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Descriptions of three new species of Megascolecid
Earthworms from the Pacific Coast Region of the
United States of America.

DESCRIPTIONS OF THREE NEW SPECIES OF MEGASCOLECID
EARTHWORMS FROM THE PACIFIC COAST REGION
OF THE UNITED STATES OF AMERICA

BY

LOLA ERNESTA SWIFT

A. B. Mt. Morris College, 1911.

THESIS

Submitted in Partial Fulfillment of the Requirements for the

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THE GRADUATE SCHOOL

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May 31, 1917

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPER-
VISION BY Lola Ernesta Swift.
ENTITLED Descriptions of Three New Species of Megascolecid
Earthworms from the Pacific Coast Region of the United States
of America.
BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE
DEGREE OF Master of Arts.

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Recommendation concurred in:*

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on

Final Examination*

*Required for doctor's degree but not for master's.

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Introduction.

The three earthworms described in the following paper are terrestrial forms from the northwestern part of the United States. They belong to the family Megascolecidae; one form in the genus Plutellus and the other two in Megascolides. The discovery of new species of these genera in North America is of interest since the great majority of the representatives are from the Australian and South Eastern Asiatic regions. Of the sixty-four species of Plutellus only four have been found in North America, the majority of the remainder being native to Australia and of the twenty-two of Megascolides but one has been recorded from North America, the others being mostly from Australia.

Terminology.

The lack of a uniform terminology used in the description of earthworms necessitates an explanation of the terms used in this paper. Arabic numerals are used to indicate the number of the somite, counting from the anterior end. Externally the somites are separated from each other by intersegmental grooves. The somites may be subdivided by a single secondary groove which produces the biannulate condition, or by two secondary grooves producing the triannulate condition. Internally transverse septa form the divisions between the somites. The intersegmental grooves and the septa for any two adjacent somites are represented by the same formula--for example 5/6, the context showing what is meant. Eight setae per somite are present and are represented for each side by the letters a, b, c, and d. They are spoken of as closely or widely paired. The term "closely paired" indicates that the distance ab and cd are less than one-

third the distance bc. If widely paired, these distances are more than one-third bc. The term "prolobic" applied to the prostomium means that it (the prostomium) is small and does not encroach upon the peristomium. Ventral papillae refer to glandular prominences found externally upon the ventral surface.

The term "male pore" is used to designate the opening through which the products of the spermaries and prostate glands pass to the exterior. Sperm sacs, frequently called seminal vesicles, open into the cavities of 10 and 11 and store temporarily the sperm cells produced in these somites. Each sperm sac is an evagination of the septal partition into a somite adjacent to the one into which it opens. The prostate glands are large contorted, tubular glands usually having close relation with the sperm ducts. They are lacking in many kinds of earthworms, notably in the Lumbricidae. The spermathecae are pouches which lie internally and open to the exterior to receive sperm cells from another individual. They are frequently called seminal receptacles.

Material.

The available material for study was scarce so great care was required in preparation and study to keep the specimens in as good condition as possible.

The study of Plutellus oregonensis was made almost entirely from serial sections. The anterior twenty-four somites of the worm had been split in a median sagittal plane and one-half cut into cross sections and the other into sagittal sections.

But one specimen of each of the species of Megascolides macelfreshi and M. cascadiensis was available. These were prepared for study in the following manner. The anterior ends were split in

the median sagittal plane. The somites from that part of the right side of each, which included the clitellum, were cut into serial transverse sections. Important facts of structure were also obtained from a study of the cut surface of the unsectioned half. Small pieces from the posterior parts were prepared for more detailed study of nephridia.

Generic Characters of Plutellus.

The general characteristics of Plutellus as given by Michaelsen (1900:163) are in substance as follows:- Setae eight per somite. Clitellum beginning with or in front of somite 14 and including $3-9 \frac{2}{3}$ somites. One pair of oviducal pores and occasionally one unpaired oviducal pore. Two to five pair of spermathecal pores, the last pair always on 8/9. One gizzard in somite 5 or 6 or 5-6, occasionally in 6-7. Nephridia strictly meganephric. Usually two pair of spermaries and sperm ducts in 10 and 11, or occasionally only one pair in 10 or 11. Sperm vesicles seldom present. Prostates tubular; seldom racemose.

Plutellus oregonensis nov. spec.

Plate I. Figs. 1-10.

Definition- Length, 77mm. Diameter, $3-3 \frac{1}{2}$ mm. Somites, about 116. Prostomium, prolobic. Setae, widely paired; eight per somite; anterior to clitellum aa:ab:bc:cd: = 5:2:4:4; posterior to clitellum aa:ab:bc: cd = 4:1:3:3; dd is a little less than one-half the circumference. Penial setae are present. First dorsal pore in 18/19. Clitellum on 13-18; incomplete ventrally on 13, 17, and 18; complete on 14-16. Three median ventral papillae are on 7/8, 8/9, 9/10 and two asymmetrical papillae, one on the left side of 19/20, and one on the right side of 20/21. Male pores, one pair; each

opens in a depression which is bordered laterally by a semicircular ridge. Oviducal pores on 14. Spermathecal pores, two pair on 7/8 and 8/9. Septa 7/8-11/12 are noticeably thickened. Gizzard in 5; large. Nephridia are strictly meganephric. Spermaries and funnels are in 10 and 11. Sperm ducts, two pair; the two ducts of each side join in 12, extend posteriorly to 18, and join the prostate duct. Sperm sacs, one pair in each of somites 11 and 12. Ovaries and oviducal funnels in 13. There is a pair of spermathecae in each of somites 8 and 9; each with a short thick diverticulum.

The specimens used for study are in the collection of Professor Frank Smith, Urbana, Illinois. Two worms, one mature and one immature were collected by F. M. McElfresh in April 1901 and sent to Professor Smith. They were found in the Cascade Mountains in the bottom lands along the Mary's River. The region was very heavily wooded and subject to overflow during parts of the year. The altitude of Mary's River is between 4000 and 6000 feet.

External Characters.

No record was kept of the color of the living specimens. The mature worm is small having a length of 77 mm. and a diameter of 3-3 1/2 mm. There are 116 somites. The immature specimen, although containing the same number of somites (116) has a length of but 60 mm. and a diameter of 2 1/2-3 mm. The first five somites are unannulate, 6 and 7 are biannulate, and 8-12 are triannulate. The lining of the buccal sac may be everted as is shown in the immature specimen which was preserved in this condition. The prostomium is prolobic and shows no indication of a division of the first somite.

Setae- There are eight setae per somite except on the first and last and they are widely paired. Setae a and b are longer

than c and d and all are slightly curved. The ventral setae anterior to the clitellum are farther apart than those posterior to the clitellum. The setal formula anterior to the clitellum is; aa:ab:bc:cd = 5:2:4:4. Posterior to the clitellum the formula is aa:ab:bc:cd = 4:1:3:3. dd is a little less than one-half the circumference. The setae on somite 18 are somewhat modified. In the place of a and b, on each side there are present two larger, stronger, slightly curved setae, located in the position of b, just mesad of the prostate pore and so close to it that they appear to project through the prostate pore. Setae c and d retain their normal positions on this somite. The penial setae are .23 mm. in length and .042 mm. in diameter at the widest part and are slightly curved near the inner ends. They gradually taper toward the outer extremity and end in a rather blunt point. (Fig. 1.) The central part of the seta is finely sculptured and has the appearance of being spirally wound by a finely fringed band. The two extremities are smooth.

Clitellum- The clitellum is strongly thickened and includes 13-18. It is complete on somites 14-16 but is thicker dorsally and laterally than ventrally. On somites 13, 17, and 18 the clitellum is incomplete except for a slight ventral thickening of the posterior part of 13 and the anterior part of 17.

Dorsal Pores- The first dorsal pore is in 18/19.

Nephridial Pores- The nephridial pores are paired in each of the intersegmental furrows beginning with the first. They are irregularly disposed and they often do not correspond exactly on the two sides of the same somite. In somites 2-10 the pores are at the same level of the somite. Posterior to 10 there is no regularity in the level at which each pair of pores open to the exterior. Some

lie in a line with or just dorsad of d, while others lie between b and c but nearer to c.

Male Pores- There are two male pores arranged in a pair on 18. Each pore opens in a depression bordered by a semicircular elevation which is concave medially.

Oviducal Pores- The oviducal pores are paired on 14 and open a little mesad of a almost midway of the somite antero-posteriorly.

Spermathecal Pores- Two pair of small spermathecal pores open on a line just laterad of b in 7/8 and 8/9 respectively.

Ventral Papillae- There are three median ventral papillae in the form of small glandular areas in 7/8, 8/9 and 9/10. There is a ventral papilla on the left side of 19/20 and one on the right side of 20/21. Each in on a level with ab of that side.

Internal Characters.

Septa- The first septum noticeable in the sections is that lying between somites 5 and 6. This septum and the following one are very thin. The septa 7/8 and 12/13 are slightly thickened and 8/9-11/12 are noticeably thickened. The septa posterior to 12/13 are all thin. The middle portions of septa 5/6-7/8 are pushed out of place to such an extent that each lies in the region of somite 6. Septa 16/17 and 17/18 are pushed slightly forward by the large prostate glands in 18.

Alimentary Tract- The alimentary tract begins with a buccal cavity which is eversible. Following this is the pharynx which has a dorsally thickened wall. The esophagus begins in 3 and extends back to the fourth somite as a constricted tube. It expands in 4 into a thin walled cavity which fills the greater part of this

somite. Between this region and that directly behind is a deep constriction of the wall which leaves but a very narrow passageway between the two. This opens directly into a large extremely muscular walled gizzard which lies in 5 but is so large that it fills the greater part of 5-8, pushing the septa posteriorly into 8. In 8-11 the esophagus is very narrow. It widens out in 12 and 13 and is again constricted in 14. From 15 posteriorly, it is gradually enlarged to 18 where it joins the intestine. The intestine is large and sacculated dorsally and laterally. A typhlosole is slightly developed.

Vascular System- (Figs. 4, 5, 6.) This system includes two vessels which extend from the anterior to the posterior ends of the body, these are the dorsal and the ventral or supraneural vessels. Besides these there is a pair of laterals which extend from the 5th to the 11th somites where they join a plexus of vessels in the wall of the alimentary tract. This plexus begins in the middle of 10 and extends as far as sections were studied. Three pair of dorsal hearts connect the dorsal and ventral vessels in somites 7, 8 and 9. Four pair of intestinal hearts lie in somites 10-13 and connect the ventral vessel with the intestinal plexus. A pair of slender branches connect each pair of intestinal hearts with the dorsal vessel.

The dorsal vessel is single and lies in a median position dorsad of the alimentary tract. (Fig. 4, 5, 6^{dv}) Near the anterior end in 3, the vessel breaks up into four or more minute branches which extend anteriorly. In 5 there are two pair of branches of which the anterior one completely encircles the alimentary tract and gives off three branches on each side. (Fig. 6^{cv}.) Of these one pair of branches are small and extend anteriorly in a lateral position.

The second pair (Fig.4,6 l v) form large lateral vessels which become smaller and more ventral in position as they extend posteriorly. They join the intestinal plexus in 11. The third pair of branches extend dorsally for some distance. The posterior pair of branches from the dorsal vessel in 5 are very small and extend to the gizzard. There is a pair of branches, similar to the last mentioned, but larger in size in 6 which also extend to the gizzard. In 7, 8 and 9, the dorsal vessel is connected with the ventral vessel by one pair of dorsal hearts. In 10-13 the diameter of the dorsal vessel is greater than it is more anteriorly and one pair of very small branches in each somite connects this vessel with the intestinal hearts. (Figs. 5,6,i h d) In each of the following somites (which were studied) a pair of small dorso-intestinal branches connects the dorsal vessel with the intestinal plexus. (Fig. 6.d i) From 14-19 the dorsal vessel is moniliform due to constriction by the septa through which it passes.

The ventral vessel lies in a median position just above the nerve cord in the anterior somites but posteriorly it assumes a more dorsal position under the alimentary canal. (Fig. 4,5,6,v v) In 4 the vessel divides into two branches which extend anteriorly for a short distance then dorsally lying directly under the esophageal commissures. In each of somites 4 to 10, at least one pair of branches are given off to the septa and body wall. (Figs. 4,6,v t) There are other branches in some of the somites but these were not worked out in detail.

The dorsal hearts in 7-9 are small and show indications of valvular constrictions (Figs. 4,6,d h) The intestinal hearts in 10-13 are much larger and more distinctly constricted than the

dorsal hearts. (Figs. 5,6,i h) They connect the ventral vessel with the intestinal plexus, joining the plexus in the mid-dorsal line.

The intestinal blood system is rather complicated. It lies imbedded within the outer wall of the intestine and is composed of a network of vessels. In somites 10-15 (Fig. 6 i p) the plexus is represented in diagram with the outer intestinal wall removed. The longitudinal vessels are numerous and vary in size from very small to quite large. (Figs. 5,6,l v p) They are connected very closely and irregularly by transverse vessels (Figs. 5,6,t v p) In many places the component vessels are more or less fused while in other regions the net work is quite distinct.

The gizzard in 5 and the esophagus in 6-8 are well provided on their outer surface with small blood vessels.

Excretory System- The excretory system consists of one pair of large meganephridia in each somite with the exception of the first and last. The nephridia in 2, 3 and 4 are larger than those found in the following somites and each one connects with a straight duct which opens into a pore to the exterior. The ducts which open in line with d or dorsad to such a line are longer than those which open between seta lines b and c. The ducts lie free in the body cavity for some distance before entering the body wall. After entering the wall they may open almost directly to the exterior or may extend for a considerable distance in the body wall before opening to the exterior. In some forms which have a variable arrangement of nephridial openings the point at which the ducts enter the body wall is always on a straight line. This is not the case in Plutellus oregonensis, the points of entrance into the wall are as variable as the openings themselves.

Spermaries and Sperm Ducts- There is one pair of spermaries in each of somites 10 and 11. They are located in the ventral anterior part of the somite and lie free except at the point of attachment to the anterior septum. They are racemose in structure. Posterior to the spermaries in 10 and 11 is a pair of large ciliated spermiducal funnels which narrow into a pair of ducts and pass through the posterior septa of these somites. The ducts of either side are inbedded in the epithelium of the body wall, in a ventro-lateral position and join in 12, from which point they extend posteriorly to 18. Here the sperm ducts join the prostate ducts at their point of union with the prostate gland.

Prostate Glands- The prostate glands are one pair of tubular contorted organs in somite 18.

Sperm Sacs- Two pair of large lobed sperm sacs are prominent, in somites 11 and 12. They are attached to the anterior septa of the somites in which they lie and occupy the anterior half of these. In addition to the sperm sacs a mass of loose sperm cells is present in 11. Somite 10 contains a mass of sperm cells but no sperm sacs.

Ovaries and Oviducts- One pair of large, rather deeply lobed ovaries are attached to the anterior septum of 13 near the ventral body wall. A pair of ciliated oviducal funnels lie in the ventral posterior part of the somite. They connect with the oviducts and pass through the septa to open to the exterior in 14.

Spermathecae and Ducts- There is one pair of spermathecae in each of somites 8 and 9. They are similar in size and shape but differ in their position in the somites. The anterior pair in 8 are in an upright position with the long axis inclined slightly posterior-

ly from the vertical while the second pair in 9 have the long axis almost horizontal in the somite. These positions are probably not characteristic. The following description of the spermathecae will apply to both pair. They are fair sized organs filling about one-third of the somites in which they lie. They are made up of three parts, the large oval ampulla, the smaller blunt diverticulum and the short thick duct. (Figs. 7,8,9,10) The thin walled ampulla is joined at the base with the thick walled diverticulum by a very short connection between the two parts. The lower thick walled diverticulum has in its dorsal part, two lateral evaginations and an anterior one. (Figs. 9,10) These three evaginations are small and have a direct connection with each other internally. The sperm cells are lodged in the cavities of these evaginations.

Tubular Arrangement of Important Characters.

A comparison of Plutellus oregonensis with other species of the genus shows a close relationship with but two species. These are P. collinus (Eisen) and P. marmoratus (Eisen) both from California. Originally these two species and the variety P. marmoratus papillifer (Eisen) were described (Eisen 1894: 41-56 and 1900: 163-165) as three varieties of the same species under the name Argilophilus marmoratus but were later referred by Michaelsen (1900: 166, 167) to Plutellus, and P. collinus recognized as a distinct species.

Characters.	<u>Plutellus</u> <u>oregonensis</u>	<u>P. marmoratus</u>	<u>P. collinus</u>
Length	77 mm.	38-152 mm.	
Diameter	3-3 1/2 mm.	6-9 mm.	
Prostomium	Prolobic	Epilobic 1/2-3/3	Epilobic dividing somite, .

Characters	<u>Plutellus</u> <u>oregonensis</u>	<u>P. marmoratus</u>	<u>P. collinus</u>
			1/2-9/10 of distance.
Setae	Eight per somite widely paired; <u>aa</u> > <u>ab</u> < <u>bc</u> = <u>cd</u> .	Eight per somite, widely paired; <u>aa</u> > <u>ab</u> < <u>bc</u> < <u>cd</u> .	Eight per somite, widely paired.
Penial setae	Slightly curved and taper grad- ually toward the outer extremity. The middle part is sculptured, and has the appearance of being spirally wound by a fringed band. Fig. 1.	Strongly curved (sickle-like). The point is sharp and curved. A short distance back of the tip the surface is covered with numerous slender spines, which are rather closely distributed. Fig. 3.	Straight with a curv- ed tip and the sculp- tured part has broad, flat scales, toothed on the outer edge. A few large spines are present between the scales and the tip. Fig. 2.
Clitellum	Incomplete on somites 13, 17 and 18; complete on somites 14- 16.	Incomplete on 3/4 12-18.	Incomplete on 13-18.
Dorsal pores	Begin in 18/19	Lacking.	Lacking.
Male pores	One pair of openings on 18,	One pair of openings on a	One pair on 18 on lunar papillae which

Characters	<u>Plutellus</u> <u>oregonensis</u>	<u>P. marmoratus</u>	<u>P. collinus</u>
	on a line with <u>b</u> , in a depression bordered by a semicircular elevation, concave medially.	line with <u>b</u> on 18 on elevated papillae which are surrounded by circular depressions encroaching on the two adjoining somites. Outside the depression is a semicircular ridge which is concave medially.	are somewhat depressed and are each encircled by a continuous oval ridge. The two ridges are connected by a median elevated longitudinal band.
Ventral papillae	Three median ventral papillae in 7/8, 8/9 and 9/10. One single papilla in 19/20, on the left side of the body and one in 20/21 on the right side. Each of the latter lies on a level with <u>ab</u> of that side.	Arrangement variable. There may be from two to five pair of intersegmental papillae with occasionally one or two papillae asymmetricaly placed.	Never paired. Located in a median line with the long axis of the body.

Characters.	<u>Plutellus</u> <u>oregonensis</u>	<u>P. marmoratus</u>	<u>P. collinus</u>
Septa.	5/6-7/8 are noticeably pouched. Septa 8/9-11/12 strongly thickened.	5/6-12/13 are all strongly thickened and pouched.	Presumably the same as <u>P. marmoratus</u> .
Hearts.	Three pair of dorsal hearts in 7-9. They connect the dorsal and ventral vessels. Four pair of intestinal hearts in 10-13 connect the ventral vessel with the intestinal plexus.	Three pair of stout oblong thrice con-tracted and sac-like hearts in 10-12 and two smaller pair in 13-14 connect the dorsal and ventral vessel.	Same as in <u>P. marmoratus</u> .
Nephridia	Meganephric. Begin in somite 2. The first three pair are larger than the following.	Meganephric. Begin in somite 2. First five or six pair larger than the following.	Same as in <u>P. marmoratus</u> .
Sperm sacs.	One pair in each of somites 11 and 12. They occupy about one-half	One pair in each of somites 10, 11 and 12. Very large, extending far back,	

Characters.	<u>Plutellus</u> <u>oregonensis</u>	<u>P. marmoratus</u>	<u>P. collinus</u>
	of each somite and are attach- ed to the anter- ior septa of the somite in which they lie.	often to the region of the prostate glands in 18.	
Spermathe- cae.	One pair in each of somites 8 and 9 occupying about one-third of the somites in which they lie. A short thick diverticulum is present attached near the basal part of each spermatheca.	One pair in each of somites 8 and 9, occupying from one-half to three-fourths of the somites in which they lie. Diverticula are lacking.	Same as in <u>P.</u> <u>marmoratus</u> .
Habitat.	In heavily wooded areas subject to overflow.	In rich soils, wet, soggy places and manure piles.	In dry hill sides.

The main points of difference in the species compared, as indicated by the tabulation are: the relation of the clitellum; shape and sculpturing of penial setae; presence of dorsal pores in Plutellus oregonensis; shape and position of genital papillae; arrangement of ventral papillae; position and thickening of septa; number and location of hearts; presence of spermathecal diverticula in P. oregonensis; and the number and location of the sperm sacs.

The differences seem sufficient to require the recognition of a distinct species for the Cascade worm.

An examination of the article on Argilophilus (Eisen 1894: 48; Figs. 86 A and B) reveals contradictory statements concerning the position of the gizzard which Eisen describes as lying in 6 and he also figures it in 6, but at the end of the same paper in a comparison of Argilophilus with Plutellus he states that the gizzard in Argilophilus is in 5. The conflicting statements led the writer to examine sections of P. marmoratus papillifer in the collection of Professor Frank Smith, in which the gizzard is found to be in 5. In this respect it corresponds with P. oregonensis.

Generic Characters of Megascolides.

The genus Megascolides as defined by Michaelsen (1900:182) is in substance as follows: Setae, eight per somite. Clitellum begins anterior to 14 or 16 (?) and includes 6-9 $1\frac{1}{3}$ somites. Oviducal pores, one pair on 14. Spermathecal pores, two to five pair; the last pair on 8/9. One gizzard in 5 or 6 or 5-6. Nephridia diffuse; in the posterior part of the body a pair of meganephridia are additional in each somite. Prostates tubular (seldom racemose).

Megascolides cascadensis nov. spec.

Plate II. Figs. 11, 14, 15, 17.

Definition- Length, 185 mm. Diameter, 5-7 mm. Somites, about 275. Prostomium, slightly developed, prolobic (?). Setae, eight per somite; widely paired; aa:ab:bc:cd = 8:2:4:6; dd is about $\frac{2}{3}$ the circumference. Penial setae are present. Dorsal pores in post clitellar region. Clitellum 13-20 (8 somites); incomplete ventrally. Ventral papillae, paired on 15/16, 16/17, 19/20, 20/21. Male pores on 18; each in a deep depression. Oviducal pores on 14. Spermathecal pores on 7/8 and 8/9; conspicuous. Septa 6/7-11/12 much thickened, 12/13 less thickened. Gizzard large in 5. Nephridia plectonephric. Spermaries, two pair, in 10 and 11. Sperm sacs, two pair, in 11 and 12. Ovaries, one pair in 13. Spermathecae, two pair in 8 and 9.

A single alcoholic specimen was available for study. It was sent to Professor Frank Smith by Mr. F. M. McElfresh in the fall of 1899. It came from the Cascade Range in Oregon. No data concerning the living specimen was recorded.

External Characters.

The color of the living worm is not known. The length of the preserved specimen is about 185 mm. and it has a diameter of 7 mm. in the anterior part of the body and from 5-6 mm. in the posterior part. There are about 275 somites in the body. Somites 1-5 are biannulate and 6-12 are triannulate but not deeply indented. The clitellum on 13-20 is irregularly, but not deeply grooved. The post clitellar somites are faintly grooved. The prostomium is very indistinct in the preserved specimen and apparently prolobic, though its exact relation is obscure.

Setae- There are eight setae per somite and they are widely paired. The formula, $\underline{aa}:\underline{ab}:\underline{bc}:\underline{cd} = 8:2:4:6$ indicates approximately their relations. The arrangement of the setae is very uniform along the entire length of the body. The distance $\underline{dd}$ is about two-thirds the circumference. The setae are very indistinct. On 18 $\underline{a}$ and $\underline{b}$ are replaced by two modified penial setae which lie very close together just mesad at the male pore and in seta line $\underline{b}$. They lie so closely apposed that they appear to open into the same pore. The penial setae are relatively long and are curved distinctly at the tip. They are sculptured. A careful study was not made since it would have involved removal from the specimen and consequent damage.

Clitellum- (Fig. 11) The clitellum involves somites 13-20 and it is incomplete ventrally. It is not strongly thickened and is evident because of a slightly greater diameter of the worm and the darker color of these somites. The intersegmental grooves are somewhat deeper and the secondary grooves are more irregular than on other parts of the body. It covers the dorsal and lateral surface of the somites and the ventral margin is not at all abrupt.

Dorsal Pores- Dorsal pores are present posterior to the clitellum.

Male Pores- One pair of male pores are present on 18 about in line with $\underline{b}$. They open in the centre of a pair of large circular depressions. (Fig. 11, g d) As already stated, the penial setae are present just mesad of the male pore on each side and appear to open through this pore.

Oviducal Pores- One pair are present on somite 14 but are very indistinct.

Spermathecal Pores- There is one pair of spermathecal pores in each of 7/8 and 8/9 in line with b. They are large and conspicuous.

Ventral Papillae- The ventral papillae are circular, paired elevations on 15/16, 16/17, 19/20 and 20/21. Those on 16/17 are somewhat larger than the others. (Fig. 11, v p)

Internal Characters.

Septa- The first distinct septum 4/5 is very thin, 5/6 and 12/13 are a trifle thickened and 6/7-11/12 are much thickened. Septum 17/18 is pushed forward into 17, and 18/19 is pushed into 19 because of the large size of the prostate gland in 18. Septa 7/8-16/17 are connected with each other and the body wall by oblique muscular fibres.

Alimentary Tract- The alimentary tract begins with a large buccal sac. This is followed by the pharynx which fills the greater part of 2-4. The dorsal wall of the pharynx is very thick and muscular. The gizzard, located in 5, is large and muscular and fills practically all of the middle part of 5-1/2 8 displacing the septa of these somites accordingly. The esophagus extends back to 19 fairly uniform throughout. A well developed typhlosole is present in the intestine. Calciferous glands are lacking.

Vascular System- A dorsal and a ventral vessel are present. The dorsal vessel is enlarged in 15-18. In each of somites 7-9 is a pair of small hearts and in 10-13 a pair of large sacculated hearts which are very conspicuous. In the sections available for study, only the hearts in 13 are shown and they connect the ventral vessel with the mid dorsal part of a plexus of vessels imbedded in the alimentary canal. The plexus was continuous as far back as the sections were

available for study. As far as studied, the vascular system very closely resembles that of Plutellus oregonensis described above. A more complete study was not made because of the lack of sectioned material.

Excretory System- The excretory system is distinctly plectonephric. In the anterior and middle parts of the body there are present 7 pair of micronephridia in each somite. (Fig. 14 mc n) These nephridia are all of about the same size and are tightly coiled into a cone shaped mass and are arranged in the somite in a definite order. The most ventral pair lie on the ventral floor in the anterior part of the somite. Lateral and a little posterior to these are the second pair, each succeeding pair lies a little more dorsal and posterior in the somite than the pair preceeding it. The seventh pair is frequently attached to the posterior septum of the somite very near the mid dorsal line. These nephridia are all attached to a narrow thin band of tissue (Fig. 14 n c) which extends obliquely along the body wall from the anterior ventral to the posterior dorsal part.

A microscopic study of these nephridia reveals small nephridial ducts, one from each nephridium. The ducts of the different nephridia vary in length. The nephridial pores of each somite are very nearly in the transverse line which is in the plane passing through the most anterior ventral pair of nephridia and hence it is evident that the ducts from the posterior nephridia are much longer than those leading from the more ventral anterior ones. In the posterior part of the body there is in the ventral part of each somite a pair of large meganephridia and four pair of micro-nephridia. (Fig. 15 mg n mc n).

Spermaries and Sperm Ducts- One pair of spermaries and large spermiducal funnels are located in the ventral part of each of somites 10 and 11. The spermaries extend freely into the somite from their attachment to the anterior ventral part of the septum. The sperm ducts of either side lie close together between the epithelium and muscle layer of the body wall in a latero-ventral position. They extend to 18 as two straight ducts. In 18 they ascend from the body wall into the body cavity and join the prostate gland. The two sperm ducts do not unite before entering the prostate; one enters directly and the second ascends to a higher point, loops back upon itself and enters the prostate duct very near the point at which the first enters.

Prostate Glands- The prostate glands, of which there are but one pair, are large, much contorted, tubular organs filling the greater part of 18. They open to the exterior through a pair of long thick somewhat contorted ducts.

Sperm Sacs- A pair of small sperm sacs in each of somites 11 and 12 are attached to the anterior septa just below the alimentary tract.

Ovaries and Oviducts- One pair of small ovaries is located in the anterior ventral part of 13. The small oviducal funnels are attached to the posterior ventral surface of septum 13/14. A pair of short straight oviducts lead from the oviducal funnels to the external openings.

Spermathecae- One pair of spermathecae are present in each of somites 8 and 9. They are large elliptical organs lying obliquely in the somites. The spermathecal ducts are short, thick and without diverticula.

Megascolides macelfreshi nov. spec.

Plate II. Figs. 13, 18.

Definition- Color, pale flesh tint with anterior ten somites more pronounced; clitellum fleshy orange, (living specimen). Length 155 mm. Diameter, 7-8 mm. Somites, 282. Prostomium, incomplete. Setae eight per somite; widely paired; anterior to clitellum, aa:ab:bc:cd = 10:4:5:5; posterior to clitellum, aa:ab:bc:cd = 12:3:5:5; dd is slightly more than one-half of the circumference. Clitellum 13-21 (9 somites); incomplete ventrally. Papillae paired on 14/15 - 16/17, 19/20, and on 22 and 23. Dorsal pores not visible. Male pores on 18; on large circular papillae. Oviducal pores on 14; mesad of a; conspicuous. Spermathecal pores on 7/8, and 8/9; conspicuous. Septa 7/8-10/11 strongly thickened, 5/6, 6/7, 11/12 and 12/13 somewhat thickened. Gizzard, small in 5. Nephridia plectonephric; one pair of meganephridia and several micronephridia in posterior somites. Spermaries, one pair in each of somites 10 and 11. Sperm ducts extend to 18, unite before entering prostate duct. Sperm sacs, one pair in each of somites 11 and 12. Ovaries, one pair in 13. Spermathecae, one pair in each of somites 8 and 9.

The description is based upon a single specimen in the collection of Professor Frank Smith which was received from Mr. F. M. McElfresh, January 1903, and was collected from Salem, Oregon.

External Characters.

The color of the living specimen was a pale flesh tint, more pronounced on the anterior 10 somites. The worm was unpigmented and the internal organs were faintly visible. The clitellum was fleshy orange in color and definitely distinct. The surface adjacent to the spermathecal pores on 7/8 and 8/9 was faintly brownish. The

length of the worm when relaxed was about 300 mm.

The specimen after preservation in alcohol measures 155 mm. in length and 7-8 mm. in diameter. There are 282 somites in the body and they are triannulate back to 22. The prostomium is small and incomplete giving an indication of the prolobic condition.

Setae- There are eight setae per somite, widely paired. Anterior to the clitellum aa:ab:bc:cd = 10:4:5:5. Posterior to the clitellum aa:ab:bc:cd = 12:3:5:5. The distance dd a little over one-half the circumference. On 18 there is no superficial evidence of a and b. Sections reveal the presence of a single penial seta imbedded in a large muscular sac located just mesad of the opening of the prostate gland. Indications of a muscular sac just laterad of the other are obvious although no seta could be found. The penial setae are rather short, straight and somewhat sculptured. Setae c and d retain their normal positions on 18.

Clitellum- (Fig. 13) The clitellum is considerably thickened and involves somites 13-21. It is incomplete ventrally, the ventral margins being approximately half way between the seta lines c and d. The surface is deeply grooved showing distinctly the triannulate divisions of the somites.

Male Pores- One pair of male pores is present on somite 18, each of the pores being in the center of a large circular papillae. (Fig. 13, gp.)

Oviducal Pores- The pair of oviducal pores is on somite 14. They are conspicuous and lie in a position a little mesad of seta a on an elongate elliptical elevation which extends across the ventral surface of the somite reaching as far as c on either side. (Fig. 13, op.)

Spermathecal Pores- One pair of spermathecal pores on each of somites 7/8 and 8/9 are conspicuous openings in the seta line b and each is surrounded by two lip-like elevations.

Ventral Papillae- Paired ventral papillae are located in 14/15, 15/16, 16/17 and 19/20. They are circular and uniform in size shape and position. (Fig. 13 vp.) A pair of oval papillae is present on each of somites 22 and 23 in the intervals between a and c.

Internal Characters.

Septa- The first distinct septum is 5/6 which is very thin. 6/7 and 11/12 are somewhat thickened and 7/8-10/11 are much thickened. Septum 17/18 is pushed forward into 17 and 18/19-20/21 are pushed into 21 by the large prostate gland in 18. Septa 7/8-14/15 are connected by longitudinal fibres.

Alimentary Tract- There is an eversible buccal sac at the anterior end of the alimentary tract, followed by the pharynx which has a thick muscular dorsal wall. The gizzard is muscular and relatively small. It lies in 5 and fills 6 as well, pushing the septa 5/6 and 6/7 back into somite 7. The esophagus extends back to 19 and is somewhat enlarged in 10 and 11. In 18 it enlarges and joins the intestine in 19. A large typhlosole is present in the intestine. Calciferous glands are lacking.

Vascular System- The vascular system could not be worked out in detail because of the lack of material. The dorsal vessel is single and is greatly enlarged in 15-18. The ventral vessel is located just ventrad of the intestine. In each somite 7, 8 and 9 is found a pair of small hearts and in 10-13 a pair of hearts which are somewhat larger.

Excretory System- The excretory system has the condition typical in Megascolides, there being several micronephridia in the somites in the anterior part of the body and besides micronephridia one pair of meganephridia in each of the posterior somites. It is rather difficult to determine the exact number of nephridia and pores present but there are at least five pair and perhaps more.

Spermaries and Sperm Ducts- There is a pair of spermaries in each of somites 10 and 11 which project freely into these somites from their attachment to the ventral part of the anterior septum. The pair of spermiducal funnels in each of somites 10 and 11 are large and fill a considerable part of the posterior ventral portion of these somites. The two sperm ducts of either side lie close together and parallel just beneath the inner epithelial tissue of the body wall. They lie in a latero-ventral position. In 18 they become free from the body wall and extend dorsally and then ventrally forming a loop and then join the outer, lower part of the prostate gland along which they extend for some distance gradually penetrating deeper into the tissues of the wall. The two ducts which have had a parallel course finally unite into one duct just before entering the prostate gland.

Prostate Glands- The prostate glands are a pair of large tubular contorted organs which fill the dorsal and lateral portion of somite 18, and displacing the septa encroach extensively on 17 and 19. They open to the exterior through a pair of long tubular ducts which are joined by the sperm ducts as described above.

Sperm Sacs- There is a pair of small sperm sacs in each of somites 11 and 12 attached to the anterior septa of the somites in which they lie. They are slightly ventrad of the alimentary canal.

Ovaries- There is a pair of small racemose ovaries in the anterior ventral part of somite 13. The oviducts open through conspicuous pores on somite 14.

Spermathecae- (Fig. 18) There is a pair of spermathecae in each of somites 8 and 9, those in 8 being only about one-half as large as those in 9. They are bluntly elliptical in shape. Spermathecal diverticula are lacking and each spermatheca opens to the exterior through a short, thick, straight duct.

Megascolides americanus Smith.

Plate II. Figs. 12, 16.

Definition- Length, 180-190 mm. Diameter, 6-7 mm. Somites, average (four specimens) 226; extremes, 190-240. Prostomium, pro-lobic. Setae, eight per somite; widely paired; anterior to clitellum $\underline{aa}:\underline{ab}:\underline{bc}:\underline{cd} = 10:2:8:4$; posterior to clitellum, $\underline{aa}:\underline{ab}:\underline{bc}:\underline{dc} = 12:3:7:4$; $\underline{dd}$ is about $2/3$ of circumference; penial setae, present. Clitellum incomplete on 13-1/n 23. Median circular papillae on 14/15, 15/16, 16/17, paired papillae on 19/20, 20/21. Median papillae were lacking on one specimen. Dorsal pores, posterior to clitellum. Male pores paired on 18 on an elliptical elevation which extends across the ventral surface of the somite. Oviducal pores on 14, very conspicuous. Spermathecal pores not visible. Septa, 5/6 and 12/13 somewhat thickened. 6/7-11/12 strongly thickened. Gizzard, large in 5. Plectonephric; one pair of meganephridia and 7 pair of micro-nephridia in posterior somites. Spermaries, one pair in each of somites 10 and 11. Sperm ducts of either side join in 16, extend to 18, and unite with the prostate duct. Sperm sacs, one pair, in each of 11 and 12. Ovaries, one pair in 13. Spermathecae one pair in each of somites 8 and 9.

The determination of the relationships of M. cascadenis and M. macelfreshi to that of M. americanus Smith has involved a reexamination of the specimens on which the description of the latter species was based, and has resulted in some additional information which is here presented.

Somites 1-6 are biannulate and 7-12 are triannulate. The clitellum is but slightly thickened and shows almost no traces of external separation into somites. (Fig. 12) There are four pair of setae per somite, ab being less than cd. Anterior to the clitellum aa:ab:bc:cd = 10:2:8:4. Posterior to the clitellum aa:ab:bc:cd = 12:3:7:4. The distance dd is about two-thirds of the circumference. The penial setae are straight and sculptured. There is a pair of male pores on 18 in the middle part of the somite. They open on an elongate elliptical elevation which extends across the ventral surface of the somite to a point midway between b and c of either side. (Fig. 12, gp.) The elevation encroaches anteriorly on 17 and posteriorly on 19. The spermathecal pores are not visible, probably due to the immaturity of the specimens.

The first distinct septum 4/5 is very thin; 6/7-11/12 are strongly thickened. A single dorsal vessel and a ventral vessel are present. There is in each of somites 7-9 a pair of small hearts and in each of somites 10-13 a pair of large hearts of which 12 and 13 are the largest. There are seven pair of micronephridia on the anterior somites and besides these there is present an additional pair of meganephridia in each somite in the posterior part of the body. (Fig. 16, mg n , mc n) The spermathecae are very small, elliptical organs lying obliquely in 8 and 9. Diverticula are lacking..

Comparison of Species.

The only species of Megascolides which is sufficiently similar to the new ones just described to require a comparison is M. americanus Smith (1897: 202 - 204) from Pullman, Washington. A tabular arrangement of the important characters follows:

Characters	<u>Megascolides</u> <u>americanus</u>	<u>M. cascadenis</u>	<u>M. macelfreshi</u>
Length	180-190 mm.	185 mm.	155 mm.
Diameter	6-7 mm.	5-7 mm.	7-8 mm.
Somites	226, 1-6 biannuate, 7-12 triannulate	275, 1-5 biannu- late, 6-12 triannu- late.	282, 1-22 trian- nulate.
Clitellum	13-1/n23, incom- plete ventrally.	13-20, incomplete ventrally.	13-21, incom- plete ventrally.
Setae	Widely paired; anterior to clitel- lum <u>aa:ab:bc:cd</u> = 10:2:8:4; posterior to clitellum <u>aa:ab:bc:cd</u> = 12:3:7:4; <u>dd</u> is about 2/3 the cir- cumference.	Widely paired; very uniform on entire length of body. <u>aa:ab:bc:</u> <u>cd</u> = 8:2:6:4; <u>dd</u> is about 2/3 the circumference.	Widely paired; anterior to clitellum <u>aa:ab:</u> <u>bc:cd</u> = 10:4:5: 5; posterior to clitellum <u>aa:ab</u> <u>bc:cd</u> = 12:3:5: 5; <u>dd</u> is between 1/2 to 2/3 the circumference.
Penial setae	Short and straight,	Long and curved at the tip, sculp- tured.	Short and straight, sculp- tured.
Dorsal	Posterior to	Posterior to	Lacking.

Characters	<u>Magascolides</u> <u>americanus</u>	<u>M. cascadiensis</u>	<u>M. macelfreshi</u>
pores	clitellum	clitellum	
Male pores	One pair on 18 on an elliptical elevation. (Fig. 12 gp.)	One pair on 18 each in a circular depression. (Fig. 11. gd.)	One pair on 18 each on a circular papilla. (Fig. 13 gp.)
Oviducal pores	Paired on 14 very indistinct.	Paired on 14, indistinct.	Paired on 14, distinct. On an elliptical elevation.
Spermathecal pores	One pair, indistinct.	One pair, large, conspicuous.	One pair, conspicuous openings, surrounded by two lip-like elevations. Paired circular papillae on 14/15, 15/16, 16/17, 19/20. One smaller pair on each of somites 22 and 23. (Fig. 13, vp.)
Ventral papillae	Median papillae on 14/15, 15/16 and 16/17 paired in 19/20 and 20/21. Median papillae lacking in one specimen. (Fig. 12, vp.)	Paired circular papillae on 15/16, 16/17, 19/20, 20/21. (Fig. 11, vp.)	
Septa	4/5 first distinct septum, 6/7-11/12 strongly thickened, 5/6 12/13 are somewhat	4/5 first distinct septum 6/7-11/12 are strongly thickened, 5/6 and 12/13 are somewhat	5/6 first distinct septum. 7/8-10/11 are strongly thickened. 6/7 and

Characters	<u>Magascolides</u> <u>americanus</u>	<u>M. cascadiensis</u>	<u>M. macelfreshi</u>
	thickened.	thickened.	11/12 somewhat thickened.
Nephridia	Plectonephridia. Seven pair of micro nephridia, and in each of posterior somites a pair of meganephridia in addition. (Fig.16)	Plectonephridia Seven pair of micronephridia in anterior somites. One pair of meganephridia and four pair of micro-nephridia in somites in posterior part.	Plectonephridia About five pair of micro-nephridia and one pair of meganephridia in addition in posterior somites.
Spermathecae	Two pair, small, elliptical.	Two pair, large, elliptical. (Fig. 17.)	Two pair, those in 8 about one-half the size of those in 9. (Fig. 18.)

Discussion of Relationships.

An examination of the principal differences tabulated above indicates a closer relationship between M. cascadenis and M. americanus than that which exists between either of them and M. macelfreshi. The main differences between M. americanus and M. cascadenis are: The number of somites included in the clitellum; shape of penial setae; position of male pores on a genital papilla in M. americanus and in genital depressions in M. cascadenis; number and position of ventral papillae; and the number of nephridia per somite. The main points of difference between M. macelfreshi and the two forms just previously compared are; length of clitellum intermediate between the other two forms; setae more nearly equally paired; penial setae similar to M. americanus and different from M. cascadenis; genital pores on a pair of papillae in contrast to a single elongate papillae in M. americanus and a pair of depressions in M. cascadenis; shape and position of spermathecae; number and arrangement of ventral papillae; number of septa greatly thickened; and the number of nephridia per somite.

A sufficient number of differences exist in the Cascade and Salem worms when compared with each other and with M. americanus to require the recognition of a distinct species for each of them.

The three new species described in this paper belong to the family Megascolecidae and to the genera Plutellus and Megascolides which are separated from each other chiefly through the character of the nephridia which are meganephric in Plutellus and plectonephric in Megascolides. The remaining characters are very similar in the two genera.

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Explanation of Plates.

Abbreviations.

am	ampulla
cl	clitellum
c v	connecting vessel
d h	dorsal heart
d i	dorso-intestinal branches
d v	dorsal vessel
e s d	evagination of spermathecal diverticulum
g d	genital depression
g p	genital papilla
i h	intestinal hearts
i h d	connective between intestinal hearts and dorsal vessel
i p	intestinal plexus
e v p	longitudinal vessel of plexus
lt v	lateral vessel
mc n	micronephridia
mg n	meganephridia
n c	tissue band connecting nephridia
o p	oviducal papilla
s di	spermathecal diverticulum
s du	spermathecal duct
t v p	transverse vessel of plexus
v p	ventral papilla
v t	ventro-tegumentary
v v	ventral vessel

Explanation of Plates.

Plate I.

- Fig. 1. Penial seta of Plutellus oregonensis.
Fig. 2. Penial seta of P. marmoratus.
Fig. 3. Penial seta of P. collinus.

Plutellus oregonensis.

- Fig. 4. Schematic diagram of transverse section of
somite 9 to show parts of circulatory sys-
tem.
Fig. 5. Schematic diagram of transverse section in
somite 11 to show parts of circulatory sys-
tem.
Fig. 6. Schematic diagram of circulatory system in
somites 5-15.
Fig. 7. Anterior view of spermatheca.
Fig. 8. Lateral view of spermatheca.
Fig. 9. Spermatheca of somite 8 in sagittal section
of worm.
Fig. 10. Spermatheca of somite 9 in transverse section
of worm.

The vertical lines beside the figures 7-10
represent 0.1 mm.

Explanation of Plates.

Plate II.

- Fig. 11. Clitellar somites of Megascolides cascades, ventral view.
- Fig. 12. Clitellar somites of M. americanus, ventral view.
- Fig. 13. Clitellar somites of M. macelfreshi, ventral view.
- Fig. 14. Somites from anterior part of M. cascades to show nephridia.
- Fig. 15. Somites from posterior part of M. cascades to show nephridia.
- Fig. 16. Somites from posterior part of M. americanus to show nephridia.
- Fig. 17. Spermatheca of M. cascades.
- Fig. 18. Spermatheca of M. macelfreshi.

The ventral lines beside the figures
represent 2 mm.

Figure 21

Plate I.

2
9c
9s
5
9b
12
10
13
9v

21
9v
21
21
21
9b
12
12
12
9v
13
12
12
12
13

2
9v
21
9b
12
9v
12
12
12
13

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12

Plate II.

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