THE HARVARD EMBRYOLOGICAL COLLECTION.[1]

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The collection of serial sections of embryos in the Embryological Laboratory of the Medical School has now grown to sufficient size to render clear the scope of the collection, and to enable us to form some estimate of its usefulness in facilitating study and promoting research. At this date it comprises nine hundred and thirty-seven series. The plan which has been followed was drawn up in 1895, and its execution was begun in January, 1896, and since that time work on the enlargement of the collection has been unremitting, although, of course, many other duties had to receive attention in the laboratory; the preparation of serial sections being only one of the things to be attended to in the course of the regular work. Our means have not hitherto permitted us to employ assistance which should be devoted exclusively to the development of the collection. In spite of these difficulties, however, the actual achievement may, I think, be regarded as encouraging.

A preliminary statement of the plan of the collection was published in the Anatomischer Anzeiger, pages 128, 129, of Vol. XVIII. (1890).

The collection is intended to afford large facilities for the study of the embryology of vertebrates as represented by a certain number of carefully selected types. In choosing these it was, of course, necessary to pay considerable attention to the very practical question of whether material could be obtained readily and abundantly or not. Originally eighteen types were selected, and since then four have been added, making a total of twenty-two. It seems probable that ultimately other types will be included. Especially desirable would be Myxine, a dipnoan, an insectivor, and a monkey. The present list is as follows:

[1] Received for publication June 29, 1905.

AMNIOTA.	ANAMNIA.
Man.	Rana.
Cat.	Amblystoma.
Rabbit.	Necturus.
Pig.	Lepidosteus.
Sheep (not yet begun).	Amia.
Opossum.	Ameiurus.
Chick.	Salvellinus.
Lacerta.	Batrachus.
Chrysemis (not yet begun).	Torpedo.
Eutænia (not yet begun).	Squalus.
	Petromyzon.
	Amphioxus.

It should be mentioned that in addition to our regular types we have a few others represented by a few series which have been prepared in connection with special researches. Such supplemental forms are the dog, guinea-pig, Caluromys, Torpedo marmorata, Raja clavata, and Scyllium canicula. The number and variety of these series will doubtless increase hereafter.

The plan is, further, to obtain of each of these typical species a complete series of embryos, to select systematically graded stages, and of each stage, so far as possible, three identical embryos. The three specimens thus picked out are intended to be cut into serial sections, one embryo transversely, the second sagittally, and the third frontally. By this means views of the structures in the embryo, according to the three planes of space, can be obtained, and at the same time there is the advantage of some indication of the variations which occur from embryo to embryo in a given stage. In order to carry out this plan it has been indispensable to resist the frequently recurring temptation of cutting up a fine embryo, which did not fit into the scheme adopted, for this would delay indefinitely the completion of the plan. Series of sections, gotten up according to this scheme, may be regarded as normal series, illustrating the development of a particular type, and through that type the development of

the class to which it belongs. The various forms selected can be compared with one another, and thus there is always on hand material for comparative investigation. It is evident that such a collection as this could not answer for all the requirements of research, but serves well to enable one to make a preliminary study of the development of any organ or tissue, to find out exactly at what stages changes may be occurring which it is desired to investigate more closely, and to give more or less information as to the nature of those changes. In actual practice it has been found, and will surely continue to be found, necessary to make many special preparations for special purposes, or to follow out certain details of modification, which may not be well illustrated with the material in hand, or which can be better brought out by other methods of preservation and of staining than those used for the specimens in the collection. In spite of all these limitations, however, the collection has proved itself already of substantial use for purposes of embryological research. So far as I am aware, no other collection of this kind has yet been attempted. There are, of course, in the possession of various individuals, and in a few laboratories, collections of serial sections of embryos of considerable size and great value, but unless I am mistaken the Harvard collection is the only one which was planned to be perfectly systematic, and which has been actually built up on the system originally proposed. In practice the system has been slightly departed from in certain cases, where the material at hand rendered this indispensable. This is chiefly the case with the series of human embryos, now 42 in number, for obviously the embryos of the human species must be taken as they are obtained, and cannot be selected as they are desired.

The collection is intended to become a sort of a cyclopedia of vertebrate embryology to which one can turn at any time and get the desired information as to the principal features of development of any structure whatsoever. It is hoped, therefore, that the laboratory will be regarded as a useful central place to which persons may come who are

seeking embryological information, or who desire for the completion of their original researches the use of a larger material than they could command by their own individual unaided efforts. In a collection so extensive as this has now become, there is abundance of material for many workers, and there is never likely to be any great clashing of interests in the use of the specimens. It is with pleasure that I note that several professors of other universities have already utilized the opportunities which we are able to place at their disposal, and it is hoped that the number of these will increase from year to year. The most liberal policy in this regard is surely for the best interests of all, and best calculated to promote the higher interests of science.

It is evident that, as a rule, the collection must remain in the laboratory and be used there, for its usefulness for reference and study would be impaired if the specimens which are needed cannot be found at hand. To a limited extent, perhaps, the practice may be accepted of sending specimens to workers elsewhere, and this has been done, opossum material having been sent to Prof. C. F. W. McClure, of Princeton, and material for the study of the development of the human jaw sent to Prof. Edward Fawcett, of University College, Bristol, Eng. At the end of this article will be found a list of published researches which have been based chiefly, or in part, upon the collection. It is pleasant to note much generous assistance which has been given us, especially in the way of aid in getting the material. The laboratory has been specially indebted in this respect to Prof. S. H. Gage, of Cornell, for specimens of the lamprey; to Prof. R. G. Harrison, of Baltimore, for lizard embryos; to Professor McClure, of Princeton, for opossum material; to Prof. Anton Dohrn for a fine set of torpedo embryos; to Prof. A. C. Eycleshymer, of St. Louis University, for various material; to Prof. W. A. Locy, of Northwestern University, for necturus; to Prof. Karl Peter, of Breslau, for lacertas; to Professor Dendy for several sphenodons, and to several other generous friends. Our human embryos we have received chiefly from practitioners in Boston and the neighborhood, to all of whom our

most sincere thanks are due. Among these human embryos are some of the very finest, and scientifically most valuable, which have been as yet obtained for scientific study. A gift of two hundred dollars from Dr. Walter G. Chase enabled us to employ aid, which contributed very much to the growth of the collection.

It seems desirable to describe some of the technical methods used in the preparation and cataloguing of the series.

With regard to fixation of the specimens we have contented ourselves with employing the standard reagents. Of these, the three which we have found most useful are Zenker's fluid, a saturated solution of corrosive sublimate, and ten per cent formalin. Zenker's fluid has proved very satisfactory for the embryos of all the Amniota and for the young stages of Amphibia and fresh water fish. It cannot, however, be used with very large specimens, as it has no great penetrating power. It does not work satisfactorily with the embryos of salt water fishes. For these we have found the saturated solution of corrosive preferable. Even better results are obtained, according to our experience, with the embryos of Elasmobranchs when five per cent of glacial acetic acid is added to the corrosive. This aceto-corrosive mixture has been very satisfactory also with reptilian embryos. For larger specimens we consider ten per cent formalin preferable to everything else which we have tried, and the results of this reagent have far surpassed our expectations, for we have even observed fairly good karyokinetic figures in material preserved with it. It is the only reagent with which we have obtained even tolerable preservation of the more advanced stages of the opossum, although the early development of the epitrichium and horny layer in this species prevents the penetration of the ordinary preservatives except in very early stages. Formalin we use almost exclusively for human embryos. It is easy for a practitioner to obtain this mixture, or to make it when he secures a human embryo, and its use being so very simple, this reagent finds favor among physicians in general practice. Formalin specimens

contract when transferred to alcohol, but this contraction may be largely reduced by putting the specimens in Müller's fluid for forty-eight hours before placing them in alcohol.

It seems not to be really necessary to wash the specimens which are preserved in Zenker's fluid. All of our embryos are transferred gradually to alcohols of increasing strength, but they are never put in alcohol of greater than eighty per cent until just before they are cut, when they are transferred to ninety-five per cent alcohol for twenty-four hours to harden them. I consider the use of stronger than eighty per cent alcohol for permanent preservation of embryos very undesirable. In the case of older embryos it causes a shrinkage, and in the case of all embryos it is apt to make a true final hardening, for the purposes of embedding, difficult or even impossible.

For the storing of embryos a convenient method has proved to be the use of a combination of small vials and large jars. A single museum jar is used for one species only, and is labelled accordingly. The embryos are sorted according to stages, methods of preservation, etc., in cylindrical vials, which have flat bottoms, so that they will stand upright, and straight sides (Fig. 1). The size we have used most measures sixty millimeters in height by twenty millimeters in diameter. Vials with mouths narrowed are excessively inconvenient. The vials are closed with plugs of absorbent cotton. When necessary a slip of paper, bearing memoranda concerning the specimens in a vial, is put in alongside the plug of cotton, by which it is held in place. The writing on the slip is turned towards the outside of the vial, so that it can be read without displacing it or disturbing the specimens. Data are written with a lead pencil, but when a more permanent record is desired it is better to use Higgins's waterproof ink. A dozen or more vials may be kept together in a single jar.

In regard to the selection of stages we have had, of course, in the case of each new form to proceed somewhat arbitrarily, but experience has shown that so soon as the embryo is sufficiently advanced for its length to be measured, one may say that an addition of one-fifth or one-sixth to the length

corresponds to a sufficient advance in development for the embryo to be said to have passed into a new stage. At the same time such an increase in length does not bring about so great an alteration of structure as to render it difficult to trace the nature of the change which has gone on. On the other hand, it is occasionally necessary for some special study to have the stages closer than this, but the stages, arbitrarily fixed by the rule indicated, we have found by experience to be sufficiently close to one another to afford command of the whole course of development. As stated above, we have endeavored to procure of each of these stages three specimens alike in length, but we have learned that it is also very desirable to get them as nearly as possible alike in form and external proportions. If this is done the internal development is usually very much the same in the three representatives of a given stage. If, on the other hand, we have three embryos, say of a pig, which are of the same length measured from the vertex to the tail, but differ from one another in external form, we shall find that they vary considerably in their internal organization.

It is desirable to have a drawing or a photograph of every embryo which is sectioned. In practice we rely chiefly upon drawings, but we think photographs would be preferable, and we should have made them were it not that photography in our present cramped quarters is so inconvenient. When we move into our new laboratory we hope to substitute photography for the drawings upon which we depend at present.

Almost all of our specimens have been stained in toto before they were embedded, the stains upon which we have chiefly relied have been alum cochineal and borax carmine. At first we contented ourselves with a single stain, but we now habitually employ a counter stain as well, the three chief counter stains which we use being orange-G, Lyons blue, and eosine. We consider borax carmine and Lyons blue a particularly useful combination. It sometimes happens that the cochineal or carmine stain is too faint, and in such cases our practice has been to stain the sections on the slide with

saffranine. Occasionally, but not often, we have stained a series with Haidenhain's iron hematoxyline, counter staining with orange-G.

It is important to have uniform rules for the making of sections so that they may be in similar orientation in all the series. To accomplish this our series have nearly all been cut according to the following directions:

DIRECTIONS

FOR CUTTING SERIAL SECTIONS OF EMBRYOS.

(NOTE. The lower edge of the ribbon is the one to the left, when the observer has the object between himself and the knife.)

1. Transverse Series:

   Normal thickness.....10 μ.

   Dorsal surface to be towards the lower edge of the ribbon.

   Series to begin with the head.

   In cutting, the left side of the embryo must strike the knife first.

2. Sagittal Series:

   Normal thickness. Small embryos.....10 μ.
   Medium embryos .....15 μ.
   Large embryos.....20 μ.

   The head of the embryo to be towards the lower edge of the ribbon.

   Series to begin with the right side.

   In cutting, the ventral side of the embryo must strike the knife first.

3. Frontal Sections:

   Normal thickness. Small embryos.....10 μ.
   Medium embryos .....15 μ.
   Large embryos .....20 μ.

   The head of the embryo is to be towards the lower edge of the ribbon.

   The series is to begin with the ventral side.

   In cutting, the left side of the embryo must strike the knife first.

   MOUNTING:

   Leave space for the label at the left hand end of the slide. Keep the sections in the order cut. Arrange them on the slides in the sequence of ordinary written lines. Care must be taken to make the rows of sections as straight as possible.

All of our series are mounted on slides, forty by seventy-six millimeters, and we now insist upon the slides being from 1.8 to 2 millimeters thick. The thin slides, which have so long been favorites, are very fragile and often get broken. The thicker slides are much less subject to accident, and have

no disadvantages, so far as I know, except that of not permitting the use of a very short focussed condenser with the microscope. This disadvantage seems to be more theoretical than real. The size of slide adopted was chosen after considerable deliberation, and seems to me, on the whole, to be the most convenient for such series as we have gathered. On this slide we use a standard size of cover-glass, one measuring thirty-five by fifty millimeters. The sections are mounted so as to leave one end free for the label, which is placed as shown in the accompanying figure (Fig. 2). On this label the name of the species, direction, and thickness of the sections and their staining are recorded. The label also carries the number of the series and a letter to indicate the position of the slide in the series. This is merely for facilitating the quick arrangement of the slides in cabinets. And finally, the label indicates the numbers of the sections, there being recorded for each row of the sections the number of the first and of the last section in that row. This makes it very easy to determine quickly by counting from either end of the row the exact number of any section in the series. In order to have permanent labels we use for writing either Stevens's blue-black writing fluid or Higgins's waterproof ink. I prefer the former.

When researches are published, in which any figures are given, taken from any of our sections, we require that the number of the series and the number of the section should be given, together with the figure. In this way the original evidence of the author's observation can be quickly found, and his statements easily verified. In consequence of this rule the collection is becoming more and more comparable to a collection of types, such as systematic zoölogists value so highly. It is to be hoped that this practice will extend to other laboratories, so that the custom may become general of preserving in each institution, in a readily accessible form, the material which has served as the basis for researches, thus rendering permanently possible the after verification of the actual observations. Certainly no investigator will work less accurately because he knows that his specimens may be

restudied by his successors in order to test the reliability of his observations.

In regard to the cataloguing it is only to be remarked that we have of course a double catalogue. First, a book in which each series is entered in numerical order. For each series the following data are entered: the species, size, age, locality, drawing, nature of the sections, date of preservation, date of sectioning, method of preservation, staining, mounting. There is also a column for special remarks. Second, there is a card catalogue in which the series are grouped first, according to species; second, according to the stage; and third, for each stage according to the plane of section, the order being always for each stage, transverse series first, sagittal second, frontal third. The arrangement of the series in the cabinets agrees with the card catalogue, following precisely the same order, so that by consulting the card catalogue it may be seen at once precisely what material we have of any given animal, and the position of the card indicates also the position of the series in the cabinet.

In regard to the storing of the series a few words may be added. We have tried both the small wooden slide boxes, and also the pasteboard trays, which are stacked together and kept in boxes, the latter of the type so much used in Germany, but neither of these have we found convenient. For several years we relied upon wooden cabinets with small trays, which could be pulled in and out, but these cabinets even when they are made with great care are not wholly satisfactory, because no method has yet been devised of making the trays simply and cheaply, yet in a form in which they will not warp. By far the best trays, however, which we have succeeded in getting are those which are made of California redwood. These hold very well, and change their shape so slightly that they go out and in their places quite smoothly, which is more than we can say of trays made of any other wood which we have tried. But there is another objection also to wooden cabinets — the danger from fire. If a fire should once start in them, it might easily destroy the entire collection. Another objection

to wooden cabinets is that the wood forms a cloudy deposit on the surface of the glass slides. If the preparations are left for several months it becomes necessary to clean off the slides and cover-glasses to render them fit for microscopic examination. These considerations have led us to adopt a metal cabinet, which has been specially devised for our needs. It is made of sheet tin in such a manner that the trays are very compact, are absolutely interchangeable, and take up a minimum amount of room. The construction adopted is such that the tendency to warp is entirely done away with (Fig. 3) The trays are all japanned so that they do not rust, and we slip a bit of white paper into each tray to make a background for the sections. Each tray is, moreover, furnished with a little label holder, and they are put together in cabinets of thirty trays each, the trays themselves being of such a size that they will hold twenty-four of the ordinary slides, three inches by one. Moreover, the cabinets themselves are so devised that they can be stacked one on top of another, taking up a minimum amount of room. We devote a vertical column of these cabinets to a species, and simply interpolate from time to time a new cabinet in the column as the growth of the collection may render necessary. The cabinets are made by Peter Gray & Co., of Union street, Boston, and are now kept in stock by several of the dealers in microscopical supplies in this country. They cost only a trifle more than the wooden cabinets, and are, according to our trial of them, certainly to be preferred to any other form of cabinet which we have tested.

The account of the Harvard Embryological Collection would be incomplete without a word of appreciative acknowledgment of the zealous aid given by the members of the laboratory staff. This is especially due Dr. Alfred Schaper, now professor at Breslau, who coöperated very extensively in the foundation and early development of the collection, and to three of our present members, Drs. J. L. Bremer, F. T. Lewis, and E. Taylor. All of these gentlemen have used the collection for important investigations which they have made.

The following tables show the present extent of our collection. They are so arranged as to be self-explanatory. For each species there are four columns. The first gives the length or age. The second is for the transverse series, the third for the sagittal, the fourth for the frontal series. The numbers are the numbers of the series. Thus, in the first table of human embryos, the second specimen is an embryo of four millimeters in length. It was cut into transverse sections, and the series was entered as Number 714. It will be noticed that the most nearly complete set of series which we have is of Torpedo ocellata. With very few exceptions all our series up to the present are of embryos not of the earlier stages, which it is hoped will be added later.

Certain of our human embryos deserve special mention.

The youngest specimen we have furnished Series 825. The embryo is in a good state of preservation and is in the stage just before the formation of the medullary plate. The chorionic vesicle was received intact, and measured without the villi 7 by 8 by 11.5 millimeters. A description of this embryo for publication has been undertaken by Dr. F. T. Lewis. It is the youngest stage which I personally have ever had the opportunity of examining, and it belongs among the half dozen youngest human embryos known.

A fine embryo of four millimeters has furnished Series 817. It was preserved in formalin and exhibits good karyokinetic figures. So far as the condition of the embryo itself indicates, the specimen is normal, but it differs in many respects from the few human embryos of this size which have been hitherto described. The anterior neuropore is wide open, and the caudal end of the spinal cord is still in the stage of the medullary plate. It shows very striking peculiarities, by which it differs from the other human embryos of this size which have heretofore been studied. The question arises whether this embryo is really not more normal than the others. It will form the subject of a monograph by Dr. J. L Bremer. He has just completed wax plate reconstructions of all the more important parts.

The following five embryos are all normal specimens in

first-class condition, which have yielded exceptionally fine series:

Embryo of	8	mm.	Series 817.
	12		816.
	13.6		839.
	23		181.
	22.8		737.

The two embryos last mentioned represent the stage at the end of about two months. Series 181 consists of sagittal sections and Series 737 of frontal sections. The brain of this last is being investigated by Dr. Ewing Taylor. It is one of the finest embryonic mammalian brains which I have ever seen, so far as the perfection of its preservation goes and the clearness with which the various parts have been differentiated by the stain, in this case borax carmine and Lyon's blue.

Another embryo also good, but not quite in perfect condition, measured 10.2 millimeters, and now exists in sagittal sections as Series 736.

HARVARD EMBRYOLOGICAL COLLECTION (June 16, 1905).

Includes Series 1–937 (Nos. 278–287 omitted from Catalogue. Total number of series =).

HUMAN.

Length.	Age.	Transverse.	Sagittal.	Frontal.
1.0	. . .	825		
4.0	. . .	714		
7.5	. . .	256		
8.0	. . .	. . . . .	. . . . .	817
9.2– 9.4	. . .	529		
		734		
10.2–11.5	. . .	189	736	
12.0	. . .	. . . . .	. . . . .	817, 818[1]
13.6	. . .	839		
19.0	. . .	819		
21.0	. . .	744		
				737
21.8–24.0	. . .	B. 38	181	H. 24
		192[2]		
29.0	. . .	871	851	852
				914
32.0	. . .	H. 648	H. 290	H. 291
		B. 649	292	
		193[3]	194[4]	
37.0	. . .	820		
42.0	. . .	B. 838, H. 841		
78.0	3 mos.	. . . . .	722[7]	720[5]
			723[8]	721[6]
			724[9]	
			725[9]	
	4 mos.	. . . . .	728[10]	
			729[11]	
			730[12]	
	5 mos.	727[10]		

[1] 818, yolk sack only.
[2] 192, yolk sack only.
[3] 193, left foot.
[4] 194, right foot.
[5] Face only.
[6] Vertex of head.
[7] Neck and base of head.
[8] Thorax.
[9] Abdomen.
[10] Penis only.
[11] Finger only.
[12] Toe only.
[13] Head horizontal.

CAT.

Length.	Transverse.	Sagittal.	Frontal.
Very early.	411	412	451
Very early.	413		
Very early.	415[1]		
Very early.	452		
4.6	398	405	
5.2	379		
6.2	380	397	395, 396[1]
9.7	446	447	448
10.6–10.7	474	475	476
12.0	399, H. 403	400	404
15.0	436	437	438
17.0	. . . . .	492	
23.0–24.0	466	467	468
31.0–32.6	500	527	505
39.0	H. 360	H. 368	
	B. 361	B. 394	B. 289
50.0	195[2]		

[1] 415, 396, oblique. [2] 195, right hind foot.

DOG.

Length.	Transverse.	Sagittal.	Frontal.
12.5	178	179	180

RABBIT.

Age.	Transverse.	Sagittal.	Frontal.
6.5 days.	625		
7.0 "	4		
	12		
	13		

RABBIT. — *Continued.*

Age.	Transverse.	Sagittal.	Frontal.
	14		
	15		
	217		
7.5 days.	622		
	188		
	253		
8.0 "	182		
	169		
	257		
	271		
8.5 "	624	573	
	650		
	571	572	
9.0 "	619	570	569
	709		
	620		
	621		
9.5 "	568		
	565	567	566
	623		
10.0 "	562	564	563
10.5 "	559	561	560
11.0 "	566	558	557
11.5 "	553, 821, 822, 823	555	554
12.0 "	104	147	105
	146	. . . . .	148
			461
12.5 "	149	150	151
			460[1]
			454[2]
13.0 "	1	153	154
	152	. . . . .	465[3]
	498		
14.0 "	155	156	157
14.75 "	143	142	141

RABBIT. — *Continued.*

Age.	Transverse.	Sagittal.	Frontal.
15.0 days.	158	159	160
16.0 "	161	162	163
16.5 "	574	575	576
17.0 "	164	165	166
	738		
18.0 "	167	168	169
	H. 238[4]	. . . . .	H. 237
20.0 "	170	171	172
	710[5]		
21.0 "	H. 235		
			H. 238
			H. 236

[1] 460, transverse of renal region.
[2] 454, transverse of pelvic region.
[3] 465, plane symmetrical through pelvic region.
[4] 238, horizontal.
[5] 710, abdomen only.

RABBIT IN UTERO.

Age.	Transverse of Uterus.
8.0 days.	3
9.0 "	2
	37
	220
9.75 "	216
10.5 "	199
11.0 "	200
12.0 "	190
13.0 "	218[1]
	222
14.0 "	381
16.5 "	510

[1] 218, horizontal of placenta.

GUINEA-PIG.

Length.	Transverse.	Sagittal.	Frontal.
Blastocyst.	33		
8.0	770		

PIG.

Length.	Transverse.	Sagittal.	Frontal.
5.5	915	916	917
6.0	9 / 918	919	920
7.0	35	11	10
7.2	34		
7.5	. . . . .	756	
7.8	428	429	430
9.0	52 / 36	53	54
10.0	402	414	401
11.0	. . . . .	8	
12.0	5	7	6
	518		
14.0	65	66	67
15.0	135		
17.0	51	50	39
18.5	. . . . .	. . . . .	130[1]
20.0	59	60	61
	H. 542	. . . . .	H. 40
24.0	62	63	64
	22[2]		
32.0	H. 72	H. 73	
	B. 136[3]	. . . . .	H. 74
45.0	. . . . .	. . . . .	H. 713

[1] 130, kidney region only.
[2] 22, " " "
[3] 136, pelvic end only.

DIDELPHYS VIRGINIANA.

Length.	Transverse.	Sagittal.	Frontal.
Blastocyst.	835		
7.5	924		
8.0	. . . . .	718	
10.5	614		
11.0	925		
11.5-12.0	613	616	617
12.5	. . . . .	. . . . .	618
13.0	921	922	923

CALUROMYS.

Length.	Transverse.	Sagittal.	Frontal.
17.0	706		
	707		
18.0	708		

CHICK.

Stage.	Transverse.	Sagittal.	Frontal.
1 segment.	373	374	
1 "	626		
1 "	627	628	
3 segments.	629	630	
4 "	631		
5 "	632	633	634
6 "	367	366	372
	635	637	638
	636		
7 "	639	640	641
	510		
8 "	642	643	644
9 "	645	646	647
10 "	42	43	

CHICK. — *Continued.*

Stage.	Transverse.	Sagittal.	Frontal.
43 hours.	89	90	91
	521		
46 "	520	93	94
	551		
	552		
	92		
68 "	95	96	97
	502		
72 "	. . . . .	511	
90 "	. . . . .	512	
		513	
96 "	98	99	100
4.5 days.	482	477	478
5.0 "	526	472	483
5.5 "	. . . . .	272 [1]	
5 dys., 14 hrs.	. . . . .	267 [2]	
5 " 16 "	H. 343		
	B. 344		
5 " 18 "	H. 484	H. 470	H. 345
	B. 485	B. 471	B. 346
6 "	258	491	
	H. 486	H. 479	H. 488
	B. 487	B. 480	B. 489
		B. 254	
7 "	H. 358	H. 354	H. 356
	B. 359	B. 355	B. 357
8 "	H. 365	H. 264	H. 364
		H. 469	B. 755
	B. 321	B. 265	B. 276
8 days, 1 hr.	. . . . .	493	
9.0 days.	H. 303	H. 349	H. 275
	B. 299	B. 266	B. 274
10.0 "	. . . . .	H. 473	H. 481
21.5 "			
11 "	. . . . .	H. 516	H. 517
	B. 255	B. 259	

CHICK. — *Continued.*

Stage.	Transverse.	Sagittal.	Frontal.
	260 [3]	261 [3]	
34.0	. . . . .	H. 499	H. 504
43.0–45.0 mm.	. . . . .	H. 509	H. 514
	B. 408		
54.0 mm.	. . . . .	H. 515	
60.0 "	. . . . .	H. 528	
65.0 "	. . . . .	. . . . .	H. 519

[1] 272, oblique.
[2] 267, cloacal region only.
[3] 260 and 261, foot only.

LACERTA.

(*Includes L. agilis, muralis, and vivipara.*)

Transverse.		Sagittal.		Frontal.	
Series.	*Length.*	*Series.*	*Length.*	*Series.*	*Length.*
605	1.6 mm.	606	1.8 mm.	890	1.6 mm.
892	1.5 "	. . . . .		893	1.8 " (oblique).
888	1.6 "				
889	1.9 "	891	2.0 mm.	898	2.0 mm.
607	2.2 "	899	2.6 "		
41	4.0 "				
897	1.6 "	895	1.8 "	896	2.0 "
894	1.8 "	901	2.0 "	900	1.6 "
909	1.8 "	908	1.9 "		
591	3.4 "	592	3.4 "	612	4.0 "
611	3.1 "	. . . . .		593	?3.4 "
907	2.0 "	903	2.0 mm.		
905	2.2 "	904	2.0 "	910	1.9 "
589	2.4 "				
902	2.4 "	906	2.4 "		
868	2.4 "	590	2.4 "	869	2.7 "
864	3.0 "	865	3.2 "	866	2.8 "
867	3.8 "				

LACERTA — *Continued.*

Transverse.		Sagittal.		Frontal.	
Series.	*Length.*	*Series.*	*Length.*	*Series.*	*Length.*
608	3.2 mm.	609	3.6 mm.	610	3.6 mm.
855	3.8 "				
856	4.0 "	857	4.0 "		
494	3.6 "	495	3.6 "	496	3.8 "
858	4.8 "	859	4.5 "	860	4.5 "
861	4.6 "	862	4.2 "	863	4.4 "
506	4.0 "	507	4.0 "	508	4.0 "
726	5.0 "	733	5.0 "	731	5.0 "
853	5.2 "	. . . . .		854	5.2 (Special.)
827	6.4 "	. . . . .		815	6.4 mm.
813	6.4 "	814	6.4 mm.		
812	7.4 "	. . . . .		811	7.4 "
		810	7.8 mm.		
809	7.6 "				
602[1]		603[1]		604[1]	

[1] Length of head only, 5.0 mm.

AMBLYSTOMA PUNCTATUM.

Length.	Transverse.	Sagittal.	Frontal.
2.0	175		
	423		
	424		
	425		
2.5	174	297	296
4.5	298	307	
			310
6.0	306	183	184
8.0	173	187	185
	305		
10.0	667	669	670
12.0	664	665	666
15.0–15.4	662	663	668
18.0	657	658	659
23.0	660		
25.0–26.0	654	655	656
33.5	651	652	653

RANA VIRESCENS.

Length.	Transverse.	Sagittal.	Frontal.
5.5	322+a	323+a	324+a
6.0	325	326	327+a
6.5	328	329	330
7.0	331	332	333
7.5–7.6	312	313	314
7.8	300	301	302
8.0	334	335	336
8.5–8.6	315	316	317
9.0	308	311	309
9.5–9.6	318	319	320
		319a	

NECTURUS MACULATUS.

Length.	Transverse.	Sagittal.	Frontal.
Egg.	124		
Egg.	126		
Egg.	127		
Egg.	125		
Egg.	128	129	
Egg.	133	134	
Egg.	131	123	
7.0–7.4	44	46, 840, 870, 911, 912	45
10.0	268	269	

NECTURUS MACULATUS. — *Continued.*

Length.	Transverse.	Sagittal.	Frontal.
	270		
12.0	47		
12.0	48	49	
12.4	. . . . .	674	
12.4	. . . . .	675	
13.0–13.4	594	595	
15.0	78	79	80
16.5–17.5	539	540	541
18.0	16	23	84 850
19.0–19.2	530	531	532
21.0	81	82	83
23.2–24.0	533	534	535
26.0	376	377	378
29.6–31.4	536	537	538

AMIA CALVA.

Length.	Transverse.	Sagittal.	Frontal.
7	17	88	
	18		
10	19		
	20	21	
13.0	55	56	57
16.0	68	59	70
19.0	75	76	71
19.0	. . . . .	219	77
22.0–23.0	340	341	342
26.0–27.0	337	338	339
32.0	273	262	263

LEPIDOSTEUS OSSEUS.

Length.	Transverse.	Sagittal.	Frontal.
8.0	350 886	351	352
9.0–9.4	348		
	937		
12.0	928		
14.5	929		
15.0	887		

AMIURUS.

Length.	Transverse.	Sagittal.	Frontal.
6.0	25	26	
	27		
9.0	85	86	87
10.0	387	388	389

SALVELLINUS FONTINALIS.

Length.	Transverse.	Sagittal.	Frontal.
9.0	497		
10.0	522	458	459
11.0	523	524	525
11.2	453		
12.0	455	456	457
13.0	385	445	443
	386		
	442		
14.0	431	432	433
15.0	439	440	441
16.8	434	450 449	435
18.0	596	597	598

SALVELLINUS FONTINALIS.—*Continued.*

Length.	Transverse.	Sagittal.	Frontal.
19.0	599	600	601
20.0	586	587	588
21.0	583	585	585
23.0	577	578	579
25.0	580	581	582

BATRACHUS TAU.

Length.	Transverse.	Sagittal.	Frontal.
3.0	108		
3.5	106	107	
5.0	109	110	
	111		
6.5	112	113	
	114		
8.0	115	116	
	117		
9.5	118	119	
	120		
11.0	121	122	
	123		
23.0	140	144	145

TORPEDO OCELLATA.

Length.	Transverse.	Sagittal.	Frontal.
Segmentation			
Blastoderm.	661	878	
	877	880	

TORPEDO OCELLATA.—*Continued.*

Length.	Transverse.	Sagittal.	Frontal.
	879	882	
	881		
0.8– 1.0	842	843	
1.2– 1.4	826	837	
		847	
		834	
1.6– 1.8	836	829	833
		832	
2	102		
	101	103	
2.1– 2.3	244 824 831 844 846	243 830 845	
2.8– 3.0	842	761	767
	764		
3.2	241	240	
4.0	765	762	768
4.8– 5.0	766	763	769
5.8– 6.0	874	873 875	872
6.7	. . . . .	876	
7.2	700	701	702
8.0	. . . . .	848 849	
8.2– 8.5	697	698	699
9.2	694	695	696
10.0	691	. . . . .	693
12.8	688	689	690
16.5–17.0	735	686	687
19.0–19.5	682	683	684
22.2	679	615	681
24.0–25.0	676	677	678
27.7–28.2	671	672	673
32.0	758	680	715
37.0–37.4	757	716	719
41.0–43.0	760	717	
51.5–52.0	732	711	712

TORPEDO MARMORATA.

Size.	Transverse.	Sagittal.	Frontal.
9.3	. . . . .	926	927

RAJA CLAVATA.

Length.	Transverse.	Sagittal.	Frontal.
57.0	58		

ACANTHIAS, SQUALUS.

Length.	Transverse.	Sagittal.	Frontal.
1.0	288	490	
	741		
	742		
	503		
2.0	277		
2.5–2. 6	304		
	739		
	743		
2.75	462		
3.5	463	747	
	740		
4.0–4. 5	464	745	
	930	931	
	750		
5.0	213	214	215
			746
6.0	293	294	295
7.0–7.6	751	748	

ACANTHIAS, SQUALUS.—*Continued.*

Length.	Transverse.	Sagittal.	Frontal.
	933	749	
8.0–8.6	209	210	212
	934	. . . . .	935
		211	
9.0	937	936	
11.5	206	208	207
13.0	223	224	226
		225	
15.0	227	228	230
		229	
18.0	203	204	205
19.0	137	138	139
22.0–22.5	197	231	201
28.0	232	233	221
		234	
34.0	202	362	186
37.0	363	176	353
40.0–41.5	369	B. 419	371
		370	
50.0	. . . . .	B. 418	
50.0	. . . . .	H. 444	
60.0	. . . . .	H. 427	B. 409
70.0	. . . . .	H. 421	
86.0	. . . . .	H. 426	B. 410

SCYLLIUM CANICULA.

Length.	Transverse.	Sagittal.	Frontal.
1.0	753		
2.0	375		
	754		
7.0	. . . . .	390	

PETROMYZON PLANERI.

	Transverse.	Sagittal.	Frontal.
Stage A.	805	806	
" B.	788	789	790
" C.			
" D.	782	783	784
" E.	800	801	802
" F.	794	795	796
" G.	803	804	
1.8 mm.	785	786	787
2.3 "	779	780	781
2.7 "	791	792	793
3.0 "	382	383	384
	392	391	
3.2 "	797	798	799
4.75 "	776	777	778
5.5 "	771	772	773
6.8 "	774	775	807
7.0 "	28		
	29		
7.5 "	759	808	

PETROMYZON FLUVIATILIS.

Length.	Transverse.	Sagittal.	Frontal.
24.6	246		
27.6–27.8	. . . . .	247	248
37.0	249		
40.0–42 0	. . . . .	250	251
46.0	252		
73.0	245		
92.0	H. 420	H. 393	H. 416
	B. 422	B. 406	B. 417
		B. 407	
115.0	. . . . .	191	
150.0	198		
185.0	. . . . .	. . . . .	177

AMPHIOXUS LANCEOLATUS.

Length.	Transverse.	Sagittal.	Frontal.
7.5	548	549	550
9.0	543	544	
10.0	545	546	547
11.5	30	31	
	32		
15.1	703		
17.2	704		
19.0	705		

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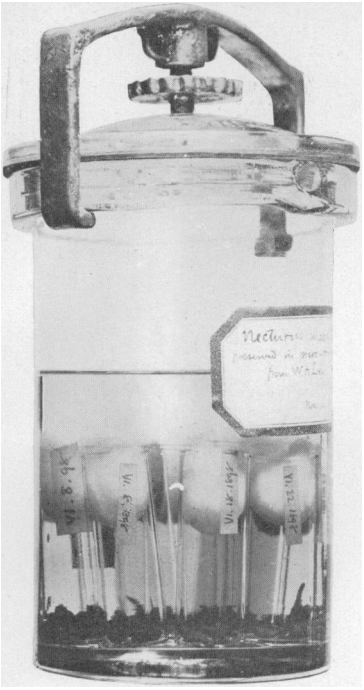

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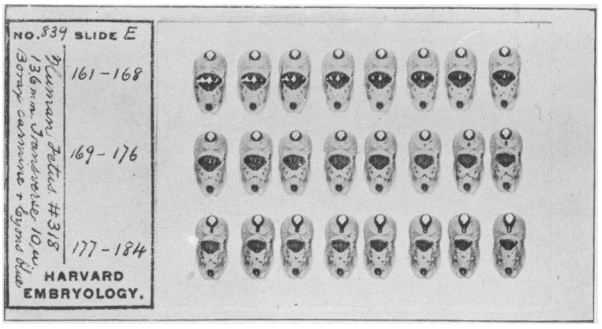
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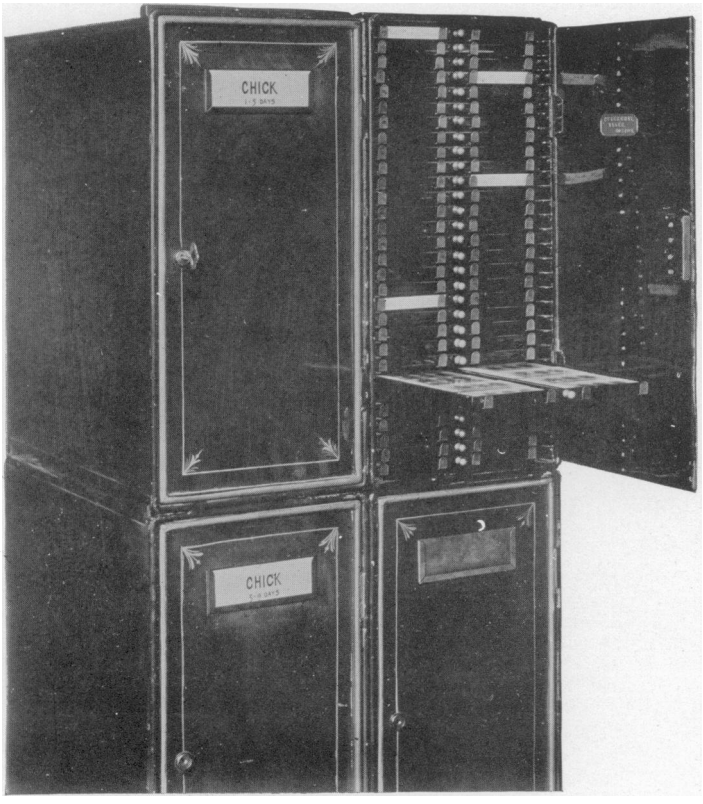
Human Fetal #318
136 mm. Transverse 10 w.
Borax carmine + Lyons blue
161-168
169-176
177-184
HARVARD
EMBRYOLOGY.

2.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3.