

THE ANATOMY OF A NOTOSTRACAN BRANCHIPOD  
APUS LONGICAUDATUS LE CONTE

THESIS

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THESIS

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By

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The Anatomy of a Notostracan Branchipod  
Apus longicaudatus Le Conte

Very little work has been published on Apus longicaudatus Le Conte. A few articles describe the gross structure of this organism, but these works are relatively incomplete. It is for this reason that this work and description is made.

The material was collected and preserved by Dr. R. W. Strandtmann, who presented the specimens for study. Collection was made May 24, 1949, in a temporary lake south of Lubbock, Texas. The lake had been completely dessicated for about three years when it was suddenly filled by a heavy rain received on May 6, 1949. It appears from this fact that eggs may lie dormant over periods of time awaiting ideal conditions. After spring rains these organisms appear in large numbers, but in summer under unfavorable conditions they disappear.

The author wishes to express his sincere appreciation to Dr. J. C. Cross and Dr. R. W. Strandtmann, Department of Zoology, Texas Technological College for their advice and

criticism during the preparation of this paper. The author also wishes to thank Dr. Folke Linder, of the University of Uppsala, Sweden, who identified the species used in this study.

### Methods

Part of the specimens were preserved in 5% formalin, the remaining specimens were fixed in hot Bouin's fluid. To insure a better penetration of the fixative, small cuts were made along the body walls with a knife. The incisions were not made on the same surface in all of the individuals. After fixation, the specimens were washed and preserved in 70% alcohol.

For dissection work, the specimens were pinned in a dissecting glass, and covered with 70% alcohol, or water. Dissection was made from specimens preserved by both methods employed. The work of dissection was made under a dissecting binocular microscope, and the drawings shown were made at the time of dissection and are diagrammatic.

After a complete removal of all obstructing materials from the gut, histological

sections were made. The materials were removed by completely severing the organism just posterior to the mandibles, and with the use of a pipette the debris was washed from the intestine. Cross-sections were made from tissue imbedded in paraffin. The sections were stained with eosin Y and fast green stains.

### Body Plan

The body appears to be divided into three main regions; the head, thorax, and abdomen. The head is covered by a broad flattened shieldlike carapace. The carapace is concave ventrally but arches dorsally. It extends anteriorly, posteriorly, and laterally over the head. The attachment of the carapace is the dorsal head region. A cylindrical portion, the trunk, contains the thoracic and abdominal regions. The thoracic region is the more anterior part of the trunk and ends with the genital opening on the eleventh thoracic somite. The abdomen begins posterior to the thorax and ends with a caudal fork of elongated extensions, the rami.

### Exoskeleton

The entire body is covered with an ex-

tremely thin cuticular surface. Molting seems to occur periodically in the adult. This was exhibited by the fact that several of the specimens incased within the two layers were females. Adulthood was confirmed by the fact that the ovaries were filled with eggs.

The cuticle gives support to the body wall, and additional support arises from muscular fibers attached to the cuticle. The external surface is covered with irregular rows of spines. Each somite has on its dorsal surface about ten spines, all of which project backward.

The most conspicuous structure of the exoskeleton is the carapace. The carapace is a broad shieldlike structure nearly circular in outline. The posterior margin is wide and contains a deep excavation. This excavation is armed with about twenty-six minute denticles. The posterior margin of the carapace terminates above the thorax so that about one half of the body is covered with the carapace (Pl. I, fig. 1).

The dorsal surface of the carapace shows a well sclerotized area that marks the attach-

ment of the carapace to the head region. Anterior to this area of attachment a transparent triangular portion appears. This area is called the dorsal organ. Histological sections failed to reveal any significant cellular structure present in this organ. Anterior to the dorsal organ a pair of concrescent structures are present. These paired structures are transparent portions of the carapace that cover the ommatidia of each of the paired compound eyes.

#### Paired Appendages

Like most branchipods, the head bears five pairs of appendages, all of which are modified for special functions. The antennules are flattened, three-segmented appendages fringed with minute setae. A pair of antennae are present but are less conspicuous, and lie posterior to the antennules. The mandibles are large, well sclerotized appendages ending ventral to the oral opening. They arch dorso-ventrad from under the carapace where they are attached by a pair of strong muscles. The oral ending of the mandibles shows a meshing of teethlike projections. The ventral

view of these teeth show only strong projections, whereas the side view clearly demonstrates broad serrate endings of the mandibles. Covering the mandibles is an extended flap-like process, the labrum. This square shaped process is convex on its outer surface, but a slight concavity appears on the inner surface. Two prominent horizontal muscles are attached to the labrum making it capable of a lapping movement. Histological sections revealed what appeared to be a glandular structure present in the labrum. Smaller paired appendages, the paragnathum, the maxillule, and the maxilla are aligned posterior to the mandibles to form a ventral groove between their innermost margins. These appendages serve as food gathering organs (Pl. II, fig. 1).

The trunk bears eleven pairs of appendages, or phyllopoda; a pair for each somite. Each appendage gives rise to its various parts, the exopodite, the endopodite, and a flabellum, from a central portion. The central portion that gives rise to the parts is called the protopodite. The central portions of the protopodite are aligned so that their median



surfaces continue the ventral groove. Through this groove food may be swept to the oral opening by the brush ends found on the median surfaces of each of the protopodites. Each median surface is called a gnathobase.

The first appendages are greatly elongated by segmented extensions of the exopodite and the endopodite. Attached to the posterior surface of the protopodite is a broad leaflike structure, the flabellum. The flabellum, unlike the segmented exopodite or endopodite, is unsegmented and is fringed with setae along its posterior margin. All of the appendages are of common type, yet the various parts are slightly modified. Anterioposterior modification consists of a shortening and a broadening of each process of the appendage to form leaflike swimmers (Pl. II, fig.1).

The last thoracic somite contains the opening of the genital system, and its appendage is modified into an ovisac. The ovisac is a cuplike depression formed in the broad part of the appendage, over which the flabellum fits as a lid.

The abdominal appendages begin with the appendages of the twelfth somite. The thirteenth and fourteenth somites each possess a pair of appendages. Each of the following fourteen abdominal somites bear from three to five pairs of appendages, which function as gills. The remaining nine abdominal somites bear no appendages. The abdomen terminates with a telson. The telson is a spiny, semi-cylindrical portion ending in a pair of long rami. The rami are paired, spiny, segmented processes extending posteriorly for about two-thirds the length of the body.

#### The Circulatory System

The heart is an extended tube, dorsal to the mid-gut, extending the length of the thorax and terminating by opening in the region of the fourteenth abdominal somite. Surrounding the heart is a pericardial sac, so that the heart functions in a pericardial sinus. The sinus thus formed communicates with the lumen of the heart by ostia. The ostia are valvelike apertures that open into the pericardial sinus. The heart is more or less swollen in each somite forming

segmental chambers, separated by slight constrictions.

Histological sections revealed very little muscular tissue in the heart, although muscular attachments were found on the lateral surface of the heart. Muscular fibers, similar to the alary muscles of the insects, extend from the lateral region of the heart to the dorsolateral region of the body wall.

Only one blood vessel is associated with the circulatory system. A primitive aorta extends anteriorly to open into the cephalic blood sinus. Communicating with the pericardial sinus is the coelomic cavity which is part of a haemocoel. From this haemocoel blood sinuses communicate freely to all parts of the body (Pl. III, fig. 1).

#### The Nervous System

The supraesophageal ganglia receive the optic nerves and nerves from the frontal ganglion. The frontal ganglion is an enlarged mass of nerve tissue extending ventrad to the supraesophageal ganglion. Circumesophageal connectives unite the supraesophageal ganglia with chainlike commissures of nerve

ganglia which continues as the ventral nervous system. The circumesophageal connectives also receive the nerve from the antenna and the antennule. This nerve is received by the circumesophageal connectives about two-thirds of the distance from the supraesophageal ganglia and the first of the ventral nerve ganglia. These nerve ganglia occur in each somite and send three lateral nerves to the body wall. Dorsal nerves also arise from each ganglion. These nerves apparently supply the coelomic structures (Pl. IV, fig. 1). As the ganglia proceed posteriorly they decrease in size and terminate at the fourteenth abdominal somite. Following this termination a pair of slender nerves continue posteriorly (Pl. V, fig. 1).

The optic nerve is a large nerve composed of numerous nerve fibers that originate from an optic cup. The optic cup receives nerves from the ommatidium of each compound eye. An ommatidium is composed of a group of visual nerve cells covered by a transparent part of the cuticle. Each compound eye contains many of these ommatidia grouped

together.

### The Digestive System

A mouth opens into a simple muscular esophagus, a vertical tubular structure that joins at right angles the thin, delicate foregut. Above the entrance of the esophagus the foregut expands into a pair of lateral pouches. These lateral pouches each receive five tubules. The tubules are ducts leading into the pouches of the foregut from the secretory gland. This gland is a mass of convoluted tubules occupying the main portion of the anterior part of the carapace. The gland ramifies into a network of numerous branches, all opening into the five main channels that lead to the foregut (Pl. VI, fig. 1).

The midgut is the longest part of the digestive system. It is a thin, delicately muscular tube that extends most of the length of the body. In the region of the sixteenth abdominal somite additional muscular fibers strengthen the wall of the gut. In this area the gut narrows considerably to form a constriction. Pos-

venter to this constriction an enlarged, oblong portion identifies the rectum, or hindgut. The hindgut opens to the exterior at the anus between the paired rami (Pl. VII, fig. 1).

### The Reproductive System

These organisms are primarily diecious, that is only one sex is represented by one individual.

The female reproductive system is represented by a pair of tubular ovaries that extend posteriorly from the area of the second thoracic somite to the region of the fourteenth abdominal somite. Each ovary is surrounded and suspended from the lateral body walls by a thin membrane. This membrane covers the ovaries and the smaller branches of the ovary, the ovarioles. The ovaries are therefore held lateral to the midgut (Pl. VII, fig. 1).

The eleventh thoracic somite contains the opening of the genital tube. The opening is on the appendage possessed by this somite. This appendage is modified into an ovisac for storage of eggs. About fourteen eggs

may be stored in the ovisac. Many of the ovisacs examined contained numerous small, well sclerotized eggs, and several larger white eggs. One end of these eggs appeared to be larger than the other end. It is possible that the large eggs were maturing in the ovisac, while the small eggs were deposited from the ovisac to lie dormant over several years awaiting ideal conditions.

Only a few male organisms were observed. The male reproductive system is similar to that of the female. The testes are small tubules extending the length of the thorax lateral to the midgut. The eleventh thoracic appendage contains no ovisac, but a genital tube extends the length of the appendage.

Although the description of the male reproductive organs is made, the number of males which were obtained as specimens were few. Because of the lack of male organisms at certain times it is believed that reproduction takes place by parthenogenesis.

#### The Excretory System

Attempts to find an excretory system

were unsuccessful.

### Summary

An attempt has been made to describe more completely the anatomy of the fresh water branchipod, Apus longicaudatus Le Conte. The work was done from material collected in Lubbock, County, Texas. The material was preserved in 5% formalin and in hot Bouin's fluid. Most of the information for the text of the paper was obtained by dissection under a binocular microscope, but histological sections were also made from tissue imbedded in paraffin.

This paper discusses the various systems of the organism; the circulatory, the nervous, the digestive, the exoskeletal, and the reproductive systems. Some of the systems are similar to those of Artemia. The digestive gland is unusual in the position that it occupies in the carapace.



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## Explanations of Plates

### Explanation of Plate I, fig. 1

A dorsal view of the carapace. 1. Exopodite 2. Endopodite of the first thoracic appendage 3. Eye 4. Dorsal organ 5. Attachment of the carapace 6. Shell gland 7. Excavated margin with denticles

### Explanation of Plate II, fig. 1

A ventral view showing the modification of thoracic appendages. The appendages are spread laterally to show their parts. The mouth parts and the abdominal appendages are in place. 1. Antennae 2. Antennule 3. Labrum 4. Mandibles 5. Praganathum 6. Maxillule 7. Maxilla 8. Gnathobase of first thoracic appendage 9. Abdominal appendages

### Explanation of Plate III, fig. 1

Ventral view of the heart and the pericardial cavity. 1. Aorta 2. Ostia 3. Alary muscles 4. Pericardial sac

### Explanation of Plate IV, fig. 1

A dorsal view of the ventral nerve connectives. 1. The fifth ventral nerve ganglion 2. Lateral nerve fibers 3. Dorsal nerve fiber

### Explanation of Plate V, fig. 1

Dorsal view of the ventral nervous system. The frontal ganglion has been pulled forward. 1. Frontal ganglion 2. Compound eyes and connectives 3. Optic cup 4. Supraesophageal ganglia 5. Circumesophageal connectives 6. Nerve from the antennae and the antennule 7. First ventral nerve ganglion 8. Twenty-sixth ventral nerve ganglion 9. Posterior nerve fiber

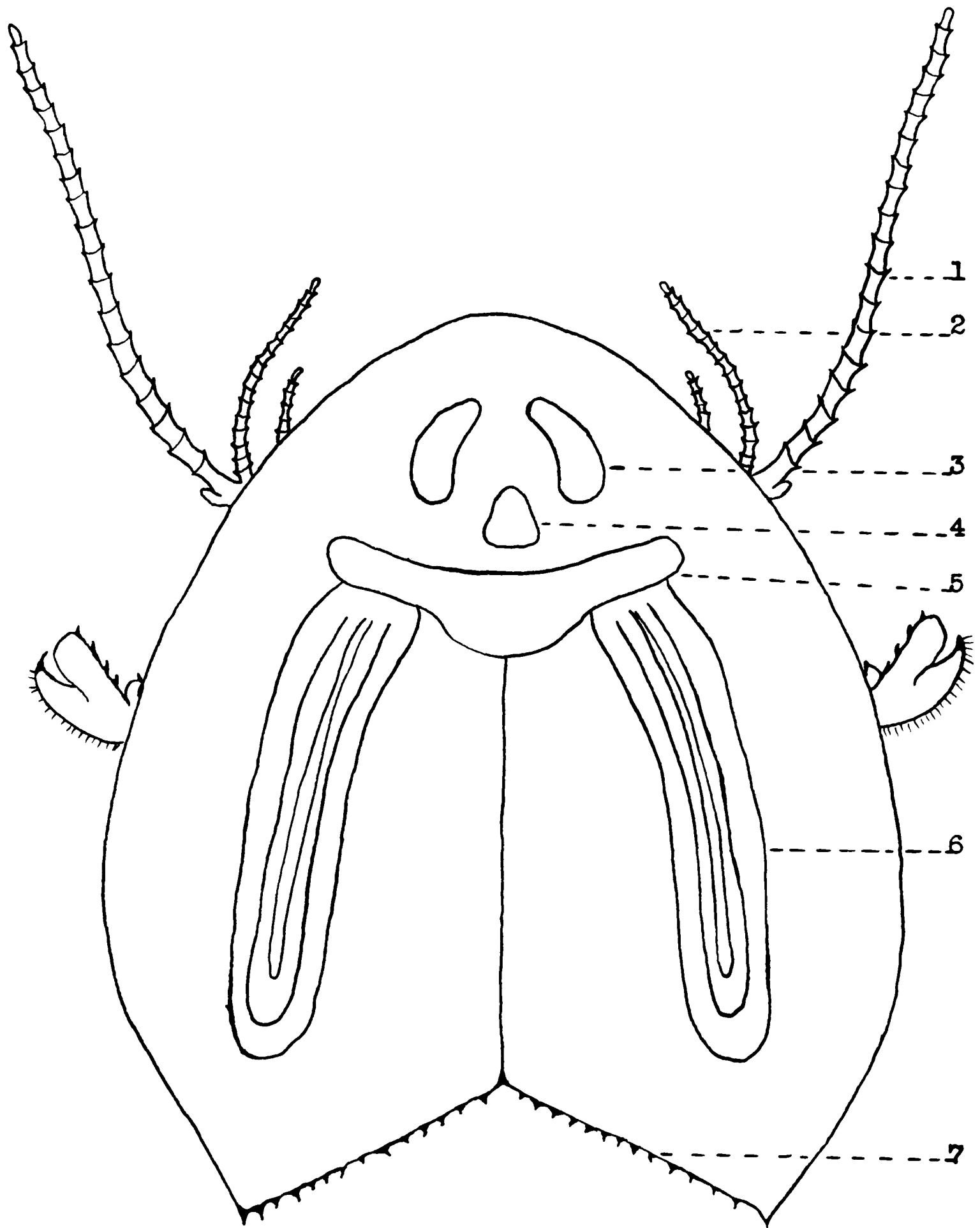
Explanation of Plate VI, fig. 1

A histological section of a tubule of the digestive gland, drawn with the aid of a camera lucida.

Explanation of Plate VII, fig. 1

A dorsal view of the organism showing the digestive system and the reproductive systems. The eleventh thoracic appendage is placed over the reproductive system.

1. The digestive gland
2. Connective tubules
3. Esophageal opening
4. The gut
5. Ovary
6. Eleventh thoracic segment
7. Rectum
8. Anus
9. Rami



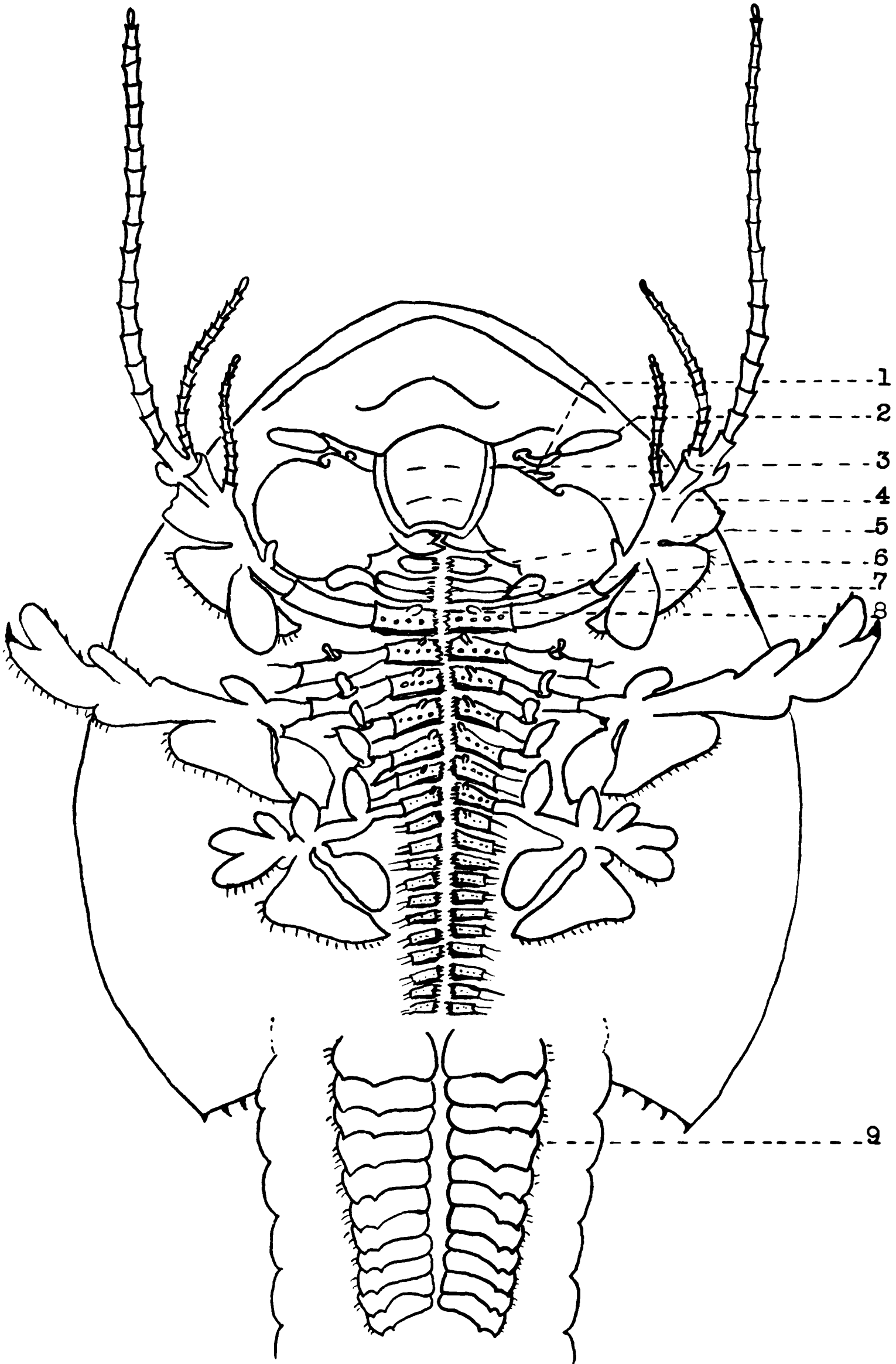
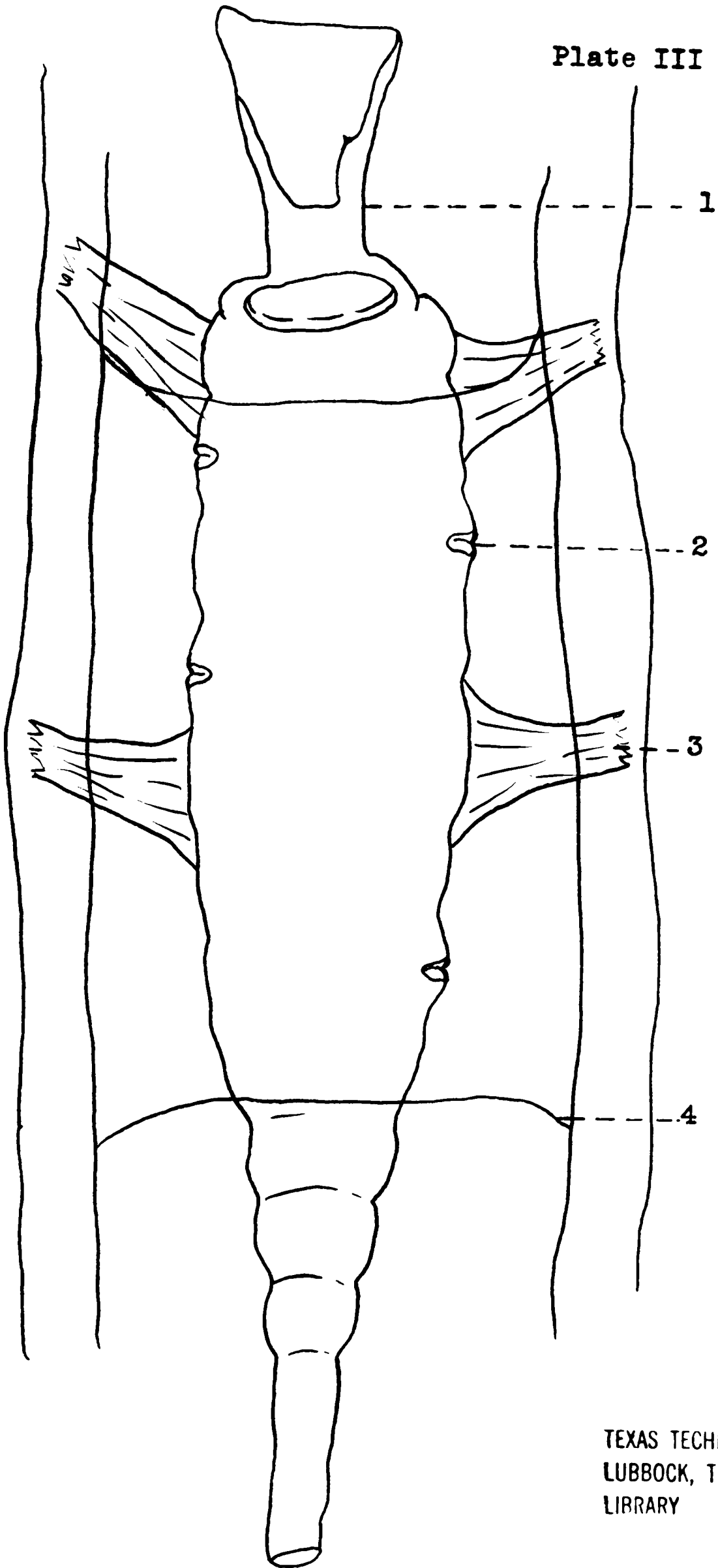


Plate III



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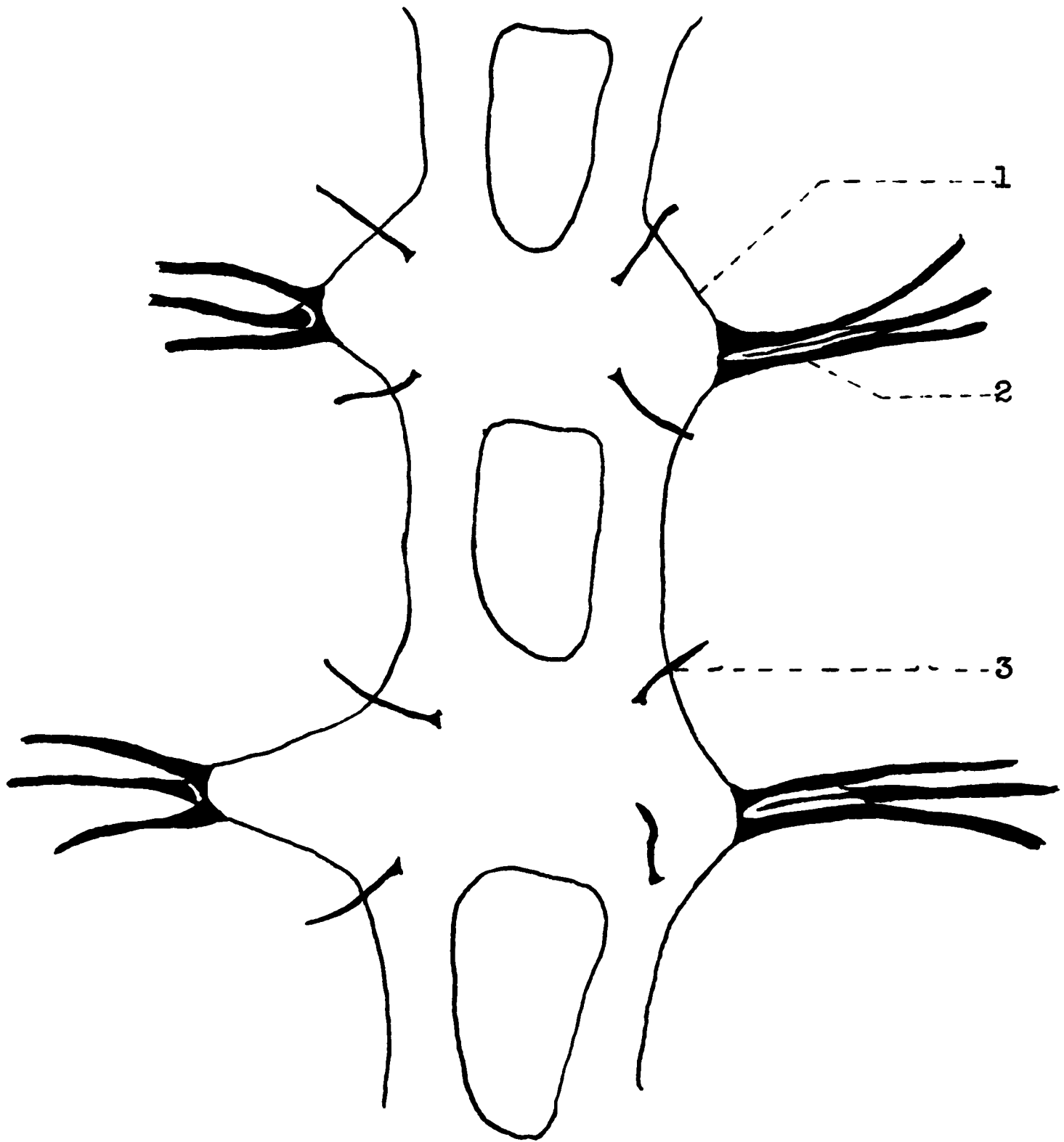


Plate V

