of *M. margaritifera* in retaini its specific characteristics, it is evident that the separation of th Siamese race must have taken place at a remote period.

The conclusion of the whole matter, so far as the question of th origin of the genus is concerned, would, therefore, seem to be tha There is no direct evidence available at the present proving eith that it was American or Asiatic. So that, for the time being, th decision must be based upon such legitimate deductions as can b drawn from the known facts of present distribution, taken in co nexion with such recognized palæogeographic changes in continent areas as would seem to substantiate the theory proposed. If a Asiatic centre of dispersal be assumed, for purposes of argume and a subsequent western migration through northern Europe across the Greenland bridge in Miocene or early Pliocene ti (Scharff, loc. cit., p. 123), there is at once at hand a reasona explanation for the peculiar distribution of the species in eas North America. Whether this intercontinental migration w eastward or westward, it must have taken place at this per Not only it could not have occurred later, but it must have b sufficiently prior to the Glacial Period to allow the species to pro far enough south along the American coast to allow a remnant survive the ice-sheet, and to serve as a new centre of dispersal u its retirement.

Whether this original immigration, if it came from the east, succeed in reaching central British America, is not known. If it did, it w no doubt wholly exterminated by the ice in that region. That it w entirely wiped out at this time by the glaciers along the sea-coast not so clear. There is apparently reason to believe that a considera portion of the fauna survived through the Glacial Period as far north Greenland (Scharff, loc. cit., p. 123). And the fact that *M. margaritif* is at the present time found on both Newfoundland and Anti would seem to show that on both of these islands it was, by favoura environmental conditions, enabled to survive during that period. As it is quite possible that similar conditions may have enabled isola colonies to survive on the coast of the mainland. There is also rea to believe that a similar survival of the fauna in favourable locali during the Glacial Period may have occurred on the Pacific coast (

Adams, 1905, pp. 56–61). But however that may be, after the retreat of the ice, the surviving colonies of the species gradually spread out and re-peopled the post-Glacial drainage systems, and finally attained the distribution of the present time.

The western extent of the present range of the species has been no doubt determined by two main factors: first, suitable conditions of environment; and second, opportunity of access by water toward the west from the several points of post-Glacial dispersal.

The first of these has been apparently the preponderating one in the case of the species under discussion, although it must be confessed that we do not know just what these are. The fact is, however, that during the one citation from the Saskatchewan (to be considered later) there is no evidence that since Glacial times it has succeeded in extending its range further west through Canada than the neighbourhood of Quebec.

That its range further westward has not been for lack of opportunity is shown by the fact that characteristic species of the Atlantic fauna, such as *Unio complanatus*, Dill., and *Anodonta marginata*, Say, which no doubt shared with *Margaritana* the vicissitudes of the Glacial period, and in Post-Glacial times presumably started from practically the same centres of dispersal, have succeeded in obtaining a wide range to the west and north. Thus *A. marginata* is an abundant species throughout the whole of the St. Lawrence drainage area from Anticosti Island to Lake Superior, and north to Keewatin and Hudson Bay. *U. complanatus*, though found in but few of the southern tributaries of the Great Lakes between Ontario and Superior, is the most abundant Unionid in the Lake Superior basin, from which it ranges north to the Saskatchewan.

In this connexion the distribution of the well-known *A. cataracta*, (syn. *fluviatilis*, Dill.), is of interest and significance. This species is closely related to the European *A. cygnea*, and is the east coast analogue of the west coast species of the same group. There is reason to believe that it was a co-immigrant with *M. margaritifera* to the east coast of North America. It is probable, too, that the common European snail, *Helix hortensis*, Müll., was also a participant in the same migration (see Johnson, 1906, p. 80). It has, however, since its arrival in this continent become much more modified from the ancestral type than the west coast race and has better claims to varietal recognition. The range of both races on the two coasts is remarkably similar. Both have extended further south than *Margaritana*, but both have substantially the same inland range as that species. Thus *cataracta* is found in the streams of the Atlantic drainage from North Carolina, north to the St. Lawrence. In the St. Lawrence drainage it does not apparently occur west of Ottawa, Ont. and Buffalo, N.Y. It has been cited from some of the southern tributaries of Lake Huron and Lake Superior, but Simpson questions these, and it is quite probable that the citations are based on specimens of *A. marginata*, which does occur in those districts. But even if they be correct, it is clear that the western range of the species is very much more restricted than either *A. marginata* or *U. complanatus*.

Now, it would seem to be evident that, if the latter two species have been able since the close of the Glacial Period to obtain such a wide range to the north-west, *M. margaritifera* and *A. cataracta*, which have apparently always been associated with them since pre-Glacial times, could have accompanied them in this western migration had the environmental conditions of the more western waters been favourable to their existence.

There is apparently no satisfactory explanation to be offered as to why the western region does not offer a suitable environment, but such would seem to be the fact. Under the assumption, therefore, that the east coast *Margaritana* is an immigrant from Europe, it is clear that, if in pre-Glacial times it succeeded in reaching central British America, it was wholly exterminated in that region by the ice, and that since the close of the Glacial Period it has not succeeded in getting into that region, although other associated species have been amply able to do so.

But did it succeed in getting into central British America in pre-Glacial times? There is no direct evidence, so far as I know, showing just what the Unione fauna in that region was at that time. But as we know that the Atlantic drainage was prior to the Glacial Period peopled by an immigration from the then fauna of the Mississippi Valley through that region, it is to be presumed that the fauna was composed of substantially the same species (or their prototypes) that now are found in the Atlantic drainage. The climatic conditions of the region at that time were presumptively favourable to the existence of such a fauna. They certainly were at the time when the eastern migration took place, and there is no reason to predicate any substantial change in these conditions until the commencement of the Glacial Period. That being so, it is a fair inference that the climate of the region at that time was not greatly different from what it is at the present time. It is also evident that if at that time the western Unionidæ were able to make their way to the Atlantic coast there was no reason, so far as opportunity of access is concerned, why *Margaritana*, which at that period had arrived on the coast, should not have been able to pass westward along the same system of waterways, unless prevented by the same unfavourable conditions of local environment which have apparently since post-Glacial times restricted its range to the westward. It is certainly a fair presumption that the species at that time was subject to the same limitations that it evidently is at present. There is indeed no evidence that it ever did reach that region. And between the two presumptions that doubtless is the more reasonable which is in accord with the known facts affecting the inland range of the species, at the present time.

It might be argued that if *Margaritana* was a member of the pre-Glacial fauna of central British America, it is strange that it did not participate in the retreat southward of the fauna upon the advent of the Glacial conditions, and from the surviving remnant of that migration, after the retreat of the ice, spread out again to the north and reoccupy the region from which it had been driven.

While there was, no doubt, such a recession of the terrestrial molluscan fauna southward at that time, and that the "survivors crowded with the boreal forms in a band along the states bordering the glaciated area" (Pilsbry, 1906, p. 531), there is no evidence that there was any such survival of the pre-Glacial Unione fauna of that region. Indeed, the probability is all the other way, as it was wholly impossible for the fluviatile fauna to escape by migrating to the south unless the existing systems of drainage afforded the necessary water communications for them to reach the unglaciated area in the south. There is no evidence that any such waterways were then in existence, and a consideration of the present fauna shows that it is wholly unlikely. The eastern migration of the primitive Mississippi fauna was undoubtedly a very ancient one, and it is probable that the differentiation of the species taking part in it into the distinct races now existing on either side of the Appalachian Mountains took place before the advent of the Glacial Period. This is apparently shown by the fact that the fossil relics of the Interglacial Unione invasion of Illinois are specifically identical with the species now living in the Ohio Valley (see Simpson, 1893, p. 592). This would certainly seem to show that there has been no radical change in the character of the fauna since Glacial times.

The entire area now comprised within the St. Lawrence drainage system was within the glaciated area. In order, therefore, for any of the pre-Glacial Unione inhabitants of that region to have escaped extermination by the ice, they must have succeeded in escaping from that region and in obtaining a refuge in the Ohio and Mississippi Valleys. If *Margaritana* and its pre-Glacial associated species, such as *U. complanatus*, *A. marginata*, and *A. cataracta*, ever succeeded in effecting such an escape, it is certainly very remarkable that not a single one of them has left any survivors in the Ohio and Mississippi Valleys to bear witness of their ancient place of refuge. And not only that, if there were any survivors left south of the ice-cap, why did they not accompany the then existing species of those rivers in their invasion of the glaciated area upon the retreat of the ice? The present fauna of the upper Great Lakes and central British America is solely the result of two distinct immigrations, one from the south of the dominant species of the Ohio and Mississippi faunas, and the other from the east of the more vigorous species of the Atlantic fauna (see Walker, 1898). It would seem to be certain, therefore, that the pre-Glacial Unione fauna of the glaciated area was wholly exterminated.

The occurrence of *Margaritana monodonta*, Say, west of the Appalachian Mountains, occupying a territory in which *M. margaritifera* is wholly unknown, is of great interest. It is quite similar apparently in general appearance to the Siamese *M. Laosensis*, and the relation of such species of *margaritifera* would appear to be very much the same. It is probable that both are ancient offshoots from the more ancient *margaritifera* stock.

The distribution of *M. monodonta* is comparatively a limited one. In Ohio its most eastern record is at Cincinnati (Sterki, 1907,

p. 393). It does not appear to range as far east as western Pennsylvania (Ortmann, 1909). In Indiana it is cited by Call (1900, p. 526) and Daniels (1903, p. 650) from the Ohio and Wabash, and from there ranges west through Illinois (Baker, 1906, p. 76) into the Mississippi drainage of eastern Iowa (Keyes, 1889, p. 19). It has been listed from the Elkhorn and Blue Rivers in Nebraska by Aughey (1877, p. 703), but these records, like many others of that author, require verification. In the Mississippi it is recorded by Baker from Adams County, Illinois, which is the extreme southwesterly record. Its range northward in that river is apparently a limited one, as it is not recorded from Wisconsin by Chadwick (1906), nor from Minnesota by Grant (1885 and 1887). It is found also in the Tennessee drainage system at Knoxville, Tenn., in the Holston and Little Rivers, and in the Tennessee River at Florence, Alabama (Walker). It has not yet, however, been recorded from the head-waters of the Tennessee system. Its distribution is apparently very local and discontinuous, as shown by the chart (Plate II). In the absence of any record of its occurrence in the south and west beyond the points mentioned, the inference would be that its original point of dispersal was in the east, and that it had migrated westward by two routes, one down the Ohio and thence into the Mississippi Valley, and the other down the Tennessee from its tributaries or head-waters. That it reached its present range by a migration from the south-west is, in view of the known facts of its present distribution, quite improbable.

On the other hand, that it was originally an immigrant from the head-waters of the Atlantic drainage into those of the Ohio and Tennessee is most probable. While it has not as yet been recorded from the head-waters of those river systems, that is no reason why it may not yet be discovered in both, for as already remarked, the species is remarkably local in its distribution, and, even if no longer resident, it may *not* have formerly lived there. The head-waters of the eastern and western drainage systems of the Appalachian slopes are not so widely separated that there has not been in past ages stream transference from one system to the other, with the consequent introduction of the fauna from one system into the other. This is shown by the occurrence of *Anculosa*, a characteristic western genus, in the Atlantic drainage (see Pilsbry, 1891, p. 26). The presence of *Quadrula* and *Pleurobema*, two of the most prevalent genera of the Tennessee system, in the Atlantic drainage of Virginia and North Carolina points unmistakably to the same fact. And if these distinctly western forms, by means of ancient orographic changes, were enabled to cross the divide and obtain a foothold in the Atlantic rivers, there is no reason why in the same way the molluscan fauna of the early eastern streams should not at some time have succeeded in obtaining access to the head-waters of the western drainage system. That the migration was a very ancient one is shown by the specific differentiation that has taken place in the species thus transferred from one area into the other. It may be fairly concluded, therefore, that the presence of *Margaritana* in the

Ohio and Tennessee systems is rather the result of an ancient migration from the north-east than one from the south-west.

The occurrence of *M. margaritifera* in the lower Saskatchewan near Lake Winnipeg, quoted by Dall (1905), is certainly remarkable, and from our present knowledge difficult of explanation. According to Dall, the specimens are of the eastern white-nacred (typical) race. It seems quite impossible that this colony could be a survivor from any pre-Glacial fauna. That its present range in that region is a very limited one is apparently shown by the fact that the very considerable collecting in that region done by the Canadian naturalists in recent years, and reported upon from time to time by Whiteaves, has so far failed to discover it. Nor is there any record of its occurrence in the Hudson Bay system to the south or east. If the colony was of the purple-nacred western race, its occurrence in the Saskatchewan might be accounted for in the same way, that it is probable it obtained a foothold in the head-waters of the Missouri. But there is as yet no record of its presence in any of the headwaters of the Saskatchewan or its tributaries. In view of the fact, however, that the western race not infrequently has the nacre quite as light-coloured as that of the eastern or typical form, there would seem to be no intrinsic improbability in the western derivation of the Saskatchewan colony. It is possible, of course, that its occurrence in this particular locality is one of those cases of sporadic colonization (possibly by bird transportation) that occasionally occur to puzzle the zoo-geographer. The discovery of the *Planorbis bicarinatus*, Say, at Antioch, California, many years ago is a case in point (see Walker, 1909, p. 23). But, of course, that is, at the best, a mere possibility. It is very desirable that its occurrence in the Saskatchewan should be verified, and if discovered, that the extent of its range should be accurately determined with the purpose of finding the true explanation for its occurrence there, and until that is done there is very little that can be said that would be of any value.

In conclusion, it is submitted that from all the data accessible at present time the following inferences as to the distribution of *margaritifera* may fairly be deduced:—

1. That it is not probable that the species originated in North America.
2. That it is probable that it did originate in Asia.
3. That its presence on the western coast of North America is due to migration in Miocene or early Pliocene times from Asia over the Behring bridge, or perhaps even earlier.
4. That its occurrence on the east coast of North America is best explained by a similar immigration from Europe over the Greenland bridge.
5. That there is no evidence to show that it was an inhabitant of Arctic British America in pre-Glacial times.
6. That there is reason to believe that the causes which, since the Glacial Epoch, have prevented it from invading that region were sufficiently efficacious in restricting its western range before that time, so that it consequently was not exterminated in that region by the great ice-cap, for the reason that it was not there to be exterminated.

II. LOCAL DISTRIBUTION IN NORTH AMERICA.

East Coast.

Labrador (Packard).—This citation is questioned by White (1901) on the ground that it was based on hearsay only.

Newfoundland.—Newfoundland (Marshall); St. Barbes; Ha Brook, near Sandy Pond (Coll. Bost. Soc. Nat. Hist., fide C. W. Johnson in lit.).

Anticosti Island.—Fox River (Coll. B.S.N.H., *teste* C. W. Johnson).

Quebec.—Green and Rimouski Rivers; Lake St. John; the Metapedia Lakes; River St. Charles near Quebec City and Assumption River near Rawdon; Lac de la Ferme, Rivière de Loup (*en haut*), and Romaine River (Whiteaves). "*M. margaritifera* occurs in many probably in all the streams flowing southward to the St. Lawrence from far out in the Gulf, westward to the St. Charles at the City of Quebec. It may be found in the north shore streams west of Quebec but I have no knowledge that it so occurs.

"The streams along the south shore of the St. Lawrence seem to be barren of this shell, but that is only, I think, because they have not been well searched. I feel sure I can find it in the proper streams near Caconna or Rivière de Loup (*en bas*) and along the north shore of New Brunswick, and in the streams running into the Bay of Chaleurs" (F. R. Latchford in lit.).

New Brunswick.—Tributary of Loch Lomond (Walker). "A frequent species in swiftly running streams in this province" (G. F. Matthew in lit.).

Nova Scotia.—"Fresh-water lakes and streams" (Jones).

Maine.—Portland (Chickering); Aroostook River (Nylander, Dawe, Walker); Red Brook, Scarboro; Payson's Brook, North Warren; Oyster River, East Warren; Hebron (Davis); Madawaska River (Walker); "all over the state in rocky and muddy brooks" (Lermond).

Vermont.—Burlington; Middlebury (Adams); Winooski River (Davis, Walker); Wallingford, Ct. or Vt. (Davis); Connecticut River, Hartland (Marshall).

Massachusetts.—Lunenburg (Davis, Walker); Lansfield; Springfield; Ware (Davis); Haydenville (Davis, Marshall); "found in most running streams in the interior. I have never found it near the seaboard" (Gould).

Rhode Island.—Roaring Brook, Exeter (Carpenter, Davis).

Connecticut.—Trumbull River (Linsley); Pequabuck River, Bristol (Davis); Bissel's Brook, Granby; Waterford (Davis, Walker); West Granby (Walker).

New York.—"Rockland County; Champlain; Oneida and many other localities" (De Kay); Oneida Lake (Beauchamp); Lake Champlain; tributaries of Mohawk, Oneida County (Marshall); Fish Creek, Lewis Co. (Walker); Hudson River (Jay).

Pennsylvania.—White Clay Creek, Chester Co. (Hartman and Michener); Crum Creek, Delware Co.; Middle Pennsylvania (Lea); Still Creek, Quakake, Schuylkill Co. (Connor, Ortmann).

Doubtful and erroneous citations:—

New York.—Lake Erie, "Jay" (Letson). This citation is an error on the part of the author of the "Check List". The reference given is to Jay's Catalogue of 1852, p. 69. There is no reference to this species on p. 69 and no citation of it from Lake Erie elsewhere. *Alasmodonta marginata*, Say, from Lake Erie, is, however, listed on p. 69, so that the error is, no doubt, one of transcription.

Illinois.—Joliet (Marshall). This citation is given on the authority of Mr. A. A. Hinkley, of Du Bois, Ill. Mr. Hinkley in a recent letter informs me that the citation was an error, that the species was really *nanodonta*, Say.

Illinois River (Baker). Mr. Baker informs me that this citation is based on an undoubted specimen of *M. margaritifera*, so labelled, in the Calkin collection now in the Museum of the Chicago Academy of Sciences; that it has never been found in that region by any other collector; that "a number of Calkin's shells are inaccurate as to locality, and it is probably another case of the mixing of shells". I have no doubt but that this is correct, as I have in my own collection a specimen of this species from the collection of the late J. M. Delaney, New York, which is labelled "Ohio River, Grindall, Ohio". This place is in Ashtabula County, a few miles south of Lake Erie and in the St. Lawrence drainage, and many miles from the Ohio River. The specimen is a large one, and very similar to the large form from the Winooski River, Vt. The locality is given on the label as an impossible one, and there can be no question but that again is a "case of mixing shells".

WEST COAST.

Alaska.—Naha Bay, lat. 55° 35′ North (Dall).

British Columbia.—Small streams entering Malaspina Strait; Kakwous Lake, the source of the Bonaparte River, alt. 4000 feet; Campbell's Creek, Douglas (Whiteaves); Victoria; Nawaimo; Vancouver Island; Fraser River, Kakwous Lake, and streams in lat. 59 degrees (Dall); Fort Hope, Fraser River (Stearns); Frazer River (Hannibal in lit.).

Washington.—Chehalis River (Cooper, Stearns, Keep); Seattle (Rudolph *teste* Hannibal in lit.); Walla Walla (Gould, Stearns); streams running into Puget Sound and most of the branches of the Columbia (Cooper, Stearns); Steillacoom Creek, Puget Sound (Walker).

Oregon.—Klamath River (Lea, Keep, Cooper, Stearns); Shasta River (Stearns); Deer Creek, Yeamill Co.; Rogue River; Deschutes River; Klamath Co.; Douglas Co. (Walker).

Idaho.—Spokane River, Cœur d'Alena (Cooper, Bland, Stearns, Hannibal, Walker); Snake River, Weiser (Hannibal, Walker).

Montana.—Missouri River about the Falls (Bland & Cooper); Judith River and head-waters of the Missouri (Call); Crow Creek, Indian Reservation; tributary of the Pend'Oriello River; "in all the western mountain streams" (Elrod); Bitterroot River (Elrod, Walker).

California.—Yuba River, 40 miles above its confluence with the Feather (Trask, Stearns, Lea, Dall); Sacramento River, Redding (Keep, Pilsbry); Outlet Lake Tahoe, Placer Co., alt. 6247 feet (Cooper); Bear Mountain near Copperopolis; South Pitt River, Likely; Pitt River, Lower Cañon, above Squaw Creek; Sacramento River, Red Bluff; San Lorenzo River at Boulder and Felton, Santa Cruz Co.; Lake Co. (Hannibal); Sacramento River (Gould, Stearns, Dall); McCloud River (Stearns); Stanislaus River (Cooper, Stearns, *teste* Hannibal); Santa Cruz (Cooper, Stearns, Dall, Button *teste* Hannibal); Merced Co. (Cooper); Plumas Co., alt. 7400 feet (Dall). Devil's Coral, Plumas Co., alt. 5200 feet (Stearns).

Nevada.—East Humboldt River (Stearns); Humboldt River at Elko (Call); Truckee River (Carlton, Stearns, Call).

Utah.—Salt River, Fort Hall (Cooper, Stearns); Salt Lake City (Call).

Arizona.—"Arizona" (Call, Cooper); Call (1884) gives no exact locality. Cooper's citation (1888) is based on Call's. Mr. Harold Hannibal, of Stanford University, Cal., who has made a special study of the West Coast Unionidæ, informs me that he seriously doubts whether it occurs south of central Nevada.

Saskatchewan, Canada.—Lower Saskatchewan River, near Lake Winnipeg (Dall).

Fossil Records.—It is reported by Call from the Quaternary deposits in the Lahontan Area at Walker River Canyon, Nev., and in the Bonneville area; as semi-fossil at "numerous localities and notably in Sevier Desert". Also from the Tejon formation (Eocene) at Tesla, Cal., by Hannibal.

III. BIBLIOGRAPHY.

1841. Adams (C. B.). "Catalogue of the Mollusca of Middlebury, Vt.": Amer. Journ. Sci., o.s., xl, pp. 266–77.

1842. —— *Thompson's History of Vermont.*

1905. Adams (C. C.). "The Post-Glacial Dispersal of the North American Biota": Biol. Bull., ix, pp. 53–71.

1877. Aughey (Samuel). "Catalogue of the Land and Freshwater Shells of Nebraska": Bull. U.S. Geol. and Geog. Survey of the Territories, iii, pp. 697–704.

1906. Baker (F. C.). "A Catalogue of the Mollusca of Illinois": Bull. Ill. St. Lab. Nat. Hist., xii, pp. 53–137.

1886. Beauchamp (W. M.). *Land and Freshwater Shells of Onondaga Co. (N.Y.)*, pp. 1–12.

1861. Bland (Thomas) & Cooper (J. G.). "Notice of Land and Freshwater Shells collected by Dr. J. G. Cooper in the Rocky Mountains, etc., in 1860": Amer. Lyc. Nat. Hist. N.Y., vii, separate, pp. 1–9.

1882. Call (R. E.). "Note on the Geographical Distribution of certain Mollusca": Amer. Nat., xvi, pp. 401–2.

1884. —— "On the Quaternary and Recent Mollusca of the Great Basin": Bull. U.S. Geol. Surv., xi.

Call (R. E.). "A Geographic Catalogue of the Unionidæ of the Mississippi Valley": Bull. Des Moines Acad. Sci., i, pp. 1–57.

—— "A Descriptive, Illustrated Catalogue of the Mollusca of Indiana": Ann. Rep. Dept. Geol. and Stat. Resources, Ind., 1899, pp. 335–536.

Carlton (H. P.). "On the Shells of the Truckee River and Vicinity": Proc. Cal. Acad. Nat. Sci., iv, pp. 50–2.

Carpenter (H. F.). "The Shell-bearing Mollusca of Rhode Island": Naut., iv, pp. 35–6.

Chadwick (G. H.). "Notes on Wisconsin Mollusca": Bull. Wis. Nat. Hist. Soc., iv, pp. 67–99.

Chickering (J. W.). *List of Marine, Freshwater, and Land Shells found in the vicinity of Portland, Me.*

Connor (C. H.). "*M. margaritifera* in Pennsylvania": Naut., xiv, p. 91.

Cooper (J. G.). Proc. Cal. Acad. Nat. Sci.

—— *Geographical Catalogue of the Mollusca found West of the Rocky Mountains, etc.*

—— Proc. Cal. Acad. Nat. Sci., iv.

—— Tami. Cal. Miner, 1888, p. 249.

Cooper (William). "Report upon the Mollusca collected on the Survey": P.R.R. Surv., xii, pt. ii, pp. 360–86.

Dall (W. H.). "Land and Freshwater Mollusks": Rep. Harriman, Exp., xiii.

Daniels (L. E.). "A Check-list of Indiana Mollusca": Ann. Rep. Dept. Geol. and Nat. Resources, Ind., 1902, pp. 629–52.

Davis (C. A.). "Unios of New England": Bull. xii, Roger Williams Park Museum, Providence, R.I.

De Kay (J. E.). *Zoology of New York*, pt. v, Mollusca.

Elrod (M. J.). "Collecting Shells in Montana": Naut., xv, p. 82.

—— "A Biological Reconnaissance of the vicinity of Flathead Lake": Bull. Univ. Mont., x, pp. 170–4.

Gould (A. A.). Rep. on Invertebrata of Massachusetts.

—— "Descriptions of New Species of Shells": Proc. B.S.N.H., iii, pp. 292–6.

Grant (U. S.). "Conchological Notes": Ann. Rep. Geol. and Nat. Hist. Surv., Minn., 1885, pp. 113–24.

—— "Notes on the Molluscan Fauna of Minnesota": Ann. Rep Geol. and Nat. Hist. Surv., Minn., 1887, pp. 481–4.

Hartman (W. D.) & Michener (Ezra). *Conchologia Centrica.*

Jay (J. C.). *Catalogue of Recent Shells, etc.*, 4th ed.

Johnson (C. W.). "On the Distribution of *Helix hortensis*, Müller, in North America": Naut., xx, pp. 73–80.

Jones (J. M.). *List of Mollusca of Nova Scotia.*

Keep (Josiah). *West American Shells.*

Keyes (C. R.). "An Annotated Catalogue of the Mollusca of Iowa": Bull. Essex Inst., xx, separate, pp. 1–25.

1838. Lea (Isaac). "Observations on the Genus *Unio*," ii, p. 56.
1860. —— "Observations on the Genus *Unio*," vii, p. 42.
1868. —— "Observations on the Genus *Unio*," xi, p. 111.
1908. Lermond (W. H.). *Shells of Maine*, pp. 1–46.
1905. Letson (E. J.). "Check List of the Mollusca of New York" Bull. 88, N.Y. St. Museum.
1845. Linsley (J. H.). "Catalogue of the Shells of Connecticut" Amer. Journ. Sci., xlviii, pp. 271–85.
1895. Marshall (W. B.). "Geographical Distribution of New York Unionidæ": 48th Ann. Rep. N.Y. St. Museum pp. 45–99.
1900. Nylander (O. O.). "A List of Shells from North-Eastern Maine": Naut., xiii, pp. 102–6.
1902. Ortmann (A. E.). "The Geographical Distribution of Freshwater Decapods and its bearing on Ancient Geography" Proc. Amer. Phil. Soc., xli, pp. 267–417.
1909. —— "A Preliminary List of Unionidæ of Western Pennsylvania, etc.": Ann. Carnegie Museum, v, pp. 178–210.
1864. Packard (A. S.). "View of the Recent Invertebrate Fauna of Labrador": Mem. B.S.N.H., i.
1894. Pilsbry (H. A.). "Critical List of Mollusks collected in the Potomac Valley": Proc. A.N.S.P., 1894, pp. 11–31.
1894. —— *Manual of Conchology*, ix.
1899. —— "Mollusks collected by R. C. McGregor in Northern California": Naut., xiii, pp. 64–7.
1906. —— & Ferriss (J. H.). "Mollusca of the Ozarkian Fauna" Proc. A.N.S.P., 1906, pp. 529–67.
1907. Scharff (R. F.). *European Animals*.
1893. Simpson (C. T.). "On some Fossil Unios and other Freshwater Shells from the Drift at Toronto, Canada, etc.": Proc. U.S. Nat. Mus., xvi, pp. 591–5.
1896. —— "The Classification and Geographical Distribution of the Pearly Freshwater Mussels": Proc. U.S. Nat. Mus. xviii, pp. 295–343.
1900. —— "Synopsis of the Naiades": Proc. U.S. Nat. Mus. xxii, pp. 501–1044.
1882. Stearns (R. E. C.). "On the History and Distribution of the Freshwater Mussels, etc.": Proc. Cal. Acad. Nat. Sci., 1882, pp. 1–21.
1892. —— "List of North American Land and Freshwater Shells received from the Dept. of Agriculture, etc.": Proc. U.S. Nat. Mus., xiv, pp. 95–106.
1907. Sterki (V.). "A Preliminary Catalogue of the Land and Freshwater Mollusks of Ohio": Proc. O. St. Acad. Sci., iv, pp. 367–402.
1855. Trask (J. B.). "Californian Freshwater Shells": Proc. Cal. Acad. Nat. Sci., i, pp. 28–30.
1898. Walker (Bryant). *Distribution of the Unionidæ in Michigan*, pp. 1–23.
1909. —— "Notes on Planorbis II": Naut., xxiii, pp. 21–32.


ASIA
GREENLAND
BAFFIN BAY
HUDSON BAY
HUDSON STRAIT
LABRADOR
NEWFOUNDLAND
MANITOBA
ONTARIO
QUEBEC
MINN.
N.DAK.
MONT.
WASH.
OREG.
CALIF.
NEV.
IDAHO
WYO.
S.DAK.
NEBR.
COLO.
UTAH
KANS.
ARIZ.
N.MEX.
OKLA.
TEXAS
TROPIC OF CANCER
GULF OF MEXICO
CARIBBEAN SEA
P A C I F I C O C E A N
A T L A N T I C O C E A N

1881. WETHERBY (A. G.). "On the Geographical Distribution of certain Freshwater Mollusks of North America," pt. ii: *Journ. Cin. Soc. Nat. Hist.*, 1881, separate, pp. 1–11.

1882. —— "The Distribution of *M. margaritifera*": Amer. Nat., xvi, pp. 375–6.

1895. WHITE (C. A.). "The Ancestral Origin of the North American Unionidæ": Smithsonian Misc. Coll., xlviii, pp. 75–88.

1895. WHITEAVES (J. F.). "Notes on Recent Canadian Unionidæ": Canadian Record of Science, 1895, pp. 250–63.

1901. —— "Notes on some Land and Freshwater Mollusca from Fort Chimo, Ungava Bay, Ungava": Ott. Nat., xiv, pp. 221–3.

1906. —— "Notes on some Land and Freshwater Shells from British Columbia": Ott. Nat., xx, pp. 115–19.

EXPLANATION OF PLATE II.

The circular dots indicate the present range of *M. margaritifera* in North America.
The triangular dots that of *M. monodonta*.
The square dots that of *M. Hembeli*.
The X that of *M. decumbens*.