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MORPHOLOGICAL NOTES,
FROM THE BIOLOGICAL LABORATORY OF THE JOHNS HOPKINS UNIVERSITY.

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The Vertebration of the Tail of Appendiculariae.
By GEORGE LEFEVRE.

While the Johns Hopkins Marine Laboratory was stationed at Port Henderson, Jamaica, in the summer of 1893, I collected some Appendiculariae which upon examination exhibited a striking irregularity in the so-called vertebration of the tail. After returning to the laboratory in Baltimore I carefully studied my specimens with the aid of an oil-immersion lens, and convinced myself that the interruption in the continuity of the muscle-fibres of the tail is merely an artificial one, and does not represent a true metamerism, as usually described. In the living animals no breaks in the muscle-fibres were observed, and so far as I am aware, this appearance has never been seen except in preserved specimens.

The muscle-fibres in the tail of Appendiculariae are arranged in two layers or plates, a dorsal and a ventral one, while between them lie the notochord and nerve-cord. At definite intervals the muscle-fibres are seen to be interrupted by transverse splits, which involve both the dorsal and ventral layers at about the same level; the number of these splits is perfectly constant. By using a high power of the microscope the artificial character of the splits becomes apparent, and the ragged ends of the broken fibres are clearly seen, where they have been torn apart. Usually these transverse splits, a surface view of which is shown diagrammatically in Fig. 1, extend uninterruptedly across the entire width of the layer of muscle-fibres, but in many cases they are represented by zig-zag rows of isolated clefts, Fig. 2. This condition, where only some of the fibres have been broken, while the rest have remained intact, certainly cannot be taken as representing a true vertebration. In those specimens, in which the transverse splits were continuous across the whole width of the tail, all of the splits were of this character, while in those exhibiting the zig-zag rows of isolated clefts no continuous splits were found. Other splits, besides the transverse ones, are frequently seen; of these some are simply large irregular clefts of no uniform character and lying anywhere along the tail, while others have a peculiar and constant form. The latter are circular, the splitting having taken place in such a way as to completely isolate in the centre of the circle a little group of portions of muscle-fibres. There were two or three splits of this kind in nearly every specimen which I examined, one always occurring near the base of the tail and close to the large caudal ganglion; such a split is shown in Fig. 3.

Lankester* described seven myotomes in the tail of Fritillaria furcata, while Langerhans† states that in the species of Oikopleura and Fritillaria, which he examined, ten muscle segments were present. In my specimens, however, the number of such divisions of the muscle-fibres was always nine. In the article just referred to, Lankester says, "I could not trace a distinct fibrous septum separating the myotomes from one another, but merely a break in the continuity of the muscular fibres. It is probable that a very delicate membrane separates each myotome from its successor, but my specimens did not enable me to distinguish such." I have examined my specimens with an oil-immersion lens both as whole objects and in sections, and am confident that no such membrane is present, and that the appearance which Lankester did see, namely, "merely a break in the continuity of the muscular fibres," is the true condition.

I had at my disposal some Appendiculariae which had been collected by the U. S. Fish Commission in the Gulf Stream, and which belonged to the same genus, Oikopleura, as the Jamaica specimens; these were found on careful examination to exhibit not the slightest trace of breaks of any kind in the muscle-fibres. On gently stretching the tails of these Appendiculariae between forceps, I was enabled, however, to produce in several cases the

†Zeitschr. fär Wir. Zool., Vol. 34, p. 144.
entire number of eight transverse splits, exactly similar to the ruptures shown in my other specimens. I mention this as furnishing additional evidence of the artificial nature of the breaks.

In the light of the above facts there can scarcely be a doubt that the splits observed in the tail of Appendiculariae are due to the shrinking of the muscle-fibres, caused by the action of reagents. That they have only been seen in preserved specimens; that frequently the transverse splits are not continuous across the entire width of the tail, but are simply rows of isolated clefs; that other breaks are present besides the transverse ones; that no fibrous septa exist between the divisions of the fibres; that in some cases no splits at all are to be found, as in the specimens obtained from the Fish Commission; and finally, that when highly magnified, the splits appear so evidently to be merely tears in the fibres—all these facts point conclusively to the artificial character of the interrruptions in the continuity of the muscle-fibres.

Just why the transverse splits should take place at definite intervals is a question upon which I am not able to throw any light. The only other structures which do occur at regular intervals in the tail, are the paired nerves which are given off from the nerve-cord, and it might be that the splitting of the muscle-fibres at definite points is in some way connected with their innervation. This supposition is strengthened by the fact that one pair of nerves is present for each myomote in the tail of Appendiculariae.

The irregular splits evidently are purely accidental, while those, which exhibit a constant circular form, might also be connected with the innervation.

In my specimens I was unable to satisfactorily stain the nerve-cord and "spinal" nerves, and hence can say nothing as to the distribution of the nerves or their endings in the muscle-fibres. I hope, however, this summer to collect more material, and with fresh specimens to be enabled to successfully stain the nerves.

I would say in conclusion that the tendency of the muscle-fibres in the tail of the Appendiculariae to break at definite intervals may be regarded as the first step towards an incipient vertebraation. Lankester's view, that this "metamerism" is "most satisfactorily explained as a remnant of a more fully expressed 'vertebration,' which was possessed by a larger and more elaborate ancestor of the Appendiculariae, of which existing forms are the reduced and degenerate descendants," would appear in the light of the above facts to be untenable.

I am indebted to Dr. Bigelow of the Massachusetts Institute of Technology, for specimens of Appendiculariae, which he has kindly placed at my disposal.

Origin of the "Nasutus" (Soldier) of Eutermes. By H. McC. Knower.

In his monograph on Termites, Dr. Hagen pointed out that certain species of his sub-genus Eutermes were peculiar in having an individual not found elsewhere. He called this form "nasutus," on account of the nose-like process of the head, and believed it to be a worker, though always spoken of by observers as a soldier. He however made the following statement: "But it seems useless to theorise as to their significance, and an explanation must be sought in further observations."

Since Dr. Hagen's contribution such observations have not been forthcoming.

While in Jamaica, in 1891, I found a species of Eutermes very numerous, living in large conical nests built chiefly in trees. This species undoubtedly belongs within the sub-genus Eutermes, and is probably nearly related to Termes Ripperii; but, following Dr. Hagen's classification, it certainly must be ranked as a distinct and new species.

Communities of this species have two kinds of wingless individuals, which I shall speak of as workers and soldiers (these latter are "nasutus"). The workers are not remarkable. They are 3 mm. long, and have 14 segments to the antenna. The head is large, and bears well-developed, strong mandibles. It is quite flattened from before back. The abdomen is large, and distended by its load of wood, causing the animal to move sluggishly.

The soldier is quite unlike the worker in both structure and habits. It is a "nasutus," is 4 mm. long, has antennae of 13 joints, and its mandibles are extremely small. The whole creature is smaller than the worker; the difference being chiefly however in the size of the abdomen, which is very much smaller in the "nasutus." As a result of this, the animal can move much more actively than the worker.

The head is the most remarkable part of the "nasutus." As Dr. Hagen pointed out, it is somewhat pear-shaped. The long nose-like process runs out anteriorly over the mouth to a point, and expands posteriorly to form the globular head. The head is black and highly polished. Inside of it Dr. Hagen saw a retort-shaped vesicle, which lay among the muscles and opened to the exterior at the point of the nose. A light spot, on either side of the base of the nose, has been described as an eye. Several observers have seen a drop of clear fluid exuding from the perforated end of the nose.

I have examined sections of the head of the adult "nasutus," as well as of larvae just preceding the last moult. These larvae are practically adult in structure, differing from full-grown specimens chiefly in the amount of connective tissue which everywhere surrounds the organs, in their consequent white color, and in the softness of chitinous structures. Sections of the adult head show that the vesicle is quite large, occupying nearly a third of the head cavity. It lies in the posterior portion between the large mandibular muscles, which however are not attached to it, with its upper surface nearly in contact with the hypodermis. To either side there is a lateral extension among the muscles, while anteriorly the cavity narrows down to a funnel-like process, which runs forward in the median plane over the brain. It passes just above the union of the two halves of the brain to the end of the snout, being surrounded by loose connective tissue in its course. There is apparently no connection between the cavity of this vesicle and the tracheal system or the head-cavity, but it is entirely closed, except at the one point where it opens to the exterior. The walls (except the roof) of the vesicle are thick and formed of a single layer of high, columnar, glandular cells. These have dense protoplasm, a large nucleus at the base, and secrete a thin cuticular lining to the cavity. The roof is, however, very thin, and formed of a flattened layer of epithelial cells. The cells of the vesicle rest on an outer thick chitinous membrane, which separates its cavity from that of the head. Lining the duct are small flattened cells, like those of the roof of the vesicle and of the hypodermis. The cuticular lining of the duct secreted by these cells is quite thick, and is folded in longitudinal ridges in the adult. In the lumen a refractive concretion is often found in sections, which is probably the hardened secretion of the glandular cells of the vesicle. At the base of the nose, just under the hypodermis and above and in front of the brain, there is a collection of what appear to be large ganglion cells, but no connection has been traced between them and the brain or other structures. These cells extend out nearly to the end of the snout. Similar cells are found in the hypodermis of the abdomen, but widely separated and few in number. Sections show no trace of eyes.

Dr. Hagen saw similar vesicles, lying among the muscles of the head and opening on a slight protuberance, in winged individuals and in ordinary soldiers of several species. He believed them to be glands which pour out their secretion when pressed by the muscles of the mandibles. The structure of the vesicle of the Jamaican "nasutus" is certainly glandular, but I have never seen any fluid flow from it, though observing the soldier carefully.

Though this gland is such a prominent feature in the structure of the head of the nasutus of the Jamaican species, there is no trace of it in the worker's head. A large number of workers and larvae of all sorts were examined.
without any sign of the gland, except in adult "nasuti" and in young "nasuti" ready for their last moult. Adult nasuti are relatively few as compared with workers, so it was not surprising to find few larval nasuti; but it seemed for a long time very odd that, among hundreds of larvae, no larval soldiers were found younger than the stage just preceding the last moult. This was explained, as well as the origin of the nasutus, when at last a worker-like larva was found nearly as large as a young nasutus, with 13 joints to the antennae, and with worker head and jaws. This worker-like larva had a small head-gland with no nose process outside of head, though sections show essentially the same structure in the gland as that of the "nasutus."

Another specimen, discovered later, settled the matter; and proved conclusively that the "nasutus" is, like the more ordinary form of soldier, merely a more specialized worker. This is a young "nasutus," fixed in the act of withdrawing from its younger larval skin. The antennae and legs are but half way out of the exuvia, which without doubt was the skin of a worker larva, as shown by the head and jaws. These latter are large in worker larvae, while in the "nasuti" they are extremely small.

Though the presence of the head-gland has therefore furnished conclusive proof of the origin of the "nasutus" from the worker larva; I have as yet been unable to trace the formation of this peculiar vesicle, since my material contains so few of the early stages of the "nasutus." I hope to study this question later. The "nasuti" are undoubtedly soldiers, though they lack the powerful jaws found in soldiers of other species. They apparently never work. They perform all the functions of soldiers when advancing with a column of workers; marching on either flank, keeping the workers in line, and sending out scouts in all directions. They stand on guard in a line around the workers when these are busy, and on an attack assemble from all sides to cover the retreat. In all respects they show a remarkable adaptation to soldier's duties. I have been unable to determine whether the secretion of the head-gland is poisonous to enemies, but unless this is the case its function is not evident. Some observations go to prove that ants avoid "nasuti" while attacking workers fearlessly, though, as has been pointed out (Figure 6), the latter have powerful jaws. So it would seem that in nasute soldiers the snout with its secretion has proved a better weapon of defense than jaws, and consequently has been continually improved, while the jaws have decreased in size and importance. The small mandibles of the "nasutus," hidden at the base of the nose, can be of little use in fights with the very active and powerful tropical ants. The long ruandibles of the "nasutus," hidden at the base of the nose, can be of little use in fights with the very active and powerful tropical ants.

The Development of the Fins of Teleosts.

By ROSS GRANVILLE HARRISON.

[Preliminary Communication.]

[This work, undertaken at the suggestion of Prof. M. Nussbaum, was carried on partly in the Anatomical Institute in Bonn, and partly in the Biological Laboratory of this University.]

Excepting the elasmobranch fishes, we have no complete knowledge of the development of the extremities of any group of vertebrates. The skeleton alone has received due attention. The muscular system of the limbs of the higher vertebrates has been supposed by recent writers who have touched upon the subject, to take its origin from masses of cells derived from the myotomes. These myotomic cells are in a general way to be regarded as homologous with the cells of the musculo-buds (Muskelknospen), out of which the definitive muscles of the elasmobranch fins are known to develop. The following observations made upon the salmon (Salmo salar) render a modification of this view necessary.

The Unpaired Fins.

The unpaired fins arise as proliferations of the mesenchyme cells, which, in the form of a loose meshwork, fill the median fin folds. The caudal fin is the first to appear, and is followed by the dorsal, the anal, and the adipose, in the order named.

Shortly after the dorsal thickening has appeared, muscle-buds appear at the anterior dorsal angles of the myotomes of that region, and grow rapidly into the fin-rudiment, as has been described by Dehnh (Studien IX. Mittheilungen aus der Zool. Stu. zu Neapel, Bd. VI). These processes converge considerably towards one another, so that, while the middle ones project at right angles to the long axis of the body of the fish, those at each end of the fin cut the axis at an angle of about forty-five degrees. Cross sections show that the buds are solid; a few cells are enclosed by an epithelium of similar cells. The nuclei closely resemble those of the mesenchyme and the cell boundaries are indistinct. The buds are continuous with the cells of the lateral layer of the myotomes (cutis-plate). Similar buds grow out from the anterior ventral angle of the myotomes in the region of the anal fin. The tail fin also receives outgrowths from several of the terminal myotomes; the adipose fin never contains muscle-buds or muscle-tissue of any kind. As the buds grow farther into the fin-rudiment, their outer ends become enlarged and somewhat flattened against the epidermis, in which a considerable bulging is caused. The stalk now disintegrates, and its component cells can no longer be distinguished from the mesenchyme. In the meantime the nuclei which lie in the median half of each bud accumulate considerable cytoplasm as a first step towards differentiation into muscle cells. These masses of embryonic muscle cells now grow centripetally; they ultimately become the erector muscles of the fin-rays. The lateral half of the bud now loses its identity as a cell-mass, having become undistinguishable from mesenchyme, but very soon the cells which lie opposite the peripheral end of each bud accumulate more cytoplasm, and these masses also grow towards the body, remaining close to the epidermis. They ultimately become the superficial muscles of the rays, which in the adult take origin from the skin. By this time the mesenchyme has developed to such an extent that the muscle masses are not at all clearly defined, so that it is impossible to draw a sharp dividing line between nuclei which will ultimately belong to muscle and those of the connective tissue.

By this time cartilaginous rods, alternating with the muscle-pairs, have appeared in the middle plane of the fin. These become the interspinal bones which support the rays of the dorsal fin; in the anal fin they are the interhaemals. The chondrification takes place centripetally. I shall call them ray-supports.

Horizontal sections of this stage show clearly the serial arrangement of the various structures of the fin. Opposite the cartilaginous rods, the ectoderm is constricted to a marked degree. At these constrictions mesenchyme cells have aggregated close to the ectoderm, forming loose strands of cells, one on each side of each ray-support. This is the beginning of the definitive depressor muscles of the fin-rays.

The dermal rays now begin to develop, in lines which are distally continuous with each erector muscle rudiment, the cells of which are not separated from those of the corresponding rays by any sharp dividing line. Considerably later a small nodule of cartilage is formed at the tip of each
carpilaginous ray-support, which has in the meantime become considerably bent with its convexity forward. Each pair of dorsal rays grasps with its basal end the corresponding cartilaginous ball, and a strong fibrous tissue binds them together. Muscles now become inserted into this mass, in such a manner that each ray receives one pair of each of the three muscles belonging to each segment of the fin. Anterior to the pivot on which the cartilaginous ball rests, the erector is attached; posterior to the pivot, the depressor, and the muscle which takes origin from the skin. The depressor and the erector arise from the ray-supports. The fin has now practically reached its adult condition except that the cartilaginous skeleton has not yet ossified.

The above account holds good only for those segments which do not lie at the ends of the fin. In the first two or three segments the course of development is considerably modified, although the same definitive arrangement is reached.

The number of myotomes which produce buds is variable, but as a rule ten or eleven reach the dorsal fin, and eight the anal. Both anterior and posterior to these, buds may be formed, but they do not reach more than rudimentary development. The number of these buds is very variable. When the cartilage has just begun to appear, and the muscle-masses are on their way to segregation from the surrounding mesenchyme, these rudimentary buds have disappeared, presumably having disintegrated into ordinary mesenchyme tissue. Both anterior and posterior to the regularly formed muscles, are paired masses of closely packed mesenchyme cells which form a distinct layer under the epidermis. These masses are undoubtedly derived both from the original mesenchyme of the fin and from the breaking down of the rudimentary buds. The posterior mass of each side differentiates into two muscles, one corresponding to the erectors, the other to the skin muscles. These become attached to the posterior ray of the fin. A depressor muscle is wanting in the case of this ray.

Anterior to the first of the regularly formed muscles is a cartilaginous ray-support, and anterior to this are the masses or laminae of undifferentiated cells described above. In the middle plane, anterior to the first cartilage, at the regular distance existing between the other ray-supports, cells aggregate, and later chondrify, forming another ray-support. That portion of the undifferentiated muscle mass lying between this new cartilage and the one next succeeding it, segregates from the rest, and from it, muscles corresponding to those of the region of the muscle-buds are developed. This process continues until the usual number of rays and muscles found in the adult fin is reached. In Salmo salar this is fourteen in the dorsal and ten in the anal. The anterior ray-support and its muscles are not so fully developed as the others.

Each fin is innervated by a series of spinal nerves. The nerves of each fin are connected by a longitudinal commissure which is a branch of the ramus lateralis vagi. I am unable at present to trace the development of this interesting plexus.

In late embryonic and in the adult stages the metameres of the fin correspond to that of the body of the fish. In earlier stages the fin is more concentrated, as exhibited by the strong convergence of the muscle buds which enter into it. This varies, however, greatly in different species and is a matter to which but little importance is to be attached.

The Ventral Fin.

The ventral fin appears considerably later than the median fins. The first traces of it to be seen are slight aggregations of cells in the body wall just below the ventral edge of the myotomes which lie in the region of the dorsal fin. About the same time the epidermis covering these parts becomes considerably thickenened through multiplication of its cells. Before the aggregations of mesenchyme cells become very numerous, muscle-buds grow out from the anterior ventral angle of each myotome in this region. About six enter the fin-rudiment; those at each end of it projecting very obliquely to the axis of the body, converge towards the middle of the fin.

Dohrn (Studien IX, p. 401) draws a sharp distinction between the mode of origin of the musculature of the anal fin and that of the ventral. In this he is followed by Kaestner (Arch. f. Anatu. u. Physiol. Anatu. Abt., 1892, p. 200). Dohrn remarks that while the anal fin derives its muscles from muscle buds, the musculature of the ventral originates "ohne Vermittelung von Muskelknospen, direkt durch Einwachsen der Musculatur vom Urwirbel aus, wie sich leicht an Lachs- und Forellenembryonen nachweisen lässt." I am unable to confirm this statement as my preparations, both surface views and sections, show distinctly that the muscle-buds which grow into the ventral fins are similar to those which enter the anal, except that the latter are considerably larger.

At this stage nerve fibres from the spinal nerves of corresponding segments which give off muscle-buds may be detected in the fin. This is a very much earlier stage than the earliest at which nerves could be seen in the median fins.

The mesenchyme proliferates rapidly, while the ectoderm is raised into a fold which projects from the ventro-lateral surface of the body, parallel to its long axis. The mesenchyme forms a compact mass lying under the epidermis; the region next to the somatopleure is filled with less densely packed tissue. The muscle-buds project far into the fin, but, unlike those in the paired fins, are separated from the epidermis by a layer of mesenchyme. Very soon the buds disintegrate.

The region, in which the first steps towards differentiation of muscle first appear, is the space previously occupied by the muscle-buds. From the very first there are no traces of metamery in this muscle, although it is safe to assume that the cells from the buds take part in its formation. About the same time, at a corresponding position on the opposite or inner side of the fin, a similar differentiation takes place. It is not so likely that cells from the muscle-buds take part in this. Between these two muscle-layers the cartilaginous skeleton has by this time appeared. The development of the skeleton has received such thorough treatment at the hands of Wiedersheim and others as to render further mention of it here unnecessary.

The fin rotates so that its line of attachment to the body makes an angle of about forty-five degrees with the long axis of the body. The inner muscle, of which the beginning was described above, becomes the protractor or abductor profundus, and the outer, the retractor or adductor profundus. The superficial muscles develop before the twisting of the fin takes place. They are formed through differentiation of the mesenchyme cells which lie between the deeper muscles and the epidermis. It is extremely improbable that cells from the muscle-buds take any part in their make up. The musculature and skeleton grow forward in the body wall between the ventral ends of the myotomes, so that eventually only a very small portion of each of the muscles lies in the free extremity. In embryonic stages these muscle-masses are continued distally, without sharp dividing lines, into the mother-cells of the dermal rays.

The Pectoral Fin.

The pectoral fin diverges from the primitive type more than the other fins, both in its definitive structure and in its course of development. It develops considerably earlier than the others, and lacks of histological differentiation of the tissues at that time renders it study more difficult.

The first trace of this fin is to be seen in a thickening of the somatopleure; the thickening of the ectoderm and its fold arise later. This is in accordance with Boyer's observations on Fundulus (Bulletin Mus. Comp. Zööl., Vol. XXIII, No. 2). The thickened portion of the somatopleure is not confined to the "pectoral plate," but extends to the portions of the splanchnopleure, on the same level, and through the nephrostome to the Wolffian duct. This thickened portion of the peritoneum is due to the bυdoidal or columnar character of the epithelium composing it. Anteriorly, laterally, and posteriorly to it, the cells flatten out. There is, just anterior to it, a portion of the body wall in which are numerous mesenchyme cells, derived from the head mesoderm. Ziegler (Arch. f. Mikr. Anatu. Bd. XXX) has regarded this as the rudiment of the fin. Study of the later stages shows, however, that this region lies completely anterior to that in which the fin develops.

At a somewhat later stage, the cells belonging to the pectoral plate become much more distinctly columnar than the others; and, multiplying rapidly, soon become several layers thick, and are much more densely packed than those lying anterior to them. A thickening of the epidermis now takes place, which, unlike that of the ventral fin, consists in an increase in size of the individual cells and not in a multiplication of the same. At the crest of the prominence which the proliferation of the mesoderm has caused, the ectoderm is thrown into a fold, parallel to the axis of the body and extending through three somites. In cross section the structure is triangular; the somatopleure, which extends out over the yolk sac, is its base, and is nearly horizontal. In profile the crest is semicircular. Through rapid proliferation of the mesoderm cells, the prominence becomes
much more pronounced and soon the height greatly exceeds the breadth. The cells which lie near the base are not so densely packed as those lining the external walls.

In the meantime the myotomes have sent out processes from their ventral growing edges, but instead of entering into the fin-rudiment, as given by Kaestner (Arch. f. Anat. u. Phys. Abh. Jahrg., 1892, p. 200) for Salmo and Boyer for Fundulus, they become greatly elongated, and growing forward, give rise to the coraco-hyoid muscle, as has been described by van Wijhe (Verh. d. Konink. Akad. van Wetenschappen, Amsterdam, Dec. 22) for Pristurus, and by van Bemmelen (Anat. Anziger, Ed. IV) for Lacerta. The first myotome is at this stage quite rudimentary; the second and third lie entirely anterior to the fin which is on a level with the fourth, fifth and sixth. The anterior end of the Wolffian duct is opposite the middle or posterior portion of the fifth segment. The first myotome has no ventral process. The second, third and fourth send out long strands consisting entirely of cells from the cutis plate. These grow ventrally in the somatopleuric wall of the pericardial cavity. After a certain time the first one attaches, the second and third bend forwards, and are followed by the fourth (from the fifth myotome), which grows straight forwards and sliglhy ventrally. The foremost one becomes attached to the base of the hyoid arch, by means of a tendon, the stalks connecting the buds with the myotomes atrophy, and the three buds unite to form a muscle which takes origin from the membranous shoulder-girdle, and is attached to the urohyal. This muscle is still divided into three segments, at least in young fish, in which the yolk-sac is entirely absorbed. The last of these buds extends for one whole segment under the pectoral fin with the cells of which it is in close contact. Sections through this, a little anterior to the point of origin of the outgrowth, give such a figure as has been drawn by Kaestner (Fig. 82). This outgrowth is less well defined than the others, and in cross section it can often scarcely be distinguished from the mesoderm of the fin. It is not at all unlikely that individual cells may detach themselves from it and remain in the fin, but it is certain that, as a mass it takes no part in the formation of the fin muscles.

The sixth myotome has a ventral process, which, however, does not grow forward as the others do. It ultimately pinches itself off from the whole length of the myotome, and becomes an independent longitudinal strand of muscle fibres which runs dorsal to the attachment to the fin, but which is afterwards probably incorporated into the lateral muscle masses. The seventh and succeeding myotomes grow ventrally and are concerned in forming the ventral muscles of the fin.

The changes that the fin has undergone are now considerable. The attachment has constricted considerably, at least in comparison with the free portion, which has become a fan-like expansion. With the absorption of the yolk the fin is brought to the ventro-lateral surface of the body, and rotating on its axis, so that the line of attachment, instead of being parallel to the axis of the body, now makes an angle of about forty-five degrees with it, the anterior extremity is thus brought into a corresponding position with that described in the posterior. The internal changes that have taken place during this time are the differentiation of the central core of cells into cartilage, and of the proximal portions of the superficial mesenchyme layer into muscle. It may be regarded as certain that the cells which give rise to these muscles originate from the somatopleuric thickening, and, as is the case with most of the muscles of the ventral fin, are in no way connected with the myotomes. At first there are but two muscle-masses, a primitive abductor or protractor, lying on the outer side of the cartilaginous skeleton, and an adductor or retractor on the inner side. A superficial muscle is developed later from a mass of cells lying just within the fin between the deeper abductor and the inner epidermic wall. The superficial protractor or adductor does not appear until much later and probably arises through delamination from the primitive muscle, though I am not perfectly convinced of this.

The nerves of this fin are distinguished very early in its development, just as in the ventral, i.e. before any differentiation of the tissue has taken place. They arise from the first four spinal roots. The first root corresponds to the second myotome, and its ramus ventralis unites soon with the second nerve to form the hypoglossal. This gives off a branch to the fin-plexus and one to the coraco-hyoid muscle. The arrangement is completed very early in the life history of the individual and seems to be quite typical for the teleosts.

The mesodermic structures of the median fins are derived from mesenchyme cells deriving from the somatopleure and from muscle-buds, which are outgrowths of either the dorsal or the ventral edge of the myotomes. To a certain extent these fins retain their primitive metamericism, in that each muscle-bud may be traced directly into a certain muscle of each segment of the fin. Other muscles are derived from cells which are indistinguishable from mesenchyme cells, and which are in all probability to some extent derived from the same. The segmentation of the extreme anterior portion of the fins is secondary, although in the adult no difference can be seen between the two portions.

The ventral fins show in the early stages of development traces of a similar metamericism. The buds, in this case, soon disintegrate and in the space occupied by them a single muscle-mass develops, the adductor or retractor profundus. The other three muscles of this fin are developed from cells which have arisen from the somatopleure and perhaps also from the slerkeron. This condition in the teleosts seems to be a step between the Elasmobranchs and the Amphibia. In Triton a few isolated cells break off from the ventral edge of several myotomes and merge with the cells of the posterior extremity which are, however, mostly derived from the somatopleure.

According to Paterson (Quart. Jour. Micr. Sci., Vol. XXVIII), the myotomes in the chick take no part in the formation of the muscles of the limbs. Kaestner has cast doubt upon this statement, but it is doubtful whether his grounds for so doing are sufficient.

The pectoral fin is derived entirely from somatopleuric cells. The muscle-buds of this region are greatly modified and take part in the formation of the coraco-hyoid muscle.

I wish to postpone the full discussion of the meaning of this diversity in the origin of the muscles, until some observations on other forms are completed. It is in all probability to be referred to the differentiation of the component parts of the fin until they take up their position within it. In other words, instead of so much connective and skeletal tissue, and so much muscle being contributed to the fin, it receives cells which still retain the potentiality to become any of these, and their position with regard to surrounding cells rather than their origin determines their ultimate fate.

**Pteropods with Two Separate Sexual Openings.**

By H. McC. Knowler.

Having recently had occasion to review the anatomy of Cavolinia longirostris, by means of sections of specimens obtained by the U. S. Fish Commission Schooner Grampus; I find that the statement in text-books and elsewhere, that all Pteropods have but a single external opening for the hermaphroditic sexual organs, is not correct. Cavolinia longirostris (to which species my specimens apparently belong) has two distinct and separate sexual openings.

There is a large hermaphroditic gland, lying posteriorly and dorsally in the visceral sac, which is asymmetrical, being more developed on the left side. In this gland the youngest ova are found in the center, immediately around the intra-glandular portion of the duct, the oldest ova with considerable yolk at the periphery. The male elements arise from lines of cells running from the periphery towards the center. A single duct leaves the gland from its anterior face, dorsally and far to the left. Receiving the seminal vesicle near this point of origin, the duct runs over to the right towards the median plane. Near the middle line it opens into the anterior face of a large glandular sac, which has much folded walls. This sac is the muciparous gland, and the duct ends on reaching it. Sections do not show a separate albumen-gland described for the genus. They do show that some of the folds of the walls of the single cavity of the gland are lined with non-glandular ciliated cells, while others have distinctly glandular cells. The seminal vesicle is, as described, a long sacular growth of either the dorsal or the ventral edge of the myotomes. To a certain extent these fins retain their primitive metamericism, in that each muscle-bud may be traced directly into a certain muscle of each segment of the fin. Other muscles are derived from cells which are indistinguishable from mesenchyme cells, and which are in all probability to some extent derived from the same. The segmentation of the extreme anterior portion of the fins is secondary, although in the adult no difference can be seen between the two portions.

The ventral fins show in the early stages of development traces of a similar metamericism. The buds, in this case, soon disintegrate and in the space occupied by them a single muscle-mass develops, the adductor or retractor profundus. The other three muscles of this fin are derived from cells which have arisen from the somatopleure and perhaps also from the slerkeron. This condition in the teleosts seems to be a step between the Elasmobranchs and the Amphibia. In Triton a few isolated cells break off from the ventral edge of several myotomes and merge with the cells of the posterior extremity which are, however, mostly derived from the somatopleure.

According to Paterson (Quart. Jour. Micr. Sci., Vol. XXVIII), the myotomes in the chick take no part in the formation of the muscles of the limbs. Kaestner has cast doubt upon this statement, but it is doubtful whether his grounds for so doing are sufficient.

The pectoral fin is derived entirely from somatopleuric cells. The muscle-buds of this region are greatly modified and take part in the formation of the coraco-hyoid muscle.

I wish to postpone the full discussion of the meaning of this diversity in the origin of the muscles, until some observations on other forms are completed. It is in all probability to be referred to the differentiation of the component parts of the fin until they take up their position within it. In other words, instead of so much connective and skeletal tissue, and so much muscle being contributed to the fin, it receives cells which still retain the potentiality to become any of these, and their position with regard to surrounding cells rather than their origin determines their ultimate fate.
right corner, to the left of the median line. This is a closed ciliated tube, not a ciliated groove, (in which this species differs from all other Pteropods), which curves around on the right to the dorsal surface of the fins, to run anteriorly and open at the sac of the invaginated penis. On the left side of the uterine gland, sections in all planes show a second opening from the reproductive system to the exterior. This is a slit-like aperture on a slight papilla, on the anterior surface of the visceral sac and to the left. The opening leads directly into a ciliated fold of the uterine gland, the ciliated cells of which turn out at the tips of the aperture and become continuous with the epithelium of the external surface of the body. There can be no doubt that this is a natural opening, and near it is found the seminal receptacle, a thin walled sac filled with spermatozoa and lying on the left face of the uterine gland. This seminal receptacle opens into a fold of the uterine gland, not far from the external opening just described, which I take to be a vaginal opening.

In the possession of two separate sexual openings, Cavolinia longirostris differs from all other Pteropods. The opening on the right side leading to the penis is perhaps to be homologized with the single aperture of other species. All that is necessary is the closure of the usual ciliated groove to form a tube to the penis, and this is an evident advantage in ensuring the transference of the male products. Another opening (vagina) becomes a necessity, as soon as the more primitive right one is given over entirely to the male products, and this may account for the new aperture on the left side. In other words and other Pteropods represent the more primitive condition of the hermaphroditic duct, while Cavolinia longirostris has become more specialized by the acquisition of a separate opening for each sex. The anatomy of the adult does not of course show whether, as Korschelt and Heider would put it, there has been a splitting of a primitively single opening into two; or whether a new, independent opening has been acquired into the left side of the uterine gland. Perhaps the study of the ontogeny of the sexual organs of this species will settle the question.

Korschelt and Heider, Lehrbuch der vergleichenden Entwicklungs geschichte der wirbellosen Thiere, page 1088, fig. 644 c.

Contrary to Pelseneer, Challenger report on the Pteropods, part 3, page 19, the heart of Cavolinia longirostris is on the left side agreeing with Sou leyet's figure of Cavolinia tridentata, for which see Lang, Lehrbuch der vergl. anatomie, page 604, fig. 469.

Muscles in the fins are distinct striated, a condition which Lang states is not found in Molluscs, but which Kellogg found in the adductors and heart muscles of Lamellibranchs. Paneth, describing a similar appearance in the fins of Cymbulia and Tiedemannia, decides this is not natural but artificial striation. I have not been able to study living tissue, but the striation, as I find it, is very distinct and is found in every way like ordinary striated muscle.


Under this head are to be considered, the mm. supra-carinolae; the infra-carinolae including the retractor ischii; the rectus abdominis, and the coraco-hyoides. These muscles are all slender bands of longitudinal fibres, are paired in origin, and generally lie close to the mid line, in the case of the supra-carinolae at the dorsal edge of the lateral body muscles or myotomes, and in the case of the others at the ventral edge. Of the dorsal muscles there are two; one extends from the occipital to the first ray-support of the dorsal fin; the other, from the posterior ray-support of this fin to the tail. The analogous muscles of the ventral side connect the hard parts of the extremities in a similar way. An infra-carinal extends from the anal fin to the tail; a similar muscle originates from the posterior portion of the pelvic; and running posteriorly, encircles the anus, and is attached to the first ray-support of the anal fin; this muscle has been called the retractor ischii. The anterior end of the pelvic bone is connected with the shoulder girdle by a similar muscle. This naturally varies according to the position of the ventral fin varies with respect to the pectoral. It varies also in the degree of its independence from the lateral body muscles. In the salmon it is a quite independent band of muscle fibres, and its position in the adult and its mode of development justify us in homologizing it with the rectus abdominis profundus of the amphibia. [See Maurer, Der Aufbau und die Entwicklung der ventralen Rumpfmasse des bei den Urodelen Amphibien. Morph. Jahrb., Bd. 18.] Anterior to the shoulder girdle, this muscle is continued forwards as the coraco-hyoides, which is attached to the base of the hyoid arch.

These facts regarding the myology of the adult teleosts have long been known. The points which I am here able to contribute to our knowledge of their development in the salmon may not prove uninteresting.

Excepting the coraco-hyoides, the anterior of the supra-carinolae is the first to make its appearance. In the region of the anterior myotomes of embryos in the dorsal fins of which muscle buds have just appeared, there arise aggregations of mesoderm cells, on each side on the mid line, dorsal and median to the dorsal edge of the lateral muscles. The cells which make up these masses are of doubtful origin; they may wander there singly from the dorsal edge of the myotomes, where the cells are still undifferentiated, or they may be mesenchyme cells which have collected at these points. At first no traces of segmentation are present. These cell aggregations extend slowly backwards until they nearly reach the dorsal fin, and finally they become attached to its anterior ray-support by means of a tendon of some length. Long before these loose strands of cells have reached the dorsal fin, the anterior ones begin to differentiate into muscle cells. Segmentation now arises in the young muscle, which becomes divided into a series of small segments connected by tendons. This segmentation arises independently of the metamerism of the body and bears no constant relation to it; the segments are from one and a half times to twice as long as the myotomes. These of the two sides do not correspond with one another but show a tendency to alternation.

Just after the completion of the anterior muscle the posterior makes its appearance in a similar way and develops in like manner except that it is formed almost simultaneously throughout its entire length. The ventral muscles or infra-carinolae also arise similarly except that the cells giving rise to them show at first an undoubted connection with the ventral edge of the myotomes. These muscles are all segmentated in a manner similar to the dorsal ones.

The development of the rectus abdominis differs in important details from that of the other ventral muscles, although, like them, it arises from the undifferentiated ventral edge of the myotomes. In young salmon in which the anterior supra-carinal muscle has reached the dorsal fin, but which still possess a large yolk, the myotomes posterior to the pectoral fin have grown in the body wall, out over the yolk-sac for some distance, forming a rather thin lamina of muscle (ventraler Wirbelbogenstrans of Maurer). The intermuscular septa run obliquely forwards and ventrally. The periphery of this muscle lamella is composed of a band of undifferentiated cells.

Beginning with the myotome just in front of the anterior end of the definitive pelvis, this band of cells soon separates from the myotomes. This separation, gradually extending forwards, there arises a strand of undifferentiated cells which is independent of the lateral muscles. A good while before the anterior portion of this embryonic muscle has acquired its independence, the posterior portion begins to differentiate into muscle fibres, and like the other muscles becomes segmentated, but not correspondingly with the metamerism of the body. The anterior portion also differentiates into muscle cells, and not yet having lost its connection with the processes from the myotomes, septa are formed here at corresponding points, and, unlike the posterior portion of the muscle, the anterior portion corresponds in its metamerism with the rest of the body. The factor which renders this difference in the two portions of one and the same muscle possible is that, while in general all differentiations appear first in the anterior metaneres and extend gradually backwards, this muscle becomes independent at its posterior end first; its tissue, however, differentiates in accordance with the general law and the consequence is, that when differentiation begins, conditions not being alike throughout the extent of the muscle, a difference arises in the metamerism of the two parts.

*The development of this muscle is described in my paper on the fins.
In conclusion then, it is seen that certain muscles, although segmented, have acquired their segmentation independently of the general metamerism of the body, and that even the same muscle may in different portions exhibit different relations between its own segmentation and that of the myotomes. The segmentation of muscles, as observed in the adult, therefore, may or may not have been secondarily acquired, and in view of this, it would seem that observations on the adult anatomy alone are not to be relied upon for determining the number of myotomes which originally took part in the formation of the muscle.

The Family Mniotiltidae in Baltimore County. By J. Hall Pleasant, Jr.

(Abstract of an address delivered before the Baltimore Naturalists’ Field Club, March 19, 1894.)

Up to the present time, some thirty-three species of warblers have been taken in Baltimore County and doubtless this number will be increased by future investigation. Of the two hundred and twenty-five, or more, species of birds going to make up the avifauna of this region, no family is as largely represented as the Mniotiltidae. Yet, with the exception of a few species, the average observer is entirely unconscious of the presence here, in immense numbers of these interesting, and for the most part highly colored, birds. This can to a certain extent be attributed to their retiring habits and diminutive size, few species exceeding six inches in length. If we wish to study the members of this group, they must be patiently and carefully sought after. They do not thrust themselves upon our attention. Largely migratory at this elevation and latitude, the majority pass through the county during late spring to their more northern breeding grounds, to return southward again in early autumn. Many species remain here during the summer months to breed, and one, at least, spends the winter occasionally with us. During the periods of migration the warblers are very generally distributed throughout the county, local conditions, such as differences in the flora and topography, playing but a comparatively small part in their distribution at this time. In the case of the summer residents, however, these factors enter largely into the choice of breeding places. Thus the district to the west of the city exhibits numerous peculiarities in its avifauna as well as in its geology. Here the blue-winged warbler (Ileminthophila cyanura), nowhere a common species, has been several times found nesting. Many similar cases could be cited. Moreover many species occurring throughout the entire county are especially abundant in certain sections. There also seems to be considerable fluctuation from year to year in the number of individuals of some species.

Migration is generally performed at night, the greater part of the day being spent in procuring food. During the first three weeks in May and all through September the warbler migration is at its height. Some species, however, as the Palm Warbler (Dendroica palmarum hypochrysea), arrive much earlier and remain longer than this.

In the following list the relative abundance, and the length of the stay of the various species with us, will be indicated briefly. In the case of a few rare species, the dates of their occurrence will be added. It is to be regretted that lack of space prevents as full a treatment of local distribution as is desirable.

**Mniotilta varia.**—Black and White Warbler.

Summer resident. Especially abundant during migration. It arrives about the middle of April, and leaves early in October. It is very generally distributed over the county in summer, and its nest has several times been found.

**Helmitheros serinus.**—Worm-eating Warbler.

Summer resident. Rather common. Arrives early in May. It has been found breeding in various parts of the county. Several pairs nest along the range of hills extending from Towson to Loch Raven.

**Ileminthophila pinnis.**—Blue-winged Warbler.

Summer resident. Uncommon. Mr. Geo. H. Gray during the past few years has found them breeding west of the city.

**Ileminthophila chrysopena.**—Golden-winged Warbler.

Rare migrant. Only three specimens have been observed; May 7th, 1892; May 29th, 1892, and September 6th, 1898.

**Helmithophila rufa.**—Nashville Warbler.

Uncommon migrant. It has been several times observed in May, and once in September.

**Helmithophila peregrina.**—Tennessee Warbler.

Extremely rare autumn migrant. But two have been observed at this season, and it has not as yet been found in spring. All the members of this genus are comparatively rare birds here.

**Compsosphyia americana.**—Parula Warbler.

Summer resident. It has been noted several times during the summer months, but is comparatively rare at this season. As a migrant it is abundant, arriving the last week in April. By the third week in May the majority have passed to more northern breeding grounds. In the fall they are abundant again from September 1st to October 15th.

**Dendroica tigrina.**—Cape May Warbler.

Migrant. Only two specimens have been taken. One of these was shot by Mr. Arthur Resler, October 22d, 1890; the other by Mr. W. N. Wholey, October 21st, 1893.

**Dendroica castanea.**—Yellow Warbler.

Summer resident. Locally distributed. Many nest in the heart of the city. It arrives about the 20th of April, and remains until late in September.

**Dendroica cerulea.**—Black-throated Blue Warbler.

Migrant. It is found in spring from the last week in April until May 20th, and again in autumn, from the last of August to the middle of October. It frequents thickets in woodland.

**Dendroica coronata.**—Myrtle Warbler.

Winter resident. It has been found from the first week in October to May 20th. They are quite abundant in the spring and fall, frequenting orchards and open woods.

**Dendroica maculata.**—Magnolia Warbler.

Migrant. Abundant from May 1st to 25th, and again in autumn from the last of August to the first week in October. This is chiefly a woodland bird.

**Dendroica cerulea.**—Cerulean Warbler.

July 14th, 1893, I obtained an adult and two young near Towson. The former had been heard singing about a week previous. This species has never before been found in summer east of the Alleghanies. This is the only record of its occurrence in Baltimore county.

**Dendroica penelope.**—Chestnut-sided Warbler.

Migrant. Abundant from the last of April to May 25th, and again from the 15th of August until the middle of October. This is distinctively a woodland species.

**Dendroica solstitialis.**—Bay-breasted Warbler.

Migrant. It occurs sparingly in May and September.

**Dendroica striata.**—Black-poll Warbler.

Migrant. In spring during May, and in autumn from September 15th to the middle of October. Quite common in woodland during some seasons.

**Dendroica blackburnii.**—Blackburnian Warbler.

Migrant. Rather common in spring during the first three weeks of May, and again from the last of August until the second week in October.

**Dendroica virens.**—Black-throated Green Warbler.

Migrant. Very abundant in woodland from April 20th to May 15th, and from late August to the third week in October.

**Dendroica vigorsii.**—Pine Warbler.

Summer resident. This is a very uncommon bird. It doubtless breeds here in suitable localities. Mr. A. Resler has several times observed it, once June 28th, 1892, when it was probably nesting.

**Dendroica palmarum hypochrysea.**—Yellow Palm Warbler.

Migrant. In spring during the greater part of April, and in autumn from the last week in September to the third week in October.

**Dendroica discolor.**—Prairie Warbler.

Summer resident. It arrives the 20th of April, and remains until September. During this period it frequents chiefly scrub-pines.

**Saxicola austrocinclus.**—Oven-bird.

Summer resident. Abundant from the 10th of April until early in October. It spends most of its time on the ground frequenting chiefly damp woodland hill-sides.
President Gilman, with the consent of the Trustees, made a journey, at the end of February and in the beginning of March, through the Southern States. He visited Columbia and Charleston, S. C., Savannah and Atlanta, Ga., Tuskegee, Montgomery, Florence, and Mobile, Ala., New Orleans, La., Nashville, Sewanee, Chattanooga, and Knoxville, Tenn., and Asheville, N. C. He met and conferred with many persons who are interested in the progress of education, and received many courtesies, not only from those whom he had known as students, but from other teachers in universities, colleges, and schools.

President Gilman delivered an address commemorative of the life and work of Adam Itzel, Jr., late a Professor in the Peabody Conservatory of Music, at the Peabody Institute, February 20.

Professor Adams gave an address in Frederick before the Alumni Association of Frederick College on the evening of February 22. His subject was "The Relation of Preparatory Schools to Higher Education."

Dr. M. D. Learned gave four lectures, in the Peabody Institute course, on German Influence on American Life and Letters, February 6, 8, 13, 15.

Dr. G. H. F. Nuttall has been designated as a delegate to represent the Johns Hopkins University at the International Medical Congress to be held in Rome in April, 1894, and also at the Eighth International Congress of Hygiene and Demography to be held in Budapest in August, 1894.

Professor Haupt will represent the University at the two hundredth anniversary of the founding of the University of Halle, to be celebrated in August, 1894.

The Young Men's Christian Association of the University gave a reception in honor of President Hill, of the University of Rochester, the Levering Lecturer for 1894, in Levering Hall, on the evening of March 16, and the Graduate Students' Association tendered a reception to Professor Norton, the Turnbull Lecturer, on the evening of April 6.

Benjamin F. newcomer, Esq., was elected by the Trustees, April 2, a member of the Board, to succeed the late Hon. Charles J. M. Gwinn.

The Marine Zoological Station has been opened for the session of 1894 at Beaufort, N. C., under the direction of Professor Brooks. The party consists of the following advanced students: H. McE. Knowler, G. Lefevere, C. P. Sigerfoos, D. S. Johnson, J. G. Needham, of this University, and F. S. Conant, of Williams College. They will be joined later by Professor H. V. Wilson, with a party of students from the University of North Carolina.

Professor Henry A. Rowland has been chosen a Foreign Member of the Royal Swedish Academy of Sciences at Stockholm.

CURRENT NOTES.

At the Medical School Commencements recently held in Baltimore, the following graduates and former students of the Johns Hopkins University received the degree of M. D.: University of Maryland.—George W. Dobbin (A. B., 1891); A. Duval Atkinson (Special Student, 1889—91); David Salinger (Special Student, 1889—90).

College of Physicians and Surgeons.—A. T. Gundy (Special Student, 1889—90); John Ruhrih (Special Student, 1892—94).

Baltimore Medical College.—Robert Reuling (Special Student, 1890—93). Dr. Dobbin shared with one student the University Prize offered to the best student in the graduating class, and with another the Surgical Prize.

Thirty-two members of the Northwestern Association of the Johns Hopkins University Alumni attended the third annual meeting at the University of Chicago on February 22. After a business meeting at the Kent Chemical Laboratory a luncheon was served at the Hotel Barry. A letter was read from President Gilman favoring the cooperation of universities in graduate work. President Harper, of the University of Chicago, who was present as the guest of the Association, spoke in commendation of the plan.

On motion of Professor Jastrow, of the University of Wisconsin, the President of the Association was instructed to appoint a committee of five, of which the officers of the Association should be members, to take the initiative in proposing some plan for inter-university graduate work. Professor Jastrow was appointed chairman of this Committee, and Professor Donaldson, of the University of Chicago, was also named as a member.

The officers of the Association for 1894—5 are: President, Professor A. V. E. Young, of Northwestern University, Evanston, Ill.; Vice-President, Professor G. L. Hendrickson, of the University of Wisconsin; Secretary, Professor A. H. Tolman, of the University of Chicago.

Thirteen members of the Association belong to the faculty of the University of Chicago, twelve to that of the University of Wisconsin, and six to that of the Northwestern University.

There will be a meeting of the New England Alumni of the University in Boston, Friday, May 4.

The twelfth series (1894) of the Studies in History and Politics is in progress. The following papers are now ready:


NOTES FROM THE ASTRONOMICAL DEPARTMENT.

Researches upon Comet 1889 V. By CHARLES LANE POOR.

(Abstract from Astronomical Journal, Nos. 202 and 203.)

This comet was discovered by Brooks on July 6th, 1889, and was observed until January, 1891. It was a telescopic comet of short period, and a very interesting member of Jupiter's so-called family. Dr. S. C. Chandler first investigated its history and showed that its orbit had been radically changed by a close approach to Jupiter in 1886; that before that time the comet was moving in an entirely different ellipse from that in which it is at present moving. The interest in the problem was further increased by the great probability of the comet's identity with that of Lexell, 1770, as was also clearly pointed out by Dr. Chandler. The results given in his original paper (Astronomical Journal, No. 205) depended, however, upon the observations of only about three months. In this paper the period of the comet in 1886 was given as 26.5 years, and upon the substantial correctness of these figures depended his conclusions as to the identity with Lexell. In a later number of the Journal, No. 244, I gave the results obtained by taking account of the action of Jupiter during the entire interval between the time of appulse and that of the comet's appearance. The orbit on which this work was based, while far more accurate than that used by Dr. Chandler, was not definitive, being obtained by the method of variation of geocentric distances from ten normal places between July, 1889, and December, 1890.

As my results, given in the above-mentioned paper, differed greatly from those obtained by Dr. Chandler, I determined last spring, to reinvestigate the entire subject and to do the work in as thorough a manner as possible. I was greatly aided in the undertaking by the appearance of a definitive orbit of the comet, computed in a most careful and painstaking manner by Dr. Julius Baaschinger. This work is entitled "Untersuchungen über den periodischen Kometen 1889 V (Brooks)." Unfortunately, however, Dr. Baaschinger found a direct solution of his normal equations impossible; the last element determined being quite uncertain. Hence, the final elements as given in his paper were still subject to an uncertainty, very slight indeed, but enough to affect, to some extent, the character of the appulse with Jupiter. In order to take account of this uncertainty and to show at a glance all the various possible orbits of the comet about the sun, I solved his equations anew and expressed the elements in terms of an indeterminate quantity. Thus the elements on which I based my work took the following variable form:

1889, Sept. 30.5, Berlin Mean Time.

\[
\begin{align*}
M &= 0^\circ 1^\prime 5^\prime\prime 01 + 1^\prime/\sigma \\
\pi &= 31 54 29.9 - 3.0767v \\
\Omega &= 17 59 4.37 - 0.0174s' \\
\omega &= 343 35 50.02 - 3.0593s' \\
i &= 6 4 65.7 - 0.1140v \\
\phi &= 28 5 57.7 - 1.3961v \\
\mu &= 501/72306 + 0.0114v
\end{align*}
\]

The indeterminate, \(v\), may be any number, positive or negative, between the extreme limits of \(\pm 40\). A comparison with the equations of condition showed, however, that the true elements are, most probably, to be found by making \(v\) vary between the much smaller limits of \(\pm 15\). The elements that best represent the present motion of the comet are those obtained when \(v\) is put equal to zero.

The perturbations suffered by the comet during the interval 1889-1886 were then considered; those due to the Earth, Mars, Jupiter, and Saturn being taken into account. Those due to the Earth and Mars were computed for the interval between the epoch of osculation to October, 1888; those due to Saturn until March, 1887; while those due to Jupiter were computed for the entire interval. The intervals of computation were as follows: From September, 1889, to March 25.5, 1887, twenty days; then to December 25.5, 1888, ten days; and from then to October 26.5, 1886, four days. All the final results were tested by differencing and by independent computations. The perturbations, thus found, were then applied directly to the adopted elements without any regard to the changes that might be introduced into them by the different values that \(v\) may attain.

The general method used in computing the great disturbance suffered by the comet in this year was first proposed by D'Alembert, and consists in supposing the planet to have a "sphere of activity," within which the relative motion of the comet is affected only by the planet's attraction, and beyond which the absolute motion of the comet about the sun is performed as if the sun alone acted upon it. The radius of this sphere depends upon the mass of the planet and its distance from the sun. This was the simple method afterwards used by La Place and again by Le Verrier. But, while beautiful and simple, it neglects entirely the effect of the sun as disturbing body, whilst the comet is traversing its relative orbit about the planet. It will become more effective, if we merely use the idea of the "sphere" as defining approximately the point, at which we may conveniently transpose the sun and the planet, as disturbing and central forces; and, after the transformation has been made, we may treat the sun and the comet as bodies revolving about the planet as central body; the sun acting as disturbing body upon the comet. The perturbations of the comet by the sun may be computed in a manner entirely similar to the usual methods. The exact point in the comet's orbit, at which the transformation is made, is of no great importance, provided that the perturbations be carefully computed both before and after.

The relative orbit about Jupiter was a hyperbola, which is represented by the following elements.


\[
\begin{align*}
\pi &= 283^5 41^\prime 55^\prime 12^\prime + 240^\prime 59^\prime \\
\Omega &= 258 10 11.80 - 14.21v \\
i &= 74 52 8.00 - 120.66v \\
F &= 76 34 22.83 + 19.30v \\
a &= -0.085 6771 + 0.000 010 274v \\
\mu &= 1.009 7088 + 0.000 179 192v
\end{align*}
\]

During the time that the comet was traversing the relative orbit about Jupiter the sun acted as a disturbing body, and this action had to be taken account of. In order to do this I computed the solar perturbations for the entire interval between October and March, using an eight-day period. The method used was that of the variation of constants, the necessary formulas being specially derived from the equations of hyperbolic motion as given in Watson. On applying these perturbations I found the osculating hyperbola in which the comet was travelling about the planet on March 24.5, 1886, at which date the motion of the comet was refered back again to the sun as central body. The following table contains the final results of the investigation. It gives the complete elliptic elements for seven different values of the indeterminate, \(v\), and therefore shows at a glance all the various possible orbits of the comet about the sun on the date of transformation, namely, March 24.5, 1886. The elements are all oscillating for that date and are referred to the mean equator and equinox of 1886.0.

For some months before this time, the planet and comet were so close together that the orbit of the latter was continually subject to change, and it was, therefore, necessary to compute the planetary perturbations for an interval of over two years. Applying these the resulting definitive elements of the comet, those corresponding to \(v\) equal to zero, are then as follows:

1884, March 14.5, Greenwich Mean Time.

\[
\begin{align*}
L &= 161^\circ 49^\prime 54^\prime \\
\pi &= 188 46 12 \\
\Omega &= 186 19 14 \\
i &= 6 45 44 \\
\phi &= 26 47 33 \\
\mu &= 133^\circ 6020 \\
\log a &= 0.097 7932
\end{align*}
\]

From these results the time of perihelion passage is found to be 1886, July 20.2416 and the period of the comet appears as 31.88 Julian years.
Comparing these results with those obtained by former investigations, by both Dr. Chandler and myself, one or two facts stand out pretty clearly. First, the angular elements of the orbit are known with a reasonable degree of accuracy; the inclination and the line of nodes appearing as practically the same in all the discussions, while the longitude of the perihelion varies but a few degrees from the value assigned in Dr. Chandler’s original paper. Second, the size of the orbit is by no means so well determined; the period varying in the different investigations from 26.5 to 32.6 years. But the mean result of the present work is, I think, very near the truth. Third, the investigation just completed shows that however accurately the various transformations may be made, that exercise what care we will in the work, there is still bound to be at present an uncertainty of fully two years in this most critical element; and that this uncertainty is due, not to any incompleteness of method or formulas, but to the original observations themselves.

As to Identity with Comet, Lexell, 1776.

Lexell’s comet underwent its notable disturbance in the year 1776, and, moreover, this disturbance took place in that part of Jupiter’s orbit in which Comet 1889 V suffered its great change of elements, as above discussed, in the year 1886. Between these two appulses there intervened a period of 107 years, which period must be accurately accounted for in order to establish the identity of these two remarkable bodies. But, assuming the substantial correctness of the present investigation, we cannot directly account for these necessary years. For the period of Comet V in 1884, or previous to its disturbance, has been shown to be 31.38 ± 1.50 years, which is not an aliquot part of 107. Hence, unless in the intervening years the comet suffered other and marked disturbances in its orbit, the entire question as to the identity between the two bodies falls at once. A further investigation shows us that such disturbances did take place during this interval, but leaves us utterly in the dark as to the resulting changes in the orbit. The uncertainty in the original observations becomes so magnified in this part of the comet’s orbit that we can no longer trace its path with absolute accuracy, we cannot say with certainty that the two comets are, or are not, identical. The probability now seems to be that they are not one and the same body. For a definite solution of the problem we must await the reappearance of the comet in 1896. The first few observations in that year will furnish a very fair approximation to the value of \( r \), from which, by the aid of the tables above given, we can at once derive the elements of the orbit that the comet was describing in 1884, and these elements should be close enough to the true ones to furnish a final answer to the question of identity.

These changes in the orbit of the comet will be better understood by referring to Figure 1. The three concentric circles represent respectively the orbits of the Earth, Jupiter and Saturn; the small ellipse, part full, part dotted, the present orbit of the comet, while the two large ellipses, with the shaded space between them, the possible orbits of the comet before the great disturbance by Jupiter, in 1886. All these various paths for the comet are tangent to one another at the point of closest approach to the orbit of Jupiter, namely, P. This figure shows at a glance the great change that took place in the motion of the body.

The heavily drawn portion of the small ellipse represents that part of the comet’s path which it was actually seen to describe during the years 1889 and 1890. The remainder of this curve and the large ellipses were determined by tracing the comet backward step by step: such curves are entirely theoretical. The still outstanding uncertainty in the present orbit of the comet is so slight that it cannot be represented in the diagram. But fortunately we cannot speak so definitely in regard to the orbit before 1884; the uncertainty is here much magnified and is clearly shown in the diagram.

All that we can definitely say at present is, that previous to 1884, the comet was travelling about the sun, in an ellipse of about 31 years’ period; that its path lay somewhere within the shaded portion of the figure; that during nearly a century this path was undisturbed. In whatever one of these various paths the comet was travelling, it reached the point of tangency in the summer of 1886; at this same time Jupiter arrived at the corresponding part of its orbit, and the comet was gradually drawn from
The Passage of Comet, 1889, V through Jupiter's Satellite System. By Charles Lane Poor.

In 1889, as above stated, the comet passed very close to the planet Jupiter: probably within the orbit of the Fifth Satellite. Exactly how close the two bodies were at any given time is impossible to say; the uncertainty introduced through the original observations here becomes very prominent and precludes many interesting investigations. We can, however, readily place limits, within which the comet certainly passed. It may be stated quite definitely that the comet passed the center of the planet at a distance not greater than 3.65 and not less than 1.00 radius of the planet itself. In other words the center of the comet may have grazed the surface of Jupiter, and it certainly approached that surface to within 2.63 radii of the planet, or only 112,300 miles.

In Figure 2, I have tried to represent what actually occurred. The five satellites of Jupiter revolve about that planet in ellipses differing but slightly from circles, and all lying nearly in the same plane. In figure 2 we are supposed to be looking down upon this plane and to see these satellite orbits in their full size. The orbit of the comet was in a plane inclined nearly 70° to this, and intersecting it in the line Ω, Ω'. The projection of the comet's path on the plane of the satellites' orbits is given, and as the actual path is unknown, I have drawn two curves between which the true orbit is certainly known to lie. The most probable path of the comet is a curve about midway between the two. It must be understood that during the time the comet was thus moving about Jupiter, that body was in rapid motion itself in the direction of the large arrow, and it carried with it, the entire system, satellites and comet.

A careful inspection of the figure will show that the comet rose up suddenly from below the plane of the satellites' orbits, crossing it nearly at right angles, then passed upward and almost directly over Jupiter, and then gradually descended and finally passed below this orbital plane again. So that, as the comet neared Jupiter, there could be no close approach to any of the satellites, excepting at the point where it passed through the plane of their motion. But, on the other hand, as the comet receded from the planet, it hovered over the satellites, and close approaches might occur, provided that the satellites were in the proper places at the right time.

A careful investigation of all possible positions of the comet and of the satellites showed that a collision was impossible; that the comet did not even approach near enough to any one of the four large satellites to cause the slightest change in the relative motion of the nucleus about Jupiter. Such a collision, or, at least, a close appulse, has been repeatedly invoked, to account for the observed disruption of the comet. (The comet, as observed, consisted of four separate parts.) The following table shows at a glance the character of the approach to each of the four satellites for different values of \( \nu \).

### Approach to Satellites

<table>
<thead>
<tr>
<th>( \nu )</th>
<th>( \Omega )</th>
<th>( \Omega' )</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>Differences in Longitude, Comet-Satell.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-40</td>
<td>29.93</td>
<td>1.00</td>
<td>4.87</td>
<td>1.33</td>
<td>1.09</td>
<td>1.09</td>
<td>-24.7</td>
</tr>
<tr>
<td>-20</td>
<td>33.50</td>
<td>1.75</td>
<td>4.18</td>
<td>3.21</td>
<td>2.69</td>
<td>1.67</td>
<td>-65.0</td>
</tr>
<tr>
<td>0</td>
<td>41.93</td>
<td>2.45</td>
<td>3.50</td>
<td>4.12</td>
<td>4.32</td>
<td>2.50</td>
<td>-80.6</td>
</tr>
<tr>
<td>+20</td>
<td>49.43</td>
<td>3.0</td>
<td>2.79</td>
<td>5.12</td>
<td>5.08</td>
<td>5.09</td>
<td>-109.8</td>
</tr>
<tr>
<td>+40</td>
<td>55.43</td>
<td>3.5</td>
<td>2.10</td>
<td>5.46</td>
<td>5.94</td>
<td>6.02</td>
<td>-154.9</td>
</tr>
</tbody>
</table>

The two first columns give the respective distances of the nodes from the centre of Jupiter, the equatorial radius of the planet being taken as unity. The following four columns give the smallest possible distances between the orbits of the various satellites and that of the comet for the four different values of \( \nu \); the remaining columns give the differences of longitude of the comet and satellites at the moment when the comet passed the point of closest approach to the orbits of the satellites.

There are many interesting problems connecting this comet with the Fifth Satellite of Jupiter. There is certainly great probability that the satellite passed directly through the comet; the mean path of the comet intersected that of the satellite, so that a direct collision was possible. Unfortunately the slight uncertainty in the comet's motion is here complicated by an additional uncertainty in the motion of the satellite, which renders it impossible to say definitely that a collision did or did not take place. It is possible, therefore, that the observed disruption of the comet was caused by the action of the satellite. But, all things considered, it is more probable, I think, that it was caused by Jupiter itself.

Jupiter differs greatly from a sphere; its ellipticity being one-seventeenth. Hence in treating of its action upon the comet, the shape of the planet must be taken into account. An investigation shows that the introduction of terms depending upon the shape of the planet caused little or no difference in the actual motion of the nucleus about the Sun. On the other hand, we find in the unequal attractions, due to the non-sphericity of Jupiter, on the various parts of the comet, when at perijove, a ready explanation of the observed disruption.

Among the many interesting problems yet to be fully discussed is this entire question of the breaking up of the comet; as well as the possibility that a portion of it was permanently drawn into the Jovian System, thus forming a new satellite, or satellite ring.

Preliminary Note on the Probable Mass of the Asteroids. By B. M. Roszel.

The accuracy with which astronomical observations are capable of being made at the present time requires a correspondingly high degree of approximation in the mathematical expressions for the position of any celestial body. The time has arrived when the effect of the Asteroids must be investigated, although their almost inappreciable mass would at first sight seem to render them negligible in the general theory of planetary motions.
In this connection mathematicians were formerly chiefly concerned in attempting to prove or disprove the hypothesis of Olbers as to the origin of the Asteroid ring. If these bodies were, as he suggested, the debris of a disrupted planet, their orbits should have a common point of intersection. In order to test this hypothesis the secular perturbations of some of the Asteroids by the larger planets were computed and their former orbits studied and no indication of the existence of such a point being found, the hypothesis was abandoned.

There is another side to the problem, namely, the effect of these small planets on the orbits of the larger ones, and especially the secular perturbations to which a ring of matter, such as they form about the sun, would give rise.

To investigate this latter question is the object of the work on which I am now engaged. The problem divides itself naturally into two parts, first, to determine the combined mass of the asteroid belt; and second, knowing the mass to derive the secular perturbations of the elements of the orbits of certain of the major planets caused by this elliptic ring of matter.

This paper is a short account of the method of carrying out the first part of the work.

The mass must be determined with the greatest possible accuracy. These bodies appear in the largest telescopes as mere points of light and no direct measure of their dimensions is possible. The problem must be attacked indirectly.

The only systematic attempt to investigate the structure of the planetary ring is a paper by A. Berberich (Astronomische Nachrichten, No. 2827). In this paper the author studies the distribution of the asteroids according to their magnitudes and mean motions and endeavors to discover the law of composition of the ring if such a law exists. In default of accurate knowledge several assumptions are required and his results are derived from them.

There are some reasons why a later and more accurate determination of the mass seems desirable. The rapid development of photometric and photographic methods of observing, and the incidental additions to the number of known bodies belonging to this planetary belt have added largely to our data. This in itself is a sufficient reason for a rediscussion of the problem.

The elements of the orbits of some two hundred and fifty members of the group have been derived, and the total number of bodies now recognized as minor planets has nearly reached four hundred. As a starting point, observations furnished the position of the planet at the time of discovery, and its apparent magnitude. The total number discovered and a knowledge of the elements of the orbits of some of them complete the data.

A planet is most likely to be discovered when it is closest to the earth and in opposition. The positions at the time of discovery will show whether the majority of these bodies has been found when they were most favorably situated. If this proves to be so it is reasonable to believe that more will still be discovered than could otherwise be the case.

The Berliner Astronomisches Jahrbuch publishes the mean opposition magnitudes of all the planets whose mean distances have been computed, and in order to obtain an idea of the relative size of these small bodies, their magnitudes were reduced to apparent magnitudes at a standard distance, 27 astronomical units, a distance somewhere near the mean of the distances of the individual members of the group. A curve was plotted of which any ordinate is proportional to the number of asteroids of a given magnitude and the abscissas are the magnitudes themselves. This curve will at once show the relative size of the planets on the assumption that the albedo is a constant quantity.

If the total number of the asteroids were known it would only be necessary to determine the most probable mass of one member of the group to derive immediately the combined mass of the whole group. However, this is not the case. New planets are being discovered continually, and while we can believe that we now recognize the greater number of those bodies which revolve between Mars and Jupiter, we must expect this number to be increased in the future, and a careful study of the probability with which we should expect additions to this group must be made.

Photography introduces a new element into the problem, for a photographic plate, within certain limits, can detect a small object as readily as a larger one and the mean motion of the body is a more important factor than its size in this case.

At the present time I cannot say anything definite regarding the structure of the ring nor of the probability of additions to its mass through the discovery of new asteroids, but a result of the study of two hundred and sixteeen of these minor planets may be of interest.

Professor Pickering derives the probable diameter of Vesta, the largest of the asteroids, from photometric observations (Harvard College Observatory Annals, Vol. XI). He assumes that the albedo of Vesta is the same as that of Mars and finds for its diameter a value $319 \pm 10$ in miles.

The magnitudes of the two hundred and sixteen asteroids vary from the sixth to the fifteenth and one-half, the greater number lying somewhere between the eleventh and twelfth magnitudes.

Now the ratio of the total quantities of light reflected by two planets at the same distance from the observer is equal to the ratio of the squares of their diameter. Their volumes being proportional to the cubes of their diameters we can write:

$$ \frac{V_1}{V_2} = \frac{d_1^3}{d_2^3} = \left(\frac{10}{\sqrt{3}}\right)^3 \left(\frac{m - m_1}{m_2 - m_1}\right) $$

Where $V_1$, $d_1$, $m_1$ and $m$ are respectively the volumes, diameters and opposition magnitudes of two planets at a given distance; the magnitudes being based on a light ratio of 2.5 for one magnitude.

In this way the volumes of all the two hundred and sixteen were expressed in terms of the volume of Vesta. Knowing the dimensions of Vesta we find that it would take roughly three hundred and ten asteroids of the sixth magnitude, or twelve hundred of the seventh to equal our moon in volume. And in round numbers the combined volume of a ring of two hundred and sixteen would be only one two-hundredth part of that of our satellite.

In order to determine the mass the density must be known. Probably a mean density equal to that of Mars would not be far wrong. The densities of Mars and the Moon are $\frac{72}{2}$ and $\frac{1}{2}$, respectively; the density of the earth being unity, or Mars is about 1.18 times as dense as the Moon. This would make the mass of our planetary ring about one one-hundred and seventieth part of the mass of the Moon.

From these considerations we think we are justified in believing that the probable mass of the entire asteroid belt will be somewhere between one-fiftieth and one one-thousandth part of that of our Moon. At least this will be its probable order of magnitude.

**Jupiter's Satellites in 1664. By Frank H. Clutz.**

Under this head is found in the Nation, New York, January 11, 1894 [reprinted in Natures, London, Feb. 1, 1894], a note from President Gilman giving a letter written by John Winthrop, January 27, 1864 (old style). From this letter, which may be found in the volume for 1878, p. 220 of the Proceedings of the Massachusetts Historical Society, the following extract is taken:

"Having looked upon Jupiter with a Telescope, upon the 6th of August last, I saw 5 (+?) Satellites very distinctly about that planet: I observed it with the best curiosity I could, taking very distinct notice of the number of them, by several aspects with some convenient tyne of intermission; & though I was not with out some consideration whether that fifth might not be some fixt starr with which Jupiter might at that tyne he in neare conjunction, yet that consideration made me the more carefully to take notice whether I could discern any such difference of one of them from the other foure that might by the more twinkling light of it, or any other appearance give ground to believe that it might be a fixt starr, but I could discern nothing of that nature, and I consider that the tube with which I looked upon them, though so good as to shew clearly the Satellytes yet was of but 3 foot and halfe with a concave ey-glass."  

Thinking it might be of interest to see if there was any "fixt starre at that tyne in neare conjunction with Jupiter," I have made some investigations in the matter with the following results. Since the letter is dated January 27, 1864 (old style), in our present reckoning, the date of observation was August 16, 1664. For the evening of this date Leverrier's Tables give for the heliocentric coordinates of Jupiter:

- $r = 5.156\,\text{RSU}$
- $\lambda = 296^\circ 27' 29.81''$
- $b = -6^\circ 12' 51.79''$
for the geocentric coordinates of the sun:

\[
\begin{align*}
R &= 1.0113151 \\
\theta &= 14^\circ 29' 25.7'' \\
\varpi &= -0^\circ 0' 7.75''
\end{align*}
\]

and for the obliquity of the ecliptic:

\[
\epsilon = 23^\circ 25' 20.06''
\]

These quantities give for Jupiter as seen from the earth the spherical coordinates:

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<tbody>
<tr>
<td>834</td>
<td>Sagittarii</td>
<td>5</td>
<td>18 45 6.7</td>
<td>-22 55' 26.07''</td>
</tr>
<tr>
<td>835</td>
<td>Sagittarii</td>
<td>5</td>
<td>18 46 3.0</td>
<td>-22 51 11.72</td>
</tr>
<tr>
<td>838</td>
<td>B. A. C.</td>
<td>6.4</td>
<td>18 46 55.6</td>
<td>-23 21 33.04</td>
</tr>
</tbody>
</table>

Reducing the last star, No. 888, for precession to 1604, its Right Ascension and Declination at the date of Winthrop's observation were:

<table>
<thead>
<tr>
<th>R. A.</th>
<th>Dec.</th>
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<tbody>
<tr>
<td>18 35 6</td>
<td>-23 32 6</td>
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We have for purposes of comparison the table:

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<td>18 46 55.6</td>
<td>-23 21 33.04</td>
</tr>
</tbody>
</table>

According to Young the farthest possible distance that the outer satellite of Jupiter, can be from the planet, as seen from the earth is nearly 10.75. In brightness the satelites vary, but on an average the third, which is the largest, is between the fifth and sixth magnitudes. The other three are all about the sixth, or between the sixth and seventh according to different observers. Finally—in distance we see that the star No. 838 was at a distance from Jupiter of about 0.7 m. or 10.75. This is approximately the distance that the outer satellite may reach. In brightness the star is about the same as the three smaller satellites—between the sixth and seventh magnitudes.

In view of these facts I think we may say with a fair degree of certainty that this star was the object which Winthrop took for a fifth satellite on the night of August 16, 1604.

**Postscript.**

A letter from Hon. Robert C. Winthrop, of Boston, addressed to President Gilman, calls attention to a second note on the observations of John Winthrop, which was printed in the Proceedings of the Massachusetts Historical Society for October, 1892.

In this note Mr. Winthrop says that two letters of John Winthrop establish the following facts:—

"First, that within half a century of Galileo's discovery of four satellites of Jupiter, the existence of a fifth satellite was referred to in a work by "Joh. Phociliden."

Second, that on the night of August 6th, 1604, a supposed fifth satellite was observed at Hartford by John Winthrop, Jr., and communicated by him to the Royal Society.

Third, that as early as the winter of 1671-72, Harvard College was engaged in astronomical observations with the assistance of John Winthrop, Jr., although no historian of the University appears to have been aware of it."

The work here attributed to "Joh. Phociliden" is probably the third of three which are thus entered in the catalogue of the British Museum as follows:—

Holwaria (Joannes Phocilides) Epitome astronomiae reformatae generalis. Franeker, 1642. 12o.


This writer is Johann Fokkens, who was born at Holwaden in Friesland in 1618, and who died at Franeker in 1651. Cf. Jöcher, ii, p. 183.
LECTURES ON DANTE, BY PROFESSOR C. E. NORTON.
I. THURSDAY, MARCH 29, 1894.
The Function of Poetry—The Beginning of Italian Poetry.—The Thirteenth Century in Italy.—Dante.


References.
The literature relating to the thirteenth century in Italy is of enormous extent, and to master it is a study for years. Even to make a satisfactory list for a student of the works best worth his reading would be a long and difficult task.

In the following notes and in those to the other lectures of this course, I propose to mention only a few of the more important works, and for the most part such only as may be accessible with comparative ease to the general reader, and such as may serve as an introduction to further studies.

Milman's History of Latin Christianity, vols. IV and V, affords an intelligent, interesting, learned, and in the main, accurate account of the conditions of Europe and especially of Italy, in the thirteenth century.

The best History of Italian Literature is that of Gaspari (2 vols., Svo.) either in the original German, or in the Italian translation. Bartoli's Storia della Letteratura Italiana, 6 vols., 12mo., the last vol. published in 1880, may also be recommended, but it is diffuse and the judgment of the author is less sound than that of Gaspari.

The book with a similar title by De Sanctis, 2 vols., 12mo., 3d ed., 1879, is of value; but is not free from the faults of the Italian genius.

Dante, et les origines de la Langue et de la Littérature Italiennes, par M. Fauriel, Paris, 1854, 2 vols., Svo., was an excellent book in its time, and is still worth reading.

For Florence, the Chronicle of Giovanni Villani is of highest interest and importance. If the Chronicle of Dino Compagni were what it professes to be, a contemporary record of events, it would be of incomparable worth; and tho' it be of doubtful genuineness it is still of value.

The Chronica of Fr. Salimbene, mainly written in 1284, gives a most vivid, naive and picturesque image of the conditions of northern Italy.

To enter into the religious spirit of the time the Fioretì di San Francesco, and the Life of St. Francis, by St. Bonaventura, should be read; and for the religious dogma and moral philosophy of the period, the Summa Theologica of St. Thomas Aquinas is indispensable.

II. FRIDAY, MARCH 30.
The New Life.


References.
The best editions of La Vita Nuova are those by Witte, Leipzig, 1876; by Grillioni, Firenze, 1883; by d'Ancona, Pisa, 1884, and by Casini, Firenze, 1885, and subsequently.

Much has been written about this little book, but not much that deserves reading.

Boccaccio in his Vita di Dante and in his Comento gives an account of Beatrice, which, so far as it is not derived from the New Life itself, is little to be trusted, but should be read as being the generally accepted tradition concerning her.


Mr. Lowell in his Essay on Dante, and Carducci in his Domen di Dante, (originally published in 1865, and reprinted in his Studi Letterari, Bologna, 1889) treat of the Vita Nuova with poetic sympathy and insight.

It is in many respects fortunate that little is known concerning the life of Dante but what he himself tells us. Mr. Lowell in his essay gives a comprehensive account of it. Dante and his early Biographers (London, 1890), by the Rev. Dr. Edward Moore, Principal of S. Edmund Hall, Oxford, the most eminent living English scholar of Dante, is an interesting and valuable study of the original external sources of information concerning his life.

III. MONDAY, APRIL 2.
The Prose Works of Dante and their Relation to the Divine Comedy.


References.
There is no entirely satisfactory edition of Dante's Minor Works. That of Fraticelli, Firenze, 1856 (and since reprinted), in three vols., small Svo., is convenient and easily procured.

An edition of Dante's complete works in a single volume, edited by the Rev. Dr. Moore, is soon to be issued from the Clarendon press, and will unquestionably afford a much better text of the prose works than any hitherto published. It will be a great boon to the student.


IV. WEDNESDAY, APRIL 4.
The Divine Comedy.—Hell.

Dante's conception of his work. Contrast between his outward and his inner life. Qualities of character manifest in the conception and execution of the Divine Comedy.


References.
The most useful edition of the Divine Comedy for students proposing to make a careful study of the poem is that of Scartazzini, with notes in Italian, 3 vols., and Prolegomeni, 1 vol., Leipzig, 1874-1890.

The English reader will find Mr. Longfellow's comment of great service, but it leaves many points of interest untouched.
More is required than any single comment affords, and among the books which may be commended, but which must be read with discrimination, are:

A Shadow of Dante, by Miss M. F. Rossetti, London, 1871; A Companion to Dante from the German of Scartazzini, by A. J. Butler, London, 1893 (valuable, but with much questionable speculation and interpretation); Dante's Divine Comedy, its Scope and Value, by Hettiger, translated by Bowden, London, 1887 (interesting, but not always trustworthy); the essays on Dante by Lowell, Church, Cairel and Carlyle, in their respective works.

The history of the text of the Divine Comedy is told by Karl Witte in the Prolegomeni to his admirable edition, Berlin, 1862, 4to. And, in addition to this, every student of the text must have recourse to Dr. Moore's important work On The textual criticism of the Divine Comedy, Cambridge, Eng., 1889, 5vo.

The Vocabolario Dantesco, of Blanc, Leipzig, 1852, 4vo. (of which an edition in English is needed), translated into Italian by Carbone, Florence, 1859, and the Concordance of the Divina Commedia, by Professor E. A. Fay, 4vo., 1888, published by Ginn & Co., Boston, for The Dante Society, Cambridge, Mass., are indispensable to the student.

V. FRIDAY, APRIL 6.

The Divine Comedy.—Purgatory.


References.

As to the doctrine of Purgatory, held by the Church in the thirteenth century, that part of the Trivatut de Redemptione of St. Thomas Aquinas, should be read which relates to it; Summa Theologiae, Suppl. qu. ixix, lxxii.

OBITUARY.

Dr. Walter Lefevre died in Baltimore, February 2, 1894. Dr. Lefevre was a Fellow by Courtesy of this University in 1882-90. He graduated from the Baltimore City College in 1875, received the degree of Master of Arts from the University of Virginia in 1882, and the degree of Doctor of Philosophy from the University of Heidelberg in 1889. He had been for four years Adjunct Professor of Philosophy and Political Science in the University of Texas.

At a mass meeting of the students of the University of Texas the following resolutions were adopted:

Resolved: First,—That we humbly bow in sorrowful submission to the will of the Almighty in taking from us a kind and faithful friend, from the University a brilliant and zealous instructor, and from his family a loving and dutiful member.

Second,—That we extend our heartfelt sympathy to the bereaved family in this their hour of trial and darkest affliction.

Third,—That a copy of these resolutions be published in The Austin Statesman, the Baltimore Sun, the Johns Hopkins University Circulars, and the Texas University Magazine.


Mr. Arthur Lacy Reese died in Baltimore, March 12, 1894. Mr. Reese entered this University as a special student in October, 1890, and received a certificate of proficiency in Electrical Engineering in June, 1892. He was a foreman and for some years the manager of the electric plant of the Maryland Steel Company at Sparrow's Point, and his death was caused by a shock from an electric wire.

Mr. Benjamin G. Hinde died in Columbia, Mo., February 6, 1894. He was a graduate student of Chemistry in this University from 1888 to 1890. During the year 1890-91 he taught in the State Normal College at Warrensburg, Mo. He next became Professor of Physics in Trinity College, N. C., a position which he held at the time of his death. He spent the year 1892-93 at Clark University, as an Assistant and Fellow in Physics.

FREDERICK D. WESTERFELD, for many years the trusted engineer in charge of the heating apparatus of the University buildings, died on Friday, April 20, 1894, aged 45 years.

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Photographic Map of the Normal Solar Spectrum,

MADE BY

Professor H. A. ROWLAND.

These photographs of the solar spectrum were made in the Physical Laboratory of the Johns Hopkins University. Several concave gratings, of 6 inches diameter and 21 feet radius, having 10,000 or 20,000 lines to the inch, were used for the purpose. The process of making this map is the well known Rowland method, and is based on the property of the concave grating as discovered by Professor Rowland.

As to comparison with other maps of the spectrum made by measurement and drawing, it may be said that no comparison is possible. The photograph is the work of the sunlight itself, and the user of this map has the solar spectrum itself before him, and not a distorted drawing full of errors of wave length and of intensity. The superiority is so great that there is no possibility for comparison.

The following is a list of the plates:

<table>
<thead>
<tr>
<th>Letter</th>
<th>Wave Length (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>3000 to 3330</td>
</tr>
<tr>
<td>b</td>
<td>3270 to 3730</td>
</tr>
<tr>
<td>c</td>
<td>4000 to 4550</td>
</tr>
<tr>
<td>d</td>
<td>4450 to 4950</td>
</tr>
<tr>
<td>f</td>
<td>4850 to 5350</td>
</tr>
<tr>
<td>g</td>
<td>5250 to 5750</td>
</tr>
<tr>
<td>h</td>
<td>5650 to 6150</td>
</tr>
<tr>
<td>i</td>
<td>6050 to 6550</td>
</tr>
<tr>
<td>j</td>
<td>6450 to 6950</td>
</tr>
</tbody>
</table>

The plates will be delivered in Baltimore or New York or will be sent by express or mail, securely packed, at the charge and risk of the purchaser, at the following net prices:

- Set of ten plates, wave length 3000 to 6950, $20.00
- Single plates, $2.50

Should any extra plates continuing the spectrum in either direction be published, subscribers can have them at $2.00 each.

**Extra Plates.**—Two plates have been made of the B and D lines. The latter are 3 inches apart, and the former has an extent of about 24 inches. Two enlargements of some of the carbon bands from the arc electric light have also been made. They show the wonderful structure of these bands, each containing many hundred lines, each one of which is a close double or, in some cases, a triple. These plates will be sold for $2.25 each, unmounted, or for $2.50 mounted on cloth.

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**Memoirs from the Biological Laboratory of the Johns Hopkins University.**

**THE GENUS SALPA,**

**A MONOGRAPH WITH FIFTY-SEVEN PLATES**

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Professor in the Johns Hopkins University and Director of its Marine Laboratory,

WITH A SUPPLEMENTARY PAPER BY MAYNARD M. METCALF,

Fellow of the Johns Hopkins University.

The Johns Hopkins Press has now ready the Memoir on the Genus Salpa by Professor W. K. Brooks. It is issued in two volumes, one volume of text with three hundred and ninety-six pages large quarto, and one volume with fifty-seven large colored plates. The memoir is based for the most part upon material collected by the United States Fish Commission.

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