ducts of Cuvier to the auricle, but the space, in a later stage, is seen to be provided with definite walls and is known as the sinus venosus.

By the time stage F is reached some changes have taken place in the circulation. A diagram of the principal vessels at this stage is shown in Fig. 62. Four aortic arches (ao to ao^4) are now present on each side of the pharynx, instead of one. One of these lies in each of the gill arches and they are separated from one another by the gill slits. They lie at the sides of the pharynx and unite above it to form a single artery on each side, these latter then uniting to form the dorsal aorta. Most of the blood from the aortic arches then passes backward into the dorsal aorta, and so around through the caudal artery and vein into the posterior cardinal veins and vitelline veins, as in the preceding stage. Some of the blood passes forward through the carotid arteries (crt.) to the head and is returned through the anterior cardinals (crd. a. r., crd a. l.). The walls of the sinus venosus are now better marked, and it is seen to be made up by the junction of the right and left ducts of Cuvier (d. cuv. r and d. cuv. l.) with a third vein (v. hp.) which was not before present. This third vein returns the blood from the liver to the sinus venosus. The vein by which the blood is carried to the liver is difficult to make out in the living specimen, but from the fact that blood is passing from the liver there can be no doubt of the existence in this stage of a vein which carries it to the liver. The blood is now red through the presence in it of numerous red blood-corpuscles which began to appear on the thirteenth day and have since become more numerous. The advances in the circulation between stage E and stage F consist then in the formation of the aditional aortic arches, of the anterior and posterior cardinal veins, the hepatic vein, the sinus venosus and of the formation of numerous red blood corpuscles.

The *excretory organs* of the embryo are now established. They consist of two tubes, the segmental ducts. At their posterior ends they open to the exterior, apparently just behind the opening of the alimentary canal. Each tube runs forward from the external opening, at the side of the alimentary canal until it reaches the level of the pectoral fin. At this point one of the tubes is shown in Fig. 53 at prn., where it is seen lying a little way in front of the liver, above the alimentary canal and below the pectoral fin. If the embryo be turned so as to look at the tubes through the yolk from below, it may be seen in favorable cases that at its anterior end each tube turns in toward the middle line of the body and is there lost. High powers also show that at the anterior ends of the tubes their cells are provided with cilia which cause a stream of fluid to flow through the tubes. These anterior ciliated portions of the tubes form the head kidney of the embryo fish, the pronephros. It is likely that in all embryos the fluid which is seen in the tubes has been drawn into them from the body cavity by the action of the cilia in the tubes. The fluid is thus carried back and expelled at the external opening of the segmental ducts. Dissolved in the fluid are doubtless the soluble waste matters which are usually present in the urine of animals and which, in this case, have been transferred from the blood to the fluid in the body cavity, to be carried thence to the outside by the segmental ducts. Opposite the point where each tube opens into the body cavity there has been distinguished in other fish embryos a rich network of small blood vessels forming an irregular mass which projects into the body cavity. These masses are the glomeruli of the pronephros and through these the blood probably gives up some of its constituents to the fluid of the body cavity.

The *hatching* of the fish now depends on the temperature. They are continually moving and turning about within the egg membranes and if the temperature of the water be slightly raised their movements become sufficiently vigorous to rupture the membranes. What the lowest temperature may be at which this is accomplished is not known to the writer, but at a temperature of 55° F. the fish hatch rapidly. The rupture of the membranes seems to be brought about by the attempts of the embryo to straighten the body and tail. In this way the tail is brought violently against the membranes and finally ruptures them so that it protrudes. The embryo then often swims about with the head still enveloped in the egg membranes, but usually it manages to free itself entirely from the egg membranes by a few vigorous movements of the body and tail. It swims with an undulating movement of the body and tail and this serves to carry it toward the top of the water. It then usually becomes quiet while it sinks slowly to the bottom again. If not disturbed it may rest quietly on the bottom for a long time. If disturbed it recommences the undulating movements which carry it to the surface, from whence it again sinks to the bottom.

Embryos kept in a dish through which water was running slowly often lay so close together as to entirely cover the bottom of the dish. Any disturbance in the water then caused them to swarm up instantly and fill the water with wriggling fish. If the dish which contains them be placed between the observer and the sunlight the water appears filled with little tongues of flame, an effect due to the refraction of the light as it passes through the tails of the embryo fish. Owing to the lightness of the oil globule it, together with the yolk, is always turned uppermost during these early movements, so that the embryo swims on its back and it is only when the pectoral fins have become sufficiently developed to be of use that the fish is able to keep its back uppermost. As has been stated, the age of the fish at the time of hatching varies greatly, as also does its structure. If the fish hatch at twenty-five days, they are likely to be in the condition which we have described as stage F. But hatching may be delayed until about the thirtieth day and in that case the fish is in the more advanced condition shown in Fig. 63. It is probable that the hatching may be delayed indefinitely beyond thirty days, though how long is not known.

The oldest embryo that the writer has observed is shown in Fig. 64. It was drawn on the forty-fifth day after impregnating the egg and therefore twenty days after hatching. The embryo has now approached closely to the adult condition with regard to most of its organs, and it may be taken as the type of a stage which may be described as

STAGE G.

The great increase in size is apparent from a comparison of Figs. 63 and 64, which are drawn to the same scale and to which the scale may be applied in measurement. The yolk and oil globule have now disappeared, so that the protrusion which the yolk sac caused on the ventral surface is absent. In Fig. 63 (31 days), a considerable portion of both yolk and oil globule is seen to be still present. But by the 38th day the yolk is entirely gone and on the 44th the oil globule also has disappeared. Both the upper and lower jaws have now extended forward so that the snout has lost its bluntness, and appears sharp, as in the adult. The pectoral fin is much larger and contains supporting rays similar to those in the median fin-folds, It has long since begun to be moved with a very rapid, fluttering movement. The dorsal portion of the median fin-fold is now more elevated in the middle of its length.

The pigment cells have increased greatly in number and are found along the borders of both jaws, on the top of the head and over the sides of the body. There are also a few of them in the caudal fin. As a result of this, the embryo has lost some of its transparency and appears gray to the naked eye.

The *notochord* appears in the figures only at its posterior end, where its structure is seen to be the same as in the preceding stage. Its anterior portion does not appear in the figures on account of the greatly increased thickness and opacity of the embryo. The branchial cartilages, the hyoid cartilage and the cartilages of the lower jaw (Meckel's cartilage) are present, as in the preceding stage. In addition to these a cartilaginous rod has made its appearance in the upper jaw and a second in the region of the pectoral fin. The first of these is shown at p. q. in Fig. 63, and the second is shown at a. pct. in Figs. 63 and 64. The second is the rudiment of the pectoral arch which supports the pectoral fin and gives attachment to the muscles which move it. Each of the cartilages of the pectoral arch is a vertical rod which lies at the base of the pectoral fin, just back of the gill arches.

The *lateral body-muscles* have not undergone any considerable change. Muscles are now found attached to the pectoral fin and others to the gill arches, to the hyoid arches and to the lower jaw. These have been omitted from the figure in order not to reuder it too complicated. The embryo now moves by darting rapidly here and there. Its earlier movements were bendings of the entire body from its head to the tip of its tail and resembled the movements of a tadpole. This resemblance is so great that a person unaccustomed to the embryo fish speaks of them at once as tadpoles and is only convinced of his error when he has seen them under the microscope. In the embryo of stage G, locomotion is accomplished, for the most part, by the movement of the tail alone, and is the same as that of the adult fish. Owing to the disapperance of the oil-globule and to the use which the embryo now makes of its pectoral fins, it is able to mantain a position with the back uppermost. This it does as soon as the pectoral fins can be used and before the oil-globule has disappeared. This, in the embryos observed, was on the twenty-eigth day. On the same day there are seen movements of the lower jaw, gasping movements, as though the embryo were beginінng to breathe by drawing water in through the mouth. These movements soon become the regular swallowing movements by which the breathing of the adult fish is accomplished.

In the *nervous system* the most noticeable change is the increase in the size of the cerebrum. A comparison of Figs. 56, 63 and 64 cbr., shows this increase.

In the *eye* the intensely black color of the preceding stage has given place to a metallic coloring of the exposed surface. Silver, gold and copper colors are seen as though the surface of the eye had been sprinkled with bright, intermingled flakes of these metals. These metallic colors are on the outside of the black pigment of the preceding stage and are due to a coat that has been since added to the eye. This coat is known as the argentea. It covers the retina on its outer surface so that it prevents one's seeing the black pigment except at the pupil. Here one is able to look

through the lens, vitreous humour and sensory portion of the retina, at the black pigment layer.

In the *ear* the semi-circular canals have been better defined and the otoliths have increased greatly in size. The posterior has grown larger than the anterior, so that while the posterior has about six times the diameter that it had in the preceding stage, the anterior has not more than twice its former diameter.

In the *olfactory pit* a further increase is noticed in the size of its cavity, with a consequent greater exposure of surface to the water.

In the *alimentary canal* there are numerous changes. The growth forward of the upper jaw has greatly extended the roof of the mouth and increased the size of its cavity. The lower jaw and floor of the mouth have also extended forward. In Fig. 63, the lower jaw does not yet extend forward quite so far as the upper, but in Fig. 64, the lower jaw has passed beyond the upper and the appearance is that of the adult fish. In both jaws teeth have appeared. The points appear first and lie embedded in the jaw as shown in Fig 63. Each causes the tissue above it to project as a conical elevation, but the point of the tooth is not yet exposed at the top of the elevation and the base of the tooth is not yet in contact with the jaw bone. By the time stage G. is reached the teeth (Fig. 64, th.) are much more numerous and the front ones have grown much larger. They are conical and curved so that the tip of each tooth points toward the throat. The base of each tooth is now in contact with the jaw bone and is probably united to it, while the crown of the tooth projects a little way beyond the jaw. The back teeth are still in the condition shown in Fig. 63. The tongue has made its appearance as a rounded elevation on the floor of the mouth and by stage G., has increased to a considerable size (Figs. 63 and 64, tn.).

In the pharyngeal region the gill slits are now entirely covered by the operculum, which has gradually extended itself backward (Fig. 63, opc.). Four branchial arches are seen on each side in side views, and each is seen to be supported by its branchial cartilage. In Fig. 64, the hinder-most arch is not shown, being covered by the one in front of it.

From the arches finger-like processes have grown out. These are shown beginning in Fig. 63, gl. f., where they appear as blunt rounded prominences. In Fig. 64 they are seen to have become very much longer and those on the posterior arch are beginning to be branched. These are the gill filaments. Just back of the eye there is seen projecting backward into the pharyngeal cavity (at Fig. 63, h. gl. f.) a lobed body. In Fig. 64, this is seen to have become much larger and each of its two prongs is provided with lateral branches. These are the gills produced in connection with the first or hyoidean gill slit, the slit which was formed between the lower jaw and the hyoid arch and which has itself, at this stage, disappeared. All the gill filaments are richly supplied with small blood vessels, the arrangement of which we shall see in considering the vascular system. The blood in the filament is thus brought very close to the water which is passing in at the mouth and out through the gill slits in the act of breathing. This permits an exchange of gases between the water and the blood, the blood giving up to the water its carbonic-acid gas, and taking from the water its oxygen. In other words the gill filaments, which, taken together, we call the gills, are now the organs of respiration.

The *liver* is much larger than in the preceding stage, and its division into lobules is more evident. With a high power it is easy to observe the blood circulating through the liver. It passes by way of numerous small vessels which everywhere divide and unite with another, so that the liver looks as full of them as a sponge is full of holes. In Fig. 64 the blood spaces (bld.) are the darker areas shown on the surface of the liver.

Back of the liver the cavity of the alimentary canal is greatly enlarged. This is shown in Fig. 63 st. where the inner surface is also seen to be thrown up into folds (fld.). This enlarged portion of the canal is the stomach. In the stage shown in Fig. 63, the canal again becomes smaller behind the stomach to form the intestine (ins.), which is marked on the inner surface by regular ring-like folds. In the stage shown in Fig. 64, the absorption of the oil-globule and yolk has given room into which the stomach and intestine have extended, so that the cavities of both are much larger. Stomach and intestine are now separated by a constriction (Fig. 64, pyl.) and the folds of the intestinal wall are not so regular as in the stage shown in Fig. 63. At the posterior end the intestine bends downward to open as before at a notch in the ventral fin fold. Across this, the anal opening, is seen a band of muscle fibres, forming the sphincter muscle by which the opening is kept closed (Fig. 64, mu.). The portion of the alimentary canal between the pharynx and stomach is not readily seen at any stage, but it may be made out in Fig. 63, at oes. It is, the œsophagus. Peristaltic movements of the intestine may be seen in this stage and are present as early as the twenty-seventh day. They consist of waves of contraction, beginning at the anterior end of the intestine and travelling backward, so as to drive ahead of them, toward the anus, the contents of the intestine.

In Fig. 63, at a. bl. there is seen just above the alimentary canal and underneath the pectoral fin a small ovoid vesicle with thick walls. This is the air bladder, or swim bladder, which has doubtless been formed as in other fish as a hollow outgrowth from the alimentary canal. In Fig. 64, it is seen to be much larger and to have thinner walls. It is also covered along its dorsal surface by intensely black pigment cells, which send branching processes downward onto its sides. Tbe alimentary canal is thus brought nearly into its adult condition, being with its appendages, made up of the following parts: the mouth with teeth and tongue, the pharynx with the gills, the æsophagus, the stomach, the intestine, the liver and the air-bladder.

When the fish are first hatched they do not take food, as the teeth are not then well developed, nor are the jaws large or strong enough. Besides, the fish does not yet need the food, being able to draw abundant nourishment from the yolk and oil globule. On the thirty-eighth day in the fish studied, the yolk had disappeared and the fish were darting rapidly about as if in search of food. As this had not yet been provided for them they began eating one another. Fish do not chew their food, their teeth serving only to catch and hold it while it is being swallowed. The food is therefore swallowed whole unless it can be torn into pieces by shaking it violently by sidewise movements of the head. When the embryo fish feed upon one another, the fish that is eaten is swallowed tail foremost, so that only the head is left projecting from the mouth of the swallower. A fish swimming about with the head of another protruding from its mouth then seems to have two heads. In most cases the head of the fish that is swallowed is gradually freed from the body by the action of the teeth and by the shaking of the head of the other fish. The remainder of the swallowed fish seems to be then gradually forced down the throat into the stomach,

where it is digested. If the young fish are provided with other food, their cannibal tendencies are temporarily checked. To obtain such food it is only necessary to strain some of the water from a stagnant pool. Abundance of small fresh-water crustacea, daphnia and cyclops predominating, are thus obtained and these are eagerly eaten by the fish. If they cannot be had the fish will eat liver that has been chopped fine and strained, but they will not eat the liver if they can get living food. It is interesting to watch one of the little fellows as the bits of liver sink through the water. With tail bent ready to dart upon the morsel, and with snout close to it, he poises himself and follows it as it falls. If he concludes to take it, the tail is suddenly straightened, the mouth opened, there is a flash as he moves forward and the morsel is gone.

It is likely that under natural conditions the fish feeds entirely on living animals and that in poising himself before the bit of liver, he is waiting for some movement to tell him whether or not the morsel is living and should be seized. Just what living animal is the food of the embryo of the wall-eyed pike is not known. That it could live indefinitely, on small crustacea, as many other fish embryos do, there is no doubt; but that it does so has not been shown. It seems likely to the writer that the fry of the yellow perch may perish in large numbers as food for the wall-eyed pike fry. The perch eggs are laid a trifle later than those of the pike and probably hatch as soon or sooner and the young perch might offer a tempting bait to the somewhat older pike, should they chance to meet.

The *heart* has been more sharply divided into auricle, ventricle and truncus arteriosus. This is shown in Fig. 64, and in Fig. 59. The opening between the auricle and ventricle is now provided with a pair of valves, (vlv.) which serve to prevent blood that has once reached the ventricle from returning again into the auricle. Similar valves are seen between the ventricle and the truncus and the workings of both sets of valves may be readily studied under a high power of the microscope. Each acts as a swinging door which has been arranged so that it swings but one way. If the door is marked "push" you may get through it by pushing, but once through, push as you may, you can not get back again. You must then pull, as an examination of the label on the door will tell you. So it is with the valves in the heart, the blood pushes against them from one side and they yield readily, allowing the blood to pass them. But once past them the blood can not return, for the harder it pushes the more tightly the valves are closed.

The *sinus venosus* whose connection with the heart was, in the preceding stage difficult to observe, may now be seen to be continuous with the auricular end of the heart. It is a large sac with thinner walls than those of the auricle and into it is poured the blood from the ducts of Cuvier and from the hepatic vein or veins which bring the blood from the liver. Thus the blood from the whole body passes into the sinus venosus, and so into the auricle. The relation of the parts of the heart to one another has now changed. In the preceding stage the ventricle lay anterior to or in front of the auricle and the point where auricle and ventricle joined lay toward the left side of the body and not in the middle line. Now the point of union has been carried downward, and from left to right, until it lies in the middle line. The result is that the plane in which the heart lies, which was before horizontal, is now, in the natural position of the embryo, nearly vertical. At the same time the ventricle is carried farther backward, so as to lie, not in front of the auricle as in Fig. 56, but more nearly beneath the auricle and sinus venosus, as in Figs. 63 and 64. Both these changes are brought about by the reduction in size and final absorption of the yolk and oil globule. In the earlier stage the presence of these large bodies crowds the heart to the left and upward. But as they gradually disappear the apex travels downward, inward and backward to the position shown in Fig. 64. The movement downward towards the middle line is doubtless due to the weight of the heart, which merely falls into position when there is room for it. The backward movement of the apex is due to the contraction of the ventral body wall, as it follows up the diminishing yolk. Being thus forced upward the ventricle travels backward rather than forward and since there is more room for it behind, it thus comes to lie beneath the auricle.

The vitelline vein is obliterated, so that, as an examination of the diagram Fig. 62 shows, all the blood from the caudal vein must now pass forward through the posterior cardinal veins. But all the blood from the caudal vein does not pass directly into the posterior cardinals. Some of it passes a little way along the vitelline vein and then upward to the posterior cardinals through small vessels which have been formed, and which connect the posterior part of the vitelline vein and the posterior cardinals. There are usually four of them on each side. The vitelline vein begins to disappear near its posterior end on the twenty-seventh day, at a time when the yolk has been so much reduced that what is left of it is probably absorbed through the blood vessels of the alimentary canal and liver, which at this time are growing rapidly. The vitelline vein thus persists only so long as it is of use in the yolk absorption, and along the line where the vein ran there is developed a black band of pigment. The circulation through the liver is readily made out and is remarkable for the close interweaving of the tissue of the liver with the blood vessels, the two forming two systems of meshes which interlace with one another, so that each fills the spaces between the meshes of the other.

The number of *aortic arches* has increased to five and there may be a sixth, as it is difficult to count them. The blood passing through the arches does not make its way directly to the dorsal aorta. In each of the gill filaments there is a capillary blood vessel forming, a loop which, starting at the base of the filament, runs to its tip and thence returns to the starting point. Each of these capillary loops is connected at one of its ends with the aortic arch coming from the heart. These arches do not now communicate with the dorsal aorta but each sends all its blood into the capillary loops. The blood having traversed the loops and reached their opposite ends is taken up into another vessel which runs parallel to the aortic arch and is known as a branchial vein. The part of the arch connected with the heart may now be spoken of as a branchial artery. Each gill arch thus contains two parallel blood vessels by one of which (Fig. 62[a], a. br.) the blood enters the arch and by the other of which (v. br.) it leaves the arch and the blood passes from one to the other of these vessels by way of the loops tin the branchial filaments. By this arrangement the blood exposes a much larger surface to the surrounding water and respiration, that is the interchange of gases between blood and water, is more perfect. Many smaller vessels both veins and arteries have now been formed, but these are all offshoots of the main trunks already described. They are difficult to follow with certainty and, leaving them aside, the circulation has assumed so nearly the adult condition that it does not require further description.

In the *excretory system* it may be seen that the segmental ducts have united to form a common tube which has an opening just posterior to the anal opening and is apparently surrounded by the same sphincter muscle that surrounds the anal end of the alimentary canal. This common tube has a spindle shaped dilation (u. bld.) just back of the vertical portion of the intestine. It is the urinary bladder which serves to store up the urinary secretion until it is expelled. In front of the urinary bladder the two segmental ducts are difficult to trace and the excretory system is not again seen until one reaches the region opposite the base of the pectoral fin. Here there is seen a mass of dark colored coiled tubules (Fig. 64, prn.) the tubules of the head kidney or pronephros. In these the cilia may be seen moving but not much more is to be made out about them in the living embryo.

The seven stages that have been described may, for convenience of reference, be summed up as follows:

Stage A: Stage of the triangular, two-layered embryonic area, before the appearance of the embryo.

Stage B: Stage of the trumpet shaped embryo, marked along the middle dorsal line by a groove, the neural groove.
The caudal plate is not yet formed.

Stage C: The embryo projects as a ridge. The medullory groove is obliterated.
Solid optic and auditory vesicles are present.
There is no differentiation in the brain.
There are four to six mesoblastic somites.
The caudal plate is formed from the rim of the blastoderm.

Stage D: The embryo surrounds two-thirds the yolk and its tail forms a blunt projection.
The brain is divided into forebrain, midbrain and hindbrain.
The auditory and optic vesicles are hollow and the olfactory pit is formed.
The lens has begun to form.
There are about twenty-five mesoblastic somites.
The alimentary canal is forming.
Amoeboid cells are accumulating in the place where the heart is to form.

Stage E. The tail is elongated and flattened.
Pigment cells are present on the yolk sac.
All parts of the adult brain are established and the neuromeres have disappeared.
The lens is separated from the epiblast.
The otoliths are formed.
There are about forty-five mesoblastic somites.
A horn-shaped heart is present and beating. It draws a colorless fluid from the space which lies beneath the head, in front of the oil globule.

Stage F: The yolk is reduced to one-half its former bulk.
The lower jaw is established but does not reach the end of the snout.
The pectoral fin is established but does not move.
The caudal fin is marked out.

The eye is black and the choroid slit is closed.
The semi-circular canals are established.
The gill slits and gill arches are established and the operculum is begun.
The mouth and anus are formed.
The liver is established.
The heart is divided into auricle, ventricle and truncus arterosus.

Stage G: The adult form is assumed and there is pigment over the whole body.
The yolk and the oil globule are absorbed.
The cerebrum is much larger.
The argentea is formed in the eye.
The posterior otolith is much larger than the anterior.
The pectoral fin is moved vigorously.
Teeth and tongue are formed and the embryo feeds.
Stomach and intestine are separated by a constriction.
Peristaltic movements take place in the intestine.
The air bladder is established.
All parts of the heart are present and the valves are established.
The vitelline vein is obliterated.
Gill filaments are formed and the blood is circulating through them.

PART IV.

Study of sections of stages A to E to show the history of the germ layers.

In order to gain a knowledge of the fundamental processes that result in the building up of the body of the adult fish, we must study thin sections through some of the earlier stages.

STAGE A.

A section passing lengthwise through the embryonic area of this stage is shown in Fig. 29, Pl. IV, and a small part of the embryonic area from the same section is shown more highly magnified at 29ª. The embryonic area lies close against the yolk from which it is separated by the parablast only. It is made up of two layers of cells, the external epiblast, (epb.) and the primary or primitive hypoblast (h. p.). The epiblast is made of an external layer of much flattened cells, the covering layer, and a deeper layer of regular cells, the lower or sensory layer of the epiblast.

STAGE C.

A transverse section through the middle part of an embryo of this stage is shown in Fig. 65, Pl. X. The section passes in the direction of the line marked Fig. 65, in Fig. 34, Pl. V. The epiblast is thicker than in the preceding stage and is thickest in the middle, where it forms a keel-like ridge directed toward the yolk. The ridge causes a groove on the surface of the yolk. The epiblast consists, as before, of the covering layer and of the lower layer or sensory layer of cells. It is evident that the increase in thickness is due to an increase in the number of cells in the sensory layer. In the section the nuclei of some of these cells are seen in the act of dividing, and the division of

the cells follows that of their nuclei. The parablast (prb.) lies beneath the embryo, covering the yolk and shows three of its characteristic, enormous nuclei. The cells of the primary hypoblast have arranged themselves so as to form three distinct structures. Those cells which lie next the parablast have become somewhat flattened out, and are united to one another by their edges so as to form a tolerably well defined layer, which, to distinguish it from the primary hypoblast is known as the secondary hypoblast (h. se.) or simply as the hypoblast. Between the secondary hypoblast and the keel-like projection of the epiblast in the middle line the cells are grouped to form the notochord (ch.) the limits of which are not yet very sharply defined. Occupying the spaces at the sides of the keel, between the secondary hypoblast and the epiblast are two masses of cells, one on either side. These, together, make up the mesoblast.

For the reader who is not familiar with the interpretation of sections the relations of these parts will be more intelligible from an examination of the perspective diagram shown in Fig. 75. Cell structure is not represented in any of the parts of the diagram. It includes about one quarter of the egg and the cut surface of the yolk is dotted. The yolk is seen to be marked along its upper surface by a shallow groove into which the embryo fits. The yolk is further covered closely by the parablast (prb.), the cut surface of which is represented as darker than the cut surface of the underlying yolk. On the outside is seen the epiblast (epb.), with the keel-like thickening along its middle. This keel runs the entire length of the embryonic area and causes the groove on the surface of the yolk.

Next the parablast is seen the secondary hypoblast (h. se.), in the form of a thin sheet of tissue, like a piece of paper or cloth. It runs out only a little way at the side of the keel and conforms closely to the underlying parablast. In the middle line, between the epiblastic keel and the hypoblast, is seen the end of the notochord (ch.). It is represented here as a cylinder, the form which it assumes very shortly after stage C. It runs nearly the whole length of the embryo, its anterior end lying only a little way back of the anterior end of the embryo and its posterior end passing insensibly into the tissues of the tail.

At the sides of the epiblastic keel are the solid masses of mesoblast cells which reach to the ends of the notochord.

We thus have the embryo beginning as two layers of cells, epiblast and primary hypoblast. The epiblast has formed a keel-like thickening along the middle line, while the primary hypoblast has divided into secondary hypoblast, mesoblast and notochord. The epiblast, mesoblast and hypoblast are known as the three germ layers. They lie one outside the other like three continuous sheets of paper, only one of them, the mesoblast, being interrupted along the middle line by the presence of the epiblastic keel and the notochord. The young fish is formed entirely by the metamorphosis of these three sheets of tissue. It is one of the most fundamental, and most far reaching facts in embyology, that each of the germ layers gives rise to certain organs of the adult fish and always to the same organs. This is a fact of the widest application, holding, not for the fish merely, but for all many-celled animals. It is made use of by histologists in classifying the tissues of all animals and is a guiding principle in the study of the changes which are produced in tissues as the result of disease.

The following table shows what organs of the adult fish are derived from each of the germ layers.

1. *From the epiblast is derived:*
   a. The epidermis which is the external covering of the body.
   b. The entire central nervous system (comprising the brain and spinal cord) and probably the entire peripheral nervous system (comprising all the nerves of the body).
   c. The essential parts of all the sense organs, that is of the ear. olfactory organ, organs of taste and organs of the lateral line.
   d. The cells liuing the posterior end of the alimentary canal and the outer ends of the gill slits.
2. *From the hypoblast is derived:*
   a. The cells which line the alimentary canal, forming the epithelium of its mucous layer (except its posterior end and the outer ends of the gill slits).
   b. The essential parts of the appendages of the alimentary canal the liver, the air bladder and the pyloric coeca.
3. *From the mesoblast is derived:*
   a. All parts of the skeleton.
   b. The muscles.
   c. The heart and blood vessels and probably the blood.

The notochord is the center about which the vertebral column or back bone is formed. Investigations do not agree as to what becomes of the parablast. This point will be referred to later.

An examination of sections of later stages shows in what way each of the germ layers give rise to the organs derived from it.

STAGE D.

Fig. 66 represents a section through the middle of the optic vesicles of an embryo of the stage shown in Fig. 41, Pl. V. The section is in the direction of the line marked Fig. 66, in Fig. 41, and is somewhat oblique, passing through the right optic vesicle a little further back than it passes through the left. Over the upper surface in the section is seen the epiblast (epb.) with its two layers of cells. Over the lower surface is shown the parablast which is represented as darker than the yolk below it. In the middle line underneath the external epiblast is seen an oval aggregation of cells (twb.) in the center of which is a slit-like space occupying the long axis of the oval. This structure lies in the position occupied in the preceding stage by the epiblastic keel. Sections of intermediate stages show that it is in fact this keel, which has increased in size, separated itself from the external epiblast and acquired a central cavity. The tube thus formed is the rudiment of the central nervous system and the section passes through that part of it which we have called the forebrain. At the sides of the forebrain are seen the sections of the optic cups, but the connection of these with the forebrain lies in front of the plane of section and is not shown. The great thickening of the lateral wall of the cup (rtn.), is shown and the thinness of the medial wall (rtn. p.). The pushing in of the lateral wall against the medial is also seen and the position of the slit-like cavity of the original vesicle is indicated by a heavy line between the two walls. Over the cup on the left side of the figure the external epiblast is seen to be thickened and depressed to form the lens rudiment. On the right the section passes a little behind the middle of the lens rudiment. Above the parablast and separating it from the forebrain and optic vesicle is seen a layer of cells. This is probably the hypoblast layer. It may also contain some mesoblast cells, but it is not certain that the mesoblast extends so far forward in this stage.

Fig. 67, represents a section through an embryo of the age shown in Fig. 38, and along the line marked Fig. 67, in that figure.

The external epiblast and the parablast appear as before, but as the section is a little further back the parablast is thicker. The neural tube, the rudiment of the nervous system, appears under the middle line as in the preceding section. In this case it is the hindbrain. Connected with the neural tube, where it touches the external epiblast, are two masses of cells, (nrv.) one on each side. These are the rudiments of nerves which are growing out from the hindbrain to connect it with adjoining parts.

Underneath the neural tube is the section of the notochord (ch.), in which the large nuclei are prominent. It is much more rounded and much better defined than in the stage of which Fig. 65 is a section.

Underneath the notochord is seen the hypoblast, which now has an appearance as though its edges had been folded under. It is seen to pass across the middle line uuderneath the notochord aud neural tube and then upward and outward at the sides. Before reaching the epiblast it turns back and the parts thus turning back pass toward the middle line again but end before reaching it. There is thus only a single layer of hypoblast under the notochord while at the side of it there are two layers separated by a considerable space. This space is the cavity of the alimentary canal and at this place it is the pharynx. At the sides of the pharynx are seen some loosely packed mesoderm cells and below the alimentary canal is seen on each side a mass of mesoblast cells (pc.) in which there has appeared a space, the space is the cavity which in later stages surrounds the heart and is called the pericardial cavity.

Figs. 68 and 69 represent sections through the region of the mesoblastic somites. The direction of the section shown in Fig. 69, is indicated by the line marked Fig. 69 in Fig. 40. Fig. 68, is taken from the same portion in a slightly younger embryo. In both Figures the epiblast is seen composed of two layers. The neural tube in both is seen to be less separated from the external epiblast than it is in the sections taken farther forward. It is also seen to have a cavity in Fig. 69, but to be still solid in Fig. 68. We thus learn that the separation of the nervous system from the external epiblast begins in front and travels backward, and that the formation of the central cavity of the nervous system begins in front and travels backward. The notochord is in the same condition as in the preceding stage. The mesoblast is shown in both sections occupying all the space at the sides of the neural tube and notochord. But on each side it is now divided into two parts. Next to the neural tube on each side is seen a somewhat rectangular mass of closely packed cells. This is a section of one of the mesoblastic somites. Outside of the mesoblastic somite on each side is a more flattened mass of cells which is already divided into two layers by a slit-like cavity, represented by a black line in the figures. These flattened masses of mesoblast, at the sides of the mesoblastic somites, are called the lateral plates. The cavity which each encloses is a part of the *body cavity* of the adult fish. By this cavity each of the lateral plates is divided into two layers of cells. One lies toward the epiblastand is known as the somatic layer of mesoblast (som.), while the other lies toward the hypoblast and periblast and is called the splanchnic layer of the mesoblast (spl.), the two layers are also sometimes called somatopleure and splanchnopleure.

On the lower surface of both sections is seen the parablast, which is a little thicker than it is farther forward and, above this and in contact with it, is the hypoblast. In Fig. 68, the hypoblast has not yet been folded under to make the alimentary canal. But in Fig. 69, which is from a slightly older embryo, the hypoblast is seen to be folded up toward the notochord in the middle line. The part thus folded up forms three sides of a tube which when complete, is the alimentary canal. Thus the folding of the hypoblast to form the alimentary canal takes place in front by the turning under of its edges, behind by a folding up of its middle. The result in both places is to enclose a tube.

Fig. 70, represents a section through the caudal plate of an embryo of the stage shown in Fig. 38. A corresponding section through the embryo shown in Fig. 40, would lie in the position of the line marked Fig. 70, and differs but little from the section figured. The epiblast is here somewhat thicker than farther forward and the neural tube is not yet separated from it. The nervous system is at this point in much the same condition that it exhibited throughout its length in the preceding stage. The notochord is not seen, since the section passes through a region where the notochord cells are not to be distinguished from the other cells of the tail. At the sides of the nervous mass are the masses of mesoblast cells (mes.), not divided into protovertebrae and lateral plates and showing no trace of a body cavity. Underneath lies the parablast which is still more thickened than in the preceding stage, particularly at the sides. In the middle line between the parablast and the nervous mass is the hypoblast; its cells are here columnar and the layer appears to be folded under at its edges so as to form three sides of a tube very much as in the preceding sections. The cavity thus enclosed (k. v.) is bounded below by the parablast and is the posterior end of the cavity of the alimentary canal. In some bony fishes this cavity presents certain peculiarities and is usually described under the name of *Kupffer's vesicle.*

Most of the facts shown in Figs. 66 and 70 are shown again in the perspective diagram, Fig. 76, which like Fig. 75, shows about one quarter of the yolk with those parts of the embryo that lie upon it. In this case the posterior one-third of the embryo is represented. The yolk, covered by the parablast and marked by the groove, is shown as before. The epiblast (epb.), is represented as cut away over a part of one side in order to expose the underlying structures. The nervous system (sp. c.) is seen to form a tube with a small central cavity and very thick walls. This tube is now entirely separated from the external epiblast. It runs the entire length of the embryo. Underneath this nervous tube is seen the cylindrical notochord (ch.) as in the preceding stage. Underneath the notochord is seen the hypoblast (h. se.), which is being folded up toward the notochord in the middle line to form the alimentary canal.

Occupying the remaining space between epiblast, nervous tube and hypoblast and parablast on each side is the mesoblast, which is divided into mesoblastic somites (of which three are shown) and lateral plates. The mesoblastic somites (ms.so.) are seen to be rectangular blocks which lie in a row at the side of the neural tube. They are sharply separated from one another and from surrounding structures by well marked clefts. Lying under the somites but extending further outward are the lateral plates of mesoblast. Each of them contains a part of the body cavity (coel.), and each is therefore a sac. The somatic wall of the sac is in contact with the epiblast and protovertebrae; its splanchnic wall is in contact with the hypoblast and parablast. The two body cavity sacs extend as far as the anterior and posterior ends of the notochord. They are continuous sacs with continuous walls, not being broken into parts as is the mesoblast that forms the mesoblastic somites.

STAGE E.

Fig. 71 represents a section through the optic vesicle of an embryo of this stage (ten days). It is in the direction of the line marked Fig. 71, in Fig. 47. The section is somewhat oblique, passing through the middle of the optic cup on the right but behind its middle on the left. The epiblast is rather thinner than in the preceding stages, but is otherwise unchanged. The neural tube is at this point the midbrain. Its cavity is broadened and its roof is thin in the middle line.

Underneath the midbrain is seen the section of a second body (inf.), which has a central cavity and looks much like the neural tube. It is the infundibulum, cut across back of its connection with the 'tweenbrain. At the side are seen the optic cups. The one on the right is a deep cup in the mouth of which lies the lens. The difference in thickness between the retinal and retinal pigment walls of the cup is more pronounced than in the preceding stage. The lens is separated from the external epiblast and is nearly globular. Its central cells are already elongating to form the characteristic fibres of the adult lens. Between the lens and the retinal wall of the cup there is now a considerable space, but none of the cells shown in this space in Fig. 46 are to be seen in the section.

Underneath the optic vesicle and infundibulum is seen the hypoblast which has here the appearance of having been folded under at the edge, the same appearance that in stage D was obtained farther back and shown in Fig. 67. The very much flattened space which is thus enclosed is the cavity of the mouth mth. in the figure. Filling the space between the optic cup infundibulum and mouth are some scattered irregular cells. These cells have probably come from the lateral plates of the mesoblast further back. Cells which thus become detached from the mesoblast and travel to different parts of the body are called mesenchyme cells (msch.). On each side of the infundibulum some of the mesenchyme cells have arranged themselves so as to enclose a space. This is a part of the cavity of the carotid artery of which the mesenchyme cells thus form the wall. Beneath the œsophogus is seen a large space (pc.) with walls composed of much flattened cells. It is the pericardial cavity whose cavities, two in the preceding stage, have enlarged greatly and united with each other.

Fig. 72 represents a section through the reigon of the auditory vesicles. It is taken from an embryo of the age shown in Fig. 46 and a little younger than that shown in Fig. 47. It passes along the line marked Fig. 72, in Figs. 46 and 47. The epiblast is unchanged. The neural tube is here the medulla oblongata and is remarkable for the thinness of its roof. In the preparation of the section the roof has been pressed down so as to make the cavity of the medulla appear much smaller than it is in the natural state. The normal dimensions may be seen in Fig. 47, vn[4]. At the sides of the medulla are seen the auditory vesicles (au. v.) They are sacs with walls made of a single layer of columnar cells. In an earlier stage they are solid thickenings of the sensory layer of the epiblast. They have now separated from the epiblast and acquired a central cavity. Their history is thus similar to that of the neural tube. The notochord appears below the medulla.

Below this is seen the hypoblast. A comparison with Fig. 67 which passes through about the same region in stage D shows that this hypoblastic pharyngeal tube, which in that stage was incomplete and open below, is now closed, so that there are two layers of hypoblast under the notochord, in the middle line as well as at the sides. At its sides the pharyngeal tube is seen to reach upward toward the external epiblast at (g. ss. h.) These protrusions of the pharyngal wall are also shown in Fig. 67 of the preceding stage. Sections a little in front of that shown in Fig. 72, or a little behind it, show that these protrusions do not run the whole length of the pharynx. They are seen in a few sections and are not found in those that precede and follow these few. This indicates that there are several such protrusions instead of a single one and that each of them is in fact a pocket-like out-pushing of the hypoblast. These pockets are the inner ends of the gill slits shown at the sides of the neck at a later stage, in Fig. 54. Opposite each of these hypoblastic pockets is seen a pocket like in-growth of the sensory layer of the epiblast (g. s. epb.). The covering layer does not follow the sensory layer in this invagination, but stretches across the month of the pocket and closes it. The epiblastic pocket is the outer end of a gill slit. The bottoms of the two pockets are in contact and it is only necessary that these bottoms should disappear in order to transform each pair of pockets into a tube leading from the pharynx to the exterior. By the rupture of the very thin covering layer, water might then pass from the pharynx to the outside. It is in this way that the gill slits are ultimately formed. A few mesenchyme cells are seen in the section, filling in the space between the structures mentioned, but the blood vessels have not been represented. Underneath upon the yolk is the parablast (prb.), with its nuclei.

Fig. 73 Shows a section a little further back than the preceding and along the line marked Fig. 73 in Fig. 47. The epiblast is unchanged. In the middle dorsal line it is extended upward to form a wedge-shaped ridge (f.f.d.) which is the beginning of the median dorsal fin-fold. On the left side the sensory layer is seen to be thickened in one place (l. li.) and bent inward so as to form a shallow pit, the mouth of which is closed by the covering layer of epiblast. This pit-like depression resembles closely the olfactory pit shown in some of the figures of the living embryo. It is one of a line of similar pits. This line extends along the middle of the side of the body and is very noticeable in the adult fish, where it is marked by a row of scales that are peculiar in form and coloring. Each of the pits is the rudiment of one of the organs of the lateral line, sense organs that are believed to take note of mechanical disturbances in the water.

The neural tube is here the spinal cord with its small central canal. At the sides of it are seen the mesoblastic somites, as in the preceding stage and beneath it is the notochord. The notochord now contains numerous fluid-filled spaces so that the cell material which appeared uninterrupted in the previous stage is reduced to mere strands which stretch from side to side of the notochord uniting with one another and so separating the spaces. These spaces, at first spherical, have become angular from mutual pressure and give the notochord the peculiar appearance seen in the living embryo. Beneath the notochord is the section of the dorsal aorta and beneath this the section of the alimentary canal, at this point the intestine (ins.). Beneath the intestine and closely connected to it are seen the cross sections of three somewhat smaller tubes (hpr.) which bear a close resemblance to the intestine itself. These three tubes may be traced in successive sections until they are found opening into the intestine. In some sections they are more numerous than in this one and may be traced into one another. This shows that the tubular outgrowths are branched. This system of tubes is the beginning of the liver which is thus, at this stage, a branching hollow outgrowth from the intestine. Underneath each mesoblastic somite is the section of a tube (w. d.) which has the general appearance of the liver tubes. These tubes are the segmental ducts or Wolffian ducts which have been formed since the preceding stage, probably by constriction from the wall of the body cavity. Outside the segmental ducts and extending far outward are seen the body cavities. The layers of cells that bound them, the somatapleure and splanchnopleure, are more flattened than in the preceding stage and the cavity is larger. A few mesenchyme cells are shown in the section and the parablast is shown as before covering the yolk.

Fig. 74, is from a section made a little way in front of the anus, along the line marked Fig. 74, in Fig. 47. The epiblast is unchanged. The dorsal portion of the median fin-fold is seen above, and below in the middle line, is a similar projection, the ventral portion of the median fin-fold. The neural tube, here the spinal cord, is not so broad as in the preceding section and shows a slit-like cavity. Beneath it is the notochord (ch.) as in the preceding section. Beneath the notochord is the section of the caudal artery (ao. d.) and beneath this the section of the caudal vein. At the sides are the mesoblastic somites (ms. so.), extending further in a dorso-ventral direction than in the preceding stage. Beneath the mesoblastic somites are the body cavities (coel.), one of which is shown smaller than in the preceding stage. Owing to the absence of the yolk from this region they occupy more nearly a vertical direction than in the preceding section. Beneath the caudal vein in the middle is the section of the intestine with walls of high, columnar cells. It is now formed into a tube by the completion of the folding process which was seen beginning in Figs. 69 and 70. At the sides are the sections of the Wolffian or segmental ducts, as in the preceding section. A few mesenchyme cells fill the spaces between the other structures.

Fig. 77, is a perspective diagram of an embryo of about this stage. It is from a region just anterior to where the tail joins the yolk sac. The mass of yolk (yk.) is therefore small. The epiblast is represented as cut away over a part of the side that is turned toward the observer. The neural tube (sp.c.), here the spinal cord, appears as in the diagram, Fig. 76. At its sides are the mesoblastic somites. These are here more extended dorso-ventrally and so fitted against the neural tube that their inner faces are concave. Each shows the beginning of its separation into dorsal and ventral parts. The notochord, (ch.) lies, as before, beneath the neural tube in the form of a longitudinal rod. Beneath it is the intestine (ins.) which has, by the folding of the hypoblast layer, now been formed into a tube the walls of which are not anywhere interrupted. The method of its formation is better gathered from the diagrams than from a minute description.

At the sides of the intestines are the two body cavities (coel.). Each is larger than in the preceding stage, and their walls are thinner. As the yolk has disappeared the edges of the body cavities which are outermost in Fig. 76, have been permitted to sink downward so that the largest diameter of the sacs is now vertical instead of horizontal as in the preceding stage. The outer edges of the sacs are thus brought nearer to one another. Their outer or somatic walls lie close against the epiblast and the lower faces of the mesoblastic somites, while their inner or splanchnic walls are in contact with the intestine and yolk.

Above the body cavities, at the sides of the notochord are two tubes which were not present in the preceding stage. These are the segmental ducts. The writer has not traced their origin in the wall-eyed pike and it is not shown in the figures of actual sections. In the diagrams it is represented as being formed in the manner described by investigators. The beginning of the process is shown in Fig. 76, where, at the point where the somatic layer of mesoblast passes into the splanchnic, there is seen to be a fold, (w. d.). This fold is such a one as may be made in a sheet of paper by placing a pencil along the middle of it and then folding the two halves of the sheet toward one another. If the two halves of the sheet thus folded be not allowed to touch one another, but be bent back into their original position before meeting, there will be formed a cylindrical tube, with a slit-like opening on one side of it and with its walls continuous on each side of this slit with the remainder of the sheet of paper. The segmental duct is described as folded off from the body cavity by a process similar to this. The tubes thus formed still open widely into the body cavity in Fig. 76, w. d. In Fig. 77, the edges of the slits have come together so as to close the tubes and the tubes have separated from the body cavity sacs.

At their front ends they do not separate from the walls of the body cavity but remain connected with them, so that the cavities of the tubes are in communication with the body cavities. This communication of each segmental duct with the body cavity at its anterior end becomes drawn out into a tube of considerable length, which passes from the anterior end of the segmental duct of each side to the body cavity of that side and there opens into the body cavity by a funnel shaped expansion. This cross tube with its funnel like ending is the first formed tube of the pronephros or head kidney in the wall-eyed pike. For a long time it is the only pronephric tubule, but whether others are afterward added to it the writer does not know. At their back ends the segmental ducts open to the exterior but neither of the ends appears in the diagram.

The mesenchyme cells are now seen closely surrounding the neural tube and the notochord, and separating them from one another and from the muscles formed by the mesoblastic somites. They are soon to be used in the formation of the vertebral column or backbone.

Fig. 78 is a perspective diagram of a portion of the body of a much later embryo; only the important organs are represented. Most of the structures remain as in Fig 77 and do not require separate mention. The yolk has now disappeared so that the outer edges of the two body cavities have come together under the intestine. The two cavities were thus separated from one another for a time by only a thin partition and this partition was double, being made up of a layer derived from each of the two body cavities. It stretched in a vertical plane from the lower middle line of the intestine to the opposite wall of the body cavity in the position of the dotted line m. v. in the diagram. By the time the stage represented in the diagram, Fig. 78, is reached, this partition, which is called the ventral mesentery has disappeared, so that there is free access from one body

cavity into the other, and we may now speak of a single body cavity or simply of the body cavity. The body cavities also approach one another above the intestine and are there separated from one another by a thin double partition similar to the one below the intestine. This partition, the dorsal mesentery, persists throughout the life of the animal and, as shown in the figure, it serves to suspend the intestine and passes in a vertical plane from its middle dorsal line to the opposite wall of the body. When the ventral mesentery has disappeared, the dorsal mesentery is spoken of as the mesentery. Between the two sheets of tissue which compose it, small arteries pass from the dorsal aorta to the intestine and the veins take the same course in carrying blood from the intestine to the liver.

By the same process of extension of the body cavity above and below the intestine, the splanchnic layer (spl.) of each body cavity comes to be wrapped about the intestine, and forms in the adult fish the serous coat of the alimentary canal. This whole lining of the body cavity together with the little mesenchyme tissue that supports it is now known as the peritoneum.

As the result of these changes we have the two originally separate body cavity sacs united, and their walls converted into the following structures:

1. A somatic or parietal layer of peritoneal cells, which lines the body cavity on the outside next the body wall.

2. A splanchnic or visceral layer of peritoneal cells which covers the intestine closely.

3. A mesentery which suspends the alimentary canal and connects the parietal and visceral sheets with one another.

The mesenchyme cells (msch.) are now more densely packed about the neural tube and notochord. Some of them have been represented as forming a rod (rb.) which runs out at the side and is the rudiment of a rib. This mesenchyme tissue becomes ultimately transformed into bone and forms the vertebræ or joints of the back-bone. Thus, by the metamorphosis of the three originally separate germ layers, the embryo is brought into the adult condition, so far as concerns its essential plan of structure. It may be described as consisting of a dorsal tube, the neural tube, enclosed in a bony canal and of a ventral tube, the body cavity, in which is enclosed a third tube, the alimentary canal. A supporting rod, the notochord, runs between the neural tube and the alimentary canal and body cavity. Such a description is equally true for every backboned animal.

PART V.

The development of the organs.

In what precedes the development of the wall-eyed pike has been followed by stages and in the principal stages each organ has been described, as it appears in the living embryo and as it is seen in series of sections. This method of dealing with the subject enables the reader to make use of the account in studying the embryo for himself. But the method takes up the development of each organ only at intervals, a part of the development of the brain, for instance, being considered at one stage and a part at another. The method takes no account of the changes that take place between the stages described. In order to make the account of the development of each organ continuous and complete, there is given in what follows a connected history of each. In doing this it is necessary to repeat a part of what precedes and it is also necessary to refer to the age of the embryo. The ages given refer to embryos that hatched in twenty-five days after impregnation of the egg. The eggs during the first twenty-four hours were at a temperature which is not known, but which was probably not far above freezing, perhaps 45°F. After between twelve and twenty-four hours they reached the hatchery and were placed in water at a temperature of 48°F. The temperature of the water gradually rose as the weather grew milder, reaching 49°F. on the nineteenth day and between 51° and 52°F, on the twenty-fifth day, when the eggs hatched.

1. The organs derived from the epiblast.—As early as twenty-seven hours the covering layer of cells is formed and is the first part of the epiblast that can be made out. When the primary hypoblast is formed we are able to distinguish the tiers of angular cells lying beneath the covering layer as the lower layer cells or cells of the sensory layer of the epiblast, and we then speak of them and the overlying cells of the covering layer as together forming the epiblast.

When the gastrulation is completed and the blastopore is closed the epiblast forms a complete envelope for the egg. The various organs to which it gives rise separate themselves from the remaining epiblast, as they are formed, and sink into the underlying mesoblast. The epiblast which is then left on the surface continues to form the external covering of the animal in adult life. It becomes gradually thicker by the multiplication of its cells; glands are developed in it and it forms the epidermal portion of the skin of the adult fish or the epidermis. The deeper parts of the skin, making the dermis, are derived from the mesoblast.

One of the first structures to separate from the epiblast is the central nervous system. As early as the seventieth hour there is seen a broad linear opacity running lengthwise of the embryonic area and sections (Fig. 65) show that this is due in large part to a keel-like thickening of the sensory layer of epiblast along this line. This keel is well established by the eightieth hour. It is from the beginning broader in front and gradually narrows behind. Soou its outlines become rounded and it begins to separate itself from the rest of the epiblast. It thus becomes converted into a solid rod of cells flattened slightly from side to side. The separation of the rod from the external epiblast begins at the anterior end and travels gradually backward, but it is only at a comparatively late stage that the rudimentary nervous system is entirely separated from the epiblast posteriorly. By the end of the fifth day the separation is complete in front and there has appeared a small diamond shaped cavity in the rod of cells near its front end. A small part of the rod is thus converted into a tube. The cavity extends rapidly backward as a vertical slit, the whole rod thus becomes eventually converted into a tube—the neural tube. Even before the cavity has extended itself backward it is noticed that the anterior part of the neural tube is larger than its posterior portion (Fig. 38), and we have thus established the primary division of the central nervous system into brain and spinal cord.

The later changes in the cord do not fall within the scope of this paper, and are not again referred to. At the same time, the end of the fifth day, the brain becomes marked by two constrictions which divide it into three

parts, lying as swellings of the tube one behind another. These are the three primary divisions of the brain, forebrain, midbrain and hindbrain. The central cavity is continuous as a narrow slit through them all. We may follow separately the transformations of each of these parts of the brain.

Before the keel-like thickening of the sensory layer is separated from the remaining epiblast, it is nearly twice as broad at its anterior end as further back (Fig. 30). When the separation takes place this broadening of the anterior end forms two lateral extensions of the forebrain, like the halves of the horizontal bar of a T. Soon after, by the increase in length of the embryo and the consequent pushing forward of the end of the neural tube, these extensions of the forebrain become pressed back against its sides (Fig. 34 a) so that their connection with the fore brain is at its anterior end. The halves of the horizontal portion of the T thus make with each other an acute angle and the whole T takes the form of an arrow-head. Meantime the lateral extensions have separated at every point from the external epiblast and each has acquired a cavity, Fig. 38, (5 days). These solid masses are thus converted into the hollow optic vesicles, whose future history falls properly under the head of the eye.

Over the first diamond-shaped space that appears in the forebrain the roof of the forebrain becomes thin and protrudes as a thin-walled, heart-shape vesicle attached to the forebrain by the narrow apex of the heart. This vesicle becomes the pineal gland or rudimentary pineal eye. In Figs. 63, and 64, pn., it is seen lying in the notch which separates the cerebrum and 'tweenbrain. It consists of an expanded extremity which lies immediately under the transparent epiblast and has its cells and nuclei perpendicular to the surface, and of a narrow stalk, like the stem of a toad stool, connecting the expanded portion with the roof of the brain. In general appearance it bears a close resemblance to the eyes of some invertebrate animals.

At about the time the cavities appear in the optic vesicles there is formed from the floor of the forebrain a backwardly directed outgrowth, the infundibulum, the principal features of which have been already pointed out in the living embryo and in sections.

On the seventh day the forebrain begins to send forward a blunt, rounded projection which is the rudiment of the cerebrum. This and its great increase in size have been already pointed out. When the cerebrum has been formed the part of the forebrain from which the optic vesicles, infundibulum, and pineal gland have grown out is left as a small connecting portion between it and the midbrain. It is then known as the 'tweenbrain. The midbrain begins to broaden out behind on the seventh day; on the ninth it is so broad as to overlap the optic cups at the sides. In front it narrows to join the 'tweenbrain and overlies the infundibulum, which in views from above is seen through it. It does not undergo any further considerable changes up to the forty-fifth day. The hindbrain also broadens at its anterior end, being on the seventh day much broader than the midbrain, and on the ninth still a little broader. It gradually narrows and passes into the cord behind. Its roof becomes very thin, as if pulled out in the broadening process and its side-walls become divided by transverse clefts into six divisions. These are the neuromeres. The anterior one becomes the cerebellum. The posterior five are no longer visible by the ninth day and the region where they were is the medulla oblongata. The result has been to divide the original hindbrain into cerebellum and medulla oblongata.

The originally uniform cavity of the neural tube has been divided by these changes into the spaces that have been already described, as the lateral ventricle, the third ventricle, the aqueduct of Sylvius and the fourth ventricle.

The peripheral nervous system, comprising the nerves, that connect the central nervous system with the other parts of the body, is believed by most morphologists to be formed by cells or cell processes growing out from the central nervous system to these parts. This is a subject about which but little is to be made out in the living specimen and its investigation in series of sections is beset with many difficulties of technique and interpretation and requires much time. It is passed over here with the reference already made to Fig. 67.

The Eye—On the seventh day each optic vesicle is a hollow body lying at the side of the forebrain and connected at its anterior end with the anterior part of the forebrain. This connecting portion subsequently acquires a cavity so that there is a free passageway from the cavity of the forebrain into that of the optic vesicle. This connecting portion soon becomes narrowed to form the optic stalk, while at the same time the lateral or retinal wall of the optic vesicle becomes thickened and the medial wall becomes thinner. On the sixth day the lateral wall is already four or five times as thick as the medial (Fig. 41). The epiblast which overlies the lateral wall of the optic vesicle thickens on the sixth day and becomes depressed to form the lens. It thus, according to the usual view, presses upon the lateral wall of the vesicle and causes it to become concave. In other words the optic vesicle has now become the optic cup. The lateral or retinal wall of the vesicle is on the inside of the cup, while its medial wall is on the outside. The cavity of the original vesicle is thus obliterated and its two walls brought into contact (compare Figs. 38 and 41). The completion of the lens, as well as the growth of the inner wall of the cup, causes the cup to become continually deeper, until, on the ninth day, it is a flattened sphere with a large cavity almost filled by the lens (Figs. 44, 44ª, 46, 46ª). The walls of the cup are not continuous, being interrupted on the lower side by a triangular notch or slit, wrongly called the choroid slit. Through this notch amoeboid cells pass into the cavity of the cup behind the lens, and through it also blood vessels pass to the lens. The amoeboid cells form the vitreous humour of the adult eye, and the slit gradually closes, only a trace of its outer end showing on the thirty-second day.

While the slit is closing and the vitreous humour is forming, pigment is appearing in the eye. First noticed on the thirteenth day, it has on the twenty-second rendered the whole eye intensely black. The pigment is deposited in the outer wall of the optic cup, which thus becomes the pigment layer of the retina. This pigment layer is lacking where the choroid slit lies, and there is consequently a light line here. As soon as sufficient pigment appears outside the optic cup, this line must be covered and obliterated; so that the fact that the slit is visible on the twenty-second day, shows that the pigment deposited up to that time, is in the pigment layer of the retina, and not outside of it.

On the twenty-fifth day the pigment of the retina is, in its turn, obscured by the formation about it of a layer of tissue which shows metallic colors. This layer is derived from the mesoblast, but its metallic colors are not due to pigment but to the presence in the layer of numerous crystals of guanin. The layer is the argentea already described.

Between it and the pigment layer of the retina is now doubtless formed the choroid coat, or, if the argentea be reckoned a part of the choroid, the remainder of the choroid coat. The choroid is a very vascular layer which protects and nourishes the parts within and which, together with the argentea, extends over the opening of the cup in such a way as to form a curtain about its edge and to narrow the opening. This curtain is the iris and the silvery color of its surface is due to the argentea. The opening in its center is the pupil. The writer has not studied the formation of the sclerotic coat of the eye in the wall-eyed pike, but it is no doubt formed, as in other animals, from the mesoblast about the optic cup. The mesoblast cells here form between themselves numerous fibres which make a very tough felt work, a protective covering for the parts within. This felt work of fibres extends from the optic stalk over the whole of the eye, and is opaque and very white. Over the pupil and iris it is in contact with the overlying epidermis, and is here very transparent, allowing the light to pass to the lens and retina. This transparent part, with the overlying epiblast, is called the cornea. There is thus formed from the epiblast, the retina, the pigment of the retina, the optic nerve (formed from the optic stalk) and the lens. These are the essential parts of the eye, by which the image is formed and its presence known. The other parts serve for the nutrition and protection of these essential parts. There are two coats or coverings of mesoblastic origin, which envelop and protect the parts of epiblastic origin. The inner one is vascular and contains the metallic colors. It is the choroid, the outer part of which may be called the argentea. In front it is called the iris, and has in it an opening, the pupil. The outer mesoblastic covering is the sclerotic, for protection; its anterior transparent part with the adjacent epidermis is the cornea. There are no eyelids and no glands.

The ear:—In man the ear consists of three parts known as external ear, middle ear and internal ear. The external and middle ear serve mainly to collect the sound waves and transmit them to the internal ear, and it is only in the internal ear that sounds are recognized as sounds. In the fish the internal ear, only, is present and, in the adult, it is enclosed in the bones of the head, so that there is no trace of it seen from the outside. The sound waves in the water are thus transmitted through the tissues of the head to the internal ear, to be there recognized as sounds.

In the transparent embryo fish the development of this internal ear is readily studied, until it has reached nearly its adult condition. Like the optic vesicle and neural tube, it begins as a thickening of the sensory layer of the epiblast, beneath which it lies as a solid bean-shaped mass of cells. This mass soon acquires a cavity (Figs. 40 and 41), and is then, on the sixth day, the auditory vesicle. The vesicle rapidly enlarges, and on the tenth day there appear in it the two otoliths. On the eighteenth day the otoliths have enlarged and become compact, and the surface of the vesicle is marked by lines which are the optical sections of folds in the walls.

The following description of the folds is difficult to understand without a model. In the lateral surface of the vesicle there is formed a shallow depression which causes the lateral wall to approach the medial, and which consequently narrows the cavity. From the bottom of this depression there start three hollow tubular extensions of the lateral wall. The cavities of these tubes or cylinders communicate with the space around the vesicle. Two of the cylinders are directed toward the medial wall. They are not transverse but one is directed slightly forward and the other slightly backward. We may call them the anterior extension of the lateral wall (Figs. 55^a and 55^b, a. l.) and the posterior extension of the lateral wall (p. l). The third extension arising from the depression of the lateral wall, is directed downward toward the inferior wall, and may be called the inferior extension of the lateral wall (i. l.). As the three extensions start, there are produced three similar extensions which pass toward them and meet them. Two of these rise from the medial wall and are directed laterally. One is the anterior median extension (a. m.), and meets the anterior lateral extension so that the bottoms of the two fuse. The other is posterior, the posterior median extension, (p. m.), and meets the posterior lateral extension in the same way. The third out-growth rises from the inferior wall, the inferior extension, (in), and meets the inferior lateral extension. The bottoms of the extensions then become obliterated, so that each pair of them forms a tube passing entirely through the auditory vesicle. These tubes may be thought of as arising from the lateral wall of the vesicle, one directed forward and inward, one backward and inward, these two being at right angles to one another, and the third directed downward. Over each of these tubular spaces that part of the auditory vesicle that is on the outside of it, forms an arched canal, and these three arched canals are the three semicircular canals of the adult ear. Ss. c. is the anterior vertical canal, ss. c^3 the posterior vertical canal and ss. c^2 the horizontal canal in Fig. 56. The three canals thus lie in three planes at right angles to one another and in the three directions of space, and are usually stated to be the organs of equilibrium. The other notable change in the internal ear in the embryos studied is, the great increase in size of the posterior otolith. The whole auditory vesicle with the supporting mesoblast tissue outside of it, is known as the membranous labyrinth in the adult fish. It is embedded in the bones of the head as these develop and is thus protected.

The olfactory organ is formed as a pit-like depression of the epiblast which, during the stages studied, undergoes no other noticeable change than increase of size. It is formed, as are the other special sense organs, from the sensory layer of the epiblast only.

The organs of the lateral line have already been alluded to. They are formed as pit-like depressions of the sensory layer of epiblast, one of them being shown in Fig. 73. The writer has not studied them carefully. In the adult fish they are situated along the middle of the sides of the body, where their position is indicated by a peculiarly colored row of scales. They are connected with the brain by nerves and are believed to take note of mechanical disturbances in the water.

Organs derived from the mesoblast:

The mesoblast divides, in the manner already described, to form the lateral plates and the mesoblastic somites.

a. The Muscular System:—The mesoblastic somites are at first few in number. They are separated from one another by clefts which run outward and a little backward from the neural tube, parallel to one another (Fig. 34). They are at first continuous with the lateral plates, to which they bear the same relation that the teeth of a comb bear to its back. At the end of the fifth day, when there are ten or a dozen pairs of somites present, each is seen to be marked off from the lateral plate by a plane of division that runs parallel to the middle line. The somites give rise to the voluntary muscles of the body and perhaps also to the mesenchyme cells which form the axial skeleton.

The cells of the somites elongate, and become converted into muscle fibres. On the thirteenth day there is found a horizontal partition running lengthwise of the animal, so as to divide each somite into dorsal and ventral portions. The dorsal portion forms the dorsal lateral muscles and the ventral portions, the ventral lateral muscles. The muscles which move the pectoral fin are probably formed as outgrowths from the mesoblastic somites, and those which move the jaws and gill arches are believed to be formed from the mesoblast in those regions. The writer has not made observations on this point.

b. The Peritoneum:—After the separation of the mesoblastic somites, the remainder of the mesoblast forms the lateral plates. These split, by the formation in them of the body cavity, into somatic and splanchnic layers. Their metamorphosis into the various parts of the peritoneal epithelium has been already traced.

c. The Excretory System:—In the embryo the excretory system is the pronephros or head kidney, the general appearance of which was pointed out in the living specimen. The writer has not traced its development in detail and the following account refers to bony fishes in general. The segmental duct is said to be formed by the folding of the splanchnic layer of mesoblast, and has been so represented in the diagrams and so described.

It is present in the wall-eyed pike on the eighth day. It is said, moreover, that it does not become separated from the body cavity at its anterior end but remains there connected with it by a funnel-shaped opening. The portion connecting the funnel to the remainder of the duct becomes enlarged, and forms a tube lying at right angles to the segmental duct. The fluid in the body cavity is thus able to pass in at this funnel and so out at the posterior end of the segmental duct. Opposite the funnel, is to be found a mass of small blood vessels, supplied with blood from the dorsal aorta. This mass, called the glomerulus of the pronephros, projects into the body cavity; and it is doubtless through the blood in these vessels that most of the fluid that passes down the tubules, finds its way into the body cavity. That part of the body cavity into which the funnels open, and in which the glomerulus lies, becomes shut off from the rest of the body cavity, and forms then a closed capsule, containing the glomerulus and communicating with the segmental duct by way of the funnel. The fluid in this capsule has thus no choice but to pass down the segmental duct. The embryonic excretory system is, according to this account, formed entirely from the mesoblast. In embryos of the wall-eyed pike of twenty-four days and more, there is seen a mass of coiled tubes at the side of the body opposite the pectoral fins. Whether they are due to the coiling of the segmental duct or to the formation of new pronephric tubules connecting it with the body cavity, has not been determined.

d. The testes and ovaries arise from the mesoblast which forms the peritoneal epithelium, but they do not fall within the limits of this paper.

From the mesoblast which forms the lateral plates and the mesoblastic somites, cells separate themselves and travel to various parts of the body. These cells, the mesenchyme cells, fill the spaces that are left between the structures derived from epiblast, hypoblast and mesoblast. The tissue which is thus found packed in everywhere between the other organs, has been pointed out in the living embryo (Figs. 38 and 41 amb.) and in the sections. It is the mesenchyme which, according to the more recent work on the subject, is not derived from the parablast, but is formed, in large part at least, from the mesoblast and may be considered as a part of the mesoblast.

The organs derived from the mesenchyme are:

e. The Skeleton: The development of those parts of the skeleton that are to be made out in the living embryo has been pointed out. A complete account can not be attempted here. The notochord has been spoken of as a skeletal structure and its farther history may be alluded to. Up to the forty-fifth day it does not show any change except that already noted. In the adult fish it is found that the vertebral column or back-bone has been formed in the mesenchyme about the notochord. The notochord is much constricted where it is surrounded by the body of each vertebra, and is expanded between the vertebræ. It thus comes to have the appearance of a string of beads, in which the parts corresponding to the beads are globular enlargements, and serve as packing between the vertebræ. Each vertebra is hollowed at its ends to fit against these enlargements of the notochord, and the consequent peculiar hour-glass shape of the vertebrae is familiar to everyone.

f. The heart, blood vessels and blood are all formed from the mesenchyme. In the region where the heart is to be formed, mesenchyme cells are shown, in Fig. 38 and in Fig. 41, ht. The first cells that are to form the heart flatten themselves, and arrange themselves into a tube which is situated at the anterior end of the notochord (Ziegler). This tube is between the two body cavities which extend into this region, and is held, like the intestine, in a vertical partition formed from the splanchnic walls of the two body cavities. The ventral portion of this partition or mesocardium subsequently disappears (Ziegler) and leaves the heart suspended by the dorsal portion only.

This anterior part of the body cavity in which the heart lies is called the pericardial cavity, and becomes subsequently shut off from the rest of the body cavity. Soon after the endothelial portion of the heart is formed and before the ventral mesocardium has disappeared cells pass off from the *splanchnic* layer of mesoblast, where it is in contact with the endothelial heart sac. These cells pass around the heart sac above and below it (Henneguy) and form the muscular wall of the heart. When the ventral mesocardium disappears, the splanchnic layer of mesoblast remains outside the muscular wall of the heart, as the pericardium, which corresponds to the peritoneum of the intestine. The pericardium passes upward, serves to attach the heart to the body wall above it, and also forms a lining for the pericardial cavity. The heart as thus formed, consists of three sacs one within the other, the innermost or endothelial, the muscular and the pericardial, all of mesodermic origin. The endothelial and muscular sacs are separated from one another by a considerable interval.

It is in this condition that the heart first attracts attention in the living embryo and is seen on the eighth day lying underneath the head, with its smaller end at the anterior end of the notochord and its larger end turned toward the left side. It is beating regularly about sixty times per minute at a temperature of seventy degrees, drawing in fluid at its larger end and driving it along toward the smaller. The heart subsequently changes form by becoming divided into auricle, ventricle, sinus venosus and truncus arteriosus, and valves are formed in it. These processes are readily observed and have been sufficiently described in the preceding pages.

The blood vessels, like the heart, are, according to the best observers, formed from the mesenchyme. Along the line where a blood vessel appears, the cells separate from one another by the formation of a fluid between them, until there is formed in this way a fluid-filled space, in which the cells float. The cells about this space then flatten and form the endothelial wall of the blood vessel. The fluid is the plasma of the blood, while the cells floating in it are the first blood corpuscles.

The organs derived from the hypoblast:

The hypoblast is formed by differentiation from the primitive hypoblast. It is at first a sheet of cells lying over the parablast, underneath the embryo. This sheet almost immediately rolls itself into a tube—the process being different in front, where a broad flat tube is formed from what it is behind, where the tube is cylindrical. The tube is fully formed by the eighth day, and is at first closed at both ends. On the eighth day pocket-like outgrowths of the anterior end of the tube meet with similar ingrowths from the sensory layer of the epiblast. The two fuse later, and the gill slits are formed. The region where this takes place is thus marked off as the pharynx. Farther back, at about the same time, the liver is formed as one or more hollow branching outgrowths from the tube. The liver marks the limit between the intestine, which lies behind its point of origin, and the stomach and œsophagus, which lie in front of its point of origin. At its back end the intestine passes for a way into the tail and, after the tenth day, is seen to bend downward and open in a notch at the lower border of the tail. The part below the bend is probably formed as an invagination of the external *epiblast.*

Up to about the eighteenth day there is no mouth opening seen at the front end of the alimentary tube. It appears at about this time as a shallow triangular depression leading into the pharynx. Whether the hypoblastic tube reaches forward to the epiblast and breaks through to the outside directly, or whether it comes in contact with a depression of the epiblast and breaks through into the bottom of this depression, the writer has not determined. The weight of authority is in favor of the first view. The second method is the one followed in forming the gill slits and posterior end of the intestine. About the seventeenth day the alimentary canal becomes larger just in front of the liver, and this enlarged portion is the stomach. The portion of the tube between stomach and pharynx is thus marked off as the œsophagus. The subsequent enlargement of stomach and intestine, as the yolk and oil globule disappear, and the formation of folds in their walls, have been described. Although the mouth appears on the 17th day and there is thus a complete passage through the alimentary canal, food is not taken until much later. This is owing, not to the lack of a mouth, but to the absence of teeth and tongue and to the absence or weakness of the muscles which move the jaws and gill arches. Not until these structures have developed, and the stomach and intestine have acquired a cavity of considerable size, is food taken. There is, of course, no necessity that it should be taken until the yolk and oil globule have been used.

The air bladder is shown in the figures for the first time on the thirty-second day (Fig. 63.). Its early development has not been followed. According to the usual account it appears as a hollow outgrowth from the intestine on its dorsal side, nearly opposite the liver. It afterward becomes greatly enlarged and, in the wall-eyed pike, looses its connection with the alimentary canal.

The parablast may be considered as a specially modified portion of the hypoblast. Its fate is the subject of as much difference of opinion as its origin. According to some writers (Hoffman), many of its nuclei pass into the blastoderm, each with some of the protoplasm about it, and become cells of the body of the embryo. According to another account the parablast is a structure which serves as a means of converting the yolk into a form suitable for the use of the embryo and, after it has served this purpose, its nuclei degenerate (Ziegler). According to another account the parablast breaks up into little masses which pass into the body of the embryo and are there used as nutriment, but do not themselves form any permanent part of the body. The writer's observations do not yet lead him to any conclusions in the matter.

The whole history of the embryo may be thus briefly summed up. By the union of ovum and spermatozoön then is formed the fertilized ovum, the germinal disc of which then segments to produce the blastoderm. The cells of the blastoderm are at first alike. But as it spreads over the yolk in the process of gastrulation and finally encloses the yolk, its cells become divided into two layers, the epiblast and the primary hypoblast. The primary hypoblast then divides into hypoblast, notochord and mesoblast, and from these and the epiblast, by inequalities of growth, the various organs of the embryonic body are shaped. The epiblast gives rise to its peculiar structures and the hypoblast to those peculiar to it, while the mesoblast divides into mesoblastic somites, from which arise the voluntary muscles of the body, and the lateral plates, from which come the lining of the body cavity and the excretory and reproductive organs. From the mesoblast also comes the mesenchyme, which gives rise to the skeletal and vascular systems.

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A complete list would contain about two hundred titles.

EXPLANATION OF THE FIGURES.

The following abbreviations have the same meaning in all the plates:

a, non embryonic part of the blastoderm.
a. bl, air bladder.
a. brn, branchial artery.
a. br, branchial arch.
a. l, anterior extension of lateral wall of auditory vesicle.
alm, alimentary canal.
a. m, anterior extension of medial wall of auditory vesicle.
amb, amoeboid cells.
an, anus.
ao^{1}, first aortic arch.
ao^{4}, fourth aortic arch.
ao. l, left aortic arch.
ao. cd, caudal artery.
a. pct, pectoral arch.
au, auricle.
au. v, } auditory vesicle.
aud. v, }
bl, blastopore.
bld, urinary bladder.
bls, blastoderm.
br, brain.
br. slt, branchial slit or gill slit.
cav. sg, segmentation cavity.
cbl, cerebellum.
cbr, cerebrum.
c. br, branchial cartilages.
c. d, tail.
ch, notochord.
ch. slt, choroid slt.
c. hy, hyoid cartilage.
c. l, cell limit.
c. Mck, Meckels cartilage.
c. nu, cell nucleus.
coel, body cavity.
con^{1}, constriction between forebrain and midbrain.
con^{2}, constriction between midbrain and hindbrain.
c. op, cavity of optic vesicle.
c. p, cell protoplasm.
c. pl, caudal plate.
cr, metal cross.
crk, cork.
crn, cornea.
crt. l, left carotid artery.
crt. r, right carotid artery.
c. w, cell wall.
d. cuv. duct of Cuvier.
d. cuv. r, right duct of cuvier.
d. cuv. l, left duct of cuvier.
e. a, embryonic area.
e. m, external egg membrane.
end, endothelium of heart.
emb, embryo.
epb, epiblast.
fb, forebrain.
f. cd, caudal fin.
f. f. d, dorsal fin fold.
f. f. v, ventral fin fold.
fld, folds of intestines and stomach.
f. pct, pectoral fin.
fr^{1}, first segmentation furrow.
fr^{2}, second segmentation furrow.
fr^{3}, third segmentation furrow.
f. r, fin rays.
g. d, germinal disc.
gl. f, gill filaments.
gls, glass vessel.
gls. tb, glass tube.
gr, groove between rim of blastoderm and parablast.
g. s. epb, epiblastic portion of gill slit.
g. s. h, hypoblastic portion of gill slit.
gz. col. wire gauze collar.
h, head or anterior end.
h. b, hindbrain.
h. gl. f, hyoidean gill filiament.
h. p, primary hypoblast.
h. pr, liver.
h. se, or h. s, secondary hypoblast.
ht, heart.
in, extension of inforior well of auditory vesicle.
inf, infundibulum.
ins, intestine.
K. v. Kupffer's vesicle.
l. c, covering layer of epiblast.
ld. p, lead pipe.
ld. cn, lead cone.
l. l, lower layer or sensory layer of epiblast.
l. li, lateral line organ.
lns, lens.
m. b, midbrain.
med, medula oblongata.
mes. or ms, mesoblast.
ms. so, mesoblastic somite.
mi, micropyle.
mnd, mandible.
msch, mesenchyme.
mth, mouth.
mu, sphincter muscle of anus. in Fig. 50, muscular wall of heart.
mxl, maxilla.
n. gr, neural groove.
nmr, neuromeres.
n, or n. r, neural keel.
nrv, nerve.
nu, nucleus.
oes, œsophagus.
o. d, oil-drop or oil globale.
olf, olfactory pit.
op. c, optic cup.
opcr, operculum.
op. v, optic vesicle.
otl, otolith.
p. c, pericardial cavity.
pgm, pigment cell.
p. l, posterior extension of lateral wall of auditory vesicle.
pn, pineal gland.
pq, palato-quadrate cartilage.
prb, parablast.
prb. nu, nuclei of parablast.
prc, proctodaeum.
prn, pronephros or head kidney.
prt, septum between dorsal and ventral lateral muscles.
pyl, pylorus.
r. bl, rim of blastoderm.
rbr, rubber band.
rbr. p, rubber pipe.
rtn, retina or retinal layer of optic cup.
rtn. p, retinal pigment layer of optic cup.
slp. and slp^{1}. glass slips.
som, somatic layer of mesoblast.
sp, space beneath the head.
sp. c, spinal cord.

spl, splanchnic layer of mesoblast.
sp. o. d, space occupied by oil-drop.
ss. c1, anterior, vertical semi-curcular canal.
ss. c2, horizontal semi-circular canal.
ss. c3, posterior vertical semi-circular canal.
st, stomach.
s. v, sinus venosus.
sz. sp, subzonal space.
t, tail or posterior end.
th, tooth.
tn, tongue.
tr, truncus arteriosus.
'twb, 'tweenbrain.
v, ventricle.
vac, vacuole.
v. br, branchial vein.
v. cd, caudal vein.
v. crd. a. l, left anterior cardinal vein.
v. crd. a. r, right anterior cardinal vein.
v. crd. p. l, left posterior cardinal vein.
v. crd. p. r, right posterior cardinal vein.
v. hp, hepatic vein.
vlv, valve of heart.
vn3, third ventricle.
vn4, fourth ventricle.
v. v, vitelline vein.
yk, yolk.
yk. i, yolk investment.
yk. m, yolk mass.
yk. sc, yolk sac.
yk. sp, spongy yolk.
z. r, zona radiata.
wr, wire for holding lead cone free from glass.

PLATE I.

Fig. 1.—Fresh laid eggs, before filling, as seen from above, i. e., with microscope tube vertical.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 1 a.—One of the eggs shown in *Fig. 1.*, partly filled.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 1 b.—One of the same eggs partly "filled," showing amoeboid movements in the germinal disc.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 2.—Egg after "filling," seen from the side, i. e., with microscope tube horizontal.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 3.—Egg after "filling," seen from above.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 4.—Egg membranes. *a.* shows the pore canals of the zona, as seen in a fold: *b.* shows surface of the membranes.
Gundlach 1-5 obj. Oberhäuser camera.
Fig. 5.—Optical section of egg membranes.
Hartnack Nr. 5 obj. Oberhäuser camera.
Fig. 6.—Surface of the external egg membrane by reflected light.
Drawn with Oberhäuser camera. Scale not determined.
Fig. 7.—Sketch of micropyle and surrounding portion of membranes.
Fig. 8.—Optical cross section of portion of the egg in region of the micropyle. The sub-zonal space is partly filled. The yolk and germinal disc are drawn only in outline.
Gundlach ⅙ obj. Oberhäuser camera.
Fig. 9.—A portion of the germinal disc showing elevation of the protoplasm toward the micropyle.
Camera drawing scale not determined.
Fig. 10.—Spermatozoa, killed in osmic acid, mounted in glycerine containing eosin.
Gundlach 1-5 obj. Oberhäuser camera.
Fig. 11.—Egg four hours after fertilization.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 12.—The egg shown in Fig. 11 four and one-half hours after fertilization.
Gundlach 2 in. obj. Oberhäuser camera.

PLATE II.

Fig. 13.—Is on Plate III.
Fig. 14.—The egg shown in Fig. 11 four hours and fifty minutes after fertilization.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 15.—The egg shown in Fig. 11 six hours after fertilization.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 15 a.—Sketch from above of blastoderm of egg shown in Fig. 15.
Fig. 16.—Egg twenty-seven hours after fertilization.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 17.—Egg thirty hours after fertilization.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 18.—Is on Plate III.
Fig. 19.—Section of egg after first segmentation furrow is formed. The section passes at right angles to the furrow.
Leitz oc. 1 obj. 3. Abbe camera.
Fig. 20.—Section of an egg of between twenty and twenty-seven hours.
Leitz, oc. 1 obj. 3. Abbe camera.

PLATE III.

Fig. 13.—*a.* Diagram of egg of wall-eyed-pike. *b.* Diagram of typical cell.
Fig. 18.—Egg thirty-seven hours after fertilization.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 21.—Section through the blastoderm of an egg of twenty-seven hours.
Zeiss oc. 4 obj. A. Abbe camera.
Fig. 22.—Section of blastoderm of egg at end of segmentation.
Leitz oc. 3. obj. 3. Abbe camera.
Fig. 23.—*a.* Outline of paper which is shown at *b* folded so as to represent the rim of the blastoderm and the embryonic area.
Fig. 24.—Egg, fifty-six hours after fertilization.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 24a.—Section of an egg, about fifty-six hours after fertilization.
Leitz oc. 1, obj. 3. Abbe camera.

PLATE IV.

Fig. 25.—Egg of seventy hours, seen obliquely from the side.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 26.—Egg of seventy-two hours, seen from the side.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 27.—Outline of the egg shown in *Fig. 25.* The embryonic area is seen from the surface.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 28.—Diagrams illustrating the manner in which the egg turns during gastrulation.
For explanations consult the text.
Fig. 29.—Section of egg of about seventy hours. The section passes lengthwise of the embryonic area and perpendicular to its surface.
Leitz oc. 1, obj. 3. Abbe camera.
Fig. 29a.—A portion of the embryonic area, shown in *Fig. 29.*
Leitz oc. 1, obj. 7. Abbe camera.
Fig. 29b.—A portion of the non-embryonic part of the blastoderm, shown in *Fig. 29.*
Leitz oc. 1, obj. 7. Abbe camera.
Fig. 30.—Egg of seventy-eight hours. The embryo is in a position at right angles to that which it usually occupies.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 31.—Outline of an egg of seventy-eight hours, in which the embryo is in nearly the normal position.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 32.—Experimental apparatus for hatching eggs.
Fig. 33.—Sketch of apparatus for observing the eggs under the microscope.

PLATE V.

Fig. 34.—Egg of about one hundred hours. (The embryo is at right angles to the usual position and is represented as seen through the yolk.)
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 34a.—Part of egg of about same age, showing anterior end of embryo as seen from above.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 35, Fig. 36 and Fig. 37 are diagrams illustrating the relation of the embryo and of the embryonic area to the yolk and to the rim of the blastoderm.
Fig. 38.—Anterior end of an embryo at the end of the fifth day.
Gundlach ⅙ obj. Oberhäuser camera.
Fig. 39.—Posterior end of the same embryo.
Gundlach ⅙ obj. Oberhäuser camera.
Fig. 40.—Egg of six days and four hours, seen from the side.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 41.—Anterior end of embryo of six days and four hours.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 42.—Posterior end of the same embryo.
Gundlach 2 in. obj. Oberhauser camera.
Fig. 43.—Optical cross section of trunk region of an embryo at the end of the fifth day.
Gundlach ⅙ obj. Oberhäuser camera.

PART VI.

Fig. 44.—Anterior end of an embryo at the end of the seventh day, seen from above.
Gundlach ⅙ obj. Oberhäuser camera.
Fig. 44a.—Side view of anterior end of same embryo.
Gundlach ⅙ obj. Oberhäuser camera.
Fig. 45.—Sketch of the heart of an embryo at the end of the eighth day, seen from below.
Fig. 46.—Anterior end of an embryo of nine days and four hours.
Gundlach obj. ⅙. Oberhäuser camera.
Fig. 46a.—Outline of the eye of an embryo at the end of the tenth day.
Gundlach obj. ⅙. Oberhäuser camera.
Fig. 47.—Embryo at the end of the tenth day, as seen from the right side.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 48.—Embryo at the end of the tenth day. Camera outline.
Scale was not determined, but measurements may be made on *Fig. 47.*
Fig. 49.—Sketch of the embryo shown in *Fig. 48.*
Fig. 50.—Heart of an embryo of ten days and twelve hours, seen from below.
Camera drawing. Scale not determined.

PLATE VII.

Fig. 51.—Embryo at the end of the thirteenth days, from the right side. The pigment cells are omitted and the yolk sac and oil globule are drawn only in outline.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 52.—Embryo at the end of the sixteenth day, seen from below. The pigment is omitted from the yolk sac.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 53.—Anterior end of an embryo at the end of the eighteenth day, from the left side.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 54.—Anterior end of an embryo at the end of the twenty-second day, from below.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 55.—Outline of auditory vesicle. (a)—from the side; (b)—from above; ant.—anterior; pst.—posterior; lat.—lateral; med.—medial borders.

PLATE VIII.

Fig. 56.—Embryo at the end of twenty-four and one-half days, seen from the left side. The embryo had hatched.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 57.—Diagram of the heart of an embryo of eight days.
Fig. 58.—Diagram of the heart of an embryo of twenty days.
Fig. 59.—Diagram of the heart of an embryo of forty-five days.
Fig. 60.—Diagram of the heart of an adult bony fish.
Fig. 61.—Diagram of the circulation of an embryo of thirteen days.
Fig. 62.—Diagram of the circulation in an embryo of twenty-one days.
Fig. 62 a.—Diagram of the circulation in the branchial arch and gill filaments of an embryo of forty-five days.

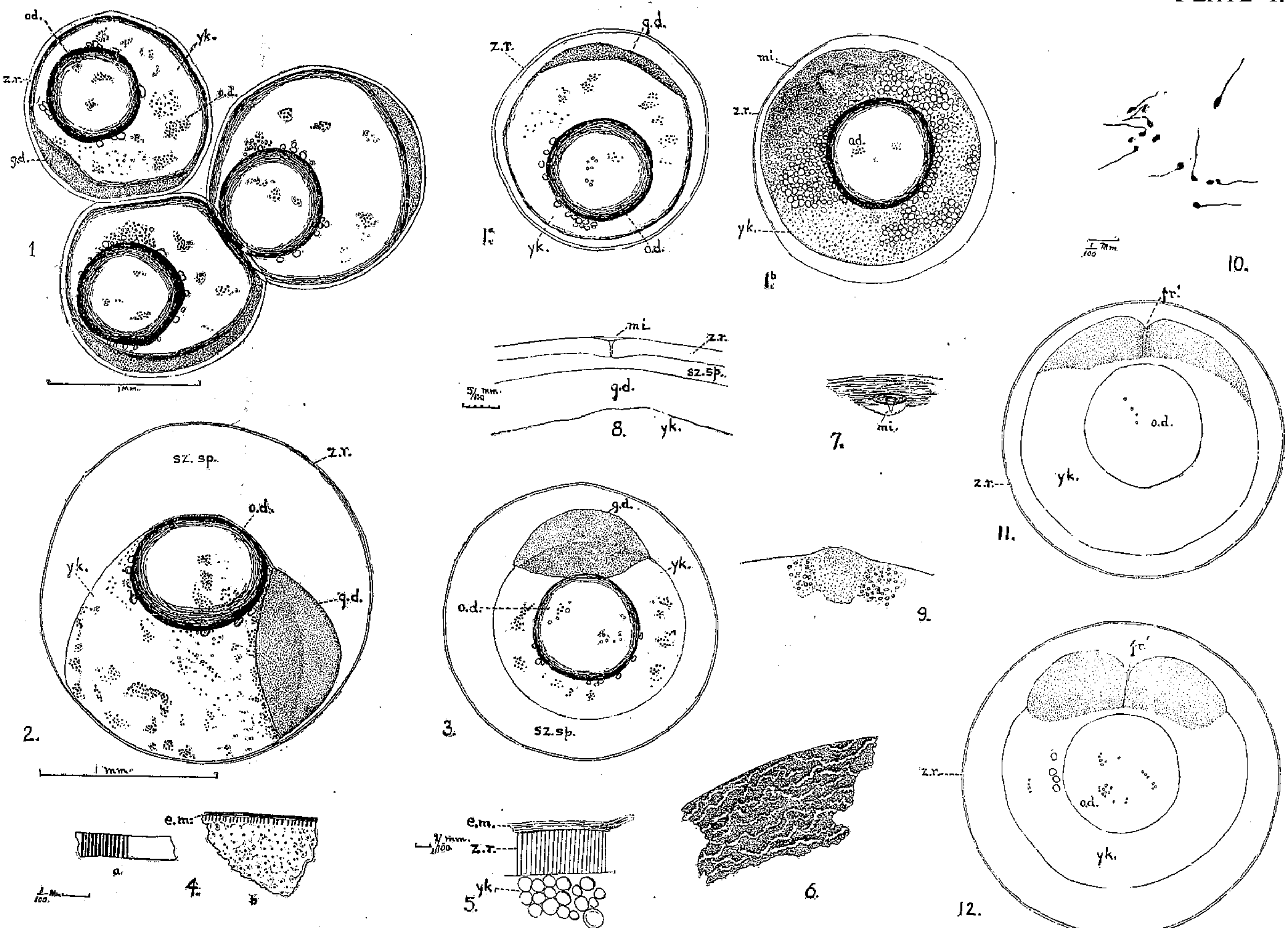
PLATE IX.

Fig. 63.—Embryo at the end of thirty-one and one-half days, from the left side.
Gundlach 2 in. obj. Oberhäuser camera.
Fig. 64.—Embryo of forty-five days, from the left side.
Gundlach 2 in. obj. Oberhäuser camera.

PLATE X.

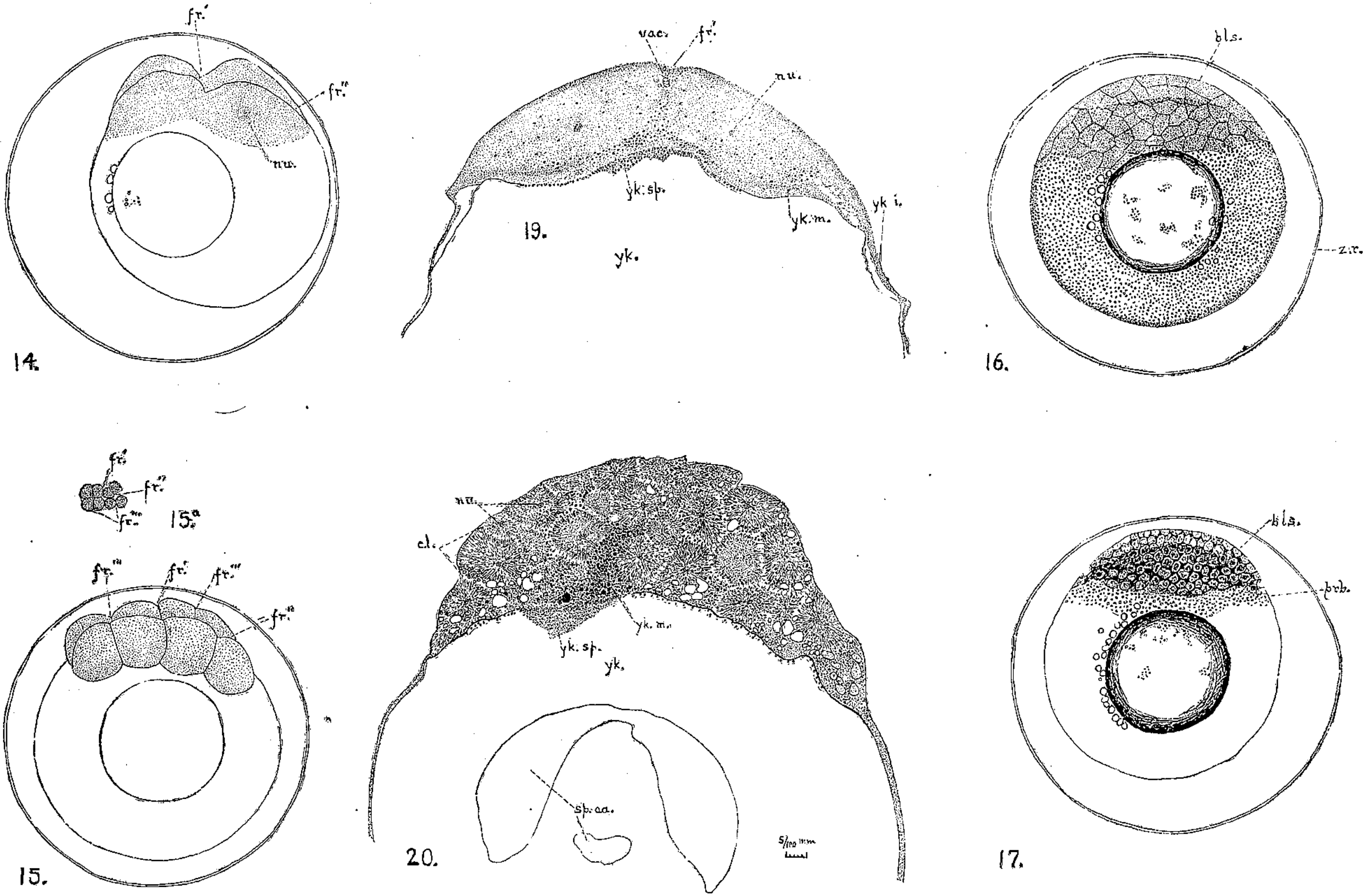
Fig. 65.—Transverse section through the middle of an embryo of eighty hours.
Zeiss oc. 1, obj. D. Abbe camera.
Fig. 66.—Transverse section through the optic vesicle of an embryo at the end of the sixth day, along the line marked Fig. 66 in Figs. 40 and 41.
Fig. 67.—Transverse section through the pharnyngeal region of an embryo at the end of the fifth day, along the line marked *Fig. 67* in *Figs. 38 and 40.*
Fig. 68.—Transverse section through an embryo at the end of the fifth day, along the line marked *Fig. 68* in *Fig. 41.*
Fig. 69.—Transverse section through the dorsal region of an embryo at the end of the sixth day, along the line marked *Fig. 69* in *Fig. 40.*
Fig. 70.—Transverse section through the tail region of an embryo at the end of the fifth day, along the line marked *Fig. 70* in *Fig. 40.*
Fig. 71.—Transverse section through the optic cups of an embryo at the end of the tenth day, along the line marked *Fig. 71* in *Fig. 47.*
Fig. 72.—Transverse section through the auditory vesicles of an embryo at the end of the eighth day, along the line marked *Fig. 72* in *Fig. 47.*
Fig. 73.—Transverse section through the region of the liver in an embryo at the end of the tenth day, along the line marked *Fig. 73* in *Fig. 47.*
Fig. 74.—Transverse section just in front of the anus through an embryo at the end of the tenth day, along the line marked *Fig. 74* in *Fig. 47.*
Fig. 75.—Perspective diagram of one-quarter of an egg of about eighty hours.
Fig. 76.—Perspective diagram of one-quarter of an egg of the sixth day, showing the posterior one-third of the embryo.
Fig. 77.—Perspective diagram of part of an embryo of the tenth day, taken from the point where the tail joins the yolk sac.
Fig. 78.—Perspective diagram of an embryo in which the yolk sac has disappeared from the trunk region.
Figs. 66 to 74, inclusive, are drawn with Leitz oc. 3 obj. 3. Abbe camera.
Figs. 69, 73 and 74 are from an embryo that suffered considerable shrinkage in preparation.
Figs. 75-78 are not taken from reconstructions; they are diagrams.

All the drawings, except of course the diagrams and the drawings of sections, and that of spermatozoa, are made from the living specimens.



J. E. REIGHARD, DEL.

Development of the Wall-Eyed Pike.



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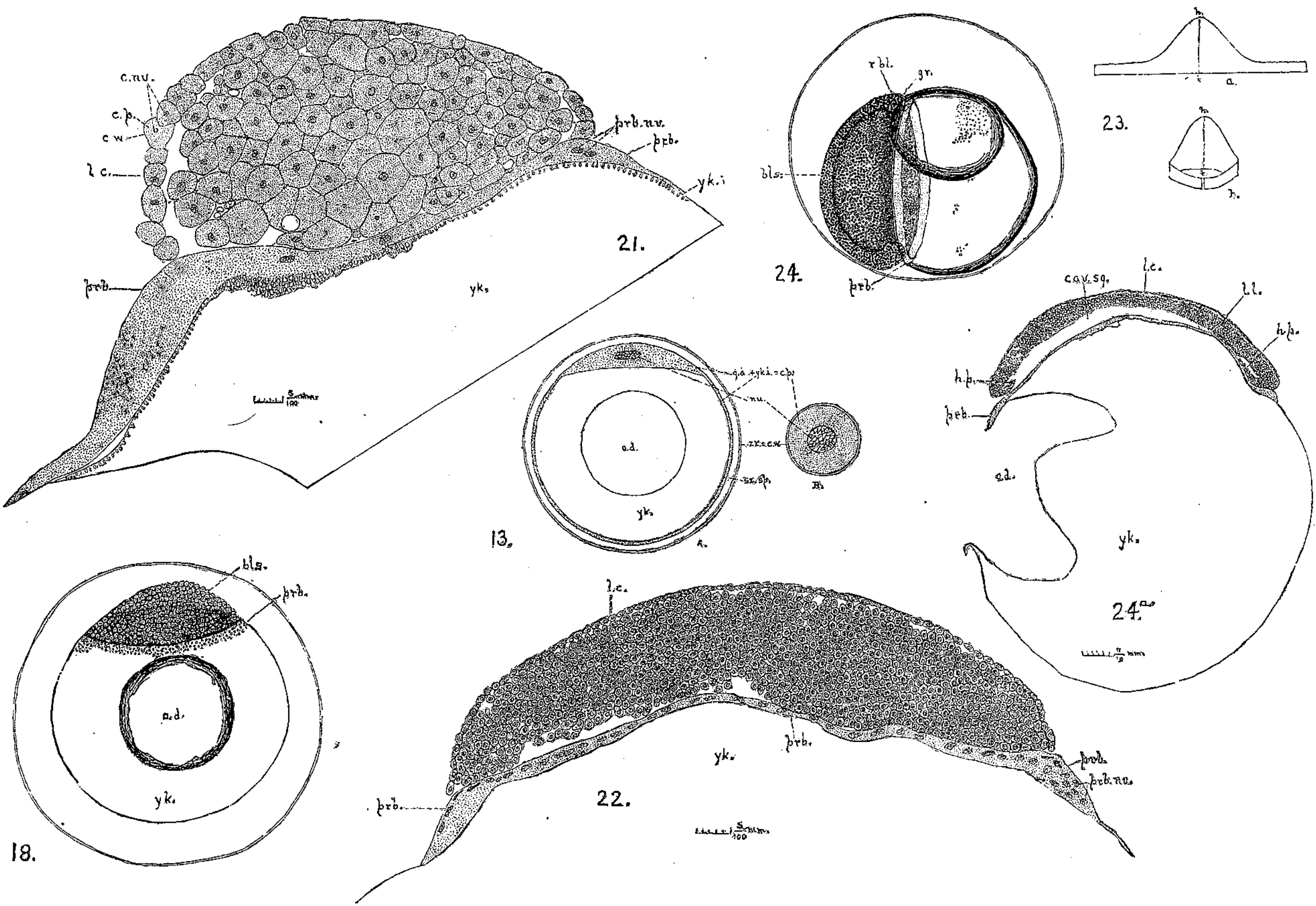
Development of the Wall-Eyed Pike.



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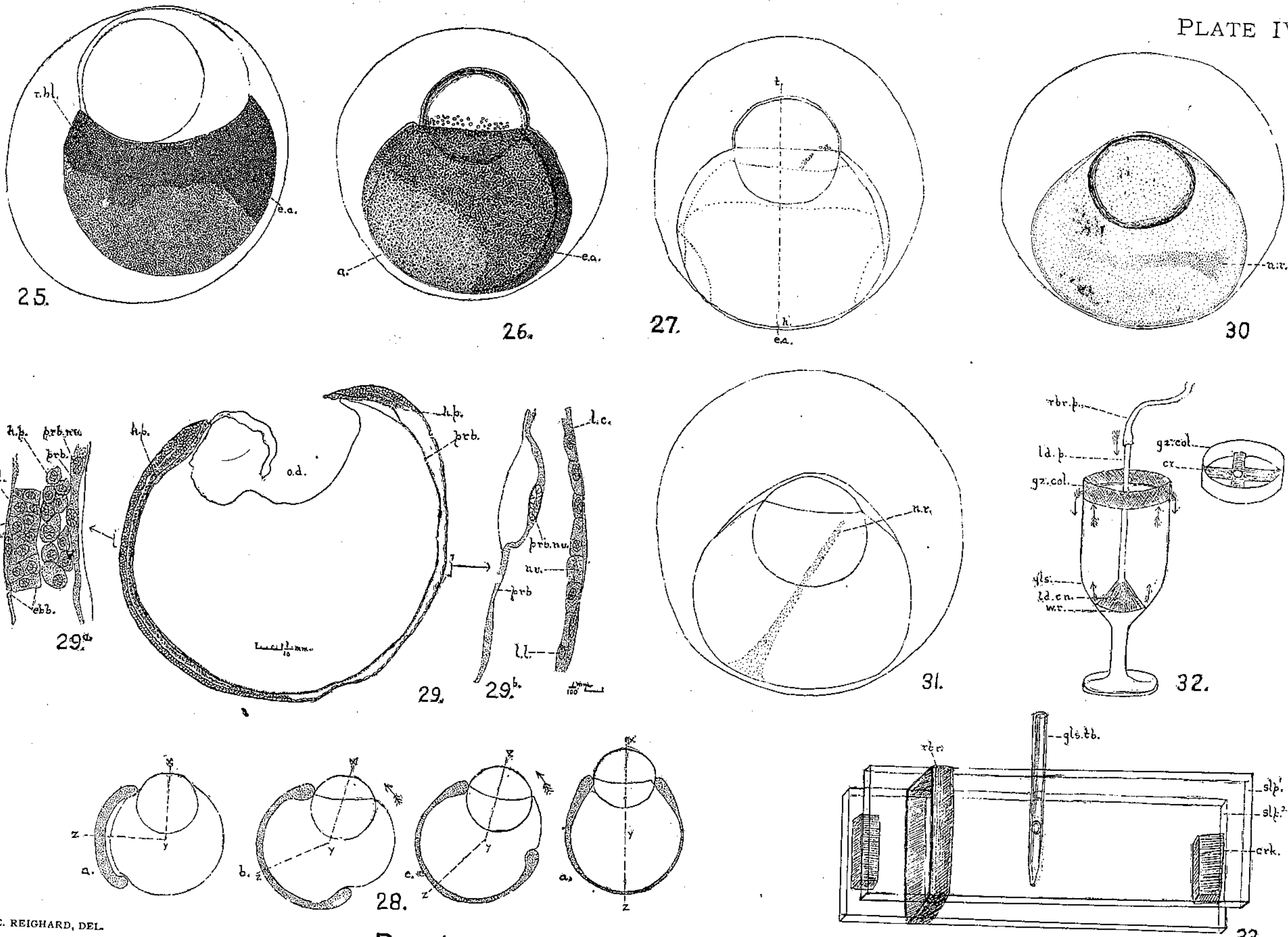
Development of the Wall-Eyed Pike.



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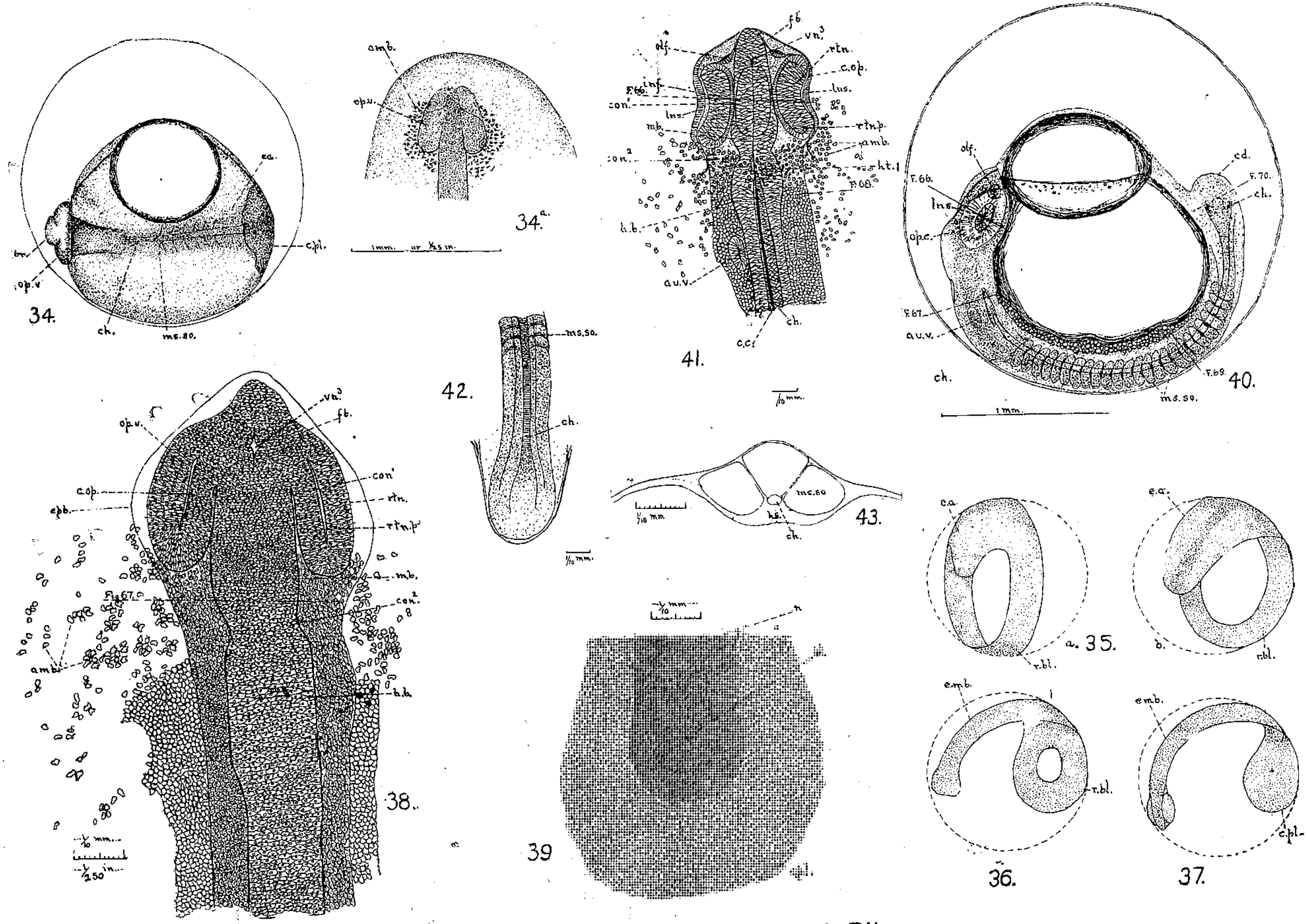
Development of the Wall-Eyed Pike.



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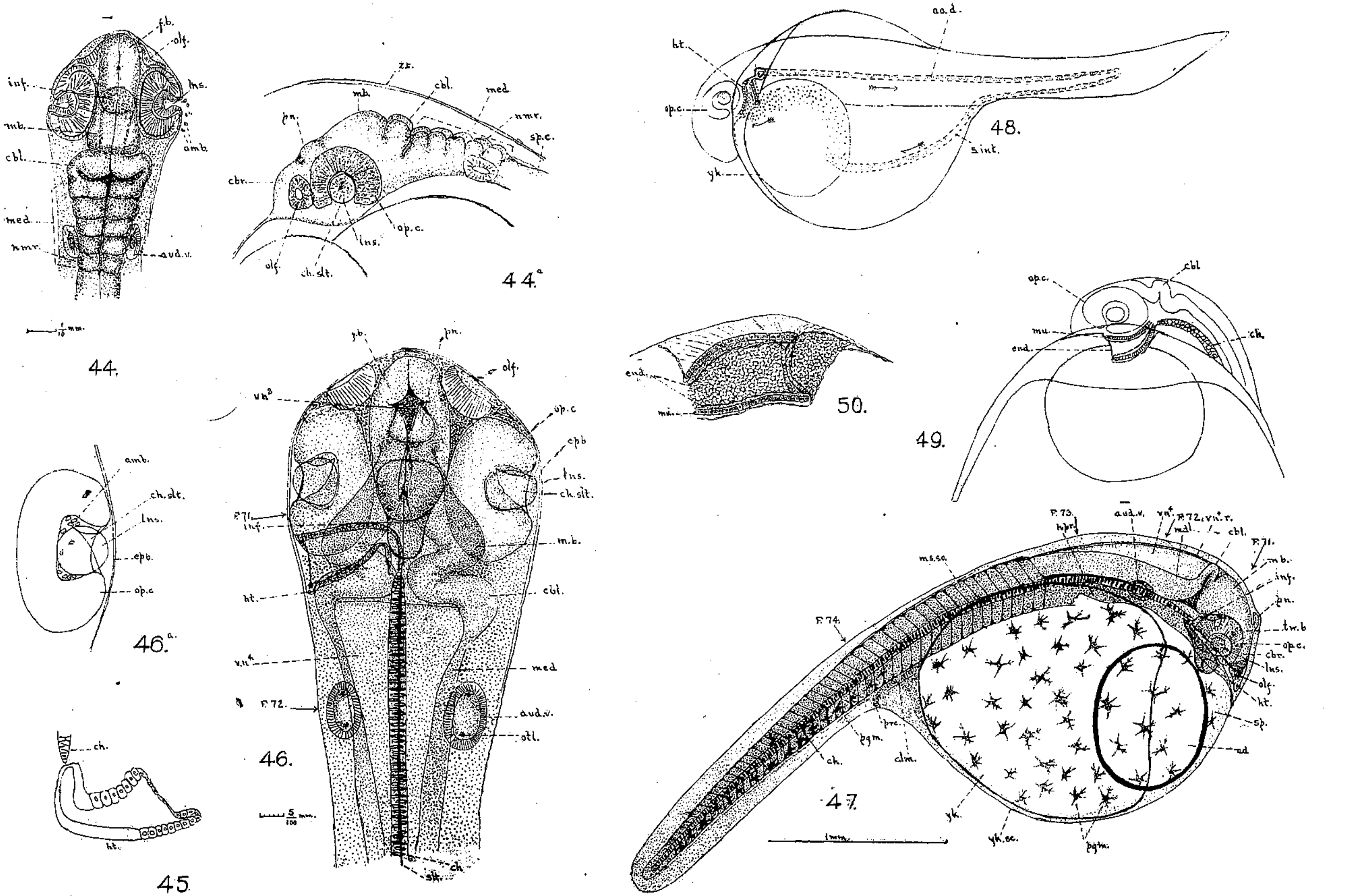
Development of the Wall-Eyed Pike.



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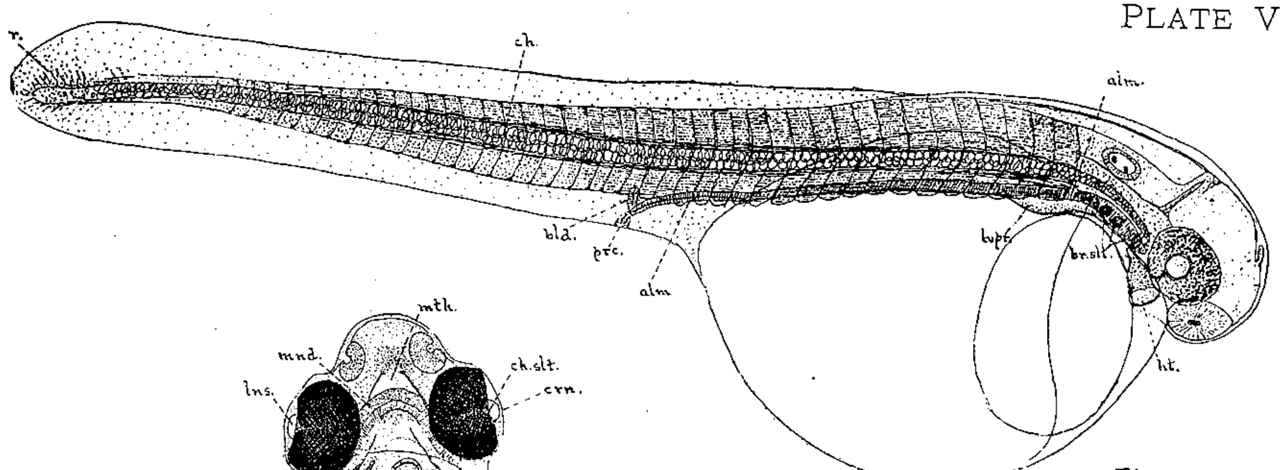
Development of the Wall-Eyed Pike.



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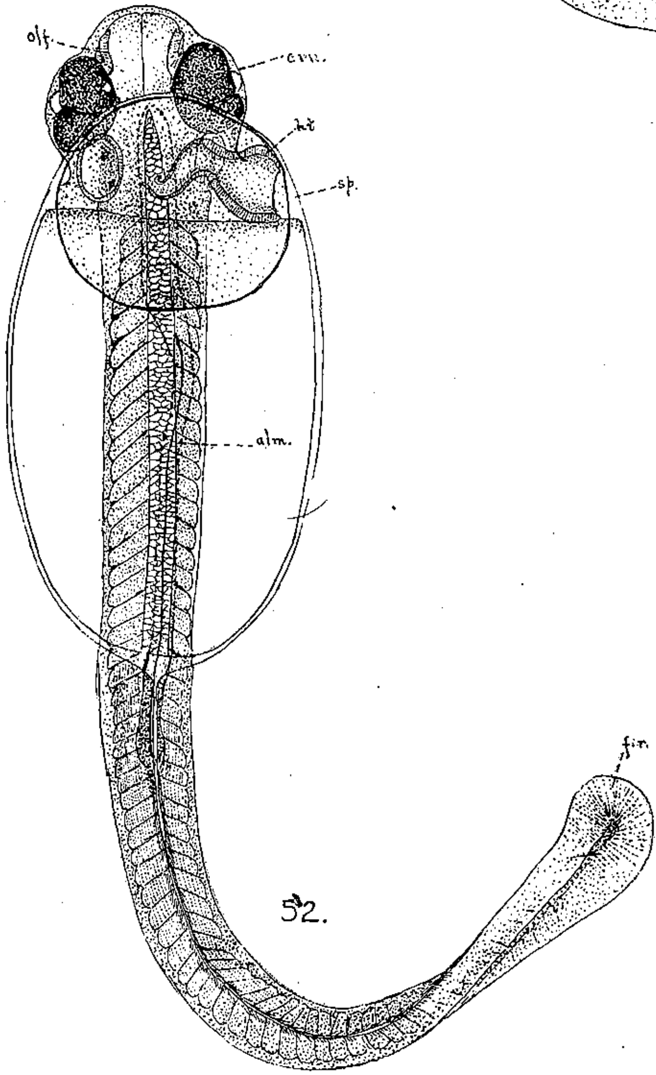

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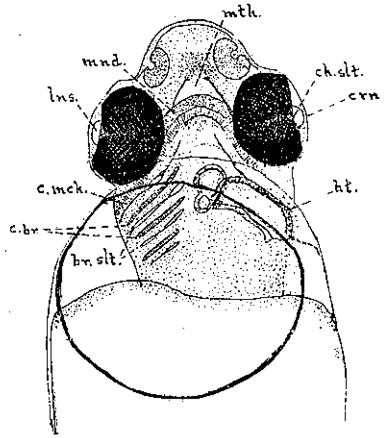

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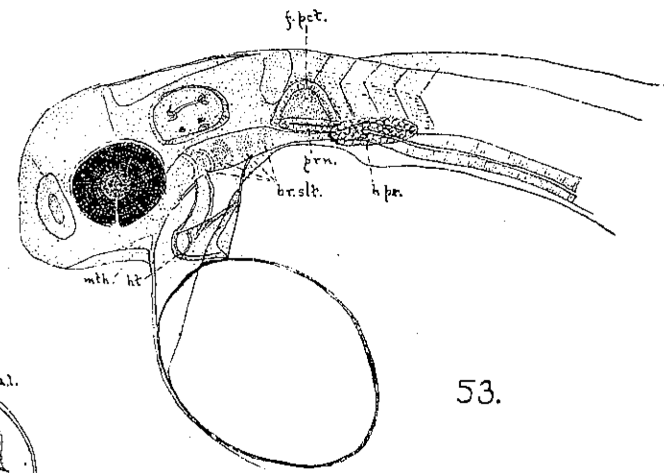

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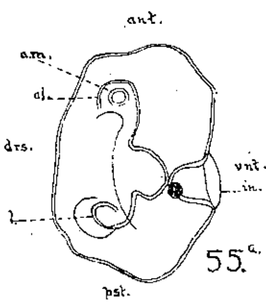

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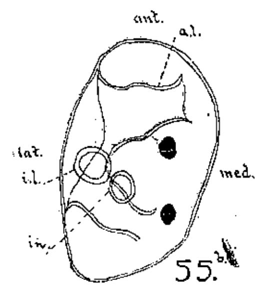

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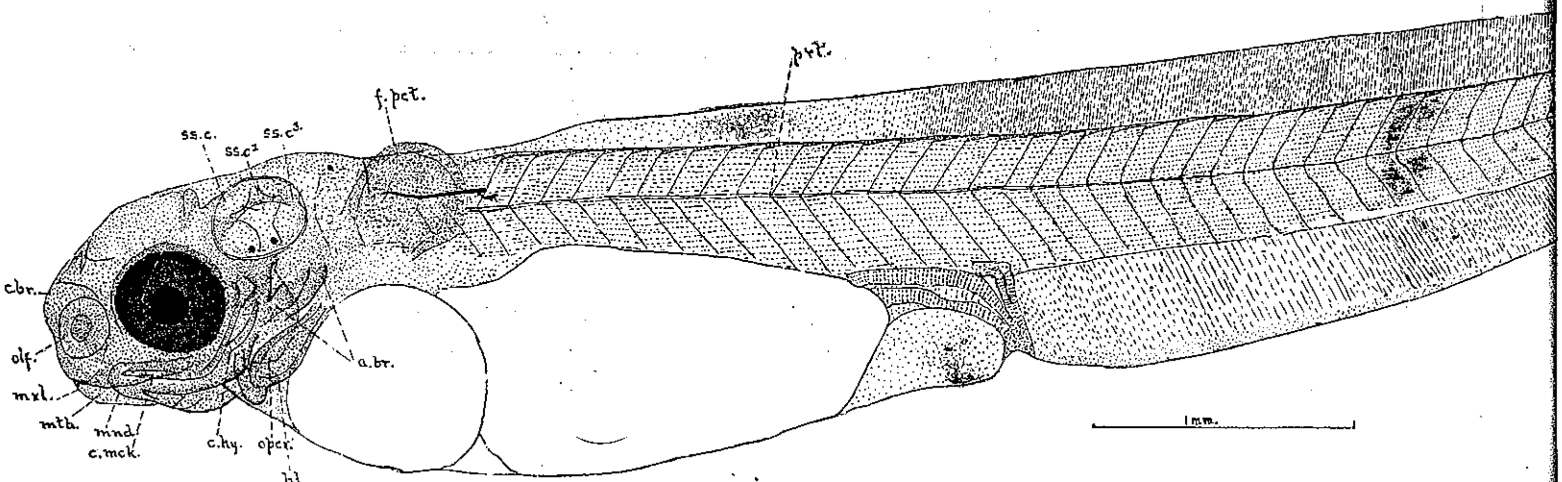
Development of the Wall-Eyed Pike.



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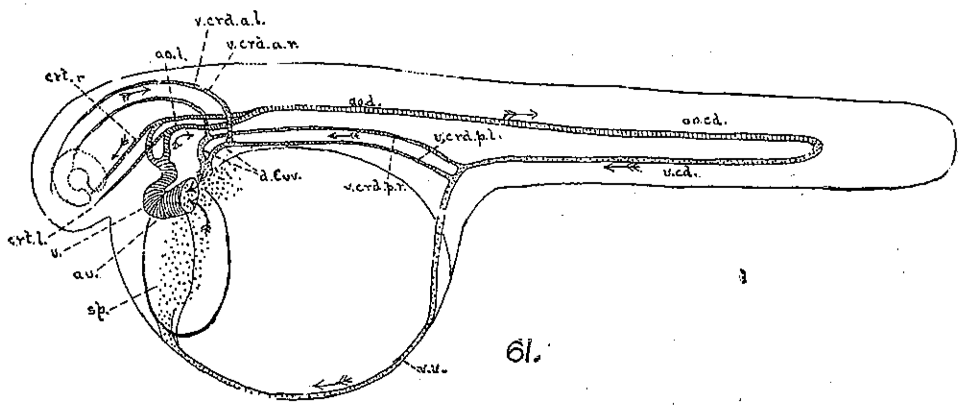

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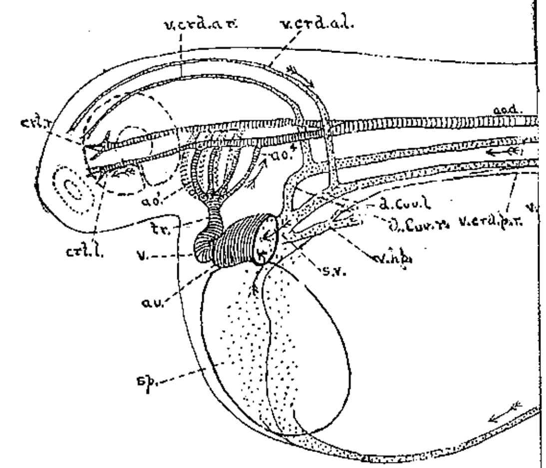

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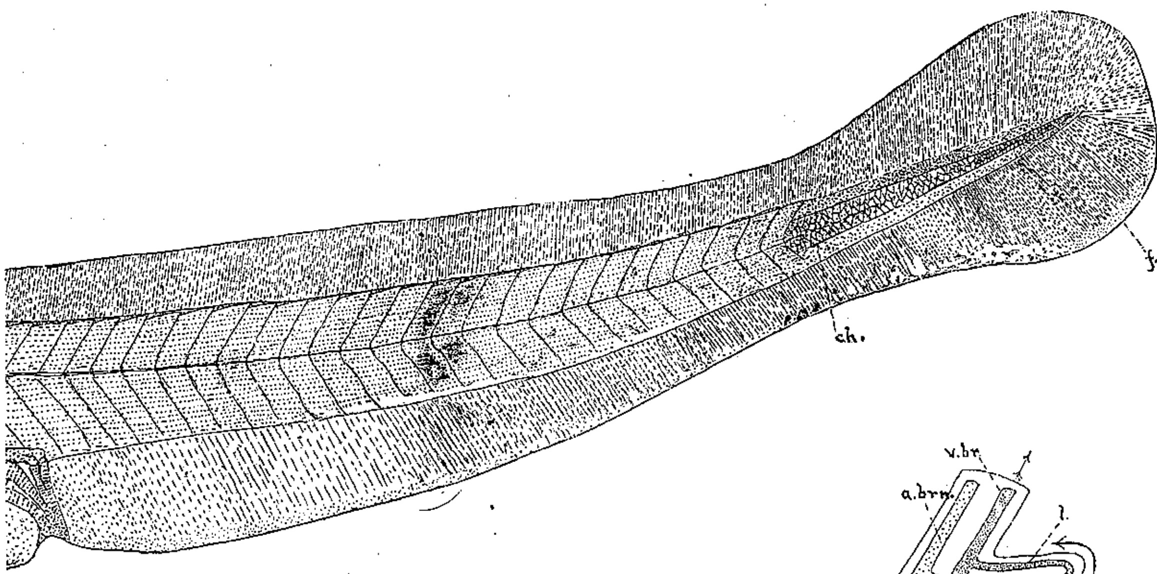
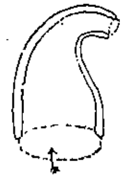
Development of the Wall-Eye

PLATE VIII.





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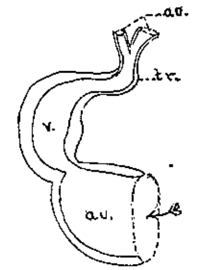

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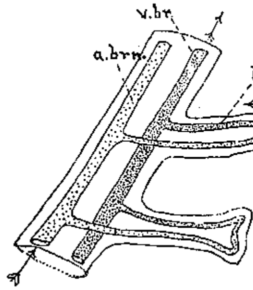

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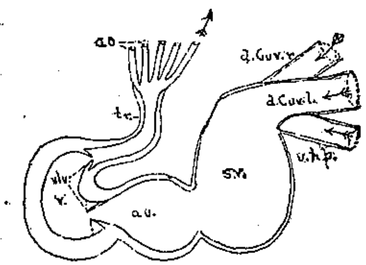

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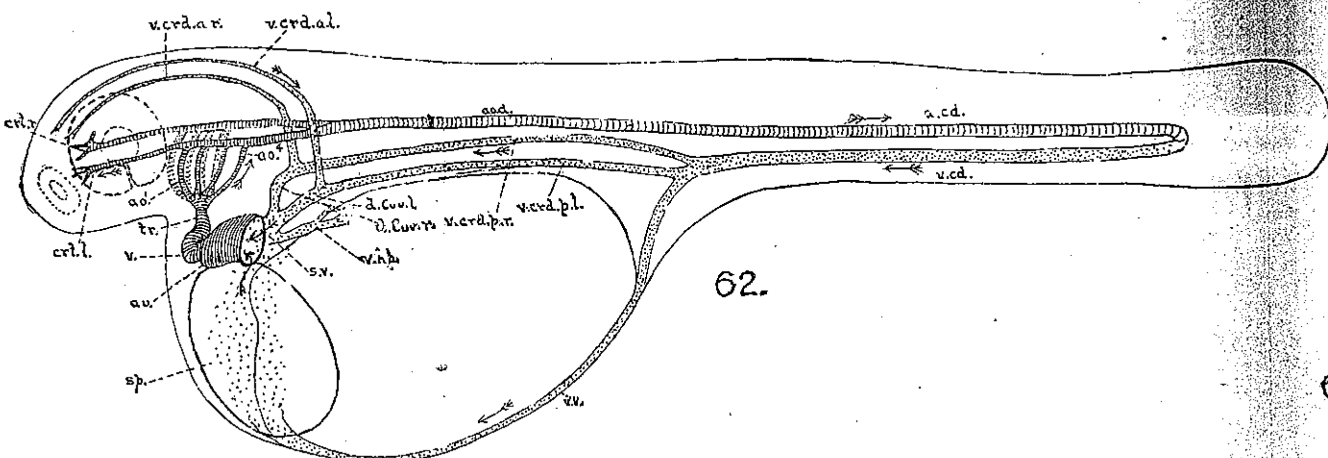

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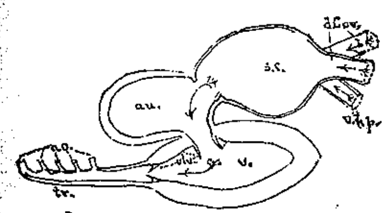

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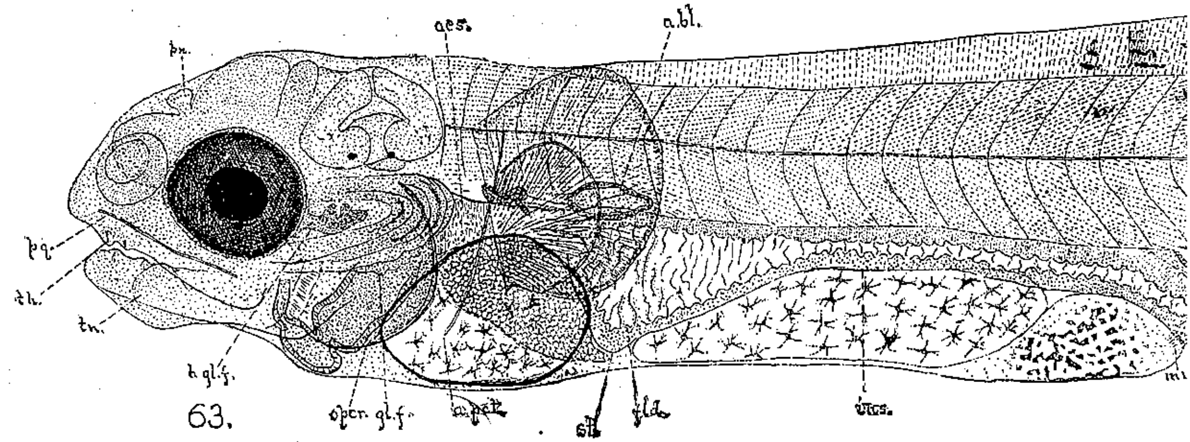
Development of the Wall-Eyed Pike.



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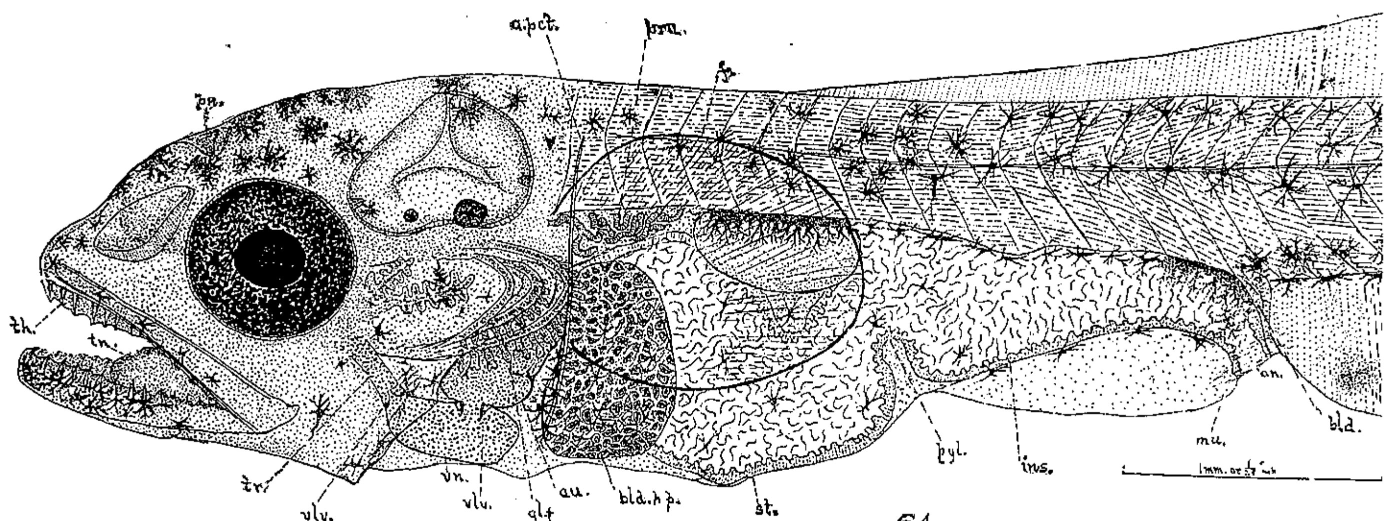

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Development of the V

PLATE IX.

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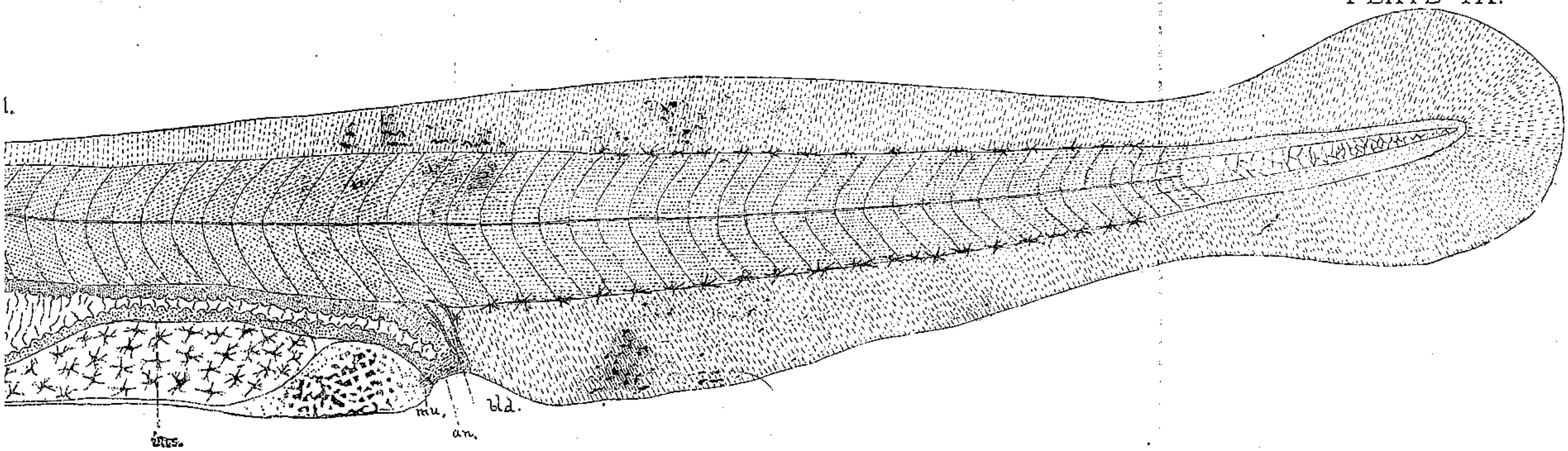

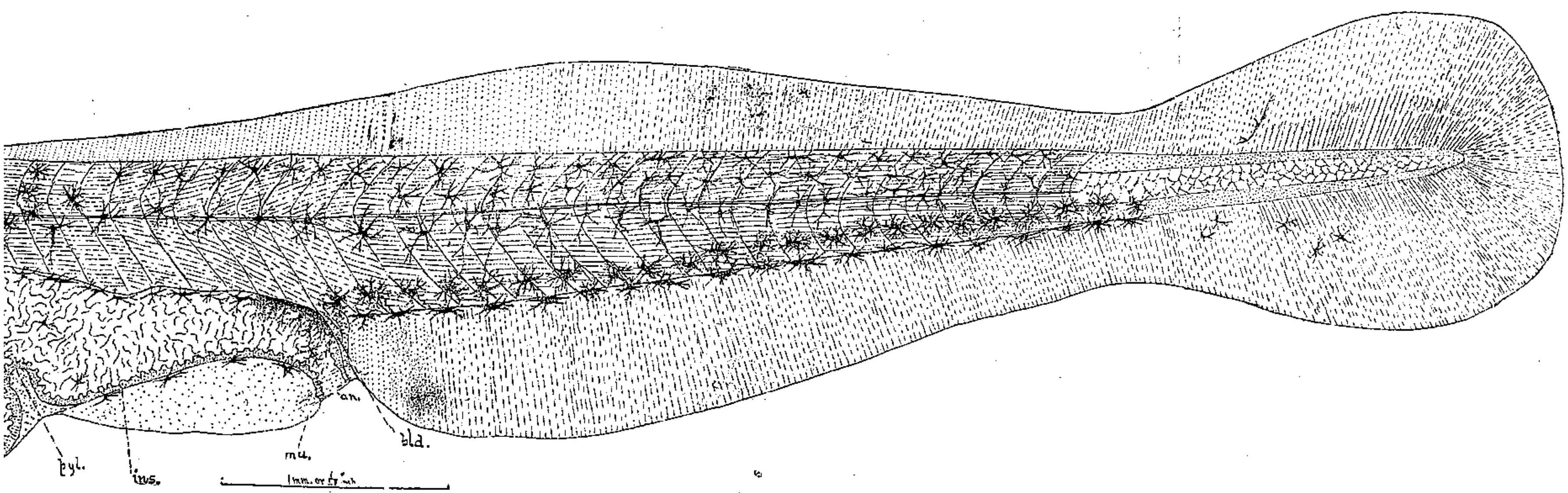

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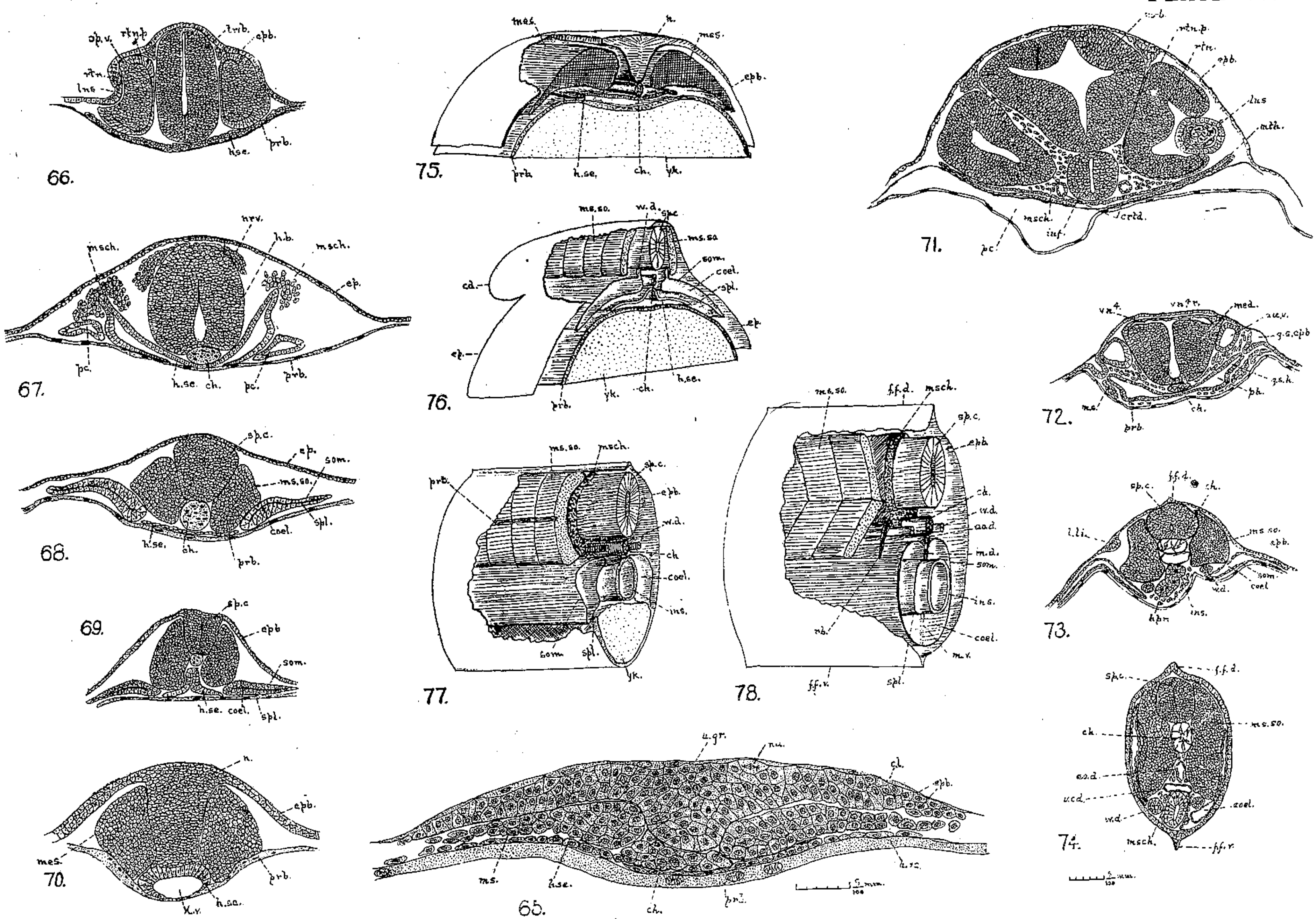
Development of the Wall-Eyed Pike.



J. E. REIGHARD, DEL.

Development of the Wall-Eyed Pike.

COMPLIMENTARY RESOLUTION.

On the first of January, 1889, the term of Commissioner John H. Bissell expired. Owing to the pressure of business affairs he did not seek a reappointment. At the regular meeting of the board, held February 23, 1889, being the first meeting held after the appointment of Mr. Bissell's successor, the following was adopted by the board, ordered entered upon its minutes and a certified copy delivered to Mr. Bissell:

"The term of Mr. John H. Bissell, as one of the Board of Michigan Fish Commissioners expired on the first day of January, 1889, and owing to the demands of increasing personal business affairs he has deemed it best not to accept a reappointment for another term, therefore it is the duty and pleasure of this board to enter upon its minutes an expression of their appreciation of his official conduct and his personal worth.

Mr. Bissell upon his appointment brought to the performance of his duties as Commissioner a natural love and zeal for his work. He possessed all the enthusiasm of a true sportsman, and to this was added business sagacity and judgment and a keen appreciation of the possibilities of the work with which the board is charged. His personal devotion of time and effort to the details of the work of the board, demanding as it did at times a sacrifice of his time which should have been devoted to his own affairs, have never been and cannot be compensated; yet he may retire with the satisfaction that his energy and foresight have largely contributed to the development of one of the most important interprises of this State, and that it has been raised during his term of office, and largely by his aid, from an insignificant and small condition to such a degree of efficiency and thoroughness that it now ranks with the work done by the best boards in the United States.

In his retirement from his field of work he carries with him the esteem of his fellow commissioners, who feel that the State has lost a valuable and faithful commissioner, and the board a friend and efficient co-worker."

OBSERVATIONS ON THE POSSIBILITIES OF FISH CULTURE IN THE FUTURE.

BY DR. J. C. PARKER.

The power of man to change natural conditions finds a most striking example in the distribution of the inhabitants of the waters, and in their artificial fecundation and preservation to a point in fish life when it may be said that they are self supporting.

The past experience and constantly accumulating information of this most interesting of subjects, leads those interested in these matters to feel that we are as yet only in the infancy of a vast economic problem, which when successfully solved, will add most materially to the well being of the individual, and the financial and food developing interests of the State.

The operations of the commission for the past two years, with the increased means placed at its disposal, have carried the economic features of our work far beyond that of any two preceding years, and demonstrated beyond a doubt, the power of increasing in a direct arithmetical ratio the producing powers of the board, by improved powers of production with a minimum of disbursement; and this ratio can undoubtedly be increased until the amount of young fish to be planted in the waters of this State each year shall be made equal to the amount taken out as adult fish and an equal balance obtain.

One of the most gratifying results is the increasing intelligent information that is being disseminated and the interest manifested in regard to this work throughout the State. Letters of inquiry in regard to the methods of the commission are rapidly increasing, showing an active interest and an earnest desire to aid in this important work, and if there could be put into the hands of the commissioners the means and power from time to time, to print for distribution among the inhabitants of the State such practical information as the commissioners may desire furnished it would, in our estimation, be of vastly greater importance than the passage of retaliatory and prohibitory laws. The broad fact is that the largest portion of the people of the State are reasonable, intelligent men, law abiding and err through ignorance, rather than inclination. The cultivation and conservation of fish is a comparatively new thought in the body politic, but there is

every reason to hope that in process of time the point may be reached when every individual who controls an acre of water will so use it as to fully secure the best result through intelligent culture and care.

The following from an article in the Popular Science Monthly, by a native of China on the water system of his mother land, seems thoroughly pertinent to the matter under consideration.

"Through the abundance of water everywhere, my countrymen, instead of being satisfied to cover the sea, rivers and lakes with their fishing boats, have been able to devote themselves extensively to the raising of fish. The spawn is carefully collected wherever it is found; instead of abandoning it to the channels of the rivers, the watchful shore dweller puts it under protection wherever a suitable supply of water is to be found. The fallow rice fields dammed and flooded in winter are alive with wriggling carps; and even the rain water cistern is turned into a breeding pond.

This economical management permits us, without piscicultural societies, to stock the rivers with millions of fry, and to add a considerable variety of fish to fill our bill of fare, a part of which is consumed fresh, while the rest, salted or dried, is dispatched into all parts of the empire and sold at a moderate, but always remunerative price."

The above quotation serves to show what may ultimately be done with our own waters. With the advancing settlement and development of our country, when a denser population shall have grown up, and the necessities for husbanding all our recourses for the production of food shall become more urgent and imperative than now, there will probably result a necessity for the use of every available water for the production of fish food.

SUGGESTIONS TOUCHING THE INCREASE OF PERCENTAGE OF FERTILIZATION OF THE EGGS OF THE WALL-EYED PIKE.

BY PROF. JACOB E. REIGHARD.

ASSISTANT PROFESSOR OF BIOLOGY OF THE UNIVERSITY OF MICHIGAN, AND READ BEFORE THE AMERICAN FISHERIES SOCIETY AT PUT-IN-BAY, IN MAY, 1890.

The following was prepared by Prof. Reighard at the request of the board of commissioners to prepare a practical paper to be read on this occasion, showing the causes as developed by his investigations on Saginaw bay, Michigan, of the large percentage of loss in the impregnation of the wall-eyed pike eggs. A detailed report of a more scientific nature and relating particularly to the development of the embryo of the wall-eyed pike will be found in the appendix of this report:

The eggs of the wall-eyed pike, after having been for some time in water, measure 2.2 millimeters (about 1-12 inch) in diameter. The egg has an enveloping membrane (or zona radiata) of the usual form. Outside this is a second thinner membrane which wrinkles, and stains more deeply in haematoxylin than does the inner zona radiata. The eggs are very adhesive and it is to this outer membrane that the adhesiveness is due. There is probably also a third membrane within the zona, but this has not been determined with certainty. Within these membranes is the yolk, having a diameter of 1.4 mm (about 1-18 inch). The yolk is spherical and in one side of it is embeddied a spherical oil-drop having a diameter of .8 m. (About 1-31 inch). The oil-drop causes the surface of the yolk sphere to protrude on one side. The oil-drop being lighter than the yolk is always turned upward, so that in looking at the egg from above, the oil-drop appears to be in the middle of the yolk, while in looking at the egg from the side the oil-drop appears to be at the top of the yolk.

I shall speak of that pole of the yolk in which the oil-drop is embedded, as the upper pole, and of the opposite side as the lower pole. A line drawn about the yolk half way between these two poles will be spoken of as the equator. When the egg is at rest the lower pole of the yolk rests

upon the egg membrane, so that the space which separates the yolk from the zona is altogether above and at the side of the yolk and oil-drop. This space may be spoken of as the breathing space. Surrounding the yolk and oil-drop is a layer of protoplasm, which forms an investment for them and separates them from the water in the breathing space.

This layer of protoplasm is extremely thin over the greater part of the yolk and is tightly stretched over the protuberance formed by the oil globule. It is not, however, uniformly thin, but in one place has a disc-shaped thickening. This thick disc of protoplasm (germinal disc) is concave towards the yolk and convex on its opposite side and is fitted like a saucer against one side of the yolk. The position is such that its center is upon the equator of the yolk, so that in looking at the egg from above, one sees the edge of the germinal disc. Outside the disc the layer of enveloping protoplasm is so thin that it cannot be easily seen except by the use of reagents. So long as the yolk is within this enveloping layer of protoplasm it is entirely transparent and colorless. If the enveloping layer be ruptured so that the yolk passes out and comes into contact with the water it becomes instantly opaque and of a milk-white color.

The foregoing description applies to the egg after it has been some time in the water. As the egg leaves the female the egg membranes are not separated from the yolk by a water filled space, but are everywhere in close contact with the layer of protoplasm which invest the yolk. When the egg is placed in water, the water passes rapidly through the egg membranes and accumulates between them and the yolk. In this way the membranes become gradually separated from the yolk by a water filled space, "the breathing space."

By this passage of water through the membranes they become tightly stretched and tense so that an egg which at first feels, under the finger, like a piece of soft putty, becomes hard to the touch by the absorption of water and feels like a shot. This "filling" of the egg takes about two hours.

The foregoing account of the structure of the egg is sufficient to an understanding of the mechanical arrangements that it presents.

As it seems likely that for some reason a large per cent of the eggs failed to be impregnated, my intention was first directed to determining the first difference between impregnated and unimpregnated eggs.

In order to determine the question with certainty for this particular animal, the following experiment was tried. (Quoted from note-book.)

April 16, 8:45 A. M.

After washing the surface of the body of a female fish, in the region of the external opening, with weak acetic acid, in order to destroy any spermatozoa, the eggs were stripped into two dishes containing water. Into one dish milt was immediately stripped, the other was left without milt. These were marked lot 1 and lot 2, respectively.

Lot 1 examined at 1:45 P. M. (the eggs having been kept in a cold room) and found segmentation going on. The germinal disc is divided into either two or four cells.

Lot 2 examined 8 A. M., April 17, 24 hours after impregnating lot 1.

The eggs were firmly set in a mass on the bottom of the dish. 100 taken at random were examined with the following results:

Showing normal germinal disc without trace of segmentation.	82= 82%
Showing abnormal germinal disc with possible traces of first or second segmentation,	4= 4%
Injured by rupture of protoplasmic investment of yolk so that yolk had escaped and egg had turned white,	14= 14%
Total	100=100%

This experiment was after repeated without, however, counting the eggs and always with the same result.

Segmentation of the germinal disc is therefore the first easily recognized sign of impregnation.

In order to determine the percentage of unimpregnated eggs among those taken by the men and ready for shipment to the Detroit hatchery, the following counts were made:

April 17, 1 P. M., 252 eggs taken at random from a tub, after stirring the eggs in the tub, were examined with the following results:

Segmented normally (i. e. impregnated)	141= 56%
Unsegmented normally (not impregnated)	26= 11%
Injured by escape of yolk (white eggs)	85= 33%
Total	252=100%

The eggs marked as unimpregnated were set aside and were found to be still unsegmented after 24 hours.

This was several times repeated on other lots of eggs with similar results.

It shows that about 33% of the eggs are injured mechanically by the rupture of the protoplasmic investment of the yolk, while only about 11% perish from lack of impregnation. Even superficial examination shows that in nearly every case this rupture of the yolk takes place over the oil globule. A consideration of the mechanical arrangement of the parts of the egg shows that this is the weak spot.

In the natural position the yolk sphere lies with its lower half against the egg membranes. These membranes, therefore, support this half of the yolk, surrounding it as if it were resting at the bottom of a cup.

The upper half of the yolk is, on the contrary, not of the same form as the investing membrane, its spherical surface is interrupted by the protruding oil globule.

The result of this arrangement is that when any pressure is brought to bear on the egg membrane, so that the space within which the yolk lies is reduced, the yolk is able to resist this pressure by fitting itself against the egg membrane at every part of its surface except over the oil globule. The strain therefore comes on that part of the protoplasmic investment of the yolk which covers the oil globule and here it bursts. In almost every case the white spot which indicates the rupture of the yolk investment makes its appearance at the oil globule, usually at its equator.

Owing to the fact that the eggs are adhesive, it is the practice of the men in taking them to stir the eggs with the hand. By this means they detach the eggs that have adhered to the sides of the pail and separate from one another those that have adhered together in bunches. This stirring takes place shortly after the eggs are placed in the pail and before they have filled with water. In this condition the space between the membranes and yolk is either absent or it is so small that it forms rather an aid than a hinderance to the bursting of the yolk investment.

It is therefore desirable to find some means of handling the eggs so they will not adhere to the vessel in which they are placed, and so they will not adhere to one another to such an extent as to render it necessary to separate them by the hand.

As to the first point, the men handling the eggs have found they do not adhere to an ordinary unpainted, wooden pail which by use has become rough inside, while they do adhere to the galvanized iron pails now in use. I have observed that while the eggs adhere strongly to glass, they adhere but slightly to cloth. I have no doubt that by the substitution of wooden pails for metal this difficulty will be overcome.

It is likely that a metal surface might be oiled or otherwise so prepared as to prevent the adhering of the eggs.

With regard to the second point, it has been found that if water be added to the eggs *very slowly*, while at the same time they are kept in motion by rocking the containing vessel, they do not then adhere to one another. This is true whether or not milt be mixed with the water.

Two lots of eggs were taken from the female and placed in two similar glass dishes and to one milt was added. Water was then gradually added to each lot with continual agitation of the eggs by rocking the dishes. This was continued until the dishes had been filled with water and until the eggs had "filled." In neither dish did the eggs adhere to one another or to the dishes. Eggs taken from either dish and transferred to another dish containing a larger quantity of water adhered at once.

In order to test the effect on the eggs of not introducing the hand, about two quarts of eggs were impregnated in a galvinized iron pail. The water was added slowly and the pail kept in motion. The eggs did not adhere to one another, but adhered in a layer one or two eggs thick over the bottom and sides of the pail. Without disturbing those eggs that had adhered to the pail, those in the center were removed and 154 taken at random were examined with results as follows:

Injured	15=10%
Not impregnated	0= 0%
Impregnated and afterwards segmented	139=90%
Total	154=100%

A second trial resulted as follows:

Injured	12= 7%
Not impregnated	2= 1%
Impregnated	165=92%
Total	179=100%

An attempt was made to determine the result of using a wooden pail and taking account of all of the eggs, whether they had adhered to the pail or not. About a quart of eggs was used and they were examined shortly after being impregnated. They had not adhered to the pail, nor to one another, and the percentage of injured eggs did not appear to be more than five (5). Unfortunately the eggs were afterwards mixed with others and the whole lot roughly handled before an opportunity was had of making a careful examination of them. The suspension of opertions shortly after this prevented a repetition of the experiment.

It is to be noted that when the eggs are permitted to adhere to the pail and to one another so that the percentage of those injured is large, the percentage of those unimpregnated is also greater. The same method of handling that reduces the percentage of injured eggs reduces also the percentage of those unimpregnated.

From the two causes about 45% of the eggs examined could never have developed. Since the percentage of the eggs lost during the present year is estimated at 40, there remains 15% still to be accounted for.

A lot of eggs, 45% of which are dead, requires much more handling than would be the case if all were sound. Such a lot of eggs also invites the attacks of fungus which spreads from the dead eggs to the living ones and is likely to kill those in turn.

In such a lot many living eggs become clogged among the dead ones and are probably either smothered or poisoned.

In short, if the loss of eggs which takes place at first from mechanical injury and lack of impregnation can be stopped it is fair to expect that the subsequent loss will be much reduced.

FISH PLANTS, 1888-1889.

Whitefish Plants, 1889.

Name of Waters.	Where Planted.	Date.	Number.
Lake Michigan	St. Joseph	April 1	4,000,000
Lake Michigan	South Haven	" 3	4,000,000
Lake Michigan	Ludington	" 5	4,000,000
Detroit River	Grassy and Mammy Judy Islands	" 6	4,000,000
Lake Michigan	Manistee	" 7	4,000,000
Saginaw Bay	Bay City	" 9	4,000,000
Detroit River	Fort Wayne	" 9	4,000,000
Lake Michigan	Muskegon	" 11	4,000,000
Lake St. Clair	Grosse Point	" 11	4,000,000
Straits of Mackinac	Mackinaw	" 13	4,000,000
Lake Huron	Cheboygan	" 15	4,000,000
Straits of Mackinac	Mackinaw	" 17	3,000,000
Lake Michigan	Pentwater	" 19	3,000,000
Lake Superior	Marquette	" 21	3,000,000
Lake Superior	Marquette	" 24	3,000,000
Lake Huron	Port Huron	" 27	4,000,000
Lake Michigan	Grand Haven	" 29	3,000,000
Total			63,000,000

Whitefish Plants, 1890.

Name of Waters.	Where Planted.	Date.	Number.
Detroit River	Belle Isle	Feb. 5	2,000,000
Detroit River	Belle Isle Shoals	" 22	2,000,000
Lake Michigan	Grand Haven	Mar. 1	3,000,000
Lake Michigan	St. Joseph	" 7	3,000,000
Lake Michigan	Grand Haven	" 9	3,000,000
Lake Michigan	St. Joseph	" 12	3,000,000
Lake Michigan	Saugatuck	" 13	3,000,000
Lake Erie	Monroe	" 15	3,000,000
Lake Erie	Monroe	" 17	3,000,000
Lake Michigan	South Haven	" 17	3,000,000
Lake Michigan	Frankfort	" 17	3,000,000
Lake Michigan	Ludington	" 20	3,000,000
Lake St. Clair	Grosse Point	" 22	4,000,000
Lake Huron	Port Huron	" 22	3,000,000
Saginaw Bay	Bay City	" 23	3,000,000
Detroit River	Grassy and Mammy Judy Islands	" 24	4,000,000
Lake Michigan	Frankfort	" 24	3,000,000
Lake Erie	Monroe	" 24	3,000,000
Detroit River	Belle Isle	" 26	3,000,000
Lake Michigan	South Haven	" 27	3,000,000

Whitefish Plants, 1890.—Continued.

Where Planted.	Name of Waters.	Date.	Number.
Lake Michigan	Ludington	Mar. 28	4,000,000
Lake Michigan	Manistee	" 31	3,000,000
Lake Michigan	Muskegon	" 31	3,000,000
Saginaw Bay	Bay City	April 2	3,700,000
Lake Michigan	Muskegon	" 2	3,000,000
Straits of Mackinac	Cheboygan	" 4	4,000,000
Lake Huron	Sand Beach	" 5	6,000,000
Lake Huron	Port Huron	" 8	6,000,000
Straits of Mackinac	Cheboygan	" 6	3,000,000
Straits of Mackinac	Mackinaw	" 9	2,000,000
Straits of Mackinac	Mackinaw	" 11	3,000,000
Straits of Mackinac	Mackinaw	" 15	3,000,000
Lake St. Clair	Grosse Point	" 18	6,000,000
Total			109,700,000

Brook Trout Plants, 1889.

County and Name of Waters.	Town.	Depositor.	Date.	Number.
Allegan County:				
Little Rapid river	Burnip's Corners	Henry Ebmeyer	February 25	10,000
Miller's creek	Allegan	E. C. Reid	" 25	6,000
Munn's and Uhlem creeks	Otsego	Conrad Bros	" 25	16,000
Big creek	Otsego	J. D. Kelley	" 25	6,000
Brow's creek	Plainwell	Ed. Anderson	" 25	10,000
Laraway's creek	Shelbyville	D. D. Harris	March 12	6,000
Alcona County:				
West Byers and Ricker's creeks	West Harrisville	S. B. Anges	" 20	10,000
Antrim County:				
Rootville creek	Mancelona	Lewis Way	" 25	10,000
Cedar creek and Intermediate river	Mancelona	O. W. Kibby	" 25	20,000
Jordan river and branches	Alba	Dwight Lydell	" 28	40,000
Alpena County:				
Osink's and King's creeks	Alpena	Henry Bolton	" 20	30,000
Avery's creek	Alpena	E. O. Avery	" 20	10,000
Branch County:				
Warsop and Underwood creeks	Union City	Joseph Warsop	February 20	10,000
Berrien County:				
No name	Three Oaks	F. V. Martin	" 20	5,000
Lemon, Ford, Peterborough, Wilson, Law and Spring creeks	Berrien Springs	Wm. Dester	" 20	30,000
Ox, Sutton and Eastman creeks	Benton Harbor	Fred Jordan	" 20	10,000
Blue, Sand, Macord's and Yellow creeks	Benton Harbor	C. Colby	" 20	5,000
Spring brook	Freeport	J. C. Baker	March 12	6,000
Pipe Stone creek	Benton Harbor	C. Colby	April 18	3,000
Barry County:				
Fall and West creeks and three streams no name	Hastings	Philip T. Colgrove	" 2	15,000
Glass creek	Irving	J. M. Rodgers	May 4	25,000
Cass County:				
Christian creek	Cassopolis	J. P. Smith	February 20	10,000
Empties into Dowagiac creek	Dowagiac	W. J. Hartfield	" 28	10,000
	Glenwood	W. Wells	" 28	10,000
Calhoun County:				
Bear and Wilder creeks	Marshall	F. H. Wherry	" 28	10,000
North Branch of Kalamazoo river	Albion	F. J. Parsons	" 28	10,000

Brook Trout Plants, 1889.—Continued.

County and Name of Waters.	Town.	Depositor.	Date.	Number.
Clare County:				
Dock and Tom creeks	Lake George	E. J. Roys	March 4	10,000
South branch of Tobacco, Little Tobacco and Spring brooks	Clare	Ebenezer Perry	" 4	15,000
North branch of Tobacco river	Harrison	W. W. Green	" 4	20,000
Branch of Sugar river	Clare	Wells, Stone & Co.	" 4	15,000
Cat creek	Hersey	Sanford Keeler	April 2	10,000
Cheboygan County:				
Echo lake outlet on Bois Blanc island	Cheboygan	E. T. Webb	March 20	9,000
Nigger and Bush creeks	Topinabee	H. H. Pike	" 20	9,000
Little Bear and Cold Spring creeks	Rondo	W. H. Merritt	" 20	9,000
Crawford County:				
Au Sable and east branch of Au Sable creeks	Frederic	E. Flagg	" 20	20,000
No name	Pere Cheney	H. Thayer	" 20	3,000
Charlevoix County:				
North and south branches of Boyne river	Boyne Falls	Mich. Fish Com.	" 28	25,000
Cedar or Deer creek	Boyne Falls	Mich. Fish Com.	" 28	25,000
Eaton County:				
Herring creek	Kalamo	C. M. Woodward	April 2	12,000
Emmet County:				
Newman and Munroe creeks	Petoskey	L. D. Bartholomew	March 25	20,000
Horton's creek	Petoskey	J. Sanford	" 25	10,000
Minnehaha creek	Petoskey	J. M. Metheany	" 25	10,000
Page, Harding and Wequetonsing brooks	Petoskey	" "	" 25	10,000
Kegomie creek	Petoskey	" "	" 25	6,000
Wilton and fountain brooks	Conway and Ogden	" "	" 25	9,000
Six mile post creek	Six Mile Post	" "	" 25	6,000
Conway creek	Conway	" "	" 25	6,000
LeRoy creek	Le Roy	" "	" 25	15,000
South branch of Manistee river	Tustin	" "	" 25	15,000
Tributary to Manistee river	Summit City	" "	" 25	15,000
Head of Bear river	Petoskey	Mich. Fish Com.	" 28	30,000
Carp river	Carp Lake	Mich. Fish Com.	" 28	30,000
Nadolski's creek	Petoskey	J. M. Metheany	April 5	6,000
Genesee County:				
Thread creek	Grand Blanc	E. J. Jennings	March 4	18,000
Lewis creek	Linden	Wm. H. Johnson	" 7	6,000
Grand Traverse County:				
Nickerson and Mayfield creeks	Mayfield	C. E. Brewster	" 25	20,000
Mayfield and East creek, one mile east of Mayfield	Mayfield	J. M. Metheany	" 25	18,000
Hillsdale County:				
Emery Spring brook	Hillsdale	A. A. Smith	April 2	15,000
Iosco County:				
Porterfield creek	Whittemore	Frank A. Duplantz	" 20	12,000
Tawas, Cold, Sims and Silver creek	Tawas City	N. C. Hartingh	" 20	30,000
Isabella County:				
Headwaters of west branch of Pine river	Blanchard	H. P. Blanchard	" 9	20,000
Ionia County:				
Prairie creek	Ionia	H. L. Bailey	January 28	20,000
Belloways creek	Ionia	H. L. Bailey	February 15	20,000
Randall's and Monk's creeks	Saranac	J. W. Toles	March 7	6,000
Mill creek	Saranac	A. W. Huntley	" 7	6,000
Brown's creek	Muir	H. M. Brown	" 7	6,000
Popple, Dugway and Carpenter creeks	Pewamo	Geo. A. Chatterton	" 7	12,000
Spring, Spice, Lake, Strumble, Seasings or Goose, Murphy and East Liblow creeks	Lyons	N. Hitchcock	" 7	10,000
Stony and Tubulan's creeks	Pewamo	John Bitts	" 7	10,000
Prairie creek	Ionia	S. B. Webber	" 11	6,000
In pond on State farm	Ionia	E. C. Watkins	" 11	6,000
Van Buren, Peck and Town creeks	Portland	W. D. Crane	" 11	10,000

Brook Trout Plants, 1889.—CONTINUED.

County and Name of Waters.	Town.	Depositor.	Date.	Number.
Ionia County—cont'd:				
Cission creek	Ionia	H. L. Bailey	March 11	9,000
Timberland, Halliday and Brooks creeks	Ionia	H. L. Bailey	" 9	9,000
Jackson County:				
Snyder's creek	Jackson	C. B. Bush	February 28	10,000
No name	Grass Lake	S. Campbell	" 28	6,000
Branch of Snyder's creek	Jackson	C. B. Bush	April 2	15,000
Kalamazoo County:				
Spring run	Schoolcraft	T. Hewitt	February 25	6,000
Augusta creek	Hickory Corners	John Shaw	" 25	10,000
Campbell creek	Galesburg	A. H. Hubbard	" 28	3,000
Tributary to Kalamazoo river	Galesburg	J. H. Innes	" 28	3,000
Parker's creek	Kalamazoo	M. Gibbs	March 12	9,000
Tributary to Pine river, sec. 19, Alamo tp.	Kalamazoo	E. W. Sleeper	" 12	6,000
Little Portage river	Kalamazoo	D. B. Merrill	" 12	6,000
Pine creek	Kalamazoo	A. A. Phelps	" 12	6,000
Portage river	Kalamazoo	C. D. Root	" 12	9,000
Spring brook and Portage river	Vicksburg	G. W. Chamberlin	" 12	6,000
Kent County:				
Winegas, Parker and Spence's creeks	Lowell	C. B. Corbin	" 7	9,000
Bonne creek	Logan	L. Kelley	" 7	6,000
Alden, Church, Copp, Mill, Snow and Cherry creeks	Logan	Charles Atthens	" 7	18,000
Spring, Little Cedar, Butternut and Crimion creeks	Cedar Springs	C. S. Ford	" 12	21,000
Bear creek	Bostwick	H. D. Davis	" 12	12,000
Bear creek	Canonsburg	G. T. Young	" 12	9,000
Ardi's and Smith's creeks	Belmont	Joseph Bapke	" 12	6,000
Coldwater creek	Grand Rapids	H. W. Davis	" 12	25,000
Seeley creek	Gratton	C. M. Slayton	" 12	9,000
Frost creek	Grand Rapids	W. E. Macard	" 12	3,000
Cooley creek	Labarge	H. N. Cooley	" 12	6,000
Stow creek	Caledonia	D. P. Hale	" 12	9,000
Inlet to Hilton creek	Ross	J. K. Hilton	" 12	3,000
Silver creek	Sparta	A. A. Place	" 12	9,000
South, Crocker, Muma and Bell creeks	Casnovia	E. Farnham	" 12	9,000
Spring brook	Sparta	Frank Baird	April 5	9,000
Kalkaska County:				
South branch of Boardman river	Kalkaska	Mich. Fish Com.	March 28	20,000
Boardman river	Kalkaska	" " "	" 28	20,000
Rapid river	Kalkaska	" " "	" 28	20,000
Livingston County:				
Ore, West Woodruff and East Woodruff creeks	Brighton	C. E. Cushing	February 25	10,000
Lenawee County:				
Little Raisin creek	Ridgeway	T. H. Temple	" 25	10,000
Lapeer County:				
Pine creek	Lapeer	S. N. Vincent	March 4	10,000
Hemmingway and Elk creeks	Columbiaville	J. D. Brown	" 4	6,000
Andrus, Pleasant Valley and Beach creeks	Highland	H. S. Holdridge	" 4	15,000
Lake County:				
Piquette creek	Wingleton	W. D. Wing	" 12	6,000
Silver creek	Nirvana	Jay Sprague	April 4	9,000
Sanborn and Kenney creeks	Baldwin	Sanford Keeler	" 2	15,000
Mecosta County:				
Cedar, Strong and Stevens creeks	Morley	J. C. Boyd	February 15	20,000
Perry, Town line and Painter's creeks	Mecosta	Geo. Minkle	March 11	10,000
No name	Reed City	E. L. Hayes	" 4	10,000
	Big Rapids	D. M. McLellan	" 4	30,000
Hyde's creek	Rig Rapids	Wm. Laduer	" 12	6,000
Cedar creek	Stanwood	C. T. Barnard	" 12	6,000
Seaton and Davis creeks	Morley	G. B. Kibbey	" 12	9,000
Robinson's creek	Big Rapids	J. D. Robinson	April 2	3,000
Philio creek	Big Rapids	James Philio	" 8	4,000
Ryan creek	Big Rapids	L. L. Blair	" 15	4,000
Headquarters of Paris creek	Paris	Mich. Fish Com.	" 20	15,000
Headquarters of Buckhorn creek	Paris	" " "	" 25	15,000

Brook Trout Plants, 1889.—CONTINUED.

County and Name of Waters.	Town.	Depositor.	Date.	Number.
Mecosta County—cont'd:				
Hersey river and branches between Reed City and Milton Junction	Paris	Mich. Fish Com.	April 26	30,000
Dalzell or King's creek	Big Rapids	James Dalzell	May 5	25,000
Midland County:				
Darrow and Cedar creeks	Coleman	Geo. Granger	May 4	18,000
Cedar creek	Coleman	C. Craft	" 4	9,000
Muskegon County:				
Green, Bear and Black creeks	Muskegon	Charles Gunn	February 13	20,000
Cleland creek	Whitehall	A. J. & C. E. Covell	March 18	12,000
Cleland and Silver creeks	Whitehall	E. M. Ruggles	" 18	15,000
Montcalm County:				
Indian, Tamarack and Church creeks	Howard City	C. E. Murray	February 15	20,000
Black creek	Six Lakes	R. Flick	March 7	10,000
Fountain and Cedar creeks	Six Lakes	A. E. Hunter	" 7	10,000
Tamarack creek	Lake View	A. T. Call	" 7	10,000
Brandy creek	Lake View	M. W. Kelsey	" 7	6,000
Fish creek	Stanton	C. F. Briant	" 11	10,000
Little Pine, Butternut and Crystal creeks	Crystal	J. E. Yondon	" 11	10,000
Rice creek	Howard City	J. N. Hathaway	" 12	6,000
Grant creek	Pierson	N. A. Poter	" 12	3,000
South branch of Fish creek	Sheridan	E. Follett	April 9	9,000
Clear creek and Wabasie's creek and lake	Greenville	F. J. Phelps	" 9	9,000
Mason County:				
Lincoln creek and Little Sable river	Fountain	Dodge Squire	March 12	15,000
Freeman and Cedar creeks	Free Soil	Wm. Freeman	" 12	9,000
Sable river	Free Soil	C. A. Toby	" 12	9,000
Weldon creek	Weldon Creek	Wm. Neelon	" 14	9,000
Black and Cedar creeks	Custer	Edward Stock	" 14	12,000
North branch of Little Sable river	Scottsville	J. N. Clark	" 14	10,000
South branch of Lincoln river	Scottsville	Simon Warner	" 14	12,000
Reid, Quince, Micco and Swan creeks	East Riverton	J. Griffin	April 4	30,000
Two branches of Sweetwater creek	Branch	Sanford Keeler	" 2	15,000
In a small stream Sec. 20, Webber township	Branch	Sanford Keeler	" 2	9,000
Manistee County:				
Pine and Claybank creeks	East Lake	T. A. Brown	March 12	15,000
Claybank creek	Manistee	L. Kaufman	" 12	3,000
Lorenson creek	Manistee	J. White	" 12	6,000
Tributary to Portage, Onekama township	Manistee	A. W. Farr	" 14	9,000
Tributary to Portage, Onekama township	Manistee	Fred Culver	" 14	3,000
Chief creek	Manistee	P. Schneider	April 4	9,000
Newaygo County:				
Spring and Crystal creeks	Ashland	Herman Marvin	March 12	9,000
Cole, Four Mile, Whittmore and Bigelow creeks	White Cloud	P. Rodell	" 12	10,000
Spring creek	Lilley	S. Seeley	" 12	30,000
Porter and Crary creeks	Fremont	L. S. Addison	" 18	6,000
Brooks creeks	Newaygo	Charles Kritzer	April 2	12,000
Pennoyer creeks	Newaygo	E. O. Shaw	" 2	15,000
Ottawa County:				
Branch of Bush creek	Hudsonville	B. E. Green	February 20	5,000
Spring creek	Talmadge	Peter Malone	March 7	6,000
Black creek	D.G.H.& M. Cross'g	F. S. Wilson	" 12	9,000
Osceola County:				
Reed and McDonald creeks	Reed City	E. L. Hayes	February 15	10,000
Big Stone creek (two branches)	Evart	Z. W. Brigham	March 4	10,000
Brooks, Finney, and Silver creek and tributaries	Evart	J. J. Reik	" 4	20,000
West branch of Clark's and Deer lake branches of the Hersey	Ashton	J. M. Metheany	" 25	10,000
Hersey creek	Hersey	Sanford Keeler	April 2	6,000

Brook Trout Plants, 1889.—Continued.

County and Name of Waters.	Town.	Depositor.	Date.	Number.
Osceola Co.—cont'd:				
Stream on Sec. 17, Hersey Tp.	Hersey	Sanford Keeler	April 2	3,000
Stream on Secs. 6 & 7, Hersey Tp.	Evart	" "	" 2	9,000
Twin creek	Evart	" "	" 2	6,000
Chippewa creek	Chippewa station	" "	" 2	15,000
Tributaries to Tobacco river	Farwell	" "	" 2	12,000
Oakland County:				
North branch of Clinton river	Oxford	M. E. Martin	March 4	10,000
Stony creek	Rochester	C. E. Crissman	" 4	6,000
Buckhorn creek	Holly	E. P. Boisford	" 7	10,000
Watercress creek	Birmingham	T. C. Trowbridge	" 7	6,000
Ogemaw County:				
Chapman, Edwards, west branch of Edwards and middle branch of Tittabawassee	West Branch	S. V. Thomas	" 20	20,000
Ammond creek	West Branch	Jerry Ammond	" 20	10,000
Houghton creek	West Branch	Wm. Bentley	" 20	10,000
Wilson, Rust and Stockade creeks	West Branch	A. S. Rose	" 20	20,000
Thumb lake and west branch of Sturgeon river	Vanderbilt	J. J. Waggoner	" 20	15,000
Otsego County:				
Hay, Meadow and Bargehr creeks	Gaylord	W. L. Leach	" 20	10,000
Oceana County:				
Branch of Stony creek	Shelby	E. J. Shirtz	" 18	12,000
Cunningham creek	Cob Moo Sah	Harris Lattin	" 18	9,000
Walker, Gales, Roby, Ward's and Baldwin's creeks	Hart	E. D. Richmond	" 18	20,000
Quince and Nickerson creeks	Pentwater	D. C. Wickham	" 18	20,000
Roscommon County:				
Robinson creek	Roscommon	H. H. Woodruff	" 20	10,000
West branch of Klacking brook	Prudenville	J. H. Crabtree	" 20	10,000
St. Joseph County:				
Mill creek	Three Rivers	Charles Rice	February 20	8,000
St. Clair County:				
Silver creek	Jeddo	Hugh Stevenson	March 4	10,000
Van Buren County:				
Tributary to east branch of Paw Paw river	Lawton	C. L. Balch	February 28	6,000
Tributary to Paw Paw river	Lawton	J. W. Clark	" 28	3,000
Spring brook and tributary to Paw Paw river	Lawton	C. F. Dey	" 28	9,000
Tributary to Paw Paw river	Paw Paw	S. Hawkins	" 28	10,000
Cold Spring brook	Paw Paw	F. C. Thomas	" 28	6,000
Washtenaw County:				
Fellows, Mud, Bond, Spring, Hoyt's and Fales creeks	Saline	J. H. Battle	" 25	20,000
Honey creek	Ann Arbor	J. F. Lawrence	" 28	10,000
Boyer's creek	Ann Arbor	Jasper Innes	" 28	10,000
Paint creek	Ypsilanti	A. H. Martin	" 28	10,000
Wexford County:				
North fork of west branch of Clam river, west branch of Clam, and north branch of Pine rivers	Cadillac	W. J. Cornwell	March 25	20,000
Cedar creek and four streams out of Manitou tributary to Manistee river	Manitou	Mich. Fish Com.	" 28	30,000
Total				2,468,000

Brook Trout Plants, 1890.

County and Name of Waters.	Town.	Depositor.	Date.	Number
Alcona County:				
East, west and south branches of Pine river; Backus creek	Gustin & Mikado	J. H. Killmaster	Mar. 19	20,000
Devil's river	Harrisville and Gustin	G. B. Killmaster	" 19	18,000
North and south branches of Black river	Alcona	J. L. Sanborn	" 19	20,000
Allegan County:				
Laraway's creek	Wayland and Martin	D. D. Harris	Feb. 26	6,000
Button's creek	Hopkins	Charles W. Button	" 26	3,000
Miller creek and tributaries	Manlins	E. C. Reid	" 14	9,000
Miller's creek	"	Harvey D. Sears	" 14	3,000
Little Rapid river	Dorr	Henry Ebmeyer	" 20	6,000
Munn's creek; Uhlem creek	Otsego	Conrad Bros.	" 20	9,000
Cold stream brook	"	J. D. Kelley	" 20	3,000
Alpena County:				
Norwegian creek	Alpena	Christ. D. Hanner	Mar. 19	6,000
Avery's creek; King creek; Bean creek	Wilson and Ossineke	Henry Bolton	" 19	20,000
Antrim County:				
Shanty creek; Saloon creek; Holly's creek	Custer	O. W. Holly	" 26	12,000
Cedar creek; Intermediate creek	Kearney and Mancelona	Oscar W. Kibby	" 26	18,000
Atchinson creek; Elk river	Milton	E. C. Noble	" 26	7,000
Jordan river and branches	Alba	J. M. Metheany	April 2	25,000
Barry County:				
Augusta creek	Barry	John Shean	Feb. 10	6,000
Glass creek	Yank Springs	J. M. Rogers	Mar. 3	10,000
Spring brook	Irving	John C. Baker	" 3	5,000
Coldwater creek	Odessa	Oliver J. Wait	" 3	6,000
Baraga County:				
Silver river; Falls river	L'Anse	Wm. L. Mason	" 6	25,000
Slate river	Avon	Chas. M. Ferrer	" 6	15,000
Berrien County:				
Blue creek	Bainbridge	D. J. Morrison	Feb. 17	9,000
South branch Galiero river	Three Oaks	Francis V. Martin	" 17	6,000
Mud run; Spring creek	Three Oaks	C. D. Brownell	" 17	9,000
Pokagon branch	Bertrand	E. M. Copp	" 17	6,000
Calhoun County:				
Meseroll's creek	Burlington	L. L. Harsh	" 20	6,000
Woodworth creek; Ferris creek	Athens	George M. Ferris	" 20	9,000
Martin brook	Battle Creek			
Simons brook	Bedford			
Quaker brook	Maple Grove			
Foster's brook	Newton	N. A. Osgood	" 4	21,000
Crystal spring brook	Leroy and Battle Creek			
Kelsey brook	Leroy			
Bear creek	Marshall	F. H. Wherry	" 4	15,000
Wilder creek	Eckford			
Rice creek	Marshall & Marengo	Thos. L. Cronin	" 4	3,000
Spring brook	Concord			
Gillet's creek	Clarence	F. C. Courter	" 4	9,000
Rice creek	Parma			
Cass County:				
Christian creek	Penn, Calvin and Jefferson	James P. Smith	" 17	6,000
Christian creek	Penn	N. Jones	" 17	3,000
Glenwood spring brook	Wayne	Worden Wells	" 17	3,000
Crane creek	"	Matt. Kinney	" 17	3,000

Brook Trout Plants, 1890.—Continued.

County and Name of Waters.	Town.	Depositor.	Date.	Number
Charlevoix County:				
West branch Sturgeon river	Hudson	James A. Waggoner	Mar. 19	9,000
Monroe creek	South Avon			
Neuman creek	Marion	L. D. Bartholomew	" 26	28,000
Horton's creek	Hayes	Isaac Stauffer	" 26	21,000
North and south branch of Boyne river				
Cedar or Deer creek	Boyne Falls	J. M. Metheaney	April 2	30,000
Cheboygan County:				
Austin or Crumley creek	Nunda	J. R. Shook	Mar. 19	12,000
Cold spring creek				
Little Bear creek	Mentor	W. H. Merritt	" 19	6,000
Clare County:				
Dock or Tom creek	Lake George	E. J. Roys	" 12	12,000
South branch of Tobacco river				
Little Tobacco river	Grant	Ebenezer Perry	" 12	18,000
Spring brook				
North branch of Tobacco river	Hayes	W. W. Green	" 12	25,000
Mill creek	Winterfield	Cairns E. Smith	" 12	6,000
Middle br. of Muskegon river	Marion	G. Desbrow	" 31	9,000
West branch of Clam river	Winterfield	E. W. Chapin	" 31	15,000
Littlefield's creek	Farwell	F. E. Presley	" 31	9,000
Crawford County:				
AuSable river				
East branch of AuSable river	Frederick	Elijah Flagg	" 19	18,000
Eaton County:				
Carrier's creek	Delta	Waterman Lazell	" 7	9,000
Butternut creek				
Fish creek	Eaton	G. W. Sherwood	" 3	25,000
Battle creek				
Emmet County:				
Willow creek				
Fountain creek				
South br. of Conway creek				
South br. of Kegomic creek				
Page creek	Petoskey	F. & P. M. R. R. Co.	April 2	42,000
Waquetonising creek				
Naadolskis creek				
Minnehaha creek				
Headwaters of Bear river	Petoskey	" " "	" 2	15,000
Carp river	Carp Lake	" " "	" 2	10,000
Maple river and tributaries	Pellston	" " "	" 2	18,000
Genessee County:				
Thread creek				
Kersley creek	Grand Blanc and Atlas	Eli J. Jennings	Mar. 12	15,000
Gladwin County:				
Sugar river and branches	Butman	Wells, Stone & Co.	" 12	30,000
Grand Traverse County:				
Mill creek				
Vinton creek				
Kaiser creek	Whitewater	E. S. Noble	" 26	5,400
Hammond's creek				
Cedar run	Long Lake	L. M. Thomas	" 26	9,000
Mayfield creek	Paradise			
Nickerson creek	Mayfield	C. E. Brewster	" 26	20,000
Payne's creek				
Knight creek	Paradise and Fife Lake	T. M. Wilson	" 26	12,000
Hillsdale County:				
Kalamazoo river				
Grand river	Moscow and Somerset	Charles W. Harris	Feb. 10	15,000
Ionia County:				
VanBuren creek				
Peck creek	Portland and Danby	W. D. Crane	Mar. 7	9,000
Foam creek				
Stony creek	Sebewa			
Derby creek		H. L. Beneschoter	" 7	9,000
Popple creek	Ronald			
Dingway creek	Lebanon & N'rth Plains	Geo. A. Chatterton	" 24	20,000
Carpenter's creek	Crystal and Ferris			

Brook Trout Plants, 1890.—Continued.

County and Name of Waters.	Town.	Depositor.	Date.	Number
Ionia County.—cont'd:				
Stony creek				
Loss creek	Lyons	John Betts	Mar. 24	12,000
Luburtans creek				
Murphy's brook				
Spring brook				
Spires brook	Lyons	H. Hitchcock	" 24	15,000
Searney's brook				
Goss creek				
Brown's creek	N'rth Plains and Reynolds	H. M. Brown	" 24	6,000
Beckwith creek				
East Sibert brook	Berlin	L. C. Walker	" 24	6,000
Randall creek				
Monk's creek	Boston	James W. Toles	" 24	6,000
Session creek	Berlin			
Tibbitt's creek	Berlin	H. L. Bailey	" 7	39,000
Prairie creek	Ronald			
Bellamy creek	Euston			
Alden creek				
Church's creek	Boston	Chas. D. Pease	" 24	5,000
Iosco County:				
Tawas creek	Baldwin and Wilber			
Cold creek	Tawas			
Sims creek	Baldwin and Tawas	N. C. Hartnigh	" 19	25,000
Silver creek	Baldwin, Tawas and Wilber			
Porterfield creek	Burleigh	Frank Duplantz	" 19	9,000
Isabella County:				
Cedar river	Gilmore	S. Craft	" 31	15,000
Salt river	Lincoln and Coe	A. W. Hurst	" 31	15,000
Headwaters of west branch of Pine river	Rolland	H. P. Blanchard	" 31	9,000
Jackson County:				
Willow brook	Grass Lake	Samuel Campbell	Feb. 24	3,000
One source of the Kalamazoo river	Pulaski	L. N. Keeler	" 20	6,000
Snyders creek	Spring Arbor	C. B. Bush	" 20	12,000
Outlet to Gillet's lake	Leoni	T. J. Conely	" 20	6,000
Kalamazoo County:				
Shaffer's brook				
Parker's brook	Kalamazoo and Cooper	Wm. A. Glover	" 24	6,000
Leepers brook				
Four Mile creek	Ross	Eli R. Miller	" 24	9,000
Gun creek	Charleston	Charles P. Cory	" 24	3,000
Campbell's creek	Richland	A. H. Hubbard	" 24	3,000
Spring creek	Charleston & Comstock			
Portage creek	Schoolcraft	Geo. W. Chamberlain	" 24	6,000
Portage creek	"	Chester D. Root	" 24	6,000
Pine creek	Alamo	A. A. Phillips	" 24	3,000
Portage creek	Cooper	Morris Gibbs, M. D.	" 24	6,000
Spring brook	Richland			
Little Portage creek	Kalamazoo	D. B. Merrill	" 24	3,000
Tributary to Pine creek	Alamo	Henry S. Sleeper	Mar. 20	3,000
Wells creek	Portage			
Harrison's creek	Prairie Ronde	Thomas Hewitt	" 20	6,000
Spring run	Schoolcraft			
Cold stream brook	Alamo	C. C. Adams	" 20	3,000
Davis creek	Cooper			
Travis creek	"	Ed. J. Anderson	" 20	15,000
Duncan creek	"			
Brow's creek	Adams			
Lillies creek	Kalamazoo	E. S. Shaffer	" 20	3,000
Kent County:				
Inlet to Hilton lake	Byron	J. K. Hilton	Feb. 26	1,000
No name	Grand Rapids	A. S. Ainsworth	April 28	6,000
Kopp creek	Lowell			
Mill creek	"	Chas. D. Pease	Mar. 24	20,000
Snow creek	Cascade			
Cherry creek	Lowell and Vergennes			
Bowne brook	Bowne	Lewis Kelley	" 24	6,000
Seely creek	Gratton	C. M. Slayton	" 7	9,000
Tributary to Buck creek	Paris and Wyoming	Charlie Putt	Feb. 26	3,000
Bear creek	Cannon	G. T. Young	Mar. 3	5,000
Archie McFarlin brook				
M. Smith's brook	Plainfield	Joseph Babka	" 3	6,000

Brook Trout Plants, 1890.—Continued.

County and Name of Waters.	Town.	Depositor.	Date.	Number
Kent County.—cont'd:				
Butternut creek	Dutton	A. W. Blain	Mar. 3	6,000
Hendrick creek				
Smith's Spring brook	Nelson	Chas. A. Green	" 3	10,000
County Line creek	Solon	J. V. Crandall	" 3	3,000
Bear creek	Cannon	H. D. Davis	" 3	5,000
Allen creek	Algoma	J. Coon	" 3	15,000
Austin creek	Algoma and Courtland			
Clear creek	Cannon			
Hutchings creek	Algoma			
Bear creek	Cannon	W. E. Ward	" 3	6,000
Graws creek	Sparta	A. H. Saur	" 1	6,000
Spring creek	"	Frank Baird	" 1	3,000
Silver creek	"	A. A. Place	" 1	9,000
Cooley's creek	Caledonia	Henry N. Cooley	" 3	6,000
Stow creek	"	D. P. Hale	" 3	6,000
Kalkaska County:				
South br. of Boardman river	South Boardman	G. R. & I. R. R. Co.	April 2	30,000
Boardman river				
Rapid river				
Copeland creek	Wilson	E. S. Noble	Mar. 26	2,600
Barber creek				
Desmond creek	Clear	" "	" 26	4,000
Lake County:				
Piquette brook	Pleasant Plains	W. D. Wing	" 14	3,000
Silver creek	Cherry Valley	Jay Sprague	" 1	6,000
Sanborn creek	Cherry Valley & Webber	Sanford Keeler	April 14	10,000
Kinney creek	Webber			
Two br's. of Sweetwater creek	Elk	" "	" 14	10,000
Small stream on sec. 20	Webber	" "	" 14	5,000
Lapeer County:				
North br. of Clinton river	Almont	M. E. Martin	Feb. 6	9,000
Townsend's creek	Metamora	Ira Read	" 6	3,000
Hemmingway creek	Marathon	John D. Brown	" 6	9,000
Elk creek				
Pine creek	Attica and Lapeer	Shad N. Vincent	" 6	9,000
Elm creek	Deerfield			
Leelanaw County:				
Cedar run	Solon	James G. Johnson	Mar. 26	9,000
Lenawee County:				
Grngg creek	Clinton	C. D. Keys	Feb. 10	9,000
Smalley creek	Clinton and Franklin			
Little Raisin river	Ridgeway	T. H. Temple	" 10	9,000
Livingston County:				
Lewie creek	Oceola and Deerfield	Wm. H. Johnson	Mar. 24	12,000
Ore creek	Hartland, Brighton and Hamburg	B. T. O. Clark	" 7	6,000
Ore creek	" " " "	C. E. Cushing	" 7	18,000
West Woodruff creek	Brighton	" "	" 7	
East Woodruff creek	"	" "	" 7	
Appleton creek	Geneva and Hamburg	" "	" 7	
Walker creek	" " "	" "	" 7	
No name	Hamburg	Will Cady	" 7	6,000
Macomb County:				
Stony creek	Washington	Chas. E. Crissman	Feb. 6	9,000
East br. of Stony creek	Bruce	R. B. Owen	" 6	15,000
North br. of Clinton river				
Manistee County:				
Claybank creek	Manistee and Stronach	T. A. Brown	Mar. 14	6,000
Pine creek	Brownstown			
Chief creek	"	Peter Schneider	" 14	6,000
Claybank creek	Manistee	L. Kaufman	" 14	3,000
Fowlers creek	"	G. R. Fowler	" 14	6,000
Mason creek	"	Jerry White	" 14	3,000
Beaver creek	"	J. Higgins	" 14	3,000
Gable creek	"			
East br. of Bear creek	"	W. R. Smith	" 14	15,000
Mason County:				
Spring creek	Amber	V. R. Penney	" 14	3,000
Tribntary to Sauble river	Eden	Wm. R. Smith	" 14	6,000
Weldon creek	Custer	Wm. Nielan	" 14	6,000

Brook Trout Plants, 1890.—Continued.

County and Name of Waters.	Town.	Name of Depositor.	Date of Deposit.	Number.
Mason County.—cont'd:				
Black creek	Custer	Edward Stock	Mar. 14	12,000
Cedar creek				
Weldon creek	Custer	C. H. Bates	" 14	6,000
North br. of Little Sauble river	Victory	Joseph N. Clark	" 14	9,000
Gensen creek	Sherman	Dodge Squires	" 14	3,000
Lincoln creek	Sherman	BaR rnes Jmtas. o	" 14	15,000
Little Sauble river				
Cedar creek	Grant	Wm. Freeman	" 14	6,000
Sauble river	Free Soil	C. A. Toby	" 14	6,000
Qnin creek	Riverton	D. C. Wickham	" 14	25,000
Nickerson creek				
Marquette County:				
Pesheke river	Michigamme	John C. Fowle	" 26	15,000
Silver creek	Ishpeming	George H. Hewett	" 26	18,000
North lake	Ely			
Lake Sally	Tilden			
Mecosta County:				
Hydes creek	Mecosta	Wm. Ladner	" 3	6,000
Ryan creek	Mecosta	L. L. Blair	" 5	3,000
Cedar creek	Stanwood	C. F. Barnard	" 3	6,000
Davis creek	Hinton	W. J. Griffin	" 3	6,000
Russell creek	Deerfield	James Boyd	" 3	35,000
Stony creek				
Brush creek				
Burney creek				
Scott creek				
Gill creek				
Cedar creek				
Stevens stream	Winfield			
Sand brook	Deerfield			
Quigle brook	Deerfield			
Montmorency County:				
Hay Meadow creek	Briley	Wm. Lawrence Leach	" 19	15,000
Stanager creek	Albert			
Bargehr creek	Briley			
Turtle lake outlet	Rust	E. H. Gilman	" 19	25,000
Dollar pond outlet				
Avery creek				
Cold creek				
Weber creek				
Bolton creek				
Montcalm County:				
Black creek	Belvidere	P. Flick	" 24	9,000
Brand creek	Winfield	M. W. Kelsey	" 24	9,000
Tamarack creek	Cato	A. T. Call	" 24	12,000
Town line creek	Belvidere	Albert E. Hunter	" 24	12,000
Cedar creek				
Black creek	Winfield & Maple	J. A. Barry	" 7	6,000
Town line creek				
Little Pine creek	Ferris & Crystal	J. E. Youndan	" 7	15,000
Butternut creek	Crystal & Bloomer			
Crystal inlet	Crystal			
South br. of Fish creek	Evergreen	Ephraim Follett	" 7	9,000
Fish creek	Sidney	C. F. Briant	" 7	9,000
Spring creek				
Spring creek	Day	S. Frost & Co.	" 7	9,000
Jones creek	Home	Wm. R. Jones	" 7	6,000
Clear creek	Maple Valley	T. J. Phelps	" 7	6,000
Wabsis creek	Eureka	T. J. Phelps	" 7	6,000
Rice creek	Pierson & Reynolds	J. N. Hathaway	" 3	10,000
Indian creek	Reynolds	C. E. Murray	" 3	20,000
Tamarack creek	Reynolds			
Church creek	Winfield			
Muskegon County:				
Crockery creek	Casnovin	Elliot T. Slocum	" 1	9,000
Silver creek	Whitehall & Blue Lake	E. M. Ruggles	" 10	15,000
Cleveland creek	Blue Lake			
Cleveland creek	Blue Lake	A. J. & C. E. Covell	" 10	9,000
Little Cedar creek	Cedar creek	John Dagen	" 10	12,000

Brook Trout Plants, 1890.—CONTINUED.

County and Name of Waters.	Town.	Name of Depositor.	Date of Deposit	Number
Muskegon County—cont'd:				
Green's creek	Laketon			
Bear creek	Muskegon & Delton	Chas. L. Gunn	Feb'y 14	35,000
Black creek	Norton, Fruitport, Eggleston & Moorland			
Bayou or Spring brook	Norton	O. P. Barcus	" 14	6,000
Newaygo County:				
Williams creek	Sheridan, Sherman & Brooks	Andrew Gerber	Mar. 10	15,000
No name	Dayton & Sherman	John Cole	" 10	6,000
Chidester creek	Bridgeton	W. S. Bartron	" 1	9,000
Gulley creek	Ashland	M. V. Bartron	" 1	9,000
Brook's creek	Brooks & Garfield	Charles Kritzer	" 1	6,000
Bigelow creek	Everett & Wilcox	Phil Rodel	" 1	32,000
Wilcox creek	" " "			
Four mile creek	" " "			
Freeman creek	Troy	Albertns Andrus	" 1	12,000
Winnipedogee creek	Beaver			
No name	Hawkins	David Hatch	" 12	4,000
Oceana County:				
Baldwin creek				
Wards creek				
Roby brook	Colfax	E. D. Richmond	" 10	35,000
Walker creek				
Gales creek				
Branch of Stony creek	Shelby & Benona	E. J. Shirts	" 10	12,000
Cunningbam creek	Newfield	Horace Lattin	" 10	9,000
Oscoda County:				
Silver creek	Comins	C. M. Comins	" 19	12,000
Osceola County:				
Clarks creek				
White's creek				
Sweeney's creek	Ashton	J. M. Metheany	April 2	12,000
Arnold creek				
Knapp's creek				
Rose lake outlet				
East br. of Pine river	Tustin	J. M. Metheany	" 2	9,000
Townsend creek				
Cat creek	Hersey	F. & P. M. R. R. Co.	" 14	9,000
Stream on sec. 20				
Stream on secs. 6 & 7	Evart	F. & P. M. R. R. Co.	" 14	5,000
Twin creek	"	F. & P. M. R. R. Co.	" 14	10,000
Reed creek	Richmond	E. L. Hays & Jas. M. Reed	Mar. 1	9,000
McDonald creek				
Beaver creek	Le Roy	Dell Roberts	" 26	9,000
Brooks Creek	Middle Branch			
Tinny creek	Sylvan & Middle Branch	J. J. Reik	" 12	25,000
Sylvan creek	Osceola & Sylvan			
Norway creek	Sylvan & Stanford			
Two brs. of Big Stone creek	Evart & Hersey	J. W. Bingham	" 12	15,000
Big Stone creek	" " "	Frank Goff	" 12	9,000
West br. of Clam river	Park Lake	M. L. Rice	" 31	9,000
Ogemaw County:				
Middle and west branches of the Tittabawassee river	Edwards	Charles Woods	" 19	15,000
Chapman creek				
Wilkins creek	Cumming & Klacking			
Rust creek				
Nestor creek	Rose	A. S. Rose	" 19	15,000
Stockade creek				
Dale creek				
Dunham creek	West Branch	S. V. Thomas	" 19	6,000
Houghton creek	Rose & Cumming	Wm. Bentley	" 19	9,000
Spring creek	Horton	C. N. Ashford	" 19	9,000
Ammond creek	Cumming & Klacking	Jerry Ammond	" 19	9,000
Spring creek	Edwards	George L. Lamb	" 19	6,000
Oakland County:				
Buckhorn creek	Rose	A. E. Botsford	" 12	9,000
Andrus creek	Highland			
Pleasant Valley creek	Milford	H. S. Holdridge	" 12	15,000
Beech creek	Highland			
Indian Garden lake and brook	Milford	E. J. Bissell	" 12	9,000

Brook Trout Plants, 1890.—CONTINUED.

County and Name of Waters.	Town.	Name of Depositor.	Date of Deposit	Number
Otsego County:				
East branch of Sturgeon river	Corwith	D. H. Fitzhugh	Mar. 19	9,000
Stacey creek	"	E. A. Cooley	" 19	9,000
Pigeon river				
Sturgeon river	Dover, Charlton, Livingstone & Corwith	A. A. Crane	" 19	18,000
Black river				
Ottawa County:				
Sand creek	Chester & Wright	Norman Harris	" 1	9,000
Spring creek	Talmadge	Peter Malone	Feb'y. 17	6,000
Branch of Rush creek	Georgetown	Benton E. Green	" 17	6,000
Deer creek	Polkton	D. O. Watson	" 15	6,000
Roscommon County:				
Robinson creek	Higgins	H. H. Woodruff	Mar. 19	12,000
Tuscola County:				
White creek	Ellington	F. S. Wheat	" 24	15,000
Sucker creek	Indian Field & Wells			
Van Buren County:				
Tributary to Paw Paw river	Antwerp	James W. Clark	Feb'y. 26	3,000
South br. of Paw Paw river	"	T. H. Elliget	" 26	3,000
Sink brook	Almena	T. A. Sprague	" 26	6,000
Hayden Spring brook	"	John W. Free	" 26	3,000
Spring creek and tributaries	Antwerp	C. F. Dey	" 26	9,000
South br. of Paw Paw river	Porter			
Cold Spring brook	Almena	F. C. Thomas	" 26	3,000
Hayden's brook	"	George Langdon	" 26	6,000
Pine creek	Hartford & Keeler	A. H. Young	" 17	6,000
Cold creek	Lawton	James McKeyes	" 26	3,000
Spring creek				
Tributary to east branch of Paw Paw river	"	Charles L. Balch	" 26	9,000
Kinneys creek	"	J. F. Gould	" 26	6,000
Spring brook	"	C. S. Adams	" 26	3,000
West br. of Paw Paw river	Paw Pew	D. L. Herrick	" 26	3,000
Washtenaw County:				
Honey creek	Ann Arbor	J. F. Lawrence	" 24	6,000
Bayders creek	Webster	Jasper Innes	" 24	6,000
Paint creek	Ypsilanti	A. H. Martin	" 24	9,000
Fellows brook	Lodi			
Bond brook	Saline			
Mud brook	York	J. H. Bortle	" 10	25,000
Spring brook	"			
Hoyt's brook	Saline			
Tates creek	Pittsfield			
Hales creek	Lodi			
Basset creek	"	E. R. Aldrich	" 10	9,000
Lashier creek	Pittsfield			
Wexford County:				
Headquarters of Pine river	Hobart	J. M. Metheaney	April 2	9,000
Fairchild's creek	Colfax & Cadillac	D. T. Diggins	Mar. 31	12,000
North branch of Pine river				
Slagel creek	Harrietta	B. Cooley	" 31	9,000
North fork of west branch of north branch of Pine river	Cherry Grove	W. J. Cornwell	" 26	25,000
Harris' lake and creek	Colfax	Hiram Harris	" 26	9,000
Total				2,578,000

Plants of Wall-eyed Pike, 1889.

County.	Name of Waters.	To Whom Delivered.	Date.	Number.
Bay	Saginaw bay	Michigan Fish Com.	May 11	3,750,000
Berrien	Paw Paw lakes	C. Colby	" 17	1,800,000
	Paw Paw lakes	C. D. Whitcomb	" 17	
Branch	Rose, Matteson, Morrison, Coldwater and Patterson's lakes	James Dickey	" 17	1,350,000
	No name given	Abel Coon	" 17	1,200,000
Calhoun	Brace lakes	F. H. Wherry	" 16	450,000
Clare	Ore lake	A. M. Tinker	" 16	750,000
	No name given	W. W. Green	" 16	450,000
Hillsdale	Bawbeese, Bankers, and Sand lakes	A. A. Smith	" 15	3,000,000
	Long lake	Michigan Fish Com.	" 11	4,500,000
Ionia	Long lake and Grand river	H. L. Bailey	" 16	900,000
Jackson	Clark's lake	J. L. Delmonta	" 15	3,000,000
	Grass lake	Wm. Mohr	" 11	1,050,000
	M. C. mill pond, Vander Cooks & Browns lakes	G. E. Beebe	" 11	1,350,000
	No name given	W. H. Sproat	" 11	900,000
	Gilet's lake	T. J. Conely	" 11	900,000
Kalamazoo	Gull lake	Michigan Fish Com.	" 11	4,500,000
	Gunn lake	T. S. Cobb	" 16	1,050,000
	No name given	L. A. Longwell	" 27	900,000
	Howard and Rawson lakes	Thomas Hewitt	" 17	900,000
Kent	Silver and Bostwick lakes	G. T. Young	" 16	450,000
	Sand lake	C. S. Ford	" 16	900,000
Livingston	Clark's and Bidwell lakes	F. T Hynes	" 16	450,000
	Ore, Ryan's, Rankin's, Ward and Maltly lakes	C. E. Cushing	" 16	1.800,000
	Bishop's lake	H. B. Bishop	" 16	450,000
Montcalm	Baldwin, Woodbeck and Burgess lakes	T. J. Phelps	" 16	900,000
Mackinac	Brevoort lake	M. F. Mulcome	" 16	2,220,000
	Brevoort lake	Capt. Rogers		
	Brevoort lake	J. H. Warren		
Mason	No name given	H. C. Cole	" 1	600,000
Oakland	Handy's, Lee, and Mayfield lakes	H. S. Holdridge	" 16	600,000
	Lone, Hartland, and North lakes	Giles Ross	" 16	900,000
	Orchard lake	F. D. Taylor	" 16	420,000
St. Joseph	Kaiser lake	J. F. Kaiser	" 11	1,050,000
	Klinger lake	V. S. Wilson	" 17	900,000
Total				44,340,000

Plants of Wall-eyed Pike, 1890.

County.	Name of Waters.	To Whom Delivered.	Date.	Number.
Antrim	Lac La Belle and Five lakes	H. T. Cook	May 13	400,000
	Crystal lake	F. H. Thurston	" 13	200,000
Branch	Gilead lake	E. C. S. Green	" 26	400,000
Barry	Sugar Bush lake	Walter Burling	" 16	200,000
Cheboygan	Long lake	E. J. Roos	" 16	400,000
Cass	Diamond lake	James M. Shepard	" 22	400,000
	Pleasant lake	Edwin Case	" 22	220,000
	Pleasant lake	B. F. Parsons	" 22	220,000
	Baldwin lake	S. E. Dibble	" 22	400,000
Calhoun	Keslar lake	F. F. Honglin	" 21	400,000
	Duck lake	Wm. H. Leonard	" 26	400,000
Clinton	Ford lake	T. W. Curtis	" 16	200,000
Genesee	Lobdell lake	Wm. Johnston	" 16	200,000
	Byron lake	Anson Shotwell	" 16	200,000
	Lobdell lake	G. G. Sutherland	" 16	200,000
	Long lake	Wallace Becker	" 16	200,000
	Bigle lake, McCormick lake	Z. B. House	" 26	200,000
Hillsdale	Farwell lake	G. T. Reenshaw	" 26	400,000
Ingham	Mud lake	Mahlon A. Bray	" 13	200,000
	Pine lake	John M. Potter	" 22	240,000
	Pine lake	E. W. Sparrow	" 22	240,000
Isabella	La Strange lake	A. W. Hurst	" 30	200,000
Jackson	Swain's lake	W. H. Spratt	" 21	200,000
	Vandercook lake, M. C. Ponds	George E. Beebe	" 21	800,000
	Grass lake	George D. Burton	" 21	200,000
	Swain's lake	Frank McKenzie	" 21	200,000
Kalkaska	Island lake	W. G. Grovenger	" 13	200,000
Kalamazoo	Gourd Neck lake	A. L. Lakey	" 21	400,000
	Rawson and Howard lake	Henry W. Moyer	" 22	480,000
Kent	Blood lake	George P. Stark	" 16	200,000
	Finney lake	Lawrence H. Goodall	" 28	400,000
Lake	Forman lake	James Armstrong	" 30	200,000
Lenawee	Devil's lake	J. B. Allen	" 27	200,000
Livingston	Long Lake	J. W. Lawson	" 13	400,000
	Island, Briggs', Rankin's, Appleton's, Bishop, Ore, Pickerel, Fonda, School, Bidewell, Noble, Upper Ore, Round aud Warden lakes	C. E. Cushing	" 13	1,400,000
Mackinac	Mackinaw Straits	J. W. Powers	" 13	400,000
Mecosta	Chippewa lake	R. B. Hughes	" 13	400,000
Muskegon	Big Blue lake, Little Blue lake, Crystal lake, Fox lake	E. M. Ruggles	" 28	400,000
Missaukee	Muskrat lake	Cornwell Bros.	" 13	400,000
Newaygo	Big and Little Marl lakes	E. J. Hewes	" 28	400,000
	" " "	S. D. Bonner	" 28	400,000
Osceola	Wright, Goose, Big, Mud, Tiff, Saddle Bag, Rattail, lake's, Hicks and Long lakes	J. J. Reik	" 30	600,000

Plants of Wall-eyed Pike, 1890.

County.	Name of Waters.	To Whom Delivered.	Date.	Number.
Oakland	Pine lake	Detroit Bank Clerks' Ass'n	May 16	720,000
	Wing lake	E. C. Poppleton	" 16	200,000
	Three Mile lake	John S. Gray	" 16	80,000
	Cass lake	C. R. Freeman	" 16	400,000
	Lakeville lake	Geo. A. Nettleton	" 16	200,000
	Cooley lake	Sloan Cooley	" 16	200,000
	Orion lake	C. Henri Leonard, M. D.	" 16	1,000,000
	Stony lake	E. R. Clark	" 16	400,000
Otsego	Otsego lake	H. B. Comstock	" 19	200,000
	Big lake	Alfred Savage	" 19	200,000
	Porcupine lake	John Green	" 19	200,000
	Crooked, McCormick's and Lench lakes	Allen Briley	" 19	500,000
Oceana	Crystal Lake	Fred J. Russel	" 28	400,000
Shiawassee	Myers, Bishop and McLain's lakes	J. E. Martenis	" 30	400,000
	Shiawassee River	Roll E. Kelsey	" 16	200,000
Van Buren	Eagle lake	W. D. Lane	" 21	200,000
	Cedar lake	F. W. Surdam	" 21	400,000
	Bankson's, Huzzy and Coral lakes	C. F. Dey	" 21	600,000
	Gravel lake	E. J. Elliget	" 21	200,000
	Bankson's lake	T. H. Elliget	" 21	200,000
Wexford	Big and Little Clam lakes	J. G. Mosser	" 13	1,000,000
Total				22,300,000

Distribution of Carp for 1889.

County.	Name of Distributor.	Location.	Date.	No.
Allegan	Lo Conrad	Leighton	October 16	40
	S. Swaney	Glen	August 20	40
	R. E. Kelley	Moline	September 30	30
	Henry Ebemeyer	Burnip's Corners	October 1	40
	Joseph Marshall	Wayland	April 19	30
	Fred. A. Whitney	Bradley	" 2	30
Alpena	Casper Alpern and Geo. S. Maltz	Alpena	October 31	100
Barry	C. H. Brady	Nashville	August 28	30
	Sol. Traxel	"	" 28	40
	H. Perkins	"	" 28	30
	J. M. Rogers	Hastings	October 30	40
Berrien	N. B. Rector	Sodus	March 13	30
	R. V. Clark	Buchanan	August 20	30
	E. P. Spaulding	"	" 20	30
Branch	George G. DeMott	Union City	October 1	100
Cass	E. Gilbert	Dowagiac	August 30	60
	Lee Tatman	"	" 30	60
	J. A. Root	"	" 30	60
Cheboygan	E. J. Roos	Cheboygan	October 31	100
	H. H. Packard	"	April 29	30
Clare	W. W. Green	Harrison	September 9	30
Clinton	W. S. Dills	Dewitt	October 21	40
	A. E. Cobb	Elsie	" 21	40
Eaton	Willard Freemire	Vermontville	April 10	25
	J. B. Ellsworth	"	" 10	25
	C. E. Wells	"	October 15	40
	O. W. Gridley	Kalamo	" 15	40
	O. W. Mead	"	" 15	40
Grand Traverse	W. E. Grulick	Norrisville	August 28	30
Gratiot	Joseph Ray	Elwell	October 10	30
Hillsdale	F. B. Smith	Waldron	April 15	50
	Charles E. Case	Jonesville	" 10	50
Huron	William H. Wallace	Bayport	October 15	40
Isabella	H. P. Blanchard	Blanchard	September 15	30
Iosco	Frank Duplantz	Whittemore	April 10	30
Ingham	E. P. Rowe	Mason	October 15	40
	Mahlon A. Bray	Okemos	" 21	40
	Moore Hunt	Dansville	" 24	40
Ionia	L. Millard	Palo	" 10	30
	J. D. Strachan	Muir	" 15	40
Kalamazoo	Jacob Lemon	Vicksburg	" 12	100
	Otis & Baker	Kalamazoo	August 20	40
Kent	George P. Stark	Cascade	September 9	30
	H. O. Braman	Grand Rapids	October 15	40
	A. W. Blain	Dutton	" 16	40
Leelenaw	M. E. Evarts	Burdeckville	April 2	30
	W. E. Greillick	Norrisville	August 28	30
Lenawee	J. & F. Salter	Adrian	September 5	30
Livingston	J. S. Montague	Howell	October 16	40
Mason	Edwin Goodrich	Branch	August 28	40
Monroe	Charles Krause	Ida	April 10	30
	Seward Baker	Monroe	" 10	30
Manistee	Wm. Kransch	Manistee	" 10	30
	H. F. Muller	"	" 10	30

Distribution of Carp for 1889.—CONTINUED.

County.	Name of Distributor.	Location.	Date.	No.
Mecosta	Thomas G. Horton	Mecosta	September 5	30
Montcalm	Llewellyn G. Zeigenfuss	Greenville	" 9	30
	Frederick Papke	Howard City	October 1	30
	Henry Henkel	" "	" 1	30
Muskegon	W. E. Osmun	Montague	" 15	40
Oakland	James H. Peabody	Bloomfield	August 20	40
	Thomas D. Donovan	Holly	September 5	30
	R. L. King	Waterford	October 21	40
	Will McClung	Southfield	" 24	40
Oceana	J. A. Weyant	Hart	" 21	40
Osceola	M. L. Rice	Park Lake	" 21	40
	W. L. Rich	Marion	" 21	40
Otsego	M. H. Chapin	Vanderbilt	" 21	30
Ottawa	S. M. Sage	Jamestown	September 5	30
Shiawassee	T. J. Caruthers	Vernon	" 30	50
	Thomas A. Lawrie	Byron	" 30	50
	James F. B. Curtis	Corunna	" 30	50
Sanilac	William Walker	Marlette	April 15	30
St. Clair	George Garlick	Port Huron	" 29	30
St. Joseph	Wm. Parker	Sturgis	" 2	40
Van Buren	C. H. Kemp	McDonald	October 16	40
	W. O. Cook	South Haven	April 15	30
	E. R. Hayden	Lawton	" 10	40
	C. B. Whitcomb	Hartford	" 10	40
Wexford	Bernard Kolnick	Hobart	September 30	30
Washtenaw	Deubel Bros	Scio	April 2	100
	Cornwell & Bro	Ann Arbor	" 15	100
	D. C. Griffin	Ypsilanti	August 20	40
	Wilber Jarvis	Salem	" 20	40
	L. D. Watkins	Manchester	September 30	40
	Louis P. Hall	Ann Arbor	October 21	40
Total				3,490

Distribution of Carp for 1890.

County.	Depositor.	Location.	Date.	Number.
Allegan	D. D. Tourtellette	Glen	April 24	40
	A. L. Buskirk	Shelbyville	August 21	40
	A. J. Wohma	Graafschap	October 6	50
Alpena	Chris D. Hamman	Alpena	August 29	40
Berrien	H. E. Williams	Dowagiac	May 5	100
	C. D. Brownell	New Buffalo	" 21	40
	H. M. Caldwell	Hartford	" 27	40
	John Caldwell	Velair	" 27	30
	A. J. Easton	Berrien Center	June 7	30
	F. M. Walker	Sodus	August 6	100
	B. Kern	New Buffalo	" 12	50
	Theo. W. Ransom	St. Joseph	" 12	50
Barry	L. S. Hills	Irving	" 25	40
Calhoun	Wm. Withington	Burlington	October 6	100
Cass	L. C. Phelps	Dowagiac	May 24	75
	Charles Mann	Dowagiac	" 26	35
	F. M. Bent	Marcellus	" 29	200
	Edgar Wetherbee	Jones	" 30	100
	Charles Wetherbee	Jones	June 6	70
	A. M. Bachelor	Jones	" 6	165
	J. C. Lindsley	Dowagiac	July 30	20
	W. Wells	Glenwood	August 7	50
	D. C. Thickstun	Cassopolis	" 12	70
	George Dietrich	Williamsville	" 15	23
	M. S. Storey	Williamsville	" 15	23
	James Phick	Jones	Sept. 9	26
	Samuel Miller	Pokagon	" 13	70
	Eugene B. Gilbert	Dowagiac	" 29	100
	Ben. Graham	Glenwood	October 14	20
	M. S. Storey	Williamsville	" 21	35
	George Dietrich	Williamsville	" 21	35
	John Biekle	Jones	" 24	100
	A. B. Weatherbee	Jones	" 24	64
	F. M. Finn	Jones	" 24	50
	John Draper	Jones	" 24	25
	A. M. Bachelor	Jones	" 24	150
	Leslie Wells	La Grange	" 24	300
Clare	E. W. Chapin	Marion	August 21	40
Cheboygan	Thomas Crump	Topinabee	" 25	40
	George V. Brill	Buckhorn	Sept. 9	40
Eaton	Robert Hubbard	Chester	October 24	100
Emmet	Thomas Sherrett	Levering	Sept. 22	40
Grand Traverse	J. M. Thomas	Traverse City	August 25	40
Ingham	F. Miller	Leslie	April 28	40
	John J. Hunt	Holt	Sept. 13	65
Ionia	H. L. Bailey	Ionia	August 15	40
	E. P. Clark	Pewamo	" 21	40
	Milo Rowland	Pewamo	" 21	40
	H. L. Bailey	Ionia	Sept. 22	150
	John Floater	Ionia	" 22	40
	H. L. Bailey	Ionia	" 29	50
	J. F. Monroe	Portland	October 10	60
Kalamazoo	Nate Spicer	Kalamazoo	April 19	150
	M. R. Squier	Kalamazoo	" 19	50
	Solomon Shelham	Alamo	August 18	40
	Wm. Maile	Schoolcraft	" 25	40
	F. R. Davenport	Kalamazoo	" 25	40
Lapeer	Walter Randall	May	" 25	40
Kent	W. C. Bowman	Caledonia	" 28	40
	Moore & Co	Grand Rapids	" 28	40
	James Phillips	Byron Center	" 28	80
	Charles Rowland	Casnovia	" 29	40
	E. Hayward	Kent City	October 6	50

Distribution of Carp for 1890.—CONTINUED.

County.	Depositor.	Location.	Date.	Number.
Lenawee	Herman Loomis	Adrian	April 24	40
	C. H. Peck	Hudson	August 21	40
	W. T. Lawrence	Adrian	" 25	40
Livingston	A. G. Weston	Unadilla	Sept. 22	40
Macomb	J. H. Pound	Lenox	August 25	40
	Charles Waterman	Ray	" 15	40
Manistee	C. C. Young	Manistee	" 25	40
Mecosta	H. D. Rice	Big Rapids	" 25	40
Montcalm	Ed. Dean	Gowen	" 21	40
	S. G. Ziengenfess	Greenville	Sept. 9	40
Muskegon	John Miller	Muskegon	October 6	50
Newaygo	John Cole	Fremont	August 15	40
	John Cole	Fremont	Sept. 22	40
	A. Andrus	Kirk	October 6	50
Oakland	Lewis Young	Orion	August 18	40
	G. H. Auten	Clyde	" 25	40
	Bert Vincent	Milford	Sept. 15	40
Osceola	C. W. Chapin	Marion	August 21	40
Otsego	N. L. Parmeter, M. D.	Gaylord	Sept. 29	150
	F. N. Humeston	Gaylord	October 20	100
Van Buren	G. W. Arnold	Bangor	April 17	50
	A. E. Gregory	Keelerville	May 7	200
	John Ihling	Lawton	July 9	100
	R. J. Evans	Keeler	October 5	150
	Ed. Arnold	Decatur	" 12	60
	Charles McNutt	Kibbies	" 13	65
Washtenaw	Caleb Eaton	Ypsilanti	May 2	40
	Everett Wiard	Ypsilanti	" 16	40
Wayne	S. F. Smith	Flat Rock	April 24	40
	John Jones	Detroit	August 4	34
	H. R. Burgess	Redford	" 25	40
	C. A. Seeley	Detroit	Sept. 15	8
Total				5,798

Plants of Loch Levin Trout, 1890.

Name of Waters.	County.	Date.	Number.
Thumb lake	Charlevoix	March 19	30,000

Plants of Swiss Trout, 1890.

Name of Waters.	County.	Date.	Number.
Colfax lake	Oceana	March 7	17,380

Plants of Schoodic Salmon, 1889.

Name of Waters.	County.	Date.	Number.
Log lake	Kalkaska	May 10	5,000

Plants of Schoodic Salmon, 1890.

Name of Waters.	County.	Date.	Number.
Torch lake	Antrim	May 14	24,888
Elk lake	Grand Traverse	" 14	10,000
Rapid river	Kalkaska	" 14	10,000
Total			44,888

Plants of Lake Trout (2 years old), 1889.

Name of Waters.	Where Planted.	Date.	Number.
Lake Michigamme	Michigamme	May 2	2,520
Klinger lake	Klinger Lake	" 6	3,000
Gull lake	Yorkville	" 9	2,500
Cora lake	Cora	" 31	2,000
Lake Michigamme	Michigamme	June 5	1,987
Lake Michigamme	Michigamme	July 7	1,000
Total			13,007

Plants of Lake Trout (2 years old), 1890.

Name of Waters.	Where Planted.	Date.	Number.
Crystal lake	Frankfort, Benzie County	March 5	460

Brown Trout Plants, 1889.

Name of Waters.	Where Planted.	Name of Depositor.	Date.	Number.
Inlet to Deer Lake	Boyne Falls	Michigan Fish Com	March 28	20,000

Brown Trout Plants, 1890.

Name of Waters.	Where Planted.	Name of Depositor.	Date.	Number.
Lundlum creek Sandiago creek McGraw's creek	Holmes	W. L. Benham	March 5	35,000
Echo lake outlet	Holmes	E. T. Webb	" 5	25,000
Total				60,000

California Trout Plants, 1889 (yearlings).

Name of Waters.	Where Planted.	Name of Depositor.	Date.	Number.
Andrews' lake	Highland	Michigan Fish Com	May 11	3,000
Birch lake	Jonesville	Michigan Fish Com	June 3	1,000

California Trout Plants, 1890 (fry).

Name of Waters.	Where Planted.	Name of Depositor.	Date.	Number.
Hersey creek	Reed City	Michigan Fish Com	May 19	8,000
Buckhorn creek	Paris	Michigan Fish Com	June 5	8,000

California Trout Plants, 1890 (adults).

Name of Waters.	Where Planted.	Name of Depositor.	Date.	Number.
Muskegon river	Paris	Michigan Fish Com	Sept. 23	475

Total Plants of Brook Trout in Twelve Years.

1879	12,000	1885	408,000
1880	50,400	1886	719,000
1881	388,500	1887	1,090,000
1882	251,000	1888	1,639,000
1883	219,000	1889	2,468,000
1884	353,000	1890	2,578,000
Total			10,175,900

The above is a statement of the plants of brook trout made from the Paris Station from and including 1879, the year in which the trout work of the Commission was removed from Pokagon to Paris.

Total Plants of Whitefish.

1874	1,532,000	1883	23,735,000
1875	2,211,500	1884	37,750,000
1876	9,310,000	1885	40,000,000
1877	8,001,000	1886	61,620,000
1878	12,520,000	1887	72,984,000
1879	14,545,000	1888	72,968,000
1880	10,695,000	1889	63,000,000
1881	3,000,000	1890	109,700,000
1882	18,170,000		
Total			561,741,500

Total Plants of Wall-eyed Pike.

1882	1,120,000	1888	11,492,000
1884	2,040,000	1889	44,340,000
1886	1,806,256	1890	22,300,000
1887	3,280,000		
Total			86,378,256

Total Plants of Carp.

1881	1,093	1888	3,878
1885	2,088	1889	3,490
1886	3,422	1890	5,798
1887	2,843		
Total			22,612

Total Plants of Lake Trout.

1875	150,000	1885	215,000
1877	168,500	1886	490,000
1878	433,834	1889 (two years old)	13,000
1879	379,000	1890 " " "	467
1880	28,500		
Total			1,876,301

Total Plants of California Salmon.

1873	45,900	1878	73,000
1874	419,930	1879	215,246
1875	323,000	1880 (adults)	575
1876	227,000		
Total			1,304,651

Total Plants of Schoodic Salmon.

1876	20,300	1885	48,000
1878	26,000	1886	23,000
1879	4,867	1887	23,638
1880	20,000	1888	73,424
1882	13,517	1889	5,000
1883	27,874	1890	44,000
Total			329,618

Total Plants of Eels.

1877	265,000	1881	390,000
1878	405,000	1883	236,000
1879	317,000	1885	325,000
Total			1,938,000

Total Plants of Black Bass.

1880	3,500	1888	1,560
1881	7,000	1890	185
Total			12,245

Total Plants of California Trout (Fry).

1880	12,000	1889	4,000
1884	6,000	1890	16,000
1885	25,000	1890 (adults)	475
1887	20,000		
Total			83,475

Total Plants of Swiss Lake Trout.

1890	17,360

Total Plants of Atlantic Salmon.

1873	21,350	1874	139,000
Total			160,350

Total Plants of Brown Trout.

1889	20,000	1890	60,000
Total			80,000

Total Plants of Loch Leven Trout.

1885	8,000	1890	30,000
1888	5,000		
Total			43,000

TEMPERATURE.

DETROIT STATION.

Temperature of water during whitefish hatching season from October 31, 1888, to April 22, 1889, and season for hatching wall-eyed pike from April 13, to May 24, 1889:

1888.		
Oct.	31	50°
Nov.	1-3	50
	4	49
	5	50
	6-9	40
	10-11	48
	12	46½
	13-14	47
	15	47½
	16	46
	17-18	45
	19	44
	20-21	40
	22	43
	23	42½
	24	42
	25	41½
	26	41
	27-28	40
	29-30	39
Dec.	1-2	40
	3-5	39
	6	38
	7	39
	8	36
	9	37½
	10	36
	11	35½
	12-15	35
	16-17	36
	18	35
	19-21	34
	22-23	33½
	24-31	34
1889.		
Jan.	1-10	34
	11-18	33
	19-22	34
	23-25	33
	26-28	34
	29-31	33
Feb.	1-3	33
	4-27	32
	28	33
1889.		
Mar.	1-3	33°
	4-7	34
	8-10	33
	11-13	34
	14-18	35
	19-22	36
	23-25	37
	26	38
	27-28	39
	29	38½
	30	38
	31	37
April	1	36
	2	39
	3	39½
	4	38
	5	39½
	6-7	39
	8-9	39½
	10-11	40
	12	41
	13	42
	14-15	43
	16-17	44
	18-19	45
	20	46
	21	47
	22	46
	23-30	44
May	1-3	44
	4	45
	5-6	46
	7	50
	8	51
	9	53
	10-11	56
	12	58
	13	57
	14-15	58
	16-18	57
	19-20	58
	21	57
	22-24	55

Temperature of water during whitefish hatching season from November 3, 1889, to February 23, 1890, and season for hatching wall-eyed pike April 10, to May 22, 1890:

1889.		
Nov.	3-4	48°
	5-8	47
	9-10	46
	11-13	45
	14-15	46
	16-17	45
	18-26	44
	27-28	43
	29	41
	30	40
Dec.	1-3	39
	4-7	38
	8-10	39
	11-12	38
	13-14	39
1889.		
Dec.	15-16	40°
	17-24	41
	25-26	42
	27-31	41
1890.		
Jan.	1	39
	2	40
	3	41
	4-5	40
	6-7	41
	8	40
	9-12	39
	13	40
	14-16	39
	17	37½

DETROIT STATION.—*Continued.*

1890.		
Jan.	18-22	37°
	23-24	35½
	25	35
	26-31	36
Feb.	1-7	36
	8	36½
	9-16	36
	17	36½
	18	37
	19	37½
	20	37
	21	36½
	22-23	35
April	10-11	39
	12	40
	13	42
1890.		
April	14-15	45°
	16-21	46
	22	47
	23-27	48
	28-30	49
May	1	49
	2-5	50
	6-8	49
	9	50
	10	49
	11-12	48
	13-14	49
	15-18	51
	19-21	52
	22	53

PARIS STATION.

Temperature of water during the trout hatching season at Paris from September 22, 1888, to April 10, 1889:

1888.		
Sept.	22-24	46°
	25	45
	26	44
	27	46
	28	43
	29	44
	30	43
Oct.	1-2	44
	3	42
	4	43
	5	44
	6	42
	7	44
	8	45
	9	42
	10	41
	11	42
	12	44
	13	45
	14	44
	15	43
	16-17	44
	18-19	45
	20	42
	21	44
	22	41
	23	44
	24	43
	25	42
	26	43
	27-28	46
	29-30	42
	31	46
Nov.	1-2	48
	3-6	44
	7-11	42
	12	40
	13	42
	14	44
	15	45
	16	41
	17-20	38
	21	40
	22	41
	23-24	40
	25	41
	26-27	40
	28	42
	29-30	41
Dec.	1-3	40
1888.		
Dec.	4	42°
	5-8	41
	9	40
	10	41
	11	40
	12	39
	13	38
	14	39
	15	40
	16	38
	17	36
	18	38
	19	37
	20-21	36
	22	39
	23-24	42
	25	40
	26-27	37
	28-29	38
	30	39
	31	40
1889.		
Jan.	1	38
	2	37
	3	39
	4	38
	5	39
	6-8	40
	9	41
	10-11	37
	12	35
	13	36
	14	37
	15	36
	16	40
	17-18	36
	19	34
	20	36
	21-23	37
	24-25	38
	26	39
	27	38
	28	37
	29	36
	30-31	38
Feb.	1	34
	2	37
	3	38
	4	37
	5	34

PARIS STATION.—*Continued.*

1889.		
	6	33°
	7	35
	8-9	37
	10	35
	11	37
	12	35
	13	32
	14	35
	15	36
	16	38
	13	39
	18	38
	19-21	36
	22-23	35
	24-25	34
	26	36
	27	39
	28	42
Mar.	1	40
	2	41
	3	39
	4-5	40
	6	39
	7	41
	8	39
	9	40
	10-11	38°
	12	39
	13	40
	14	38
	15	40
	16	38
	17	39
	18-20	38
	21	39
	22	40
	23	41
	24	45
	25	40
	26-27	38
	28	39
	29	38
	30	37
	31	38
April	1	38
	2	39
	3	40
	4	39
	5	38
	6-7	40
	8-10	41

Temperature of water during the trout hatching season from Sept. 23, 1889, to May 16, 1890:

1889.		
Sept.	23-26	44°
	27-29	42
	30	46
Oct.	1-5	44
	6-7	42
	8	40
	9	44
	10	42
	11-12	44
	13	42
	14	40
	15	40
	16	42
	17	44
	18-22	40
	23-25	38
	26-27	40
	28	38
	29	40
	30	42
	31	44
Nov.	1-3	44
	4-5	42
	6	40
	7	41
	8	42
	10-13	44
	14	42
	15	40
	16-17	38
	18	40
	19-21	44
	22-23	43
	24-25	42
	26	38
	27	39
	28-29	38
	30	36
Dec.	1	38
	2	42
	3	40°
	4	37
	5	40
	6	39
	7	40
	8	42
	9	40
	10-11	41
	12	40
	13-14	41
	15-16	42
	17-18	43
	19	42
	20	41
	21-22	40
	23	39
	24	41
	25-27	39
	28	38
	29	39
	30	38
	31	37
1890.		
Jan.	1	42
	2	40
	3-4	38
	5	42
	6	41
	7-8	38
	9	47
	10	40
	11	39
	12	41
	13	35
	14	36
	15	40
	16-17	37
	18	38
	19	39
	20	40

PARIS STATION.—*Continued.*

1890.		
Jan.	21	37°
	22	36
	23-28	38
	26	40
	27	41
	28	40
	29-30	41
	31	42
Feb.	1	38
	2	41
	3	42
	4	41
	5	40
	6-7	38
	8	39
	9-11	38
	12	39
	13-14	40
	15	38
	16-17	40
	18	41
	19	38
	20	37
	21-22	36
	23	38
	24	41
	25-26	40
	27-28	39
Mar.	1-2	38
	3	37
	4	36
	5	35
	6-8	34
	9	38
	10-12	40
	13	39
Mar.	14	37°
	15	38
	16	40
	17	38
	18	40
	19	39
	20	40
	21	41
	22-24	40
	25	42
	26-27	38
	28-29	40
	30	38
	31	36
April	1	37
	2	38
	3	40
	4-7	42
	8-9	40
	10	42
	11	44
	12	48
	13	46
	14-16	42
	17	40
	18-19	39
	20-21	40
	22	42
	23	45
	24-28	40
	29	44
	30	42
May	1-3	40
	4-15	42
	16	44

INVENTORY.

PARIS STATION.

158 acres of land with overseer's dwelling and meander of Cheney creek		$4,000 00
Superintendent's house	$1,400 00	
Barn	315 00	
Ice house	28 00	
Shop and office	100 00	
Old hatchery	600 00	
New hatchery	4,000 00	
Car house	200 00	
Apparatus, tools, and camp outfit	2,001 80	
Pump logs	260 00	
Windmill, tank, pipe and connections	400 00	
Ponds, races, and other improvements to ponds	3,969 00	
		13,273 80
		$17,273 80
Car for transporting fish	$3,550 00	
Outfit, lamps, curtains, stoves, bedding, etc.	125 00	
		3,675 00
Total		$20,948 80

DETROIT STATION.

Buildings, with frames, tanks, boiler and pump	$9,772 81
Chase automatic jars	2,000 00
Fish cans	875 00
Tools, apparatus and furniture	700 00
Fort Wayne fishery and outfit	275 00
Stony Island fishery and outfit	300 00
Total	$13,922 81

GLENWOOD STATION.

Winter house	$150 00
Cans	75 00
Tools, apparatus and fixtures	25 00
Total	$250 00

SECRETARY'S OFFICE.

Furniture	$210 00
Books and stationery	65 00
Library	30 00
Total	$305 00

RECAPITULATION.

Paris station	$17,273 80
Detroit station	13,922 81
Glenwood station	250 00
Car	3,675 00
Secretary's office	305 00
Total	$35,426 61

INSURANCE.

PARIS STATION.

New hatchery	$2,500 00	
Old hatchery	300 00	
Superintendent's dwelling	600 00	
Superintendent's barn	100 00	
Wagons, harness, etc.	50 00	
Troughs, trays, etc.	350 00	
Camp outfit, etc.	300 00	
Tanks, boxes, cans, etc.	200 00	
Office and shop	200 00	
Office furniture and fixtures	100 00	
Overseer's dwelling	400 00	
Car house	125 00	
		$5,225 00

DETROIT STATION.

House	$4,000 00	
Automatic jars	1,600 00	
		5,600 00
Total		$10,825 00

REPORT OF LEGISLATIVE COMMITTEES.

REPORT OF THE SENATE COMMITTEE ON FISHERIES, SESSION OF 1888-89.

The committee on fisheries, to whom has been entrusted by the Senate the duty of investigating the work of the board of fish commissioners hereby respectfully reports:

That the committee of the Senate, conjointly with the committee of the House of Representatives, visited the hatchery at Paris on the first day of February, and made a careful examination of the work there done in the propagation of trout. There was every evidence that the interests of the State are cared for, to the best advantage. The building, 82½x40 feet, is in every way fitted for the work. The interior arrangements seem almost perfect. Your committee saw trout during the various stages, and we say that the trout hatchery at Paris has become a valuable food supply. The committee visited the breeding ponds, saw the fish feeding, found about 15,000 breeding trout in the ponds, and investigated the interests of the State, both at the ponds and in the buildings as carefully as possible. Of the work done some conception may be formed when it is here stated that the orders for trout fry throughout the State since 1883 are as follows:

In 1883	14	orders.
1884	38	"
1885	49	"
1886	75	"
1887	121	"
1888	163	"

The figures show the value placed by our people on the propagation of trout.

When the committee was in Paris there were about 3,000,000 eggs, of which 100,000 were hatched. There were also 8,000 Adirondack trout, contributed by the New York Commission, and 20,000 German trout, supplied by the U. S. Fish Commission. This German trout closely resembles our own brook trout.

The commission in distributing trout considers the nature of the water for which they are asked. As a matter of economy to the State this is an important feature of the work. Unless the stream is suitable, it is a waste of money to plant trout. For this reason the Commission has investigated the waters of a large portion of the State, and a demand for trout is sent to the Superintendent, Mr. W. D. Marks; he has a fair knowledge as to whether the fish will thrive in the stream. But, in addition, he sends to the applicant a blank requesting information as to the temperature and other qualities of the water. If all is satisfactory the fish will be sent; if not, the order is not filled. If trout are not suitable for a stream for which they are asked black bass, wall-eyed pike, or some suitable fish will be sent.

At Paris the water supply has become one important consideration. The purchase of 80 acres of land adjoining the State property seems to your committee an absolute necessity if the work is to be continued. In a few years, even if the hatchery were discontinued, the land would be worth much more than is now asked for it. The committee, therefore, recommends that the lands should be bought.

Your committee visited the grayling pond, but it was frozen over. Every evidence, however, goes to show that in certain streams the cultivation of this fish is profitable.

On February 4 the committee visited the Detroit hatchery. The propagation of whitefish is of very great importance to the State. Our lakes were almost depleted of this fish until the State took up the work of re-stocking them.

In Detroit your committee found the building admirably suited to its purpose and well cared for, the work going on in a satisfactory manner and the whole institution a credit to the State. The number of fish hatched has been greatly increased. For reasons hereinafter mentioned the jars of the Petoskey hatchery have been moved to Detroit, and your committee respectfully states that the reasons given by the Board of Fish Commissioners for doing this will meet with our full approval.

At the date of your committee's visit to the Detroit hatchery there were about 67,000,000 eggs on hand. Last year over 50,000,000 young fish were planted. The Board of Fish Commissioners, knowing the necessity of extending the work, desire to have the means of doing so, and your committee respectfully recommends that the appropriations asked for shall be granted. We have evidence that the increase of whitefish in our lakes within the past few years is entirely owing to the work of the State in this direction. Practical fishermen unanimously say so. For this reason your committee recommends the appropriation.

We visited the carp hatchery at Glenwood, Cass county. The carp is not so well known as it deserves to be. It is adapted to some waters where some other fish will not thrive. At our visit to Glenwood we found 20,000 carp in the ponds, of which there are eight. Under the main building is a pond, fed by a spring, and this is the winter quarters of the fish. The dimensions of the building are 18x20 feet. The State is fortunate in acquiring the property, and in the management of Mr. Wells. The amount asked per annum is $575. Your committee recommends that this be granted.

The committee approves the action of the Board of Fish Commissioners in abandoning the station at Petoskey as a whitefish hatchery. The temperature of the water is so high that the fish hatched before they could be planted. In addition to this it contains a vegetable matter destructive to the eggs. The building was erected on the understanding that the supply of water should be from the lake. Unfortunately the expectation was a disappointment. When the well was sunk at the edge of the lake water from the heights and banks percolated and filled it, and it has proved unfit for fish hatching purposes. We therefore recommend that the State property there be sold for what it will bring, and that the Board of Fish Commissioners account to the State for the same.

The board has asked an appropriation for a hatchery in the Northern Peninsula. Your committee, after full consideration of the subject, deems it best, for the present, to recommend that $500 be appropriated for a proper investigation as to the best location for such a hatchery, in case its establishment should be considered advisable.

With this the committee submits to the senate the estimates made by the Board of Fish Commissioners for the ensuing two years, from July 1, 1889, to July 1, 1891. With the exception that we reject the proposition for a northern hatchery and insert the appropriation of $500 for investigation of this subject your committee indorses the report of the board, and recommends the estimates therein made. In the estimates of the board the Senate will find the details of the expenses, and, after careful examination of these details, your committee recommends the adoption of the estimates.

Your committee would further suggest that the question of the increase or extinction of fish in the waters of the State is one that effects thousands of our citizens. There are large interests involved in this business. Capital and labor are both interested. The State has done much to encourage both, but where the outlay is comparatively so small, your committee hopes that the Senate will further encourage this beneficent work. On every hand we have heard favorable reports of what has been done. From practical fishermen, from sportsmen and from humble laborers and others living near our lakes and streams we have learned, by diligent inquiry and by petitions sent to us, that the labors of the commission and the expenditures of the State have not only added to our wealth but have given a food supply to our people which can scarcely be appreciated except by those who have investigated this matter as your committee has done.

T. S. GURNEY, *Chairman.*

REPORT OF HOUSE COMMITTEE ON FISHERIES SESSION, OF 1888—89.

The undersigned, committee on fisheries, beg leave to report that in accordance with custom and during the vacation of the Legislature during the month of February, they visited the fish hatching stations of the State, located at Paris, Mecosta county, Glenwood, Cass county, Petoskey, Emmet county and Detroit, Wayne county.

Your committee met at the office of the commission in Detroit, and were shown the books, accounts and manner of keeping the same; also the method employed by the board in gathering statistics regarding the fishery interests of the State, and the data which has been gathered during the past three years relating to the examination of the interior lakes of the State, bearing on the same, etc.

In order that your honorable body may better understand the magnitude of this great industry your committee would state that the catch of whitefish alone, for the years 1885, 1886, 1887 and 1888 was as follows:

Year.	No. of Reports.	Lbs.
1885	432	7,443,459
1886	180	2,652,325
1887	146	2,756,419
1888	100	2,373,394

The average number of pounds for each report was as follows:

Year.	Lbs.
1885	10,285
1886	14,735
1887	18,880
1888	23,734

The difficulty in obtaining accurate aud reliable statistics is very great, and they can only be obtained by sending an agent personally at the proper season of the year to gather them. In 1885 a statistical agent was employed and 432 reports were filed that year. No agent has been employed since, and the number of reports returned to the office of the Commission has gradually declined every year until the year 1888, when but 100 were received. This is probably not more than one-sixth or one-seventh of the reports that should have been made. The value of these reports can readily be seen and the small amount asked for by the commission for this purpose is well expended and your committee recommend that it be allowed as one of the most important parts of the work is to ascertain what have been the results.

Your committee would state that the fishing grounds within the jurisdiction of the State embrace an area of 34,000 square miles, nearly three-fifths of the land area of the whole State. The coast line extending along the east and north shores of Lake Michigan, and the south shore of Lake Superior and the shores of Lakes Erie and St. Clair is over 2,000 miles in length. The coast line so designated does not include the inland waters of the State, such as its lakes and rivers, and is referred to for the purpose of calling the attention of the Legislature to the facts, and for the purpose of enlisting their support in behalf of this great industry.

PARIS STATION.

This hatchery is situated on the Grand Rapids and Indiana R. R. in Mecosta county, and is principally used for the propagation of brook trout. In addition to this work the German trout, Loch Leven, mountain trout, land locked salmon and the grayling are being bred upon a somewhat smaller scale, and bid fair to become an important part of the work done at this station. The station is also adapted to the hatching of the salmon or lake trout. The hatchery is a large, well-constructed wooden building, but recently completed, and is 40x80 feet. Its interior is a model of neatness and perfection. The property connected with this station comprises 118 acres of land, which is of much greater value to the State than the prices which were originally paid for it. In this connection we would say that the Fish Commission wishes to purchase 80 acres of land adjoining the premises, for the purpose of securing and keeping control and maintaining the sources and supply of water in the Cheney creek, by which the ponds and hatchery are fed and maintained. Your committee are of the opinion that this land should be bought, and would recommend that the appropriation asked for be allowed, to enable the commission to purchase. This is for the purpose of keeping timber standing to protect the water.

When your committee visited the station there were nearly 3,000,000 brook trout eggs in process of hatching, and about 100,000 had already been hatched out. The ponds upon the premises are filled with trout, varying in size from the fry just hatched to fish weighing five or six pounds and about 15,000 adult fish are kept in the ponds the year round for breeding purposes. There are also at present about 8,000 Adirondack trout which have been donated by the New York Commission for the purpose of improving the present stock, about 20,000 German trout and one pond stocked with the grayling.

The demand for brook trout throughout the State is large and constantly increasing. Your committee believe that in a very few years, under the able management of Mr. Walter D. Marks, the superintendent of fisheries, the trout streams of this State will be filled with these beautiful fish, as well as many others which are not now stocked.

Your committee after visiting this hatchery, took pains to inquire of people whom they met from different parts of the State, who resided on or near the streams where trout had been planted, whether they had noticed any increase in the number of fish since the commencement of planting, and invariably received answers in the affirmative, and in some cases the increase noticed was remarkable. This was especially the case in Silver creek, Kalamazoo county, which six or seven years ago contained no trout whatever, but which today is abundantly supplied. Attention is called to the fact that until trout were artificially propagated and planted by the commission they were almost wholly unknown in the waters south of Traverse bay.

DETROIT STATION.

When your committee visited this station they found a commodious building, 40x80 feet in size, used as a hatchery and office, with a large wing, heretofore used for a shop and for storage purposes. The main room of the building is used for hatching whitefish during the fall, winter and spring, and after the whitefish have been planted, and in the month of June, it is devoted to the hatching of wall-eyed pike.

The number of whitefish eggs on hand and in process of hatching, at the time the committee visited this station, was about 67,000,000. Your committee, after throughly examining this hatchery, were greatly impressed with the magnitude and importance of this work, and with the great benefit which must result to the State in the re-stocking of its waters with whitefish. From this station alone over 50,000,000 of whitefish fry were planted last year along the shores of Lakes Michigan, Huron, Erie and St. Clair, and in the Traverse and Saginaw bays, the Detroit river and Torch lake. The benefit of whitefish planting in the great lakes has passed the period of doubt as to its success; the largely increased catch of last season on Lake Erie, the Detroit river and Lake St. Clair was so convincing that the unanimous opinion of the fishermen is that it is the result of the planting solely. The appointments of this hatchery are of the most complete character, it being the largest in the country, and your committee believe the work is intelligently and economically carried on.

The commission desire to double the capacity of this station by utilizing the wing of the main building, now used as a shop and for storage purposes for a hatchery addition. This change can be made at a comparatively small expense, and will result in putting out annually 160,000,000 of fry while its present capacity is 80,000,000. Your committee recommend that the appropriation asked for this purpose be granted.

GLENWOOD STATION.

This station is used for the propagation of carp. At the time your committee visited it, they found a small wooden building 18x20 feet in size and inside and beneath this building is a spring the full size of the building, which is used for winter quarters of the stock fish. At the time of our visit the house contained about 20,000 carp. These fish are very prolific, and a few of them planted in a pond or lake adapted to their habits will in two or three years furnish an abundance of food. The fish are fed throughout the winter upon wheat and other grains. As usually kept in ponds they require no feeding in the winter. At this station there are eight breeding ponds, and about 3,700 young carp were shipped last season to different parts of the State, with gratifying results. More of these fish could have been furnished if orders for them had been received. The demand for these fish has not been large, but is constantly increasing. Few of the people of our State seem to know that they may be had for the asking.

We would say to those who want this variety of fish, that they may be had by applying to the secretary of the commission, at Detroit, or to Worden Wells, in charge of the station at Glenwood, Cass county. The commission lease from Mr. Wells the ponds and buildings necessary to conduct this work, and allow him a stated amount for the lease and for his services in breeding and distributing the carp. The sum allowed for this purpose is five hundred dollars per annum, with an additional amount of seventy-five dollars per year for incidental expense. The State was fortunate in being able to secure carp ponds already made, and it has necessitated a very much smaller outlay than would have been demanded if they had been compelled to make a new plant entirely. The amount asked for the maintenance of this station is $575 per year and we recommend its allowance.

PETOSKEY STATION.

This station was established by the board for the purpose of breeding and distributing whitefish in the northern waters of Lakes Huron and Michigan, and in the waters of Lake Superior. It consists of a hatchery building 25x75 feet in size, together with a small cottage for the overseer in charge of the work. These buildings are upon leased ground but belong to the State.

Your committee fond that work at this station had been suspended for the present owing to the poor quality of water furnished for hatching purposes.

Your committee on investigating the reasons of the commission for the abandonment of this station, found that the reasons justified the action of the board. When the hatchery was originally established at this point, one of the conditions guaranteed by the village as an inducement to locate at that point, was that all the water needed by the board for the purposes of conducting the hatchery should be furnished free to the State, and that the works which the village was then putting in for the purpose of supplying the city with water would furnish water from the bay, which was the water required for the purpose of hatching. After the works were completed the well from which the supply was obtained, being sunk at the edge of the lake was found to furnish spring water which leached in from the hills surrounding the well. This was contrary to the expectation of the engineer who supervised the construction of the works and to the citizens of the village. The temperature of this water is considerably higher than that of the lake or bay, and has resulted in bringing out a premature hatch of fish, the hatch occurring so early that the waters in which they were planted are still frozen, and thereby the very object for which the house was constructed is defeated. It may be said in passing that the hatch of the young fry at this station is from two to three weeks earlier than that at Detroit, about 300 miles further south. The fish so hatched were weak and unhealthy fish. The period necessary to hatch whitefish fry is only about 80 days at this station when the usual period is about 130 days. Another reason for the discontinuance was that a sediment from decayed vegetable matter adhered to the eggs, and was quite destructive, decreasing the percentage of the hatch. Under these discouraging conditions the commission concluded to abandon the station.

Your committee, at the time of their visit to Petoskey, conferred with several of the leading citizens of the village to ascertain if the village would be willing to guarantee a supply of lake water or bay water sufficient to conduct this station, in order to insure the continuance of the the hatchery at that point, but your committee were informed that the expense would be more than they could afford, and after a full investigation by the committee we are satisfied that the action of the commissioners in discontinuing work at that point was justified by the circumstances. The jars formerly carried at this station were removed to the Detroit house, which was fitted up to accommodate them, and they have been run during the present season at the Detroit station, so that the output of whitefish fry has not been diminished.

IMPROVEMENTS.

Your committee recommends that the small appropriation asked for to increase the capacity of the Detroit hatchery, be granted, as it will result in doubling the present capacity, and it will be capable of carrying and hatching 160,000,000 of whitefish eggs.

Your committee desire to say that they have taken especial pains to inquire of practical fishermen from all parts of the State as to the result of whitefish planting, and we have been assured by them that the catch of whitefish in certain parts of the State, especially in portions of Lakes Huron, Erie and St. Clair and the Detroit river, have been very much larger the past year than ever before, and it is attributable to artificial propagation.

In conclusion we desire to say that the present Board of Fish Commissioners are gentlemen of high character and enthusiastic in their work, and devote a large share of their valuable time without compensation to this work. As a result of our investigations, we believe that every dollar asked for by the commission should be granted, as anything less would cripple them in their work.

All of which is respectfully submitted.

T. J. WELLS, *Chairman.*

TREASURER'S REPORT.

STATEMENT of Wm. A. Butler, Jr., Treasurer, in Settlement with Board of State Auditors, for year ending September 30, 1889.

	Current Account.		
1888. Oct. 1	Overdrawn	$118 13	
	Cash from State Treasurer		$4,178 99
	Cash from sale of fish		863 12
	Vouchers paid	5,636 04	
Dec. 31	Overdrawn		712 06
		$5,754 17	$5,754 17
1889. Jan. 1	Overdrawn	$712 06	
	Cash from State Treasurer		$4,178 53
	Cash from U. S. Fish Commission		126 82
	Vouchers paid	4,519 84	
Mar. 31	Overdrawn		926 55
		$5,231 90	$5,231 90
1889. April 1	Overdrawn	$926 55	
	Cash from State Treasurer		$4,179 44
	Vouchers paid	3,252 89	
		$4,179 44	$4,179 44
1889. July 1	Cash from State Treasurer		$5,638 12
	Vouchers paid	$6,139 67	
Sept. 30	Overdrawn		501 55
		$6,139 67	$6,139 67
	Special Account.		
1889. July 1	Cash from State Treasurer		$8,016 40
	Vouchers paid	$1,896 35	
Sept. 30	Cash on hand	6,120 05	
		$8,016 40	$8,016 40

OFFICE OF BOARD OF STATE AUDITORS,
Lansing, 29, 1890.

I hereby certify that the Board of State Auditors this day examined the within account current of the receipts and disbursements of Wm. A. Butler, Jr., for the year ending Sept. 30, 1889, and find the same to agree with the vouchers on file in the office of the Auditor General, and find the balance on hand at that date to correspond with the books of the Auditor General, and have settled with the said Wm. A. Butler, Jr., as treasurer of the Michigan Fish Commission, on that basis.

G. R. OSMUN.
Chairman Board State Auditors.

MICHIGAN FISH COMMISSION.

Examination of Interior Lakes.

County .... Lake ....

Township .... Nearest Railroad Station, ...

Season of 18___ Crew ....

DESCRIPTION:—Length .... Width .... Greatest Depth ....

Shores ....

Bottom ....

Inlets ....

Outlets ....

								Remarks.
Dates of Examinations,								
Weather,								
Temperature—Surface,								
" Bottom,								
Hours, and Number of Hauls,								
Condition of Water,								
Number and kinds of Fish taken,								

Nets used, ... Kind. .... Length. .... Depth. .... Mesh. ....

Remarks on Fish Taken: ....

Recommendation as to Future Planting: ....

Reported by ....

MICHIGAN FISH COMMISSION.

Rules for Examination of Interior Lakes.

1. To make soundings and locate deep places.
2. To take temperatures each day, morning and evening, at surface and bottom.
3. Set nets in deep water and on and off banks.
4. To dredge bottom and grasses, to look for larvæ of flies, shrimps, and small crustaceans; also ascertain quantities and kinds of small fish.
5. To examine the stomachs of fish taken, and where food is identified, examine to see its quantities in lake.
6. To try bait fishing, fly fishing, and trolling with spoons and live bait, surface and deep water trolling.
7. Describe fully the kinds, sizes, and number of fish taken. When in doubt as to kind, ship specimens to office in Detroit by nearest express route.
8. Make accurate and complete reports on blanks, *at the time.*
9. Reports to be forwarded to office weekly, signed by officer in charge.

By order of the Board,
JOHN H. BISSELL,
HERSCHEL WHITAKER,
Committee.

Detroit, June 25, 1886.

MEMORANDA.

No. ....
Letter Received ....
Blank Sent ....
Blank Returned ....
Application Entered ....
Granted for ....
Refused, cause ....
Filled in ....

Shipper's Number ....

MICHIGAN FISH COMMISSION,
Detroit, ... 18____

DEAR SIR:

Your application of .... for fish has been received, in which you say your waters are private.

The State is engaged in the stocking of waters for the benefit of the public only, and it is against the policy of the State to stock any waters from which the public is excluded.

For the foregoing reason your application must be refused,

Very respectfully,
Mich. State Board of Fish Commissioners.

MICHIGAN FISH COMMISSION.

WALL-EYED PIKE.

Detroit, Mich.,____________189

*Mr.*____

____

DEAR SIR:

Our fish car will leave Detroit on________________________________
With wall-eyed pike for your lakes, and will arrive at ____________________________
via______________________________on the______________at___________o'clock, __M.

Answer at once if you can meet the car and attend to planting the fish intended for you.

If no answer is received the fish will not be sent.

W. D. MARKS,
Superintendent.

CAR REPORT OF MICHIGAN FISH COMMISSION.

________________________________189

To the President Michigan Fish Commission:

The car______________________________left________________________________189__
for________________________________with________________________
Number and Kind.

The following employés manned the car:____

____

____

The car returned to__________________________on the______________________________

Distributions were made at the following points:__________________________________

____

____

____

Was the trip successful or otherwise________________________

Number of cans____

____
In charge of car.

MICHIGAN FISH COMMISSION,
Detroit, Mich., Dec. 1, 1889.

DEAR SIR:

Enclosed you will find blanks for an Annual Report of food fish caught. If you have been engaged in fishing during the past year, it is your duty, under the law, to make the report and return it at once to this office. Please make it as full and accurate as possible, as these reports are of great value to this Board.

There are a great number of fishermen whose names we do not know and several extra blanks are enclosed, which we will thank you to hand to any fishermen you know, who have not received blanks direct from this office.

It is as much for your interest as for ours that every fisherman shall send us a full report, as the object of these reports is to inform us whether or not, our efforts to increase the number of fish have been successful.

Please render us all the assistance you can in obtaining full reports this year from everybody who has been engaged in fishing.

Very truly yours,
MICHIGAN FISH COMMISSION.

In the spring of 1890, when the three years had expired under the law for opening of streams planted in 1887, the board feeling that the public, who contributed to the means which sustained the board, should be fully informed as to the localities of all streams open to public fishing at that date, in order to give it as large circulation as possible had the list published in several newspapers of the State. It also had prepared a list of all streams which have been planted since 1885 and had the same published for general distribution. The list prepared for public distribution is as follows:

A list of streams which have been stocked with brook trout, by the Michigan Fish Commission, since 1885 and are open for fishing, May 1, 1890.

ALCONA COUNTY.

East, West and Middle Branch of Killmaster Creek. Pine River. Mill Creek.

ALLEGAN COUNTY.

Silver Creek. Mann's Creek. Red Run. Bear Creek. Rapid River. Campbell's Creek.

ALPENA COUNTY.

Devil River.

ANTRIM COUNTY.

Spencer Creek. Jordan River.

ARENAC COUNTY.

Gilbert Creek. Meadow Creek.

BERRIEN COUNTY.

Beaver Creek. Sykes Creek. Great Blue Creek. Little Blue Creek. Spring Creek. Bear Creek.

BRANCH COUNTY.

Riley's Creek. Turtle Creek.

BARRY COUNTY.

Portage Lake. Cold River.

CALHOUN COUNTY.

Oliver's Brook. Locke Brook. Spring Brook. Harmon Brook. Hart's Brook. Austin's Brook. Wandago Brook. Fendan Brook. Tamerac Creek. Bear Brook. Goss Brook. Crooked Brook. Pool's Spring Brook. Hicklin Brook. Bullis Brook. Mead's Brook. Way's Brook. Tekonsha Creek.

CASS COUNTY.

Dowagiac River. Spring Creek. Battle Creek. Red Run.

CHARLEVOIX COUNTY.

Newman Creek. Stone River. Boyne River. Cedar River. Antrim Creek. Van Arman Creek. Inwood Creek. North Boyne River.

CHEBOYGAN COUNTY.

Niggar and Bush Creeks. Bear Creek. SturgeonRiver and Branches. Little Sturgeon River. Topinabee Creek. Indian River. Keyes Creek.

CLARE COUNTY.

Tobacco River and Branches.
Walker Creek.
Chippewa River and Branches.
Mill Brook.

CRAWFORD COUNTY.

Au Sable River and Branches.

EMMET COUNTY.

Stream emptying into Crooked Lake Tributary.
Horton's Creek.
Kegomic Creek.
Bear Creek.
Minnehaha Creek.
Clear Creek.
Willard Creek.

EATON COUNTY.

Sandstone Creek.

GENESEE COUNTY.

Ore Creek.
Begole's Creek.
Yellow Creek.
Cherry Creek.

GLADWIN COUNTY.

Howland Creek.
Bush Creek.
Spring Creek.
West, North and Main Branches of Sugar River.

GRAND TRAVERSE COUNTY.

Dodd's Creek.
Beitner's Creek.

GRATIOT COUNTY.

Head Waters of Pine River.

HILLSDALE COUNTY.

Perry Creek.

INGHAM COUNTY.

Sycamore Creek.

ISABELLA COUNTY.

Little Cedar Creek.
Cedar Creek.
Big Cedar Creek.
Big Creek.
Skidmore Creek.
Rattail Creek.
Stony Creek.
Ellis Brook.
Chippewa River.
Salt Creek.
N. Branch Little Salt Creek.
S. Branch Little Salt Creek.
Pine River and Headwaters.

IOSCO COUNTY.

Silver Creek.
Cedar Creek.
Wilber Creek.
Sins Creek.
Cold Creek.

IONIA COUNTY.

Arnold Creek.
Calvin Brook.
Mill Brook.
Clear Creek.
Spring Brook.
Stony Brook.

KALAMAZOO COUNTY.

Tributary to Kalamazoo River.
Portage Creek and Brs
Campbell Creek.
Palmer Creek.
Big Portage Creek.
Tributary to Portage Creek.
Hasho Run.
Bear Creek.
Harris Creek.
Comstock Creek.
Four Mile Creek.
Dunning Creek.
Tributary to Kalamazoo River.
Silver Creek.
Carle Creek.
Allerton Creek.
Gull Creek.
Spring Creek.
Pine Creek.
Augusta Creek.
Spring Run.

KALKASKA COUNTY.

Rapid River.
Boardman River.

KENT COUNTY.

Buckardson Creek.
Dopp Creek.
Ball Creek.
Butternut Creek.
Ellis Brook.
Little Cedar Creek.
Spring Creek.
Huron Creek.
Harold Creek.
Hawn Creek.
Bull Creek.
Duke Creek.
Atchinson's Creek.
Cedar Creek.
Indian Creek.
Kellogg Creek.
Sillway Creek.
Callender Creek.
Ball's Creek.
Mill Creek.
Harold Creek.
Bear Creek.
Rathford Creek.
Craneton Creek.
Smith's Creek.
Baker Creek.
Clear Creek.
Crimion Creek.
Duck Creek.
Cedar Springs.
Sand Creek.
Bear Creek.
Outlet to Sand Lake.
Big Cedar Creek.
Crockery Creek, South and West Branches.
Simon's Brook.
Rush Creek.
White Creek.
Boys Creek.
Spring Creek.
Boyer Creek.
Rough River and Tributaries.
Walker Creek.
Kenyon Creek.
Turner Creek.

LAKE COUNTY.

Pies Creek.
Farnsworth Creek.
Howell Creek.
Little Manistee River.
Ram Creek.
N. Branch Pere Marquette.
Sanford Creek.
Sanborn Creek.
Sweetwater Creek.
King Creek.
Trib. to Little Manistee.

LAPEER COUNTY.

S. Branch of Flint River.
Hunter's Creek.

LIVINGSTON COUNTY.

Spring Brook.
Dibble Creek.

LENAWEE COUNTY.

Howell Creek.

MANISTEE COUNTY.

Hatch's Run.
Chief Creek.

MASON COUNTY.

Hatch's Run.
Dun's Creek.
Swan Creek.
Clear Creek.
Kibble Creek.
Quinn Creek.

MECOSTA COUNTY.

N. S. and W. Branch of Big Creek.
Dalzell Creek.
Beaver Dam Creek.
Brockway Creek.
Trib. to Chippewa River.
King Creek.
Buckhorn Creek.
Mitchell Creek.
Mack's Creek.
Parish Creek.
Cold Spring Creek.
Painer Creek.
Bingen Creek.
Cedar Creek.
Foggy Creek.
Brush Creek.
Trib. to California Lake.
Horner's Creek.
Bull Creek.
Muskegon River.
Quigley Creek.
Headwaters of Pine River.
Cheney Creek.
Hudnut Creek.

MONTCALM COUNTY.

Richie Creek.
Pierson Creek.
Tamarac Creek.
Fish Creek.
Allen Spring Creek.
Hemmingway Creek.

MUSKEGON COUNTY.

Duck Creek.
Green Creek.
Crockery Creek and Tributarie.
Coon Creek.
Moon Creek.
Bear Creek.
Buell Creek.
Carlton Creek.
Bear Creek.
Clear Lake Creek.
Black Creek.
Flower Creek.
Green Creek.
Sanford Creek.
Black Creek.

MENOMINEE COUNTY.

Menominee River and Branches.

NEWAGO COUNTY.

Colbough Creek.
Wilcox Creek.
Davis Creek.
West Branch of Pere Marquette River.
Burton Creek.
Bigelow Creek.
Martin Creek.
Wilcox Creek.
Holmes Creek.
Spring Creek.
Robinson Creek.
Four Mile Creek.
Trib. to White River.
Williams Creek.
Spring Creek.
Cole Creek.
Odd Creek.
Robbin's Creek.
Bigelow Creek.
Pennoyer Creek.
Grass Mound Creek.
Warner's Creek.
Brook's Creek.
Four Mile Creek.
Outlet to Bill's Creek.
Whitman Creek.
Cushman Creek.
Dowling Creek.
Davis Creek.
Martin Creek.

OAKLAND COUNTY.

Stony Creek.
Paint Creek.
Mill Creek.
Andrew's Creek.
Sand Creek.

OCEANA COUNTY.

Flower Creek.
Crandall Creek.
Russell's Creek.
Judge Creek.
Wilcox Creek.
Jermain Creek.
McGill's Creek.
Farnum Creek.
Minnie Creek.
Wright Creek.
Pentwater River.

OGEMAW COUNTY.

Prisner Creek.
Farrington Creek.
Eddy Creek.
Kreb's Creek.
Regan's Creek.
Klocking Creek.
Johnson's Creek.
Kelley Creek.
Rouge Creek.

OSCEOLA COUNTY.

Center Fork Middle Br'ch.
Cedar Creek.
Husey Creek.
Twin's Creek.
Bull Kill Creek.
Ranney Creek.
Cat Creek.
W. Branch Clam River.
Crockery Creek.
Tole's Creek.
Turner's Creek.
N. Branch Chippewa River.

OTTAWA COUNTY.

Rio Grande Creek.
Crockery Creek.
Cedar Creek.
Kelley Creek.

ROSCOMMON COUNTY.

North Branch Sugar River.
West Branch Sugar River.
Main Branch Sugar River.

SAGINAW COUNTY.

Allison Creek.
Works Creek.

ST. CLAIR COUNTY.

Tributary to Mill Creek.

ST. JOSEPH COUNTY.

Spring Creek.

SHIAWASSE COUNTY.

Three Mile Creek.

VAN BUREN COUNTY.

Head Waters Paw Paw River.
Loomis Brook.
West Branch Paw Paw River.
Butternut Creek.
Cold Brook.
Spring Brook.
Boy's Spring Brook.
Bay's Creek.

WASHTENAW COUNTY.

Paint Creek.
Mill Creek.
Cross Creek.
Spring Brook.
Mud Creek.
Fellows Creek.
Bond Creek.
Maycon Creek.
Harney Creek.
Spring Creek.
Hoyt's Creek.
Mullets Creek.
Tole's Creek.
Hall's Creek.
Paint Creek.
Bull Creek.

WEXFORD COUNTY.

Sligo Creek.
Cole Creek.
Andrew's Creek.
Trib. to Little Manistee River.
Cedar Creek.
Urwick Creek.

LIST OF FISH COMMISSIONERS.

THE UNITED STATES:
Col. Marshall McDonald, Commissioner, Washington, D. C.
Capt. J. W. Collins, Assistant in charge of Fisheries Division.
Richard Rathbun, Assistant in charge of Scientific Inquiry.
Col. John Gay, Inspector of Stations.

Alabama:
Col. D. R. Hundley, Madison.
Hon. Chas. S. G. Doster, Prattville.

Arizona:
J. J. Gosper, Prescott.
Richard Rule, Tombstone.
J. H. Taggart, Business Manager, Yuma.

Arkansas:
H. H. Rottaken, President, Little Rock.
W. B. Worthen, Secretary, Little Rock.
J. W. Calloway, Little Rock.
(This State has never made an appropriation for fish culture.)

California:
Joseph Routier, Sacramento.
J. D. Harvey, Los Angeles.
(Commissioner T. J. Sherwood resigned March 15, 1888.)

Colorado:
G. F. Whitehead, Denver.

Connecticut:
Dr. Wm. M. Hudson, Hartford.
Robert G. Pike, Middleton.
James A. Bill, Lyme.
(This State has no official superintendent, most of the hatching being done by Henry J. Fenton, Poquonnock.)

Delaware:
Charles Schubert, Odessa.

Georgia:
J. H. Henderson, Atlanta.
(Superintendent, Dr. H. H. Cary, La Grange.)

Illinois:
N. K. Fairbank, President, Chicago.
S. P. Bartlett, Quincy.
Geo. Breuning, Centralia.

Indiana:
Enos B. Reed, Indianapolis.

Iowa:
E. D. Carlton, Spirit Lake.
(Superintendent, Ole Bjorenson.)

Kansas:
S. Fee, Wamego.

Kentucky:
Wm. Griffith, President, Louisville.
P. H. Darby, Princeton.
John B. Walker, Madisonville.
Hon. C. J. Walton, Munfordville.
Hon. John A. Steele, Midway.
W. C. Price, Danville.
Hon. J. M. Chambers, Independence.
A. H. Goble, Catlettsburg.
J. H. Mallory, Bowling Green.

Maine:
E. M. Stillwell, Bangor.
Henry O. Stanley, Dixfield.
B. W. Counce, Thomaston, Sea and Shore Fisheries.

Maryland:
Dr. E. W. Humphries, Salisbury.
G. W. Delawder, Oakland.

Massachusetts:
E. A. Brackett, Winchester.
F. W. Putnam, Cambridge.
E. H. Lathrop, Springfield.

Michigan:
Herschel Whitaker, Detroit.
Joel C. Parker, M. D., Grand Rapids.
Hoyt Post, Detroit.
(Superintendent, Walter D. Marks, Paris.)
(Secretary, Geo. D. Mussey, Detroit.)
(Treasurer, Wm. A. Butler, Jr., Detroit.)

Minnesota:
William Bird, Fairmount.
Niles Carpenter, Rushford.
Robt. Ormsby Sweeny, Duluth.
(Superintendent, S. S. Watkins, Willow Brook, St. Paul.)

Missouri:
H. M. Garlichs, Chairman, St. Joseph.
J. L. Smith, Jefferson City.
H. C. West, St. Louis.
A. P. Campbell, Secretary, St. Joseph.
(Superintendents: Philip Kopplin, Jr., St. Louis; Elias Cottrill, St. Joseph.)

Nebraska:
William L. May, Fremont.
R. R. Livingston, Plattsmouth.
B. E. B. Kennedy, Omaha.
(Superintendent, M. E. O'Brien, South Bend.)

Nevada:
W. M. Cary, Carson City.

New Hampshire:
Geo. W. Riddle, Manchester.
Elliott B. Hodge, Plymouth.
John H. Kimball, Marlborough.
(Superintendent of Plymouth and Sunapee hatcheries, Com. E. B. Hodge.)

New Jersey:
William Wright, Newark.
Frank M. Ward, Newton.
J. R. Elkinton, Pennsgrove,

New York:
E. G. Blackford, President, New York.
Gen. R. U. Sherman, New Hartford.
Wm. H. Bowman, Rochester.
A. S. Joline, Tottenville.
Henry Burden, Troy.
(Secretary, E. P. Doyle, room 56, Fulton Bank Building, New York city.)
(Superintendents: Fred Mather, Cold Spring Harbor; Monroe A. Green, Caledonia; James H. Marks, Bloomingdale; E. L. Marks, Fulton Chain; and E. F. Boehm, Sacandaga, Newton's Corners, N. Y.)
(Shellfish Commission: E. G. Blackford, Commissioner; J. W. Merserau, Oyster Protector, 80 Fulton Market, New York.)

North Carolina:
Wm. J. Griffin, Chairman, Elizabeth City.
J. B. Watson, Englehard.
Wm. T. Caho, Bayboro.

Ohio:
C. V. Osborn, President, Dayton.
A. C. Williams, Secretary, Chagrin Falls.
J. C. Hofer, Bellaire.
John H. Law, Cincinnati.

Ohio—*Continued:*
Hon. Emory D. Potter, Toledo.
(Superintendent, Henry Douglass, Sandusky.)
(Chief Warden, L. K. Buntain, Dayton.)
Oregon:
F. C. Reed, President, Clackamas.
E. P. Thompson, Portland.
R. E. Campbell, Renier.
Pennsylvania:
Henry C. Ford, President, 524 Walnut street Philadelphia.
James B. Long, Corresponding Secretary, 75 Fifth avenue, Pittsburgh.
H. C. Demuth, Secretary of Board, Lancaster.
S. B. Stillwell, Scranton.
A. S. Dickson, Meadville.
Treasurer, W. L. Powell, Harrisburg.
(Superintendents: John P. Creveling, Allentown; William Buller, Corry.)
Rhode Island:
John H. Barden, President, Rockland.
Henry T. Root, Treasurer, Providence.
Wm. P. Morton, Secretary, Johnston.
South Carolina:
Hon. A. P. Butler, Columbia.
Tennessee:
W. W. McDowell, Memphis.
H. H. Sneed, Chattanooga.
Edward D. Hicks, Nashville.
Utah:
A. Milton Musser, Salt Lake City.
Vermont:
Herbert Brainard, St. Albans.
F. H. Atherton, Waterbury.
Virginia:
Dr. J. T. Wilkins, Bridgetown.
West Virginia:
C. S. White, President, Romney.
F. J. Baxter, Treasurer, Sutton.
James H. Miller, Secretary, Hinton.
Wisconsin:
The Governor, *ex-officio.*
Philo Dunning, President, Madison.
C. L. Vallentine, Secretary and Treasurer, Janesville.
Mark Douglas, Melrose.
A. V. H. Carpenter, Milwaukee.
Calvert Spensley, Mineral Point.
E. S. Miner, Sturgeon Bay.
(Superintendent, Jas. Nevin, Madison.)
Wyoming Territory:
Louis Miller, Laramie.

DOMINION OF CANADA:
Hon. John Tilton, Deputy Minister of Fisheries, Ottawa.
(Inspectors of Fisheries for the Dominion of Canada, 1888: A. C. Bertram, North Sydney, C. B., N. S., W. H. Venning, St. John, N. B.; Wm. Wakeman, Gaspe Basin, P. Q.; J. H. Duvar, Alberton, P. E. I.; Thomas Mowat, New Westminster, B. C.; Alex. McQueen, Winnipeg, Man.)
(Officers in charge of the Fish Breeding Establishments: S. Wilmot, Superintendent of Fishculture, Newcastle, Ont.; Chas. Wilmot officer in charge, Newcastle hatchery, Ont.; Wm. Parker, Sandwich, Ont.; L. N. Cattellier, Tadoussac, Q.; Philip Vibert, Gaspe, Q.; A. H. Moore, Magog, Q.; Alex. Mowat, Ristigonche, Matapedia, P. Q.; A. B. Wilmot, Bedford, N. S.: C. A. Farquharson, Sydney, N. S.; Isaac Sheasgreen, Miramichi, N. B.; Charles McCluskey, St. John River, Grand Falls, N. B.; Henry Clark, Dunk River, P. E. I.; Thos. Mowat, B. C. hatchery, New Westminster, B. C.)