DEPARTMENT OF THE INTERIOR

BULLETIN

OF THE

UNITED STATES

GEOLOGICAL SURVEY

No. 34

WASHINGTON
GOVERNMENT PRINTING OFFICE
1886

UNITED STATES GEOLOGICAL SURVEY

J. W. POWELL, DIRECTOR

ON THE RELATION

OF THE

LARAMIE MOLLUSCAN FAUNA

TO THAT OF THE

SUCCEEDING FRESH-WATER EOCENE

AND OTHER GROUPS

BY

CHARLES A. WHITE, M. D.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1886

CONTENTS.

ILLUSTRATIONS.

RELATION OF THE LARAMIE MOLLUSCAN AND FRESH-WATER EOCENE FAUNAS.

BY CHARLES A. WHITE, M. D.

GENERAL REMARKS.

Certain equivalent strata which are found exposed at various and widely separated localities in Utah and Southern Wyoming containing fresh-water types only among their fossil molluscan forms, have for several years past been known to contain a few species which are elsewhere characteristic of the Laramie Group. At a few of the localities referred to the strata have been regarded as belonging to the Laramie Group, but generally they have been assigned to the base of the fresh-water Eocene series. No difference of opinion seems to have existed among the geologists who have observed them as to their position in the stratigraphical series. They seem to have differed only in regard to the position of a plane of demarkation which should separate them from the unmistakable Laramie strata beneath. The strata which are found exposed at the following-named localities are especially referred to in the following remarks: The vicinity of the town of Wales, the valley of Twelve Mile Creek east of Mayfield, the west base of Musinia Mountain—all in the large county of San Pete, Utah; Soldier's Fork, Utah County, Utah; Desolation Cañon of Green River, Eastern Utah; and near Evanston, Southwestern Wyoming. Besides these, certain localities near Panguitch and Upper Kanab, respectively, in Southern Utah, ought also to be mentioned.

Not having had until the past season a satisfactory opportunity to study the strata at any of the localities just mentioned, I have heretofore regarded them as belonging to the upper part of the Laramie Group, because of the presence in them of the Laramie species referred to. Investigations in Utah during the past season, together with a further study of the collections which were previously made in that region by different parties of the Government surveys, have satisfied me that the strata of the localities which have just been named, although they contain those Laramie species, are all equivalent portions of the Wasatch Group, the lowest group of the purely fresh-water Eocene series.

In the prosecution of my field studies during the past season more especial attention was given to the strata which were found exposed in San Pete Valley and the adjacent portion of the Wasatch Mountains. My principal collections of Wasatch fossils were also made from these strata, mainly near the town of Wales, in the hills which form the western side of San Pete Valley. In that vicinity these hills are composed from base to summit of strata of the Wasatch Group, which there reach an estimated thickness of about 2,500 feet. These strata consist of sandstones, shales, marlites, and a few layers of impure limestone, resting upon a very coarse conglomerate which forms the base of the hills, all evidently forming one uninterrupted series from bottom to top.[1]

The base of the Wasatch Group was not recognized at this locality, but it is probably not much beneath the surface of the valley here. Some two or three hundred feet above the conglomerate there is a bed of coal, which has been worked at several points, the openings being known as the Wales Coal Mines. The fossils which were collected from these strata were found at different horizons, ranging from about 100 feet beneath the coal to the top of the hills, the vertical range of the fossil-bearing strata being more than 1,500 feet. I have recognized 26 species of invertebrate fossils which were obtained here, all plainly belonging to one and the same fauna, and in a layer immediately above the coal some undetermined vertebrate remains were found.

Some of these invertebrate forms are common in the Wasatch Group elsewhere; three or four of them are known to occur also in the Green River Group; some of them are characteristic Laramie species, and some of them are new. A part of them have also been found at the Almy Coal Mines, near Evanston, Wyo., and a part were found by Major Powell in Desolation Cañon; others at localities in Southern Utah and at the west base of Musinia Mountain; a part were found by Mr. E. E. Howell at Twelve Mile Creek, and one of them is apparently identical with a form which Professor Cope obtained from his Puerco Group in New Mexico.

The equivalents of the strata which are exposed near the town of Wales are also largely exposed in the Wasatch Mountains upon the east side of San Pete Valley, and, as is mentioned further on, those strata are there found to rest conformably upon the Laramie. It is worthy of note in this connection that the Laramie strata upon which these fresh-water Eocene strata rest are referable to the Laramie proper, and not

[1] This conglomerate is probably a part of the great Wasatch conglomerate which is so largely exposed in the valley of Weber River, in Echo Cañon, and elsewhere in Southern Utah.

to the strata known as the Bear River Laramie, upon which the Wasatch apparently lies unconformably in the vicinity of Evanston.[1]

The following is a list of the species which were collected at the Wales locality. They are tabulated so as to show in part the localities and the different horizons at which they have been recognized. Those species which are indicated in the table as ranging from the Laramie into the Wasatch Group have been found mainly in the lower portion of the latter group, but some of them range more than 500 feet above the coal at the Wales locality, which is more than 1,000 feet above the base of the group. Furthermore, a small number of the species found in the Wasatch strata at the Wales locality are known to range into the Green River Group, and one at least into the Bridger Group. To this list is added the Helix and the Pupa which were obtained by Professor Cope from his Puerco Group in New Mexico. Some of the names in this list are now regarded as synonyms, as will appear from remarks in connection with the description of species on following pages.

Table showing range of species.

List of fossils.	Wasatch.							Puerco Group.	Typical Laramie.	Green River Group.	Bridger Group.
	Wales, Utah.	Twelve-Mile Creek.	Musinia Mountain.	Soldier's Fork.	Southern Utah.	Evanston.	Desolation Cañon.				
Unio mendax White	×			×			×				
Unio rectoides, n. s	×							×?			
Sphærium formosum Meek & Hayden.	×					×?			×		
Limnæa ——?	×										
Limnæa (Leptolimnæa) minuscula White.	×									×	
Acella micronema, n. s	×									×?	
Planorbis convolutus Meek & Hayden.	×								×		

[1] There is now some reason to doubt whether the strata which have hitherto been known as the Bear River Laramie should be regarded as a portion of the Laramie Group. That their position is between the uppermost of the marine Cretaceous groups and the basal portion of the Wasatch, as is that of the Laramie proper, is apparently beyond question, but so far as is now known not a single fossil species is common to both the Bear River strata and the Laramie proper. It seems therefore necessary to infer that the fauna of the former strata lived in a separate body of water; but whether it preceded, followed, or was contemporary with the Laramie cannot be asserted now with confidence. The question is rendered still more obscure by the fact that the Bear River fauna contains types which are not known in any other North American strata, nor among living faunas of this continent. In these discussions reference is made to the fauna of the Laramie proper, and not to that of the Bear River Laramie

Table showing range of species—Continued.

List of fossils.	Wasatch.										
	Wales, Utah.	Twelve-Mile Creek.	Masinia Mountain.	Soldier's Fork.	Southern Utah.	Evanston.	Desolation Cañon.	Puerco Group.	Typical Laramie.	Green-River Group.	Bridger Group.
Planorbis (Gyraulus) militaris White.	×									×	
Physa pleromatis White	×									×	
Physa bullatula, n. s	×										
Physa kanabensis White	× ?				×						
Bulinus atavus White	×										
Acroloxus actinophorus, n. s	×								× ?		
Helix nacimientensis, n. s								×			
Helix adapis, n. s								×			
Pupa leidyi Meek								× ?			×
Goniobasis tenuicarinata Meek & Hayden.	×								×		
Goniobasis nebrascensis Meek & Hayden.	×	×				×	×		×		
Goniobasis filifera, n. s	×										
Goniobasis tenera Hall	×									×	×
Hydrobia recta White	×					×					
Hydrobia utahensis White	×	×									
Micropyrgus minutulus Meek	×								×		
Viviparus trochiformis Meek & Hayden.	×	×	×	×			×		×		
Viviparus leidyi Meek & Hayden.	×	×	×	×			×		×		
Viviparus raynoldsianus Meek & Hayden.	×								×		
Viviparus panguitchensis White.	×	×	×	×	×		×				
Viviparus nanus, n. s	×										
Cypris sanpetensis, n. s	×										

The following general remarks are presented in this connection for the purpose of explaining the relation which the Wasatch Group, as it is developed in Utah, is understood to hold to the Laramie and other groups. The intimate stratigraphical relation of the Laramie Group to the marine Cretaceous series beneath it has been recognized by every field geologist who has studied those strata, and it is this fact, in addition to the discovery of dinosaurian remains in the Laramie, that has led them to range that group as a member of the Cretaceous series. While there seems to be no reason to doubt that sedimentation was continuous, not only through the marine Cretaceous series, but also from that series into and through the Laramie, it is true that there was at the beginning of the Laramie period a comparatively sudden change in the character of the previously existing molluscan fauna over the whole area which was then occupied by the Laramie waters; that is, at a certain horizon in the unbroken succession of strata there is an abrupt disappearance of all distinctively marine forms,[1] and an equally abrupt accession of brackish water and fresh water forms which continue through the whole Laramie Group.

On the other hand similar evidence of continuous sedimentation from the Laramie into the Wasatch Group has not hitherto been publicly announced. It is true that a conformity of the Wasatch upon the Laramie in some places has been distinctly recognized by Major Powell[2] and myself, but others have denied the existence of any such conformity.[3] Wherever later strata have been discovered resting upon those of the Laramie Group, as its limits are indicated in note 2, below, they have been found to be free from all fossil forms which can be reasonably referred to even a slightly saline habitat, while the Laramie strata contain many brackish water forms throughout their vertical range.

That is, those overlying strata contain such genera of fresh-water and land mollusca as characterize existing lakes and rivers and the land adjacent to them. In my former writings upon the Laramie Group I have suggested that its whole molluscan fauna ceased abruptly with the close of that period, for I did not then know that any of the numerous fresh water species of the Laramie Group survived their brackish-water contemporaries and became members of the Wasatch fauna. I thought it probable that the physical changes which attended the extinction of the brackish-water mollusca of the Laramie sea were also attended by a like extinction of their fresh-water contemporaries. Still, I had expressed a hope that certain of the fresh-water species

[1] One species each of *Nuculana*, *Axinæa*, and *Odontobasis* appears to have survived the partial freshening of the Laramie waters; but this fact is not regarded as affecting the general statement that true marine conditions ceased at the beginning of the Laramie period.

[2] Reference is here made to the Report on the Geology of the Uinta Mountains, by J. W. Powell. The plane which he then recognized as separating the Laramie (Point of Rocks Group) from the marine Cretaceous group beneath it gave certain layers to the Laramie which contain fossils properly belonging to the Cretaceous, but none of which fossils belong to the true Laramie fauna, as it is now understood. He also referred certain layers containing only characteristic Laramie forms to the base of the Wasatch (Bitter Creek Group). In these views I then concurred, as will appear by referring to Chapter III of the report cited, but I have since regarded the Laramie as beginning where the distinctively marine forms cease and ending where the brackish water forms cease. It will thus be seen that the unconformity which we referred to (*loc. cit.*) as existing between the Laramie and the Wasatch groups really occurs within the Laramie. For my observations on the conformity of the Wasatch upon the Laramie, see Tenth Annual Report of the United States Geological and Geographical Survey of the Territories, page 33; Eleventh Report, pages 210 and 223; and Twelfth Report, Part I, page 53.

[3] See report of the Geological Survey of the Fortieth Parallel, Volume I, page 553; Volume II, page 201.

would yet be found to have continued their existence into the Wasatch epoch.[1]

This tentative opinion not having been then confirmed by known facts, I considered the few species I had recognized among the collections from Utah and Southern Wyoming as being identical with certain forms from the Laramie strata of the Upper Missouri River region to belong to the upper part of the Laramie beds in that more southern region. This idea of a definite restriction of the upward range of all the Laramie species seemed to be supported by Professor Cope's discovery in New Mexico,[2] in strata holding an intermediate position between well recognized Laramie strata beneath and equally well recognized Wasatch strata above, of a vertebrate fauna which is distinctly different from that of either of those groups. According to Professor Cope,[2] so different is this vertebrate fauna from the faunas which preceded and those which followed it that he has separated the strata containing it as a distinct group under the name of the Puerco Group. At the typical localities of this group in New Mexico and Southern Colorado he recognizes the strata containing the Puerco fauna as having distinguishing stratigraphical characteristics. Dr. F. M. Endlich[3] and Mr. W. H. Holmes[4] also recognized that distinction in Southern Colorado; but in other places at which the Laramie and the Wasatch have been studied in juxtaposition, especially in Utah and Southern Wyoming, the Puerco Group has not hitherto been recognized either by stratigraphical or by paleontological characteristics. Professor Cope gives the maximum thickness of the Puerco beds in New Mexico as about 850 feet. With this estimate Mr. Holmes essentially agrees, but Dr. Endlich estimates their thickness at something more than this in Southern Colorado. All three of these authors agree, however, that the Puerco beds are conformable with the Laramie beneath and with the Wasatch above; and they all, when those beds were first discovered, regarded them as a part of the Wasatch Group.

As has been already intimated, it is now known that within an area which comprises a large part of the Territory of Utah not only is there a true conformity of the Wasatch upon the Laramie, but several of the characteristic molluscan species of the Laramie Group pass up into the Wasatch strata and there become members of the purely fresh-water fauna of that group. In all the region where this intimate stratigraphical and paleontological relation of the Wasatch to the Laramie

[1] Twelfth Annual Report of the United States Geological and Geographical Survey of the Territories, pp. 51 and 52.

[2] For a concise statement concerning the Puerco Group and its vertebrate fauna by Professor Cope, see American Naturalist, Volume XIX, p. 985. For important references to its vertebrate fauna by him, see the same Volume, pp. 385 and 493.

[3] Ninth Annual Report United States Geological and Geographical Survey of the Territories for 1875, p. 189.

[4] *Ibid.*, pp. 243 and 248.

was observed the character of none of the strata of either the Laramie or the Wasatch was such as to suggest the propriety of separating them from either or both of those formations as a distinct group or even as a subordinate division. That is, I observed nothing in the character of these strata which suggested to me the presence in that region of the Puerco Group of Cope. Having received from Professor Cope a small collection of fresh-water and land shells which he obtained from typical Puerco strata near the town of Nacimiento, N. Mex., and which are figured on Plate I, special search was made for like forms in the Utah strata just referred to, but with the exception of the somewhat satisfactory identification of the Puerco *Unio* with *U. rectoides* of the Wasatch strata near the town of Wales, this search was without material success. The probabilities are that the lower portion of the Wasatch series in that part of Utah represents the Puerco Group of Cope; but because of the now known range of molluscan species from the Laramie into the Wasatch Group, the actual identification of such species alone in both the Wasatch and the Puerco would not serve to fix the Puerco horizon in the Utah region with precision. That is, the facts at present known seem plainly to indicate that while the Puerco fossils which have been published by Professor Cope indicate a distinct epoch in the history of North American vertebrate life, neither the stratigraphy nor the remains of molluscan life, so far as it is now known, give any corresponding indication of either physical or faunal changes.

For the present, therefore, while I do not hesitate to recognize the Puerco epoch as it is indicated by the vertebrate fauna which Professor Cope has published, I am not able to recognize the existence of a distinct group of strata representing that epoch in the region which I have examined; that is, I admit that a record of the Puerco epoch has been made in the history of vertebrate life, but not in that of aqueous invertebrate life, nor, except locally, in the stratigraphical series.

The species which have been found to pass from the Laramie into the Wasatch are figured and described, together with others, on following pages of this bulletin. Such a perpetuation of specific forms of gill-bearing mollusks seems to make it necessary to infer that there was an unbroken continuity of aqueous habitat and also continuous sedimentation from the Laramie to the Wasatch Group. The condition of the strata in that part of Utah which I have recently examined also favors the inference as to the continuity of sedimentation. The area within which this blending of the Laramie with the Wasatch took place, although large, is evidently much smaller than that over which the blending of the marine Cretaceous strata (not its fauna) with those of the Laramie has been observed.

The strata which indicate the intimate relation of the Laramie with the Wasatch are much disturbed in that district and the difficulty of tracing their succession is largely increased by the presence of surface débris and vegetation upon the mountain slopes. Still, this succession was traced with a good degree of satisfaction in the cañons upon the eastern face of the Wasatch Range in Emery and San Pete Counties, Utah. Beginning with the bluish marls of the Colorado Group in Castle Valley I traced the successive strata without a break, as I think, through the Fox Hills and Laramie Groups into and through the Wasatch Group. In addition to this is the well-known intimate relation of the three groups of Eocene fresh-water deposits with each other, namely, the Wasatch, the Green River, and the Bridger, especially in the Green River Basin north of the Uinta Mountains. That is to say, certain species of mollusks range through these three groups, which are everywhere conformable, and it is evident that sedimentation was continuous through the whole series.

We seem, then, to have conclusive proof that there is a complete and unbroken stratigraphical series in that western region, extending from the Middle Cretaceous to the top of the Eocene, and aggregating nearly or quite two miles in thickness. A remarkable fact connected with the production of this great series is that, while sedimentation was evidently not materially interrupted in at least a large part of the area within which those deposits are now found, the aqueous life was changed first from that of a purely marine character to that of alternating brackish and fresh waters, and finally to that of a purely fresh-water character; that is, the waters in which this series of strata were deposited were first marine, then alternating brackish and fresh, and finally wholly fresh. This, of course, implies the occurrence of great physical changes upon the North American continent during the Cretaceous and Eocene periods, which, however, did not interrupt sedimentation in a large part of its interior.

The inability of geologists to fix upon a definite plane of demarkation which shall separate the uppermost of the marine Cretaceous strata from those of the Laramie Group has been referred to and is well known. It is now also known that a similar state of things really obtains within a large part of the Territory of Utah with regard to the strata of the Laramie and the Wasatch groups; and it is not strange that strata upon the confines of each of these groups, and containing an identical fauna, should have been sometimes referred to one and sometimes to the other group before the fauna had been recognized as identical. So far from there being an abrupt faunal break between the Laramie and the Wasatch groups, as was formerly supposed, it is now known that the faunal relation between the two groups is more intimate than that between the Laramie and the marine Cretaceous, for no species are yet known to have passed from the latter up into the Laramie.

The fact of the survival into the Wasatch epoch of several fresh-water molluscan species which have hitherto been regarded as belonging exclusively to the Laramie naturally leads us to inquire whether the upper portion of the Laramie series in the Upper Missouri River region and elsewhere may not be as properly referred to the Wasatch as to the Laramie. Applying the rule for the determination of the upper limit of the Laramie Group which I have designated on a previous page, it appears probable that at least the upper portion of the series of strata which are exposed in the vicinity of Fort Union, near the mouth of Yellowstone River, should be referred to the Wasatch Group. That the lower portion of the series known as the Fort Union beds belongs to the Laramie Group cannot be doubted, because of the presence there of characteristic dinosaurian and other vertebrate remains; but there is evidently no break in that series of strata which should separate them as two formations. In the upper part of the series, however, only fresh water molluscan forms have been found, if we except one species of *Corbula*, and this is understood to have come from a comparatively low horizon. Moreover, several of the same species of mollusks which are found in the Fort Union series of Laramie strata are also found in the Wasatch strata of Utah.

This suggestion of the intimate relation of the Laramie of the Upper Missouri River region to the fresh-water Eocene series is apparently supported by the discovery of some fresh-water beds on the top of Sentinel Butte, in that region. These beds are connected with the Laramie strata beneath by direct continuity, and I have suggested that they probably represent the Green River Group.[1]

Before closing these remarks, it is thought desirable to state concisely the grounds for my conclusion that the strata in the western portion of our national domain form one uninterrupted series from the lowest of the marine Cretaceous formations to the top of the Bridger Group, the uppermost of the fresh-water Eocene series, inclusive. These reasons fall under two separate categories, the one based upon observed stratigraphical conditions and the other upon the character and distribution of the fossil contents of the respective groups of strata.

The stratigraphical conditions which indicate continuous sedimentation from one group or formation to the next succeeding one in this great series are, first, conformity, and second, absence of abrupt change in the character or composition of the material deposited. That is, although there are numerous instances of unconformity within the vertical range of the great series in question, especially above the distinctively marine Cretaceous strata, that unconformity in no case involves the whole of any formation of the series. In other words, where unconformity between any two formations, or any two portions of the same formation, is apparent at any one locality, perfect conformity is to be found at some other localities. The greatest and most complete unconformity in the great series has hitherto been understood to exist between the Laramie and the Wasatch groups; but it is now known that at even this horizon there is perfect conformity within a great area which includes a large part of the Territory of Utah. This area has doubtless been

[1] American Journal of Science, third series, Vol. XXV, pp. 411–414.

materially reduced, because the strata have been so much displaced and eroded.

The paleontological evidence of the unbroken continuity of the series of formations in question consists mainly in the known passage of certain species of fossils from one formation up into the next. That some of the species which existed in and about the estuaries of the marine waters in which the Cretaceous formations were deposited survived in the brackish waters of the Laramie sea is probable, but it has not yet been demonstrated by the specific identification of any such fossils in the Laramie strata. That certain species of molluscan fossils range through all three of the purely fresh-water Eocene Groups has long been known, and it is now also known that there is a similar range of a considerable number of fresh-water species of the Laramie period which coexisted with its brackish water forms, up into the Wasatch Group. This demonstrates the faunal continuity of the series from the base of the Laramie to the top of the Bridger Group. The passage of these fresh-water species from one group to another is understood to indicate that there must have been a continuity of congenial habitat from the one epoch to the other. If that habitat was not continuously lacustrine, the only way in which it is thought possible that any of the fresh-water species in question could have survived was by escaping into fluviatile waters from their original lacustrine habitat and returning to a similar one subsequently established on the same ground. The character of the deposits in which these fossils are found indicates that sedimentation was continuous from the Laramie to the Wasatch, and an aqueous habitat was therefore continuous from the one epoch to the other. The survival into the latter epoch of certain species which flourished in the former one shows that that habitat was continuously a congenial one to them. This conclusion, of course, implies that the individuals of those surviving species whose remains are found in the upper formation were direct lineal descendants of those in the lower. There appear to be only two alternatives to this conclusion, first, that the species have been incorrectly identified, or, second, that they were reintroduced after they had once become extinct. In the light of modern zoology the latter proposition is not thought to demand serious consideration. As to the former, it can only be said that the specific determinations in those cases have been made with as much confidence in their accuracy as may reasonably attend any work of that kind.

In connection with this statement of the grounds upon which are based the opinions advanced in the foregoing pages, it is proper to make some remarks upon the estimated value of fossils of fresh-water origin in geological determinations. As fossil mollusca are the principal forms which characterize fresh-water deposits, they alone will now be referred to. The differentiation of the mollusca into generic, family, and ordinal groups, and the diversification of specific forms among these groups, are immensely greater in marine waters than in any other. In brackish waters it is much less than in the open marine, and in lacustrine waters the minimum of differentiation is found. The large collections of fossil mollusca which have been made in different parts of the world indicate that this slight tendency to differentiation among fresh-water mollusca has always obtained in past geological time; also, that types once established have persisted through a long series of geological periods. Therefore it has become known that fossils of fresh-water origin are of little value, compared with those of marine origin, as indices of the true geological age of the strata containing them. In consequence of this, the real value of fresh-water fossils as aids in the study of stratigraphical geology has been underestimated. While it is admitted that these fresh-water forms are of little value in determining the geological age of strata, they are really of as great importance in the study of local, and even of continental, geology as are any other fossils. Indeed, it would be quite impracticable to ascertain whether the waters in which formations have been deposited were marine, brackish, or fresh, except by the character of the contained fossils.

Fresh-water formations of considerable extent can only be produced upon continental areas, and they consequently record phases of continental history of which marine formations give no indication. In Western North America the fresh-water deposits rival in extent and thickness the great marine formations; and it would have been impossible to arrive at the knowledge of them which we have now attained except by a study of their fossils. Each of these great lacustrine formations has its own distinguishing fauna, the uniform character of which over great areas is quite remarkable. So large has been the area of some of the fresh-water seas in which these deposits were formed, and so uniform the conditions under which they existed, that the geographical distribution of species in them has been nearly or quite as great as the average of that of marine mollusca. For example, some of the species of the Laramie Group have been found at points more than a thousand miles apart; and in the fresh-water Eocene groups the molluscan fauna is practically identical at points as much as 200 miles apart.

In view of the above indicated estimate of the value of fossils of fresh-water origin in the study of the geology of great continental areas, I have not hesitated to use them with confidence in the foregoing discussions.

DESCRIPTION OF SPECIES—MOLLUSCA.

UNIONIDÆ.

Genus UNIO Retzius.

UNIO MENDAX White.

(Plate IV, Figs. 2, 3, and 4.)

Unio vetustus (Meek) White, 1876; Report upon United States Geographical Surveys West of the One Hundredth Meridian, Vol. IV, p. 206, pl. xxi, fig. 12, *a, b, c, d*.
Unio mendax White, 1877; Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. III, p. 605.
Unio mendax White, 1883; Third Annual Report United States Geological Survey, 1881–'82, p. 433, pl. 18, figs. 3, 4, 5.

Shell of medium size, subelliptical in marginal outline; valves moderately gibbous, the postero-dorsal portion of each valve more or less flattened, and in the case of the examples which are regarded as females there is a slightly increased convexity of the median portion; test somewhat thin; beaks situated near the front, inconspicuous, and only slightly elevated above the hinge line; the umbones scarcely differing in their convexity from that of the adjacent portion of the valves; anterior margin rounded by a somewhat regularly diminishing curve to the basal margin; the convexity of the latter margin sometimes slight and sometimes considerable, the difference being probably due to sex; dorsal margin nearly straight or slightly convex; posterior margin sloping downward and backward from the dorsal margin to the postero-basal extremity, which is narrowly rounded to the basal margin. Surface marked by the ordinary lines of growth. Numerous small wrinkles are usually visible upon the beaks; and two sharply-raised lines radiate from the beak upon the postero-dorsal portion of each valve. The test being somewhat light the hinge is also more delicate than is usual with shells of *Unio* of equal size, but the lateral and cardinal teeth are those of true *Unio*.

Length of an adult example, which is probably a female, 64^{mm}; height, 39^{mm}. The proportionate length of males is apparently a little more.

This species was first described by me in Volume IV, Report upon United States Geographical Surveys West of the One Hundredth Meridian (*loc. cit.*), and erroneously referred to the *U. vetustus* of Meek. The types of Meek's species came from the Bear River Laramie, while the specimens of this species came from the Wasatch strata near Wales, Utah. The specimens which I then figured and described are probably males, and their proportions differ a little from those of the specimens figured in this bulletin. These figures are copied from plate 18 of the Third Annual Report of the U. S. Geological Survey.

This is one of the plain oval types of *Unio* which has been so common in that great genus from the Jurassic period to the present time.

Indeed, it is closely like the *U. nucalis* of Meek and Hayden, which they published as coming from the Jurassic rocks in the vicinity of the Black Hills.

Locality and position.—This species has hitherto been collected only at the Desolation Cañon and Wales localities, in Utah, but it is likely to be found at any locality of the Wasatch Group in that region. Its vertical range was found to be more than 1,000 feet at the Wales locality.

UNIO RECTOIDES (sp. nov.).

(Plate IV, Fig. 1; and Plate V, Figs. 1 and 2.)

Shell transversely elongate, subelliptical in marginal outline; front margin regularly rounded; basal margin broadly convex; postero-dorsal margin sloping downward and backward to the postero-basal extremity, which is narrowly rounded to the base; beaks situated at about one-quarter of the length of the shell from the front, incurved; umbones prominent, elevated above the hinge line. Surface plain.

Length, 90^{mm}; height, 47^{mm}.

This form was found associated with *U. mendax* at the Wales locality. While the range of variation is doubtless great in all species of *Unio*, there seems to be too much difference between the form above described and *U. mendax* to allow them to be referred to the same species. The principal differences are the greater proportionate length of *U. rectoides*, the prominence of its umbones, and the greater distance of the beaks from the front. This fossil form bears some resemblance to the living *U. rectus* Lamarck.

Locality and position.—The specimen figured on Plate IV, together with some other less perfect examples, was obtained at the Wales locality. A fragment which is figured on Plate V, and which probably belongs to this species, was obtained by Professor Cope from his Puerco Group near the town of Nacimiento, New Mexico.

CYRENIDÆ.

Genus SPHÆRIUM Scopoli.

SPHÆRIUM FORMOSUM Meek and Hayden.

(Plate IV, Figs. 5 and 6.)

Cyclas formosa M. and H. Proceedings of the Academy of Natural Sciences, Phila., for 1856, p. 115.

Sphærium formosum M. and H. Proceedings of the Academy of Natural Sciences, Phila., for 1860, p. 185.

Sphærium formosum Meek, 1876. Report of the United States Geological Survey of the Territories, Vol. IX, p. 526, pl. 43, fig. 4, *a*, *b*, *c*.

Sphærium formosum White, 1883. Third Annual Report of United States Geological Survey, p. 539, pl. 17, fig. 11.

In the Wasatch strata, at the locality near Wales, Utah, some examples of a *Sphærium* were found which appear to be identical with the *S. formosum* of Meek and Hayden, the type specimens of which were obtained from the Fort Union Laramie strata. The best one of the specimens which were found at the Wales locality is represented by Figure 6 on Plate IV. Figure 5 on the same plate represents the type specimen of Meek and Hayden, it being a copy of their original figure.

LIMNÆIDÆ.

Genus LIMNÆA Lamarck.

LIMNÆA ———?

(Plate II, Fig. 13.)

A single imperfect example was found at the Wales locality, which evidently belongs to the genus Limnæa and the general aspect of which is like that of the living species, *L. columella.* No species of *Limnæa* is yet known from either the Laramie or the Wasatch Group to which this form can be properly referred; but it is possible that it is only a variety of the *L. similis* of Meek, from the Bridger Group of Southern Wyoming. The specimen is too imperfect to allow of a satisfactory specific description.

Subgenus LEPTOLIMNÆA Swainson.

LIMNÆA (LEPTOLIMNÆA) MINUSCULA White.

(Plate II, Figs. 10, 11, 12.)

Limnæa (Leptolimnæa) minuscula White, 1880; Proceedings of the United States National Museum, Vol. III, p. 160.

Limnæa (Leptolimnæa) minuscula White, 1883; Third Annual Report United States Geological Survey, p. 446, pl. 29, figs. 24 and 25.

Some imperfect examples, one of which is figured on Plate II, were found among the other fossils in the Wasatch strata at the Wales locality, which appear to belong to *L. (L.) minuscula* White. The type specimens of this species were found in strata upon the confines of the Wasatch and Green River Groups in Southern Wyoming. Figure 10 on Plate II represents one of the examples found at the Wales locality; and Figures 11 and 12 represent one of the type specimens.

Genus ACELLA Haldeman.

ACELLA MICRONEMA (sp. nov.).

(Plate II, Fig. 14.)

Among the fossils which were collected from the Wasatch strata at the Wales locality are several fragments of a small limnæid which is referable to the genus *Acella*. These fragments are sufficient to give a good idea of the outline and general character of the shell, but none of them are sufficiently perfect to be figured satisfactorily. I have therefore prepared an outline which is understood to represent the general aspect of the species, and which is given on Plate II, Fig. 14. The surface is marked by fine, distinct, uniform lines, the direction of which corresponds with the lines of growth of the shell and approximately also with its axis.

The length of adult shells was apparently from 10 to 12 millimeters.

This shell is perhaps specifically identical with the form which I found associated with the preceding species in strata near the junction of the Wasatch and Green River Groups in Southern Wyoming. It is mentioned but not described on page 160, Volume III, of the Proceedings of the United States National Museum.

Genus PLANORBIS Müller.

PLANORBIS CONVOLUTUS Meek and Hayden.

(Plate II, Fig. 15.)

Planorbis convolutus M. and H., 1876; Report of the United States Geological Survey of the Territories, Vol. IX, p. 536, pl. 42, figs. 11 and 12.

Planorbis convolutus White, 1883; Third Annual Report United States Geological Survey, p. 447, pl. 27, fig. 16.

Some imperfect examples of a species of *Planorbis* were found among the other Wasatch mollusca at the Wales locality which do not seem to differ specifically from *P. convolutus* Meek and Hayden. The type specimens of *P. convolutus* came from the Laramie strata of the Upper Missouri River region; and these Wasatch specimens agree with them so closely that they cannot be regarded as anything more than a variety. A few fragments of a Planorbis were also found in the Wasatch strata near Evanston, Wyo., which probably belong to this species.

Subgenus GYRAULUS Agassiz.

PLANORBIS (GYRAULUS) MILITARIS White.

(Plate II, Figs. 16 and 17.)

Planorbis (*Gyraulus*) *militaris* White, 1880; Proceedings of the National Museum, Vol. III, p. 159.

Planorbis (*Gyraulus*) *militaris* White, 1883; Third Annual Report United States Geological Survey, p. 447, pl. 28, figs. 10 and 11.

The type specimens of this species came from near the headwaters of Soldier's Fork, Utah County, Utah, the strata containing them being a portion of the Wasatch Group. Some imperfect examples were obtained at the Wales locality. The species has also been recognized in strata upon the confines of the Green River and Wasatch Groups in

Southern Wyoming. The figures on Plate II are copies of the original figures which were published in the work last above cited.

PHYSIDÆ.

Genus PHYSA Draparnaud.

PHYSA PLEROMATIS White.

(Plate III, Figs. 1, 2, 3, 4, 5, and 6.)

Physa pleromatis White, 1875; Report upon United States Geographical Surveys West of the One Hundredth Meridian, Vol. IV, p. 211, pl. xxi, fig. 1, *a*, *b*.

Physa pleromatis White, 1883; Third Annual Report United States Geological Survey, p. 450, pl. 30, figs. 6, 7, 8.

The original specimens of this species came from Wasatch strata in Utah which are equivalent with those at the Wales locality, where numerous examples were also obtained. Specimens of this species are likewise often met with in the Wasatch strata north of the Uinta Mountains, in which region it also extends up into the base of the Green River Group.

The specimens which were collected at the Wales locality, as well as those collected elsewhere, show great variation as to form and proportions. So great is this range of variation that in the absence of intermediate forms no one would hesitate to refer the specimens showing the two extremes of variation to different species. The specimens illustrated on Plate III show much variation, but not the full extremes, especially as shown in the young.

PHYSA KANABENSIS White.

(Plate III, Figs. 11, 12, and 13.)

Physa kanabensis White, 1876; Report upon the Geology of the Uinta Mountains, by J. W. Powell, p. 119.

The original specimens of *Physa kanabensis* were obtained by Major Powell from strata in Southern Utah which he then regarded as belonging to the Laramie (Point of Rocks) Group. These were described by me (*loc. cit.*), but the specimens were too imperfect to be satisfactorily figured. Several imperfect examples of a form which probably belongs to the same species were found in the Wasatch strata at the Wales locality, already often mentioned. These specimens show that the last volution was proportionally much more inflated than the others. The original specimens of *P. kanabensis* did not show this, but it is probable that they were not fully adult. Figs. 11 and 12 represent two imperfect examples from the Wales locality and Fig. 13 is a restored outline of the full adult shell.

PHYSA BULLATA (sp. nov.).

(Plate III, Figs. 14, 15, 16, and 17?.)

Shell small, ovoid; volutions four or five in number, the last one large and ventricose; spire small and short, forming only a small part of the length of the shell. Surface marked by the usual lines of growth.

Length of one of the largest examples, 15^{mm}; greatest breadth of the same, 10^{mm}.

This species is closely like the living *P. bullata* Gould, but it seems to differ from that and from other fossil forms too much to justify its reference to any published species. A considerable number of examples of this form were collected which show a good degree of variation. The last volution of some of the specimens is much expanded, making the aperture very broad, but in other examples the expansion is less. The length of the spire is also variable, but it is short in all cases.

Locality and position.—Wasatch strata, near Wales, Utah; and also at several other localities in equivalent strata in the Wasatch Mountains, east of San Pete Valley.

Genus BULINUS Müller.

BULINUS ATAVUS White?

(Plate III, Figs. 7, 8, 9, and 10.)

Bulinus atavus White, 1877; Bulletin United States Geological and Geographical Survey of the Territories, Vol. III, p. 601.

Bulinus atavus White, 1880; Twelfth Annual Report of the United States Geological and Geographical Survey of the Territories, Part I, p. 86, pl. 24, fig. 5, *a*, *b*.

Bulinus atavus White, 1883; Third Annual Report of the United States Geological Survey, p. 450, pl. 25, figs. 6 and 7.

Among the fossils collected from the Wasatch strata at the Wales locality in Utah are some examples which are closely like, if not identical with, the form which I described (*loc. cit.*) under the name of *Bulinus atavus*. The Utah specimens are not quite perfect, but so far as they exhibit their specific characters they seem to differ from the type specimens only in being of smaller size. The type specimens were collected by Professor Cope from the Judith River Laramie beds in Montana.

Among the Physidæ which were collected from the Wasatch strata at the Wales locality in Utah are some more or less imperfect examples which do not seem to be referable to any of the preceding species. Some of these closely resemble the *Bulinus subelongatus* of Meek and Hayden, the types of which they obtained from the Laramie strata at the mouth of Judith River, Montana. Some fragments found in the Wasatch strata near Evanston, Southwestern Wyoming, appear also to belong to the last-named species.

ANCYLIDÆ.

Genus ACROLOXUS Beck.

ACROLOXUS ACTINOPHORUS (sp. nov.).

(Plate II, Fig. 22.)

Shell small, elongate, subelliptical in marginal outline, somewhat wider in front than behind; apex situated at a little more than one-quarter of the full length of the shell from the posterior end. Surface marked by the ordinary lines of growth, which are crossed by a multitude of minute radiating lines, the latter being visible only under a lens.

Length, 4^{mm}; breadth, 3^{mm}.

This form is possibly identical with the *A. minutus* of Meek and Hayden, from the Laramie strata at Fort Union, Mont. It seems to differ specifically from that form, however, in possessing the finely radiate markings of the surface and in being proportionally longer.

Locality and position.—Wasatch strata near the town of Wales, Utah.

HELICIDÆ.

Genus HELIX Linnæus.

HELIX NACIMIENTENSIS (sp. nov.).

(Plate V, Figs. 3, 4, 5, 6, and 7.)

Shell large, umbilicate; volutions six or seven in number, broadly convex upon the upper side, increasing regularly in width, but the depth is somewhat rapidly increased adjacent to the umbilicus upon the maturity of the shell; the periphery of the shell somewhat sharply angular in the earlier stages of growth, but it is obtusely or even obscurely so in its later stages; spire convex; apex obtuse; under surface of the last volution broadly convex from the periphery to the border of the umbilicus, which is abruptly rounded; outline of the aperture approximately semi-lunar, obtusely angular both above and below; the outer lip is apparently neither thickened nor reflexed.

Greatest diameter of the largest example in the collection, 42^{mm}; height, 33^{mm}.

This species is related to *H. peripheria* White, but it is a much larger shell, and the peripheral angle is much sharper in specimens of equal size than it is in *H. peripheria*.

Locality and position.—Puerco strata, near the town of Nacimiento, N. Mex., where it was collected by Professor Cope.

HELIX ADIPIS (sp. nov.).

(Plate V, Figs. 11 and 12.)

Shell small; spire moderately elevated; umbilicus not very broad; outer lip apparently slightly reflexed, but not materially thickened. The surface marked by regular transverse raised lines, corresponding in direction with the lines of growth.

Height, 3mm; diameter, 5mm.

Only two examples of this little shell were obtained, and it is possible that they are immature, but they appear to be adult. In aspect this species resembles *H. evanstonensis* White, from the Wasatch beds near Evanston, Wyo., but that shell is larger and has its umbilicus closed.

Locality and position.—Puerco Group, near the town of Nacimiento, N. Mex.; where it was obtained by Professor Cope, who found it associated with both the preceding and the following species:

PUPIDÆ.

Genus PUPA Lamarck.

PUPA LEIDYI Meek?

(Plate V, Figs. 8, 9, and 10.)

Pupa? leidyi Meek, 1873; Sixth Annual Report of the United States Geological Survey of the Territories [for 1872], p. 517.

Associated with the preceding species, and among the few shells collected by Professor Cope from his Puerco Group near the town of Nacimiento, N. Mex., are some specimens which seem to be specifically identical with *Pupa leidyi* Meek. I have never been able to find Meek's type of *P. leidyi* among the collections of the National Museum, and I am therefore obliged to rely upon his description alone. This description agrees too closely with the specimens from New Mexico to justify their reference to any other species except upon the ground that they come from different horizons. Meek's types came from the top of the Green River Group or from the base of the Bridger, while the New Mexican specimens come from a horizon which is apparently 4,000 or 5,000 feet lower.

I have shown on a previous page of this bulletin that the fresh-water series of strata is complete from the Laramie Group to the Bridger, inclusive; and there seems, therefore, to be no good reason to doubt that this molluscan form lived continuously through the whole time in which those formations were deposited.

CERIPHASIIDÆ.

Genus GONIOBASIS Lea.

GONIOBASIS TENUICARINATA Meek and Hayden.

(Plate II, Figs. 6, 7, 8, and 9.)

Melania tenuicarinata M. and H.; Proceedings of the Academy of Natural Sciences, Phila., for 1857, p. 137.

Goniobasis tenuicarinata M. and H., 1876; Report on the United States Geological Survey of the Territories, Vol. IX, p. 566, pl. 43, fig. 14, *a, b, c*.

Goniobasis tenuicarinata White, 1875; Report upon United States Geographical Surveys West of the One Hundredth Meridian, Vol. IV, p. 212, pl. xxi, fig. 10, *a, b*, c.

Goniobasis tenuicarinata White, 1883; Third Annual Report of the United States Geological Survey, p. 463, pl. 26, fig. 11.

This is one of the best known of the gasteropods of the Laramie Group, it having been found at different localities in Montana and Colorado; and it was formerly supposed to be confined to that group. The type specimens of Meek and Hayden came from the Laramie strata near Fort Union, Mont.; and the specimens which I figured in Volume IV, Explorations and Surveys (*loc. cit.*), came from the Wasatch strata at the Wales locality in Utah, as did also those represented by Figs. 6, 7, and 8, Plate II, of this bulletin. A large number of specimens have been obtained from the Wales locality which, while they vary considerably among themselves, possess all the essential characteristics of the species. Indeed, there seems to be no reason to doubt that these Wasatch specimens are in all respects specifically identical with those which have been obtained from undoubted Laramie strata.

GONIOBASIS NEBRASCENSIS Meek and Hayden.

(Plate II, Figs. 4 and 5.)

Melania nebrascensis M. and H.; Proceedings Academy Natural Sciences, Phila., for 1856, p. 124.

Goniobasis nebrascensis M. and H., 1876; Report of the United States Geological Survey of the Territories, Vol. IX, p. 565, pl. 43, fig. 12, *a, b, c, d, e, f*.

Goniobasis nebrascensis White, 1875; Report upon United States Geographical Surveys West of the One Hundredth Meridian, Vol. IV, p. 213, pl. xxi, fig. 9, *a, b, c*.

Goniobasis nebrascensis White, 1883; Third Annual Report United States Geological Survey, p. 463, pl. 26, figs. 15 and 16.

This species is a very variable one, and it seems to have been in part confounded with another similar form which occurs in the Laramie strata of Montana. The specimen represented by the figures on plate 26 of the work last above cited is especially referred to. Those copied figures are still more widely different from what I regard as the typical form of

G. nebrascensis by the failure of the artist to add the revolving lines which appear in Meek's original figures of the specimen. The specimens which were found at the Wales locality many years ago by Mr. G. K. Gilbert were pronounced by Mr. Meek, who then saw them, to be identical with *G. nebrascensis*. The near relationship of *G. nebrascensis* with *G. tenuicarinata*, as the two forms occur in the Wasatch strata of Utah, is quite apparent; but the difference is constant, and the two forms were not there found associated in the same layers. The form here referred to *G. nebrascensis* has also been recognized among collections which have been made from Wasatch strata near Evanston, Wyo., and in Desolation Cañon, Utah.

GONIOBASIS TENERA Hall.

(Plate II, Figs. 1 and 2.)

Cerithium tenerum Hall, 1845; Exploring Expedition Oregon and Northern California (Frémont), p. 308, pl. iii, fig. 6.
Goniobasis tenera White, 1875; Report upon United States Geographical Surveys West of the One Hundredth Meridian, Vol. IV, p. 212, pl. xxi, fig. 11, *a*, *b*, *c*.
Goniobasis tenera White, 1883; Third Annual Report of the United States Geological Survey, p. 464, pl. 31.

This species is one of the most common forms in the fresh-water Eocene strata of the West, and it ranges from the Wasatch Group to the Bridger Group inclusive. It varies so greatly in its surface markings, and also in size, that no less than five specific names have by different authors been given to forms all of which I now regard as belonging to this species. Examples of all these varieties are figured on plate 31 of the work last above cited, so arranged as to show a gradation from nearly plain to highly ornamented examples. Some imperfect examples of the typical variety *tenera* were found near the top of the series exposed at the Wales locality.

GONIOBASIS FILIFERA (sp. nov.).

(Plate II, Fig. 3.)

Some imperfect examples of a species of *Goniobasis* were found at the Wales locality, in Utah, associated with *G. tenuicarinata* and others of the forms which are described on previous pages, which evidently belong to an unpublished species. The shell is rather small, slender; the volutions convex and marked by three or more revolving raised lines, similar to those which mark the volutions of *G. tenuicarinata*. The revolving lines are only two in number in one of the examples and in another there seems to be only one. No indication of longitudinal folds, such as mark *G. tenera*, nor of fine revolving striæ, such as appear upon *G. tenuicarinata*, between the carinæ, have been observed.

RISSOIDÆ.

Genus HYDROBIA Hartmann.

HYDROBIA RECTA White.

(Plate II, Fig. 21.)

Hydrobia recta White, 1876; Geological Report of the Uinta Mountains by J. W. Powell, p. 132.

Hydrobia recta White, 1883; Third Annual Report of the United States Geological Survey, p. 466, pl. 27, fig. 38.

The original specimens of this species were obtained from the coal-bearing Wasatch strata, near Evanston, Southwestern Wyoming. Numerous imperfect examples were also found at the Wales locality, in layers associated with the coal, and also in other layers several hundred feet above the coal. These specimens were all crushed by pressure of the strata, and are otherwise imperfect, but they seem to be specifically identical with the type specimens. The latter are also imperfect. They are represented on Plate II of this bulletin.

In view of the purely fresh-water molluscan types with which these shells have been found associated there is reason to doubt whether the species ought to be referred to the genus *Hydrobia*. Perhaps it might with better reason be referred to *Bythinella* or to *Paludistrina*.

HYDROBIA UTAHENSIS White.

(Plate II, Fig. 20.)

Hydrobia utahensis White, 1876; Geological Report Uinta Mountains, J. W. Powell, p. 132.

Hydrobia utahensis White, 1883; Third Annual Report of the United States Geological Survey, p. 466, pl. 27, fig. 35.

The type specimens of this species came from the Wasatch strata at the west base of Musinia Mountain, San Pete County, Utah. It was also found in equivalent strata at the Wales locality; but the latter specimens are not well preserved. Copies of the original figures are given on Plate II of this bulletin.

In view of the close faunal relationship which the Wasatch Group is now known to hold to the Laramie, it seems not improbable that *Hydrobia utahensis* ought to be regarded as specifically identical with *H. eulimoides* Meek and Hayden. The latter was obtained from the Laramie strata of the Upper Missouri River region. The remarks which are made concerning the generic relations of the preceding species are also applicable to this.

Genus MICROPYRGUS Meek.

MICROPYRGUS MINUTULUS Meek and Hayden.

(Plate II, Fig. 24.)

Melania minutula M. and H.; Proceedings of the Academy of Natural Sciences, Phila., for 1856, p. 123.
Micropyrgus minutulus Meek, 1876; Report of the United States Geological Survey of the Territories, Vol. IX, p. 575, pl. 43, fig. 18, *a*, *b*.
Micropyrgus minutulus White, 1883; Third Annual Report of the United States Geological Survey, p. 465, pl. 26, fig. 20.

Some small shells which were found in the Wasatch strata at the Wales locality, imbedded in one of the thin limestone layers, appear to be specifically identified with *Micropyrgus minutulus* Meek and Hayden. The only apparent difference is that the Utah specimens are somewhat larger than the dimensions given by Meek and Hayden. Their type specimens came from the Fort Union Laramie strata in Montana. The figures on Plate II are copied from Meek's original figures. They are muchen larged.

VIVIPARIDÆ.

Genus VIVIPARUS Gray.

VIVIPARUS TROCHIFORMIS Meek and Hayden.

(Plate I, Figs. 1, 2, 3, 4, and 5; conf. Figs. 6 to 13.)

Viviparus trochiformis M. and H.; Proceedings of the Academy of Natural Sciences, Phila., for 1860, p. 185.
Viviparus trochiformis White, 1875; Report upon United States Geographical Surveys West of the One Hundredth Meridian, Vol. IV, p. 214, pl. xxi, fig. 4, *a*, *b*, *c*.
Viviparus trochiformis Meek, 1876; Report of the United States Geological Survey of the Territories, Vol. IX, p. 580, pl. 44, fig. 2, *a*, *b*, *c*.
Viviparus trochiformis White, 1883; Third Annual Report of the United States Geological Survey, p. 467, pl. 24, figs. 10 to 16.
Compare also with *V. leidyi*, *V. leidyi* var. *formosus*, and *V. raynoldsianus* Meek and Hayden (*loc. cit.*), and also with *V. panguitchensis* White, Third Annual Report of the United States Geological Survey, p. 467, pl. 25, figs. 19, 20, and 21.

This species was originally described by Meek and Hayden from the Laramie strata of the Upper Missouri River region. It was afterwards recognized by me among the fossils which were brought from certain strata in Utah which have since been ascertained to belong to the Wasatch group. Upon a re-examination of the collections referred to, and also a study of those which I collected during the past season at the Wales locality, I am still convinced that those Utah examples are specifically identical with the original specimens brought from Montana. Furthermore, I find in the Utah collections varietal forms which may with propriety be referred respectively to *V. leidyi* and *V. raynoldsianus*.

Again, I find among those collections intermediate forms which seem to show that these are only varieties of *V. trochiformis*. Some of these varietal forms indicate that *V. panguitchensis* ought also to be considered as a variety of *V. trochiformis*. Besides this close relationship among themselves of the forms just named, I have shown in the work last above cited the intimate relation which *Tulotoma thompsoni* White holds to *Viviparus trochiformis*.

VIVIPARUS NANUS (sp. nov.).

(Plate II, Figs. 18 and 19.)

Viviparus ——— ? White, 1875; Report upon United States Geographical Surveys West of the One Hundredth Meridian, Vol. IV, p. 215, pl. xxi, fig. 7, *a*, *b*.

Shell small, the axis short as compared with the transverse diameter; volutions five in number, regularly convex; surface plain.

Height of the largest example in the collection, 10^{mm}; greatest diameter, 8^{mm}.

When this form was first noticed by me (*loc. cit.*) the specimens then obtained would not justify the application of a new specific name. During the past season, however, I collected a considerable number of nearly perfect examples, which indicate that it really belongs to an unpublished form. I have, therefore, given it a new specific name.

Locality and position.—Wasatch strata, near Wales, Utah, and in equivalent strata at several localities in the Wasatch Mountains.

CRUSTACEA.

CYPRIDÆ.

Genus CYPRIS Müller.

CYPRIS SANPETENSIS (sp. nov.).

(Plate II, Fig. 23.)

Shell obliquely oblong in marginal outline, wider behind than before; anterior margin rounded; ventral margin straight and also a little longer than the dorsal; posterior margin gently convex, and sloping downward and a little backward from the dorsal to the ventral margin; valves moderately convex, and a very slight transverse depression is observable towards the anterior end.

Length, 2^{mm}; height, 1^{mm}.

Locality and position.—Wasatch strata near the town of Wales, Utah.

PLATE I.

PLATE I.

Fig. 1. Viviparus trochiformis from the Fort Union beds; a copy of Meek's type figure.

Figs. 2 and 3. Opposite views of another example, also from the Fort Union beds.

Figs. 4 and 5. Opposite views of an example from the Wasatch beds near Wales, Utah. This specimen is more elongate than usual.

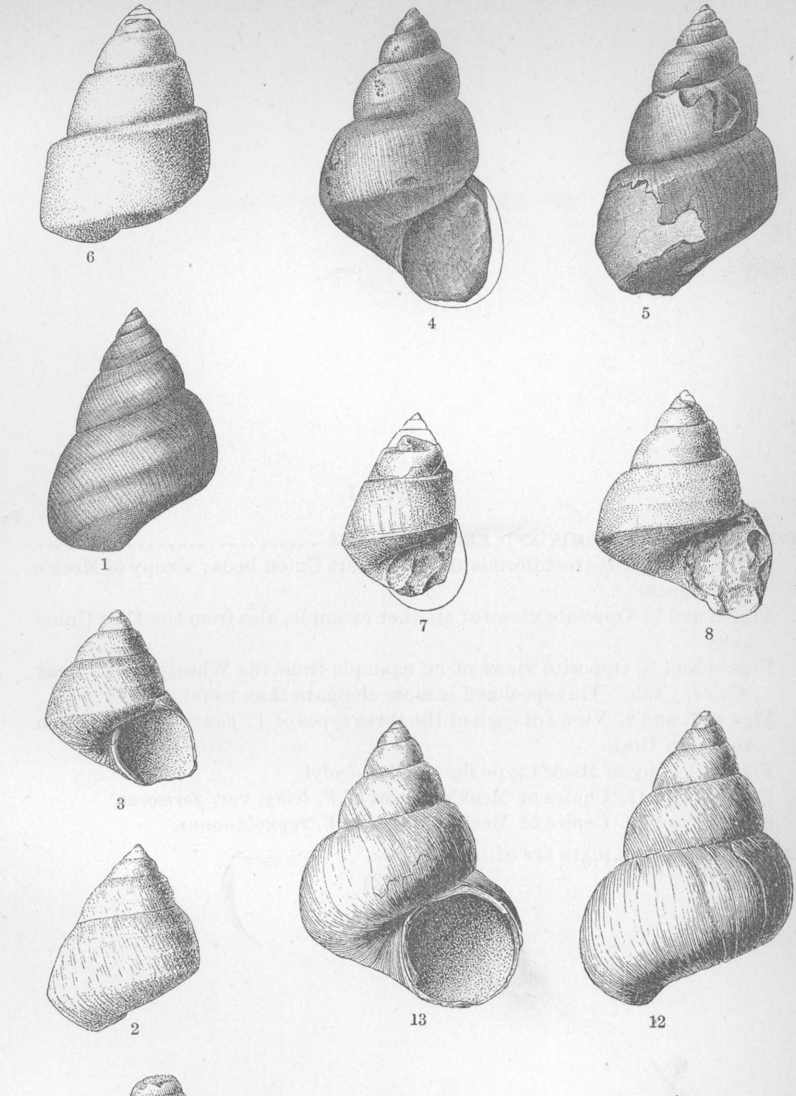
Figs. 6, 7, and 8. Views of each of the three types of *V. panguitchensis;* from Southern Utah.

Fig. 9. A copy of Meek's type figure of *V. leidyi.*

Figs. 10 and 11. Copies of Meek's figures of *V. leidyi* var. *formosus.*

Figs. 12 and 13. Copies of Meek's figures of *V. raynoldsianus.*

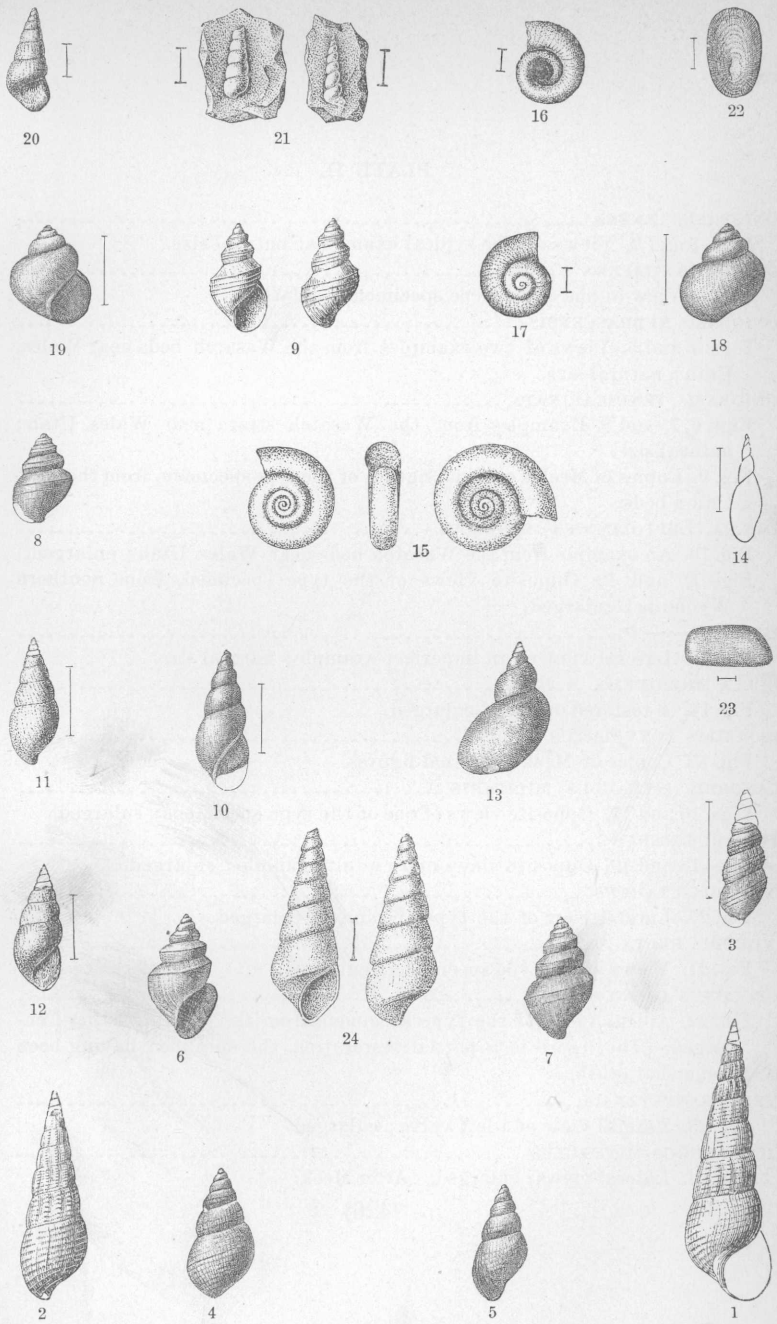
All figures on this plate are of natural size.



1, 2, 3, 4, 5. Viviparus trochiformis.
6, 7, 8. V. panguitchensis.
9. V. leidyi.
10, 11. V. leidyi var. formosus.
12, 13. V. raynoldsianus.

PLATE II.

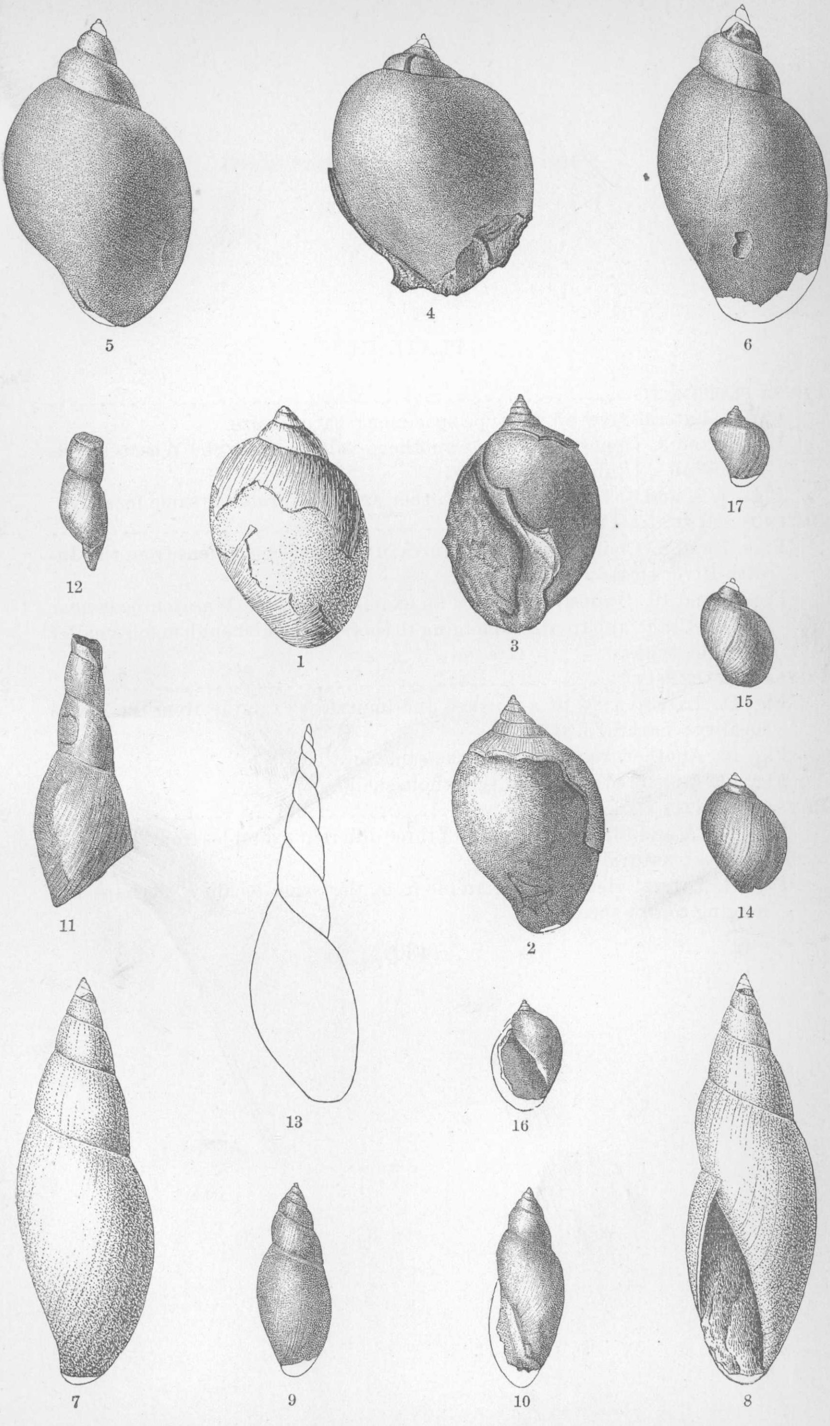
PLATE II.



1, 2. Goniobasis tenera.
3. G. filifera.
4, 5. G. nebrascensis
6, 7, 8, 9. G. tenuicarinata.
10, 11, 12. Limnæa (Leptolimnæa) minuscula.
13. Limnæa ——— ?
14. Acella micronema.
15. Planorbis convolutus.
16, 17. P. militaris.
18, 19. Viviparus nanus.
20. Hydrobia utahensis.
21. H. recta.
22. Acroloxus actinophorus.
23. Cypris sanpetensis.
24. Micropyrgus minutulus.

PLATE III.

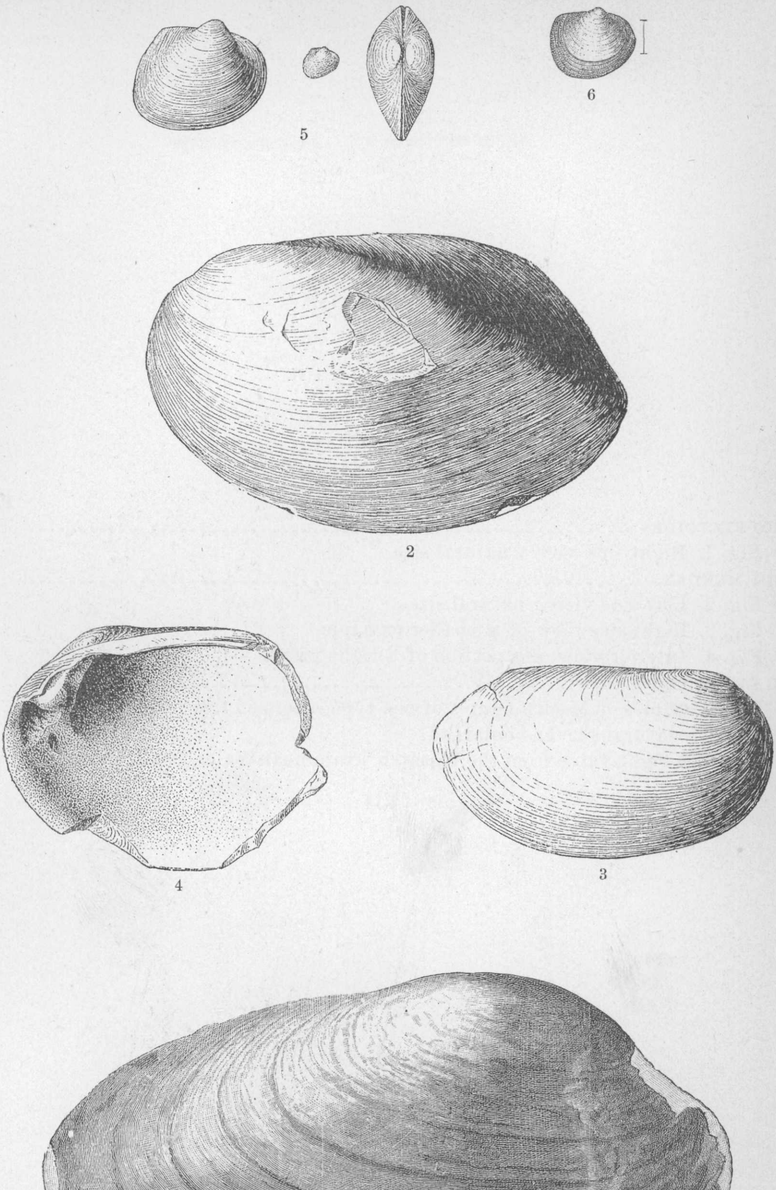
PLATE III.



1, 2, 3, 4, 5, 6. Physa pleromatis.
7, 8, 9, 10. Bulinus atavus.
11, 12, 13. Physa kanabensis.
14, 15, 16, 17. P. bullatula.

PLATE IV.

PLATE IV.



1. Unio rectoides. 2, 3, 4. U. mendax. 5, 6. Sphærium formosum.

PLATE V.

(437)

PLATE V.

Page.

UNIO RECTOIDES? 21

Figs. 1 and 2. Opposite views of a fragment of a left valve.

HELIX ADIPIS 27

Figs. 11 and 12. Lateral and apical views of one of the type specimens; enlarged.

HELIX NACIMIENTENSIS 26

Figs. 3, 4, and 5. Upper, under, and lateral views of the largest and most perfect example in the collection; natural size. The test is nearly all exfoliated.

Fig. 6. Lateral view of another example, a portion of the last volution having been distorted by pressure.

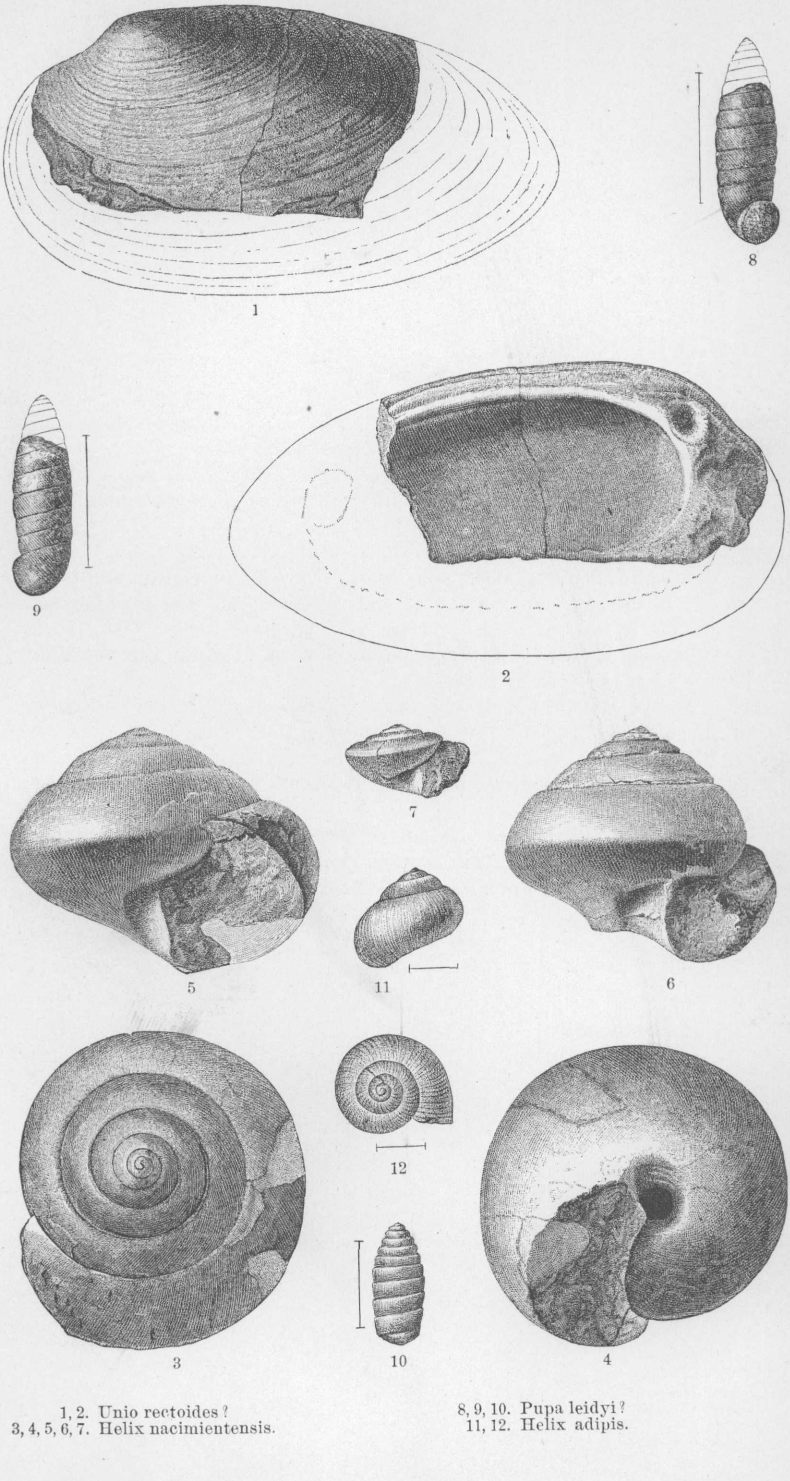
Fig. 7. An apical portion, showing the angular character of the periphery of the earlier volutions.

PUPA LEIDYI? 27

Figs. 8 and 9. Opposite views of a broken example, but the best one in the collection; enlarged.

Fig. 10. Another example, crushed and imperfect.

All the specimens figured on this plate were collected by Professor Cope from his Puerco Group, near the town of Nacimiento, N. Mex.



1, 2. Unio rectoides?
3, 4, 5, 6, 7. Helix nacimientensis.
8, 9, 10. Pupa leidyi?
11, 12. Helix adipis.

INDEX.

O

ADVERTISEMENT.

20. Contributions to the Mineralogy of the Rocky Mountains, by Whitman Cross and W. F. Hillebrand. 1885. 8°. 114 pp. 1 pl. Price 10 cents.

21. The Lignites of the Great Sioux Reservation, by Bailey Willis. 1885. 8°. 16 pp. 5 pl. Price 5 cents.

22. On New Cretaceous Fossils from California, by Charles A. White. 1885. 8°. 25 pp. 5 pl. Price 5 cents.

23. Observations on the Junction between the Eastern Sandstone and the Keweenaw Series on Keweenaw Point, Lake Superior, by R. D. Irving and T. C. Chamberlin. 1885. 8°. 124 pp. 17 pl. Price 15 cents.

24. List of Marine Mollusca, comprising the Quaternary fossils and recent forms from American localities between Cape Hatteras and Cape Roque, including the Bermudas, by W. H. Dall. 1885. 8°. 336 pp. Price 25 cents.

25. The Present Technical Condition of the Steel Industry of the United States, by Phineas Barnes. 1885. 8°. 85 pp. Price 10 cents.

26. Copper Smelting, by Henry M. Howe. 1885. 8°. 107 pp. Price 10 cents.

27. Report of work done in the division of Chemistry and Physics, mainly during the fiscal year 1884–'85. 1886. 8°. 80 pp. Price 10 cents.

28. The Gabbros and Associated Hornblende Rocks occurring in the neighborhood of Baltimore, Md., by George H. Williams. 1886. 8°. 78 pp. 4 pl. Price 10 cents.

29. On the Fresh-water Invertebrates of the North American Jurassic, by Charles A. White. 1886. 8°. 41 pp. 4 pl. Price 5 cents.

30. Second contribution to the studies on the Cambrian Faunas of North America, by Charles D. Walcott. 1886. 8°. 379 pp. 33 pl. Price 25 cents.

31. A systematic review of our present knowledge of Fossil Insects, including Myriapods and Arachnids, by Samuel H. Scudder. 1886. 8°. 128 pp. Price 15 cents.

32. Mineral Springs of the United States, by Albert C. Peale. 1886. 8°. 235 pp. Price 20 cents.

33. Notes on the Geology of Northern California, by Joseph S. Diller. 1886. 8°. 23 pp. Price 5 cents.

34. On the relation of the Laramie Molluscan Fauna to that of the succeeding Fresh-water Eocene and other groups, by Charles A. White. 1886. 8°. 54 pp. 5 pl. Price 10 cents.

35. The Physical Properties of the Iron-Carburets, by Carl Barus and Vincent Strouhal. 1886. 8°. 62 pp. Price 10 cents.

Numbers 1 to 6 of the Bulletins form Volume I; Numbers 7 to 14, Volume II; Numbers 15 to 23, Volume III; and Numbers 24 to 30, Volume IV. Volume V is not yet complete.

The following are in press, viz:

36. The Subsidence of small particles of Insoluble Solid in Liquid, by Carl Barus.

37. Types of the Laramie Flora, by Lester F. Ward.

38. Peridotite of Elliott County, Kentucky, by Joseph S. Diller.

39. The Upper Beaches and Deltas of the Glacial Lake Agassiz, by Warren Upham.

In preparation:

40. Geologic notes in Northern Washington Territory, by Bailey Willis.

41. Fossil Faunas of the Upper Devonian—the Genesee Section, by Henry S. Williams.

— Bibliography of North American Crustacea, by A. W. Vogdes.

STATISTICAL PAPERS.

A fourth series of publications, having special reference to the mineral resources of the United States, has been undertaken.

Of that series the following have been published, viz:

Mineral Resources of the United States [1882], by Albert Williams, jr. 1883. 8°. xvii, 813 pp. Price 50 cents.

Mineral Resources of the United States, 1883 and 1884, by Albert Williams, jr. 1885. 8°. xiv, 1016 pp. Price 60 cents.

In preparation:

Mineral Resources of the United States for calendar year 1885, by Albert Williams, jr.

Correspondence relating to the publications of the Survey, and all remittances, which must be by POSTAL NOTE or MONEY ORDER (not stamps), should be addressed

TO THE DIRECTOR OF THE
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

WASHINGTON, D. C., *October* 15, 1886.