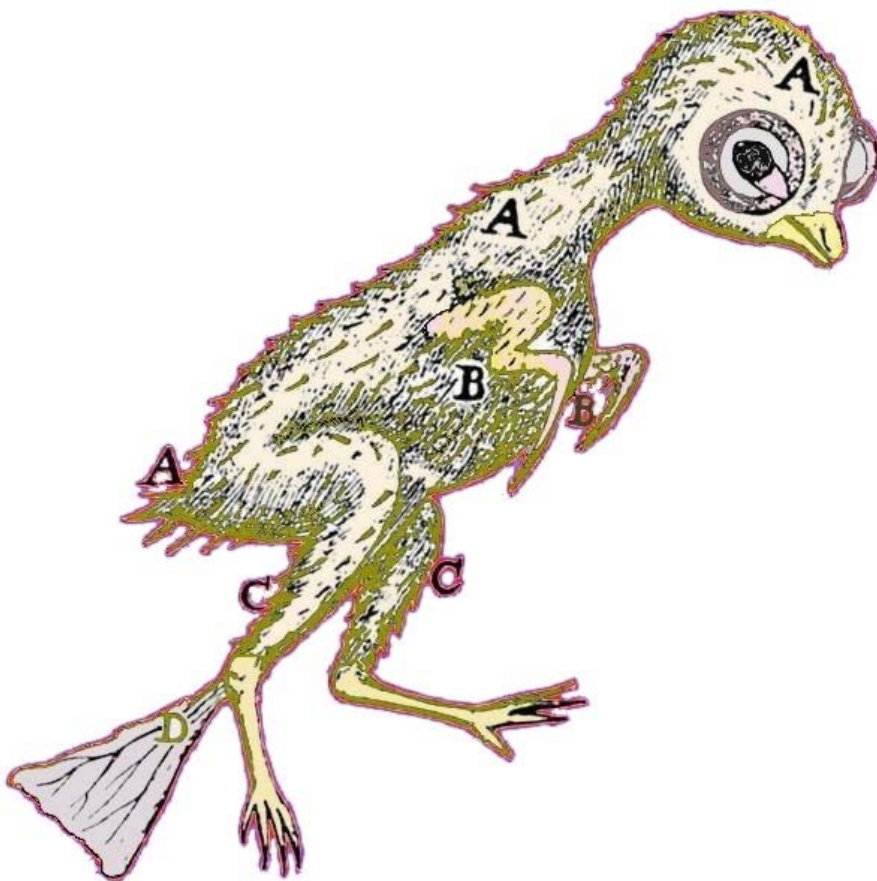


Elio Corti - Fernando Civardi
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Marcello Malpighi

De formatione pulli in ovo
The formation of the chick in the egg
February 1672



Transcribed
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The first chick of Marcello Malpighi

English text reviewed by Elly Vogelaar

December 25 - 2010

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The Latin text is drawn from
MARCELLI MALPIGHII OPERA OMNIA
Londini – apud Robertum Scott MDCLXXXVI
but because of some mistakes contained in it
it has been emended with the following source
MARCELLI MALPIGHII OPERA OMNIA
Lugduni Batavorum – apud Petrum Vander MDCLXXXVII

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The footnotes mostly come from
OPERE SCELTE DI MARCELLO MALPIGHI a cura di Luigi Belloni - Torino UTET 1967
The asterisk indicates that the item is present in lexicon of Summa Gallicana

[1] DE FORMATIONE PULLI IN OVO.

MAGNAE SOCIETATI REGIAE ANGLICANAE
MARCELLUS MALPIGHIUS S. P.

Solent in excitandis machinis praevis operis apparatus singulas efformare partes, ita ut separata prius pateant ea, quae postmodum redigi debent in compagem. Hoc in Naturae operibus plures eiusdem Mystae, circa Animalium indaginem solliciti, accidere sperabant. Corporis etenim implicatam structuram cum difficillimum sit resolvere, disparatas in primordiis singulorum productiones intueri iuvabat. Sed vereor, mortalium vitam incertis nimium finibus claudi, et aequae obscurum esse *carcerem*, ac *metam*. Quare, sicut Mors, monente *Tullio*¹, nec ad vivos, nec ad mortuos pertinet; ita quid tale in *primaeva* Animalium *initio* accidere censeo: dum enim *ab Ovo* animalium sollicitate perquirimus productionem, *in Ovo* ipso iam fere animal miramur excitatum, ita ut irritus noster labor reddatur: Nam primum ortum non assequuti, emergentem successive partium manifestationem expectare cogimur.

THE FORMATION OF THE CHICK IN THE
EGG

Marcello Malpighi very cordially greets
the great Royal English Society.

When machines are built, before starting their assemblage it is usual to make the single components, so that first are separately seen the pieces that subsequently have to be joined. Quite a lot of initiates to the mysteries of nature, very interested in investigating the animals, hoped that this happened in the works of nature. In fact, being very difficult to disentangle the tangled structure of the body, it appeared useful to attentively investigate from the beginning the separate formation of each part. But I fear that the life of the mortals is comprised within too much uncertain boundaries and that the beginning and the end are so much dark. Which is why, as Cicero* says, like the death is not concerning neither to living nor to dead people, I think that in the same manner something similar happens in the initial stages of animals' life: in fact, studying with care the formation of the animals from the egg, in the egg itself we observe the animal as if it had been created, so that our labour is frustrated. In fact, not having understood the beginning of the birth, we are forced to wait for the following appearing of the parts.

¹ TUSCULANAE DISPUTATIONES I, XXXVIII, 91: Itaque non deterret sapientem mors, quae propter incertos casus cotidie imminet, propter brevitatem vitae numquam potest longe abesse, quo minus in omne tempus rei publicae suisque consulat, ut posteritatem ipsam, cuius sensum habiturus non sit, ad se putet pertinere. Quare licet etiam mortalem esse animum iudicantem aeterna moliri non gloriae cupiditate, quam sensurus non sis, sed virtutis, quam necessario gloria, etiamsi tu id non agas, consequatur. Natura vero si se sic habet, ut, quo modo initium nobis rerum omnium ortus noster adferat, sic exitum mors: ut nihil pertinuit ad nos ante ortum, sic nihil post mortem pertinebit. In quo quid potest esse mali, cum mors nec ad vivos pertineat nec ad mortuos? Alteri nulli sunt, alteros non attinget.

In hac quidem perquisitione insudarunt quamplures; inter quos immortalis vester eminet *Harveus*, cuius absolutissimae observationes adhuc ita orbem erudiunt, ut meos praesertim labores veluti supervacaneos refellant. Quoniam tamen, eodem afferente², *latent plerumque veluti in alta nocte prima naturae stamina, et subtilitate sua non minus ingenii, quam oculorum aciem eludunt*, tamque varia Naturae vis, incerta quasi maturitate, modo accelerat, modo differt emergentiam foetus; ideo rudia quaedam Observationum inchoamenta ex incubatorum Ovorum [2] lustratione, quam adhuc saepius repetendam propono, me Vobis, Sodales doctissimi, communicare patiemini, ut si Naturae et magnis vestris Mentibus consona deprehenderitis, subsequantium annorum curriculo ea iterum confirmem, consimilium mediatione adaugeam, novisque, prout tenuitati meae sperare competit, auctiora reddam.

Inter partes, quibus Ovum integratur, Cicatricula³, seu circularis macula, primum locum obtinet; in huius enim gratiam reliqua comproducta videntur. Huius igitur mirabilis structura indaganda sese offert, cuius praecipuas mutationes, et phaenomena brevibus indicabo.

Haec itaque in *foecundo* Ovo perpetuo observatur arcte Vitelli membranae adhaerens inter chalazas⁴; et albumine cooperitur: multiplicatisque vitellis (ut videre potui) eadem Cicatricula multiplicatur, unde frequenter in unico ovo tres deprehendi Cicatriculas.

They are quite a lot of people indeed that devoted themselves with great care in this search, among whom emerges your immortal Harvey*, whose perfect observations are still so full of teachings for everyone to confute above all my labours as being useless. Since nevertheless, as he himself affirms, "the first sketches of nature are for the greater part hidden as in a deep night, and with their thinness they elude the acuteness of the intelligence no less than of the eyes", and since the so polymorphous strength of nature, almost with uncertain timeliness, now accelerates and now delays the appearing of the fetus, therefore very learned Colleagues you will grant me to communicate you some rough rudiments of observations inferred from the analysis of brooded eggs, descriptions that I am proposing to repeat rather often, so that, if you will find them consistent with nature and your renowned minds, I can again confirm them during the coming years, to amplify them by using similar finds and to increase them with new data as far as it is possible to hope from my littleness.

Among the parts composing the egg, the first place is owed to the cicatrice, or circular patch, since it seems that thanks to it all the other things are produced. Therefore its marvellous structure, of which I will shortly point out the principal changes and appearances, is offering itself to investigation.

Then, in the fertilized egg, this cicatrice is constantly observed, tightly sticking to the membrane of the yolk, that is set among the chalazas and is covered by the albumen. In case of several yolks (as I succeeded in seeing) the cicatrice is manifold, that's why often I observed three cicatrices in only one egg.

² EXERCITATIONES DE GENERATIONE ANIMALIUM, Londra, 1651, p. 42 (Exerc. 13). – Referenza citata da Luigi Belloni in OPERE SCELTE DI MARCELLO MALPIGHI (Torino UTET 1967).

³ La cicatricola o cicatricula - piccola cicatrice - è anche detta discoblastula oppure blastoderma. Blastula deriva dal latino scientifico *blastula*, diminutivo del femminile greco *blástē* = germoglio, gemma, rampollo, germe, embrione; equivalente è il maschile *blastós* che ha lo stesso significato. § Cicatricola o cicatricula deriva dal latino tardo *cicatricula* = piccola cicatrice, diminutivo di *cicatrix* = cicatrice. Ristretta zona del polo dell'uovo degli uccelli, dove, subito sotto alla membrana vitellina, si trovano il citoplasma e il nucleo. Dalla cicatricola, detta anche discoblastula o disco germinativo, si svilupperà l'embrione.

⁴ L'italiano calaza deriva dal greco *chálaza*, grandine, per l'aspetto particolare dei cordoncini che nell'uovo privato di guscio ricordano due chicchi di grandine; *chálaza* è derivato a sua volta da una radice indeuropea che significa ghiaccio. Le calaze si dipartono da ciascun polo della cellula uovo e sono dirette secondo l'asse maggiore del guscio. Si tratta di strutture cordoniformi avvolte su se stesse. Verso il polo ottuso si dirige una sola calaza, mentre dall'altro lato ne esistono due tra loro intimamente ritorte. Originano a livello dello strato calazifero e terminano da ciascun lato nella regione dei legamenti dell'albumine.



figura 1

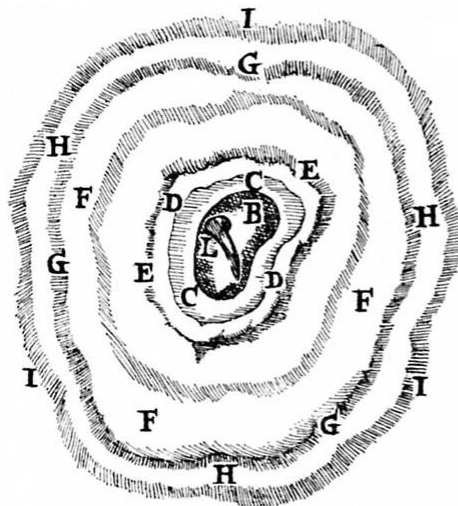


figura 2

Fig. 1. Fig. 2. - In ovis pridie editis, et *nondum incubatis* (ut elapso *Augusti* mense, magno vigente calore, observabam) Cicatricula magnitudinem habebat *A*, hic a me ruditer delineatam, in cuius centro sacculus cinerei coloris⁵, interdum ovalis *B*, quandoque alterius figurae deprehendebatur. Innatabat huiusmodi sacculus seu folliculus⁶ in colliquamenti *C* liquore⁷, vitro fuso persimili, qui irregulari quasi fovea⁸ continebatur. Candidus enim solidae substantiae circulus *D*⁹, aggeris instar, idem colliquamentum ambiebat, cuius exterior portio fuso et liquido alluebatur humore *E*. Subsequebatur parum lata substantia *F*, frequenter varie lancinata, et humore *G* pariter mergebatur. Alii insuper ampliores circuli *H*, ab eadem solidiori

In eggs laid the previous day and not yet brooded (as I was observing in the last month of August, when it was hot) the cicatrice had the size *A* (fig. 1) here by me roughly drawn, at whose centre was perceived a little sack, ash in colour, sometimes oval *B* (fig. 2) and which sometimes had a different appearance. Such saccule or follicle, floated in the liquid of colliquation *C*, very similar to molten glass contained in a kind of irregular pit: in fact a candid circle of solid substance *D*, as if being a bank, surrounded the aforesaid colliquation, and its external part was wetted by the liquid *E* melted and thawed. Immediately after, the substance *F* was coming, not very wide, often variously indented, and that likewise was soaked in the liquid *G*. Furthermore other more wide circles *H*, derived from the same more solid substance, were arranged around, with the interposition of rivulets *I* of liquid. The nature doesn't

⁵ È il nucleo del Pander, o parte svasata della latebra di vitello bianco che forma come un letto al disco germinativo. (Luigi Belloni, 1967) § Christian Heinrich PANDER naturalista ed embriologo nato in Lettonia da genitori tedeschi (Riga 1794 - Pietroburgo 1865). Allievo del medico e naturalista estone Karl Ernst von Baer (Piep 1792 - Dorpat 1876), dimostrò che lo sviluppo dell'embrione del pulcino procede attraverso la formazione di tre strati principali di tessuto, o foglietti germinali (ectoderma, entoderma, mesoderma), dai quali si formano i diversi organi. Si occupò anche di geologia e di paleontologia. Gli studi di embriologia sono contenuti in BEITRÄGE ZUR ENTWICKLUNGSGESCHICHTE DES HÜHNCHENS IM EYE (Contributi alla storia dell'evoluzione del pollo nell'uovo), Brönnner, Würzburg (1817). § Heinz Christian PANDER, name sometimes given as Christian Heinrich Pander (1794-1865) was a biologist and embryologist who was born in Riga. In 1817 he received his doctorate from the University of Würzburg, and spent several years (1827-1842), performing scientific research from his estate near Riga. In 1820 he took part in a scientific expedition to Bokhara as a naturalist, and in 1826 became a member of the St. Petersburg Academy of Sciences. Pander studied the chick embryo and discovered the germ layers (i.e., three distinct regions of the embryo that give rise to the specific organ system). Because of these findings, he is considered by many to be the founder of embryology. His work in embryology was continued by Karl Ernst von Baer (1792-1876), who expanded Pander's concept of germ layers to include all vertebrates. Pander performed important studies in the field of paleontology, and was the first scientist to describe primitive creatures known as conodonts. He also did extensive research of fossils found in the Devonian and Silurian geological strata of the Baltic regions. (www.worldlingo.com)

⁶ Follicolo: dal latino *folliculus*, diminutivo di *folliis*, sacco, borsa. In anatomia: piccola formazione tondeggiante e cava, che spesso contiene un'altra struttura o un piccolo organo.

⁷ *Colliquamentum*, che di per sé significa sostanza fluidificata, è termine introdotto da William Harvey. Qui il Malpighi indica il blastoderma e la cavità subgerminale sottostante all'area pellucida. (Luigi Belloni, 1967)

⁸ La cavità subgerminale. (Luigi Belloni, 1967)

⁹ L'area opaca è concepita come una sostanza dotata di una certa consistenza, che subisce una parziale colliquazione, onde si alternano anelli o zone concentriche di colliquamento e di materiale non colliquato. Segue ora la descrizione di questi cerchi alternantisi nell'area vitellina interna ed esterna. (Luigi Belloni, 1967)

excitati substantia circumducebantur, interpositis liquoris alveolis *I*. Exteriores praecipue circulos *H*, non uno ritu efficit Natura; nec hi perpetuo continua protrahuntur substantia. In sacculo postea, velut in amnio¹⁰, dum solis radiis illum objiciebam, inclusum foetum *L*¹¹ animadvertēbam, cujus caput¹² cum appensae carinae¹³ staminibus patenter emergebat: Amnii etenim rara et diaphana contextura frequenter translucebat, ita ut contentum appareret animal. Saepius acus acie folliculum aperiebam, ut contentum animal in lucem prodiret; incassum tamen: ita enim mucosa erant adeoque minima, ut levi ictu singula lacerarentur. Quare *pulli stamina* in ovo *praeexistere*¹⁴, altioremque originem nacta esse fateri convenit, haud dispari ritu, ac in Plantarum ovis.

make in the same way the circles *H*, above all the more external ones, neither they are always extending with continuous substance. After, while I was exposing it to the rays of the sun, I perceived the fetus *L* held in the little sack as being an amnion, and its head clearly emerged together with the sketches of the hooked carina. In fact the loose and diaphanous weave of the amnion often allowed the light to pass, so that the animal, contained in it, was visible. I rather often was opening the follicle with the point of a needle so that the animal contained in it came to the light. Nevertheless uselessly: in fact the structures were so sticky and so much little that all of them were tearing at the slightest trauma. That's why it is worthwhile to admit that the sketches of the chick are pre-existing in the egg and that they had a more remote origin, not otherwise it is happening in the eggs of the plants.

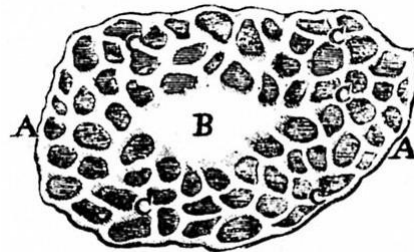


figura 3

Fig. 3 - Placebat etiam *subventanea* ova¹⁵ lustrando cicatriculam intueri, quae ut plurimum minima erat; et licet variam sortiretur circumscriptionem, et texturam, frequentius tamen delineatam *A* prae se ferebat effigiem. Non longe a centro globosum candidumque corpus, seu cinereum *B*, quasi *mola*, locabatur; quod laceratum nullum peculiare exhibebat corpus a se

Observing the windy eggs it seemed me correct to examine also the cicatrice, that for the more was very small; and even if having variable contours and structure, nevertheless rather often was showing the appearance reproduced in *A* (fig. 3). Not far from the centre a globular and snow-white formation *B*, or else ash in colour, was found, almost similar to a vesicle; after being lacerated, it didn't show some particular structure different from its one. It had adnexa *C*

¹⁰ L'area pellucida è interpretata come un sacco amniotico. (Luigi Belloni, 1967) § Amnio, amnion o amnios: dal greco *amnion*, vaso in cui si raccoglieva il sangue delle vittime. Annesso embrionale costituito da un sacco che si sviluppa a spese di una parte dei tessuti formati dall'uovo fecondato (sacco amniotico), contenente – in quantità variabile nei diversi animali e nei vari stadi di sviluppo – un liquido sieroso (liquido amniotico) nel quale è immerso l'embrione ancorato al cordone ombelicale.

¹¹ Probabilmente, allo stadio della stria primitiva. Il raggiungimento di questo stadio anteriormente all'incubazione è sottolineato dagli autori posteriori, alcuni dei quali hanno invocato a spiegazione il forte calore estivo poco sopra ricordato dal Malpighi. (Luigi Belloni, 1967)

¹² Forse il nodo primitivo. (Luigi Belloni, 1967)

¹³ Le strutture assiali del tronco. (Luigi Belloni, 1967) § Carena, dal latino *carina* (chiglia della nave, guscio della noce), per estensione significa organo animale o vegetale, o parte di esso, che richiama la forma della chiglia di una nave, elemento longitudinale dello scafo, facente parte della struttura del fondo.

¹⁴ Osservazione assai corretta. Infatti l'uovo fecondato comincia a suddividersi fino al momento in cui viene deposto. Nell'uovo fecondato il disco germinativo consta di una massa di 40.000-60.000 cellule derivate dalla divisione ripetuta dello zigote e prende il nome di discoblastula o blastoderma o cicatricola, che appare come un dischetto di colore grigio chiaro del diametro di 4 mm che riposa sulla componente bianca del vitello. Nel caso l'uovo non sia stato fecondato, il disco germinativo è costituito da citoplasma e dal nucleo femminile in degenerazione e il suo diametro è di circa 3,5 mm.

¹⁵ Dette anche ventose o uova del vento, ossia non fertili.

diversum. Appendices reticulares C habebat, quarum spatia diversas referebant figuras, non raro ovales, diaphanoque replebantur colliquamento; denique tota haec moles, Iridis instar, plurimis circumdabatur circulis.

arranged as a net whose spaces had a variable appearance, not rarely oval, and they were full of a diaphanous fluid liquid; finally this whole mass was surrounded by a lot of concentric circles as the rainbow.

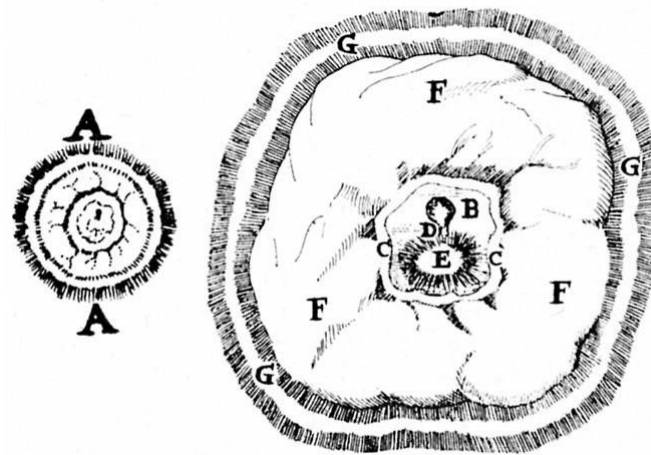


figura 4

Fig. 4. - In *incubatis* autem Gallinae ovis sub Indica vel nostrate gallina, summo vigente aestu, tales attingebam mutationes: et primo immediate [3] post *sex* incubatus horas, Cicatricula huius erat magnitudinis A; in cuius centro aderat Amnion, scilicet B, candido solidoque circumvallatum aggere C, quod colliquamenti liquore fusco replebatur. In medio, pulli carina D una cum capite innatabat. Huius inferior portio frequenter disrupto folliculo E¹⁶ contegebatur. Amplus subsequebatur circulus F, fasciae instar ambiens, qui tandem umbilicalibus pervadebatur vasis. Non ubique solidum corpus erat, sed sensim irruente ab exterioribus rivulis colliquamento solvebatur, collis instar, qui erumpentibus interluitur et mergitur fontibus. Hoc solidiori circulo subcandido, parumque lato G ambiebatur, qui rivulis et ipse intercipiebatur. Interdum alii subsequebantur circuli qui incubationis progressu frangebantur, vel tandem obliterabantur.

In eggs of hen brooded by a turkey hen or by a home hen at the height of summer - 1671 - I observed the following changes, and first of all, immediately **after 6 hours of incubation**, its cicatrice was large as A (fig. 4). At its centre was present the amnion, or B, surrounded by a snow-white and solid vallum C, full of a dark liquid of colliquation. In the centre the carina D of the chick fluctuated together with the head. Its inferior part was often covered by the lacerated follicle E. The wide circle F was following, enveloping as a band, that finally was pervaded by the umbilical vessels. It was not a solid structure in every point, but was gradually melted by a penetrating colliquation coming from external rivulets, as a hill irrigated and submerged by sources gushing with violence. This structure was surrounded by a more solid circle G, whitish and not very wide, it too interrupted by rivulets. Sometimes other circles were following each other, interrupted by the progress of incubation, or were finally deleted.

¹⁶ In realtà, il nucleo del Pander. (Luigi Belloni, 1967)

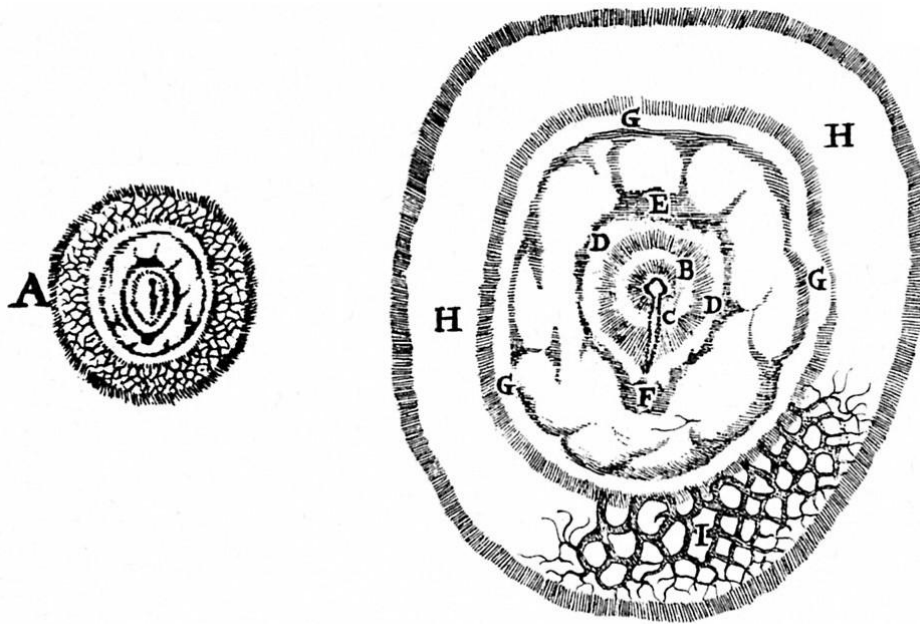


figura 5

Fig. 5. - Post horas *duodecim* incubatus, exaratae partes distinctius patebant in adaucta cicatricula, magnitudinis *A*, quae sursum emergens fere horizontalis erat. Disrupto itaque folliculo *B*¹⁷, foetus *C* erumpebat insigni capite, et duplici vertebrarum ordine¹⁸, carinae inchoamenta excitante: Hujusmodi namque candidi orbiculares sacculi, seu vesiculae, invicem contiguae, deorsum excurrerant, spinalisque medullae¹⁹ stamina stipabant; et cerebri²⁰ pariter primordia subobscurè emergebant. Candidus de more circulus *D*, Amnion efformaturus, in exteriori colliquamento *E* innatabat. Pars *F*²¹, quae tandem colliquatur, et umbilicalibus vasculis substernitur, amplior reddita ex subiecto vitello subluteum referebat colorem, et in ichorem²² fusa ab adveniente colliquamento, quasi rivulis, interrompebatur: In his tamen

After 12 hours of incubation, the described parts were more distinctly visible in the increased cicatrice, whose size was corresponding to *A* (fig. 5), and sticking out upward it was almost horizontal. Therefore, after having opened the follicle *B*, the fetus *C* emerged from it, endowed with a big head and two rows of vertebrae forming the sketches of the carina. In reality such white and round pouches or vesicles, neighbouring each other, stretched downward and surrounded the sketches of the spinal marrow; and also the sketches of the brain were emerging in a no very evident way. The circle *D*, snow-white as usual, destined to form the amnion, floated in the more external colliquation *E*. The part *F*, that at the end is liquefying and placing itself under the small umbilical vessels, after becoming greater, was taking a yellowish colour from the underlying yolk, and melted into ichor - into liquid - was interrupted as by rivulets by the tributary colliquation: nevertheless in them I didn't see any

¹⁷ In realtà, il nucleo del Pander. (Luigi Belloni, 1967)

¹⁸ I somiti. (Luigi Belloni, 1967) § Somite, singolare e maschile, deriva dal greco *sôma*, corpo+-ite. In embriologia, un somite è ciascuno dei segmenti in cui si suddivide la parte dorsale del mesoderma (o epimero), a destra e a sinistra della corda dorsale. I somiti danno origine a elementi che formeranno il derma della cute del tronco (dermatomi), alle masse muscolari (miotomi) e allo scheletro assile (sclerotomi). Ogni somite è connesso al mesoderma insegmentato, posto ventralmente, da un peduncolo (peduncolo del somite). Nella zona caudale dell'embrione il mesoderma è costituito da una massa cellulare dalla quale hanno origine nuovi somiti per cui l'embrione può gradatamente allungarsi. Per alcuni embrioni l'età si indica con il numero dei somiti (per esempio, embrione umano e del pollo).

¹⁹ È incerto cosa abbia osservato qui il Malpighi al posto del midollo spinale, che più avanti egli sembra confondere con la notocorda. (Luigi Belloni, 1967) § Notocorda deriva dal greco *nôton* = dorso. In embriologia e in zoologia, notocorda equivale a corda dorsale.

²⁰ Evidentemente, il proencefalo e le vescicole ottiche. (Luigi Belloni, 1967)

²¹ Questa parte si riferisce evidentemente all'ampia zona compresa fra *D* e *G*. (Luigi Belloni, 1967)

²² Ichore: dal greco *ichor*, *ichôros*, maschile. Secondo la mitologia greca, il purissimo sangue degli dei. Per Aristotele in *HISTORIA ANIMALIUM* 586b 32 era il liquido amniotico. Nel linguaggio medico, sia di Ippocrate che di Aristotele, era l'essudato, spesso purulento, secreto da ferite o piaghe infette.

motum aliquem non videbam. Candidus circulus *G*, omnia de more continens, subsequebatur. Non semel ulteriorem videbam latam veluti fasciam *H*, in qua reticularem plexum *I*, spadicei coloris²³, deprehendebam, vasorum implicationem aemulantem, cuius spatia exterioris ambitus arctiora erant et sensim obliterabantur, interiora autem laxiora. An vero huiusmodi sint *Umbilicalia vasa*, quae iam in colliquamenti materia latentia, progressu temporis aeruginoso ichore, et tandem rubescente sanguine turgeant; an sinus et alveoli ex fermentato colliquamento viam sibi faciente; determinare non audeo, cum ex humoris diaphaneitate, et sinuum angustia, *localis motus* imperceptibilis existat.

movement. The candid circle *G* was following, that as usual enclosed every thing. More than once I observed a following formation *H* ample as a band, in which I perceived the reticular plexus *I* of colour of the date - dark red - similar to an interlacement of vessels, whose spaces in the external area were more narrow and gradually disappeared, while those more internal were wider. But I don't dare to establish if these formations are umbilical vessels which, already latent in the material of colliquation, with the passing of time are swollen of rust coloured liquid and then of red blood, or if they are sinuses and rivulets coming from the fermented colliquation making its way. I don't dare to establish these hypotheses since, on the basis of the transparency of the humour and the narrowness of the sinuses, doesn't exist any perceivable local movement.

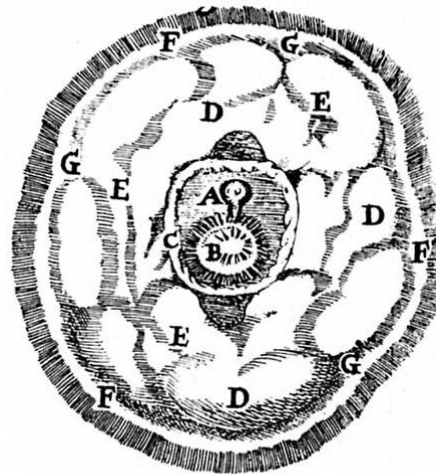


figura 6

Fig. 6. - Parum absimilis structura in incubata cicatricula per horas *decem et octo*, ovi apicem horizontaliter tenente, emergebat: Namque pullus *A* amplo capite, et oblonga spina, quae disrupto folliculo *B* obtegebatur, in adaucto colliquamento de more mergebatur, superstite adhuc circulo *C*. Ambiens pariter substantia *D*, colliquamenti rivulis *E*, versus Amnion irruentibus²⁴, irrigabatur; nondum tamen sanguinea vasa prodibant, Occurrebat amplior circulus *F*, rivulo interposito *G*, cuius continuitas in aliquibus tolli coepert, et quandoque plures ulterius circuli addebantur.

In the cicatrice incubated for 18 hours, occupying horizontally the higher part of the egg, a little dissimilar structure was evident. In fact the chick *A* (fig. 6) with a big head and a lengthened spinal column, covered by the lacerated follicle *B*, was immersed as usual in the increased colliquation, still persisting the circle *C*. Item the substance *D* placed around was irrigated by rivulets *E* of colliquation throwing themselves toward the amnion; however blood vessels had not yet appeared. A wider circle *F* was present, with the interposition of the rivulet *G*, whose continuity in some eggs had started to stop, and sometimes many further circles were adding.

²³ *Spadix*, in latino, corrisponde al ramo della palma da dattero (*Phoenix dactylifera*) col suo frutto rosseggiante, per cui l'aggettivo *spadicens* significa del colore del dattero, cioè rosso scuro. Il dattero, che anticamente suonava dattilo, deriva dal latino *dactylus*, che risale al greco *dáktylos*, il dito.

²⁴ E sono quindi concepiti come la fonte del liquido amniotico (in realtà, subgerminale). (Luigi Belloni, 1967)

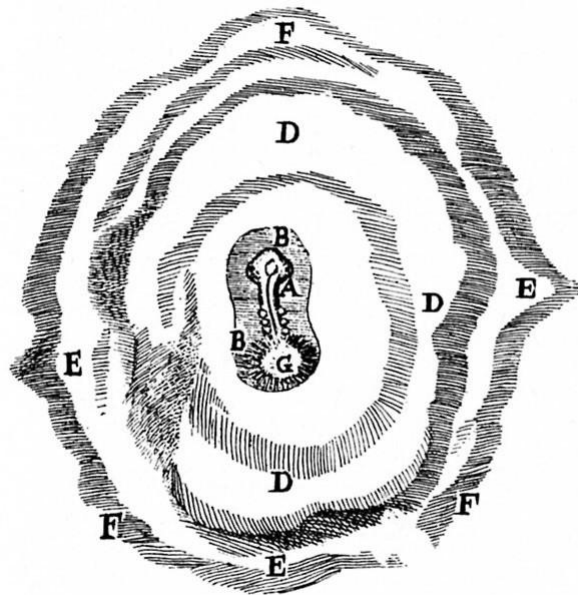


figura 7

Fig. 7. - Post *diem integrum* horarum 24, saepe cicatriculam in summo emergentem, latioremq̃ redditam, qualem hic delineavi, videbam. Pullus enim *A* cum capitis et spinae candido inchoamento, versus inferiora recurvo, in colliquamento *B* sub-oscuro innatabat, et lateri interdum [4] sinistro folliculi, vel circuli fragmento *G* haerebat; ambiens vero substantia *D*, rivulis excavata, extendebatur, et exterior circulus *E*, liquore circumdatus, cicatriculae compagem claudebat, ita tamen, ut derivato ab alveolis exterioribus *F* colliquamento versus *D* pateret aditus.

After a whole day of 24 hours I often saw that the cicatrice was sticking out at the summit and had become wider, as I have drawn it here (fig. 7). In fact the chick *A*, with the snow-white sketch of head and column bent downward, was floating in the colliquation *B* a little bit dark, and sometimes it clung to the left side of the follicle or of the circle with the portion *G*; then the surrounding substance *D* was extending, dug by rivulets, and the most external circle *E*, surrounded by liquid, was closing the structure of the cicatrice, however in such a way that to the colliquation *F*, derived from the external rivulets, a free access toward *D* was guaranteed.

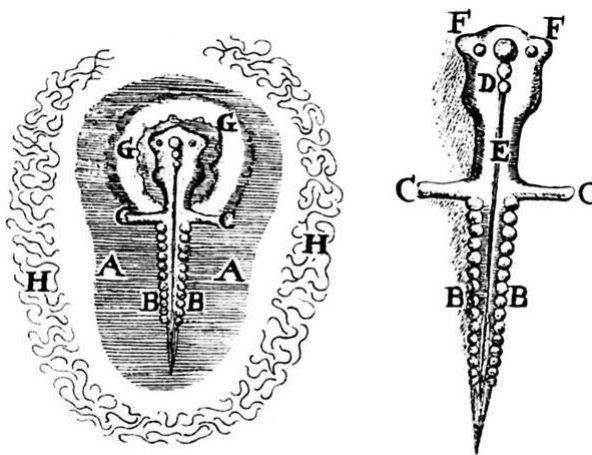


figura 8

Fig. 8. - In Vegetiori ovo interdum singula evidentiora occurrebant; pullus enim in colliquamento *A* residens oblongiori pollebat carina, eaque recta, quae multis vertebrarum

In a more vigorous egg sometimes the details were appearing more evident. In fact the chick located in the colliquation *A* (fig. 8) was endowed with a longer and straight carina, which was composed of numerous

globosis inchoamentis *B*²⁵, hinc inde a spina locatis, compaginabatur. Alae *C*²⁶ crucis in modum pariter erumpebant, et reliquum capitis, colli, et thoracis, crassius redditum elongabatur. Tres ampliores vesiculae *D*, cum producta spinali medulla *E*²⁷, usque ad extremum carinae emergebant, et binae pariter orbiculares globuli *F*, hinc inde in capite reponebantur, forte oculorum inchoamenta. Circulus *G*, olim colliquamentum ambiens, superiori foetus partì substernebatur. Umbilicalium vasorum *H* surculi primo prodibant, qui contorti e varicosi in colliquamento mergebantur, nec ipsorum continuata productio adhuc patebat, unde variae obiiciebantur species; contentus vero humor, interdum subvitellinus, quandoque rubiginosus erat; huius motum nequaquam deprehendere valebam. *Cordis motum* licet visus fuerim attingisse, non tamen certo affirmare audebam.

spherical sketches *B* of vertebrae arranged at both sides of the column. Also the crosswise arranged wings *C* were sprouting, and the remaining parts of head, neck and thorax had become thicker and longer. Three rather great vesicles *D*, together with the spinal marrow *E* in continuity with them, were emerging until the extremity of the carina, and likewise at each side of the head two spherical globules *F* were located, perhaps the sketches of the eyes. The circle *G*, before surrounding the colliquation, was below the superior part of the fetus. For the first time the small branches of the umbilical vessels *H* appeared, that, twisted and dilated, were plunged in the colliquation, but an uninterrupted extension of them was not yet evident, hence different appearances were noticed. The liquid they contained sometimes had a colour similar to yolk, other times it had a rust colour. I was not able at all to catch a movement of it. Although it seemed me to have noticed a movement of the heart, nevertheless I didn't dare to affirm it with certainty.

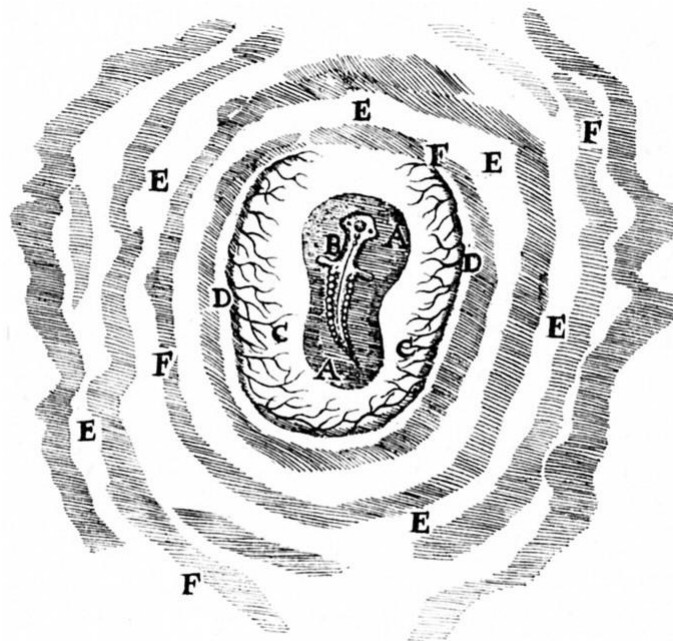


figura 9

Fig. 9. - Absumptis *triginta horis*, cicatricula taliter configurabatur: In aducto amnio *A*, iacebat pullus *B*, in quo novae nondum emergerant partes, praeter capitis appendices, in aliquibus parum elongatas. Circa amnion perpetuo varicosa umbilicalia vasa *C* observabantur, quae in exteriori limbo *D*²⁸ ampliora, et magis continua, coloris

When 30 hours passed, the cicatrice was shaped as follows. In the amnion *A* (fig. 9), that had grown, the chick *B* was laying, in which new parts not yet sprouted, except the cephalic appendixes, a little lengthen in some chicks. Around the amnion umbilical dilated vessels *C* were always observed, that in the more external edge *D* were greater and more continuous, of rust colour. Nevertheless toward the

²⁵ I somiti. (Luigi Belloni, 1967)

²⁶ Sono, in realtà, i tronchi onfalo-mesenterici primitivi. (Luigi Belloni, 1967)

²⁷ Le vescicole cerebrali e il mielencefalo. (Luigi Belloni, 1967)

²⁸ Il seno terminale. (Luigi Belloni, 1967)

ampliora, et magis continua, coloris aeruginosi, extendebantur; versus interiora tamen obscurabatur ipsorum progressus turgente colliquamento: unde tunc temporis eatenus haec in oculos incurrere dubitabam, quatenus conglobata reddebantur. Ambientes circuli *E*, fusique humoris rivuli *F*, multiplicabantur, qui recollectum umbilicalibus, et amnio subministrabant: Non tamen haec alveolorum ad amussim species obiciebatur, sed varia quandoque a Natura promebatur.

inner parts their progress was hidden by the swollen colliquation: therefore then I doubted that such vessels were visible until they were conglobated. The concentric circles *E* and the rivulets *F* of melted liquid were increasing in number, which supplied the collected matter to umbilical vessels and amnion. However this appearance of the canaliculi didn't appear exactly, but sometimes was shown different by nature.

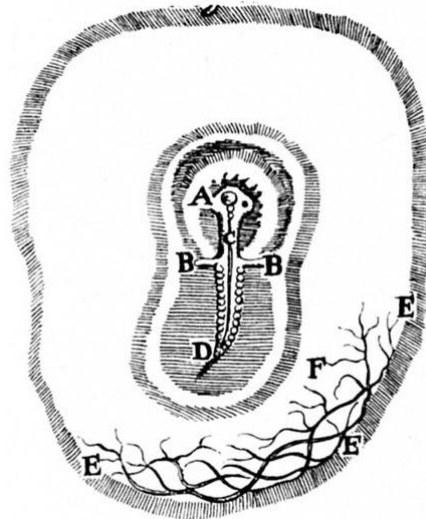


figura 10

Fig. 10. - Elapso die cum dimidio, parum absimilis occurrebat configuratio. Caput *A* solitis vesiculis turgidum, cum alarum inchoamentis *B*, et spinali medulla *C*, patebat; extremitas carinae *D* curvabatur; Umbilicalium vasorum exterior limbus *E*, quasi continuato vasculo, adhuc subruginosum continente humorem, terminabatur, et continuati surculi *F*, reticulariter impliciti, versus interiora erant producti.

When one day and a half passed, the appearance was not very dissimilar. The head *A* (fig. 10) was evident, swollen by the usual vesicles together with the sketches *B* of the wings and spinal marrow *C*; the extremity of the carina *D* was bent; the most external edge *E* of umbilical vessels was delimited by a small almost continuous vascular structure still containing an almost rust coloured liquid, and the little branches *F*, continuous in structure and netlike interwoven, were going toward the inner structures.

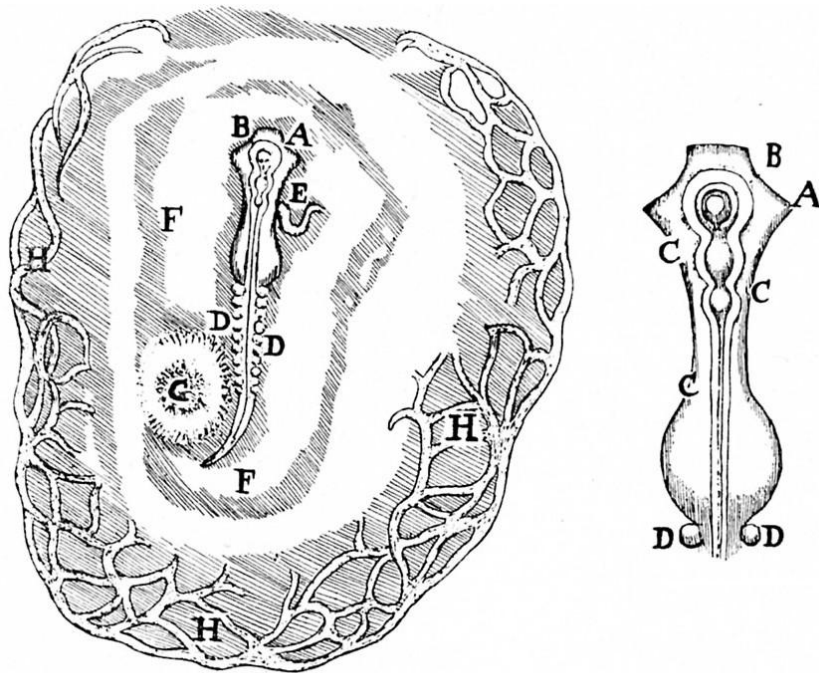


figura 11

Fig. 11. - Evidentius patuere singula post incubatum horarum *triginta octo*. Auctior pullus insigni capite *A* pollebat, in quo tres vesiculae²⁹ situabantur, quarum amplior figuram *B* prae se ferebat; circum tamen obducebantur involucra *C*, totum spinae tractum ambientia, quam vertebrarum rotundi sacculi *D* de more componebant. Supra Alarum exortum, Cordis *E* structura primo patebat; quam antea interdum, dubie tamen, mihi detexisse visus fueram: Vivente enim animali pulsus observabatur; quo cessante fusca tandem quasi linea designabatur. In colliquamento *F* fragmenta circuli *G* adhuc supererant. Umbilicalia vasa *H* conspicuis surculis varicosis et reticulariter [5] unitis circum abstabant, nec adhuc ipsorum productio usque ad Cor emergebat; supernatante enim colliquamento vel crassiori albumine obscurabantur: Ichor pariter circum-affundebatur cum innatantibus circulorum solidis fragmentis.

Each structure became more evident after an incubation of 38 hours. The chick, of higher dimensions, was endowed with a big head *A* (fig.11) in which three vesicles were located, the greater one showing the appearance *B*; nevertheless the wraps *C* were stretched all around, surrounding the whole section of the column, composed as usual by the round vertebral pouches *D*. Above the origin of the wings appeared for the first time the structure of the heart *E*, which sometimes previously seemed me to identify, even if with some doubts. In fact in the still alive animal a pulsation was visible, but at its stop a dark line so to say was drawing. In the colliquation *F* fragments of the circle *G* were still present. The umbilical vessels *H* were arranged around with large dilated branches and joined to make a net, but their lengthening until the heart was not yet noticed; in fact they were hidden by the above colliquation or denser albumen. Likewise liquid containing solid floating fragments of circles was spreading all around.

²⁹ Evidentemente, il proencefalo, il mesencefalo e il metencefalo. (Luigi Belloni, 1967)

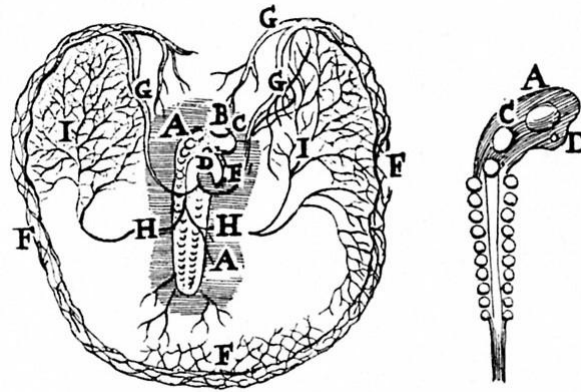


figura 12

Fig. 12. - *Quadragesima* elapsis oris, pullus in colliquamento *A* degens pulchrum exhibebat spectaculum; nam crassefacta carina, Caput *B* curvabatur; Cerebri vesiculae *C* non ita patentes erant; oculorum *D* inchoamenta emergebant; Cor *E* pulsabat recepto a venis humore, rubiginosi et interdum xerampelini³⁰ coloris: Exterior namque umbilicalium limbus venoso quasi circulo crassiori *F* circumducebatur, qui finibus praecipue *G*³¹ in cor hiabat: Talis autem ex contento sanguine via, et continentium structura indicabatur, qualem hic delineatam intuemini.

When 40 hours passed, the chick, laying in the colliquation *A* (fig. 12), was showing a beautiful appearance. In fact, the carina being increased, the head *B* was bent; the cerebral vesicles *C* were not so apparent; the ocular sketches *D* were sticking out; the heart *E* pulsated, having received from the veins some liquid rust coloured and sometimes of the colour of a drying leaf of vine: in fact the external band of the umbilical vessels was surrounded by a kind of thicker venous circle *F*, that opened in the heart mainly with the terminations *G*. Really such a way, due to the contained blood and to the appearance of the structures containing it, was put in evidence as you can see it drawn here.

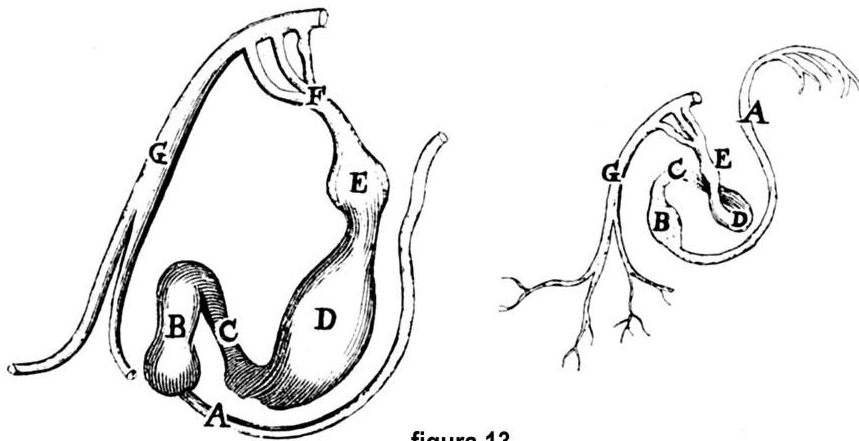


figura 13

Fig. 13. - Primo itaque *motus Constrictionis* ex appulso humore per venas *A*³² observabatur evidenter in auriculam *B*³³; a qua expressus succus propellebatur per *C*³⁴ in amplum ventriculum dextrum *D*³⁵, qui constrictione

Therefore it was first of all observed in a well visible way the movement of the systole thanks to the liquid pushed through the veins *A* (fig. 13) in the auricle *B*, and the liquid it squeezed was pushed through *C* in the wide right ventricle *D* which, after having halved itself,

³⁰ *Xerampelinus* deriva dal greco *xērampélinos*, da *xērós* = secco e *ámpelos* = vite, quindi un colore che richiama quello di una foglia di vite che sta seccando.

³¹ Vene vitelline anteriori. (Luigi Belloni, 1967)

³² Vene vitelline anteriori. (Luigi Belloni, 1967)

³³ L'atrio indiviso. (Luigi Belloni, 1967)

³⁴ Il canale auricolare. (Luigi Belloni, 1967)

³⁵ La cavità ventricolare indivisa. (Luigi Belloni, 1967)

media in continuatam appendicem *E*³⁶ protrudebatur, a qua in arteriam Aortam *F* patebat aditus; haec autem sursum in caput insignes emittebat ramos³⁷, et deorsum in truncum *G*³⁸ se elongabat, qui divisus usque ad extremum carinae producebatur; Fig. 12. - versus tamen mediam regionem umbilicales ramos *H*³⁹ promebat, qui germinatis surculis *I* in peripheria absumebantur, excitato reticulari plexu, quem in relinquorum vasorum sanguineorum extremitate perpetuo miramur. Consimilis etiam implicatio observabatur circa venosum vas *F*⁴⁰; quin adhuc vereor, ne sit latum vas, an vero conglomeratus reticularis plexus venosus, cum frequenter huius vestigia deprehenderim. Pulsantes itaque successive hasce vesiculas⁴¹ *Verum Cor* esse censeo, circa quas (ut non semel suboscure videbam) musculosae carnae portiones circumducebantur, nondum opacitatem aut rubedinem sortitae. Quare motum illum, qui in micante gutta, seu *saliente puncto*, alias observatus est, nequaquam palpitationem inclusi sanguinis⁴² esse reor, sed veri cordis motum, pulsum scilicet *constrictionis et dilatationis*, qui successive peragitur in debitis ventriculis, solo loco disparatis, qui tandem uniti, inducta carne, consuetam adulti cordis excitant fabricam.

Difficillimum quidem est sensu ipso confirmare, An Sanguis prior sit exarato Corde? Licet enim frequentissime fuscus et rubiginosus humor in exterioribus umbilicalium vasorum finibus appareat nondum videnter emergente Corde; et speciosum videri possit, Cor fieri excurvato et expanso vase, cui carnae portiones, veluti manus, exterius aptentur; quoniam tamen tunc temporis ita mucosa, candida, et lucida sunt omnia, ut sensus quocunque instrumento munitus nequeat distinctam partium compagem attingere, et, sicut in Insectis videre est, ultimi senii partes in primordiis rudimenta habere, ita de Corde adhuc mihi dubitandum superest: Hoc autem

debouched into the adjacent appendix *E*, from which the access to the aorta artery *F* was opening. Then this was sending forth some big branches in cranial direction and was lengthening downward in the trunk *G* that, after having divided, pushed until the extremity of the carina. However approximately in the central area it was sending forth the umbilical branches *H* (fig. 12), which, after gave origin to the little branches *I*, were dispersing in the periphery after having formed a reticular plexus, as we regularly observe at the extremity of the other blood vessels. Analogous interweaving was also observed around the venous vessel *F*; so that I still fear that it is not a big vessel, but a venous reticular curled up plexus, since often I observed its traces. Therefore I believe that these vesicles, subsequently pulsating, are the true heart, and around them (as many times I saw not very distinctly) were placed portions of muscular flesh that had not yet acquired redness and opacity. Then I think that that movement observed other times in the vibrating drop, or hopping point, is not at all the palpitation of the contained blood, but the movement of the true heart, that is, a tightening and dilating pulsation - systole and diastole - and that it is fulfilled in succession in the ventricles to this destined, distinguished only by their position, which finally join up and become covered with flesh, and assume the usual structure of the adult heart.

Really it is very difficult to confirm, just basing themselves on the visual experience, if the blood is pre-existing to the heart we described. In fact, although very often a dark and rust in colour liquid appears in the outer extremities of the umbilical vessels when the heart is not still clearly visible, and although it could seem beautiful that the heart derives from a bent and expanded vessel, externally to which pieces of flesh are arranging themselves as being hands; since nevertheless in such moment everything is so mucous, snow-white and bright that the eye provided of whatever tool would not be able to distinctly detect the structure of the parts, and that, as it can be seen in insects, the parts of the farthest old age have the sketches in the initial structures; then I am still doubtful about the heart. In fact to the sight it is certainly clear what follows, that

³⁶ Il bulbo cardiaco. (Luigi Belloni, 1967)

³⁷ Gli archi aortici. (Luigi Belloni, 1967)

³⁸ L'aorta dorsale. (Luigi Belloni, 1967)

³⁹ Le arterie onfalo-mesenteriche. (Luigi Belloni, 1967)

⁴⁰ Il seno terminale. (Luigi Belloni, 1967)

⁴¹ Analoga successione di cuoricini aveva già osservato il Malpighi nel *De bombyce* (1669). (Luigi Belloni, 1967)

⁴² Come ammetteva invece Harvey. (Luigi Belloni, 1967)

certo sensui patet, Sanguinem seu sanguineam materiam a primordiis non omnia illa habere, quae in ipso ex post deprehenduntur. Primo namque colliquamenti species, a rivulis versus foetum deducti, in vasis patet; mox vi fermentationis sub-vitellinus et rubiginosus emergit humor, [6] qui tandem rubicundus evadit; sub postremis hisce naturis, cordis ministerio in gyrum pellitur. Quare vereri possumus, quod, sicuti in Sanguinea materia successivae mutationes, inducto colore, manifestantur; ita pariter cordis structura solo motu evidenter pateat, et quod quiescens adhuc praexistat, licet iners, nondum scilicet firmatis carneis fibris. Hoc vero certum videtur, Ichorem, seu exaratam materiam, quae postremo rubicunda efficitur, Cordis motum antecedere; Cor vero suo etiam motu Sanguinis rubificationem.

An autem Ichor primo emergens sit simplex colliquamentum, an vitalis liquor, an sanguis inchoatus, cum sensuum ministerio determinari nequeat, vestris mentibus diiudicandum relinquo; illud unum innuens, ante Ichoris collectionem, eiusdem motum, et in sanguinis naturam conversionem, Carinam, cum capitis, cerebri, spinalis medullae, et alarum⁴³ inchoamentis, evidenter patere; et sicut in Plantarum Ovis primo colligitur colliquamentum, ex quo ab initio Plantae carina sive truncus cum foliis excitatur; quae singula diversis Vasis, succisque fermentativis concretis compaginantur: ita in Animalium primaeva et simultanea productione dubitare fas est; cum suspicari possumus, in Ovo subesse pullum, cum partium fere omnium conterminis sacculis innatantem in colliquamento, huiusque naturam nutritivis et fermentativis succis commixtis integrari, ex quorum suscitata mutua actione sanguis successive progignitur, partesque olim delineatae erumpunt, et turgent. Sed tam involuta et latentia sunt haec Naturae opificia, ut licet sensuum ministerio inquirantur, quoniam tamen circa minima versantur, facile (me saltem) decipere possint; ideo irritum prorsus censeo meis coniecturis ea prosequi. Quare redeo ad indagandas successivas pulli manifestationes.

Non in singulis incubatis quacun- que tempestate ovis, Cor et appensa Umbilicalia

the blood or haematic material doesn't possess since the beginning all those things subsequently observed in it. In fact at first in the vessels something is evident seeming a colliquation, transported by the rivulets toward the fetus; soon after through the action of the fermentation a yellowish and rust coloured liquid is highlighting, finally becoming red, and under this final appearance is pushed around by cardiac activity. Which is why we can suspect that, as in the haematic material some following changes are showing themselves through the assumed colour, so likewise the structure of the heart is showing itself in a clear way by only the movement, and that it is pre-existing still quiescent, although inactive, since the fleshy fibres didn't yet grow stronger. It seems certain what follows, that the liquid, that is, the described material finally becoming red, precedes the movement of the heart, as well as that the heart starts to pulsate before the blood becomes red.

But, being impossible to establish by the employment of the senses if the liquid at first appearing is a simple colliquation, or a vital liquid, or a sketch of blood, I leave it to be judged by your minds. I confine myself to mention that the carina, together with the sketches of head, brain, spinal marrow and wings, shows itself in evident way before the liquid gathers, starts to move and turns into blood. And as in the eggs of the plants at first the colliquation is gathering, from which since the beginning the carina of the plant originates, that is, the trunk, together with the leaves, and each structure is composed of different vessels and thick fermentative juices, it is permissible to doubt that so happens in the juvenile and simultaneous formation of the animals, since we can suspect that in the egg the chick hides itself, floating in the colliquation, with the contiguous pouches of almost all the parts, and that its nature is renewed by the mixture of nourishing and fermented juices, thanks to whose mutual stimulation the blood is subsequently begot, and the parts, for a long time delineated, erupt and increase. But these laboratories of nature are so dark and hidden that, as far as they are investigated by using the senses, being that nevertheless they concern very small things, they could easily deceive (me at least). Therefore I think undoubtedly useless to expound them by using my conjectures. Which is why I go back to the following manifestations of the chick that have to be investigated.

The heart, and the umbilical vessels suspended from it, didn't show themselves as much soon in each egg

⁴³ I vasi onfalo-mesenterici. (Luigi Belloni, 1967)

vasa tam cito manifestabantur: Frequenter enim elapso altero die emergere solebant; autumno praecipue, et vere, ut saepius mihi accidebat. Inter observandum, in obscuro etiam conclavi, nunquam micantem in Corde *lucem*, etiam minimam⁴⁴, attingere potui.

incubated in whichever season: in fact often they were accustomed to appear when the second day was passed, especially in autumn and in spring, as rather often it happened me to observe. Also during the observations in a darkroom, never I succeeded to see in the heart the slightest sparkling light.

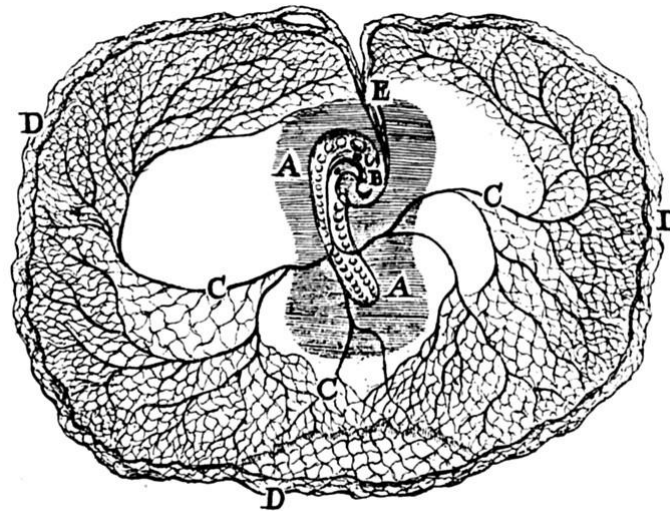


figura 14

Fig. 14. - *Binis* superatis *diebus*, ut plurimum consimilis occurrebat species, qualem delineare mea manu tentavi; prout nudis etiam oculis obiicitur. Colliquamenti sacculus, seu amnion *A*, copioso fuscoque refertus ichore, Pullum continebat, cuius vesiculae recurvum caput integrabant; vertebrarum sacculi per longum producti adhuc patebant; cor *B* extra thoracem pendulum, triplici, hocque successivo, pulsu movebatur. Nam receptus humor, quandoque adhuc rubiginosus, a vena per auriculam in cordis ventriculos, ab his in arterias, et postremo in umbilicalia vasa *C* demandabatur. Saepe servabam pullum, et exsiccato subiecto vitello, Cor per diem pulsum non intermittebat. Umbilicalium vasorum limbus *D*, lato quasi vase terminabatur, cuius quidem crassitiem ex implicatione reticulari venarum et arteriarum excitari censeo; quod tamen ulteriori eget inquisitione: Exonerabantur autem venae mediis extremis finibus *E* in auriculam cordis.

When 2 days passed, mostly was occurring an appearance similar to that I tried to draw with my hand, so as it is occurring also to naked eyes. The pouch of the colliquation, that is the amnion *A* (fig. 14), full of abundant and dark liquid, contained the chick, whose vesicles were leaning against the bent head; the pouches of the vertebrae were also visible, longitudinally placed; the heart *B*, hanging outside the thorax, was moving by triplex and following pulsation. In fact the liquid received from the vein, sometimes still rust coloured, was sent through the auricle in the ventricles of the heart and from these in the arteries, and finally in the umbilical vessels *C*. Often I conserved the chick and, after the underlying yolk dried, the heart didn't stop pulsating for one whole day. The band *D* of the umbilical vessels was ending as in a wide vessel whose size in my opinion is provoked by the reticular weaving of veins and arteries. Nevertheless this needs a further investigation. Besides the veins were discharging, through the central and terminal extremities *E*, in the auricle of the heart.

⁴⁴ Il Malpighi nega, quindi, la luminosità del *punctum saliens* (in micante gutta, seu saliente puncto – pagina 5), la *minima ignis scintillula* descritta da Harvey (cfr. ADELMANN, p. 958, nota 1). (Luigi Belloni, 1967)

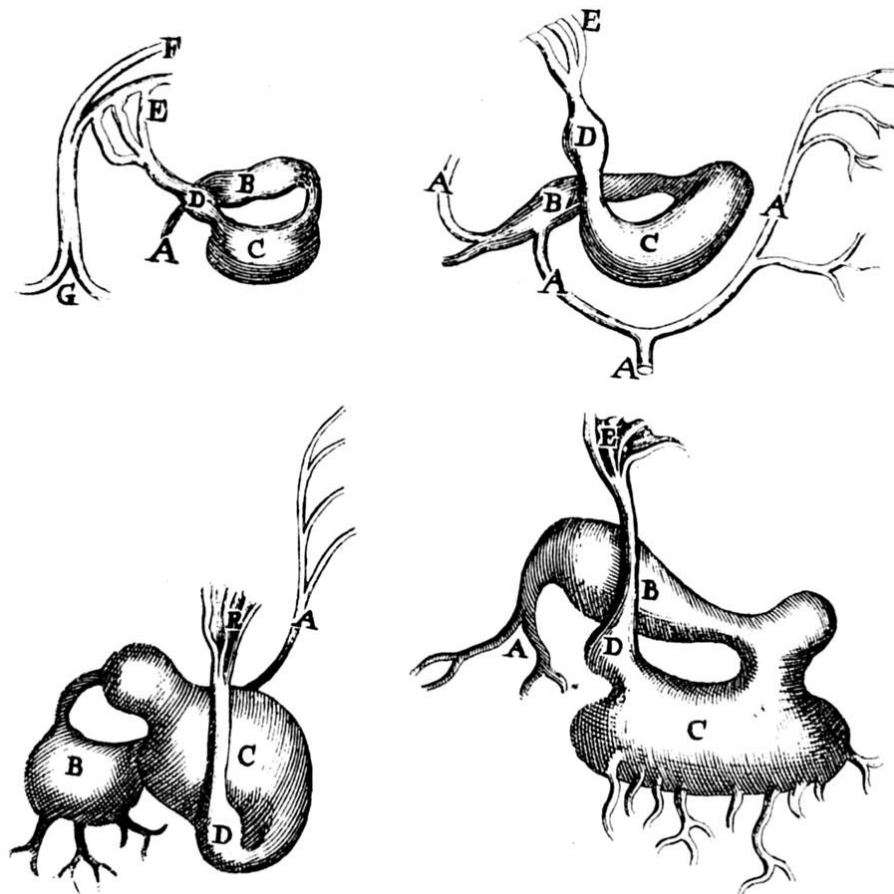


figura 15

Fig. 15. - Valde sollicitus eram circa *primaevam* Cordis apparentem formam, et, quam attingere potui a contento sanguine delineatam, hic habebitis. [7] Ex quibus patet, sanguinem perpetuo a venis *A*, a limbo deductis, deferri in auriculam *B*, a qua, brevi interdum intermedio canali, in dextrum cordis ventriculum *C* exprimitur, et inde in sinistrum *D*, et tandem in arterias *E*, a quibus in caput *F*, et umbilicalia vasa *G*.

Circa exaratos Sanguinis ductus fibrosa diaphanaque musculosae carnis portio extendebatur, ut subobscurè videbam; cuius necessitatem pulsus arguit. Non semel sanguineos ramos *A* a cordis auricula et dextro ventriculo elongatos licet deprehenderim; adhuc tamen haereo, cum mihi ambigendum occurrerit, productiones esse subiectorum Umbilicalium vasorum⁴⁵.

I was very attentive about the appearance of the primordial shape of the heart and you will find it here as I have been able to observe it outlined by the contained blood. From these images it is evident that always the blood from the veins *A* (fig. 15), coming from the band, passes in the auricle *B*, from which, through a sometimes brief intermediary channel, is pushed in the right ventricle *C* of the heart, and from here in the left *D*, and finally in the arteries *E*, and from them in the head *F* and in the umbilical vessels *G*.

Around the described blood's ducts a fibrous and diaphanous portion of muscular flesh was stretching, as I was able to observe in a rather uncertain way, and the pulsation shows the necessity of it. Even if I have observed not only once that the blood branches *A* are departing from the auricle of the heart and from the right ventricle, nevertheless I am still doubtful, being happened me a reason for doubting, if they are ramifications of the underlying umbilical vessels.

⁴⁵ Quali in realtà sono. (Luigi Belloni, 1967)

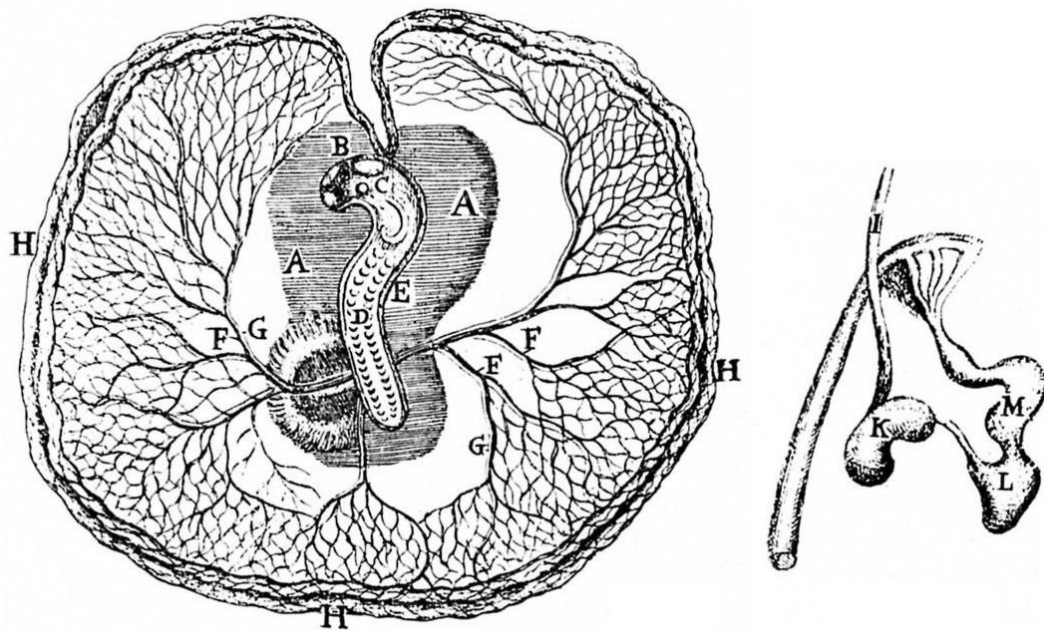


figura 16

Fig. 16. - Post *binos dies, horasque quatuordecim*, pullus pariter auctior redditus, in colliquamento *A*, curvo capite, pronus iacebat; cerebri vesiculae *B*, sanguineis vasis irrigatae, cum oculorum inchoamentis *C*; spinalis item medulla per longum exporrecta, vertebris *D* contenta, observabantur: Externum corporis habitum colliquamenti *E* portio, crassior et obscurior reddita, veluti involucrum⁴⁶, ambiebat: a corde emanabant sanguinea vasa, quae producta versus medium abdominis, umbilicales arterias *F*, et venas *G* etiam, promebant: Patebant autem venae *G*, una cum arteriis excurrentes, ex inverso sanguinis motu, et eandem fere magnitudinem cum arteriis acquisiverant. Extremus Umbilicalium vasorum limbus *H* sanguineis vasculis excitabatur crassefactis, vel saltem reticulariter implicitis. Placebat, repetitis observationibus, Cordis motum et figuram rimari, quae talis apparebat; Sanguis partim ab extremo limbo *H*, et a vena ascendente et descendente *I*, in auriculam *K* eructabatur; haec postea pulsu edito ipsum propellebat in cordis ventriculum *L*, qui constrictione media pallidus efficiebatur, et in proximum ventriculum *M*, et tandem in aortam protrudebat, a qua capiti, corporis habitui, et umbilico communicabatur.

After 2 days and 14 hours the chick had become meanwhile greater and was laying prone, with the bent head, in the colliquation *A* (fig. 16). The brain vesicles *B* were visible, bedewed by blood vessels, together with the ocular sketches *C*, as well as the spinal marrow longitudinally arranged and held by the vertebrae *D*. The portion of the colliquation *E*, made denser and darker, was surrounding, as if being a wrap, the outer part of the body. From the heart some blood vessels were departing that, going toward the middle part of the abdomen, sent forth the umbilical arteries *F*, and also the veins *G*. Really the veins *G*, flowing together with the arteries, were clearly recognizable from the inverse movement of the blood, and had acquired almost the same size of the arteries. The most outer band *H* of the umbilical vessels was composed of thickened little blood vessels, or at least woven as a net. I thought advisable to examine, with repeated observations, the movement and the shape of the heart appearing as follows: the blood, coming partly from the most external band *H* and from the ascending and descending vein *I*, flowed in the auricle *K*; then this, resorting to a pulsation, pushed it in the ventricle *L* of the heart, that at half contraction became pale, and pushed it in the near ventricle *M* and finally in the aorta, from which was sent to head, to bodily structure and to navel.

⁴⁶ Forse la plica cefalica dell'amnio. (Luigi Belloni, 1967)

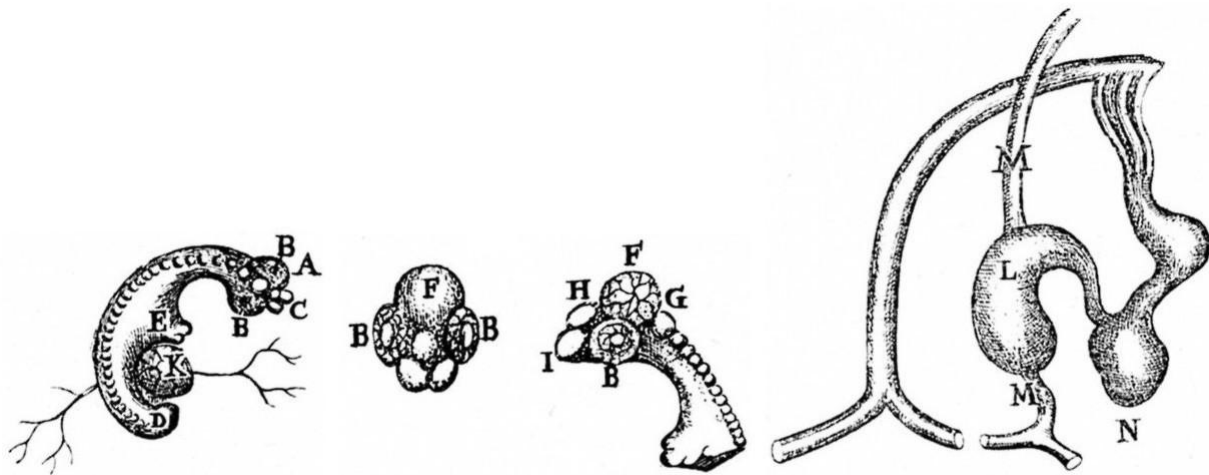


figura 17

Fig. 17. - *Transacto triduo*, curvo et prono corpore cubantem reperiebam pullum; in cuius capite *A*, ultra binos oculos *B*, quinque vesiculae *C*, humore turgidae, quibus coagmentatur cerebrum: Crurum quoque *D* et alarum *E* inchoamenta patebant. Vesicularum, cerebrum integrantium, situs et forma talis erat: In capitis vertice amplior locabatur vesicula⁴⁷, vasculis irrigata, hemisphaerae instar; haec subsequentibus diebus in binas dividebatur quasi vesiculas⁴⁸: Unde adhuc haereo, an a principio una an gemina sint vesiculae. In occipite triangularis quasi vesicula *G*⁴⁹ addebatur; sincipitis⁵⁰ vero profundam partem tenebat ovalis vesicula *H*⁵¹, cui proxime locabantur binae vesiculae *I*⁵². Corporis habitum inducta caro contegebat, ita ut sanguinis via non ita facile in oculos incurreret. Oculi *B* eminebant, et ipsorum pupilla nigra, circularique zona in ima parte discontinuata⁵³ excitabatur; centrum vero crystallinus vitreo contentus tenebat. Prope eruptionem umbilicalium vesicula *K* extra pendeat, sanguineis vasculis irrigata, quem carnosum ventriculum⁵⁴ censeo. Cordis compages talis erat, qualem hic exhibebo: Naturae enim mysterium, quod superius innuebam, hac die evidenter patebat;

When 3 days passed, I found the chick laying with a prone and bent body, and on its head *A* (fig. 17), besides the two eyes *B*, I found 5 vesicles *C* turgid of liquid, and of them the brain is made up. Also the sketches of legs *D* and wings *E* were evident. The arrangement and the shape of the vesicles composing the brain was the following: at the top of the head the greatest vesicle - *F* - was located, bedewed by little hemispheric vessels, and in the following days it was subdividing as in two vesicles; which is why I am still in doubt if initially the vesicles are only one or two. In the occipital place an almost triangular vesicle *G* was added and an oval vesicle *H* occupied the deep part of the sinciput, and near *H* were situated the two vesicles *I*. The superimposed flesh was covering the body surface, so that the way of the blood didn't easily penetrate in the eyes. The eyes *B* were bulging, and their pupil lifted in a black and circular band, interrupted in the inferior part; the crystalline contained in the vitreous body occupied the centre. Near the point of coming out of the umbilical vessels a vesicle *K* was hanging outside, bedewed by small blood vessels, I think it to be the muscular stomach. The structure of the heart was as here I will show: in fact in this day it was clearly evident the mystery of nature to which I was previously pointing. In fact the auricle *L*, receiving blood from the veins *M*, pulsated almost with a double movement, as if it was divided in two cavities, and so the blood was pushed in the heart through a way needing a further

⁴⁷ Il mesencefalo. (Luigi Belloni, 1967)

⁴⁸ I lobi ottici. (Luigi Belloni, 1967)

⁴⁹ Il metencefalo. (Luigi Belloni, 1967)

⁵⁰ Il sincipite è la parte più elevata del cranio.

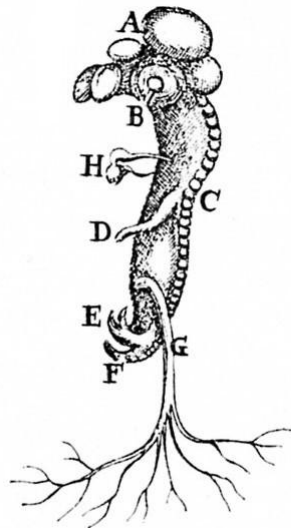
⁵¹ Il parencefalo. (Luigi Belloni, 1967)

⁵² Gli emisferi cerebrali. (Luigi Belloni, 1967)

⁵³ Per la presenza della fessura coroidea. (Luigi Belloni, 1967)

⁵⁴ È in realtà l'allantoide. (Luigi Belloni, 1967) § Allantoide: dal greco *allantoeidēs*, che ha la forma di salsiccia, essendo *allās* la salsiccia, il sanguinaccio. In embriologia, uno degli annessi fetali che, negli animali amniotici, ha funzione respiratoria, nutritiva ed escretoria per l'embrione.

Auricula namque *L* sanguinem [8] a venis *M* recipiens, quasi gemino pulsabat motu, veluti binis distincta ventriculis, et ita in cor sanguis quadam propellebatur via, quae ulteriori eget indagine. Dexter cordis ventriculus *N*, a primordiis notus, de more pulsabat, sinister vero et ipse distincto motu agitabatur, et latior indies reddebatur, donec consocio unius ventriculo pro sinistro manifestaretur; quod subsequentium dierum inspectionibus magis patebat.



pushed in the heart through a way needing a further investigation. The right ventricle *N* of the heart, known since the beginning, pulsated as usual, while also the left one got excited with a separate movement and was becoming larger day by day, until, joined with the other ventricle, it appeared as being the left one; this was more evident in the observations of the following days.

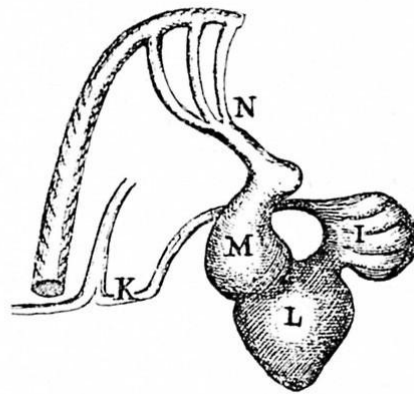


figura 18

Fig. 18. - *Quarta elapsa die* manifestior evaserat pullus. Perampli cerebri quinque vesiculae *A* adhuc patentes, magis ad invicem approximabantur, et laceratae ichorem etiam reddebant; oculi *B* magis tumidi expositam servabant figuram; alae *D*, et crura *E* magis elongata, solidiora reddebantur. Extremitas pariter carinae *F* uropygium constituta recurva prominebat; totum corpus adaucta mucosa carne tegebatur, et vasorum irrigabatur propaginibus; Interior cavae et aortae progressus condebatur, et funiculus umbilicalium vasorum *G* ab abdomine erumpebat sanguis per arterias propulsus rubicundo saturatoque inficiebatur colore; qui vero per venas regrediebatur, subluteus erat. Interius Ichoris⁵⁵ inchoamentum, et candida intestina cum carnosio praecipue ventriculo, mucosa tamen, manifestabantur. In aliquibus extra thoracem Cor *H* pendulum situabatur, cuius auriculae *I*, eidem magis approximatae, sanguinem a venis *K* recipiebant, et cordis ventriculis subministrabant: dexter etenim ventriculus *L* consuetam sortitus figuram,

When the 4th day passed, the chick was more evident. The five vesicles *A* (fig. 18), even more evident, of the very big brain, were more approaching each other and, when lacerated, they also sent forth a serosity. The eyes *B*, more swollen, were keeping the described appearance. The wings *D* and the legs *E*, longer, were becoming stronger. Item the bent extremity of the carina *F* was sticking out, that would have formed the uropygial gland*. The whole body was covered by mucous increased flesh and was bedewed by offshoots of the vessels. The inner way of vena cava and aorta was hidden, and the funicle *G* of umbilical vessels was emerging from the abdomen, and the blood pushed through the arteries was becoming tinged with a red saturated colour, while that getting back through the veins was yellowish. The sketch of the liquid - of the liver - and the very white bowels but mucous, above all with the muscular stomach, were visible more inside. In some embryos the heart *H* was pendulous outside the chest and its auricles *I*, closer to it, received the blood from the veins *K* and sent it to the ventricles of the heart. In fact the right ventricle *L*, endowed with the usual appearance, was connecting to the left ventricle *M*, which, being become greater, and the initial part of

⁵⁵ L'abbozzo del fegato. (Luigi Belloni, 1967)

sinistro *M* nectebatur, qui latior redditus, retracto aortae principio *N*, sensim debitam induebat formam: In aliis vegetioribus ovis, clausa levi tunica thoracis cavitate, cor intus celabatur, et sinister ventriculus deorsum pendulus consocio incumbebat ventriculo.

Post *quintam* diem in incubato ovo nil fere novi deprehendebatur praeter maiorem enarratorum manifestationem. Vasorum umbilicalium extremus limbus, vitellum ambiens, non excurrente trunco excitabatur, sed ipsorum extremi fines lateraliter curvati et reticulariter inosculati extremum sortiebantur terminum. Circa huiusmodi ramos, globuli seu placentulae, ex vitelli substantia excitatae, hinc inde haerebant. In Vitelli semisphaera, quae umbilicalibus vasis non tegitur, diversi alveoli, non dissimiles a cicatricis rivulis, excitabantur.

the aorta *N* having shortened, was gradually assuming the proper shape. In other more vigorous eggs, the thoracic cavity having closed through a thin membrane, the heart was hiding itself inside and the left ventricle, pendulous outside, was above the ventricle its companion.

After the 5th day almost nothing new was observed in the incubated egg, except a greater evidence of the described things. The most external band of the umbilical vessels surrounding the yolk was not made by a continuous tract, but their terminal segments, bent sideways and anastomosed as a net, were ending at the extreme periphery. Around such branches were sticking at both sides some globules or small bannocks derived from the substance of the yolk. In the hemisphere of the yolk, not covered by umbilical vessels, different small ducts non dissimilar from the rivulets of the cicatrice were taking shape.

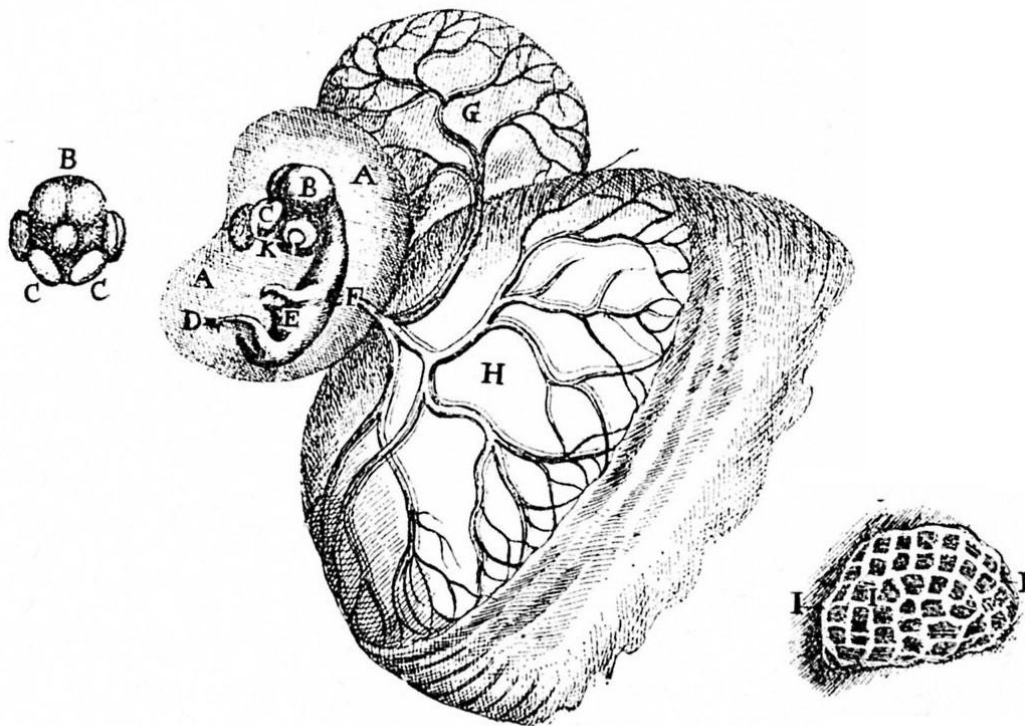


figura 19

Fig. 19. - *Sexti* superata die, taliter cubabat pullus in amnio *A*⁵⁶, insigni pollens capite, cuius amplior vesicula *B*, quasi gemina, oblonga excitata scissura, messoriae falci⁵⁷ fortasse locum praebebat, et lacerata nullum reddebat ichorem. Anteriores binae cerebri vesiculae *C*, humiliores redditae, subcrescente

When the 6th day was passed, the chick was found laying in the amnion *A* (fig. 19) in this way: it was endowed with a big head, whose almost doubled greater vesicle *B*, a lengthened fissure having taken shape, perhaps offered space to the reaping hook - the cerebral sickle or great sickle, and when lacerated it didn't send forth any liquid. The two anterior cerebral

⁵⁶ Entra finalmente in scena il vero amnio. (Luigi Belloni, 1967)

⁵⁷ In anatomia cerebrale umana esistono due falci: la falce cerebellare o piccola falce, prolungamento verticale e mediano della dura madre, che separa i due emisferi del cervelletto; la falce cerebrale o grande falce, il setto meningeo mediano e verticale che si insinua nella scissura interemisferica.

carne, parum obscurabantur, quibus appendebatur rostri inchoamentum: intercepta vero vesicula pene latitabat; quod et quintae, in occipite locatae, accidebat. Spinalis medulla, in binas divisa partes, solida per longum carinae exporrigebatur. Alae, et crura, exporrectis pedibus *D*, elongabantur. Abdomen *E* clausum, quasi hernia laborans, extra protuberabat. Erumpentia umbilicalia vasa *F* partim in tenue albumen *G*⁵⁸, vitellum et amnion ambiens, partim in vitellum *H* producebantur; et arteriae, graciliores redditae, venis ipsis valde [9] minores erant. In abdomine, Iecoris evidentior structura emergere incipiebat; reticularis namque compages *I* observabatur ex vasis et involucris structuram firmantibus, quibus miliares glandulae haerebant; et ita sensim spatia replebantur. Dubitavi interdum, quod, sicuti in testibus et conglobatis glandulis, exterius, et interius, musculosae carnaeque fibrae areas constituendo firmant et comprimunt glandularum molem, ita in iecore eadem reperiri possint. Iecoris color nondum rubicundus, sed ex candido subfuscus redditus erat. Cor interius conditum, licet mucosum, binis pulsabat ventriculis, a quibus lacertosae pendebant auriculae, duplici excitatae motu, mole adhuc insignes, una cum vasis candidis. Corporis exterior habitus cute obductus, vasorum reticularibus propaginibus irrigabatur, et evidentiores reddebantur tumores quidam, seu futurarum pennarum folliculi.

vesicles *C*, having lowered, were a little bit hidden by the growing flesh, and the sketch of the beak was hanging on them. The interposed vesicle was almost hidden, as it was happening also to the fifth vesicle located at the occiput. The spinal marrow, divided into two parts, was extending solid along the carina. The wings and the legs were lengthening and the feet *D* were enlarged. The abdomen *E*, closed, was sticking outside as suffering from hernia. The bursting umbilical vessels *F* were distributed partly in the thin albumen *G* surrounding the yolk and the amnion, partly in the yolk *H*; and the arteries, becoming thinner, were much smaller than the veins themselves. In the abdomen the structure of the liver started to emerge with greater evidence, and in fact was observed the reticular structure *I*, composed of vessels and wraps strengthening the structure, to which were sticking some small formations similar to grains of millet; and so the spaces were gradually filled. Sometimes I doubted that also in the liver the same muscular and fleshy fibres are available identical to those that, as in testicles and in compressed glands, outside and inside, by delimiting some areas, are strengthening and compressing the glandular mass. The colour of the liver was not reddish yet, but from snow-white became rather dark. The heart, hidden more inside, although mucous, pulsated with both ventricles, from which, together with white vessels, some strong auricles were hanging, stimulated by a double movement and increased in volume. The outside of the body, covered by skin, was irrigated by reticular offshoots of vessels, and some protuberances were becoming more evident, that is, the follicles of the future feathers.



figura 20

Fig. 20. - *Septima* terminata die ita configuratus iacebat pullus: Capite amplo et insigni pollebat, et cerebrum *A* etiam extra eminebat solitis contentum indumentis; quibus laceratis ichor iam fluidus in solida concreverat filamenta, ventriculorum

When the 7th day passed, the chick was shaped in the following way. It was standing out for the wide and big head, and also the brain *A* (fig. 20) was sticking out on the outside, held by usual coverings; when they were lacerated the liquid, formerly fluid, was consolidated in solid filaments forming the cavities of cerebral

⁵⁸ L'allantoide (allantocorio). (Luigi Belloni, 1967)

concamerationes excitantia. Inter amplos oculos sensim erumpebat rostrum. Alae et crura cum appensis pedibus omnimodam sortitae erant configurationem, et venter *B* tumidus turgentibus visceribus reddebatur. Umbilicalia vasa foras erumpentia, per vitellum et albumen producta elongabantur. Conclusum intra thoracem Cor hanc servabat figuram; geminis sc. ventriculis, quasi sacculis *C* contiguus, et in superiori parte unitis, cum superposito auricularum corpore *D* compaginabatur, et bini motus in ventriculis, totidemque in auriculis succedebant; deorsum enim retractum fistulosum corpus, quod in continuatas arterias sanguinem a dextro ventriculo receptum pulsu propellebat, sinistrum ventriculum mole maiorem iam excitaverat: circa utrosque musculosae spinales fibrae successive obducebantur, quibus cordis caro compaginabatur, et ambo ventriculi nectebantur, et ambiebantur. Auriculae et ipsae inaequales et rugosae ex laceratorum suborta implicatione redditae, quasi novum corculum binis distinctum cavitatibus constituebant; quod in adultis evidentius patet. Lacerata cute, carnibus, et mucoso peritoneo, renes oblongi cinerei coloris apparebant. Iecur ipsum, subluteo interdum suffusum colore, quandoque cinereo, auctius et solidius reddebatur, et ipsius glandulae non omnino rotundam et sphaericam referebant figuram, sed oblongiores et quasi caecales utriculos, ductui hepatico appensos, representabant; quod in aliquibus glandulosis hepatis racemis et miliaribus glandulis frequenter observatur. Ventriculus carnosus, licet adhuc exiguus, candidus erat, solitaque figura constans; appensa habebat intestina gracilia et alba.

ventricles. Among the big eyes the beak was slowly sticking out. The wings and the legs, with the suspended feet, had reached their complete conformation and the abdomen *B* was inflated by the entrails that were increasing in volume. The umbilical vessels, pushing their way outward, lengthened by extending themselves through the yolk and the albumen. The heart, held in the thorax, maintained the following appearance: that is, it was composed by two ventricles as being two small contiguous bags and joined in the upper part, with the overlap of the structure *D* of the auricles, and two movements alternated in the ventricles and as many in the auricles. In fact the tubular structure, that had lowered, with a pulsation pushed the blood received from the right ventricle in the following arteries, and already had stimulated the left ventricle that was greater in size. Around both ventricles were branching in succession some muscular spine-shaped fibres by which the flesh of the heart was made, and by which both ventricles were linked and surrounded. The auricles, also made unequal and wrinkled by the muscular neoformation, almost constituted a new little heart divided in two cavities, which is more evident in adult subjects. After the skin, the flesh and the mucous peritoneum had been lacerated, the lengthened and ash coloured kidneys were visible. The liver itself, sometimes suffused with yellowish colour, other times ash coloured, was appearing bigger and more consistent, and its structures didn't show a quite round and spherical appearance, but they seemed small cavities rather lengthened, and almost with blind bottom, hung on the liver duct, a thing often observed in some clusters of liver structures and in glands structured as grain of millet. The muscular stomach, although still small, was white, it showed the usual shape and had hung the delicate and white intestines.



figura 21

Fig. 21. - Post *octavae* diei incubationem grandior redditus pullus capitis amplitudinem

After the incubation of the 8th day the chick, that became bigger, still kept a big head, and when opened,

adhuc servabat, quo aperto, cerebri moles iam solidior erat; nam vesiculae olim disparatae, nunc unitae, geminas constituebant eminentias, in quibus ventriculi excitabantur, thalamus pariter seu exortus nervorum opticorum, et cerebellum cum principio spinalis medullae. Exterior corporis habitus tuberculis *A* exasperabatur, [10] a quibus pennae erumpebant, quae insigniores erant circa dorsum, et uropygium. Umbilicus *B* latus et amplus, ex amnii ambiente tunica, ultra sanguinea vasa, intestinula (velut in hernia accidit) admittebat. In aperto abdomine Iecur aeruginosum, in lobos divisum, soliditatem adquisierat; nondum tamen recollecta observabatur bilis. Cor de more pulsabat, et lateraliter pulmones candidi emergebant.

the cerebral mass was by now more compact. In fact the vesicles, before separated and now united, constituted two twin prominences in which the ventricles were forming and also the thalamus, that is the origin of the optic nerves, and the cerebellum with the beginning of the spinal marrow. The outside of the body was made rough by the bulges *A* (fig. 21) from which the feathers came out, that were more evident around the back and the uropygial gland*. The navel *B*, wide and ample, starting from the surrounding amniotic membrane, was housing, besides the blood vessels, the small intestines (as it happens in a hernia). In the abdomen, after was opened, the liver, rust in colour, subdivided into lobes, had acquired solidity, but a collection of bile was not yet perceived. The heart pulsated as usual and at its sides the white lungs were standing out.

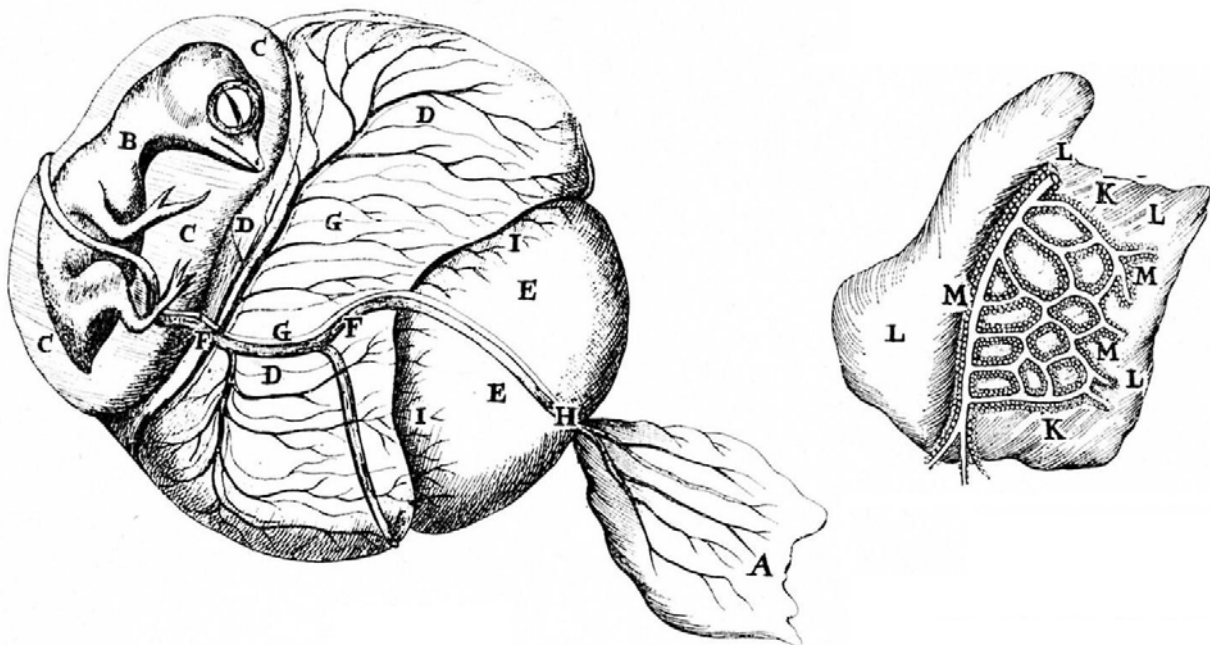


figura 22

Fig. 22. - *Decima* elapsa die, pullus ita cubabat, et ambientibus humoribus nectebatur: Laceratis membranibus, totum ovum circumvestientibus, et praecipue crassiori *A*, quae albuminis fusioem continebat, corii instar, substantiam, talis occurrebat species: Pullus *B* ita flexo corpore iacebat, innatans in humore *C*, propria tunica⁵⁹ contento. Subsequebatur continuatum vitelli involucrum *D*⁶⁰, cui appendebatur seu arcte haerebat crassior albuminis portio *E*. Singula haec venas *F*, et arterias *G*, umbilicales recipiebant; lata enim

When the 10th day passed, the chick was laying in the following way and was connected with the surrounding liquids. After the membranes wrapping the whole egg were lacerated, and above all the thickest *A* (fig. 22) that, as if made of leather, contained the more fluid substance of the albumen, the following scene occurred: the chick *B* was laying so, with the flexed body, swimming in the liquid *C* contained in its own membrane. Underneath was following the uninterrupted wrap *D* of the yolk, to which was suspended or tightly stuck the more dense part *E* of the albumen. Every one of these structures received the

⁵⁹ L'amnio. (Luigi Belloni, 1967)

⁶⁰ Il sacco vitellino. (Luigi Belloni, 1967)

vena *H* in tenuioris albuminis tunicam *A*⁶¹ deducebatur: Vitelli quoque tunica *D* venas et arterias recipiebat, quae non omnino totam ipsius peripheriam contegebant, sed relicto rotundo spatio⁶², quasi pupilla, qua crassiori albumini nectebatur, exiguos surculorum fines *I* in huiusmodi crassum albumen promebant. Elegantem circa vitellum productionem mirari licebat, dum evacuata huiusmodi tunica, et, diductis parum ipsius partibus, supra vitrum extendebatur. Arteriae mole minores erant ipsis venis, illae vero nequaquam perpetuo vitelli tunicae haerebant, sed elongatis extremitatibus invicem anastomizatis, caecas quasi appendices *K* premebant, quae a tunica *L* interius pendentes in vitelli ichore fusco innatabant, et mergebantur. Arteriis praecipue copiosi haerebant sacculi *M*, qui ambientibus sanguineorum vasorum rivulis firmabantur, et conglobata vitelli substantia turgebant: singulus utriculus plures globulos parum depressos continebat. Venarum et arteriarum umbilicalium rami nequaquam perpetuo unitim excurrerant, sed parum distantes elongabantur; et caecales arteriarum appendices a venis transversales surculos recipiebant. Vitelli ichor iam fluidior redditus subflavus, lentusque erat, et parum mole imminutus videbatur, multumque defecisse tenuior albuminis portio deprehendebatur. Pulli exterior habitus, alae praecipue et uropygium, costulis et musculis firmabantur, et pennis erumpentibus condecorabantur. Rostrum iam osseum reddebatur; scutum enim pendebat, cuius angularis portio, centrum occupans, primo candidam et osseam acquisierat naturam, hancque hexagonum quoddam fusci coloris corpus continebat, quod et ipsum quasi carnea consimili substantia ambiebatur. Oculi velamentis, et membrana, qua nicticant, contegebantur. Interius rubiginoso Iecori appensus pendebat Bilis folliculus, quae caerulea erat. Ventriculus carnosus una cum elongatis intestinis, rite configuratis, interdum abdominis cavitatem occupabat, quandoque extra pendebat; et in ventriculo nil deprehendebatur, in proximo vero intestino parum bilis stagnabat.

umbilical veins *F* and arteries *G*. In fact a wide vein *H* went to end in the membrane *A* of the more fluid albumen. Also the membrane *D* of the yolk received veins and arteries that however didn't cover entirely its whole periphery, but, leaving a round space free, almost as a pupil through which was linking to the more dense albumen, they sent thin endings of little vessels *I* into this dense albumen. Around the yolk it was possible to admire an elegant prolongation of them when, after such membrane had been emptied, it was stretched above a glass after having divaricated its parts a little bit. The arteries were of smaller dimensions in comparison to the veins and they didn't always stick at all to the membrane of the yolk, but, through lengthened extremities anastomosed each other, they dug as blind appendixes *K* that, internally hanging from the membrane *L*, were swimming and plunging into the dark liquid of the yolk. Numerous small sacks *M* mainly stuck to the arteries, and they were strengthened by the surrounding rivulets of the blood vessels and they were bulging because of the accumulated substance of the yolk. Every wrap contained numerous small round and not very crushed formations. The branches of the umbilical veins and arteries didn't flow at all always placed side by side, but remained a little bit distant, and the blind appendixes of the arteries received some transversal little vessels from the veins. The liquid of the yolk, already more fluid, was yellowish and viscous and seemed a little bit reduced in volume, and it was seen that the thinner portion of the albumen was strongly decreased. The external appearance of the chick, above all the wings and the uropygial gland, were consolidated by small ribs and by muscles and they were embellished by sprouting feathers. The beak became already bony; in fact a shield was hanging whose angular part occupying the centre had for the first time acquired a white and bony appearance, and a hexagonal body dark in colour contained this part, and also it was surrounded by an almost fleshy similar substance. The eyes were covered by voiles and by the nictitating membrane. Inside the rust coloured liver the pouch of the blue bile was suspended and hanging. The muscular stomach, together with the bowels that had lengthened and had normal appearance, sometimes was occupying the cavity of the abdomen, other times was hanging outside. And in the stomach nothing was found, while in the following bowel a little bit of bile was stagnant.

⁶¹ L'allantocorio. (Luigi Belloni, 1967)

⁶² Il c.d. ombelico ombelicale o vitellino (tra il sacco vitellino e il sacco dell'albumine). (Luigi Belloni, 1967)

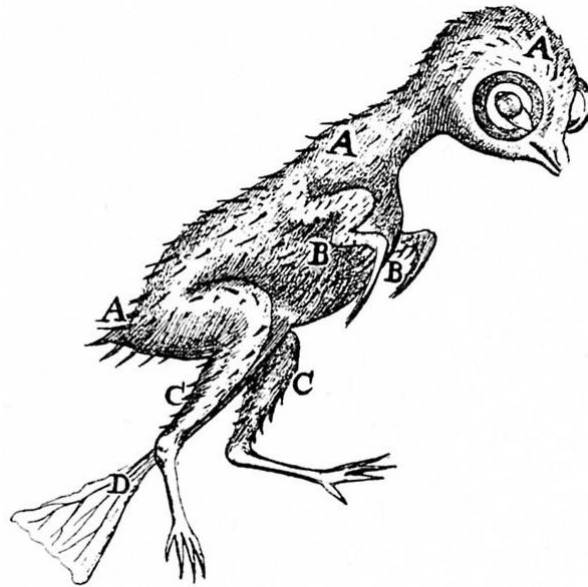


figura 23

Fig. 23. - Post *duodecimam* diem Pennarum eruptiones *A*, dorsi longitudinem contegebant, et ab extremis pariter alis *B* et coxis *C* erumpebant; subiectae vero partes quasi implumes erant. In ventre hiatus adhuc aderat, [11] quo umbilicalibus *D* patebat aditus, et quandoque etiam intestinis, et carnosio ventriculo. Fellea cistis, ab amplo iecore pendens, viridi turgebat humore, cuius portio in proximum intestinum eructabatur. Intestinulum a carnosio ventriculo erumpens glandularum⁶³ inchoamenta continebat. Pulmonum pariter compages emergebat, solidefactis costulis, et exterius extensis musculis.

After the 12th day the sprouted feathers *A* (fig. 23) were covering the length of the back, and likewise they sprouted from the end of wings *B* and thighs *C*, while the ventral areas were almost unfledged. In the abdomen was still present an opening through which the access to the umbilical vessels *D* was opening and sometimes also to bowels and muscular stomach. The gall bladder, hanging from the big liver, was bulging with a green liquid, part of which was flowing in the nearby intestine. The small intestine emerging from the muscular stomach contained sketches of glands. Also the structure of the lungs was evident, the small ribs were consolidated and externally the muscles were expanded.



figura 24

⁶³ Il Malpighi allude verosimilmente al prestomaco con gli abbozzi delle ghiandole che descriverà diffusamente nel trattato *Sulla struttura delle ghiandole conglobate e parti affini*. (Luigi Belloni, 1967)

Fig. 24. - *Decima quarta* die transacta, iam fere perfectus erat pullus; pennae *A* auctiores et copiosiores eminebant; musculosa caro sub cute turgebat; ossa fere soliditatem adepta erant; viscera clauso quasi abdomine debitam circumscriptionem sortiebantur; felleus folliculus subviridis interdum, quandoque caeruleus, a iecore pendeat, quod pertranseunti umbilicali venae parum continuabatur: In carnosio ventriculo lac stagnabat, et proxima intestini portio mucosam quodam candido replebatur, glandulaeque copiosae⁶⁴ intra eiusdem substantiam, interserebantur. Cor *B* unitis ventriculis compaginabatur, et plures arteriae *C*⁶⁵ tubuli, veluti manus digiti, olim a corde distantes, iam immediate haerebant; Auriculae *D* pariter amplae et impense rubicundae lacertis componebantur reticulariter implicitis, ita ut areae et spatia diversi coloris cernerentur.

Singula haec manifestiora magisque firma reddebantur absumptis humoribus, praecipue utroque albumine, et quasi dimidia vitelli portione, tribus decorrentibus hebdomadis, quo tempore in lucem proditurus erat pullus, qui adhuc inclusus pipiens audiebatur. Huius carnosus ventriculus concreto turgebat succo quasi lacte vel oxygala: superior intestinorum portio subviridi succo, inferior autem cinereo replebatur humore, et ab hiante vitelli brevi ductu liquorem recipiebat; extrema vero intestina cum binis appensis caecis stercoraceo humore inficiebantur. In abdomine exterius carnosae quaedam labia patentem umbilici hiatus constituebant, quo admittebatur umbilici portio extra pendens; funiculus enim quasi nerveus erumpebat, qui sanguineis vasis spiraliter ductis⁶⁶ circumambiebatur. In corii⁶⁷ cavitate reticularis alborum ductuum plexus quasi gracile omentum observabatur, mucosa et

When the 14th day passed, the chick was already almost completed. The feathers *A* (fig. 24) were sticking out greater and more numerous, the muscular flesh was swollen under the skin, the bones had almost reached the compactness, the entrails, the abdomen being almost closed, had a right delimitation, the gall bladder, sometimes greenish sometimes blue, was hanging from the liver, which was loosely linked with the umbilical vein crossing it. In the muscular stomach some milky juice was stagnating and the nearby portion of the bowel was full of a white mucus, and numerous glands were disseminated in its structure. The heart *B* was composed by the ventricles joined each other, and numerous arterial little ducts *C*, as fingers of a hand, before distant from the heart, now were tightly sticking to it. The auricles *D*, equally wide and intensely red, were composed by tortuous muscles arranged as net, so that areas and spaces of different colour were perceived.

Everyone of these structures was becoming more apparent and more solid after the disappearance of the liquids, above all of the two albumens and of almost half the yolk, three weeks being passed, the moment when the chick was about to come to the light, and still shut up it was heard peeping. Its muscular stomach was turgid of a dense juice similar to milk or to sour milk. The upper portion of the bowels was full of greenish juice, while the lower was full of an ash coloured liquid and was receiving liquid from the short duct of the yolk that was open. The terminal portions of the bowels, with both caecal appendixes, were full of a stercoraceous liquid. Externally, at abdomen level, some fleshy lips delimited the gaping opening of the navel, through which was entering the portion of the navel hanging outside: in fact a funicle similar to a nerve, surrounded by spirally shaped blood vessels, was coming out. In the cavity of the chorion a reticular plexus of white ducts was observed similar to a thin omentum sprinkled with mucous and snow-white substance. I am still uncertain if with its help a part of

⁶⁴ Il Malpighi allude verosimilmente al prestomaco con gli abbozzi delle ghiandole che descriverà diffusamente nel trattato *Sulla struttura delle ghiandole conglobate e parti affini*. (Luigi Belloni, 1967)

⁶⁵ Da sin. a d. nella figura: il tronco aortico, le due arterie anonime e il tronco polmonare. (Luigi Belloni, 1967)

⁶⁶ Forse il peduncolo allantoideo coi rimanenti vasi sanguigni dell'allantoide. (Luigi Belloni, 1967) § Allantoide: dal greco *allantoeidēs*, che ha la forma di salsiccia, essendo *allās* la salsiccia, il sanguinaccio. In embriologia, uno degli annessi fetali che, negli animali amniotici, ha funzione respiratoria, nutritizia ed escretoria per l'embrione.

⁶⁷ Còrion: dal greco *chórion* = membrana, membrana che avvolge il feto, membrana dell'uovo. Annesso embrionale degli Amnioti, costituito da una membrana che, avvolgendo l'embrione (racchiuso nell'amnios), l'allantoide e il sacco del tuorlo, delimita con la propria parete anche la cavità del celoma extraembrionario. Nei rettili, negli uccelli e nei mammiferi lo sviluppo embrionale è caratterizzato da aree extra-embriionali dette annessi embrionali. Si tratta di amnios, corion, sacco vitellino, allantoide e placenta, quest'ultima presente nei soli mammiferi placentati. § Trattasi, in realtà, della cavità allantoidea contenente frustoli di urina solida (masse di urati). (Luigi Belloni, 1967)

candida aspersum substantia: Adhuc ambigo, an eius ope albuminis portio versus foetum deducatur, an vero sit chalazarum vestigium? Vitelli folliculus ichore semiplenus intra abdominis claustra custodiebatur.

Postremo, disponebatur pullus ad exitum; Exterioris namque corticis interdum ingens portio avulsa videbatur, et parum laceratis subiectis tunicis pulli rostrum et capitis extremitas erumpebat, non ita tamen ut ambientem corticem urgere posset; quare a gallina quandoque corticem aperiri credibile est.

the albumen is carried toward the fetus, or rather it is a residue of the chalazas. The sack of the yolk, half-full of liquid, was kept and shut up inside the abdomen.

Finally the chick was getting ready to go out: in fact sometimes it was seen that a sizeable part of the outer shell had been removed and being that the underlying membranes tore a little bit, the beak of the chick and the extremity of the head were coming out, but not insomuch to be able to force the surrounding shell, which is why we can believe that sometimes the shell is opened by the hen.

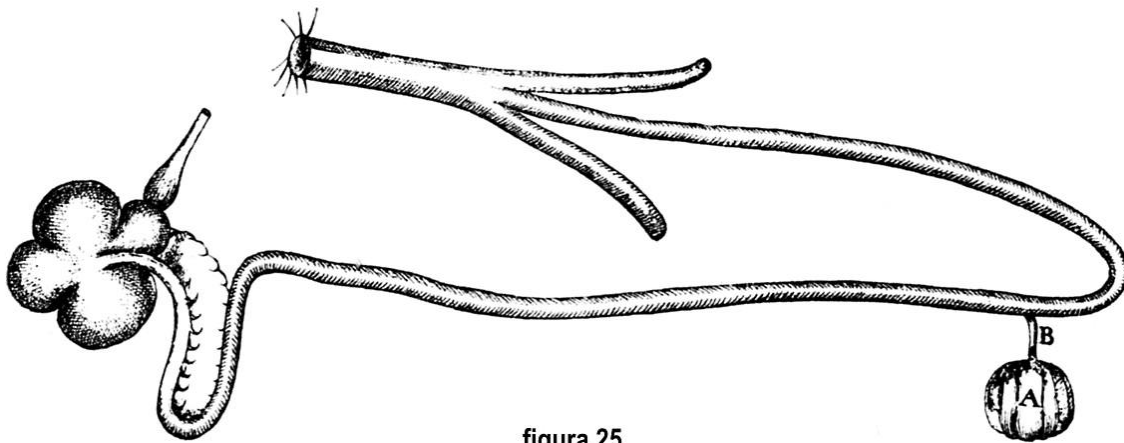


figura 25

Fig. 25. - In dissecto pullo die quarta ab ortu, vitelli folliculus hanc servabat figuram A, cum fere ex toto exinanitus brevi ductu B in mediam intestini partem hiaret; unde saepius dubitavi, ab extremis arteriarum finibus oleosam liquefieri materiam, reliquam vero, lentum scilicet humorem, reollectum in folliculi cavitate, velut excrementum in proximum propelli intestinum, cum longe a ventriculo et tenuibus intestinis eructetur.

In the chick sectioned the fourth day from birth, the sack of the yolk was keeping the appearance A (fig. 25) and, almost entirely emptied, it was opening in the middle portion of the bowel through the brief duct B. Therefore I rather often doubted that the oily material was liquefied by the extreme arterial terminations and that the remainder material, that is the viscous liquid gathered in the cavity of the sack, was pushed in the nearby intestine as if being an excrement, since it was poured far from stomach and small intestine.

[12] Hucusque latentis olim in Cicatrice pulli manifestationem, et ortas ibidem mutationes, quas in tam obscuro et profundo Naturae penu inquirebam, et suboscure deprehendebam, in compendium redactas tumultuarie Vobis exaravi. Abstini vero ab exponendis reliquis Ovi partibus, cum passim ab aliis recenseantur; hoc unum innuens, sex esse tunicas⁶⁸, quarum binae sub cortice immediate locatae sanguineis vasis non pervaduntur, reliquae vasa recipiunt, et humores varios, albumen scilicet tenuius et crassius, materiam amnii, in qua natat pullus, et vitellum continent. Successivam etiam

Up to this point I gave you the summarizing and hasty description of the chick showing itself, previously hidden in the cicatrice, and of the changes here arisen, that I was investigating and nebulously observing in a so dark and immense buttry of foods of nature. In truth I abstained from exposing the remaining parts of the egg since they are discussed here and there by other people. I confine myself to mention only this, that the membranes are six, two of which, situated immediately under to the shell, are not crossed by blood vessels, the other ones receive vessels and contain different liquids, that is the albumen which is the thinner and the thicker, the material of the amnion - the amniotic fluid - in which the chick swims, and the yolk. I also omitted

⁶⁸ Ossia: la testacea esterna, la testacea interna, l'allantocorio, il sacco dell'albumine, l'amnio, e il sacco vitellino. (Luigi Belloni, 1967)

humorum mutationem omisi, cum fuse apud alios habeatur. Hoc unum addam, tenuius albumen, Chorion contentum⁶⁹, igni appositum interdum evanescere, praecipue a die decima usque ad pulli exitum. Idem frequenter accidit contento succo in amnio, qui in tenello tamen pullo secundum aliquam sui partem concrevit, in adulto vero, et mox nascituro praecipue, salsus redditus igne evaporat: Humor pariter in folliculo vitelli coadunatus igne et aere calido concrevit. Ex his itaque interdum dubitavi, humorem, foetum immediate ambientem, nutritivas quidem commixtas servare partes, quae ventriculum patenti oris via subingrediantur, et fortasse extremi habitus laxos subintrent meatus; sed luculenter insuper fermentativis succis ditari, qui analogi sint *lympbae*, caeterisque humoribus a glandulis praecipue extremi habitus separatis; unde colliquamentum in cicatrice observatum, et a primordiis pulli stamina ambiens, hanc eandem sapere naturam saepius dubitando cogitavi.

Pro exaratorum faciliori intelligentia, ut mos est, addenda esset Spermaticorum vasorum in *Gallo* delineatio, et praecipue binarum mammillarum, quae extra erumpentes, semen fundunt; Gallinae pariter Ovarii cum ani appendicibus, in quibus glandularum copia extat. Hos autem differo labores, et alias, Vobis ita consulentibus, ulteriori instituta indagine exponam.

Quadrupedum, et Viviparorum foetuum perquisitionem, cum potiora otia et regias pene impensas⁷⁰ exigat, iam pene despero. Paucas interim hasce observationum adumbrationes in tam grandi opere inconcinne collectas, solita, qua favetis, humanitate excipite, Sodales doctissimi, et singulorum instituta discussione, vel novos indicate labores, vel perpetuo feriari iubete. Diu valeatis.

Dabam Bononiae, Calendis Februarii 1672.

the following change of the liquids since among other authors it is abundantly available. I would add only this: the thinner albumen, contained in the chorion, when put on the fire sometimes evaporates, above all starting from the 10th day up to the birth of the chick. The same thing often happens to the liquid contained in the amnion, that nevertheless in the youngster chick partially coagulated, while in the adult chick, and above all in that next to be born, on the fire becomes salty and evaporates. Item the liquid picked in the sack of the yolk coagulates at fire and warm air. Therefore on the basis of these observations sometimes I doubted that the liquid immediately surrounding the fetus contains some mixed each other nourishing fractions that would enter the stomach through the accessible way of the mouth, while perhaps they are penetrating through the wide meatus of body surface; but that besides the liquid is abundantly enriched with fermentative juices that would be analogous to lymph and other liquids secreted by the glands, mainly by those of body surface. Then repeatedly I thought with some doubts that this same nature was concerning the colliquation observed in the cicatrice and surrounding since the earliest stages the sketches of the chick.

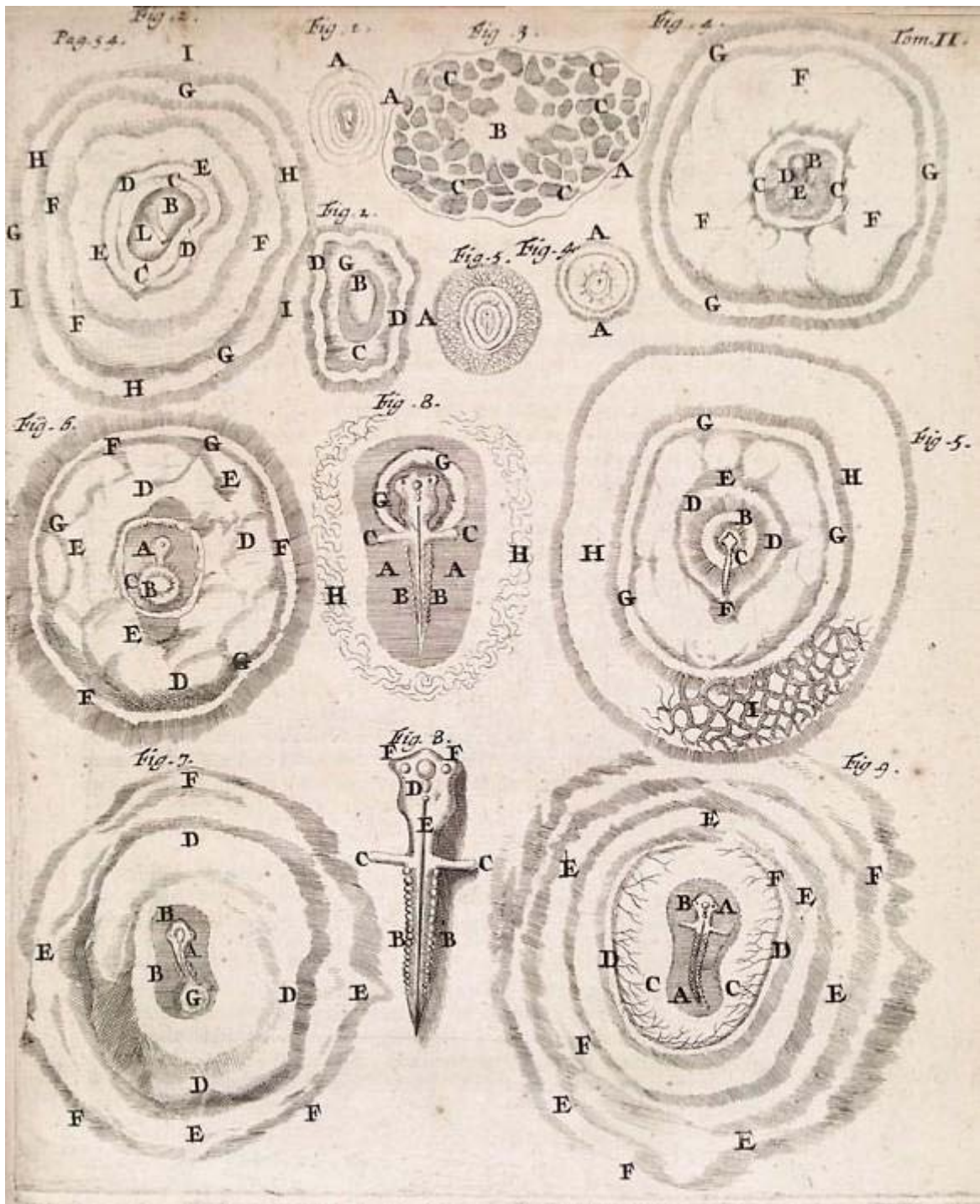
For an easier understanding of the described things, the drawing of the spermatic vessels in the rooster should be added as a rule, and especially of the two papillae that, when coming out, are pouring the semen; likewise of hen's ovary with the anal appendixes in which abundance of glands is found. But I send back these jobs and I will relate them in another relationship, if you will advise me to do it after having done further researches.

By now I almost despair to be able to do researches on fetuses of quadrupeds and viviparous, since they asks more spare time and almost royal expenses. In the meantime, very learned Colleagues, please receive with the usual benevolence, by which you sustain me, these few sketches of observations awkwardly gathered in such a great enterprise; and after having discussed every single thing, point out me new researches or enjoin me to rest forever. Do well for a lot of time.

I was delivering in Bologna on February 1st 1672

⁶⁹ Ossia, l'allantocorio. (Luigi Belloni, 1967)

⁷⁰ Echeggia qui l'inno di Harvey al mecenatismo del re Carlo I. Si veda anche la *Lettera a J. Spon.* (Luigi Belloni, 1967)



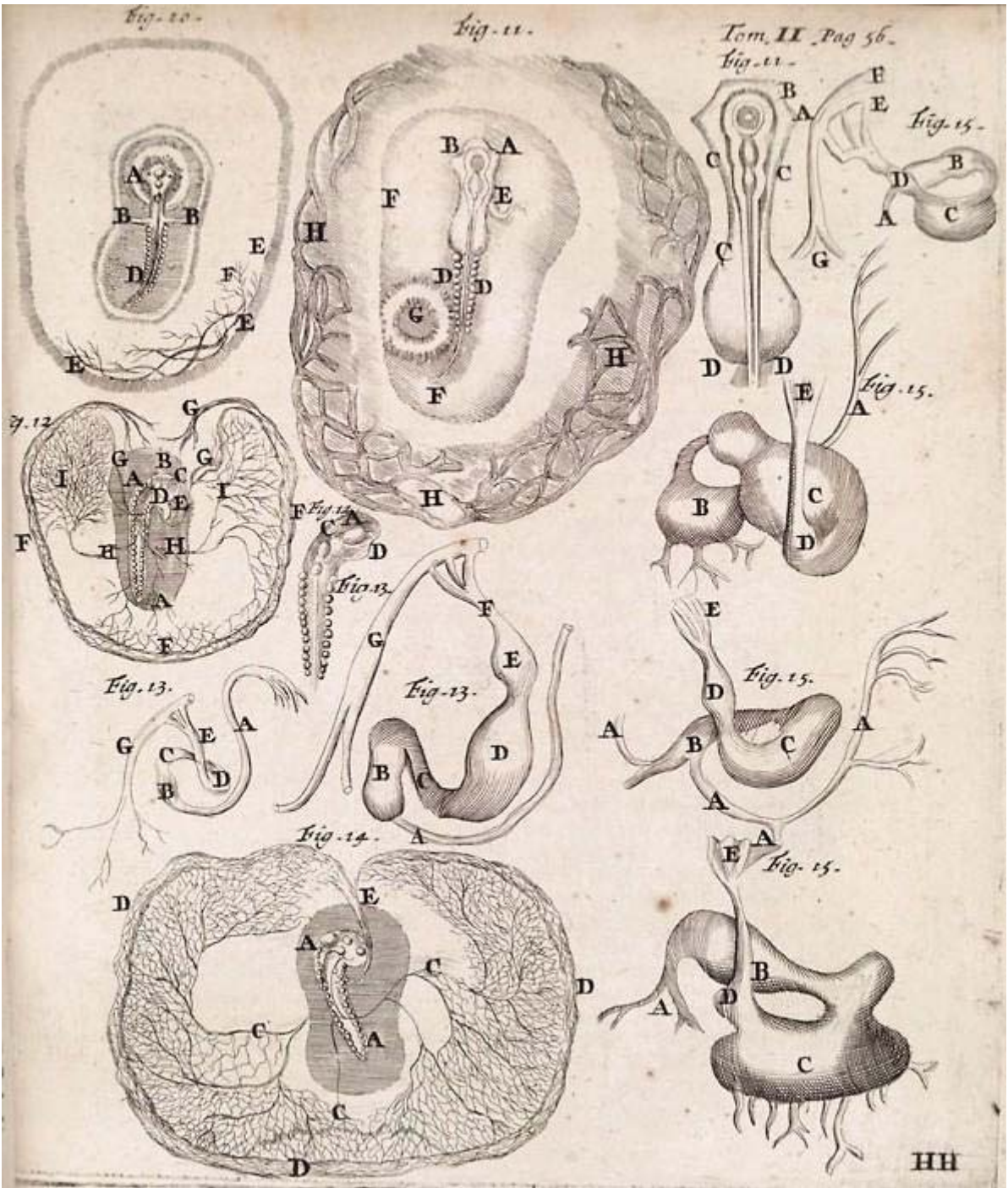


Fig. 16.

Fig. 16.

Fig. 17.

