

*Descriptions of New Pacific Coast Earthworms of the  
Genus Plutellus (Oligochaeta: Megascolecidae)*

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THE SPECIES of *Plutellus* herein described, while very distinct, are more similar to one another than to other new or known species in the authors' hands. They are, therefore, treated together at this time. The following species, represented by two geographic subspecies, is named in honor of Kenneth M. Fender (husband of the feminine coauthor) who, besides being an able coleopterist, is also an excellent worm collector.

PLUTELLUS FENDERI FENDERI, new species, new subspecies

*Material:* TYPE [deposited Calif. Acad. Sci.] PRAIRIE CREEK REDWOODS State Park, Humboldt County, California, March 10, 1953, in black, rocky soil among redwoods (*Sequoia sempervirens* Endl.), sword fern (*Polystichum munitum* (Kaulf.) Presl.), and devil's club (*Oplopanax horridum* (Sm.) Miq.), collected by Kenneth Fender; same data, three complete and one incomplete clitellate paratypes, one large aclitellate paratype and three juveniles.

*Essential features:* Length 194 mm; diameter at tenth segment 3.3 mm; segments 170. Epilobic one-half with grooves converging, usually open behind. Slender and smooth; unpigmented, clitellum tan. Clitellum xiii-xviii, thinner ventrally, lacking xiii and xvi-xviii. Dorsal pores present beginning 19/20. Quadrithecal, spermathecal pores small, round pits in furrows 7/8 and 8/9 in line B. Genital papillae intersegmental, AB diameter, paired in AB nearest B, at 9/10 (10/11), 15/16 and/or 16/17 and 20/21 to 22/23. Ovipores paired ventrally, pre-equatorial on xiv in or median to A, one-third equator to furrow distance anterior to A. Male pores on xviii in line B on crescentic porophores in AB, covering full length of xviii and encroaching slightly on xix, 2AB diameter, convexities laterad, reaching A ventrally. Nephridiopores in or just behind furrows, haphazardly in D and B. Setal intervals AA:AB:BC:CD = 4:2:3:3 midbody, DD = 1/3C. Penial setae 857.1 by 17.8  $\mu$ , arcuate, sculptured over apical fifth except tip with groups of acute, triangular teeth the tips of which curve outward. Sigmoid setae smaller in dorsal than ventral series, in posterior part of body seta *d* measuring 171.4 by 21.4  $\mu$ , seta *a* measuring 357.1 by 35.7  $\mu$ ; rather straight, sculptured over apical fourth with irregular rows of short, fine teeth. Gizzard in v. Oesophageal folds longitudinal in vii-viii, highly vascular and irregularly papillose ix-xiv,

longitudinal xiv-xvii, a longitudinal ridge ventrally ix-xviii. Intestinal valve 16/17. Typhlosole lamellar, two-thirds diameter of intestinal lumen in height, 20/21 to cxxiv. Floor of gut grooved ventrally xxvi to liii. Spermathecae paired in viii and ix; ampulla elongate-oval; duct short, with dorsal wall strongly, cordately bulged by intramural seminal chambers. Holandric, testes and funnels free in x and xi, which were filled with coagulum, vasa efferentia of each side joining in xii; vasa deferentia joining prostates entad of junction of duct and gland. Prostates in xviii, large, bulging septum 18/19 posteriorly, glandular portion long, length over twenty times width; ducts stout, shining; gland rough; parietal attachments of retractors of penial setae 19/20 and 16/17. Seminal vesicles small, acinous, reniform, postseptal on 10/11 and 11/12. Ovaries postseptal from 12/13, funnels ventral in xiii with ducts ventrally through 13/14. Nephridia holonephric exonephridia without terminal vesicles. Dorsal vessel single, three pair dorso-oesophageal hearts in x-xii. No subneural trunk.

*Detailed description:* Average length of clitellate worms 194.3 mm, maximum diameter 3.3 mm at segment vii, average diameter at tenth segment 3.1 mm, segments 170, maximum diameter in the region of vii-x. Prostomium epilobitic one-half, usually open behind, grooves strongly converging posteriorly. Form rather slender. No regular secondary annulation, a slight appearance of triannulation over segments v-x in the more contracted specimens. (These worms are all rather well extended.) Intersegmental furrows distinct. Unpigmented, clitellum tan, xiii-xviii, encroaching very slightly dorsally on xii and xix in the more mature specimens; cingulate; lacking (or very thin?) ventrally on xiii anterior to equator below *B*, on xvi below *A*, on xvii below *B* and xviii below *C*. Furrows, setae and nephridiopores evident. Dorsal pores moderately large, beginning at 19/20, a faint, probably nonfunctional pore? evident at 18/19 in the less mature specimens. Spermathecal pores two pair; small, round pits with tumescent edges, in intersegmental furrows 7/8 and 8/9 in *B*. Genital papillae paired in *AB*; rounded, pellucid glandular zones with tumescent borders and depressed centers; those anterior to the clitellum definitely centering in *B*, those in the clitellum and posterior to it more median in position but nearest *B*. Approximately *AB* distance in diameter or a little less. An anterior pair at 9/10 (and 10/11); a clitellar pair or pairs at 15/16 and/or 16/17; a postclitellar pair or pairs in the region of 20/21 to 22/23. Ovipores paired ventrally on xiv in line *A* (or very slightly median to *A*), pre-equatorial approximately one-third the distance between equator and furrow 13/14; no glandular differentiation around pores; clitellum strongly glandular ventrally on xiv. Male pores very small roundish pits through which

the penial setae protrude, on xviii, in line *B* on crescentic porophores which occupy the full anteroposterior length of segment xviii and encroach slightly on xix; porophores not extending ventrally below *AB*; inner edge of porophore nearly straight, convexities laterad, extending *AB* distance beyond seta *b*. Nephridiopores in furrows or at extreme anterior edge of their segments within intersegmental grooves; in lines *D* and slightly dorsal to *B* anteriorly, in *D* and *B* posteriorly; arrangement haphazard, for example, those of several segments being successively in *B*, those of several following segments in *D*, with no agreement with other worms or even between the two sides of the same worm. Setal intervals on segment *x* are  $AA:AB:BC:CD = 5:2:4:4\frac{1}{2}$ ; midbody = 4:2:3:3;  $DD = 1/3C$ . Penial setae arcuate, moderately slender, 857.1 by 17.8  $\mu$  (width measured at proximal limit of sculpture), sculptured over apical fifth by groups of irregular, sharp teeth, the bases of which equal approximately one-eighth setal diameter, the tips being directed outward, giving a shaggy look to the edges of the seta (Figs. 13 and 14), distance between rows a little over one-third setal diameter, length of teeth not over one-sixth distance between rows; larger in ventral than dorsal series, on a postclitellar segment seta *a* measuring 357.1 by 35.7  $\mu$ , seta *d* measuring 171.4 by 21.4  $\mu$ .

Septa 4/5 and 5/6 distinct but thin and penetrated by muscle strands, 6/7-11/12 muscularly thickened; 12/13-16/17 rather thicker than those posterior; anterior septa pouched, posterior limit of gizzard at level of 8/9 externally. Buccal cavity in *i*, simple; anterior part of pharynx (*ii-iv*) covered by salivary glands dorsally; a strongly muscularized, protrusible, rounded plate dorsally in *iii*, salivary glands thickest over this plate; pharynx in *v* naked. Gizzard posteriorly in *v*; septum 5/6 tightly adherent to gizzard surface from slightly posteriad of anterior limits of gizzard, dissectible from surface, with difficulty, to posterior limits of gizzard. Septa 5/6 and 6/7 contiguous. Gizzard shaped like a thistle bloom. Oesophagus 6/7-16/17, tubular; oesophageal segment *vii* short. Oesophageal epithelium irregularly longitudinally rugose *vii-viii*, folds two to three times height of remaining layers; irregularly papillose *ix-xiv*, folds six times height of remaining layers, a ridge ventrally in *ix-xviii*, this ridge interrupted in *ix* and *x* (perhaps an artifact?). About 11 oesophageal folds which are low, continuous and longitudinal *xiv-xvii*, forming a valve at 16/17, where the intestine begins. A simple lamellar typhlosole two-thirds the diameter of the intestinal lumen in height beginning gradually at 20/21 and extending to *cxxiv*, triangular in cross section for the first several segments, distal margin simple, not grooved nor winged (in TYPE). Floor of intestine grooved ventrally opposite typhlosole *xxvi* to *liii*.

Oesophagus (from about segment xi) and intestine covered with a smooth layer of chlorogogen cells. Spermathecae paired in viii and ix; ampulla elongate oval, two-and-one-half times length of duct, which is about one-third width of ampulla. There is no external diverticulum, but the dorsal wall of the duct is bulged, spongy, filled with masses of sperm, the bulged portion cordate in dorsal aspect (Figs. 4 and 5), extremely slight circular muscle thickening of ectal third of duct. Holandric; testes and funnels free in x and xi which are filled with coagulum. Testes ventral from 9/10 and 10/11, consisting of a number of irregular lobes along a common axis, the nephridial mesentery; septal attachment quite narrow. Funnels simple with entire edges, strong sperm iridescence in these specimens. On either side, the sperm ducts join in xii, vasa deferentia following body wall just beneath peritoneum to 17/18, then following a mesentery to the apex of the first loop of the glandular portion of the prostate gland, enter lumen near juncture of duct and gland, exact point not determined. Prostates large, in xviii, bulging septum 18/19 posteriorly, but contained within the limits of segment xviii. Prostate ducts stout, muscular, shining; bent in a J-shape entally, directed posterodorsally. Origin of posterior retractor muscle of penial setae dorsolateral at 19/20, rather stout, the more slender anterior branch ventrolateral at 16/17. Glandular portion of prostates long, length over twenty times width. Surface of gland rough. Length of coelomic portion of penisetal follicles at least three times maximum diameter of prostate duct. Seminal vesicles small, acinous, in xi and xii, reniform, vertically placed, dorsolateral to oesophagus, postseptal on 10/11 and 11/12. Rudimentary vesicles present in the same position postseptal on 12/13. Ovaries postseptal ventrally from 12/13, fimbriate; most lobes originating basally, a few produced along nephridial mesentery; ova large and distinct in mature specimens. Ovifunnels of simple form, like a calla-lily spathe, with interrupted margin ventral, preseptal ventrally in xiv with stout ducts through 13/14. Ovisacs present, paired, postseptal dorso-laterally from 13/14 containing ova. Excretory system holonephric exon-ephridia, avesculate; the first in segment ii, those of ii-iv rather compact, the remainder arranged in open loops vertically on body wall. Funnels small, in line *A* (behind clitellum). Dorsal vessel single; three pair dorso-oesophageal hearts in x-xii; dorsal hearts in vii-ix connecting dorsal and ventral vessels. Supra-oesophageal visible as a distinct vessel firmly adherent dorsally on oesophagus from ix to anterior fourth of xiii. Anterior extra-oesophageals do not unite, enter suboesophageal plexus posteriorly in xiii; two pair dorso-intestinals per segment beginning with segment xiv or xv (xiv may have only one pair). No subneural trunk.

*Remarks:* It seems evident from the averages of segment number and measurements that segment number in this species increases with maturity. The smallest juvenile measured 46.5 mm by 2.4 mm with a segment number of 141, while the largest specimen measured 226 mm by 3.3 mm with a segment number of 179. Average segment number and measurements of five clitellate specimens were 170 segments, length 194.3 mm, and maximum diameter 3.3 mm; for five immature specimens the averages were 150 segments, length 84.9 mm, and maximum diameter 3.3 mm.

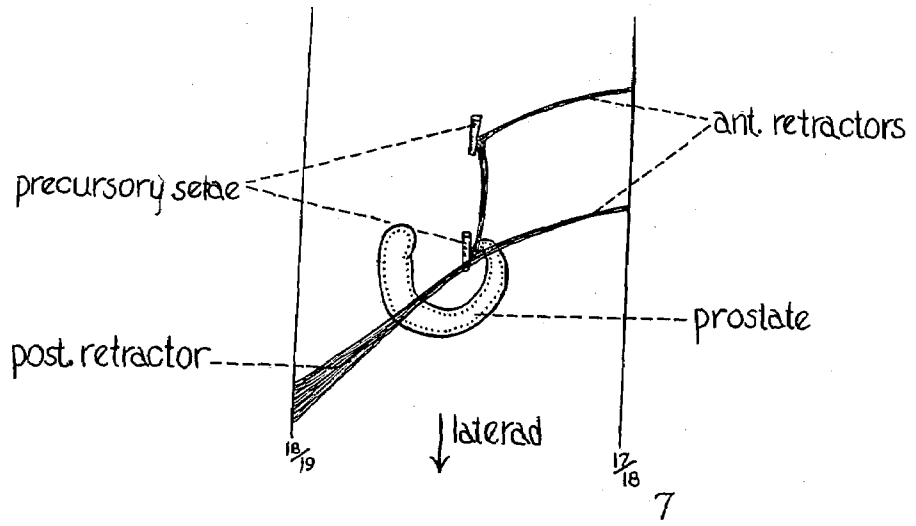
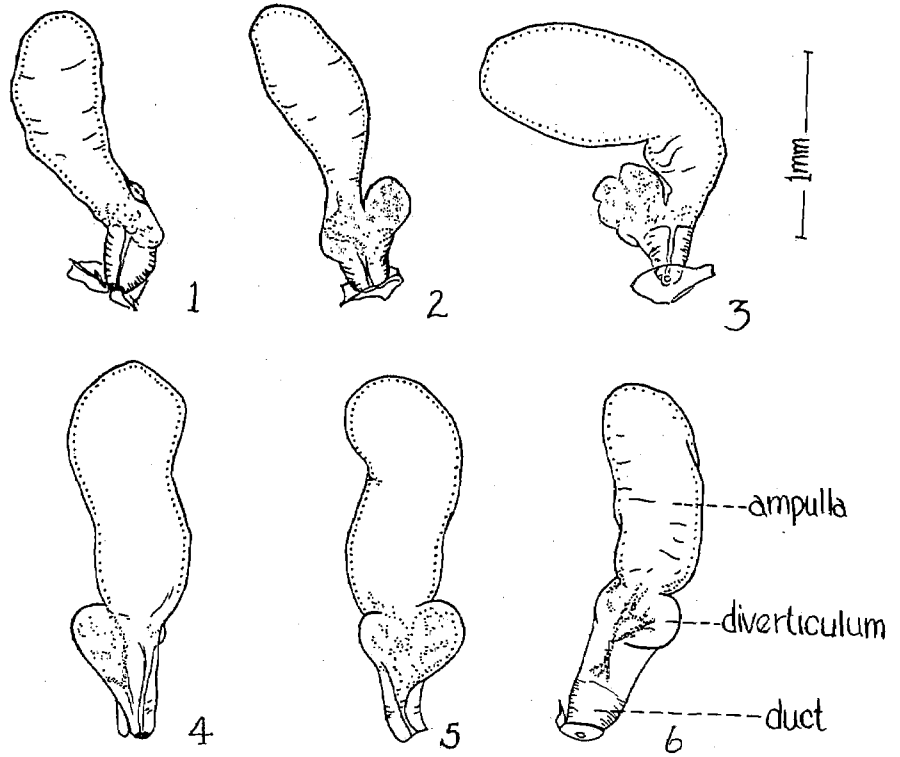
In *P. fenderi*, the lateral vessels of segment vi are unlike the pair of dorsoventral hearts occurring in this segment in certain other *Plutellus*. In this species, septum 5/6 is reduced to a thin film overlying the gizzard, and the large gizzard occupies the space bounded by septa 4/5 and 6/7, and vascularization of both segments is similar, *i.e.*, like that of the gizzard segment (segment v) in *Plutellus macnabi* McKey-Fender, 1957, *q.v.* On each side of segments v and vi, short, paired lateral vessels leave the dorsal trunk and pass to the gizzard, being guarded by valves just before contacting the gizzard wall, and each soon leaving the gizzard surface as a somewhat finer vessel to the ventral trunk, the anterior portion of the gizzard being supplied by the vessels of segment v and the posterior by those of vi.

*Biology:* The nominate subspecies of this species is at present known only from Kenneth Fender's series from Prairie Creek Redwoods State Park, California, where it was taken in association with two other species of *Plutellus*, one of which is allied to *P. collinus* Eisen, 1900, and the other with affinities toward an as yet undescribed group.

The following subspecies of the above species has been taken in three localities in Coos County, in southwestern Oregon. Although closely paralleling *P. fenderi* morphologically, in size and certain details of structure these worms are sufficiently different that a distinct subspecific designation seems advisable.

#### PLUTELLUS FENDERI EXUTUS, new subspecies

*Material:* TYPE [deposited Calif. Acad. Sci.] a large incomplete aclitellate (papillate) worm, Catching Creek Road, Flores Creek Camp, 20 miles southwest of MYRTLE POINT, Coos County, Oregon, November 30, 1957, second-growth Douglas fir (*Pseudotsuga menziesii* (Mirabel) Franco) and a few grand fir (*Abies grandis* Lindl.), heavy, granular, brown soil, pH 5.0; Catching Creek Road, 15 miles from MYRTLE POINT, Coos County, Oregon, same date, two large aclitellate paratypes and three juveniles, second-growth Douglas fir, alder (*Alnus oregona* Nutt.), sword fern, young grand fir, and cedar (*Thuja plácata* Donn.), pH 4.0; all collected by James A. Macnab. North



of Powers Junction across road from Hoffman Waysides, south of MYRTLE POINT, Coos County, Oregon, October 13, 1957, beneath myrtles (*Umbellularia californica* Nutt.) and oak (*Quercus garryana* Dougl.), soil black mud, pH 7.5, ground cover blackberry (*Rubus laciniatus* Willd.) and creeping? bent (*Agrostis* sp.), four juveniles; collected by James A. Macnab.

*Essential features:* Length 286 mm, diameter at x 4.25 mm, segments 170 (from paratype #1, the type being an amputee); epilobic two-thirds with grooves converging, open behind; unpigmented; slender and smooth; clitellum xiii-xviii, form and coloration not evident (material submature); dorsal pores beginning 20/21; quadrithecal, spermathecal pores intersegmental, small pits on rounded tumescent zones, two pair in furrows 7/8 and 8/9 in B; genital papillae AB diameter, intersegmental in A; anterior pairs in 11/12, 12/13, 13/14; posterior pairs in 20/21, 21/22, 22/23 and 23/24 (may be asymmetrical); ovipores pre-equatorial on xiv in A; male pores in AB, nearer B, on xviii, on broadly crescentic glandular porophores in AB, occupying entire anteroposterior length of segment and 2AB in width; nephridiopores alternating irregularly in intersegmental grooves immediately behind furrows in B and D; setal intervals AA:AB:BC:CD = 4:2:3:3 midbody; DD = 1/2C. Penial setae 1285.7 by 22.8  $\mu$ , arcuate, sculptured over apical fifth except tip with rather scattered, acute, broadly triangular teeth, the tips of which curve outward. Sigmoid setae larger in ventral than dorsal series, rather straight, seta a of xvii 678.1 by 28.7  $\mu$ , sculptured over apical fifth with short rows of fine, rather long teeth.

Gizzard in v (and vi?); oesophageal folds longitudinal vii-1/3 ix, oesophagus highly vascular and papillose 2/3 ix-xiv, a continuous ventral ridge in oesophagus and anterior intestine ix-xix; intestinal valve mid-xvii; typhlosole lamellar, one-third diameter of intestinal lumen in height, free edge longitudinally grooved (but not branched); floor of gut grooved circa xxv to liv. Spermathecae two pair in viii and ix, ampulla elongate-oval; duct of equal

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Plate 1

Figures 1 to 6: Camera lucida drawings of cleared spermathecae. Figures 1, 2, and 3—Spermathecae of *Plutellus umbellulariae*: 1—Left spermatheca of segment viii of PARATYPE viewed from right. 2—Dorsal view of same. 3—Ventral view of left spermatheca of segment ix of PARATYPE. Figures 4 and 5—*Plutellus fenderi fenderi*: 4—Left spermatheca of segment ix of PARATYPE viewed from left. 5—Dorsal view of same. Figure 6—*Plutellus fenderi exutus*: Dorsal view of left spermatheca of segment ix of TYPE. Figure 7—*Plutellus fenderi exutus*: Diagrammatic drawing of seta a and b (precursory penial setae) of right side of segment xviii and associated structures of 107 mm juvenile.

length, dorsal wall with reniform swelling (intramural seminal chambers). These specimens not fully developed. Holandric, testes and funnels free in x and xi; vasa efferentia of each side fuse in xii; vasa deferentia enter prostate at junction of duct and gland; prostates in xviii bulging 18/19, especially ventrally; glandular portion long, length over twenty times diameter, ducts stout, muscular, gently arcuated, directed anterodorsally in the most mature specimens, penisetal retractor muscles stout, parietal attachments in xvii and xix; seminal vesicles acinous, postseptal laterodorsally from 10/11 and 11/12; ovaries postseptal in xiii; ovifunnels simple, preseptal ventrally on 13/14 with ducts into xiv; ovisacs present, postseptal dorsally from 13/14; nephridia holonephric exonephridia, avesculate; dorsal vessel single, dorso-oesophageal hearts x-xii; no subneural trunk.

Morphology in general as in the nominate subspecies, with the following features of note:

*Detailed description:* Large, length 286 mm, diameter at x 4.25 mm, maximum diameter 4.5 mm, segments 170 (these figures 194, 3.1, 3.3 and 170 in *fenderi*). Epilobic one-half (two-thirds in *fenderi*). Unpigmented (formalin specimens colorless). Color in life pale, anterior pale pinkish, posterior blue-gray, not appreciably mottled, cuticle strongly iridescent. Genital papillae one-half to one *AB* diameter in *A* (in *B* in *fenderi*). In type, anterior pairs in grooves 11/12, 12/13 and left of 13/14; postclitellar pairs in grooves 20/21, 21/22, left of 22/23 and right of 23/24 (in *fenderi*, anterior pairs at 9/10 (and 10/11); clitellar pair or pairs at 15/16 and/or 16/17; postclitellar pairs in region of 20/21 to 22/23). Setal intervals  $AA:AB:BC:CD = 4:2:3:3$  on x;  $= 4:2:3:3$  midbody or  $5:2:3:3$  in the first paratype;  $DD = \frac{1}{4}C$  (in *fenderi*:  $AA:AB:BC:CD = 5:2:4:4\frac{1}{2}$  on x;  $= 4:2:3:3$  midbody;  $DD = \frac{1}{3}C$ ). Penial setae proportioned as in the nominate subspecies, but larger, corresponding to the larger body size, 1285.7 by 22.8  $\mu$  (857.1 by 17.8  $\mu$  in *fenderi*), sculpture as in *fenderi*, but scales fewer and slightly more regular (compare Figs. 13 and 15). Bluntness of the seta figured (Figs. 15 and 16) may be due to wear, but a precursory seta from a 107 mm juvenile was also comparatively blunt. As in *fenderi*, sigmoid setae differ significantly in size in dorsal and ventral series; in the type, seta *a* of xvii equals 678.1 by 28.7  $\mu$ , seta *d* equals 450 by 25  $\mu$  (Fig. 10), sculptured (seta *d*) over apical fifth with short rows of fine, narrow teeth, rows approximately one-half setal diameter apart, length of teeth equalling nearly one-third distance between rows. (In *fenderi*, distance between rows approximates one-third setal diameter, length of teeth not over one-sixth distance between rows.)

Gizzard posteriorly in v (and vi?), limited posteriorly by septum 6/7, sep-

tum 5/6 apparently near anterior limits of the gizzard, but dissectible from surface of gizzard, with difficulty, nearly to its posterior limits (posterior eighth?), *i.e.*, the point at which lateral vessels of segment vi adhere to gizzard. Gizzard strongly muscular, nearly cylindrical (shaped like a thistle head in *fenderi*). Anterior longitudinally rugose region of oesophagus including vii-1/3 ix (vii-viii in *fenderi*), rugae checkered in effect; oesophageal epithelium irregularly papillose 2/3 ix-xiv, folds ten times height of remaining layers (papillae ix-xiv in *fenderi*, folds six times height of remaining layers), ventral ridge in these segments (ix-xiv) continuous into segment xix, about nine continuous longitudinal folds, in addition to ventral ridge, from anterior xv to anterior 2/3 xvii, where they form a valve and expanded intestine begins (in *fenderi*, folds number about 11 and valve is at 16/17). A simple lamellar typhlosole one-third diameter of intestinal lumen in height over most of its length beginning gradually in xxii, becoming abruptly lower at cxvii and extending as a very low, diminishing ridge some five segments farther (paratype #1) (in *fenderi*, two-thirds height of lumen beginning at 20/21 and extending to cxxiv). Septa 7/8-11/12 muscularized, 7/8 and 9/10 heaviest (in *fenderi*, 6/7-11/12 muscular, 12/13-16/17 slightly thickened). Spermathecae paired in viii and ix, small and empty, consisting of elongate-oval ampulla and duct equalling ampulla in length, ectal fourth of duct muscularly thickened, a somewhat kidney-shaped, transverse intramural diverticular tumescence entally on dorsal face of duct, lateral portion of diverticular bulge largest (Fig. 6). (These specimens are submature, hence not directly comparable to *fenderi* for this feature.) Sperm funnels highly sperm-iridescent. Prostate ducts directed anterodorsally, gently curved entally in an anteroposterior plane (ducts stouter, bent in a J-shape entally and directed posterodorsally in *fenderi*). Posterior retractor muscle of penial setae stout, originating dorsolaterally in xix, the more slender anterior retractor rising similarly ventrolaterally in xvii; coelomic portion of penisetal follicles nearly three times diameter of prostate duct. Ovaries consisting of many lobes arranged, like testes, along a common axis, the nephridial mesentery (most lobes originating basally in *fenderi*). Nephridia of segments ix and x with convoluted portion preseptal on 9/10 and 10/11, which are heavily muscularized (on parietes in *fenderi*). Dorso-oesophageal hearts in x-xii and dorsoventral commissural vessels (hearts) in vii, viii, and ix loosely on anterior faces of their respective septa; commissures of vi adherent to gizzard laterally at location of their ventral valves, with large vessels to the gizzard, those of v preseptal on 5/6, surrounding gizzard at anterior border, sending a branch to gizzard laterally at location of ventral valve, but not themselves adherent (in *fenderi*, lateral vessels of both v and vi

are closely associated with the gizzard); commissures of iv surrounding posterior-most part of buccal mass at 4/5 (as in *fenderi*). Anterior extra-oesophageals paired, rising anteriorly as a larger parietal branch and smaller buccal branches which join near 4/5, ventrolaterally, lie on sides of gizzard and oesophagus anteriorly to 7/8. The posterior course of these vessels is uncertain. In the larger paratype, the anterior extra-oesophageals approach the oesophagus ventrolaterally in ix, just before 9/10, not certainly traceable farther posteriorly, but possibly present though empty at least in anterior part of x. In the type, these vessels are not filled posterior to vii, possibly present, but empty, at least in viii and ix (paired anterior extra-oesophageals enter suboesophageal plexus in xiii in *fenderi*). The course of the posterior extra-oesophageals and supra-oesophageal vessel is as in *fenderi*. Ventral vessel traceable anteriorly to segment i, where it bifurcates.

*Remarks:* It was noted that, like the types of the species described below, the cuticle of these specimens became loosened quickly and extensively after preservation, unlike that of other species collected at the same time and place and similarly preserved. It is because of this feature that the name *exutus* was chosen. The peculiar manner of support of the gonads in this subspecies seems to occur frequently in the larger species of this genus, gonads of small species more often being anchored only septally. Examination of juveniles of this subspecies shows that the relationships of penial setae, penisetal protractor muscles, and penisetal retractors are much as in *Chilota purcelli* (Bedd.) as described by Pickford (1937, pp. 453-473). However, in *P. fenderi* and related species, there are anterior as well as posterior penisetal retractor muscles, which develop as branches of the retractors of the sigmoid setae (Fig. 7). In mature worms, the anterior branches appear as a single muscle and the penial setae are closely approximated, unlike the precursory setae figured. It should be noted that relative proportions of the gizzard, which seem to differ in these subspecies, may be affected by degree of contraction, etc.

*Biology:* This subspecies was found in a variety of soils, from gritty loam to a fine gumbo and with soil acidity ranging from pH 4.0 to 7.5. Intestinal contents of these worms included soil particles ranging from fine silt to grains up to .5 mm diameter, organic fragments such as stems and spore cases of ferns, wood particles, and a head capsule of a small hymenopterous insect. Associated worms included two undescribed endemics (*Plutellus* spp.) and the widespread and common *Allolobophora trapezoides* Dugés.

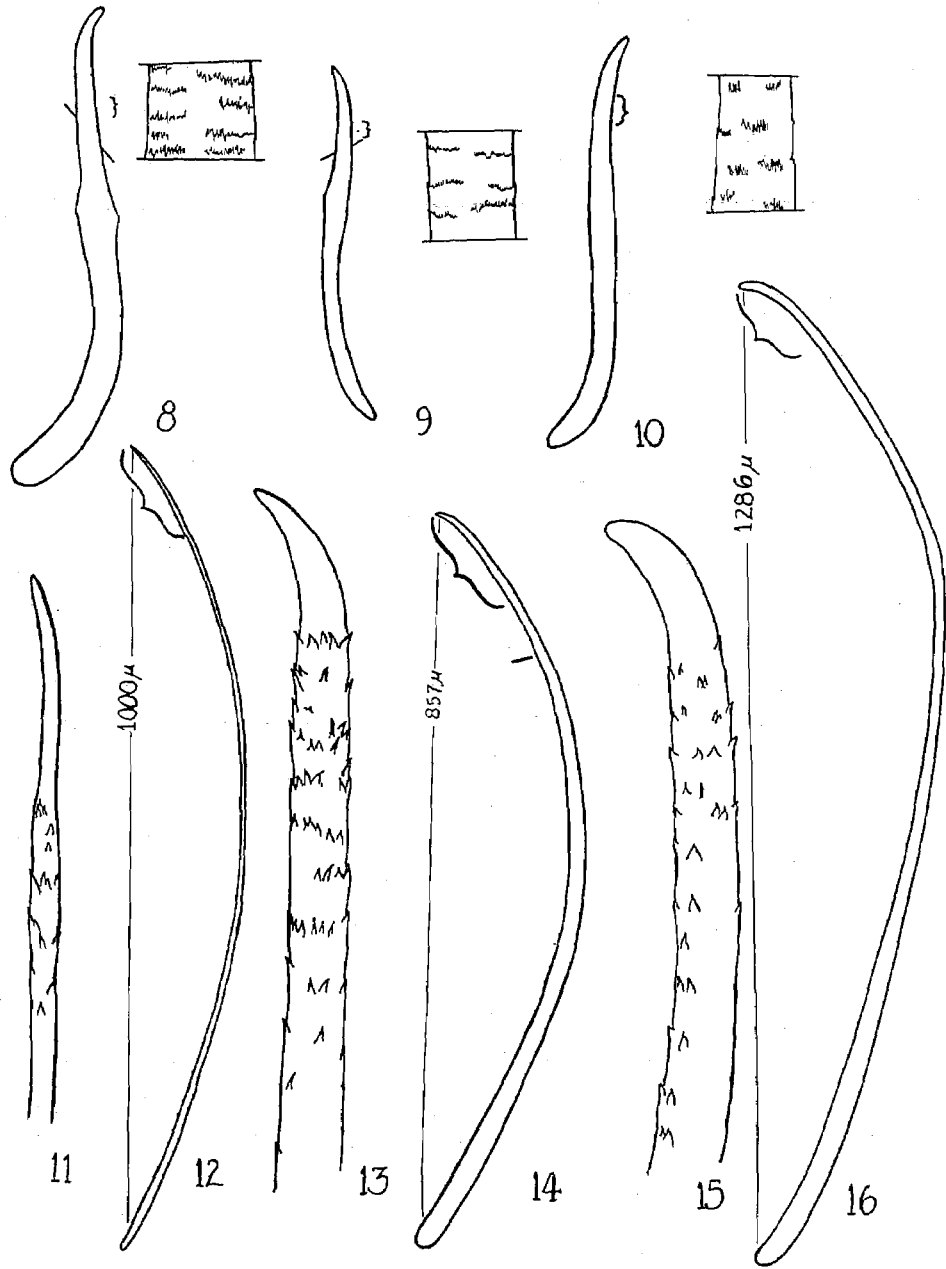
How best to treat the following species was somewhat puzzling, since, despite agreement in most features among series of worms from several southern Oregon localities, some populations were found to be sixthecal, others

octothecal, and the single worm from California (Crescent City) is quadri-thecal. There were also some differences in arrangements of sexual papillae. However, at present, at least, there is no concrete evidence supporting a division into subspecies on a geographical basis. Therefore, a conservative policy has been followed, the type and all paratypes having been selected from a single population, the other populations being considered conspecific, and associated with the type series, but not designated paratypes.

*PLUTEIUS UMBELLULARIAE*, new species

*Material:* Type [deposited Calif. Acad. Sci.] GOLD BEACH (five miles south, near Colvin Waysides), Curry County, Oregon, December 16, 1952; same data, five clitellate paratypes and one juvenile specimen, collected by Ray Albright.

*Essential features:* Length 121 to 151 mm, diameter 3 to 3.5 mm, segments 109 to 122; epilobic two-thirds to three-fourths; unpigmented; clitellum xiii-xviii, thinner ventrally below *AB*; dorsal pores beginning 18/19; quadri-thecal, sexthecal or octothecal, the type population sexthecal; spermathecal pores distinct pits on a round zone, in intersegmental furrows in *B*, the most posterior in 8/9; genital papillae round, approximately *AB* distance in diameter, intersegmental in *A* in grooves, anterior pairs in 12/13, 13/14 and one or two posterior pairs in region of (18/19) 19/20 to 24/25, most often adjoining xxiii; ovipores paired on xiv anteromesad to setae *a*; male pores on xviii on broadly crescentic glandular porophores in *AB*; nephridiopores in intersegmental grooves immediately behind furrows, alternating irregularly; setal intervals *AA:AB:BC:CD* = 4:2:4:4 midbody, *DD* = 2/5*C*; penial setae 1000 by 10.7  $\mu$ , slender, slightly arcuate, basal half of apical tenth ornamented by a few triangular scales (Figs. 11 and 12); sigmoid setae stout, ventral larger than dorsal setae, an anterior ventral seta 278.5 by 50  $\mu$ , sculptured over apical sixth with close rows of fine teeth. Gizzard in v; oesophagus irregularly longitudinally rugose vii-viii, irregularly papillose ix-xiv, longitudinal folds xiv-xvii, ventral ridge ix-xix; expanded intestine beginning mid-xvii; typhlosole T-shaped, height one-third diameter of intestinal lumen, xx-lxxx; floor of gut grooved xxvi-xl; spermathecae three pairs in vii-ix in type series, two pairs or four pairs in variants, most posterior in ix; ampulla elongate-oval, duct less than one-half length of ampulla, a rounded, broadly stalked diverticulum laterally at junction of duct and ampulla, ectal half of duct strongly muscular; holandric, testes and funnels free in x and xi; sperm ducts fuse in xii, enter prostate gland entad of duct in xix; prostates opening on xviii, but gland and most of duct displaced posteriorly into xix; gland long,



length twenty times diameter, ducts stout, directed posteriad, penisetal retractors originate xix and xvii; seminal vesicles acinous, postseptal in xi and xii; ovaries postseptal in xiii, ovifunnels in xiii with stout ducts through 13/14; ovisacs postseptal in xiv; excretory system holonephric exonephridia, avesculate; dorsal vessel single, three pair dorso-oesophageal hearts x-xii; no subneural trunk.

*Detailed description.* Length 121 to 151 mm, diameter (just anterior to clitellum) 3 to 3.5 mm; segments 109 to 122; maximum diameter near viii and ix. Prostomium epilobitic two-thirds to three-fourths, open behind, grooves converging posteriorly. Form of average stoutness. No secondary annulation. Intersegmental furrows quite distinct. Colorless, clitellum pinkish tan; cuticle iridescent. Clitellum xiii-xviii, sometimes encroaching one-third to one-half dorsally in xix; cingulate, very thin ventrally below *AB*; furrows obscured, setae and nephridiopores evident. Dorsal pores rather large, beginning with 18/19. Spermathecal pores three pairs (see section concerning variations), in *B* in grooves 6/7-8/9; consisting of distinct round pits immediately surrounded by a firm annulus, centering very slightly posterior to the furrow. Genital papillae paired in *AB*, nearest *A*; two-thirds *AB* to *AB* distance in diameter, the anterior pairs the larger; rounded tumescent zones with pellucid centers, in intersegmental grooves; an anterior pair in furrow 12/13 and a posterior pair or pairs at 20/21 to 24/25, most often including grooves bounding segment xxiii. Ovipores on xiv, anterior and very slightly median to *a* on an oval glandular zone. Male pores pre-equatorial on xviii, small round pits which are also the openings through which the penial setae may be protruded, in the center of broadly crescentic glandular porophores in *AB*, the concavities ventrad, occupying the full segment length anteroposteriorly. Nephridiopores in grooves immediately behind furrows, alternating irregularly, a typical specimen having those of most segments anterior to the clitellum in line *D*, most in the clitellum in *B* and then alternating irregularly in *D* and *B* posterior to the clitellum. Setal intervals on segment x, *AA:AB:BC:CD* = 5:2:4:4, midbody = 4:2:4:4, *DD* = 2/5*C*. Penial setae 1000 by 10.7  $\mu$ , slender, not large for the size of the worm, very slightly arcuate, tip acute,

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#### Plate 2

Figures 8 to 16. Figure 8—*Plutellus umbellulariae*: Camera lucida outline and detail of sculpture of sigmoid seta *a* of segment x of TYPE. Figure 9—*Plutellus fenderi fenderi*: same of seta *d* of an anterior segment. Figure 11—*Plutellus umbellulariae*: Camera lucida outline of details of sculpture of tip of penial seta. Figure 12—Outline of entire penial seta of same. Figures 13 and 14—Same of *Plutellus fenderi fenderi*. Figures 15 and 16—Same of *Plutellus fenderi exutus*. (Measurements of length of setae are from tip to base, disregarding curvature.)

sculpture limited to ental half of ectal tenth of seta, consisting of a dozen or more irregularly arranged acute scales, the bases of which interrupt the setal surface causing a somewhat pitted appearance, these scales large, the width of their bases equalling about one-third setal diameter; shaft of seta enlarged in sculptured zone (Figs. 11 and 12). Sigmoid setae moderately curved, dorsal and ventral setae differing in size, the ventral larger and stouter, an anterior ventral seta 478.5 by 50  $\mu$ , sculptured over apical fourth by slightly undulant rows of short, fine teeth, distance between rows equalling less than one-fourth setal diameter, length of teeth about one-fourth distance between rows (Fig. 8).

Septa distinct from 5/6; 4/5 present but penetrated by many muscle strands; septa 6/7-12/13 thickened, 7/8-10/11 strongly muscular; anterior septa pouched, posterior border of gizzard at level of 8/9 externally. Buccal cavity in i, pharynx (ii-v) with muscular dorsal plate in iii, pharynx in anterior v naked, clothed by salivary glands dorsally ii-iv. Gizzard posteriorly in v, septum 5/6 tightly adherent to posterior part of gizzard, septa 5/6 and 6/7 contiguous. Gizzard thick-walled, barrel-shaped, scarcely depressed. Oesophagus tubular 6/7 to mid-xvii, where expanded intestine begins. Oesophageal segments vii and viii short anteroposteriorly, epithelium irregularly rugose in vii-viii, the folds about two times height of the remaining layers; irregularly papillose in ix-xiv, the folds higher, height about ten times thickness of the remaining layers; a ridge ventrally in these segments which continues into segment xix; folds becoming lower, continuous and longitudinal in the posterior part xiv to xvii, where they form a valve, about nine of these folds besides ventral ridge. Chlorogogen lightly covering oesophagus in xiii-xv, a heavier layer on the intestine posterior to xix. Intestine expanding rather suddenly in xvii, valve before midsegment xvii; pouched laterally in xvii-xix, smoothly cylindrical posteriorly. Typhlosole beginning gradually with 19/20, and extending to lxxx; inverted T-shaped, reaching ventrally about one-third the diameter of the lumen, branches gradually becoming shorter and finally disappearing posteriorly, a shallow groove opposite typhlosole xxvi to xl. Spermathecae three pair in segments vii to ix, diminishing in size in the anterior pairs, consisting of the elongate-oval ampulla, a duct a little less than one-half the length of the ampulla, and a rounded diverticulum, which is broadly stalked at its ectal half, located laterally at the junction of duct and ampulla (Figs. 1, 2, and 3); the ental part of duct and diverticulum spongy, filled with sperm; ectal half of duct strongly muscular (circular layer). Diverticula of spermathecae of ix externally lobulated, indicating about three main divisions internally, spermathecae of vii and viii with simple diverticulum. Holandric, testes and funnels free; testes consisting of narrow lobes arranged

along a common axis (nephridial mesentery) with narrow septal attachment, postseptal from 9/10 and 10/11 in x and xi, which are filled with coagulum; funnels rather simple rosettes with rolled edges. Sperm iridescence present. Sperm ducts joining in xii; leaving the body wall at 17/18, they follow a mesentery in xviii through 18/19, joining the glandular portion of the prostate at the apex of its most anterior loop in xix, passing ectad along the gland beneath the gland sheath, entering the gland substance near its junction with the prostate duct. Prostates opening in xviii, but glandular portion and much of muscular duct lying in xix; large, displacing but not penetrating septum 19/20 posteriorly; glandular portion long, about twenty times as long as wide, looped irregularly in one plane, elliptical in cross section; duct very muscular, stout, over two-thirds the diameter of the glandular portion over most of its length, nearly straight, directed posteriad, the more slender ental portion bent once in a short hook; posterior retractor of penial setae slender but strong, carried back through 18/19 passing around gland to its origin dorso-laterally at 19/20; anterior retractor arising similarly dorsolaterally in xvii near 16/17. Penisetal follicles small, coelomic portion no longer than maximum diameter of prostate duct. Seminal vesicles postseptal in xi and xii, rather small, acinous, vertically placed on septa, rudimentary vesicles present in xiii. Ovaries postseptal in xiii, large, fimbriate with many distinctly visible ova in mature specimens, septal attachment narrow; ovifunnels preseptal, ventral in xiii with ducts through 13/14, shaped like a calla lily with interrupted margin ventral. Ovisacs postseptal dorsally from 13/14, in same position as seminal vesicles of xi and xii, above rudimentary vesicles of xiii, containing ova in mature specimens. Excretory system consisting of holonephric exonephridia with funnels slightly internal to B; no expanded terminal portion (muscular bladder or vesicle), the open loops being arranged vertically on the wall. Musculature not interrupted over sites of genital papillae. Dorsal vessel single; three pair dorso-oesophageal hearts in x-xii, dorsal hearts in vii-ix with connectives to the dorsal and ventral vessels. Supra-oesophageal trunk distinct but firmly adherent on dorsal surface of oesophagus ix-xii. Anterior extra-oesophageals join ventrally in ix and enter the suboesophageal plexus in x; posterior extra-oesophageal vessels leave wall and pass to oesophagus on 13/14, entering the suboesophageal plexus in xiii; two pair dorso-intestinals per segment beginning usually with xiv. No subneural vessel.

*Additional material. Variation and anomalies:* Two large juveniles of this species are at hand from just beneath the leaf mold under myrtle (*Umbellularia californica* Nuttall) in Loeb State Park on the Chetco River, six miles above BROOKINGS, Curry County, Oregon, March 9, 1948, in company with the

type material of *Plutellus davisii* Macnab and McKey-Fender (1953), collected by John Davis. These specimens agree in asexual characters and in the possession of three pair of spermathecae, but are omitted from the type series.

Sixteen additional specimens are at hand which differ in some respects from the type series but, for the present at least, are considered to be conspecific. These are *not* considered paratypes. BROOKINGS (12 miles north), Curry County, Oregon, December 15, 1952, steep hillside with heavy underbrush, one clitellate specimen, collected by Ray Albright. This specimen has genital papillae at 12/13 and 13/14 anteriorly, with one at 19/20 on the left and one at 20/21 on the right posteriorly. It is functionally sixthelcal but possesses a fourth rudiment on one side in vi. OPHIR (four miles north), Curry County, Oregon, December 15, 1952, under spruce (*Picea sitchensis* (Bong.) Carr.) and Douglas fir (*Pseudotsuga menziesii* (Mirbel) Franco) on a slope near the ocean, at a depth of one to five inches, 12 specimens, three clitellate, though not at maximum development, one aclitellate and four juveniles, collected by Ray Albright. LANGLOIS (three miles south), Curry County, Oregon, January 19, 1957, cut-over area, just beneath litter under young western hemlock (*Tsuga heterophylla* (Raf.) Sarg.), collected by D. McKey-Fender, 2 specimens. These worms from Ophir and Langlois differ in having four, rather than three, pair of spermathecae; the clitellate specimens have additional genital papillae at 18/19, merging with the posterior limits of the male porophores (five specimens); both aclitellate and clitellate worms have papillae at 13/14 and 12/13, and the intestinal origin is also more anterior, being anteriorly in xvii, the valve just behind 16/17. CRESCENT CITY (nine miles south), Del Norte County, California, December 26, 1952, canyon, among redwoods (*Sequoia sempervirens* Endl.) and shrubs, one incomplete clitellate specimen, collected by Ray Albright. This specimen has the genital papillae at 12/13 and 13/14 and at 18/19, the posterior pair being on 25/26. It differs from the others in having only two pair of spermathecae (in viii and ix) which are somewhat stouter than usual. It appears to be slightly smaller than average (diameter 2.75 mm, length unknown). Excepting as noted above, these specimens are in agreement with the type series.

*Remarks:* One or more of the full complement of four (two pairs) of dorso-intestinal vessels may be lacking in segments xiv and/or xv, but there appear to be two pair per segment thereafter. The location of all but the ectal portion of the prostates in segment xix in this species is clearly due to posterior dislocation of the ental extremities of these structures. In very small juveniles of this species the rudiments of the prostate glands and ducts are contained altogether within segment xviii. In slightly larger specimens, the ental

extremity of the gland first penetrates septum 18/19 in line CD. Several attempts to make cuticle preparations of the male pore and cuticular linings of apertures of penisetal follicles were unsuccessful, in spite of the fact that the cuticle is fully loosened on these worms. Internal relationships are therefore unknown; however, there is certainly only a single, very small, round external opening for both male duct and penial setae. In the face of the fact that the penial setae are very slender and relatively small for the size of the animal in this species, the prominent penisetal retractor muscles in this worm seem rather anomalous. Perhaps the penial setae should be considered degenerate. Vascularization of the gizzard in this species is as in *Plutellus fenderi exutus*. *q.v.*

*Biology:* *Plutellus umbellulariae* is known from five localities along the southern Oregon coast and one locality in northern California. One of the distinctive trees of this region is *Umbellularia californica* Nuttall (in Oregon known as myrtle, but southward as California laurel or bay), and several of the populations of this *Plutellus* were directly associated with myrtle trees, hence the name chosen. Worms associated with *P. umbellulariae* at the several localities included *Plutellus davisii* Macnab and McKey-Fender (1953), a *Plutellus* nearest *P. papillifer* Eisen, 1893, the undescribed species also associated with *P. fenderi* at Prairie Creek (Crescent City specimen), and the ubiquitous *Allolobophora turgida* Dugés. The two Langlois specimens when collected (January 19, 1957) were placed in soil in a plastic sack. When reexamined two days later they were found to be *in copula*. There was no slime tube, but some mucous in the immediate vicinity of the sexual pores. Orientation of the bodies was as usual, but they were adherent only in the neighborhood of the pores: the male field contacting the spermathecal zone of the other worm.

*Distinguishing characteristics:* *Plutellus fenderi* and *Plutellus umbellulariae* may be distinguished from all described North American *Plutellus* known to the authors except *Plutellus altmani* Gates, 1942, and *P. perrieri* Benh, 1892, by the presence of a single opening on each of the (paired) male porophores for both penisetal follicles and male duct. All other known *Plutellus* of this region have two penisetal pores and one male pore, *i.e.*, three separate pores on each male porophore. (However, other species as yet undescribed share this character.) *Plutellus sierrae* Michaelsen, 1921, which, like *perrieri* and *altmani* has hearts in segment thirteen, is also possibly pigmented like these species ("schmutzig grau bis graubraun," the preservative not stated). The character of the male pores in *sierrae*, which is known only from the original description, is not clear. Presumably *Plutellus marmoratus* Eisen, 1893, *P.*

*papillifer* Eisen, 1893, and *P. collinus* Eisen, 1900, also have hearts in the thirteenth segment.

Among the species lacking hearts in thirteen, *P. fenderi* and *P. umbellulariae*, with at least two pair of spermathecae, are readily distinguishable from the bithecal species, *Plutellus davisi* Macnab and McKey-Fender (1953) and *P. blacki* Macnab and McKey-Fender (1953). *Plutellus fenderi* and *P. umbellulariae* may be distinguished from *Plutellus macnabi* McKey-Fender, 1957, and *P. kincaidii* Altman, 1936, by the cingulate rather than saddle-shaped clitellum in these new species and from the latter especially by their lack of highly developed calciferous gland enlargements in the oesophagus. (*Plutellus heteroporus* Perrier, 1873, was described as having highly developed calciferous glands, but many other characters of this "lost" species remain in doubt.) *Plutellus garloughi* Smith, 1937, which has three separate pores on each male porophore, is separated from *P. fenderi* and *P. umbellulariae* by additional characters, including differences in the spermathecal pores, which are less definite and pit-like in *P. garloughi*, and by a different pattern of genital papillae. The *toutellus*-group, the known representatives of which are *Plutellus toutellus* Altman, 1936, and *Plutellus oregonensis* Smith, 1937, is further distinguished from these new species by the possession of paired, dorsolateral intestinal caeca, the position of hearts in this group being variable.

From one another, *P. fenderi* and *P. umbellulariae* may be distinguished by the form of the typhlosole (lamellar in *P. fenderi*, inverted T-shaped in *P. umbellulariae*), the shape of the spermathecal diverticulum (sessile in *P. umbellulariae*, intramural in *P. fenderi*), and, in most populations, by the number of spermathecae (four in *P. fenderi*, six to eight in most *P. umbellulariae*). Penial setae are also diagnostic. While the prostate glands and ducts are large in both species, and the penisetal retractors strongly developed, in *P. fenderi* the prostates remain confined to segment eighteen while in *P. umbellulariae* the glands and ental extremities of ducts are drawn back into segment nineteen, the stouter ducts being directed posteriad (directed somewhat dorsally in both subspecies of *P. fenderi*).

*Plutellus fenderi exutus* may be distinguished from the nominate subspecies by its larger size, arrangement of genital papillae (clitellar papillae are lacking in *P. f. exutus*), number of epithelial folds before the oesophageal valve (nine in *exutus*, eleven in *fenderi*), and location of nephridial loops in segments ix and x (on the parietes in *fenderi*, on the septa in *exutus*). There is also greater development of gonadal lobes along the nephridial mesenteries in *P. f. exutus*.

*Affinities:* Too many of the numerous species of Pacific Coast *Plutellus* are undescribed to permit adequate discussion of the affinities of these and related species at this time.

*Acknowledgements*

This paper constitutes a part of the authors' studies of Pacific Coast endemic earthworms supported by National Science Foundation Grant G-3837. Plates were drawn by Barbara Jo Hibbs, who also did most of the counts of segment number and measurements of worms.

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