Female Cloacal Anatomy of *Plethodon cinereus* and *Plethodon dorsalis*  
(Amphibia, Urodela, Plethodontidae)

David M. Sever  
Department of Biology, Saint Mary's College, Notre Dame, Indiana 46556, USA

**ABSTRACT**—Cloacae of 15 *Plethodon cinereus* and 14 *P. dorsalis* females from seasonal samples were studied anatomically by light microscopy. The cloaca is lined with epidermis except for the anterior portion of the cloacal tube. The spermatheca is the only type of gland in the female cloaca. In both species, the common duct of the spermatheca passes proximally into the anterior dorsal roof of the cloacal tube at the cephalic end of a middorsal cloacal papilla which extends posteriorly into the cloacal chamber. The distal portions of the spermatheca are expanded, lateral to the midline, and oriented transversely. In *P. cinereus* the distal portions of the spermatheca consists of up to six relatively long tubular branches. The distal portion of the spermatheca of *P. dorsalis* is a large tubule which may have up to four short irregular outpocketings.

Interspecific variation also occurs in the shape of the cloaca. In *P. dorsalis* there is a dorsoventrally flattened recess of the cloacal chamber which extends anteriorly dorsal to the cloacal papilla to dorsal of the spermatheca. No such extensive recess occurs in *P. cinereus*.

Sexual dimorphism includes not only the numbers and types of cloacal glands but also the shape of the cloacal cavity and the anatomy of its linings.

---

**INTRODUCTION**

Kingsbury (1895:284-286) briefly compared the cloacal anatomy of female *Plethodon cinereus* and *P. glutinosus*. He found parts of the cloacal tube were ciliated in *P. glutinosus* and not in *P. cinereus*, and an anterior dorsal recess of the cloacal chamber occurred in *P. glutinosus* and was absent in *P. cinereus*. The spermatheca of both species was similar, consisting of four tubules which proximally joined a common duct passing through the anterior dorsal cloacal wall. Kingsbury found no other types of cloacal glands.

No other detailed studies exist on the comparative female cloacal anatomy of congeneric plethodontid salamanders. Kingsbury's report is the only description of cloacal anatomy of female salamanders of the genus *Plethodon*.

Recently I reported on the cloacal anatomy of seasonal samples of male *P. cinereus* and *P. dorsalis* from sympatric samples in western Indiana (Sever, 1978). Significant interspecific variation was found in several of the cloacal glands and in the shape of the cloacal chamber. In this paper, I describe the cloacal anatomy of female *P. cinereus* and *P. dorsalis* from the same samples. I report on seasonal and interspecific variation in female cloacal anatomy, sexual dimorphism and present a review of the literature on female cloacal anatomy in salamanders.

**MATERIALS AND METHODS**

Individuals of *Plethodon cinereus* and *P. dorsalis* were collected in April, June, August (*P. cinereus* only) and October of 1976 at Shades State Park, Montgomery Co., and Turkey Run State Park, Parke Co., Indiana. These two parks are less than 10 km apart, and both species are seasonally abundant at both locales.

All individuals collected were killed in 30-40% ethanol and preserved in 10% formalin.
Cloacal regions of small series of specimens from each sample were histologically prepared by
the standard paraffin method (Humason, 1972:46) for examination by light microscopy
(maximum magnification 1000X). Sagittal, frontal and transverse paraffin sections were cut at
10 μm and usually stained in Mallory’s triple stain although many were stained with
hematoxylin-eosin.

Cloacae of many of the remaining specimens were examined by gross dissection. Ovaries
of all specimens were removed, and the largest follicles of similar size were measured with an
ocular micrometer and counted.

Collection dates and numbers of *P. cinereus* and *P. dorsalis* prepared histologically from
each collection were: 10 April, 5 *P. cinereus* and 5 *P. dorsalis; 17 June, 4 *P. cinereus* and 4 *P.
dorsalis*; 13 August, 2 *P. cinereus*; and 3-4 October, 4 *P. cinereus* and 4 *P. dorsalis*.

**TABLE 1. Maximum follicle diameters (MFD) and snout-vent lengths (SVL) of seasonal samples of Plethodon cinereus and P. dorsalis. All measurements are in mm.**

<table>
<thead>
<tr>
<th>Month</th>
<th><em>P. cinereus</em></th>
<th></th>
<th></th>
<th></th>
<th><em>P. dorsalis</em></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>SVL</td>
<td>MFD</td>
<td>N</td>
<td>SVL</td>
<td>MFD</td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>11</td>
<td>37.4-46.8</td>
<td>2.0-3.0</td>
<td>9</td>
<td>40.8-45.3</td>
<td>2.5-4.0</td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>11</td>
<td>36.2-44.4</td>
<td>.5-.8</td>
<td>5</td>
<td>36.4-44.5</td>
<td>.7-1.0</td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>2</td>
<td>40.7-42.9</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>16</td>
<td>37.2-45.3</td>
<td>.9-1.6</td>
<td>17</td>
<td>35.6-44.9</td>
<td>1.1-1.8</td>
<td></td>
</tr>
</tbody>
</table>

In the June sample of *P. cinereus*, two specimens contained follicles larger than those reported in Table 1. A female 43.0 mm snout-vent length (SVL) contained follicles 2.4, 3.6 and 4.0 mm in diameter, and a 39.1 mm SVL specimen contained two large follicles, one of which was 3.5 mm.

A 44.5 mm SVL *P. dorsalis* also contained follicles larger than other specimens in the June sample. This specimen contained three large follicles 1.2, 1.5 and 2.0 mm in diameter plus about 25 smaller follicles .4-1.0 mm in diameter.

Spermatozoa were found in the spermathecae of all April specimens of both species plus the two June collected *P. cinereus* which still contained large follicles. One April collected *P. dorsalis* contained the cap of a spermatophore within its cloacal chamber. No spermatozoa were present in the spermathecae of other June, August or October collected specimens.

**CLOACAL ANATOMY**

*Plethodon cinereus.*—As in males, the cloaca is divided into an anterior tubular portion,
the cloacal tube, and a posterior region surrounding the vent, the cloacal chamber (Sever,
1978). The cloacal tube begins anteriorly where the oviducts, Wolfian ducts and bladder merge
with the gut tube. In this region the simple, columnar, glandular epithelium lacks the large
goblet cells and cilia present more anteriorly in the intestine. Rugae of the cloacal tube are
thin, and caudally angled ventrally (Fig. 1A). The most prominent fold is the dorsomedial
one which begins anteriorly where the oviducts and Wolfian ducts join the cloaca.

A narrowing of the coelomic spaces occurs at the anterior end of the cloaca tube first

*FIGURE 1. Transverse sections through the cloaca of a 43.3 mm SVL October collected female Plethodon cinereus from anterior (A) to posterior (D). Scale in lower left-hand corner = 250 μm. A. Section anterior to the common tube of the spermatheca showing anteriormost appearance of spermathecal tubules. B. Section through region of the common tube. C. Section through cloacal tube posterior to the spermathecal region. D. Section through anteriormost portion of cloacal chamber. cp = cloacal papilla, cs = cloacal sheath, ct = cloacal tube, d = dermis, m = muscularis, r = rugae, s = spermathecal tubule(s), and st = common tube of the spermatheca.*
ventrally and then laterally until the coelomic spaces are obliterated. The epithelium of the cloacal tube then gradually becomes striated. Superficial to the thick muscularis is a layer of dense connective tissue and smooth muscle called the cloacal sheath (Sever, 1978). Superficial to the cloacal sheath are bundles of skeletal muscles ventrally and laterally and the vertebral column and opisthonephric masses dorsally.

Dorsal to the cloacal tube following posterior cessation of the opisthonephric masses, the spermatheca appears in the connective tissue of the cloacal sheath (Fig. 1A). The muscularis at the dorsal end of the cloacal tube splits with a lateral portion passing dorsad to surround the distal spermathecal tubules and a medial portion continuing mediad down the most dorsomedial ruga. This ruga widens laterally and can be termed the cloacal papilla (Fig. 1B).

Melanophores become abundant along the lateral walls of the cloacal papilla and around the superficial layer of the cloacal sheath, especially around the spermatheca (Fig. 1B). The common spermathecal tubule passes through the anterior end of the cloacal papilla. The common tube is angled slightly posteriorly.

The common tube and other spermathecal tubules are composed of simple, unciliated, columnar epithelium. The lumen of the common tube is relatively narrower than that of distal portions of the spermatheca.

Upon dissection, the spermatheca of *P. cinereus* resembles a small stout cord that is in a tight oblong coil. Fig. 2 shows reconstructions of spermathecae from serial sections of some April collected specimens. The spermatheca is bilaterally and radially asymmetrical. The common tube passes sharply to the right or left upon reaching the dorsal edge of the gut muscularis, and the spermathecal tubules then lie almost totally on the right or left side (Fig. 1B). Of the 15 specimens sectioned, nine had spermathecae which were largely to the left side, and five had spermathecae which were on the right side.

The spermatheca is a simple, branched, tubular, exocrine gland. The number of branches varies, but there seems to be generally less than a maximum of six major branches. The branches are largely oriented in a transverse plane rather than a dorso-ventral or antero-posterior direction. Each branch is tightly encased in a heavily pigmented fibro-muscular sheath, and the cluster as a whole is enveloped in fascia and smooth muscle continuous with that of the cloacal tube (Fig. 1B). The smooth muscle surrounding the common tube is relatively thicker than that surrounding the distal portions of the spermatheca.

Between the epithelial cells and basal lamina of the distal spermathecal tubules is a discontinuous layer of cells with round, cuboidal or cylindrical nuclei. These are probably myoepithelial cells, and they appear to be absent around the common duct.

The only seasonal variation apparent in the spermatheca occurred in the August sample in which the epithelium of the glands is relatively thicker and the lumen narrower than in other months.

Spermatozoa occur in small bundles oriented dorso-ventrally in the common tube. In the transverse tubules, spermatozoa are arranged in large transverse bundles following the long axis of the glands.

Posterior to the spermatheca, the cloacal papilla remains pigmented and narrows (Fig. 1C). Ventrally the epithelium becomes similar to epidermis. It is aglandular, striated into two or sometimes three layers, and possesses a cornified layer bordering the cloacal lumen. This change gradually spreads to the entire cloacal tube. The most posterior parts of the lining to change are those areas lateral to the
FEMALE CLOACAL ANATOMY OF PLETHODON

papilla. The muscularis of the dorsal portion of the cloacal tube remains very thick, and the walls are still highly pigmented (Fig. 1C).

At the posterior end of the cloacal tube, the lining of the cloaca is entirely epidermal. As the vent joins with the cloacal tube, the cloacal sheath becomes continuous with the dermis (Fig. 1D).

The cloacal papilla becomes very broad laterally at the posterior end of the cloacal tube. The dorsal portions of the cloacal tube and anterior cloacal chamber are much wider than the ventral portions (Fig. 1D).

At the posterior end of the cloacal tube or anterior end of the cloacal chamber there is a marked dorsal elongation of the cloaca lateral to the papilla (Fig. 1D). The papilla is then pinched off dorsally from the cloacal wall so that the free posterior end of the papilla projects into the anterior third or fourth of the cloacal chamber (Fig. 1D). A small recess dorsal to the papilla may develop before the lateral cloacal walls pinch off the sides of the papilla.

Aside from changes in the spermatheca, the only seasonal variation apparent in the cloaca involves the cloacal papilla. The cloacal papilla seems less developed in August and most June specimens. In some of these specimens, there was not a free posterior projection of the papilla into the cloacal chamber.

The cloacal papilla remains pigmented throughout its length. There is also some pigment in the dorsal walls of the cloacal chamber, but there is little elsewhere in the cloacal chamber.

The rugae from the cloacal tube end abruptly around the anterior borders of the vent. The lining of the cloacal chamber consists of thicker folds not as deep as the rugae. These folds are oriented more dorso-ventrally although they are slanted posteriorly (Fig. 3).

In the anterior portion of the cloacal chamber, the epithelium is rather regular around the widened dorsal end of the chamber into which the cloacal papilla may extend (Fig. 1D). Beyond the posterior extension of the papilla, there is a narrowing of the dorsal half and an overall dorso-ventral shortening of the chamber. The muscularis becomes very thin, and the cloacal sheath is quite loose. The cloacal chamber gradually shortens until even with the rest of the epidermis. Nowhere in the cloacal sheath are there mucous or granular glands which abound in contiguous portions of the dermis.

**Plethodon dorsalis.**—The major differences in cloacal anatomy between female *P. dorsalis* and *P. cinereus* are in the structure of the spermatheca and the cloacal papilla (Figs. 3, 4).

The spermatheca is simpler in *P. dorsalis*. The relatively narrow common tube opens into a large transversely flattened sac which may have up to four irregular outpocketings (Fig. 4A). The outpocketings of the spermatheca are short in *P. dorsalis*, not the long tubular extensions characteristic of *P. cinereus*. In *P. dorsalis* the myoepithelial layer is more distinct, and the epithelium of the large spermathecal sac seems thicker and more irregular than noted in *P. cinereus*. Unlike *P. cinereus*, the epithelium of the common tube is stratified into two cuboidal layers.

As in *P. cinereus*, the spermatheca of *P. dorsalis* is generally bent laterally from the common tube. Most specimens examined have the tubules largely on the right side.

A recess extends anteriorly from the cloacal chamber dorsal to the cloacal papilla to dorsal of the caudal portion of the spermatheca (Figs. 3A, 4B). The superficial fascia of this
FEMALE CLOACAL ANATOMY OF PLETHODON

recess is separate from that of the cloacal tube in the region of the spermatheca (Fig. 4B). Further posteriorly, the sheath of the recess becomes continuous with that of the cloacal tube (Fig. 4C-D).

Caudally the recess widens laterally (Fig. 4C). At the posterior end of the cloacal tube, the lateral ends of the recess curve ventrally (Fig. 4D). At the anterior end of the vent, the ventro-medial walls of the recess invaginate and become continuous with the dorso-lateral walls of the posterior cloacal tube or anterior cloacal chamber (Fig. 4D). This pinches off the caudal portion of the cloacal papilla so that a free posterior process of the papilla extends into the anterior fourth of the cloacal chamber (Fig. 4D). Caudally, the cloacal chamber narrows and shortens as in P. cinereus.

One of the April specimens contains the cap of a spermatophore within its cloaca. The cap is composed of a dense acellular material which stains reddish in Mallory's, the same color which characterizes the secretion of the male pelvic gland.

The spermatophore is lodged in the cloacal chamber. The posterior end of the papilla is bent ventrally and portions of the spermatophore extend far anteriorly into the recess (Fig. 5A). The spermatophore is filled with spermatozoans in a loose violet and bluish matrix. The spermatozoans are not in dense clusters.

Long portions of the cap are intact. The largest broken area of the cap is the anterior midventral portion. Many spermatozoans are outside of the spermatophore in the recess and especially in the anterior cloacal chamber.

A narrow line of spermatozoans with some bluish staining substance and other acellular and cellular material extends anteriorly along the ventral border of the cloacal papilla (Fig. 5A). Some spermatozoans are within the common tube (Fig. 5B), which is not hypertrophied, and a few are in the large spermathecal sac. The spermatozoans are not in groups. No spermatozoa are found anterior to the common tube.

An orange-staining substance is present in the epithelium of the spermatheca. Such a reaction was not seen in the spermathecal epithelium of any other specimen.

DISCUSSION

There is little detailed literature on cloacal anatomy in salamanders. I know of no histological studies on the Hynobiidae, Crytobranchidae, Amphiumidae or Sirenidae. Females of

---

FIGURE 4. Transverse sections through the cloaca of a 40.7 mm SLV October collected female Plethodon dorsalis from anterior (A) to posterior (D). Scale in lower left-hand corner = 250 \( \mu \)m. A. Level of the largest diameter of the spermatheca. B. Section through posterior portion of the spermatheca and anteriormost extension of the cloacal recess. C. Section through the cloacal tube posterior to the spermatheca. D. Section through the anteriormost portion of the cloacal chamber. cp = cloacal papilla, cr = cloacal recess, ct = cloacal tube, r = rugae, and s = spermatheca.

FIGURE 5. Sagittal sections through the cloaca of a 45.3 mm SLV April collected female Plethodon dorsalis containing a spermatophore. A. Section showing the common tube of the spermatheca and the cloacal papilla and their relationship to the spermatophore and migrating spermatozoa. Note that the cloacal papilla is bent ventrally and that the spermatophore fills the cloacal recess dorsal to the cloacal papilla. Scale in lower left-hand corner = 250 \( \mu \)m. B. Section showing spermatozoans entering the common tube of the spermatheca. The common tube is not hypertrophied, and the spermatozoa are in small groups. Scale in lower left-hand corner = 33 \( \mu \)m. cp = cloacal papilla, sm = spermatozoa, sp = spermatophore, and st = common tube of the spermatheca.
none of these families possess spermatheca or other cloacal glands (Sever, 1978). The use of the terms dorsal gland and ventral gland for females in the following discussion merely connotates position and does not imply homology with male glands with similar names.

In female *Necturus maculosus* of the Proteidae, the spermatheca consists of about 40 glands that are expanded distally and open proximally into the dorsal roof of the cloaca (Kingsbury, 1895:278). Kingsbury also noted two other types of cloacal glands in female *N. maculosus*. A mass of long convoluted glands occurs dorsal and lateral to the spermatheca, and a ventral gland mass lies cephalic to the vent.

In *Ambystoma maculatum* of the Ambystomatidae, spermathecal tubules open separately into a depression in the anterior dorsal wall of the cloaca (Kingsbury, 1895:280). Kingsbury stated that the arrangement of the tubules is quite compact about the depression from which tubules radiate on all sides. A ventral gland mass occurs in much the same position as *Necturus*, and a dorsal gland mass opens on the dorsal and lateral sides of the cloaca posterior to the spermatheca (Kingsbury, 1895:281).

The Salamandridae were studied in detail by Wahlert (1953). According to him, females in the salamandrid genera possess a ventral gland mass in addition to the spermatheca except for *Pachytriton* which also possesses a dorsal gland and *Cynops* in which neither dorsal nor ventral glands are present (Wahlert, 1953:305). However, recently female *Pleurodeles waltl* was found to contain the same three sets of glands present in males (Lemaitre-Lutz, 1968:412). There is sexual dimorphism in the shape of the cloacal cavity and arrangement and relative abundance of the three gland masses in *P. waltl*. The pelvic gland mass is larger in females than males and functions as the spermatheca in females (Lemaitre-Lutz, 1968:413).

The salamandrid spermatheca is composed of simple epithelium. The tubules open separately into paired or unpaired recesses of the dorsal wall of the cloacal tube. The form of the tubules varies considerably among the genera. *Salamandra*, *Tylotriton* and *Pleurodeles* possess long, stretched-out, drop-like spermathecal tubules while *Triturus* has tubules consisting of a thin stem and a bulbous distal part (Wahlert, 1953:301-302).

Reports on the Plethodontidae include Kingsbury (1895) for *Plethodon cinereus, P. glutinosus, Eurycea biseinata*, and *Desmognathus fuscus*; Kohering (1925) for *E. biseinata*; Dieckmann (1927a) for *Gyrinophilus porphyriticus*; Dieckmann (1927b) for *Hemidactylium scutatum*; and Noble and Pope (1929) for *D. fuscus*.

The spermatheca in *E. biseinata, G. porphyriticus*, and *H. scutatum* is more complex than in *Plethodon*. In *E. biseinata* and *G. porphyriticus* from the common tube there are many branches which are narrow proximally and bulbous distally. Seven-16 such branches occur in *E. biseinata* (Kohering, 1925:251) and 15-25 in *G. porphyriticus* (Dieckmann, 1927a:261). In *H. scutatum* there are about seven glands which open separately into the roof of the cloaca, but the distal ends of these glands are expanded and branch irregularly (Dieckmann, 1927b:282).

Noble and Pope (1929:401) stated that the spermatheca of *D. fuscus* is similar to that of *E. biseinata* except that there are only 5-6 tubules. Kingsbury (1895:287) reported that the spermatheca of *D. fuscus* closely resembles that of *Plethodon*.

Female *P. cinereus, P. glutinosus* and *D. fuscus* lack cloacal glands other than the spermatheca (Kingsbury, 1895:298). Ventral glands and rudimentary dorsal glands are present in female *E. biseinata* (Kingsbury, 1895:284; Kohering, 1925:265) and *G. porphyriticus* (Dieckmann, 1927a:259-260). Female *H. scutatum* lack ventral glands, but rudimentary dorsal glands are present (Dieckmann, 1927b:283).

A papilla as present in *Plethodon* is absent in *D. fuscus* and *E. biseinata*. In *G. porphyriticus* there are two large folds on the dorsal wall with a medial dorsal slit between them into which the common tube passes anteriorly (Dieckmann, 1927a:259-260). Anterior to the common tube, the lateral folds form a single papilla. Such folds also exist in *H. scutatum*, but they are not fused anteriorly (Dieckmann, 1927b:281).

A dorsal recess of the cloacal chamber as found in *P. dorsalis* apparently extends to just posterior of the spermatheca in *G. porphyriticus* (Dieckmann, 1927a:260) and *P. glutinosus* (Kingsbury, 1895:285; Dieckmann, 1927a:260).
FEMALE CLOACAL ANATOMY OF PLETHODON

*P. dorsalis* has stratified epithelium in the common tube, and stratified epithelium occurs in the common tube of *P. glutinosus* (Kingsbury, 1895) and in proximal portions of the tubules of *G. porphyriticus* (Dieckmann, 1927a). *P. glutinosus* is the only plethodontid in which the anterior cloacal tube is reported as ciliated (Kingsbury, 1895:286). Pool and Hoage (1973:304) found that the common tube of *Eurycea quadridigitata* is ciliated.

Ultrastructural studies by Dent (1970) on *Notophthalmus viridescens* and Pool and Hoage (1973) on *Eurycea quadridigitata* show that the spermatheca not only functions in storage of spermatozoa but also in the active transport of spermatozoa into the storage tubules and in resorption of non-functional or dead spermatozoa. Pool and Hoage (1973:308) identified the substance secreted for spermatozoa maintenance as a carboxylated polysaccharide. Expulsion of spermatozoa from the spermatheca is probably due to contraction of the myoepithelial cells around the distal tubules (Dent, 1970; Poole and Hoage, 1973). Pool and Hoage (1973:312) did not observe the stored spermatozoa in orderly bundles as I found in *P. cinereus* and *P. dorsalis*.

Noble and Weber (1929) described the appearance of the spermatophore cap in the cloacae of *P. cinereus*, *E. bislineata* and *D. fuscus*. As reported herein for *P. dorsalis*, the spermatophore is lodged in the posterior half or third of the cloacal orifice, and migrating spermatozoa are found singly or in small groups extending from the spermatophore to the common duct of the spermatheca.

Noble and Weber (1929:13-14) reported that the spermatophore cap is phagocytosed by leukocytes which pass from the cloacal epithelium underlying the spermatophore. No such cells were definitely identified in my specimen of *P. dorsalis*. However, some leukocytes stain yellow in Mallory's, and yellow-staining cells were seen scattered among the spermatozoa outside of the spermatophore.

There is relatively little smooth muscle in the posterior extension of the papilla, but contraction of the muscularis at the anterior end would cause the papilla to bend ventrally as noted in the *P. dorsalis* containing the spermatophore. This serves to enlarge the dorsal half of the cloacal chamber.

Sever (1978) described male cloacal anatomy in *P. cinereus* and *P. dorsalis*. The sexes differ not only in types and numbers of glands but also in the shape of the cloaca and the nature of its linings. In males there are at least five distinct gland clusters, the pelvic, dorsal, ventral, Kingsbury's and vent glands (Sever, 1978).

The position of the spermatheca of *P. cinereus* and *P. dorsalis* is roughly equivalent to the anterior depression of the cloacal tube described by Sever (1978) in males of the species. Anterior and lateral to this ciliated depression, Kingsbury's glands secrete into the cloaca. The proximal ends of anteriorly passing pelvic glands form the body of the anterior depression, and these glands secrete on papillae on the posterior border of the depression (Sever, 1978). No homologies can be proposed at this time between cloacal structures in male and female *P. cinereus* and *P. dorsalis*.

In *D. fuscus*, Noble and Pope (1929) performed testicular implants in females and found subsequent development of pelvic, dorsal and ventral glands. Part of the pelvic gland developed from the spermatheca, and the remainder from cloacal epithelium near the common tube of the spermatheca. They did not describe the nature of the epithelium or the shape of the cloacal cavity, so it cannot be ascertained whether any changes occurred in these structures.

ACKNOWLEDGMENTS

This study was supported by a faculty research grant from Saint Mary's College. I thank my wife Marlis and sons Philip and Robert for aid in collecting.

LITERATURE CITED

406 DAVID M. SEVER

Kingsbury, B. F. 1895. The spermatheca and methods of fertilization in some American newts and
Lemaître-Lutz, F. 1968. Anatomie des glandes pelviennes dex la femelle de Pleurodeles waltlii Michah: Leur
Noble, G. K. and S. H. Pope. 1929. The modification of the cloaca and teeth of the adult salamander,
__________ and J. A. Weber. 1929. The spermatophores of Desmognathus and other plethodontid
Pool, T. B. and T. R. Hoage. 1973. The ultrastructure of secretion in the spermatheca of the salamander,
Server, D. M. 1978. Male cloacal glands of Plethodon cinereus and Plethodon dorsalis (Amphibia:

Accepted 21 Dec 1977
Copyright 1978 Society for the Study of Amphibians and Reptiles