THE ANATOMY OF A DOUBLE MONSTER PIG

GEORGE M. HIGGINS, KNOX COLLEGE

INTRODUCTION

The literature upon various teratological forms is rather extensive; and of the cases reported, syncephaly is quite frequent. Fisher ('04) in his Teratology Handbook records about 80 cases of syncephaly among domestic animals and 50 cases within the human family. Since that time additional records of a similar condition have been made. Carey ('17) described a case of syncephalus asymmetros in a pig in which two distinct cerebro-spinal axes were present and two hearts of unequal size in distinct pericardia, thus differing from any other case previously described. William and Rauch ('17) likewise described a case of syncephaly, also in a pig, in which the heart was single, but the nervous system was fused to a much greater degree, the spinal cords alone being duplicated.

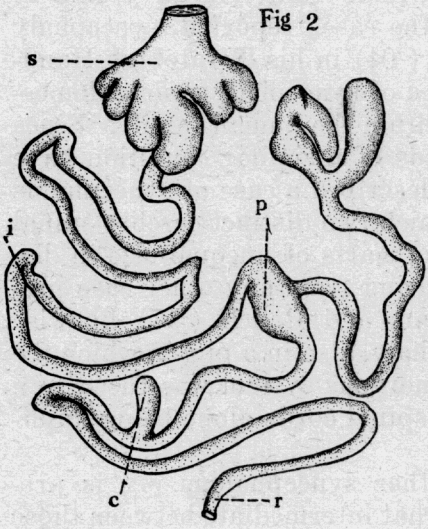
This dissection of another syncephalous pig is presented because it is somewhat intermediate between those mentioned above. In the but partial fusion of the brain, the independence of the corpora quadrigemina, cerebellar hemispheres and medulla, as well as in certain other peculiar modifications of the anatomy, the writer feels that publication is justifiable.

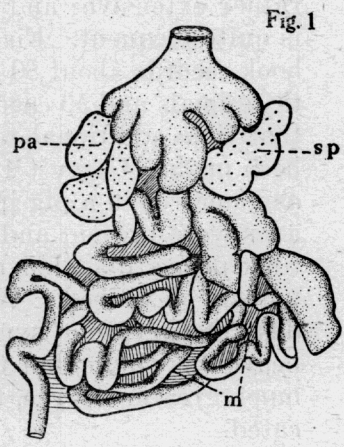
This pig was presented to Professor George W. Hunter of the Knox Biological Laboratory in October, 1922, by the farmer upon whose farm the pig had been born. The writer was assisted by Professor Hunter in the earlier dissection, and acknowledgements are made for this assistance as well as valuable suggestions throughout the entire dissection.

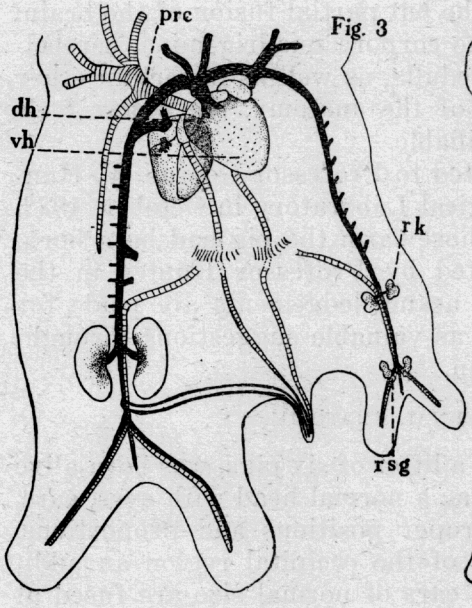
EXTERNAL ANATOMY

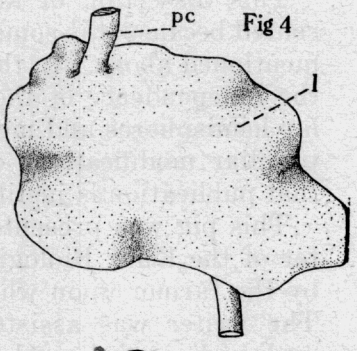
This monster, one of a litter of six pigs, was born alive but died at birth. It has a normal head with eyes, ears, nares and snout in proper positions and proportions. In the mid-dorsal line of the occipital region an additional pair of external ears of normal size are fused at their bases around a single auditory aperture, which

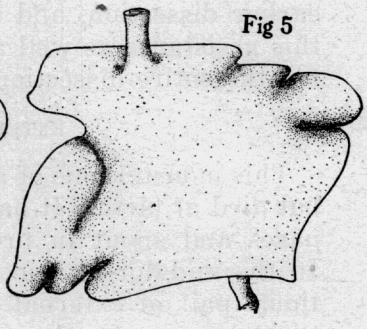
opens into the posterior part of the skull. Just in front of this median fused auditory structure is a small tubercle, similar to that described by Carey, which represents a remnant of a fused lens vesicle; for just beneath it is a vestigial optic cup connected by nervous structures to











the floor of the brain at the chiasma of the two normal optic nerves. This relationship will be discussed in more detail in the section of the nervous system in the sequel.

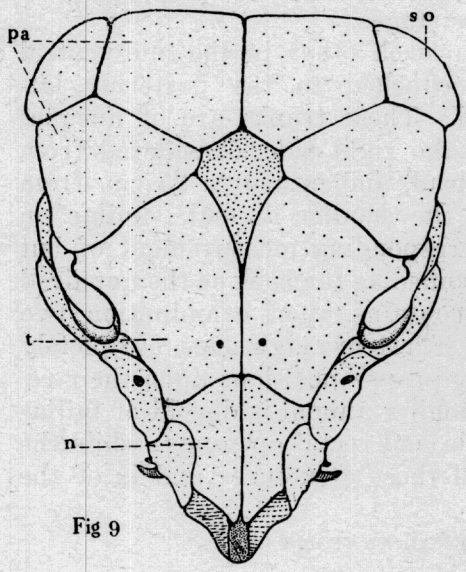


Fig 9

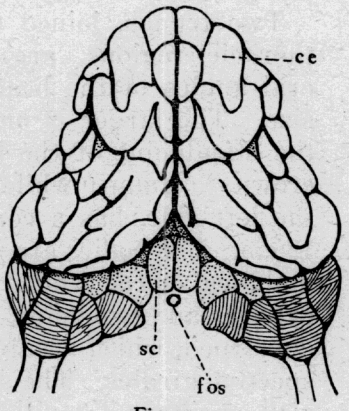


Fig 7

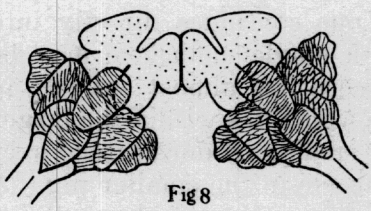


Fig 8

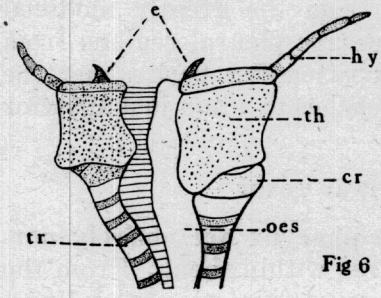


Fig 6

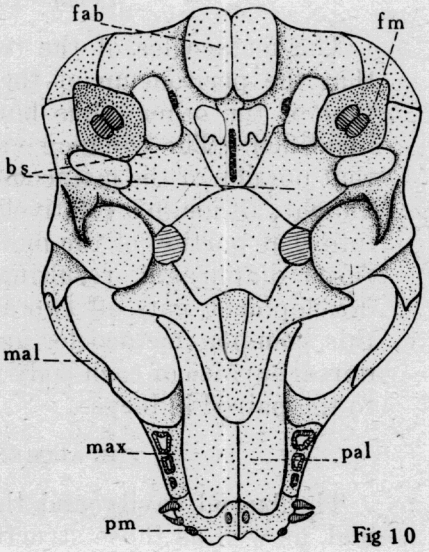


Fig 10

It is quite evident that these accessory external sensory appendages have developed through a fusion of the embryonic structures in such a way that the left organ

of one of the embryos has fused with the right organ of the other embryo. Accordingly, the normal eyes and ears are to be interpreted as the right and left organs of the two primitive embryonic stages.

Two trunks, joined to each other in the mid-ventral thoracic regions, are attached to the posterior lateral angles of the head. These trunks are of unequal size. The larger is on the right side, considered from the standpoint of the head, and measures 25 cm. from crown to rump; while the smaller animal, similar on the left side, has a corresponding measurement of but 18 cm. The bodies are joined as far back as the unpaired umbilical cord, which contains upon examination two arteries and two veins. There are eight legs, completely developed, which occupy proper positions upon their respective girdles. The smaller animal is devoid of tail as well as external genitalia and rectal openings; while the larger one possesses all these structures and is of the female sex.

INTERNAL ANATOMY

The metacoeles of the two bodies are continuous, so that the peritoneum of the one continues directly into that of the other; thus but a single metacoele may be identified. The common viscera lies almost entirely in that portion of the metacoele which lies within the larger animal; although a relatively small part does extend over into that portion of the metacoele in the smaller pig. A fused diaphragm, resulting from the greatly modified development, cuts off two anterior pleural regions from this common metacoele, and extending back along the dorsal surface of each body reaches to a line just anterior to the paired kidneys.

THE ALIMENTARY TRACT

The buccal cavity and the pharynx are entirely normal, as well as those structures within them. From the pharynx two larynges with normal epiglottes extend posteriorly, and between them, definitely opening from the more ventral larynx, is the single oesophagus which continues posteriorly between the two tracheae into the metacoele.

The alimentary tract is complete only in the larger animal, and consists of a greatly modified stomach which continues into an elongate undifferentiated intestine. The stomach is not readily differentiated into the usual cardiac and pyloric regions but it consists of five simple lobes, each connected with a centralized portion (Fig. 2). The lining of this stomach is conspicuously ridged, and the lumen into each pouch is constricted greatly by the approximation of these gastric folds. Upon dissection each pouch was found to contain coagulated masses of green material, suggesting a possible accummulation of bile secretions. Characteristic mammalian duodenum and ileum can not be identified; but an intestine, strangely twisted and coiled, continues back from the median pouch of the stomach through a small pylorus. Differentiation of the intestine into ileum and colon portions can not be made, for the entire tube is of uniform diameter throughout, except for a single enlargement where the shorter tract of the smaller pig continues into that of the larger (Fig. 2, p.).

A secondary stomach, that of the smaller pig, consists of a two-lobed structure, and is bound firmly to the left wall of the larger stomach by heavy strands of connective tissue. The cavities of the two are not continuous, neither is there a connection of the smaller stomach with the oesophagus; so that no digestive function could ever have been ascribed to this organ. Through a small pylorus, this secondary tract continues into a short intestine, one-fourth the length of that of the larger pig, which joints its mate at an enlarged region 15 cm. anterior to the caecum (Fig. 2, p.). From point of junction the two tracts are confluent and from thence continue as a single tract to the rectal opening of the larger pig.

This relationship differs from that of Carey's monster, in which the alimentary tract is entirely single to a point 16 cm. anterior to the caecum, where it bifurcates into two regions, each of which is related to its own rectal aperture. The mesentery of this monster, peculiarly twisted with the coils and twists of the intestine, is possessed of an abundance of lymphoid and glandular tis-

sues, a fact possibly correlated with the peculiar development of the monster.

The entire tracts are held within a region embraced by the livers. Of these, one lies above and the other below the fused viscera, the upper being slightly the larger of the two. In both livers characteristic lobulation is absent; for each consists of a single enlarged structure bearing two or three smaller lobules (Figs. 4, 5).

Two post-cavae are present, and from their relations to each other it would appear that the larger liver, more dorsal in position, is of the smaller pig; likewise the ventral liver belongs to the larger animal. Normal mesohepars are present, and normal gall bladders pour their secretions into normal bile ducts related to their respective intestines. A two-lobate pancreas is fixed by heavy membranes to the lobes of the larger stomach only; but normal spleens are present in both animals. Pancreatic ducts were not identified.

URO-GENITAL ORGANS

Normal kidneys, ureters, bladder and urethra are present in the larger pig, as well as ovaries, oviducts and a well-defined uterus. In the smaller animal, on the other hand, two pairs of greatly reduced structures lie in the pelvic region, and it is entirely probable that these represent rudimentary kidneys and sex glands. Neither ureters nor reproductive ducts were identified in the smaller animal; but the presence of genital arteries and veins as well as renal arteries suggest the identification of these structures. Microscopic identification has not yet been made. There are no external genitalia upon the smaller animal.

CIRCULATORY SYSTEM

Differing from the hearts of the animal described by Carey (1917), this monster has two hearts of approximately equal size, each contained within its own pericardial cavity in a normal thoracic position. These hearts are both normal, and have normal relations to the main circulatory trunks of its respective body. The hearts are so placed that their dorsal surfaces are opposed to each

other; and because of their relations to the two post cavae, it would appear that the larger heart, the more ventral one, is of the smaller pig, while the slightly smaller one is likewise of the larger pig.

Just anterior to the larger heart the main dorsal aorta, coursing from its right ventricle, bifurcates to form the two aortae, each of which passes to a normal position in its respective animal. That aorta supplying the larger animal is joined at once by a secondary aortic arch coming from the right ventricle of the smaller heart; so that the two hearts thus have a common bond in these connections to the aortae. Posteriorly each aorta gives rise to the normal intercostals, coeliac and mesenteric arteries; although in the smaller animal these branches are greatly reduced and largely devoid of blood content, and thus were relatively difficult to trace. Renals, iliacs and umbilical arteries are present in the larger animal, but no umbilicals were recognized in the smaller. Furthermore, a variation is to be noted in the point of attachment of the umbilicals to the aorta; instead of attaching to the internal iliac as we would expect, here the umbilicals connect with the aorta considerably anterior to the iliacs.

The carotid arteries have not retained their identity of relationship to each animal; but all are united to the common aorta (Fig. 3). A single brachiocephalic artery arises from the arch of the smaller aorta and divides into two carotids, from which later arise a corresponding subclavian artery, distributed to the respective limb. From the bend of the aorta, just in front of the larger heart, a pair of arteries continue forward into the head region and form the paired carotids and the left subclavian of the larger animal; while the right subclavian of the larger animal arises independently from the aortic arch of the smaller heart (Fig. 3). The complete distribution of these arteries into the head region was not ascertained, as the absence of the blood content made their identification extremely difficult; and accordingly no knowledge is available of the relation of the paired internal carotids to the circle of Willis, so graphically figured by Carey in his description of this region in his monster.

In contrast to the fused relations of the arterial systems, the venous systems were found to be completely independent of each other. Post cavae are normally present, and these are joined in each liver by respective umbilical veins, from whence a single vessel continues forward into the right auricle of the respective heart. These are joined by precavae coming from adjacent regions, although the two anterior vena cavae are independent of each other.

Within the hearts, normal relations were found to exist. Completely four-chambered structures were developed and normal canals and valves separated the chambers from each other. Well-defined Botall's ducts were identified between the pulmonaries and the adjacent aortic arches.

THE RESPIRATORY SYSTEM

Two complete sets of lungs are developed, and these lie in independent pleural cavities, separated by double folds of visceral pleurae. These cavities lie around the heart, and each pair of lungs is connected to its respective heart by normal pulmonary arteries and veins. The ventral lungs, characteristically lobulated, are slightly larger than the more dorsal pair and are understood to belong to the larger pig as evidenced by the vascular connections. Normal bronchioles and bronchi with normal cartilage supports are developed, and from the junction of the two bronchi, normal tracheae extend forward to the neck into the pharynx. As indicated above, these tracheae lie one above and the other below the unpaired oesophagus.

Anteriorly, each trachea continues into a larynx, apparently normal, with the three characteristic cartilages present, but somewhat distorted and partially fused. A greatly modified basihyal cartilage is present, and this is continuous with the hyoid apparatus, consisting of four parts. The hyoids, which are continuous with the ventral larynx, are more nearly normal, and the distal tympanohyals join the auditory bulla of each temporal bone. On the other hand, the hyoids of the more dorsal larynx are greatly reduced, because of the cramped position; but each continues upward through the connective tissue re-

gion to join a peculiar structure, the fused bulla of the other pair of temporal bones (Fig. 10, fab). The skull is understood to be a fused structure, as will appear in the discussion on the skeleton; and thus it would follow that the normal bulla are but opposites of the adjacent heads, and that the related hyoids, although apparently normal on the ventral larynx, must be of independent origin (Fig. 6).

The oesophagus joins the dorsal wall of the ventral larynx, so that the ventral tracheae and oesophagus are confluent here. A single opening, the glottis, connects this region with the unpaired pharynx above. Likewise a glottis is present on the dorsal larynx, and associated with it is a normal epiglottis, a similar one existing in connection with the ventral larynx above described.

THE NERVOUS SYSTEM

Two spinal cords are present, enclosed within separate neural canals. Posteriorly, that of the small pig reaches only to the sacrum, where it abruptly terminates; while that of the larger pig is more normal, terminating in a typical cauda equina. Lumbar and cervical swellings are present as well as normal spinal nerves.

Anteriorly, each cord passes forward through a foramen magnum on the posterior angle of the fused cranium, and then each joins its mate to form a partly fused encephalon. Myelencephalon and metencephalon are independent of each other and are joined to their respective cords; but the superior colliculi of the mesencephala represent the most posterior point of fusion of these parts, for here a firm junction is established and fiber tracts cross as in a chiasma.

Just posterior to these fused superior colliculi and in the region between the hind brains is a compound nervous structure, evidently formed by the fusion of the left optic stalk of the right encephalon with the right optic stalk of the left encephalon. This peculiar structure continues posteriorly and dorsally from the normal position of the optic chiasma, and terminates in connection with the small amorphous structure on the median dorsal line of the skull just anterior to the fused exter-

nal ears. On this interpretation, therefore, the optic nerve to the right lateral eye is of the right encephalon; while that on the left, likewise belongs to the left encephalon.

The compound cerebrum is difficult of interpretation. Its anterior is more nearly typical of the normal telencephalon; but it is quite evident that the posterior portions are parts of a fused unit. Although normal sulci and gyri abound, yet identification of frontal, temporal and occipital lobes as such is impossible (Fig. 7).

THE SKELETON

Correlated with the double cerebro-spinal axis, there are two spinal columns, two sets of ribs and two sterna. Each column is conspicuously twisted and curved; that of the larger animal is the longer of the two and consists of some forty vertebrae, while but twenty-six are present in the smaller column. The terminal vertebra of the latter is a mal-formation, and evidently is composed of portions of the vertebrae in the posterior lumbar region which have fused into a knob-like structure held between the paired ilia of the greatly reduced pelvic girdle. The numbers of vertebrae in the more anterior regions are identical for both animals, there occurring, however, a considerable reduction in the lumbar, sacral and caudal regions of the smaller animal.

The pelvic girdle is normal in the larger pig, but in the smaller one it represents the most posterior skeletal structure in the trunk. It is a peculiar Y-shaped structure. The arms of the Y are represented by normal ilia which support the end of the truncate spinal column; while the median posterior part is formed by a fusion of the two ischia and pubis bones. They are both greatly reduced and are held together by heavy strands of fibrous tissue.

THE SKULL

The skull is a fused structure. Its anterior half is normal; but the posterior half comprises corresponding halves of adjacent skulls. Consequently, two occipitals and four parietals are identified upon the dorsal surface,

while upon the ventral surface a similar fusion is evidenced; so that paired sphenoids, temporals and auditory bulla are duplicated in the structure (Figs. 6, 9, 10).

EXPLANATION OF FIGURES.

Fig. 1. Visceral mass of double monster pig.
Fig. 2. Stomachs and intestines of visceral mass teased apart.
Fig. 3. Paired hearts and main trunks of circulatory system.
Fig. 4. Ventral view of liver of large pig.
Fig. 5. Ventral view of liver of smaller pig.
Fig. 6. Tracheae, oesophagus and larynges with their connections.
Fig. 7. Dorsal view of compound encephalon.
Fig. 8. Dorsal view of posterior portion of compound encephalon.
Fig. 9. Dorsal view of fused skull.
Fig. 10. Ventral view of fused skull.

ABBREVIATIONS USED.

bs	basisphenoid	pa	pancreas
c	caecum	pal	palatine bone
ce	cerebrum	par	parietal bone
cr	cricoid cartilage	pc	post cava
dh	dorsal heart	pm	premaxillary bone
e	epiglottis	prc	pre cava
fab	fused auditory bulla	r	rectum
fm	foramen magnum	rh	rudimentary kidney
fos	fused optic stalk	rsg	rudimentary sex gland
hy	hyoid	sc	superior colliculi
i	intestine	so	superior occipital
m	mesentery	sp	spleen
mal	malar bone	st	stomach
Max	maxillary bone	t	temporal bone
n	nasal bone	th	thyroid cartilage
oes	oesophagus	tr	trachea
p	pouch	vh	ventral heart

LITERATURE CITED.

Carey, Eben; 1917—The anatomy of a double pig, Syncephalus Thoracophagus, with especial consideration of the genetic significance of the circulatory apparatus. Anat. Rec. Vol. 12.

Williams, S. R. and R. W. Rauch; 1917—The anatomy of a double pig. Anat. Rec. Vol. 13.