of the comet with that of the meteor, and remembering the prodigious velocity of the former, may we not well imagine that its collision with the highly attenuated upper atmosphere of the sun might develop latent heat sufficient to enable it to rival the sun itself in splendor?

Although much of the evidence presented in favor of the existence of "latent heat of expansion," and of its agency in the production of luminous phenomena, may be said to be circumstantial only,—I trust that it will be found sufficiently cumulative, and accordant throughout, to entitle it to examination.

PHILADELPHIA, MARCH 25TH, 1874.

ON THE PLAGOPTERINÆ AND THE ICHTHYOLOGY OF UTAH.

BY EDWARD D. COPE, A.M.

Read before the American Philosophical Society, March 20th, 1874.

The observations recorded below are based on the collections made by the naturalists attached to the United States Geological and Topographical Survey west of the 100th meridian, under direction of Lieutenant Geo. M. Wheeler, and are published by permission of that officer. To Dr. Henry C. Yarrow, in charge of the department of zoology, and to A. W. Henshaw, assistant, the survey is indebted for material more fully illustrating the character and distribution of the cold blooded vertebrata of the valleys of the Colorado River and of Utah than any heretofore brought together. As one of the results derived from a study of it, it appears that the basin of the Colorado River is the habitat of a small group of fishes of the family Cyprinidæ, which may be called the *Plagopterinæ*, which embraces three genera—*Plagopterus*, Cope; *Lepidomeda*, Cope; and *Meda*, Girard. The group differs from others of the family in the possession of two strong osseous rays of the dorsal fin, the posterior of which is let into a groove in the hinder face of the anterior without being coössified with it, thus constituting a compound defensive spine. The rays of the ventral fin, excepting the first and second, are similarly modified. The greater part of their length consists of an osseous dagger-shaped spine, with grooved posterior edge, which overlaps the border of the succeeding ray, when the fin, like a fan, is closed up. The articulated portion of the ray either emerges from the groove below the free acute apex of the spine, or appears as a continuation of the apex itself. It is worth observing that the only other instance of this ossification of the ventral rays is to be seen in the extinct family of the *Saurodontidæ* of the cretaceous period, the nearest approach among recent fishes being the internal spine in the ventral fin of *Amphacanthus*. The dentition and intestine of these fishes show them to be of carnivorous habits. Interest

attaches to the *Plagopterinæ* as the only type of fishes not known from other waters than those of the Colorado basin.

PLAGOPTERUS, gen. nov.

Pharyngeal teeth, 2.5—4.2, raptorial uncinate, without masticatory surface. A terminal maxillary barbel. Scales, none; lateral line well developed. Dorsal fin with a strong spine composed of two, the posterior received into a longitudinal groove of the anterior. Ventral fins originating (in the type species) a little anterior to the line of the dorsal, attached to the abdomen by a wide basis and length of inner radius. Superior labial fold continued round the end of the muzzle.

This genus resembles *Meda*, Girard, in the presence of the dorsal spine, the adhesion of the inner border of the ventral fin, and the absence of scales, and differs in the presence of barbels, and the inner dental series being 5—4 instead of 4—4. Physiognomy of *Rhinichthys*.

PLAGOPTERUS ARGENTISSIMUS, sp. nov.

This is a small fish of slender proportions, with a rather broad head, with slightly depressed muzzle overhanging by a little a horizontal mouth of moderate size. The caudal peduncle is of medium depth, and the caudal fin is deeply forked. The eye is somewhat oval, and enters the length of the side of the head 4.2 times, and the interorbital width 1.5 times. The greatest depth (near the ventral fin) enters the total length nearly six times, or five and three quarters, exclusive of the caudal fin. The latter measurement is four times the length of the head. The origin of the dorsal is entirely behind the proper basis of the ventral; its first spine is curved and longer than the second, and its basis is intermediate between the base of the caudal and the end of the muzzle. The dorsal rays behind the spine have the basal two-thirds to one-half thickened and completely ossified, the articulated portions issuing from the apices of the spines. Radial formula, D. II. 7; C. 19; A. I 10—9; V. 2. V; P. 16. The first or osseous ray of the anal is rudimental; the fifth spinous ray of the ventral is bound by nearly its entire length to the abdomen by a membrane. The pectoral rays from the second to the sixth exhibit a basal osseous spinous portion, which is not nearly so marked as in the ventrals. The pectorals reach the basis of the latter.

The lateral line is complete and is slightly deflexed opposite the dorsal fin. The lips are thin, and the end of the maxillary bone extends to the line of the front of the orbit. Total length M. 0.071; ditto to middle of basis of caudal fin .0565; ditto to anterior basis of anal fin .040; ditto to basis ventral .021; ditto of head .0145; of muzzle .004; width at posterior nares .006; at middle of pterotic .0078. Color, pure silver for a considerable width above the lateral line. Dorsal region somewhat dusky from minute chromatophores.

Numerous specimens from the San Luis Valley, Western Colorado.

MEDA, Girard.

Proceed. Acad. Nat. Sci., 1856, 192; U. S. and Mexican Bound. Survey, Ichthyology, p. 50.

This genus resembles *Plagopterus* in the absence of scales, while it differs in the absence of barbels and the reduction of the number of teeth of the larger pharyngeal series to 4—4. Girard also asserts twice that the dorsal spine is "articulated," a character not observed by me in any species of the group. His figure of *M. fulgida* represents the ventral radii as articulated; but as there are other points in which it differs from the description, it is probably inaccurate.

MEDA FULGIDA, Girard.

A small species from the Rio San Pedro, a tributary of the Gila, in Southern Arizona.

LEPIDOMEDA, gen. nov.

Dorsal fin originating behind the line of the ventrals, which adhere to the belly by the inner ray. Body scaled, lateral line present. Pharyngeal teeth 4—4 in the inner row. No barbels, premaxillary series complete.

This genus has the physiognomy of *Clinostomus*. The presence of scales distinguishes it from *Meda*. The spinous rays are not articulated.

LEPIDOMEDA VITTATA, sp. nov.

Form moderately stout, the greatest depth (at the first dorsal ray) entering the length to the basis of the caudal fin four and a quarter to a third times. The head is wide and flat above, with decurved pterotics, —and slightly depressed behind the interorbital region. Muzzle obtusely descending, not prominent; mouth terminal and descending to a point below the anterior line of the pupil. Length of head, 3.75 times in total length to basis of caudal fin. Orbit round, 3.75 times in length of head, and 1.3 times in interorbital width. The latter is not uniform, but the middle plane is elevated a little above the superciliary ridges, and separated from them by a shallow groove. Nares sublateral. Teeth, 2.4—4.2. Preorbital trapezoid.

Scales small, covering the whole body, except a space behind the pectoral fin, in twenty-six series above the lateral line, and fifty-six transverse in front of the dorsal fin. Radial formula, D. II. 7; C. 19; A. I. 8; V. I. VI.; P. 15. There are several peculiarities in the constitution of the spines of the fins in which the species differs from *Plagopterus argentissimus*. Thus the second dorsal spine is wider than the first, and so deeply grooved behind as to represent a V in section; it also extends to the extremity of the first, while it is shorter in *P. argentissimus*. The remaining dorsal spines are less distinctly enlarged and ossified; those of the ventrals are less developed, and their apices, instead of being free, continue into the terminal articulated portion. The pectoral radii

peduncle. Inferior fins reddish. The more anterior position of the dorsal fin is one point of difference from *R. maxillosus*.

From Provo; No. 48, a.

Var. II, back dark; a dark band from end of muzzle to caudal fin. Fins and lips red. D. I. 8 Provo; 204 a; 281 a; Colorado Chiquito, 5x., 240 Twin Lake, Colorado. Var. III. Back dusky; numerous large black spots all over the sides and head; fins and lips crimson, D. I. 8, No. 754, from Apache, Arizona.

Hybopsis timpanogensis, sp. nov.

A rather compressed species with mouth obliquely descending, and teeth 2.4—4.2, with strongly developed masticatory surfaces. The lateral line of tubules is imperfect in all the specimens, often only repre-resented by a short series in front of the dorsal fin. In larger specimens it is better developed, and in still larger it may be complete, a point which remains as yet uncertain. In the smaller specimens of *Myloleucus parovanus*, the series is imperfect for a short distance in front of the caudal fin, while it is complete in adults. I have observed the same in the *Hypsilepis anolostanus*, Girard. Scales small $\frac{13}{5}$. The dorsal fin originates a little in front of a line drawn from the base of the first ventral ray. The pectorals do not reach the ventrals, while the latter attain the vent. Radii D. I. 9; A. I. 8; V. 8.

The depth is one-fourth the length, less that of the caudal fin, and the length of the head enters the same 3.66 times. Orbit 3 3 times in length of head, 1.2 times in interorbital width; longer than muzzle. Preorbital bone trapezoid. Total length M .047; do. to basis of dorsal .0215; of head .011; width at pterotics .005.

There is a narrow leaden line from the pterotic region to the base of the caudal, below which the color is yellowish, and above brownish, all dusted with black points. Cheeks silvery. Fins dusky.

Numerous specimens were taken at Provo by Messrs. Yarrow & Henshaw, and at Gunnison (No. 668) by Mr. Klett.

Minomus platyrhynchus, sp. nov.

This Catostomoid belongs to the genus *Minomus*, Girard, as defined by the writer in Hayden's Annual Report of the U. S. Geological Survey for 1870, p. 434. It is of very elongate form, the depth of the body at the dorsal fin entering the total length seven and two-fifths times. The head is short and wide, with expanded and depressed muzzle; its length enters the total five and three-quarter times. The scales are materially larger on the caudal peduncle than on the post-scapular region, and the dorsal fin originates considerably nearer the end of the muzzle than the basis of the caudal fin. Radial formula, D. I. 11; C. 18, openly emarginate; A. I. 7; V. 9 not reaching vent; pectoral reaching half-way to ventral. Scales $\frac{15}{12}$. The orbits are excavated at their superciliary border,

and their diameter enters their frontal interspace 1.66 times, and the length of the head 4.6 times, twice in the length of the muzzle in front of its border. The muzzle considerably overhangs the mouth. The lip folds are tubercular and largely developed, forming a discoidal funnel. The posterior is deeply incised behind; and there is a notch where it joins the anterior lip. The commisure is transverse and abruptly angulate to the canthus, and covered with a cartilaginous sheath as in *Chondrostoma*. Isthmus very wide.

Total length M. 0.168; do. to basis caudal .149; do. to basis ventral .082; do. to basis of dorsal .070; do. of head .029; width of muzzle at mouth .0115; with head at pterotics .0156. Color blackish, belly and ventral fins yellowish (? pink). This species resembles the *Catostomus discobolus*, Cope, but has larger scales, besides presenting generic differences. Several specimens from near Provo. Messrs. Yarrow and Henshaw.

MINOMUS JARROVII, sp. nov.

A less elongate species than the last, with a much less enlarged muzzle. The anterior scales are smaller than the posterior, and the first dorsal ray is nearly intermediate between the end of the muzzle and the basis of the caudal fin. Radii D. 9; C. 18; A. I. 7; V. 9, well removed from both vent and pectoral fin. Depth at dorsal fin 5.75 times in total length, into which the length of the head enters 5.3 times; orbit small, 4.6 times in length of head; twice in interorbital width, and 1.75 times in muzzle, the latter projecting a little beyond mouth, not depressed, but narrowed viewed from above. Labial folds well developed, tubercular, the anterior rather narrow, the posterior deeply-incised. Commissure with acute cartilaginous edge, regularly convex forwards.

Scales $\frac{14}{11}$.

Total length M. .107; do. to basis of caudal .0933; do. to basis ventral .052; do. to basis dorsal .047; do. of head .0205; width muzzle at mouth .075; of head at pterotics .011.

Color light brown with numerous dusky spots and clouds; a narrow abdominal band light; fins and chin ? red.

Two specimens (304a) obtained by Messrs. Yarrow and Henshaw at Provo. Dedicated to Dr. Yarrow, whose zoological explorations in various portions of the United States have been productive of many interesting results.

CATOSTOMUS ? GENEROSUS, Girard.

U. S. Pacific R. R. Surv. X, p. 221.

From Provo, Utah, specimens of two and a-half pounds weight.

Recapitulation :

The fishes of the Utah Lake above enumerated, number twelve species, as follows :

Salmonidæ.

Salmo virginalis, Girard.

Coregonidæ.

Coregonus villiamsonii, Girard.

Cyprinidæ.

Siboma atraria, Girard.
Alburnellus, sp.
Alburnellus rhinichthyoides, Cope.
Clinostomus hydrophlox, Cope.
Clinostomus tænia, Cope.
Hybopsis tinpanogensis, Cope.
Rhinichthys henshavii, Cope.

Catostomidæ.

Minomus platyrhynchus, Cope.
Minomus jarrovii, Cope.
Catostomus ? generosus, Girard.

The following species were obtained at other localities in Utah and Arizona.

CERATICHTHYS BIGUTTATUS, Kirtland.

Baird, Girard, Cope Cyprinidæ of Pennsylvania, p. 366, Tab. xi., fig. 5, var. *cyclotis*, Cope, Proceed. Acad. Nat. Sciences, 1864, p. 278.

Dr. Yarrow obtained a number of specimens of this abundant eastern fish at Harmony, in Southern Utah. This is an unexpected discovery, giving the species the greatest known range of any of our Cyprinidæ, the *Semotilus corporalis* accompanying it to the eastern slope of the Rocky Mountains. The Smoky Hill River was the most western locality for the *C. biguttatus* up to the present time.

CERATICHTHYS VENTRICOSUS, sp. nov.

Allied to *C. henshavii*, Cope, but distinguished by its deeper body and more numerous scales below the lateral line, which exceed in number those above it, contrary to the rule usual in *Cyprinidæ*. Depth at ventral fin one-fourth length exclusive of caudal fin, and a little less than length of head, orbit a little less than one-fourth length of head and 1.33 times in length of muzzle and interorbital width. Muzzle compressed, projecting beyond the horizontal mouth ; maxillary bone reaching the line of the anterior nostril. Radii D. I. 7 ; A. I. 7 ; V. 7. Dorsal originating behind line of ventrals. Scales $\frac{14}{8}$. The specimens are bleached by the action of spirits, but they appear to have been of uniform color, excepting an irregular dark band from the end of the muzzle to the caudal fin. Length of a specimen to base of caudal M. .061 ; do. to base of anal .043 ; do. to base ventral .033 ; do. to base dorsal .035 ; length head .0162 ; width do. between orbits .0045 ; do. at middle of pterotics .0073. Number ccc1 ; from Arizona.

MYLOLEUCUS PAROVANUS, sp. nov.

With a general similarity to *Clinostomus montanus*, this fish may be readily determined by the generic characters of the teeth and fins, as

well as by the reduced number of radii of the anal fin. The genus *Mylolucus* was established by the writer in 1871* for species resembling *Siboma*, in having the pharyngeal teeth of the longer row 4—5, and the origin of the dorsal fin situated in advance of the ventral, but differing in the possession of well-defined masticatory surfaces on the teeth. The typical species is *M. pulverulentus*, Cope, from the warm springs of Utah, a fish which differs from the present one in the greater stoutness of form and smaller and more numerous scales.

Form moderately stout; muzzle short, conical, lips even, mouth very oblique, maxillary bone reaching anterior line of orbit. Profile of head and back gently arched. Depth of body equal length of caudal fin and measuring 4.25 in the total length less that fin; length of head, 3.5 or 6 in the same. Orbit large 3.1 times in length of head; greater than muzzle, equal interorbital width. Scales $\frac{11}{5}$, the lateral line decurved in front, and continued to base of caudal fin. Radii, D. I. 9; A. I. 8; V. 9. The pectorals reach little more than half way to the ventrals; the latter just attain the vent. Caudal well forked. The color is transparent, with a plumbeous lateral band, the ventral and pectoral fins dusky, the dorsal and caudal shaded with the same. Total length M. .0048; ditto to base caudal, .053; ditto to anal, .038; to ventral, .0288; of head, .014; to orbit, .003; width at middle pterotics, .0064.

Numerous specimens were obtained by Dr. Yarrow from Beaver River, in Southwestern Utah. This stream flows into the Sevier Lake, a very alkaline body of water, in which no fishes were found by the naturalists of the survey.

Clinostomus phlegethontis, sp. nov.

Teeth, 1.5—4.2; body, deep, short; scales larger than in any other species of the genus, viz.: eleven longitudinal and thirty-seven transverse series. There is no lateral line, which may be due to the immature state of the only specimen at my disposal. The depth enters the length without the caudal fin 3.5 times, while the length of the head is counted in the same four times. The orbit is large, entering the head 2.75 times, and .2 greater than interorbital width; in older fishes the orbit will be found as usual relatively smaller. The lips are even, and the mouth quite oblique, the end of the maxillary reaching the line of the orbit. Radii, D. I. 7; A.I. 8; the ventrals originate in front of the line of the dorsal, and extend to the vent, and are not nearly reached by the pectorals. Length without caudal fin, .034; ditto to basis of dorsal, .0180; length of head, .008; width ditto at pterotics, .0038. A broad plumbeous band on the side, below which the color is golden, above it probably translucent in life, with a dusky median dorsal line.

Discovered in Beaver River, Utah, with the *Mylolucus parovanus*, by Dr. Yarrow.

* In Hayden's annual Report of the U. S. Geological Survey, p. 475.

CATOSTOMUS ALTICOLUS, sp. nov.

A stout, rather short species of sucker, with elongate head and narrowed muzzle. The scales are larger behind than anteriorly, and number sixty transverse, and nineteen longitudinal rows. The radial formula is, D. 10; C. 18; A. 7; V. 10, originating below the middle of the dorsal fin, and neither extending to the vent nor reached by the pectoral fin. Caudal with shallow emargination. The depth enters the length with caudal five times, which is three and two-thirds the length of the head. Orbit 4.33 times in head, 1.66 times in interorbital width. The muzzle is long (1.66 times orbit), but is not produced much beyond the mouth, but is truncate and narrowed viewed from above. Lip-folds well developed; the superior pendant, the inferior full but incised to the symphysis, the surfaces tubercular. Vertex flat.

Total length M., .0863; ditto to origin caudal fin, .070; ditto to origin anal, .0546; ditto to origin of dorsal, 0365; width head at posterior nares, .008; ditto at middle of pterotics, .010; color silvery, upper part of sides and back dusky. In specimens of this size the lateral line is invisible, but in adults of eight inches obtained by my friend, J. S. Lippincott, it extends to the basis of the caudle fin.

Numerous specimens from Twin Lake, Colorado, obtained by Dr. J. T. Rothrock, botanist of the survey. This lake is situated in the South Park, at an elevation of 9,500 feet above the sea (no. 120).

CATOSTOMUS DISCOBOLUS, Cope.

(Hayden's Annual Report, U. S. Geological Survey, 1870, p. 435).

Numerous specimens from the Zuni River, Arizona, and from another not specified locality in Arizona, (No. 504), obtained by Messrs. Henshaw and Newberry.

HAPLOCHILUS FLORIPINNIS, sp. nov.

First dorsal ray standing above the second or third anal; formula, D. 10—11; A. 13—14; V. 7. Scales large in ten longitudinal and 29 transverse series. First dorsal ray half as far from base of caudal as from end of muzzle. Length of head 4.66 times in total, a little less than 4 times to basis of caudal fin. Orbit large, 3.2 times in length of head and 1.6 times in interorbital width. Mandible projecting a little beyond premaxillary; one external series of teeth in both jaws larger than the others.

Total length M. .0595; do. to anal fin .0385; do. to basis of ventral fin .027; do. of head .0138; width of head at pterotics .008. Color olive gray, the scales with ochre borders. Fins yellow, broadly edged with crimson.

Numerous specimens from the Platte River, near Denver, Colorado. No. 65. A species with large scales.

URANIDEA WHEELERI, sp. nov.

The only Physoclystous or spinous rayed fish as yet found in the Great Basin of Utah.

Radial formula, D. VII. 17; A. 12; P. 15 all simple; Br. VI. The head is depressed and enters the length minus the caudal fin, three times. Orbit large one-fifth length of head, and twice the width of the frontal interspace. Greatest depth (at first anal ray) 6.75 times in length less caudal fin. Anal commencing opposite the third ray of the second dorsal. Lateral line deflexed opposite last ray of second dorsal. The recurved preopercular spine strong, the decurved small and obtuse. Palatine teeth present; end of maxillary reaching line of pupil. Isthmus as wide as length of muzzle and orbit to front line of pupil. Skin everywhere smooth.

Total length .084; do. less caudal fin .069; do. to anal .042; do. to first dorsal .031; of head .022; width at maxillaries distally .0125; at preopercular spines .0185.

From Beaver river S. W. Utah. The other species of the Rocky Mountains, *U. punctulata*, Gill, has, according to that zoologist a much wider head, especially in the frontal region. This character is well exhibited by specimens in Dr. Hayden's collections.

Dedicated to Lieut. Wheeler, Director of the U. S. Survey west of the 100th Meridian.

ON THE ZOOLOGY OF A TEMPORARY POOL ON THE PLAINS OF COLORADO.

By Prof. E. D. Cope.

(*Read before the American Philosophical Society, March 20th*, 1874.)

Some years ago, Thomas Kite, of Cincinnati, observed an Entomostracous crustacean swimming in a temporary pool of rain-water. A species no larger than a pin's head is abundant in horse-troughs, springs, &c., and belongs to the genus *Cypris*. That observed by Mr. Kite is much larger, and is not known to occur in flowing water. It was named *Limnadella Kitei* by Girard. I have since observed it in Pennsylvania, in rain puddles standing in the ruts of roads in woods; and in New Jersey Dr. Knieskern found it in similar pools alongside of roads in the open country. The wonder naturally is, how strictly aquatic branchiferous animals can be propagated under the circumstances, and how they can be distributed from place to place. A similar species has been recently observed by M. Tissandier in pools in the valley of the Seine. These were left by a flood of the river, and before drying up became populous with a species of the Cypridiдæ.

The most remarkable examples of this kind are, however, to be observed on the plains of Kansas and Colorado.

Here rains create temporary pools in depressions of the surface, which may remain for a few days or weeks, but are all dried up by the end of September. Nevertheless, some of them at least swarm with a population of branchiferous crustaceans, worms and larvæ of insects, with the adults, which, in their developed state, come to the surface for air, or live on

in consequence of an explosion, a secondary centre of linear oscillation should be established between the primary centre and the centre of gravity, [$\frac{2}{3} - \frac{2}{3}$ of $(\frac{2}{3} - \frac{1}{2}) = \frac{5}{6}$].

47. Planets and satellites, oscillating under the combined action of centrifugal and centripetal forces, and subject to disturbances from mutual interaction, should tend to arrangements analogous to those of the particles in an exploded gas.

48. The force of superficial gravity, at the Sun and at the principal planets, should be in simple harmonic relations to other elements of planetary motion.

49. The laws of mechanical arrangement, in the particles of a homogeneous elastic æther, should give rise to polar forces.

50. The velocity of primary oscillation (Theses 16, 25, &c.,) *which satisfies the foregoing theses, by explaining all velocities which are the resultants of gravitating force, is the velocity of light.*

These Theses seem to me to be all rigorously and mathematically connected with the hypothesis of a universal elastic æther. In my accounts of the successive tentative steps, inductive, deductive, and anticipative, by which I have been brought to their recognition, there has necessarily been much that was crude, and some things that were perhaps merely visionary, but the steps have all led towards the same goal. While endeavoring to learn caution from my mistakes, I have never ceased for a moment to believe that the many harmonies and coincidences which I have pointed out, were indicative of important but unknown laws.

The identification of v^{x} and v^{λ}, (Thesis 50), is perhaps the most important conclusion of the whole, and its importance may render somewhat fuller details desirable. The common explanation of planetary motions, assumes a primitive tangential impulse and a constant gravitating pull, the resultant of the two forces determining the path at every instant. But it should be remembered that the efficient tangential impulse is by no means the one which was originally communicated; that it, as well as the pull of gravity, is continually shifting its direction, and continually renewed; and that all the known cosmical motions can be as readily accounted for by the impulse of waves upon particles differing in their relative amounts of inertia, as in any other way.

In any case of free orbital revolution around a centre of gravity, every infinitesimal pull of gravitation is assumed to be efficient, in some way or other. If the orbit is circular, the orbital velocity $(\sqrt{gr})$ is renewed, as often as a portion of the orbit, equivalent to radius, has been described. This fact is, of itself, suggestive of equal oscillations, either alternately or simultaneously centripetal and tangential, and it may well justify us in looking for some equally simple relationship to an invariable velocity of primitive and continual impulsion.

The only presumably invariable velocity that we know, being that of