The Amphipod genus *Anisogammarus* (Gammaroidea: Anisogammaridae) on the Pacific coast of North America.

E. L. Bousfield, Research Associate
Royal Ontario Museum, Toronto, ON, Canada M5S 2C6.

ABSTRACT

The genus *Anisogammarus* Derzhavin (sens. lat.) (Amphipoda: Gammaroidea: Anisogammaridae) is represented in the eastern North Pacific coastal marine region by *A. pugettensis pugettensis* (Dana), ***A. slatteryi***, n. sp., ***A. epistomus***, n. sp., and ***A. amchitkana***, n. sp. ***Anisogammarus tvetkovae***, new species, occurs in the northwestern Sea of Japan and Okhotsk Sea, along with the western Pacific subspecies *A. pugettensis dybovskyi* Derzhavin. Anisogammarids are free-living omnivores, occurring in the shallow sublittoral of cold-water, high salinity coastlines. The large coxal gills , each bearing accessory gills, are presumably advantageous for survival in partly anoxic habitats where they commonly occur.

Introduction

The first anisogammarid species was described under the name *Gammarus pugettensis* by J. D. Dana (1853) from material collected in Puget Sound by the U. S. Exploring Expedition. Common regional amphipods described by Stimpson (1857) contained the sole anisogammarid, *Gammarus confervicolus*. Stebbing (1906) summarized records of four Pacific anisogammarid species under various names within *Gammarus* (sens. lat.), mostlywithin family Gammaridae (sens. lat.). However, Stebbing (loc. cit.) assigned Dana's "*Gammarus pugettensis*", also listed by Holmes (1904), to genus *Liljeborgia*.

During the first half of the 20th century, few anisogammarids were recorded from the North American Pacific coast. Barnard (1954) more fully illustrated Dana's *Anisogammarus pugettensis* based on extensive collections from Oregon, and Shoemaker (1955) described *A. macginitiei* from Pt. Barrow, Alaska. Extensive amphipod material from British Columbia and adjacent regions was collected by National Museum of Canada marine biological expeditions during 1955-1980 (see below). Mainly from this material, the author (1979, 1981) described and illustrated a number of new anisogammarid genera and species. *Anisogammarus macginitiei* was also transferred to the new genus *Barrowgammarus* where is used as an outgroup in later analysis (p. 45). Some of these, and earlier records, are embodied in the general faunistic guides and catalogues of Ricketts & Calvin (1968), Barnard (1975), Austin (1985), and Staude (1987).

Gurjanova (1951) summarized early work on western Pacific anisogammarids, updated by the comprehensive study of Tzvetkova (1975) and the world-wide compilation of Barnard & Barnard (1983). Ishimaru (1994) summarized earlier records from Japan.

The present study attempts to provide a more complete analysis of the systematics and distributional ecology of North American Pacific species of *Anisogammarus*.

Acknowledgments

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SYSTEMATICS

Anisogammaridae Bousfield

Anisogammaridae Bousfield 1977: 295;—Bousfield 1979: 307 (+key to genera);—1981: 72-76, figs. 1-4;—:259;—1983: 267;—Barnard & Karaman 1991: 114;—Ishimaru 1994: 46;—Bousfield & Shih 1994: 129.
Anisogammarids: Barnard & Barnard 1983: 582 (+ key to genera).
Gammaridae (part): Stebbing 1906: 364;—Gurjanova 1951: 760;—Barnard, 1969 (part): 242;—Tzvetkova 1975 (part): 30.

Type Genus: *Anisogammarus* Derzhavin, 1927: 8.

Genera: *Barrowgammarus* Bousfield, 1979: 321; *Eogammarus* Birstein, 1933: 149; *Spinulogammarus* Tzvetkova, 1972: 954; *Spasskogammarus* Bousfield, 1979: 332; *Locustogammarus* Bousfield, 1979: 322; *Jesogammarus* Bousfield, 1979: 335; *Ramellogammarus* Bousfield, 1979: 337; *Carineogammarus* Bousfield, 1979: 343.

Diagnosis: Head, rostrum very short; inferior antennal sinus large, occasionally with narrow posterior notch. Antennae medium, subequal, accessory flagellum prominent, Antenna 2, peduncle large, flagellum occasionally calceolate.

Mouthparts regular, little modified. Lower lip, inner lobes variously developed. Mandible: left lacinia 5-dentate; spine-row strong.

Peraeon dorsally smooth. Coxal plates 1-4 medium deep, regular; plates 5 & 6 shallowly anterolobate. Gnathopods powerfully subchelate (male); gnathopod 1 larger than 2; palmar margins bearing peg spines (male), simple or pectinate (female); carpus short, lobe small. Peraeopods 5-7, bases weakly heterpodous; dactyls short. Peraeopods 2-7 with large coxal gills, 2-5 with 2, P6 with 3, and P7 with 1-2 accessory gills.

Pleosome and urosome variously dorsally carinate, toothed, spinose, or smooth. Uropods 1 & 2, rami usually short, linear, spinose. Uropod 3 large, subaequiramous, terminal segment small. Telson bilobate, with marginal and apical spines. Female brood plates large, unequal, with numerous long marginal setae.

Remarks: During amplexus, males position themselves dorsally and grasp the anterior margin of coxal plate 4, typically by means of the dactyl and propod of gnathopod 1 (Bousfield & Shih 1994).

Allometric growth changes are often noticeable. Compared with the adult stage, juveniles tend to be armed with fewer but relatively large spines and dorsal tooth of urosome 2, and the inner ramus of uropod 3 is relatively short.

Anisogammarus Derzhavin

Anisogammarus Derzhavin, 1927: 8;—Gurjanova 1951: 776;—Tzvetkova 1975: 94 (part, + key to species);—Barnard & Barnard 1983: 584;—Ishimaru 1994: 46.

Type species: *Gammarus pugettensis* Dana, 1853

Species: *Anisogammarus pugettensis dybovskyi* Derzhavin, 1927; *A. slatteryi* n. sp. (p. 34); *A. epistomus* n. sp. (p. 36); *A. amchitkana*, n. sp. (p. 39); *A. tzvetkovae*, n. sp. (p. 41).

Diagnosis: Anterior head lobe acute above, rounded below, with shallow lateral notch. Eye medium, reniform. Antenna 1 shorter than 2; accessory flagellum well developed. Antenna 2, peduncle stout, segment 5 shorter than 4, often with clusters of fine spines with extended tips (male); flagellum lacking calceoli (male).

Mouthparts basic, with few modifications. Lower lip, inner lobes incompletely developed. Mandible: left lacinia 5-dentate; palp slender, terminal segment with well developed "D" spines and "E" setae, but only one cluster of "A" setae (of Cole 1980). Maxilla 1, palp 2-segmented. Maxilla 2, inner plate with full row of oblique facial setae. Maxilliped, inner plate with 3 apical spine teeth; palp setose, not raptorial.

Coxae 1-4 medium deep, smooth, rounded below; coxae 5 & 6 weakly anterolobate. Gnathopod 1 (male) larger than 2 but usually similar in form; in the female it is much larger and of different form than gnathopod 2; carpus short; propodal palm (male) with peg-spines variously developed. Peraeopods 3 and 4, segment 5 short, dactyls short. Peraeopods 5-7, bases broadened proximally, weakly heteropodous; segment 5 longer than 4; peraeopod 7 not longer than 6. Coxal gills on peraeopods 2-5 and 7 each with 2 and on peraeopod 6 with 3, linear accessory gills. Female brood lamellae broad, with numerous long simple marginal setae.

Pleosome smooth above, lacking spines or setae; Epimeral plate 3, hind corner quadrate or slightly produced. Pleopods regular, outer ramus basally with split-tipped "clothespin" spines. Urosome 1 with mid-dorsal hump and 3 groups of spines; uropod 2 with

KEY TO SPECIES OF *ANISOGAMMARUS* AND *BARROWGAMMARUS*

1. Antenna 1 and 2 subequal in length; peraeopods 5-7, bases sublinear, not broadened posteriorly; urosome segments 1 & 2 lacking dorso-lateral spines or teeth; uropods 1 & 2, rami lanceolate, unarmed. ..... *Barrowgammarus macginitiei* (p. 44)
   Antenna 1 distinctly shorter than antenna 2; peraeopods 5-7, bases broadened proximo-posteriorly; urosome segment 1 with dorsolateral spines; uropods 1 & 2, rami linear, with marginal and apical spines ..... 2.

2. Gnathopod 2 (♂) small, weakly subchelate, as in ♀; uropod 3 (♂,♀), rami with marginal spines, lacking setae; telson short, length not greater than width ..... *A. amchitkana* (p. 39)
   Gnathopod 2 (♂) large, subsimilar to gnathopod 1; uropod 3, margins of rami with spines and setae; telson normal, length distinctly longer than basal width ..... 3.

3. Gnathopods 1 & 2 (♂), propodal palmar margins with heavy blunt peg spines; mandibular palp elongate; peraeopod 4, segment 4 elongate ~2X segment 5 ..... ***A. tzvetkovae*** (p. 41)
   Gnathopods (♂), spines of palmar margins regularpeg spines, tips not broadened ; mandibular palp normal; peraeopod 4, length of segment 4 ~ 1.5 X segment 5 ..... 4.

4. Antenna 1, peduncular segment 2 short, length <1/2 segment 1; epimeral plate 3, hind corner squared or slightly acuminate; urosome 1 with 1-2 weak dorsolateral spines; mandibular palp segment 3 short, "D" spines enlarging distally ..... 5.
   Antenna 1, peduncular segment 2 normal, length >1/2 segment 1; epimeral plate 3, hind corner acute, produced; urosome segment 1 with 3-4 medium strong dorsolateral spines; mandibular palp segment 3 regular, "D" spines of uniform size throughout ..... 6.

5. Coxae 1-3, lower margin richly armed with longish setae; uropod 3 inner ramus markedly shorter than (2/3 length of) outer ramus; telson. distal marginal cluster with one very large,elongate spine (>2X length of other spine) ..... ***A. slatteryi*** (p. 34)
   Coxae 1-3, lower margin weakly armed with short to medium setae; uropod 3, inner ramus large, length >3/4 outer ramus; telson, distal marginal cluster of spines not markedly unequal in size, (longest <2X other spines). ..... ***A. epistomus*** (p. 36)

6. Antenna 1 (♂), peduncular segment 5 with scattered clusters of slender, tip-extended spines; uropod 3, outer ramus broad nearly straight ..... *A. pugettensis pugettensis* (p. 31)
   Antenna 1 (♂), peduncular segment 5 with clusters of slender spines in distinct rows; uropod 3, outer ramus slender, medio-distally curved ..... *A. pugettensis dybovskyi* (p. 34)

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acute mid-dorsal tooth, and weak postero-lateral cusp on each side. Uropods 1 & 2 short, stout. Uropod 3 subequally biramous, margins spinose and/or plumose-setose; outer ramus with short terminal segment. Lobes of telson each with two groups of lateral spines.

Distribution: Panboreal North Pacific, in algae, mainly on sedimentary bottoms, low intertidal to ~30 m.

Anisogammarus pugettensis pugettensis (Dana)
(Fig. 1)

Gammarus pugettensis Dana, 1853: 957, fig. 1;—Holmes 1904; 239.

Anisogammarus pugettensis Gurjanova 1951 (part): 777, fig. 541;—Barnard 1954: 13, pls. 12-14;—Tzvetkova 1975 (part): 98, fig. 35;—Bousfield 1979: 310 (key);—Bousfield 1982: 72, fig. 1;—Barnard & Barnard 1983 (part): 584, fig. 38;—Austin 1985: 607;—Staude 1987: 383.

Material Examined: More than 600 specimens in 99 100 lots.

ALASKA.

SE Alaska, ELB Stns., 1961 (see Bousfield & McAllister, 1962):

A5, Tongass Narrows, near Ketchikan - ♂ (17 mm); lot #2 - ♀ ov (11.5 mm), **fig'd specimens,** CMNC 1980-0053; A7,

Bostwick Bay, June 2/61 - ♀ (br. II) (14.5 mm), slide mounts, CMNC 1980-0084; Lot # 2 - 2 ♀♀); Lot #3 (18 ♂♂); lot #4 - 5 ♀♀ ov, CMNC 1980-0087; CMNC 1980-0092; CMNC 1980-0094; A11 (100 ♂♂ & ♀♀ ov, small im); Lot #2 (♀, 1 im); Lot #3 (♂, im); A12 (22 ♂♂, 33 ♀♀ ov, 5 im), Lot#2 - 1 ♀ ov); A18 (1 im); A16 (1 im); A20 (1 ♂, 1 ♀ ov, 2 im); A25 (♀, 2 im); A27 (100 large ♂♂ (to 15.5 mm); A27 (Lot #2- 12 ♀♀ ov); A30 (4 ♀♀ ov, 4 im); A33 (5 ♀♀ ov, 3 juv); A34 (5♂♂, 4 ♀♀ ov, 5 im); A37 (1 ♂); A43 (1 ♀ ov), Lot #2 - 12 ♂♂, 15 ♀♀, 20 im; #3 - 14♂♂, 33♀ ♀ ov, 15 im); A48 (1 ♀♀ ov); A54 (1 juv); A55 (1 ♂, 1♀, Lot #2 - 12 im); A65 (1 ♂); A67 (1 ♀ , 14 juv); A71 (12 ♂♂, 20 ♀♀, 14 im; lot #2 - 30 im); A73 (12 ♂♂ , 9 ♀♀ ov, 5 im); Lot #2 (8 ♂♂, 14 ♀♀, 2 im); A 81 (10 ♂♂, 7 ♀♀ ov, 30 im); A83 (3 ♂♂, 10 ♀♀ ov, 17 juv); A84 (60 ♂♂, ♀♀ ov large); A86 (1♂); A88 (3♂♂, 12 ♀♀, 2 im); A93 (24 im); A136 (1 ♂, 13 im); A139 (3 ♂♂ 5 ♀♀, 5 im); A140 (9 ♂♂, 15 ♀♀, 30 im & juv); lot #2 (1 ♀, 3 im); A141 (1♂); A153 (1 im); A 171 (2 juv); A174 (1 ♂, small); Lot # 2 (25 adult, 17 juv).

ELB Stns., 1980 (see Bousfield & Jarrett 1981):
S14L1 (3 imm).

BRITISH COLUMBIA:

Queen Charlotte Islands, ELB Stns., 1957 (see Bousfield 1963):
H5 (6 ♂♂, 8 ♀♀, 12 im); N4 (2 juv).

North Central Coast, ELB Stns., 1964 (see Bousfield 1968):
H5 (1 juv); H13 (1 ♀ ov, 35 im); H16 (2♂♂, 3 ♀♀, 12 im); H17 (1 ♀, 12 im); H18 (1 juv); H39 (1 juv); H50 (2 im); H56 (4 ♂♂, 10 ♀♀, 13 juv); Lot #2 (8 im).
Pearl Harbour, nr. Prince Rupert, silty sand, eel grass, LW, D. E. McAllister, June 23/65 - 1♂.

Northern Vancouver Island, ELB Stns., 1959 (see Bousfield 1963):
V17 (7♂♂, 10 ♀♀ ov, 11 im); V18 (1 ♂, 3 im); V22 (75 spms., mostly large ♀♀ ov); lot #2 (1 ♂, gnathopods dissected); N18 (1 ♂, 4 ♀♀, 17 juv).

Southern Vancouver island, ELB Stns.
1955 (see Bousfield 1958):
F3 (1 im); F4 (♀ ov, 13 im); F6 (1 ♂, 43 ♀♀, 5 im, dried); M2 (1 im); M2 (1 ♂, 2 ♀♀); M5 (29 im & juv); G4 (3 juv); G10 (5 im & juv); G11 (8 im & juv); G15 (1 ♂, 3 ♀♀, 2 im).

1970 (for Stns. of 1970-80, see Bousfield & Jarrett 1981):
P717 (sev. im).
1975:
Friiday Harbor, May /75 - 2 ♂♂ (20 mm).
1976:
Pacific Environmental Institute, West Vancouver, in halibut tank, June 8 - 1 ♂ (18 mm).
1977:
B2 (3♂♂, 7 ♀♀, 5 im); B7a , Willis Beach, Oak Pt., Victoria, May 19 - 18 ♂♂, 30 ♀♀ subad (16 mm), slide mount, CMNC 1980-0029; CMNC 1980-0038; CMNC 1980-0039; E2 (2 ♀♀ ov).

Misc. CMN collections:
Ladysmith Hbr., Vancouver I., B. C., D.B.Quayle coll., June 8/38 - 27 ♂♂ , ♀♀ ov (broken specimens); Saturna I., Bruce Bight, B. C., J.F.L. Carl coll., Aug. 26/55 - 2 ♀ ♀ ov; Ibid., night light over kelp, Aug 24/55 - 1 ♂, 1 ♀, 2 juv;
Porpoise Hbr, B. C., 20 m, M. Waldichuk coll., Sept. 24/64 - 3 ♀♀; Ibid., Sept. 18/62 - 3 ♂♂, 7 ♀♀ ov, 1 im, NMNS Cat. No. 6-90; Nass Hbr., Iceberg Bay,on dead fish in trap, S. Gorham coll., June 20/65 - 7 ♂♂, 4 ♀♀ ov., 2 im
Off Cordova, Orca Inlet, Prince William Sound, SE Alaska, 13 m dredge, K. E. Conlan, Feb. 18/89 - ♂, ♀ mating pair.

WASH.-ORE, USA.
ELB Stns., 1955 (see Bousfield, 1958):
F8, Garrison Bay, San Juan I., 9 ♂♂, 6 ♀♀, 4 im.
ELB Stns., 1966 (see Bousfield & Jarrett, 1981):
W3 (1 ♂, 1 ♀, 10 im); W4 (1 im); W5 (1 juv); W7, Meadow Point, Puget Sound, July 17. - ♂ (14.0 mm); ♀ ov. (11 mm), slide mounts, CMNC 1980-0065; Ibid., Lot # 2 - 20 spms; W10 (4♂♂, 7 ♀♀ ov, 5 im); W11 (1 juv); W18 (1 juv); W22 (1 im); W33 (♂, 10 im); W39 (6 juv); Ibid. (Lot #2 - 3 ♂♂, 7 ♀♀, 35 im); W44 (3 im); W69 (♀ ov).

Diagnosis Male (16 mm): Anterior head lobe slightly incised. Eye medium, sub-reniform. Antenna 1, peduncular segment 2 medium, length 1/2 peduncle 1; flagellum ~20-segmented, little exceeding peduncle of antenna 2. Antenna 2, peduncular segment 5 = 4, with few clusters of tip-extended slender spines; flagellum 17-segmented, shorter than peduncle.

Mandibular spine row with 8-9 blades; palp relatively short; segment 3 > 2/3 segment 2, "D" spines uniform, extending 2/3 of inner margin; segment 2, beta and gamma setae very short. Maxilla 1, palp little broadening distally. Maxilliped, inner plate apically truncate, outer plate little broadened; palp segment 3 regular, length > 1/2 segment 2.

Gnathopods 1 & 2 stout, dactyls with short unguis; Gnathopod 1, palmar angle with 8-10 inner and outer rows of simple spines. Gnathopod 2, propodal posterodistal angle with inner submarginal row of 6 short simple spines. Peraeopods 3 & 4, segment 6 relatively

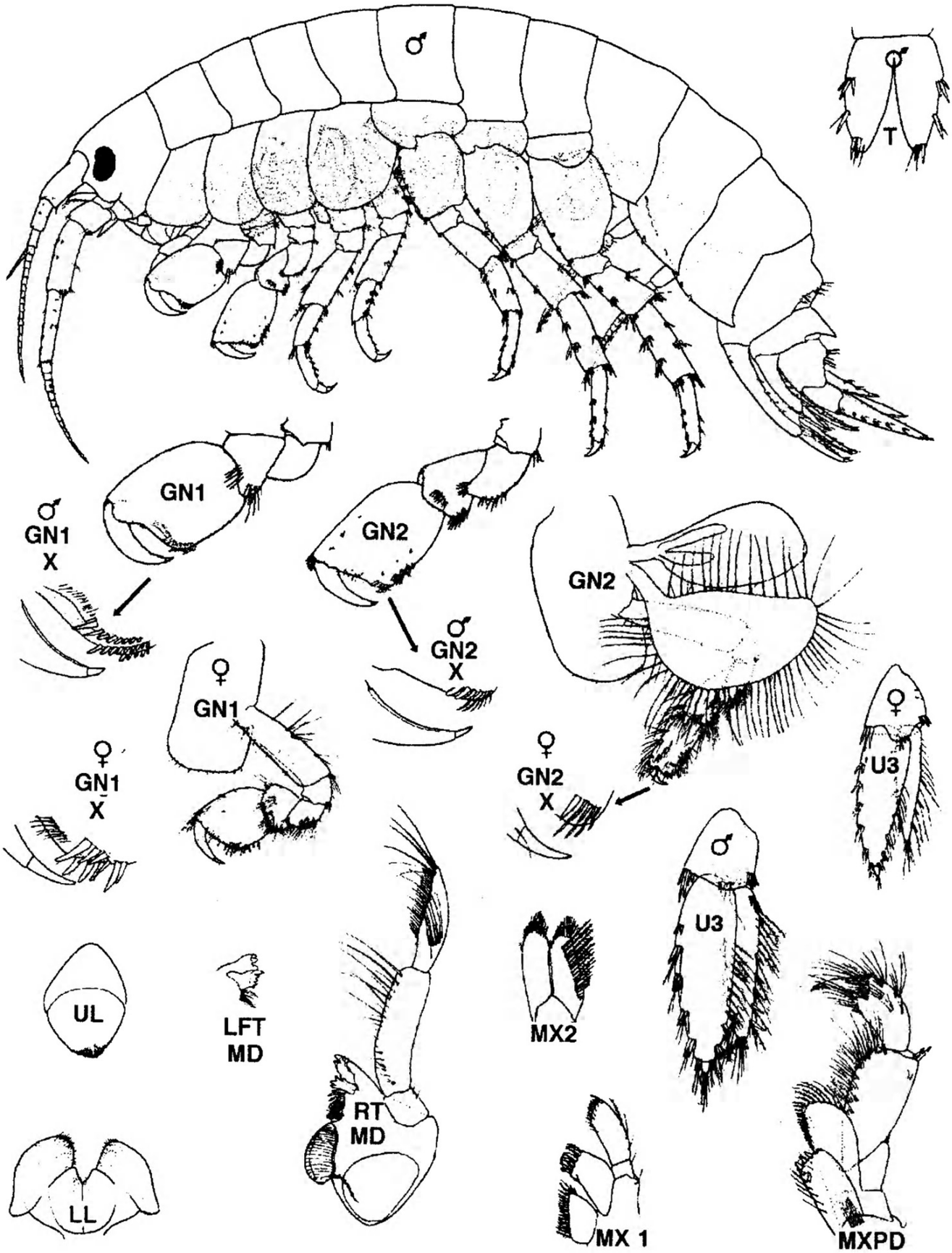

Fig. 1. ***Anisogammarus pugettensis pugettensis*** (Dana). ♂ (17 mm); ♀ ov. (11.5 mm). Tongass Narrows, SE alaska.

short, arched, little longer than segment 5. Peraeopod 7, basis with slight postero-distal marginal excavation. Coxal gill on peraeopod 7 relatively large, broad.

Epimeral plates 2 and 3, hind corner acute, distinctly produced. Urosome 1, mid-dorsal hump medium,with cluster of 8-10 medium spines; lateral clusters with 3-4 spines. Urosome 2 with strong median tooth and single postero-dorsal cusp on each side. Urosome 3 with mid-dorsal and dorsolateral clusters of 2-3 medium spines. Uropods 1 & 2, rami shorter than peduncles, margins moderately spinose. Uropod 3, outer ramus medium broad, inner margin plumose-setose, slightly but distinctly longer than slender inner ramus; terminal segment short.

Telson lobes medium, each side with proximolateral group of three spines, and distolateral longish marginal spine.

Female ov. (14 mm). Gnathopod 1, propod relatively large, subquadrate, posterodistal angle with groups of 3 inner, and 5-6 outer submarginal simple spines. Gnathopod 2, propod subrectangular, postero-distal angle with submarginal row of 1 simple and 4 pectinate spines; brood plate large, broad, with numerous marginal setae. Uropod 3, rami shorter than in male, inner margin plumose-setose.

Distributional Ecology: Aleutian Islands and S. E. Alaska, through B. C. and Washington state south to Coos Bay, Oregon, and Northern California, low intertidal to subtidal, in *Ulva* and *Enteromorpha*, and in partially anoxic bottom deposits of wood chips (Waldichuk & Bousfield 1962).

Remarks: A very similar form has been recorded under this name from the northern Sea of Japan and Sea of Okhotsk by Gurjanova (1951) and Tzvetkova (1975).

Anisogammarus pugettensis (Dana), subsp. *dybovskyi* Derzhavin (Fig. 2)

Anisogammarus dybovsky Derzhavin, 1927: 8 ;— Stephensen 1944: 47, figs. 10. 11;—Ishimuru 1994 (part): 46.
Gammarus pribiloffensis Pearse, 1913: 571, fig. 1.
Anisogammarus pugettensis Gurjanova 1951 (part): 777, fig. 541;—Tzvetkova 1975 (part): 99, fig. 35;—Ishimaru 1994 (part): 46.

Material Examined:
3 lots from East Kamchatka, USSR, K.Vinogradov coll., 1933 - ♂ (13 mm), slide mount; 2 ♂♂ (13 mm); ♀ ov. (11 mm), slide mount (identified as *A. pribilofensis* by E.F. Gurjanova, 1933), Zoological Museum collns., St. Petersburg, Russia.
Alaska-Bering Sea P. Slattery coll:
Mukmuk Bay, St. Lawrence I., 40 ft. scoop, July 1/83 - 3 ♀♀ ov, 3 juv, IZ 1989-002.
NE St. Lawrence I., July/83 - 1 ♂ (18.5 mm).
Unimak I, P. Slattery, June-Oct/82 - 2 ♂♂, 5 ♀♀.

Diagnosis: Male (16 mm). Very similar to *Anisogammarus p. pugettensis* (Dana, 1853) but differing in the following features:

Eye large, reniform. Antenna 2 (male), peduncle 5 subequal to 4, with numerous groups of tip-extended slender spines. Mandibular palp, segment 3 with fewer "A" and "E" setae. Coxa 1 more strongly setose below. Gnathop;od 1, propodal palmar spines shorter and thicker, apex more blunt ; carpus, posterior lobe narrow, subacute. Peraeopod 7, posterodistal marginal excavation lined with fine setae; segment 6 with a few clusters of longish setae, rather than clusters of short spines. Epimeral plates 2 & 3, hind corner less strongly produced. Coxal gill 7 small and short relative to coxal gill of peraeopod 6. Uropod 3, outer ramus relatively narrow, length 4X width, curved distomedially. Telson lobes each with pair of distolateral short spines.

Distributional Ecology: Western Pacific coastal marine waters, northern Japan Sea and Sea of Okhotsk to werstern Bering Sea, mostly along open coasts, on sandy and silty substrata, from lower intertidal to depths of 280 m (Tzvetova, 1975); waters around Japan (Ishimaru, 1994); animals scavenge drowned dead human bodies (Kosek et al 1962).

Remarks: This species has been synonymized with *A. pugettensis*, originally described from the eastern Pacific by Dana, 1853. However, sufficient differences exist (above, and key) as to distinguish the two forms at subspecies level.

Anisogammarus slatteryi, n. sp. (Fig. 3)

Anisogammarus sp. 1, Austin, 1985: 607.

Material Examined:
ALASKA:
St. Lawrence I., Bering Sea, 6 m sand, P. Slattery coll., June 6/87 - 7 juv (2-4 mm); Ibid., lot #2 - 7 juv (2-4 mm). Ibid., Lot # 3. - 40 juveniles, CMN collections.

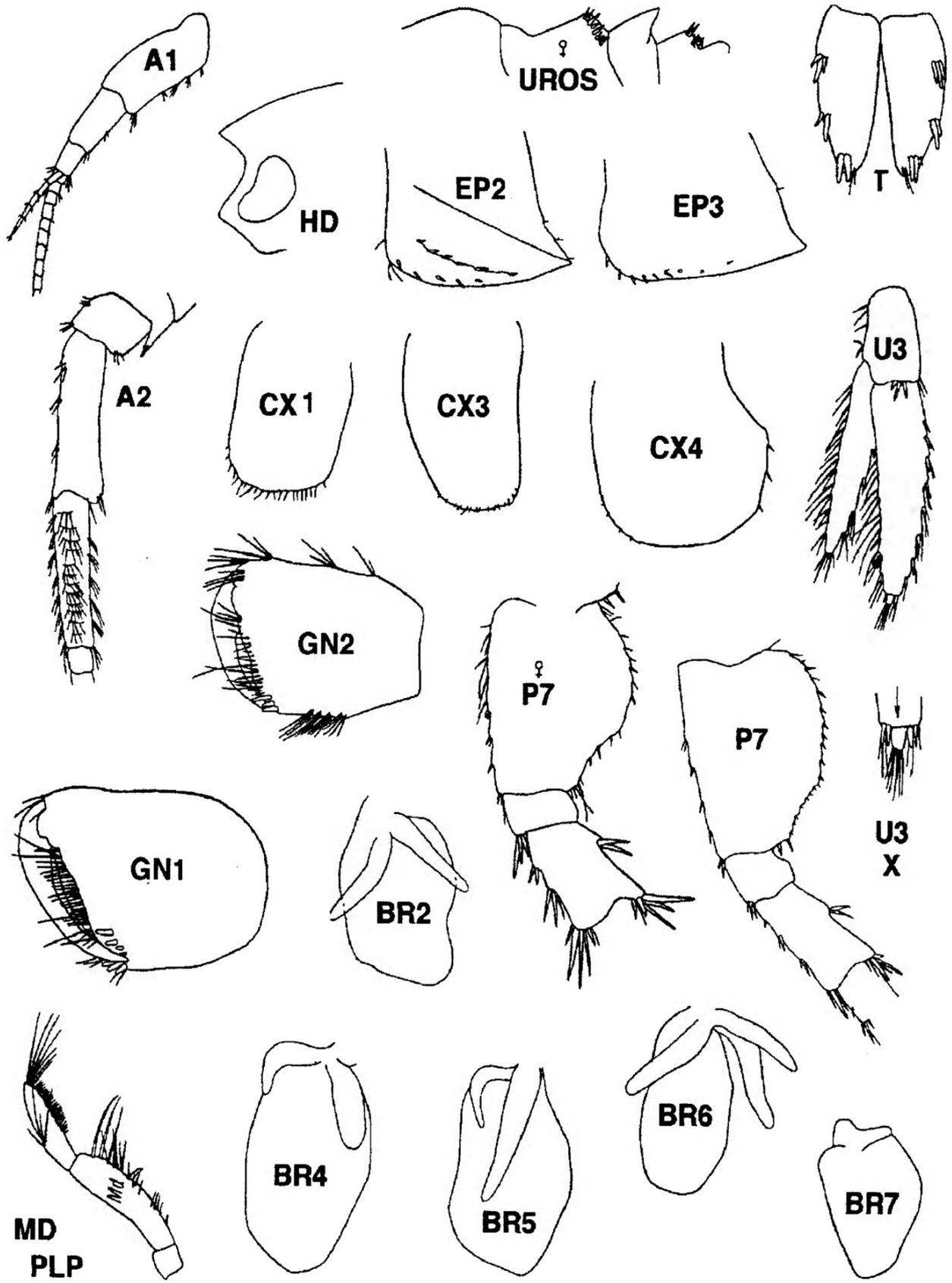

Fig. 2. ***Anisogammarus pugettensis dybovskyi*** Derzhavin. ♂ (16 mm), Japan Sea; ♀ ov (14 mm). Kurile Islands, Okhotsk Sea. [Modified from Tzvetkova (1975)].

BRITISH COLUMBIA:
ELB Stn. H13, Lulu I., NW end, July 14/64 - ♀ subadult, br. I (3.5 mm), CMN coll'ns.
Pachena Bay, Vancouver I., whale pit No. 1, 13 m sand, P. Slattery coll., April 13, 1983 - ♂ (8.0 mm), **Holotype,** (slide mount), CMNC2001-0012; ♀ ov. (6.5 mm), **Allotype,** (slide mount), CMNC 2001-0013; ♂ (8.0 mm), **Paratype,** CMNC 2001-00144; Ibid, J. Kendall & P. Slattery coll., Apr. 15/82 - 1 ♀ (5 mm), NMNS Cat. No. 121555.

WASH.-ORE., ELB Stns., 1966:
W46, Leadbetter Point, open sandy beach, LW, Aug. 4, 1966 - 1 ♂ subadult (4.5 mm), CMN coll'ns.

Diagnosis. Male (8.0 mm): Anterior head lobe, frontal margin straight. Eye medium large, subreniform. Antenna 1, peduncular segment 2 very short, length ~1/3 peduncle 1; flagellum ~14-segmented, little exceeding peduncle of antenna 2. Antenna 2, peduncular segment 5 shorter than 4, with scattered clusters of tip-extended slender spines; flagellum 10-12-segmented, shorter than peduncle.

Mandibular spine row with 5 blades; palp relatively short, segment 3 > 2/3 segment 2; segment 3, "D" spines in short row, increasing in length distally. Maxilla 1, palp slightly narrowing distally. Maxilliped, inner plate apically oblique, outer plate little broadened, with long apical pectinate setae; palp segment 3 short, length ~ 1/2 segment 2.

Coxae 2-4, lower margins with 8-10 mainly longish setae. Gnathopod 1 very stout, distinctly larger than gnathopod 2; dactyls with short unguis. Gnathopod 1, palmar angle with inner and outer submarginal rows of 6-7 and 3-4 simple spines respectively. Gnathopod 2, palmar angle with inner submarginal rows of 4 and 2 short simple spines respectively. Peraeopods 3 & 4, segment 6 straight, longer than segment 5. Coxae 3-4 distinctly anterolobate. Peraeopods 5-7, bases distinctly heteropodous; peraeopod 6 slightly the longest. Peraeopods 6 & 7, basis with slight postero-distal marginal excavation. Coxal gill on peraeopod 7 large, about equal in size to that of peraeopod 6.

Epimeral plate 3, hind corner squared. Urosome 1, mid-dorsal hump very low, with 1-2 small spines and weak lateral clusters of 2 spines. Urosome 2 with small median tooth, posterodorsal cusps lacking. Urosome 3 with single mid-dorsal and dorsolateral medium spines. Uropods 1 & 2, rami shorter than peduncles, outer ramus of uropod 2 lacking marginal spines. Uropod 3, outer ramus short, medium broad, margins spinose; terminal segment distinct; inner ramus short, ~ 1/2 outer ramus, inner margin with few plumose setae.

Telson lobes short, each side with proximolateral group of three spines, and distolateral pair of unequal spines.
Female ov. (6.5 mm). Antenna 2, flagellum 10-segmented. Gnathopod 1 medium large, subquadrate, spination of posterodistal angle similar to that of male. Gnathopod 2, propod short, subrectangular, posterodistal angle with inner submarginal row of 3 simple, outer row of 4-5 pectinate spines. Brood plate large, broad, but with relatively few (<30) marginal setae. Uropod 3, rami shorter than in male, margins spinose, with a few simple setae.

Etymology: The name recognizes marine biologist Dr. Peter F. Slattery, who has contributed broadly to knowledge of marine benthic communities on the Pacific coast of North America.

Distribution: Bering Sea south through Vancouver I. to Washington State, LW and subtidally, to depths of ~13 m, on sand and in feeding pits of the gray whale, *Eschrichtius robustus*.

Remarks: The species is very similar to *A. epistomus* but differs mainly in its smaller size, normally unproduced epistome, and other character states of the key (p. 31).

The small subadult female from Lulu I., has markedly unequal rami of uropod 3, and long coxal setae.

Although the small specimen from Leadbetter Pt. was not dissected, it exhibits some characteristics of *A. slatteryi*, including a small mid-dorsal tooth on urosome 2, and relatively large and powerful gnathopods. The inner ramus of uropod 3 is relatively short and thin.

Anisogammarus epistomus, n. sp.
(Figs. 4, 4A)

Anisogammarus sp. 2, Austin, 1985: 607.

Material Examined.
BRITISH COLUMBIA:
Southern Vancouver I., ELB Stns.
1955:
P6a, Long Beach, SE end Wickaninnish Bay, under algal debris on sand, LW, Aug. 2 - ♂ (13.0 mm), **Allotype,** (slide mount), CMNC 2001-0010; 1 ♂ subadult (10.0 mm), **Paratype,** CMNC 2001-0011.
1970:
P710b, Cape Beale (48° 47.2'N, 125° 13'W), sand, algae, and bedrock, LW level, July 19 - ♀ ov. (13.0 mm), **Holotype,** (slide mount). Fig'd type specimen, and slide mount, could not be located in CMN collections at time of writing).

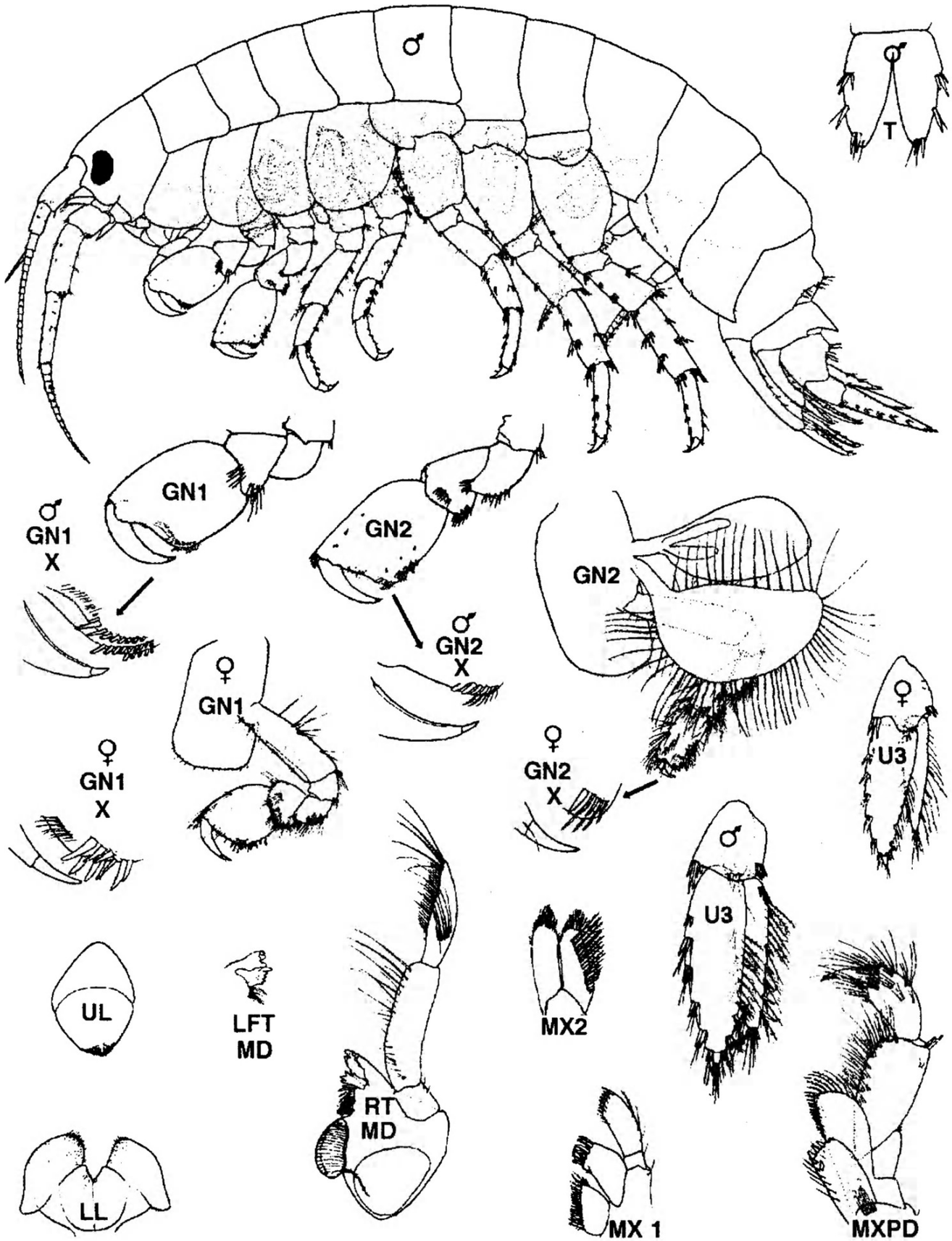

Fig. 3. ***Anisogammarus slatteryi***, n. sp. Male (8.0 mm), Holotype; ♀ ov (6.5 mm), Allotype. Pachena Bay, Vancouver I, B.C.

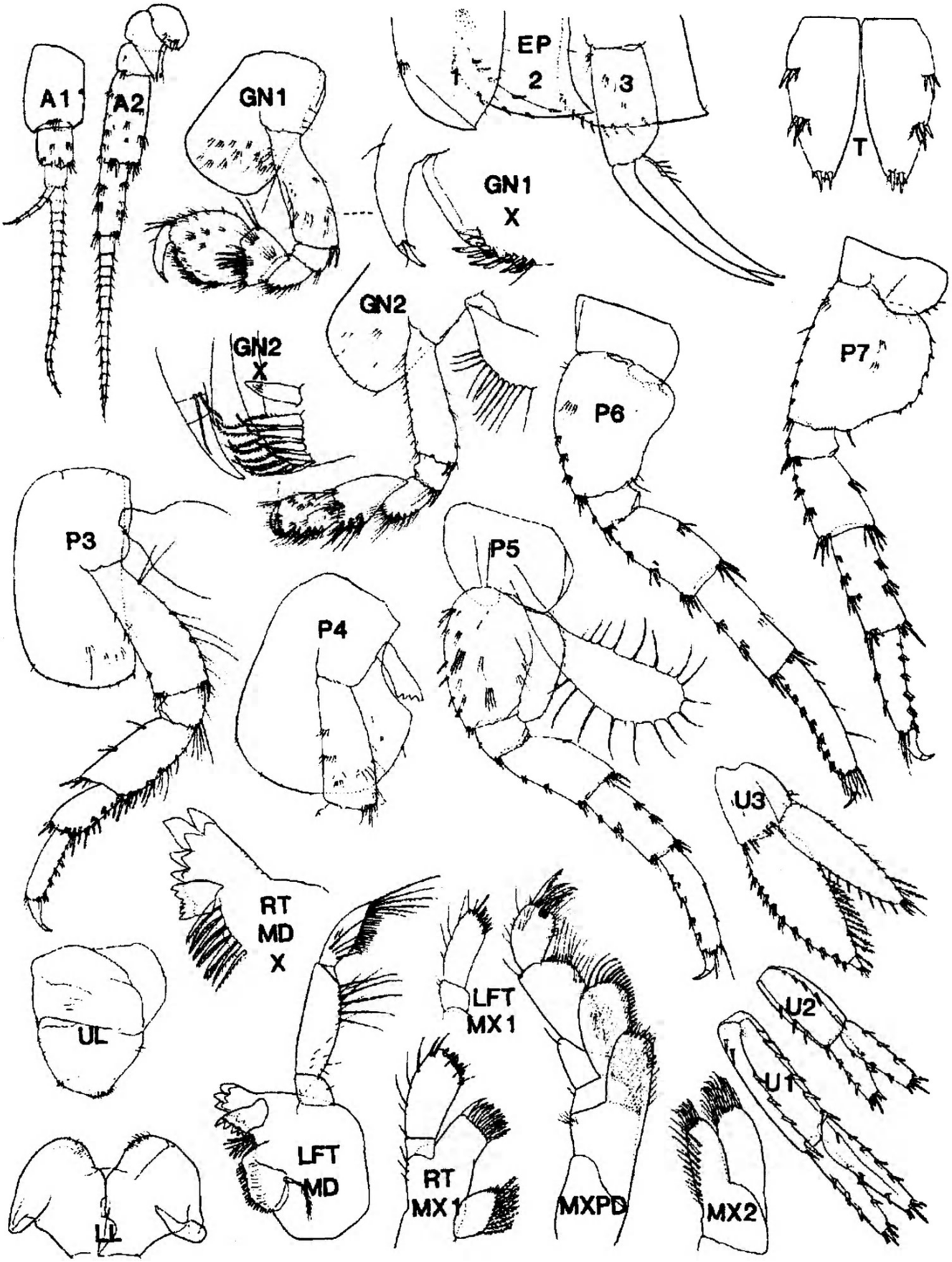

Fig. 4. ***Anisogammarus epistomus*** n. sp. ♀ ov (13 mm), Holotype. Cape Beale, Vancouver I., B.C.

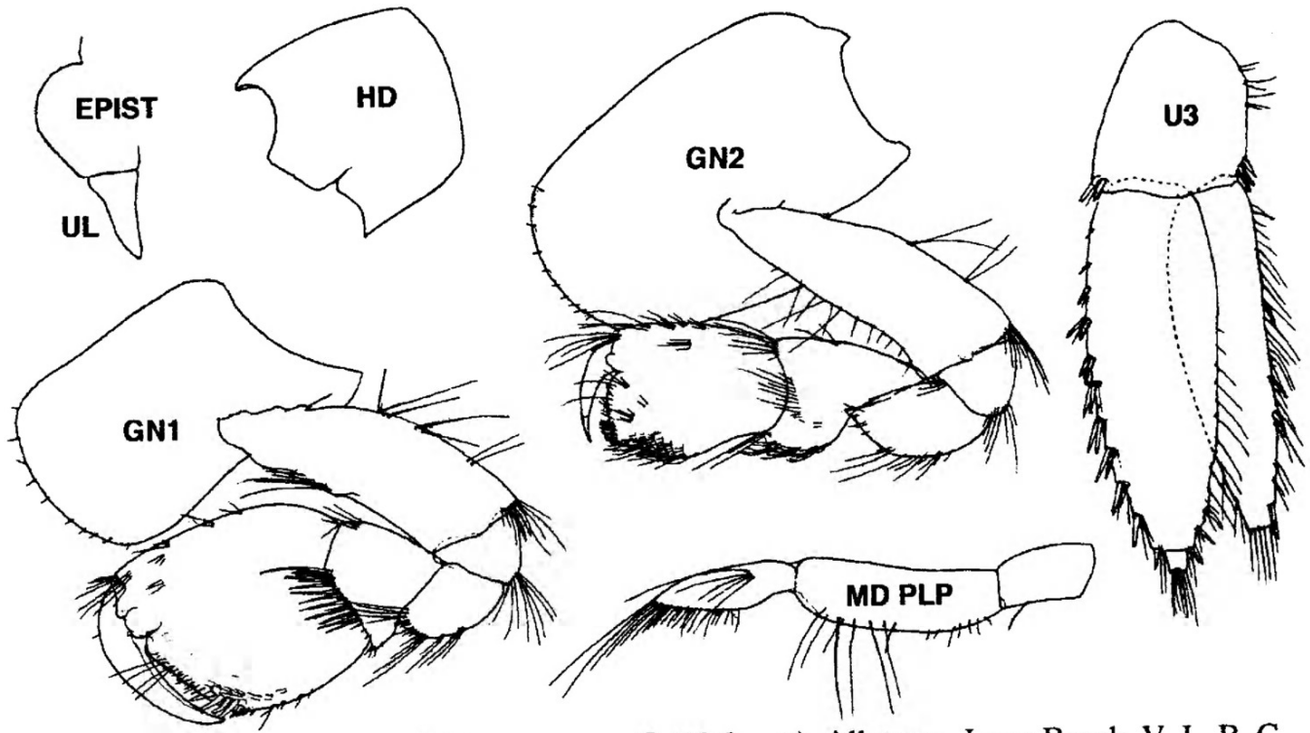

Fig. 4A. ***Anisogammarus epistomus*** n. sp. ♂ (13.0 mm), Allotype. Long Beach, V. I., B. C.

Diagnosis. Female ov (13.0 mm), Holotype: Anterior head lobe not incised; inferior antennal sinus shallow, posterior "notch" at right angles to it. Eye medium subreniform. Antenna 1, peduncular segment 2 short, ~ 1/3 peduncle 1; flagellum ~16-segmented, distinctly exceeding peduncle of antenna 2. Antenna 2, peduncular segment 5 shorter than 4, surfaces with a few clusters of short spines; flagellum 15-segmented, shorter than peduncle.

Mandibuar spine row with 7 blades; palp relatively short, segment 3 < 1/2 segment 2, "D" spines extending 2/3 of inner margin. Maxilla 1, right palp slightly broadening distally. Maxilliped, inner plate apically subtruncate, outer plate slightly broadened; palp segment 3 medium, length > 1/2 segment 2.

Gnathopods 1 & 2 large, strong; dactyls with short unguis. Gnathopod 1, palmar angle with 8-10 inner and outer rows of simple spines. Gnathopod 2, propodal postero-distal angle with inner submarginal row of 6 short simple spines. Peraeopods 3 & 4, segment 6 relatively short, arched, little longer than segment 5. Peraeopod 7, basis with slight post-erodistal marginal excavation. Coxal gill on peraeo-pod 7 relatively large, broad.

Epimeral plates 2 and 3, hind corner acute, slightly produced. Urosome 1, mid-dorsal hump medium, with cluster of 8-10 medium spines; lateral clusters with 3-4 spines. Urosome 2, with strong median tooth and single postero-dorsal cusps on each side. Urosome 3, with mid-dorsal and dorsolateral clusters of 2-3 medium spines. Uropods 1 & 2, rami shorter than peduncles, margins moderately spinose. Uropod 3, outer ramus medium broad, inner margin plumose-setose, slightly but distinctly longer than slender inner ramus; terminal segment short.

Telson lobes medium, each side with proximolateral group of three spines, and distolateral longish marginal spine.

Male (13.0 mm), Allotype: Antenna 1 elongate, flagellum of 22 segments; accessory flagellum 6-segmented. Antenna 2, peduncular segment 5 with few surfac-ial clusters of slender spines.

Upper lip, epistome prominently bulging anteriorly. Mandibular palp with 5 "A" setae.

Coxae 2-4, lower margins nearly bare, armed sparsely with short setae. Gnathopod 1, propod and dactyl powerful, propodal palmar spines regular, tips little or not broadened. Gnathopod 2, propod much less powerful, similar in form and armature to that of female but slightly more powerful.

Peraeopod 5, basis very broad, hind margin rounded. Uropod 3, rami subequal in length; outer ramus with 9-11 groups of spines, inner margin distally plumose-setose; inner ramus, inner margin with spines and setae; terminal segment very short.

Telson, lobes normal, longer than basal width.

Etymology: From "*epi*" + "*stomum*", alluding to the large epistome protruding over the upper lip.

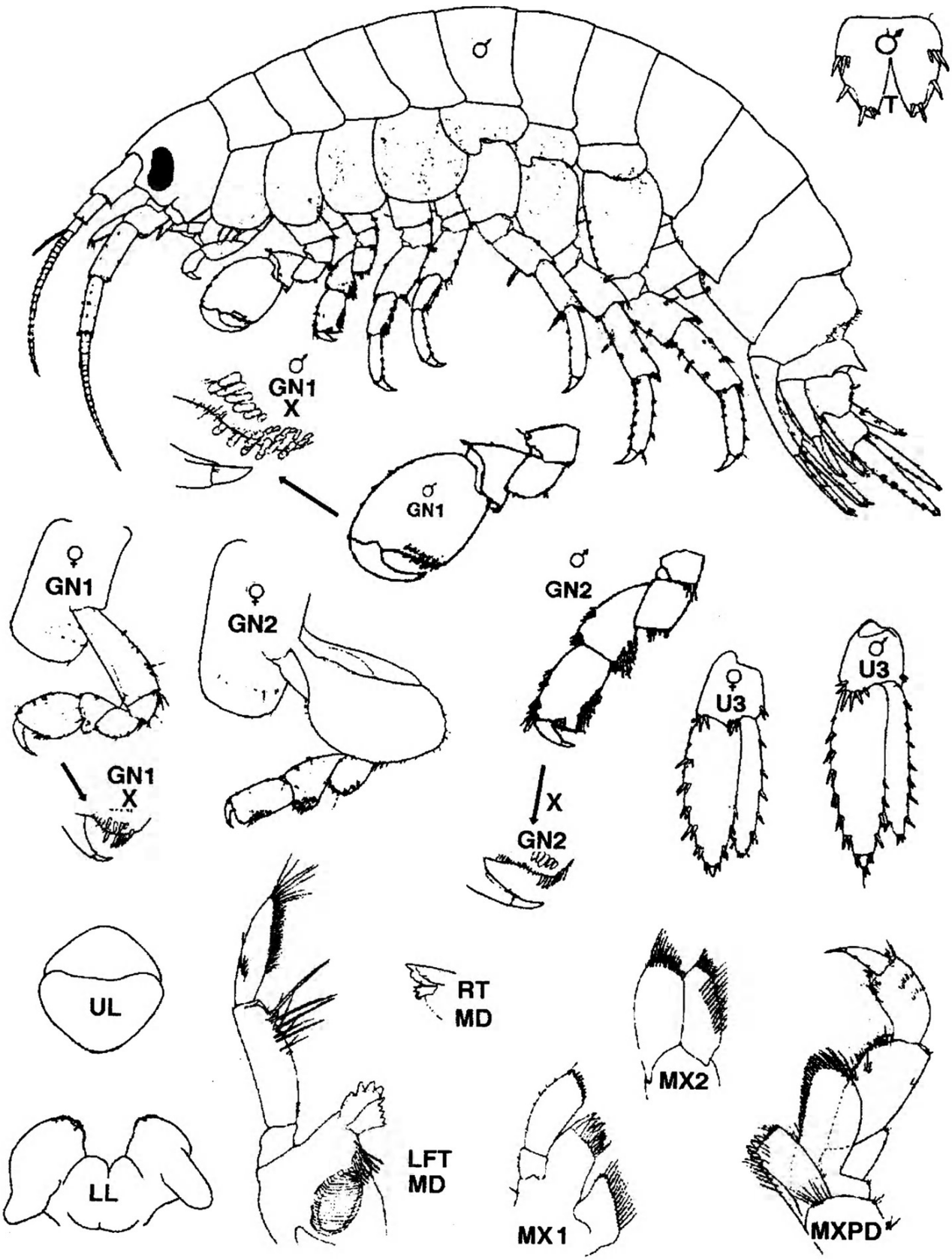

Fig. 5. ***Anisogammarus amchitkana* n. sp.** ♂ (15 mm), Holotype; ♀ ov (14.0 mm), Allotype. Cyril Cove, Amchitka, Alaska.

Distributional Ecology: Known only from the outer coast of Vancouver Island, from Pachena Bay to Wickaninnish Beach; under algal debris, on open surf-exposed sand, LW level, probably shallow subtidal.

Remarks: Character states of *Anisogammarus epistomus*, especially of the male, suggest that the species is a member of the *pugettensis* group, with weakly developed palmar peg spines, but closer to *A. amchitkana*, having weakly developed gnathopod 2 and large aequiramus uropod 3.

Anisogammarus amchitkana, n. sp.
(Fig. 5)

Material Examined.

Bering Sea-Alaska region:

Lot #1, Square Bay, Cyril Cove, Amchitka, Aleutian Islands, C. E. O' Clair coll., Mar. 24, 1969 - ♂ (15 mm), **Holotype**, slide mount, CMNC2001-0015; 1 ♀ ov, **Allotype** (14 mm), slide mount, CMNC2001-0016; 5 ♀♀ ov, **Paratypes** (1 ♀ ov, dissected), CMN collns.

Constantine Harbor, Amchitka I., among algae on dock pilings, P. Slattery coll., Sept. 7. 1969 - 1 ♂ (12 mm), CMN Acc. No. 1982-79.

St. Lawrence I., SE Cape, in kelp & mysid swarms, P. Slattery coll., June 6/86 - 54 subadult specimens (3-5 mm), CMN collns.

Kialegak camp, SW St. Lawrence Bay, Aug. 25, 1985 - 1 ♀ br. II (11 mm) + 4 ♀♀ im (8-10 mm), CMN collns.

Diagnosis. Male (15 mm): Anterior head lobe distinctly incised. Eye medium large, subreniform. Antenna 1, peduncular segment 2 medium, length >1/2 peduncle 1; flagellum ~20-24-segmented, little exceeding peduncle of antenna 2. Antenna 2, peduncular segment 5 = 4, with few clusters of tip-extended slender spines; flagellum ~20-segmented, nearly as long as peduncle.

Mandibuar spine row with 7 blades; palp short, segment 3 > 2/3 segment 2. Maxilla 1, palp slightly broadening distally. Maxilliped, inner plate apically truncate, outer plate slightly broadened; palp segment 3 regular, length > 1/2 segment 2.

Coxae 1-4 medium deep, lower margins rounded, weakly setulose. Gnathopods 1 & 2 very unequal in size; gnathopod 1 large, powerfully subchelate, gnathopod 2 weakly subchelate, as in female; dactyls with short unguis. Gnathopod 1, palmar angle with inner and outer rows of 8-12 mostly peg spines, inner row extending well up palm. Gnathopod 2, propodal subrectangular, posterodistal angle with inner and outer submarginal rows of 5 and 6 short simple spines, respectively. Peraeopods 3 & 4, segment 6 relatively short, arched, litle longer than segment 5. Coxae 5 & 6 shallowly anterolobate. Peraeopods 5-7, bases weakly heteropodous. Peraeopod 7, basis relatively narrow, posterodistal margin straight. Coxal gill on peraeopod 7 small, narrow relative to gill on peraeopod 6.

Epimeral plates 2 and 3, hind corners weakly acute. Urosome 1, mid-dorsal hump low, with cluster of 8-10 medium spines; lateral clusters each with 3-4 spines. Urosome 2 with ordinary median tooth and single posterodorsal cusps on each side. Urosome 3 with mid-dorsal and dorsolateral clusters of 2-3 medium spines. Uropods 1 & 2, rami subequal in length to peduncles, margins moderately spinose. Uropod 3, outer ramus medium broad, margins with 6-7 clusters of short spines, distinctly longer than slender spinose inner ramus; terminal segment short.

Telson lobes short, basally broad, each side with proximolateral group of three spines, and distolateral single short marginal spine.

Female ov (14 mm). Gnathopod 1, propod relatively small, subovate, posterodistal angle with groups of 5 inner, and 4 outer submarginal simple spines. Gnathopod 2, propod subrectangular, posterodistal angle with submarginal row of 1 simple and 4 pectinate spines; brood plate large, broad, with numerous marginal setae. Uropod 3, rami shorter and broader than in male, margins spinose.

Etymology: The species name acknowledges the type locality on the Aleutian Island of Amchitka.

Distributional Ecology: Amchitka and Aleutian Islands, from LW intertidal to depths of ~10 m.

Remarks: The small body size, relatively large size of both gnathopods 1 & 2 (male), and presence of more strongly developed propodal palmar peg spines remove *amchitkana* from the *A. pugettenis - slatteryi* complex (see Fig. 8).

Anisogammarus tzvetkovae, n. sp.
(Fig. 6)

Anisogammarus possjeticus Tzvetkova , 1975 (part?).

Material Examined: Peter-the-Great Bay, Russia, LW intertidal, Nina L. Tzvetkova coll. - ♂ (24. 5 mm), **Holotype**; ♀ ov. (18.0 mm), **Allotype**; slide mounts, loan material, Zoological Institute, St. Petersburg, Russia.

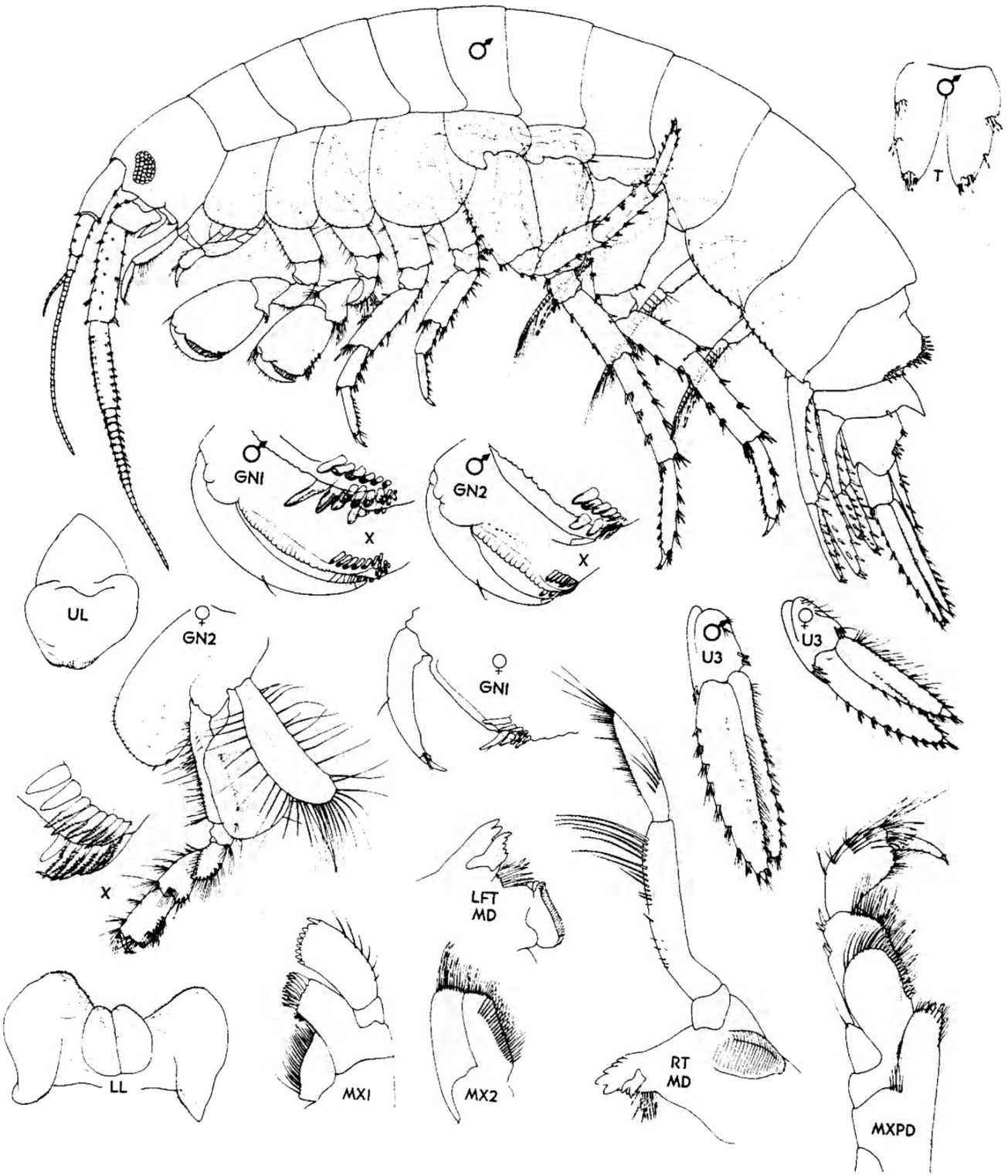

Fig. 6. ***Anisogammarus tzvetkovae***, n. sp. ♂ (24.5 mm), Holotype; ♀ ov (18 mm) Allotype. Peter-the-Great Bay, Sea of Japan.

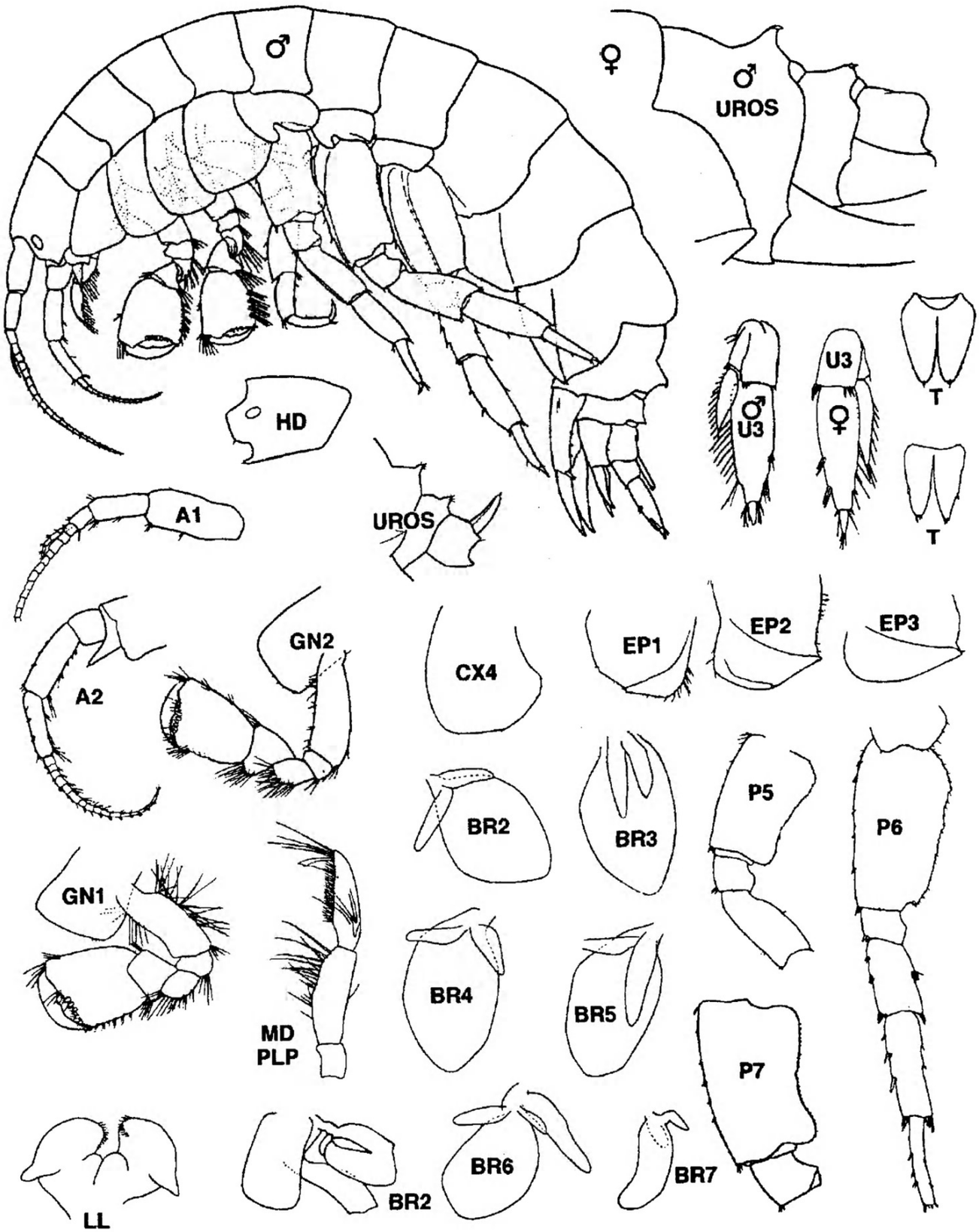

Fig. 7. ***Barrowgammarus macginitiei*** (Shoemaker, 1955). ♂ (37 mm). Point Barrow, Alaska. [after Shoemaker(1955) and Tzvetkova (1975)].

Diagnosis: Male (24.5 mm). Anterior head lobe slightly incised. Eye smallish, subreniform. Antenna 1, peduncular segment 2 medium long, 2/3 length of peduncle 1; flagellum elongate, ~30-segmented, exceeding peduncle of antenna 2. Antenna 2 large, peduncular segment 5 nearly equal in length to 4, with numerous anterior and posterior marginal clusters of slender spines with extended tips, continuing onto proximal flagellar segments; flagellum of 20+ segments, shorter than peduncle.

Mandibuar spine row with 6 blades; palp slender, elongate; segment 3 > 1/2 segment 2, "D" spines short, extending proximad of facial cluster of "A" setae; segment 2 with 8-10 long alpha setae. Maxilla 1, palp distinctly broadening distally, apex with 7-8 short spines. Maxilliped, inner plate apically truncate, outer plate tall, broadened; palp segment 3 regular, length ~ 2/3 segment 2.

Coxae 1-4 relatively deep, 1-3 narrow, lower margin with a few short setae. Gnathopods 1 & 2 stout; dactyls with short unguis. Gnathopod 1, palmar margin rugose, file-like, posterior angle with 6-8 inner, medial, and outer rows of stout peg-spines; carpus with short narrow posterior lobe. Gnathopod 2, propodal postero-distal angle with inner and outer submarginal row of 4-6 short peg spines. Peraeopods 3 & 4, segment 4 elongate, segments 5 & 6 relatively short, subequal; dactyls very short. Coxae 5 & 6 shallowly anterolobate. Peraeopods 5-7, bases relatively narrow, little broadened; basis of peraeopod 7 with slight postero-distal marginal excavation. Coxal gill on peraeopod 7 large, broad, deep, nearly as large as gill of peraeopod 6.

Epimeral plates 2 and 3, hind corner minutely acute, lower margins spinose. Urosome 1, mid-dorsal hump large, with mid-dorsal "V" of ~20 stout spines; dorsolateral clusters each with 3-4 spines. Urosome 2 with strong median tooth and single posterodorsal short spines on each side. Urosome 3 with mid-dorsal and dorsolateral clusters of 2-4 medium spines. Uropods 1 & 2, rami shorter than peduncles, margins spinose. Uropod 3, rami large, slender, inner slightly the shorter, margins with 8-10 clusters of short spines and setae; terminal segment small.

Telson lobes medium long, narrowing distally, proximolateral and distolateral spines short.

Female ov (18 mm). Gnathopod 1, propod medium large, subrectangular, posterodistal angle with groups of 5 inner, and 4 outer submarginal simple spines. Gnathopod 2, propod slender, elongate-rectangular, posterodistal angle with inner submarginal row of 2 simple and 6-7 pectinate spines, and outer submarginal row of 1 simple spine and 5-6 pectinate spines. Brood plate on peraeopod 2 relatively small and slender, with ~30 longish marginal setae. Uropod 3, rami shorter than in male, and margins less setose.

Etymology: In recogniton of Dr. Nina L. Tzvetkova, Zoological Institute, St. Petersburg, Russia, who has contributed in an outstanding manner to knowledge of gammaroideans and littoral marine amphipoda of the northwestern Pacific Ocean.

Distributional Ecology: Known only from the coasts of North and South Korea, the northwestern coast of Japan, and Peter-the-Great Bay, Russia.

Remarks: Material and illustrations from the east coast of South Korea, kindly supplied by Dr. Chang Bae Kim in 1992 (pers. commun.) is virtually identical with that of Dr. Nina Tzvetkova from Peter-the-Great Bay (above).

Barrowgammarus Bousfield

Barrowgammarus Bousfield, 1979: 321;—Barnard & Barnard 1983: 586.

Diagnosis: Body very large. Eyes small, oval. Antennae subequal in length, sparesly setose, not calceolate.

Mouthparts poorly described. Mandibular palp, segment 3 slender, "D" setae uniformly short, extending proximally to distal group of "A" setae.

Gnathopods powerfully subchelate, propodal palmar margins with peg spines (male). Peraeopods 5-7, bases little expanded, each with distinct posterodistal lobes; dactyls short. Coxal gills 2-5 with paired accessory gills; coxal gills 6 & 7 with single accessory gills.

Pleon smooth above. Urosome segments 1 and 2 each with prominent mid-dorsal tooth. Uropods 1 & 2, rami lanceolate, lacking marginal spines. Uropod 3, inner ramus short, < 1/2 outer ramus, inner margins of both are plumose-setose; terminal segment distinct.

Telson lobes narrowing distally, fused basally.

Barrowgammarus macginitiei (Shoemaker) (Fig. 7)

Anisogammarus macginitiei Shoemaker, 1955: 54, fig. 16;—Tzvetkova 1975: 103, fig. 37.
Barrowgammarus macginitiei Bousfield 1979: 321; Barnard & Barnard 1983: 586.

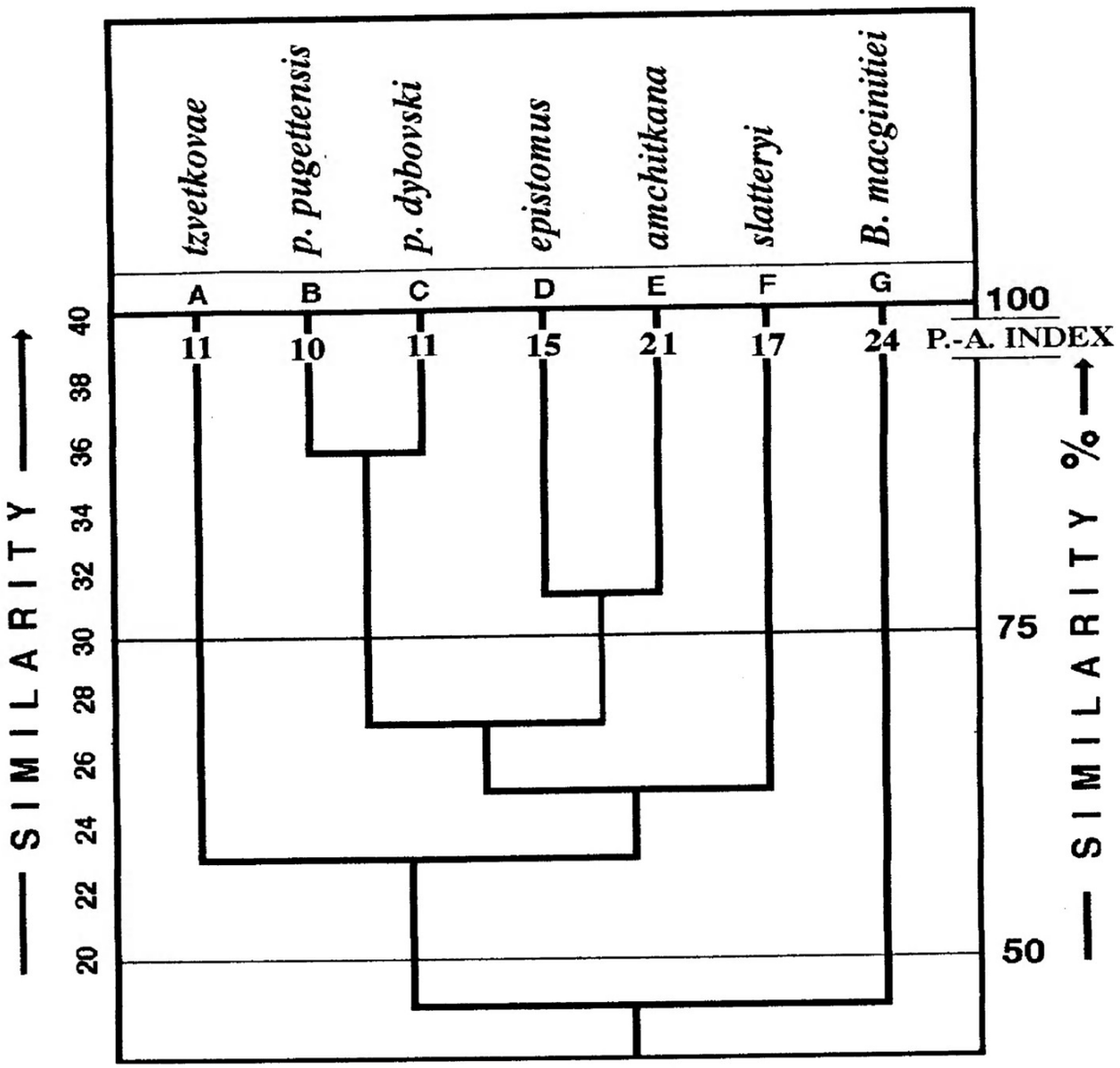

Fig. 8. Morphological smilarities and possible phyletic relationships among species of *Anisogammarus* and *Barrowgammarus*.

Diagnosis: With the characters of the genus.

Distribution: Beaufort Sea, Okhotsk Sea, sublittoral.

Remarks: This monotypic taxon is undoubtedly a member of family Anisogammaridae, most closely related to the genus *Anisogammarus*, and is included here as an outgroup. The female is about the same size as the male but has not been described in detail. The presence of dorsal protruberances on urosome segments 1 & 2,and of dorsal armature on the pleosome, the form of the gnathopods (male) and the inaequiramous form of uropod 3 suggest a common ancestry with *Anisogammarus pugettensis*. Calceolation of antenna 2 (male) has not been confirmed.

Discussion.

The present treatment of anisogammarid species utilizes a semi-phyletic modification of the UPGMA system of Sneath and Sokal (1973), as in previous analyses of other North Pacific amphipd taxa. Character states are ordered plesio-apomorphically and the relative phyletic placement of a given taxon is represented by a numerical sum of plesiomorphic, intermediate, and apomorphic character state values (0, 1, and 2, respectively) in a Plesio-Apomorphic (P.-A.) Index. Tabular data on which the resulting phenograms are based are considered overly bulky and repetitive for publication here, but can be supplied on request.

Fig. 8 portrays character state similarities within the North Pacific genus *Anisogammarus* and the selected

outgroup species *Barrowgammarus macginitiei* (Shoemaker). The outgroup species, formerly *Anisogammarus macginitiei*, is now recognized at the generic level, *Barrowgammarus*, a decision in agreement with the "less than 50% similarity" that it here demonstrates with the six other species and subspecies of *Anisogammarus*. The two subspecies of *A. pugettensis*, and the species *A. amchitkana* and *A. epistomus* cluster above the 75% similarity level and these two fuse at the 68% level. The specialized sand-dwelling species *A. slatteryi* (P.-A. Index = 17) and the primitive western Pacific species *A. tzvetkovae* (P.-A. index = 12) join these at levels of 62% and 58% similarity respectively. Positive consideration of elevating some taxa to subgeneric rank might be justified. However, since other regional species may await formal recognition, elevation of taxa at this time seems premature.

The known species of *Anisogammarus* are cold-temperate (boreal) North Pacific in biogeographic affinity. They are included in an updated list of N. American amphipod species on which comparative biogeogrographical studies were also based (Bousfield, 2001). Four species are apparently exclusively North American, ranging from the Bering Sea region southward to northern California. Two species range from the western Bering Sea and Kamchatka peninsula, southward along the Asiatic coast to the northern Sea of Japan, consistent with the penetration of cold-water elements into that region (Derzhavin 1930). The distribution of only one full species, *Barrowgammarus macginitiei*, apparently overlaps the central Bering Sea divisional region. The biogeographic separation into eastern and western species groups appears to match the east-west distributional separation of species within other anisogammarid genera, notably the species-rich and more southerly ranging genus *Eogammarus* (Tzvetkova 1975; Bousfield 1979). However, cognizant of the current lack of a fossil record and other evidence of past distributions, reasons for these biogeographical consistencies "across the anisogammarid taxonomic board" remain speculative.

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Legend for Figures

A1	-	antenna 1
A2	-	antenna 2
ACC FL	-	accessory flagellum
ABD	-	abdomen
BR	-	brood lamella
CX	-	coxal plate
EP	-	abdominal side plate
EPIST	-	epistome
GN1	-	gnathopod 1
GN2	-	gnathopod 2
HD	-	head
LFT	-	left
LL	-	lower lip (labium)
MD	-	mandible
MX1	-	maxilla 1
MX2	-	maxilla 2
MXPD	-	maxilliped
P5-7	-	peraeopods 5, 6, 7
PL	-	pleopod
PLP	-	palp
RT	-	right
SP	-	spine
T	-	telson
U	-	uropod
UL	-	upper lip (labrum)
UROS	-	urosome
X	-	enlarged
♂	-	male
♀	-	female
im	-	immature
juv	-	juvenile
ov	-	ovigerous
subad.	-	subadult