[A translation of Anders Adolf Retzius, 1830 [1831], "Anatomisk undersökning öfver några delar af *Python bivittatus* jemte comparativa anmärkningar", *Kongliga Vetenskapsacademiens Handlingar,* for the year 1830, part I (Stockholm). Numbered footnotes in this translation are Retzius' originals, although the numbering scheme is necessarily different; footnotes otherwise denoted are my own clarifications. In cases of uncertainty, the original text is given in quotation marks in square brackets after the text; plain text in square brackets represents my own clarifications. Translation ©2019 by Krister T. Smith]

Anatomical study of some parts of *Python bivittatus* together with comparative remarks

by

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Since comparative anatomy received its first real foundation through Cuvier's lectures at the end of the last century, the further perfection of the Science was promoted incomparably more than ever before. Thereafter the contemporary and multiplying Anatomists could bring about ["anställa"] more complete and exact studies than those which in science's less structured age had been possible for the great man, whose call [instead] was to comprehend the whole and, effectively, invent a whole new science. Those discoveries and corrections, which since have come into the light of day, run to all systems of organisms, to all the classes and orders of the animal kingdom. But it was long before the need for a more complete Anatomy of the Amphibia drew anyone's attention, up until MECKEL gave a full and comprehensive description of their respiratory and digestive organs. TIEDEMAN and BOJANUS made unforgettable contributions to the knowledge of the special lineages Draco and Testudo. With the exception of MECKEL's detailed work, which encompassed the whole order of the amphibians, the remaining snake anatomists concerned themselves almost exclusively with the venom organs and the glands of the head, until SCHLEMM gave an outstanding and correct description of the vascular system; he who devotes any special attention to this order of animals soon discovers that an equally careful study of the the nerves, organs of sense, and internal organs of the snakes will not be fruitless, however simple their construction might be thought to be on external examination.

The past autumn (1829) I received through the kindness of Mr. Professor NILSSON the opportunity, rare in the Nordic regions, to anatomize several parts of a newly dead *Python bivittatus* (Kuhl), which a short time before had arrived in Stockholm on a ship from Java. The animal was a female 16 feet† in length and had suffered from a wasting sickness. The results of my studies I also have the

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† A Swedish foot (*fot*) measures 29.69 cm (that is, slightly less than an English foot) and, except for very particular subjects, is not in use today. It appears, however, that Retzius refers in this work to the French foot, which came to ~32.7 cm (see next page).

honor of presenting.

Just below the skin there was an abundance of atheromatous nodes in the cellular tissue. Their size varied from the volume of a little pea to that of a fava bean ["välsk böna"]; they were enveloped in rigid sacs and contained a gray-yellow, viscous, nearly putty-like substance. Several suchlike also were encountered in the stomach and intestine, and doubtlessly arose as the result of a sickly condition.

The shape of *the eyes*, if by the eye one really means the more rigid capsule that is built of cornea and the sclera, was spherical; their diameter was 4½ lin. measured after the French fashion.*

The *cornea* was thick and on the front had nearly the same curvatureas the sclera but sloped somewhat more toward the edges. The diameter of the cornea was slightly smaller than that of the eye itself, namely 4 lin. It is located on the outside off the sclera and terminates with an outwardly wedge-shaped, sharpened edge, which the sclera again clasps.[1] Because the sclera are darkly colored both outwardly and on the inner side, there arises by this double mounting two darker borders, of which the front one is brown, the back one black.

The *sclera* are rather thick, and evenly so, without bone, and darkly colored on the outer as well on the inner side. In the place where the optic nerve enters is a single hole. The eye muscles, which are six in number, terminate behind the midpoint of the bulbus.

The *choroidea* is of fairly loose weave and richly provided with pigment on the side facing the sclera as well as on the one which verges on ["veter mot"] Ruysch's membrane [=choriocapillary layer], and on this latter the pigment forms a dark brown layer, rather dense ["tätt"] compared with the size of the eye.

Ruysch's membrane is quite apparent. It lines said pigment layer of the choroidea and gives the wall of the cavity a greenish gray hue. It terminates at the border of the ciliary body.

The *retina* is also rather thick. Because the eyes had lain for some time in spirits, it had taken on a yellowish color, was totally opaque, and seemed to terminate at the edge of the *zonula Zinnii* [=hyaloid membrane]. Upon opening of the eyes, it collapsed in its posterior portion and fell apart, so that I never came to study that place where the fovea [? "svarta punkten"] usually sits. The *optic nerve* passed undivided, obliquely through the sclera, and became somewhat narrower at the ingress.

The *vitreous body* takes up little space in comparison with the lens; its anterior portion surrounded somewhat more than half the lens.

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* By analogy with the English, the Swedish thumb or inch (*tum*, or *verktum*) was defined in 1665 as 1/12 of a *fot*. A line (*linje*) was then defined as 1/12 of a *tum*. In 1855, long after the ostensive institution of the decimal SI system in the French Revolution, the *linje* was officially redefined as 1/10 of a *tum*, and the *tum* as 1/10 of a *fot*. ("Lines" were also used in English, meaning 1/10 or 1/12 of an inch, especially in the manufacture of munitions.) The SI system was adopted in Sweden at long last in 1889. Based on the dimensions he gives of the tongue (p. 5 of this translation), Retzius clearly means for a *tum* or *fot* to have 12 *linjer* or *tummar*, respectively. According to the kind folks at the Svenska Akademien (pers. comm.), *fr. m.* (sometimes *Fr. m.* in the text) probably stands for *franskt mått* ("measured as in France"), evidently pointing to the French foot, in which system the *tum* comes to 27.2 mm and the *linje* to 2.27 mm. Hereinafter, I use the abbreviation "in." for inches and "lin." for lines. (Additional source: A. W. Carlsson, 1989, *Med mått mätt: svenska och utländska mätt genom tiderna*. LTs förlag, Stockholm.)

[1] Pl. 1*, Fig. 2.

The zonule of Zinn was quite apparent, but without all the folds ["fållor"] or openings. It is composed of a flat band, which forms a ring around the anterior portion of that part of the vitreous body which borders on the opening in which the lens is located. Its flat anterior surface is covered by the ciliary body. Its outer edge joins the retina, the inner one the annular pad ["föreningsringen"] between the corpus ciliare and lens capsule. It is completely unmistakable that it is formed of its own membrane, which when macerated in schnaps ["bränvin"] turns whitish and half-opaque, whereas the retina becomes opaque and yellow with the same treatment; likewise, it is very well differentiated from the membrane of the vitreous body, which is much clearer; and besides its outer edge stands out somewhat above this latter. A few linear, dispersed, very weak splotches of pigment had remained on it. Whether there is any *canalis Petiti* here or not, I could not determine for want of sufficiently fine instruments.

A *ciliary body* is also found in this snake; had I not first encountered the zonule, I would probably have overlooked it, because the posterior surface is completely smooth. It begins just behind the outer edge of the iris, posteriorly adjoins Ruysch's membrane, which therefore ["sålunda"] does not line it, and is somewhat more than ½ French line wide. Because the zonule, with which it is united, follows the vitreous body with preparation but Ruysch's *tunica* follows the pigment of the choroidea, the ciliary body appears in the region of the eye just mentioned as a dark-colored band, whose pigmentary lining is rather thick, black-brown and free ["fritt liggande"], without its own cover. This structure, important for the functions of the eye, also has here an inwardly projecting, sharpened but even edge, in which the capsule of the lens is fastened,[2] and by means of which this organ acquires an anterior surface turned toward the iris and separated from the hinder, smooth one, which is somewhat if fairly weakly striated ["strålfårad"]; its striae ["strålfåror"][3] are actually seen in the very union with the iris. The posteriorly facing surface is, just as mentioned a moment ago, completely smooth, so that ciliary folds ["ciliar-fållor"] and lamellae on it are lacking entirely.[4] Otherwise the structure itself is fairly low and slightly projecting.

As is known, the snakes are said to lack this organ.[5] D. SÖMMERING maintains that it is absent in Coluber Æsculapii.[6]

The *lens* with its capsule is round as a ball (spherical), close to 2¾ French lines in diameter. Between the lens itself and the capsule a small quantity of a thinner fluid could be distinguished.

The *iris* has nearly the same diameter as the bulb cavity, that is, it is fairly large. Posteriorly it is lined by a thick layer of darker, soot-brown pigment; the front side, however, is somewhat lighter. Before the pigment from the uvea was washed off, several densely packed ringlike furrows ["fåror"] were noticed, which later disappeared. The pupil is elliptical; because it could not be observed before

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[2] Pl. 1* Fig. 1 a.
[3] Pl. 1* Fig. 1 b.
[4] Pl. 1* Fig. 1 c.
[5] CUVIER's *Vergl. Anat.* Pt. 2, p. 384. [*Retzius evidently had a translation.*] RUDOLPHI *Physiol.* 2 B. 1st part, p. 193.
[6] D. W. SÖMMERING, *de Oculorum Hominis animalium - que sectione Horizontali commentatio.* Gottingæ [*Göttingen*] MDCCCXVIII. p. 62. "Choroidea-immendiate in iridem transit. Neque enim plicæ, neque processus ciliares ulli conspiciuntur, neque prominens margo in coronæ ciliaris-loco, sed lævis hæc & glabra ab uvea omnino non dis terminata, æque ac illa pigmento atro obducta."

the eye was removed and opened, I cannot determine whether it was oriented obliquely or vertically. Presumably the latter is the case.[7] The pupil's margin if somewhat uneven, and the length of the opening itself was approximately half the diameter of the iris. The outer margin was fairly tightly united with the sclera by means of a white, protruding fringe, just in the place where [the sclera] is contacted by the cornea ["der denna är uti cornea infälld"].

The *conjunctiva of the eye* runs from the cornea to the side parts of the bulbus, where it is firmly attached ["fastväxt"] to the sclera by a loose cellular tissue; just behind the middle of the sclera it separates somewhat from the same, and ["i det"] the space between is filled by an even denser cellular tissue and runs even further posteriorly in order to enclose ["omsluta"] the package which is thereby built from the eye's muscles, blood vessels and nerves. After running somewhat more than a line behind the bottom of the bulbus, it turns forward again, united outwardly with a thick layer of cellular tissue which diminishes anteriorly. Toward the area of the cornea the *adnata* becomes completely translucent, like another cornea, and arched, and at the same time is covered by a thin, shiny, completely transparent keratinous layer ["vattenklar hornlamell"], which is a continuation of the epidermis. This keratinous layer is the one which follows when the animal sheds its skin, and sits framed by the orbital ring, which is built by the ocular scales, like a round, convexoconcave glass pane. This beautiful layer retained its complete clarity after several weeks' maceration in water. Thus, one cannot say that the snakes lack the *adnata*, only the adnatal epithelium ["*adnatæ epithelium*"]. In the indicated way the conjunctiva builds a closed sac, which, like a mucus membrane has a pars reflexa, which lines the organ, and a pars parietalis, which encloses it in a capsule. Between these a cavity is formed. It is J. CLOQUET whom science has to thank for the real investigation of this part, where he has shown that the tears are produced here, keeping the cavity full and also flow down from here into the mouth through the sinus intermaxillaris.[8] The actual lacrimal duct I could not demonstrate here, because they were damaged during the removal; but in the posterior-most part of the conjunctival sac, exactly in the fold which it forms after having covered the eye muscles in order to pass into the outer wall of the sac, five very small, darker papillae are visible, each with a little opening in the middle of it, which probably are tear-duct openings.

The *lacrimal glands* are 1 in. long, 8 lin. wide, consisting of a larger, triangular posterior portion, which is thick toward the back end, and anterior of this there sits a smaller portion, which is thin and wide, with three flaps. The whole gland, with the exception of the posterior end or tip, is rolled up and surrounds the packet of the eye-muscles, outside of which the nerves and blood vessels of the eyes also lie.

The *mouth*. The teeth were surrounded by sac-like grooves of mucus membrane, which constituted the gums, and were affixed partly to the cheeks, partly to the bony palate ["gomramen"]. Medial to the cheek teeth replacement teeth lay embedded, and the corresponding ones for the palatal teeth lay on their outer side. They do not develop in bony alveoli but from papillae which sit in the

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[7] In Vipera Berus the pupil is also elliptical, vertical; thus BLAINVILLE's statement, "la pupille des serpens toujours ronde" [*the pupil of the snakes always round*], is completely incorrect; see his [*De l'organisation des animaux, ou*] *Principes d'Anatomie comparee* [sic] Pt. 1:0 Paris 1822. pag. 418.

[8] RUDOLPHI *Physiol.* 2nd B: Pt. 2, p. 60. J. CLOQUET *Memoire sur l'existence & la desposition des voies lacrymales dans les Serpens*. Paris 1821.

bottom of the corresponding depressions of the gum, so that they are so to speak ["så tillsägande"] affixed to the margin of the bone. Amongst the replacement teeth there were several different developmental grades. Some were completely developed, but soft at the back end and filled with a reddish pulp; others were much smaller and for the most part, or with the exception of the tip, completely soft, containing a looser and blood-filled pulp, likening blood-quills. They must often be shed or lost ["afslitas"], for many teeth were found loose, partly in the mouth, partly in the digestive tract, for which reason also the replacement must come easily.

The *tongue* is 2 in., 9 lin. from the outer-most tip to the end of the sheath in which it lies; from the bottom of the same sheath to the posterior cleft 1 in., 10 lin.; the width was 3½ lin., the thickness 2 lin. The front tips each had a length of 11 lin. The tongue is nearly evenly thick and evenly wide. The entire part which lies inside the sheath is covered by a thick, firm, but not hard mucous membrane, whose epithelium everywhere is smooth, thickest on top and black-speckled, thin and white below. The tongue is very elastic, firm and moveable, and has large nerve-trunks ["starka nervstammar"].

The *esophagus* was thin-walled ["tunnhinnig"], very wide, especially toward the front end, and everywhere very stretchable and pliant. Posteriorly the membranes are somewhat thicker; the inner ones were folded up into tall, mostly straight, parallel, densely packed, evenly thick folds.[9] The posterior end was very constricted. The inner membrane was otherwise smooth, slick and shined like silver. It passes almost imperceptibly into the stomach without any clearly marked boundary or constriction. The length of the esophagus came to a good 5 feet.

The *stomach* is oblong, longitudinally oriented, and continues, as noted, without constriction from the esophagus. It is nearly of constant thickness, but a little wider in the middle and narrow at its back end. Its length is about 5 feet, 2 in. In the condition in which I found it, the greatest circumference was 1 foot, 10 in. Near the posterior-most end there is a small, round expansion, or suggestion of a caecum ["blindsäck"], as big as a larger walnut. Just behind this place [the stomach] suddenly becomes narrow, so that the circumference is not greater than 2 in., 4 lin.

The stomach, like the esophagus, is embedded in a cellular tissue, and therefore lacks a peritoneal membrane. Approximately at the mid-length of the stomach, two narrow, serous canals begin, one on each side, which are closed at the end and run backward, the one to the little caecum, which it runs around ["omgifver"], the other terminates beside the caecum. The muscular membrane is thinner near the beginning and end of the stomach; its longitudinal threads are evenly distributed in the front half, but where the serous canals begin, two wide and thick muscle bundles separate, almost like colic ligaments, and run beneath the canals just mentioned up to the region of the caecum.

Where these begin, the muscle membrane quickly becomes thick (nearly 2 lin.). Its fibers are white and overall fairly tightly united with one another.

The *mucus membrane of the stomach.* At the place where the folds of the esophagus terminate, the inner membrane slowly ceases to be smooth and becomes ever more and more clearly reticulated, by the presence of small, densely packed, round mucous pits. The part of the membrane so constituted is

[9] Pl. I, Fig. 1 a.

completely white and extends for some 3 feet.[10]

[The membrane] was coated by a layer, several lines thick, of clear mucus, which was so tough and firm that it could not be washed away, but rather had to be removed with a knife. This kind of mucus ceased just at the boundary of the membrane. At the end of this membrane, an entirely different kind of inner membrane began. It namely became, suddenly, yellow-gray, very thick and, instead of the extremely small, round pits with corresponding raised knots ["maskor"], this long, narrow, straight, evenly wide, longitudinally oriented one much deeper pits, which are surrounded by eminences on the sides, which in turn also are united with each other into a network, but likening a longitudinally stretched net where the knots are pressed together.[11] At the beginning of this form of membrane even larger folds appear, which at the beginning are very prominent, parallel, running nearly straight backwards and converging ["hoplöpande"], but the further they run backwards, the shallower and more sinuous they become. This thick-walled ["tjockhinnade"] part of the stomach came to 1 foot, 10 in., until it passed into the third region of the stomach, which was so narrow that it scarcely let my index finger through.

In this the narrow part of the stomach pits and folds had almost completely disappeared. It reached 2 in., 9 lin. posteriorly, until terminated at the pylorus. The pylorus had a small swelling ["ruls"], scarcely one line tall (pyloric valve), which contained only a few of its own circular muscle fibers. In the membrane of cellular tissue, both outside as well as between the other membranes, there were several atheromas, and in the narrow part of the stomach were several deep ulcers with hard, raised margins. The mucus in the stomach's posterior half was thinner, easily washed off and in lesser quantity. It appeared to me as if the anterior portion were lined with a thin epithelium. But this was lacking with certainty in this posterior part.

From this structure, one sees that the stomach in ophidians is not always so simply constructed as one generally assumes, and that in this snake it consists of 3 regions. The anterior part appears to me to be analogous in a way to the proventriculus of birds, while the following [part], from a distance, has some similarity to the gizzard in raptors*, if one excepts that these have an epithelium. Approximately the same construction oof the stomach I have also found in our common *snok* (Coluber [=Natrix] natrix). The anterior half of the mucous membrane in this likewise beautifully reticulated, white, and much thinner than the succeeding part, whose mucous membrane is more darkly colored, reddish, completely without reticulum, and forms tall folds. Because the front part is very elastic ["uttänjelig"], the latter falls quickly apart when one stretches it perpendicularly. In the same way, a narrow pyloric also forms a part [of the stomach], and this is utterly without a network or folds.

In the *Huggorm* (Vipera berus), a part of the stomach's mucous lining is also thicker and has a darker color on the inside.

The *intestinal canal* is also, like the stomach, embedded in a cellular tissue, with the exception of its posterior-most end, which has a serous lining

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[10] Pl. I, Fig. 1 b., Fig. 2.

[11] Pl. I, Fig. 1 c., Fig. 3. –

* Retzius uses the word *roffoglar*, presumably *rovfåglar* (raptors) of modern Swedish. A similar but extinct word is *rofågel*, indicating a stuffed bird tied to a string and used as a lure in hunting other birds, e.g., larks. (Source: *Svenska akademiens ordbok*.) I have not been able to discover what birds were typically used as *rofåglar*.

and lies in the same cavity as the generative parts. It forms, as in most ophidians, short and densely packed loops consolidated by the cellular tissue,[12] all the way to the hinder portion, and consists of a longer and narrower small intestine and a wider but short large intestine, with a short, conical caecum, rounded off at the end.

Length of the small intestine from the pylorus to the caecum, 7 feet. Of the large intestine – from the insertion of the caecum to the cloacal valve, 3 feet. Circumference of the small intestine, one inch behind the pylurus, 3 in. 3 lin. Circumference of the same intestine somewhat further back, 4 in. 2 lin.

At the end, 2 in. 10 lin.

The length of the caecum, 3 in. 3 lin.

The diameter of its opening, 1 in. 4 lin.

Circumference of the large intestine, 4 in. 4 lin.

Outside the front part of the small intestine there ran a serous sac, likening a *bursa mucosa*.

The muscular lining of the intestinal canal is rather thick in the small intestine and the greatest part of the large intestine, but much thinner than at the end of the large intestine. The layer of circular fibers seems to be thinner than the outer [layer] of longitudinal [fibers], which is distributed evenly at all points. The mucous membrane of the small intestine has, from beginning to end, raised, reticulated eminences, as in most amphibians. In general these have been given the name folds (*Falten, plicæ*), but to my mind they are better seen as fringe-like growths and should rather go by the name of meshlike *raised bands* [“*upphöjda strimmor*”] or fringes [“fransar”], in contrast to true folds. In this snake, *leaf-shaped flaps* project from the same along the whole length of the small intestine, as in several other amphibians and fish. RUDOLPHI calls these folds as well; MECKEL and RATHKE call them villi.[13]

At the very beginning of the intestine these fringe-flaps are so densely packed and so large, that the bottom cannot be seen without pulling them out. Then one discovers the mentioned network, but the knots [“maskorne”] are scarcely as large as the circumference of a millet grain. Further back the knots become larger and the fringe-flaps narrower and sparse, so that the knots are visible. While the knots thus continuously increase in width posteriorly, even the shapes of the flaps also undergo two distinct changes, of which the first begins 1 foot, 10 in. behind the aforementioned, and the second 3 feet from this latter and extends until the end of the small intestine.

These structures could thus be classified under four primary shapes, of which the first belongs to that region of the intestine which corresponds to the duodenum. They consisted of leaf-like forms, which were narrower at the base and broad toward the tip, with thin edges, here and there partly toothed, partly incised.[14] The broader of them had a width of 2 lin. Altogether they were crumpled [“krusigt hoprullade”], so that their true form could not be seen without flattening them out.

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[12] MECKEL’s *System d. vergl. Anat.* 4th part. Halle, 1829, p. 368

[13] Because RUDOLPHI denies villi to amphibians and fish, he uses the appellation *Wahre Zotten*, and sees the fringe-like productions just mentioned as a transitional form from plicae to villi. See RUDOLPHI *Physiologie*, 2nd vol., 2nd part. § 406. The conflict over whether amphibians and fish have villi or not is therefore a conflict rather over a greater or lesser extension of the meaning of the appellation, than over the presence of the structure in question.

[14] Pl. I, Fig. 4 and 4*.

Among the other forms the lesser ones ["de föga"] were longer than the foregoing but much thinner, narrow as well as branch-like, as a result of several deep incisions in the margin, and also a little coiled up.[15] They were all so sparsely distributed that the mesh-pits showed.

Those of the third form were far longer than the foregoing, very narrow and of nearly equal width. They were also curled up and in this condition likened the ends of fine threads. Because they were well dispersed, one saw in the middle a thicker band like the central nerve of a narrow leaf, and the margins were extremely thin. The average length was 4 lines. They were sparser than the foregoing.[16]

Those of the fourth form were once again broad at the base, of different shapes and sizes, some lancet-like, others tongue-like etc. They extended for the most part from the corner of the knots and were as correspondingly sparse as the knots were large, and had a significantly greater thickness than the foregoing.[17]

In the little caecum and the entire large intestine the mucous membrane is without knots, sleek and mostly smoooth, with small, sparse mucous glands and some small irregular wrinkles. This part of the intestine terminates, as is usual among birds and amphibians, in a broad, ring-shaped, posteriorly directed valve, which separates it from the genito-urinary hole, or cloaca.

14 inches from the pylorus there was again on the outside of the intestine a number of small atheromatous tumors of the same constitution as the aforementioned ones. In one place they had come together in a clump, large as a walnut, where the peculiar circumstance obtained that the small tumors opened inwardly into a common passage, so that the whole thing likened a gland, roughly like the *korskörtel* [? literally 'cross-gland'] in Dicotyle torquatus.

Further away in the same intestine a three-inch long branch of a narrow reed had burrowed through the walls of the intestine. The one half of the branch sat free inside the intestine, and the other, which had pierced the wall, was enveloped in a sheath, which was formed of cellular tissue, and this contained as well a not insignificant quantity of the aforementioned putty-like atheromatous substance.

In the large intestine there was on the inner membrane several gray-yellow, rough and hard encrustations, which also were the clear products of a sickly condition.

In both the small and the large intestine there were intestinal worms of a single species *ascaris* and also of a highly peculiar species of *Bothriocephalus*, on which I have already had the honor to give drawings and descriptions.

The small intestines otherwise contained merely a little mucus mixed up with a blackish substance, which also constituted most of those scybala which were found in the large intestine.

The blackish substance which constituted the greatest part of the scybala, likened a dough of fine, mucus-mixed, purified topsoil ["fin, slemblandad, slammad svartmylla"], and were blended with hair, bone shards, grass, leaves, and teeth, which were loosed from the animals own mouth.

The *pancreas* lies at the beginning of the small intestine and consists of a mass of small, oval, flat, dark-colored glands, approximately as large as a thumb-

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[15] Pl. I, Fig. 5 and 5*.
[16] Pl. I, Fig. 6 and 6*.
[17] Pl. I, Fig. 7 and 7*.

nail, from which more than seventy distinct ducts extend. These unite immediately next to the wall of the intestine, forming a somewhat smaller number which open in the intestine at the same place as the gall-ducts, or 1 in., 8 lin. from the pylorus.

The gall-organs:

Liver 3 ft. 3½ in. long, greatest transverse width 2 in. 10 lin.; greatest thickness 11 lin. It was dark-brown in color, with a network of black streaks, between whicih the parenchyma is visible as small, light, closely spaced spots. It is cloven in twain at both ends. On the upper side a groove runs from the cleft at the one end to the other; in this groove lies the vena cava.

On the underside is another groove, corresponding to the upper one, which accepts the gallbladder and the portal vein [“portådern”].

At the hind-end the cleft is 8 in. long, at the front end 1 in., 2 lin.

The lever can thus been seen as divided into a right and a left part, with two front and two hind lobes. The right, front lobe is 4½ in. longer than the left and tapers gradually anteriorly, such that, a little before its tip, it has the same thickness as a hedgehog’s spine, and terminates with the thickness of a hog’s bristle.

The hind lobes are partly connected by the portal vein, and partly by the gall-duct and its connective tissue, which surrounds the blood vessels and gall-ducts.

The portal vein runs anteriorly in the aforementioned groove along the organ’s underside and gives off only small, short, laterally divaricating branches, which enter directly into the parenchyma. The trunk tapers anteriorly and terminates near the anterior end of the liver.

On the posterior side of the liver, the vena cava lies in a broad furrow and receives the veins of the liver directly from the parenchyma. On either side of this furrow extends [*avgår*] a serous membrane, which partly constitutes the liver’s own covering and partly runs around its sides to the under-surface and joins the connective tissue in the groove for the portal vein. In this way each half of the liver is enclosed in its own serous capsule, like in Col. natrix.

The *gall-ducts* issue from the liver at the same place where the branches of the portal vein enter and have at the point of issue the fineness of a head-hair; hidden in the connective tissue, they undertake many twists and turns as well as multiply anastamose, so that they build a loose, irregular web of nearly uncountable branches. Most of them unite into a larger duct, which is covered by the trunk of the portal vein. The wall of the liver-duct is especially thick and rigid; the diameter near the back end of the liver comes to 1⅓ lin. This duct, as in many other snakes, runs far backward, being 3 ft., 5 in. from the end of the liver to the region of the gallbladder. Along the way it admits several long, smaller branches which come from the liver’s hinder part. In the vicinity of the gallbladder it divides, running partly to the duodenum, partly to said organ. The distance from the point of division to its ingress into the gallbladder is 4 in., 2 lin.; to that into the duodenum, 1 in., 10 lin. Thus, the gall-ducts’ length to the gall-bladder 3 ft., 9 in., 2 lin.; to the duodenum 3 ft., 6 in., 2 lin. The *gallbladder* is oval, broader toward its bottom. Its length 4 in., 2 lin., the diameter at mid-length 1 in., 5 lin. Its narrower end is rounded, not pointed, and passes into seven separate ducts, which anastamose many times with one another, though now finer, now coarser anastamoses, and terminate in ten ducts, which open into the duodenum. When one makes a careful preparation of them in the tough, firm connective tissue, so

that each duct becomes distinct in itself, they liken a rich venous plexus.

The gall-ducts open into the duodenum level with the pancreatic ducts, 1 in., 8 lin. from the pylorus, via several small, closely spaced holes in a small pocket, which is surrounded by a very small, circular rim.

I had as little luck finding the *spleen* as MECKEL[18] did. According to the report of this renowned anatomist the spleen is lacking in Python, Boa, Coluber, Vipera, Crotalus, Naja, Typhlops, Tortrix, Amphisbaena; on the other hand he has discovered it in Anguis and Caecilia. Of these ophidians, apart from the present Python, I have only had the opportunity to examine carefully Anguis Eryx, Coluber natrix and Vipera berus. Among these three species of animal, near the beginning of the true intestine, or just behind the pylorus, there lies a flat, light-colored, half-transparent, mostly triangular pancreas which joins via short ducts that part of the intestine where the gall-ducts open. Alongside the front end of this gland there lies a round body of more firmly woven, darkly colored, and intransparent parenchyma, which is closely united by means of connective tissue with the pancreas and, in certain forms, enveloped in that organ's surrounding *tela cellularis*. It lacks ducts; in larger *snokar* [*Natrix natrix*] is as big as a larger pea, in *huggormar* [*Vipera berus*] of normal size it is somewhat smaller, and in the little Anguis it is as big as a lentil.

In Anguis it is most distinct from the pancreas, and has therefore sooner attracted the attention of the Anatomists and been recognized as the pancreas.

MECKEL once pointed out a little, round body in this position in Coluber Elaphis and Elaps fulgidus, which, as he says, had its greatest similarity with the pancreas, and adds here that if it occurs without exception, it ought to be considered as the pancreas.

I can only believe that this is the same organ, and that, with more detailed studies, it is to be found in most snakes. Perhaps, later on, a little pancreas might be found also in Python and Boa?

The rule maintained, that the pancreas in mammals and birds is largest among those which live in a moist and unclean atmosphere ["luftkrets"], does not apply to snakes, where this organ is less well developed than in the other orders in the same class, and reminiscent of the organ's complete absence in the lineages Myxine and Petromyzon among the fishes.

The organs of respiration

The larynx does not form a special part of the trachea but rather consists, with the exception of the arytenoid cartilages ["tutbrosken"] (*cartilagines arytaenoideae*), of incomplete, cartilaginous rings, which are grown together ["hopväxta"] and at the anterior-most end ["i slutranden"] are completely fused*. That margin is entire, obliquely truncated, not unlike the honed end of a writing pen; it closes beneath on the midline with a small stylet [*processus epiglotticus* of Kardong, 1972] and above with a short, orthogonal, projecting corner [presumably the *superior median process* of Kardong 1972], by means of which the same opening, when the arytenoid cartilages are removed, acquires a cardiac

[18] *System der vergleichende[n] Anatomie*, Part 4. Halle, 1829. p. 371.

* See Kardong (1972, "Morphology of the respiratory system and its musculature in different snake genera (Part II) *Charina bottae*", *Gegenbaur's Morphologisches Jahrbuch* v. 117, pp. 364–376) for a more modern description of the larynx of snakes and the cross-linkages formed by the fusion of the anterior-most tracheal supportive cartilages with the cricoid. That the supportive cartilages also have a tendency partly to fuse together near the anterior end of the trachea, as suggested two paragraphs below, is confirmed by CT scans of *Python molurus* (at http://www.digimorph.org).

outline. On the upper side of the trachea there is a narrow, elongate opening in the cartilage frame, which is closed by perichondrium and extends very close to the aforementioned corner; on the underside is yet another opening in the cartilage, which likewise is closed by a thin membrane, and behind this one sees some weak transverse streaks, which indicate tiny compartments.

The shape and size of the arytenoid cartilages, when both are put together, reflect the front opening of the larynx, so that together they have the form of a heart-shaped leaf, which is longitudinally cloven in two down the middle; *rima glottidis* then corresponds with the cleft. Each arytenoid cartilage has a thicker, straight edge that faces the rima glottidis, and an S-shaped one, which is united by a firm cellular tissue with the edge of the laryngeal opening. There are only four laryngeal muscles, *musculi arytænoidei*. One pair, which pulls apart the arytenoid cartilages, is larger and stronger; they originate on the sides of the anterior-most part of the trachea and insert on the anterior, most mobile end of the corresponding arytenoid cartilage. The two antagonistic muscles lie along the straight edge of the arytenoid cartilage, cover the greater part of its upper side, and insert on the upper, median part of the edge of the trachea. When they contract, the angle formed between them becomes more acute, so that the corresponding straight edges of the arytenoid cartilages approach one another. The part of the mouth's interior lining that covers the glottis is very wide, thick, and firm.

In the anterior part of the trachea the supportive cartilages are closed at the back [*distally?*], although they are very thin at the point of closure; likewise they are on each side grown together, ring to ring ["hopväxte"]. A portion were incompletely ossified ["benvandlade"]. More posteriorly the closure becomes more incomplete through many small notches [? "utringningar"], but after the end of the first quarter the rings cease to close and are connected rather by a layer of muscles whose fibers are oblique and which cross each other at approximately right angles. That portion of the mucous membrane that corresponds to the opening of the rings is thicker, more elastic, and streaked in a wavy fashion with warped, posteriorly extending folds that extend from both sides and meet at acute angles. In the posterior part of the trachea is the beginning of the division into two branches, which open each into a lung sack. These [branches] are only rudimentary, entirely open to the outer side, as if ["liksom"] truncated in a distorted fashion over the rings, so that they only have a short wall and several half-rings on the inner side. The right opening is considerably larger than the left.

The total length of the bronchus is 3 feet, 8 inches.

The *right lung* is 6 feet and 2 inches long, the left one 3 feet and 8 inches.

Both lungs are slender, oval, and embedded on all sides in cellular tissue, and they extend only a short distance anterior to the tracheal openings.

The walls of the lungs are, with the exception of the back ends, are covered by air sacs ["luftcelluler"], and they are divided into sections corresponding to the small lobes in mammal lungs, which appear externally as squares.

There extends on the inner side [of the lungs] from the edges of the rudimentary bronchial branches a network of fine cartilage, whose strands ["maskor"] are 2 to 3 lin. in width, mostly pentagonal.

These cartilaginous strands form the entrance or edge of each saccular division and are therefore analogous to the feeder rings ["mynningsringarne"] in mammal bronchii. At the corner of the strands are small, white knots of cartilage the size of mustard seeds. Each group or division of the air sacs is separated

from its neighbors by a thin membranous dissepiment. When one looks into the openings formed by the aforementioned cartilaginous strands, one sees a number of smaller dissepiments and openings, which in turn contain even smaller ones. These lead to the true air sacs and correspond in their way to the finest divisions of the bronchi in mammals. Even these are entirely separated from those around them, so that here, like in mammals, the air tubes and air sacs all open into the common passages or cavities but do not communicate directly with each other.

The depth of the saccular structure is greatest in the vicinity of the tracheal openings; it diminishes gradually toward the back and terminates 1 foot, 11 inches behind the aforementioned place [the tracheal opening] in the right lung, and 1 foot, 7 inches behind it in the left lung. The sacs may disappear here, but the cartilaginous network continues until the very end, even though it becomes merely ligamentous toward the end.

The ends of the lungs lying anterior to the tracheal openings have air sacs as well, although the cellular [*sic*, for *saccular*?] framework is not so deep as just behind the place mentioned [tracheal openings].

Apart from the cartilaginous network there is a further structure in the lungs that corresponds to the bronchial branches in mammals; namely an elastic bandlike strip ["*strimma*"], which arises from the margin of the trachea and continues along the back wall of the inner side of each lung sac, and is patently of the same texture and significance as the elastic network in the bronchial branches of mammals. Toward the front end both lungs grow together ["hopväxta"] for a length of 10 inches, and the front portion of the vena pulmonalis consists, in connection with this, of a single trunk, which lies at the place of union but divides into two where the lungs themselves separate from each other.

The position of the air sacs in these lungs has a manifest similarity to those in bird lungs, although the latter might on superficial examination be thought more similar to those of mammals. *The mass of fine tubes one sees in bird lungs are namely covered on the inside by air sacs, which form a network and open as a group altogether into the common tubes, so that the air does not pass through finer and finer branches that terminate in sacs in the end, but rather it enters into the sacs while it flows by and passes from one tube to the next.*

The heart with the great aortic branches

When the large veins unite to enter the right atrium, they form a common canal, which lies parallel to the axis of the heart and which has been called the *saccus venosus*[19]. This saccus venosus is nevertheless no real continuation of the lining of the veins, because it lacks the layer of elastic fibers and in its place has, like the atrium itself, a true muscle layer, from which one determines the length of the sac. The length here was 5 inches, 4 lines. The sac's opening to the atrium is on the lower, left side; this opening is somewhat closer to its front than its back end. A rather short, undivided trunk (vena cava anterior) joins the saccus venosus toward the front end. That trunk consists, 3 lin. from the boundary, of several trunks, namely of the vena jugularis dextra, vena oesophagotrachealis and azygea anterior. At said boundary there is an abrupt replacement of the

[19] SCHLEMM Anatomische Beschreibung des Blutgefästsystems [*sic*, for "Blutgefäßsystems"] der Schlangen. TIEDEMANN and TREVIRANUS *Untersuchungen über die Natur des Menschen, der Thiere und der Phlarzen* [*sic*, for "*Pflanzen*"], Darmstadt 1827, vol. 2, page 103.

muscle strands in the saccus venosus by yellow, elastic fibers in the tunica fibrosa of the vein. At the entrance of the aforementioned veins into the short, common trunk each and every one of them has two major lunate valves. The Vena Jugularis dextra has the largest valves; they grow together at the ends and are so large that they ["bilda en tut, som"] project a little ways into the common trunk. Where the vena cava posterior passes into the saccus venosus there is no valve, and the diameter is similar in both. Somewhat further toward the front than the back end of the same sac, is its opening into the right auricle. This [opening] is surrounded by a weakly raised cushion (limbus) of lighter color, in front of which one sees two large valves, which open inwardly to the atrium. These two valves are arranged somewhat askew from front of the back. The one close to the front can probably be viewed as analogous with the tuberculum Loweri, whereas the other, closer to the back, may correspond to the valvula Eustachii. The vena jugularis sinistra opens just in front of the lower border of said limbus, after having taken the same common passage alongside the left auricle and sulcus coronarius, as SCHLEMM states[20].

The *right atrium* is somewhat larger than the left one, an elongate oval, somewhat tapered at both ends. The hind end projects over thesulcus coronarius and covers a little bit of the right ventricle. The walls are fairly muscular, and their inner surface is covered by trabeculae and *gallergropar* [pits in between?]. In this atrium, the two mentioned valves inside junction of the venous sac are especially prominent; they are rather broad and muscular, and they lie with their two opposing sides appressed; they are united at top and at bottom, along the lines of the valvula Bauhini[21], which relationship SCHLEMM has also found in those snakes he has studied. The septum that constitutes the inner walls of the atrii is almost perfectly smooth, has rather feeble and smooth muscle fibers and is rather thin. No trace of foramen ovale could be found, except perhaps for a little depression of the upper corner of the septum, which sat blindly between the thicker muscle bundles in this location. The entrance to the ventricle is wide and has a large, rather stiff, anteriorly convex, backwardly concave valve, which extends from the back margin of the septum and has its free margin turned toward the ventricle.

The *left atrium* is somewhat smaller than the right one, nearly conical, with the tip forwards. Its inner wall is smoother and has projecting trabeculae only anteriorly and toward the upper side. One end of the vena pulmonalis opens into this atrium, close to the upper corner of its base. The ingress into the ventricular portion is fairly large and runs straight back; the inner membrane here is completely smooth, thick and yellowish. Here as well there is a semilunate valve, which runs from the septum and blocks the opening during contractions of the ventricle. In the middle above the valve's free margin is a yellow cushion in the ostium, against which the valve presses when it obstructs the ostium.

The *ventricular portion* is nearly conical, with a rounded, backwardly directed tip and somewhat flattened. The heart's length from corona to apex is 3 inches, – width across the corona 2 in. 4 lin. Its left part is thick, massive and round, projecting somewhat forward on the left side of the aorta and corresponds in external apperance to the left chamber of mammals. The anterior end of this part is what Schlemm calls *kegelförmiger Vorsprung* [conical prominence]. The

[20] Loco citato.
[21] See SCHLEMM, l.c.

right side of the ventricular portion is flaccid and thin and is similar in external appearance to the right chamber in mammals.

The left atrium adjoins the *left*, thicker *portion*; just behind its opening is a little cavity large enough to contain a hazelnut, about which several lesser holes open, and for the remainder of this, the thickest portion of the heart, is occupied by tightly interwoven muscle bundles, which run in all directions. From these bundles a number of fine passages are formed, which communicate partly amongst each other and partly with the larger cavities, and are all lined with the heart's endothelium. To put it succinctly, this, the thickest portion of the heart, is on the whole comprised of ["upptages av"] a muscular frame put together like a mushroom, into whose every pore blood penetrates. Just behind the semilunate valve a canal opens into the true ventricle in this part of the heart closest to the midline. The width of the canal is 4 lin. (measured as in France), and its front wall is formed by the right atrio-ventricular valve, which alone forms the difference between this canal and the ostium atrii istelf.

The true ventricle is contained in that part which externally has the apperance of the right chamber, and is a rather voluminous sack whose outer wall is 1½ lin. thick. The walls have no projecting trabeculae, but from the wall that borders on the recently discussed thick portion there extends an *incomplete septum*, through which the chamber can be divided in two compartments, a smaller *upper* one and a larger *lower* one. This rudimentary septum is like a great meaty valve, whose free margin, lying inwardly in the chamber, is straight, running obliquely from the middle of the chamber's left wall across its anterior end to the outer side of the junction of the left aorta ["kroppspulsåder"] with a breadth of 6 lin. On the upper side of this structure there extends a weakly raised, yellow, calloused ["callös"] edge in an oblique direction from the outer margin of the left aorta's junction with the left wall of the chamber, which ceases just behind the opening of the canal, which conveys the blood from the left spongiose cavity of the heart to the other compartiment and arteries. Another suchlike calloused edge lies in the middle above the one just mentioned on the chamber's right wall, which has the same orientation, so that both of them fall extremely close together ["de båda falla fullkomligen intill hvarandra"] when the septum nears the front portion of the right wall of the chamber.

On the other side of the septum there opens the canal just mentioned, and just in front of it lies the ostium of the right auricle, so close to the former that they are merely separated by the aforementioned valve. A few lines further forward and somewhat to the right is the ingress to the right aorta, and just behind the outer portion of this [ingress] opens the left aorta; both ["alla"] opening into the heart's upper compartment or the upper side of the septum. The pulmonary arteries run from the front end of the lower compartment or below the septum. As in other snakes the base of the aortas like the pulmonary arteries are provided with semilunate valves, two at each junction. The right aorta is the thickest, the pulmonary arteries the largest.

The function of the rudimentary septum is unmistakeably to form a closed channel that leads the arterial blood from said cavity in the heart's thick, spongiose portion to the aortic junctions, which is suggested by its form and position as well as the calloused edges. At the moment that the arterial blood passes this channel, the semilunate valve passes ["skjuter"] it through the ostium of the right auricle, which is thereby closed. In the next moment the septum retracts; the semilunate valve, which just closed the ostium to the right auricle,

now closes the canal to the thick portion, and the venous blood rushes immediately into the lower compartment. At the same time the septum touches again the outer wall, and the lower compartment is closed off from the upper one, while the blood stream ["blodcolonnen"] is driven into the pulmonary arteries, and so forth. With this organization it is therefore more than likely that the arterial and venous streams pass by at different moments, without mixing with each other, whereby the slowness of the circulation can in large part be deduced ["hvarigenom circulationens långsamhet till en stor del torde härleda sig"].

The aorta dextra gives off twin coronal arteries just in front of the valves, and farther along the arteria cephalica, from which the arteriae vertebrales and thyreoidea inferior arise. After turning backward the right aorta first gives off the great arteria collaris (SCHLEMM). During its backward course it gives off several further smaller branches, which unite with the aorta sinistra, which meets it on the other side of the esophagus. The arteria pulmonalis are much wider at their base than the aorta dextra and divide just after leaving the heart into twin branches.

In other respects I believe I have found much agreement in the course and division of the blood vessels ["ådrorne"] with the description of the circulatory system of snakes in general, which Mr. SCHLEMM submitted. It was impossible for me to work out the circulatory system myself, since the treatment of the whole thing required that parts first be separated from their connections.

The heart of Python evinces ["framter"] a considerable difference to that of Coluber natrix, in that in the latter the whole ventricular portion comprises a large cavity that only through the incomplete septum is divded into two compartments. In Python those spaces containing the thick, spongiose, left part of the heart make up a compartment of their own, which is connected by a canal with the upper compartment. Hence the upper compartmant is rather small in comparison with the lower one. Especially noteworthy is also the fact that the valvula ostii dextri l. venosi can alternately close the canal and its ostium, in order that the venous or arterial streams can pass.

As in Boa constrictor[22] and probably also in other snakes there was here a long *ductus arteriosus Botallii*, which extended from the right boundary of the arteria pulmonalis, just after the division of the trunk *a*, entered into the aorta dextra, obliquely over its arch, approximately 4 inches after it left the heart. This ductus was narrow in the middle and closed, but the ends were fully open, so that I could insert the probe into them a good distance, both from the arteria pulmonalis and the aorta.

The organs of generation and the kidneys lie on opposite sides of the large intestine in the hindmost part of the common thoracic and abdominal cavity. They are not fixed in place by cellular tissue like the organs of digestion and respiration, rather they lie in their own cavity, whose inner wall is lined with a serous membrane that also covers the aforementioned organs themselves.

Streched out, each oviduct is around 7 feet, 4½ inches, the right one being a little longer than the left one; the diameter is approximately 9 lines.

Along their whole length each hangs in its own broad fold of the serous membrane and rests on the fat bodies that lie on the inner side of the abdominal muscles. The same fold also contains the kidneys and ovaries.

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[22] SCHLEMM, p. 118.

The anterior end of each oviduct closes with an opening so large that it admits the tip of the thumb, and it is surrounded by an oval fringe ["fimbria"], tapered on both ends[23]. The front tip of the fringe terminates very close to the front end of the ovary; the back tip, which is shorter, extends a few lines behind the opening and adheres to the oviduct, similar to a *folium decurrens* [?]. A vein ["åder"] runs straight toward the fringe, accepting several minor branches; right after this vein the fringe was rolled up; the rolled-up edge forms an arch. The edge of the fringe is thin and unbroken ["helbräddad"].

Posteriorly the oviducts become narrower and terminate ultimately in the cloaca. Their openings into the cloaca were highly restricted, and their inner membrane projects out somewhat, so that it forms five folds, similar to a stellate [actinomorphic], pentamerous flower with tapering, tightly packed petals. On the outside the ovideuct is covered with the serous membrance; beneath it lies a muscular layer that cosist of pretty loose fibers, which run parallel to the organ. A portion of these fibers is shorter than the oviducts themselves and keeps them wrinkled up, like the ligamenta coli amongst mammals, although the ones here are very weak. The inner membrane is white, lies in winding, irregular longitudinal folds, is covered with a number of small knots, and is very elastic.

Near the front end and close to the upper margin of the folds in which each oviduct hangs lie the ovaries, each fixed in its own short fold of the same membrane, and very close to the vena renalis.[24]

Each *ovary* consists of a long, tapering, very narrow sack, closed at the end, between the membranes of which the eggs are found. The right ovary is 1 foot, 8 inches, the left one somewhat shorter. The greatest width of each sack, when it is flattened, is 11 lin. They are completely hollow and empty inside. The inner membrane is white and forms a number of fine trabeculae, and had near the ends irregular compartments.

The eggs sat arranged in two rows, one row on either side. The largest were as big as lentils, round and flat.

The *glandulae suprarenales* are both small bodies, 8 inches long and 3 lin. thick, which lie between the ovaries and the venae renales abducentes, tight against these vein trunks. The parenchyma is very firm, just like that which makes up the same organs in mammals. On the outside the color is dark yellowish red, on the inside it is lighter and yellow-gray; at the very center a vague trace of a cavity is visible that seems to have run lengthwise along the middle of the organ.

Among those authors whom I have had occasion to consult, CUVIER is the only one who believes that the snakes have glandulae suprarenales; yet he likely saw them only amongst females, and his entire message consists in the few words: "Ceux des ophidiens et des sauriens sont dans le repli du peritoine, qui reuait les ovaires et les oviductes" [Those of the ophidians and saurians are in the fold of the peritoneum, which brought together the ovaries and oviducts]. He says nothing of their form or composition; and just as little of where they lie, or what they are like amongst males[25].

Some time after the publication of CUVIER's lectures, MECKEL brought out

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[23] Pl. 2, fig. 1 *a*.
[24] Pl. 2, fig. 1 *b*.
[25] Lecons Dilnat. [*sic*, for "d'anat."] comp. T[om] V, p. 248.

the most complete anatomical description of these organs[26] and states about snakes: "In mehreren Schlangen, die ich deshalb nachsah, fand ich durchaus keine Spur von Nebennieren" [In several snakes that I examined in this respect, I found no trace whatsoever of adrenal glands]. In his great work CARUS has merely hinted at fat bodies in Batrachia [on meaning, see above], and in it he more or less[27] decisively expressed that he views adrenal glands as belonging solely to mammals and birds.

Apart from Python bivittatus I have only studied our common snakes, Vipera berus, Coluber natrix and Anguis Eryx. In all these the adrenal glands are rather obvious and are located along the trunks of the two venae renales abducentes. When they lie close to the ovaries or testicles, these veins also run very close to the same organs; when the veins are located further from them, then the adrenal glands are also distanced. The former is the case in Vipera, the latter in Coluber.

Only in Vipera did have the opportunity to observe the position and appearance of the organ amongst males. It lies on the backside of the lower end of the testicles, united with its membrane by means of a short, loose cellular tissue, immediately adjacent to the convolution of the vas deferens. Its color was yellow and paled somewhat in spirits; on first observation it was similar to a strand of fat. But whereas this organ became lightened in spirits, fat bodies became darkened instead; whereas these latter became looser in spirits, the organ in question became firmer. In Vipera berus as well the aforementioned vein passes very close to the organ and accepts minor vessels from the same. Since it demands some careful attention to determine whether it exists, I do not believe it is in vain to reproduce a figure[28] of these relations at natural size. In the male of Vipera berus it is completely smooth, compressed, about 8 lin. in length. In the female of Coluber Natrix it has the same yellow-gray color, is very narrow and drawn out, and it lies immediately affixed to the venæe abducent:renum, at a short distance from the ovaries. On closer observation it seems to consist here of a number of fine, crooked, weakly defined ["svagt uttryckta"] lobes.

In a young Anguis fragilis, as thick as a goose quill, the glandulae suprarenales were just as long as the ovaries and approximately half as wide, lancet-shaped on both ends, and had three surfaces; the situation was the same as in the foregoing. In a full-grown specimen they are longer and narrower.

The *kidneys* are located just behind the ovaries, enveloped in a firm and thick cellular tissue, surrounded by the same serous *fåll* that covers the oviducts and ovaries. Each of the kidneys consists of a number of partly wavily folded, flat, thin lobes, which when unfolded look like nuces vomicae ["räfkakor"]. The lobes have a little hilum toward the interior and a convex margin toward the exterior. All of the adjoin the ureters on the inner margin. The number of lobes was approximately 33 in the right kidney and somewhat fewer in the left.

width 1½ inches

length 1 foot, 3½ inches.

Each lobe consists of nearly straight, radial urine ducts ["urinkärl"], which arise very fine from the outer edge and unite into larger and fewer ducts that pass to the hilum and open into the ureter via two or three very short passages.

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[26] Abhandl. aus der menschlichen und vergleichenden Anat. Und Phys., Halle 1806.
[27] Lehrbuch d. Zootomie, Leips. [for Leipzig] 1818.
[28] Pl. 2 Fig. 2 *a*.

Consequently there is no trace of calyces, much less of a pelvis.

When they are filled the ureters have a diameter of 3½ lin. They open on the upper wall of the cloaca via a conical eminence, in which the two junctions are only separated by a thin partition. The junctions are somewhat narrower than the ureters themselves. The parenchyma of the kidneys is fairly firm, gray-brown in color; the urine duct ["urinkärlen"] is uninjected ["oinjicerade"], not as distinct as in Vipera and Coluber natrix.

Anal sacs: Behind the anal opening there were two oblong sacs, which secrete a strongly smelling, oily substance, like in the female of Coluber natrix and others. Each sac is approximately 3½ inches long, the diameter 7 lin. The front end is the largest, rounded, and adjoins a short, narrow canal behind the cloaca. The hind end is narrower and somewhat tapered.

The sacs' true, or secretory, membrane is thick, white and very firm. It contains no glands, but in their place is on the inside a number of tightly spaced cavities surrounded by projecting margins and folds, which build an irregular network. The inner surface of this membrane is covered by a thin, dry epithelium ["epithelium"] which can be easily peeled off, and whose outer surface glistens like the epithelium in the anal sacs of many mammals. On the outside the secreting membrane is covered by a tight and firm cellular membrane and surround, most externally, by muscle fibers, which partly attach to the aforementioned membrane itself, like the eye-muscles on the sclera. These muscle fibers surround the back end of the sacs almost like a capsule and continue a great distance posteriorly, inserting under the skin in the anterior part of the tail ["stjerten"].

As is well known, suchlike sacs are typically found in the order of ophidians only in the females and occupy roughly that place where the hemipenis is found in the males. It is a well-founded supposition that the odoriferous sacs in mammals are most closely related to the organs of generation, but among them they occur roughly equally commonly in both sexes. That they belong to the copulatory equipment ["generationsförrättningen"] cannot be opened to the slightest bit of doubt, since they correspond to the copulatory organ of the male. They contain in Python a large quantity of a fatty, greenish, highly malodorous substance, the smell of which is somewhat similar to that of Coluber natrix.

The fat bodies, which in most snakes are nearly the sole site of fat storage, lay here, as in Vipera and Coluber, just inside the abdominal muscles and consisted of small, grayish, oval, flat pieces with thin margins. In outer appearance they are more like lymph nodes than fat bodies, which were all separated from one another and united only by cellular tissue. Each lobe was supplied by its own little artery. When I dried them, I could clearly make out that they consisted of fat and a little quantity of connective tissue ["cellväf"]. That they were small and grayish probably arose from the animal being so lean, partly from sickness, partly from starvation.

Explanation of the Figures

Pl. I* *Fig. 1*, shows a side view of the eye together with adnata, from which the retina was removed. *a b c Corpus Ciliare*. *a* inwardly projecting edge of the corpus ciliare, or corona, some attaches around the capsula lentis. – *b* front part of the corpus ciliare, which shows weak traces of ciliary folds

["strålfållar"]. – *c* smooth, hind part. – *d* flap of iris. – *e* adnata bulbi, or reflexa. – *f* anteriorly running part of the adnata, which form the eyes outer capsule, correponding to the adnata palpebrarum. – *g* optic nerve.

Fig. 2, shows the union of cornea with sclera, *a* cornea, *b* sclera.

Pl. I *Fig. 1* shows the esophagus, stomach and a part of the duodenum cut open.

Fig. 1, *a* esophagus. – *b* front part of stomach. – *c* back part of stomach. – *d* cecum. – *e* pyloric portion of stomach. – *f* valvula pylori. – *g* pancreas. – *h* gallbladder. – *i* ductus hepaticus. – *k* openings of the ducts of the gallbladder and pancreas into the duodenum.

Fig. 2, piece of the inner lining of the front part of the stomach, which shows the network in natural size.

Fig. 3, piece of the inner lining of the back part of the stomach showing the longitudinal cavities.

Fig. 4, piece of the mucus membrane with its leaflike villi, and a spot at which these are removed, exposing the network of eminences. *Fig. 4** enlarged villus or lappet of the same piece.

Fig. 5, piece of the mucus membrane of the small intestine of second order, likewise showing the reticulum on the mucus membrane. *Fig. 5** a villus of second order, enlarged.

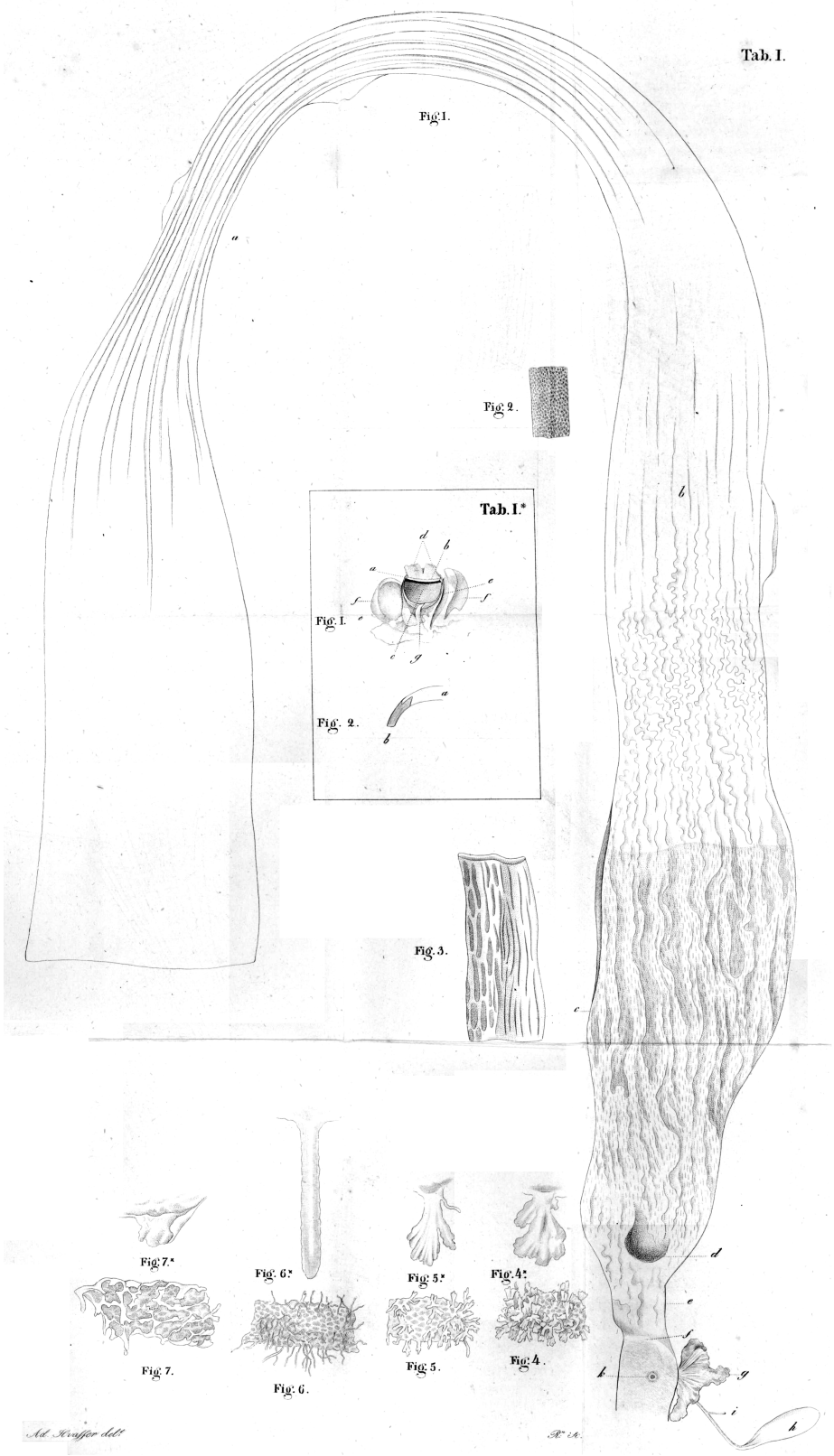
Fig. 6, piece of mucus membrane with appertaining network of third order. *Fig. 6** appertaining villus, enlarged.

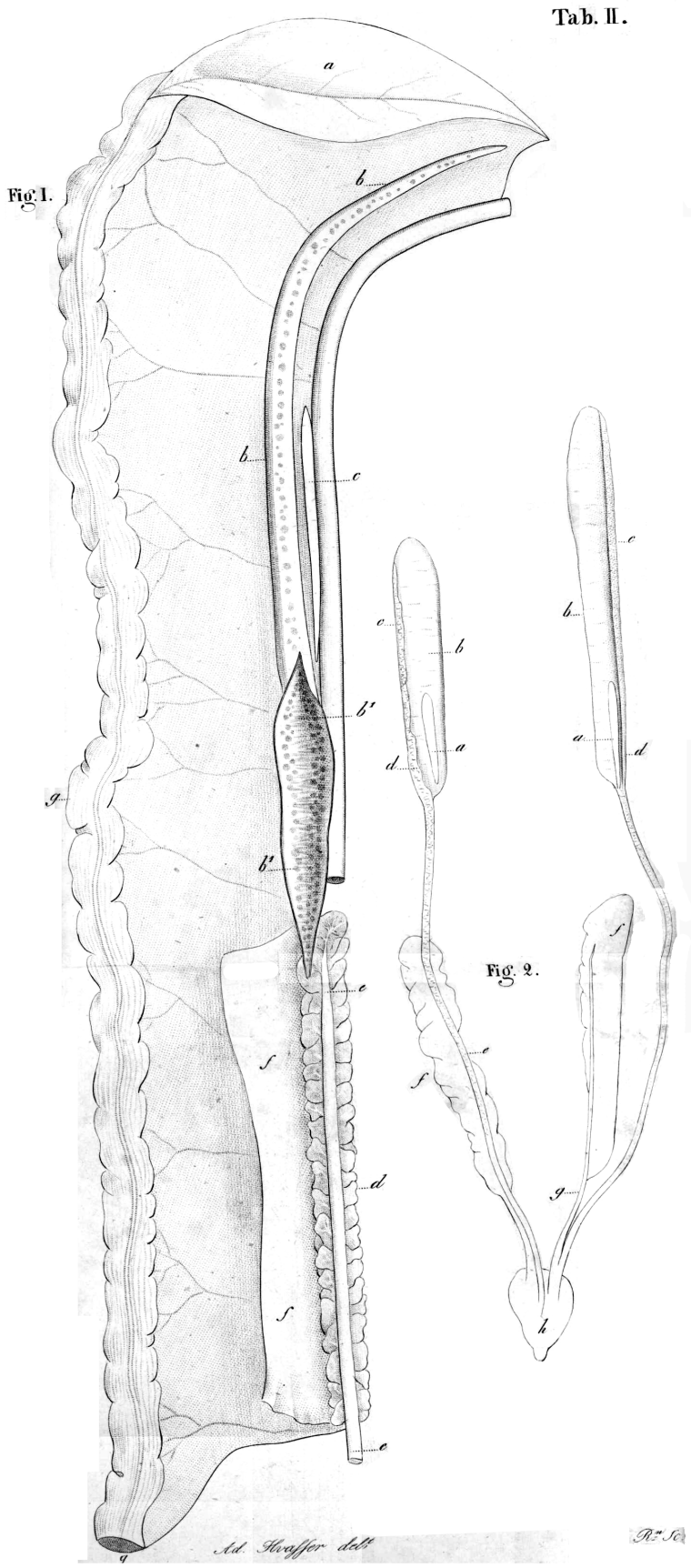
Fig. 7, piece of the terminal region of the little intestine *Fig. 7** appertaining, enlarged villus.

Pl. II. *Fig. 1*, shows the anterior section of the genital area. *a* fringe ["fimbria"]. – *b* ovary *b*' cavity of the ovary opened. *g* oviduct. *d* kidney. *e* ureter. *f f* lamella which covered the kidney. *c glandula suprarenalis*.

Fig. 2, urine and semen-producing organs of Vipera berus.

a glandula suprarenalis, – *b* testis. – *c* epididymis. – *d* front convolution of the vas deferens. – *e* vas deferens. – *f* kidney. – *g* ureter. – *h* upper wall of cloaca seen from the outside.


Tab. I.
Fig. 1.
Fig. 2.
Tab. I.*
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 7.*
Fig. 6.*
Fig. 5.*
Fig. 4.*
Fig. 7.
Fig. 6.
Fig. 5.
Fig. 4.
Ad. Hrafter delt
R. N.


Tab. II.
Fig. 1.
Fig. 2.
a
b
b'
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Ad. Hvasser delt
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