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TABLE OF CONTENTS

Volume 94

Aldrich, John W. Geographic variation in white-winged doves with reference to possible source of new Florida population 641–651

Alvariño, Angeles. *Spadella legazpichessi,* a new benthic chaetognath from Enewetak, Marshall Islands 107–121

Baker, H. R. A redescription of *Tubificoides heterochaetus* (Michaelsen) (Oligochaeta: Tubificidae) 564–568

Barnard, J. Laurens. Redescription of *Iphiplateia whiteleggei,* a New Guinea marine Amphipod (Crustacea) 1211–1218

Barnard, J. Laurens, and Charline M. Barnard. The amphipod genera *Eobrolgus* and *Eyakia* (Crustacea: Phoxocephalidae) in the Pacific Ocean 295–313

Bayer, Frederick M. *Pseudoplumarella echidna,* a new species of Primnoid octocoral from Queensland (Coelenterata: Octocorallia) 622–630

Bayer, Frederick M. On some genera of stoloniferous octocorals (Coelenterata: Anthozoa), with descriptions of new taxa 878–901

Bayer, Frederick M. Key to the genera of Octocorallia exclusive of Pennatulacea (Coelenterata: Anthozoa), with diagnoses of new taxa 902–947

Blake, James A. The Scalibregmatidae (Annelida: Polychaeta) from South America and Antarctica collected chiefly during the cruises of the R/V *Anton Bruun,* R/V *Hero,* and USNS *Eltanin* 1131–1162

Blake, James A., and Keith H. Woodwick. The morphology of *Tripolydora spinosa* Woodwick (Polychaeta: Spionidae): an application of the scanning electron microscope to Polychaete systematics 352–362

Bowman, Thomas E. First description of the male opossum shrimp, *Heteromysis bermudensis bermudensis* (Crustacea: Mysidacea) 458–461

Bowman, Thomas E. *Calasellus longus,* a new genus and species of troglobitic Asellid from Shaver Lake, California (Crustacea: Isopoda: Asellidae) 866–872

Brinkhurst, Ralph O. A contribution to the taxonomy of the Tubificinae (Oligochaeta: Tubificidae) 1048–1067

Burreson, Eugene M. A new deep-sea leech, *Bathybdella sawyeri,* n. gen., n. sp., from thermal vent areas on the Galápagos Rift 483–491

Chapman, Peter M. A new species of *Homochaeta* (Oligochaeta: Naididae) from the west coast of Canada 455–457

Chernoff, Barry, and Robert Rush Miller. Systematics and variation of the Aztec Shiner, *Notropis sallei,* a cyprinid fish from Central Mexico 18–36

Cohen, Daniel M. *Saccogaster melanomycter* (Ophidiiformes: Bythitidae), a new fish species from the Caribbean 374–377

Cohen, Daniel M. New and rare ophidiiform fishes from the eastern Atlantic: Canary Islands to the Cape of Good Hope 1085–1103

Cooke, William J., and Craig D. MacDonald. The puerulus and post-puerulus of the Hawaiian spiny lobster *Panulirus marginatus* 1226–1232

Cressey, Hillary Boyle. *Ceratocolax mykternastes,* new species (Copepoda: Bomolochidae) parasitic in the nasal sinus of *Haemulon sciurus* (Pisces: Pomadasyidae) from Belize 514–524

Cutler, Edward B. A new species of *Aspidosiphon* (Sipuncula) from the western Atlantic Ocean 445–449

Dawson, C. E. Notes on west African pipefishes (Syngnathidae) with description of *Enneacampus,* n. gen. 464–478

DeWitt, Hugh H., Paul A. Grecay, John S. Hacunda, B. Paul Lindsay, Richard F. Shaw, and David W. Townsend. An addition to the fish fauna of the Gulf of Maine with records of rare species ---------- 669–674

Downey, Maureen E. A new Goniasterid seastar, *Evoplosoma scorpio* (Echinodermata: Asteroidea), from the northeastern Atlantic ---------- 561–563

Erséus, Christer, and Michael S. Loden. Phallodrilinae (Oligochaeta: Tubificidae) from the east coast of Florida, with description of a new species of *Adelodrilus* ---------- 819–825

Ewing, R. Michael, and Daniel M. Dauer. A new species of *Amastigos* (Polychaeta: Capitellidae) from the Chesapeake Bay and Atlantic coast of the United States with notes on the Capitellidae of the Chesapeake Bay ---------- 163–168

Farfante, Isabel Pérez. *Solenocera alfonso,* a new species of shrimp (Penaeoidea: Solenoceridae) from the Philippines ---------- 631–639

Ferrari, Frank D. *Oithona wellershausi,* new species, and *O. spinulosa* Lindberg, 1950 (Copepoda: Cyclopoida; Oithonidae) from the mouth of the Pearl River, China ---------- 1244–1257

Fritzsche, Ronald A. A new species of pipefish (Pisces: Syngnathidae: *Micrognathus*) from Tahiti ---------- 771–773

Froeschner, Richard C., and Libby Halpin. Heteroptera recently collected in the Ray Mountains in Alaska ---------- 423–426

Gaston, Gary R., and David A. Benner. On Dorvilleidae and Iphitimidae (Annelida: Polychaeta) with a redescription of *Eteonopsis geryonicola* and a new host record ---------- 76–87

Gore, Robert H. Three new shrimps, and some interesting new records of decapod Crustacea from a deep-water coral reef in the Florida Keys ---------- 135–162

Grabe, Stephen A. Occurrence of *Mysidopsis almyra* Bowman, 1964 (Mysidacea) in the Patapsco River Estuary (Upper Chesapeake Bay), Maryland, U.S.A. ---------- 863–865

Grogan, William L., Jr., and Willis W. Wirth. A new American genus of predaceous midges related to *Palpomyia* and *Bezzia* (Diptera: Ceratopogonidae) ---------- 1279–1305

Grygier, Mark J. *Gorgoniscus incisodactylus,* a new isopod of the epicaridean superfamily Cryptoniscoidea, parasitic on an ascothoracican cirriped from Hawaii ---------- 122–134

Grygier, Mark J. *Scalpelloniscus,* a new genus for two species of cryptoniscid isopods (Epicaridea) parasitic on abyssal stalked barnacles ---------- 1258–1270

Haman, D., K. L. Finger, and R. W. Huddleston. *Bicornifera* Lindenberg, 1965 emend. Keij, 1969 (Microproblematica) from the type Byram Marl (Oligocene), Mississippi ---------- 696–698

Haman, Drew, and Richard W. Huddleston. *Falsipatellina,* a new name for *Pseudopatellina* Kenawy and Nyírõ, 1967 *non* Haque, 1960 (Foraminiferida) ---------- 378–379

Hastings, Philip A., and Stephen A. Bortone. *Chriolepis vespa,* a new species of Gobiid fish from the northeastern Gulf of Mexico ---------- 427–436

Ho, Ju-shey, and Laurie E. McKinney. A new species of *Eudactylina* (Copepoda: Eudactylinidae) parasitic on black shark from Chile ---------- 745–752

Holt, Perry C. A resumé of the members of the genus *Cambarincola* (Annelida: Branchiobdellida) from the Pacific drainage of the United States ---------- 675–695

Holt, Perry C. New species of *Sathodrilus* Holt, 1968, (Clitellata: Branchiobdellida) from the Pacific drainage of the United States, with the synonymy of *Sathodrilus virgiliae* Holt, 1977 ---------- 848–862

Holthuis, L. B. Description of three new species of shrimps (Crustacea: Decapoda: Caridea) from Pacific islands ---------- 787–800

Houbrick, Richard S. Anatomy of *Diastoma melanioides* (Reeve, 1849) with remarks on the systematic position of the family Diastomatidae (Prosobranchia: Gastropoda) 598–621
Houbrick, Richard S. Systematic position of the genus *Glyptozaria* Iredale (Prosobranchia: Gastropoda) 838–847
Huddleston, Richard W. *Bernardichthys zorraquinosi,* a new genus and species of salmoniform fish from the late Cretaceous of Oregon 37–42
Huddleston, Richard W. Comments on the taxonomic status of *Tommotia* Missarzhevsky 1970 (Tommotiidae: Microproblematica) 462–463
Huddleston, Richard W., and Drew Haman. *Pflugella,* new name for *Tricellaria* Pflug, 1965 (Microproblematica), *non* Fleming, 1828 (Bryozoa) 421–422
Huddleston, Richard W., and Prabha Kalia. *Shastrina,* a new genus of heterohelicid Foraminifera from the Eocene of India 652–653
Humes, Arthur G. A new species of *Tegastes* (Copepoda: Harpacticoida) associated with a scleractinian coral at Enewetak Atoll 254–263
Jara, Carlos G., and Maria T. Lopez. A new species of freshwater crab (Crustacea: Anomura: Aeglidae) from insular south Chile 88–93
Karnella, Susan J., and Ernest A. Lachner. Three new species of the *Eviota epiphanes* group having vertical trunk bars (Pisces: Gobiidae) 264–275
Kimsey, Lynn Siri. The Cleptinae of the Western Hemisphere (Chrysididae: Hymenoptera) 801–818
Kornicker, Louis S. Range extension and supplementary description of *Bathyconchoecia deeveyae* (Ostracoda: Halocyprididae) 1237–1243
Kornicker, Louis S., and Anne C. Cohen. The relative position of the left and right lamellae of the furca in the order Myodocopida (Crustacea: Ostracoda) 739–744
Lewis, Julian J. *Caecidotea salemensis* and *C. fustis,* new subterranean Asellids from the Salem Plateau (Crustacea: Isopoda: Asellidae) 579–590
Maciolek, Nancy J. A new genus and species of Spionidae (Annelida: Polychaeta) from the north and south Atlantic 228–239
Maciolek, Nancy J. Spionidae (Annelida: Polychaeta) from the Galápagos Rift geothermal vents 826–837
Manning, Raymond B., and David K. Camp. A review of the *Platysquilla* complex (Crustacea: Stomatopoda: Nannosquillidae), with the designation of two new genera 591–597
Manning, Raymond B., and C. W. Hart, Jr. *Gonodactylus lightbourni,* a new Stomatopod crustacean from Bermuda 708–712
Manning, Raymond B., and Marjorie L. Reaka. *Gonodactylus siamensis,* a new Stomatopod crustacean from Thailand 479–482
Marelli, Dan C. New records for Caprellidae in California, and notes on a morphological variant of *Caprella verrucosa* Boeck, 1871 654–662
Mayes, Monte A., Daniel R. Brooks, and Thomas B. Thorson. *Potamotrygonocotyle tsalickisi,* new genus and species (Monogenea: Monocotylidae) and *Paraheteronchocotyle amazonensis,* new genus and species (Monogenea: Hexabothriidae) from *Potamotrygon circularis* Garman (Chondrichthyes: Potamotrygonidae) in northwestern Brazil 1205–1210
Messing, Charles Garrett. Reclassification and redescription of the comatulid *Comatonia cristata* (Hartlaub) (Echinodermata: Crinoidea) 240–253
Mikkelsen, Paula M. Studies on euphausiacean crustaceans from the Indian River region of Florida. I. Systematics of the *Stylocheiron longicorne* species-group, with emphasis on reproductive morphology 1174–1204

Miller, Walter B. A new genus and a new species of Helminthoglyptid land snails from the Mojave Desert of California 437–444
Miller, Walter B. A new *Greggelix* (Mollusca: Pulmonata: Helminthoglyptidae) from Baja California Sur, Mexico 731–738
Murdy, Edward O., Carl J. Ferraris, Jr., Douglass F. Hoese, and Roger C. Steene. Preliminary list of fishes from Sombrero Island, Philippines, with fifteen new records 1163–1173
Olson, Storrs L. A revision of the northern forms of *Euphonia xanthogaster* (Aves: Thraupidae) 101–106
Olson, Storrs L. A revision of the subspecies of *Sporophila* ("*Oryzoborus*") *angolensis* (Aves: Emberizinae) 43–51
Olson, Storrs L. Systematic notes on certain oscines from Panama and adjacent areas (Aves: Passeriformes) 363–373
Olson, Storrs L. The nature of the variability in the variable seedeater in Panama (*Sporophila americana*: Emberizinae) 380–390
Pawson, David L., and Cynthia A. Gust. *Holothuria* (*Platyperona*) *rowei,* a new sea cucumber from Florida (Echinodermata: Holothuroidea) 873–877
Pawson, David L., and John E. Miller. Western Atlantic sea cucumbers of the genus *Thyone,* with description of two new species (Echinodermata: Holothuroidea) 391–403
Pawson, David L., and John F. Valentine. *Psolidium prostratum,* new species, from off the east coast of the U.S.A. (Echinodermata: Holothuroidea) 450–454
Petuch, Edward J. A volutid species radiation from northern Honduras, with notes on the Honduran Caloosahatchian secondary relict pocket 1110–1130
Poore, Gary C. B., and Brian Kensley. *Coralanthura* and *Sauranthura,* two new genera of Anthurideans from northeastern Australia (Crustacea: Isopoda: Anthuridae) 503–513
Pyburn, William F. A new poison-dart frog (Anura: Dendrobatidae) from the forest of southeastern Colombia 67–75
Pyburn, William F., and John D. Lynch. Two little-known species of *Eleutherodactylus* (Amphibia: Leptodactylidae) from the Sierra de la Macarena, Colombia 404–412
Ramírez-Pulido, José, and Marie Claire Britton. An historical synthesis of Mexican mammalian taxonomy 1–17
Remsen, J. V., Jr. A new subspecies of *Schizoeaca harterti* with notes on taxonomy and natural history of *Schizoeaca* (Aves: Furnariidae) 1068–1075
Rosewater, Joseph, and Dietrich Kadolsky. Rectifications in the nomenclature of some Indo-Pacific Littorinidae—II 1233–1236
Rozbaczylo, N., and J. C. Castilla. *Australonuphis violacea,* a new polychaete (Onuphidae) from the southeast Pacific Ocean 761–770
Rützler, Klaus, and Richard G. Bromley. *Cliona rhodensis,* new species (Porifera: Hadromerida) from the Mediterranean 1219–1225
Santos, Stuart L., Randy Day, and Stanley A. Rice. *Onuphis simoni,* a new species of polychaete (Polychaeta:Onuphidae) from south Florida 663–668
Savage, Jay M. The systematic status of Central American frogs confused with *Eleutherodactylus cruentus* 413–420
Shelley, Rowland M. A new xystodesmid milliped genus and three new species from piedmont South Carolina (Polydesmida: Xystodesmidae) 949–967
Shisko, John F. Five new polychaetes of the families Eunicidae and Onuphidae, collected in 1975 and 1976 during the southern California Baseline project 968–983
Sieg, Jürgen. A new species of the genus *Paratanais* (Crustacea: Tanaidacea), *P. spinanotandus,* from Seamount Vema 1271–1278

Sieg, Jürgen, and Richard N. Winn. The Tanaidae (Crustacea: Tanaidacea) of California, with a key to the world genera 315–343
Smith, David G., James E. Böhlke, and P. H. J. Castle. A revision of the Nettastomatid eel genera *Nettastoma* and *Nettenchelys* (Pisces: Anguilliformes), with descriptions of six new species 535–560
Springer, Victor G. Notes on Blenniid fishes of the tribe Omobranchini, with descriptions of two new species 699–707
Standing, Jon D. Occurrences of shrimps (Natantia: Penaeidea and Caridea) in Central California and Oregon 774–786
Stock, Jan H., and Glenn Longley. The generic status and distribution of *Monodella texana* Maguire, the only known North American Thermosbaenacean 569–578
Thurman, Carl L., II. *Uca marguerita,* a new species of fiddler crab (Brachyura: Ocypodidae) from eastern Mexico 169–180
Toll, Ronald B., and Steven C. Hess. A small, mature male *Architeuthis* (Cephalopoda: Oegopsida) with remarks on maturation in the family 753–760
Turner, Richard L., and David B. Campbell. A redescription of *Echinaster modestus* Perrier, 1881 (Asteroidea: Spinulosida) from the eastern Gulf of Mexico and the West Indies 344–351
Tyler, James C., and Keiichi Matsuura. Comments on the osteology of balistoid fishes (Tetraodontiformes), with notes on the triodontid pelvis 52–66
Vari, Richard P., and Jacques Géry. *Nannocharax maculicauda,* a new species of African characoid fish (Characoidea: Distichodontidae) with comments on the genus *Hemigrammocharax* 1076–1084
Villalobos-Figueroa, Alejandro, and Horton H. Hobbs, Jr. A new dwarf crayfish from the Pacific versant of Mexico (Decapoda: Cambaridae) 492–502
Voss, Gilbert L. A redescription of *Octopus ornatus* Gould, 1852 (Octopoda: Cephalopoda) and the status of *Callistoctopus* Taki, 1964 525–534
Ward, Linda A. Spionidae (Polychaeta: Annelida) from Hawaii, with descriptions of five new species 713–730
Watling, Les, and Heather Holman. Additional acanthonotozomatid, paramphithoid, and stegocephalid Amphipoda from the Southern Ocean 181–227
Weems, Robert E., Kenneth A. Beem, and Timothy A. Miller. A new species of *Bothriolepis* (Placodermi: Bothriolepidae) from the Upper Devonian of Virginia (USA) 984–1004
Wicksten, Mary K. The species of *Automate* (Caridea: Alpheidae) in the eastern Pacific Ocean 1104–1109
Williams, Lucy Bunkley, and Ernest H. Williams, Jr. Nine new species of *Anilocra* (Crustacea: Isopoda: Cymothoidae) external parasites of West Indian coral reef fishes 1005–1047
Wilson, George D. Taxonomy and postmarsupial development of a dominant deep-sea eurycopid isopod (Crustacea) 276–294
Young, David N. Taxonomic observations on eastern Pacific *Antithamnion* species (Rhodophyta: Ceramiaceae) described by E. Y. Dawson 94–100

BIOLOGICAL SOCIETY OF WASHINGTON PROCEEDINGS

1059 Meeting—16 March 1981

The 102nd Annual Meeting was called to order by President Richard Banks at 2:00 p.m. in the Waldo Schmitt Room of the National Museum of Natural History, Smithsonian Institution, Washington, D.C. There were 23 members present.

The minutes of the 101st Annual Meeting were approved as published in Volume 93, part 4 of the Proceedings.

Treasurer David Pawson submitted and summarized the Treasurer's Report for 1980. The total funds available in 1980 were $55,047.27, and expenses were $49,495.16. The proposed budget for 1981 estimates income of $32,400.00, expenses of $19,450, and $12,950 available for subsidizing publication of the Proceedings. The Finance Committee, consisting of C. W. Hart, A. C. Cohen, and D. L. Pawson, signed the report which was attached to these minutes. Pawson was thanked for his service to the Society.

The Editor's Report, in the form of Volume 93, was completed with the publication of Part 4 on 16 January 1981. Editor Hart, who is stepping down, was thanked by the members in attendance. Brian Kensley is the new Editor.

Newly elected officers for the Society are: President, R. Manning; Vice President, P. Spangler; Treasurer, L. Knapp; Secretary, M. Bogan; Councillors: F. Bayer, I. Canet, K. Fauchald, D. Pawson, and A. Williams.

President Banks summarized the year's activities of the Society. The highlight was the Centennial Dinner held on 3 December 1980. Approximately 70 members and invited guests were present for a buffet dinner followed by a talk by Paul Oesher on early members of the Society. Bulletin No. 4 of the Society, A Centennial History 1880–1980, was distributed at this time. The history was written by John Aldrich.

Mike Sweeney was announced as the new Custodian of Publications.

After thanking the officers, council, and members for their cooperation, Banks turned the meeting over to the new President, Ray Manning. President Manning called for a show of appreciation for Banks, for his services during his term, especially in coordinating the Centennial Dinner. The meeting adjourned at 2:18 p.m.

Respectfully submitted,
Michael A. Bogan
Secretary

INDEX TO NEW TAXA

VOLUME 94

(New taxa indicated in *italics*; new combinations designated n.c.)

FORAMINIFERIDA

- *Falsipatellina* 378
- *Shastrina* 652

PORIFERA

- Cliona *rhodensis* 1219

COELENTERATA

Anthozoa

- *Bathytelesto* 884
- Pseudoplumarella *echidna* 626
- *Rhodelinda* 888
- *Scyphopodium* 880
- *Stereotelesto* 884
- *Tesseranthelia* 897
  - *rhodora* 897

PLATYHELMINTHES

Trematoda

- *Paraheteronchocotyle* 1208
  - *amazonensis* 1209
- *Potamotrygonocotyle* 1206
  - *tsalickisi* 1206

SIPUNCULIDA

- Aspidosiphon (Aspidosiphon) *gosnoldi* 445

CHAETOGNATHA

- Spadella *legazpichessi* 108

ANNELIDA

Hirudinea

- *Bathybdella* 483
  - *sawyeri* 486

Oligochaeta

- Adelodrilus *acochlearis* 821
- Homochaeta *raptisae* 455
- *Quistadrilus* 1060
- Spirosperma (*Spirosperma*) 1056
- *Varichaeta* 1051
  - israelis n.c. 1054

nevadana n.c. 1051
pacifica 1051

Branchiobdellida

Cambarincola *barbarae* 677
serratus 691
Sathodrilus *attenuatus* 849
chehalisae 853
inversus n.c. 855
shastae 856
wardinus 859

Polychaeta

Amastigos *caperatus* 163
Asclerocheilus *ashworthi* 1133
tropicus 1133
Aurospio 229
dibranchiata 230
Australonuphis *violacea* 763
Australospio *mokapu* 717
Eunice *caeca* 986
multicylindri 971
Hyboscolex *equatorialis* 1134
oculatus n.c. 1137
Laonice *papillibranchiae* 719
Laubieriellus 829
grasslei 831
Nothria *exigua* 973
Oligobregma collare n.c. 1137
hartmanae n.c. 1139
notiale 1141
Onuphis *multiannulata* 976
segmentispadix 979
simoni 663
Polydora *kaneohe* 720
pilikia 722
Prionospio (Minuspio) *sandersi* 834
Pseudoscalibregma *usarpium* 1145
Pygospio *muscularis* 724
Scalibregmides *peruanus* 1149
Xandaros 827
acanthodes 828

ARTHROPODA

Crustacea

Aegla *alacalufi* 88
Anatanais *pseudonormani* 329
Anilocra *abudefdufi* 1027
acanthuri 1018
chaetodontis 1032
chromis 1024

haemuli 1006
holacanthi 1030
holocentri 1014
myripristis 1016
partiti 1037
Caecidotea *fustis* 585
salemensis 579
Calasellus 866
longus 867
Cambarellus *prolixus* 492
Ceratocolax *mykternastes* 514
Coralanthura 503
ardea 507
endeavourae 506
Discias *musicus* 787
Eobrolgus *chumashi* 301
Eudactylina *chilensis* 745
Eurycope *iphthima* 277
Gnathiphimedia sexdentata *incerta* 193
sexdentata *sexdentata* 189
Gonodactylus *lightbourni* 708
siamensis 479
Gorgoniscus 123
incisodactylus 124
Mexisquilla 595
Odius *antarcticus* 205
Odontozona *libertae* 153
Oithona *wellershausi* 1244
Paratanais *spinanotandus* 1271
Periclimenes *bayeri* 792
Platysquilloides 593
Pontonia *hurii* 796
Pontoniopsis *paulae* 139
Sauranthura 510
goldmanorum 510
Scalpelloniscus 1259
binoculis n.c. 1264
penicillatus 1259
Solenocera *alfonso* 631
Synaptotanais *notabilis* 323
Tegastes *acroporanus* 254
Uca *marguerita* 171
Veleroniopsis 145
kimallynae 147

Insecta

Amerohelea 1280
dalcyi 1289
fasciata 1283
frontispina n.c. 1301
galindoi 1294

nelsoni 1290
pseudofasciata 1286
ronderosi 1298
sordidipes n.c. 1299
spinelli 1292
vargasi 1296
Cleptes (Cleptes) *rufigaster* 814
rufifemur 814
(*Neocleptes*) 816
(*Neocleptes*) *fritzi* 816

Myriapoda

Furcillaria 953
aequalis 956
convoluta 959
laminata 961

MOLLUSCA

Gastropoda

Eremariontoides 439
Eremarionta 442
Falsilyria *garciai* 1114
kotorai 1115
retemirabilis 1117
Greggelix *punctata* 732
Nodilittorina (Granulittorina) hawaiiensis n.c. 1234

ECHINODERMATA

Asteroidea

Evoplosoma *scorpio* 561

Holothuroidea

Holothuria (Platyperona) *rowei* 873
Psolidium *prostratum* 450
Thyone *adinopoda* 397
crassidisca 400

CHORDATA

Pisces

BERNARDICHTHYIDAE 38
Bernardichthys 39
zorraquinosi 39
Bothriolepis *virginiensis* 986
Cataetyx *chthamalorhynchus* 1092
niki 1096
Chriolepis *vespa* 428
Enneacampus 466
Eviota *disrupta* 266
fasciola 268
irrasa 272

- Luciobrotula *nolfi* 1086
- Micrognathus *pygmaeus* 771
- Nannocharax *maculicauda* 1076
- Nettastoma *solitarium* 548
  - *syntresis* 546
- Nettenchelys *exorius* 556
  - *gephyra* 553
  - *inion* 555
  - *pygmaeus* 551
- Notropis sallei n.c. 29
- Omobranchus *robertsi* 701
- Omox *lupus* 704
- Saccogaster *melanomycter* 374

Amphibia

- Dendrobates *myersi* 67
- Eleutherodactylus *savagei* 404

Aves

- Chrysothlypis chrysomelas *titanota* 368
- Euphonia xanthogaster *oressinoma* 102
- Schizoeaca harterti *bejaranoi* 1068
- Sporophila angolensis *ochrogyne* 47
  - angolensis *theobromae* 50
  - maximiliani parkeri n.c. 45

MICROPROBLEMATICA

- *Pflugella* 421

CRYPTOGAMIA

Rhodophyta

- Antithamnionella mcnabbii n.c. 97
- Balliella pseudocorticata n.c. 94

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AN HISTORICAL SYNTHESIS OF MEXICAN MAMMALIAN TAXONOMY

José Ramírez-Pulido and Marie Claire Britton

Abstract.—The known terrestrial mammalian fauna of Mexico is composed of 10 orders, 32 families, 142 genera, and 436 species. Among these species, 160 are monotypic and 276 are polytypic comprising a total of 1033 subspecies; the total of species and subspecies is 1197. Among the 142 genera and 436 species, 6 and 142, respectively, are endemic. The type locality of 923 categories, among the 1193 found in Mexico, lies in Mexican territory. For the remainder, the taxa were described from specimens captured outside the country. By a historical analysis of the 923 taxa named from Mexico, we have delineated four essential periods. The first (1831–1881) was contemporary with the exploration of the western United States. In this period 77 categories were described, 27 of them by Henri de Saussure and Spencer Fullerton Baird. The second period (1887–1919) saw the awakening of interest in research in Mexico by museums and governmental agencies of the United States. This period ended with the Mexican Revolution and the first World War. Four hundred and sixty categories were described, of which Merriam classified 35%. The third period (1922–1942) saw the renewal of exploration trips inside Mexico. One hundred and eighty-four categories were described and it may be considered Nelson and Goldman's period for they classified 52.2% of the taxa named during this period. The fourth period (1943–present) represented a time of synthesis. Families, genera and species complexes were revised. One hundred and ninety categories were described of which Huey classified 28 and Goodwin 22. In all, 73.4% of the mammalian fauna native to Mexico was described by 18 authors, and 101 other authors named the remainder. Marine mammals are excluded from this report.

When one talks about the mammals of a certain region or country, several questions come to mind, for example: how many generic, specific and subspecific categories are there, and what are they? Which of them have become extinct, or are endemic, monotypic, or polytypic? What period was the most prolific in the classification of these taxa? How many authors have participated in the classification? Although the available information on Mexican mammals is extensive and diverse, it has not been summarized in order to answer the questions mentioned above.

The starting point for the preparation of this paper is the monumental work by Hall and Kelson (1959) along with the revisions of Handley (1959), and Van Gelder (1959a, 1959b). From that time, up to the end of 1978, the cutoff date for the incorporation of information, an extensive list of references about the present-day state of Mexican mammalian nomenclature has appeared. Nevertheless, we will only include the most relevant ones according to proposed nomenclatorial changes.

Among the recent literature pertinent to the historical analysis of Mexican mammalian nomenclature, we must mention the following works, in order to perceive recognized categories and names. We have not made any personal taxonomic judgments, our sole intention being to gather the results of the following authors:

Works that mention the description of new taxa: Alvarez (1962a, 1962b), Alvarez and Ramírez-P. (1968), Anderson (1972), Baker (1967), Banks (1967a, 1967b), Bogan (1978), Bradley and Cockrum (1968), Callahan and Davis (1977), Carleton (1977), Davis (1969, 1970a, 1970b), Davis and Carter (1978), Findley and Jones (1967), Gardner (1962, 1966), Genoways (1971), Genoways and Jones (1968a, 1969b), Goodwin (1963, 1964, 1966), Hall (1962), Hall and Alvarez (1961), Handley (1960, 1966), Huey (1960a, 1960b, 1960c, 1964), Jones (1964), Jones and Genoways (1967), Jones and Lawlor (1965), Jones and Phillips (1964), La Val (1973a), Lee and Schmidly (1977), Lidicker (1960b), Musser (1964), Packard (1960), Phillips and Jones (1971), Pine (1966), Robertson and Musser (1976), Roth (1976), Russell (1968a), Schaldach (1966), Schaldach and McLaughlin (1960), Van Gelder (1959a).

Works that propose changes in nomenclature: Alvarez (1961, 1963), Anderson (1962, 1972), Anderson and Gaunt (1962), Anderson and Nelson (1965), Baker (1969), Banks (1967a), Best (1978), Birney (1973), Callahan (1977), Carleton (1977), Choate (1970), Davis (1965, 1968, 1969, 1970a,1970b, 1973), Davis and Baker (1974), Davis and Carter (1962), Diersing (1976), Eger (1977), Findley and Jones (1967), Forman et al. (1968), Gardner (1973), Genoways (1973), Genoways and Jones (1968b, 1969a, 1971), Goodwin (1961, 1969), Hall (1960, 1968), Hall and Dalquest (1963), Hall and Genoways (1970), Hall and Jones (1961), Hall and Ogilvie (1960), Handley (1959), Hayward (1970), Hennings and Hoffmann (1977), Hoffmeister (1974), Hoffmeister and de la Torre (1961), Hoffmeister and Diersing (1978), Hooper (1972), Hooper and Musser (1964), Jones (1966), Jones and Alvarez (1962), Jones and Carter (1976), Jones et al. (1971), Kortlucke (1973), La Val (1973a, 1973b), Lawlor (1969, 1971a, 1971b), Lee and Hoffmeister (1963), Lidicker (1960a), Long (1972), Machado-Allison (1967), Musser (1964, 1968, 1969, 1971), Ojasti and Linares (1971), Packard (1960), Paradiso (1967), Patten and Findley (1970), Patton and Dingman (1970), Pine (1967, 1972), Pine et al. (1971), Russell (1968a, 1968b), Schaldach (1966), Schmidly (1972), Schmidly and Hendricks (1976), Smith (1970), Van Gelder (1959b), Waithman and Roest (1977), Wetzel (1975), Williams (1978), Wilson (1973), Yates and Schmidly (1977), Zimmerman (1970).

In this paper, the analysis of the terrestrial mammals of Mexico is divided into two parts. The first includes the whole mammalian fauna of the country, i.e., species and subspecies inhabiting Mexico, even though only marginally. The second group comprises those species or subspecies whose type locality lies in Mexico.

With the help of the Computation Services Coordination of the Universidad Autónoma Metropolitana-Iztapalapa (UAM-I), we developed a program which enabled us to obtain a series of results among which are the number of categories described per year, per author per year, for Mexico, per state, and those with geographical distribution in Mexico. The orders and families are mentioned in phylogenetic order, and the genera of each family are in alphabetical order. Subfamilies are not mentioned.

The terrestrial mammalian fauna with geographical distribution in Mexico is constituted of 10 orders, 32 families, 142 genera, and 436 species. Among this diversity of species, 160 are monotypic and 276 are polytypic and include 1033 subspecies; these added to the monotypic forms make a total of 1193 (Table 1). This number could increase or decrease with the revision of genera and families, and with a better understanding of those species and subspecies with taxonomic problems.

Among the 142 genera in Mexico, 6 are endemic (Table 1): 1 phyllostomatid, *Musonycteris*; 1 leporid, *Romerolagus*; 1 geomyid, *Zygogeomys*; and 3 cricetids, *Nelsonia, Neotomodon* and *Xenomys*.

Among the 436 species, 142 are endemic, as follows.

One marsupial: *Marmosa canescens*.

Nine insectivores: *Cryptotis magna, C. mexicana, Megasorex gigas, Sorex juncensis, S. macrodon, S. milleri, S. oreopolus, S. sclateri* and *S. stizodon*.

Fourteen chiropterans: *Musonycteris harrisoni, Artibeus hirsutus, Myotis carteri, M. findleyi, M. fortidens, M. milleri, M. peninsularis, M. planiceps, M. vivesi, Plecotus mexicanus, Rhogeessa alleni, R. gracilis, R. mira* and *R. parvula*.

Seven leporids: *Romerolagus diazi, Lepus flavigularis, L. insularis, Sylvilagus cunicularius, S. graysoni, S. insonus* and *S. mansuetus*.

Eleven sciurids: *Ammospermophilus insularis, Cynomys mexicanus, Eutamias bulleri, Sciurus alleni, S. colliaei, S. nayaritensis, S. oculatus, Spermophilus adocetus, S. annulatus, S. madrensis* and *S. perotensis*.

Twelve geomyids: *Geomys tropicalis, Orthogeomys cuniculus, O. lanius, Pappogeomys alcorni, P. bulleri, P. fumosus, P. gymnurus, P. merriami, P. neglectus, P. tylorhinus, P. zinzeri* and *Zygogeomys trichopus*.

Eighteen heteromyids: *Perognathus anthonyi, P. arenarius, P. artus, P. dalquesti, P. goldmani, P. lineatus, P. pernix, Dipodomys gravipes, D. insularis, D. nelsoni, D. phillipsii, Heteromys gaumeri, H. goldmani, H. lepturus, H. longicaudatus, H. nelsoni, H. temporalis* and *Liomys spectabilis*.

Table 1.—Terrestrial mammals with geographical distribution in Mexico. The genera preceded by an asterisk are endemic to Mexico.

Order Family	Genera	Number of species Monotypic	+ Polytypic	= Total	Additional subspecies
Marsupialia	*Caluromys*	–	1	1	2
Didelphidae	*Chironectes*	–	1	1	1
	Didelphis	–	2	2	3
	Marmosa	–	2	2	6
	Philander	–	1	1	1
Insectivora	*Cryptotis*	1	4	5	12
Soricidae	*Megasorex*	1	–	1	–
	Notiosorex	–	1	1	2
	Sorex	6	6	12	13
Talpidae	*Scalopus*	–	1	1	2
	Scapanus	–	1	1	2
Chiroptera	*Balantiopteryx*	1	1	2	2
Emballonuridae	*Centronycteris*	–	1	1	1
	Diclidurus	1	–	1	–
	Peropteryx	–	2	2	2
	Rynchonycteris	1	–	1	–
	Saccopteryx	1	1	2	1
Noctilionidae	*Noctilio*	–	1	1	1
Mormoopidae	*Mormoops*	–	1	1	1
	Pteronotus	1	3	4	4
Phyllostomatidae	*Anoura*	–	1	1	1
	Artibeus	2	5	7	12
	Carollia	2	1	3	1
	Centurio	–	1	1	1
	Chiroderma	–	2	2	3
	Choeroniscus	1	–	1	–
	Choeronycteris	1	–	1	–
	Chrotopterus	–	1	1	1
	Desmodus	–	1	1	1
	Diaemus	1	–	1	–
	Diphylla	–	1	1	1
	Enchisthenes	1	–	1	–
	Glossophaga	2	1	3	1
	Hylonycteris	–	1	1	2
	Leptonycteris	2	–	2	–
	Lonchorhina	–	1	1	1
	Macrophyllum	1	–	1	–
	Macrotus	1	1	2	2
	Micronycteris	3	1	4	1
	Mimon	1	1	2	1
	**Musonycteris*	1	–	1	–
	Phylloderma	–	1	1	1
	Phyllostomus	–	1	1	1

Table 1.—Continued.

Order Family	Genera	Number of species Monotypic	+ Polytypic	= Total	Additional subspecies
	Sturnira	–	2	2	3
	Tonatia	2	1	3	1
	Trachops	–	1	1	1
	Uroderma	1	1	2	3
	Vampyressa	–	1	1	1
	Vampyrodes	–	1	1	1
	Vampyrops	1	–	1	–
	Vampyrum	–	1	1	1
Natalidae	*Natalus*	–	1	1	2
Thyropteridae	*Thyroptera*	–	1	1	1
Vespertilionidae	*Anthrozous*	–	2	2	6
	Eptesicus	1	2	3	5
	Euderma	1	–	1	–
	Idionycteris	1	–	1	–
	Lasionycteris	1	–	1	–
	Lasiurus	1	4	5	7
	Myotis	8	12	20	24
	Nycticeius	–	1	1	2
	Pipistrellus	–	2	2	5
	Plecotus	1	1	2	2
	Rhogeessa	5	–	5	–
Molossidae	*Eumops*	–	5	5	6
	Molossops	–	1	1	1
	Molossus	2	3	5	3
	Promops	–	1	1	1
	Tadarida	3	2	5	4
Primates	*Alouatta*	1	1	2	1
Cebidae	*Ateles*	–	1	1	1
Edentata	*Cyclopes*	–	1	1	1
Myrmecophagidae	*Tamandua*	1	–	1	–
Dasypodidae	*Dasypus*	–	1	1	1
Lagomorpha	*Lepus*	2	3	5	18
Leporidae	**Romerolagus*	1	–	1	–
	Sylvilagus	3	5	8	28
Rodentia	*Ammospermophilus*	2	2	4	6
Sciuridae	*Cynomys*	1	1	2	1
	Eutamias	–	4	4	10
	Glaucomys	–	1	1	5
	Sciurus	1	11	12	22
	Spermophilus	3	7	10	25
	Tamiasciurus	–	1	1	1
Geomyidae	*Geomys*	1	2	3	2

Table 1.—Continued.

Order Family	Genera	Number of species Monotypic	+ Polytypic	= Total	Additional subspecies
	Orthogeomys	2	2	4	20
	Pappogeomys	4	5	9	43
	Thomomys	–	2	2	75
	**Zygogeomys*	–	1	1	2
Heteromyidae	*Perognathus*	5	15	20	79
	Dipodomys	3	7	10	41
	Heteromys	6	1	7	2
	Liomys	1	3	4	12
Castoridae	*Castor*	–	1	1	3
Cricetidae	*Baiomys*	–	2	2	12
	Microtus	4	3	7	12
	**Nelsonia*	–	1	1	3
	Neotoma	10	6	16	54
	**Neotomodon*	–	1	1	2
	Nyctomys	–	1	1	4
	Ondatra	–	1	1	2
	Onychomys	–	2	2	12
	Oryzomys	4	4	8	32
	Otonyctomys	1	–	1	–
	Ototylomys	–	1	1	2
	Peromyscus	29	22	51	104
	Reithrodontomys	3	8	11	39
	Rheomys	1	1	2	1
	Scotinomys	–	1	1	1
	Sigmodon	3	4	7	19
	Tylomys	1	1	2	5
	**Xenomys*	1	–	1	–
Erethizontidae	*Coendou*	–	1	1	2
	Erethizon	–	1	1	1
Dasyproctidae	*Agouti*	–	1	1	1
	Dasyprocta	1	1	2	2
Carnivora	*Canis*	–	2	2	12
Canidae	*Urocyon*	–	1	1	8
	Vulpes	–	1	1	3
Ursidae	*Ursus*	2	2	4	4
Procyonidae	*Bassariscus*	–	2	2	13
	Nasua	1	1	2	3
	Potos	–	1	1	2
	Procyon	1	2	3	9
Mustelidae	*Conepatus*	–	3	3	10
	Eira	–	1	1	1
	Galictis	–	1	1	1
	Lutra	–	1	1	1

Table 1.—Continued.

Order Family	Genera	Number of species Monotypic	+ Polytypic	= Total	Additional subspecies
	Mephitis	–	2	2	7
	Mustela	–	1	1	9
	Spilogale	–	2	2	10
	Taxidea	–	1	1	1
Felidae	*Felis*	–	5	5	21
	Lynx	–	1	1	6
Perissodactyla					
Tapiridae	*Tapirus*	1	–	1	–
Artiodactyla	*Dicotyles*	–	1	1	7
Tayassuidae	*Tayassu*	–	1	1	1
Cervidae	*Mazama*	–	1	1	2
	Odocoileus	–	2	2	19
Antilocapridae	*Antilocapra*	–	1	1	3
Bovidae	*Bison*	–	1	1	1
	Ovis	–	1	1	3

Sixty-five cricetids: *Nelsonia neotomodon, Neotoma alleni, N. angustapalata, N. anthonyi, N. bunkeri, N. bryanti, N. goldmani, N. martinensis, N. nelsoni, N. palatina, N. phenax, N. varia, Neotomodon alstoni, Oryzomys fulgens, O. melanotis, O. nelsoni, O. peninsulae, Peromyscus aztecus, P. banderanus, P. bullatus, P. caniceps, P. chinanteco, P. dickeyi, P. eva, P. evides, P. furvus, P. guardia, P. hooperi, P. hylocetes, P. interparietalis, P. lepturus, P. madrensis, P. megalops, P. mekisturus, P. melanocarpus, P. melanophrys, P. melanotis, P. oaxacensis, P. ochraventer, P. pembertoni, P. perfulvus, P. polius, P. pseudocrinitus, P. sejugis, P. simulatus, P. simulus, P. slevini, P. spicilegus, P. stephani, P. thomasi, P. winkelmanni, P. yucatanicus, P. zarhynchus, Reithrodontomys burti, R. chrysopsis, R. hirsutus, R. spectabilis, Rheomys mexicanus, Sigomodon alleni, S. leucotis, Tylomys bullaris, Xenomys nelsoni, Microtus oaxacensis, M. quasiater* and *M. umbrosus*.

One dasyproctid: *Dasyprocta mexicana*.

One ursid: *Ursus kennerleyi*.

Two procyonids: *Nasua nelsoni* and *Procyon pygmaeus*.

One mustelid: *Spilogale pygmaea*.

Of the 1193 categories of terrestrial mammals occurring in Mexico, 878 have a precise type locality, 15 have been later restricted, 29 have only the state or region or an even more general description and 1 is unknown, but probably was also in Mexico. Assuming that all these taxa were described

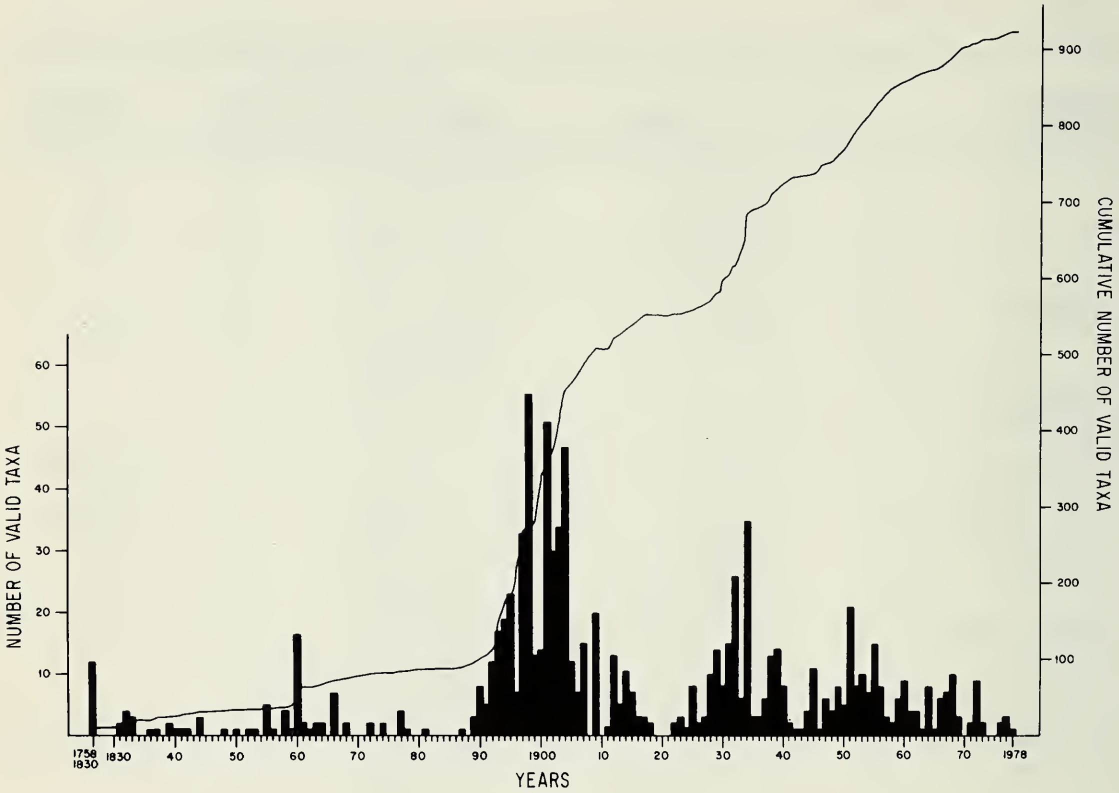

Fig. 1. Number of species and subspecies of mammals described from Mexico from 1758 to 1978. The bars represent the number of currently accepted names, and the line the cumulative number of taxa.

with Mexican specimens, we have a total of 923 (Fig. 1) that represents 77.4% of the total of the Mexican terrestrial mammals.

In the remaining 270 categories, the type locality in the original description lies outside of Mexican territory. In 242, the type locality is precise, in 23 it is not, in 4 it was later restricted, and in 1 it is unknown.

An historical analysis of the 923 taxa of mammals native to Mexico, considering the order in which they were reported in the literature, permits us to acknowledge arbitrarily 4 fundamental periods: the first from 1831 to 1881, the second from 1887 to 1919, the third from 1922 to 1942, and the fourth from 1943 to the present (Fig. 1).

Before 1831, 12 species were described by Linnaeus, Erxleben, Gmelin, Kerr, Cuvier, Richardson and Wagler (Table 2), based on specimens from America which arrived at European museums through various routes. These forms are now recognized at the subspecific level. The original information that accompanied these specimens mentioned their provenance only very generally, e.g., America, New Spain or Mexico. The type locality was established later by restriction.

The first period (1831–1881) corresponds with the great expansion of ex-

Table 2.—First taxa described for Mexico.

Taxa	Author and year
Felis pardalis pardalis	Linnaeus, 1758
Nasua nasua molaris	(Linnaeus, 1766)
Spermophilus mexicanus mexicanus	(Erxleben, 1777)
Spermophilus variegatus variegatus	(Erxleben, 1777)
Conepatus semistriatus conepatl	(Gmelin, 1788)
Odocoileus virginianus mexicanus	(Gmelin, 1788)
Coendou mexicanus mexicanus	(Kerr, 1792)
Potos flavus prehensilis	(Kerr, 1792)
Mazama americana temama	(Kerr, 1792)
Sciurus aureogaster aureogaster	(Cuvier, 1829)
Thomomys umbrinus umbrinus	(Richardson, 1829)
Lepus callotis callotis	Wagler, 1830

ploration activity in the western United States. The first works that would later have a decisive impact on research in the mammalian field appeared at this time. *The Viviparous Quadrupeds of America* by Audubon and Bachman was published between 1845 and 1854, *The Mammals of North America* by Baird in 1859, and *Furbearing Animals* by Coues in 1877.

The Smithsonian Institution was founded in 1846 and the United States National Museum, where much of the material collected by the first naturalists was deposited, was established in 1876. Among these first naturalists, the most outstanding were Spencer Fullerton Baird and the military physicians Elliot Coues and Edgar Alexander Mearns, known for their biological works and for the influence they exercised in the following periods.

In this period, 77 forms were described. Outstanding were the works of the Swiss naturalist Henri de Saussure who was in charge of a scientific mission in Central America, whence he went to Mexico where he described 19 forms, and of Baird, the greatest naturalist at the end of the nineteenth century and a pioneer of American vertebrate zoology, who described 8.

The other forms were described by the following authors: 7 by Peters; 6 by Lichtenstein (French naturalist who studied insects); 6 by Gray; 5 by H. Allen; 4 by Coues; 4 by Wagner; 3 by Bennett; 2 each by Le Conte, J. A. Allen, and Hays; and 1 each by Audubon and Bachman, Berlandier, Caton, Dobson, Hamilton-Smith, Richardson, Tschudi, Wagler, and Waterhouse.

The second period (1887–1919) was marked by the awakening of interest in exploration and research in Mexico by museums and governmental agencies of the United States. Trained personnel and large resources were available, resulting in the formation of important collections of mammals from different regions of the country.

The most important part of this period was the one between 1887 and

1909. Later, between 1910 and 1919, the country was agitated by the Mexican Revolution, a significant factor which explains the decrease in exploration, and resulted in the low number of forms described at this time (Fig. 1). Another factor that contributed to this decrease in publications was the first World War (1914–1918).

This period can be considered the one of Clinton Hart Merriam, not only because of the number of taxa he classified, but also because of his supervision of the United States Bureau of Biological Survey, which at that time included E. W. Nelson and E. A. Goldman, among others. In this period, 460 forms were described, of which Merriam classified 164, or 35%. Merriam's activity, along with that of Nelson and Goldman, resulted in 227 taxa, the equivalent of 49.3% of the total described for this period.

Other researchers that stand out for the number of taxa they described, are: J. A. Allen, 63; Nelson and Goldman, 63; Osgood, 42; Thomas, 27; Elliott, 22 and Miller, 13. These authors described 394 of the 460 categories, i.e., 85.6% of the mammals acknowledged for this period. The following authors described the remaining 66: Mearns and Townsend, 9; Howell, 8; J. A. Allen and Chapman and Bailey, 7; Andersen, 3; G. M. Allen, Bangs, Hollister, Bryant, and Ward, 2; Lydekker, Menegaux, Hahn, Sanborn, Grinnell and Swarth, Phillips, Jackson, H. Allen, Coues, Díaz, Rhoads, Stowell, and Major, 1.

The third period (1922–1942) was marked by the renewal of exploration trips inside Mexico. One hundred eighty-four forms were described, and it could be considered the period of Nelson and Goldman who described 96 taxa, or 52.2% of the ones corresponding to this period.

A detailed analysis of the researchers that named these 184 forms gives: Nelson and Goldman with 64; Goldman with 32; Burt with 25, and Huey with 23; Jackson with 6; Benson with 5; Goldman and Kellogg, Hall, Miller and G. M. Allen with 4; Benson and Tillotson, Blossom, Howell, Orr, and Osgood with 2; Anthony, Burt and Hooper, Maillard, Martínez and Villa, Sanborn, Shamell, and Villa with 1.

The fourth period (1943–present) was a continuation of the preceding one, but differs in that it was a time of synthesis. The variation between and within populations was studied. Families, genera, and complexes of species were revised with the help of other disciplines like cytogenetics and biochemistry. Mammals were studied in their natural conditions and in the laboratory. The number of institutions and persons with a professional interest in mammalogy multiplied. In some institutions, several researchers exerted influence directly by their academic production, or by the training of highly qualified personnel.

There are some particularly noteworthy institutions, that have contributed greatly to the study of the mammals of Mexico. We will only mention the most important ones: The University of Kansas, University of Michigan, San Diego Society of Natural History, Michigan State University, the

Table 3.—Selected authors and the number of presently recognized species and subspecies of Mexican mammals they described. The period in which they described the forms is also given.

Author	Number of taxa	Period
C. H. Merriam	164	1887–1907
E. W. Nelson and E. A. Goldman	73	1907–1934
J. A. Allen	65	1877–1906
E. A. Goldman	64	1904–1945
L. M. Huey	51	1905–1964
W. H. Osgood	46	1900–1945
O. Thomas	27	1892–1915
W. H. Burt	26	1932–1948
E. W. Nelson	25	1898–1912
G. G. Goodwin	22	1953–1966
D. G. Elliot	22	1896–1905
H. de Saussure	19	1860–1861
R. H. Baker	16	1951–1967
G. S. Miller	13	1897–1914
R. J. Russell	12	1952–1968
E. T. Hooper	12	1947–1957
E. R. Hall	11	1948–1962
A. H. Howell	10	1902–1928

American Museum of Natural History, the Smithsonian Institution, Texas A. and M. University, Universidad Nacional Autónoma de México and Instituto Politécnico Nacional in México, and, recently, Texas Tech University, and the Carnegie Museum of Natural History.

In this period, 190 categories were described. A detailed analysis of the authors gives: Huey, 28; Goodwin, 22; R. H. Baker, 16; Hooper, and Russell, 12; Anderson, and Dalquest, 9; Hall, 7; Davis, 5; Banks, and Russell and Baker, 4; Alvarez, Genoways and Jones, Goldman, Handley, and Setzer, 3; Benson, Hoffmeister and de la Torre, La Val, Osgood, Packard, Schaldach, and Villa-R., 2; Alvarez and Ramírez-P., Baker and Stains, Bogan, Bradley and Cockrum, Burt, Callahan and Davis, Carleton, Dalquest and Hall, Davis and Lukens, Findley, Findley and Jones, Gardner, Hall and Alvarez, Hall and Dalquest, Hall and Villa, Genoways, Hoffmeister, Jackson, Jones, Jones and Genoways, Jones and Lawlor, Jones and Phillips, Laurie, Lawrence, Lee and Schmidly, Lidicker, Musser, Phillips and Jones, Pine, Robertson and Musser, Roth, Schaldach and McLaughlin, and Van Gelder, 1.

A summary of the researchers who have formed the catalogue of mammals of Mexico is presented in Tables 3 and 4. It is interesting to note that 18 of them described 678 forms or 73.4% of those described for Mexico (923), and the remaining 245 were described by 101 authors, giving 119 as the sum of authors who have proposed names.

Table 4.—Number of authors that have contributed the description of fewer than ten species and subspecies of Mexican mammals.

Number of authors	Taxa	
	Per author	Total
53	1	53
20	2	40
8	3	24
5	4	20
2	5	10
3	6	18
4	7	28
2	8	16
4	9	36

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Literature Cited

Alvarez, T. 1961. Taxonomic status of some mice of the *Peromyscus boylii* group in eastern Mexico, with description of a new subspecies.—Univ. Kansas Publ., Mus. Nat. Hist. 14(7):111–120.

———. 1962a. A new subspecies of ground squirrel (*Spermophilus spilosoma*) from Tamaulipas, Mexico.—Univ. Kansas Publ., Mus. Nat. Hist. 14(8):121–124.

———. 1962b. A new subspecies of wood rat (*Neotoma*) from northeastern Mexico.—Univ. Kansas Publ., Mus. Nat. Hist. 14(11):139–143.

———. 1963. The recent mammals of Tamaulipas, Mexico.—Univ. Kansas Publ., Mus. Nat. Hist. 14(15):363–473.

———, and J. Ramirez-Pulido. 1968. Descripción de una nueva subespecie de *Spermophilus adocetus* (Rodentia, Sciuridae) de Michoacán, México y estado taxonómico de *S. a. arceliae* (Villa R., 1942).—Rev. Soc. Mex. Hist. Nat. 29:181–190.

Anderson, S. 1962. Tree squirrels (*Sciurus colliaei* group) of western Mexico.—Amer. Mus. Novitates 2093:1–13.

———. 1972. Mammals of Chihuahua taxonomy and distribution. Bull. Amer. Mus. Nat. Hist. 148:149–410.

———, and A. S. Gaunt. 1962. A classification of the white-sided jack rabbits of Mexico.—Amer. Mus. Novitates 2088:1–16.

———, and C. E. Nelson. 1965. A systematic revision of *Macrotus* (Chiroptera).—Amer. Mus. Novitates 2212:1–39.

Baker, R. H. 1967. A new subspecies of pallid bat (Chiroptera: Vespertilionidae) from northeastern Mexico.—Southwestern Nat. 12(3):329–330.

———. 1969. Cotton rats of the *Sigmodon fulviventer* group.—Univ. Kansas Mus. Nat. Hist., Misc. Publ. 51:177–232.

Banks, R. C. 1967a. The *Peromyscus guardia-interparietalis* complex.—J. Mamm. 48(2):210–218.

———. 1967b. A new insular subspecies of spiny pocket mouse (Mammalia; Rodentia).—Proc. Biol. Soc. Washington 80:101–104.

Best, T. L. 1978. Variation in kangaroo rats (genus *Dipodomys*) of the *heermanni* group in Baja California, Mexico.—J. Mamm. 59(1):160–175.

Birney, E. C. 1973. Systematics of three species of woodrats (genus *Neotoma*) in central North America.—Univ. Kansas Nat. Hist., Misc. Publ. 58:1–173.

Bogan, M. A. 1978. A new species of *Myotis* from the Islas Tres Marias, Nayarit, Mexico, with comments on variation in *Myotis nigricans*.—J. Mamm. 59(3):519–530.

Bradley, W. G., and E. L. Cockrum. 1968. A new subspecies of the meadow vole (*Microtus pennsylvanicus*) from northwestern Chihuahua, Mexico.—Amer. Mus. Novitates 2325:1–7.

Callahan, J. R. 1977. Diagnosis of *Eutamias obscurus* (Rodentia: Sciuridae).—J. Mamm. 58(2):188–201.

———, and R. Davis. 1977. A new subspecies of the cliff chipmunk from coastal Sonora, Mexico.—Southwestern Nat. 22(1):67–75.

Carleton, M. D. 1977. Interrelationships of populations of the *Peromyscus boylii* species group (Rodentia, Muridae) in western Mexico.—Occas. Papers Mus. Zool., Univ. Michigan 675:1–47.

Choate, J. R. 1970. Systematics and zoogeography of Middle American shrews of the genus *Cryptotis*.—Univ. Kansas Publ., Mus. Nat. Hist. 19(3):195–317.

Davis, B. L., and R. J. Baker. 1974. Morphometrics, evolution and cytotaxonomy of mainland bats of the genus *Macrotus* (Chiroptera: Phyllostomatidae).—Syst. Zool. 23(1):26–39.

Davis, W. B. 1965. Review of the *Eptesicus brasiliensis* complex in Middle America with the description of a new subspecies from Costa Rica.—J. Mamm. 46(2):229–240.

———. 1968. Review of the genus *Uroderma* (Chiroptera).—J. Mamm. 49(4):676–698.

———. 1969. A review of the small fruit bats (genus *Artibeus*) of Middle America. Part I.—Southwestern Nat. 14(1):15–29.

———. 1970a. The large fruit bats (genus *Artibeus*) of Middle America, with a review of the *Artibeus jamaicensis* complex.—J. Mamm. 51(1):105–122.

———. 1970b. A review of the small fruit bats (genus *Artibeus*) of Middle America. Part II.—Southwestern Nat. 14(4):389–402.

———. 1973. Geographic variation in the fishing bat, *Noctilio leporinus*.—J. Mamm. 54(4):862–874.

———, and D. C. Carter. 1962. Notes on Central American bats with description of a new subspecies of *Mormoops*.—Southwestern Nat. 7(1):64–74.

———, and ———. 1978. A review of the round-eared bats of the *Tonatia silvicola* complex, with descriptions of three new taxa.—Occas. Papers Mus., Texas Tech Univ. 53:1–12.

Diersing, V. E. 1976. An analysis of *Peromyscus difficilis* from the Mexican-United States boundary area.—Proc. Biol. Soc. Washington 89(39):451–466.

Eger, J. L. 1977. Systematics of the genus *Eumops* (Chiroptera: Molossidae).—Life Sci. Contr. R. Ont. Mus. 110:1–69.

Findley, J. S., and C. Jones. 1967. Taxonomic relationships of bats of the species *Myotis fortidens*, *M. lucifugus*, and *M. occultus*.—J. Mamm. 48(3):429–444.

Forman, G. L., R. J. Baker, and J. D. Gerber. 1968. Comments on the systematic status of vampire bats (Family Desmodontidae).—Syst. Zool. 17(4):417–425.

Gardner, A. L. 1962. A new bat of the genus *Glossophaga* from Mexico.—Los Angeles Co. Mus., Contrib. Sci. 54:1–7.

———. 1966. A new subspecies of the Aztec mastiff bat, *Molossus aztecus* Saussure, from southern Mexico.—Los Angeles Co. Mus., Contrib. Sci. 111:1–5.

———. 1973. The systematics of the genus *Didelphis* (Marsupialia: Didelphidae) in North and Middle America.—Special Publ. Mus., Texas Tech Univ. 4:1–81.

Genoways, H. H. 1971. A new species of spiny pocket mouse (genus *Liomys*) from Jalisco, Mexico.—Occas. Papers Mus. Nat. Hist., Univ. Kansas 5:1–7.

———. 1973. Systematics and evolutionary relationships of spiny pocket mice, genus *Liomys*.—Special Publ. Mus., Texas Tech Univ. 5:1–368.

———, and J. K. Jones, Jr. 1968a. A new mouse of the genus *Nelsonia* from southern Jalisco, Mexico.—Proc. Biol. Soc. Washington 81:97–100.

———, and ———. 1968b. (1971). Notes on spotted skunks (genus *Spilogale*) from western Mexico.—An. Inst. Biol., Univ. Nal. Autón. México 39, Ser. Zool. (1):123–132.

———, and ———. 1969a. Taxonomic status of certain long-eared bats (genus *Myotis*) from the southwestern United States and Mexico.—Southwestern Nat. 14(1):1–13.

———, and ———. 1969b. Notes on pocket gophers from Jalisco, Mexico, with descriptions of two new subspecies.—J. Mamm. 50(4):748–755.

———, and ———. 1971. Systematics of southern banner-tailed kangaroo rats of the *Dipodomys phillipsii* group.—J. Mamm. 52(2):265–287.

Goodwin, G. G. 1961. Flying squirrels (*Glaucomys volans*) of Middle America.—Amer. Mus. Novitates 2059:1–22.

———. 1963. A new subspecies of bobcat (*Lynx rufus*) from Oaxaca, Mexico.—Amer. Mus. Novitates 2139:1–7.

———. 1964. A new species and a new subspecies of *Peromyscus* from Oaxaca, Mexico.—Amer. Mus. Novitates 2183:1–8.

———. 1966. A new subspecies of vole (genus *Microtus*) from Oaxaca, Mexico.—Amer. Mus. Novitates 2243:1–4.

———. 1969. Mammals from the state of Oaxaca, Mexico, in the American Museum of Natural History.—Bull. Amer. Mus. Nat. Hist. 141:1–269.

Hall, E. R. 1960. *Oryzomys couesi* only subspecifically different from the marsh rice rat, *Oryzomys palustris*.—Southwestern Nat. 5(3):171–173.

———. 1962. A new bat (*Myotis*) from Mexico.—Univ. Kansas Publ., Mus. Nat. Hist. 14(13):161–164.

———. 1968. Variation in the blackish deer mouse, *Peromyscus furvus*.—An. Inst. Biol., Univ. Nal. Autón. Mexico 39, Ser. Zool. (1):149–154.

———, and T. Alvarez. 1961. A new subspecies of pocket gopher (*Heterogeomys*) from northern Veracruz.—An. Esc. Nac. Cienc. Biol. 10(1–4):121–122.

———, and W. W. Dalquest. 1963. The mammals of Veracruz.—Univ. Kansas Publ., Mus. Nat. Hist. 14(14):165–362.

———, and H. H. Genoways. 1970. Taxonomy of the *Neotoma albigula*-group of woodrats in central Mexico.—J. Mamm. 51(3):504–516.

———, and J. K. Jones, Jr. 1961. North American yellow bats, "Dasypterus" and a list of the named kinds of the genus *Lasiurus* Gray.—Univ. Kansas Publ., Mus. Nat. Hist. 14 (5):73–98.

———, and K. R. Kelson. 1959. The mammals of North America.—The Ronald Press Co., New York, Vol. I:xxx + 546 + 1–79, Vol. II:viii + 547 + 1–79.

———, and M. B. Ogilvie. 1960. Conspecificity of two pocket mice, *Perognathus goldmani* and *P. artus*.—Univ. Kansas Publ., Mus. Nat. Hist. 9(18):513–518.

Handley, C. O., Jr. 1959. A revision of American bats of the genera *Euderma* and *Plecotus*. Proc. U.S. Nat. Mus. 110:95–246.

———. 1960. Description of new bats from Panamá.—Proc. U.S. Nat. Mus. 112(3442):459–479.

———. 1966. Description of new bats (*Chiroderma* and *Artibeus*) from Mexico.—An. Inst. Biol., Univ. Nal. Autón. México 36(1–2):297–301.

Hayward, B. J. 1970. The natural history of the cave bat *Myotis velifer*.—Western New Mexico Univ Res. Sci. 1(1):1–74.

Hennings, D., and R. S. Hoffmann. 1977. A review of the taxonomy of the *Sorex vagrans* species complex from western North America.—Occas. Papers Mus. Nat. Hist., Univ. Kansas 68:1–35.

Hoffmeister, D. F. 1974. The taxonomic status of *Perognathus penicillatus minimus* Burt.—Southwestern Nat. 19(2):213–214.

———, and L. de la Torre. 1961. Geographic variation in the mouse *Peromyscus difficilis*.—J. Mamm. 42(1):1–13.

———, and V. E. Diersing. 1978. Review of the tassel-eared squirrels of the subgenus *Otosciurus*.—J. Mamm. 59(2):402–413.

Hooper, E. T. 1972. A synopsis of the rodent genus *Scotinomys*.—Occas. Papers Mus. Zool., Univ. Michigan 665:1–32.

———, and G. G. Musser. 1964. Notes on classification of the rodent genus *Peromyscus*.—Occas. Papers Mus. Zool., Univ. Michigan 635:1–13.

Huey, L. M. 1960a. A new race of pocket gopher (*Thomomys*) from San Fernando Mission, Baja California, Mexico.—Trans. San Diego Soc. Nat. Hist. 12(23):407–408.

———. 1960b. Two new races of *Perognathus spinatus* from Baja California, Mexico.—Trans. San Diego Soc. Nat. Hist. 12(24):409–412.

———. 1960c. Comments on the pocket mouse, *Perognathus fallax*, with descriptions of two new races from Baja California, Mexico.—Trans. San Diego Soc. Nat. Hist. 12(25):413–420.

———. 1964. The mammals of Baja California, Mexico.—Trans. San Diego Soc. Nat. Hist. 13(7):85–168.

Jones, J. K., Jr. 1964. A new subspecies of harvest mouse, *Reithrodontomys gracilis*, from Isla del Carmen, Campeche.—Proc. Biol. Soc. Washington 77:123–124.

———. 1966. Recent records of the shrew, *Megasorex gigas* (Merriam), from western Mexico.—Amer. Midland Nat. 75(1):249–250.

———, and T. Alvarez. 1962. Taxonomic status of the free-tailed bat, *Tadarida yucatanica* Miller.—Univ. Kansas Publ., Mus. Nat. Hist. 14(9):125–133.

———, and D. C. Carter. 1976. Annotated checklist, with keys to subfamilies and genera. *In* Biology of bats of the New World family Phyllostomatidae. Part I.—Baker, R. J., J. K. Jones, Jr., and D. C. Carter (eds.), Special Publ. Mus., Texas Tech Univ., 10, pp. 7–38.

———, and H. H. Genoways. 1967. A new subspecies of the free-tailed bat, *Molossops greenhalli*, from western Mexico (Mammalia; Chiroptera).—Proc. Biol. Soc. Washington 80:207–210.

———, and T. E. Lawlor. 1965. Mammals from Isla Cozumel, Mexico, with description of a new species of harvest mouse.—Univ. Kansas Publ., Mus. Nat. Hist. 16(3):409–419.

———, and G. L. Phillips. 1964. A new subspecies of the fruit-eating bat, *Sturnira ludovici*, from western Mexico.—Univ. Kansas Publ., Mus. Nat. Hist. 14(16):475–481.

———, J. D. Smith, and R. W. Turner. 1971. Noteworthy records of bats from Nicaragua, with a checklist of the chiropteran fauna of the country.—Occas. Papers Mus. Nat. Hist., Univ. Kansas 2:1–35.

Kortlucke, S. M. 1973. Morphological variation in the kinkajou, *Potos flavus* (Mammalia: Procyonidae), in Middle America.—Occas. Papers Mus. Nat. Hist., Univ. Kansas 17:1–36.

La Val, R. K. 1973a. A revision of the neotropical bats of the genus *Myotis*.—Nat. Hist. Mus., Los Angeles County Sci. Bull. 15:1–54.

———. 1973b. Systematics of the genus *Rhogeessa* (Chiroptera: Vespertilionidae).—Occas. Papers Mus. Nat. Hist., Univ. Kansas 19:1–47.

Lawlor, T. E. 1969. A systematic study of the rodent genus *Ototylomys*.—J. Mamm. 50(1): 28–42.

———. 1971a. Distribution and relationships of six species of *Peromyscus* in Baja California and Sonora, Mexico.—Occas. Papers Mus. Zool. Univ. Michigan 661:1–22.

———. 1971b. Evolution of *Peromyscus* of northern islands in the Gulf of California, Mexico.—Trans. San Diego Soc. Nat. Hist. 16(5):19–124.

Lee, M. R., and D. F. Hoffmeister. 1963. Status of certain fox squirrels in Mexico and Arizona.—Proc. Biol. Soc. Washington 76:181–190.

———, and D. J. Schmidly. 1977. A new species of *Peromyscus* (Rodentia: Muridae) from Coahuila, Mexico.—J. Mamm. 58(3):263–268.

Lidicker, W. Z., Jr. 1960a. An analysis of intraspecific variation in the kangaroo rat *Dipodomys merriami*.—Univ. California Publ. Zool. 67(3):125–212.

———. 1960b. A new subspecies of the cliff chipmunk from central Chihuahua.—Proc. Biol. Soc. Washington 73:267–274.

Long, C. A. 1972. Taxonomic revision of the North American badger, *Taxidea taxus*.—J. Mamm. 53(4):725–759.

Machado-Allison, C. E. 1967. The systematic position of the bats *Desmodus* and *Chilonycteris*, based on host-parasite relationships (Mammalia; Chiroptera).—Proc. Biol. Soc. Washington 80:223–226.

Musser, G. G. 1964. Notes on the geographic distribution, habitat and taxonomy of some Mexican mammals.—Occas. Papers Mus. Zool., Univ. Michigan 636:1–22.

———. 1968. A systematic study of the Mexican and Guatemalan gray squirrel, *Sciurus aureogaster* F. Cuvier (Rodentia: Sciuridae).—Misc. Publ. Mus. Zool., Univ. Michigan 13:1–112.

———. 1969. Notes on *Peromyscus* (Muridae) of Mexico and Central America.—Amer. Mus. Novitates 2357:1–23.

———. 1971. *Peromyscus allophylus* Osgood: a synonym of *Peromyscus gymnotis* Thomas (Rodentia, Muridae).—Amer. Mus. Novitates 2453:1–10.

Ojasti, J., and O. J. Linares. 1971. Adiciones a la fauna de murciélagos de Venezuela con notas sobre las especies del género *Diclidurus* (Chiroptera).—Acta Biol. Venezuélica 7(4):421–441.

Packard, R. L. 1960. Speciation and evolution of the pygmy mice, genus *Baiomys*.—Univ. Kansas Publ., Mus. Nat. Hist. 9(23):579–670.

Paradiso, J. L. 1967. A review of the wrinkle-faced bats (*Centurio senex* Gray), with description of a new subspecies.—Mammalia 31(4):595–604.

Patten, D. R., and L. T. Findley. 1970. Observations and records of *Myotis* (*Pizonyx*) *vivesi* Menegaux (Chiroptera: Vespertilionidae).—Los Angeles County Mus., Contrib. Sci. 183:1–9.

Patton, J. L., and R. E. Dingman. 1970. Chromosome studies of pocket gophers, genus *Thomomys* II. Variation in *T. bottae* in the American southwest.—Cytogenetics 9:139–151.

Phillips, C. J., and J. K. Jones, Jr., 1971. A new subspecies of the long-nosed bat, *Hylonycteris underwoodi*, from Mexico.—J. Mamm. 52(2):77–80.

Pine, R. H. 1966. *Baeodon meyeri* (Chiroptera: Vespertilionidae) a new species of bat from Veracruz.—Southwestern Nat. 11(2):308–310.

———. 1967. *Baeodon meyeri* Pine (Chiroptera: Vespertilionidae) referred to the genus *Antrozous* H. Allen.—Southwestern Nat. 12(4):484–485.

———. 1972. The bats of the genus *Carollia*.—Technical Monogr., Texas Agric. Exp. Station, Texas A. and M. Univ. 8:1–125.

———, D. C. Carter, and R. K. La Val. 1971. Status of *Bauerus* Van Gelder and its relationships to other nyctophiline bats.—J. Mamm. 52(4):663–669.

Robertson, P. B., and G. G. Musser. 1976. A new species of *Peromyscus* (Rodentia: Cricetidae) and a new specimen of *P. simulatus* from southern Mexico, with comments on their ecology.—Occas. Papers Mus. Nat. Hist., Univ. Kansas 47:1–8.

Roth, E. L. 1976. A new species of pocket mouse (*Perognathus*: Heteromyidae) from the Cape Region of Baja California Sur, Mexico.—J. Mamm. 57(3):562–566.

Russell, R. J. 1968a. Evolution and classification of the pocket gophers of the subfamily Geomyinae.—Univ. Kansas Publ., Mus. Nat. Hist. 16(6):473–579.

———. 1968b. Revision of the pocket gophers of the genus *Pappogeomys*.—Univ. Kansas Publ., Mus. Nat. Hist. 16(7):581–776.

Schaldach, W. J., Jr. 1966. New forms of mammals from southern Oaxaca, Mexico, with notes on some mammals of the coastal range.—Säugetierk. Mitteilungen 14(4):286–297.

———, and C. A. McLaughlin. 1960. A new genus and species of glossophagine bat from Colima, Mexico.—Los Angeles Co. Mus. Contr. Sci. 37:1–20.

Schmidly, D. J. 1972. Geographic variation in the white-ankled mouse, *Peromyscus pectoralis*.—Southwestern Nat. 17(2):113–138.

———, and F. S. Hendricks. 1976. Systematics of the southern races of Ord's Kangaroo rat, *Diplomys ordii*.—Bull. Southern Cal. Acad. Sci. 75:225–237.

Smith, J. D. 1970. The systematic status of the black howler monkey, *Alouatta pigra* Lawrence.—J. Mamm. 51(2):358–369.

Van Gelder, R. G. 1959a. Results of the Puritan-American Museum of Natural History expedition to western Mexico. 8. A new *Antrozous* (Mammalia, Vespertilionidae) from the Tres Marías Islands, Nayarit, Mexico.—Amer. Mus. Novitates 1973:1–11.

———. 1959b. A taxonomic revision of the spotted skunks (genus *Spilogale*).—Bull. Amer. Mus. Nat. Hist. 117:233–392.

Waithman, J., and A. Roest. 1977. A taxonomic study of the kit fox, *Vulpes macrotis*.—J. Mamm. 58(2):157–164.

Wetzel, R. M. 1975. The species of *Tamandua* Gray (Edentata, Myrmecophagidae).—Proc. Biol. Soc. Washington 88:95–112.

Williams, D. F. 1978. Karyological affinities of the species groups of silky pocket mice (Rodentia, Heteromyidae).—J. Mamm. 59(3):599–612.

Wilson, D. E. 1973. The systematic status of *Perognathus merriami* Allen.—Proc. Biol. Soc. Wash. 86:175–192.

Yates, T. L., and D. J. Schmidly. 1977. Systematics of *Scalopus aquaticus* (Linnaeus) in Texas and adjacent states. Occas. Papers Mus., Texas Tech Univ. 45:1–36.

Zimmerman, E. G. 1970. Karyology, systematics and chromosomal evolution in the rodent genus, *Sigmodon*.—Publ. Mus., Michigan State Univ., Biol. Ser. 4(9):385–454.

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SYSTEMATICS AND VARIATION OF THE AZTEC SHINER, *NOTROPIS SALLEI*, A CYPRINID FISH FROM CENTRAL MEXICO

Barry Chernoff and Robert Rush Miller

Abstract.—*Notropis sallei* (Günther) inhabits upper tributaries of the Río Balsas, Río Lerma, and Río Pánuco drainages, the Valley of Mexico, and the small endorheic basin of the Río Grande de Morelia. The Aztec shiner has had a confusing taxonomic history, having been placed in no fewer than eight genera and 16 nominal taxa. There is much variation within populations and overlap of ranges for most characters analyzed among disjunct populations, thus supporting our conclusion that recognition of only a single highly variable taxon, properly named *Notropis sallei,* is warranted. A redescription is presented and the generic assignment of the Aztec shiner is discussed.

The Aztec shiner, *Notropis sallei* (Günther), is one of the southernmost representatives of the American Cyprinidae. It is confined to the Río Lerma system, including its former Pleistocene connectives within the geological limits of the Mesa Central of Mexico (West, 1964:Fig. 8). The species inhabits upper tributaries of the Río Lerma, Río Balsas, and Río Pánuco drainages, the Valley of Mexico, and the small endorheic basin of the Río Grande de Morelia (Fig. 1). All of these are or have been tributary to the Pacific except the Río Pánuco, which flows to the Gulf of Mexico. Headwater erosion by the Río Pánuco into the Mexican Plateau (Segerstrom, 1962) has transferred the Aztec shiner and other Lerma basin fishes to the Atlantic Slope (Hubbs and Turner, 1939; Barbour, 1973; Barbour and Miller, 1978).

The minnow populations here referred to *Notropis sallei* had a confusing taxonomic history over the last century, with assignment to no fewer than 8 genera, 7 species, and 16 nominal taxa (see below). Papers by Meek (1904), Regan (1906–08), de Buen (1940) and Alvarez (1970) failed to resolve the number of taxa represented by the Aztec shiner or to clarify their geographical distributions. This situation resulted from inadequate study material and from different concepts of what constitute recognizable species and genera. Not enough was known to permit proper evaluation of traits that were thought to distinguish the Aztec shiner generically from its northern relatives, especially within the species-rich genus *Notropis*. Although we still need more information for confident generic assignments of American min-

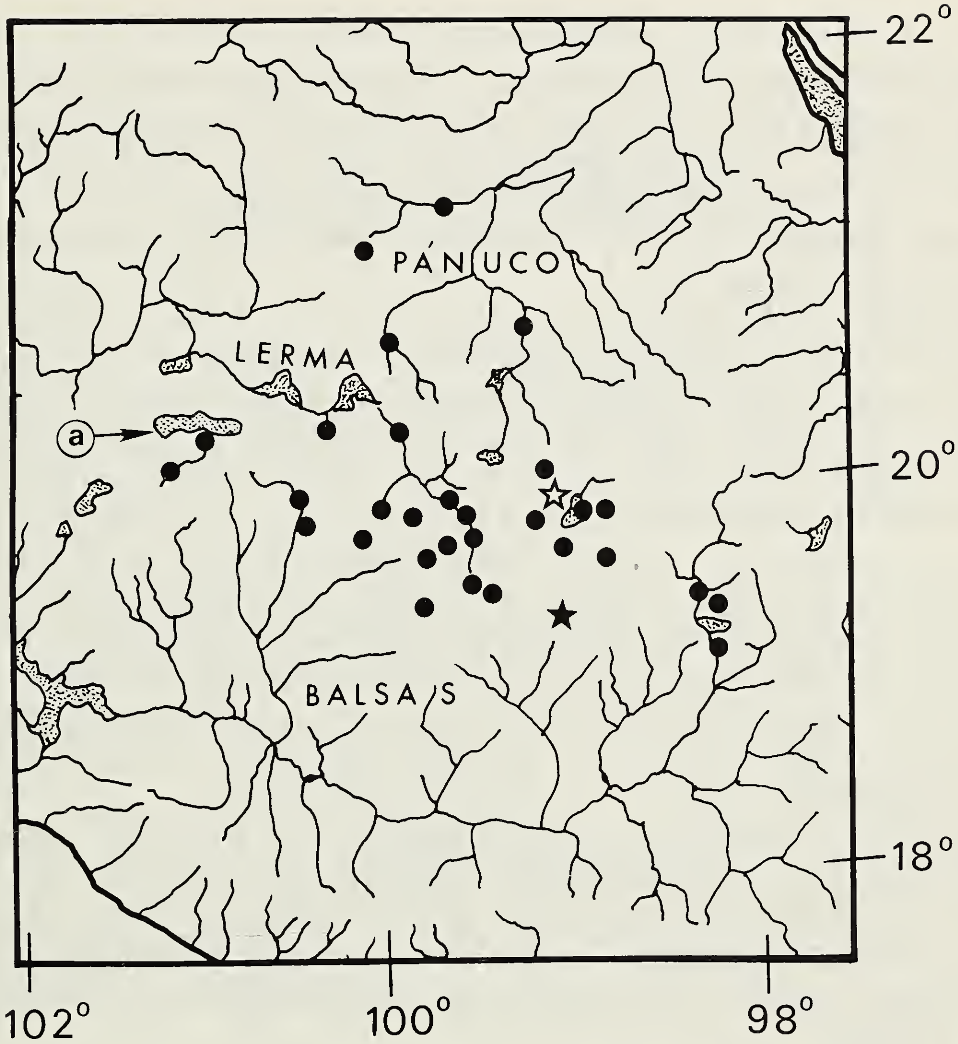

Fig. 1. Study locations (solid dots) of *Notropis sallei* from the Mesa Central of Mexico. The solid star indicates the type locality of *Ceratichthys sallaei*; the open star shows Mexico City in the Valley of Mexico; "a" points to Lago de Cuitzeo and the Río Grande de Morelia drainage; Balsas is the Río Balsas drainage; Lerma is the Río Lerma drainage; and Pánuco is the Río Pánuco drainage.

nows, this study demonstrates for the first time that the Aztec shiner belongs to a single taxon—a conclusion tentatively reached by Miller (1976). Gilbert (1978) followed Miller (1976) but corrected the spelling from *N. sallaei* to *Notropis sallei,* because the species was named for Mr. A. Sallé (Regan, 1906–08:vii).

The purpose of this paper is to determine the proper specific name for the Aztec shiner, analyze the geographic variation of its disjunct populations, and decide whether they represent more than one taxon. In addition, we comment on the generic placement of *N. sallei* and provide a redescription.

Methods and Materials

Most specimens were examined for 13 meristic and 15 morphometric variables, including those previously considered to be diagnostic among the nominal taxa. Counts and measurements are as per Hubbs and Lagler (1964). Vertebral counts include the Weberian complex as four and the urostylar vertebra as one. All measurements were made with dial calipers to the nearest 0.1 mm.

To correct for distributional properties of ratios, means and 95% confidence intervals were computed from the arcsine transformed morphometric ratios (Sokal and Rohlf, 1969). Accordingly, the upper and lower confidence limits are asymmetric about the mean. The variability of several characters was compared, independent of the mean, with the coefficient of variation (CV). Principal components analysis (see Sneath and Sokal, 1973) was used to assess concordant changes in morphometry; a priori groups are not formed with this method. Principal components were computed from the correlation matrix of standardized log-transformed morphometric variables (variables in Table 1 plus eye diameter and standard length). The Michigan Interactive Data Analysis System, developed by the Statistical Research Laboratory at The University of Michigan, was used to perform numerical and statistical analyses.

Specimens examined or recorded belong to the following institutions: British Museum of Natural History (BMNH); Field Museum of Natural History (FMNH); Texas Cooperative Wildlife Collection, Texas A&M University (TCWC); Tulane University (TU); University of Michigan Museum of Zoology (UMMZ); and United States National Museum of Natural History (USNM).

Types of the following taxa were examined (the name of the Mexican state follows each locality). *Ceratichthys sallaei:* Syntypes, BMNH 1868.3.3.1–3 (3 specimens), Río Balsas at Cuernavaca, Puebla. *Notropis aztecus:* Lectotype, USNM 45569 (1), Mexico City, Distrito Federal (DF); Paratypes, USNM 47505 (1), USNM 125172 (1), FMNH 6604 (5), Mexico City, DF. *Notropis lermae:* Holotype, USNM 50003 (1), Lake Lerma, México. *Aztecula mexicana:* Syntypes, FMNH 3606 (50), UMMZ 162462 (10), USNM 55764 (85), San Juan del Río, Querétaro.

Other material listed by drainages. Río Balsas: FMNH 4557 (2), UMMZ 66263 (1), Puebla, Puebla; UMMZ 124457 (13), Manantial at Hacienda de Polaxtla, Puebla; UMMZ 172177 (115), Río Tuxpan at Tuxpan, Michoacán; UMMZ 173637 (3), E branch Río Cuitzamola, W Toluca, Michoacán; UMMZ 191695 (383), Río Atepitzingo, SE Totimehuacán, Puebla. Río Lerma: UMMZ 97439 (150), Río Lerma near Lerma, México; UMMZ 124430 (2), Almoloya del Río, México; UMMZ 172173 (260), Laguna Agua Blanca, SW Toluca, México; UMMZ 192374 (4), Río Lerma N Toluca, México;

UMMZ 192378 (2), Río Lerma N Toluca, México; UMMZ 192382 (2), trib. Río Lerma S Maravatío, Michoacán; TU 31872 (28), Río Lerma W Atlacomulco, México; UMMZ 193482 (3), Presa near Tabernillas, México; UMMZ 193478 (50), trib. Río Lerma NW Toluca, México; UMMZ 201548 (3), Río Lerma at Toluca, México; UMMZ 201550 (22), trib. Río Lerma E Zitácuaro, México. Río Pánuco: UMMZ 193440 (8), Río San Lorenzo at Peña Blanca, Querétaro; TCWC 0035.1 (41), 3.5 km S Huimilpan, Querétaro; UMMZ 192368 (57), UMMZ 124322 (10), Río Tula at Ixmiquilpan, Hidalgo. Valley of Mexico: FMNH 4528 (4), FMNH 4530 (5), UMMZ 108625 (192), Lago de Chalco, México; UMMZ 97440 (23), Lago de Texcoco, DF; UMMZ 97441 (2), Xochimilco, DF; UMMZ 189622 (135), UMMZ 192373 (369), UMMZ 192555 (39), Presa de Guadalupe, México. Río Grande de Morelia: UMMZ 172178 (2), Presa de Cointzio, Michoacán; UMMZ 182346 (23), Río de Morelia, Michoacán.

Osteological comparisons were made from the following cleared and stained (CS) and skeletal (S) UMMZ material: *Agosia chrysogaster* 162668-CS (4); *Algansea aphanea* 192196-CS (6); *A. barbata* 194166-CS (2); *A. tincella* 193665-CS (6); *Hybopsis storeriana* 150037-CS (4); *Notropis amnis* 157459-CS (11); *N. atherinoides* 147017-CS (16), 203986-S (19); *N. boucardi* 178579-CS (5); *N. calientis* 154338-CS (6); *N. cerasinus* 198728-S (2); *N. chihuahua* 161735-CS (10), 161750-CS (2); *N. chrysocephalus* 203935-S (4); *N. cornutus* 203936-S (10); *N. emiliae* 166119-CS (2); *N. formosus* 182402-CS (5); *N. galacturus* 198735-S (2); *N. hudsonius* 163857-CS (2), 203803-S (25); *N. imeldae* 188855-CS (2); *N. lutrensis* 113359-CS (6), 198730-S (2); *N. mekistocholas* 197680-CS (2); *N. nazas* 161725-CS (8); *N. ornatus* 196726-CS (4); *N. sallei* 172173-CS (12), 172177-CS (6), 182346-CS (6), 189622-S (1), 191695-CS (6), 192373-CS (6); *N.* sp. (Mexico) 172218-CS (4); *N. stramineus* 161911-CS (2), 203943-S (83); *N. tropicus* 192897-CS (6); *N. venustus* 166280-CS (8); *N. zonistius* 157882-CS (11); *Yuriria alta* 179703-CS (1).

Results and Discussion

The number of lateral-line scales has long been used to distinguish nominal taxa here referred to *N. sallei* (Meek, 1904; Regan, 1906–08; Alvarez, 1970). Frequency distributions show that Río Balsas and Río Pánuco individuals usually have more than 50 scales, whereas specimens from the Valley of Mexico and Río Lerma have fewer than 50 (Fig. 2). However, 26% of the Valley of Mexico fish have more than 50 scales. Populations within and among drainages exhibit a large degree of phenotypic overlap; this character clearly is not indicative of separate taxa. Rather, these data either support the recognition of a single highly variable taxon (with a total range of 26 counts) or are not useful for discriminating formerly recognized taxa.

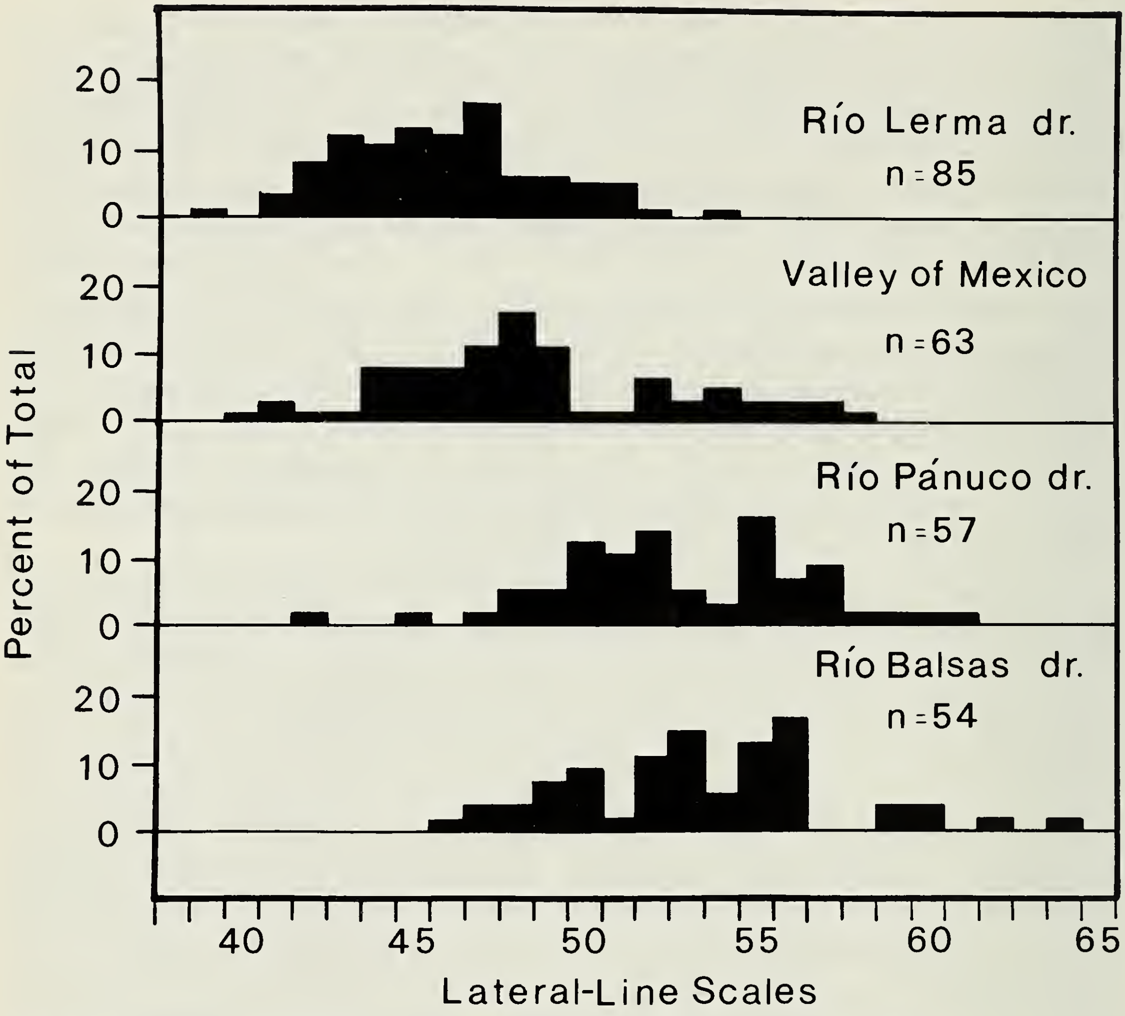

Fig. 2. Variation of lateral-line scales among *N. sallei* from four drainages.

Large populational variation (15–20 scales) and broad overlap of ranges are also manifest in the number of body-circumference scales within and among drainages (Fig. 3). On the average, Río Balsas and Río Pánuco fish have more circumferential scales than those in the Valley of Mexico and Río Lerma (means are 43.7 and 44.8 vs. 38.0 and 38.8, respectively). Separating this character into its components, i.e. scales above and below the lateral line (Table 1), reveals the same pattern. Similarly, the number of scales around the caudal peduncle (Table 1) exhibits the greatest degree of phenotypic overlap among the drainages for scale variables, and again indicates the presence of only one taxon.

Comparison of numbers of precaudal, caudal and total vertebrae reveals that ranges and means are not significantly different among populations ($P > .05$; Table 1). Vertebral numbers are considerably less variable than longitudinal or circumferential scale counts. For example, the range of CV's among drainages for several variables follows: total vertebrae 1.5–2.7; lat-

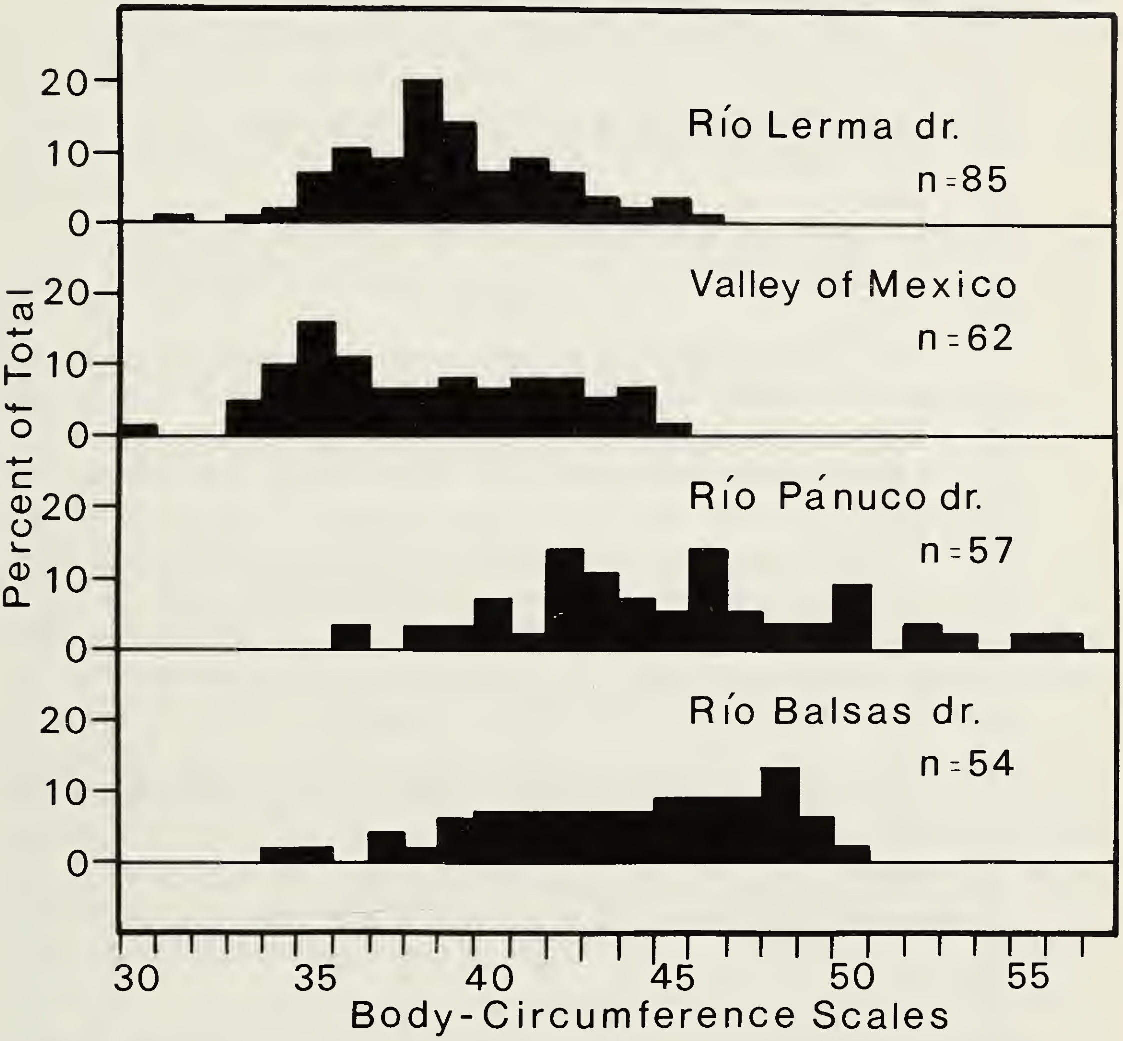

Fig. 3. Variation of body-circumference scales among *N. sallei* from four drainages.

eral-line scales 6.4–8.7; body-circumference scales 7.5–10.0; and scales around the caudal peduncle 7.1–10.5. Nonetheless, significant correlations between vertebral and scale variables exist. Total vertebrae and caudal vertebrae are correlated with lateral-line scales and body-circumference scales (r > .185, 114 df, $P < .05$), and caudal vertebrae are correlated with scales around the caudal peduncle (r = .259, 114 df, $P < .01$). Because precaudal vertebrae are not correlated with scale variables, the trend of total vertebrae reflects the variation of caudal vertebrae. This does not imply that precaudal vertebrae are less variable than caudal vertebrae; the range of CV's for each are 2.8–4.4 and 3.1–4.6, respectively. This similarity is difficult to interpret because it could also be due to problems in assigning the first caudal vertebra. Concordant variation of scales and vertebrae was also noted by Stewart (1977) for *Barbus radiatus*.

Meek (1904:60) indicated that *Aztecula lermae* (Evermann and Golds-

Table 1.—Comparison of ranges and means of meristic and mensural variables (in % SL) among populations of *Notropis sallei* from the four drainages; sample sizes given parenthetically.

	Río Balsas			Río Pánuco			Valley of Mexico			Río Lerma		
Characters	Range	(N)	$\bar{x}$	Range	(N)	$\bar{x}$	Range	(N)	$\bar{x}$	Range	(N)	$\bar{x}$
Scales above lateral line	15–23	(54)	19.4	16–28	(32)	20.8	14–21	(61)	17.4	15–20	(85)	17.3
Scales below lateral line	17–27	(54)	22.4	17–39	(32)	23.2	13–24	(61)	18.7	13–25	(84)	19.5
Scales around peduncle	17–28	(54)	23.1	18–25	(55)	22.4	17–23	(61)	19.8	17–24	(85)	20.1
Dorsal rays	7–8	(44)	8.0	7–8	(40)	8.0	7–9	(48)	8.1	7–8	(65)	8.0
Anal rays	6–8	(44)	7.1	6–7	(40)	7.0	6–8	(48)	7.2	6–7	(65)	7.0
Total vertebrae	34–37	(39)	36.1	35–38	(15)	36.8	36–37	(25)	36.4	34–38	(20)	35.9
Precaudal vertebrae	18–20	(39)	19.3	19–20	(15)	19.7	19–21	(25)	20.0	18–21	(20)	19.4
Caudal vertebrae	16–19	(40)	16.9	16–18	(15)	17.1	16–17	(25)	16.4	15–18	(20)	16.5
Predorsal length	36.8–61.1	(44)	57.6	54.6–74.2	(40)	57.2	52.8–63.5	(48)	58.0	53.2–59.8	(63)	56.6
Preanal length	67.0–76.7	(44)	72.9	67.8–75.0	(40)	71.5	67.3–77.7	(48)	72.6	66.9–75.7	(63)	71.7
Prepelvic length	38.4–56.5	(44)	53.9	49.5–54.8	(40)	52.5	49.0–58.9	(48)	53.7	35.2–57.4	(63)	52.3
Postdorsal length	31.6–38.6	(44)	34.4	32.8–38.7	(40)	35.7	29.7–38.5	(48)	35.0	31.7–40.2	(63)	35.9
Length caudal peduncle	15.5–25.0	(44)	19.8	18.2–24.9	(40)	20.8	16.3–24.5	(48)	20.5	16.8–24.9	(63)	20.6
Head length	24.6–29.4	(44)	26.8	24.8–28.9	(40)	26.8	24.6–31.8	(48)	27.1	24.5–29.9	(63)	27.1
Postorbital head length	12.4–14.9	(44)	13.6	12.1–14.6	(40)	13.3	12.3–15.4	(48)	13.8	11.7–15.5	(63)	13.5
Snout length	5.8–8.4	(44)	7.0	5.3–7.1	(40)	6.2	5.1–7.2	(48)	5.9	4.9–7.8	(63)	6.4
Upper jaw length	6.2–8.7	(44)	7.1	6.2–7.6	(40)	6.9	5.6–7.6	(48)	6.8	5.3–8.9	(63)	7.1
Body depth	21.2–31.7	(44)	27.8	23.9–30.9	(40)	27.2	21.0–31.6	(48)	26.5	23.4–34.0	(63)	26.5
Body width	10.6–20.9	(44)	16.9	10.3–20.2	(40)	14.1	9.2–18.3	(48)	12.3	10.1–19.0	(63)	14.4
Least depth caudal peduncle	11.1–15.3	(44)	13.5	11.0–14.5	(40)	12.8	9.4–13.8	(48)	12.1	9.8–14.8	(63)	12.7
Caudal peduncle width	3.7–7.4	(44)	5.3	3.1–6.1	(40)	4.5	2.5–7.3	(48)	4.0	2.9–7.3	(63)	4.8

borough) has nine dorsal rays; the other taxa he recognized have eight. This was probably a misprint. We examined the types as well as other material from the Río Lerma system, and found no specimens with nine dorsal rays (Table 1). Nine rays occurred, infrequently, only in Valley of Mexico populations, and their mean was within the 95% confidence limits of the other drainages.

Eye diameter and least depth of caudal peduncle were used by Meek (1904) to distinguish between *Aztecula vittata* (=*Notropis aztecus*; see Miller, 1976) and *A. lermae*. Río Balsas *N. sallei* have smaller eye diameters; the mean and 95% confidence limits do not overlap those from other drainages (Fig. 4). However, the range of Río Balsas populations is almost totally contained within the ranges of Valley of Mexico and Rio Lerma *N. sallei*. We consider the variability of this character to be extreme, especially for the Valley of Mexico populations. These data show that eye diameters of fish within and among drainages can vary by as much as 4% of the standard length of the fish. In contrast, Río Balsas populations tend to have the largest average snout lengths (Table 1). The combination of small eye diameters and larger snout lengths for Río Balsas populations, and the converse for the other drainages, coupled with similar postorbital lengths, has resulted in rather uniform head lengths among the Aztec shiners from the different drainage basins (Table 1). The data for eye diameter, snout length, and least depth of caudal peduncle (Table 1) support recognition of only one taxon; however, these data do indicate that, on the average, Río Balsas populations are somewhat modified from those of other drainages.

Alvarez (1970) distinguished *N. sallei* from *N. lermae* and *N. aztecus* by the position achieved in projecting the postdorsal length anteriorly from the origin of the dorsal fin. For example, if this projected length reaches as far as, or anterior to, the nares, then *N. sallei* is indicated. This character is really a complex variable dependent upon postdorsal length, eye diameter, snout length, and postorbital head length. That is, the same result could be achieved by changes in either the head components or the postdorsal length. This complex, as well as other concurrent variations in morphology, is more appropriately assessed by multivariate ordination procedures (e.g. principal components analysis).

Principal components analysis identifies suites of characters that contribute to morphological variation. The character complexes indicated below are those upon which former taxa have been based. The first principal component explains 88.4% of the variance (eigenvalue = 13.3) and is related to size; all variables are highly correlated with this axis ($.79 < r < .99$, $P < .01$). Axes II and III are interesting because they elucidate trends in character variation independent of size. Axis II explains 3.4% of the variation (eigenvalue = .51), is positively correlated with eye diameter ($r = .54$, $P < .05$), and negatively correlated with maximum body width ($r = -.26$,

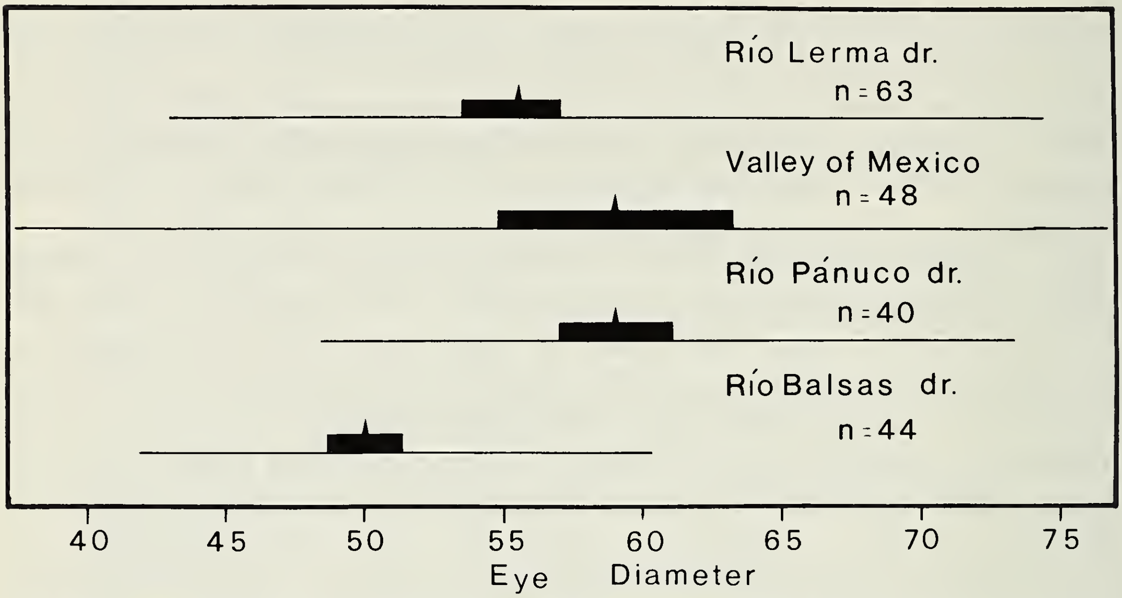

Fig. 4. Comparison of eye diameter (thousandths of SL) among *N. sallei* from four drainages. Horizontal line indicates range; shaded portion is the mean ± upper and lower 95% confidence limits; and vertical point indicates the mean.

$P < .05$) and caudal peduncle width ($r = -.33$, $P < .05$). When projection scores for individuals are plotted on the first two principal component axes and clusters for populations within drainages outlined, a morphocline results, with fish having smaller eye diameters and wider bodies on the left, and laterally compressed morphs with larger eyes on the right (Fig. 5; fish from Río Pánuco and Río Grande de Morelia drainages overlapped broadly with clusters shown and were deleted from the figure for clarity of presentation). These axes fail to segregate any population or those from a drainage into a discrete cluster, thereby confirming the broad range of phenotypic variability within and among populations, especially for Río Lerma individuals. The third principal component explains 2.7% of the variance (eigenvalue = .41) and is positively correlated with snout length ($r = .20$, $P < .05$) and negatively correlated with caudal peduncle length ($r = -.46$, $P < .05$) and postdorsal length ($r = -.27$, $P < .05$). When projection scores for this axis are plotted against scores for the first two axes, discrete clusters do not occur, and results similar to those in Fig. 5 are obtained.

These comparisons lead us to accept only one taxon, *Notropis sallei*. Presumably diagnostic characters have been shown to be highly variable among populations and do not delimit the former taxa. It is, therefore, understandable why previous researchers having far less material for study assigned several names to these minnows. Furthermore, we now resolve the epithet to be *sallei* because one of us (RRM) examined the syntypes of *Ceratichthys sallaei* and determined that this species is not a synonym of

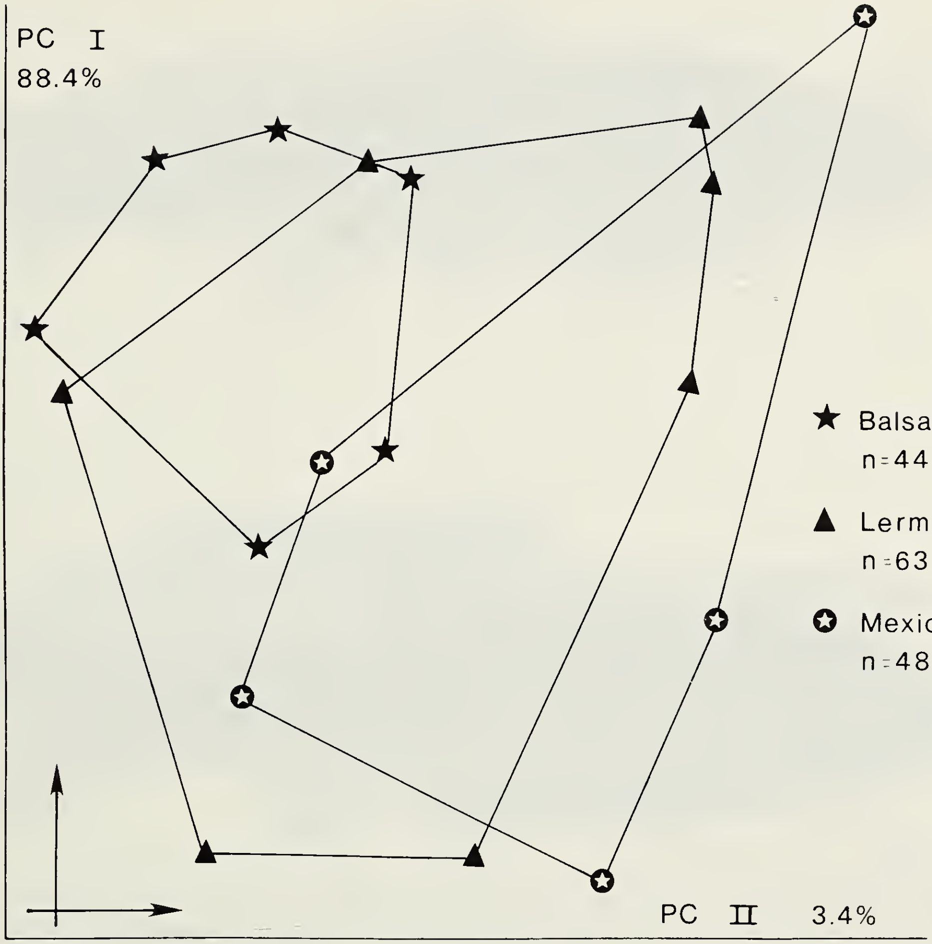

Fig. 5. Outlines of population clusters for *N. sallei* on the first two principal component axes (I, II). The variance explained by each component is indicated.

Algansea tincella, as stated by Meek (1904:45), nor does it belong in the genus *Algansea,* as placed by Jordan and Evermann (1896:212); see below.

The variation of *N. sallei* is comparable to, if not greater than, other highly variable minnows, e.g. *N. atherinoides* (Bailey and Allum, 1962; Resh et al., 1976), *N. cornutus* (Gilbert, 1964), *Pimephales promelas* (Vandermeer, 1966), *Campostoma ornatum* (Burr, 1976), and *Barbus radiatus* (Stewart, 1977). However, each of these cyprinids occupies a much greater geographic range than does *N. sallei.* The overall morphological plasticity of the Aztec shiner may be a function of adaptations and responses to the diverse and often isolated environments in which they occur (lakes, pools, high- and low-gradient streams). For example, *N. sallei* from lakes, e.g. Presa de Guadalupe in the Valley of Mexico, tends to have larger eyes and is more laterally compressed (occupying the right hand side of Fig. 5), whereas those from high-gradient streams of the Río Balsas, Río Lerma and

Fig. 6. *Notropis sallei*. A. ♂ UMMZ 191695, 56.3 mm SL, Mexico, State of Puebla, Río Balsas drainage, Río Atepitzingo SE Totimehuacán. B. ♀ UMMZ 124322, 62.6 mm SL, Mexico, State of Hidalgo, Río Pánuco drainage, Río Tula at Ixmiquilpan.

Río Pánuco drainages are more terete, with smaller eyes (occupying the left portion of Fig. 5).

Hubbs (1941) and Smith (1966) have noted that populations from fast water were more attenuate than their quiet-water conspecifics. Similarly, the third principal component axis is related to elongation of the caudal peduncle (see above), and *N. sallei* from high-gradient streams has the lowest scores on this axis (the characters are negatively correlated). Stewart (1977) speculated that body attenuation could be associated with an increase in vertebrae due to the influence of such factors as temperature. Scale and vertebral variables were tested for correlation with the 2nd and 3rd principal components to evaluate relationships among meristics and morphological variation in the lateral and longitudinal planes, respectively. The second axis is negatively correlated with body-circumference scales and scales around the caudal peduncle ($r < -.26$, $P < .01$) and positively correlated with precaudal vertebrae ($r = .38$, $P < .01$); the third axis was not correlated ($P > .05$) with meristics. As the body (thorax and caudal peduncle)

Fig. 7. *Notropis sallei.* A. ♂ UMMZ 193478, 63.9 mm SL, Mexico, State of Mexico, Río Lerma drainage, Río Lerma NW Toluca. B. ♂ UMMZ 192555, 52.1 mm SL, Mexico, State of Mexico, Valley of Mexico drainage, Presa de Guadalupe.

increases in width, the number of circumferential scales increases, while precaudal vertebrae decrease in number. The physical relationship between circumferential scales and body width is clear; however, we cannot explain the decrease in precaudal vertebrae. Elongation of the caudal region does not seem to be associated with changes in longitudinal meristic elements (i.e. scales or vertebrae).

Because we synonymize formerly recognized taxa with *N. sallei,* and our data base significantly expands published ranges for various characters, a redescription of the Aztec shiner follows.

Notropis sallei
Aztec Shiner
Figs. 6, 7

Codoma vittata (*non Leuciscus vittatus* DeKay) Girard, 1856:195 (original description; type locality: Valley of Mexico; unavailable due to secondary homonymy created when Günther (1868:207) united *Codoma* with *Leuciscus*); 1859:53 (redescription).—Gilbert, 1978:87 (synonymy).

Ceratichthys sallaei Günther, 1868:484 (original description; type locality: Cuernavaca, Puebla).—Gilbert, 1978:77 (synonymy).

Hudsonius sallaei: Jordan, 1879:226 (synonymy, description).

Zophendum australe Jordan, 1880:300 (misidentification, =*Algansea tincella,* based on our re-examination of types: USNM 23130 (3), USNM 23131 (1)). Jordan, 1890:288 (synonym of *Algansea tincella*).

Cliola sallaei: Jordan and Gilbert, 1883:164 (synonymy, description).

Cliola vittata: Jordan and Gilbert, 1883:172 (synonymy, description).

Notropis aztecus Woolman, 1894:63 (original description; type locality: canals around Mexico City).—Jordan and Evermann, 1896:258 (description).—Regan, 1906–08:160 (synonymy, description).—Alvarez and Navarro, 1957:23 (synonymy, description).—Alvarez, 1970:61 (keys).—Miller, 1978:369 (may equal *Ceratichthys sallaei*).—Gilbert, 1978:28 (synonymy).

Algansea sallaei: Jordan and Evermann, 1896:212 (description).—de Buen, 1940:14 (synonymy).

Aztecula mexicana Meek, 1902:81 (original description; type locality: San Juan del Río, Querétaro).—Meek, 1904:61 (description).—de Buen, 1940:21 (synonymy).—Alvarez, 1950:53 (keys).—Gilbert, 1978:61 (synonymy).

Aztecula azteca: Meek, 1902:82 (listed, distribution).

Notropis lermae Evermann and Goldsborough, 1902:147 (original description; type locality: Lago de Lerma, México).—Alvarez, 1970:61 (keys).—Gilbert, 1978:54 (synonymy).

Algansea tincella: in part: Meek, 1904:45 (included *Ceratichthys sallaei* and *Algansea sallaei* as synonyms).

Aztecula vittata: Meek, 1904:59 (synonymy, description).—de Buen, 1940:20–21 (synonymy).—Alvarez, 1950:53 (keys).

Aztecula lermae: Meek, 1904:60 (synonymy, description).—de Buen, 1940:21 (synonymy).—Alvarez, 1950:53 (keys).

Notropis sallaei: Regan, 1906–08:157 (synonymy, description).—Alvarez, 1970:61 (keys).—Miller, 1976:10 (synonymy).

Aztecula sallaei: Alvarez, 1950:52 (keys).

Notropis sallei: Gilbert, 1978:20 (synonymy, corrected spelling of epithet).

Diagnosis.—Distinguishable among all congeners by some combination of: small scales, 39–64 in lateral line, with apical radii only; reduced pharyngeal dentition, 0,4–4,0; short head with blunt snout; small fins; simple intestine with 1 loop; head and body of breeding males with profuse small tubercles that are larger on pectoral rays 2–8 (9) and weak on 1 and 9 or 10–14; maxilla without barbels; ventral surface of urohyal ovoid, without lateral projections joining ventral midline to form V-shaped notch; ascending process of angular not extending above ⅓ height of coronoid process of dentary; interneural elements extending posteriorly from Weberian apparatus for only 2–4 vertebrae; juveniles and smaller adults with concentration of melanophores on dorsal and ventral sides of caudal peduncle near base of procurrent caudal rays. *Notropis sallei* differs from *Algansea, Gila crassicauda* and *Temeculina* (subgenus of *Gila*), in having a tubular dermosphenotic (platelike in others, except *A. aphanea*; see Barbour and Miller, 1978).

Description.—Measurements expressed in thousandths of SL, n = 212 except where indicated; means given in parentheses. Standard length to 80 mm; predorsal length 368–742 (573), dorsal fin originating over or anterior to insertion of pelvic fins; preanal length 669–777 (723); posterior edge of dorsal and anal fins straight; dorsal fin when depressed extends posteriorly from vertical at ⅓ anal base to beyond anal base; prepelvic length 252–589 (531); postdorsal length 297–401 (353); caudal peduncle length 155–273 (204); head length 245–317 (270); postorbital head length 117–155 (135); eye diameter 37–77 (56); snout length 49–84 (64); upper jaw length 53–87 (70); mouth often oblique and terminal, corner just reaches anterior margin of orbit; maximum body depth 210–340 (269); body laterally compressed to moderately terete, maximum width 92–209 (145); caudal peduncle least depth 155–273 (204); caudal peduncle width 25–74 (47).

Dorsal rays 7 (5 counts), 8 (205), 9 (4); anal rays 6 (5), 7 (195), 8 (14); lateral-line scales 39 (1), 40 (1), 41 (5), 42 (9), 43 (14), 44 (15), 45 (17), 46 (19), 47 (29), 48 (23), 49 (20), 50 (18), 51 (12), 52 (19), 53 (13), 54 (9), 55 (18), 56 (16), 57 (7), 58 (2), 59 (3), 60 (3), 61 (1), 62 (1), 63 (0), 64 (1); lateral line incomplete to complete; body-circumference scales 30 (1), 31 (1), 32 (0), 33 (4), 34 (9), 35 (17), 36 (18), 37 (15), 38 (25), 39 (25), 40 (22), 41 (24), 42 (24), 43 (17), 44 (14), 45 (12), 46 (14), 47 (8), 48 (9), 49 (5), 50 (6), 51 (0), 52 (2), 53 (1), 54 (0), 55 (1), 56 (1); scales above lateral line 14 (2), 15 (7), 16 (32), 17 (63), 18 (51), 19 (40), 20 (19), 21 (13), 22 (15), 23 (4), 24 (2), 25 (0), 26 (0), 27 (0), 28 (1); scales below lateral line 13 (2), 14 (0), 15 (0), 16 (15), 17 (24), 18 (23), 19 (37), 20 (30), 21 (30), 22 (27), 23 (23), 24 (16), 25 (10), 26 (7), 27 (2), 28 (0), 29 (2); scales around caudal peduncle 17 (6), 18 (14), 19 (44), 20 (57), 21 (42), 22 (39), 23 (26), 24 (24), 25 (11), 26 (5), 27 (3), 28 (1); total vertebrae 34 (2), 35 (15), 36 (60), 37 (37), 38 (2); precaudal vertebrae 18 (7), 19 (52), 20 (54), 21 (3); caudal vertebrae 15 (2), 16 (40), 17 (62), 18 (12), 19 (1).

Color in preservation variable, from pallid to dark (Figs. 6, 7); melanophores always small, present on dorsal half of body, becoming concentrated towards dorsum, not generally present below lateral line; scattered melanophores on lips, becoming concentrated on snout, head, and circumorbital regions; upper ⅔ of opercle and ⅓ of preopercle with melanophores; pigment lacking on intermandibular, gular and branchiostegal regions; predorsal stripe diffuse to distinct, expanded and intensified near dorsal-fin origin (often obscured in melanistic specimens); postdorsal stripe less well defined than predorsal, expanded and intensified where it approaches anteriormost base of procurrent caudal rays (a similar, but usually weaker, concentration of melanophores lies directly opposite on ventral surface of peduncle, but is frequently lacking; see Fig. 7); lateral stripe often diffuse anteriorly and uniform or darker behind, extending posteriorly from opercle to end of caudal peduncle; melanophores often form blotch at base of caudal rays, sometimes extending onto caudal rays; a herringbone pattern of thin lines of pigment extending dorsally from lateral stripe and terminating on caudal peduncle (obscured in darkest individuals); melanophores scattered on dorsal, caudal and along outermost rays of pectoral fins in non-breeding individuals; breeding fish additionally with milky substance on anal fin (similar to *Cyprinella*) and blotches of pigment along anal rays; breeding males with pigment on distal portions of pelvic fins.

Breeding males, in life, with pinkish red on mandibles and throat; males with small profuse tubercles over head and body; pectoral fins large and rounded in males, short and pointed in females; head and snout rounded and blunter in males than females.

Generic Status

Our placement of *sallei* in *Notropis* is provisional. The problem was succinctly stated by Hubbs and Miller (1974:3), who noted: ". . . the present chaotic state of generic evaluations among American cyprinids . . . ."

Jordan and Evermann (1898:2799) placed *Notropis aztecus* in their subgenus *Aztecula*, a replacement for *Azteca* Jordan and Evermann (1896:258) which was preoccupied in entomology. Meek (1904) elevated *Aztecula* to generic level and referred four taxa to it (see above). Is *sallei* best referable to *Notropis, Aztecula,* or perhaps to some other genus (e.g. *Algansea*)? A similar problem was faced by Hubbs and Miller (1977) with respect to the generic status of *Dionda*.

Studies by Cortés (1968), Snelson (1971), and Gilbert and Bailey (1972) have eliminated characters previously considered to be diagnostic of *Notropis* (e.g. absence of maxillary barbels, more than four pharyngeal teeth in the major row, a single-looped intestine, etc.). Gilbert (1978) concluded that of six diagnostic characters, two remained: scales never numbering more than 55 and usually fewer than 40, and standard length less than 100 mm. The inclusion of *sallei* in *Notropis,* thus, eliminates another characteristic—low scale numbers. Furthermore, *Notropis nazas* Meek, with 44–57 lateral-line scales (original counts of paratypes, FMNH 33572), also proves to be an exception to the upper limit of 55 scales. Moreover, the numerous scales of *N. sallei* and *N. nazas* tend to form a morphocline within *Notropis,* rather than an hiatus. We conclude that the number of

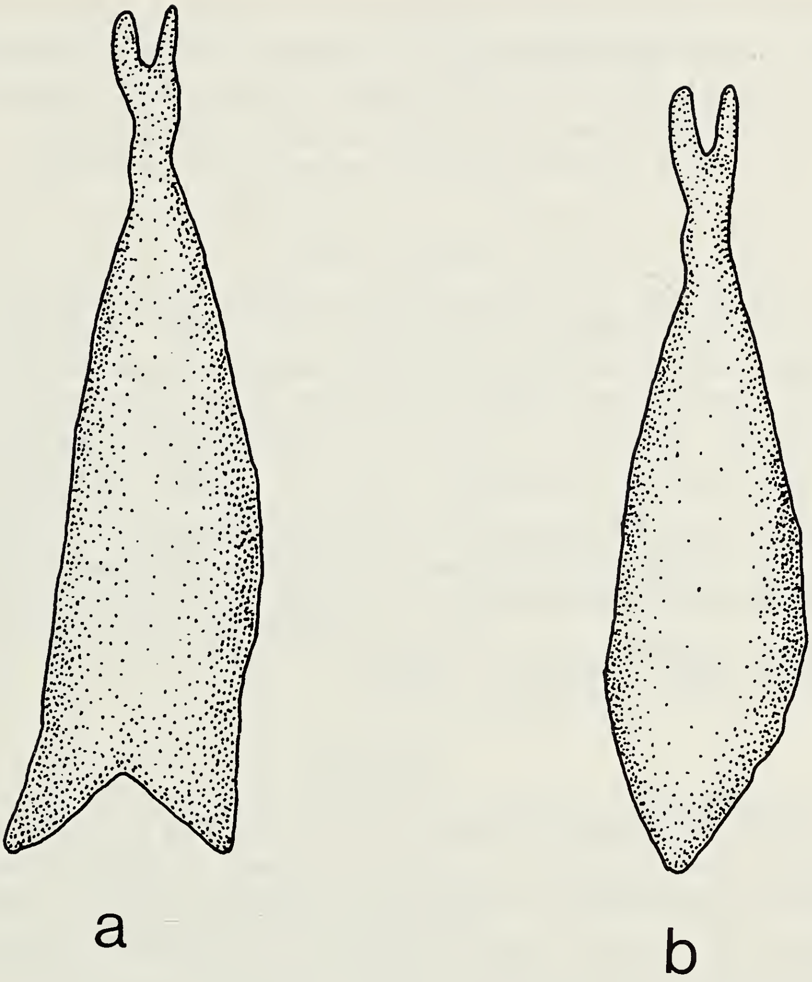

Fig. 8. Ventral view of the urohyal bone of (a) *N. lutrensis* and (b) *N. sallei.*

scales (as stated above) is not diagnostic for *Notropis,* and that seemingly only body size remains.

Comparison of the urohyal among selected American cyprinids yields some interesting results. With the exception of *N. amnis, N. boucardi, N. imeldae, N. ornatus,* and *N. sallei,* the urohyals of all *Notropis* examined (see methods and materials) have the ventral surface with lateral projections that extend up to or beyond the posterior margin of the dorsal aspect of the bone, joining the ventral midline to form a V-shaped notch (Fig. 8). *Notropis sallei, N. amnis* and *N. ornatus* have urohyals with an ovoid ventral surface (Fig. 8); this surface is reduced laterally and less than ovoid in *N. boucardi* and *N. imeldae.* The urohyals of these five species are phenetically similar to non-*Notropis* examined (*Hybopsis storeriana, Agosia chrysogaster, Yuriria alta, Algansea aphanea, A. barbata* and *A. tincella*; also see Barbour and Miller, 1978). We cannot determine, at this time, which of the states is primitive or derived. However, it is clear that the five putative species of *Notropis* cannot share the derived state with the other species of *Notropis* examined. Furthermore, we decline to infer relationships of these five species with other cyprinid genera because of the possibility that ovoid or subovoid urohyals are primitive, and relationships based upon symplesiomorphy should be avoided (Hennig, 1966). It is of further interest that *N. amnis, N. boucardi, N. imeldae,* and *N. ornatus* are also debatably referred to *Notropis* (see Clemmer, 1970; Miller, 1976, 1978; and Gilbert, 1978).

Although *sallei* is distinguished from many *Notropis* (including the type species, *N. atherinoides* Rafinesque) by the shape of the urohyal, the small scales, and its "chub-like" rather than "shiner-like" appearance, we do not propose that *sallei* be reassigned to *Aztecula.* Rather, we provisionally refer *sallei* to *Notropis* because generic changes should not be made until relationships among diagnosable genera have been determined (clearly beyond the scope of this paper); therefore, we maintain nomenclatural stability and follow recent authors who have placed *sallei* in *Notropis* (e.g. Alvarez, 1970; Miller, 1976; and Gilbert, 1978).

Resumen

Notropis sallei (Günther) habita los ríos del este de la Mesa Central incluyendo las cabeceras de las systemas siguientes: Río Balsas, Río Lerma, Río Pánuco, y las cuencas cerradas del Valle de México, y el Río Grande de Morelia. *N. sallei* ha tenido una historia taxonómica confusa y ha sido incluido en no menos de ocho géneros y diéciseis especies. Los carácteres morphológicos varian mucho dentro de las diferentes poblaciones y se superponen mucho entre poblaciones alopátricas. La variabilidad de las carácteres diagnósticos de las especies identificadas con anterioridad también se superponen. Este estudio muestra por la primera vez que estas poblaciones comprenden una sola especie. Gilbert (1978) corregió el deletreo de *N. sallaei* a *N. sallei* porque la especie era en honor del Sr. A. Sallé. La posición genérica de la especie es discutida y al mismo tiempo una redescripción es dada.

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Literature Cited

Alvarez, J. 1950. Claves para la determinación de especies en los peces de las aguas continentales Mexicanas.—Sec. Marina, Dir. Gen. Pesca e Indust. Conex., México.

———. 1970. Peces Mexicanos (claves).—Inst. Nac. Inv. Biol. Pesq., Estudio No. 1, México.

———, and L. Navarro. 1957. Los peces del Valle de México.—Sec. Marina, Dir. Gen. Pesca e Indust. Conex., México, pp. 1–62.

Bailey, R. M., and M. O. Allum. 1962. Fishes of South Dakota.—Misc. Publ. Mus. Zool., Univ. Michigan 119:1–131.

Barbour, C. D. 1973. A biogeographical history of *Chirostoma* (Pisces: Atherinidae): A species flock from the Mexican Plateau.—Copeia 1973:533–556.

———, and R. R. Miller. 1978. A revision of the Mexican cyprinid fish genus *Algansea*.—Misc. Publ. Mus. Zool., Univ. Michigan 155:1–72.

Burr, B. M. 1976. A review of the Mexican stoneroller, *Campostoma ornatum* Girard (Pisces: Cyprinidae).—Trans. San Diego Soc. Nat. Hist. 18:127–144.

Clemmer, G. H. 1970. Systematics and biology of the *Hybopsis amblops* complex.—Unpublished Ph.D. dissertation, Tulane University.

Cortés, M. T. 1968. Consideraciones sobre el género *Notropis* y descripción de una especie nueva, procedente del Río Atoyac, en Juchatengo, Oax., México.—An. Esc. Nac. Cien. Biol., México 15:185–192.

de Buen, F. 1940. Lista de peces de agua dulce de México. En preparación de su catálogo.—Estac. Limnol., Pátzcuaro, Trab. 2:1–66 [mimeo].

Evermann, B. W., and E. L. Goldsborough. 1902. A report on fishes collected in Mexico and Central America, with notes and descriptions of five new species.—Bull. U.S. Fish Comm. 21(1901):137–159.

Gilbert, C. R. 1964. The American cyprinid fishes of the subgenus *Luxilus* (genus *Notropis*).—Bull. Florida State Mus. 8:95–194.

———. 1978. Type catalogue of the North American cyprinid fish genus *Notropis*.—Bull. Florida State Mus., Biol. Sci. 23:1–104.

———, and R. M. Bailey. 1972. Systematics and zoogeography of the American cyprinid fish *Notropis* (*Opsopoedus*) *emiliae*.—Occ. Pap. Mus. Zool., Univ. Michigan 664:1–35.

Girard, C. 1856. Researches upon the cyprinoid fishes inhabiting the fresh waters of the United States of America, west of the Mississippi Valley, from specimens in the museum of the Smithsonian Institution.—Proc. Acad. Nat. Sci. Philadelphia 8:165–213.

———. 1859. Ichthyology of the Boundary.—U.S. and Mexican Boundary Survey 2(2):1–85.

Günther, A. 1868. Catalogue of the fishes in the British Museum, London, 7:1–512.

Hennig, W. 1966. Phylogenetic Systematics.—Univ. Illinois Press, Urbana.

Hubbs, C. L. 1941. The relation of hydrological conditions to speciation in fishes. pp. 182–195 *In:* A symposium on hydrobiology.—Univ. Wisconsin Press, Madison.

———, and K. F. Lagler. 1964. Fishes of the Great Lakes Region. 2nd Edition.—Univ. Michigan Press, Ann Arbor.

———, and R. R. Miller. 1974. *Dionda erimyzonops*, a new dwarf cyprinid fish inhabiting the Gulf coastal plain of Mexico.—Occ. Pap. Mus. Zool., Univ. Michigan 671:1–17.

———, and ———. 1977. Six distinctive cyprinid fish species referred to *Dionda* inhabiting segments of the Tampico embayment drainage of Mexico.—Trans. San Diego Soc. Nat. Hist. 18:267–336.

———, and C. L. Turner. 1939. Studies of the fishes of the Order Cyprinodontes. XVI. A revision of the Goodeidae.—Misc. Publ. Mus. Zool., Univ. Michigan 42:1–80.

Jordan, D. S. 1879. Notes on certain typical specimens of American fishes in the British Museum and in the Museum D'Histoire Naturelle at Paris.—Proc. U.S. Nat. Mus. 2:218–226.

———. 1880. Notes on a collection of fishes obtained in the streams of Guanajuato and in Chapala Lake, Mexico, by Prof. A. Duges.—Proc. U.S. Nat. Mus. 2(1879):298–301.

———. 1890. Notes on fishes of the genera *Agosia, Algansea,* and *Zophendum.*—Proc. U.S. Nat. Mus. 13:287–288.

———, and B. W. Evermann. 1896. The fishes of North and Middle America.—Bull. U.S. Nat. Mus. 47(1):1–1240.

———, and ———. 1898. The fishes of North and Middle America.—Bull. U.S. Nat. Mus. 47(3):2183–3136.

———, and C. H. Gilbert. 1883. Synopsis of the fishes of North America.—Bull. U.S. Nat. Mus. 16(1882):1–1018.

Meek, S. E. 1902. A contribution to the ichthyology of Mexico.—Field Columb. Mus. Publ. 65 (Zool. Ser., vol. 3, no. 6):63–128.

———. 1904. The freshwater fishes of Mexico north of the Isthmus of Tehuantepec.—Field Columb. Mus. Publ. 93 (Zool. Ser., vol. 5):1–252.

Miller, R. R. 1976. An evaluation of Seth E. Meek's contributions to Mexican ichthyology.—Fieldiana, Zool. 69:1–31.

———. 1978. Composition and derivation of the native fish fauna of the Chihuahuan Desert region. pp. 365–381 *In:* Wauer and Riskind (eds.), Transactions of the Symposium on the Biological Resources of the Chihuahuan Desert Region United States and Mexico.—U.S. Dept. Interior, Nat. Park Serv. Trans. and Proc. Ser., 3, 1977.

Regan, C. T. 1906–08. Pisces. *In:* Biologia Centrali-Americana, 8:1–203.

Resh, V. H., D. S. White, S. A. Elbert, D. E. Jennings, and L. A. Krumholz. 1976. Vertebral variation in the emerald shiner *Notropis atherinoides* from the Ohio River: an apparent contradiction to "Jordan's Rule."—Bull. S. California Acad. Sci. 75:76–84.

Segerstrom, K. 1962. Geology of south-central Hidalgo and northeastern Mexico, Mexico.—Bull. U.S. Geol. Surv. 1104-C:87–162.

Smith, G. R. 1966. Distribution and evolution of the North American catostomid fishes of the subgenus *Pantosteus,* genus *Catostomus.*—Misc. Publ. Mus. Zool., Univ. Michigan 129:1–132.

Sneath, P. H. A., and R. R. Sokal. 1973. Numerical Taxonomy.—W. H. Freeman and Co., San Francisco.

Snelson, F. F., Jr. 1971. *Notropis mekistocholas,* a new herbivorous cyprinid fish endemic to the Cape Fear River basin, North Carolina.—Copeia 1971:449–462.

Sokal, R. R., and F. J. Rohlf. 1969. Biometry.—W. H. Freeman and Co., San Francisco.

Stewart, D. J. 1977. Geographic variation of *Barbus radiatus* Peters, a widely distributed African cyprinid fish.—Env. Biol. Fish 1:113–125.

Vandermeer, J. H. 1966. Statistical analysis of geographic variation of the fathead minnow, *Pimephales promelas.*—Copeia 1966:457–466.

West, R. C. 1964. Surface configuration and associated geology of Middle America, pp. 33–83 *In:* Wauchope and West (eds.), Handbook of Middle American Indians, vol. 1.—Univ. Texas Press, Austin.

Woolman, A. J. 1894. Report on a collection of fishes from the rivers of central and northern Mexico.—Bull. U.S. Fish Comm. 14(1895):55–66.

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BERNARDICHTHYS ZORRAQUINOSI, A NEW GENUS AND SPECIES OF SALMONIFORM FISH FROM THE LATE CRETACEOUS OF OREGON

Richard W. Huddleston

Abstract.—Field samples from the Bernard Formation (lower Cenomanian) of Oregon contained a single well-preserved teleost otolith that represents a new genus and species, *Bernardichthys zorraquinosi* (Salmoniformes: Bernardichthyidae). A Kevex analysis of the otolith's composition revealed the presence of calcium, silica, aluminum, iron, potassium, and magnesium. This is in contrast to the composition of Pliocene otoliths from the Purissima formation which consisted only of calcium, probably in the form of aragonite. This specimen constitutes the third reported occurrence of Cenomanian age otoliths and the earliest reported occurrence of an otolith in North America.

Samples collected by Bruce Welton from the basal Bernard formation, Oregon, yielded a single well-preserved teleost otolith. The Bernard formation, established by Dickinson and Virgrass (1965), lies unconformably on Paleozoic, Triassic, and Jurassic strata and is overlain unconformably by Tertiary volcanics. The formation is approximately 1500 feet (460 m) thick and consists of a pebbly sandstone to conglomerate with minor amounts of clayey sandstones and mudstones. From invertebrate data it is considered lower Cenomanian (lower-most upper Cretaceous age) by Dickinson and Vigrass (1965).

Although Koken (1891) first described Cretaceous otoliths from Europe, their occurrence in North America was not mentioned until some 64 years later when Tychsen and Vorhis (1955) reported, but did not describe, otoliths from the Fox Hills Sandstone (Maastrichtian age) of South Dakota. The first description of taxa based on Cretaceous age otoliths from North America followed ten years later when Frizzell (1965a, 1965b) described new genera and species of the families Albulidae and Vorhisiidae, the latter subsequently found to be a junior synonym of the family Ariidae (J. E. Fitch, personal communication). Discussions pertaining to Cenomanian age otoliths are restricted to reports concerning a single otolith and an otolith impression (Gowda, 1967a, 1967b; Stinton, 1973).

The otolith terminology follows that of Frizzell and Dante (1965); see Fig. 1. Additional terms used but not shown in Fig. 1 are: ventral furrow, a narrow depression below the sulcus parallel to the ventral margin; excisura,

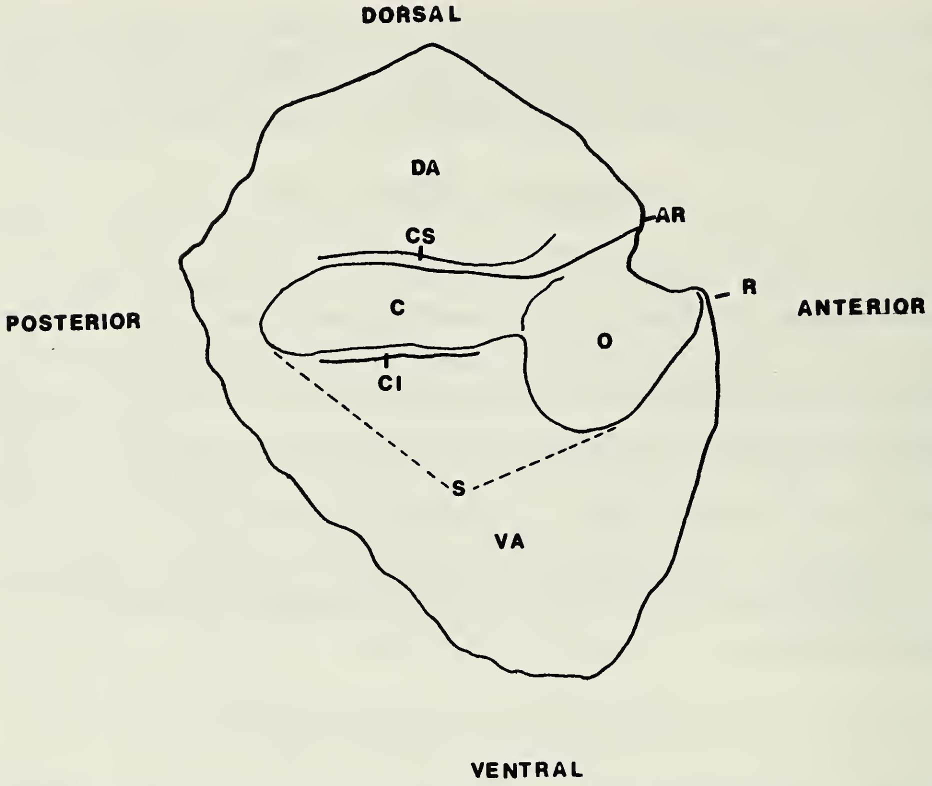

Fig. 1. Diagram of sagitta of *Antigonia eos* (Beryciformes: Antigoniidae) showing terminology used in this paper. AR, antirostrum; C, cauda; CI, crista inferior; CS, crista superior; DA, dorsal area; O, ostium; R, rostrum; S, sulcus; VA, ventral area.

a notch or indentation between the rostrum and antirostrum; and collum, a small ridge or division line between the ostium and cauda. The term otolith is a general term for three pairs of discrete elements occurring within the auditory labyrinth of fishes. These elements are the sagitta, asteriscus and lapillus.

Order Salmoniformes (*sensu* Greenwood et al., 1966)

Bernardichthyidae, new family

Type-genus.—Bernardichthys, new genus.

The sagitta of the Bernardichthyidae differs from that of other families in the following combination of characters: nearly straight, horizontal cauda, lower margin of cauda straight, upper margin tapering posteriorly; short anteriorly expanding ostium; possessing a reduced rostrum, no antirostrum; lacking any form of depression on the dorsal area; lacking ventral furrow; possessing a deep ventral margin; lacking well defined crista superior and crista inferior as preserved (the sagitta displays some attrition which may have affected the crista superior and crista inferior); sulcus situated above

Fig. 2. *Bernardichthys zorraquinosi,* n. gen., n. sp. Holotype, LACM 4483/118693, left sagitta.

horizontal midline of sagitta; all margins smooth as preserved. Additional characters are as defined for the genus.

Bernardichthys, new genus

Type-species.—*Bernardichthys zorraquinosi,* new species.

Diagnosis.—Sagitta semi-ovate; dorsal margin angular; ventral margin broadly rounded, ventral margin asymmetrical, anteroventrally skewed; dorsal-ventral height greater than anterior-posterior length; sulcus horizontal, situated nearer dorsal margin; sulcus nearly straight; cauda narrow; dorsal rim of cauda slightly convex tapering posteriorly; ostium short, wider than cauda; excisura absent as preserved; ostium expanding anteriorly; rostrum weakly developed; crista superior and crista inferior weakly developed or absent as preserved; dorsal and ventral areas without depressions; ventral furrow absent.

Bernardichthys zorraquinosi, new species
Fig. 2

Holotype.—Complete left sagitta, Los Angeles County Museum of Natural History (LACM) 118693; Fig. 2.

Type locality.—LACM 4483, Bernard Formation, Crook County, Oregon; Lat. 44°06′52″N, Long. 119°40′42″W; in the NE ¼ of the SE ¼ of the NE ¼ of Sec. 11, T 17S, R 25E, Dayville map, 30 min. series. The site is approximately 3½ mi N of Saplee, Oregon and ½ mi NE of the Bernard Ranch, on the north side of Beaver Creek, on the southeast side of a northeast–southwest trending low ridge, in concretionary sandstone beds outcropping on the slopes of the ridge.

Description.—Small left sagitta, 3.76 mm antero-posterior length, 4.00 mm dorsal-ventral height, greatest thickness 0.84 mm; sagitta semi-ovate; inner face slightly convex; greatest thickness near sagitta midpoint; dorsal margin (see Fig. 1 for terminology) angular, posterodorsally inclined at a steep angle from the mid-ostium level, reaching greatest height at mid-sagitta, then posteroventrally inclined at a low angle; posterior margin posteroventrally inclined at a steep angle above sulcus, rounded at sulcus, anteroventrally inclined at a steep angle below sulcus; ventral margin deep, asymmetrically rounded, reaching greatest depth anterior of vertical midline of sagitta; ventral margin abruptly rounded at deepest point; anterior margin anterodorsally inclined below level of sulcus; anteriormost portion of sagitta missing, reconstruction of this area suggesting only a weakly developed rostrum; antirostrum and excisura not present as preserved; sulcus situated on dorsal half of sagitta; sulcus nearly straight, horizontal; ostium and cauda distinct; ostium short, elliptical, anteriorly expanding, open anteriorly; collum represented by a low posterodorsal-anteroventrally inclined shelf; cauda narrow, shallow, widest near collum, ventral margin of cauda straight, dorsal margin slightly curved, tapering posteriorly; cauda closed posteriorly, deepest along dorsal edge, uniformly shallowing to ventral edge; crista superior weakly developed as preserved; crista inferior absent as preserved; dorsal and ventral areas smooth, lacking depressions; ventral furrow absent; all margins smooth as preserved; outer face smooth, unsculptured.

Comparison.—The sagitta of *Bernardichthys zorraquinosi* differs from other otoliths by the following combination of characters: sagitta semi-ovate; angular dorsal margin; anterior margin with short pointed rostrum; posterior margin sharply rounded; ventral margin deeply rounded, deepest nearest anterior end; sulcus nearly straight, approximately horizontal, located on dorsal half of sagitta; ostium short, open anteriorly; weakly developed crista superior; absence of depressions on dorsal and ventral areas.

The slightly elevated position of the sulcus, the small distinct ostium, and the lack of an outward projecting flange on the dorsal portion of the sagitta prevent association of this form with the Osteoglossomorpha. The height-length ratio, well developed sagitta, nearly straight sulcus, and deeply rounded ventral margin of the sagitta prevent association of *Bernardichthys* with the Ostariophysi. The nearly straight sulcus, small ostium, relatively flat outer face, thin sagitta, deeply rounded ventral margin, and presence of a rostrum are within the acceptable limits of the Salmoniformes (*sensu* Greenwood et al., 1966). Several of these characters are reflected in members of the families Osmeridae (Suborder Salmonoidei) and Argentinidae (Suborder Argentinoidei).

Sagittae of the extant Osmeridae and Argentinidae are characterized by a generally subangular external shape; strongly developed rostrum; straight, horizontal sulcus; deep subangular ventral margin; ventral margin usually reaching greatest depth nearest anterior end in the Argentinidae, nearest the posterior end in the Osmeridae; cauda either closed or open posteriorly; dorsal area with prominent depression in the Osmeridae, not pronounced or absent in the Argentinidae.

Greenwood et al. (1966) defined the Salmoniformes as containing eight suborders (Salmonoidei, Argentinoidei, Galaxoidei, Esocoidei, Stomiatoidei, Alepocephaloidei, Bathylanconoidei, and Myctophoidei). The straight horizontal sulcus, elevated position of the sulcus from the horizontal midline of sagitta, lack of a strong rostrum, and ovate sagitta differentiates the Bernardichthyidae from the Alepocephaloidei, Bathylaconoidei, Esocoidei and Galaxoidei. *Bernardichthys* differs from the Salmonoidei and Argentinoidei primarily by the lack of a well developed rostrum, absence of a subangular ventral margin, and the lack of shallow depressions on the dorsal area. The narrow cauda, wider ovate ostium, and curved dorsal rim of the cauda differentiates Bernardichthyidae from the Stomiatoidei. Among the Myctophoidei the characters are similar to the Harpadontidae, having the sulcus elevated to the dorsal half of sagitta, a well defined cauda margin, and a shorter rostrum.

The Bernardichthyidae is sufficiently distinctive to prevent assignment to any of the extant suborders of the Salmoniformes. It is advisable to leave the subordinal position of the Bernardichthyidae as *incertae sedis*.

Discussion.—A Kevex analysis of the sagitta of *Bernardichthys zorraquinosi* indicated the presence of the following elements, in order of significance: calcium, silica, aluminum, potassium, iron, and magnesium. With the exception of calcium these probably represent replacement of the original components which have been leached out. Similar analysis of otoliths from the Purissima formation (lower Pliocene) revealed only calcium, probably in the form of aragonite (Huddleston, unpublished data).

Etymology.—This species is named in honor of Joseph A. Zorraquinos of Rosemead, California, for his life-long pursuit of knowledge and science.

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Literature Cited

Dickinson, W. R., and L. W. Virgrass. 1965. Geology of the Suplee-Izee area, Crook, Grant and Harney counties, Oregon.—Bull. Oregon Geol. and Min. Indust. 58, 39 pp.

Frizzell, D. L. 1965a. Otolith-based genera and lineages of fossil bonefishes (Clupeiformes, Albulidae).—Senck. Leth. 46a:85–110.

———. 1965b. Otoliths of new fish (*Vorhisia vulpes,* N. gen., N. sp. Siluroidei?) from Upper Cretaceous of South Dakota.—Copeia 1965(2):178–181.

———, and J. Dante. 1965. Otoliths of some early Cenozoic fishes of the Gulf Coast.—Jour. Paleontol. 39:687–718.

Greenwood, P. H., D. E. Rosen, S. H. Weitzman, and G. S. Myers. 1966. Phyletic studies of teleostean fishes, with a provisional classification of living forms.—Bull. Amer. Mus. Nat. Hist. 131:339–456.

Gowda, S. S. 1967a. The first fossil otolith from India.—Bull. Geol. Soc. India 4:15–17.

———. 1967b. On a new fossil fish known from an otolith from the South Indian Cenomanian.—Jour. Geol. Soc. India 8:119–129.

Koken, E. 1891. Otolithes. *In* Bohm, J., De Kreidebildungen des Furbergs und Sulzbergs bei siegsdorf in Oberbayern.—Palaeontographica 38:37–40.

Stinton, F. C. 1973. Fish otoliths from the English Cretaceous.—Palaeontol. Soc. Monogr. 2:57–126, pls. 4–8.

Tychsen, P. C., and R. C. Vorhis. 1955. Reconnaissance of geology and ground water in the lower Grand River Valley, South Dakota.—U.S. Geol. Surv., Water-Supply Pap. 1298. 33 pp.

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A REVISION OF THE SUBSPECIES OF *SPOROPHILA* ("*ORYZOBORUS*") *ANGOLENSIS* (AVES: EMBERIZINAE)

Storrs L. Olson

Abstract.—Because of similarities in plumage and morphology, and the occurrence of several "intergeneric" hybrids, the genus *Oryzoborus* is merged with *Sporophila*. *Sporophila maximiliani parkesi* nom. nov. is proposed to replace the preoccupied name *Oryzoborus crassirostris magnirostris* Phelps and Phelps 1950. Within *Sporophila angolensis* there are two groups, distinguished by the adult male plumage. In the *funerea* subspecies group, currently considered monotypic, four subspecies are now recognized, based on female and subadult plumages: *S. a. funerea* (Sclater), *S. a. salvini* (Ridgway), *S. a. ochrogyne* new subspecies, and *S. a. aethiops* (Sclater). In the *angolensis* subspecies group, *S. a. angolensis* (Linnaeus) is the only taxon recognized east of the Andes, with *S. a. torrida* (Gmelin) a synonym; *S. a. theobromae* new subspecies is named for a population isolated in the upper Magdalena Valley of Colombia.

Currently there are three species admitted in the genus *Oryzoborus,* a group of heavy-billed Neotropical finches in the subfamily Emberizinae. The smallest species, *O. angolensis,* the type of the genus, occurs from Mexico to Argentina and includes the nominal species *O. funereus* of earlier authors. The other two species, *O. crassirostris* and *O. maximiliani,* are considerably larger forms confined to South America, except for small disjunct populations of the latter species in Panama and Nicaragua. The seven subspecies of *O. maximiliani* were considered to be races of *O. crassirostris* until Meyer de Schauensee (1970) showed these two taxa to be sympatric, or nearly so, over a wide range.

Despite the obvious resemblance of *Oryzoborus* to members of the large genus *Sporophila,* in many works (e.g. Sharpe, 1888; Ridgway, 1901; Hellmayr, 1938) these two genera were separated by varying numbers of seemingly less similar genera, although in later treatments *Oryzoborus* has been placed immediately following *Sporophila* (Meyer de Schauensee, 1966; Paynter, 1970).

With the exception of the *angolensis* subspecies group, the males of *Oryzoborus* are all black in color, apart from a white speculum and white under the wing in some taxa, so that they resemble, for example, *Sporophila americana corvina*. Males of the *angolensis* group have chestnut on the lower breast and belly, and males of several species of *Sporophila* likewise have chestnut in the underparts. As in *Sporophila,* the females of *Oryzoborus* differ in plumage from males and are generally dull brownish, similar to females of *Sporophila americana* and other species.

In reading through the generic descriptions given by Ridgway (1901:564, 603), which are not written in a comparative manner so that it is not evident which characters are "diagnostic," about the only difference one can find between *Oryzoborus* and *Sporophila* is in the "enormously thick and broad" bill of the former. This is not necessarily of generic value, however. In the proportions of the bill the differences between *O. angolensis* and *Sporophila americana* are scarcely any greater than between *O. crassirostris* and *O. angolensis* (Fig. 1). The species of *Sporophila* tend to have the culmen more curved than in *Oryzoborus,* but there is so much variation in bill shape within *Sporophila* itself (e.g. the peculiar *S. falcirostris*) that this appears to be of minor importance.

Perhaps the most telling evidence for a very close relationship between *Oryzoborus* and *Sporophila* was presented by Sick (1963:166), who found that hybridization between species of these two genera was not uncommon in Brazil. He discussed five wild-taken apparent hybrids between *O. a. angolensis* and *S. c. caerulescens,* two between *O. a. angolensis* and *S. lineola,* and one between *O. a. angolensis* and *S. ardesiaca.* Sick likewise called attention to the fact that the differences between the smaller forms of *Oryzoborus* and the larger forms of *Sporophila* were not nearly as great as had previously been supposed.

The structure of the skull in *Oryzoborus* and *Sporophila* is similar, although that of *Oryzoborus* is more robust, with a more sharply angled rostrum and broader anterior portions of the palatines. Again, there are striking differences between *O. angolensis* and *O. crassirostris.* The differences in skull structure between *Oryzoborus* and *Sporophila* are considerably less than those between the various species of the emberizine genus *Geospiza,* as illustrated by Bowman (1961).

Considering the broader generic limits now being admitted in the Passeriformes, I find it strange that *Oryzoborus* has continued to be recognized. Although the three species of *Oryzoborus* appear to be more closely related to each other than any one of them is to a particular species of *Sporophila,* they are surely part of a monophyletic assemblage that includes *Sporophila,* in which they represent only the extremes in size and crushing adaptations of the bill. I believe that it is best to emphasize the close relationship of these birds, and the fact that they constitute a single radiation, by uniting *Oryzoborus* Cabanis 1851 with *Sporophila* Cabanis 1844. The three species presently recognized in *Oryzoborus* therefore become *Sporophila angolensis* (Linnaeus), *Sporophila crassirostris* (Gmelin), and *Sporophila maximiliani* (Cabanis).

Fortunately, this creates no problems of homonymy, as I have found no duplication in *Oryzoborus* of any of the trivial names currently applied to *Sporophila*. However, Kenneth C. Parkes (*in litt.*) has drawn my attention to the fact that *Oryzoborus crassirostris magnirostris* Phelps and Phelps 1950, is preoccupied by *Coccoborus magnirostris* Swainson 1837, proposed as a new name for *Loxia angolensis* Linnaeus 1766. In accordance with the systematic conclusions outlined above, I propose:

Sporophila maximiliani parkesi, nom. nov.

to replace *Oryzoborus crassirostris magnirostris* Phelps and Phelps 1950.

Revision of the Subspecies of *Sporophila angolensis*

The Lesser or Thick-billed Seed Finch, *Sporophila angolensis,* includes two groups that were previously regarded as separate species. In the *angolensis* subspecies group the adult males have the lower breast and belly chestnut, whereas in the *funerea* subspecies group the chestnut is replaced with black. The *S. angolensis* group is found in most of tropical South America east of the Andes and in the upper Magdalena Valley of Colombia. The *S. funerea* group extends from southern Mexico through Middle America to western Colombia and Ecuador and east to the Magdalena Valley. I have dealt with the interesting interaction between these two groups in the Magdalena Valley in another paper (Olson, in press). Here I shall review the geographic variation within each of these two subspecies groups.

The *S. a. funerea* Subspecies Group

Because the adult males are almost entirely black, they are not useful for showing plumage variation, and at present *S. a. funerea* is not subdivided. Females and subadult males, however, show considerable geographic variation which has been overlooked until now. At one time, Hellmayr (1911) admitted a southern race, *aethiops* (Sclater) based on coloration of females and alleged differences in bill size, for birds from western Colombia and western Ecuador, but he later considered that its recognition was not warranted (Hellmayr, 1938). Doubtless contributing to past difficulties in subdividing the *funerea* group is the fact that subadult males are more intensely colored than females in the same population, so that comparison must be made sex for sex; otherwise there would appear to be considerable overlap in characters. Subadult males were not infrequently missexed by earlier collectors, who may have made their determinations by plumage rather than by gonads. Individuals that are apparently missexed are not difficult to detect, given sufficient material. In any case, adequate series of correctly sexed specimens permit the identification of no less than four subspecies within the *funerea* group. Names are available for all but one of these, which, as it turns out, is the most widespread form and the best represented

Fig. 1. Bills of selected species of *Sporophila* to show the gradation in size between typical *Sporophila* and the forms of "*Oryzoborus*": (left to right) *S. americana corvina, S. angolensis ochrogyne, S. crassirostris, S. maximiliani nuttingi.*

in collections. For the *funerea* group, the following descriptions, and the lists of specimens examined, refer to females and subadult males only.

Sporophila angolensis funerea (Sclater)

Oryzoborus funereus Sclater 1859, Proc. Zool. Soc. London 1859:378. Suchapam, Oaxaca, Mexico.

Characters.—Females and subadult males with underparts lighter, more brownish, and less intensely reddish than in *salvini* or *aethiops,* but darker than in *ochrogyne.* Dorsum less reddish than in *salvini* or *aethiops* but not as pale and grayish as in *ochrogyne.*

Range.—The Caribbean slope of southeastern Mexico, Guatemala, Belize, and Honduras.

Specimens examined.—MEXICO. TABASCO: Teapa (1, USNM; 1, FM). VERA CRUZ: La Gloria, 45 mi S of Acayucán (1, WFVZ). GUATEMALA. Secanquim (1, AMNH); Finca Chama (1, AMNH). BELIZE (BRITISH HONDURAS). Near Manatee Lagoon (5, CM); All Pines (2, CM); Sittee River, Freetown (1, CM). HONDURAS. Lake Yojoa (1, CM); Planes (2, CM); La Ceiba (1, CM).

Remarks.—The two females from Mexico are somewhat more reddish dorsally than the remainder of the series, but the material is insufficient to determine if this character is constant.

Sporophila angolensis salvini (Ridgway)

Oryzoborus salvini Ridgway 1884, Proc. U.S. Nat. Mus. 6:401. Los Sábalos, Nicaragua.

Characters.—Females and subadult males much more richly colored than any of the other subspecies; underparts, particularly of the subadult males, deep reddish chestnut; most similar to *aethiops* but not as sooty below, and dorsum more reddish.

Range.—Southern Nicaragua, Costa Rica except in the extreme southwest, and the Caribbean coast of Panamá east at least to western Veraguas.

Specimens examined.—NICARAGUA. Escondido River (6, USNM); Greytown (1, USNM); Los Sábalos (2, USNM—cotypes; 1, AMNH). COSTA RICA. SARAPIQUI: 1.5 mi SE of Puerto Viejo (1, WFVZ); LIMON: Limón (5, AMNH; 2, FM); Cariari (3, WFVZ); CARTAGO: Juan Viñas (1, MCZ); PUNTARENAS: Boruca (2, MCZ). PANAMÁ. BOCAS DEL TORO: Almirante (5, USNM); Changuinola (1, USNM); VERAGUAS: Guabal, Río Calovévora (1, AMNH).

Remarks.—The two specimens from Boruca, Costa Rica, and that from Changuinola, Panamá, while nearest *salvini,* appear to show signs of intergradation with the following subspecies. The birds from the western Caribbean coast of Panamá are instantly separable from those of the rest of the country by their much richer coloration. The subspecies *salvini* and *ochrogyne* exhibit a pattern of distribution common to a number of other species, whereby a northern, usually darker, form extends into Panamá only along the western Caribbean coast and is replaced elsewhere in the country by a different subspecies that may extend into southwestern Costa Rica.

Sporophila angolensis ochrogyne, new subspecies

Holotype.—USNM 410128, female, collected 25 March 1949 at Utivé, Río Cabobré, Panamá Province, Panamá, by Alexander Wetmore and W. B. Perrygo (original number 14402).

Characters.—Females and subadult males paler than any of the other subspecies of the *funerea* group, underparts deep buffy, not chestnut; brown of breast and upperparts suffused with a grayish olivaceous wash, not reddish, and much lighter than in other forms.

Range.—Southwestern Costa Rica, Panamá except the western Caribbean coast, and western Colombia south at least to Buenaventura and east as far as the Magdalena River Valley.

Etymology.—Greek, *ochros,* pale, and *gyne,* female, in reference to the pallid coloration of the females of this subspecies. The name is a noun in apposition.

Specimens examined.—COSTA RICA. PUNTARENAS: Helechales (1, WFVZ); 13 km S of Palmar Sur (1, WFVZ). PANAMA. VERAGUAS: Wilcox Camp, San Lorenzo River [Caribbean slope] (1, AMNH); Soná (2, USNM); Isla Cébaco (1, USNM); Isla Coiba (3, USNM; 1, AMNH); Paracoté (1, CM); CANAL ZONE: Gatun (7, USNM); Bohio (1, USNM);

Curundu (1, USNM); Juan Mina (2, USNM); Pac, K-6 road (1, USNM). PANAMA PROVINCE: Chico (1, USNM); Utivé, Rio Cabobré (1, USNM—holotype); ARCHIPIELAGO DE LAS PERLAS: Isla San José (5, USNM); COLON: Colón (1, FM); Portobello (1, USNM); SAN BLAS: Mandinga (1, USNM). COLOMBIA. CHOCO: Atrato River (1, AMNH); Andagoya (5, CM); El Tambo (1, CM); ANTIOQUIA: Arenosas (1, AMNH); La Bodega, N side of Río Negrito, Highway Sonson-Nariño (1, USNM); El Pescado, 12 km below Puerto Valdívia (1, USNM); Valdívia, Sevilla (1, USNM); Hacienda Belén, 8 mi W of Segovia (1, USNM); CALDAS: Hacienda Sofia, Río Samaná (1, USNM); VALLE: Buenaventura (1, AMNH); CORDOBA: Nazaret, 12 mi NW of Tierra Alta, Río Sinú (1, USNM); Tierra Alta, Río Sinú (1, USNM); Quebrada Salvajin, Río Esmeralda, Upper Río Sinú (2, USNM); BOLIVAR: Norosí (2, USNM); Regeneración, Quebrada San Marcos, Lower Río Cauca (2, USNM); La Raya, Río Cauca (1, USNM).

Remarks.—Wetmore (1957) commented on the larger size of the bill in four specimens from Isla Coiba, Panama, and felt that these birds probably should be recognized as a distinct subspecies, an action he failed to take in the absence of a more adequate sample. He noted one individual from the Canal Zone and one from Colombia that also had larger bills than normal. I examined a female specimen of *S. a. angolensis* from the upper Caura River, Venezuela (CM 32398), in which the bill was grotesquely enlarged, being almost the size of that of *S. c. crassirostris,* although the wing was of normal size for *angolensis.* While such specimens as these represent aberrations, the Coiba birds probably do not, but, like Wetmore, I would prefer to see more material before naming this population.

I have been unable to distinguish females and subadult males of *ochrogyne* from those of *angolensis* (including *torrida*), although the adult males differ markedly. Virtually the only place where this becomes a problem is in the Magdalena Valley, where both types of adult males occur, along with intergrades (see Olson, in press).

Sporophila angolensis aethiops (Sclater)

Oryzoborus aethiops Sclater 1860, Proc. Zool. Soc. London 1860:88. Nanegal, Ecuador.

Characters.—Females and subadult males darker than *funerea* and much darker than *ochrogyne*; similar to the widely disjunct *salvini* but more sooty, less intensely reddish above and below.

Range.—Southwestern Colombia in Nariño, and western Ecuador.

Specimens examined.—COLOMBIA. NARIÑO: La Guayacana (2, LSU; 2, WFVZ); Barbacoas (1, AMNH). ECUADOR. ESMERALDAS: Esmeraldas (1, AMNH); 10 km N of Quininde on Quininde-Esmeraldas highway

(1, USNM); LOS RIOS: Hacienda Puerto Nuevo, Abras de Mantequilla, ca. 3 km NE of Vinces (1, USNM); GUAYAS: Bucay (1, ANSP); San Rafael, near Tenguel, 7 km S of Balao (1, USNM); Naranjo (1, AMNH); DEL ORO: Zaruma (1, AMNH); Río Pindo (1, AMNH); Portovelo (1, AMNH).

The *S. a. angolensis* Subspecies Group

In this group the adult males have chestnut rather than black bellies. I do not recognize any subspecies, other than the nominate one, in the extensive range of the species east of the Andes. A very distinctive new subspecies, isolated in the upper Magdalena Valley, is described below.

Sporophila angolensis angolensis (Linnaeus)

Loxia angolensis Linnaeus 1766, Syst. Nat. 12th ed. 1:303. "Angola" = eastern Brazil.
Loxia torrida Scopoli 1769 Ann. I Hist. Nat. page 140. [Venezuela].
?*Oryzoborus polinskii* Sztolcman 1926, Ann. Zool. Mus. Pol. Hist. Nat. 5:230. Yurimaguas, Peru.

Characters.—Adult males with brown portions of underparts rich, deep chestnut, rather than chocolate-brown.

Range.—Almost all of South America east of the Andes and south to northern Argentina.

Specimens examined.—The majority of those in the institutions listed in the acknowledgments.

Remarks.—Throughout most of the literature of the species, there have been two races recognized east of the Andes: *angolensis,* which is stated to range from central and eastern Brazil through eastern Bolivia, Paraguay, and northern Argentina; and *torrida,* which is said to occur in Amazonian Brazil, northeastern Peru, Colombia, Venezuela and the Guianas. According to Hellmayr (1938:246), *torrida* is "very similar to *angolensis* but slightly smaller, the tail especially shorter, and with decidedly smaller, less bulky bill." With the very large series available to me, I was unable to discern any color differences in adult males and I could see no consistent difference in the size of the bill. Furthermore, I found no significant difference in the tail lengths of samples of adult males from the ranges of the two putative subspecies (Table 1). Although the northern birds are very slightly smaller on the average, there is broad overlap and it would be impossible to make any distinction based on size. The single bird available from Paraguay had a tail 58 mm long, which exceeds that of any of the others measured; it is possible that the birds from the southernmost part of the range in Paraguay and Argentina are larger, but there is insufficient material to ascertain this.

Table 1.—Tail length (mm) of adult males of *Sporophila angolensis*.

	n	Range	Mean
Eastern Brazil (*angolensis*)	6	52–56	54
Bolivia (*angolensis*)	5	51.5–56	53
Venezuela and Trinidad (''*torrida*'')	6	51.5–53	52
French Guiana (''*torrida*'')	9	50.5–53.5	52

I cannot accept the validity of *torrida* and consider it to be a synonym of *angolensis*.

There was some variation in the coloration of females and subadult males, with certain individuals from Peru being considerably darker than typical birds. There is a possibility that the name *polinskii* (Sztolcman) is valid. However, I could find no logical pattern to the distribution of dark individuals in Peru. Perhaps the molt patterns are different in portions of the Peruvian range of the species, and with better material it could be possible to differentiate subspecies with specimens known to be in truly comparable plumage. In any case, for the present I do not recognize any subdivision of *S. angolensis* east of the Andes.

Sporophila angolensis theobromae, new subspecies

Holotype.—USNM 582224, adult male, collected 1 March 1968 at Melgar, Tolima, Colombia, by C. J. Marinkelle (received in exchange from WFVZ).

Characters.—Adult males nearest *S. a. angolensis* but lower breast and belly decidedly chocolate-brown, rather grayish, not chestnut.

Range.—Known only from two specimens from the upper Magdalena River Valley in Tolima and Huila, Colombia.

Specimens examined.—Holotype, and a single additional adult male (USNM 447682) from La Plata, Huila, Colombia, collected 14 April 1952 by M. A. Carriker, Jr.

Etymology.—Of *Theobroma,* the genus of the cacao or chocolate tree (literally ''food of the gods'' from Greek *theos,* god, and *broma,* food), in reference to the coloration of the underparts in this bird.

Remarks.—This very isolated population is the only representative of the *angolensis* group from west of the eastern Andes. Farther toward the mouth of the Magdalena, only black-bellied individuals or intergrades are known (see Olson, in press).

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Literature Cited

Bowman, R. I. 1961. Morphological differentiation and adaptation in the Galapagos Finches.—University of California Publications in Zoology 58:vii + 302 pages.

Hellmayr, C. E. 1911. A contribution to the ornithology of western Colombia.—Proceedings of the Zoological Society of London 1911:1084–1213.

———. 1938. Catalogue of Birds of the Americas. Part 11.—Field Museum of Natural History Zoological Series 13(11):1–662.

Meyer de Schauensee, R. 1966. The Species of Birds of South America and Their Distribution.—Livingston Publishing Company, Narberth, Pennsylvania. 577 pages.

———. 1970. A review of the South American finch *Oryzoborus crassirostris*.—Notulae Naturae 418:1–6.

Olson, S. L. [In press.] Interaction between the two subspecies groups of the seed-finch *Sporophila angolensis* in the Magdalena Valley, Colombia. Auk.

Paynter, R. A., Jr. 1970. Family Emberizidae. *In* R. A. Paynter, Jr., ed. Check-list of Birds of the World. Volume 13.—Harvard University Press, Cambridge, Massachusetts. 443 pages.

Phelps, W. H., and W. H. Phelps, Jr. 1950. Seven new subspecies of Venezuelan birds. Proceedings of the Biological Society of Washington 63:115–126.

Ridgway, R. 1901. The Birds of North and Middle America. Part I.—Bulletin of the United States National Museum 50:1–715.

Sharpe, R. B. 1888. Catalogue of the Birds in the British Museum. Volume 12.—British Museum, London. 871 pages.

Sick, H. 1963. Hybridization in certain Brazilian Fringillidae (*Sporophila* and *Oryzoborus*).—Proceedings of the XIIIth International Ornithological Congress: 161–170.

Wetmore, A. 1957. The birds of Isla Coiba, Panamá.—Smithsonian Miscellaneous Collections 134(9):1–105.

National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

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COMMENTS ON THE OSTEOLOGY OF BALISTOID FISHES (TETRAODONTIFORMES), WITH NOTES ON THE TRIODONTID PELVIS

James C. Tyler and Keiichi Matsuura

Abstract.—Two workers recently have independently described the osteological structure of cleared and stained specimens of a large number of genera and species (ca. half the same) of fishes of the families Balistidae and Monacanthidae (the superfamily Balistoidea, Tetraodontiformes). The phylogenetic and classificatory conclusions reached by Matsuura (1979) and Tyler (1980) are rather similar, as are the majority of their osteological observations. The few differences (ca. 5%) in their anatomical reports are discussed herein.

Introduction

Matsuura (1979) published a detailed osteologically based phylogenetic study of the balistoid fishes (Balistidae, triggerfishes; Monacanthidae, filefishes) utilizing cleared and alizarin stained specimens of 15 species representing 11 genera of balistids and 28 species representing 22 genera of monacanthids. In his similarly based study Tyler (1980) used 21 species representing 11 genera of balistids and 32 species representing 17 genera of monacanthids. Matsuura's coverage includes 57% of the balistids and 44% of the monacanthids treated by Tyler, while Tyler's coverage includes 80% of the balistids and 50% of the monacanthids treated by Matsuura. Thus, of the total of 70 species and 36 genera of balistoids treated by either Matsuura or Tyler, 26 species and 25 genera are shared between the two (Table 1). The species studied by Matsuura are mainly from Japan and the western Pacific, while those used by Tyler are of more worldwide localities.

Since Matsuura and Tyler worked independently of one another, and are of somewhat different (although cross-fertilized) cultural schools of ichthyology, yet studied osteologically many of the same species and genera, an opportunity to test the degree of similarity of their materials and observations presents itself. If one assumes that both researchers were careful in their observations and precise in their descriptions, then similar results can be presumed to be accurate in the vast majority of cases, for it is unlikely that two attentive workers would frequently commit the same observational error independently. Therefore, only the few differences in the osteological descriptions of Matsuura and Tyler need to be discussed to clarify or rectify these observations for the benefit of subsequent workers. The latter will

Table 1.—List of species studied (X) by Matsuura (1979) and Tyler (1980), and indication of synonyms.

Species	Examined by:	
	Matsuura	Tyler
Balistidae		
Abalistes stellatus	X	X
Balistapus undulatus	X	X
Balistes capriscus	—	X
Balistes forcipatus	—	X
Balistes polylepis	—	X
Balistes vetula	X	X
Balistoides conspicillum	X	X
Balistoides viridescens	—	X
Canthidermis maculatus	X	X
Sufflamen bursa	X	X
= *Hemibalistes bursa*		
Sufflamen chrysopterus	X	X
= *Hemibalistes chrysopterus*		
Melichthys niger	—	X
Melichthys vidua	X	X
Odonus niger	X	X
Pseudobalistes flavomarginatus	X	—
Pseudobalistes fuscus	X	—
Rhinecanthus aculeatus	X	X
Rhinecanthus echarpe	X	X
= *Rhinecanthus rectangulus*		
Rhinecanthus verrucosus	—	X
Sufflamen fraenatus	X	X
Sufflamen verres	—	X
Xanthichthys lineopunctatus	—	X
Xanthichthys mento	X	—
Xanthichthys ringens	—	X
Monacanthidae		
Acanthaluteres spilomelanurus	—	X
Acreichthys hajam	X	—
Alutera heudelotii	X	X
Alutera monoceros	X	X
Alutera schoepfi	X	X
Alutera scripta	X	X
Amanses scopas	X	X
Anacanthus barbatus	X	X
= *Psilocephalus barbatus*		
Arotrolepis filicaudus	X	—
Brachaluteres trossulus	—	X
Brachaluteres ulvarum	X	—
Cantherhines dumerili	X	—
Cantherhines pardalis	—	X
Cantherhines pullus	—	X

Table 1.—Continued.

Species	Examined by:	
	Matsuura	Tyler
Cantherhines sandwichiensis	—	X
Chaetoderma penicilligera	X	X
= *Chaetoderma spinosissimus*		
Eubalichthys mosaicus	X	—
Laputa cingalensis	—	X
Meuschenia freycineti	X	—
Meuschenia hippocrepis	X	—
Meuschenia trachylepis	X	—
Monacanthus chinensis	X	X
Monacanthus ciliatus	—	X
Monacanthus mylii	—	X
Monacanthus tuckeri	—	X
Navodon modestus	X	—
Navodon setosus	—	X
Navodon tesselatus	X	—
Nelusetta ayraudi	X	—
Oxymonacanthus longirostris	X	X
Paraluteres prionurus	X	X
Paramonacanthus barnardi	—	X
Paramonacanthus cryptodon	—	X
Paramonacanthus curtorhynchus	—	X
Paramonacanthus japonicus	X	—
Pervagor melanocephalus	X	X
Pervagor spilosomus	—	X
Pseudalutarius nasicornis	X	X
= *Pseudaluteres nasicornis*		
Pseudomonacanthus peroni	X	—
Rudarius ercodes	X	X
Rudarius minutus	—	X
Scobinichthys granulatus	X	—
Stephanolepis auratus	—	X
Stephanolepis cirrhifer	X	X
Stephanolepis hispidus	—	X
Stephanolepis setifer	—	X

have the opportunity to test in the arena of the 95% agreement between Matsuura and Tyler what is here considered the likely assumption that they are relatively careful reporters. It is here postulated that only about 5% of the osteological observations of Matsuura and Tyler are in any kind of conflict.

Even though Matsuura attempted a cladistically based analysis which should exclusively use shared advanced character conditions (cladistic approach) to link groups in phylogenetic interpretations and generic segregations, while Tyler utilized the weighting and balancing of both generalized and specialized features (gradistic or phenetic approach) to the same end, the phylogenetic conclusions and generic recognitions between these two osteologically based works are rather similar, with only a few notable exceptions (e.g., see *Canthidermis,* below).

The differences in the interpretative methodologies are not discussed further here, with the following comments confined to the differential osteological observations. Most of these are accountable to statements about genera based on different sets of species examined, or to different sizes of individuals of the same species examined for what prove to be ontogenetic features, and to individual variation between specimens of the same species.

Unless otherwise stated, references are to Matsuura (1979) and Tyler (1980).

Balistidae

Frontal of Abalistes stellatus.—Matsuura states (p. 112, Fig. 40) that this species is unique among the balistids in "having the frontal expanded greatly . . . posteriorly beyond the level of the rounded postero-dorsal surface of the cranium," while Tyler makes no such distinction. The explanation is undoubtedly that Matsuura's three specimens were all large adults (200.0–230.2 mm SL) while Tyler's single specimen was much smaller (87.6 mm SL) and did not yet possess this posterolateral expansion of the frontal which apparently develops only in larger adults. This region of the skull in the 87.6 mm specimen is very similar to that of most other balistids.

Encasing scales of Balistapus undulatus.—Tyler states (1962, 1980) that this species has but a single pair of scales in Segment III of the encasing scale series at the posterior end of the pelvis, in contrast to two pairs in this segment in *Balistes* [*Verrunculus*] *polylepis, Balistes vetula,* and other balistids; Matsuura states (p. 73) that there are two pairs of scales there in *B. undulatus* as well as in all other balistids. Matsuura examined 11 specimens of 41.8 to 226.0 mm SL and Tyler examined 5 specimens of ca. 120 to 124.3 mm SL. Re-examination of Tyler's material and of 3 additional specimens (USNM 301981, 30.2 mm SL; USNM 197525, 46.0–68.7 mm SL) recently cleared and stained shows Matsuura to be correct. However, there tends to be fusion of the two pairs of scales in Segment III to the extent that it often appears in large specimens that there is a single pair. Thus, in the recently prepared 68.7 mm SL specimen, only a single pair of scales was evident until all of the surface granulations and spiny processes had been shaved away with a scalpel and the scale plates substantially thinned. Only then in transmitted light was it possible to detect the closely apposed surfaces of the two pairs, which even in this relatively small specimen were so consolidated that they nearly fused in places. Re-examination of the 124.3 mm SL specimen previously reported by Tyler as having a single pair of scales in

Segment III shows that this would be more accurately characterized as 1½ pairs (3 pieces), for the two pairs seem fully fused on one side but distinct on the other. In the previously examined 121.6 mm SL specimen, both pairs seem fully fused. It is obvious that Matsuura is correct in pointing out that Segment III has two pairs of scales, at least developmentally, in all balistids, even though some fusion between elements of the pairs can be expected in some (usually larger) specimens of some species (such as *B. undulatus*).

Balistid postcleithrum.—Matsuura states (p. 78) that all balistids he examined have the postcleithrum as two pieces (dorsal and ventral postcleithra), while (p. 80) all monacanthids have the postcleithrum as a single piece. Tyler states (p. 101) that balistids have it as either a single piece or divided into dorsal and ventral segments, in contrast to monacanthids in which the postcleithrum is always a single piece. Tyler gives lateral view illustrations (Figs. 70–72) of the entire skeleton of the balistids *Rhinecanthus echarpe, Sufflamen fraenatus,* and *Canthidermis maculatus* showing the postcleithrum as a single piece, in contrast to illustrations (Figs. 51, 69, 73) of *Balistapus undulatus, Balistes polylepis,* and *Xanthichthys lineopunctatus* showing the two segments of the postcleithra. Re-examination of the specimens used by both Matsuura and Tyler indicates that Tyler is correct in showing fusion of the postcleithrum into a single piece in some balistids.

Supposed scale bone of Canthidermis maculatus.—Matsuura describes and illustrates (p. 109, Fig. 38) a scale bone as being present in this species alone among all the balistoids, while Tyler (p. 43) says that a scale bone is absent in all balistoids and in all other plectognaths (tetraodontiforms). This is but one example among many of a bone that is present in such possibly ancestral or sister group perciforms as acanthuroids and chaetodontoids but lost by plectognaths in their largely reductive evolutionary processes. Matsuura's two specimens were large adults (218.4 and 251.5 mm SL), while Tyler's was an especially nicely cleared 80.1 mm SL specimen, for which a lateral view illustration of the entire skeleton is presented, and one larger (216.9 mm SL) specimen. Tyler's illustration (Fig. 72) shows a bone similar to that thought to be a scale bone by Matsuura. Notes on the original drawing state that this is simply the posterior portion of the sphenotic, which superficially, on the lateral surface of the skull, is separated from the more anterior portion of the sphenotic by a ventrad extension of the frontal. The frontal makes slight contact with a dorsad extension of the pterotic and apparently divides the sphenotic into an anterior and posterior portion which are still fully continuous just below the surface. The 80.1 mm specimen has been especially carefully re-examined to verify this point, and the ventrad extension of the frontal that overlies the middle of the lateral surface of the sphenotic laid back and excised on one side. This reveals (Fig. 1) the depression on the sphenotic that accommodates the extension of the frontal. The

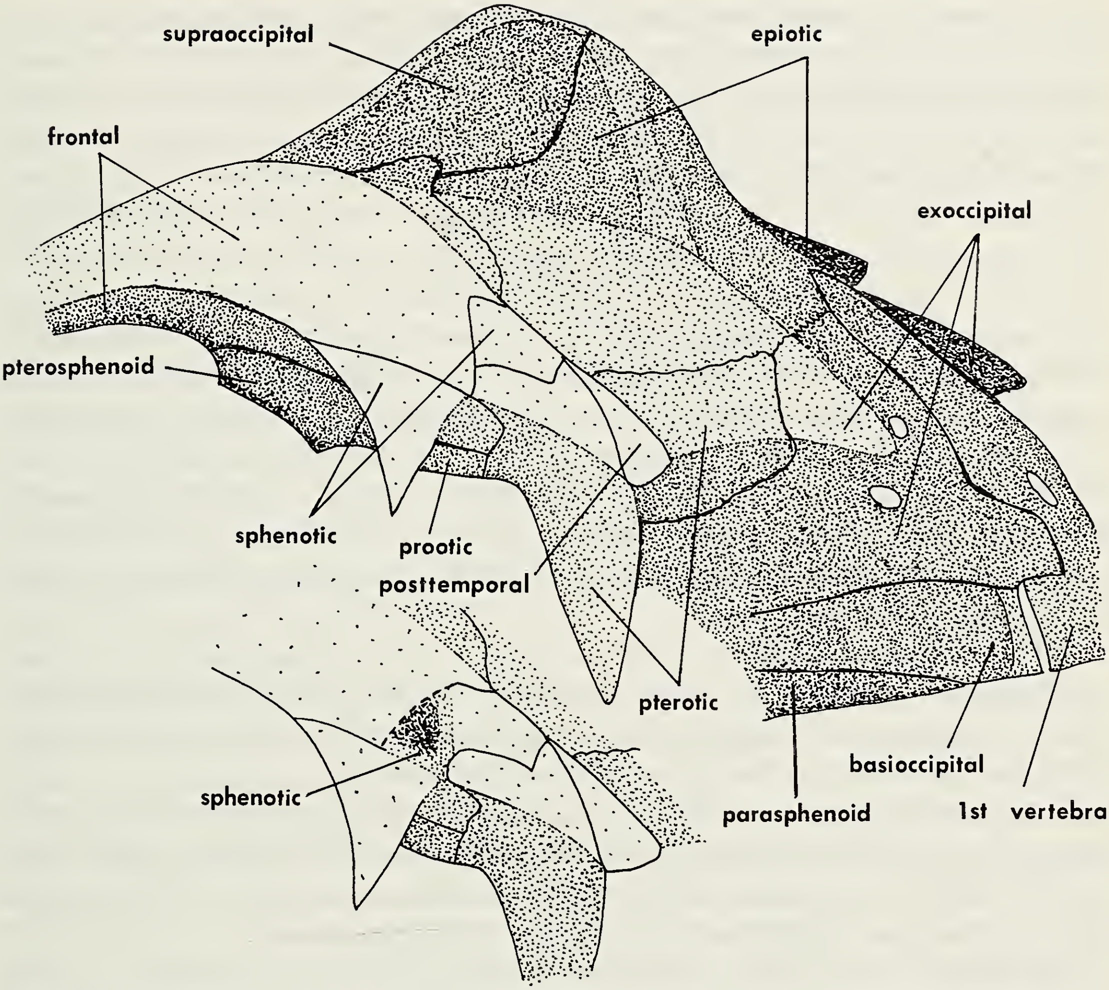

Fig. 1. Posterior portion of cranium of *Canthidermis maculatus*, ANSP 100085, 80.1 mm SL. Larger drawing above shows the downward flange of the frontal meeting the upward extension of the pterotic, superficially dividing the sphenotic into forward and rear sections which are clearly continuous below the surface as seen in the lower drawing in which the downward flange of the frontal has been cut away (dashed line).

more posterior portion of the apparently divided sphenotic could be misinterpreted as a scale bone. Re-examination of the specimens used by Matsuura also shows the element described as a scale bone to be the rear of the sphenotic.

This separation of the sphenotic by a superficial meeting of a ventrad flange of the frontal and a dorsad flange of the pterotic also occurs to some degree in at least large individuals of *Balistes capriscus* (Tyler, Fig. 74) with partial external separation, in *Sufflamen fraenatus* (Tyler, Fig. 70) with partial external separation, and in *Balistes polylepis* (Tyler, Fig. 69) with external separation as complete as in *Canthidermis*.

Matsuura placed great emphasis on the supposed presence of a scale bone in *C. maculatus* as an indicator of its primitiveness, and separated it off first (Fig. 79) as the sister group of all other balistids on this basis. Fraser-Brunner (1935:660–661) also thought *Canthidermis* to be the most generalized balistid, but only on the basis of it lacking enlarged tympanic scales above the pectoral fin. Conversely, Tyler (p. 123) considered *Canthidermis* to be only slightly less specialized than the most specialized of the balistids (the *Xanthichthys-Odonus* line) and of about the same level of specialization in its own way as *Melichthys*. Tyler considered *Canthidermis* specialized for a more oceanic and pelagic existence than the other balistids (even more so than *Abalistes*, an offshore form) with the scales of the body "all being reduced in size and nonoverlapping [explaining the absence of distinctive tympanic scales] and thus more flexible . . ." and "also specialized in having the full ossification of the skeleton much delayed, as well as in having the most rudimentary pelvic apparatus among the balistids," including its especially rudimentary pelvic fin ray element and relatively inflexible series of encasing scales.

Balistoid urohyal shape.—Matsuura (p. 92 *et seq.*, Figs. 26, 28) describes a difference between the urohyal in balistids (plate-like with several projections) and monacanthids (flattened and boomerang-like) overlooked by Tyler in his comparative diagnoses of the two families.

Balistid epipleurals.—Matsuura states (p. 149) that the epipleurals in balistids never extend posteriorly beyond the first caudal vertebra, while Tyler (p. 167, Fig. 71) correctly shows that in *Rhinecanthus* they are attached as far posteriorly as the fifth and sixth caudal vertebrae.

Balistoid posttemporal.—Both Matsuura and Tyler call attention to a familial distinction in the posttemporal between balistids and monacanthids, but describe it with different emphasis. Matsuura states (p. 148–149) that the posttemporal in balistids articulates with the epiotic, but that it does not contact that bone in monacanthids. Tyler (p. 101, 135) states that the posttemporal in balistids is held in a deep groove on the lateral surface of the pterotic, but that in monacanthids it is held more superficially in a much less deep groove on the lateral surface of the pterotic. Tyler makes no direct statement on the relationship of the posttemporal to the epiotic. Matsuura is correct in pointing out that the less sturdy posttemporal of monacanthids is usually distinctly farther removed from the epiotic (least so in *Oxymonacanthus*, see Matsuura Fig. 47 and Tyler Fig. 122) than in balistids. In some specimens of some species of balistids, however, it appears that the posttemporal either does not make contact with the epiotic or barely does so (see Tyler, Fig. 52, for *Balistapus undulatus*). It is excluded, or mostly so, from that contact by the juncture of the sphenotic and pterotic behind it, which intervenes between the posttemporal and epiotic. Perhaps there are ontogenetic changes in the degree of exclusion. The proximity of the posttemporal to the epiotic in balistids is sometimes closer as seen from the inside of the cranium (cephalic vault) since the sphenotic and pterotic overlap the posterodorsal end of the posttemporal less extensively internally than externally. In any case, the relationship of the posttemporal to the epiotic is more of a quantitative than a qualitative distinction between the two families.

Monacanthidae

Monacanthid scapular foramen.—Matsuura states (p. 80) that "the inner surface of the scapula foramen is completely enclosed by the scapula in all the monacanthid members, though the anterior edge of the outer surface of the scapula foramen is surrounded by the cleithrum in these members: *Stephanolepis, Rudarius, Alutera, Oxymonacanthus, Pseudalutarius,* and *Anacanthus,*" whereas Tyler states (p. 172) that the scapular foramen is completely enclosed by the scapula in all monacanthids (as in balistids) except *Anacanthus* and *Pseudalutarius,* two of the most specialized genera of the family. Re-examination of the specimens used by Tyler, including the careful disarticulation of the delicate scapula from previously undisturbed pectoral girdles, reaffirms that the scapula is incomplete around the foramen (Fig. 2) anteriorly in *A. barbatus* and *P. nasicornis,* where the border of the foramen is formed by the cleithrum. However, there is individual variation in the closure of the foramen, for re-examination of Matsuura's specimens (4 of *P. nasicornis,* 124.3–150.2 mm SL; 2 of *A. barbatus,* 157.1–206.4 mm SL), all of which are slightly to substantially larger than those used by Tyler (2 of *P. nasicornis,* 50.8–108.3 mm SL; 3 of *A. barbatus,* 142.3–138.7 mm SL) shows the foramen sometimes to be complete.

Monacanthid pharyngobranchial and basibranchial elements.—Matsuura extensively surveyed and amply illustrated the branchial arches in balistoids, probably more fully than ever before with any familial grouping of fishes. Tyler's interpretations of the branchial arches differ in only two respects. Matsuura states (p. 102–103) that *Oxymonacanthus longirostris* and *Paraluteres prionurus* are unique among the monacanthids in having a toothless suspensory first pharyngobranchial in addition to the two toothed elements found in all other monacanthids, and that *P. prionurus* is also unique in having four basibranchials rather than the three of all other monacanthids (except *Anacanthus* with only two). By omission to the contrary, Tyler implies that both of these species have the normal monacanthid branchial arrangement of only two pharyngobranchials (both toothed) and three basibranchials.

Re-examination of Tyler's specimens of these two species (8 of *O. longirostris* and 1 of *P. prionurus*) indicates that none of them has a first toothless suspensory pharyngobranchial and that *P. prionurus* has only three

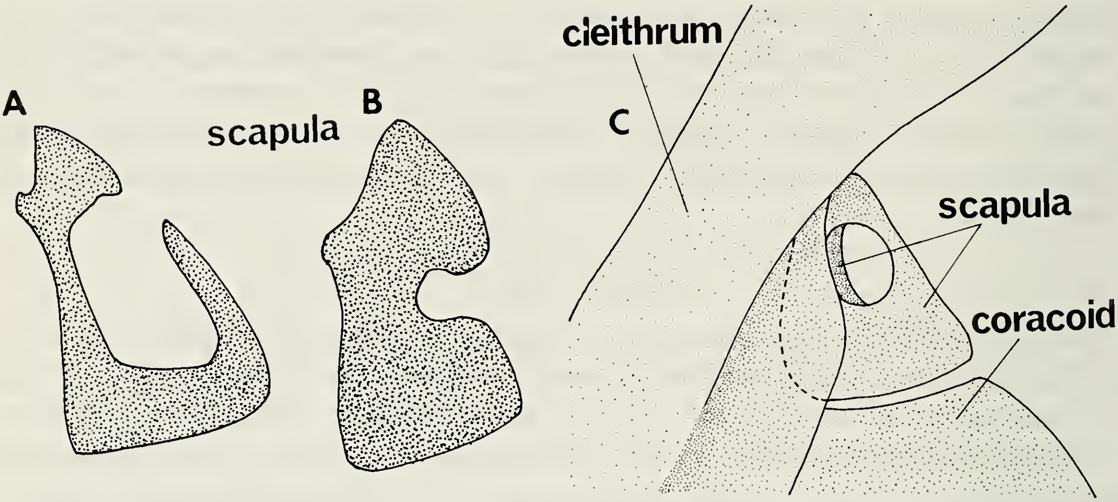

Fig. 2. Medial view of left scapula of (A) *Pseudalutarius nasicornis*, USNM 294075, 50.1 mm SL, and (B) *Anacanthus barbatus*, ANSP 109648, 142.3 mm SL, in contrast to the more normal condition of the scapula (C) as seen, for example, in *Alutera monoceros*, HUMZ 38062, 155.2 mm SL, in lateral view.

basibranchials, as do most other monacanthids. Re-examination of Matsuura's specimens (2 of *O. longirostris* and 2 of *P. prionurus*) shows that the element described as the toothless suspensory first pharyngobranchial is actually a distal part of the first epibranchial. This distal part is abnormally separated from the proximal part of the first epibranchial by an unossified portion. Examination of additional specimens of *O. longirostris* (HUMZ 40658, 50366) confirms the normal pharyngobranchial arrangement in this species, with two pharyngobranchial elements only, both toothed. Re-examination of Matsuura's specimens of *P. prionurus* indicates that the bone interpreted as the fourth basibranchial is actually the anterior portion of the fourth ceratobranchial, abnormally fused into a shaft-like element and separated from its posterior region by an unossified segment.

To avoid confusion, it should be noted that there is a typographical error in Table 4 (p. 108) of Matsuura's work, for *Paraluteres* is listed as having the normal two pharyngobranchials, while it is described in the text (p. 108) and illustrated (Fig. 34) as having three pharyngobranchials.

Posttemporal of Anacanthus barbatus.—Tyler states (p. 167) that the "posttemporal is present in all monacanthids except *Psilocephalus barbatus*, none of the three adult specimens of which shows any evidence of one. Whether the ossification center for the posttemporal is lost or incorporated indistinguishably with that of the pterotic remains problematical," while Matsuura (p. 116) has been able to distinguish a bump on the pterotic in his specimens [*Anacanthus*] which may represent the fused posttemporal.

Dewlap expansion in monacanthids.—Matsuura states (p. 77) that "In contrast with the primitive monacanthids, the advanced monacanthids such as the fishes of the genus *Brachaluteres* can only slightly extend downward the reduced pelvis without the incasing scales, however, they have the other mechanism to inflate their abdomen" [=inflatable stomach]. This statement was made to explain the functional significance of the stomach of *Brachaluteres*. However, it should be borne in mind that one of the most highly specialized of all monacanthids, the exceptionally elongate *Anacanthus*, which is like the deep bodied *Brachaluteres* in its very weakly developed pelvis without encasing scales, can flare one of the largest dewlaps among all of the monacanthids, generalized and specialized. The ability to flare a dewlap is of little phylogenetic significance.

Third tooth of dentary in monacanthids.—Matsuura states (p. 83) that the third or posteriormost (last) tooth in the dentary "is extremely reduced in size" in *Brachaluteres* (*ulvarum* examined) and *Pseudomonacanthus* (*peroni*), and absent altogether in *Rudarius* (*ercodes*), *Oxymonacanthus* (*longirostris*), *Paraluteres* (*prionurus*), and *Anacanthus* (*barbatus*). Tyler states (p. 173) that the third tooth of the dentary is much smaller than the others in *Pseudalutarius* (*nasicornis*), and absent altogether in *Rudarius* (*ercodes* and *minutus*), *Oxymonacanthus* (*longirostris* examined, and presumably in *halli* also), *Paraluteres* (*prionurus*), *Anacanthus* (*barbatus*), and *Brachaluteres* (*trossulus* examined, and presumably in *baueri* and *wolfei* also), while Tyler did not examine *Pseudomonacanthus*. It seems obvious on the basis of these two reports that the development of the third dentary tooth is variable within *Brachaluteres*, being reduced in size in the species (*ulvarum*) studied by Matsuura and absent in that (*trossulus*) studied by Tyler or reported in the literature (*baueri* and *wolfei*), and that it is absent in all species of *Rudarius*, *Oxymonacanthus*, *Paraluteres* and *Prionurus*.

This leaves in conflict the reported size of the third dentary tooth of the monotypic *Pseudalutarius* (*nasicornis*). Matsuura shows it (Fig. 22) to be of relatively large size in the illustrated individual among his four specimens of 124.3–150.2 mm SL, whereas Tyler reports this tooth as of much reduced size in his two smaller specimens (50.8–108.3 mm SL). As a check on variability in the size of the third dentary tooth in *Pseudalutarius nasicornis*, an additional specimen has been cleared and stained (USNM 294075, 50.1 mm SL), and it too has the third dentary tooth much reduced in size (Fig. 3, left) as reported by Tyler. On the other hand, re-examination of Matsuura's specimen of this species (HUMZ 38074, 150.2 mm SL) confirms that the third tooth is relatively larger (Fig. 3, right). There obviously is variation in the size of the third dentary tooth in this species, and it may increase with increasing specimen size.

Ribs of Pseudalutarius nasicornis.—Matsuura describes (p. 140) the rib-

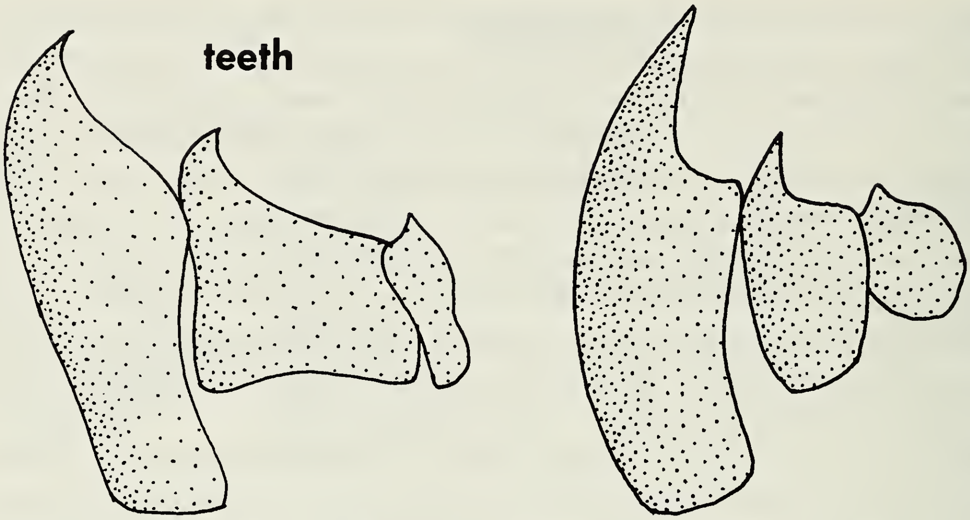

Fig. 3. Lateral view of teeth in left dentary of *Pseudalutarius nasicornis,* USNM 294075, 50.1 mm SL (left) and HUMZ 38074, 150.2 mm SL (right), to show the variation in size of the third (posteriormost) tooth; anterior to left.

like element attached to the first vertebra as an epipleural, and so illustrates it (Fig. 56). Conversely, Tyler (p. 167) states that the element attached to the first vertebra is a pleural rib like those that follow it on the other abdominal vertebrae, and so illustrates it (Figs. 114, 123). Re-examination of Matsuura's four specimens and of an additional recently cleared and stained specimen (USNM 294075, 50.1 mm SL) indicates that the element attached to the first vertebra should be recognized as a pleural rib rather than an epipleural, for the following reasons: 1) the element is longer than the epipleurals that are attached to the pleural ribs of the second to seventh vertebrae; 2) the element and the pleural ribs are distinctly more ventrally directed in position than are the epipleurals; 3) the element is in positional orientation and symmetrical series with the other pleural ribs (second to seventh vertebrae); 4) the element courses along the peritoneal wall of the abdominal cavity like the other pleural ribs, rather than, as with the series of epipleurals, being in the septum between the epaxial and hypaxial musculature.

Matsuura also states (Table 9, p. 139) that the epipleurals in monacanthids other than *Pseudalutarius* (including in *Rudarius ercodes* and *Brachaluteres ulvarum*), start on the second abdominal vertebra, while Tyler (p. 167) says and illustrates that they usually start from the second abdominal vertebra, but that they start from the third vertebra in *Rudarius ercodes* and *R. minutus* as well as in the single species he examined of *Brachaluteres* (*trossulus*). Re-examination of Matsuura's specimens of *R. ercodes* and *B. ulvarum* confirms Matsuura's statements. Thus, there is occasional variation between species and between individuals of the same species in the place of origin of the first epipleural, variously from the second abdominal vertebra (usually) or from the third (more rarely).

Second dorsal spine of Brachaluteres.—Matsuura states (p. 126) that all monacanthids have two dorsal spines, except *Anacanthus* which has only one, while Tyler says (p. 146) that both *Brachaluteres* and *Anacanthus* have only a single dorsal spine. The conflict is between the species studied of *Brachaluteres,* Matsuura examining *B. ulvarum,* in which a second spine is present, and Tyler examining *B. trossulus,* in which it is absent. Tyler should have known this, for he had radiographed the two co-types of *B. ulvarum* (Stanford University 7128, now California Academy of Sciences), as reported in his table of plectognath vertebral counts, and the radiographs clearly show a small but normally developed second spine to be present. The second spine is absent in two cleared and stained and 20 radiographed specimens of *B. trossulus* studied by Tyler.

Upper free hypural in monacanthids.—Matsuura states (p. 147) that an upper free hypural is absent in *Rudarius ercodes, Brachaluteres ulvarum,* and in adult *Alutera scripta.* Tyler reports (p. 173, 179, *et seq.*) the uppermost hypural to be free in *Alutera scripta* and the other three species of *Alutera* he examined (*heudelotii, monoceros* and *schoepfi*) as well as in *Brachaluteres trossulus,* but to be absent in most specimens studied of *Monacanthus ciliatus,* both species studied of *Rudarius* (*ercodes* and *minutus*), and in *Amanses scopas.* Matsuura describes (p. 147) and illustrates (Fig. 66) an upper free hypural in a juvenile *Alutera scripta* and its absence (through fusion) in an adult. Matsuura's four specimens of *A. scripta* were 59.0–295.8 mm SL and the two of Tyler were 46.2–73.3 mm SL. Fusion of the upper free hypural obviously occurs with increasing specimen size in *A. scripta* and in other species of monacanthids.

Palatine of Anacanthus barbatus.—Matsuura emphasizes (p. 88) the unique close articulation of the palatine with the ectopterygoid in *Anacanthus barbatus,* which is a more distant articulation mediated by a strong ligament of varying length in all other monacanthids. Both Matsuura (Fig. 25) and Tyler (Figs. 110, 120) illustrate this close apposition of articulation in *A. barbatus,* but Tyler does not comment on it in the text.

Pelvis-pectoral girdle articulation in Pervagor.—Tyler (p. 180, Fig. 105) comments on a unique specialized feature of the pelvis in *Pervagor* not mentioned by Matsuura, this being the development on the anterior region of the pelvis, just behind the pectoral girdle, of a lateral knob-like expansion which articulates with a similar expansion on the posterior edge of the coracoid, forming a point of pivot around which the pelvis rotates.

Encasing scales of Chaetoderma penicilligera.—Matsuura states (p. 59) that there are three series of encasing scales at the end of the pelvis in *C. penicilligera* and so illustrates it (Figs. 7–8), while Tyler describes (p. 178, Fig. 88) only two series of encasing scales in this species. Examination of

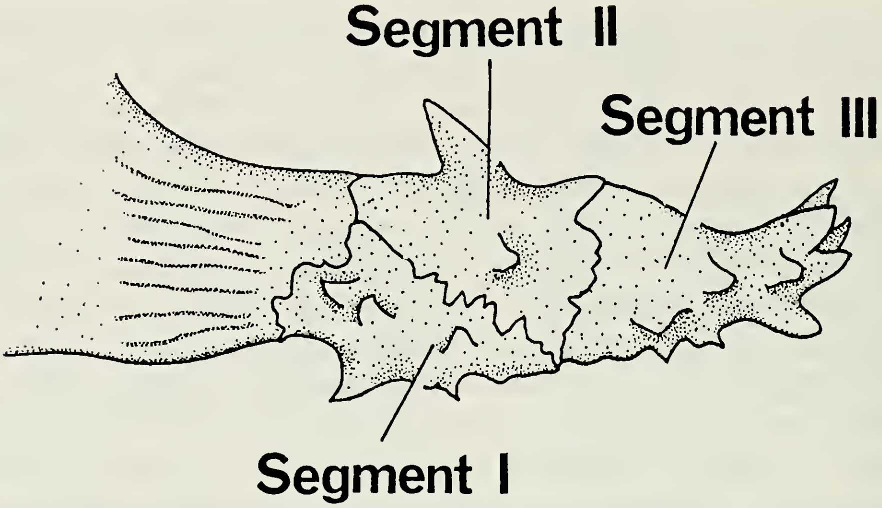

Fig. 4. Lateral view of encasing scales at end of pelvis (anterior to left) of *Chaetoderma penicilligera*, HUMZ 40645, 172.3 mm SL.

an additional specimen of *C. penicilligerum* (HUMZ 40645, 172.3 mm SL) clearly shows the encasing scales in three series (Fig. 4), although the second segment is not broadly present on the ventral surface of the apparatus.

Triodontidae

Pelvis of Triodon.—Matsuura presents an extensive survey of the pelvic apparatus of balistoids, greatly expanding on the coverage provided by Tyler (1962, 1980), especially for the rudimentary fin ray element. The latter lies buried beneath encasing scales and is difficult to dissect free for detailed study and illustration. As an aside to that exposition on the balistoid pelvic apparatus, Matsuura describes the pelvis of *Triodon,* the most generalized Recent member of the gymnodont line of plectognaths. Matsuura states (p. 78) that there is a "very small cartilage plug which is quite similar to the structure found in the advanced monacanthids" although "it is very difficult to locate since the plug is tightly enclosed by tough connective tissue at the end of the posterior part of the pelvis." In Tyler's descriptions (1962, 1980) of the pelvis in *Triodon* no mention is made of these or of most other cartilaginous elements of the skeleton.

Re-examination of one (ANSP 98917, 463.3 mm SL) of the two specimens of *Triodon* previously studied by Tyler shows that cartilaginous plugs exist at both the anterior and posterior ends of the pelvis (Fig. 5). The plugs surround the paired ends of the pelvis, as one would expect in an endochondral bone of a plectognath. Each plug is bilaterally paired, with the two halves of the plug bound together by connective tissue and terminating both anteriorly and posteriorly the ossifications of the pelvis (which two halves are fused together in much of the posterior half of their lengths but not at

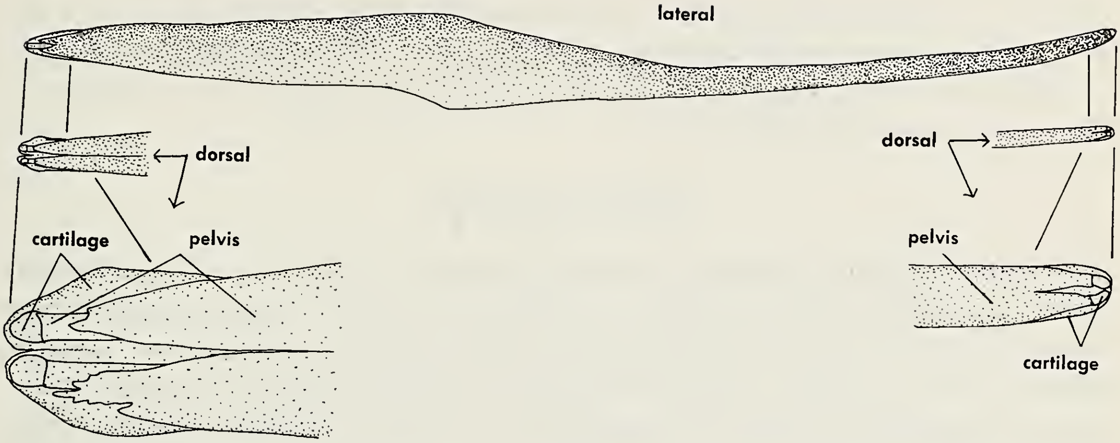

Fig. 5. Pelvis of *Triodon macropterus,* ANSP 98917, 463.3 mm SL. Above, lateral view of the entire pelvis (178 mm length); middle, dorsal views of the anterior and posterior ends of the pelvis; below, enlargements of the dorsal views of the anterior and posterior ends of the pelvis.

the extreme posterior end). The structure of the paired plugs is basically similar at both ends of the pelvis, although far larger at the anterior end. Therefore, Tyler does not believe that the paired plug at the posterior end of the pelvis in *Triodon* is necessarily homologous to the far more complex and less distinctly paired plug supporting the highly modified fin ray element in balistoids.

Examination of an additional specimen of the rarely collected *Triodon* (NSMT-P 3415, 370.0 mm SL) by Matsuura shows the same structure of the pelvis and cartilages as in Tyler's specimen. However, Matsuura believes that the plug at the posterior end of the pelvis of *Triodon* is possibly homologous to the cartilaginous plug of the fin ray element of balistoids for the following reasons: 1) the condition of the plug in *Triodon* is closely similar to that of such advanced monacanthids as *Pseudalutarius* and *Oxymonacanthus,* except for being paired; 2) the paired nature of the plug in *Triodon* is related to the divided condition of the pelvis, while the single plug of monacanthids corresponds to the undivided pelvis of that family; 3) the advanced monacanthids have a cartilaginous region at the anterior end of the pelvis similar to that of *Triodon.*

Only detailed histological analysis of the ontogenetic development of these cartilagenous plugs in *Triodon* and balistoids will solve the question of their possible homology.

Summary

The majority of the osteological observations that were made independently by Matsuura (1979) and Tyler (1980) on a largely similar coverage of

genera and species of balistoids are compatible. Most of the differences are due to statements made about genera based on different sets of species examined or about species based on different sized specimens examined, and on other intraspecific variation.

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Literature Cited

Fraser-Brunner, A. 1935. Notes on the plectognath fishes.—I. A synopsis of the genera of the Family Balistidae.—Ann. Mag. Nat. Hist. (10)15:658–663.

Matsuura, Keiichi. 1979. Phylogeny of the Superfamily Balistoidea (Pisces: Tetraodontiformes).—Mem. Fac. Fish., Hokkaido Univ. 26(1/2):49–169.

Tyler, James C. 1962. The pelvis and pelvic fin of plectognath fishes; a study in reduction.—Proc. Acad. Nat. Sci. Philadelphia 114(7):207–250.

———. 1980. Osteology, phylogeny and higher classification of the fishes of the Order Plectognathi (Tetraodontiformes).—U.S. Dep. Commerce, Nat. Ocean. Atmos. Admin., Nat. Mar. Fish. Serv., NOAA Tech. Rep., NMFS Circ. 434, 422 pp.

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A NEW POISON-DART FROG (ANURA: DENDROBATIDAE) FROM THE FOREST OF SOUTHEASTERN COLOMBIA

William F. Pyburn

Abstract.—*Dendrobates myersi,* a new species of poison-dart from from the Colombian rain forest, is related to members of the *Dendrobates femoralis* species group. The new frog is terrestrial, diurnal, and probably territorial. Its call is a long series of double-noted chirps given by isolated individuals. In captivity *D. myersi* is aggressive toward other dendrobatids. The larva and reproductive characteristics of the new species are unknown.

Early in August 1972, near the Cacua Village of Wacará, I listened to the penetrating notes of a dendrobatid frog calling from the leaf litter of the forest floor. The call was a long series of double-noted chirps, unlike that of any frog I had heard before. I recorded the call with a Uher 4000 Report L tape recorder, and a Cacua Indian companion captured the brightly patterned frog where it sat at the base of a low shrub. The time was about one hour before sunset.

Since that initial encounter, I have obtained six additional specimens of this unusual frog, one of which was sent alive to Charles Myers of the American Museum of Natural History. Analysis of the skin gland secretions, to be reported by Myers elsewhere, together with the color pattern and unusual, apparently territorial call, show that these seven specimens represent an unnamed species of poison-dart frog.

Dendrobates myersi, new species
Fig. 1

Holotype.—UTA A-3989, adult male collected near Wacará (elev. 216 m, long. 69°53′W, lat. 1°08′N), Comisaria de Vaupés, Colombia, 2 Aug. 1972 by J. K. Salser, Jr., Vincente López, Arquelao Gallego, and W. F. Pyburn.

Paratypes.—UTA A-7634, juvenile collected at type-locality, 3 Aug. 1972 by J. K. Salser, Jr. and W. F. Pyburn; AMNH 104681, juvenile collected at type locality, 3 Aug. 1972 by J. K. Salser, Jr. and W. F. Pyburn; AMNH 102173 adult male (skinned carcass) obtained 21 April 1976 by Pyburn at Yapima (69°28′W, 1°03′N), Comisaria de Vaupés, Colombia; AMNH 104682, adult female obtained 5 Aug. 1974 by Nathan Waltz at Yapima; AMNH 104683, adult male obtained 2 Sept. 1975 by Nathan Waltz near

Fig. 1. *Dendrobates myersi*, paratype, AMNH 102173. SVL = 29.5 mm. From a color transparency by C. W. Myers.

Yapima; FM 1331, adult male collected 7 April 1979 by William W. Lamar near Mitú, Comisaria de Vaupés, Colombia.

Diagnostic characters.—A moderate sized *Dendrobates* with a snout-vent length in males of about 28 mm. Combinations of the following characteristics distinguish *Dendrobates myersi* from all other dendrobatid frogs: maxillary and premaxillary teeth present; toes basally webbed; first finger longer than second; tarsal tubercle and ridge present; omosternum present; no light dorsolateral stripe, sides black; a complete light ventrolateral stripe; dorsum brown; bright yellow flash colors in groin and on lower arm surface; voice a long series of double-noted chirps.

In general appearance, *Dendrobates myersi* resembles *D. femoralis* (Fig. 2) and *D. zaparo* of the *femoralis* species group of Silverstone (1976). *Dendrobates myersi* differs from *Dendrobates femoralis* in having an indistinct, or no, light dorsolateral stripe separating the brown back color from the black of the sides. *D. femoralis* has a complete, well defined, dorsolateral

Fig. 2. *Dendrobates femoralis* from Pebas (Loreto) Peru, AMNH 103570. SVL ≈ 26 mm. From a color transparency by C. W. Myers.

stripe (Boulenger, 1883; Cochran and Goin, 1970) that is said by Silverstone (1976) to be yellow or golden color in life. I have seen color transparencies of live *D. femoralis* from Amazonian Peru (Loreto, Pebas) and from the Coppername River of Surinam (Saramacca, Raleigh Cataracts). The Peruvian specimen showed a pale cream-colored dorsolateral stripe and the one from Surinam showed a golden yellow stripe. There is also a difference between the two species in the marking on the thigh. In life, *D. femoralis* has, on the proximal part of its upper thigh surface, a sharply defined red or yellow diagonal mark that is not present in *D. myersi*. The upper thigh surface of *D. myersi* may be red, but the red area, when present, is distal and its leading edge is diffuse so that it does not form a sharply defined mark.

Dendrobates myersi differs from *D. zaparo* in the color and texture of the dorsal skin. In life the dorsum of *D. zaparo* is red (Silvertone, 1976), whereas live *D. myersi* has a brown dorsum, sometimes with evenly distributed dark reticulations or spots. Although the dorsum of both species is granular, the granules of *D. zaparo* are more densely packed together and more numerous than the granules of *D. myersi*. In preserved specimens, the dorsal granules of *D. zaparo* are pale on a dark ground color, whereas the reverse is true of *D. myersi*.

With the possible exception of *Dendrobates tricolor,* all of the species in the *femoralis* group are much smaller than *Dendrobates myersi*. In preservative, *D. tricolor,* unlike *myersi,* has a yellow dorsum and a yellow or white dorsolateral stripe. The small species may further be distinguished from *D. myersi* as follows: *D. anthonyi* has light middorsal and dorsolateral stripes (absent in *myersi*); *D. boulengeri* has in life a complete yellow or red dorsolateral stripe (Silverstone, 1976) that fades to cream or white in preservative, and has an irregular, reticulated or spotted pattern on the upper thigh surface (both absent in *myersi*); *D. espinosai* is in life a red-backed frog (Funkhouser, 1956) that in preservative has a dark brown dorsum, no ventrolateral light stripe and sometimes an incomplete dorsolateral light stripe (*D. myersi* has a medium to light brown dorsum and a white ventrolateral stripe).

Description (five adults including the holotype).—A medium sized dendrobatid (Table 1) with teeth on the premaxillary and maxillary bones. Vocal slits are present in males, absent in females. The tongue is free laterally and posteriorly, and has prominent papillae on the lateral and anterior parts of its upper surface. Dorsal skin of the head, back and shank is granular; ventral and lateral skin surfaces are smooth. Some specimens have a poorly defined, glandular, dorsolateral ridge.

The lower eyelid is transparent. Males have two longitudinal pleat-like folds in the skin of the gula. The posterodorsal rim of the tympanum is concealed. There are basal webs between toes II and III and between III and IV. The tarsal tubercle is connected by a dermal ridge to a prominent inner metatarsal tubercle. The outer metatarsal tubercle is small but distinct and there are large, ovoid subarticular tubercles on the toes. On the hand, a large palmer tubercle is about twice the size of the thenar tubercle and there are well developed, rounded subarticular tubercles on the fingers. The first finger is longer than the second. An omosternum is present and the muscle tissue is pink.

In life the skin of the dorsum is medium to light brown with closely spaced, darker brown granules. The sides of the head and body are blue-black and there is no light dorsolateral stripe separating the dorsal color from the color of the side. The iris is golden, densely suffused with black. There is a pale cream ventrolateral stripe passing from below the nostril, along the upper lip and side of body, to the groin, where it becomes bright yellow. The black of the side extends to the anterior base of the thigh and around the posterior end of the body to, or nearly to, the vent. The blue-grey to dark brown of the gula and chest merges with dark reticulations and/or spots on the otherwise cream-white abdomen. Lower surfaces of the hind limbs are generally marked like the skin of the abdomen. The axilla, pos-

Table 1.—Measurements (in mm) of the type series of *Dendrobates myersi*.

Catalog number	Sex	Snout-vent length	Head width	Head length	Eye length	Snout to eye	Tympanum diameter	Tibia length	Third finger disc width	Third finger width
UTA A-3987*	♂	27.8	9.0	9.1	3.4	4.4	2.0	13.1	0.8	0.5
UTA A-7634	juv.	11.7	4.0	4.2	1.9	2.2	1.0	5.9	0.4	0.2
FM 1331	♂	26.4	9.1	9.7	3.7	4.5	1.6	12.7	0.9	0.5
AMNH 104682	♀	32.8	10.5	12.8	4.1	5.5	2.3	15.0	1.0	0.6
AMNH 102173†	♂	29.5								
AMNH 104683	♂	30.6	11.4	10.0	4.2	5.5	2.3	14.3	1.2	0.7
AMNH 104681	juv.	12.9	4.5	4.3	2.3	2.2	1.3	5.9	0.4	0.2

* Holotype.

† Skin and skeletal preparation.

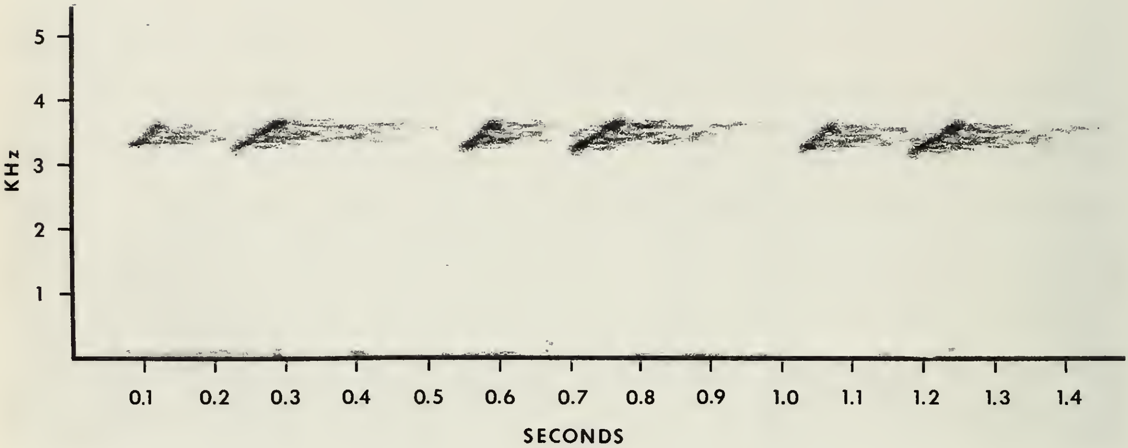

Fig. 3. Sound spectrogram (narrow band filter) of 6 notes (3 couplets) of *Dendrobates myersi* from a recording of the holotype at the type locality, 2 August 1972, air temp. ≃ 24°C.

terior surface of the upper arm, and anterior thigh surface are yellow. There is an irregular black band or group of black spots on the posterior thigh surface extending from the bend of the knee toward the vent; above this the thigh is reddish brown to coral red. The upper surface of the shank is medium brown with darker granules much like the dorsum. There is an irregular dark brown spot or stripe in the bend of the tarsus, and the fingers and toes may bear brown spots.

There is no sexual dimorphism in color pattern. The various color markings of the female are duplicated by one or more of the males.

Color of juveniles.—Two juveniles in the type series have the color pattern of the adults, except that the limbs of the young frogs are straw-colored to creamy pink and are unmarked.

Voice.—The call (Fig. 3) is a long series of whistle-like notes sometimes continuing for a minute or more if the caller is not disturbed. The notes are "chirp calls" (Myers and Daly, 1976), but unlike the chirps of other dendrobatids they are uttered in couplets or note pairs.

Two frogs at Wacará, timed with a stop watch, called at a rate of 228.6 notes per min (160 notes, air temperature about 24°C). Sound spectrograms show a dominant frequency band between 3100 and 3800 Hz and a note-pair duration of about 0.5 s.

Dendrobates espinosai is the only member of the *femoralis* group whose voice has been recorded and published as a sound spectrogram (Myers and Daly, 1976: Fig. 23). The voice of *D. espinosai* is a "buzz" consisting of a uniform series of pulses produced too rapidly to be resolved by the human ear. The call of *D. espinosai* does not resemble the easily resolved double note chirps of *D. myersi* (Fig. 3). Several dendrobatids produce calls consisting of evenly spaced chirps (Myers and Daly, 1976) but *D. femoralis* is the only other species known to produce a double noted call. Duellman (1978) described the call of *D. femoralis* as ". . . a series of high-pitched, quickly repeated pairs of notes: 'peep-peep, peep-peep, peep-peep.'" The apparent similarity in call and in morphology between *D. femoralis* and *D. myersi* suggests that these two species are closely related.

Natural history.—Dendrobates myersi is terrestrial and, like other dendrobatids, it is diurnal. Males call from isolated positions in the leaf litter on the forest floor. The frogs are not common and are always well separated from each other (10 m or more) when calling, suggesting that the call is a territorial advertisement. Myers (personal communication) observed a captive adult male *D. myersi* behaving aggressively toward dendrobatids of other species (*Phyllobates aurotaenia, P. vittatus* and *P. terribilis*) in the same terrarium. The *D. myersi* gave a short series of "peeps" and hopped on the other frogs. At other times it called from a certain, seemingly preferred, position in the terrarium.

In nature males of *D. myersi* answer to playback recordings of their calls. Most of the specimens were active when collected, but one (AMNH 104683) was found on a rainy day under cut palm leaves.

The larva and reproductive characteristics of *myersi* are unknown.

Remarks.—Dendrobates myersi is presently known only from the valley of the Vaupés River and its tributaries in southeastern Colombia. The Indians of the region (Cacua, Cubeo, Guanano) are familiar with this species, but they do not fear it and apparently do not use its skin secretions to poison their blow gun darts.

Myers et al. (1978) reassigned several species to the genus *Dendrobates* that were included in the genus *Phyllobates* by Savage (1968), Silverstone (1976), Cochran and Goin (1970), and others. Among the species reassigned to *Dendrobates* were members of Silverstone's *femoralis* group, to which the new species apparently belongs. I have tentatively accepted the arrangement of Myers et al. (1978) and have therefore placed the Vaupés species in the genus *Dendrobates*.

Etymology.—This species is named for Charles W. Myers of the American Museum of Natural History in recognition of his innovative research in dendrobatid systematics.

Specimens Examined

Abbreviations: AMNH, American Museum of Natural History, New York; FM, Federico Medem private collection, Villavicencio, Colombia; USNM, JAP, National Museum of Natural History, Washington, D.C.; UTA, University of Texas at Arlington, Arlington, Texas; CWM, Charles W. Myers field series.

Dendrobates anthonyi Noble—ECUADOR: El Oro, 3 km E Pasaje, 30 m (AMNH 89630–635).

Dendrobates boulengeri Barbour—COLOMBIA: Nariño, Isla Gorgona, Gorgonilla (AMNH 62892–93), near prison camp (USNM 145248, 145249–52).

Dendrobates espinosai Funkhouser—ECUADOR: Pichincha, Rio Baba, 5–10 km SSW Santo Domingo de las Colorados, 500 m (AMNH 89671–76), Centro Cientifico Rio Palenque, 200 m (CWM 16021–024); Rio Blanco, near mouth of Rio Yambi, about 700 m (USNM 204506–10).

Dendrobates femoralis Boulenger—BRASIL: Amazonas, Igarape Puruzino, Rio Madeira (USNM 201861–63), Curuca, Rio Madeira (USNM 201864); GUYANA: Kartabo (AMNH 39679–80); PERU: Loreto, Centro Union, lower Rio Aucayo, 20 km SE Iquitos, 3°48′S, 73°3′W (AMNH 88526–28).

Dendrobates tricolor Boulenger—ECUADOR: Azuay, Rio Minas, 20 km W Santa Isabel on Cuenca-Machala Rd, 1250 m (USNM 166897, JAP 3600–01, 3606–08), ca. 16 km W Santa Isabel, 1000 m, Rio Jubones drainage (CWM 16025–029).

Dendrobates zaparo Silverstone—ECUADOR: no specific locality (AMNH 52881); Pastaza, 0.5 NE Puzo, 985 m (USNM 204534); Vera Cruz, about 10 km E Puzo, 1016 m (USNM 204544–45); Cabeceras del Rio Bobonaza, Camino a Guamajaco, 677 m (USNM 204546); 2 km S Shell Mera, 985 m (USNM 204547); PERU-ECUADOR frontier: Gauches (on Rio Pastaza) (AMNH 52882).

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Literature Cited

Boulenger, G. A. 1883. On a collection of frogs from Yurimaguas, Huallaga River, Northern Peru.—Proc. Zool. Soc. London IV:635–638.

Cochran, D., and C. J. Goin. 1970. Frogs of Colombia.—Bull. U.S. Nat. Mus. 288:1–655.

Duellman, W. E. 1978. The biology of an equatorial herpetofauna in Amazonian Ecudaor.—Univ. Kansas Mus. Nat. Hist. Misc. Publ. 65:1–352.

Funkhouser, J. W. 1956. New frogs from Ecuador and Southwestern Colombia.—Zoologica 41:73–80.

Myers, C. W., and J. W. Daly. 1976. Preliminary evaluation of skin toxins and vocalizations in taxonomic and evolutionary studies of poison-dart frogs (Dendrobatidae).—Bull. Amer. Mus. Nat. Hist. 157:175–262.

———, ———, and B. Malkin. 1978. A dangerously toxic new frog (*Phyllobates*) used by Embera Indians of western Colombia, with discussion of blowgun fabrication and dart poisoning.—Bull. Amer. Mus. Nat. Hist. 161:309–365.

Savage, J. M. 1968. The dendrobatid frogs of central America.—Copeia 1968:745–776.

Silverstone, P. A. 1975. A revision of the poison-arrow frogs of the genus *Dendrobates* Wagler.—Nat. Hist. Mus. Los Angeles County, Sci. Bull. 21:1–55.

———. 1976. A revision of the poison-arrow frogs of the genus *Phyllobates* Bibron *in* Sagra (family Dendrobatidae).—*Ibid.* 27:1–53.

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ON DORVILLEIDAE AND IPHITIMIDAE (ANNELIDA: POLYCHAETA) WITH A REDESCRIPTION OF *ETEONOPSIS GERYONICOLA* AND A NEW HOST RECORD

Gary R. Gaston and David A. Benner

Abstract.—The symbiotic polychaete, *Eteonopsis geryonicola* Esmark (Dorvilleidae, Polychaeta), occurs in the branchial chambers of the crabs *Geryon tridens* Krøyer, *Geryon quinquedens* Smith, and *Cancer borealis* Stimpson in the North Atlantic. The latter is a new host record. The species is herein redescribed and the original genus, *Eteonopsis,* revived. A historical summary is provided to clarify confusion concerning the original description. The family, Iphitimidae, a similar group of branchiate polychaetes, are synonymized with Dorvilleidae. *Eteonopsis* occurs with significantly greater frequency and intensity in male than female crabs. Gut analyses of the worms failed to discern their mode of nutrition. A key to the Dorvilleidae is provided.

Introduction

The symbiotic annelid, *Eteonopsis geryonicola* Esmark, 1874 (Polychaeta, Dorvilleidae), lives unattached among the gills and in the branchial chamber of the deep-sea crab *Geryon tridens* Krøyer (Esmark, 1874; Bidenkap, 1895; Wesenburg-Lund, 1938; Desportes et al., 1977) and *Geryon quinquedens* Smith collected from the Atlantic Canyon (250–400 fm) in the western North Atlantic. Wesenburg-Lund (1938) reported small worms most often occurred in newly molted host crabs (*G. tridens*) and larger worms in crabs which had not recently molted. Little is known about the life history of this worm (e.g. entry into the host, mode of nutrition, reproduction, and survival through host ecdysis).

A great deal of confusion exists in the literature concerning the original description of *Eteonopsis geryonicola.* The following historical summary is provided to alleviate such problems.

Eteonopsis geryonicola was named by Esmark (1874, often misquoted as 1873) in a brief summary of an oral presentation. A number of authors, including Hartman (1951), Desportes et al. (1977), and Hartmann-Schröder (1971) incorrectly date the description to 1878, presumably in reference to a second oral presentation given by Esmark that year, but first published in 1880. Through a *lapsus* the name was incorrectly given as *E. geryonis* in the latter report. A more complete description of Esmark's material followed several years later (Bidenkap, 1895). Since the species is superficially similar to the phyllodocid polychaete, *Eteone,* Bidenkap established a new family for *Eteonopsis*: Pseudophyllodocidae. All specimens collected at that time were from the branchial chambers of the red crab, *Geryon*; hence the species name, *E. geryonicola.*

The generic name survived until Wesenburg-Lund (1938) referred *Eteonopsis* to the eunicid genus *Ophryotrocha,* and submerged the family name, Pseudophyllodocidae. Wesenburg-Lund (1938) must have been unaware that Esmark provided the original description (albeit poor) and incorrectly cited Bidenkap as the original author: *Ophryotrocha geryonicola* (Bidenkap). Subsequent authors have recognized Esmark as the original author, and referred the species to *Ophryotrocha geryonicola* (Esmark), now in the Dorvilleidae. Until recently, this species has been known only from the branchial chambers of two crabs, *Geryon tridens* Krøyer and *G. quinquedens* Smith. All other species of *Ophryotrocha* are free-living, interstitial burrowers (Åkesson, 1976).

In 1970, Fauchald established the family Iphitimidae for a number of polychaetes found primarily in crustacean branchial chambers. Though closely allied with dorvilleids, iphitimids could be distinguished in external morphology by the presence of conspicuous branchiae across the dorsum. *Ophryotrocha geryonicola* is abranchiate, as were all dorvilleids when Fauchald erected the Iphitimidae. Except for the presence of branchiae the general external morphology of iphitimids and dorvilleids is similar. Several analogous structures exist among the jaws of the two families as well. These are discussed below.

Recent discovery of branchiate dorvilleid species further eliminated the distinction between Iphitimidae and Dorvilleidae (Rullier, 1974; Armstrong and Jumars, 1978). It is proposed, therefore, that the two families be combined under Dorvilleidae, and furthermore, that the genus *Eteonopsis* Esmark, 1874 be revived for *E. geryonicola* to distinguish it from free-living species of *Ophryotrocha.* Since the original description of *E. geryonicola* was brief, a more complete description is provided herein.

This paper also reports on the occurrence of *E. geryonicola* in the red crab, *Geryon quinquedens* off the U.S. east coast, as well as the first documented evidence of *Eteonopsis* inhabiting the gills and branchial cavity of the Jonah crab, *Cancer borealis.* Collections were made at Station J-1 (Fig. 1) on the western Atlantic continental slope in May and August, 1977.

Occurrence Along United States East Coast

A total of 34 of 277 (12.3%) *Geryon quinquedens* and 1 of 197 (0.51%) *Cancer borealis* contained polychaetes in the branchial chambers (Table 1). In contrast, Wesenburg-Lund (1938) recorded infestation by this polychaete

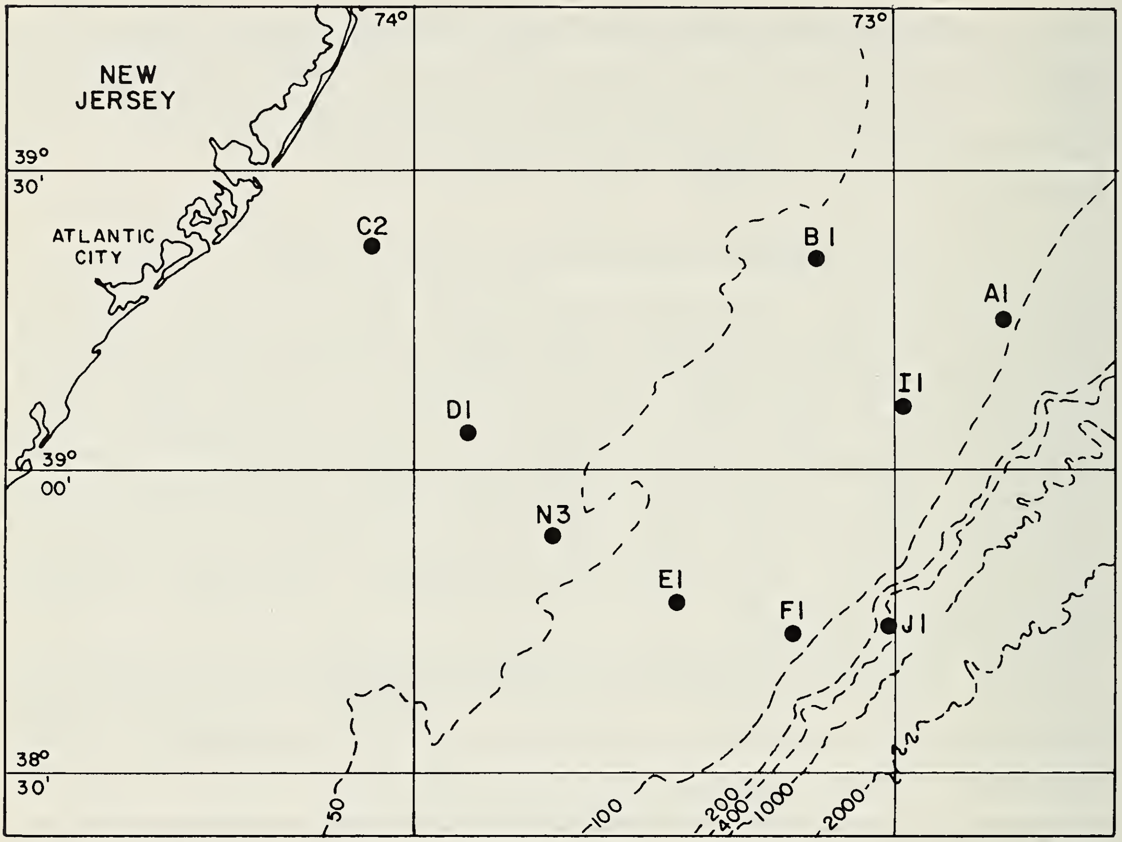


Fig. 1. Collection sites for host crabs, *Geryon quinquedens* and *Cancer borealis*. Virginia Institute of Marine Science, Bureau of Land Management Outer Continental Shelf benchmark study, 1975–1977. (Depths in meters.)

in 33% of 65 *Geryon tridens* examined in the Atlantic off Europe. Desportes et al. (1977) reported it from the western Mediterranean. *G. quinquedens* is quite common on the continental slope of the western North Atlantic (Williams and Wigley, 1977) while the distribution and abundance of *E. borealis* varies considerably with temperature (latitude) and depth. *C. borealis* is a common inhabitant of the waters off the United States east coast (MacKay, 1943) and is found in waters ranging in depth from several meters to 750 meters (Squires, 1966). Of the specimens of *C. borealis* collected on the continental shelf (<200 m), none was found to be infested with *E. geryonicola*. *C. borealis* occurred rarely in slope samples and only one specimen contained the symbiotic worm. *G. quinquedens,* however, was taken in large numbers from slope station J-1 (Fig. 1) and contained considerable numbers (range 0–12) of *E. geryonicola*.

In agreement with Wigley et al. (1975), a substantial difference in the occurrence of female vs. male *G. quinquedens* (Table 1) was found in the present study, where males constituted only 9.7% of the sample. The percentage of infestation of worms in male hosts was significantly greater than

Table 1.—Incidence of infestation by size and sex for the red crab, *Geryon quinquedens* by the polychaete, *Eteonopsis geryonicola*.

	Female	Male
No. crabs collected	250	27
No. and (percent) infested	22 (8.8)	12 (44.4)
No. worms in infested crabs mean and (range)	2.0 (1–7)	3.4 (1–12)
Carapace width—mean and (range) of infested crabs (mm)	108.8 (87–122)	138.1 (122–151)
Carapace width—mean and (range) of non-infested crabs (mm)	105.2 (84–122)	135.3 (120–144)

in females (chi-square test; $\alpha < 0.05$). Intensity of infestation (number of worms per host) was significantly greater for males than females ($\alpha < 0.05$, median test, Brown and Mood, 1951). The mean carapace width of infested males (138.1 mm) was noticeably larger than that of the infested females (108.8 mm) but no correlation between the occurrence of *E. geryonicola* and the size of the crabs could be determined. Factors which govern the investation of *G. quinquedens* and *C. borealis* by this dorvilleid cannot be resolved without additional data.

Gut Analysis

A microscopic analysis of the gut contents of these worms revealed an amorphous and acellular substance along with distinct clumps of bacteria. This substance stained well with astrablue (specific for mucopolysaccarides) and may, therefore, be digested mucus from the host crab. The question as to whether these worms are commensals or parasites with a metabolic dependence on the host, however, remains unclear.

Family Dorvilleidae Chamberlin, 1919
Eteonopsis geryonicola Esmark, 1874

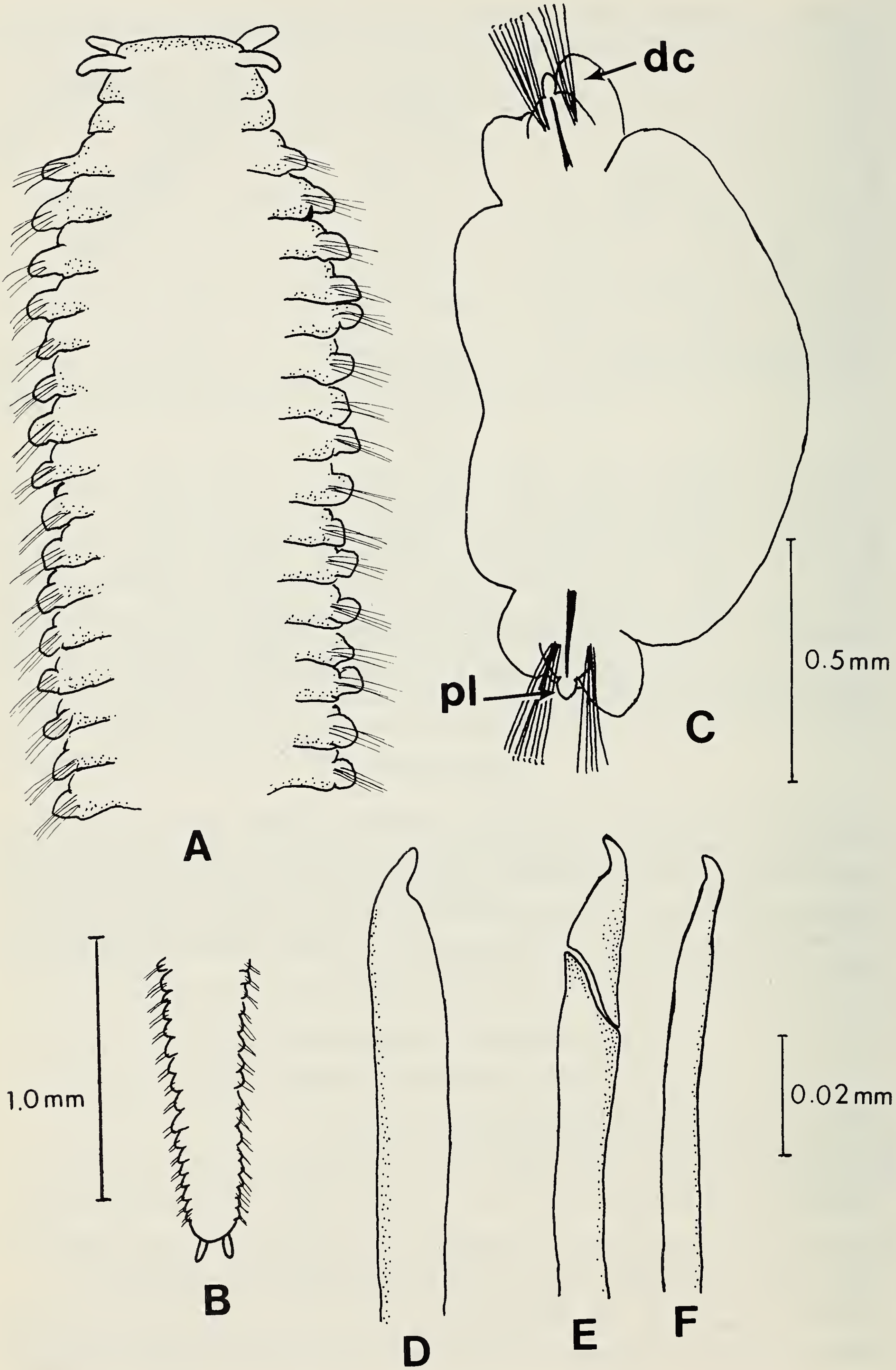
Eteonopsis geryonicola Esmark, 1874:497–498.

Eteonopsis geryonis Esmark, 1880:14.

Eteonopsis geryonicola n. gen., n. sp. (Esmark, 1873) O. Bidenkap, 1895:72–74, pl. 3, figs. 1–3.

Ophryotrocha geryonicola (Bidenkap).—E. Wesenberg-Lund, 1938:1–14, figs. 1–11.—Pettibone, 1961:181.—Hartman-Schröder, 1971:264.

Material examined.—NORWAY: Skagerrak, 4 specimens from branchial chamber of *Geryon tridens,* B. Åkesson, coll.—EAST COAST NORTH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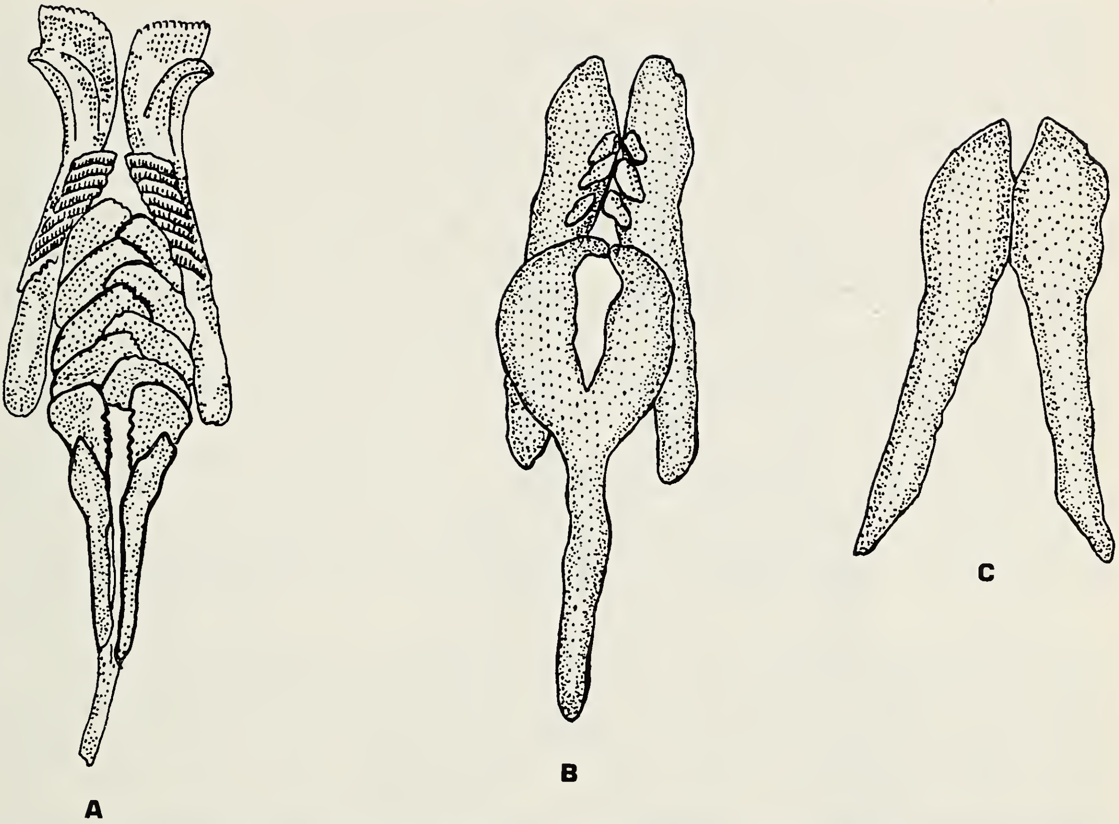

Fig. 3. *Eteonopsis geryonicola:* A, Maxillae and mandibles of a juvenile (5 mm long) specimen; B, Maxillae and mandibles of an adult (140 mm long) specimen; C, Mandibles of same. (A, B, C after Wesenberg-Lund, 1938.)

AMERICA: 3 specimens from branchial chamber of *Geryon quinquedens,* 38°44′N, 73°00′W, 350 m, D. Benner, coll. (USNM 55174). 2 specimens from branchial chamber of *Cancer borealis,* 38°40.8′N, 73°04.3′W, 342 m, D. Benner, coll. (USNM 54957). 5 specimens from branchial chamber of a red crab, Atlantis Canyon, 39°50′N, 70°10′W, 250–400 fm, K. A. Wilhelm, coll. (USNM 54339). 2 specimens from red crab, Gloucester, Maine, K. A. Wilhelm, coll. (USNM 54338). 10 specimens from *Geryon quinquidens,* 38°44′N, 73°00′W, 350 m, D. Benner, coll. (VIMS Acc. No. 736). 1 specimen from *Geryon quinquidens,* 38°45.3′N, 73°01.0′W, 350 m, D. Benner, coll. (VIMS Acc. No. 1250).

Description.—Specimens of *Eteonopsis geryonicola* range from 5–140

←

Fig. 2. *Eteonopsis geryonicola:* A, B, Anterior and posterior ends in dorsal view of 100 mm specimen; C, Transverse section, anterior view of segment 73 with presetal lobe (pl) and dorsal cirrus (dc) indicated; D, Simple falciger from middle notopodium; E, Composite falciger from middle neuropodium; F, Simple falciger from same.

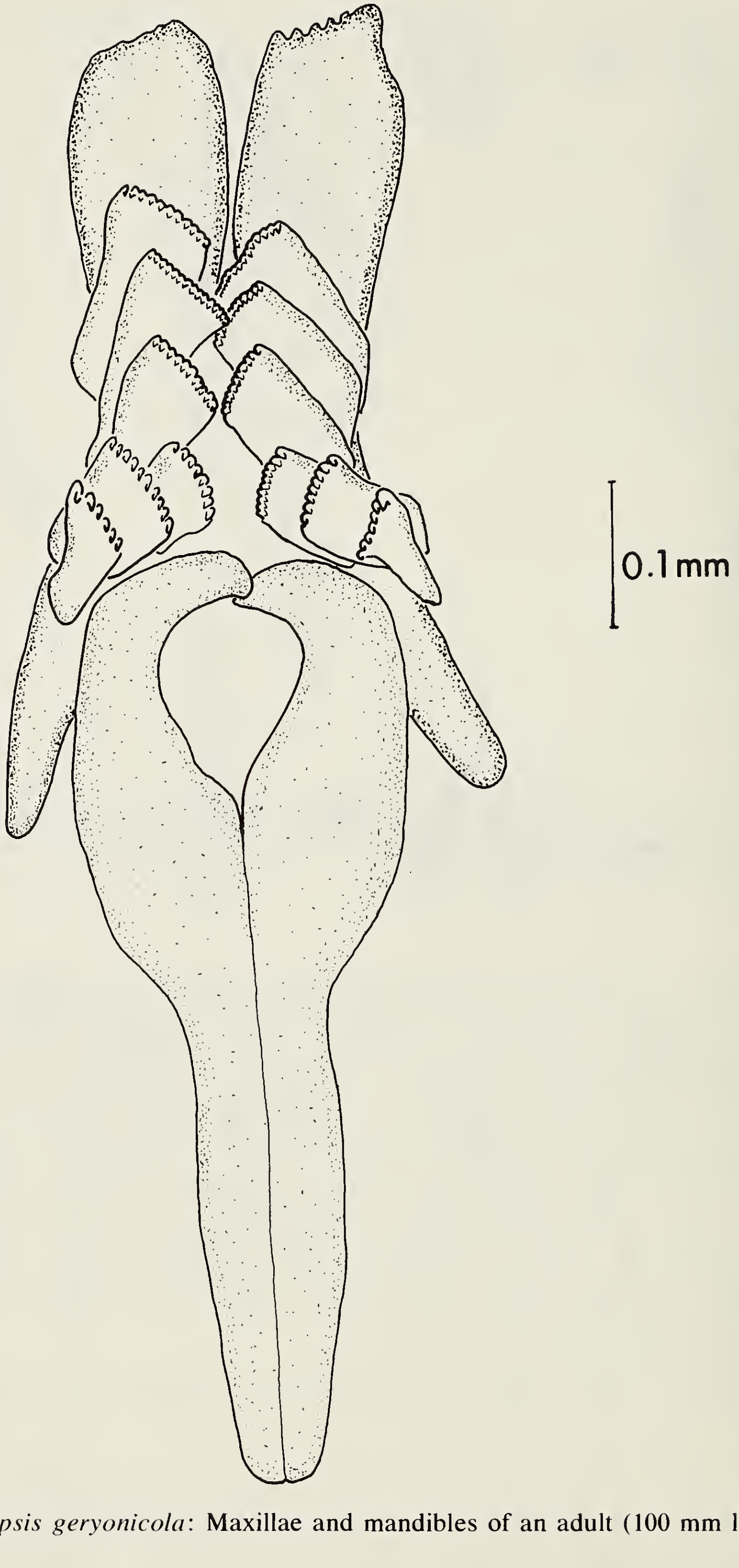

Fig. 4. *Eteonopsis geryonicola*: Maxillae and mandibles of an adult (100 mm long) specimen.

mm in length, 0.3–5.0 mm wide, and 25 to several hundreds of segments long. Body white in fresh and preserved specimens. Prostomium rounded lobe with a pair of papilliform antennae and similar pair of palps (Fig. 2A). No eyes present. Body gradually tapers posteriorly. Two short anal cirri present (Fig. 2B). Between prostomium and first setigerous segment are 2 apodous and achaetous segments.

Maxillary carriers (Fig. 3B) fused medially, free ends form pincer-like structure. Maxillae vary in number depending on size. Two small specimens (40–50 mm) have 2 sets of maxillae with up to 14 paired maxillae total (Fig. 3A). Largest specimens (120–140 mm) have as few as 3 small paired maxillae with Maxillae I (Mx I) fused to maxillary carriers (Fig. 3B). Intermediate-sized specimens (ca. 100 mm) have large maxillary carriers fused to Mx I and 6 additional maxillae (Fig. 4). Maxillary carriers and Mx I of similar size and general form in all specimens 80–140 mm long. These structures of smaller specimens poorly developed (Fig. 3A). Mandibles fused medially (Figs. 3C, 4).

Parapodia uniramous and similar throughout. Conspicuous presetal lobe, 2 rounded postsetal lobes, and blunt dorsal cirrus present (Fig. 2C). A translucent aciculum bisects each parapodium. Each parapodium contains: dorsally—4–8 long, simple, falcigers with blunt tip (Fig. 2D); ventrally—5–8 long, composite falcigers and 0–3 simple, hooked setae of similar length but more narrow shafts (Fig. 2E, F). Branchiae lacking.

Remarks.—Bidenkap (1895) failed to mention the simple setae in the lower parapodial bundle. These are not present in all parapodia and may be difficult to see. The most conspicuous difference in the morphology of *Ophryotrocha* (Fig. 5) and *Eteonopsis* (Fig. 2) is the greater size of *Eteonopsis*. Most species of *Ophryotrocha* are less than 10 mm long while *Eteonopsis* may attain a length of 140 mm. In addition, *Ophryotrocha* species are free-living, interstitial forms and *E. geryonicola* is known only as a symbiont in crab branchial chambers. Ciliary rings present in many *Ophryotrocha* are lacking in *Eteonopsis*. The setae of the two genera differ. Blades of composite falcigers are shorter in *Eteonopsis* (Figs. 2D, E, F; 5B, C). Both genera, however, reportedly have a reduction in maxillae with age (Wesenberg-Lund, 1938).

There are a number of similarities between the species of Iphitimidae (Fig. 6) and *Eteonopsis geryonicola* (Fig. 2): both inhabit crab branchial chambers; the mandibles of each (Figs. 3C, 7) are simplified and maxillary carriers are fused with Mx I into pincer-like structures (Figs. 4, 7); setae of both (Figs. 2D, E, F; 6C) include composite falcigers and simple hooks (Hartnoll, 1962); both *Iphitime* and *Eteonopsis* may occur in crab branchial chambers, but certain species of *Iphitime* (e.g. *I. hartmanae*) may also occur beneath the abdomens of egg-bearing female crabs (Kirkegaard, 1977).

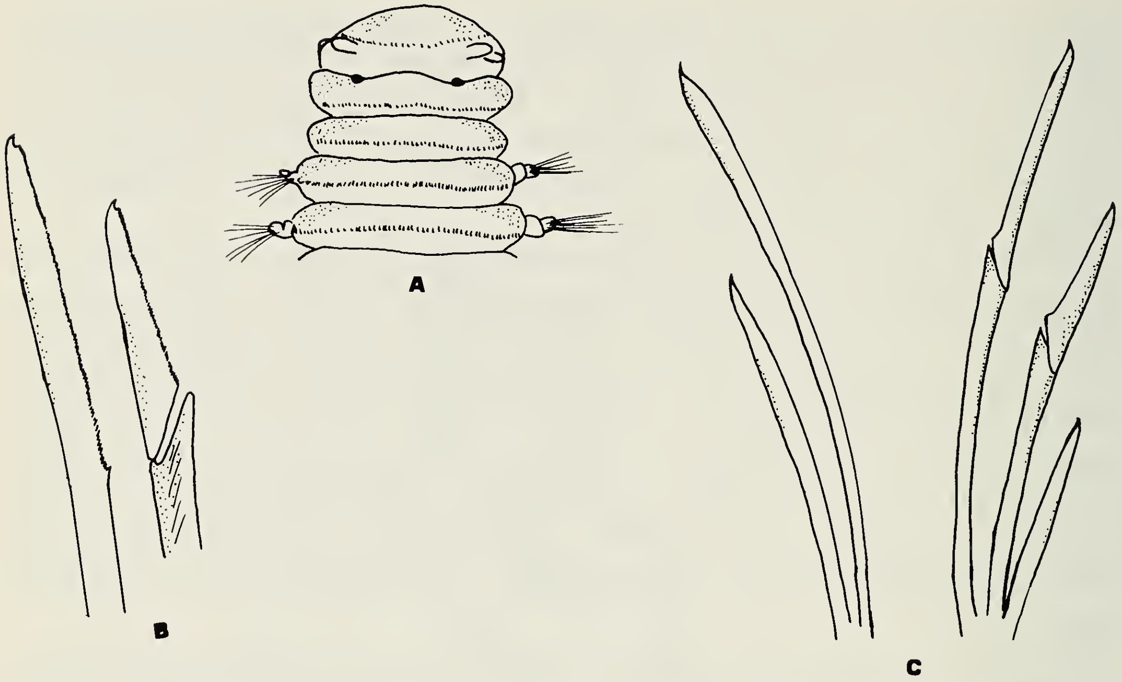

Fig. 5. *A, Ophryotrocha puerilis siberti,* dorsal view of anterior end; B, simple and composite falcigers; C, *Ophryotrocha gracilis,* simple and composite falcigers. (A, B, C after Hartman-Schröder, 1971.)

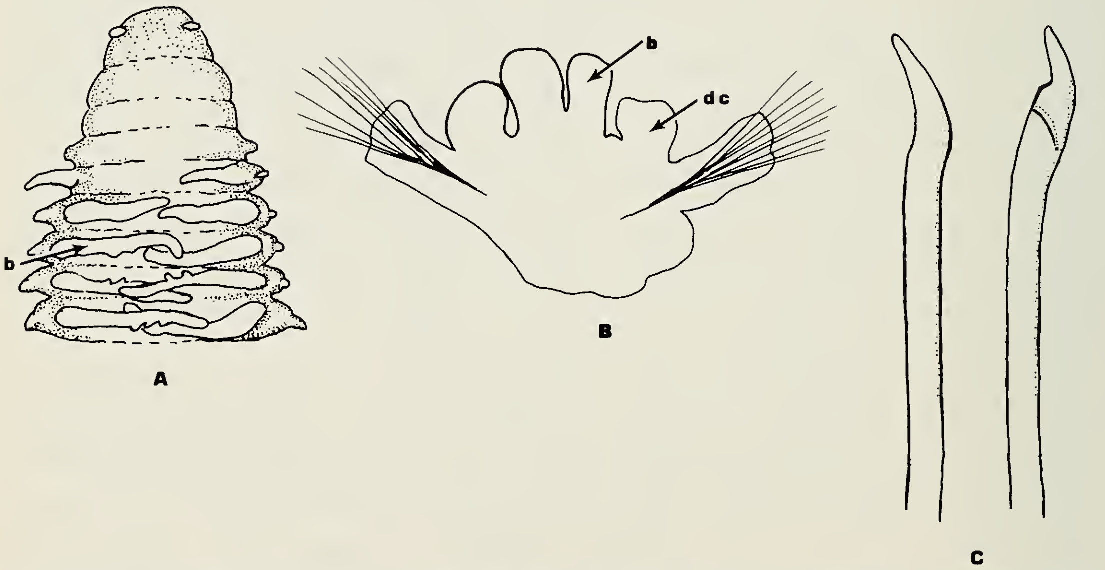

Fig. 6. A, *Iphitime loxorhynchi,* anterior end in dorsal view, branchiae (b) indicated (after Fauchald, 1977); B, *I. hartmanae* Kirkegaard, transverse section of middle segment with branchiae (b) and dorsal cirri (dc) indicated (after Kirkegaard, 1977); C, *I. loxorhynchi,* simple and composite falcigers (after Hartman, 1952).

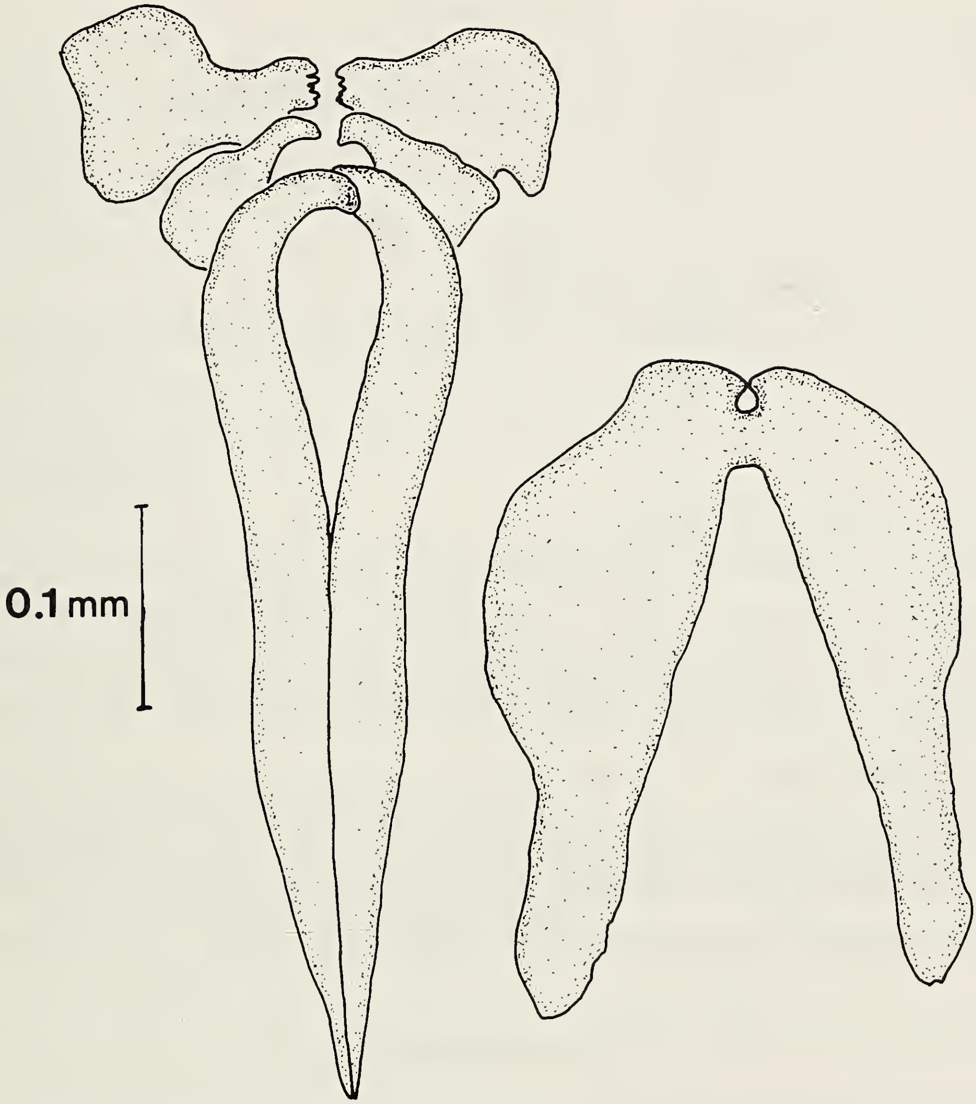

Fig. 7. *Iphitime loxorhynchi:* Maxillae and mandibles.

The fusion of the maxillary carriers with Mx I in adult *Iphitime* (Fauchald, 1970) and *Eteonopsis* distinguishes them from other Eunicea such as Onuphidae, Lumbrineridae, and Eunicidae whose pharangeal apparatus may otherwise be similar. Both *Iphitime* and *Eteonopsis*, like many dorvilleids, have reduced maxillae in adult specimens (Fig. 3A, B). *Eteonopsis* may be separated from *Iphitime* by its lack of branchiae and presence of palps (Figs. 2A, C; 6A, B).

Key to the Genera of the Dorvilleidae
(after Jumars 1974)

1. Parapodia uniramous, without notoacicula 4
– Parapodia sub-biramous, with enclosed notoaciculum 2

2. Furcate setae present 3
– Furcate setae absent .... *Dorvillea*
3. Antennae small, simple; jaw pieces with 14 denticle rows .... *Pettiboneia*
– Antennae long, multiarticulate; jaw pieces with 4 denticle rows .... *Schistomeringos*
4. Furcate or geniculate setae present 5
– Furcate and geniculate setae absent 6
5. Palps well developed, with at least one article; jaws with 4 denticle rows .... *Protodorvillea*
– Palps very small, simple or biarticulate; jaws with 2 denticle rows .... *Meiodorvillea*
6. Setae all simple, acicular .... *Paraophyrotrocha*
– Setae include some falcigers 7
7. Setiger 1 modified, with 2 types of large specialized setae: a simple recurved spine and a large, thick, sharply recurved composite falciger; antennae and palps biarticulate .... *Exallopus*
– Setiger 1 not modified; antennae and palps reduced, papilliform ... 8
8. Branchiae present across dorsum .... *Iphitime*
– Branchiae absent 9
9. Composite falcigers with elongate blades (Fig. 4B, C); body small (<10 mm); interstitial burrowers .... *Ophryotrocha*
– Composite falcigers with short blades (Fig. 2E); body large (25–140 mm); symbiotic in crab branchial chamber .... *Eteonopsis*

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Literature Cited

Åkesson, B. 1976. Morphology and life cycle of *Ophryotrocha diadema*, a new polychaete species from California.—Ophelia 15(1):23–35.

Armstrong, J. W., and P. A. Jumars. 1978. Branchiate Dorvilleidae (Polychaeta) from the North Pacific.—Bull. South. Calif. Acad. Sci. 77(3):133–138.

Bidenkap, O. 1895. Systematisk Oversigt over Norges Annulata Polychaeta.—Vidensk. Selsk. Christiania Forh. Volume for 1894. No. 10:72–74.

Brown, G. W., and A. M. Mood. 1951. On median tests for linear hypotheses.—Proc. 2nd Berkeley Symp. Math. Statist. and Prob. (Univ. Calif. Press). 159 pp.

Desportes, I., L. Laubier, and J. Theodorides. 1977. Présence d'*Ophyrotrocha geryonicola* (Esmark) (Polychète: Dorvilleidae) en Mediterranée Occidentale.—Vie Milieu 27(1):131–133.

Esmark, L. 1874. *Eteonopsis geryonicola*.—Vidensk. Selsk. Christiania Forh. Volume for 1873:497–498.

———. 1880. *Eteonopsis geryonis*.—Vidensk. Selsk. Christiania Forh. Volume for 1879:14.

Fauchald, K. 1970. Polychaetous annelids of the families Eunicidae, Lumbrineridae, Iphitimidae, Arabellidae, Lysaretidae and Dorvilleidae from western Mexico.—Allan Hancock Monogr. Mar. Biol. 5:1–335.

———. 1977. The polychaete worms, definitions and keys to the orders, families and genera.—Nat. Hist. Mus. Los Angeles County, Science Series 28:1–190.

Hartman, O. 1951. Literature of the polychaetous annelids.—Los Angeles [privately printed]. 290 pp.

———. 1952. *Iphitime* and *Ceratocephala* (polychaetous annelids) from California.—Bull. South. Calif. Acad. Sci. 51:9–20.

Hartman-Schröder, G. 1971. Annelida, Börstenwurmer, Polychaeta.—Tierwelt Dtl. 58:1–594.

Hartnoll, R. G. 1962. *Iphitime cuenoti* Fauvel (Eunicidae), a polychaete new to British waters.—Ann. Mag. Nat. Hist. series 13, 5:93–96.

Jumars, P. A. 1974. A generic revision of the Dorvilleidae (Polychaeta), with six new species from the deep North Pacific.—Zool. J. Linn. Soc. 54:101–135.

Kirkegaard, J. B. 1977. A new species of *Iphitime* (Polychaeta: Iphitimidae) living under the tail of *Hyas* (Crustacea: Decapoda) in the Oslo Fjord.—Allan Hancock Foundation Special Publication: 199–207.

MacKay, O. C. 1943. Temperature and the world distribution of crabs of the genus *Cancer*.—Ecology 24:113–115.

Rullier, F. 1974. Quelques Annélides Polychètes de Cuba recueillies dans les Éponges.—Trans. Mus. Histoire Nat. "Gr. Antipa" 14:9–77.

Squires, H. J. 1966. Serial atlas of the marine environment. Folio 12. Distribution of decapod crustacea in the Northwest Atlantic.—Amer. Geogr. Soc.

Wesenburg-Lund, E. 1938. *Ophryotrocha geryonicola* (Bidenkap) (=*Eteonopsis geryonicola* Bidenkap) refound and redescribed.—Göteborgs K. Vetensk. Handl., Ser. B. 6(8):1–13.

Wigley, R. L., R. B. Theroux, and H. E. Murray. 1975. Deep-sea red crab *Geryon quinquedens* survey off N.E. United States.—Mar. Fish. Rev. 37(8):1–21.

Williams, A. B., and R. E. Wigley. 1977. Distribution of decapod crustacea off northeastern United States based on specimens at the Northeast Fisheries Center, Woods Hole, Mass.—NOAA Tech. Rep. NMFS Circ. 407, 44 pp.

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A NEW SPECIES OF FRESHWATER CRAB (CRUSTACEA: ANOMURA: AEGLIDAE) FROM INSULAR SOUTH CHILE

Carlos G. Jara and María T. López

Abstract.—A new species, *Aegla alacalufi* (Crustacea, Anomura, Aeglidae) from Madre de Dios Island in far southern Chile is described. Morphologically it closely resembles *A. papudo* Schmitt and *A. concepcionensis* Schmitt from Chile and *A. serrana* Buckup and Rossi from Brasil. Its most distinctive feature is the undivided telson plate, a character that is also present in *A. papudo* with which the new species probably shares a common ancestry.

Little information concerning the presence of members of the genus *Aegla* in the insular and continental Chilean territory south of Puerto Montt is available. Two species have been recorded from Chiloé Island (Haig, 1955; Bahamonde and López, 1963) and one from the Taitao Peninsula (46°30′S, 74°30′W) (Porter, 1917). The new species described here was collected on Madre de Dios Island during cruise 72-2 of the oceanographic vessel *Hero* to far southern Chile.

Aegla alacalufi, new species
Fig. 1

Holotype.—Instituto de Zoología, Univ. Austral de Chile, IZUA C-471-1, adult male collected in a brook at Puerto Henry, Madre de Dios Island (50°01′10″S, 75°18′45″W), Ultima Esperanza, Chile, at sea level, on 7 October 1972 by H. Moyano.

Allotype.—IZUA C-471-2, adult female. Paratypes: IZUA C-471-3 and MUZUC 16352 (Museo Zoológico, Univ. de Concepción, Chile), 2 males; IZUA C-471-4, C-471-5, MUZUC 16353, 4 females. Same locality and date as holotype.

Diagnosis.—(1) Rostrum short and triangular with apical chitinous scale amidst short hairs; (2) orbital spine absent; (3) rostral carina without scales; (4) anterolateral angle of second abdominal epimeron rounded; (5) sternum of fourth thoracic segment with medial, flattened, subdisciform offset; (6) telson plate undivided.

Description of holotype.—Carapace longer than wide, ovoid; gastric area conspicuously convex, appearing swollen and protuberant; dorsal surface of carapace and chelae quite punctate and sparsely studded with fine bristles. Chitinous scales limited to those areas mentioned below.

Rostrum short, triangular, acuminate, with broad base and depressed dorsally; apical scale concealed by bristles; rostral carina moderately well developed, rounded dorsally, decreasing in height anteriorly and terminating near rostral tip; surface smooth but somewhat hairy; flanking troughs lacking.

Orbits wide; orbital spine absent although weak tubercle present on lateral margin; anterolateral angles of carapace short and blunt. Epigastric areas semicircular, protuberant, punctate, and sparsely setiferous; protogastric eminences inconspicuous. First hepatic lobe with margin slightly upturned, limited frontally by wide, shallow notch; second and third hepatic lobes poorly delineated.

Anterolateral branchial lobe short and blunt, edge of branchial areas hairy and somewhat nodose; cardiac area wide and trapezoidal; areola subrectangular and moderately convex. Dorsum of abdominal terga strongly convex; anterolateral angle of second epimeron rounded and hairy, its ventrolateral edge straight; telson plate undivided, its lateral margins straight and apex rounded. Sternum of fourth thoracic segment with broad low anteromedian tubercle, free border of which subdisciform, border immediately lateral to tubercle somewhat concave, and lateral margin of sternum elevated ventrally.

Antennal flagellum long and slender, longer antenna 1.25 times as long as cephalothorax. Chelipeds slightly robust, equal in size; chelae subrectangular and not inflated, their dorsal and ventral surfaces densely punctate and covered with fine setae, latter longer on dactylus, palmar crest, and ventrolateral margin of fixed finger; blunt nodule present near dorsal base of dactyl, that on left chela with minute apical scale; palmar crest insignificant, not surpassing contour of chela, its free border nodulated; dorsum of carpus scabrous with arcuate row of low blunt tubercles flanked apically by transversely aligned hairs; carpal crest clearly defined, nodulate proximal to long, conical, slightly curved distal spine, latter separated from anterior carpal lobe by wide semicircular notch; apex of carpal lobe blunt and inclined toward distal end of carpus; ventral margin of merus nodulate, dorsal margin with longitudinal row of 9 or 10 small blunt tubercles; distodorsal border smooth and somewhat hairy; ventral margin of ischium with low non-acute swelling at proximal end; remaining pereiopods long and slender; dactylus of fourth pereiopod longer than that of second.

Description of allotype.—Differing from holotype in following respects: rostral carina prominent and well marked almost to rostral apex; middorsal line on gastric area slightly elevated, darker, and covered by narrow band of short setae; anterior margin of protogastric eminences well delimited and bearing sparsely and irregularly placed hairs; proximal nodules of palmar

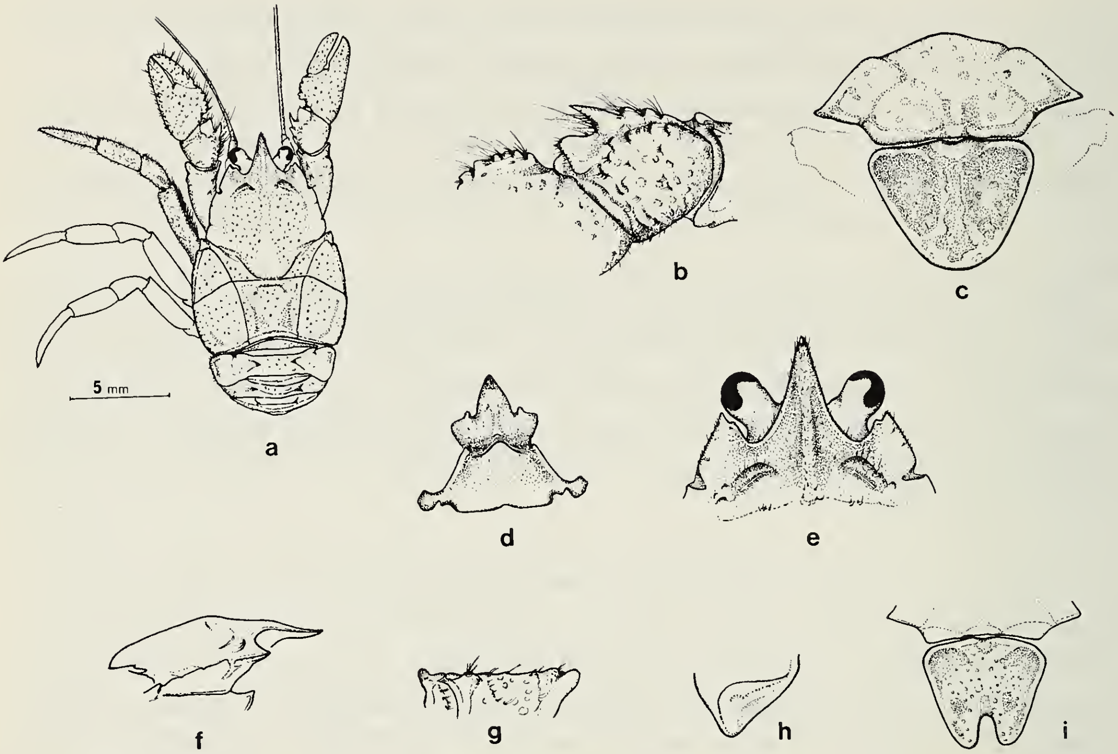

Fig. 1. *Aegla alacalufi*, n. sp. (all illustrations from holotype except i from female P_5): a, Dorsal view; b, Carpus of left cheliped; c, Telson plate; d, Third and fourth thoracic sterna; e, Dorsal view of rostral area; f, Lateral view of anterior part of cephalothorax; g, Inner ventral margin of ischium of left cheliped; h, Lateral view of second abdominal epimeron; i, Telson plate.

crest inconspicuous; apex of telson plate slightly notched and devoid of plumose setae.

Color.—(Alcohol fixed.) Gastric and cardiac surfaces bluish white (Cyaneus 1), other dorsal cephalothoracic and abdominal surfaces yellowish brown tan (Flavus 3); pereiopods smoky tan (Flavus 5); dorsal surface of carpus and propodus of cheliped yellowish white, somewhat irridescent; ventral surfaces marmoraceous to light brown or ferrugineous. (Color standards according to Paclt, 1958.)

Variations and measurements.—The type-series is morphologically homogeneous, the shape of the telson constituting the most variable character. All specimens have undivided telsons without a trace of a longitudinal suture; however, 1 male and 3 females have an obvious semicircular apical notch of variable depth, the margin of which lacks plumose setae. The telson with the deepest notch is depicted in Fig. 1i. Less conspicuous is the variation in the shape of the rostrum which varies from distinctly triangular to slightly ligulate, the apical part broadened and flattened. The chelae of the female are less robust than in the male, but the difference is not remarkable.

Table 1.—Somatometry of *A. alacalufi* n. sp., type-series. All measurements in mm; M: male; F: female; Holo: holotype; Allo: allotype; P_1 to P_6: paratypes.

Collection	IZUA-C 471-1	IZUA-C 471-2	IZUA-C 471-3	MUZUC 16352	IZUA-C 471-4	MUZUC 16353	IZUA-C 471-5	MUZUC 16353
Specimen:	Holo	Allo	P_1	P_2	P_3	P_4	P_5	P_6
Sex:	M	F	M	M	F	F	F	F
CL:	10.6	9.5	10.2	9.4	10.2	8.6	8.5	8.5
RL:	2.2	2.0	2.1	2.0	2.2	1.9	1.9	1.8
PCL:	7.7	6.9	7.3	6.8	7.3	6.2	6.1	6.1
FW:	3.5	3.2	3.4	3.2	3.4	3.0	3.0	2.8
PCW:	6.6	6.0	6.3	5.8	6.2	5.3	5.2	5.1
CW:	8.2	7.8	8.1	7.2	8.1	6.8	7.0	6.5
LCL:	12.1	11.0	—	10.7	12.0	10.1	9.9	9.4
RCL:	12.4	11.0	11.8	10.7	12.0	10.0	9.8	9.4
L2PL:	13.9	12.4	13.8	11.8	13.5	11.4	11.6	10.4
L2DL:	3.8	3.2	3.4	3.1	3.4	2.9	2.9	2.7
L4DL:	4.0	3.6	3.8	3.4	3.9	3.2	3.1	3.0
TL:	2.2	2.1	2.1	2.0	2.2	1.9	1.9	1.9

Measurements of the specimens constituting the type-series are presented in Table 1. These were made with the aid of calipers to the nearest 0.1 or 0.2 mm, depending on the size of the structure. Areas or structures measured are defined as follows: CL, carapace length, distance between rostral apex and posterior margin of cephalothorax; RL, rostral length, distance between rostral tip and midpoint of transverse line tangent to deepest points of orbital margins; PCL, precervical length, distance between rostral tip and midpoint of cervical groove; FW, frontal width, distance between tips of anterolateral angles of carapace; PCW, maximum precervical width, distance across third hepatic lobes; CW, maximum carapace width; LCL, left cheliped length; RCL, right cheliped length; L2PL, length of second left pereiopod; L2DL, dactylar length of second left pereiopod; L4DL, dactylar length of fourth left pereiopod; TL, telson length (when apical notch present, posterior margin considered as line joining caudalmost parts of telson).

Natural history.—Little information is available; the type-series was collected on the sandy bottom of a forest brook outlet to the sea. Some specimens were found under detached *Macrocystis* Agardh (Phaeophyta) holdfasts about 50 m from the seashore.

Distribution.—Known only from the type-locality.

Etymology.—Latin genitive singular form of Alacalufes, a tribe of aborigines that inhabited the southern Chilean Archipelago (Encyclopaedia Britannica, 1961).

Comparison.—*Aegla alacalufi* should be included in the "Pacific rostrum type" group of species proposed by Schmitt (1942). Morphologically it resembles *A. concepcionensis* Schmitt (1940) and *A. papudo* Schmitt (1942) from Chile and *A. serrana* Buckup and Rossi (1977) from Brasil. It shares the following features with them: dorsum of gastric area swollen and strongly convex; areola wide, subrectangular, and slightly convex; orbital spine absent, and apex of carpal lobe displaced distally. It differs from these aeglids as follows: rostral carina smooth and lacking scales; propodus of chela not inflated; palmar crest reduced, its free edge nodulated; upper longitudinal margin of merus of cheliped without spines; and sternum of fourth thoracic segment with anteromedial prominence. *Aegla alacalufi* resembles *A. concepcionensis* and *A. serrana* in lacking well defined protogastric eminences, and the inner ventral margin of the ischium of the cheliped bears neither spines nor scales. As in *A. papudo* and *A. serrana,* the anterolateral angle of the second abdominal epimeron of *A. alacalufi* is rounded. The latter differs from *A. concepcionensis* and *A. papudo* in lacking a small concavity behind the dorsal base of the anterolateral angle of the carapace. A comparison of the type-series of *A. alacalufi* with a sample of *A. papudo* (IZUA C-414: 1 male, 6 females, adults) from La Ligua (Aconcagua, Chile) revealed that both species have an undivided telson plate. Dr. Alan Solem (Field Museum of Natural History, Chicago, U.S.A.) (personal communication) confirmed that this character is also present in the type-series of *A. papudo.* None of the specimens of *A. papudo* examined, however, has a notch on the apex of the telson.

Remarks.—The finding of *A. alacalufi* at Madre de Dios Island extends the previously known range of the Aeglidae about 400 km to the south (see Porter, 1917; and Ringuelet, 1948).

Telson morphology places *A. alacalufi* and *A. papudo* in a subgroup apart from the other members of the genus *Aegla* in which it is dimerous. It is difficult at the present, however, to judge the systematic value of the character, particularly its relevance in establishing a new generic or subgeneric category. Unfortunately, previous authors have not consistently noted whether or not the telson of the species described by them was divided. Leach, 1821, and Hobbs, Hobbs, and Daniel, 1977, included the longitudinally articulated telson in their diagnoses of the genus, unaware of the undivided plate in *A. papudo.* Whereas the structure of the telson suggests a common ancestry for *A. alacalufi* and *A. papudo,* the possibility of morphological convergence in disjunct lineages cannot at present be disregarded.

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Literature Cited

Bahamonde, N., and M. T. López. 1963. Decápodos de aguas continentales en Chile.—Inv. Zool. Chilenas 10:123–149.

Buckup, L., and A. Rossi. 1977. O Genero *Aegla* no Rio Grande do Sul, Brasil (Crustacea, Decapoda, Anomura, Aeglidae).—Rev. Brasil. Biol. 37(4):879–892.

Haig, J. 1955. The Crustacea Anomura of Chile.—Rep. Lund Univ. Chil. Exped. 1948–49, 20, Lund Univ. Arsskrift. N.F. Avd. 2, Bd 51, Nr 12, 68 pp.

Hobbs, H. H., Jr., H. H. Hobbs III, and M. A. Daniel. 1977. A review of the troglobitic decapod crustaceans of the Americas.—Smithsonian Contrib. Zool. 244:1–183.

Leach, W. E. 1821. Galateadées, pages 49–56 *in* F. G. Levrault, ed., Dictionnaire des Sciences Naturelles, 18 (1820). Strasbourg.

Paclt, J. 1958. Farbenbestimmung in der Biologie.—Gustav Fisher Verlag, Jena.

Porter, C. 1917. Los crustáceos de la expedición Taitao.—Bol. Mus. Nac. Hist. Nat., Chile 10:94–101.

Ringuelet, R. 1948. Los cangrejos argentinos del gènero *Aegla* de Cuyo y la Patagonia.—Rev. Mus. La Plata, nov. ser., Zool. 5:297–349.

Schmitt, W. L. 1940. Two new species of *Aegla* from Chile.—Rev. Chilena Hist. Nat. 44(1940):25–31, pl. 1.

———. 1942. The species of *Aegla,* endemic South American freshwater crustaceans.—Proc. U.S. Nat. Mus. 91:431–520.

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TAXONOMIC OBSERVATIONS ON EASTERN PACIFIC *ANTITHAMNION* SPECIES (RHODOPHYTA: CERAMIACEAE) DESCRIBED BY E. Y. DAWSON

David N. Young

Abstract.—Three of the six species of the red algal genus *Antithamnion* described by E. Y. Dawson are studied critically. Re-examination of the type specimens and study of new material of *A. hubbsii, A. pseudocorticatum,* and *A. mcnabbii* reveal that the latter two are more correctly transferred to *Balliella* and *Antithamnionella* respectively. Gland cells previously unrecognized for *B. pseudocorticata* are described, and tetrasporangia reported for the first time for *Antithamnionella mcnabbii* and *Antithamnion hubbsii.* Distribution and new records are noted for each taxon.

E. Yale Dawson (see Abbott, 1966) described a number of new taxa from the eastern North Pacific, including 6 species of *Antithamnion* Nägeli (1847) (Ceramiaceae, Ceramiales) from the Gulf of California and the Pacific coasts of California, Mexico, and Central America: *A. breviramosus* Dawson (1949), *A. dumontii* Dawson (1960), *A. hubbsii* Dawson (1962), *A. mcnabbii* Dawson (1950), *A. pseudocorticatum* Dawson (1962), and *A. scrippsiana* Dawson (1949). Later, Dawson (1953) recognized *A. scrippsiana* to be a form of *A. glanduliferum* Kylin (1925), which was later transferred by Wollaston (1971) to *Antithamnionella* Lyle (1922). She also considered *Antithamnion breviramosus* Dawson in this genus, as *Antithamnionella breviramosa* (Dawson) Wollaston (in Womersley and Bailey, 1970). Abbott (1979) transferred *A. dumontii* to *Wrangelia* C. Agardh (1828). The remaining species of Dawson, *Antithamnion hubbsii, A. mcnabbii,* and *A. pseudocorticatum,* were known only from the type collections (all sterile and their taxonomic status was incompletely known). New observations on the type specimen and on additional material identified as these species add new information on these species and, in the case of *Antithamnion pseudocorticatum* and *A. mcnabbii,* justify their transfer to other genera.

Balliella pseudocorticata (Dawson) comb. nov.
Figs. 1, 2

Basionym.—*Antithamnion pseudocorticatum* Dawson, Allan Hancock Pacific Expedition 26:20, Pl. 7, Figs. 1, 5 (1962).

Description.—Erect thallus branches to 5 mm high arising from prostrate axes attached to substrate by long, multicellular rhizoids; branches of erect axes in opposite pairs, slightly incurved, distichous, bearing opposite pairs of 1–3 celled often once-branched, incurved whorl branchlets and with smaller, subrectangular basal cell; lateral branches with opposite whorl branchlets and with same branching as erect axes; whorl branches and branchlets incurved but not surrounding apical cell and bearing whorl branchlet initials in irregular sequence; basal cells of branches and whorl branchlets each bearing two adaxial and one to two abaxial branchlets, these remaining meristematic and becoming compound, enveloping basal portions of major branches and forming loose cortication. Gland cells spherical, (8–) 11 (–13) μm diameter, born abaxially on basal cell of whorl branchlets (Fig. 1). Gland cells usually occurring singly, but two gland cells may be present on a single whorl branchlet basal cell in older portions of the thallus. Corticating branchlets also with gland cells. Reproductive material not found.

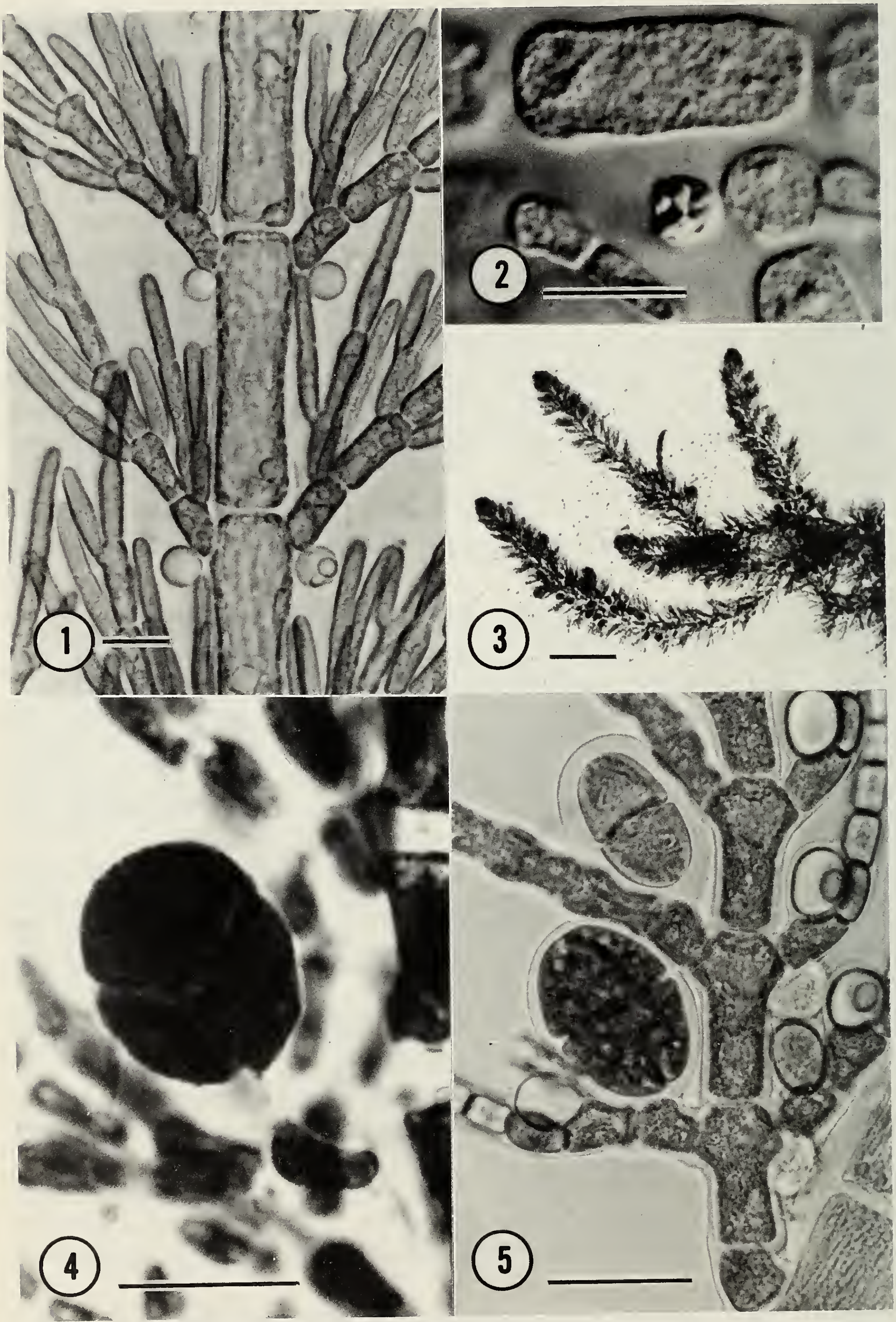
Holotype.—Dawson 6934b (AHFH 71122), 15.iii.49, San Lorenzo Channel, dredged between Isla Espiritu Santo and Baja coasts, near La Paz, Baja California del Sur, Mexico.

Additional records.—Galápagos Islands, R/V *Searcher* station 327, near Punta Espinosa, Isla Fernandina (*P. C. Silva,* AHFH 85054).

Remarks.—Dawson (1962, p. 20–21) accurately describes the plant except for the statement "gland cells absent," which is in error. It is unclear why Dawson failed to observe the gland cells in the type material. The distinctive, refractive nature of certain types of living glandular cells is lost by fixation in formalin (Young, 1977), but the cells on the formalin-preserved, Karo-mounted type specimen are clearly present (Fig. 2).

The morphology of *Antithamnion pseudocorticatum* differs from the characteristic vegetative features which define the genus *Antithamnion* (see Wollaston, 1968): axes completely lacking rhizoidal cortication; pinnae distichous and either opposite, alternate, or secund and with a small basal cell which does not bear pinnules; gland cells born on special short branches. The Gulf of California plant agrees with the features of the genus *Balliella* Itono and Tanaka (1973) in apical organization, branching pattern, development of nodal cortication of the axes, and unique gland cell shape and position. *Balliella* bears cruciately divided, adaxial tetrasporangia, and many procarps on the basal cell of subapical lateral branches. Unfortunately, the absence of reproductive material on *A. pseudocorticatum* precludes comparison of reproductive structures, but the vegetative features alone are strong evidence warranting transfer of *A. pseudocorticatum* to *Balliella.*

Prior to these observations, *Balliella* contained two species, *B. crouanioides* (Itono) Itono and Tanaka and *B. subcorticata* (Itono) Itono and Tanaka. *Balliella pseudocorticata* is easily distinguished from *B. crou-*



Figs. 1, 2. *B. pseudocorticata:* 1, Living specimen with adaxial gland cells; 2, Holotype with gland cell. Figs. 3, 4. *A. mcnabbii:* 3, Habit; 4, Tetrasporangium. Fig. 5. *A. hubbsii,* pinnules with tetrasporangia. Figs. 1, 2, 4, 5, bar is 50 μm; Fig. 3, bar is 200 μm.

anioides by its irregular branching pattern and the compact nature of the nodal cortication in the latter species. *Balliella pseudocorticata* is smaller and stouter than *B. subcorticata,* but otherwise seems similar. The recently described *Bakothamnion curassavicum* van den Hoek (1978) from the eastern Caribbean may be placed more properly in *Balliella* (van den Hoek, pers. comm.). In view of environmental effects on thallus form in the Ceramiaceae (Murray and Dixon, 1973), re-examination of variation in *B. subcorticata* and comparisons with the Caribbean and western Pacific plants is desirable.

Antithamnionella mcnabbii (Dawson) comb. nov.

Figs. 3, 4

Basionym.—Antithamnion mcnabbii Dawson, Los Angeles County Museum Contributions in Science 27:28, Fig. 7C. 1959.

Description.—Erect thallus minute, to 8 mm tall (Fig. 3), attached to substrate by unbranched, multicellular rhizoids originating from basal cell of lateral branchlets; axes ecorticate; whorl branchlets short, slightly incurved, usually in threes, forked 3–5 times with a digitate appearance, from subrectangular basal cells; axial cell bearing lateral branches also with a whorl of three branchlets; lateral branches 304 segments apart with whorl in branchlets as in main axis; gland cells absent in type; tetrasporangia (Fig. 4) spherical to subspherical, tetrahedrally divided, sessile, frequently with additional branchlets on the basal cell of a lateral branch; male and female structures unknown.

Holotype.—Dawson 18855, 20.iv.58, from El Solitario Rock, Bahía Agua Verde, Baja California del Sur, Mexico (LAM now AHFH 81902).

Additional records.—I have examined material of this species from the Gulf of California, now deposited in AHFH and US. Sterile material from Isla Fernandina, Galápagos Islands (*P. C. Silva,* AHFH 85053) and tetrasporic material from Caleta Santa Maria, Baja California del Sur (*J. Norris* 3406, US) was examined.

Remarks.—Tetrasporic material from the Gulf of California (*J. Norris* 3406) clearly exhibits stages in the simultaneous, oblique cleavage process characteristic of tetrahedral division (Wollaston, 1968). The previous report (Itono, 1969) of cruciate tetrasporangia in *Antithamnion mcnabbii* from Japan is considered by Itono (1977) to be a doubtful record for that species. The Japanese specimen is similar to Mexican specimens, and Itono's (1969) Fig. 5A, if judged alone, could represent tetrahedral division.

This species exhibits features in common with *Antithamnionella* Lyle (1922) and excluding it from *Antithamnion* Nägeli (Wollaston, 1968): the shape and tetrahedral cleavage of tetrasporangia, the pinnae in whorls of three, the shape of basal cell of pinnae, the absence of gland cells on special gland cell branches. Likewise, the branch morphology and the sessile tetrasporangia of *A. mcnabbii* exclude this species from *Scagelia* Wollaston (1971) and *Hollenbergia* Wollaston (1971). The digitate morphology of the whorl branchlets and absence of gland cells distinguish *Antithamnionella mcnabbii* from the North Pacific species of this genus, *A. glandulifera* (Kylin) Wollaston and *A. pacifica* (Harvey) Wollaston and from the Japanese species, *A. miharai* (Tokida) Itono (1977). Vegetatively, *A. mcnabbii* seems most closely related to *A. breviramosa* (Dawson) Wollaston, also from Pacific Mexico and the Gulf of California (Dawson, 1962), which has considerable variation in numbers of gland cells present.

Antithamnion hubbsii Dawson
Fig. 5

Antithamnion hubbsii Dawson, Allan Hancock Pacific Expeditions 26:16, Pl. 5, Fig. 2; Pl. 6, Fig. 3. 1962.

Description.—The vegetative aspects of this species were described completely by Dawson (1962) and Wollaston (in Abbott and Hollenberg, 1976). Recent California collections identified as this species allow the following description of previously unknown tetrasporangia. Mature tetrasporangia (Fig. 5) are ovoid, 35 × 60 μm, sessile, usually in place of gland cells on pinnules of first or second cell (not basal cell) of pinnae on erect axes.

Holotype.—Dawson 8302 (AHFH 71130), 19.xii.49, from 70 m depth, Melpomene Cove, Isla Guadalupe, Mexico (R/V *Velero* station 1919-49).

Additional records.—Various collections from subtidal areas at Santa Catalina Island, California (*Hageman 24,* AHFH; *Young 998*), and from the Dana Point Marina, Orange County, California (AHFH 85052, 85053) were examined. Previously known only from type locality and Santa Catalina Island (Wollaston in Abbott and Hollenberg, 1976).

Remarks.—The tetrasporangial and vegetative features of this distinctive species are consistent with its placement in *Antithamnion. Antithamnion hubbsii* has similarly placed, but smaller, tetrasporangia than the similar *A. callocladus* Itono (1971), which is overall more robust and contains 1–2 more orders of branching than the former species.

California specimens differ somewhat from the holotype in that the basal cells of the pinnae on prostrate axes bear two attachment rhizoids whereas single rhizoids are formed from pinnae on erect axes.

This species is relatively abundant in appropriate habitats in southern California, but gametangial material remains unknown. To date, my attempts to obtain gametophytes by cultivation of tetraspores have been unsuccessful.

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I am grateful to Drs. P. C. Silva (Herbarium, University of California, UC) and J. N. Norris (U.S. National Herbarium, Smithsonian Institution, US) for kindly providing specimens from their collections. R. Setzer, Drs. M. J. Wynne and J. N. Norris made helpful comments on the manuscript, and R. Moe provided useful discussions. This is contribution number 381 from the Allan Hancock Foundation.

Literature Cited

Abbott, I. A. 1966. Elmer Yale Dawson (1918–1966).—Journal of Phycology 2:129–132.

———, and G. J. Hollenberg. 1976. Marine Algae of California.—Stanford University Press, Stanford, California. 827 pp.

Agardh, C. A. 1828. Species Algarum Rite Cognitae, cum Synonymis, Differentiis Specificis et Descriptionibus Succinctis, Vol. 2.—Mortiz, Greifswald, Germany. 189 pp.

Dawson, E. Y. 1949. Contributions toward a marine flora of the southern California Channel Islands.—Allan Hancock Foundation Occasional Papers 8:1–57.

———. 1954. Notes on Pacific Coast marine algae, VI.—Wasmann Journal of Biology 11:323–351.

———. 1959. Marine Algae from the 1958 cruise of the *Stella Polaris* in the Gulf of California.—Los Angeles County Museum Contributions in Science 27:1–39.

———. 1960. New records of marine algae from Pacific Mexico and Central America.—Pacific Naturalist 1:31–53.

———. 1962. Marine red algae of Pacific Mexico. Part 7. Ceramiales: Ceramiaceae, Delesseriaceae.—Allan Hancock Pacific Expedition 26:1–207.

Hoek, C. van den. 1978. Marine algae from the coral reef of Curaçao, Netherland Antilles, I: Three new and one rarely observed species from the steep fore-reef.—Aquatic Botany 5:47–62.

Itono, H. 1969. The genus *Antithamnion* (Ceramiaceae) in southern Japan and adjacent waters, I.—Memoirs of the Faculty of Fisheries, Kagoshima University 18:29–45.

———. 1971. The genus *Antithamnion* (Ceramiaceae) in southern Japan and adjacent waters, II.—Memoirs of the Faculty of Fisheries, Kagoshima University 20:209–216.

———. 1977. Studies on the Ceramiaceous Algae (Rhodophyta) from Southern Parts of Japan.—Bibliotheca Phycologica Bd. 35. J. Cramer, Vaduz. 499 pp.

———, and T. Tanaka. 1972. *Balliella*, a new genus of Ceramiaceae.—Botanical Magazine, Tokyo 86:241–252.

Kylin, H. 1925. The marine red algae in the vicinity of the biological station at Friday Harbor, Washington.—Lunds Universitets Årsskrift N.F. 21:1–87.

Lyle, L. 1922. *Antithamnionella*, a new genus of algae.—Journal of Botany 60:346–350.

Murray, S. N., and P. S. Dixon. 1975. Effect of light intensity and light period on the development of thallus form in the marine red alga *Pleonosporium squarrulosum* (Harvey) Abbott (Rhodophyta: Ceramiales), I: Apical cell division.—Journal of Experimental Marine Biology and Ecology 13:15–27.

Nägeli, C. 1847. Die neuern Algensysteme und Versuch zur Begründung eines einen Systems der Algen und Florideen.—Neue Denkschriften Allgemeine Schweiz Gesellschaft Naturwissenschaftlich 9(2):1–275.

Wollaston, E. M. 1968. Morphology and taxonomy of southern Australian genera of Crouanieae Schmitz (Ceramiaceae, Rhodophyta).—Australian Journal of Botany 16:217–417.

———. 1971. *Antithamnion* and related genera occurring on the Pacific Coast of North America.—Syesis 4:73–92.

———. 1972. Generic features of *Antithamnion* (Ceramiaceae, Rhodophyta) in the Pacific region. Pp. 142–145 *in* Nisizawa, K. *et al.* (editors), Proceeding 7th International Seaweed Symposium. Sapporo, Japan, 1971. J. Wiley & Sons, New York.

Womersley, H. B. S., and A. Bailey. 1970. Marine Algae of the Solomon Islands.—Philosophical Transactions Royal Society of London 259:275–352.
Young, D. N. 1977. Comparative Fine Structure and Histochemistry of Vesiculate Cells in Selected Red Algae. Unpublished Ph.D. dissertation, University of California, Berkeley. 155 pp. (Dissertation Abstracts #7812834, University Microfilms, Ann Arbor, Mich.).

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A REVISION OF THE NORTHERN FORMS OF *EUPHONIA XANTHOGASTER* (AVES: THRAUPIDAE)

Storrs L. Olson

Abstract.—Analysis of geographic variation in populations of *Euphonia xanthogaster* from Panamá, Colombia, and Venezuela, shows *E. x. chocoensis* to be divisible into a small lowland subspecies, *E. x. chocoensis* Hellmayr, in western Colombia and Ecuador, and a larger upland one, *E. x. oressinoma,* new subspecies, in the western and central Andes and on the western slope of the northern part of the eastern Andes. *E. x. badissima,* new subspecies, from the Sierra Perijá south to the Táchira Valley, and Boyacá, Colombia, is distinguished from *E. x. exsul* Berlepsch of northern Venezuela. *E. x. badissima* and *E. x. oressinoma* intergrade in Santander del Norte, the intergrades having previously been misidentified as *E. x. brevirostris* Bonaparte, which now appears to be unknown north of Cundinamarca in the eastern Andes.

The following revision treats the subspecies of the Orange-bellied Euphonia, *Euphonia xanthogaster,* that occur in Panamá and most of Colombia and Venezuela. I have considered only those populations that have in the past been recognized under the names *chocoensis, exsul,* and *brevirostris.* The distribution of these taxa, two new subspecies, and their intergrades, is shown in Fig. 1. The analysis was based mainly on adult male specimens.

Euphonia xanthogaster chocoensis Hellmayr

Euphonia xanthogaster chocoensis Hellmayr 1911, Rev. Franç. d'Orn. 2:23. Río Cajón, Chocó, Colombia.

Characters.—Small, wing of adult males 60 mm or less (55.8–60.8, average 58.6, n = 16), bill small. Cap yellowish, underparts yellow, only faintly tinged with ochraceous.

Range.—Lowlands of western Colombia west of the Andes, from Chocó south through Nariño into Ecuador at least as far as Esmeraldas and Imbabura.

Specimens examined.—COLOMBIA. CHOCO: Bahia de Solano (1, AMNH); Río Uva mouth, near Río Bojaya (1, AMNH); Río Nuquí, base of Baudó Mountains (6, USNM); Río Jurubidá, Baudó Mountains (3, USNM); El Tambo (6, CM); Potedó (2, CM); Quibdo, Río Atrato (2, CM). VALLE:

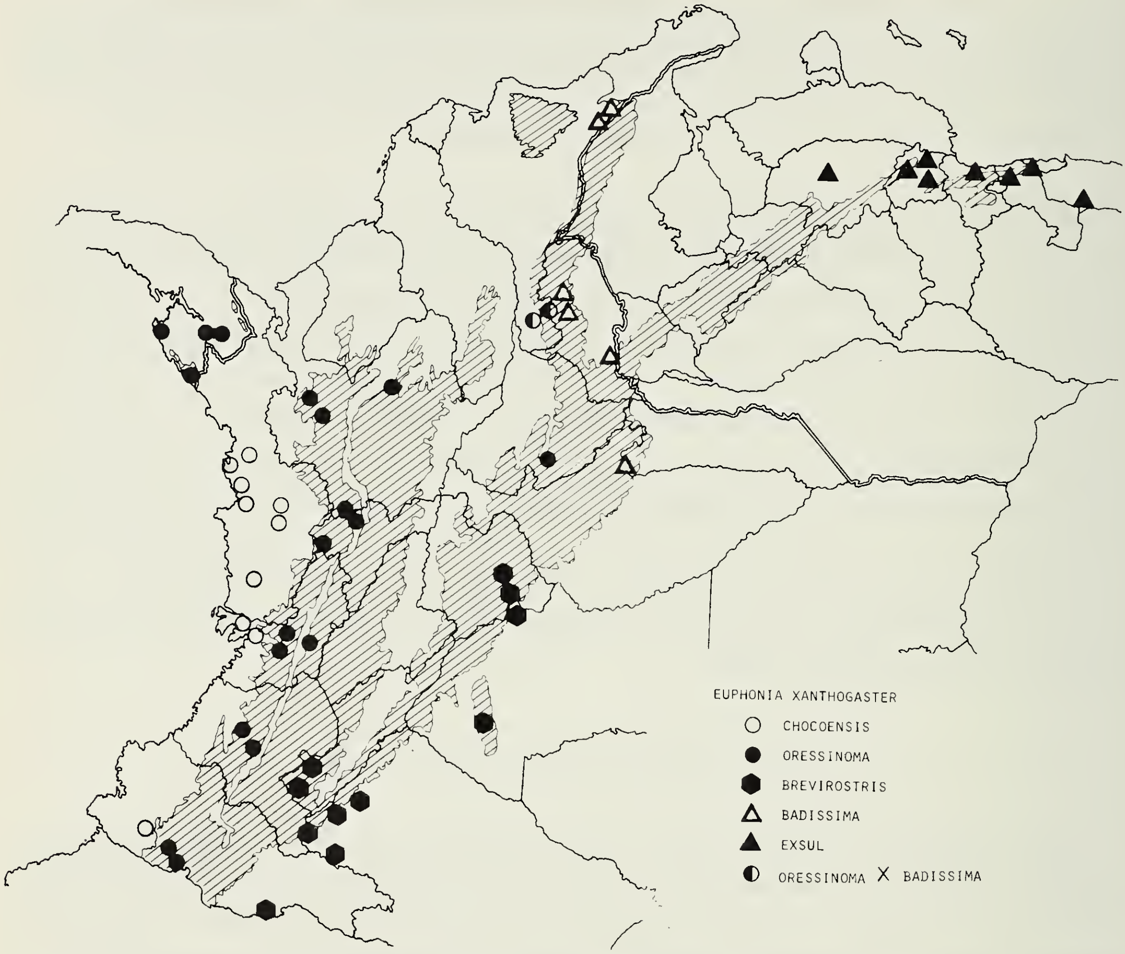

Fig. 1. Outline map showing the distribution of the northern forms of *Euphonia xanthogaster* in Colombia, Venezuela, and eastern Panamá, based on specimens examined in this study. Fine lines indicate provincial boundaries; cross-hatched areas indicate elevations above 1000 m.

Malaguita (2, CM); Córdoba (2, CM; 2, ANSP); Punto Muchimbo, just below mouth of Río Calima (1, USNM). CAUCA: Novita, Río San Juan (1, USNM). NARIÑO: Barbacoas (2, AMNH). ECUADOR. ESMERALDAS: Cachabí (4, AMNH). IMBABURA: Lita (1, AMNH).

Remarks.—This is a small form restricted to the lowlands west of the western Andes. Two males from Río Jurubidá in the Baudó Mountains have the wing slightly longer than typical *chocoensis* (61.0, 61.7), but are nevertheless smaller than all but two specimens of the following subspecies.

Euphonia xanthogaster oressinoma, new subspecies

Holotype.—USNM 436904, adult male, Hacienda Sofia, Río Samaná, Caldas, Colombia, elevation 3750 feet (1143 m). Collected 26 May 1951 by M. A. Carriker, Jr., original number 20308.

Characters.—Coloration like that of *chocoensis* but size larger, wing of adult males usually 63 mm or longer (61.0–68.6, average 63.9, n = 35), bill noticeably larger.

Range.—Panamá in Darién, and in Colombia on both slopes of the western Andes south at least to Nariño, and the western slope of the central Andes; also known from a widely disjunct locality on the western slope of the eastern Andes in Santander.

Specimens examined.—PANAMA. DARIEN: Río Jaqué, mouth of Río Imamadó (1, USNM); Río Jaqué, Las Peñitas (1, USNM); 9 mi E of Cana (2, USNM); Cerro Pirre (4, USNM); Cerro Sapo (1, ANSP).

COLOMBIA. ANTIOQUIA: Hacienda Potreros, 15 mi (24 km) SW of Frontino, Río Herradura (4, USNM); Valdívia, above Sevilla (3, USNM); La Bodega, N side of Río Negrito on Sonson-Nariño highway (1, USNM); Alto Bonito (1, AMNH). VALLE: Km 18 on Cali-Buenaventura road (1, USNM); Height of Caldas (5, CM); Bitaco Valley (2, CM); La Cumbre (1, CM; 1, ANSP); San Antonio (1, AMNH). CALDAS: Hacienda Sofia, Río Samaná (8, USNM); La Selva (4, ANSP). CAUCA: Cocal, W of Popayán (1, AMNH); E of Palmira (2, AMNH); El Tambo (5, ANSP). NARIÑO: Ricuarte (4, ANSP); Mayasquer (1, ANSP). SANTANDER: Virolin, 28 km S of Charalá (5, USNM).

Etymology.—Greek *oressinomos,* ranging the mountains.

Remarks.—Hellmayr (1936:26) has already noted that birds from the highland portions of the range attributed to *chocoensis* are larger than those from the lowlands. Inasmuch as these are consistently separable, I have chosen to recognize this variation nomenclaturally. Measurements do not adequately convey the noticeably smaller size of *chocoensis,* particularly of the bill. Caution must be used in taking wing measurements because adult males in definitive plumage often retain primaries from the previous subadult plumage, and these consistently give a smaller measurement. Such specimens were eliminated from consideration in the measurements discussed above.

There is some variation within *oressinoma*; birds from Panamá tend to be somewhat darker, more ochraceous below, and those from Caldas are yellowest, but individual variation bridges the differences. The specimens reported here from Virolin in Santander apparently constitute the first record of "*Chocoensis*"-like birds from the eastern Andes and are widely separated from the nearest known population of *oressinoma*. Nevertheless, I cannot distinguish them in any way from topotypes of *oressinoma* from Caldas, although all the specimens from Santander are near the maximum size for the subspecies and would certainly average larger.

I would assume that *oressinoma* ranges into Ecuador, but I have not seen Ecuadorian specimens referable to this subspecies. It is replaced to the south by *quitensis* Nelson, which differs from *oressinoma* in having the cap more extensive, the cap and underparts more deeply ochraceous, as well as averaging larger. Hellmayr (1936) considered *quitensis* to be doubtfully distinct from *brevirostris* east of the Andes, but the former is a larger bird with a markedly longer bill and a less intensely colored cap.

Euphonia xanthogaster brevirostris Bonaparte

Euphonia brevirostris Bonaparte 1851, Rev. Mag. Zool. 2(3):136. "Columbia" = Bogotá.

Characaters.—Differs from *chocoensis* and *oressinoma* in having the underparts and cap darker, more ochraceous, less yellow. Cap plusher, more velvety, without noticeable dark bases to the feathers, hence mostly unspotted. Bill smaller than in *oressinoma.*

Range.—In Colombia found on the eastern slope of the eastern Andes from Cundinamarca southward, and on the southern end of the eastern slope of the central Andes in Huila. The stated range also includes eastern Ecuador and Peru, southern Venezuela, the Guianas, and northwestern Brazil.

Specimens examined.—COLOMBIA. CUNDINAMARCA: "Bogotá" (6, USNM); vicinity of Bogotá (1, USNM); near Quetame (1, ANMH). META: Buena Vista (1, ANSP); Mt. Macarena (2, AMNH). CAQUETA: Río Caquetá (1, USNM); La Murelia [=Morelia], Río Bodoquera (1, USNM; 3, AMNH; 1, ANSP); Florencia (1, AMNH). PUTUMAYO: Río Rumiyaco (2, ANSP); Río Churo Yacu (3, ANSP). NARIÑO: Río San Miguel (5, ANSP). HUILA: La Candela, 10 mi (16 km) SW of San Agustín (8, USNM; 1, AMNH; 16, ANSP); Belen, 45 km SW of La Plata (3, USNM), La Palma (1, AMNH); Caquetá Trail (1, ANMH); El Isno (1, ANSP). Specimens from elsewhere in the range were examined but not studied in detail.

Remarks.—Records of this subspecies from Santander del Norte (Meyer de Schauensee, 1951) are erroneous, being based on intergrades between *E. x. oressinoma* and *E. x. badissima* (*q.v.*). Thus there appears to be no evidence that this subspecies occurs any farther north in the eastern Andes than the Bogotá region.

Euphonia xanthogaster exsul Berlepsch

Euphonia xanthogaster exsul Berlepsch 1912, Verh. V Intern. Ornith. Kongr. Berlin 1911, p. 1017. San Esteban, near Puerto Cabello, Carabobo, Venezuela.

Characters.—Markedly distinct from any of the preceding subspecies. Adult males with cap rich orangish chestnut; breast and midline of belly very deep fulvous, almost chestnut. Females much buffier on breast and undertail coverts, cap suffused with chestnut, not yellowish.

Range.—Mountains of northern Venezuela from Lara east to Miranda.

Specimens examined.—VENEZUELA. LARA: mountains near Bucarito, Tucuyo (1, AMNH). YARACUY: Lagunita de Aroa (1, CM); Aroa, Bolivar RR (1, CM). CARABOBO: San Esteban, inland of Puerto Cabello (2, AMNH); La Cumbre de Valencia (1, CM); La Cumbre (1, CM); Las Quigas (2, CM). ARAGUA: Rancho Grande (2, USNM). DISTRITO FEDERAL: El Limón (1, USNM; 2, CM). MIRANDA: Santa Lucia (1, USNM; 1, CM). ?MONAGAS: Caripé (1, AMNH) [Hellmayr (1936) questioned the provenance of this specimen and I have not included the locality in Fig. 1].

Remarks.—Birds from the Sierra Perijá, Santander del Norte, and Boyacá, previously referred to *exsul,* belong to the following new subspecies.

Euphonia xanthogaster badissima, new subspecies

Holotype.—USNM 375042, adult male, Bellavista, "pumping station 100 km from Petrolea" [=65 km NW of Petrolea as marked on map of Carriker localities on file at USNM], Santander del Norte, Colombia. Collected 4 July 1943 by M. A. Carriker, Jr., original number 4595.

Characters.—Like *exsul* but adult males with chestnut of cap darker, less orangish, fulvous portions of underparts darker and somewhat more extensive. In females the cap is darker and more restricted than in *exsul.* Males are very similar to the widely disjunct *ruficeps* Lafresnaye and D'Orbigny 1834 of Bolivia; they do not differ in the color of the cap but are more extensively and deeper fulvous below.

Range.—Colombia in the Sierra Perijá area of Magdalena, south to Santander del Norte, including the Táchira Valley, and on the east slope of the eastern Andes in Boyacá.

Specimens examined.–COLOMBIA. MAGDALENA: Monte Elias, Sierra Negra, SE of Fonseca (1, USNM); Tierra Nueva, Sierra Negra, SE of Fonseca (1, USNM). SANTANDER DEL NORTE: Palo Gordo, 10 mi (16 km) SE of Villa Felisa, Táchira Valley (1, USNM); Bellavista, 65 km NW of Petrolea (3, USNM). BOYACA: Río Negro (2, CM).

Etymology.—"Most chestnut," from Latin *badius,* chestnut brown, and *-issimus,* an adjectival superlative.

Remarks.—A male and female from Río Negro, Boyacá, are clearly more similar to *badissma* than to *exsul,* although the underparts of the male are lighter than in the other specimens of *badissima.*

Euphonia xanthogaster oressinoma × *Euphonia xanthogaster badissima*

Characters.—Underparts and cap of adult males more ochraceous than in *oressinoma* but not nearly as dark as in *badissima.* Superficially somewhat similar to *brevirostris,* but cap not plush and velvety, with bases of feathers darker, giving a spotted appearance; bill larger.

Range.—Western slope of the eastern Andes of Colombia in Magdalena and Santander del Norte, west of Ocaña.

Specimens examined.—COLOMBIA. MAGDALENA: La Palmita (1, ANSP; 4, CM; 2, USNM). SANTANDER DEL NORTE: Ocaña, beyond Pueblo Nuevo (1, USNM); Pueblo Nuevo (1, ANSP).

Remarks.—These birds had previously been identified as *brevirostris* (Meyer de Schauensee, 1951), but they are clearly intergrades between the two disparate subspecies listed above, whereas the nearest known occurrence of *brevirostris* is from far to the south, on the other side of the eastern Andes. All of the intergrades come from a rather limited area west of Ocaña. The male labelled ''beyond Pueblo Nuevo'' comes from slightly farther to the east than those from Palmita and has a darker crown, hence tending more towards *badissima*. The specimen labelled simply ''Pueblo Nuevo,'' however, looks like those from Palmita.

Acknowledgments

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Literature Cited

Hellmayr, C. E. 1936. Catalogue of Birds of the Americas. Part 9.—Field Museum of Natural History, Zoological Series 13(9):1–458.

Meyer de Schauensee, R. 1951. The birds of the Republic of Colombia. Part 4.—Caldasia 5:873–1112.

National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

Note added in proof: The record of *Euphonia xanthogaster* from El Real, Darien, Panama, reported *fide* Wetmore in Haffer (1975, Bonner Zoologische Monographien 7:158–9), was based on a specimen that I have re-identified as *E. luteicapilla* (USNM 484881); this happens to be the easternmost record of the species.

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SPADELLA LEGAZPICHESSI, A NEW BENTHIC CHAETOGNATH FROM ENEWETAK, MARSHALL ISLANDS

Angeles Alvariño

Abstract.—*Spadella legazpichessi* is described from adult mature individuals and compared with related species, *S. schizoptera, S. moretonensis, S. johnstoni, S. sheardi, S. nana, S. pulchella, S. hummelincki,* with which it agrees in the presence of adhesive digital organs. The diagnostic characteristics of these species and *S. legazpichessi* are compiled in a table together with information on their geographical distribution.

Spadella is a genus of Chaetognatha including animals of benthic regimen. These animals are small, from less than 1 mm to less than 1 cm. Their restricted habitat and movements limit the distribution of the species. Specimens of *Spadella* do not appear in the usual plankton collections, and collectors of benthic animals usually overlook these small organisms. Therefore, they are obtained only occasionally. Up to now the number of species is one dozen, but I am sure that with proper sampling along the coastal regions of the world, many new species will be found, and a more adequate distributional range of all the known species of *Spadella* will be obtained.

Alvariño (1970) reviewed the geographic distribution of the species. Since then two more species of *Spadella* have been described, *Spadella bradshawi* Bieri, 1974 and *Spadella gaetanoi* Alvariño 1978, inhabiting California and the Hawaiian Islands, respectively. Also, *S. angulata* was observed at the Laccadive Islands (Nair and Rao, 1973). Now specimens of a new *Spadella* have been collected at the lagoon of Enewetak (formerly Eniwetok), Marshall Islands.

The new species of *Spadella* described here is related to *S. schizoptera, S. moretonensis, S. johnstoni, S. sheardi, S. nana, S. pulchella, S. hummelincki,* in the presence of adhesive digital organs on the ventrolateral sides of the tail segment. However, *S. schizoptera, S. johnstoni,* and *S. sheardi* have been described with two pairs of lateral fins, while *S. moretonensis, S. nana, S. pulchella,* and *S. hummelincki* have only one pair of lateral fins. Intestinal diverticula are absent in these species and in *Spadella* n. sp., although Yosii and Tokioka (1939) indicated they were present in *S. schizoptera,* where they are absent according to Conant (1895), Ritter-Zahony (1911), Mawson (1944). Probably the specimens analyzed by Yosii and Tokioka (1939) do not belong to *S. schizoptera*.

Spadella legazpichessi new species
Figs. 1, 2

Material.—Holotype (USNM No. 60191), paratypes (USNM No. 60192) collected at Enewetak atoll lagoon, Marshall Islands, in May 1979.

Diagnosis.—The anatomical features described here are based on mature adult specimens.

The body is opaque, with well developed muscles on the dorsal and ventral sides. Lateral sides very narrow. The whole animal presents a peculiar iridescence characteristic of most Chaetognatha. No pigment or pigmentation patterns have been observed (Fig. 1A, B).

Total length when mature, up to 2 mm, tail fin not included. The body is widest at the region of the transverse septum separating trunk and tail segments.

The head is large, strong, about the same length and width, but wider than the neck. It is about 13% of the total length of the animal. The neck is distinct and covered by a thick collarette (Fig. 2A).

The caudal segment constitutes 50% of the total length of the animal.

The eyes are large, oval, placed at center of dorsal side of the head, and at about the same distance from each other or slightly closer to each other than to the sides of the head. The pigmented region is large, formed by 2 branches; the longer extending parallel to the longitudinal axis of the body and curving laterally at each end; it is crossed at midlength by a short, thick, bifurcated transverse branch that runs medially. The pattern of the pigment in the eyes of *Spadella legazpichessi* is similar to that found in most species of *Spadella*. The pigment separates 3 large and one small clear amber spaces, filled by lenses. The bifurcation of the transverse branch of pigment is at times quite deep (Fig. 2A).

The hooks are strong, thick, strongly curved, as in *Sagitta ferox* and *S. robusta,* usually a group of 8 or 9 at each side of the head. The anterior teeth are 3 to 5 per set, long curved inward and posteriorly. The second and third teeth at each side, counting from the center of the head, are longer than the others, the third being the longest; the fifth is the shortest. No posterior sets of teeth were observed.

The corona ciliata is ring-shaped, with the transverse axis slightly longer than the longitudinal axis. It is located at the dorsal side of the neck, extending into the collarette region of the neck (Figs. 1A and 2A).

The collarette extends in a thick stratum from the head to level of posterior septum. It is thickest at the neck, tapering towards the posterior part of the trunk, and extending as a narrow stratum to the tip of the tail.

Intestinal diverticula absent.

The ventral ganglion is large, thick, occupying totally the width of the

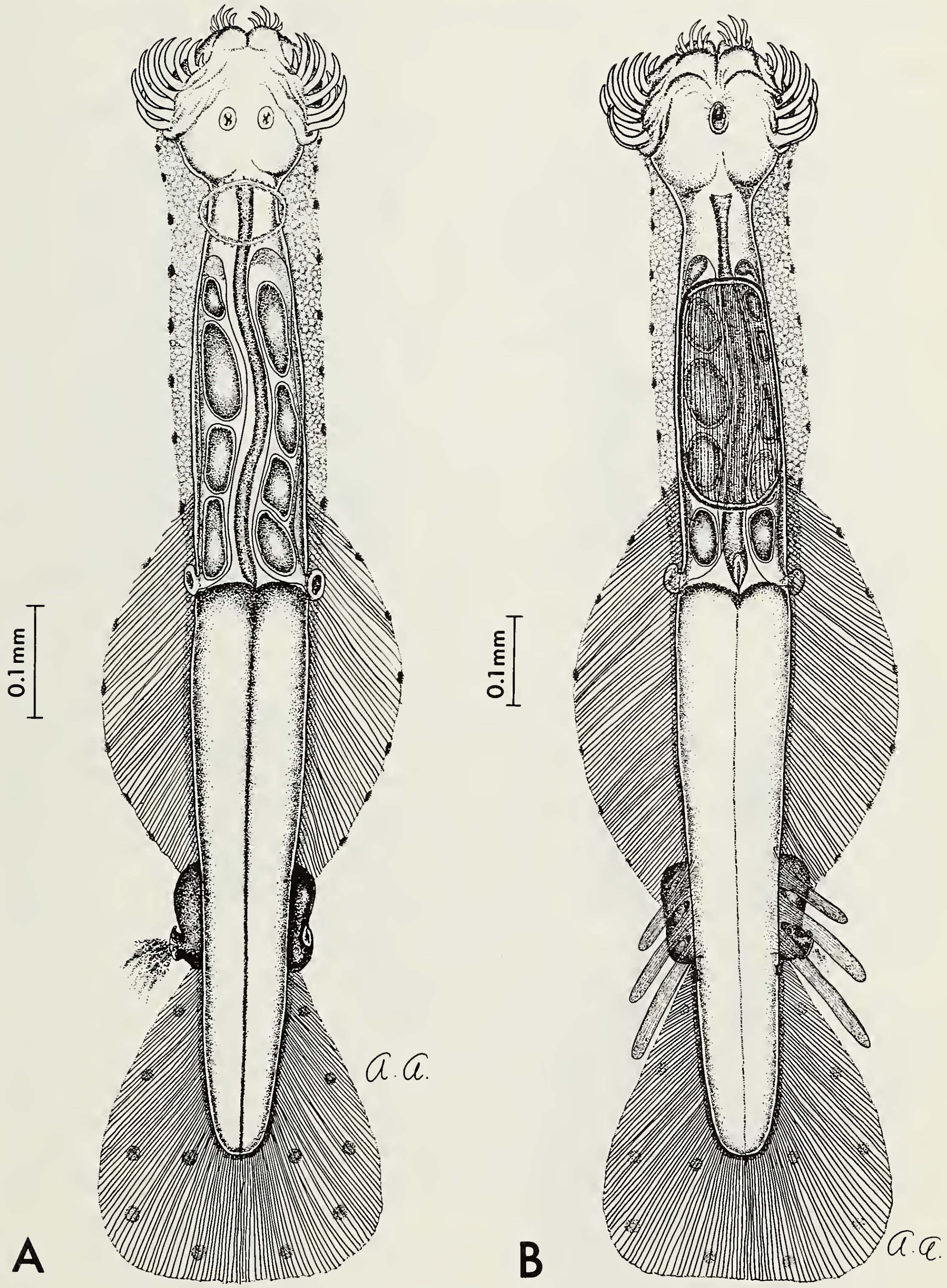

Fig. 1. *Spadella legazpichessi:* A, Dorsal view; B, Ventral view.

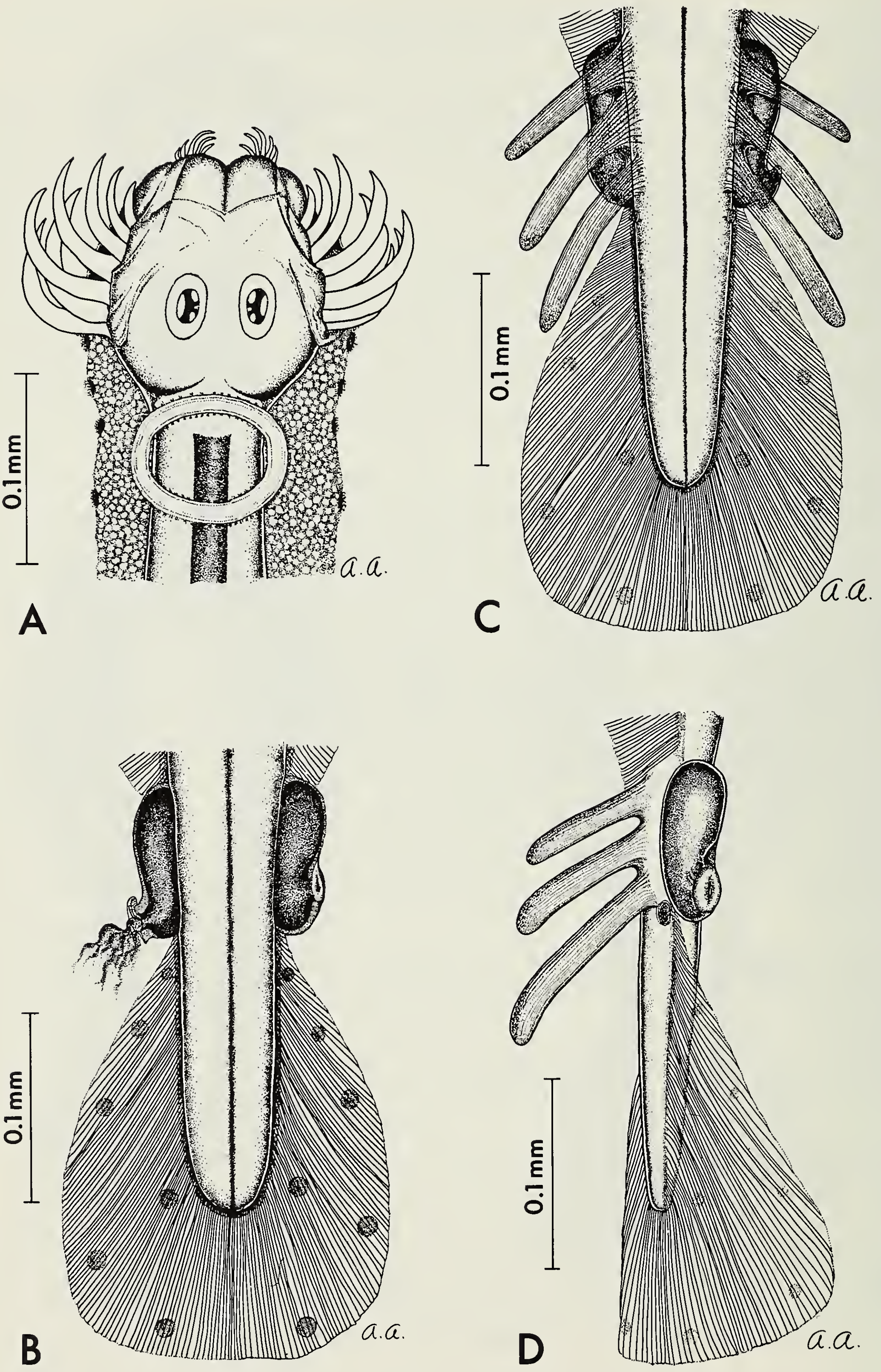

Fig. 2. *Spadella legazpichessi:* A, Dorsal view of head, with detail of hooks, teeth, eyes, corona ciliata, neck, collarette, and anterior part of intestine; B, Dorsal view of posterior part

trunk and half the length of the trunk segment. It is located at midlength of the trunk, as close to the neck as to the posterior septum (Fig. 1B).

There is one pair of lateral fins, extending from a level on the trunk anterior to the opening of the oviducts, to the seminal vesicles. They are completely rayed. The caudal fin is long, spatula-shaped, rounded laterally along the tip of the tail segment, with a straight posterior edge. It is not continuous with the lateral fins, and starts at posterior edge of the seminal vesicles. The portion of the tail segment surrounded by the tail fin is about 16% of the total length of the animal (Fig. 1A, B).

Adhesive digital organs are formed by three long rigid finger-like processes covered by a few small thin papillae. They extend along the ventrolateral side of the tail segment. The most anterior finger-like structure has part of the anterior edge joined to the posterior edge of the lateral fins, but the other 2 fingers are free. The posterior finger is the longest, and the anterior one is the shortest. The adhesive organs are at the ventrolateral side of the tail segment, exactly at the level of the seminal vesicles. Thus in the tail segment the seminal vesicles are dorsolateral, while the adhesive organs are ventrolateral (Fig. 2C, D). The adhesive organs are strengthened by long thin rays or muscle-like fibers, similar to the fin rays. The tip of the longest finger when extended, reached half-way between the seminal vesicles and the tip of the tail segment. These finger-like organs extend ventrally to support the animal away from the substratum while crawling, or to help in fastening the animal strongly to the substratum during the crawling motion, while the fins are used during the darting and swimming activities. In the dozens of specimens analyzed no variability was observed in the adhesive digital organs, such as that found by Feigenbaum (1976) in *S. schizoptera* reared in the laboratory. Such variability might be an artifact of the culture environment, not occurring in nature. However, adhesive organs in young specimens are not fully developed, the anterior finger appears first and the other two at each side of the animal are already incipient.

A cup-like structure is located ventrally at each side of the tail between the origin of the tail fin and the seminal vesicles. These cups may have additional adhesive function from the papillae covering the cup process and the secreted mucus (Fig. 2C, D).

The ovaries extend to the neck region. The ova are few and large, and they press laterally against the intestine, which usually runs in an S-shape

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of tail segment, with detail of seminal vesicles and tail fin. The left seminal vesicle is bursting; C, Ventral view of posterior part of tail segment, with detail of seminal vesicles, adhesive digital organs, and tail fin; D, Left side view of posterior part of tail segment, showing the dorsolateral position of seminal vesicles, and ventrolateral position of adhesive digital organs.

Table 1.—Differential characteristics of mature adult species of *Spadella* with digital adhesive organs.

Species Charact.	*S. schizoptera* Conant 1895	*S. moretonensis* Johnston and Taylor 1919	*S. johnstoni* Mawson 1944	*S. sheardi* Mawson 1944
Body length (mm)	1.9–4.9; wider at level of posterior septum	3.68	4.6; slender, yellow with brownish spots on corona ciliata	3.9–6.5; opaque, mauve brownish pigment along 3 longitudinal and 2 transverse bands. At level of oviducts, yellow spots on body.
Head	Broader than body with narrow neck. A pair of pads at mouth.	Broader than long. Neck conspicuous.		
Tail segment % to total length	47.0–53.7	56.5; two club-shape papillate bodies on posterior part of ventral side	52.0	44.8
Lateral paired fins	2 pairs; anterior pair extending from a point slightly behind the ventral ganglion to opening of oviducts. The second pair from this point to seminal vesicles.	1 pair, from oviducts to tail fin. Completely rayed and covered with sensory spots.	Similar to *S. schizoptera*	2 pairs; anterior short, on trunk. Posterior from opening of oviducts to seminal vesicles.

Table 1.—Continued.

S. nana Owre 1963	*S. pulchella* Owre 1963	*S. hummelincki* Alvariño 1970	*S. legazpichessi* Alvariño n. sp.
0.75–2.40	1.9–2.7; clusters of redish cells at anal region	2.0–3.0; broadest at the trunk	1.8–2.2; thick, strong, opaque, widest at mid-length.
Broader than widest part of body. Neck distinct. A pair of papillae between anterior teeth and mouth	Slightly broader than widest part of trunk. Neck distinct. A pair of prominences as in *S. nana* but with fewer papillae.	Large, roundish; smaller than in *S. pulchella*. Neck thick but distinct.	Large, roundish. Neck well distinct.
40–50	52–55	49	50
1 pair; from a level anterior to opening of oviducts to seminal vesicles.	1 pair; from a point anterior but close to oviducts to seminal vesicles extending ventrally over seminal vesicles joining tail fin	1 pair, long, narrow, from level anterior to opening of oviducts to seminal vesicles extending ventrally over seminal vesicles joining tail fin	1 pair, extending from posterior part of trunk to seminal vesicles.

Table 1.—Continued.

Species Charact.	*S. schizoptera* Conant 1895	*S. moretonensis* Johnston and Taylor 1919	*S. johnstoni* Mawson 1944	*S. sheardi* Mawson 1944
Caudal fin	Long, spatula shape	Spatula shape, completely rayed, covered with sensory spots.		Spatula shape
Eyes		Large, with no pigment		Small, widely spaced and overlain by brown pigment
Hooks	8–11, long, curved. Points sharp	9, slightly curved like in *E. hamata*	10–11	Up to 11
Anterior teeth	2–3 long, slender curved towards the midline where they meet.	3–4, stout, curved.	2, long, about half length of hooks.	3, long, about ⅓ to ½ length of hooks.
Posterior teeth	None	None	None	None
Corona ciliata	Three corned shape or pear-shaped to roughly triangular. Part on head and part on neck.	Roughly elliptical, slightly pointed at anterior end.	Elliptical-rectangular, mainly on neck.	Triangular
Ventral ganglion	Large, thick, overlaid by numerous sensory spots.	Large at anterior half of trunk.		

Table 1.—Continued.

S. nana Owre 1963	*S. pulchella* Owre 1963	*S. hummelincki* Alvariño 1970	*S. legazpichessi* Alvariño n. sp.
Spatula shape, starting at posterior end of seminal vesicles	Spatula shape starting at a distance of posterior end of seminal vesicles. This distance is equal to the length of the vesicle.	Long spatulated shape, starting at a distance of posterior end of seminal vesicles equal to half the length of the vesicle. No rayless zone.	Spatulate in shape, starting at posterior end of seminal vesicles. Covered by 12 sensorial spots. No rayless zone.
	The pigment in a longitudinal band crossed by a short band at the center.	Large, roundish. Larger than in *S. pulchella*. Pigment in a thick X-shape.	Large, oval. Pigment in a longitudinal band tilted towards the sides, and at midlength a short band towards the center
5–9	8–10	8–9 each side. Slender, slightly curved.	8–9 at each side. Strong, curved like in *S. ferox*
1–3, the innermost longer than the others. Curved towards the midline.	2–4, long, slender, curved.	4 at each side. Long, thin, bent at about midlength.	Up to 5 at each side. First 3 longer than the others. The 3rd at each side is the longest. Curved towards the ventral side.
None	None	None	None
Variable in shape. Located at the neck extending towards the head.	Broad, irregular oval, located at neck and extending towards the head.	On neck, roundish with peak towards center of head.	Like a ring at dorsal part of neck.
As broad as long.	Large, midway between posterior edge of corona ciliata and posterior septum.	Large, thick, about half length of trunk, and almost as wide as trunk. Closer to posterior septum than to neck.	Large, thick at midlength of trunk, and about 50% length of trunk. As close to neck as to posterior septum.

Table 1.—Continued.

Species Charact.	*S. schizoptera* Conant 1895	*S. moretonensis* Johnston and Taylor 1919	*S. johnstoni* Mawson 1944	*S. sheardi* Mawson 1944
Sensorial spots	Abundant, extending on longitudinal and transverse rows.	On tail fin, lateral fins, sides of body and head.	Arranged in two symmetric groups along the body.	
Ovaries	Reaching neck or anterior end of ventral ganglion or its midlength.	Reaching to level of ventral ganglion. Few large ova. Opening of oviducts swollen and trilobed.		Up to neck. Open at clear space between posterior end of anterior fin and anterior end of posterior fin.
Seminal vesicles	Ellipsoidal, reniform, touching both lateral and tail fins.	Small, inconspicuous, on posterior third of tail segment.	Oval, yellow in color in living specimens.	
Intestinal diverticula	Present or absent (1)		Absent	
Adhesive organs	Hand shaped, prolongation of lateral fins with 4, 5, 6 finger-like processes, extending from posterior end of lateral fins. First finger longest and outmost shortest. All	Rudimentary.	At ventral side of seminal vesicles, extending over length of tail fin.	Laterally at ventral side tail between posterior fins and seminal vesicles, arranged in 2 groups at each side, one towards the anterior part of the animal and other towards the end. 10–11

Table 1.—Continued.

S. nana Owre 1963	*S. pulchella* Owre 1963	*S. hummelincki* Alvariño 1970	*S. legazpichessi* Alvariño n. sp.
Arranged symmetrically in pairs on caudal fin and longitudinal rows on the body.	Arranged symmetrically as in *S. nana*. Lateral spots on outer edges of collarette and lateral fins are conspicuous.	Numerous	Symmetrically arranged on tail fin (6 at each side) and 6 conspicuous along edge of lateral fins and more than 6 at each side along edges of collarette.
Reaching to neck. 2–5 huge ova and intestine is pushed into an S-shape.	Up to midlength of trunk, 2–3 large ova.	Reach to neck or anterior end of ventral ganglion. Few large ova.	Reach neck region. Few large ova, pushing intestine into an S-shape.
Oval, roundish anterior to tail fin. Protected ventrally by prolongations of lateral and tail fins.	Oval, extending from posterior end of lateral fins to adhesive organs.	Oval or pear shaped, touching posterior end of lateral fins to the adhesive organs and apart from tail fin. Open by lateral dorsal slit at about midlength.	Ellipsoidal, reniform, touching posterior end of lateral fins and anterior end of tail fin. Open at middle of edge towards posterior half of vesicle.
Absent	Absent	Absent	Absent
Extending ventrally from posterior end of lateral fins to seminal vesicles. Divided in 2 stout distally tubercular fingers, with muscular fibers. First finger is longest. In small specimens, only one finger per organ.	Extending from posterior end of seminal vesicles to the point the caudal fin starts. Not associated with lateral fins, not attached to caudal fin. 2–3 fingers in each organ. The innermost finger longer, slender, undivided; the	One hand shaped at each side, with 3 short, thick stout fingers each covered by thin papillae. Appear as extension of lateral fins, strengthened by ray-like pattern, continuation of the lateral fins and rising from latero-ventral	Three long thin fingers in each organ, prolongations of posterior end of lateral fins, but attached also at latero-ventral part of tail at level of seminal vesicles only. Not attached to tail fin. Outermost finger

Table 1.—Continued.

Species Charact.	*S. schizoptera* Conant 1895	*S. moretonensis* Johnston and Taylor 1919	*S. johnstoni* Mawson 1944	*S. sheardi* Mawson 1944
	have adhesive papillae. A sensory spot at base of outermost branch.			fingers on each side, covered with papillae.
Collarette	Thick at neck, extending along base of lateral fins to seminal vesicles.	Thick at neck reaching lateral fins. Thus neck appears wider than the head.		
Geographic distribution	Bahamas, Florida, New South Wales? Misaki (Japan)?	Queensland	New South Wales	New South Wales.

(1) Characteristic varies with authors (see Alvariño, 1970).

from neck to anus. The opening of the oviducts are dorsolateral cups with an outer rim. The lateral fins extend ventrally anterior to the openings of the oviducts. The ventral disposition of the fins and dorsal placement of oviducts constitute a protective functional device to help in the transference of sperm during the copulatory process.

The seminal vesicles touch both posterior end of lateral fins and anterior end of caudal fin. They are large, reniform, about 8% of the total length of the animal. They open at the dorsal side by a dorsolateral slit in the posterior half, just beyond the midlength of the vesicle. This opening protrudes toward the posterior part in a short bottle neck, which adapts to the opening of the oviducts (Fig. 2B, D).

The sensory spots appear distributed on the tail fin, and along the edges

Table 1.—Continued.

S. nana Owre 1963	*S. pulchella* Owre 1963	*S. hummelincki* Alvariño 1970	*S. legazpichessi* Alvariño n. sp.
	other may split at the tip. Abundant papillae cover tip of 2 or 3 digitations.	side of tail segment between posterior end of seminal vesicles and start of tail fin. Attached by a point at tail fin, at the sensory club.	is the longest, reaching midlength from vesicle to tip of tail. Fingers strengthened by thin muscular fibers. Large sensory club on ventral side of tail at posterior end of seminal vesicles.
Thick at neck, tapering progressively towards the seminal vesicles. At head appears continuous with hood.	Very thick at neck and anterior part of trunk, extending along base of lateral fins to posterior septum.	Wide, thick, extending from head to posterior septum, widest at anterior half of trunk.	Thick at neck extending along lateral part of trunk, tapering towards posterior part of tail segment.
Florida	Puerto Rico	Southwest of Bahia Fosforescente, Puerto Rico	Enewetak (Marshall Islands)

of the lateral fins and edges of the collarette, from the head to the posterior part of the trunk. In the tail fin are 6 at each side, 6 along the edge of each lateral fin, and more than 6 along the edge of the collarette, from the point the collarette joins the anterior edge of the lateral fins to the head.

Remarks.—Spadella legazpichessi differs from *S. schizoptera, S. johnstoni, S. sheardi* in many anatomical characters, especially in the number of lateral fins, from *S. schizoptera* probably also in the intestinal diverticula, and from *S. moretonensis, S. nana, S. pulchella,* and *S. hummelincki* mainly in the shape of hooks, head, characteristics of the adhesive organs, position of ventral ganglion, and position of seminal vesicles (Table 1).

Distribution.—The specimens studied were collected at Enewetak atoll, Marshall Islands, on sand, rubble coral, and living coral. The collections were obtained with a bottom emergence trap for epibenthic and hypopelagic organisms, during studies on benthic marine communities. In those collections were also trapped pelagic species of Chaetognatha, *Sagitta ferox, S. robusta, S. neglecta, S. oceania,* which might be swimming and feeding in the water stratum over the bottom.

Etymology.—Named after the navigator Miguel López de Legazpi, whose party discovered the Marshall Islands in 1565, then named "Islands of Bearded people," and James R. (Tony) Chess, who kindly provided me with the material for this study. Legazpi's expedition reached those islands and atolls with four sailing vessels under Legazpi's Command (*San Pedro, San Pablo, San Juan* and *San Lucas*) departing from Navidad port (north of Acapulco) on November 1564 and reaching those islands, coral reefs, and atolls in January 1565, in their route to the Philippines. Legazpi's expedition constitutes the initiation of the first round trip across the Pacific, inaugurating with their return from the Philippines to Acapulco, the first regular transoceanic route, which also lasted longest in history, 1564 to 1815 (Colección de Diarios y Relaciones para la Historia de los Viajes y Descubrimientos).

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Literature Cited

Alvariño, A. 1970. A new species of *Spadella* (Benthic Chaetognatha).—Studies on the Fauna of Curaçao and other Caribbean Islands 24:73–89.

———. 1978. *Spadella gaetanoi,* a new benthic Chaetognath from Hawaii.—Proc. Biol. Soc. Washington 91(3):650–657.

Bieri, R. 1974. A new species of *Spadella* (Chaetognatha) from California.—Publ. Seto Mar. Biol. Lab. 21(3–4):281–286.

Conant, F. S. 1895. Description of two new Chaetognaths (*Spadella schizoptera* and *Sagitta hispida*).—Johns Hopkins Univ. Circ. 14(119):77–78.

Feigenbaum, D. L. 1976. Development of the adhesive organ in *Spadella schizoptera* (Chaetognatha) with comments on growth and pigmentation.—Bull. Mar. Sci. 26(4):600–603.

Johnston, T. H., and B. B. Taylor. 1919. Notes on Australian Chaetognaths.—Proc. Roy. Soc. Queensland 31(3):28–41.

Mawson, P. M. 1944. Some species of the Chaetognatha genus *Spadella* from New South Wales.—Trans. Roy. Soc. South Australia 68(2):327–333.

Nair, V. R., and T. S. S. Rao. 1973. Chaetognaths from the Laccadives with the new record of *Spadella angulata* (Tokioka, 1951). Pp. 319–327 in: Bernt Zeitschel, ed., The Biology of the Indian Ocean, XIII + 549 pp., Springer-Verlag, New York, Heidelberg, Berlin.

Owre, H. B. 1963. The genus *Spadella* (Chaetognatha) in the western North Atlantic Ocean, with descriptions of two new species.—Bull. Mar. Sci. Gulf and Caribbean 13(3):378–390.

Ritter-Zahony, R. 1911. Revision der Chätognathen. Deutsch.Südpolar-Exped. 1901–1903, 13, Zool. 5(1):1–71.

Yosii, N., and T. Tokioka. 1939. Notes on Japanese *Spadella* (Chaetognatha).—Annot. Zool. Japan 18(4):267–275.

National Marine Fisheries Service, NOAA, Southwest Fisheries Center, P.O. Box 271, La Jolla, California 92038.

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GORGONISCUS INCISODACTYLUS, A NEW ISOPOD OF THE EPICARIDEAN SUPERFAMILY CRYPTONISCOIDEA, PARASITIC ON AN ASCOTHORACICAN CIRRIPED FROM HAWAII

Mark J. Grygier

Abstract.—A description of a cryptoniscoid isopod, *Gorgoniscus incisodactylus,* n. gen. et sp., is presented. This is the first isopod parasite to be described from an ascothoracican cirriped and the first cryptoniscoid from Hawaii. The new species is compared to representatives of other cirriped-infesting cryptoniscoid families, but its familial status remains uncertain. The significance of the first antennae, mandibles, pleopodal chitinous rings, and uropod setation of the cryptoniscus larva, and the posterior structures, and cuticular spicules of the female is discussed. It is suggested that this isopod is a parasitic castrator or an egg parasite, and that observed high infestation rates (up to 67%) may affect the reproductive success of the host population.

Cryptoniscoidea is a superfamily of epicaridean isopods, various members of which are parasites of peracarids, ostracods, cirripeds (thoracicans and rhizocephalans), and copepods (as larvae). They are protandric hermaphrodites, and have a complex life cycle usually involving 2 larval stages parasitic on copepods, the "cryptoniscus" larva which seeks out the definitive host, the protandric male indistinguishable from the cryptoniscus larva, and the female, derived by more or less catastrophic metamorphosis from the protander. The term "cryptoniscus larva" will be used herein to refer to either the larva or the protander, while the term "cryptoniscoid" will refer to the superfamily as a whole. The cryptoniscus larva is relatively unmodified; the female, however, is commonly simplified to a large brood sac, though sometimes part of the cryptoniscus larval externum is retained.

Two published reports exist of isopods parasitic upon ascothoracican cirripeds (Ascothoracica is a primitive group of crustaceans whose members are parasites of echinoderms and anthozoans). Newman (1974) mentioned in his description of *Synagoga sandersi* that a gravid female was host to an isopod occupying the space of an egg. The isopod was given to Newman's student, the late Larry Ritchie, for study; it has not yet been possible to locate the specimen, but Newman is certain that it was a cryptoniscoid (personal communication). Pyefinch (1939) reported the discovery of cryptoniscoid parasites from three species of the zoanthid-infesting ascothoracican *Baccalaureus.* These specimens have not yet been described, but they are to be included in the Isopoda volume of the John Murray Expedition Reports (Boxshall, personal communication).

Gorgonians (USNM Acc. no. 330459) were collected by the *Star II* submersible at a site off Makapuu Point, Oahu, Hawaii, at 366 meters depth on 27 January 1978. Galls from specimens of several paramuriceid genera presumably containing barnacles were sent to Scripps Institution of Oceanography for identification. These galls contained representatives of the cirriped order Ascothoracica, which have been identified as a new species of *Gorgonolaureus* Utinomi, 1962. A description of the ascothoracican is in preparation. Several apparently mature, but not gravid specimens of *Gorgonolaureus* contained cryptoniscoid isopods in the dorsal brood chamber formed by the fusion of the carapace valves. A *Placogorgia* with *Gorgonolaureus* galls was collected at a later date at the same locality, and was dried. Some of the ascothoracicans from this gorgonian were also infested with cryptoniscoid isopods, including 2 post-metamorphic females.

The families of Cryptoniscoidea have historically been delimited by their hosts. However, a revision of these isopods is in progress (Strömberg, personal communication), so I will not now consider a new family for the present species despite the novel taxonomic position of its host. Nonetheless, it will be compared to representatives of those cryptoniscoid families known to parasitize cirripeds: Liriopsidae on rhizocephalans and Hemioniscidae and Crinoniscinae (formerly Crinoniscidae, but incorporated into Liriopsidae by Bocquet-Védrine, 1974) on thoracicans.

Isopods were prepared for study as follows. Dried material was reconstituted overnight in a 10% trisodium phosphate solution. Most specimens were studied whole in lactic acid mounts, but 1 cryptoniscus larva and 1 female were dissected and the parts mounted in Turtox CMC-10 with acid fuchsin. Drawings were done by the author with the aid of a camera lucida.

Order Isopoda Latreille, 1817
Suborder Epicaridea Latreille, 1831
Superfamily Cryptoniscoidea
(nom. transl. herein pro Cryptoniscinae Bonnier, 1900)
Family incertae sedis
Genus *Gorgoniscus,* new genus

Diagnosis.—Cryptoniscoid isopod parasitic on ascothoracican cirriped *Gorgonolaureus.* Cryptoniscus larva about 0.8–1.0 mm long, fusiform. Eyes absent. Prominent transverse cuticular striations on dorsum of body. Basal segment of first antenna with 5 posterior teeth, lateralmost tooth with pronounced shoulder. Second antenna extending posteriorly to third free thoracic segment. Oral cone pointing anteriorly; mandibles styliform. Epimeral plates of pereon longitudinally ridged, posterior margins entire. Dactyli of pereopods 6 and 7 longer and narrower than others, claws notched. Pleopods with typical setation, endopodites with 5 setae (3 on fifth pair), exopodites with 5, lateralmost one-third length of others; endopodites with chitinous ring. Uropod endopodites twice as long as exopodites; endopodite dorsal setae not necessarily numerically symmetrical. Telson margin entire.

Females about 4 mm long, ellipsoidal to round in dorsal view, dorsoventrally compressed with anterior and posterior ends curled ventrally. Most appendages absent. Mouthparts varying, either spatulate mandibles or median proboscis.

Etymology.—From a shortened form of *Gorgonolaureus,* the ascothoracican host of the present species and Latin oniscus (=wood louse). Gender masculine.

Type-species.—*Gorgoniscus incisodactylus,* new species.

Gorgoniscus incisodactylus, new species
Figs. 1–4

Material.—Holotype, cryptoniscus larva at U.S. National Museum of Natural History (USNM 181126); Paratypes: 2 cryptoniscus larvae (1 dissected and mounted, USNM 181127-8); 2 cryptoniscus larvae at Museum of Comparative Zoology, Harvard University; 1 cryptoniscus larva retained at Scripps Institution of Oceanography; 2 ♀♀ (1 dissected and mounted, USNM 181129-30).

Type-locality.—Off Makapuu Point, Oahu, Hawaii (21°18′N, 157°32′W) at 366 meters depth, collected by B. Bartko and K. Muzik in *Star II* submersible 27 January 1978.

Distribution.—Type-locality and nearby location 10 kilometers off Makapuu Point, where B. Bartko collected more specimens at 366 meters depth with *Star II* submersible in 1979.

Host.—Found within brood chamber formed by carapace of *Gorgonolaureus* sp. (Cirripedia: Ascothoracica) living in galls on paramuriceid gorgonians. See Table 1 for distribution of isopods on *Gorgonolaureus* and various gorgonians.

Etymology.—From Latin inciso (=to cut in) and Latin dactylus (=digit), referring to the notched claws of pereopods 6 and 7.

Description.—Characteristics of genus with following amplifications.

Cryptoniscus larva (Figs. 1–3): Dorsal profile (Fig. 1A) tapering narrowly posteriorly, more broadly anteriorly, cephalon bluntly pointed. Length (not including uropods) 0.84–1.00 mm (Holotype longest); maximum width (at midlength) 0.25–0.35 mm (Holotype widest). Cross section of body convex dorsally, flat ventrally, with slight ventral curvature of body longitudinally. Body (Fig. 1A, B) divided into cephalon with 2 pairs of antennae and oral

Table 1.—Distribution of *Gorgoniscus incisodactylus* on its host, the ascothoracican *Gorgonolaureus* sp., from various gorgonians. The *Placogorgia* was collected in 1979, the other three gorgonians in January 1978.

Gorgonian	*Gorgonolaureus*	Isopods
Paramuricea or *Placogorgia*	1 mature	2 cryptoniscus larvae (including Holotype)
	1 immature	none
	1 probably immature	not examined
Villogorgia	1 mature	none
	1 mature	none
	1 nearly mature	none
Muriceides	1 mature	none
	1 mature	none
	1 mature	none
Placogorgia	1 nearly mature	1 cryptoniscus larva
	1 mature	3 cryptoniscus larvae
	1 mature	1♀ (first female)
	1 mature	1♀ (second female) 1 cryptoniscus larva (lost)
	1 immature	none
	1 mature	none

cone, 7 free thoracic segments, seventh longer than others, each bearing pair of pereopods, 6 abdominal segments with 5 pairs of pleopods and 1 pair of uropods, and telson. Anterior end of body dorso-ventrally striated (Fig. 1C). Color white to gray in preserved specimens.

First antenna (Fig. 1D) not extending past cephalon; peduncle triarticulate, distal segment bearing 2 rami. Basal segment large (0.11 mm long); medial spines absent; medial posterior teeth originating more proximally than lateral teeth; teeth simple except for lateralmost; this tooth with 1 short seta at base, 1 at shoulder, 1 just proximal to shoulder; ventral surface of first segment covered with cuticular plates (Fig. 1C); 3 setae near anterior end, longest one medial, shorter 2 of subequal length; single large spine on dorsal surface between bases of all teeth. Second segment cylindrical, smaller than "palm" of first, bearing 3 setae on lateral side ventrally, 2 long, 1 short; possibly another long seta on medial side; large spine on dorsal side overlapping lateral edge of first segment. Third segment very short, arising from dorsal side of second; bundle of 14 aesthetascs apparently arising from it; also 2 setae, 1 lateral, other medial. Terminal rami uniarticulate; dorsal one with 4 long terminal setae, 2 aesthetascs apparently arising from shoulder near base; ventral one with 2 terminal setae and single terminal spinule.

Second antenna originating beneath teeth of first antenna's basal segment;

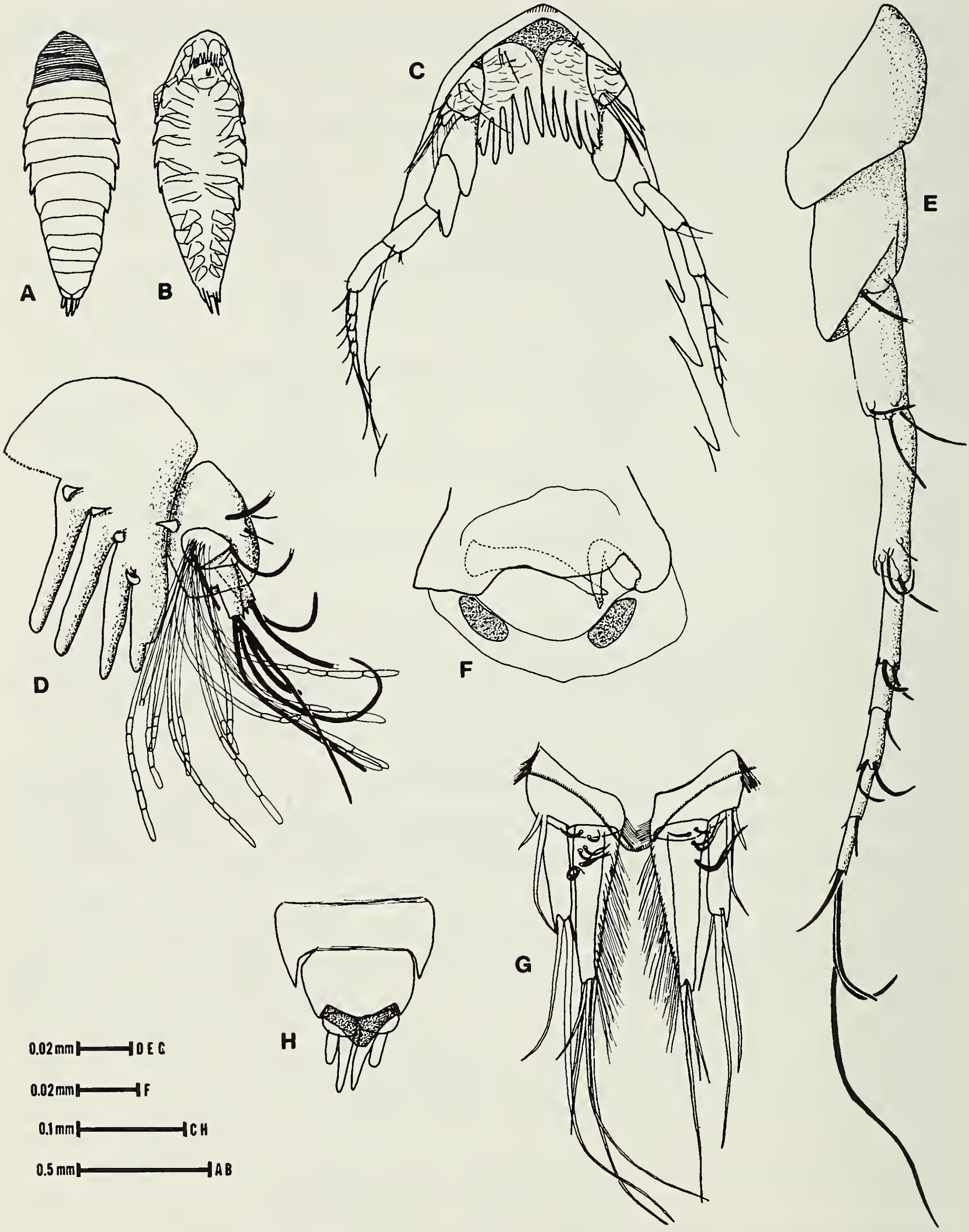

Fig. 1. Cryptoniscus larva of *Gorgoniscus incisodactylus*. A, Dorsal view of Holotype, cephalon and first free thoracic segment showing cuticular striation, uropod setae not shown; B, Ventral view of Holotype, bases only of pereopods and sympodites only of pleopods shown; C, Ventral view of cephalon showing positions of first and second antennae; D, Dorsal view of first antenna, medial posterior tooth missing, setae shown as solid, aesthetascs open; E, Second antenna, basal segment broken off proximally; F, Oral cone showing mandibles and posterior oval pieces (remnants of second maxillae); G, Dorsal view of uropods, hatched line near base representing posterior margin of telson; H, Dorsal view of abdominal segments 5 and 6, showing uropods without setae and telson (stippled).

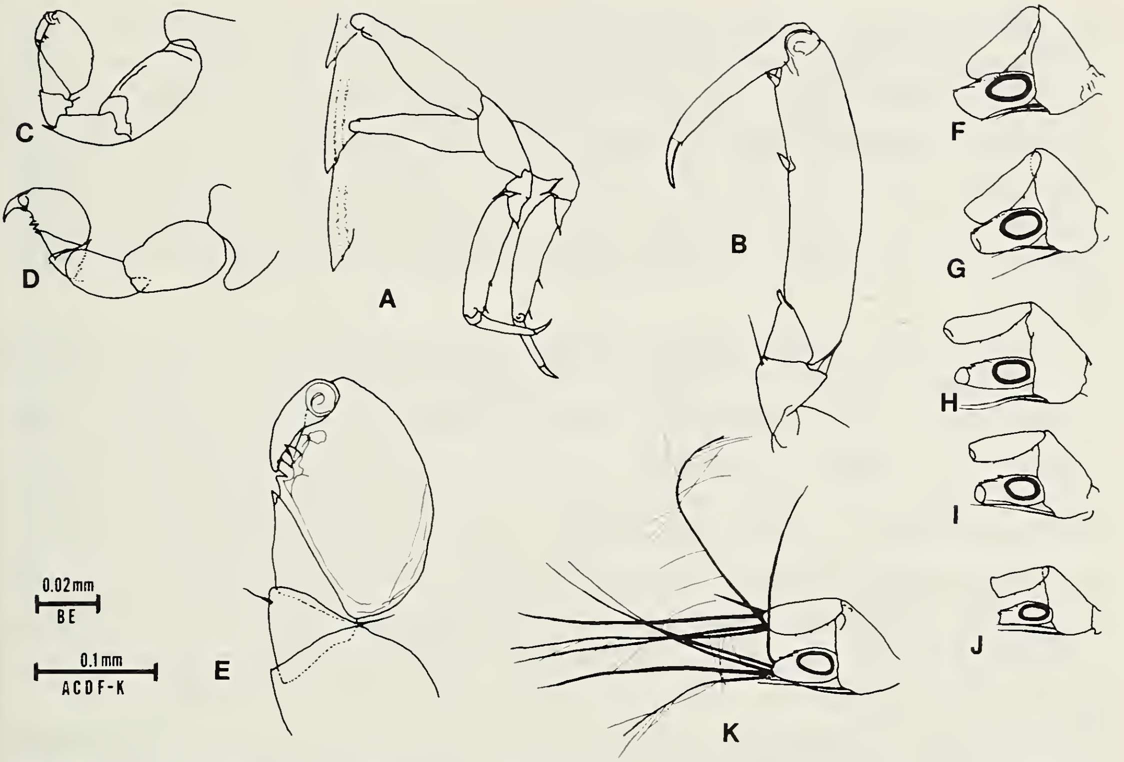

Fig. 2. Appendages of *Gorgoniscus incisodactylus* cryptoniscus larva. A, Pereopods 3 (above) and 4, showing relation to ridged epimeral plates; B, Detail of distal region of pereopod 5; C, Pereopod 1; D, Pereopod 2; E, Detail of pereopod 2 distal region; F–J, First through fifth pleopods showing size gradation and endopodite ring, terminal setae not shown; K, Typical pleopod showing terminal setation, not all setules shown.

4-segmented peduncle and 5-segmented flagellum, extending to third free thoracic segment (not including terminal setae). Setation apprently not consistent; description based on dissected specimen (Fig. 1E). First and second segments cylindrical with medial distal extension. No setae on first segment; 1 seta on second. Third segment cylindrical, same length as previous segments but half as wide, with 3 setae at tip. Fourth segment slightly narrower than third, bearing 4 setae. Flagellar segments cylindrical, distal ones narrower; first and third segments with 2 setae each; second and fourth with 1 each; 4 terminal setae on fifth segment, 3 quite long; lateral terminal spine on each flagellar segment, thinner and longer on distal segments.

Oral cone between bases of second antennae. Mouthparts (Fig. 1F) enclosed anteriorly by labrum, more or less exposed posteriorly near tip of cone. Mandibles arising at sides of cone's base, extending ventrally and bending slightly posteriorly; tip roughened with small knobs. Pair of oval plates at posterior base of cone probably representing second maxillae (Goudeau, 1969, 1977).

First 2 pairs of pereopods similar (Fig. 2C–E), with dactylus and propodus forming subchela. Basis cylindrical, twice as long (0.09 mm) as wide. Ischium two-thirds as long as basis, much narrower, bowed posteriorly. Merus triangular with large seta on lateral corner, small seta distally on medial side. Carpus an elongate triangle with stout spine distally. Propodus as long as ischium, attached firmly to long lateral side of carpus, with distal articulation of dactylus, latter modified as heavy claw. When closed, dactylus engaging 2 heavy spines on propodus, proximal one bifid, distal one trifid. Dactylus not opposing terminal spine of carpus, but gap between them small.

Five other pairs of pereopods similar to one another (Fig. 2A, B). Basis 0.12 mm long, narrow but clavate with expanded distal half. Ischium half as long as basis with lateral edge convex. Merus triangular with large seta on latero-distal angle and long, fine seta on medio-distal angle. Carpus also triangular with stout spine medio-distally. Propodus 0.1 mm long, slender, distal half bearing 2 stout spines (distal one bifid) opposing dactylus. Dactylus not forming subchela; long and narrow, tapering to slightly recurved claw at tip; small spine at base of claw more pronounced in posterior pairs. Pereopods 6 and 7 with dactyli 25% longer and more slender than those of other pairs (Fig. 3).

Five pairs of pleopods similar to one another, becoming gradually smaller posteriorly (Fig. 2F–J). Pleopods biramous, with sympodite, exopodite, and endopodite each uniarticulate. Sympodite triangular, about twice as wide as long, sharpest angle lateral; 2 setae on medio-distal apex. Endopodite rectangular, twice as long as wide, outline slightly convex; 3 short spines on lateral side; chitinous ring either on anterior surface or within. Exopodite slightly narrower and longer than endopodite, constricted basally with 3 spinules on medial side. Longer setae of each ramus (Fig. 2K) about 0.15 mm long; setules 0.04 mm long.

Uropods (Fig. 1G) biramous. Sympodite short, disc-shaped; 2 strong setae at latero-distal corner, medial one 3 times longer than lateral; lateral and medial sides of sympodite lined with fine hairs. Exopodites 0.04 mm long, cylindrical with short lateral spine, 2 long setae, and 1 shorter, narrow seta distally. Endopodite a tapering cylinder lined medially with fine hairs; few (3–5?) long and short terminal setae as long but weaker than those of exopodite; several short setae (6 on left, 8 on right of specimen examined for them) basally on dorsal side. Telson short (Fig. 1H), rear margin sinusoidal, medial part protruding posteriorly.

First female (Fig. 4A–C): Color in preserved state brownish-yellow. Slight left-right asymmetry (Fig. 4A, B), 4.55 mm long, 4.22 mm wide. About 10 segments visible dorsally, 3 short ones anteriorly, 7 large ones following. Bilobed labrum (Fig. 4C) 0.4 mm wide, nearly bisected by posterior incision; 3 translucent regions, 1 medial and pair lateral. Anteriorly directed proboscis 0.25 mm long, tapering distally. Two small papillae, possibly reduced mandibles or openings of maxillary glands, posterior and lateral to base of

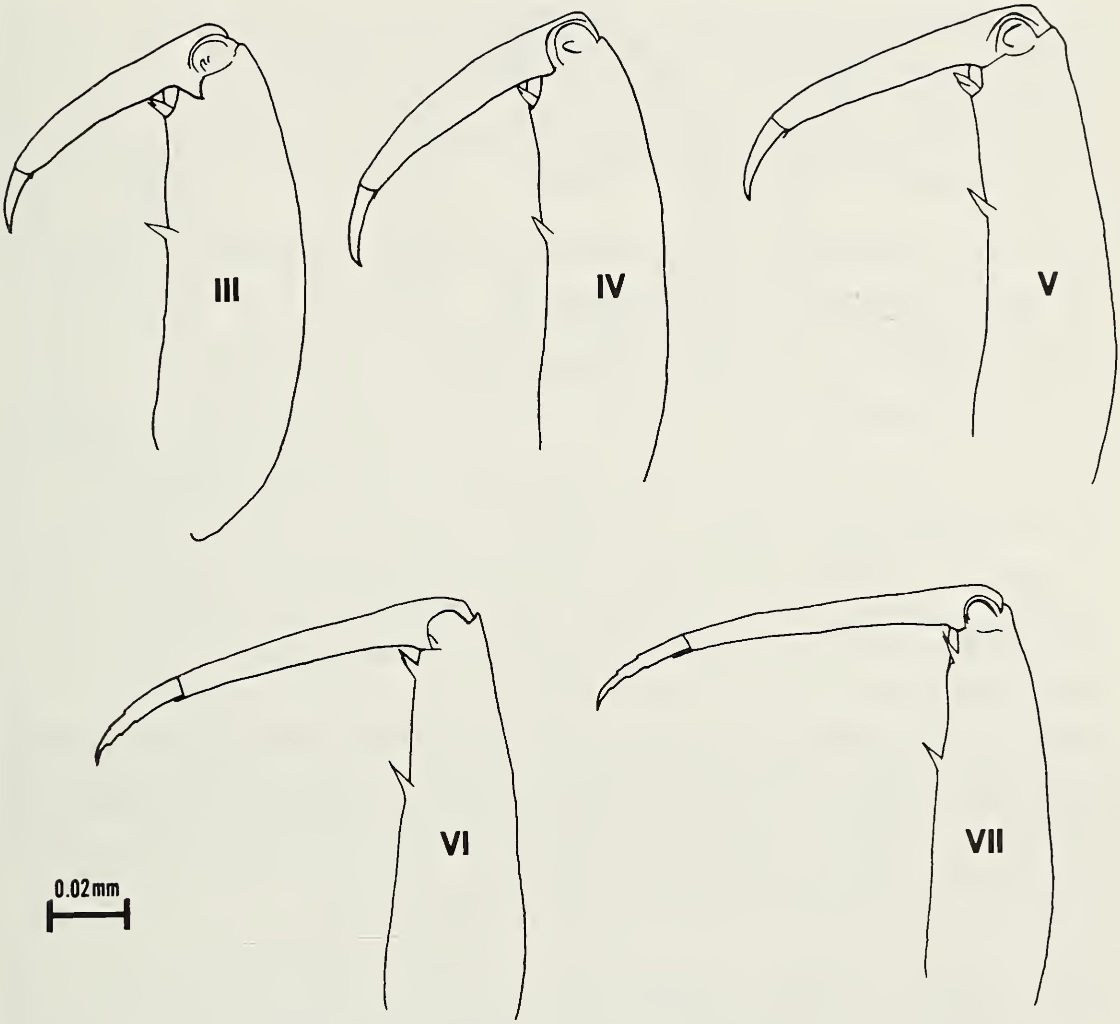

Fig. 3. Propodi and dactyli of pereopods 3–7 in cryptoniscus larva of *Gorgoniscus incisodactylus,* showing longer and narrower dactyli with notched claws in pereopods 6 and 7.

proboscis near posterior margin of labrum. Two featureless flaps of tissue just posterior to labrum. Other appendages absent. Telson not visible, though posterior end of body obscured by longitudinal folds in posteriormost segments (Fig. 4B). Eggs absent.

Second female (Fig. 4D, E): Color in preserved state dull yellow. About same size as first female, but more elongate. Anterior end squared off, hoodlike. Demarcations of few anterior segments visible, but most of body covered with fuzzy growth. Mouthparts near base of cephalic hood (Fig. 4D), consisting of anterior-pointing labrum and mandibles similar to those in cryptoniscus larva, but laterally flattened and relatively shorter with numerous small hooks on distal margins. Posterior conical structure (telson?) with distal depression (anus?) (Fig. 4E); uniarticulate structure at one side

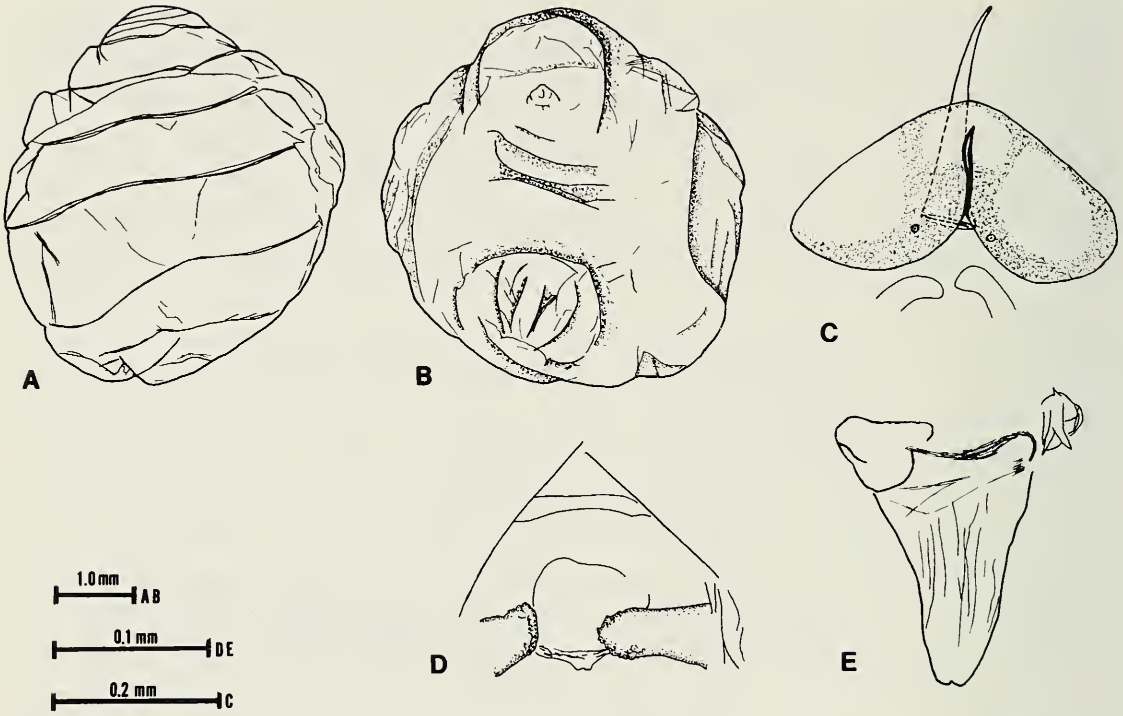

Fig. 4. Females of *Gorgoniscus incisodactylus*. A, Dorsal view of first female, anterior end above; B, Ventral view of first female showing oral region above, longitudinally folded posterior region below; C, mouthparts of first female showing labrum, proboscis, pair of papillae, and tissue flaps; D, Mouthparts of second female showing mandibles; E, Posterior body protrusion of second female with possible rudimentary uropod at base on right.

of base bearing 3 spines posteriorly, 1 anteriorly. Integument, where not fuzzy, studded with denticulate spicules in tight groups of 1–4. Eggs absent, large quantities of lipid or yolk present.

Remarks.—Nielsen and Strömberg (1965, 1973) have reviewed the families and genera within Cryptoniscoidea, and, in the latter paper, have listed pertinent diagnostic features of the cryptoniscus larvae for each family. It can be shown using these criteria and information from other authors that *Gorgoniscus* does not readily fit into any established genus or family of Cryptoniscoidea.

Liriopsidae (*sensu stricto*) have cryptoniscus larvae without dorsal cuticular ridges, with the posterior margin of the first antenna's basal segment entire, and with very short propodi on pereopods 6 and 7, conditions contrary to those in *Gorgoniscus*. The mature females in this family have their body divided into 2 parts connected by a thin waist, and the second pereopod is retained well into metamorphosis (Caullery, 1907). This description does not recall the characteristics of the present females.

Crinoniscinae have cryptoniscus larvae that differ from the present one only in having an entire posterior margin on the basal segment of the first antenna. Two genera, *Crinoniscus* Pérez, 1900, and *Leponiscus* Gruvel, 1901, have adult females in which the body is a cruciform sac quite unlike *Gorgoniscus* (Bocquet-Védrine and Bocquet, 1972a, 1972b), while a transitional metamorphic form known in *Crinoniscus* and *Proteolepas* Darwin, 1854 retains the second pereopods as grasping organs (Bocquet-Védrine, 1972, 1979).

Among Hemioniscidae, only *Hemioniscus balani* Buchholz, 1866 is well enough known for comparison. The cryptoniscus larva of this species has recently been redescribed (Goudeau, 1970). Differences with the *Gorgoniscus* cryptoniscus larva include toothed posterior margins of the thoracic epimeral plates in *H. balani*; the latter also has more posterior teeth on the basal segment of the first antenna. The female retains the anterior portion (forward of fifth free thoracic segment) of the cryptoniscus larval body but expands the posterior part into a stellate sac during metamorphosis (Goudeau, 1967, 1977), producing a form dissimilar to *Gorgoniscus*.

The other cryptoniscoid families, Podasconidae, Asconiscidae, Cyproniscidae, and Cabiropsidae all parasitize hosts far removed from cirripeds and have many more differences distinguishing them from the present genus than have the families discussed above. Finally, according to the compilation of characters given in Nielsen and Strömberg (1973), the combination of a toothed first antennal basal segment and entire epimeral plate margins is unique to *Gorgoniscus*.

It is unlikely that *Gorgoniscus* can be synonymized with any known genus of cryptoniscoids. It is less certain whether a new family need be erected for it. Despite great differences in the morphology of the females, differences between the present genus and both Crinoniscinae and Hemioniscidae are minor in the cryptoniscus larval stage. Therefore, it may prove expedient to incorporate *Gorgoniscus* into one of these families. Until Strömberg's revision is published, it seems wisest to retain the genus separately, incertae sedis.

Goudeau (1972) showed that the first and second segments of the first antenna in the cryptoniscus larva of *H. balani* are independently articulated to the cephalon, independently movable, and not articulated with each other. She concluded that the second segment is the actual basal segment. The first segment (her "plaque aliforme"), once part of the first antenna, is now separated and partly fused to the body, a situation analogous to the transformation of pereopod coxae into epimeral plates. In my dissected specimen, the first antenna was removed in one piece. The first segment is evidently articulated to the cephalon near the base of the medial tooth, which was torn away, but there is no evidence of any articulation of the second segment directly to the cephalon. Having had no opportunity to observe live animals, I cannot say whether the segments are independently movable. If Goudeau's observations are correct, I agree that the "plaque aliforme" must be derived from a first antennal segment; perhaps in *H. balani* a secondary attachment of the second segment has occurred. Such an arrangement does not seem to be present in *G. incisodactylus*.

Goudeau (1970, Fig. 9) shows rings in the pleopods of *H. balani* similar to those in *G. incisodactylus,* but she does not mention them in the text. References to these rings are made in the descriptions of certain other cryptoniscoids, but not all. This could be the result of the dearth of complete descriptions in this group, but Nielsen and Strömberg's otherwise exemplary description of the cryptoniscus larva of a cabiropsid (1965) includes no mention of these structures. The presence or absence of chitinous rings in the pleopods may be an unappreciated taxonomic character. I could not determine whether the rings are external features or internal. If external, they may be sucking discs for attachment to the host, but setae from anterior pleopods overlay posterior ones, presumably limiting the rings' utility for this purpose. If internal, they may serve as a kind of brace.

The styliform shape and roughened tips of the mandibles suggest that they are used both for piercing and trituration.

The asymmetry in the number of dorsal setae on the uropod endopodites is striking, for possession of 6 setae in this position has previously been considered a conservative feature of the superfamily (Nielsen and Strömberg, 1973).

The uniarticulate structure near the base of the posterior protrusion in the second female may be a rudimentary uropod. There is a scar opposite this structure which may show the location of the other uropod, ripped off during dissection. The cuticular spicules are similar to those described by Goudeau (1974) in *H. balani* females, though in the latter each spicule is rectangular in side view with a dentate distal margin. The fuzz covering much of the second female appears pathological, perhaps a fungal infestation; however, it is sticky, suggesting a secretion of the isopod, the ascothoracican, or the gorgonian.

The only *Gorgonolaureus* specimens infested were mature or nearly mature females without eggs (Table 1). Maturity was judged on the basis of comparisons with other, fecund, specimens. This fact suggests that the isopod is either a parasitic castrator or an egg parasite. The latter possibility is supported by the fact that isopods were never attached orally to their hosts, but could be removed with no difficulty from the brood chamber. There is a large difference in infestation rate between the 2 collection dates. As Table 1 shows, only 1 of 8 *Gorgonolaureus* specimens collected in 1978 was infested by *G. incisodactylus,* while 4 of 6 specimens collected from *Placogorgia* in 1979 were parasitized. Though the number of hosts examined is small, these data suggest that *G. incisodactylus* may at times have a large detrimental influence on the reproductive success of its host population.

The depth of collection (366 m) is greater than usual for cryptoniscoids, but other such instances have been reported; e.g., an undescribed deep-sea ostracod parasite (Nielsen and Strömberg, 1973) and the parasite from *Synagoga sandersi,* which was collected at 5000 m (Newman, 1974). Finally, *G. incisodactylus* is the first cryptoniscoid isopod recorded from Hawaii.

Acknowledgments

I would like to thank Mss. Katherine Muzik and Catharine Kessler of the Museum of Comparative Zoology for supplying the host ascothoracicans, Dr. William Newman and Mr. George Wilson of Scripps Institution of Oceanography for reviewing earlier drafts of this manuscipt, and Dr. Jarl-Ove Strömberg of Kristineberg Marine Biological Laboratory for helpful suggestions on the taxonomic treatment. Dr. Newman provided laboratory space. This work was done during the tenure of a National Science Foundation Graduate Fellowship and is a Contribution of Scripps Institution of Oceanography, new series.

Literature Cited

Bocquet-Védrine, J. 1972. Suppression de l'ordre des Apodes (Crustacés Cirripèdes) et rattachement de son unique représentant, *Proteolepas bivincta,* à la famille des Crinoniscidae (Crustacés, Isopodes, Cryptonisciens).—C. R. Acad. Sci. Paris 275D:2145–2148.

———. 1974. Parenté phylogénétique des Isopodes Cryptonisciens rangés jusqu'ici dans les familles des Liriopsidae et des Crinoniscidae, *in* Arvy, L., ed. Recherches Biologiques Contémpéraines (Imp. Wagner, Nancy). [Not seen by author.]

———. 1979. Interprétation actuelle de la description de *Proteolepas bivincta* Darwin, 1854 (représentant unique de l'ancien ordre des Cirripèdes Apodes).—Crustaceana 37:153–164.

———, and C. Bocquet. 1972a. Réalisation de la forme définitive chez *Crinoniscus equitans* Pérez, au cours de l'étape femelle du cycle de cet Isopode Cryptoniscien.—C. R. Acad. Sci. Paris 275D:2009–2011.

———, and ———. 1972b. Sur la validité des genres *Leponiscus* Gruvel, 1901 et *Crinoniscus* Pérez, 1900.—Arch. Zool. Exp. Gén. 113:395–400.

Bonnier, J. 1900. Contribution a l'étude des Épicarides, les Bopyridae.—Trav. Statn. zool. Wimereux 8:1–475. [Not seen by author.]

Caullery, M. 1907. Recherches sur les Liriopsidae, Épicarides Cryptonisciens parasites des Rhizocéphales.—Mitth. Zool. Stat. Neapel 18:583–643.

Goudeau, M. 1967. Transformation morphologique du mâle en femelle chez l'Isopode Épicaride *Hemioniscus balani* Buchholz.—Cah. Biol. Mar. 8:437–448.

———. 1969. Appareil buccal et mécanisme alimentaire chez l'Isopode Épicaride *Hemioniscus balani* Buchholz.—Arch. Zool. Exp. Gén. 110:437–512.

———. 1970. Nouvelle description d'*Hemioniscus balani* Buchholz, Isopode Épicaride, au stade de mâle cryptoniscien.—Arch. Zool. Exp. Gén. 111:411–446.

———. 1972. Mode d'articulation à la capsule céphalique et conformation de l'antennule chez le mâle cryptoniscien d'*Hemioniscus balani* Buchholz, Isopode Épicaride.—C. R. Acad. Sci. Paris 275D:1997–1999.

———. 1974. Structures cuticulaires chez *Hemioniscus balani* Buchholz, Isopode Épicaride.—C. R. Acad. Sci. Paris 278D:3331–3334.

———. 1977. Contribution à la biologie d'un crustacé parasite, *Hemioniscus balani* Buchholz, Isopode Épicaride. Nutrition, mues et croissance de la femelle et des embryons.—Cah. Biol. Mar. 18:201–242.

Newman, W. 1974. Two new deep-sea Cirripedia (Ascothoracica and Acrothoracica) from the Atlantic.—J. Mar. Biol. Ass. U.K. 54:437–456.

Nielsen, S., and J. Strömberg. 1965. A new parasite of *Cirolana borealis* Lilljeborg belonging to the Cryptoniscinae (Crustacea Epicaridea).—Sarsia 18:37–62.

———, and ———. 1973. Morphological characters of taxonomic importance in Cryptoniscina (Isopoda Epicaridea). A scanning electron microscopic study of cryptoniscus larvae.—Sarsia 52:75–96.

Pyefinch, K. 1939. Ascothoracica (Crustacea, Cirripedia).—Scient. Rep. John Murray Exped. 5(9):247–262.

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Note added in proof: The various gorgonians listed in Table 1 represent a single undescribed species of *Placogorgia* (K. Muzik, pers. comm.). Nierstrasz and Brender à Brandis (1930, Proc. U.S. Natn. Mus. 77(9):1–9) described a supposed cryptoniscoid, *Faba glabra,* from a shrimp collected near Waikiki, Oahu, so *G. incisodactylus* may not be the first of this superfamily from Hawaii, as stated above.

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THREE NEW SHRIMPS, AND SOME INTERESTING NEW RECORDS OF DECAPOD CRUSTACEA FROM A DEEP-WATER CORAL REEF IN THE FLORIDA KEYS

Robert H. Gore

Abstract.—A small collection of 55 specimens of decapod crustaceans, obtained using a research submersible on a deep-water coral reef off Key Largo, Florida, produced one new genus and three new species of natantian shrimp, plus several major range extensions to the continental United States for other decapods. The new taxa included *Veleroniopsis kimallynae* new genus and species, and *Pontoniopsis paulae,* new species, in the Palaemonidae, and *Odontozona libertae,* new species, in the Stenopodidae. The discovery of new taxa in depths of less than 100 m suggests that the cryptic, coral-associated decapod crustacean fauna may be richer than previously suspected.

The decapod crustacean fauna of the Florida Keys has long been recognised as being both speciose and numerous. Although no comprehensive specific inventory has ever been conducted, the fauna is considered relatively well known as a result of several regional and monographic studies (e.g. Rathbun's monographs on brachyurans), which included species whose ranges extended either to, or north- or southward through the Florida Keys. As might be expected, the intertidal and shallow subtidal decapods are relatively better known than their deeper-living counterparts, because of the various logistical problems encountered in sampling deep, rocky or reeflike areas using either conventional surface-towed gear, or SCUBA.

In June 1979 a geophysical and biological survey of deep-water coral reefs off Key Largo, Florida was conducted by the Office of Coastal Zone Management for NOAA, using a manned research submersible. Among the 55 specimens of decapod crustaceans collected were 2 new genera and 4 new species. Included in the new taxa was a remarkable new genus of axiid shrimp, described elsewhere (Kensley and Gore, 1980), an unusual new genus of palaemonid shrimp, as well as the first western hemispheric record for the rare Indo-West Pacific genus *Pontoniopsis* (Palaemonidae), and the second western hemispheric record for the stenopodid shrimp genus *Odontozona*. Other notable range extensions included the first western hemispheric record for the alpheid shrimp *Alpheopsis trispinosus* (Stimpson), and the first continental United States record for the pagurid crab genus

Nematopaguroides Forest & St. Laurent, from Brazil. Additional continental U.S. records included specimens of *Pseudocoutierea antillensis* Chace (Palaemonidae) and *Synalpheus sanctithomae* Coutière (Alpheidae), the former previously known from the unique type-specimen, and the latter from a small type-series collected at various localities in the lesser Antilles. The collection was thus remarkable both for the novelty of the contained taxa, and from the fact that 11% of the 55 specimens, comprising 36 species, were new to science.

Materials and Methods

The specimens in this report were collected from a series of 5 of 10 stations occupied by the Research Submersible Johnson-Sea-Link I, operated by the Harbor Branch Foundation, Inc. Station data are listed in Table 1. In the following report, only new species, and new or interesting records of previously known species are considered. The few remaining taxa in the collections, all relatively common associates of coralline habitats, were of less consequence and will not be discussed further, although they are listed in Table 2. Catalog numbers for the species include those of the National Museum of Natural History, Washington, D.C. (USNM) for new or exceptionally interesting taxa, and the Indian River Coastal Zone Museum (IRCZM) at Link Port, Ft. Pierce, Florida. With the exception of holotypes, most paratypes, and those species noted below in the text, the remainder of the collection has been deposited in the Indian River reference collections.

Measurements were made with a substage micrometer calibrated to an ocular reticle on a dissecting stereomicroscope, and the abbreviations are as follows: rcl, rostral carapace length, measures the medial length from the distal rostral tip to the posterior carapace margin; sl, shield length, was used only with the pagurid species, and is the length of the carapace from the rostrum posteromediad to the cervical groove.

The three new species in this study are named for my research assistants, Mrs. Paula M. Mikkelsen, Miss Kim Allyn Wilson, and Mrs. Liberta E. (Scotto) Poolt, in recognition of their cheerful and willing help both in the field and in the laboratory over the past 8 years.

Section Caridea

Family Bresiliidae Calman, 1896

Discias atlanticus Gurney, 1939

Material examined.—1 ♀; rcl 3.2 mm; IRCZM 89:3802.

The single specimen constitutes the second record for the continental United States, the species having been previously reported from the central eastern Florida coast by Gore and Wilson (1978). Members of the genus are

Table 1.—Collection data for decapod crustaceans associated with the deep reef survey, Key Largo Marine Sanctuary.

J-S-L dive no.	Date	Locality	Coordinates	Collection method	Depth (m)	Habitat
I-679	03-VI-79	French Reef	Not available	Manipulator	42.1	Coralline rock
I-679	03-VI-79	French Reef	Not available	Manipulator	76.2	Coralline rock
I-681	04-VI-79	French Reef	25°02.08′N 80°19.27′W	Lockout diver	37.5	Algae and rock
I-682	04-VI-79	Carysfort Reef	25°10.30′N 80°12.82′W	Manipulator	62.5	*Meoma ventricosa* and sandy bottom
I-687	06-VI-79	Carysfort Reef	25°10.20′N 80°13.23′W	Lockout diver	27.4	Scleractinia
I-688	06-VI-79	Elbow Reef	25°07.79′N 80°14.32′W	Manipulator	56.4	Sponge, with *Siliquaria modesta* colony
I-690	07-VI-79	Elbow Reef	25°07.70′N 80°15.90′W	Manipulator	18.3	Relict *Montastrea* with *Eunicea* sp.

Table 2.—List of decapod crustacean species collected during the deep reef survey Key Largo Marine Sanctuary.

Family	Genus/species	Station	No./Sex
Alpheidae	*Alpheopsis trispinosus* (Stimpson)	I-679	1 ♀
		I-688	3 ♂♂, 2 ♀♀
	Alpheus amblyonyx Chace	I-690	1 ♀
	Alpheus normanni Kingsley	I-690	1 ♂, 1 ♀ ovigerous
	Synalpheus pandionis Coutière	I-690	1 ♂
	Synalpheus sanctithomae Coutière	I-681	1 ♂
		I-690	1 ♀ ovigerous
	Synalpheus townsendi Coutière	I-690	1 ♂
	Synalpheus sp. (?*townsendi*)	I-690	1 ♂
Bresiliidae	*Discias atlanticus* Gurney	I-679	1 ♀
Hippolytidae	*Thor manningi* Chace	I-682	1 ♀ ovigerous
Palaemonidae	*Pontoniopsis paulae* sp. nov.	I-682	1 ♂
	Pseudocoutierea antillensis Chace	I-687	2 ♀♀ ovigerous
	Veleroniopsis kimallynae n. gen. et sp.	I-690	1 ♂
Processidae	*Processa* cf. *tenuipes* Manning & Chace	I-679	1 ♀
Stenopodidae	*Odontozona libertae* n. sp.	I-688	2 ♂♂, 1 ♀ (spent)
Axiidae	*Coralaxius abelei* Kensley & Gore	I-679	1 ♀
Paguridae	*Nematopaguroides* cf. *fagei* Forest & St. Laurent	I-690	1 ♂
Galatheidae	*Munida angulata* Benedict	I-679	1 ♀ ovigerous
		I-681	1 ♂
		I-682	3 ♀♀ ovigerous
		I-688	1 ♂, 1 ♀ ovigerous
		I-690	1 ♂, 1 ♀
Xanthidae	*Actaea bifrons* Rathbun	I-681	1 ♀ ovigerous
		I-690	1 ♀
	Melybia thalamita Stimpson	I-688	1 ♀
		I-690	1 ♂, 1 ♀, 1 juv.
	Micropanope nuttingi (Rathbun)	I-690	1 ♀ ovigerous
	Micropanope sculptipes Stimpson	I-679	1 ♂, 2 ♀♀
		I-681	1 ♂ juv.
		I-688	1 ♂, 2 ♀♀, 1 juv.
	Micropanope sp.	I-688	1 juv.
	Juvenile xanthid	I-688	1 (crushed)
	Pilumnus sp.	I-690	1 ♂ juv.
	Pseudomedaeus distinctus (Rathbun)	I-679	1 ♀ juv.
Majidae	*Mithrax acuticornis* Stimpson	I-679	1 ♂

known associates with sponges, usually in water shallower than 40 m. The 76 m record in this study is the deepest yet for the species. Chace and Brown (1978) discussed the status of and reason for synonymizing the family Disciadidae with the Bresiliidae.

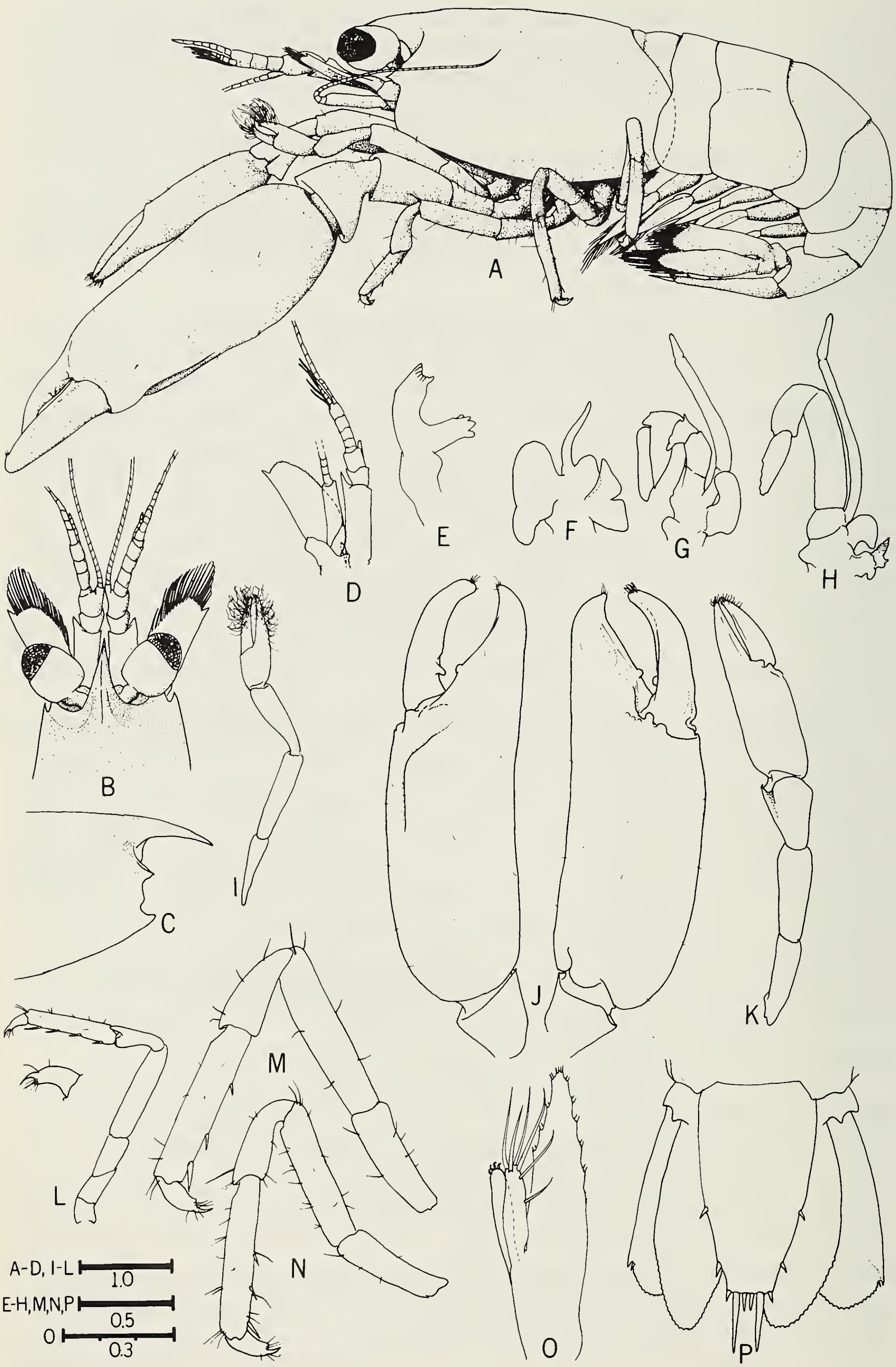
Family Palaemonidae Rafinesque, 1815
Subfamily Pontoniinae Kingsley, 1878
Pontoniopsis paulae, new species
Fig. 1A–P

Material examined.—Holotype, 1 ♂; rcl 3.2 mm; USNM 181240.

Diagnosis.—A small, short, heavy-bodied smooth pontoniine shrimp with a short acute rostrum, and a massive major second cheliped bearing a distinct subdistal medial groove, which appears as if ventrally located when cheliped is seen in lateral view.

Description.—Carapace smooth, shining, without grooves or ornamentation; rostrum compressed, toothless, faintly carinate, acutely triangular in dorsal view, produced into spinelike point, narrower than eye width, falling short of distal margin of basal antennular segment; adrostral depressions absent; orbital margin distinctly concave, shallowly excavate into frontal margin, basal margin underlying ophthalmic peduncles. Lower margin of orbit produced anteriorly into short, sharp, obscurely carinate antennal spine; no other carapacial spines present. Eyes noticeably ovoid, large dark corneas. Basal antennular segment elongate, distolateral margin a spinous projection extending to anterior margin of following segment, this and third segment about equal in length and width; stylocerite very reduced, only slightly produced laterally, rounded, covered by proximomesial expansion of scaphocerite; latter lamellate, twice as long as wide, extending beyond antennular peduncle, anterior margin convex, a distolateral spine overreaching same; basal antennal peduncular segment unarmed, carpocerite similarly so, latter narrowly cylindrical, about 5 times longer than wide, falling short of distal end of basal segment of antennule. Mandibles without palp, molar process with 4 blunt teeth, incisor with 7 bluntly rounded spines. Maxillule and maxilla not dissected to avoid further damage to specimen. All maxillipeds with well-developed exopods; maxilliped 1 with caridean lobe well developed, bearing elongate lash, endopod entirely absent, a distinctly bilobed, rectangular epipod; maxilliped 2 and 3 as illustrated, both with well-developed epipod; maxilliped 3 barely attaining base of carpocerite and antennular peduncle, a poorly developed arthrobranch present.

Pereopods 1 and 2 chelate. First pereopods equal, extending beyond distal margin of antennular peduncle, chela reaching beyond scaphocerite; former short, somewhat inflated, gaping, fingers 0.6 times longer than palm, distally hirsute; carpus 0.8 times length of either chela or merus, about equal to ischium, all segments smooth, unarmed. Second pereopods dissimilar, extending greatly beyond first pair. Major chela massive, smooth, unarmed, inflated, elongate, sparsely setose; a distinct longitudinal groove subdorsally on distal medial surface, opening into deep transverse notch paralleling angle of fixed finger; fingers curved, gaping, shorter than palm, comprising about ⅓ length of chela, equal to about half length of palm, a small rounded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tooth basally on cutting edge of each; 2 bluntly rounded teeth, plus several small tubercles basally at exterior junction of dactyl and palm (Note: this surface held ventrally when animal is alive, Fig. 1A); tips of both with small tuft of hair; carpus short, smooth, shining, widely expanded distally, inner distal angle a bluntly rounded tooth; merus 1.2 times longer than carpus, proximally compressed, distally inflated, ventral surface flattened; ischium compressed, shorter than merus, about equal in length to carpus. Minor second pereopod shorter than major, chela elongate, conically cylindrical; fingers curving laterally without noticeable gape, comprising about 0.4 length of chela, ¾ length of palm, unarmed; carpus oblately pyramidal, expanded distally, ventrally excavate along distal margin, 0.8 times length of merus; latter cylindrical, equal in length to compressed ischium, all 3 segments unarmed. Pereopods 3, 4, 5, similar in configuration, slender, segments decreasing in length in relation to respective meri as follows: propodus (0.9), carpus (0.6), dactyl (0.3); ventral margin of pereopod 3 propodus with 3–4 spines, remaining legs with 3, other segments unarmed; dactyls compressed, falcate, tips drawn into elongate, curved hooklike spine, not bifid, but ventral margin with rectangular dentiform prominence only slightly developed into supernumerary tooth. All pereopods apparently lacking epipods.

Abdominal somites smooth, shining, unarmed; posterolateral margins of somites 1–3 bluntly rounded, those of somites 4–5 more truncate; telson about 1.4 times longer than somite 6, shorter than uropods, with 2 pairs lateral spines placed just posterior to midpoint, and at posterior $^1/_7$ of length, respectively; posterior margin with 3 pairs spines, intermediate pair about 4 times length of submedian, 6 times length of lateral pair at posterodistal margin; uropods longer, narrower, than telson proper, distolateral angle of exopod with strong, fixed tooth, followed by much smaller, movable spine; a very faint diaresis present.

Gill formulae not determined to avoid further damage to specimen.

Ecology.—The single male was collected from the ventral surface of the spatangoid echinoid *Meoma ventricosa* Lamarck, 1816, and is apparently commensal with this species. The only other species in the genus, *Pontoniopsis comanthi* Borradaile, 1915 is a littoral form and a known commensal

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Fig. 1. *Pontoniopsis paulae*. Male, holotype. A, Lateral view; B, Cephalothorax, anterior region; C, Same, lateral view; D, Antennule and antenna, ventral view; E, Mandible; F, Maxilliped 1; G, Maxilliped 2; H, Maxilliped 3; I, Left pereopod 1; J, Pereopod 2, major (left) chela, outer view (left), inner view (right); K, Pereopod 2, minor (right) chela, outer view; L, Left pereopod 3, and detail of dactyl; M, Left pereopod 4; N, Left pereopod 5; O, Appendix masculina, left pleopod 2; P, Tailfan, dorsal view. Scale lines as indicated.

with the crinoid *Comanthus timorensis* (Mueller) according to Borradaile (1917). No crinoids were noted in the area where *P. paulae,* a decidedly deeper water species, was collected.

Remarks.—Although agreeing in the generic diagnosis with characters defining *Pontoniopsis* as provided by Borradaile (1917) and also delineated in Holthuis' (1952b) key, the Floridan species is not closely related to either *Pontoniopsis comanthi* Borradaile, 1915, or to *Pontoniopsis* sp. noted by Potts (1915) and apparently redescribed by Borradaile in his 1917 paper. Holthuis (1952b) synonymized the latter with *P. comanthi,* although several characters in Borradaile's description differed from those described by Holthuis from his specimen. *Pontoniopsis paulae* may be quickly distinguished from *P. comanthi* by several important and easily observed features. The most easily noticed of these include the distally-grooved major second cheliped, the different relative lengths of the cheliped fingers to their respective palms, the more spiniform rostrum, the lack of a postorbital marginal groove, the position of the lateral spines on the telson and the different lengths of the posterior submedian and intermediate pairs, and by the distolateral tooth of the scaphocerite which overreaches the anterior margin of the lamella. These and other features are summarized in Table 3 where the 2 species may be easily compared.

The new species also shows some resemblance to *Dasella herdmaniae* Lebour 1939, a pontoniine shrimp commensal with the ascidian *Herdmania* in the Indian Ocean. In addition to the characters cited above, *P. paulae* differs from *D. herdmaniae* in the armature of the dactyls on the walking legs, in the absence of a palp on maxilliped 1, and in the much shorter rostrum which does not extend beyond the very large eyes. Dr. A. J. Bruce (*in litt.*) agreed that the two species bore a superficially close resemblance to each other, but will demonstrate in a forthcoming paper still other differences between the two taxa, emphasizing carapacial characters overlooked by Lebour in her original description.

Distribution.—The genus *Pontoniopsis* was heretofore known from only a few specimens recorded from the Indo-West Pacific (Holthuis, 1952b). The discovery of the species described herein is the first time the genus has been reported from the western North Atlantic. Presently it is known only from the type-locality, Carysfort Reef, off Key Largo, Monroe County, Florida (JSL I-682, Table 2).

Pseudocoutierea antillensis Chace, 1972

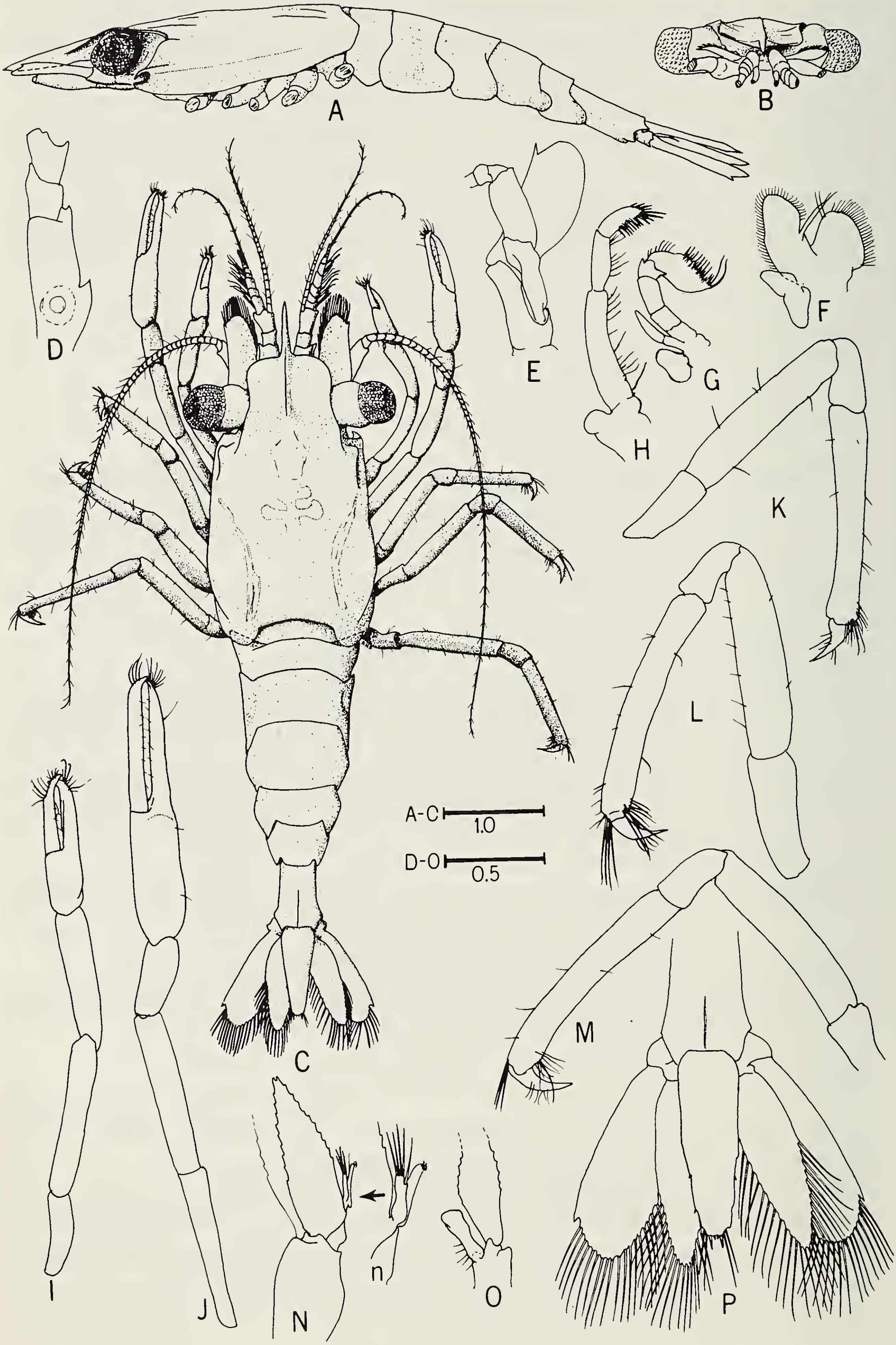
Material examined.—2 ♀♀, ovigerous; rcl 3.9, 3.6 mm; IRCZM 89:4666.

Both specimens agreed in every respect with the description given by Chace, who also compared his new species with the eastern Pacific *P. elegans* Holthuis, 1951, the only other member in the genus. Both species

Table 3.—Comparison of morphological characters in two species of *Pontoniopsis*.

	Pontoniopsis paulae	*Pontoniopsis comanthi* [*fide* Holthuis, 1952b]
Rostrum:	Narrow, spiniform	Lanceolate, compressed
Carapace:	Smooth	Posterior margin or orbit with oblique groove behind
Abdomen:	Somites truncately rounded	Somites broadly rounded
Telson:	1.4× longer than somite 6; Spines placed 0.6, 0.8× length	Slightly longer than somite 6; Spines placed 0.6, 0.8× length
Posterior spines:	Intermediate 4× larger than submedial; 6× larger than posterolateral	Submedial greater than half length of intermedial
Stylocerite:	Greatly reduced	Extending beyond middle of basal segment
Scaphocerite:	Extending beyond antennule peduncular segments; Distolateral spine reaches beyond lamella margin	Extending slightly beyond antennule peduncular segments Distolateral spine falls short of lamella margin
Mandible:	Molar with 4 processes, incisor with 7 processes	Molar with 4 processes, incisor with 3 processes
Maxilliped 1:	No palp	Palp present
Maxilliped 3:	Arthrobranch present; appendage extending barely to carpocerite base	Arthrobranch absent; appendage extending well beyond carpocerite base
Pereopod 1:	Chela reaching beyond scaphocerite; fingers longer than palm; carpus shorter than chela	Chela and carpus reaching beyond scaphocerite; fingers equal to palm; carpus longer than chela
Pereopod 2:	Longer than pereopod 1; fingers shorter than palm	Shorter than pereopod 1; fingers longer than palm
Pereopods 3–5:	Tips not bifid; obtuse prominence present	Tips bifid; obtuse prominence not mentioned.

are rare, but this may be a consequence of their habitat, rocky reeflike regions with associated gorgonians and antipatharians, and thus an area not easily sampled by conventional surface-towed gear. The 2 specimens from Florida constitute the first continental United States record for the species, which was previously known only from the type-locality, Saba Bank, northwest of the Leeward Islands, approximately 1900 km southeast of Key Largo.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Veleroniopsis, new genus
Fig. 2A–P

Diagnosis.—A small, flattened pontoniine shrimp with a noticeably rectangular rostrum. Body dorsoventrally depressed overall, carapace smooth, without spination of any kind; rostrum well developed, elongate, widely expanded proximally, subrectangular distally, forming shelflike expansions over eyes, with prominent median compressed, knifelike rostral spine; eyes large, pigmented; scaphocerite well developed; mandibles without palp; maxilliped 2 with exopod, maxilliped 3 lacking same, and without pleurobranch. Posterior orbital margin inflated, a noticeable postorbital tubercle; anterior margin of carapace recurved to form tubelike opening into branchial chamber. Pleura of first 5 abdominal somites more or less broadly rounded or truncate, without ventral spines. Pereopods smooth, thin, elongate, dactyli of last 3 pairs simple. Telson with 2 pairs of spines on posterior margin.

Type-species.—*Veleroniopsis kimallynae*, new species (see below).

Etymology.—A combination of *Veleronia*, a palaemonid genus to which the new taxon shows some resemblance, and "*opsis*" from the Greek, "having the appearance of." Gender feminine.

Remarks.—The new genus bears much resemblance in a variety of characters to several genera, including *Lipkebe* Chace, 1969, *Veleronia* Holthuis, 1951, *Anchistioides* Paulson, 1875, *Pontonides* Borradaile, 1917, and *Neopontonides* Holthuis, 1951. *Veleroniopsis* has, perhaps, its closest relationships with the western Atlantic *Lipkebe holthuisi* and species of the eastern Pacific *Veleronia*, especially in the notched anterior margin of the carapace which forms a tubular opening into the branchial chamber, by the rather obsolete or ill-defined posterolateral orbital margin, the third maxilliped lacking an exopod, by the broadly truncate rostrum expanded into eaves above the orbits, and the simple dactyli of the last 3 pairs of pereopods. The new genus differs from *Veleronia* in possessing a well-developed lash on the first maxilliped (although this lash is also present in *Lipkebe*), a second maxilliped with a well-developed exopod (absent in *Lipkebe*), and in having a noticeable postorbital tubercle (in *Lipkebe* a spine is present at this position). The dactyli of the walking legs in *Lipkebe* show a superficial

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Fig. 2. *Veleroniopsis kimallynae*. Male, holotype. A, Lateral view; B, Frontal view; C, Dorsal view; D, Antennule, dorsal view; E, Antenna, ventral view; F, Maxilliped 1; G, Maxilliped 2; H, Maxilliped 3; I, Left pereopod 1; J, Left pereopod 2; K, Right pereopod 3; L, Left pereopod 4; M, Left pereopod 5; N, Left pleopod 2 (exopod omitted); n, same, detail of appendix masculina; O, Left pleopod 1, detail of endopod; P, Tailfan, dorsal view. Scale lines as indicated.

resemblance to those in the new genus, but the chelipeds differ in relative lengths of the fingers to the palms among the three genera discussed.

Although *Veleroniopsis* shares with the genus *Anchistioides* exopods on maxillipeds 1 and 2, a postorbital tubercle, and 2 pairs (occasionally only 1 pair in the latter genus) of the telsonal marginal spines, the general morphology of *Anchistioides,* such as the laterally compressed body and rostrum (the latter being toothed), the presence of an antennal spine, and the minutely bifid dactyli on the last 3 pereopod pairs allows easy distinction.

Both *Pontonides* and *Neopontonides* resemble *Veleroniopsis* in some features. However, in the former 2 genera the rostrum is either entirely depressed without dorsal teeth, or is distally compressed, often with a variable number of dorsal teeth, respectively. *Pontonides* is primarily an Indo-West Pacific genus, exhibiting a distinct antennal spine, and rather large and well-developed chelipeds, as opposed to no antennal spine, and elongate, thin chelipeds in *Veleroniopsis. Neopontonides,* presently known from a single species each in the eastern Pacific and western Atlantic, is easily separated from *Veleroniopsis* by the form and dentition of the rostrum, as noted above, by the presence of an endopod on the first maxilliped, and the absence of an exopod on maxilliped 2. Moreover, both *Pontonides* and *Neopontonides* carry 3 pairs of spines on the telsonal margin, thus sharing this feature with *Lipkebe* and *Veleronia,* but not *Anchistioides* or the new genus.

Two other genera showing a superficial resemblance to *Veleroniopsis* are *Coutierea* Borradaile, 1917, and *Pseudocoutierea* Holthuis, 1951. Both of the latter genera have well-developed antennal spines, the rostral expansions are armed with either sharp supraocular teeth or elongate spines (similar to that seen in *Lipkebe*), and the abdominal pleura of somites 3–5 are drawn into sharp teeth, all features which are lacking in the new genus.

Veleroniopsis seems to be yet another genus with relationships toward those pontoniine genera which have dispensed with, or are in the evolutionary process of eliminating, exopods on the maxillipeds. It differs from all of these in retaining (at least in the male) the exopod on the second maxilliped. Several of these same genera share dorsoventrally depressed carapaces, expanded or modified frontal or rostral regions, and in at least 2 instances having the anterolateral carapace margin modified into a tubelike opening into the branchial chamber. It is, perhaps, also significant that these genera have few species, usually 1 or 2, suggesting that the evolutionary factors which produced this morphology, while successful to some degree, have left little room for further expansion. The genera in question are also known associates of coral reefs and reef-type habitats, including gorgonid soft corals in some cases, all habitats where the ability to utilize small cracks and crevices, or to lie more or less appressed against a substrate, may have conferred selective advantage to the species against predation. Shaw et al.

(1977), following an earlier suggestion by Bruce (1976) that the genus *Lipkebe* would probably prove to be a commensal, confirmed the relationship with the crinoid *Comactinia meridionalis meridionalis* (Agassiz 1865). The very close similarity between *Veleroniopsis* and *Lipkebe* suggests a similar possibility, although no crinoids were noted in the habitat at the time the new genus was collected.

Chace (1969) discussed the status of the various genera noted above, establishing his new genus *Lipkebe* with some hesitation because the presumably generic characters used to define the other genera had resulted in several monotypic taxa. Regrettably, *Veleroniopsis* becomes yet another presently monotypic genus in this taxonomic grouping, although reconsideration of perhaps the most important generic distinction, that of the presence of an exopod on maxilliped 2, could conceivably allow its placement in Chace's *Lipkebe*. Until further material becomes available, or the generic groupings revised, I believe the establishment of the new genus to be warranted.

Veleroniopsis kimallynae, new species

Material examined.—1 ♂; rcl 3.2 mm; USNM 181241. Holotype male.

Description.—Carapace elongate, smooth, shining, naked, microscopically punctate, dorsoventrally depressed; rostrum shelflike, broadly expanded, flattened, elongate, excluding spine about ⅓ carapace length, wider proximally, constricted mesially, bluntly rectangular distally, corners distinctly and broadly rounded, without spines; an elongate, acute, medial rostral spine, appearing bladelike in lateral view, unarmed dorsally and ventrally, reaching just beyond scaphocerite distal margin, extending posteriorly onto expanded rostral portion as thin, carinate medial ridge, becoming obsolete just posteriad to eyes; posterior orbital margins bluntly rounded, a postorbital tubercle forming noticeable prominence viewed dorsally, extending backward from which an obsolescent ridge, anterior margin sweeping obliquely forward and down past eyestalks to form thin plate, recurving laterally outward and ventrally to form thin tubelike opening for branchial chamber; lateral margin of latter very obscurely produced anteriorly into blunt angle, extending posteriad as thin ridge, becoming obsolete at posterolateral carapace margin; latter truncate, excavated dorsomedially; no supraorbital, antennal, branchiostegal or pterygostomial spines.

Eyes enlarged, well-developed, protuberant, pigmented, stalks unarmed. Antennular peduncle 3-segmented, barely reaching beyond tip of rostral spine; basal article longest, about 3 times length of second, about twice length of third, produced anterodistally into sharp tooth, mesially into sharply rounded small lobe, both extending to about midlength of following article; second article cylindrical, third truncate, both unarmed; upper flagellum with 5–6 fused, 3–4 unfused articles, plus elongate hairlike whip; lower flagellum thin, reaching beyond both pairs of extended chelae; stylocerite reduced to small basal spine-tipped expansion on basal article. Antennal peduncle 3-segmented; carpocerite proximal segment unarmed, distal segment 2.7 times longer than wide, slightly overreaching proximal margin of antennular second article; scaphocerite unarmed basally, broadly lamellate, produced distally into rounded lobe reaching about midlength of antennular third article, greatly exceeding length of small, but distinct distolateral tooth; first flagellar segment rounded, ball-like, remaining articles relatively stout, sparsely setose, total length of flagella reaching region of second abdominal somite.

Mandibles, maxillule and maxilla not dissected; former without palp. Maxilliped 1 with well-developed bifid epipod, caridean lobe produced, a thin lash; endopod wanting; maxilliped 2 with thin, well-developed epipod, 2-segmented exopod, 5-segmented endopod, ultimate segment of latter with numerous sharp spines and stout setae; maxilliped 3 with epipod, lacking exopod; endopod 3-segmented, meral and carpal articles fused, ultimate segment with spines and stout setae as in maxilliped 2.

Pereopod 1 thin, chelate, reaching when extended beyond antennular peduncle; ischium truncate, slightly inflated distally, unarmed; merus about twice ischial length, smooth; carpus distally expanded, shorter than merus, unarmed; chela subequal to merus, fingers about equal to palmar length, gaping, upper crossing over lower, gape of movable finger with thin irregular tooth about midway, tips of both fingers with tuft of hairs and elongate, crooklike setae; except for sparsely scattered hairs cheliped naked. Pereopod 2 more robust than former, chelate, elongate, extending well beyond antennular peduncle by most of chelae; ischium elongate, smooth, unarmed; merus slightly shorter (about $^5/_6$ length) of ischium, barely inflated distally; carpus short, curved, slightly less than half meral length; chela heavy, elongate, about 3.5 times longer than carpus, fingers equal to palmar length, hooked at tip, each bearing small apical tuft of setae, gaping slightly but evenly, unarmed. Pereopods 3–5 similar in morphology to each other, smooth, unarmed, sparsely setose except distal margin of propodi which carry tufts of elongate setae and fine hairs, dactyli bluntly falcate, simple, without supernumerary teeth.

Sternal plate wide, flattened, smooth, shining. Abdominal somites dorsoventrally depressed, smooth, broadly and evenly rounded dorsally, very sparsely setose, unarmed; pleura truncately rounded, posterolateral angles on somite 3 bluntly angular, that of somites 4, 5, ellipsoidal; somite 6 about 2.3 times longer than fifth, a faint dorsomedial carina. Pleopods on somites 1–5, peduncles unarmed; rami elongate, foliaceous, first 2 pairs when extended forward reaching level of coxae of pereopod 3; pleopod 1 endopod modified into shortened, bluntly spatulate accessory gonopod bearing several setae basally; pleopod 2 with setose appendix masculina; endopods shorter than exopods on all five pairs, those of second to fifth pairs with well-developed appendices internae.

Telson about 1.2 times as long as somite 6, narrow, rounded dorsally, 2 pairs of minute lateral spines on margins of posterior half, placed about ⅔ and ⅚ total telson length, respectively; posterior margin with 2 pairs spines, inner pair about ⅓ length of outer, plus 4 elongate setae on posterodistal margins; uropodal exopod and endopod about equal in length, former more expanded, with distinct fixed spine at distolateral angle; endopod elongate, narrow, margins without spines; both appendages heavily setose.

Remarks.—As noted in the discussion under the generic description, *Veleroniopsis kimallynae* is an unusual palaemonid shrimp. Although appearing similar to the western Atlantic *Lipkebe holthuisi* Chace, and to species of the eastern Pacific genus *Veleronia,* it is easily distinguished from both of these by the rostral configuration, the telsonal spine and setal formula, and the exopod on the second maxilliped. The appendix masculina illustrations of *Lipkebe holthuisi* provided by Shaw et al. (1977) are superficially similar to that of *V. kimallynae,* but differ in lateral spination being present on the former species, but absent in the latter. Unfortunately, the female of *V. kimallynae* is as yet unknown so any variation or sexual dimorphism within the species remains to be determined.

The general habitat, relict *Montastraea* coral, may explain why the species has not been discovered until now, for unless such large and ponderous coral heads are carefully pulverized and the debris examined in sieves, many inquiline species will be missed.

Distribution.—Known only from the type-locality, Elbow Reef, off Key Largo, Monroe County, Florida (JSL I-690, Table 2).

Family Alpheidae Rafinesque, 1815

Alpheopsis trispinosus (Stimpson, 1861)

Fig. 3A–G

Material examined.—2 ♂♂, 2 ♀♀ (1 ovigerous); rcl 3.8, 3.6; 5.1, 2.3 mm; IRCZM 89:4667; 1 ♂, 89:4668; 1 ♀ ovigerous, gift to A. H. Banner.

The present material, with distinctly trispinose front, the carapace lacking any dorsal carinae, and both chelae bearing a distinct longitudinal groove, differs from all known western Atlantic species of *Alpheopsis,* although it is extremely close to *A. africanus* Holthuis, 1952a. The material was sent to Dr. and Mrs. A. H. Banner for confirmation, and they identified it as Stimpson's species, pointing out that the chelipeds in the Florida specimens were equal both in size and length, whereas those appendages in *A. africanus* are distinctly unequal. The Floridan specimens agreed in all important respects with the redescription and subsequent neotype designation for *A. trispinosus* (Banner and Banner, 1966), differing only in relative proportions

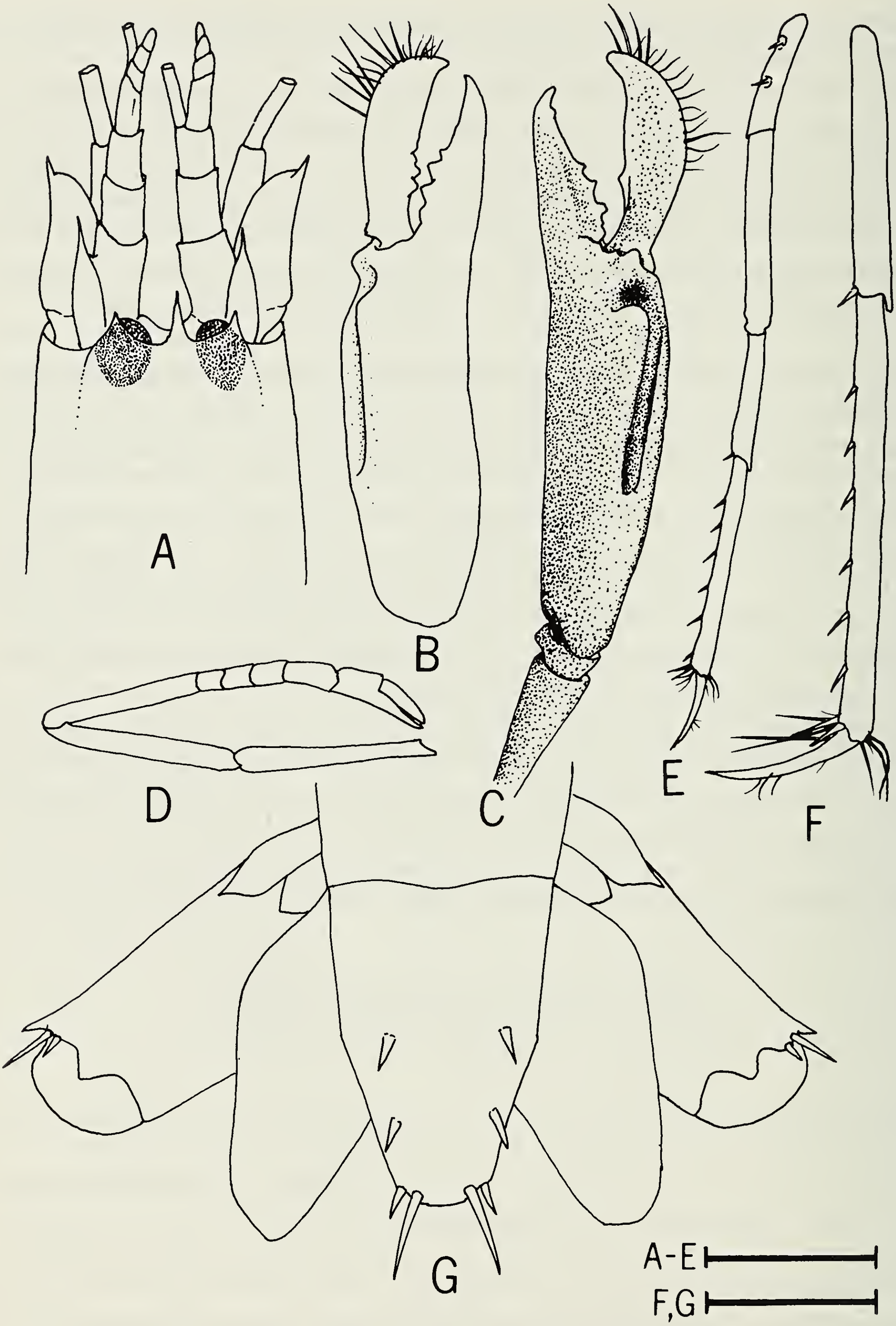


Fig. 3. *Alpheopsis trispinosus*. Male, IRCZM 89:4668. A, Cephalothorax, anterior region; B, Left major chela, lateral view; C, Same, dorsal view; D, Left pereopod 2; E, Right pereopod 3; F, Same, detail of distal articles; G, Tailfan, dorsal view. Scale lines equal 1.0 mm.

of rostral and frontal spines, carpal articles of pereopod 2, dactylar length on pereopods 3–5, and telsonal length-width ratio. None of these differences are, in my opinion, sufficiently significant to warrant establishment of a western Atlantic subspecies at this time. I thus concur with the suggestion made by Mrs. Banner (*in litt.*) that *Alpheopsis trispinosus* may be pantropical in distribution. Previous records in the literature are from the Australian region, with possible distribution in the tropical Pacific and perhaps in the eastern Atlantic off the Azores, as well (see Banner and Banner 1966).

Five other specimens (1 ♂, 3 ♀♀, ovigerous) collected from off the central eastern Florida coast by R/V Gosnold (G-222/274D; 27°52.5′N, 79°57.5′W, 75–98 m, Smith-MacIntyre grab, 28 February 1974.—G 246/709; 27°44.3′N, 79°58.0′W, 72 m, pipe dredge, 4 September 1974) possess a trispinose front and lack carapacial carinae. But unfortunately, all are mising chelipeds so specific identification remains tentative.

Alpheus amblyonyx Chace, 1972

Material examined.—1 ♀; rcl 2.9 mm; IRCZM 89:3791.

Previously recorded from Dominica, Puerto Rico, St. Thomas, Bahía de la Ascension, Quintana Roo, and the northwest Gulf of Mexico (Chace, 1972; Pequegnat and Ray, 1974), the Key Largo female is the second to be recorded from the continental United States. However, several other specimens of this species, as well as some which appear to be more closely allied to *Alpheus macrocheles* Hailstone, 1835, have been collected from offshore stations on the central eastern Florida coast by R/V Gosnold. The species range can thus be considered as extending from the lesser Antilles to eastern Florida. Depth range is from about 1 to 24 m. Some Indian River region material off central Florida collected by R/V Gosnold in 70–90 m, plus a single cheliped from 135–145 m, would extend the depth range considerably if all this material belongs to *A. amblyonyx*.

Synalpheus pandionis Coutière, 1909

Material examined.—1 ♂; rcl 3.9 mm; IRCZM 89:3789.

The species is rare in collections and was previously known from the eastern and western Gulf of Mexico, and the Virgin Islands southward to Barbados and Curacao. Undoubtedly a coral associated species, both the Key Largo specimen, and a spent female from off St. Lucie Inlet on the central eastern Florida coast, were taken from relict coral heads. The male was taken in 18 m, the female in 48 m, well within the recorded depth range from the intertidal to 80 m (Chace, 1972; Pequegnat and Ray, 1974).

Synalpheus sanctithomae Coutière, 1909

Material examined.—1 ♂, 1 ♀ ovigerous; rcl 3.9, 3.8 mm, respectively; IRCZM 89:3799, 89:3792.

The identification of the 2 specimens, which conformed quite well with Coutière's (1909) original account and illustrations, was confirmed by Dr. R. B. Manning who compared the Florida material with Coutière's syntypic series. Until now, the species was known from only 3 specimens, including the two designated as types by Coutière, collected off St. Thomas. The Key Largo material extends the range approximately 1800 km northwestward from the type locality, and constitutes the first continental United States record for the species. Although the color in life was not noted, the fingers on the major chela of the male from Key Largo are a distinct golden yellow after more than one year in preservative.

Family Hippolytidae Bate, 1888

Thor manningi Chace, 1972

Material examined.—1 ♀ ovigerous; rcl 2.2 mm; IRCZM 89:3795.

This widely distributed little grass shrimp has been found associated with intertidal grassflats, and subtidally (previously to 11 m) with living and dead coral. The single specimen from 62.5 m on Carysfort Reef, among algal covered rock, is the deepest yet recorded.

Family Processidae Ortmann, 1896

Processa cf. *tenuipes* Manning & Chace, 1971

Material examined.—1 ♀; rcl 5.9 mm; IRCZM 89:4669.

Although exhibiting general characters which allow it to be placed near *P. tenuipes* in Manning and Chace's (1971) key, the specimen differs from that species in having the distal interior angle of the stylocerite drawn into a distinct spine instead of bluntly angled, in having 12 and 33 articles in the merus and carpus of the second leg (instead of 5–9, 17–26, respectively), and in lacking the characteristic transverse row of fine hairs across the dorsal base of the telson. The specimen was compared with type-material in the National Museum of Natural History by Dr. R. B. Manning, who informed me (*in litt.*) that he suspects it to be undescribed. The single specimen is, unfortunately, incomplete, lacking the right pereopod 2, and several other walking legs, so establishing it as a new species must await additional material.

The Key Largo female was collected from coralline rock on a sandy substratum in 42–76 m. *Processa tenuipes* also appears to prefer deeper waters (31–331 m) and has been taken off North Carolina, in the northeastern Gulf of Mexico, and a single specimen from off Havana, Cuba. All were associated with fine sands or clay oozes.

Section Stenopodidea
Family Stenopodidae Huxley, 1878
Odontozona libertae, new species
Figs. 4A–C, 5A–L

Material examined.—1 ♂, Holotype, rcl 3.6, USNM 181242; 1 ♀, Allotype, rcl 3.2, USNM 181243; 1 ♂, paratype, rcl 2.8 mm (rostrum broken); USNM 181244.

Diagnosis.—A small, robust, heavy-clawed, spiny shrimp, with a distinct cincture of spinules along posterior margin of cervical groove, smooth abdominal somites, a heavily spined manus on pereopod 3, maxilliped 3 ischium with a ventrolateral row of spinules, and distinctly biunguiculate dactyls on the walking legs.

Description.—Rostrum compressed, bladelike, slender, straight, about ¾ or less carapace length, reaching distal margin of antennular second article, falling far short of scaphocerite tip; armed dorsally with 5, ventrally with 4–5 spines. Carapace short, robust, heavy, microscopically punctate; gastric region inflated, 2 pairs large medial spines about center and on posterior slope, 2–3 others of varying size on anterior slope above orbital margin; a smaller postorbital spinule; cervical groove distinct, postcervical groove less prominent, posterior margin of former with cincture of about 14 large, horizontal, anteriorly-directed spines; latter groove with interrupted transverse dorsal rows of about 8–10 smaller spinules, between which lie 2 larger spines, plus lateral row of 12–16 spinules of decreasing size, extending obliquely anteriad; dorsal and lateral carapace surface between these 2 grooves with scattered, short, forwardly-directed spinules. Posterodorsal margin concave, unarmed medially, a single row of 10–12 tiny spinules dorsolaterally, preceded by shorter, similar row of about 6; ventrolateral margins oblique, unarmed. Antennal spine large, massive, branchiostegal spine smaller, both with faint carina; pterygostomial spine smallest, may be doubled, posterior to which 1 or 2 larger spines parallel anteroventral margin; branchial ridge present, becoming more or less obsolete posteriad. Orbital margins formed medially from rostral base, becoming obsolete laterad; eyes large, corneas inflated, pigmented, an interrupted series of several small spinules along corneal base dorsally and anteriorly.

Antennular peduncle 3-segmented; basal segment elongate, exceeding length of following 2 articles, somewhat sculptured, curved dorsally, 1 or more small spinules on distal dorsal margin; second segment about ⅛ length of first, third still smaller, both unarmed; flagella greatly elongate, whiplike, extending beyond telson when complete, articles noticeably setose. Antennal peduncle with 3 large segments, basal and penultimate largest, latter subglobose, 2 proximoventral, 2 distoventral spinules; carpocerite about ⅓ length of scaphocerite, unarmed; scaphocerite blade narrow, elongate, lamellate, far overreaching rostral spine tip, 4 times longer than wide, spi-

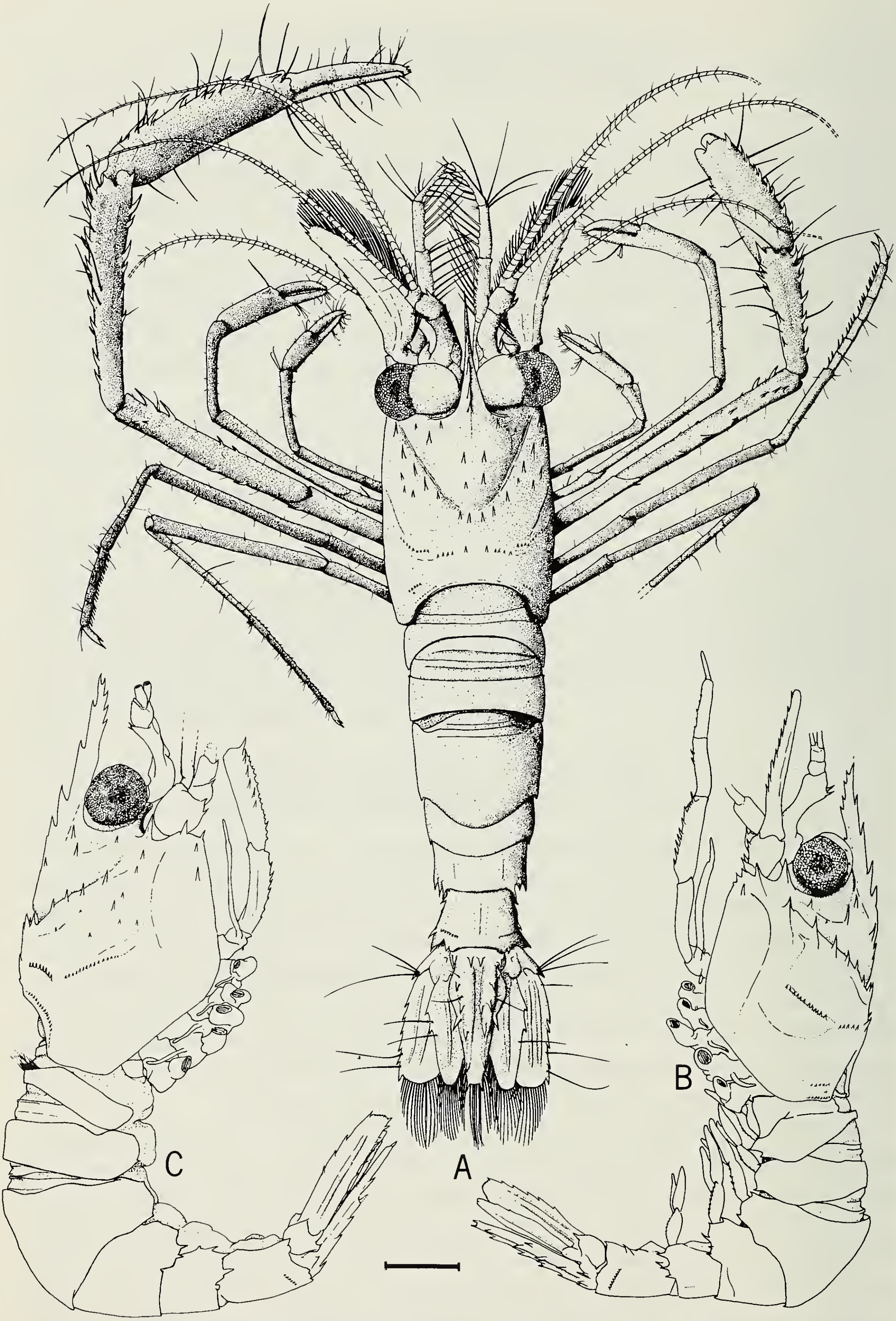
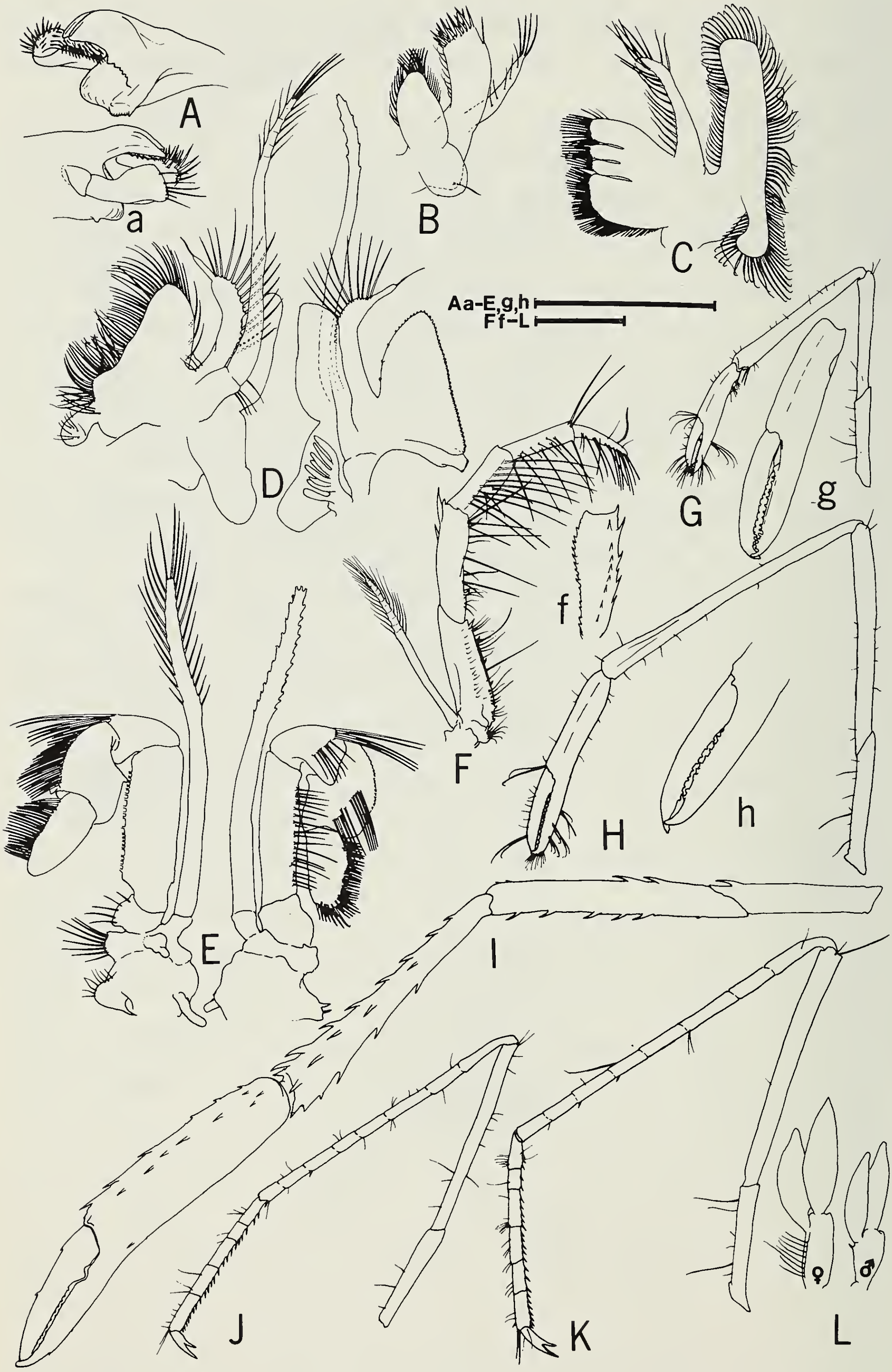


Fig. 4. *Odontozona libertae*. Male, holotype. A, Dorsal view; B, Lateral view, pereopods not illustrated; C, Female allotype, lateral view, pereopods not illustrated. Male right pereopod 3 and chela broken. Scale lines equal 1 mm.

nulate along concave outer margin, a strong apical spine, heavily setose along convex inner margin, dorsal and ventral surfaces unarmed; flagella extremely long, whiplike, reaching to or beyond telson, articles noticeably setose.

Mandibles heavily chitinized, scoop-shaped molar process bluntly rounded, an oblique dentate protuberance, incisor process 2 strong blunt teeth; 3-segmented palp, setose along distal margin of second article, heavily spined over surface of third. Maxillule and maxilla as illustrated, both with well-developed endopod; coxal and basal endites distinct; scaphognathite heavily setose. Maxillipeds 1–3 with exopods; first maxilliped with large, bifid epipod, a distinctly setose endopod; second maxilliped endopod 5-segmented, a noticeable arthrobranch and simple epipod; third maxilliped endopod extremely elongate, reaching beyond scaphocerite tip by distal half of propodal, and entire dactylar segment, all except last article armed ventrally or ventrolaterally with series of small spinules; mesially a series of elongate, strong setae mesh with those on opposite appendage, plus several still longer setae at dactylar-propodal junction; exopod long, multiarticulate distally, attaining midlength of meral article; epipod simple.

First 3 pereopods chelate, elongate, increasing in size posteriad, all reaching to, or well beyond, scaphocerite tip; each with epipod. Pereopod 1 thin, smooth, without spines except for 2 distoventrally on carpus; latter article longest, ischium about 0.6 times length of same, 0.8 times length of merus; merus about ¾ length of carpus, inflated distally; chela about ¾ carpal length, compressed, distally hirsute, unarmed; fingers gaping, crossing at tips, with series of small, more or less evenly rounded or serrate teeth along length, becoming irregular distally; movable finger half length of palm. Pereopod 2 similar to first in shape, larger, more robust, unarmed; articles increasing in length from ischium to carpus, former about half carpal length, ⅔ meral length; merus about 0.7 times carpus, inflated distally, without spines; chela about ⅔ carpal length, compressed, bearing several separated tufts of long, distally curved setae, plus dense tuft of hairs apically; fingers gaping, with irregularly spaced, ragged teeth on cutting edges, crossing at tips, about 0.4 times length of palm. Pereopod 3 largest, most robust, articles increasing in length and armature distally; ischium about half length of chela, a single dorsodistal spine; merus about 0.6 times chela length, an interrupted series of short, curved spines along dorsal and ventral margins, strongest at distal angles; carpus about 0.8 times chela length, a paired series of 8–9 spines dorsally, becoming larger, more curved distally, a second series of single spines along ventral margin, enlarging as in preceding series; manus interiorly smooth, with 2 irregular paired rows of sharp spines along dorsal margin, a smaller spinule on mesioventral margin below propodal-dactylar junction; fingers thick, heavy, crossing at tips, angled slightly inward from plane of manus, about 0.7 times length of palm, slightly gaping, armed along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cutting edges with irregular series of minute spinules; movable finger with 2 small, widely-spaced mediodorsal spinules, plus single triangular basal tooth fitting into similarly shaped excavation on fixed finger. Pereopods 4 and 5 thin, fifth longest, carpi and propodi on both multiarticulate, dactyli distinctly biunguiculate. Pereopod 4 carpus longest, 8-segmented, length of segments numbered distally as: 5=7=8, 4, 6, 3, 2, 1, all unarmed; propodus about half carpal length, 5-segmented, lengths numbered distally increasing as: 2, 1, 4, 3, 5, all armed ventrally with short spinules, numbered from first to last 2, 4, 4, 4–5, 6–8; merus 0.7 times, ischium about 0.4 times, carpal length, both unarmed; a simple epipod. Pereopod 5 similar to preceding, carpus longest, eighth article indistinctly separated, segments increasing in lengths as 5, 8=7, 2, 6, 4, 3, 1, all unarmed; propodus about half carpal length, 6-segmented, lengths increasing as: 2, 5, 1=4, 3, 6, with ventral series of spinules progressing distally, 2, 3, 5, 5, 3, 7; ischium about ⅓, merus about ⅔ carpal length, both unarmed; no epipod.

Dorsal and lateral surfaces of abdominal somites without spines or spinules; first to third each with transverse grooves and carinae along anterior dorsal margin, sculptured so that posterior part of somite 2 and 3 raised up and overriding anterior carinae of same somites; third somite largest, posterior margin overlapping anterior margin of fourth, latter without transverse grooves or carinae; somite 5 smallest, smooth; somite 6 with single oblique row of small spinules on dorsolateral surface. Ventral and posterior margins of pleura in males more spinose than females, pleuron of somite 1 large, acute, directed ventrally, followed by smaller tooth at posteroventral margin; somites 2–4 with distinct spinous tooth at antero- and posteroventral angles, pleuron of somite 4 also produced ventromedially into tooth, plus 2 smaller spines dorsad to posteroventral angle; somite 5 posteroventral angle with teeth more noticeably spiny; somite 6 ventrolateral angle produced into distinct tooth, a single lateral spine, plus a second anterolateral spinule just beneath posterolateral series of preceding somite. Abdominal pleonal surface in male each with single median spine. Female abdominal sculpturing and armature on pleura more or less similar to that of male but much less developed; spines on abdominal pleonal surface lacking.

Pleopods on somites 1–5, those of first uniramous, remaining biramous;

←

Fig. 5. *Odontozona libertae*. Male, paratype. A, Left mandible, sternal view; a, Same, interior view; B, Maxillule; C, Maxilla; D, Left maxilliped 1, sternal view (left), interior view (right); E. Left maxilliped 2, sternal view (left), interior view (right); F, Maxilliped 3; f, Same, detail of meral article; G, Left pereopod 1; g, Same, detail of chela; H, Left pereopod 2; h, Same, detail of chela; I, Left pereopod 3; J, Left pereopod 4; K, Left pereopod 5; L, Pleopod 2, female allotype (left), male paratype (right). Scale lines equal 1.0 mm.

peduncles of males triangular in cross-section, serrated posteriorly, a small, short, sharp spinule basal to endopod; peduncles of females more lamellate, non-serrate, lacking spinule, but with row of straight thin setae; no appendix masculina; both sexes without appendices internae.

Uropodal peduncle produced distally into large sharp spine; dorsal surface of exopod with 2 longitudinal, unarmed carinae; lateral margin bearing 4–6 teeth, including largest at distolateral angle; endopods with single unarmed median carina, 2 lateral spines proximal half of appendage. Telson elongate, expanded proximally, narrowing distally, 2 longitudinal carinae on dorsal surface, separated by deep longitudinal groove; dorsal surface armed with 16 large, strong spines as follows: basally, one each laterally, plus a pair medially; these followed distally by 4 spines, paired on each carina (occasionally an extra spine as in holotype male), last pair of spines terminating each carina; 2 strongest spines on telson lateral margin about midlength, a smaller spine at each posterolateral angle. Uropodal and telsonal margins heavily clothed with long setae; individual longer, hairlike setae dorsally on same articles, including triple setae at base of uropodal peduncular spine.

Ecology.—The 3 specimens on which the preceding description was based were all collected from a sponge and *Siliquaria* (Mollusca) colony. It seems probable, based on the structure of the chelipeds, and the greatly lengthened antennular and antennal flagella, that the genus and species is a ‘‘cleaning shrimp.’’ Other members of the family, most notably the genus *Stenopus,* are well known for their symbiotic relationships with various species of reef-dwelling fishes, attracting attention of their hosts by waving and snapping their brightly colored flagella and rocking slowly from side to side. Regrettably, no behavioral observations were made when *Odontozona libertae* was collected so the exact behavioral sequence remains as yet unknown for this species.

Remarks.—The genus was previously known from West Africa and the Indo-West Pacific region (e.g. Holthuis, 1946) and it was only recently discovered to occur in the western Atlantic (Goy, in press). With the finding of the second species described herein, and thus constituting the first record for the continental United States, the genus may safely be considered to be established in the tropical western Atlantic.

Odontozona libertae differs from *O. spongicola* (Alcock and Anderson, 1899) in possessing spinules behind the cincture of the cervical groove, these being absent in the latter species. The new species differs from *Odontozona sculpticaudata* Holthuis, 1946, in the third abdominal somite, which lacks distinct longitudinal grooves, and in the absence of transverse grooves on somites 4–6. The carapace is also much less spinulose in the new species than in *O. sculpticaudata.* Although superficially resembling *Odontozona ensifera* (Dana, 1852) the new species is easily distinguished by the general armature on the abdominal pleura, by the lack of a transverse carina on abdominal somite 3, by the more poorly armed rostrum, by the greatly reduced number of spinules on the postcervical groove, fewer paired spines on the telsonal carinae, the longer basal antennular segment, and by the scaphocerite greatly overreaching the tip of the rostral spine. The description of *Odontozona edwardsi* (Bouvier, 1908) is incomplete (*fide* Holthuis, 1946), but *O. libertae* is easily separated from this species by a greater number of segments in the carpus and propodus of pereopods 4 and 5 (8, 5; 8, 6; as opposed to 4, 5; 4, 5, in *O. edwardsi*). *Odontozona libertae* will be seen to differ from Goy's new species (in press) primarily by the less developed spinulation on the carapace of *O. libertae,* by the less sculptured abdominal somites, the distinctly spinose third chela, and a telsonal spine formula differing from Goy's material.

Distribution.—At present the species is recorded only from the type-locality, Elbow Reef, off Key Largo, Monroe County, Florida (JSL I-688, Table 2). The genus can be considered to be more or less pantropical, although it is not yet known from the eastern Pacific region.

Section Thalassinidea
Family Axiidae Huxley, 1879
Coralaxius abelei Kensley & Gore, 1980

Material examined.—1 ♀; rcl 4.5 mm; USNM 173629.

This species, described from the female collected off Key Largo, and additional material from Carrie Bow Cay, Belize, has been previously considered by Kensley and Gore (1980).

Section Anomura
Family Paguridae Latreille, 1803
Nematopaguroides cf. *fagei* Forest & St. Laurent, 1967

Material examined.—1 ♂ juv; sl 1.1 mm; IRCZM 89:4699.

Forest and St. Laurent's species was described from only 3 specimens, the male holotype and 2 very small (*ca.* 2 mm sl) females, one of which was ovigerous. If the Key Largo specimen is indeed this species, then it would appear that *N. fagei* is a remarkably small pagurid. The single specimen was collected from a habitat similar to that occupied by those originally described from Brazil, viz. coralline rock. Dr. Patsy A. McLaughlin who examined the Key Largo juvenile stated that it appeared to belong to *N. fagei,* but because of the small size positive identification could not be made. She noted that the Floridan specimen differed from the description of *N. fagei* in having fewer spines on the dorsal surface of the left cheliped carpus, the dactyl of the right cheliped lacked the minute tubercles described in the type from Brazil, and the telson was slightly different from that illustrated by Forest and St. Laurent (1967). The Floridan material, if correctly assigned, constitutes a range extension of approximately 6300 km northward from the type locality, off Recife, Brazil.

Family Galatheidae Samouelle, 1819
Munida angulata Benedict, 1902

Material examined.—3 ♂♂, 6 ♀♀ (5 ovigerous); rcl 4.6–5.0; 3.2–5.9 mm; IRCZM 89:3788, -3790, -3797, -3879, -3801.

Mrs. Barbara Shuler Mayo had previously informed me (*in litt.*) that Benedict's (1902) illustrations of *M. angulata* (Fig. 4, p. 253) and *M. media* (Fig. 12, p. 263) have been transposed, so that of *M. media* actually illustrates *M. angulata,* and *vice versa.* The oblique angle of the cheliped, to which the specific epithet *angulata* refers, is clearly seen in Benedict's Fig. 12. *Munida angulata* has been recorded from the Gulf of Mexico (Benedict, 1902; Pequegnat and Ray, 1974) and off the central eastern Florida coast (Avent et al., 1977). The Key Largo records suggest that the species will be found around the southern tip of the Floridan peninsula.

Discussion

It is not often that a collection as small as the one made available contains such a rewarding number of new genera, species, and records. This is especially true because the specimens were obtained in an area previously considered to be rather well known in regard to the decapod crustacean fauna. If nothing else the Key Largo collections underscore the caution that must be exercised when statements concerning the knowledge of such a fauna are made. The poorly sampled areas, such as the deeper, rocky and coralline reef areas, remain for the most part *terra incognita,* especially for the associated cryptic fauna inhabiting the crevices within relict or living coral heads. It may well be that further knowledge of this fauna can only be gained by *in situ* sampling using manned submersibles or lock-out divers, because of the attrition of nets and trawls towed from the surface in such topographically complex regions.

Literature Cited

Alcock A., and A. R. Anderson. 1899. An account of the deep-sea Crustacea dredged during the surveying-season of 1897–98. Natural history notes from H.M. Royal Indian Marine Survey Ship "Investigator", Commander T. H. Heming, R.N., commanding.—Series III, No. 2.—Ann. Mag. Nat. Hist. ser. 7, 3:1–27, 278–292.

Avent, R. M., King, M. E., and R. H. Gore. 1977. Topographic and faunal studies of shelf-edge prominences off the central eastern Florida coast.—Int. Revue Ges. Hydrobiol. 62(2):185–208.

Banner, A. H., and D. M. Banner. 1966. The alpheid shrimp of Thailand.—The Siam Society, Monograph series, No. 3:i–iv, 1–168.

Benedict, J. E. 1902. Description of a new genus and forty-six new species of crustaceans of the family Galatheidae, with a list of the known marine species.—Proc. U.S. Nat. Mus. 26:243–334.

Borradaile, L. A. 1915. Notes on Carides.—Ann. Mag. Nat. Hist. ser. 8, 15:205–213.

———. 1917. On the Pontoniinae. The Percy Sladden Trust Expedition to the Indian Ocean in 1905, under the leadership of Mr. J. Stanley Gardiner.—Trans. Linn. Soc. Lond., Zool. ser. 2, 17:323–396.

Bouvier, E. L. 1908. Sur les relations zoologiques des Crevettes de la tribu des Stenopides.—C. R. Acad. Sci. Paris 146:887–891.

Bruce, A. J. 1976. A further occurrence of *Lipkebe holthuisi* Chace (Decapoda Natantia, Pontoniinae).—Crustaceana 30(3):310–312.

Chace, F. A., Jr. 1969. A new genus and five new species of shrimps (Decapoda, Palaemonidae, Pontoniinae) from the western Atlantic.—Crustaceana 16(3):251–272.

———. 1972. The shrimps of the Smithsonian-Bredin Caribbean Expeditions with a summary of the West Indian shallow-water species (Crustacea: Decapoda: Natantia).—Smithsonian Contrib. Zool. 98:i–x, 1–179.

———, and D. E. Brown. 1978. A new polychelate shrimp from the Great Barrier Reef of Australia and its bearing on the family Bresiliidae (Crustacea: Decapoda: Caridea).—Proc. Biol. Soc. Wash. 91:756–766.

Coutière, H. 1909. The American species of snapping shrimps of the genus *Synalpheus*.—Proc. U.S. Nat. Mus. 36(1659):1–93.

Dana, J. D. 1852. Crustacea, Part I.—United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842 . . . Vol. 13:i–viii, 1–685.

———. 1855. *Ibid.* Atlas:1–127, pls. 1–96.

Forest, J., and M. de Saint Laurent. 1967. Crustacés Décapodes: Pagurides.—Result. Scient. Camp. Calypso. Fasc. 8(6):47–169.

Gore, R. H., and K. A. Wilson. 1978. Studies on decapod crustacea from the Indian River region of Florida, X. A first continental record for *Discias atlanticus* Gurney, 1939 (Caridea, Disciadidae).—Crustaceana 35:109–111.

Gurney, R. 1939. A new species of the decapod genus *Discias* Rathbun from Bermuda.—Ann. Mag. Nat. Hist. ser. 11, 3:388–393.

Hailstone, S. 1835. Descriptions of some species of crustaceous animals; with illustrations and remarks by J. O. Westwood.—Mag. Nat. Hist. 8:261–277, 394, 395, 549–553.

Holthuis, L. B. 1946. The Decapoda Macrura of the Snellius Expedition. I. The Stenopodidae, Nephropsidae, Scyllaridae and Palinuridae. *In* Biol. Result. Snellius Exped. XIV.—Temminckia 7:1–178.

———. 1951. A general revision of the Palaemonidae (Crustacea Decapoda Natantia) of the Americas. II. The subfamilies Euryrhynchinae and Pontoniinae.—Allan Hancock Found. Occas. Pap. 11:1–332.

———. 1952a. Crustacés Décapodes, Macrures.—Expéd. Océanog. Belge dans les Eaux Côtières Africaines de l'Atlantique Sud (1948–1949). Résult. Sscient. 3(Fasc. 2):1–88.

———. 1952b. The Palaemonidae collected by the Siboga and Snellius Expeditions with remarks on other species. II. Subfamily Pontoniinae.—Siboga Expeditie XXXIXa^{10}:1–253.

Kensley, B., and R. H. Gore. 1980. *Coralaxius abelei,* genus et species novum (Crustacea Decapoda: Thalassinidea; Axiidae) a remarkable coral-inhabiting shrimp from the Florida Keys and the western Caribbean Sea.—Proc. Biol. Soc. Wash. (in press).

Manning, R. B., and F. A. Chace, Jr. 1971. Shrimps of the family Processidae from the northwestern Atlantic Ocean (Crustacea: Decapoda: Caridea).—Smithsonian Contrib. Zool. 89:1–41.

Paulson, O. 1875. Investigations on the Crustacea from the Red Sea with notes on Crustacea of the adjacent seas. Part 1. Podophthalmata and Edriophthalmata (Cumacea):i–xiv, 1–144 [Translation: Israel Program for Scientific Translations, 1961; National Science Foundation and Smithsonian Institution, Washington, D.C.].

Pequegnat, L. H., and J. P. Ray. 1974. Crustaceans and other arthropods. *In* Biota of the West Flower Garden Bank, Pt. II.—Publ. Flower Garden Ocean Res. Cent.:232–288.

Potts, F. A. 1915. The fauna associated with the crinoids of a tropical coral reef: with special reference to its color variation.—Carnegie Inst. Wash. Pap. Dept. Mar. Biol. III:73–97.

Shaw, J. K., Heard, R. W., Jr., and T. S. Hopkins. 1977. Notes on the biology of the pontoniine shrimp *Lipkebe holthuisi* Chace, with a description of the male.—Proc. Biol. Soc. Wash. 90:284–290.

Stimpson, W. 1861. Prodromus descriptionis animalium evertebratorum quae in expeditione ad Oceanum Pacificum Septentrionalem . . . Pars VIII. Crustacea Macrura.—Proc. Acad. Nat. Sci. Philadelphia. pp. 24–46 [Proc. for 1860].

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Note added in proof: In the course of this study the manuscript and illustrations describing the 3 new species were sent to Drs. L. B. Holthuis and A. J. Bruce to obtain their advice. Because of delays, replies were not received until after the final manuscript was accepted for publication. According to Dr. Bruce, the new species of *Pontoniopsis* does not much resemble members of that genus, and only shows superficial resemblance to *Dasella*. Dr. Holthuis agreed but also thought it not close to *Dasella,* but rather to *Onycocaris*. Using Holthuis' (1955) key, the characters could conceivably place the new species either in *Pontoniopsis* or *Onycocaris,* based on rostral configurations. It does not, however, agree with any known species within the latter genus, using Bruce's key (J. nat. Hist., 1971, vol. 5, pp. 293–298). It is apparent, especially when Bruce's work with Indo-Pacific pontoniine shrimps is considered, that many species show intermediate relationships within established genera, often requiring (as Bruce has done) establishment of new genera. This may eventually prove to be the case with *Pontoniopsis paulae*. Until additional material becomes available, and the limits of the pontoniine genera to which *Pontoniopsis paulae* shows affinity are better defined, I have assigned the new species to *Pontoniopsis*.

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94(1), 1981, pp. 163–168

A NEW SPECIES OF *AMASTIGOS* (POLYCHAETA: CAPITELLIDAE) FROM THE CHESAPEAKE BAY AND ATLANTIC COAST OF THE UNITED STATES WITH NOTES ON THE CAPITELLIDAE OF THE CHESAPEAKE BAY

R. Michael Ewing and Daniel M. Dauer

Abstract.—A new species of Capitellidae *Amastigos caperatus* from the lower Chesapeake Bay and Atlantic Ocean off the east coast of the United States is described below. *Capitomastus aciculatus* Hartman 1959 is redescribed. A key to the Capitellidae of the lower Chesapeake Bay is given.

Capitellidae Grube, 1862
Amastigos Piltz, 1977
Amastigos caperatus, new species
Fig. 1, a–e

Mediomastus acutus (in part).—Hartman, 1969:385–386, figs. 1–3.

Material examined.—Holotype (USNM 61107), 10 paratypes (USNM 61108), CHESAPEAKE BAY (37°07′N, 75°59′W), 6.7 m, in clean medium sand, 19 June 1978, D. M. Dauer and staff, collectors. Ten specimens (USNM 61109): Jones Inlet Dumpsite (40°34′N, 73°38′W), 10 m, in clean medium sand, May 1979, Interstate Electronics Corporation, collectors for Taxon, Inc. Other specimens: About 20 specimens from type-locality; 8 animals from Cape Henry, Virginia (36°56′N, 75°55′W), 18.9 m, in clean fine sand, 13 June 1979, Virginia Institute of Marine Science, collectors.

Description.—Length of holotype 18.5 mm, width 0.5 mm, 61 setigerous segments. Lengths of 10 additional complete specimens ranged from 10.5 to 16.0 mm, widths 0.3 to 0.5 mm, setigers 34–51.

Color tan to reddish-brown in alcohol; scattered dark pigment spots along dorsum in some specimens. Surface epithelium nearly smooth except for shallow transverse wrinkles of contraction; intersegmental furrows pronounced in posterior setigers. Thorax and abdomen not clearly separable; however, setigers 9 and 10 appear to be transitional in their length, number of neurosetae per fascicle, and length of notosetae. There are no branchiae or conspicuous parapodial processes; nephridial pores not observed.

Prostomium slightly depressed, triangular, tapering anteriorly to a fine tip (Fig. 1a), with 2 inconspicuous nuchal slits at posteriolateral borders. Achaetous peristomium with 2 subdermal eyespots. Eversible pharynx bulbous, covered with minute papillae.

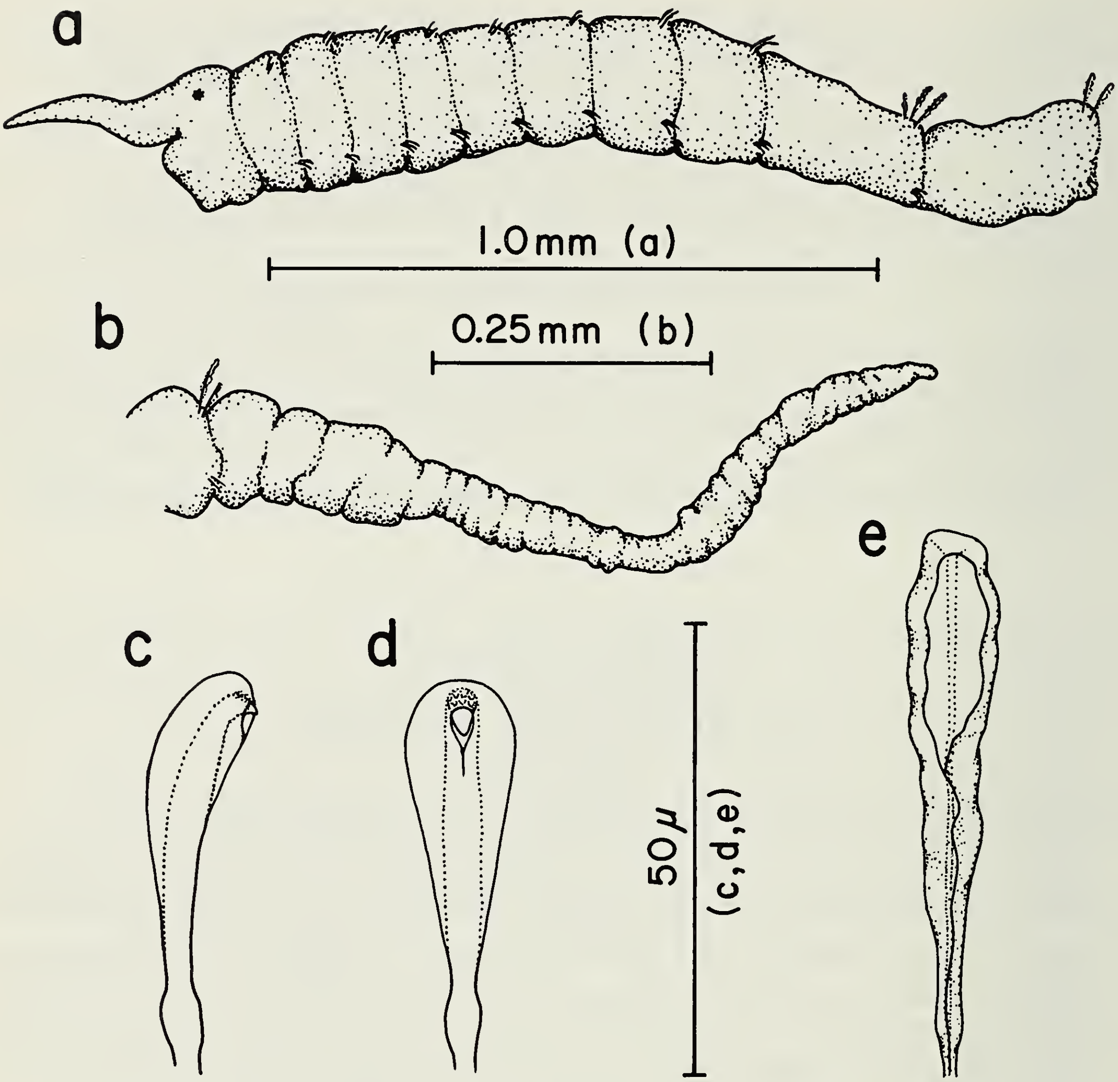

Fig. 1. *Amastigos caperatus:* **a,** Anterior end in lateral view; **b,** Posterior end in lateral view; **c–d,** Lateral and frontal view of neuropodial hooded hook from setiger 4; **e,** Frontal view of notopodal hooded hook from setiger 9.

Anterior 8 setigers approximately 1½–2 times wide as long; ninth setiger distinctly longer and slightly narrower (conspicuous change in segmental length occurring at setigers 10 or 11 in several specimens); thereafter, segments gradually increasing in length until mid-abdominal region where they are 2–3 times as long as wide; posterior setigers becoming shorter and slightly inflated in front of each segmental groove, terminating in a partly annulated pygidium with cylindrical anal cirrus 2–7 times long as preceding segments (Fig. 1b). Anteriormost notopodia dorsolateral, well separated, but approach middorsally by setiger 5–6. Neuropodia ventrolaterally throughout body.

Neuropodia with 2–5 multidentate hooded hooks (Fig. 1c, d) per fasicle through setiger 9; abrupt increase in number of neuropodial hooks to about 10 per fascicle (6–10) in tenth setiger; as many as 16 hooded hooks per fascicle in abdominal neuropodia of several specimens, decreasing in number toward posterior but present in all segments to pygidium. These structures appear to terminate in a beak consisting of a strong, slightly curved fang surmounted by a crest of at least 7 teeth arranged in 2 or more rows.

Notopodia with 2–3 hooded hooks per fascicle in anterior setigers, gradually increasing to as many as 5 per fascicle in middle, then decreasing to 1–2 in far posterior segments. Multidentate hooded hooks of setigers 1–4 short, thick-shafted, similar in structure to neurosetae. Notopodial hooks becoming longer and thinner through setigers 5–8; hood gradually enclosing main fang, becoming compressed from front to back (i.e., perpendicular to fang); margin appearing slightly crenulate. Notosetae from setiger 9 noticeably elongate, approximately twice as long as those of the preceding setiger and greater than 5 times as long as notopodial hooks of setiger 1; margin of hood distinctly wrinkled in most specimens, appearing as a bilimbate seta with scalloped edges; aperture tightly closed around beak; fang and crest nearly invisible in frontal view in ordinary light microscopy, appearing only as a minute button-shaped structure at the distal end of the long and slender shaft (Fig. 1e).

No sexual dimorphism was noted in a comparison of 2 ovigerous females and a single ripe male.

Remarks.—As noted by Fauchald (1977) the exact number of thoracic segments is often difficult to assess in the capitellids. In most specimens examined the achaetous peristomium was not easily recognized though its presence was confirmed through scanning electron microscopy (SEM). The asetigerous segment (first thoracic) thus should not be regarded as a key taxonomic character in *Amastigos caperatus*.

Recent detailed studies of capitellid setae (i.e., Thomassin and Picard, 1972; Warren, 1976) have shown the microstructure of hooded hooks to be more complex than often assessed using conventional optical microscopy. SEM techniques similar to Warren (1976) were employed in this study with only marginal success, since the sheath surrounding the neuropodial and anterior notopodial hooks in *A. caperatus* was only partly removed.

As noted earlier, the length of the main fang of notopodial hooks decreases in size as the shaft lengthens along posterior thoracic setigers. Our observations with SEM indicate that the decreasing size of the beak and hood and construction of the hood aperture around the fang is accompanied by a reduction in the number of teeth in the crest.

Amastigos caperatus resembles the type-species, *A. acutus* Piltz 1977, in that both lack capillary setae and have the characteristic flattened, modified notopodial hooks from the posterior thoracic region. The 2 species differ in several respects. In *A. caperatus* anterior setigers are relatively uniform in width, gradually increasing in length posteriorly, with thorax and abdomen separated by 2–3 transitional segments, whereas, in *A. acutus* the first 2 thoracic setigers are distinctly longer and broader than the following segments, with an abrupt transition from thorax to abdomen at setiger 9. In addition, *A. caperatus* is provided with an anal cirrus while the posterior end of *A. acutus* terminates in a short conical pygidium. The external appearance of the modified notosetae of *A. caperatus* is of considerable interest; the unique wrinkled margin of the hood in most notopodial hooks is highly consistent among individuals examined over a wide geographic range and is an easily observed taxonomic character.

Ecology.—Amastigos caperatus occurs primarily in subtidal clean, fine to medium sands.

Etymology.—The specific name refers to the wrinkled appearance of the notopodial hoods, particularly in the abdomen.

Distribution.—Lower Chesapeake Bay; Atlantic Ocean, from Charleston, South Carolina to Broad Sound, Massachusetts.

Capitomastus aciculatus Hartman 1959

Hartman (1959) described *Capitomastus aciculatus* from St. Andrews Bay, Florida, with the setal formulae illustrated in Fig. 2 (where A = acicular spine, C = capillary seta, H = hooded hook, G = genital spine, M = mixed fascicle of capillary setae and hooks). Individuals collected from the Chesapeake Bay did not consistently show this pattern.

Variations from the setal arrangement reported by Hartman (1959) were as follows:

Males: 1. Some individuals had acicular spines only in the notopodia of the first 2 setigers or lacked these spines entirely. In each case parapodia without acicular spines had capillary setae only. There was no apparent relationship between the setal arrangement and size although a greater proportion of larger males have the acicular spines.

2. Fascicles of mixed capillary setae and hooks were occasionally found in the neuropodia of setiger 8.

3. Most males examined (24 of 30 specimens) lacked capillary setae in the neuropodia of setiger 9, which according to Hartman should be mixed.

Females: 1. Individuals were also found that lacked acicular spines in the notopodia of the first 2 setigers.

2. Several specimens had capillary setae only in the notopodia of setiger 8.

When the acicular spines are absent *Capitomastus aciculatus* may be confused with *Capitella capitata.* Males of the 2 species differ in the presence of some capillary setae in the eighth neuropodia in *C. aciculatus* where

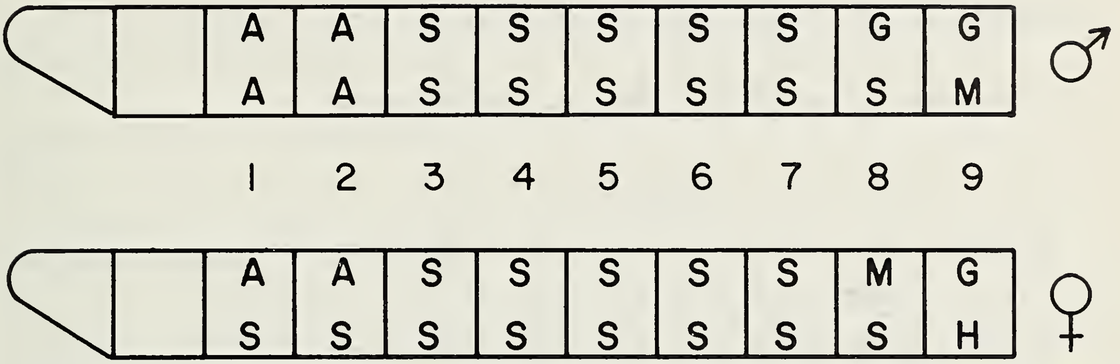

Fig. 2. Thoracic setal arrangement of *Capitomastus aciculatus* as described by Hartman (1959).

only hooded hooks are present in *C. capitata*. Although Warren (1976) noted that capillary setae rarely appear in the neuropodia of setiger 8 in *C. capitata*, this situation was not encountered in 124 *C. capitata* specimens examined from Chesapeake Bay. All possible setal combinations were observed in the eighth neuropodia of *C. aciculatus* males; capillary setae may be absent in one, but never in both, neuropodial fascicles. *C. aciculatus* females have genital spines only in the notopodia of the ninth setiger and are easily recognized since *C. capitata* females have only hooded hooks.

Key to the Capitellidae of the lower Chesapeake Bay*

1. Capillary setae present 2
– Capillary setae absent . . . . *Amastigos caperatus*
2. No more than 4 anterior setigers with capillary setae only 3
– At least 5 anterior setigers with capillary setae only 5
3. First 3 setigers with capillary setae only . . . . *Capitella jonesi*
– First 4 setigers with capillary setae only (*Mediomastus*) 4
4. Notopodia of posterior abdominal segments with both hooks and capillary setae or with capillary setae only . . . . *M. ambiseta*
– Abdominal notopodia with hooks only . . . . *M. californiensis*
5. First 5 setigers with capillary setae only . . . . *Heteromastus filiformis*
– More than 5 thoracic setigers with capillary setae 6
6. Genital spines present 7
– Genital spines absent 9
7. Genital spines present in setigers 8 and 9 8

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* Setal characters may vary with age (Warren, 1976). This key is based upon setal characters of adults.

– Genital spines present only in ninth setiger ....
.... *Capitomastus aciculatus* (female)
8. Neuropodia of setiger 8 with some capillary setae ....
.... *Capitomastus aciculatus* (male)
– Neuropodia of setiger 8 with hooks only ... *Capitella capitata* (male)
9. First 7 setigers with capillary setae or mixed capillary setae and hooks .... *Capitella capitata* (female)
– First 11 setigers with capillary setae only (*Notomastus*) 10
10. Setiger 1 with capillary setae in both noto- and neuropodia ......
.... *N. latericeus*
– First setiger without neurosetae .... *N. hemipodous*

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The authors are especially grateful to Dr. Kristian Fauchald of the Smithsonian Institution for examining several of our specimens and for critically reviewing the manuscript. We also thank Linda Lutz for preparing the figures for press.

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Literature Cited

Fauchald, K. 1977. The polychaete worms. Definitions and keys to the orders, families, and genera.—Nat. Hist. Mus. Los Angeles County. Science Series 28:1–190.

Grube, A. E. 1862. Noch ein Wort über die Capitellen and ihre Stellung im Systeme der Anneliden.—Arch. Naturgesch. Berlin 28:366–378.

Hartman, O. 1959. Capitellidae and Nereidae (Marine Annelids) from the Gulf side of Florida, with a review of freshwater Nereidae.—Bull. Mar. Sci. Gulf and Caribbean 9(2):153–168.

Hartman, O. 1969. Atlas of sedentariate polychaetous annelids from California.—Allan Hancock Found., Univ. of Southern California, Los Angeles, 812 pp.

Piltz, F. M. 1977. A new genus and species of polychaete (Family Capitellidae) from southern California.—Bull. So. Calif. Acad. Sci. 76(1):57–60.

Thomassin, B., and C. Picard. 1972. Étude de la microstructure des soies de polychètes Capitellidae et Oweniidae au microscope électronique à balayage: un critère systématique précis.—Mar. Biol. 12:229–236.

Warren, L. M. 1976. A review of the genus *Capitella* (Polychaeta: Capitellidae).—J. Zool., Lond. 180:195–209.

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UCA MARGUERITA, A NEW SPECIES OF FIDDLER CRAB (BRACHYURA: OCYPODIDAE) FROM EASTERN MEXICO[1]

Carl L. Thurman II

Abstract.—A species of fiddler crab new to science, *Uca marguerita*, on the eastern terrigenous coastline of Mexico is reported. Previously, several specimens of the newly described species were confused with either *Uca virens* Salmon and Atsaides, *Uca burgersi* Holthuis, or *Uca speciosa* Ives. A detailed morphological description of adult specimens along with a general description of the male's courtship display is presented. The new species is compared with sympatric congeners. On both morphological and behavioral grounds, *Uca marguerita* appears to be a member of the subgenus *Minuca* of Crane (1975).

Several authors have reviewed the North American fiddler crabs. However, only Rathbun (1918), Buitendijk (1950), and Crane (1975) have reported new records from the east coast of Mexico. Rathbun identified *Uca mordax* Smith in collections from Tampico, Mexico. Buitendijk also believed *U. mordax* as well as *U. speciosa* Ives were present in the Mexican state of Veracruz. Recently, Holthuis (1967) and von Hagen (1970) considered Buitendijk's *U. mordax* records to be *Uca burgersi* Holthuis. In a major taxonomic revision, Crane reclassified Rathbun's Mexican specimens as either *Uca vocator* Herbst, *Uca spinicarpa* Rathbun or *Uca pugnax virens* Salmon and Atsaides. Simultaneously, she also added 20 new specimens which she believed to represent *U. p. virens* from southern Veracruz. These gifts to the New York Zoological Society extended the presumed range of *Uca virens* from the area between Ocean Springs, Mississippi, and Port Aransas, Texas (Salmon and Atsaides, 1968), into southeast Mexico. *Uca rapax* Smith was also recognized to range as far north as Tamaulipas.

The taxonomic assessments of both Crane (1975) and Holthuis (1967) are based on examination of a few preserved museum specimens from eastern Mexico. In addition several authors have expressed the opinion that the original type characteristics for *Uca virens* as well as *Uca longisignalis* Salmon and Atsaides are unreliable (Crane, 1975:203; von Hagen, 1975, 1980). On the one hand, Crane tentatively proposed five traits to distinguish

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[1] Adapted as part of a doctoral dissertation submitted to the Graduate School, University of Minnesota, Minneapolis.

U. virens from other *Minuca* but felt her choice to be marginally acceptable without a more complete collection series. On the other, von Hagen's (1980) approach has been to synonymize the newer species with older, traditionally described taxa. Complete resolution of this controversy is beyond the scope of the present study. However, as a result of field collections and examination of available preserved museum specimens, it is apparent that Crane's difficulty in obtaining reliable traits for *U. virens* arises from the simultaneous treatment of at least two species. Part of the *U. pugnax virens* as well as some of the *U. burgersi* and *U. speciosa* from eastern Mexico are members of an undescribed species. This new species, *Uca marguerita,* is limited to the terrigenous areas of eastern Mexico. It does not occur in the United States or upon the biogenic soils of the Yucatan peninsula.

Materials and Methods

Populations of fiddler crabs in the western and southern Gulf of Mexico were studied during December 1972, September 1974, March 1976 and September 1976. More than 3000 specimens were collected from 77 localities between Ocean Springs, Mississippi, and Chetumal, Quintana Roo, Mexico. Two hundred thirteen individuals of the new species were found in localities between the states of Tamaulipas and Campeche, Mexico. From these collections, lots were deposited in the USNM, Department of Invertebrate Zoology, Washington, D.C. Samples of the new species were supplied from Tamaulipas, La Pesca; Veracruz, Rio Panaco; Veracruz, La Barra; Veracruz, Nautla; Veracruz, Laguna La Mancha; Veracruz, Boca del Rio; Tabasco, Puerto Ceiba; Tabasco, Frontera; Campeche, Rio San Pedro. The specimens from Laguna La Mancha in Veracruz are designated as male holotype (USNM 180400) and female allotype (USNM 180401). The remainder (USNM 180443 through 180450) are designated as paratypes. In addition, older preserved materials also were examined. The following *Minuca* were made available by the USNM:

Uca burgersi Holthuis 1967—138490 (Belize), 139173 (Belize), 13488 (Florida).

Uca longisignalis Salmon and Atsaides 1968—121599 (Holotype) 122204 (Paratype), 2259 (Grand Isle), 21845 (Biloxi), 33035 (Matagorda), 72132 part (Texas), 74902 (Ocean Springs), 122764 (Yankeetown), 138647 (Yankeetown), 138648 (Galveston).

Uca minax (LeConte 1855)—42618 (Sarasota), 64083 (Ft. St. Phillip), 64155 (Grand Isle), 98144 (Lake Pontchartrain).

Uca mordax (Smith 1870)—18430 (Swan Island), 50950 (Belize).

Uca pugnax (Smith 1870)—17488 (Winyah Bay), 71196-7 (Ft. Macon), 74455 (Brigantine).

Uca rapax (Smith 1870)—15057 (Mobile Bay), 25033 (Matagorda), 95526 (Yucatan), 96475 (Laguna Madre).

Uca virens Salmon and Atsaides 1968—121598 (Holotype), 122205 (Paratype), 30570 (Cameron), 33031 (Matagorda), 72132 (Texas), 122765 (Port Aransas), 72131 (Texas), 138642 (Corpus Christi), 138643 (Port Aransas), 43353 (Tampico), 138644 (Veracruz), 138645 (Veracruz), 18689-dry (Tampico).

Uca vocator (Herbst 1804)—21373 (Belize), 138855 (Veracruz), 139175 (Tampico).

The following lots were made available by the Rijksmuseum:

Uca burgersi Holthuis 1967—7577 (Veracruz), 7578 (Veracruz).

Uca speciosa (Ives 1891)—7574 (Veracruz).

A number of morphological characteristics were measured in order to characterize the new species. Measurements were taken to the nearest 0.05 mm with a vernier caliper. Carapace breadth was measured at maximal distance between anterior dorsolateral margins. Body length was taken from the front of carapace to posterior margin above abdomen. Frontal width was taken between the inner junctions of the eyebrows with the lower frontal margin of the carapace. The length and width of the merus was measured along the respective central axis of the fourth ambulatory segment. Propodal ratios were obtained from measurements taken on the fifth segment of the ambulatory. The details of gonopodium and gonopore structures were studied with the aid of a stereo dissecting microscope.

The cheliped waving behavior of male fiddler crabs was recorded in the field using a 16 mm movie camera where ambient temperatures were always above 25°C. General wave form and temporal components of the courtship display were determined by frame analysis. Since this behavior was recorded at either 16 or 24 frames per second, estimates of temporal characteristics were determined by multiplying the number of frames involved by either 0.0625 or 0.0416 seconds for respective recording speeds.

Results

Uca marguerita, new species

Figs. 1, 2

Uca mordax.—Rathbun, 1918:391–393 [part].
Uca mordax.—Buitendijk, 1950:279 [part].
Uca speciosa.—Buitendijk, 1950:279 [part].
Uca burgersi.—Holthuis, 1967:51–54 [part].
Uca burgersi.—von Hagen, 1970:225 [part].
Uca speciosa.—von Hagen, 1970:227 [part].
Uca pugnax virens.—Crane, 1975:200–205 [part].—not *Uca virens* Salmon and Atsaides, 1968.

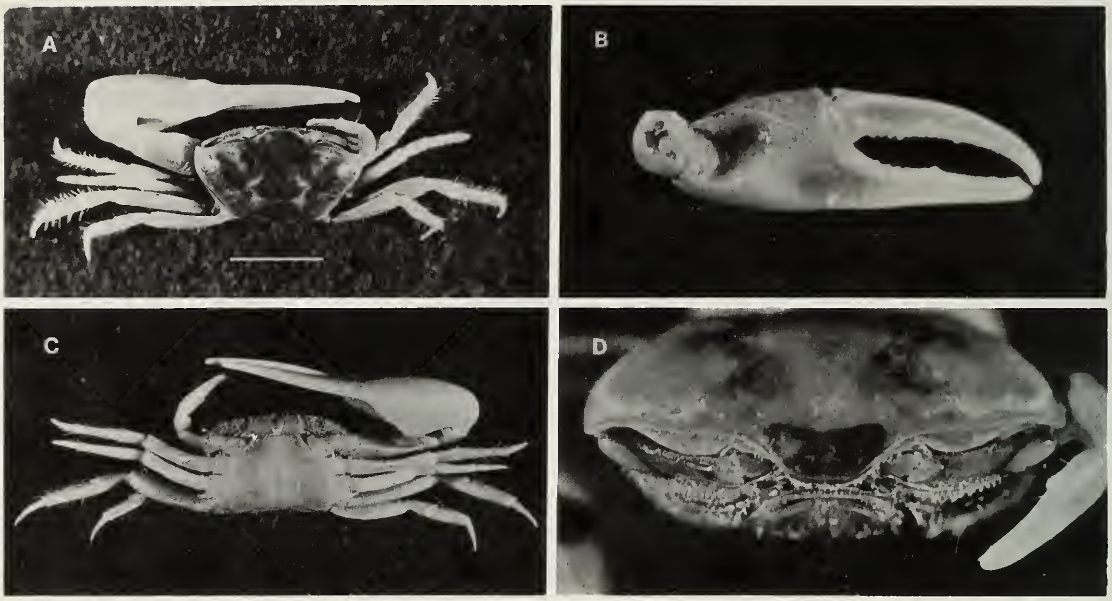

Fig. 1. *Uca marguerita:* A, Dorsal view; B, Inner surface of male cheliped; C, Ventral view; D, Frontal view of interocular region. White bar = 1 cm.

Type-locality.—Mexico, Veracruz, Laguna La Mancha (19°40′N, 96°20′W) between Villa Rica and Cardel. In addition to the USNM paratypes, examples from the following lots have been identified as *Uca marguerita*: USNM 43353 part, USNM 138644, USNM 138645, RMNH 7574 part, RMNH 7577 part, and RMNH 7578 part.

Diagnosis.—Fig. 1. Width of rounded frontal lobe less than ⅓ maximum carapace width. Ventral margins of distal ambulatory segments without pubescence. In males, superior carina above carpal cavity in palm of cheliped consists of a row of tubercles. Distal end of this carina turned forward toward dactyl. In females, genital operculum without prominent tubercle.

Etymology.—Marguerita a common christian name used in the endemic region of the crab.

Morphological description.—From dorsal view (Fig. 1A), carapace length 66.0% or less of breadth. Carapace widest slightly posterior to anterior margins. Largest male 24.7 × 15.1 mm; largest female 17.3 × 12.0 mm at Nautla, Veracruz. Surface finely granular and pitted in both sexes. Females have few large tubercles in epibranchial regions. Neither pubescence nor numerous setae on dorsal carapace. H-depression in cardiac-mesogastric region very prominent. Color in preserved specimens homogeneously dark except for occasional concentration in depression. Carapace of living specimens brown, dark green, or gray. Frontal lobe between eyestalks less than 33.0% of maximum carapace width (Fig. 1D); in males near 27%, in females near 31%. From dorsal view, frontal lobe distinctly rounded or spatulate and very shallow. Maximum width of eyebrow almost equal to diameter of adjacent eyestalk peduncle. Distal cornea occupies between 25 and 33% of peduncle length. Anterior margins finely granular in both sexes. Sulcus posterior to eyebrow forms deep transverse depression curving toward mesogastric region. Anteriorly, dorsolateral margins of carapace curving inward slightly. Junction of anterior and posterior forming curved but obtuse angle. Posteriorly lateral margins converging toward midline of carapace giving body shortened appearance.

When carapace is viewed from anterior (Fig. 1D), lobed interocular region very shallow and rounded. Carapace moderately arched through axis of width. From lateral view, carapace strongly convex, almost subcylindrical. Eyebrows strongly inclined horizontally.

Outer and upper manus of cheliped covered with very large tubercles. Dorsal margin distinctly tuberculate. Ventral margin of manus with tubercles forming a distinct keel. Submanus sulcus prominent. Tubercles of outer manus becoming minute on pollex. Both pollex and dactyl flattened, more bladelike than tubular (Fig. 1B). Pollex with 3 rows of tubercles in gape. Usually 1 large tubercle or "tooth" more than halfway along pollex in gape. Three to 5 tubercles at distal end of pollex. Tip thick. Pollex with 4 or 5 large tubercles on ventral margin of dactyl-propodus articulation that do not traverse from outer to inner pollex surfaces. Dactyl with teeth in gape. Upper margin of carpal cavity on inner manus lined with a prominent ridge of tubercles or superior carina (Fig. 1B). Some pubescence may be present in cavity. Distal end of carina turned distinctly toward dactyl as it approaches palm. Region dorsal to end of carina forming a smooth, triangular sulcus. Ventral manus with oblique tuberculated ridge extending about ¾ distance to pollex. Distally, this consists of 2 or 3 ill-defined rows of smaller tubercles. Proximately, these converge into a prominent, elevated apex consisting of larger tubercles at ventral border of carpal cavity. Apex vertical to surface of palm. From apex, a row of tubercles follows outer edge of carpal cavity and extends upwards, almost intersecting with superior carina. Proximal palm covered with numerous large tubercles equal in size to those on oblique ridge. Palm area appears swollen because of deep sulcus at intersection of pollex and high apex of oblique ridge. Two rows of tubercles near dactyl articulation: one row on predactyl ridge, other more proximal to palm. Proximal row divergent from distal with dorsal end curving toward dactyl.

Form of minor cheliped similar to that of other *Minuca*. Distal end of pollex and dactyl sparsely setose. Usually fewer than 10 short hairs on either finger. Serrations in gape weakly developed. Distal end of merus with a few long setae parallel to dorsal propodal articulation.

Dorsal margins of ambulatory merus slightly convex. Both anterior and posterior surfaces covered with short setae. Merus of third ambulatory

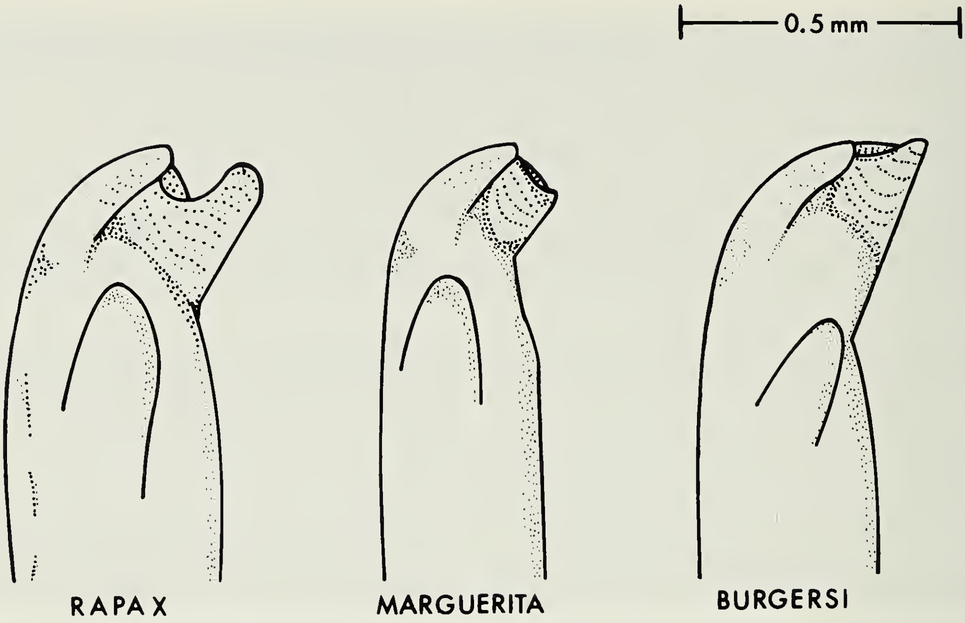

Fig. 2. Gonopodium structures of *Uca rapax* Smith, *Uca burgersi* Holthuis and *Uca marguerita* from eastern Mexico. Anterior view of right gonopodium from males of carapace widths 17 to 18 mm. 60×.

about 2.56 times longer than wide in males and about 2.22 times in females. Ventral surface of first, second, and third meri with numerous setae but no pubescence (Fig. 1C). Usually at least 5 setae per merus. Fourth leg with 0 to 5 setae per merus. Propodal and carpal segments of first 3 ambulatories with pubescence only on dorsal surfaces. Occasionally pubescence present on fourth ambulatory propodus and carpus, more frequent in females than males. Numerous long setae present in rows on anterior, posterior, dorsal and ventral surfaces of propodus. Two rows on dorsal surface. Propodus width about 30% of length on first ambulatory in males.

Copulatory pleopods of male thin and nearly straight when viewed from sternum. After terminal setae are removed, distal end appears constricted before angling of tip (Fig. 2). Tip turned almost to right angle with lateral margins of carapace. Distal tip with small shield-shaped cuticular process. Free edge smooth and undeveloped. Two soft palps present. One subterminal near constriction extending distally to near origin of cuticular process. Second palp terminal on inner lateral surface with distal end embracing cuticular process. Figure 2 compares tip of nude gonopodium of *Uca marguerita* with those of *U. burgersi* and *U. rapax* of comparable size. These differences appear consistently across the range of the new species. Female gonopore without tubercle. Operculum lined with thin rim from sternum. Anterior margin may show small microscopic fold with edge protruding toward center of operculum.

Geographical distribution.—The new species was collected in brackish

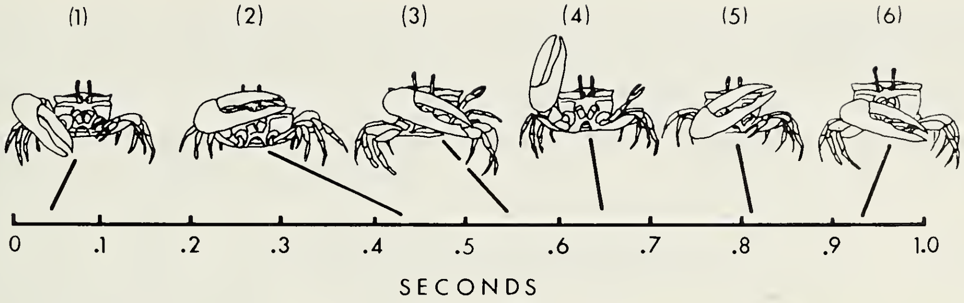

Fig. 3. High intensity courtship display in male *Uca marguerita*. Major positions of cheliped indicated by parentheses. (See text.)

habitats between La Pesca, Tamaulipas, and Rio San Pedro, Campeche, Mexico. The specimens reported as *Uca pugnax virens* from Mexico (Crane, 1975; USNM 43343 part, 138644 and 138645) belong to the new species. The additional 16 specimens from Rio Tonchochapa could not be located. Holthuis (1967) and von Hagen (1970) both consider the entire lots RMNH 7577 and 7578 to be *U. burgersi* from Veracruz. One male from RMNH 7577 (Nautla) and 3 males and 1 female from RMNH 7578 (Casitas) are *Uca marguerita*. The clawless male from *U. speciosa* lot RMNH 7574 is also the new species (Casitas). The new species thus appears to be endemic to the western shores of the Bay of Campeche.

Male courtship display.—The cheliped waving of the new species has been recorded at two localities within its geographic range. Temporal and topological components of this supplementary characteristic are useful for distinguishing the new species in the field and aiding in the determination of phylogenetic affinities. Thirty waves from seven males at La Pesca, Tamaulipas, and Puerto Ceiba, Tabasco, were studied by frame analysis.

The form of the wave in the new species is relatively simple and appears consistent between northern (n = 2) and southern (n = 5) males. As illustrated in Fig. 3, the heel of the cheliped (proximal manus) and carpus are raised to a level near the front of the carapace (position 1 and 2). The fingers of the claw then follow and are held momentarily at the carapace front (position 2). At this point, the axis of the manus and dactyl are more or less parallel with the substrate. The cheliped is oscillated laterally while in this position (3). The propodus is then quickly flexed vertically through a vertex (position 4) and downward (position 5) to a frontal position (6). There is no apical pause but the cheliped is rotated slightly exposing the inner manus during the apical transition. On the rapid return or downstroke, the fingers of the claw do not touch the substrate. Also during the descent phase, the proximal carpal segment is lowered before the distal manus and dactyl (position 5).

The singular frontal pause appears to be characteristic of the wave. Only

Table 1.—Temporal and topological characteristics of waving behavior in *Uca marguerita* from Eastern Mexico.

Type of wave	No.	Mean duration (sec) SE	Heel to hold (sec) SE	Pause (sec) SE	To apex (sec) SE	Return (sec) SE
High	6	0.92 ± 0.14	0.41 ± 0.05	0.14 ± 0.05	0.12 ± 0.08	0.28 ± 0.10
Moderate	19	1.54 ± 0.21	0.76 ± 0.22	0.19 ± 0.09	0.23 ± 0.09	0.38 ± 0.14
Low	5	2.63 ± 0.61	1.66 ± 0.57	0.32 ± 0.13	0.18 ± 0.09	0.37 ± 0.18
					0.18 ± 0.06	0.34 ± 0.06

	Duration between waves (sec)
High	0.80 ± 0.06 (n = 4)
Moderate	1.35 ± 0.21 (n = 10)
Low	3.28 ± 1.40 (n = 5)

one individual waving at low intensity expressed two pauses. Pauses at the apex or on the return flexure were never noted. During the upward movement of the claw after the frontal pause, the second and third ambulatories on the minor side and the second on the major may be extended laterally to a position parallel with the substrate. These are returned to supporting positions before the cheliped is brought down to the frontal position (6). The minor cheliped is also flexed laterally after the initial pause and oscillation of the large cheliped.

The wave displays may be classified into three intensities on the basis of duration (Table 1). The highest intensity waves are observed with the approach of a female. These waves are approximately 1.0 s in duration. Low intensity waves are a little more than 2.5 s. The latter were observed when no other crabs were near. The time course of successive waves changes with the approach of another crab. At first, waves are expressed very rapidly and the upward pausing phase (position 2 and 3) is scarcely discernable. As a female approaches, durations are then increased and a bobbing or curtsy (Crane, 1975:496, 658) is incorporated. During this slower waving, the legs may or may not be extended laterally.

The movement of the cheliped from an initial pause to a frontal position at the completion of a wave does not change with increase in waving intensity (Table 1). The complete execution from initial pause to unflexed frontal position occurs in approximately 0.5 s without stop at vertex. Apparently wave duration is determined by the amount of time spent raising the heel and dactyl to a frontal position (1 & 2) and time spent in oscillation pause phase (3). The initial step may vary from 1.66 to 0.41 s while the pause may simultaneously vary from 0.32 to 0.17 s between low and high intensity waving.

On the other hand, pauses between successive waves are proportional to wave duration. During high intensity waving, interwave duration is 0.80 s. At intermediate intensity, the interval is increased to 1.35 s while at low intensity there are 3.28 s between waves. The lowest intensity waves are extremely variable in this component.

Discussions and Conclusions

The general morphology of the new species is most closely allied with the fiddler crab subgenus *Minuca* (Crane, 1975). In the Atlantic, this taxon possesses two more or less related superspecies, *galapagensis* and *minax*, as well as the species *U. burgersi*. Of the superspecies, *galapagensis* possesses frontal breadths less than ⅓ carapace width while the *minax* superspecies and *U. burgersi* have frontal-carapace relationships exceeding this value. Consequently, *Uca marguerita* may be distinguished from the broad-fronted western Atlantic *Uca mordax, U. pugnax, U. longisignalis, U. vocator, U. burgersi,* and *U. minax*. Moreover, it can be separated from *U. mordax* and *U. longisignalis* by a lack of pubescence on the ventral surfaces of ambulatory meral, carpal and propodal segments (Crane, 1975:630–631). Females also lack a genital tubercle, which aids in discerning them from *U. mordax, U. pugnax, U. vocator, U. minax* and *U. longisignalis* as well as the narrow-fronted *U. rapax*.

The *Uca pugnax virens* of Crane from Mexico (USNM 138645) do not possess the genital tubercle. On the other hand, the only female specimen claimed by Salmon and Atsaides (1968) as a *U. virens* (USNM 72132) has this structure. Also, the female from Crane's Texas lot (USNM 72131) which is believed to be *U. p. virens* is equipped with the genital tubercle. The Mexican samples of females discussed by Crane are thus quite distinct from the Texas samples of *U. virens,* and are considered to be *Uca marguerita*. By the same token, the largest female of the *U. burgersi* sample (Holthuis, 1967) from Mexico, in which all lack genital tubercles, possesses a frontal width less than ⅓ carapace width. This is also *U. marguerita*.

Of the Atlantic *Minuca, U. marguerita* was found sympatric with only *U. burgersi, U. vocator* and *U. rapax*. The males of the new species are readily distinguished from *U. vocator* on the basis of absence of pubescence from the carapace and dorsal surfaces of ambulatory meri, a highly developed oblique ridge across the palm of the major cheliped, and a short appearing body. The new species is more difficult to distinguish from the *galapagensis* superspecies and *U. burgersi*. However, it may be segregated from *U. burgersi* by its narrower frontal region, and a more granular, shorter appearing carapace. On the inner surface of the male's large cheliped (Fig. 1B), the tubercles of the superior carina along the upper margin of the cheliped carpal sinus turn toward the dactyl in *U. marguerita,* but back to the edge of the cavity in *Uca burgersi*. On the inner palm, the proximal predactyl ridge is not as arched in *U. marguerita* as in either *U. burgersi* or *U. mordax*. Although *U. burgersi* and *U. marguerita* possess similar gonopores, the male gonopods are distinct in their areas of sympatry (Fig. 2). Those in the new species are thinner, more straightened proximately and have a more sharply angled tip than *U. burgersi*. The cuticular tip is shorter in the new species while the proximal and medial palps appear longer in *U. burgersi*.

Unfortunately, the general dimensions of the carapace and frontal lobe in males of both *Uca rapax* and the new species are quite similar. The frontal lobe of the new species is distinctly spatulate as opposed to the angular or truncated lobe of *U. rapax*. The eyebrows are broader in *Uca marguerita* than in either *U. rapax* or *U. pugnax*. In *U. marguerita* the eyebrows are horizontally inclined to such a degree that they appear almost as wide as the adjacent eyestalk peduncle. The eyebrows of *U. rapax* as well as *U. virens* (Crane, 1975:201) are sufficiently angled so that they are clearly visible in a dorsal carapace view. Since the eyebrows of *U. pugnax* are nearly vertical in a lateral view they are barely visible from the median dorsal perspective (Rathbun, 1918:395, 398). The cheliped contains tubercles that are large and an arched, proximal predactyl ridge that is distinct from the smooth palm and parallel ridge of male *U. rapax* or *U. virens*. The oblique ridge of *U. marguerita* is developed to a much higher apex than in other local *Minuca*. The distal extension of the superior carina is also distinct from those found in both *U. rapax* and *U. pugnax*. The gonopod of *U. rapax* is distinctly broader and possesses a more extended cuticular tip than in the new species (Fig. 2). The male gonopod was helpful in identifying the clawless *U. marguerita* in RMNH 7574.

The waving display of the new species also is distinct from other Atlantic *Minuca*. These are similar to those expressed by other members of the *galapagensis* superspecies. The duration of single waves in *U. longisignalis, U. minax, U. pugnax, U. vocator* and *U. burgersi* are considerably longer than the waves of the new species. In particular, the duration of the lowest intensity waves in the new species is approximately equal to the high intensity waves of both *Uca rapax* (Salmon, 1967; Crane, 1975) and *U. virens* (Salmon and Atsaides, 1968). Moreover, the ascending portion of waves contains fewer ascending pauses than any other Atlantic *Minuca*. On the basis of ethology, the new species is obviously readily distinguishable in the field.

Relationships.—Although less is known about the Pacific *Minuca,* von Hagen (1968) described in some detail the waving behavior and gonopod structure of both *U. galapagensis* Rathbun and *U. herradurensis* Bott from Peru. These Pacific relatives differ from *U. rapax* and *U. pugnax* by having the palm of the cheliped tuberculate, the oblique ridge of the claw developed to a high apex and strong postorbital sulcus on dorsal carapace. Both are moderately narrow-fronted *Minuca* (Crane, 1975:183). The genital tubercle is absent in the female of the Pacific species. The same ensemble of characters may be used to distinguish the new species from its Atlantic relations.

Although the waves of male *Uca galapagensis* are highly variable, they are distinct from those of *U. rapax* and *U. herradurensis*. In *U. galapagensis,* vibrational components accompany a single apical pause. Although the new species lacks any pause at the vertex, the positioning of the cheliped in front of the mouth parts at the end of a wave, oscillatory movements, and short wave durations in *U. marguerita* courtship display are reminiscent of the patterns in *Uca galapagensis* (von Hagen, 1968; Crane, 1975). Consequently, on the basis of similarity in morphology and behavior, *Uca marguerita,* the new species, tentatively appears to be phyletically close to the Pacific relatives in the *Minuca* superspecies, *galapagensis*.

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Literature Cited

Buitendijk, A. M. 1950. Note on a collection of decapod Brachyura from the coasts of Mexico, including the description of a new genus and species.—Zool. Meded. (Leiden) 30:269–282.

Crane, J. 1975. Fiddler Crabs of the World (Ocypodidae; genus *Uca*).—Princeton University Press, Princeton. 1–736.

von Hagen, H. O. 1968. Studien an peruanischen Winkerkrabben (*Uca*).—Zool. Jahrb. System. 95:395–468.

———. 1970. Verwandtschaftliche Gruppierung und Verbreitung der karibischen Winkerkrabben (Ocypodidae, Gattung *Uca*).—Zool. Meded. (Leiden) 44:217–235.

———. 1975. Klassifikation und phylogenetische Einordnung der Lautäusserungen von Ocypodiden und Grapsiden (Crustacea, Brachyura).—Z. f. Zool. System. Evol. 13:300–316.

———. 1980. A key to the "x-species" of North American fiddler crabs (genus *Uca*).—Zool. Meded. (Leiden) 55:87–96.

Holthuis, L. B. 1967. On a new species of *Uca* from the West Indian region (Crustacea, Brachyura, Ocypodidae).—Zool. Meded. (Leiden) 42:51–54.

Rathbun, M. J. 1918. The grapsoid crabs of America.—Bull. U.S. Natn. Mus. 97:1–461.

Salmon, M. 1967. Coastal distribution, display and sound production by Florida fiddler crabs (genus *Uca*).—Animal Behav. 15:449–459.

———, and S. P. Atsaides. 1968. Behavioral, morphological and ecological evidence for two new species of fiddler crabs (genus *Uca*) from the gulf coast of the United States.—Proc. Biol. Soc. Wash. 81:275–290.

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PROC. BIOL. SOC. WASH.
94(1), 1981, pp. 181–227

ADDITIONAL ACANTHONOTOZOMATID, PARAMPHITHOID, AND STEGOCEPHALID AMPHIPODA FROM THE SOUTHERN OCEAN

Les Watling and Heather Holman

Abstract.—*Odius antarcticus* n. sp. is described and 2 new subspecies of *Gnathiphimedia sexdentata* are named. In addition 14 acanthonotozomatid, 5 paramphithoid, and 4 stegocephalid species are recorded, with most redescribed. *Iphimediella discoveryi* Watling and Holman is herein considered synonymous with *Gnathiphimedia macrops*. A combined key to *Gnathiphimedia* and *Iphimediella* is given. In the genus *Epimeria, E. excisipes* is placed into synonymy with *E. georgiana* and *Subepimeria geodesiae* with *E. puncticulata*. The boreal North Pacific *Uschakoviella echinophora* is recorded from Antarctic waters for the first time.

This paper is the second in a series directed toward the redescription of poorly known or incorrectly described species as well as the description of new species. In the first paper (Watling and Holman, 1980) we described 6 new species and one new genus of Acanthonotozomatidae, 2 new species of Paramphithoidae and one new species of Stegocephalidae, chiefly from the Scotia Sea region. New revisions were also offered for the acanthonotozomatid genera *Acanthonotozomella, Iphimedia, Iphimediella* and *Pseudiphimediella,* and the paramphithoid genera *Epimeria* and *Parepimeria*. The present paper contains one new species (*Odius antarcticus*), two new subspecies of *Gnathiphimedia sexdentata,* and redescriptions of 10 acanthonotozomatids, 5 paramphithoids, and 2 stegocephalids. Several other species are also recorded.

Acanthonotozomatidae

Acanthonotozomoides Schellenberg

Acanthonotozomoides Schellenberg, 1931:124.

Type-species.—*A. sublitoralis* Schellenberg, 1931 (original designation).

Diagnosis.—Mandible with narrow, slightly toothed apex; maxilla 1 palp biarticulate, inner plate minute; maxilliped palp exceeding outer plate, 4-articulate, article 2 slightly produced medially; gnathopods simple; coxa 1 distally acute.

Acanthonotozomoides oatesi (K. H. Barnard 1930)

Acanthonotozomella oatesi K. H. Barnard, 1930:346, figs. 20, 21.—K. H. Barnard, 1932:117, fig. 65.
Acanthonotozomoides oatesi.—J. L. Barnard, 1969:119.—Bellan-Santini, 1972:167, pl. 1.

Material.—*Eltanin* Cruise 12, Sta. 1003, 15 Mar. 1964, 62°41′S, 54°43′W, 210–220 m, 1 juvenile.

Diagnosis.—Pereonite 1 with single pair of sub-dorsal processes; coxa 1 not bidentate distally.

Distribution.—From Adelie Coast, along western Antarctica to Palmer Archipelago and South Georgia, 82–236 m.

Anchiphimedia K. H. Barnard

Anchiphimedia K. H. Barnard, 1930:357.

Type-species.—*A. dorsalis* K. H. Barnard, 1930 (original designation).

Diagnosis.—Upper lip incised; mandibles meet along frontal plane with cutting edge angled downwards and toward posterior of body; maxilla 1 palp biarticulate, very short, outer plate bears numerous curved setae instead of strongly chitinized, toothed spines; maxilliped palp article 4 very small, partly covered by hood-like extension of article 3, article 2 medially expanded but not produced along article 3; gnathopods 1 and 2 chelate.

Anchiphimedia dorsalis K. H. Barnard 1930
Figs. 1, 2

Anchiphimedia dorsalis K. H. Barnard, 1930:357, figs. 29, 30.—K. H. Barnard, 1932:123.

Material.—*Eltanin* Cruise 27, Sta. 1924, 27 Jan. 1967, 75°11′S, 176°13′W, 728–732 m, 1 ♂.

Diagnosis.—As for genus.

Description.—The following supplements the description of K. H. Barnard (1930). Upper lip incised. Right mandible with prominent, toothed accessory plate; left mandible with minute accessory plate. Maxilla 1 outer plate slender, with numerous non-plumose setae distally; inner plate subacute apically, with approximately 15 plumose setae on distal half of medial margin. Maxilla 2 inner plate wider than outer, both densely setose distally, setae on outer plate slightly longer than those on inner plate; inner plate with plumose setae along medial margin. Maxilliped outer plate broad; palp article 4 minute, articles 1 and 3 subequal, article 2 expanded medially and only slightly shorter than either articles 1 or 3. Gnathopod 1 chelate; lateral margins of articles 5 and 6 setose; article 3 one-third length of article 6.

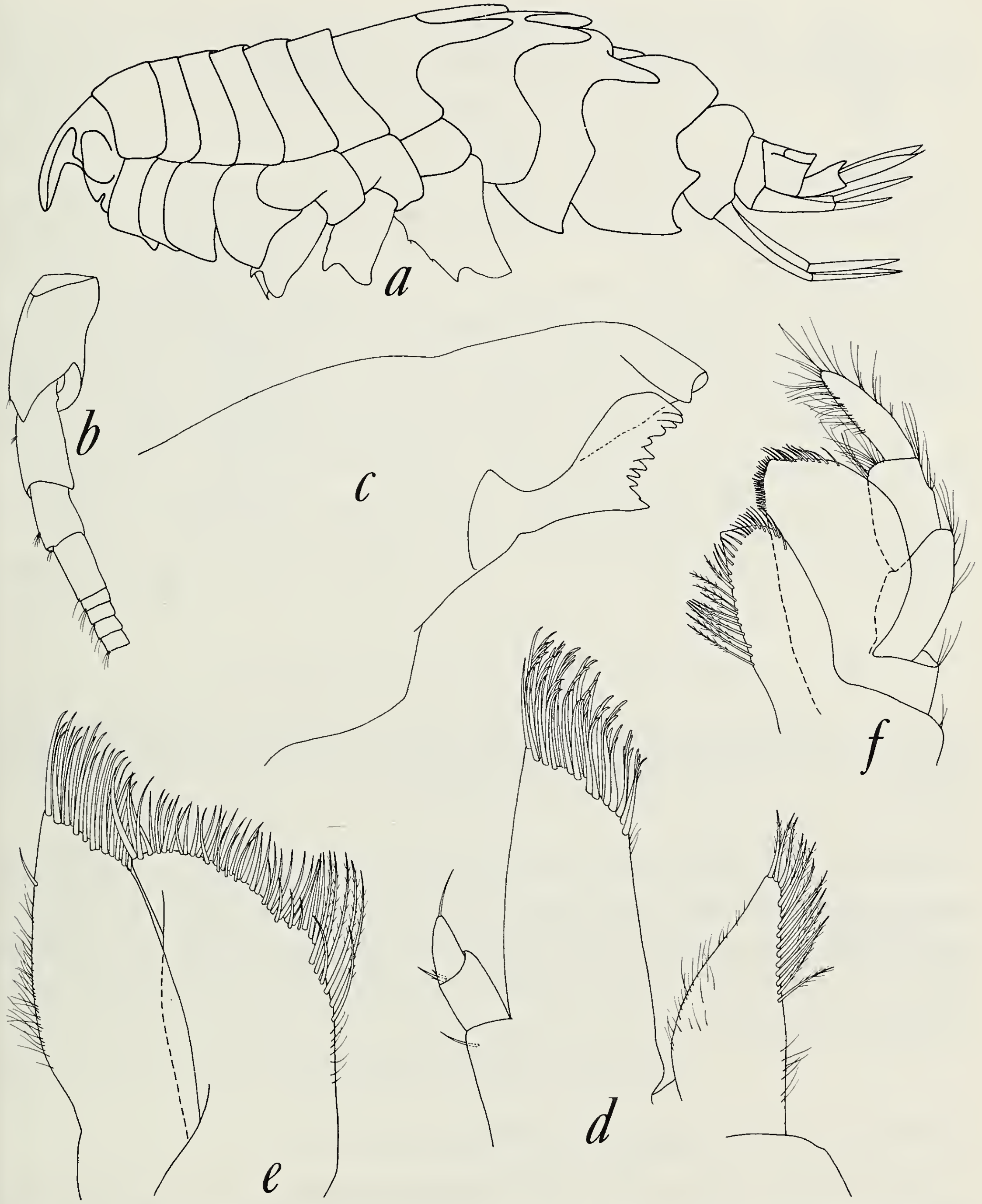

Fig. 1. *Anchiphimedia dorsalis, Eltanin* Sta. 1924: a, Body side view; b, Antenna 1 peduncle; c, Right mandible; d, Maxilla 1; e, Maxilla 2; f, Maxilliped.

Gnathopod 2 chelate; lateral margins of articles 5 and 6 more setose than on gnathopod 1; articles 5 and 6 subequal, longer than article 3.

Distribution.—Palmer Archipelago along western Antarctic to McMurdo Sound, 259–732 m.

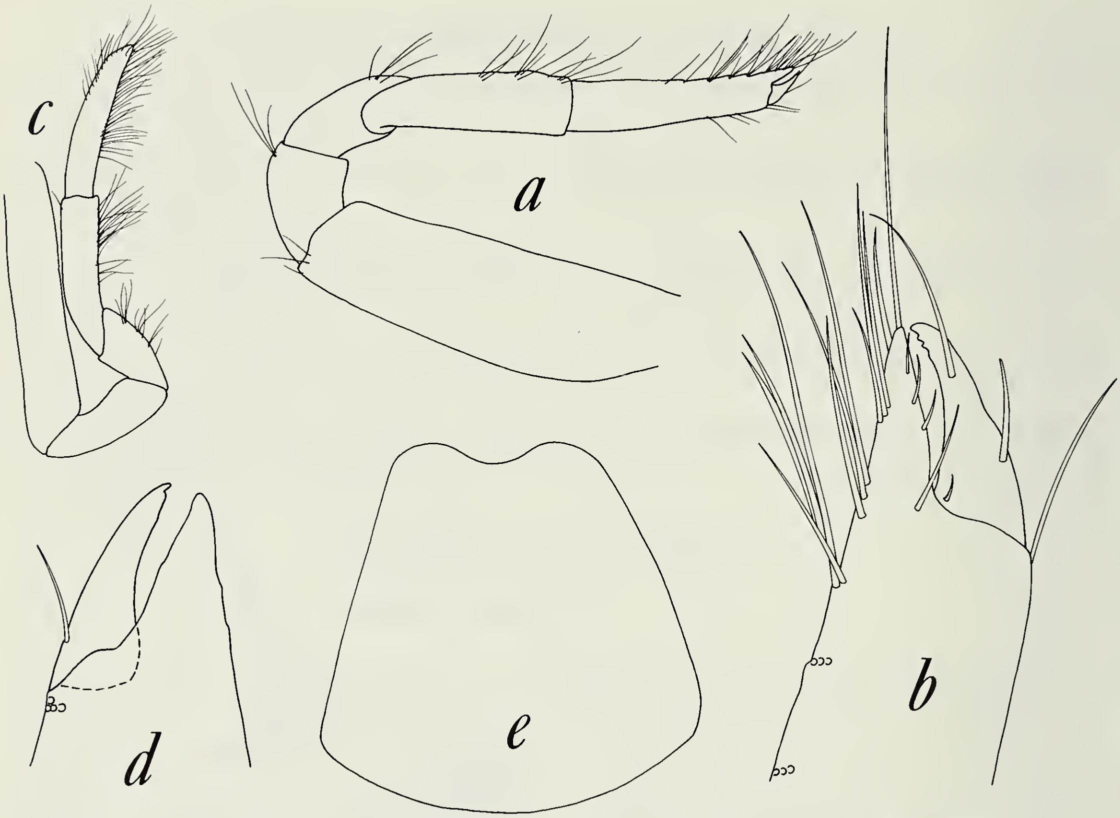

Fig. 2. *Anchiphimedia dorsalis, Eltanin* Sta. 1924: a, Gnathopod 1, b, Gnathopod 1 propodus and dactylus; c, Gnathopod 2; d, Gnathopod 2 propodus and dactylus without setae; e, Telson.

Remarks.—The orientation of the mandible in this species is intermediate between the condition seen in species of *Iphimediella* and that seen in *Pseudiphimediella* (documented by Watling and Holman, 1980). The cutting edges of the incisors meet in a plane oriented more to the frontal than to the transverse plane.

Echiniphimedia K. H. Barnard

Echiniphimedia K. H. Barnard, 1930:358.

Type-species.—Iphimedia hodgsoni Walker, 1906.

Diagnosis (from description in J. L. Barnard, 1967).—2 or more coxal plates with submarginal fixed teeth; some or all body segments covered with rows or groups of erect cusps on lateral surfaces; epistome broad; maxilla 1 palp biarticulate; maxilliped palp 4-articulate, article 4 extremely minute; gnathopods 1 and 2 chelate.

Echiniphimedia echinata (Walker 1906)

Iphimedia echinata Walker, 1906:150; 1907:28, pl. 10, fig. 16.—Chevreux, 1912:119.

Echiniphimedia nodosa.—K. H. Barnard, 1930:361, fig. 33.
Echiniphimedia echinata.—K. H. Barnard, 1932:126.—Nicholls, 1938:80, fig. 42.—J. L. Barnard, 1967:9, figs. 4, 5.
Pariphimediella echinata.—J. L. Barnard, 1964:51.

Material.—*Eltanin* Cruise 32, Sta. 1995, 10 Jan. 1968, 72°04′S, 172°38′E, 360–342 m, 1 juvenile; Cruise 32, Sta. 2065, 26 Jan. 1968, 78°23′S, 173°06′W, 473–475 m, 1 juvenile.

Diagnosis (from description in J. L. Barnard, 1967).—Pereonites 5–7 (occasionally 2–7), pleonites 1–4, coxae 5–7 (occasionally 3–7), and bases of pereopods 5–7 sparsely covered with small, fixed, marginal and submarginal teeth; pereonite 1 smooth; antenna 1 peduncle article 1 lacking strong distal teeth; maxilla 2 outer plate lateral margin with only 1 or 2 setae.

Distribution.—Davis Sea, Adelie Coast, Ross Sea and western Antarctica to Palmer Archipelago, South Orkneys and South Georgia, 10–585 m.

Remarks.—The specimen from Sta. 2065 (8 mm) possessed teeth beginning on pereonite 2 hind margin, similar to specimens reported by Nicholls (1938).

Echiniphimedia hodgsoni (Walker 1906)

Iphimedia hodgsoni Walker, 1906:152; 1907:30, pl. 11, fig. 18.
Echiniphimedia hodgsoni.—K. H. Barnard, 1930:359, fig. 31.—Nicholls, 1938:82, figs. 43–44.—J. L. Barnard, 1967:3, figs. 1–3.

Material.—*Eltanin* Cruise 12, Sta. 1003, 15 Mar. 1964, 62°41′S, 54°43′W, 210–220 m, 1 juvenile.

Diagnosis (from description in J. L. Barnard, 1967).—Pereonites 1–4 densely covered with elongate teeth; pereonites 2–6 with 2 vertical rows of very slender teeth; coxa 3 with more than 5 teeth.

Distribution.—From Davis Sea, around the western Antarctic coasts to South Orkney Islands and South Georgia, 20–1120 m.

Gnathiphimedia K. H. Barnard

Gnathiphimedia K. H. Barnard, 1930.

Type-species.—*G. mandibularis* K. H. Barnard, 1930.

Diagnosis (modified from J. L. Barnard, 1969).—Antenna 1 with uniarticulate accessory flagellum; upper lip entire or sinuous; epistome broadened, greater than 3 times as broad as high; mandible short, incisor thickened, oriented to cut in transverse plane; lower lip without inner lobes, distal apices broadly rounded; maxilla 1 palp biarticulate, reaching end of outer plate; maxilliped palp 4-articulate, article 2 slightly expanded, not produced along article 3, article 4 minute, covered by hood-like extension of article 3; gnathopods 1 and 2 chelate; telson slightly cleft.

Remarks.—This genus and *Iphimediella* are externally very similar but differ in the width of the epistome and shape of the mandible, suggesting two quite different modes of feeding. The incisor of *Iphimediella* is much thinner indicating a cutting or tearing function whereas the incisor of *Gnathiphimedia* is thickened, indicating a crushing function.

Key to species of *Gnathiphimedia* and *Iphimediella*

1. Pleonites with enlarged mid-dorsal carinae, paired dorsal processes not prominent .... *I. imparidentata* (Bellan-Santini)
– Pleonites with distinct paired dorsal processes 2
2. Pleonites without paired dorsal processes on pleonite 3 3
– Pleonites with paired dorsal processes on pleonite 3 7
3. Pereonites 6 and 7 with paired dorsal processes .... *I. octodentata* (Nicholls)
– Pereonite 6 without paired dorsal processes 4
4. Coxa 1 rectangular, smoothly rounded anterodistally; upper lip incised 5
– Coxa 1 tapering distally; upper lip entire 6
5. Pleonite 3 with slightly projecting keel, dorsal processes meet to form a "U" .... *I. georgei* Watling and Holman
– Pleonite 3 smooth, without keel, dorsal processes short, meet to form a "V" .... *I. bransfieldi* K. H. Barnard
6. Antenna 1, article 1, distal tooth extending past article 3; lateral head sinus broadly rounded .... *G. sexdentata* (Schellenberg)
– Antenna 1, article 1, distal tooth not extending past end of article 2; lateral head sinus narrow .... *G. macrops* K. H. Barnard
7. Paired dorsal processes on pereonites 6 and 7 and pleonites 1–3 .... *I. serrata* (Schellenberg)
– Paired dorsal processes on pereonite 7 and pleonites 1–3 8
8. Coxa 7 posterior margin produced as an elongate process; pereopod 7 basis with 2 posterior teeth ...... *I. acuticoxa* Watling and Holman
– Coxa 7 smoothly rounded behind, at most with small tooth; pereopod 7 basis smoothly rounded with single small tooth at posterodistal corner 9
9. Prominent distal tooth on antenna 1 peduncle article 1 extending well past third peduncle article 10
– Teeth on antenna 1 peduncle article 1 not extending past third article 12
10. Coxa 1 rectangular, smoothly rounded anterodistally .... *G. mandibularis* K. H. Barnard
– Coxa 1 not smoothly rounded, tapering distally, often bidentate 11

11. Lateral head sinus a well rounded notch; mandible smooth; thick .... *G. barnardi* Thurston
– Lateral head sinus narrow; subacute mandible incisor multidentate, thin .... *I. margueritei* Chevreux
12. Paired dorsal teeth form a distinct "V," mid-dorsal keel present on pleonites 1–3, additional upright keel on urosomite 1 .... *I. rigida* K. H. Barnard
– Paired dorsal teeth meet to form a "U," no mid-dorsal keel present 13
13. Coxa 1 distally tapering to an acute or subacute tip .... *G. fuchsi* Thurston
– Coxa 1 rounded anterodistally 14
14. Dorsal processes short, stubby; upper lip entire .... *I. microdentata* (Schellenberg)
– Dorsal processes elongate, slender; upper lip incised .... *I. cyclogena* K. H. Barnard

Gnathiphimedia barnardi Thurston 1974
Fig. 3

Gnathiphimedia barnardi Thurston, 1974:15, figs. 3, 4.

Material—Eltanin Cruise 6, Sta. 410, 31 Dec. 1962, 61°18–20′S, 56°09–10′W, 220–240 m, 1 ♂.

Diagnosis.—Body with paired dorsal processes on pereonite 7 and pleonites 1–3; head, lateral sinus broadly rounded; antenna 1 peduncle article 2 dorsal tooth not extending beyond article 3; coxa 1 distally truncate; coxa 7 posterodistal corner slightly produced.

Description.—The following supplements the description of Thurston (1974). Antennule with minute uniarticulate accessory flagellum; mandible palp article 3 heavily setose, setae increasing in length distally; maxilliped with minute article 4 concealed by hood-like extension of article 3; coxa 7 posterodistal corner slightly produced.

Distribution.—South Georgia, South Shetland Islands, 26–250 m.

Remarks.—Aside from the additions to Thurston's description noted above, the specimen from the South Shetland Islands differs from his material as follows: the mandible palp and maxilla 1 inner plate and palp are more setose; dorsal processes on pleon somite 3 are not as strong; upper tooth on epimeral plate 3 is more dorsally positioned. Superficially, *G. barnardi* resembles *Iphimediella margueritei,* especially with respect to processes on the body and antennules. The two species can be distinguished on the basis of mouthparts, head sinus (broad in *G. barnardi*) and coxa 6 (posteriorly acute in *I. margueritei*).

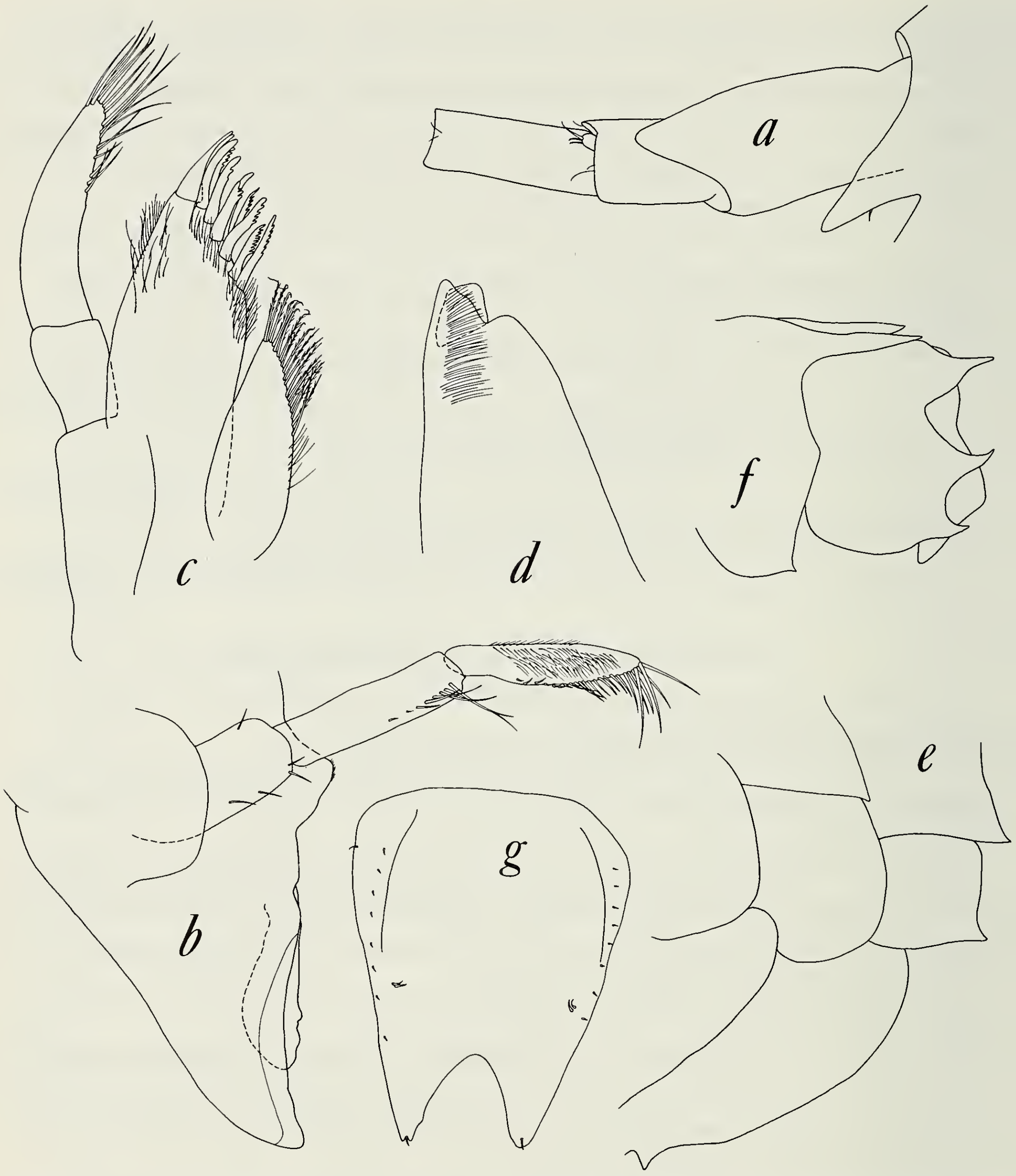

Fig. 3. *Gnathiphimedia barnardi, Eltanin* Sta. 410: a, Antenna 1 peduncle articles 2, 3 and accessory flagellum; b, Mandible; c, Maxilla 1; d, Distal end of maxilliped palp article 3 and minute article 4; e, Coxae 6 and 7; f, Epimeral plates 2 and 3; g, Telson.

Gnathiphimedia macrops K. H. Barnard, 1932

Gnathiphimedia macrops K. H. Barnard, 1932:122, fig. 68.—Nicholls, 1938:78, fig. 41.—Thurston, 1974:13, fig. 2b.
Gnathiphimedia sexdentata.—K. H. Barnard, 1932:122 (in part).
Iphimediella bransfieldi K. H. Barnard, 1932:119 (in part).
Iphimediella discoveryi Watling and Holman, 1980:635.

Material.—Discovery Sta. 123, 15 Dec. 1926, off mouth of Cumberland Bay, South Georgia, 230–250 m, 1 ♀ with eggs; Sta. 148, 9 Jan. 1927, off Cape Saunders, South Georgia, 132–148 m, 1 ♀ non-setose brood plates; Sta. 175, 2 Mar. 1927, 63°17′S, 59°48′W, 200 m, 1 ♀ with eggs.

Diagnosis.—Body with short, paired dorsal processes on pereonite 7, pleonites 1 and 2; antenna 1 peduncle article 1 ventrodistal tooth extending only to middle article 3; head lateral sinus bounded below by acute tooth, bluntly rounded above; coxa 1 distally tapering and multidentate ventrally.

Description.—The following supplements the description given by K. H. Barnard (1932) and Nicholls (1938). Body with 3 pairs of short processes meeting dorsally in a narrow "U" shape. Upper lip entire. Mandible short and stout but incisor smoothly dentate, not extremely thickened; molar setose; palp article 3 only slightly shorter than article 2; accessory plate present on both mandibles, better developed on left. Gnathopods 1 and 2 chelate; carpus and propodus short in gnathopod 1, carpus slightly longer than propodus; gnathopod 2 carpus and propodus subequal. Pereopod 5 basis only slightly expanded, anterior and posterior margins parallel, posterodistal corner produced into small acute point.

Distribution.—Adelie Coast and South Georgia, 120–540 m.

Remarks.—The mandible of this species is not as heavily chitinized and smooth as that found in other species of *Gnathiphimedia*. This, along with some variation in length of the dorsal spines with body size, have probably been the primary reasons for the confusion of this species with *G. sexdentata* and *I. bransfieldi* and the designation of one specimen as a new species, *I. discoveryi* (Watling and Holman, 1980). Smaller specimens (from Sta. 123 and 148) carried proportionately longer dorsal teeth than did the larger female from Sta. 175. *G. macrops* can be distinguished from the only other species of *Gnathiphimedia* with 3 pairs of dorsal processes, *G. sexdentata,* by the short tooth on antenna 1 article 1 and by the shape of the lateral head sinus. For a summary of the distinctions between *I. bransfieldi* and *G. macrops* see the discussion concerning the differences between the former and *I. discoveryi* in Watling and Holman (1980).

Gnathiphimedia sexdentata (Schellenberg 1926)

Diagnosis.—Body with paired dorsal processes on pereonite 7, pleonites 1 and 2; head lateral sinus broadly rounded; antenna 1 peduncle article 1 ventrodistal tooth extending beyond peduncle article 3; coxa 1 distally tapering, generally bidentate.

Gnathiphimedia sexdentata sexdentata, new subspecies

Figs. 4–6

Iphimediella sexdentata Schellenberg, 1926:331.
Iphimedia pacifica.—Walker, 1907 (part):27.—Chevreux, 1913:118.

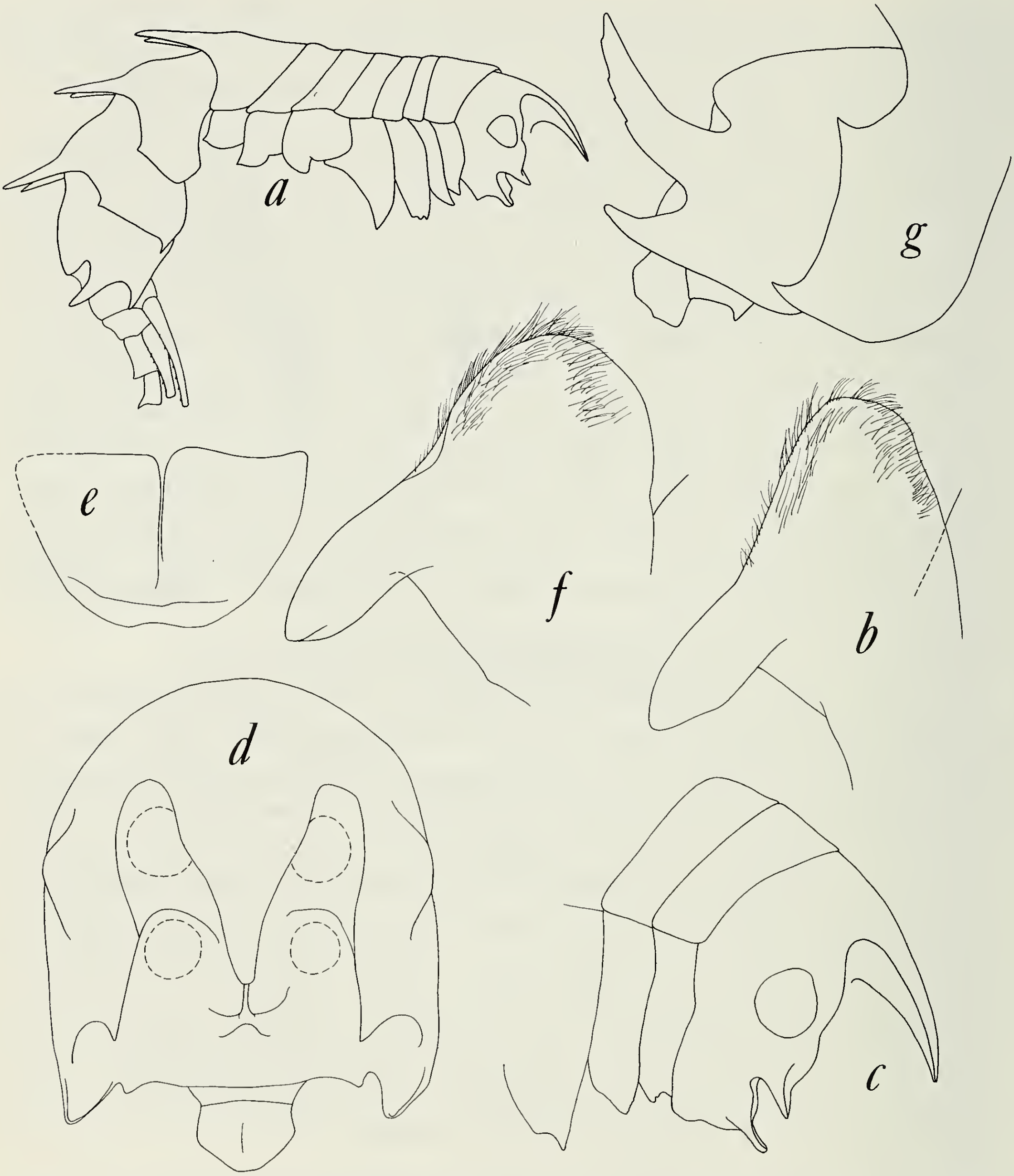

Fig. 4. *Gnathiphimedia sexdentata sexdentata, Terra Nova* Sta. 8 male: a, Body, side view; b, Lower lip. Female: c, Head side view; d, Head front view antennules and antennae removed; e, Upper lip; f, Lower lip; g, Epimeral plates 2 and 3.

Gnathiphimedia pacifica.—K. H. Barnard, 1930:353, 449, fig. 27.
Gnathiphimedia sexdentata.—K. H. Barnard, 1932:122 (part).—Nicholls, 1938:77, fig. 40.—Thurston, 1974:13, fig. 2A.

Material.—Terra Nova Sta. 8 (?339) McMurdo Sound, 256 m, 2 ♂♂, 3

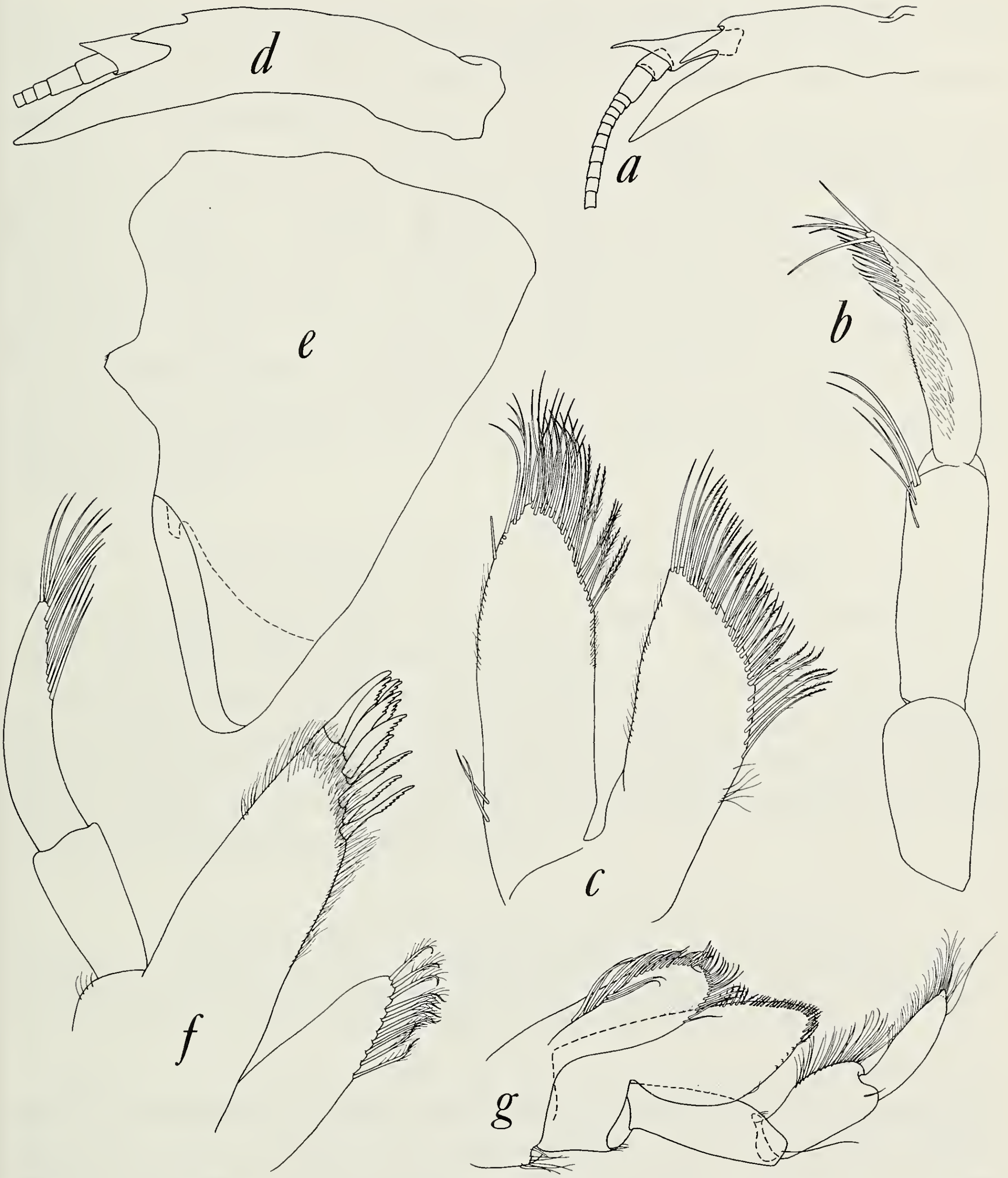

Fig. 5. *Gnathiphimedia sexdentata sexdentata, Terra Nova* Sta. 8, male: a, Antenna 1; b, Mandible palp; c, Maxilla 2. Female: d, Antenna 1; e, Mandible; f, Maxilla 1; g, Maxilliped.

♀♀. *Eltanin* Cruise 6, Sta. 418, 2 Jan. 1963, 62°39–40′S, 56°08–10′W, 311–426 m, 2 juveniles; Cruise 51, Sta. 5769, 77°09.1′S, 158°59.6–159°00.2′W, 344–357 m, 2 ♀♀, 1 juvenile.

Diagnosis.—Dorsal processes long, extending to posterior margin of following somite, projecting outward and slightly upward from body.

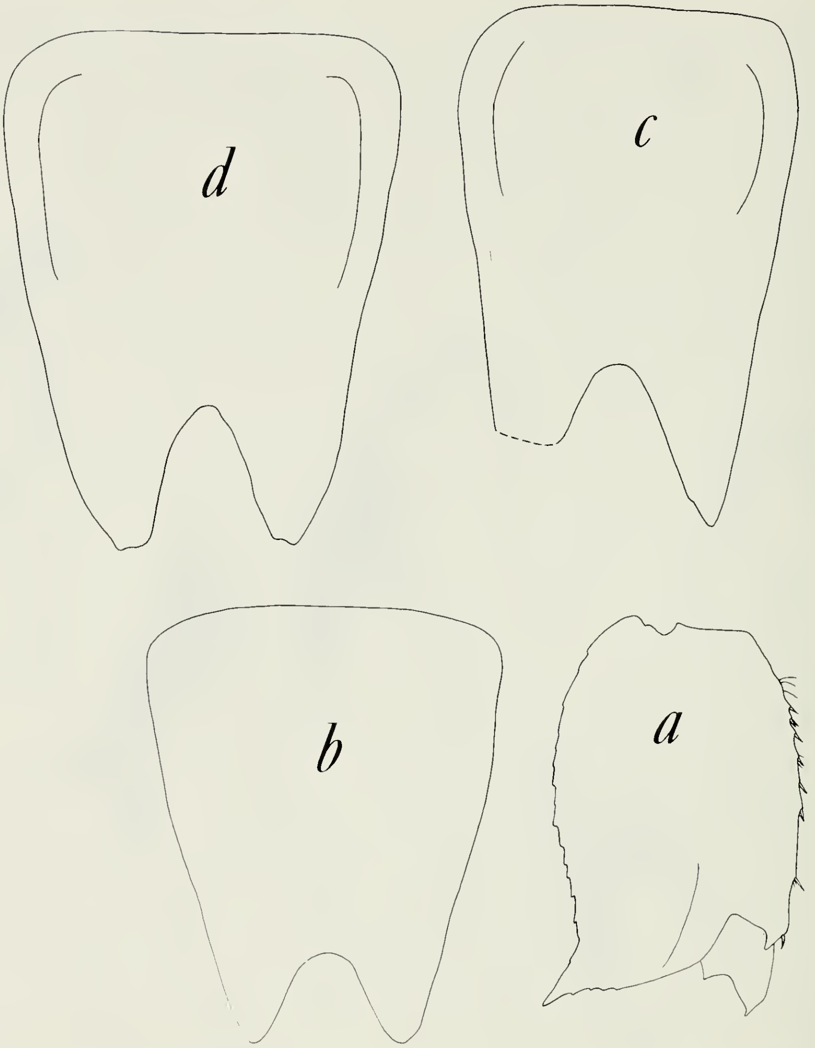

Fig. 6. *Gnathiphimedia sexdentata sexdentata, Terra Nova* Sta. 8, female: a, Pereopod 7 basis; b, Telson 21 mm specimen; c, Telson 22 mm specimen; d, Telson 28 mm specimen.

Description.—The following supplements the description given by K. H. Barnard (1930). Antenna 1 peduncle article 2 ventrodistal tooth of variable length, occasionally extending beyond peduncle article 3; accessory flagellum uniarticulate. Upper lip lower margin entire to sinuous. Mandible incisor thick, smooth; molar a short, broad-based cone, not as figured for *G. mandibularis* (K. H. Barnard, 1930); accessory plates on right and left mandibles, that on right mandible minute, often broken; palp articles 2 and 3 subequal. Lower lip, distal apices vary from narrowly to broadly rounded. Maxilla 1 palp article 2 armed along distal half of medial margin; outer plate distally tapering; inner plate sub-acute, armed with approximately 10 plumose setae. Maxilla 2 inner plate broadened distally. Maxilliped palp article 4 minute, not covered by hood-like extension of article 3, article 1 longer than article 3, article 2 not produced along article 3; outer plate pointed distally, ovate; inner plate narrow, distally truncate.

Distribution.—Davis Sea, Adelie Coast, Ross Sea, Palmer Peninsula, South Shetland Islands, 9–720 m.

Remarks.—Our examination of 5 British Museum specimens has demonstrated this species to be extremely variable with regard to the following features: antenna 1 peduncle article 2 distal tooth extends to or beyond article 3; head sinus broad or narrow; mandible incisor of variable thickness and degree of denticulation; coxa 1 narrowly or widely bidentate; maxilliped palp article 2 equal to or shorter than article 1; pleurae on pereonites 3–7 lie flat against the body or project postero-laterally as acute processes. The only constant character that separates *G. s. sexdentata* from *G. s. incerta* appears to be the length of the dorsal body processes on pereonite 7 and pleonites 1 and 2.

Gnathiphimedia sexdentata sexdentata, juvenile

Material.—Eltanin Cruise 6, Sta. 418, 2 Jan. 1963, 62°39–40′S, 56°08–10′W, 311–426 m, 2 juveniles (6 mm length).

Remarks.—These specimens look very much like the adults described above with the exception of the mandible which is much more slender. Thus, these individuals are listed separately here in the event future workers find the narrow mandible incisor not to be a juvenile character but rather a feature indicative of a distinct species.

Gnathiphimedia sexdentata incerta, new subspecies

Figs. 7, 8

Gnathiphimedia incerta Bellan-Santini, 1972:170, figs. 2, 3.

Material.—Eltanin Cruise 6, Sta. 418, 2 Jan. 1963, 62°39–40′S, 56°08–10′W, 311–426 m, 1 ♂; Cruise 12, Sta. 1003, 15 Mar. 1964, 62°41′S, 54°43′W, 210–220 m, 1 ♂, 1 ♀, 1 juvenile; Cruise 32, Sta. 1995, 10 Jan. 1968, 72°04′S, 172°38′E, 342–360 m, 2 juveniles.

Diagnosis.—Dorsal processes short, each pair projecting along contour of body but not reaching to posterior margin of following somite.

Distribution.—Adelie Coast, South Shetland Islands, 60–426 m.

Remarks.—The morphological variation exhibited by these specimens was similar to that listed for *G. sexdentata sexdentata.* Because of the overlap in morphology for nearly all characters, *G. incerta* could not reliably be distinguished from *G. sexdentata* other than by the length of the dorsal body processes. Further study of many specimens will be required to fully document the variability of the *G. sexdentata* complex.

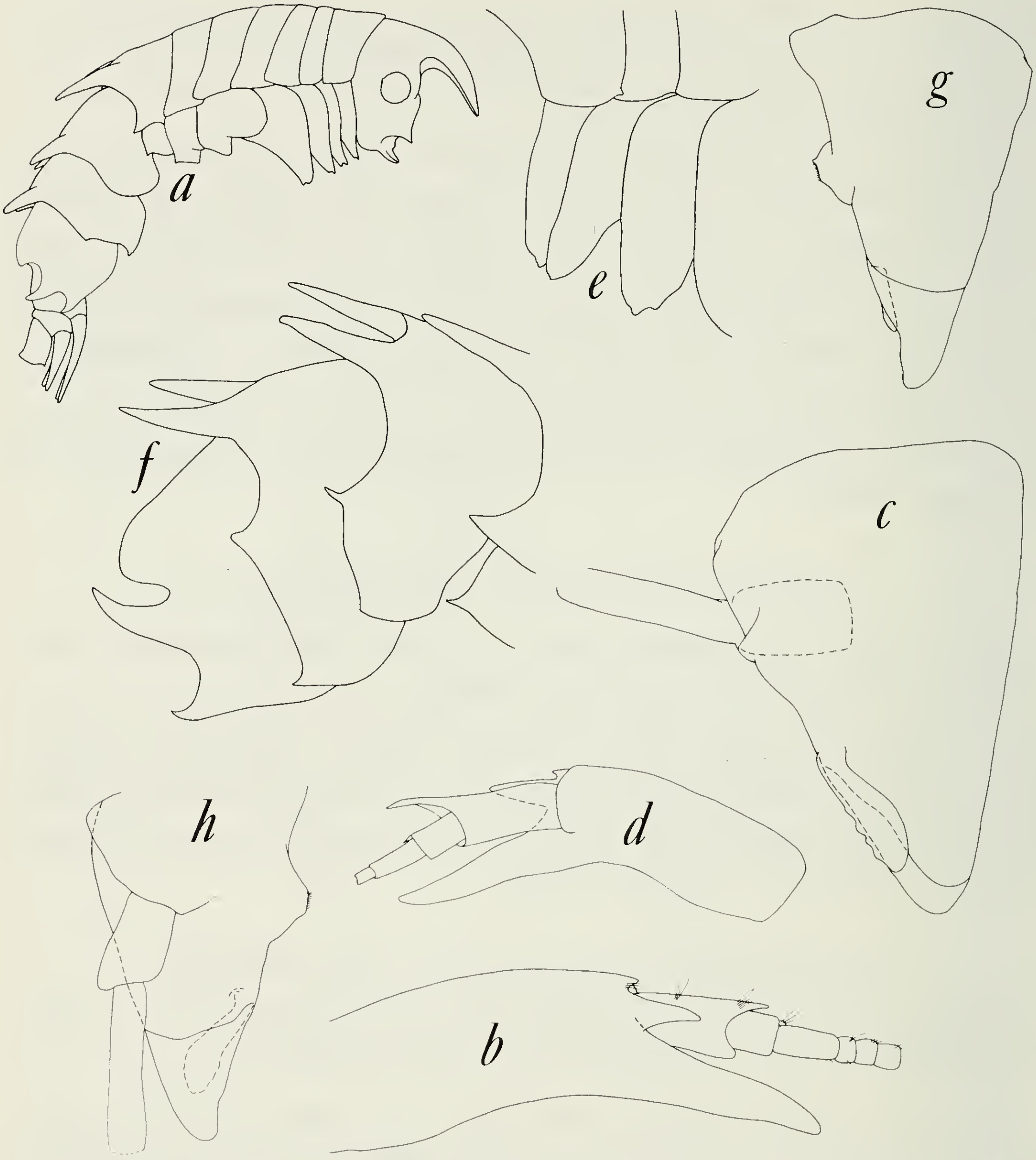

Fig. 7. *Gnathiphimedia sexdentata incerta* male. *Eltanin* Sta. 1003: a, Body side view; b, Antenna 1. Male *Eltanin* Sta. 418: c, Right mandible. Female *Eltanin* Sta. 1003: d, Antenna 1; e, Coxae 1–3; f, Pleosome. Juvenile *Eltanin* Sta. 1003: g, Left mandible; h, Right mandible.

Iphimedia Rathke

Iphimedia Rathke, 1843:85.
Panoploea Thomson, 1880:2.—Karaman and J. L. Barnard, 1979:110.
Cypsiphimedia K. H. Barnard, 1955:87.—Watling and Holman, 1980:615.

Type-species.—I. obesa Rathke, 1843.

Diagnosis.—Upper lip entire or slightly emarginate; maxilla 1 palp biar-

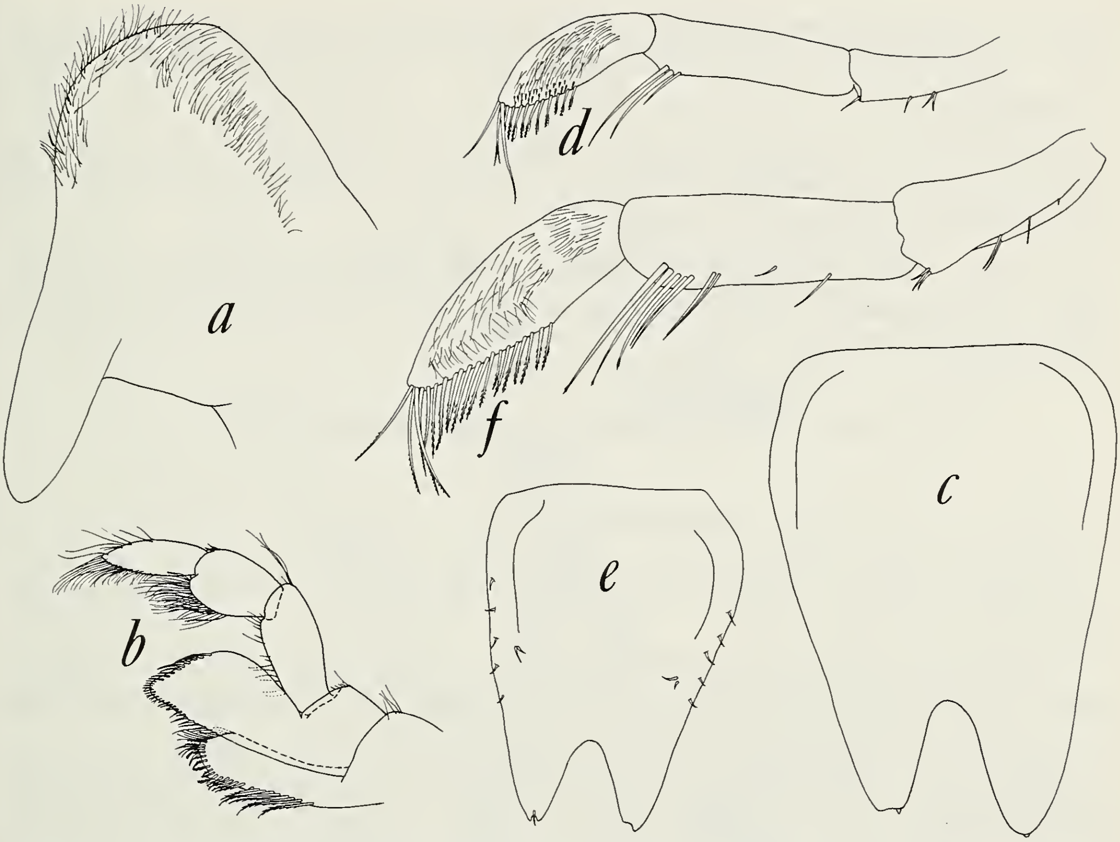

Fig. 8. *Gnathiphimedia sexdentata incerta* male. *Eltanin* Sta. 1003: a, Lower lip; b, Maxilliped; c, Telson. Male *Eltanin* Sta. 418: d, Mandible palp; e, Telson. Female *Eltanin* Sta. 1003: f, Mandible palp.

ticulate, of variable length; maxilliped palp exceeding outer plate, 3-articulate, article 2 produced medially along article 3; gnathopod 1 chelate; gnathopod 2 chelate or subchelate; telson variably emarginate or incised.

Remarks.—The above synonymy and current list of accepted species for this genus is discussed in detail in Watling and Holman (1980).

Iphimedia joubini (Chevreux 1912)

Panoploea joubini Chevreux, 1912:212; 1913:114, figs. 19–21.—Nicholls, 1938:64, fig. 33 (var. *bidentata*).—Bellan-Santini, 1972:175, pl. 5.

Material.—*Eltanin* Cruise 6, Sta. 418, 2 Jan. 1963, 62°39–40′S, 56°08–10′W, 311–426 m, 1 ♀; Cruise 12, Sta. 1003, 15 Mar. 1964, 64°41′S, 54°43′W, 210–220 m, 3 ♂♂, 1 juvenile. *Hero* Cruise 731, Sta. 1946, 11 Mar. 1973, 64°52–53′S, 62°52–53′W, 264–272 m, 1 juvenile. *Burton Island* Cruise 592, Sta. 5, 29 Jan. 1958, 66°32.9′S, 92°54′E, 1 juvenile.

Diagnosis.—Body with elongate, paired dorsal processes on pereonite 7 and pleonites 1 and 2, with mid-dorsal keel on pleonite 3 extended posteriorly as acute process; pereopod 7 basis posterior margin excavate distally, coxa 7 with single posterodistal tooth; coxa 5 posterior margin produced as strong point.

Distribution.—Around most of the Antarctic Continent, from Davis Sea to Adelie Coast, through western Antarctic to Palmer Archipelago and South Shetland Islands, 45–540 m.

Remarks.—The specimens examined fit the original description of Chevreux very well, and thus would be assigned to the subspecies *joubini* as diagnosed by Nicholls (1938).

Iphimedia multidentata (Schellenberg 1931)
Fig. 9

Panoploea multidentata Schellenberg, 1931:117, fig. 63.

Material.—*Hero* Cruise 715, Sta. 894, 2 Nov. 1971, 54°55′S, 64°18–20′W, 263–285 m, 1 ♂.

Diagnosis.—Body with paired dorsal processes on pereonite 7 and pleonites 1 and 2; pleonite 3 with dorsal keel; pereopod 7 basis with 4 large teeth on posterior margin; coxa 7 with 2 teeth on posterior margin.

Description.—The following supplements the description of Schellenberg (1931). Head, anteroventral corner an acute process. Antenna 1 peduncle article 1 with ventrodistal tooth extending to end of article 2; peduncle article 2 with distal tooth dorsally, extending to end of article 3. Mandible long and slender; incisor narrow, smooth; accessory plates on both mandibles, that on right mandible bidentate; palp article 3 half the length of article 2. Maxilla 1 palp biarticulate, shorter than outer plate, article 2 twice the length of article 1; inner plate not seen. Maxilliped palp 3-articulate, article 2 strongly produced medially along article 3, the latter blunt distally; outer and inner plates distally tapering. Gnathopod 1 chelate, dactyl tip overhanging end of propodus fixed finger, each with a long plumose seta; basis attached to coxa on inside of anterior margin and is directed forwards.

Distribution.—Falkland Islands and Magellanic area, 5–285 m.

Iphimediella Chevreux

Iphimediella Chevreux, 1911.
Pariphimediella Schellenberg, 1931 (part).—Watling and Holman, 1980.

Type-species.—*I. marguerítei* Chevreux, 1912.

Diagnosis (modified from J. L. Barnard, 1969).—Antenna 1 accessory flagellum uniarticulate; epistome not broad, less than 3 times as wide as high; upper lip entire or weakly incised; mandible incisor elongate, not excessively thickened or broadened, oriented to cut in transverse plane; lower lip without inner lobes, distal apices generally subacute; maxilla 1 palp bi-

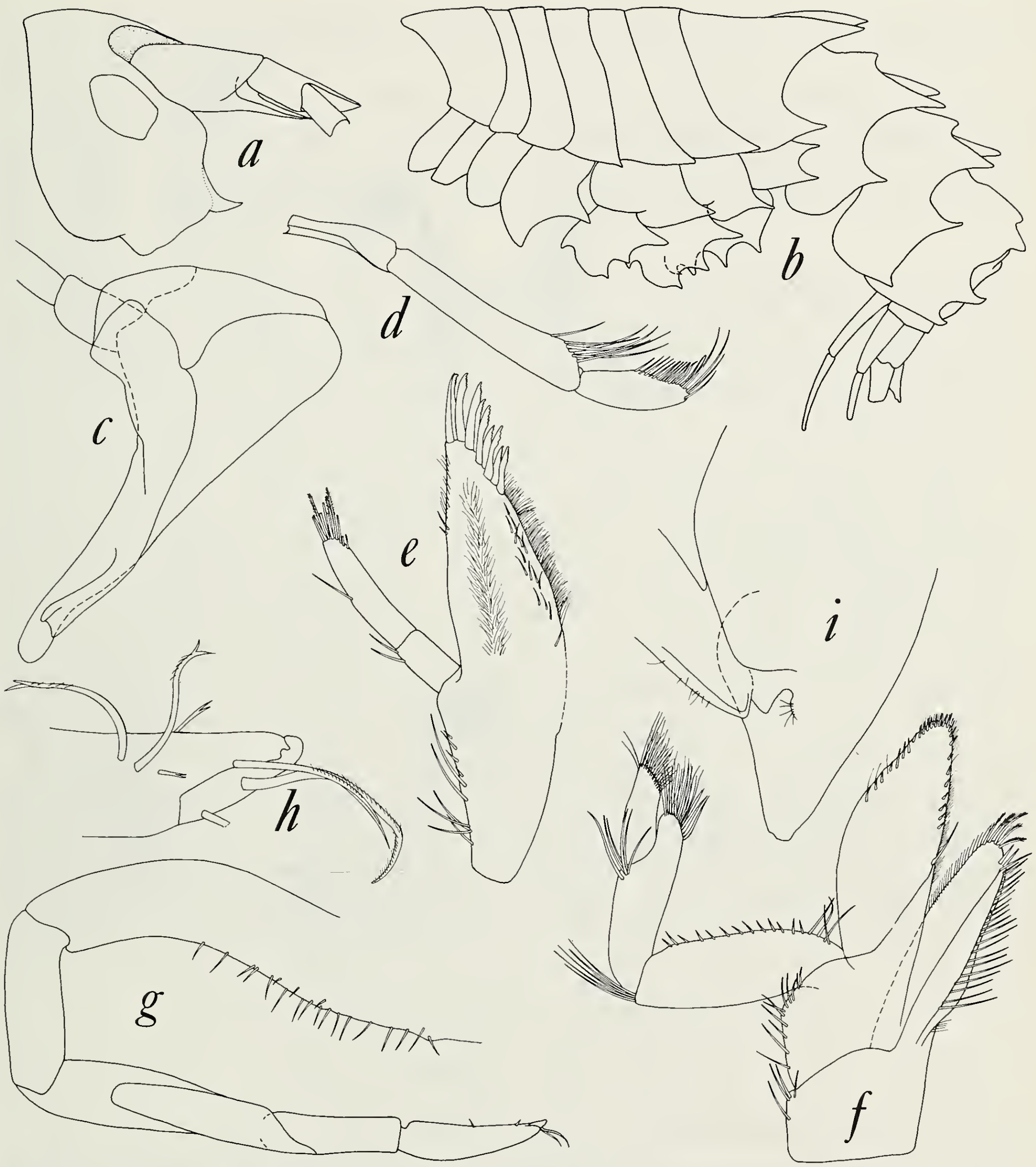

Fig. 9. *Iphimedia multidentata, Hero* Sta. 894: a, Head and antenna 1 peduncle; b, Body side view; c, Right mandible; d, Mandible palp; e, Maxilla 1. inner plate missing; f, Maxilliped; g, Gnathopod 1; h, Gnathopod 1 propodus and dactylus; i, Coxa 1 inside showing position of attachment to basis.

articulate, reaching end of outer plate; maxilliped palp 4-articulate, article 2 scarcely or not produced; gnathopods 1 and 2 chelate; telson slightly cleft.

Remarks.—The above synonymy, list of accepted species, and significance of mandible incisor orientation are discussed in detail in Watling and Holman (1980).

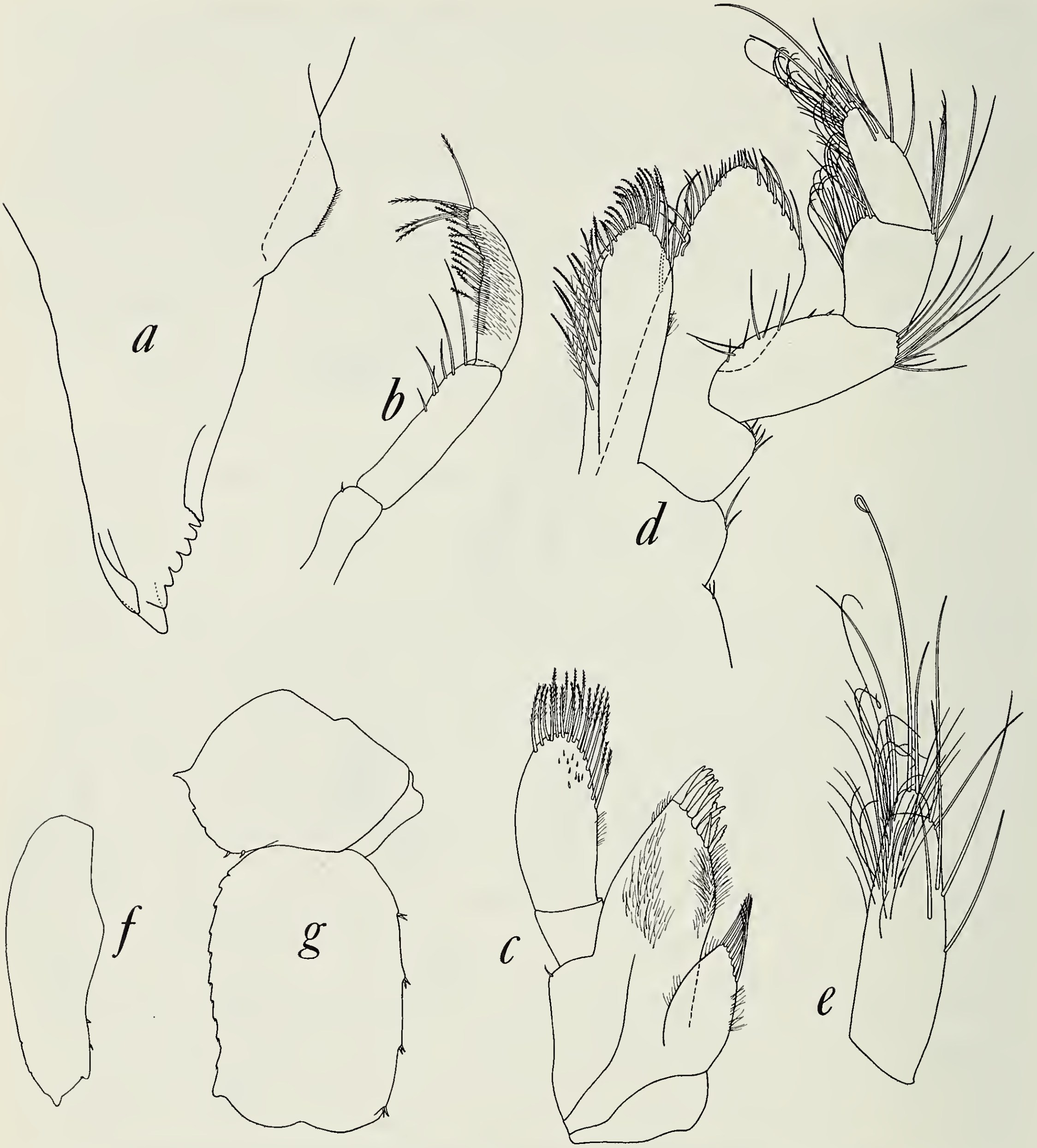

Fig. 10. *Iphimediella margueritei*, *Eltanin* Sta. 1003: a, Mandible; b, Mandible palp; c, Maxilla 1; d, Maxilliped; e, Maxilliped palp articles 3 and 4; f, Coxa 1; g, Pereopod 6 coxa and basis.

Iphimediella margueritei Chevreux 1912
Fig. 10

Iphimediella margueritei Chevreux, 1912:213.—Chevreux, 1913:120, figs. 22–24.—K. H. Barnard, 1930:348, fig. 22.
I. margueritei var. *acuta* Nicholls, 1938:69, fig. 36.

Material.—*Eltanin* Cruise 12, Sta. 1003, 15 Mar. 1964, 62°41′S, 54°43′W, 210–220 m, 2 ♂♂.

Diagnosis.—Body with paired, broad-based, smooth dorsal processes on pereonite 7 and pleonites 1–3; coxa 1 distally bidenticulate; antenna 1 peduncle article 1 ventrodistal tooth extending beyond peduncle article 3; head lateral margin with deep notch bounded above and below by acute processes.

Description.—The following supplements the description given by Chevreux (1913). Antenna 1 with minute accessory flagellum. Mandible incisor in smaller specimens multidenticulate. Maxilla 1 palp slightly longer than outer plate, article 2 broadened, armed with plumose setae along distal half of medial margin; outer plate distal margin tapering, armed with distal group of strong spines, proximal margin with fine setae; inner plate subovate, short, with few setae. Maxilliped palp article 4 small, partly covered by hood-like extension of article 3; palp article 1 longer than article 3, article 2 slightly broadened; outer plate distal margin armed with few widely spaced setae. Coxa 1 distally tapering, bidenticulate, teeth widely separated. Pereopods 6 and 7 coxae pointed posteriorly; bases posterior margin serrate.

Distribution.—Adelie Coast, Ross Sea, Antarctic Peninsula, Bransfield Strait, Shag Rocks, South Georgia, South Sandwich Islands, 10–720 m.

Remarks.—The specimens described here differ only slightly from the description given by Chevreux (1913). Some of these differences may be related to the size of the individual; however it appears that the mandible incisor becomes more robust and smooth as it wears. In both individuals examined, the newly formed incisor, which could be seen through the old exoskeleton, was finely dentate.

Iphimediella octodentata (Nicholls 1938)

Pariphimediella octodentata Nicholls, 1938:75, fig. 39.

Material.—*Aurora,* Sta. 2, 28 Dec. 1913, Commonwealth Bay, 527–550 m. (Holotype, Australian Museum #P18720.)

Diagnosis.—Body with paired dorsal processes on pereonites 6 and 7 and pleonites 1 and 2, pleonite 3 with single, strong dorsal process; paired processes noticeably serrate along upper margin.

Distribution.—Commonwealth Bay, 527–550 m.

Remarks.—Referring to *I. octodentata,* Nicholls (1938:75) stated "As seen in profile this is scarcely to be distinguished from *P. serrata* Schell. from which, however it differs in that the high median tooth on pleon 3 of the latter is replaced in this present species by a pair of dorsal spines." This statement was interpreted to mean that while *I. octodentata* carried paired dorsal processes on pleonite 3, Nicholls believed *I. serrata* carried only a single tooth. As will be pointed out below *I. serrata* does, in fact, have

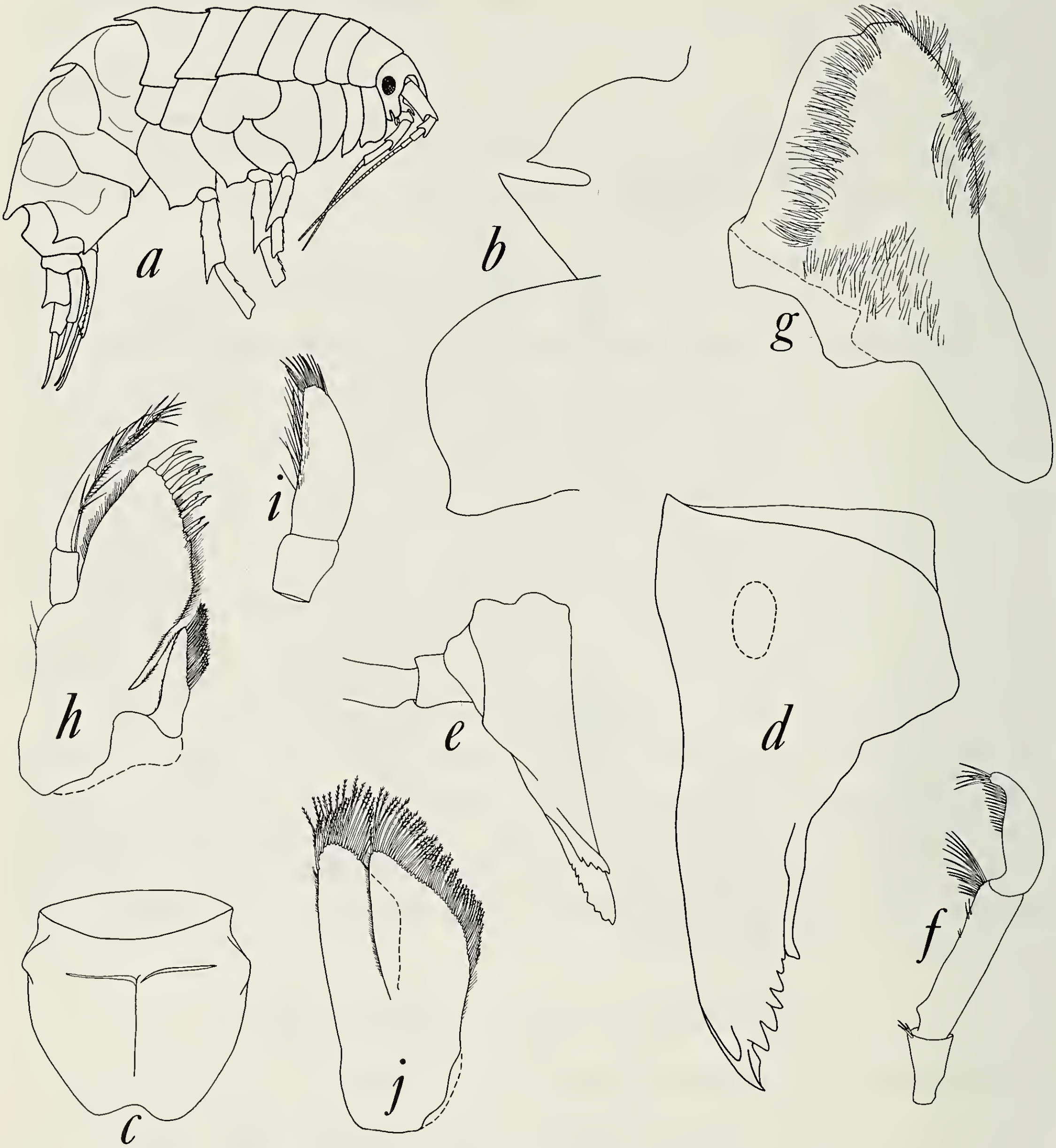

Fig. 11. *Iphimediella rigida*, *Eltanin* Sta. 1002: a, Body side view; b, Anteroventral corner of head and distal end coxa 1; c, Upper lip; d, Left mandible; e, Right mandible; f, Mandible palp; g, Lower lip; h, Maxilla 1; i, Maxilla 1 palp.

paired dorsal processes on pleonite 3, suggesting that *I. octodentata* and *I. serrata* may be synonymous. Examination of the holotype of *I. octodentata* showed that *I. octodentata* rather than *I. serrata* possessed the high median tooth and the two species are therefore quite distinct.

Iphimediella rigida K. H. Barnard 1930
Figs. 11, 12

Iphimediella rigida K. H. Barnard, 1930:351, fig. 25.

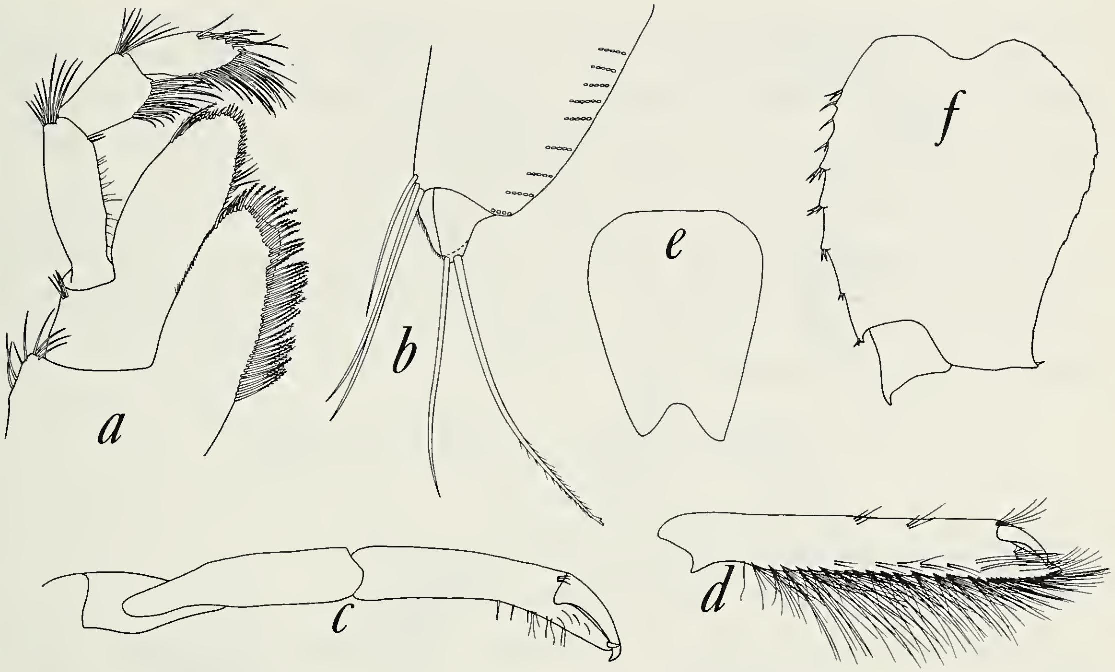

Fig. 12. *Iphimediella rigida, Eltanin* Sta. 1002: a, Maxilliped; b, Articles 3 and 4 of maxilliped palp; c, Distal end gnathopod 1; d, Distal end gnathopod 2; e, Telson; f, Basis pereopod 7.

Material.—Eltanin Cruise 12, Sta. 1002, 15 Mar. 1964, 64°40′S, 54°44–45′W, 265 m, 1 ♀. *Terra Nova* Sta. 339, McMurdo Sound, 256 m, 1 ♂ (BMNH Cat. No. 1930. 8.1. 188).

Diagnosis.—Body with paired, short, smooth dorsal processes on pereonite 7 and pleonites 1–3; coxa 1 anteroventral corner broadly rounded; antenna 1 peduncle article 1 medial ventrodistal tooth not extending beyond article 3; head lateral margin with narrow notch bounded below by acute process; maxilla 1 outer plate and maxilliped inner plate broadened.

Description.—The following supplements the short description given by K. H. Barnard (1930). Head lateral margin with narrow notch bounded above by a lobe bearing a short point, below by an acute process. Urosomite 1 with strong middorsal carina. Coxa 1 anteroventral corner rounded, ventral margin slightly excavate. Coxa 2 and 3 anterior margins rounded, tapering posterodistally to short points. Antenna 1 with minute accessory flagellum. Upper lip slightly excavate. Mandible distally tapering, incisor multidentate; molar conical without setae; accessory cutting plate multidentate on right side, with fewer teeth on left side. Lower lip slightly emarginate distally, inner lobes absent. Maxilla 1 palp article 2 with setae along three-fourths of inner margin; outer plate broad, rhomboidal; inner plate short, subtriangular. Maxilla 2 inner and outer plates broadened distally. Maxilliped palp article 4 minute, covered by hood-like extension of article 3; outer plate narrow, armed distally with short, plumose and non-plumose setae;

inner plate truncate distally, as broad as outer plate. Gnathopod 1 dactyl overhangs fixed finger of propodus, scarcely setose. Gnathopod 2 dactyl shorter than fixed finger of propodus, the latter elongate and heavily setose. Pereopod 7, basis posterior margin slightly serrate. Telson shallowly cleft.

Distribution.—McMurdo Sound, Bransfield Straits, 210–256 m.

Remarks.—This species is distinctive in the genus in its possession of a strongly tapering mandible, broadened maxillae and maxilliped, and carinae on pleonites 1–3 and urosomite 1. The ovigerous female obtained from the *Eltanin* material does not differ perceptibly from the male K. H. Barnard described from McMurdo Sound.

Iphimediella serrata (Schellenberg 1926)

Fig. 13

Iphimedia serrata Schellenberg, 1926:328, fig. 43.
Pariphimediella serrata.—Schellenberg, 1931:121.

Material.—*Eltanin* Cruise 6, Sta. 418, 2 Jan. 1963, 62°39–40′S, 56°08–10′W, 311–426 m, 1 juvenile.

Diagnosis.—Body with paired dorsally-serrate dorsal processes on pereonites 6 and 7 and pleonites 1–3; coxa 1 ventral margin serrate; head lateral margin with broad, shallow notch.

Description.—The following description supplements that given by Schellenberg (1926). Right mandible with multidenticulate accessory plate; molar small, conical. Lower lip distally narrow. Maxilla 1 palp article 2 with setae only on distal margin; outer plate distally tapering; inner plate short, acute, with few setae on medial margin. Maxilla 2 outer plate distal setae nearly as long as article. Maxilliped palp article 4 minute, covered by hood-like extension of article 3; palp articles 1–3 subequal in length. Gnathopod 1 dactyl and fixed finger of propodus armed with long setae bearing recurved setules. Gnathopod 2 fixed finger of propodus with row of minute setae.

Distribution.—Davis Sea (off Wilhelm II Coast), Bransfield Straits, 311–426 m.

Remarks.—Much of the distinctiveness in the mouthparts of this species is due to reduced or unusual setation. Since the mouthparts of an adult have not been examined, it is difficult to determine whether these differences are size-dependent. The form of the dorsal body processes distinguish *I. serrata* from all other *Iphimediella* species. Our finding of this species in the Bransfield Straits extends the known distribution of this species to the opposite side of Antarctica.

Maxilliphimedia K. H. Barnard

Maxilliphimedia K. H. Barnard, 1930:355.

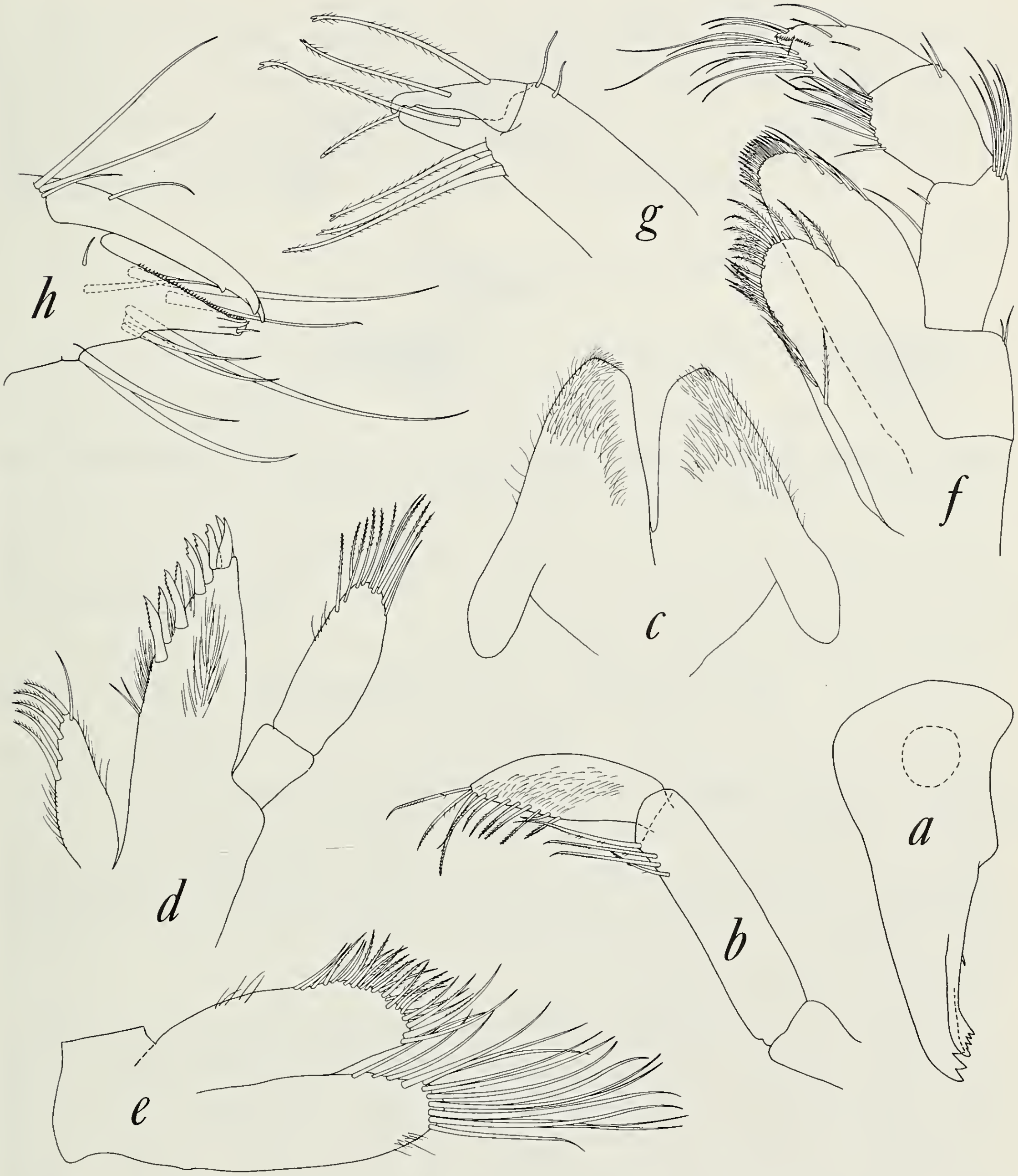

Fig. 13. *Iphimediella serrata, Eltanin* Sta. 418: a, Mandible; b, Mandible palp; c, Lower lip; d, Maxilla 1; e, Maxilla 2; f, Maxilliped; g, Gnathopod 1 tip; h, Gnathopod 2 tip.

Type-species.—Maxilliphimedia longipes (Walker 1906).

Diagnosis.—Epistome moderately broadened; upper lip broad, asymmetrically incised; mandible incisor broad but flattened, cutting edge multi-dentate, oriented to cut in frontal plane; lower lip without inner lobes; maxilla 1 palp biarticulate, article 2 greatly expanded; maxilla 2 inner and outer

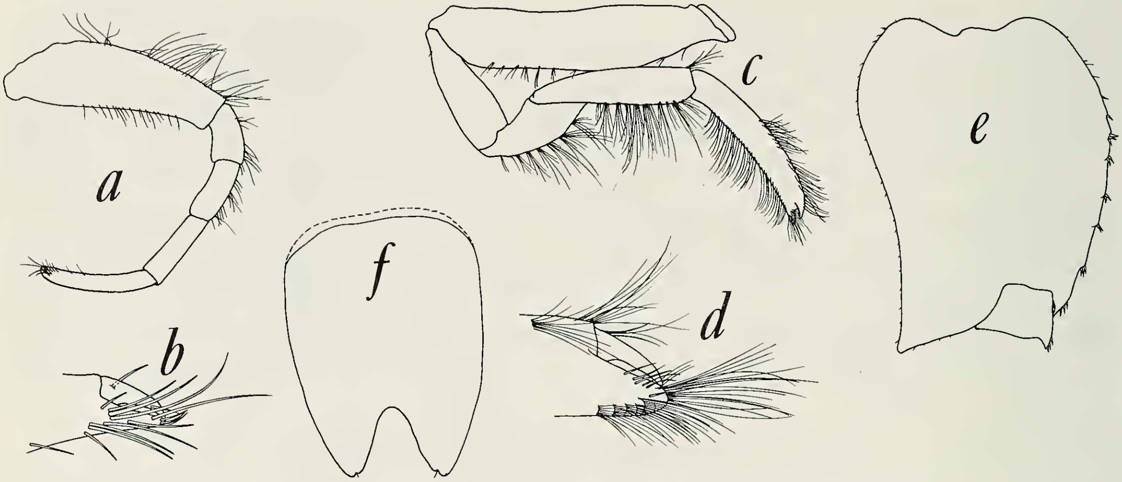

Fig. 14. *Maxilliphimedia longipes, Eltanin* Sta. 1002: a, Gnathopod 1; b, Gnathopod 1 tip; c, Gnathopod 2; d, Gnathopod 2 tip; e, Basis pereopod 7; f, Telson.

plates obovate; maxilliped palp 3-articulate, article 2 expanded but not produced along article 3; gnathopods chelate.

Maxilliphimedia longipes (Walker 1906)
Fig. 14

Iphimedia longipes Walker, 1906:151; 1907:29, pl. 9, fig. 17.
Maxilliphimedia longipes.—K. H. Barnard, 1930:355, fig. 28.

Material.—Eltanin Cruise 12, Sta. 997, 14 Mar. 1964, 61°44–46′S, 55°54–56′W, 769 m, 1 ♀ ovigerous; Cruise 12, Sta. 1002, 15 Mar. 1964, 62°40′S, 54°44–45′W, 265 m, 1 ♂, 1 ♀.

Diagnosis.—As for genus.

Description.—The following supplements the description of K. H. Barnard (1930). Gnathopod 1 chelate, basis with long setae along distal part of lateral margin; article 6 longer than 5; fixed finger of propodus with several hairs, partly covering dactyl. Gnathopod 2 chelate; article 6 longer than 5, both articles with dense covering of setae; fixed finger of propodus longer and thicker than dactyl, apically rounded. Pereopod 7 basis posterior margin slightly concave distally.

Distribution.—Ross Sea to Bransfield Strait, 100–769 m.

Remarks.—This record extends the known range of the species from the Ross Sea region to the tip of the Antarctic Peninsula.

Odius Lilljeborg

Otus Bate, 1862:125.
Odius Lilljeborg, 1865:19.—Stebbing, 1906:210.

Type-species.—*Otus carinatus* Bate, 1862 (original designation).

Diagnosis (emended from J. L. Barnard, 1969).—Upper lip narrow, incised; mandible with narrow, dentate apex, molar prominent; palp of maxilla 1 uniarticulate, of varying length; maxilliped palp 4-articulate, article 2 slightly expanded but not produced along article 3; gnathopod 1 slender, chelate; gnathopod 2 stout, subchelate; telson notched.

Odius antarcticus, new species
Figs. 15–17

Material.—*Eltanin* Cruise 12, Sta. 1003, 15 Mar. 1964, 62°41′S, 54°43′W, 210–220 m, 3 ovigerous ♀♀, 5 mm maximum size.

Diagnosis.—Pleonites 1–3 and urosomite 1 dorsally smooth, without upright teeth; pleonite 3 posterior margin slightly gibbous; pereopods 5–7 bases smoothly rounded behind without posterior teeth; eye small, not reniform; maxilla 1 palp uniarticulate, long, reaching end of outer plate; maxilliped palp 4-articulate, article 4 strongly reduced, only about $^1/_{10}$ length of article 3; telson visibly cleft.

Description.—Body smooth dorsally, pleonite 3 slightly gibbous. Rostrum well-developed, extending past antenna 1 peduncle article 1 distal margin. Coxa 1–3 longer than wide. Coxa 4 ventral margin straight. Eye small, not reniform. Antenna 1 shorter than antenna 2; lacking accessory flagellum. Upper lip longer than wide; distal margin asymmetrically incised. Mandible incisor multidentate; accessory plate present on left side; molar prominent, setose; strong spine row present between incisor and molar; on left mandible, spines closest to incisor widened distally and become multidentate, similar in shape to the accessory plate; palp 3-articulate, articles 2 and 3 subequal in length. Lower lip notched along midline; apices narrow, setose. Maxilla 1 with uniarticulate palp exceeding length of outer plate; outer plate carrying short, heavy spines distally, densely setose proximally; inner plate with 3 plumose setae distally. Maxilla 2 outer plate narrower than inner; setae on outer plate twice length of those on inner. Maxilliped palp 4-articulate, article 2 slightly expanded medially, article 4 small. Gnathopod 1 chelate, articles 5 and 6 subequal. Gnathopod 2 strongly subchelate, palm border serrate. Pereopods 5–7 similar, posterior margin bases smooth, pereopod 7 basis slightly more elongate. All uropods biramous; uropod 1 inner and outer rami subequal; uropod 2 inner ramus longer and wider than outer; uropod 3 inner ramus approximately 1.5 × length of outer; telson longer than wide, cleft ⅓.

Distribution.—Known only from type-locality.

Remarks.—Three other species are included within the genus *Odius*: *O. carinatus* Bate 1852; *O. kelleri* Brüggen, 1907; *O. cassigerus* Gurjanova, 1972. All 3 of the above species have a minute uniarticulate palp on maxilla

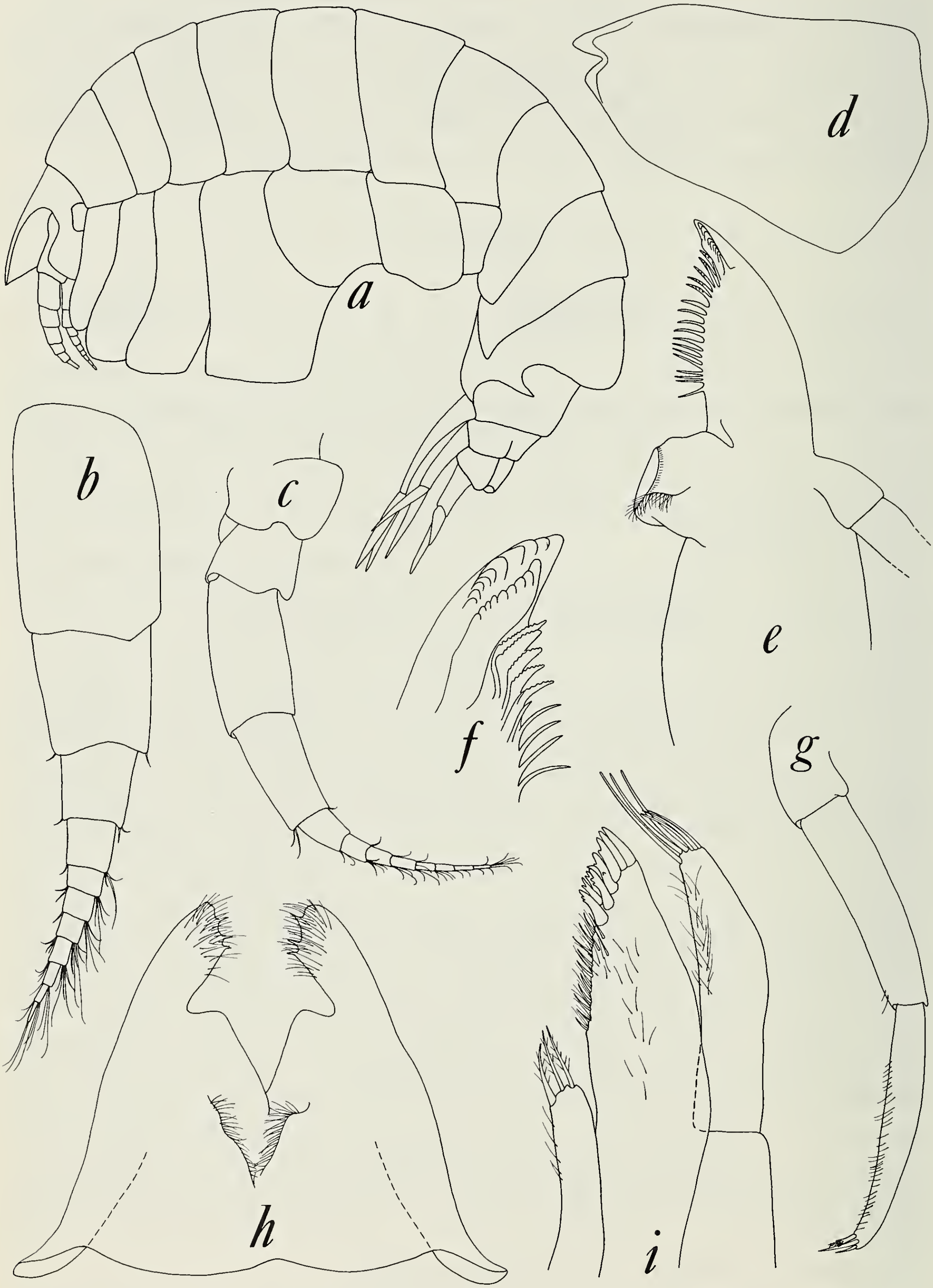

Fig. 15. *Odius antarcticus*, *Eltanin* Sta. 1003: a, Body side view; b, Antenna 1; c, Antenna 2; d, Upper lip; e, Mandible; f, Mandible incisor and spine row; g, Mandible palp; h, Lower lip; i, Maxilla 1.

Fig. 16. *Odius antarcticus, Eltanin* Sta. 1003: a, Maxilla 2; b, Maxilliped; c, Gnathopod 1; d, Gnathopod 1 tip; e, Gnathopod 2; f, Pereopod 5; g, Pereopod 6.

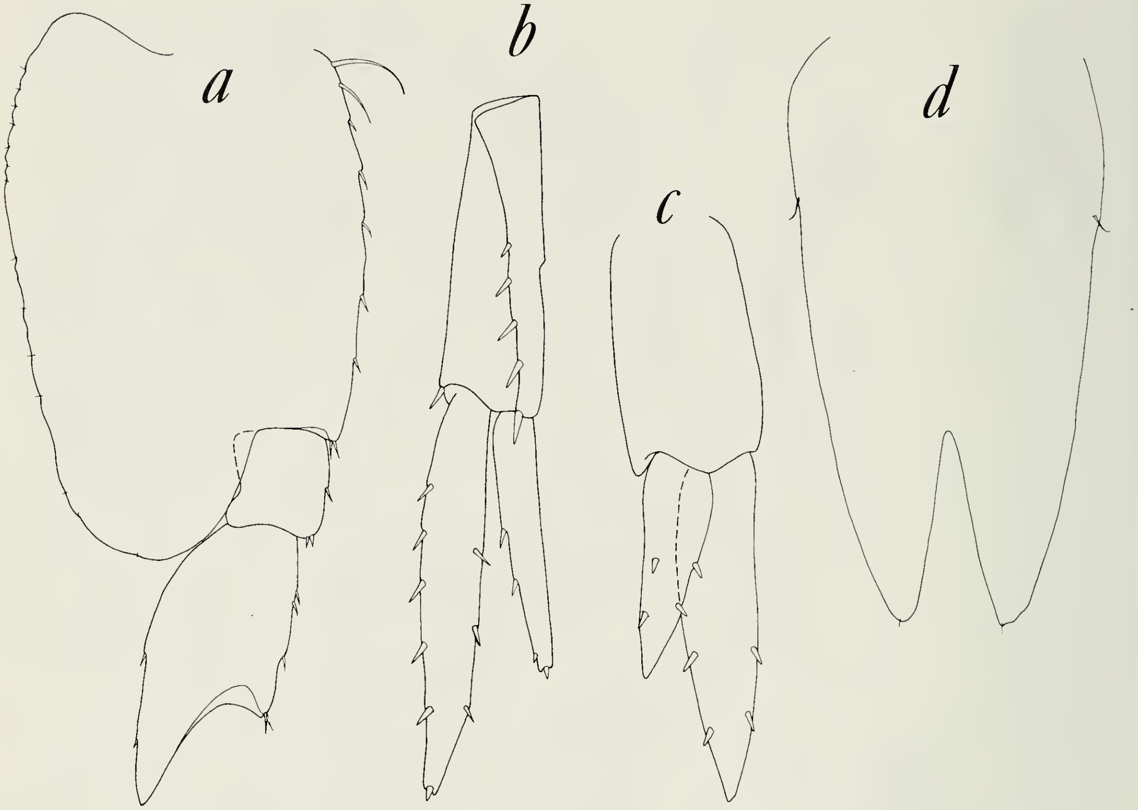

Fig. 17. *Odius antarcticus, Eltanin* Sta. 1003: a, Pereopod 7 articles 2–4; b, Uropod 2; c, Uropod 3; d, Telson.

1 whereas the palp is quite large for the new species described here. Similarities in basic body shape and in most other mouthparts, especially the mandibles, serve as unifying features, however, and the difference in palp length was not considered to be outside the scope of the genus. *O. antarcticus* is also distinctive from all other species of *Odius* heretofore described by its smooth body profile, small fourth article on the maxilliped palp, smooth bases of the pereopods, and the degree to which the telson is cleft.

Etymology.—This is the first known species of *Odius* to be described from the Antarctic.

Holotype.—USNM 181323; 2 ♀ paratypes USNM 181324.

Parapanoploea Nicholls

Parapanoploea Nicholls, 1938:65.

Type-species.—*Parapanoploea oxygnathia* Nicholls, 1938, p. 66.

Diagnosis (modified from J. L. Barnard, 1969).—Upper lip broad, faintly emarginate; mandible incisor narrow, elongate; lower lip lobes not incised; maxilla 1 palp biarticulate, reaching end of outer plate; maxilliped palp

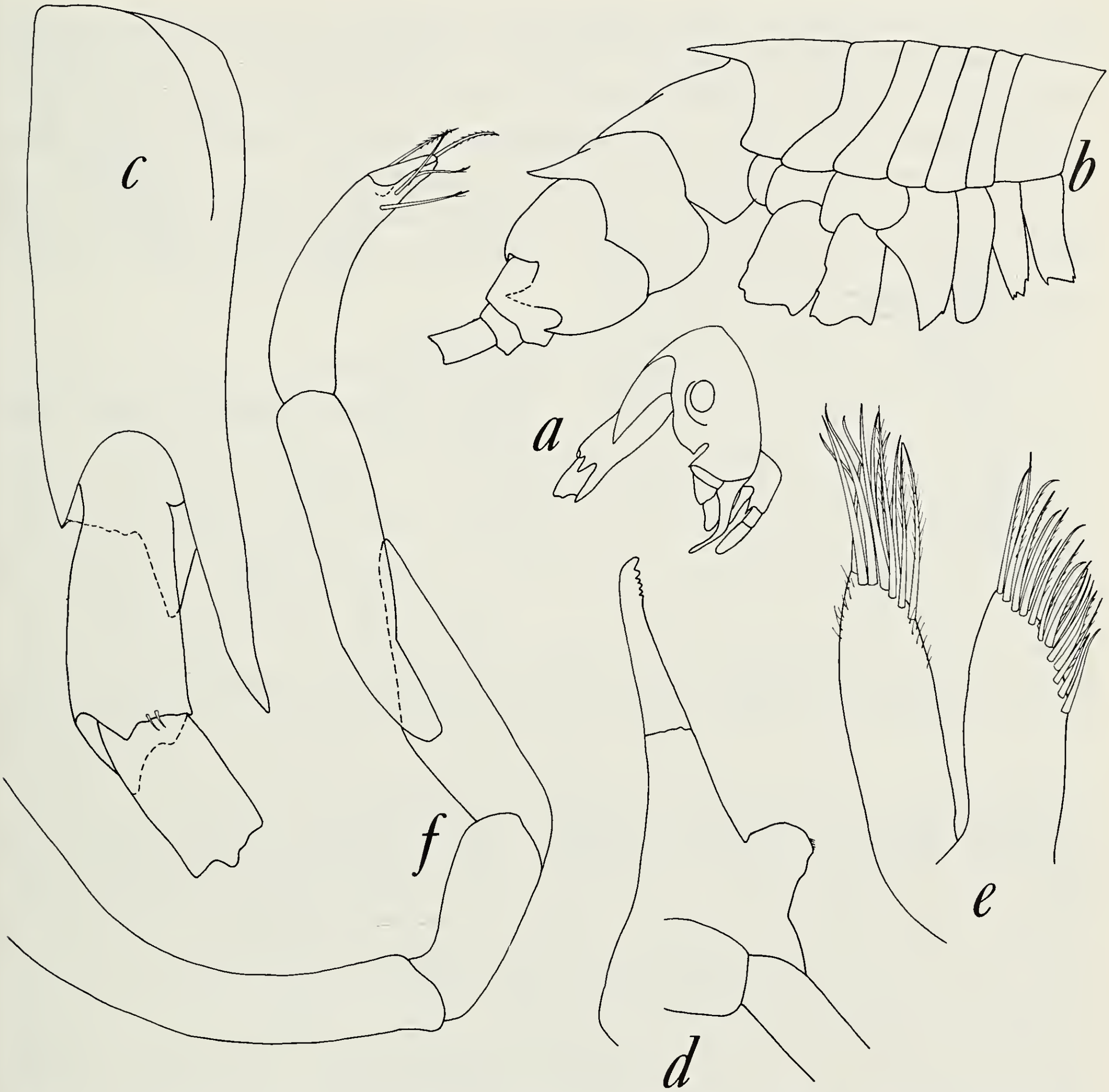

Fig. 18. *Parapanoploea oxygnathia*, *Eltanin* Sta. 5769: a, Head; b, Body side view; c, Antenna 1 peduncle; d, Mandible; e, Maxilla 2; f, Gnathopod 1.

4-articulate, article 2 slightly expanded but not produced along article 3; gnathopods 1 and 2 chelate; telson notched.

Parapanoploea oxygnathia Nicholls 1938
Fig. 18

Parapanoploea oxygnathia Nicholls, 1938:66, figs. 34, 35.

Material.—*Eltanin* Cruise 51, Sta. 5769, 9 Feb. 1972, 77°09.1′S, 158°59.6′–159°00.2′W, 344–357 m, 1 juvenile.

Diagnosis.—Rostrum one-half of antenna 1 peduncle article 1;

distal tooth on antenna 1 peduncle article 1 extends at least to distal margin of peduncle article 2; gnathopod 1 article 6 $^4/_5$ the length of article 5; dorsal processes on pereonite 7 and pleonites 1 and 2 directed posteriorly.

Description.—The following supplements the description of Nicholls (1938). Body with paired dorsal processes, separated by wide U-shaped gap, on pereonite 7 and pleonites 1 and 2; processes on pleonite 1 parallel with dorsal margin of pleonite. Antenna 1 peduncle article 1 distal tooth extends to distal margin peduncle article 2.

Distribution.—Davis Sea and Ross Sea, 216–357 m.

Remarks.—Since the specimen at hand is a juvenile, it is with some hesitation that we have assigned it to *P. oxygnathia.* While it agrees with Nicholls' (1938) description in terms of the distal tooth on antenna 1 peduncle article 1, and the length of gnathopod 1 article 6, it otherwise was very similar to *P. longirostris* Bellan-Santini (1972), who differentiated the 2 species using the following characters: (1) lateral margin of the head at the level of the eye is sinuous in *P. longirostris,* simply rounded in *P. oxygnathia*; (2) mandible incisor possesses 8 teeth in *P. longirostris,* 6 in *P. oxygnathia*; (3) rostrum extends $^4/_5$ the length of antenna 1 peduncle article 1 in *P. longirostris,* versus one-half in *P. oxygnathia*; (4) gnathopod 1 merus/carpus ratio is opposite in the 2 species; (5) uropod 3 rami equal in *P. longirostris,* unequal in *P. oxygnathia.* Characters (1), (2), (3), and (4) are slight differences which eventually may be found to be gradational (to date, only 2 specimens of *P. oxygnathia* and 1 of *P. longirostris* are known). Nicholls' illustration of uropod 3 suggests that the inequality of the rami is due to the outer ramus being broken. Our specimen was missing both rami of uropod 3 so this could not be checked. Thus, it appears for the present that the real differences between these 2 species are: (1) the presence of the long distal tooth on antenna 1 peduncle article 1 in *P. oxygnathia*; and (2) the backwardly-directed paired dorsal processes on pleonites 1 and 2 in *P. oxygnathia* versus the upwardly-directed paired dorsal processes on pleonites 1 and 2 in *P. longirostris.* Bellan-Santini does not figure the paired dorsal processes on pereonite 7 in *P. longirostris,* therefore no comparison of this feature can be made with *P. oxygnathia.*

Paramphithoidae

Epimeria Costa

Epimeria Costa in Hope, 1851:46.
Pseudepimeria Chevreux, 1911:1167.
Subepimeria Bellan-Santini, 1972:225.—Watling and Holman, 1980.

Type-species.—*Gammarus corniger* J. C. Fabricius, 1779.

Diagnosis (emended from J. L. Barnard, 1969).—Rudimentary accessory flagellum; mandible molar large, ridged; lower lip lacking inner lobes; max-

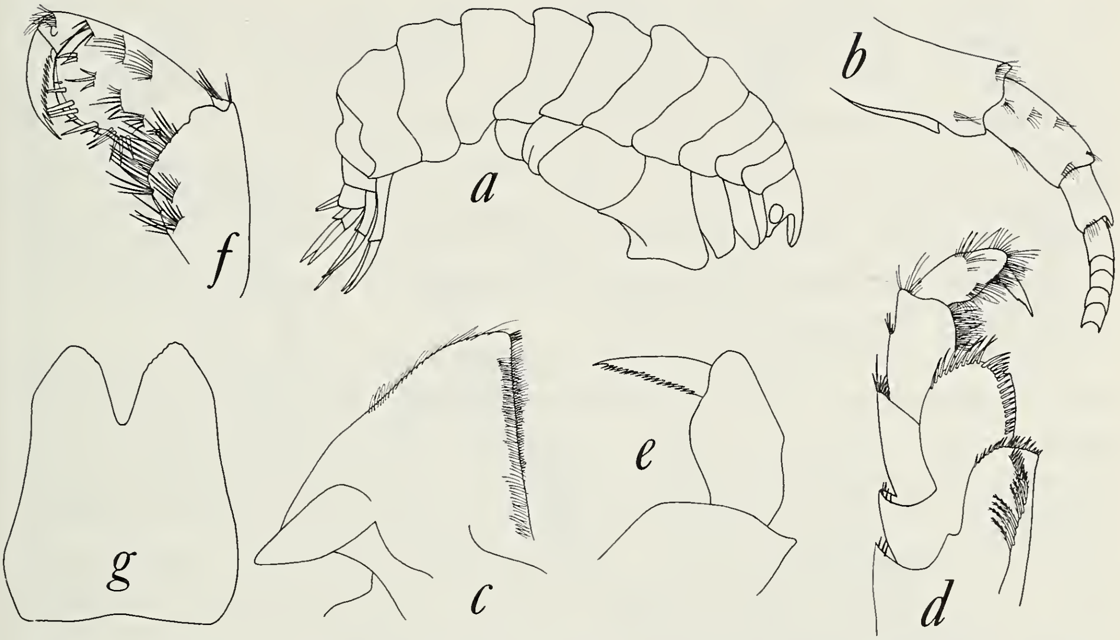

Fig. 19. *Epimeria georgiana, Eltanin* Sta. 1003: a, Body side view; b, Antenna 1; c, Lower lip; d, Maxilliped; e, Maxilliped articles 3 and 4 with setae omitted; f, Gnathopod 1 articles 6, 7; g, Telson.

illiped palp 4-articulate; gnathopods simple to subchelate, dactyls often spinose, much shorter than propodus; coxae 4–5 together forming a more or less crescentic curve below.

Epimeria georgiana Schellenberg 1931
Fig. 19

Epimeria georgiana Schellenberg, 1931:160.
Epimeria excisipes K. H. Barnard, 1932:174, figs. 104e, 106, 107 (new synonymy).

Material.—*Eltanin* Cruise 6, Sta. 410, 31 Dec. 1962, 61°18–20′S, 56°09–10′W, 220–240 m, 1 ♀; Cruise 12, Sta. 1002, 15 Mar. 1964, 62°40′S, 54°44–45′W, 265 m, 9 ♀♀ (6 with eggs, 1 with young), 1 ♂; Cruise 12, Sta. 1003, 15 Mar. 1964, 62°41′S, 54°43′W, 210–220 m, 1 ♀ with eggs; *Discovery* Sta. 42, 1 Apr. 1926, 120–204 m (Br. Mus. #1936. 11.2. 1551–1580); Cumberland Bay, South Georgia (54°11′S, 36°18′W), 5 June 1902, 252–310 m, (Naturhistoriska Riksmuseet Type No. 673).

Diagnosis.—Body with dorsal carinae on at least pereonites 4–7 and pleonites 1–3; coxa 4 anteroventral margin slightly concave, not acutely pointed ventrally; coxa 5 not produced posteriorly; pereopods 5–7 bases, hind margins with distal notch.

Description.—The following supplements the description of Schellenberg (1931) and K. H. Barnard (1932). Antenna 1 with minute accessory flagellum; peduncle article 2 twice as long as wide. Lower lip apex subacute; medial margin with dense cover of setae. Maxilliped palp article 2 longer than articles 1 and 3, article 4 with many closely-spaced short spines on inner margin. Gnathopod 1 subchelate; article 6 three-fourths as wide as long, subequal to article 5; palm circular, finely serrate; dactyl inner margin with many closely-spaced spines. Third epimeral plate posterodistal margin with acute tooth, without accessory tooth. Telson cleft nearly one-third.

Distribution.—Palmer Archipelago, Bransfield Strait, South Shetland Islands, South Georgia, 75–391 m.

Remarks.—K. H. Barnard (1932) suggested that *E. excisipes* was probably a synonym of *E. georgiana* Schellenberg (1931). We examined the types of both species and agree with K. H. Barnard's suggestion. J. L. Barnard (1961) separated the 2 in his key to the species of *Epimeria* by the presence of an accessory tooth above the lower posterior corner of epimeron 3 in *E. excisipes*. McCain (1971) suggested that coxa 4 was "broadly quadrate" in *E. excisipes* and "narrowly truncate" in *E. georgiana*. Neither of the type specimens had an accessory tooth on epimeron 3, and their fourth coxae could both be described as broadly quadrate.

Epimeria macrodonta Walker 1906

Fig. 20

Epimeria macrodonta Walker, 1906:16.—Walker, 1907:24, pl. 8, fig. 14.
Epimeria similis Chevreux, 1912:215; 1913:149, figs. 41–43.
Epimeria macrodonta forma *macrodonta* K. H. Barnard, 1930:372; 1932:172, fig. 105.
Epimeria macrodonta forma *similis* K. H. Barnard, 1930:372; 1932:172.

Material.—*Eltanin* Cruise 6, Sta. 410, 31 Dec. 1962, 61°18–20′S, 56°09–10′W, 220–240 m, 1 ♂ (f. *similis*); Cruise 12, Sta. 1002, 15 Mar. 1964, 62°40′S, 54°44–45′W, 265 m, 3 ♀♀ (f. *similis*); Cruise 12, Sta. 1003, 15 Mar. 1964, 62°41′S, 54°43′W, 210–220 m, 4 ♀♀ (3 ovigerous), 3 juveniles, 2 ♂♂ (f. *similis*). *Hero* Cruise 731, Sta. 1946, 11 Mar. 1973, 64°53′S, 62°53′W, 264–272 m, 1 ♀ (f. *macrodonta*).

Diagnosis.—Body with dorsal carinae on pleonites 1–3 and most pereonites, but never on pereonite 2; urosomite 1 with mid-dorsal upright tooth; coxa 5 acutely produced posteriorly; pereopods 5 and 6 bases posterior margin without notch, posterodistal corners acutely produced, anterior and posterior margins parallel.

Description.—The following supplements the description of Walker (1907) and Chevreux (1913). Antenna 1 with minute accessory flagellum. Upper lip asymmetrically incised. Mandible palp article 3 slightly longer than article 2, with proximal seta group on dorsal margin. Lower lip apex blunt, with tuft of stiff setae on medial margin at apex. Maxilla 1 palp with stout setae

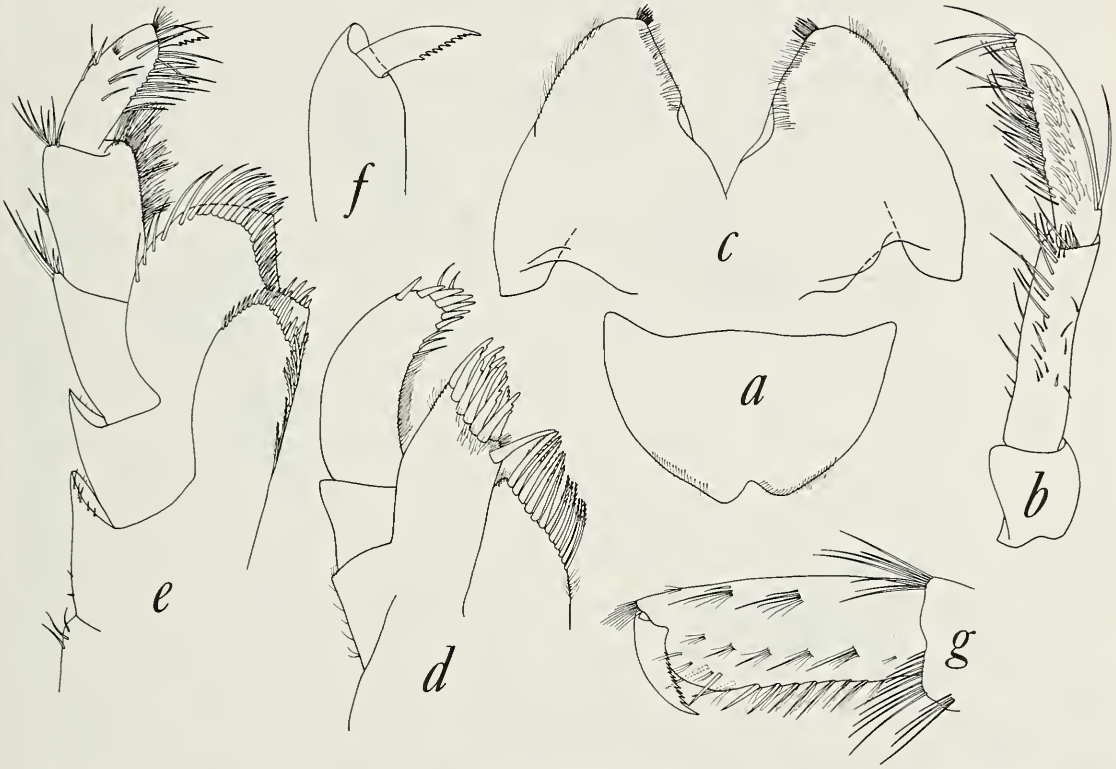

Fig. 20. *Epimeria macrodonta*, *Eltanin* Sta. 1002: a, Upper lip; b, Mandible palp; c, Lower lip; d, Maxilla 1; e, Maxilliped; f, Maxilliped articles 3 and 4 with setae omitted; g, Gnathopod 1.

at tip, grading into fine setae proximally along medial margin; inner plate broader than outer with setae long and thick distally, shorter, thinner and more plumose proximally. Maxilliped palp articles 1–3 subequal in length; article 4 covered proximally by slight extension of third article, with several short spines on medial margin. Gnathopod 1 subchelate; palm narrowly rounded, finely serrate; dactyl with many short, closely-spaced spines on inner margin; propodus linear.

Distribution.—Circum-Antarctic, 30–900 m.

Remarks.—The specimen from Station 410 is similar to the other specimens of *E. macrodonta* f. *similis* except that it does not possess a carina on pereonite 1 and its antenna 1 peduncle article 2 possesses a mid-ventral tooth on the distal margin. This form is presently regarded as being aberrant and not deserving of separate subspecies status.

Epimeria puncticulata Barnard 1930
Fig. 21

Epimeria puncticulata K. H. Barnard, 1930:376, fig. 42; 1932:175, fig. 104d.
Subepimeria geodesiae Bellan-Santini, 1972:225, figs. 33, 34 (new synonymy).

Fig. 21. *Epimeria puncticulata, Eltanin* Sta. 1003: a, Pleonites 1–3 dorsal view; b, Antenna 1; c, Mandible palp; d, Lower lip; e, Maxilla 1; f, Maxilliped; g, Maxilliped articles 3 and 4 with setae omitted; h, Gnathopod 1; i, Pereopod 5; j, Pereopod 6; k, Pereopod 7.

Material.—Eltanin Cruise 12, Sta. 1003, 15 Mar. 1964, 62°41′S, 54°43′W, 210–220 m, 1 ♀ with eggs; Cruise 32, Sta. 1995, 10 Jan. 1968, 72°04′S, 172°38′E, 360–342 m, 1 juvenile. *Discovery* 1936.11.2, 1581–1590 m, (British Museum), South Georgia, 2 ♀♀.

Diagnosis.—Body without dorsal carinae on pereonites, carinae present on pleonites 1–3; coxa 5 not produced posteriorly; pereopod 5 basis posterodistal corner subacutely produced, hind margin without notch.

Description.—The following supplements the description of Barnard (1930). Carinae on pleonites 1–3 forming a distinct keel, the second strongly pointed posteriorly. Antenna 1 with minute, uniarticulate accessory flagellum; peduncle article 2 as wide as long. Lower lip apically subacute, with strong group of stiff setae on apex medial margin. Mandible palp article 3 as long as article 2, armed along entire ventral margin with setae, last 3 setae double the length of others. Maxilla 1 palp biarticulate, armed with distal group of stout setae; inner plate apical setae stout, plumose. Maxilliped palp 4-articulate, articles 1–3 subequal in length; article 4 with few spines along medial margin. Gnathopod 1 subchelate; articles 5 and 6 elongate, slightly longer than article 6; dactyl with 6 spines on inner margin; palm excavate near base of dactyl, proximal margin finely serrate. Pereopod 5 basis posterior margin excavate, posterodistal corner subacute. Pereopod 6 basis posterodistal corner rounded. Pereopod 7 basis broader than in pereopods 5 and 6, hind margin convex. Telson cleft one-fourth.

Distribution.—Ross Sea, Antarctic Peninsula, South Georgia, 60–270 m.

Remarks.—Our specimen from *Eltanin* Sta. 1003 differed from the *Discovery* material examined in lacking a small mid-dorsal tooth on the posterior margin of pereonite 7; however, in all other respects they were indistinguishable. Of the species in this genus which lack dorsal carinae on the pereonites, the following 4 species form a group characterized by distally broad 4th coxae and posterodistally blunt 5th coxae: *E. geodesiae* (Bellan-Santini), *E. monodon* Stephenson, *E. puncticulata* K. H. Barnard and *E. robusta* K. H. Barnard. The posteriorly notched bases on pereopods 5 and 6 readily separate *E. robusta* from this group. Pereopods 6 and 7 bases are both posteriorly expanded in *E. monodon* whereas, in *E. geodesiae* and *E. puncticulata,* only the basis of pereopod 7 is posteriorly expanded. We have elected to synonymize *E. geodesiae* with *E. puncticulata* since the 2 differ only in the presence or relative strength of a mid-dorsal carina on pleonite 1. We have seen some variability in this character as noted above, and as well, K. H. Barnard (1916) found that for large specimens of *E. semiarmata,* such carinae could become obsolete.

Metepimeria Schellenberg

Metepimeria Schellenberg, 1931:162.

Type-species.—*Metepimeria acanthurus* Schellenberg, 1931.

Diagnosis (emended from J. L. Barnard, 1969).—Antenna 1 with accessory flagellum; mandibular molar large, ridged; lower lip without inner lobes; maxilliped palp 3-articulate; gnathopods simple.

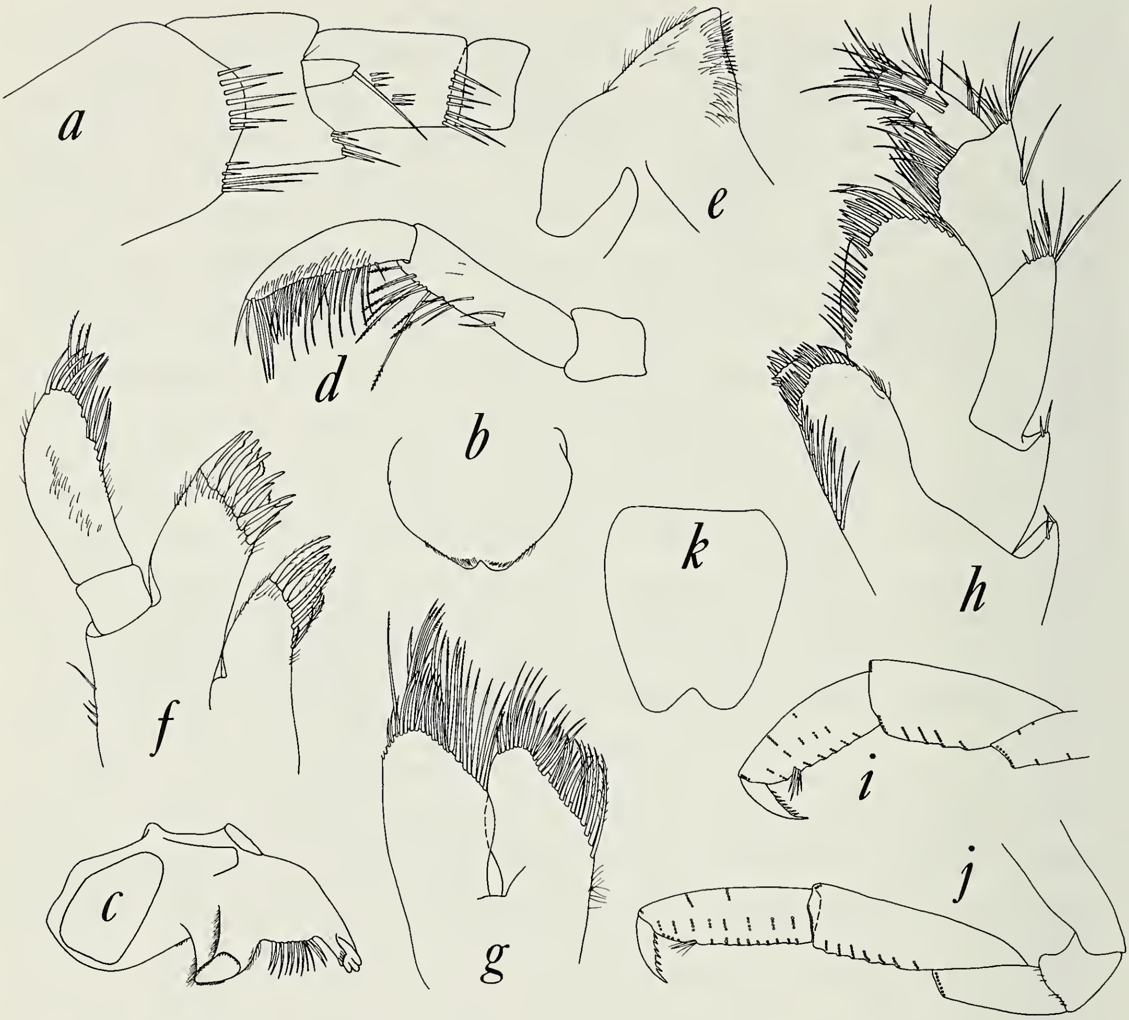

Fig. 22. *Metepimeria acanthurus*, *Hero* Sta. 894: a, Antenna 1; b, Upper lip; c, Mandible; d, Mandible palp; e, Lower lip; f, Maxilla 1; g, Maxilla 2; h, Maxilliped; i, Gnathopod 1 (setae omitted); j, Gnathopod 2 (setae omitted); k, Telson.

Metepimeria acanthurus Schellenberg 1931
Fig. 22

Metepimeria acanthurus Schellenberg, 1931:162, fig. 85, pl. 1, fig. G.
Epimeria acanthurus.—K. H. Barnard, 1932:176, figs. 104B, 108; pl. 1, fig. 2.

Material.—*Eltanin* Cruise 9, Sta. 740, 18 Sept. 1963, 56°06–07′S, 66°19–30′W, 384–494 m, 1 ♀. *Hero* Cruise 715, Sta. 894, 2 Nov. 1971, 54°54.8–55′S, 64°18–20′W, 263–285 m, 1 ♀, 9 ♂♂. *William Scoresby* Sta. 86, 3 Mar. 1927, 53°53′S, 60°34′W, 151–147 m, 1 ♀ ovigerous.

Diagnosis.—As given for genus.

Description.—The following supplements the description of Schellenberg

(1931) and K. H. Barnard (1932). Antenna 1 with minute accessory flagellum, bearing single terminal seta. Upper lip shallowly notched. Mandible incisor multidenticulate, left lacinia mobilis with 6 teeth; molar large, triturative, with lateral and anterior setose ridges; palp articles 2 and 3 subequal in length; palp article 3 with heavy cover of long setae on ventral margin, article 2 with several setae on distal half of ventral margin. Lower lip without inner lobes; medial margin near distal apex with group of short, blunt, stiff setae. Maxilla 1 palp article 2 with setae along distal half of medial margin; inner plate with long, thick, sparsely plumose setae. Maxilla 2 inner and outer plates broadened distally. Maxilliped palp 3-articulate, palp article 2 slightly longer than article 3; palp article 3 with dense apical tuft of setae arranged in 3 whorls; outer plate extends halfway along palp article 2. Gnathopod 1 simple, articles 5 and 6 subequal in length, article 5 wider than article 6; dactyl armed with series of short, stiff spines along inner margin. Gnathopod 2 simple, articles 5 and 6 longer than in gnathopod 1, subequal in length and width; dactyl armed with series of stout, stiff spines. Telson shallowly cleft.

Distribution.—Magellanic area, Falkland Islands, 151–194 m.

Remarks.—This species is very similar to the species in the genus *Epimeria,* especially in the form of the mandible, lower lip and maxillae. The absence of a fourth article on the maxilliped palp combined with the simple gnathopods does not allow its inclusion in the genus *Epimeria* despite its superficial resemblance to *E. puncticulata* (as noted by K. H. Barnard, 1932).

Uschakoviella Gurjanova

Uschakoviella Gurjanova, 1955:199.

Type-species—*U. echinophora* Gurjanova, 1955.

Diagnosis (as modified from J. L. Barnard, 1969).—Body covered with articulated spines; accessory flagellum minute; lower lip lacking inner lobes; mandible molar large, ridged; maxilliped palp 4-articulate; gnathopods scarcely subchelate but palms transverse; telson cleft.

Uschakoviella echinophora Gurjanova 1955

Fig. 23

Uschakoviella echinophora Gurjanova, 1955:200, figs. 14, 15.
U. e. echinophora Gurjanova, 1955:203.
U. e. abyssalis Gurjanova, 1955:203, figs. 16–18.
U. echinophora.—Shoemaker, 1964:417, fig. 12.

Material.—*Islas Orcadas* Cruise 19, Sta. 14, 18 Mar. 1979, 59°48′S, 45°06′W, 1 juvenile.

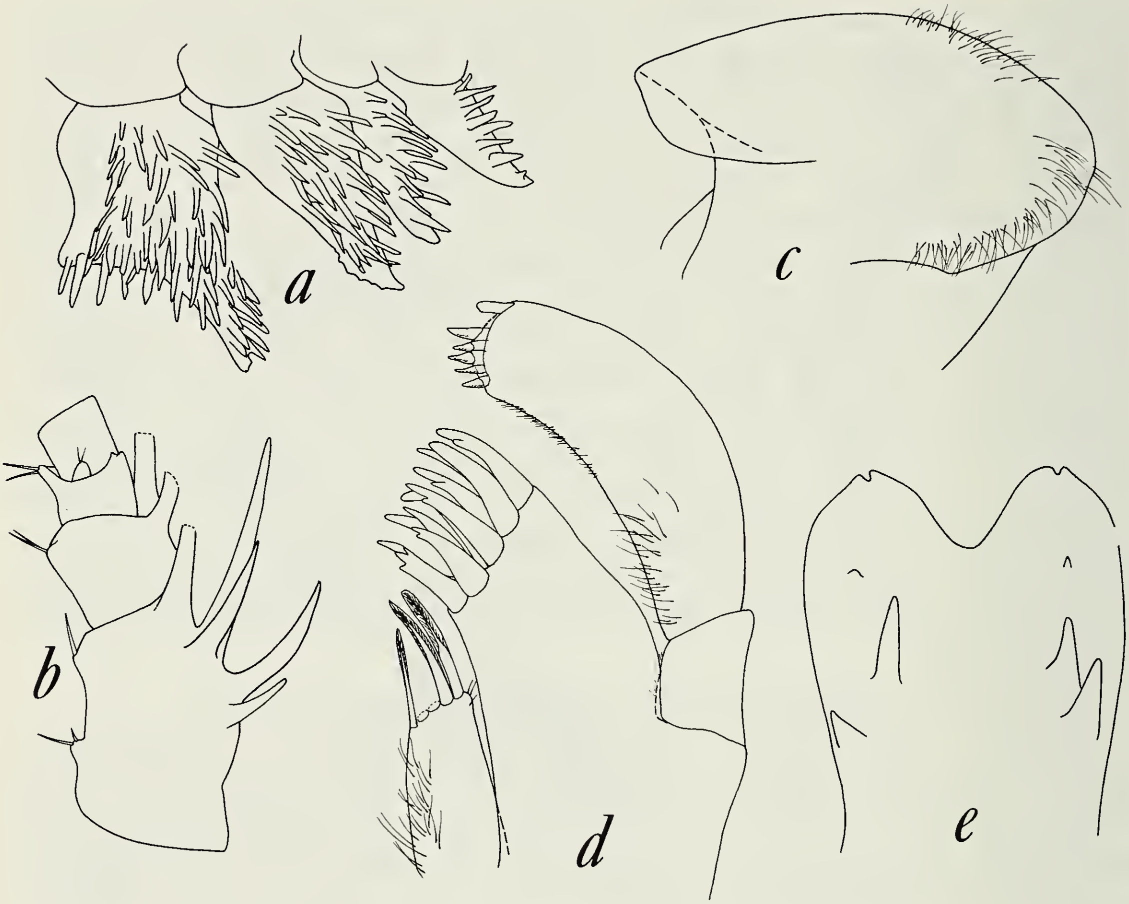

Fig. 23. *Uschakoviella echinophora, Islas Orcadas* Cruise 19, Sta. 14: a, Coxae 1–4; b, Antenna 1; c, Lower lip; d, Maxilla 1; e, Telson.

Diagnosis.—See generic diagnosis.

Description.—The following supplements the description given by Gurjanova (1955) and Shoemaker (1964). Spines on body become slightly heavier at posterior of body. Pleonite 3 has, in addition to single upright dorsal tooth, a slightly more slender tooth at posterior margin. Antenna 1 accessory flagellum minute. Upper lip incised. Maxilla 1, inner plate with 5 "velvety" setae distally; palp with only short spines. Lower lip with single prominent seta at distomedial margin. Telson with 4 prominent dorsal spines, lobes with minute grooves distally.

Distribution.—Boreal North Pacific, Antarctic, 54–2550 m.

Remarks.—Our specimen differs from those of Shoemaker (1964) and Gurjanova (1955) in the possession of short spines on the palp of maxilla 1 instead of longer, tufted setae and in the presence of prominent spines on the telson. The presence of the accessory flagellum and the additional smaller tooth on pleonite 3 was probably overlooked in the earlier studies as both these characters are difficult to see. The importance of the additional characters is uncertain because of disagreements in the earlier descriptions. Shoemaker described the upper lip of his specimens as broad, symmetrical and not incised while Gurjanova figured an incised upper lip. Gurjanova illustrated 2 distomedial spines on the lower lip whereas Shoemaker figured only fine setae. Because this species has been reported so few times, assessment of possible specific differences is difficult.

Stegocephalidae

Andaniotes Stebbing

Andaniotes Stebbing, 1897:30.
Metandania Stephensen, 1925:136.

Type-species.—*Anonyx corpulentus* Thomson, 1882.

Diagnosis (from J. L. Barnard, 1969).—Antenna 1 flagellar article 1 equal to or shorter than peduncle; antenna 2 peduncle article 5 equal to or shorter than article 4; mandible incisor not toothed; maxilla 1 palp uniarticulate; maxilla 2 outer plate not geniculate or gaping; maxilliped palp article 2 not produced; pereopod 5 article 2 slender; pereopods 6 and 7 article 2 broad; pleonite 6 longer than uropod 3 peduncle.

Andaniotes corpulentus (Thomson 1882)

Fig. 24

Anonyx corpulentus Thomson, 1882:231, pl. 17, fig. 1.
Andania abyssorum Stebbing, 1888:739, pl. 37.
Andaniotes corpulentus.—Stebbing, 1897:31, pl. 8; 1906:96, fig. 21.—Schellenberg, 1931:51.—J. L. Barnard, 1972:307 (key).

Material.—*Eltanin* Cruise 6, Sta. 410, 31 Dec. 1962, 61°18–20′S, 56°09–10′W, 220–240 m, 2 individuals; Cruise 6, Sta. 428, 5 Jan. 1963, 62°39–41′S, 57°46–51′W, 622–1120 m, 1 ♀ ovigerous; Cruise 9, Sta. 740, 18 Sept. 1963, 56°06–07′S, 66°19–30′W, 384–494 m, 1 ♀, 3 juveniles, 1 sex unknown; Cruise 12, Sta. 1003, 15 Mar. 1964, 62°41′S, 54°43′W, 210–220 m, 1 individual; Cruise 12, Sta. 1079, 13 Apr. 1964, 61°25–26′S, 40°55′W, 593–598 m, 1 ♀.

Diagnosis.—Maxilla 1 palp not reaching end of outer plate; maxilliped palp 4-articulate; pereopod 6 article 2 slightly expanded, posterior margin distally rounded, article 2 more than twice width article 3.

Description.—The following supplements the description of Stebbing (1888). Antenna 1 accessory flagellum uniarticulate. Epistome tall, usually with small conical projection from ventral margin, one specimen (?male) from *Eltanin* Sta. 410 with large, ventral, anteriorly-directed recurved

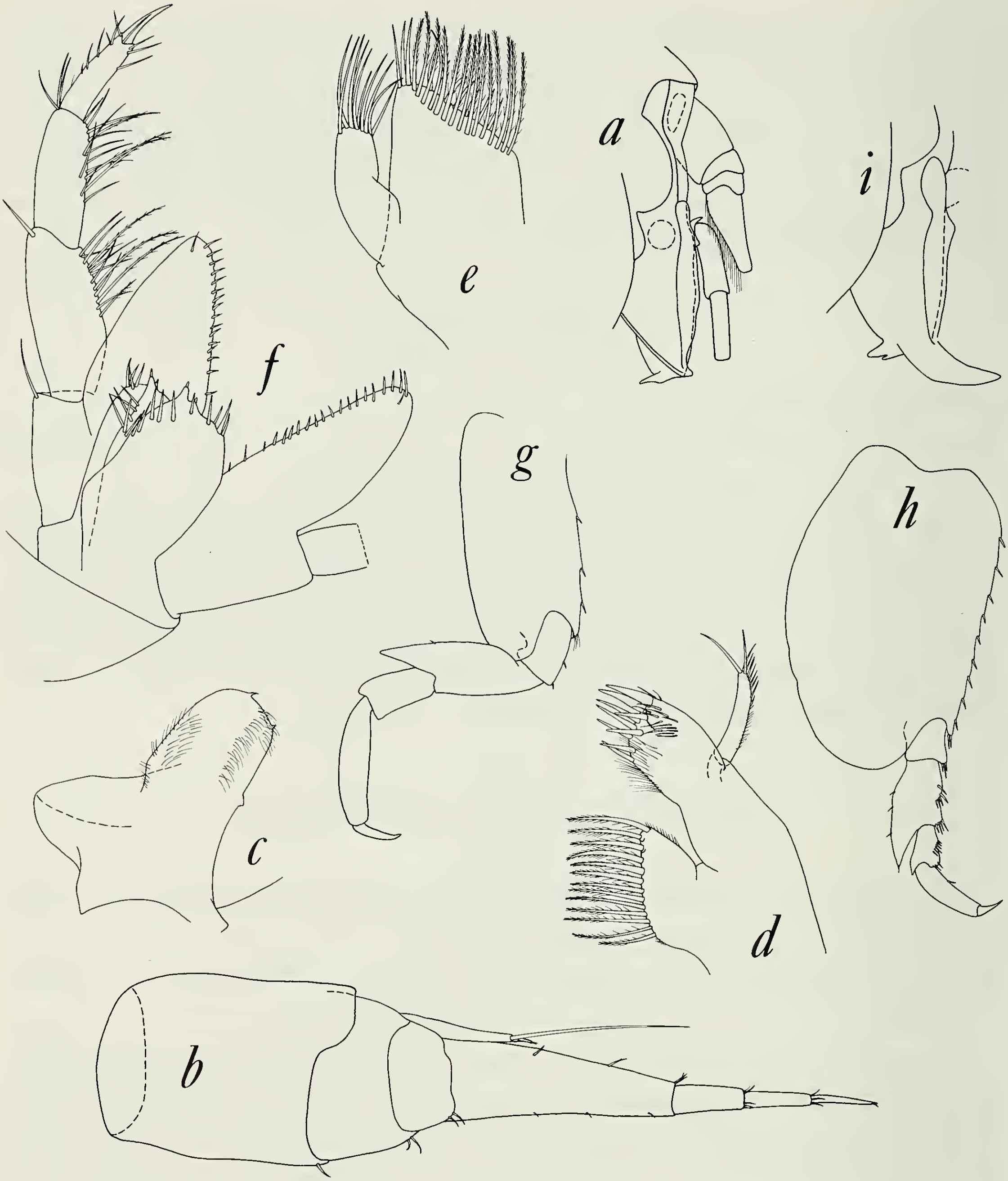

Fig. 24. *Andaniotes corpulentus, Eltanin* Sta. 410: a, Head; b, Antenna 1; c, Lower lip; d, Maxilla 1; e, Maxilla 2; f, Maxilliped; g, Pereopod 6; h, Pereopod 7; i, Head with unusual epistome.

tooth. Maxilla 1 more heavily setose than described by Stebbing. Maxilliped inner plate truncate distally, inner corner produced as a tooth; palp article 1 more than twice as long as wide. Pereopod 6 basis hind margin slightly convex. Pereopod 7 basis broadly rounded posteriorly.

Distribution.—Falkland Islands, Magellanic Area, South Shetland Is-

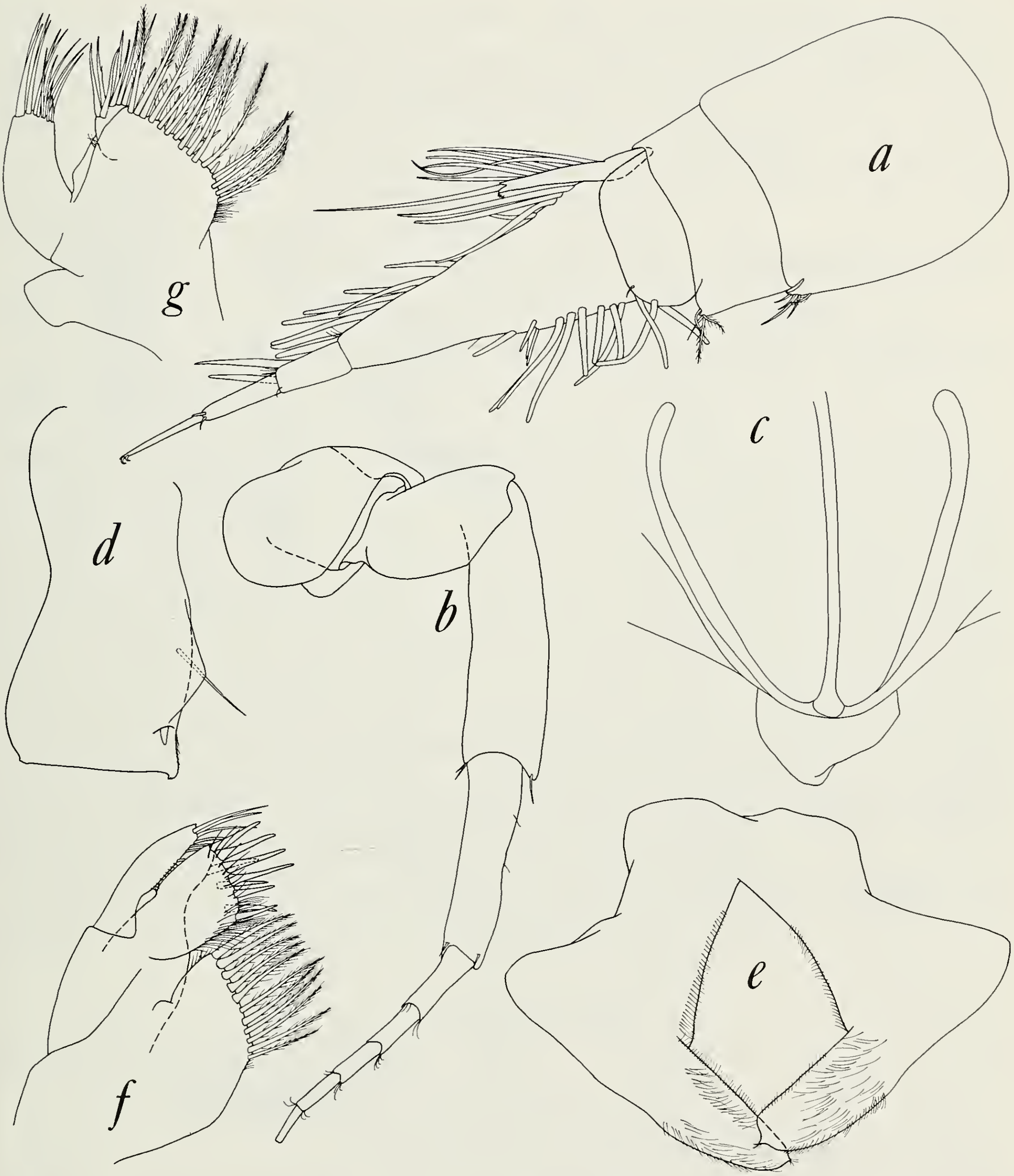

Fig. 25. *Andaniotes linearis, Islas Orcadas* Cruise 575, Sta. 91: a, Antenna 1; b, Antenna 2; c, Epistome and upper lip; d, Mandible; e, Lower lip; f, Maxilla 1; g, Maxilla 2.

lands, South Orkney Islands, Atlantic sector of Southern Ocean, and New Zealand, low tide to 1120 m.

Andaniotes linearis K. H. Barnard 1932

Figs. 25, 26

Andaniotes linearis K. H. Barnard, 1932:80, fig. 36.—Nicholls, 1938:41, fig. 21.

Fig. 26. *Andaniotes linearis, Islas Orcadas* Cruise 575, Sta. 91: a, Maxilliped; b, Gnathopod 1; c, Gnathopod 2; d, Pereopod 5; e, Pereopod 6; f, Pereopod 7; g, Telson.

Material.—Eltanin Cruise 6, Sta. 410, 31 Dec. 1962, 61°18–20′S, 56°09–10′W, 220–240 m, 7 ♀♀, 8 juveniles; Cruise 6, Sta. 428, 5 Jan. 1963, 62°39–41′S, 57°46–51′W, 622–1120 m, 1 ♀ with young, 1 juvenile; Cruise 7, Sta. 558, 14 Mar. 1963, 51°58′–52°01′S, 56°38′W, 646–845 m, 1 ♀; Cruise 9, Sta. 684, 25 Aug. 1963, 54°55′S, 38°05–07′W, 595–677 m, 11 ♀♀, 1 ♂; Cruise 9, Sta. 740; 18 Sept. 1963, 56°06–07′S, 66°19–30′W, 384–494 m, 2 ♀♀, 1 sex unknown; Cruise 11, Sta. 977, 13 Feb. 1964, 52°32′S, 63°53′W, 229 m, 1 ♀ ovigerous, 3 juveniles. *Islas Orcadas* Cruise 575, Sta. 82, 6 June 1975, 55°29.0′S, 35°20.5′W, 413–462 m, 1 juvenile; Cruise 575, Sta. 90, 7 June 1975, 54°50.6′S, 37°23.8′W, 223–227 m, 4 ♀♀ (3 with eggs), 3 ♂♂, 1 juvenile; Cruise 575, Sta. 91, 7 June 1975, 55°00.6′S, 37°42.6′W, 494–501 m, 1 ♀ with eggs, 6 ♂♂, 4 juveniles. *Hero* Cruise 715, Sta. 894, 2 Nov. 1971, 54°55′–54.8′S, 64°20–18′W, 263–285 m, 1 juvenile.

Diagnosis.—Maxilla 1 palp reaching outer plate; maxilliped palp 4-articulate; pereopod 6 article 2 rectilinear, twice as wide as article 3.

Description.—Antenna 1 accessory flagellum long but uniarticulate, armed distally with a single long seta; main flagellum of 4 articles, first article more than half length of peduncle. Antenna 2 peduncle article 4 longer than article 5. Epistome triangular, as long as basal width, with low medial keel. Upper lip asymmetrically incised. Mandible greater than twice as long as broad; molar conical. Lower lip distal apices elongate, densely covered with setae, proximal apices short, subacute. Maxilla 1 palp reaching end of outer plate; inner plate not as broad as outer plate. Maxilla 2 inner plate 3 times width of outer plate at apex. Maxilliped palp 4-articulate; palp article 1 less than twice as long as wide; outer and inner plates broad. Gnathopod 1 propodus with dense covering of setae on distal half of dorsal margin. Gnathopod 2 propodus linear, without well-defined palm. Pereopod 5 basis linear, as wide as article 3. Pereopod 6 basis rectilinear, twice width article 3. Pereopod 7 basis hind margin broadly rounded, tapering distally. Uropod 3 outer ramus biarticulate. Telson cleft one-half.

Distribution.—Adelie Coast, around western Antarctica to Palmer Archipelago, South Georgia and Falkland Islands, 81–1120 m.

Euandania Stebbing

Euandania Stebbing, 1899:206.

Type-species.—*Andania gigantea* Stebbing, 1888.

Diagnosis (from J. L. Barnard, 1969).—Mandibular incisor not toothed; maxilla 1 palp uniarticulate; maxilla 2 outer plate not geniculate or gaping; maxilliped palp article 2 not produced; pereopod 5 article 2 slender; pereopod 6 article 2 broad or slender; pereopod 7 article 2 broad; telson cleft one-third; antenna 1 flagellar article 1 much longer than peduncle; pleonite 6 shorter than peduncle of uropod 3.

Euandania gigantea (Stebbing 1883)

Fig. 27a–d

Andania gigantea Stebbing, 1883:206; 1888:730, pl. 35.
Euandania gigantea.—Stebbing, 1899:206.—K. H. Barnard, 1932:80.

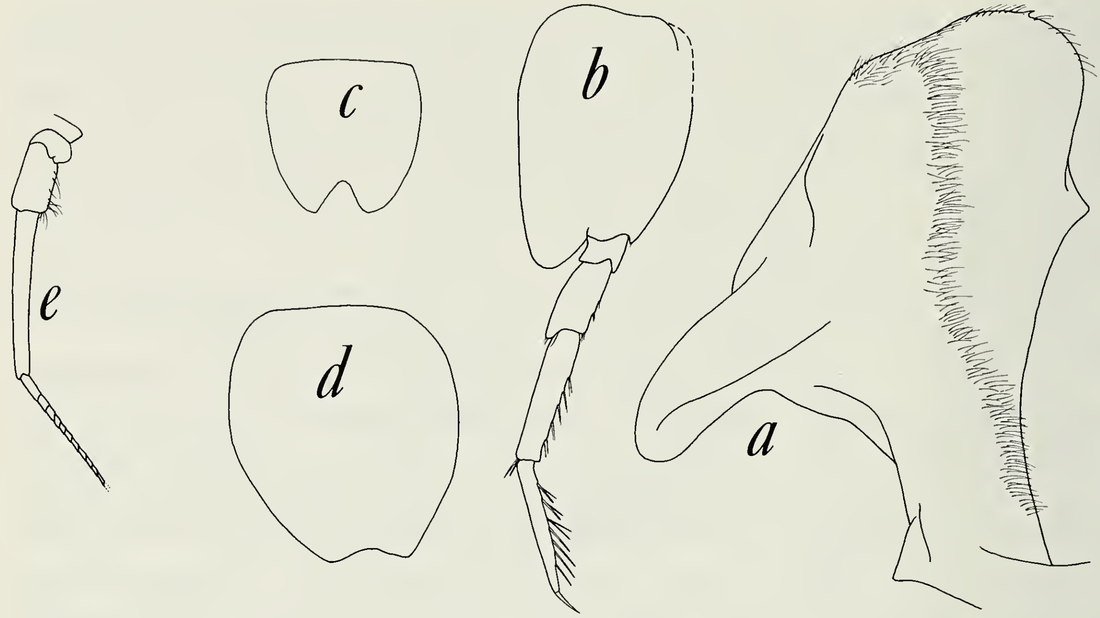

Fig. 27. *Euandania gigantea, Islas Orcadas* Cruise 575, Sta. 6: a, Lower lip; b, Pereopod 7; c, Adult telson; d, Juvenile telson. *Parandania boecki, Eltanin* Sta. 466: e, Antenna 2.

Material.—Eltanin Cruise 9, Sta. 720, 7 Sept. 1963, 56°05–07′S, 34°00–03′W, 2818–2873 m, 1 juvenile; Cruise 10, Sta. 862, 21 Nov. 1963, 61°17–26′S, 78°55–57′W, 4575 m, 1 juvenile. *Islas Orcadas* Cruise 575, Sta. 6, 9 May 1975, 51°02.2′S, 42°47.6′W, 1480–1545 m, 1 ♀.

Diagnosis.—Antenna 1 flagellar article 1 much longer than peduncle; antenna 2 peduncle article 5 longer than article 4; pleonite 6 shorter than peduncle of uropod 3; pereopod 6 article 2 broad.

Description.—The following supplements the description of Stebbing (1888). Lower lip medial margin with small protuberance near distal apex. Pereopod 7 basis broad, tapering distally. Telson widely cleft.

Distribution.—Ross Sea, Prince Edward Islands, Indian and Pacific sectors of Southern Ocean, Kermadec Trench, South and Northwest Atlantic Oceans, bathypelagic, 0–4575 m.

Remarks.—Our specimens differed from that illustrated by Stebbing (1888:35) in having pereopod 7 basis slightly more expanded. There appeared to be some slight variation in the degree to which the telson was cleft; that of one junveile was only slightly cleft.

Parandania Stebbing

Parandania Stebbing, 1899:206.

Type-species.—Andania boecki Stebbing, 1888.

Diagnosis (from J. L. Barnard, 1969).—Mandible incisor not toothed;

maxilla 1 palp uniarticulate; maxilla 2 outer plate not geniculate or gaping; maxilliped palp article 2 not produced; pereopod 5 article 2 slender; pereopods 6 and 7, article 2 broad; telson entire.

Parandania boecki (Stebbing 1888)
Fig. 27e

Andania boecki Stebbing, 1888:735, pl. 36.
Parandania boecki.—Stebbing, 1899:206; 1906:95, figs. 19, 20.

Material.—*Eltanin* Cruise 7, Sta. 466, 12 Feb. 1963, 55°02–03′S, 44°27–38′W, 3348–3596 m, 1 ♂.

Diagnosis.—As for genus.

Distribution.—Cosmopolitan, bathypelagic.

Remarks.—We have figured antenna 2 from our specimen since it differs from that illustrated by Stebbing (1888, pl. 36) and J. L. Barnard (1961, fig. 27). Stebbing showed peduncle article 5 to be 3 times the length of article 4 whereas Barnard indicated article 5 to be less than twice the length of article 4. In both cases the flagellum was longer than the peduncle. In our specimen peduncle article 5 was 2½ times the length of article 4.

Acknowledgments

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Literature Cited

Barnard, J. L. 1961. Gammaridean Amphipoda from depths of 400 to 6000 meters.—Galathea Rep. 5:23–128.

———. 1964. Revision of some families, genera and species of gammaridean Amphipoda.—Crustaceana 7:49–74.

———. 1967. *Echiniphimedia*, an amphipod genus from the Antarctic Ocean.—Proc. U.S. Natl. Mus. 124:1–15.

———. 1969. The families and genera of marine gammaridean Amphipoda.—U.S. Natl. Mus. Bull. 271:1–535.

———. 1972. Gammaridean Amphipoda of Australia, Part 1.—Smithsonian Contr. Zool. 103:1–333.

Barnard, K. H. 1916. Contributions to the crustacean fauna of South Africa.—Annls. S. Afr. Mus. 15:105–301.

———. 1930. Crustacea. Part XI.—Amphipoda.—British Antarctic ('Terra Nova') Expedition, 1910, Zoology 8:307–454.

———. 1932. Amphipoda.—Discovery Reports 5:1–326.

———. 1955. Additions to the fauna list of the South African Crustacea and Pycnogonida.—Annls. S. Afr. Mus. 43:1–107.

Bellan-Santini, D. 1972. Invertébrés marins des XII et XV Expéditions Antarctiques Françaises en Terre Adelie 10,—Amphipodes Gammariens.—Tethys 4:683–702.

Chevreux, E. 1911. Sur les amphipodes des Expéditions Antarctiques Françaises.—C. R. Acad. Sci. Paris 153:1166–1168.

———. 1912. Deuxième expédition dans l'Antarctique, dirigée par le Dr. Charcot 1908–1910, diagnoses d'amphipodes nouveaux.—Bull. Mus. Hist. Nat. Paris 4:208–218.

———. 1913. Amphipodes: Deuxième Expédition Antarctique Française (1908–1910) commandeée par le Dr. Jean Charcot.—Sci. Nat. Doc. Sci. 77–186.

Gurjanova, E. 1955. Novye vidy bokoplavov (Amphipoda, Gammaridea) iz severnoi chasti Tixogo Okeana.—Trudy Zool. Inst. Akademiia Nauk SSSR 18:166–218.

Hope, F. W. 1851. Catologo dei Crostacei Italiani e di molti altri del Mediterraneo, Napoli, 48 pp.

Hurley, D. E. 1954. Studies on the New Zealand amphipodan fauna, No. 9, the families Acanthonotozomatidae, Pardaliscidae and Liljeborgiidae.—Trans. Roy. Soc. New Zealand 82:763–802.

Karaman, G. S., and J. L. Barnard. 1979. Classificatory revisions in gammaridean Amphipoda (Crustacea), Part I.—Proc. Biol. Soc. Washington 92(1):106–165.

Krapp-Schickel, G. 1976. Marine amphipods from Pantelleria and Catania (Sicily).—Bull. Zool. Mus. Univ. Amsterdam 5(5):31–45.

McCain, J. C. 1971. A new deep-sea species of *Epimeria* (Amphipoda, Paramphithoidae) from Oregon.—Crustaceana 20:159–166.

Nicholls, G. E. 1938. Amphipoda Gammaridea.—Australasian Antarctic Expedition 1911–14, Sci. Rep. ser. C, 2(4):1–145.

Rathke, H. 1843. Berträge zur Fauna Norwegens.—Verhandl. Kaiserl. Leopolinisch-Carolinischen Akad. Naturforsch., Breslau 20(1):1–264, 264b, 264c.

Schellenberg, A. 1926. Die Gammariden der Deutschen Südpolar-Expedition 1901–1903.—Deutsch. Südpolar Expedition 10, Zool., 18:233–414.

———. 1931. Gammariden und Caprelliden des Magellangebietes, Südgeorgiens und der Westantarktis.—Further Zool. Res. Swedish Antarctic Exped. 1901–1903, 3(6):1–290.

Shoemaker, C. R. 1964. Seven new amphipods from the west coast of North America with notes on some unusual species.—Proc. U.S. Natl. Mus. 115:391–430.

Stebbing, T. R. R. 1883. The Challenger Amphipoda.—Ann. Mag. Nat. Hist., ser. 5, 11:203–207.

———. 1888. Report on the Amphipoda collected by H.M.S. Challenger during the years 1873–1876.—Report on the Scientific Results of the Voyage of H.M.S. Challenger during the years 1873–76, 29:1–1737, pls. 1–210 (in 3 volumes).

———. 1897. Amphipoda from the Copenhagen Museum and other sources.—Trans. Linn. Soc. London, ser. 2, Zool. 7:25–45.

———. 1899. Revision of Amphipoda (continued).—Ann. Mag. Nat. Hist. ser. 7, 4:205–211.

———. 1906. Amphipoda I, Gammaridea.—Das Tierreich 21:1–806.

Stephensen, K. 1925. Amphipoda II. Crustacea Malacostraca. VI.—The Danish Ingolf-Expedition, Vol. III, pt. 9, pp. 101–178.

Thomson, G. M. 1880. New species of Crustacea from New Zealand.—Ann. Mag. Nat. Hist., ser. 5, 6:1–6.

———. 1882. Additions to the crustacean fauna of New Zealand.—Trans. Proc. New Zealand Inst. 14:230–238.

Thurston, M. H. 1974. Crustacea Amphipoda from Graham Land and the Scotia Arc, collected by Operation Tabarin and the Falkland Islands Dependencies Survey, 1944–59.—Br. Antarct. Surv., Sci. Rep. 85:1–89.

Walker, A. O. 1906. Preliminary descriptions of new species of Amphipoda from the "Discovery" Antarctic Expedition, 1902–1904.—Ann. Mag. Nat. Hist., ser. 7, 18:150–154.

———. 1907. Amphipoda.—National Antarctic Expedition 1901–1904, ("Discovery") 3:1–38.

Watling, L., and H. Holman. 1980. New Amphipoda from the Southern Ocean with partial revisions of the Acanthanotozomatidae and Paramphithoidae.—Proc. Biol. Soc. Washington, 93:609–654.

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A NEW GENUS AND SPECIES OF SPIONIDAE (ANNELIDA: POLYCHAETA) FROM THE NORTH AND SOUTH ATLANTIC

Nancy J. Maciolek

Abstract.—A new genus and species of spionid polychaete has been discovered in collections from widespread areas in the north and south Atlantic Ocean. *Aurospio dibranchiata* n. gen., n. sp., described herein, occurs from slope to abyssal depths ranging from 300 m to 3600 m, and from areas as far north as the Rockall Trough off Ireland to as far south as the Argentine Basin. *Aurospio* is closely related to *Prionospio,* with which it is compared. The holotype of *Anaspio boreus* Chamberlin, 1920 was re-examined, and determined to be a damaged *Prionospio* sp., thus invalidating the genus *Anaspio.*

Extensive collections of deep-sea infauna from several areas in the north and south Atlantic have been made available for study through the work of Drs. Howard L. Sanders and J. Frederick Grassle of the Woods Hole Oceanographic Institution. Examination of the spionid polychaetes in these collections has revealed a new genus and species to be a common component of the fauna. Some specimens were found in samples previously examined by Hartman (1965), and Hartman and Fauchald (1971) and deposited in the Allan Hancock Foundation. Additional material was obtained from collections made by Dr. John Gage, Dunstaffnage Marine Research Laboratory, in the Rockall Trough west of Ireland.

These specimens agreed with the generic diagnosis of *Anaspio* Chamberlin, 1920, which has not been reported since its original description from Alaska. The holotype of *Anaspio boreus* Chamberlin was located at the Museum of Comparative Zoology, Cambridge, Massachusetts (MCZ Catalog No. 2323) and re-examined. It was found to be a damaged specimen of *Prionospio* sp. which had lost the first gill pair and any gills subsequent to the third pair. (These branchial pairs are apparently lost very easily; this condition is routinely seen in deep-sea specimens of *Prionospio.*) The hooded hooks, which were described by Chamberlin as lacking an apical denticle, with the process ''cleft somewhat like the beak of a bird'' (Chamberlin, 1920, p. 19B), were seen under oil immersion to be multidentate, with 6–8 teeth above the main fang. Thus, the genus *Anaspio* Chamberlin is considered a junior synonym of *Prionospio,* and the specimens reported upon herein are referred to a new genus, *Aurospio,* which is described below.

The holotype and a set of paratypes have been deposited in the Smithsonian Institution (USNM), Washington, D.C. Paratype materials have been deposited in the following museums: Allan Hancock Foundation (AHF), California Academy of Sciences (CAS), Museo Argentino de Ciencias Naturales, Buenos Aires (MACN), British Museum of Natural History (BMNH), and the Zoological Museum of Hamburg (ZMH). Some material has been retained for histological and SEM examination, and some material has been returned to the collectors: Drs. Howard L. Sanders (HLS), J. Frederick Grassle (JFG), and John Gage (JG).

Aurospio new genus

Type-species.—*Aurospio dibranchiata* n. sp. Gender, feminine.

Diagnosis.—Prostomium broadly rounded anteriorly, prolonged posteriorly as a keel, eyes 0–2 pairs, no occipital tentacle. Peristomium partly fused to setiger 1, not developed into wings or hood. Branchiae 2 pairs, on setigers 3–4, cirriform, partly fused to notopodial lamellae. No interramal or interparapodial pouches. Anterior setae capillaries, notopodial and neuropodial multidentate hooded hooks posteriorly, lacking secondary hood, one ventral sabre seta posteriorly. Pygidium with 1 long medial and 2 short lateral cirri.

Remarks.—*Aurospio* is closely related to *Prionospio* Malmgren, 1867, in the nature of the development of the peristomium and setiger 1, form of the dorsal lamellae, and nature of the pygidium. The major character separating the two genera is the initial appearance of the branchiae on setiger 2 in *Prionospio* and on setiger 3 in *Aurospio*. As mentioned above, specimens of *Prionospio* often lose the first branchial pair and those subsequent to the third pair, and workers must be careful not to confuse damaged *Prionospio* with *Aurospio* or other genera. However, other, more subtle differences in the branchiae also distinguish *Aurospio* from *Prionospio*: in *Aurospio* the gills appear thin and flat (in light microscopy, but see Fig. 3), and are partially but obviously fused to the notopodial lamellae, while in *Prionospio* the gills are stouter, rounder, and clearly separated from the dorsal lamellae. In over 2000 specimens of *Aurospio* examined, 2 individuals were found having an additional branchial pair on setiger 2, these being about as long as the pair on setiger 3. Because the 2 specimens agreed in all other characters with *Aurospio,* they are considered to represent anomalous individuals of the genus.

Hooded hooks are present in both rami of the 2 genera, but differ in that in *Prionospio* a secondary hood is present, although inconspicuous; while in *Aurospio* a secondary hood is lacking.

In a recent study of Australian Spionidae, Blake and Kudenov (1978) recognized a complex of 4 closely related genera: *Paraprionospio* Caullery, *Streblospio* Webster, *Orthoprionospio* Blake and Kudenov, and *Prionospio* Malmgren (*sensu lato*), with the latter including 3 subgenera: *Prionospio* (*sensu stricto*), *Aquilaspio* Foster, and *Minuspio* Foster. This arrangement reflects Blake and Kudenov's position that branchial form alone is not a sufficient character on which generic distinctions can be based, as was suggested by Foster (1971a) in her revision. In the context provided by Blake and Kudenov, *Aurospio* should be considered the fifth genus in this complex. A single species is known.

Etymology.—*Aurum,* L.—gold; *spio,* L.—sea nymph. The deep golden color of the pigmented inclusions in the first setiger of many specimens suggested the generic name.

Aurospio dibranchiata new species
Figs. 1–3

Prionospio cirrifera: Hartman, 1965 (in part; SL4, Bel, Be4, E3).—Hartman and Fauchald, 1971 (in part; *Chain* cruise 58, Sta. 105). (Not Wirén, 1883).
Prionospio steenstrupi: Hartman, 1965 (in part; SL3). (Not Malmgren, 1867).
Laonice antarcticae: Hartman and Fauchald, 1971 (in part, *Chain* cruise 50, Sta. 87). (Not Hartman, 1953).

Material examined.—Atlantic Ocean: Gay Head–Bermuda Transect.—*Panulirus,* Bermuda Sta. 1, 13 April 1960, 32°16.5′N, 64°42.5′W, 1000 m, anchor dredge, 31 specimens (AHF). Bermuda Sta. 4, 2 May 1960, 32°17.0′N, 64°35′W, 1700 m, anchor dredge, 1 specimen (AHF).—*Atlantis* cruise 264, Sta. HH3, 21 May 1961, 38°47′N, 70°08′W, 2900 m, anchor dredge, 2 specimens (AHF). Sta. E3, 25 May 1961, 39°50.5′N, 70°35′W, 824 m, anchor dredge, 20 specimens (6 for SEM, 14 AHF).—*Atlantis* cruise 283, Sta. Slope 3, 28 August 1962, 39°58.4′N, 70°40.3′W, 300 m, anchor dredge, 1 specimen (AHF). Sta. Slope 4, 30 August 1962, 39°56.5′N, 70°39.9′W, 400 m, anchor dredge, 2 specimens (AHF).—*Atlantis II* cruise 12, Sta. 71, 24 August 1964, 38°08′N, 71°47.5′W, 2946 m, anchor dredge, 15 specimens (AHF).—*Chain* cruise 50, Sta. 87, 6 July 1965, 39°48.7′N, 70°40.8′W, 1102 m, epibenthic sled, 19 specimens (AHF).—*Chain* cruise 58, Sta. 105, 5 May 1966, 39°56.6′N, 71°03.6′W, 530 m, epibenthic sled, 4 specimens (AHF).—*Oceanus* cruise 10, Sta. 350, 10 July 1976, 38°17.0′N, 69°37.8′W, 3600 m, box core, 11 specimens (JFG). Sta. 352, 11 July 1976, 38°16.5′N, 69°38.5′W, 3600 m, box core, 14 specimens (JFG). Sta. 367, 19 July 1976, 39°45.5′N, 70°37.2′W, 1764 m, box core, 65 specimens (JFG).—*Alvin* Dive, WHOI Deep Ocean Station No. 1, 39°46′N, 70°40′W, 1760 m. Dive #407, 12 June 1972, 3 specimens (JFG). Dive #408, 14 June 1972, 2 specimens (JFG). Dive #459, 26 September 1972, 5 specimens (JFG). Dive #460, 11 October 1972, 10 specimens (JFG). Dive #546, 5 October 1974, 1 specimen (JFG). Dive

#597, 30 August 1975, 4 specimens (JFG). Dive #773, 29 July 1977, 3 specimens (JFG). Dive #744, 30 July 1977, 1 specimen (JFG). Dive #776, 1 August 1977, 4 specimens (JFG).—*Alvin* Dive, WHOI Deep Ocean Station No. 2, 38°18′N, 65°35′W, 3600 m. Dive #657, 10 June 1976, 2 specimens (JFG). Dive #777, 3 August 1977, 3 specimens (JFG).—*Alvin* Dive, Tongue of the Ocean, 24°53.4′N, 77°40.2′W, 2032 m. Dive #753, 5 May 1977, 1 specimen (JFG). Dive #755, 12 May 1977, 2 specimens (JFG).—Ireland–Woods Hole Transect. *Chain* cruise 106. Sta. 313, 17 August 1972, 51°32.2′N, 12°35.9′W, 1491–1500 m, epibenthic sled, 586 specimens (50 specimens, HLS; 536 specimens, USNM 60343). Sta. 323, 21 August 1972, 50°08.3′N, 13°53.7′W, 3338–3356 m, epibenthic sled, 193 specimens (USNM 60344).—Rockall Trough. *Challenger* cruise 12B/75, 7 September 1975, Sta. 46, 55°03.7′N, 12°06′W, 2875 m, box core, 22 specimens (JG). Sta. 47, 55°03.5′N, 12°03.5′W, 2875 m, box core, 28 specimens (JG). Sta. 48, 55°03.9′N, 12°03.9′W, 2875 m, box core, 21 specimens (JG). Sta. 49, 55°03.4′N, 12°05.3′W, 2875 m, box core, 22 specimens (JG). Sta. 50, 55°04.1′N, 12°02.6′W, 2875 m, box core, 21 specimens (JG). Sta. 51, 55°03.3′N, 12°02.7′W, 2875 m, box core, 5 specimens (JG).—*Challenger* cruise 9/76, 23 June 1976, Sta. 58, 54°41′N, 12°17′W, 2900 m, box core, 24 specimens (JG). Sta. 60, 56°35′N, 11°03′W, ca 2500 m, box core, 2 specimens (JG). Sta. 61, 57°08′N, 12°09′W, ca 1200 m, box core, 8 specimens (JG). Sta. 63, 56°37′N, 10°12′W, ca 1800 m, box core, 2 specimens (JG). Sta. 65, 56°39′N, 09°40′W, ca 1600 m, box core, 38 specimens (JG).—*Challenger* cruise 10/76, 1 July 1976, Sta. 68, 58°42′N, 09°43′W, ca 1800 m, box core, 38 specimens (JG).—Bay of Biscay. *Sarsia* Sta. 33, 13 July 1967, 43°40.8′N, 03°36′W, 1784 m, anchor dredge, 18 specimens (USNM 60329). Sta. 44, 16 July 1967, 43°40.8′N, 03°35.2′W, epibenthic sled, 1739 m, 1 specimen (NJM). Sta. 65, 25 July 1967, 46°15.0′N, 04°50′W, epibenthic sled, 1922 m, 152 specimens (USNM 60330).—Canary Islands. *Discovery* Sta. 6697, 15 March 1968, 27°57′N, 13°46′W, 1564 m, epibenthic sled, 44 specimens (USNM 60331). Sta. 6709, 18 March 1968, 27°29.8′N, 15°20′W, 2351 m, epibenthic sled, 76 specimens (USNM 60332). Sta. 6710, 19 March 1968, 27°23.6′N, 15°39.6′W, 2670 m, epibenthic sled, 71 specimens (USNM 60333). Sta. 6711, 20 March 1968, 27°13′N, 15°41′W, 2988 m, 38 specimens (USNM 60334).—Walvis Bay–Luanda Transect. *Atlantis II* cruise 42. Sta. 193, 17 May 1968, 22°56′S, 12°18′E, 2094–2191 m, anchor dredge, 1 specimen (USNM 60335). Sta. 200, 22 May 1968, 09°41′S, 10°55′E to 09°43.5′S, 10°57′E, 2644–2754 m, epibenthic sled, 4 specimens (USNM 60336). Sta. 201, 23 May 1968, 09°29′S, 11°34′E to 09°25′S, 11°35′E, 1964–2031 m, epibenthic sled, 59 specimens (USNM 60337). Sta. 202, 23 May 1968, 09°05′S, 12°17′E to 08°56′S, 12°15′E, 1427–1643 m, epibenthic sled, 47 specimens (USNM 60338).—Argentine Basin. *Atlantis II* cruise 60. Sta. 239, 11 March 1971, 36°49.0′S, 53°15.4′W, 1661–1679 m, epibenthic sled, 92 specimens (12 removed for histology, 30 paratypes USNM 60328, 10 paratypes AHF Poly 1289, 10 paratypes CASIZ type-series 1133, 10 paratypes MACN 29.610, 10 paratypes BMNH ZB1980:82–91, 10 paratypes ZMH P-16407). Sta. 264A, 28 March 1971, 36°12.7′S, 52°42.7′W, 2041–2048 m, epibenthic sled, 52 specimens (1 entire specimen, holotype USNM 60326, 51 paratypes USNM 60327).—Surinam. *Knorr* cruise 25. Sta. 293, 27 February 1972, 08°58.0′N, 53°04.3′W, 1456–1518 m, epibenthic sled, 169 specimens (USNM 60339). Sta. 295, 28 February 1972, 08°04.2′N, 54°21.3′W, 1000–1022 m, epibenthic sled, 260 specimens (1 entire specimen, USNM 60340, 259 specimens USNM 60341). Sta. 301, 29 February 1972, 08°12.4′N, 55°50.2′W, 2487–2500 m, epibenthic sled, 11 specimens (USNM 60342).

Diagnosis.—Prostomium broadly rounded anteriorly, extending as keel to end of setiger 1, 0–2 pairs of indistinct red eyespots; no occipital tentacle. Peristomium partly fused to setiger 1, not developed into wings or hood; surrounding prostomium posteriorly as a yoke. Branchiae 2 pairs, on setigers 3–4, each partially fused to dorsal lamellae, first pair longer than second, both usually shorter than lamellae. Setiger 1 reduced; subsequent notopodial lamellae larger, foliaceous, becoming prolonged medially over dorsum, largest on setigers 2–6, thereafter smaller, rounded; neuropodial lamellae largest on setiger 3, thereafter small, rounded, displaced dorsally in anterior setigers, ventrally placed by setiger 10. Setae of 3 types: narrow, striated capillaries, multidentate hooded hooks, heavily granulated ventral sabre setae. Anterior setae all capillaries, arranged in 2 tiers; neuropodial hooded hooks from setiger 9–11 (usually 10); long-shafted notopodial hooded hooks from setiger 24–38; ventral sabre setae from setiger 9–11. Pygidium with 1 long, thin medial cirrus and 2 short, stout lateral cirri.

Description.—This is a small species, measuring up to 0.6 mm wide and 5.0 mm long for 38 setigers. The color in alcohol is white to pale yellow; some specimens have dark golden inclusions on the dorsal edge of setiger 1, and sometimes also on the posterior tip of the prostomium.

The prostomium is broadly rounded anteriorly, extending posteriorly as a narrow keel to the end of setiger 1 (Fig. 1A). On some specimens, a pair of small red eyes, each composed of a cluster of pigment spots, are present about halfway down the length of the prostomium. On a few specimens, a second pair of eyespots is present anterior to the first pair. There is no occipital tentacle. Some variation in the shape of the prostomium is seen; most specimens have a prostomium as in Fig. 1A, but some prostomia were found with tiny peaks either medially or at the lateral edges (Fig. 1B, C). These variations are thought to be fixation artifacts, or due to the eversion or non-eversion of the pharynx, and are not considered to be taxonomically significant.

The peristomium is partly fused to setiger 1, appearing distinct ventrally and laterally, but fused dorsally (Fig. 1A). The peristomium forms a yoke

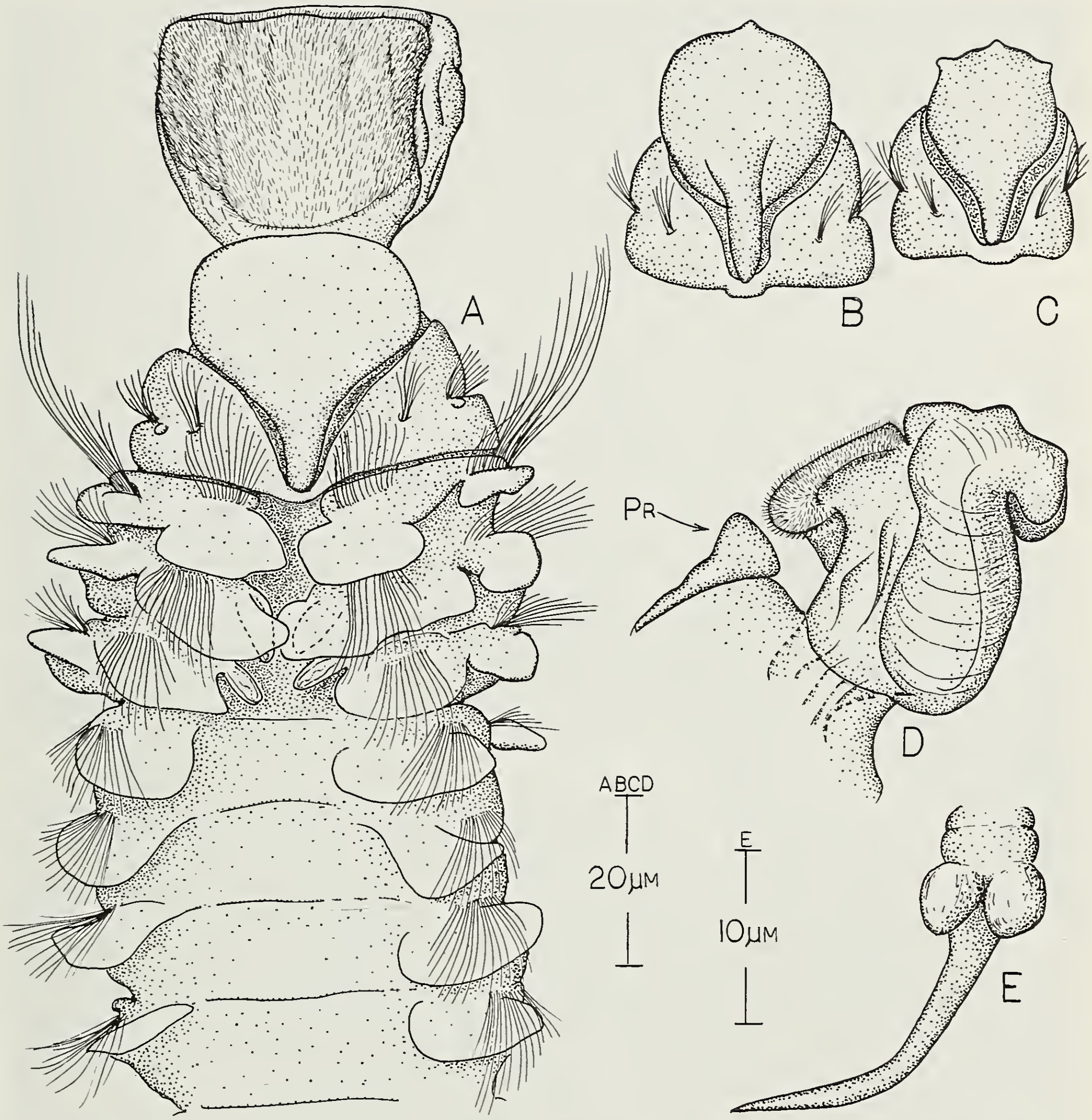

Fig. 1. *Aurospio dibranchiata:* A, Anterior end in dorsal view; B–C, Prostomia, showing medial and lateral peaks of some specimens; D, Everted pharynx in lateral view [Pr = prostomium]; E, Pygidium.

around the posterior tip of the prostomium. This yoke is most obvious in specimens which have large amounts of the golden pigment mentioned above. A pair of grooved palps are present at the junction of the peristomium and prostomium, and extend about one-third to one-half the length of the body. The palps were lost in all but a few (3–4) of the specimens examined.

The pharynx is an eversible pouch, heavily muscularized on the ventral surface, and ciliated on the anterodorsal surface (Fig. 1A, D).

Branchiae are present on setigers 3–4. They are short and fused for one-

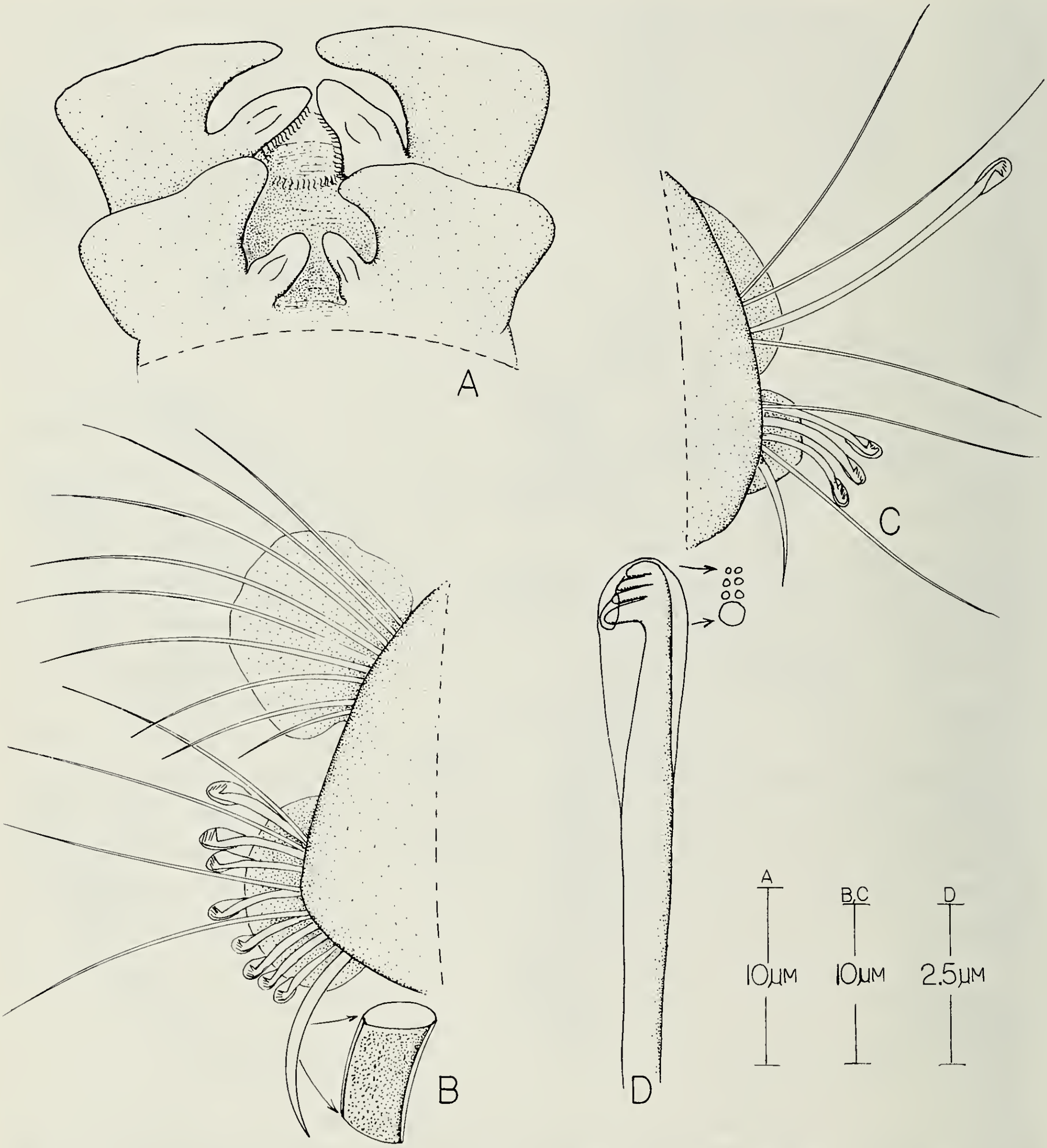

Fig. 2. *Aurospio dibranchiata:* A, Notopodia and branchiae of setigers 3 and 4 in posterior view; B, 15th setiger, with enlargement of sabre seta, in anterior view; C, 30th setiger in anterior view; D, Neuropodial hooded hook, inset [not to scale] showing arrangement of teeth.

quarter to one-third their length to the dorsal lamellae, beyond which they do not extend, and by which they are usually completely hidden (Figs. 1A, 2A, 3). The gills on setiger 3 are longer than those on setiger 4, which are stubby in appearance. Cilia line the medial edge of the gills on setiger 3, and continue across the dorsum (Fig. 3A, B), but are not present on the gills on setiger 4.

The notopodium of setiger 1 is reduced; on setigers 2–6, the notopodial

Fig. 3. *Aurospio dibranchiata:* A, SEM of anterior end in dorsolateral view [scale = 20 μm]; B, SEM of branchiae on setigers 3 and 4 [scale = 4 μm].

lamellae are large, broad and foliaceous, with the medial edge prolonged over the dorsal surface. From setigers 6–14 the lamellae become increasingly smaller. A few specimens appear to have very low dorsal ridges on setigers 5–10, but the appearance of this character is variable within the species.

The neuropodium of setiger 1 is also reduced to a small, rounded lamella, and displaced dorsally. On setiger 2 it is a small auricular lobe which becomes larger on setiger 3 and then smaller on subsequent setigers. The neuropodia of setigers 2–10 are increasingly ventral in position (Fig. 1A). In posterior setigers, both noto- and neuropodia are small, rounded lobes (Fig. 2B, C).

Setae consist of 3 types: capillaries, multidentate hooded hooks and ventral sabre setae. Anterior setae are all capillaries, arranged in 2 tiers. These setae are often extremely long, particularly the neurosetae in setiger 2 (Fig. 1A), but also both the noto- and neurosetae posteriorly. They appear narrow, uni- or bilimbate (depending on the angle at which they are viewed; see Foster, 1971b), and striated with punctations along the striae. Neuropodial hooded hooks appear from setiger 10, occasionally from setiger 11, and less frequently from setiger 9. Long-shafted notopodial hooks appear in the last few setigers (24–38), and will probably not be seen unless complete specimens are collected. These hooks appear quadridentate if viewed from the side (Fig. 2D), but actually have 3 pairs of teeth arranged above the main denticle (Fig. 2D—inset). There is no secondary hood. Hooks number 6–9 per neuropodial ramus, and 2–3 per notopodial ramus. Accompanying capillaries number up to 8 in the neuropodium; up to 3 in the notopodium. A single heavily granulated and bilimbate ventral sabre seta is present from setiger 10 (9–11) (Fig. 2B). Rarely, a second sabre seta is present.

The pygidium is rarely retained in entirety. The pygidium of the holotype has 1 long medial cirrus and 2 short, stout lateral cirri (Fig. 1E).

Remarks.—*Aurospio dibranchiata* is an extremely widespread species, occurring over most of the Atlantic Ocean (Fig. 4), and from slope depths of 300 m to abyssal depths of 3600 m. Twenty-six of the 30 records are from depths greater than 1000 m. The records from shallower depths are all from the Gay Head–Bermuda transect, although stations in less than 1000 m were sampled on most of the other transects.

A. dibranchiata was the second most common species, comprising 5.1 percent of the fauna, in core samples taken by Grassle (1977) at 1760 m off Woods Hole. It was also found in samples taken from recolonization experiments conducted at the same site. Almost nothing is known about its life history: only one specimen containing oocytes was found; these measured 50–90 microns for the greatest visible dimension.

The consistency of taxonomic characters in *A. dibranchiata* over its depth and geographic range is notable. Neuropodial hooded hooks began in setiger

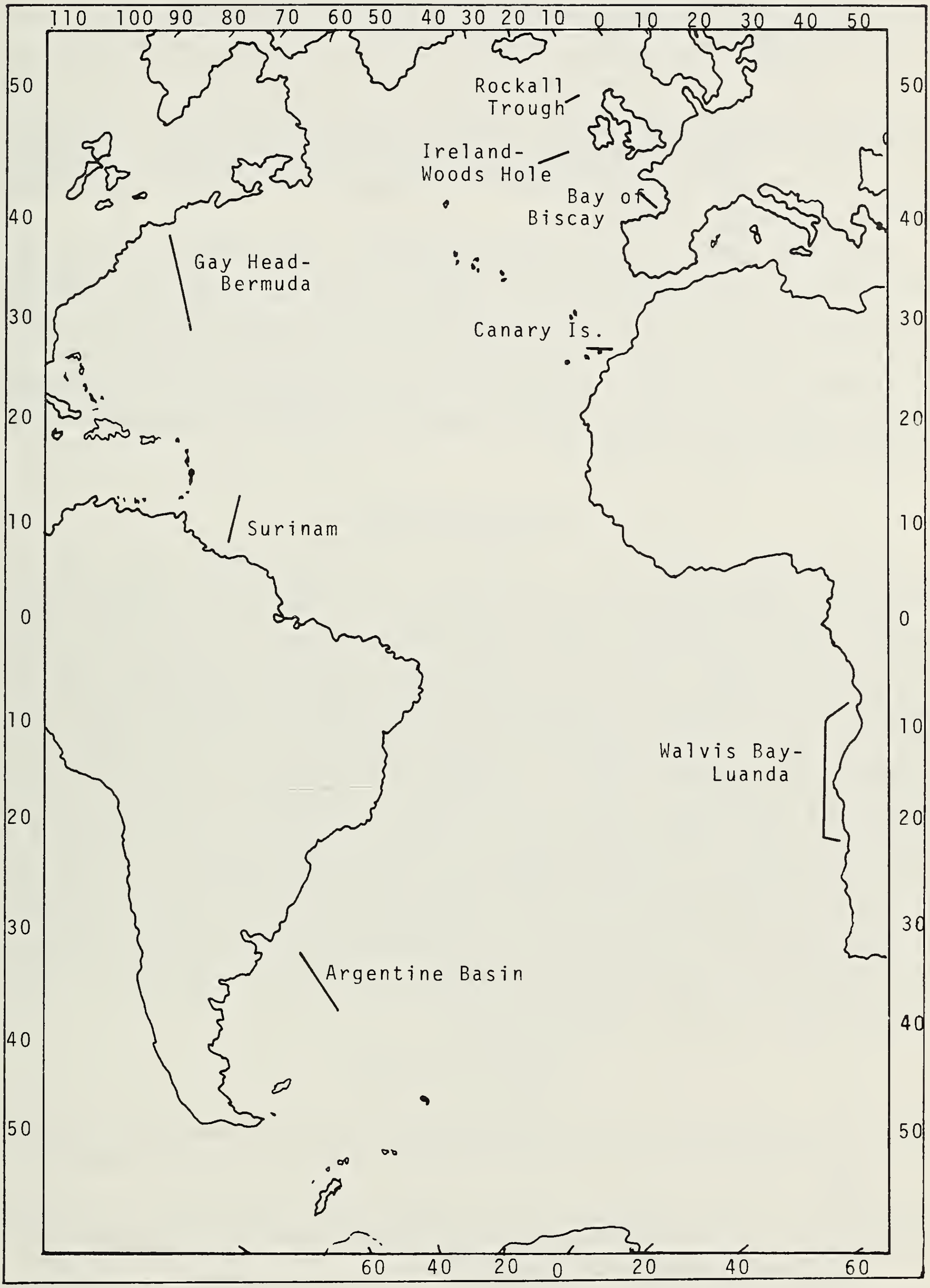

Fig. 4. Sampling transects in the north and south Atlantic Ocean from which *Aurospio dibranchiata* was collected.

10 in nearly every specimen examined. Only 2 or 3 individuals were found in which hooded hooks began in setiger 9. In the 4 samples from the Canary Islands, roughly 10 to 25 percent of the specimens had hooded hooks starting in setiger 11, suggesting a small variation on a regional basis. Other characters, such as shape of prostomium, length of setae in setiger 2, shape of parapodial lamellae and presence or absence of dorsal crests varied little between or among samples.

The golden pigment in the peristomium/first setiger region is most pronounced in the material from the Argentine Basin, and present although somewhat less obvious in most specimens from Surinam and many specimens from other locations. Initial histochemical tests reveal this material to be a lipofuscin. Further histological work is in progress on this and other spionid species in which a similarly pigmented material is found (Maciolek, Hillman and Lahey, in prep.).

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Literature Cited

Blake, J. A., and J. Kudenov. 1978. The Spionidae (Polychaeta) from southeastern Australia and adjacent areas with a revision of the genera.—Mem. Nat. Mus. Victoria 39:171–280.

Chamberlin, R. V. 1920. Polychaeta.—Report Canadian Arctic Exped. 1913–1918, 9B:1–41B.

Foster, N. M. 1971a. Spionidae (Polychaeta) of the Gulf of Mexico and the Caribbean Sea.—Stud. Faun. Curaçao Caribb. Islands 36:183 pp.

———. 1971b. Notes on spionid (Polychaeta) setae.—Trans. Amer. Microscop. Soc. 90(1): 34–42.

Grassle, J. F. 1977. Slow recolonisation of deep-sea sediment.—Nature 265(5595):618–619.

Hartman, O. 1965. Deep-water benthic polychaetous annelids off New England to Bermuda and other North Atlantic areas.—Allan Hancock Found. Occ. Pap. 28:378 pp.

———, and K. Fauchald. 1971. Deep-water benthic polychaetous annelids off New England to Bermuda and other North Atlantic areas. Part 2.—Allan Hancock Monogr. Mar. Biol. 6:327 pp.

Battelle's New England Marine Facility, The William F. Clapp Laboratories, Inc., P.O. Drawer AH, Duxbury, Massachusetts 02332.

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RECLASSIFICATION AND REDESCRIPTION OF THE COMATULID *COMATONIA CRISTATA* (HARTLAUB) (ECHINODERMATA: CRINOIDEA)

Charles Garrett Messing

Abstract.—*Comatonia cristata* (Hartlaub) is redescribed and illustrated on the basis of new and existing material. Well-developed pinnular combs, the only character relating this species to the Comasteridae, are modifications of rudimentary combs found in heliometrine antedonids. *Comatonia* agrees with all diagnostic characteristics of, and is here transferred to, the family Antedonidae, approaching most closely the heliometrine *Anthometra adriani* (Bell). Cirrus morphology may be convergent with sympatric *Coccometra hagenii* (Pourtalès).

The comatulid genus *Comatonia* A. H. Clark contains a single species, *C. cristata* (Hartlaub), found primarily at moderate depths off the southeastern United States. A. H. Clark (1916, 1921, 1931) included it in the family Comasteridae (suborder Comasteracea) entirely on the basis of the well-developed combs on the first pair of oral pinnules. Such combs, the teeth of which are flat, usually triangular or spade-shaped expansions of the aboral surface of distal pinnule segments, are diagnostic of this family. In all other respects, however, *Comatonia* belongs in the family Antedonidae (suborder Antedonacea). Although Gislén (1924) proposed that the species be referred to this family, he was not followed by later authors (Clark, 1931; Messing, 1975; Rasmussen, 1978) with the exception of Meyer (1972). In the course of revising the extant crinoids of the tropical western Atlantic, I have discovered that the comb teeth of *Comatonia* appear to be modifications of comb rudiments found in some antedonid genera; they are convergent with rather than homologous to comasterid comb teeth. No reason remains for retaining this comatulid within the Comasteridae. Its placement within the Antedonidae is discussed below.

In addition, new material, collected primarily by the University of Miami's R/V *Gerda,* together with a re-examination of existing collections, has revealed several previously unrecorded variations. I have, therefore, redescribed and illustrated the species as follows. The tabular arrangement of data follows that of A. M. Clark (1970) and Messing (1978). USNM, UMML and MCZ refer to National Museum of Natural History, University of Miami Marine Laboratory (Rosenstiel School of Marine & Atmospheric Science) and Museum of Comparative Zoology (Harvard University) catalogs, respectively.

Genus *Comatonia* A. H. Clark (1916)

Diagnosis.—Radials 5; arms 10, aborally rounded; cirri slender and numerous, up to 20 mm with 23 cirrals and lacking aboral processes; comb on P_1 and P_a, rarely absent, rarely present on P_2, occupying all but proximal third of pinnule and composed of large, round teeth; one or more proximal pinnulars of P_1 sometimes longer than wide; Br_5–Br_8 (sometimes Br_4–Br_{14}) each with spinose, median, aboral knob or ridge; division series lacking spines. (Modified from A. H. Clark, 1931:289.) Type-species: *Actinometra cristata* (Carpenter MS.) Hartlaub, 1912, by original designation and monotypy (A. H. Clark, 1916:115).

Comatonia cristata (Hartlaub)

Figs. 1–3, 4b, c, h, i, 5a–g

Antedon sp. Carpenter, 1881:155.

Actinometra cristata (Carpenter MS.) Hartlaub, 1912:280, 413, 473–475; pl. 10, figs. 1–5; pl. 15, figs. 10–11.

Comatonia cristata: A. H. Clark, 1916:115.—H. L. Clark, 1918:7, 9.—A. H. Clark, 1921:144, 214, 232, 281, 284, 292, 293, 305, 372, 595, 619; 1931:57, 61, 63, 64, 78, 82, 87, 88, 89, 231, 288–292, 399, 400; pl. 6.—Meyer, 1972:64.—Meyer et al., 1978:416–417, 428, 430, 431, 432.

Description.—Centrodorsal hemispherical or low, rounded conical, 1.3–4.4 mm across; DH 1.3–1.8 (Figs. 1a, d, e). Cirrus sockets crowded, arranged in spiral whorls overlain by irregular columns of 3–6 sockets and almost completely covering centrodorsal. Aboral pole small, not more than 0.4 × basal diameter of centrodorsal, flat or convex, almost smooth to strongly papillose, rarely depressed and ringed with papillae; when present, papillae arising, one each, from obsolete, apical sockets. Centrodorsal margin midradially concave; interradial projections rounded or triangular; central cavity broad and deep, with prominent oral lip and slightly more than half basal diameter of centrodorsal; interior, lateral walls of cavity bearing narrow, interradial buttresses; oral opening pentagonal or irregularly scalloped (Fig. 2j).

Cirri (Figs. 2a–g) slender, about L-C, 12–23, up to 20 mm long, laterally compressed distally. Apical cirri shorter, weaker and composed of fewer cirrals than peripheral cirri. First cirral short; second squarish; third with LW almost 2.0; third to sixth (usually fifth) longest, with LW 2.3–4.0; following cirrals decreasing in length but remaining longer than wide; antepenultimate squarish; all but basal few cirrals somewhat expanded distally; aboral spines or carinae absent; opposing spine directed obliquely distally; terminal claw curved and slightly shorter than penultimate cirral.

Rosette at or just below aboral surface of radial pentagon, bearing large, orally curved, flaring, radial processes and short, triangular, interradial pro-

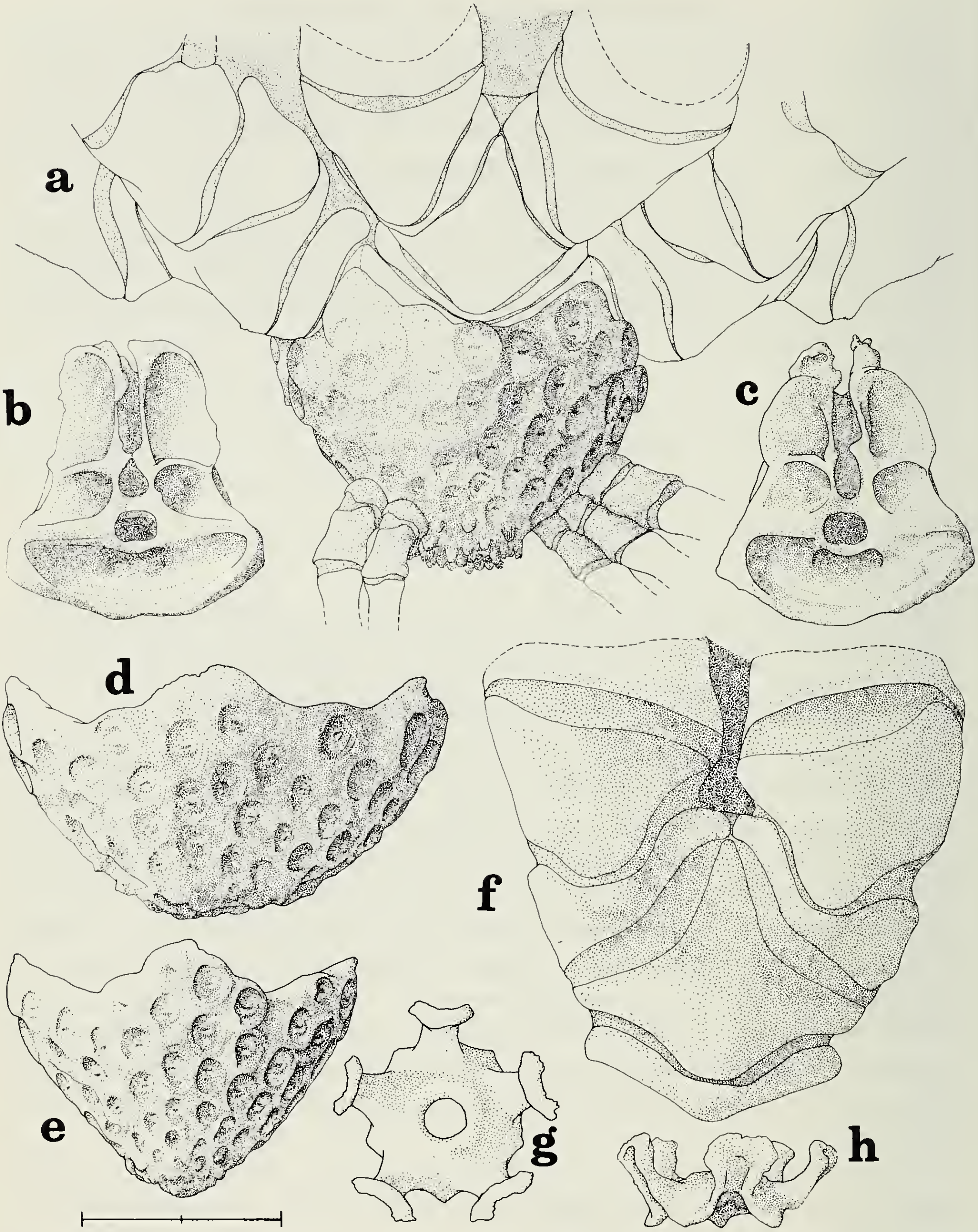

Fig. 1. *Comatonia cristata:* **a,** Radial side view of a specimen (USNM E17863) showing centrodorsal, bases of five cirri and proximal part of three rays (partly shaded); **b,** Radial articular facet (USNM E19971) showing calcareous deposit bridging high, intermuscular walls; **c,** Another radial facet from same specimen; **d,** Interradial side view of centrodorsal (USNM E19971); **e,** Same (USNM E19188); **f,** Proximal part of single postradial series (IBr_1 to Br_3), aboral view (USNM E19971); **g,** Oral view of rosette (USNM E19188); **h,** Same, radial side view. Scale: a–f = 2 mm; g–h = 1 mm.

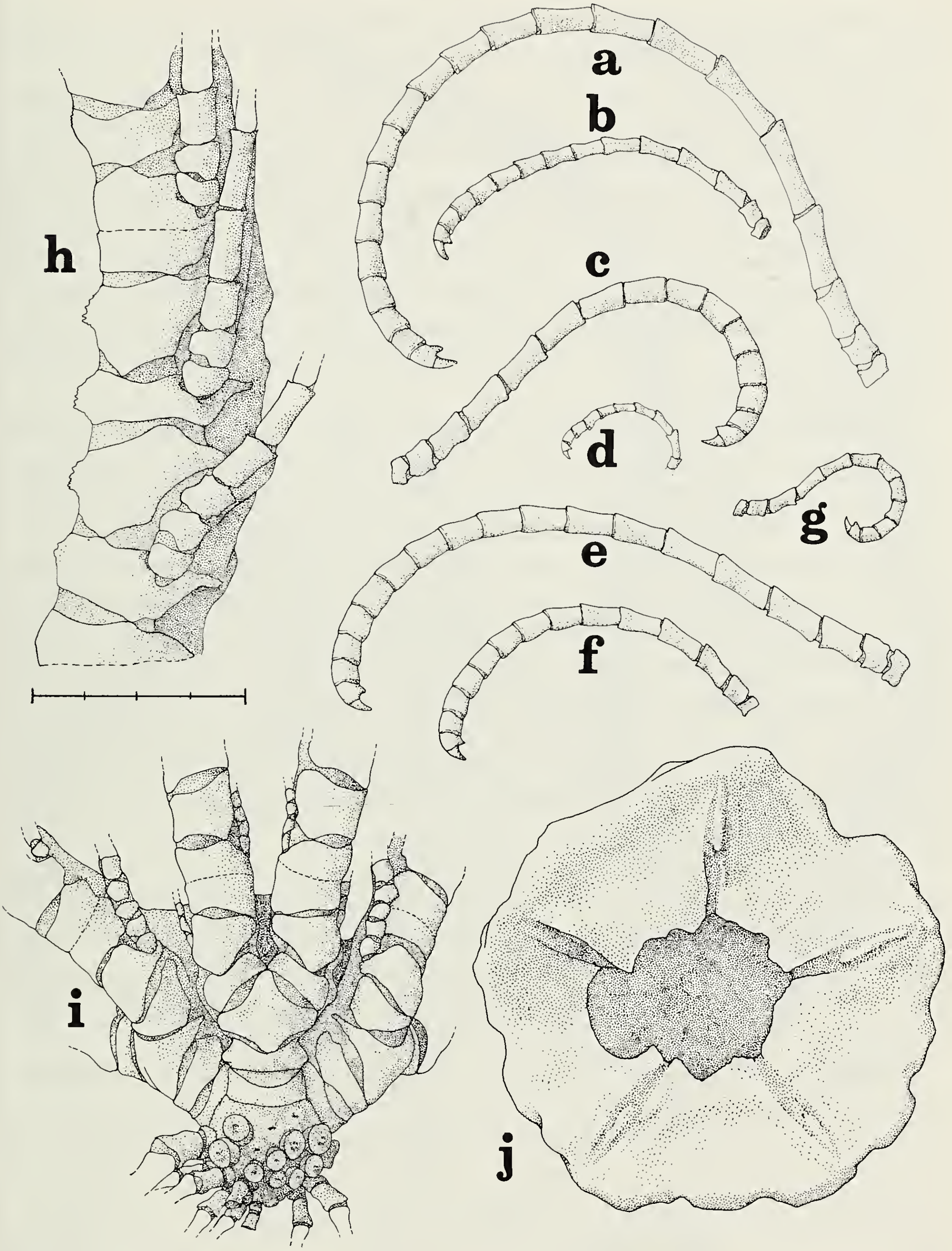

Fig. 2. *Comatonia cristata:* **a,** Peripheral cirrus (USNM E19971); **b,** Apical cirrus, same specimen; **c,** Peripheral cirrus (USNM E19177); **d,** Cirrus of small specimen (USNM E19971); **e,** Peripheral cirrus (USNM E17863); **f,** Apical cirrus, same specimen; **g,** Apical cirrus, same specimen as c; **h,** Proximal brachials (Br_4–Br_{11}), lateral view, showing bases of P_2, P_3, P_4 and spinose, aboral knobs on Br_5–Br_8 (USNM E19177); **i,** Radial side view of small specimen (USNM E19971) showing centrodorsal, bases of several cirri and proximal part of 3 rays; **j,** Centrodorsal, oral view, with lip cut away at left to show actual extent of central cavity (USNM E19188). Scale: a–g = 4 mm; h–j = 2 mm.

cesses (Figs. 1g, h). Basal rays absent; possible vestiges in one specimen fused to centrodorsal (Fig. 2j).

Radials visible only interradially or as extremely narrow band (Fig. 1a). Articular facet slightly longer along oral-aboral axis than wide, deeply excavated and not parallel to oral-aboral axis of specimen; muscular fossae about twice height of interarticular ligament fossae, thin and laminar, flat or overhanging orally, separated by low, narrow ridge. In a single specimen (USNM E19971, Figs. 1b, c), a pair of thin, irregular septa project distally (along the longitudinal axis of the ray) from the margins of the intermuscular ridge to the level of the central canal opening; these vary among the facets and, at one point on one facet, fuse together, creating the illusion of a double central canal (Fig. 1b).

Division series (Figs. 1a, f) separated. IBr$_1$ very short, usually with median tubercle and concave distally. Primaxil (IBr$_2$) rhombic or triangular, round and swollen proximally, forming, with median tubercle of IBr$_1$, prominent synarthrial swelling; distal half flat, narrow and acute; WL 1.2–1.3.

Arms increasing slightly in width from base to Br$_5$–Br$_6$ before tapering; longest attached fragment 40 mm; estimated original length up to 70 mm. Br$_1$ very short, longer exteriorly, united interiorly over primaxil, deeply incised distally by prominent, usually swollen, proximal synarthrial projection of large, irregularly quadrate Br$_2$ (Figs. 1a, f). Br$_{3+4}$ oblong, up to 2.1 mm across; WL 1.2–1.7. Br$_5$ to Br$_8$ oblong or slightly trapezoidal, rarely bearing prominent, alternating articular swellings; WL 1.7–2.5. Br$_{9+10}$ oblong; following brachials trapezoidal, becoming triangular between Br$_{12}$ and about Br$_{15}$; WL 1.3–2.0.

Spinose, median, aboral knob or longitudinal ridge present on Br$_5$–Br$_8$, sometimes present but weak as far as Br$_{14}$, disappearing abruptly thereafter or incorporating into finely crenulate distal margin of brachials, usually absent from syzygial pairs but sometimes present on Br$_4$ (Fig. 2h). In smallest individual (Fig. 2i), synarthrial swellings reduced, brachials elongated after Br$_{15}$ and never triangular.

Syzygies at Br$_{3+4}$, Br$_{9+10}$, usually Br$_{14+15}$ (sometimes Br$_{15+16}$); subsequent interval three or, rarely, four.

P$_1$ (Figs. 3c, j) flagelliform, up to 14 mm with as many as 52 pinnulars; all

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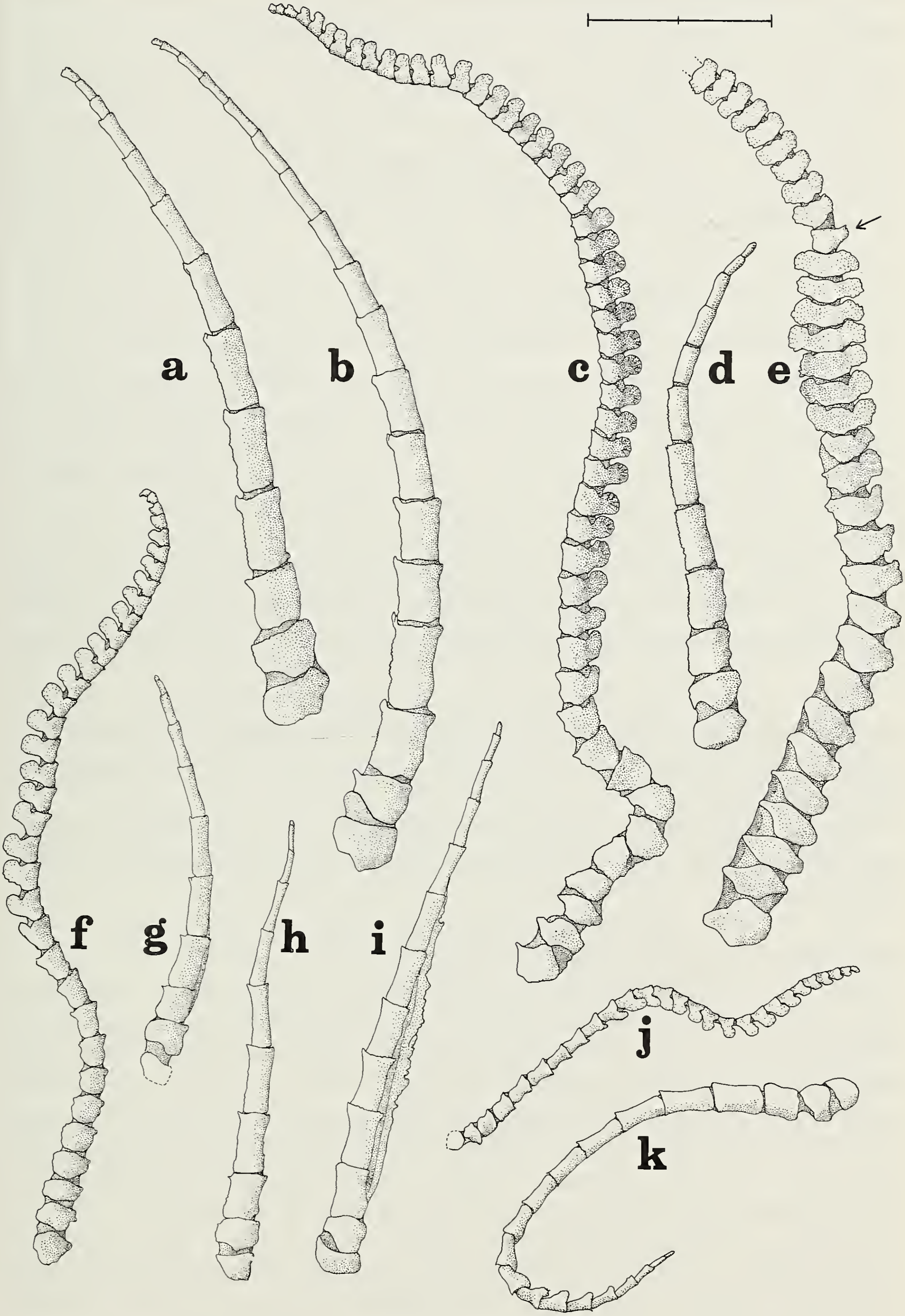
Fig. 3. *Comatonia cristata:* **a,** P$_a$ lacking comb (USNM E19971); **b,** P$_b$, same specimen and arm; **c,** P$_1$ (USNM E19188); **d,** P$_2$, same specimen and arm; **e,** P$_a$ with comb developed on both sides of pinnule; arrow denotes pinnular with comb tooth similar to that of *Anthometra adriani* (USNM E19971); **f,** P$_a$ (USNM E19177); **g,** P$_b$, same specimen and arm; **h,** P$_c$, same; **i,** P$_h$, same; **j,** P$_1$, small specimen (USNM E19971); **k,** P$_2$ with rudimentary comb (USNM E17863). Scale: 2 mm.


a
b
c
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but proximal 8–12 pinnulars each bearing a flat, round, somewhat distally-directed comb tooth at least as high as width of pinnular bearing it and sometimes 2–3× higher; proximal 3–6 pinnulars short and rhombic; subsequent pinnulars squarish to twice as long as wide but appearing short due to relative height of comb teeth; teeth rarely developed on both sides of pinnular (Fig. 3e). P_2 (Fig. 3d) basally stouter than P_1, up to 10 mm with 18 pinnulars but often only half length of P_1; proximal 2 pinnulars short; third squarish; following of about equal length (except near tip) but with LW increasing from about 1.3 to 4.0 as pinnule tapers; all except basal 2 with finely spinose, expanded, distal margins or with 1 or 2 stout, distal, aboral spines. P_2 occasionally bearing a comb similar to that of P_1 but with fewer, less well-developed teeth or with relatively few, low, distal teeth on pinnulars similar to those of combless P_2 (Fig. 3k). Following pinnules similar to combless P_2 but with second segment becoming abruptly tapered. P_3 slightly longer or shorter than P_2, of about 11 segments. P_4 up to 10 mm with 18 pinnulars. Genital pinnules (Fig. 3i) stouter than distal pinnules. Longest intact distal pinnules incomplete, at least 10 mm with at least 19 segments. P_{13} 6.5 mm with 15 pinnulars on arm of specimen bearing P_4 of 5.5 mm with 11 segments. Interior pinnules similar to exterior ones (Figs. 3a, b, e–i). Single P_a lacking comb and resembling subsequent pinnules though shorter and composed of fewer segments than succeeding P_b (Figs. 3a, b).

Gonads borne on third through sixth to eighth pinnulars from P_4–P_5 (rarely, P_2 or P_3 and, perhaps in one specimen, P_1) to at least P_{13}. Pinnule ambulacra lined with fine, unbranched rods sometimes slightly expanded and perforated at one end.

Tegmen naked; mouth central or subcentral; anus submarginal; a few, small dark saccules present on pinnule ambulacra in two specimens (USNM E548, 34634).

Color.—In life, yellow. In alcohol, white or pale brown, sometimes with dark brown ambulacra, gonads, and tegmen.

Biology.—A. C. Neumann and J. C. Lang, during a DSRV *Alvin* dive, collected a single individual in 580 m clinging to a fragment of the branching, ahermatypic coral *Lophelia prolifera* (Pallas) and in association with large numbers of the small comasterid *Comatilia iridometriformis* A. H. Clark which is usually found on this coral (Messing, unpublished). Most specimens have been collected with the Pourtalès Terrace south of the Florida Keys apparently on hard, sediment-free substrates and usually in association with large numbers of the antedonid *Coccometra hagenii* (Pourtalès).

Material examined.—NORTH CAROLINA: *Fish Hawk* sta. 7302 (USNM 34634, 1 specimen). POURTALES TERRACE (SOUTH OF THE FLORIDA KEYS): *Gerda* sta. 220 (UMML 44-169, 1), *Gerda* sta. 589 (USNM E19178, 1), *Gerda* sta. 840 (USNM E19180, 1), *Gerda* sta. 865

(USNM E19177, 1), *Gerda* sta. 977 [USNM E17863, 1; UMML 44-174, 2 (1 sent to D. B. Macurda, Jr.)], *Gerda* sta. 978 (USNM E19188, 1 dissociated), *Gerda* sta. 1102 (USNM E19971, 4, 1 dissociated), *Fish Hawk* sta. 7298 (USNM 34628, 1), Univ. Iowa Bahama Exped. 1893, sta. 48 (USNM E4290, 1 dissociated, not Univ. Iowa Barbados-Antigua Exped. as labelled; MCZ 747, 1), *Eolis,* J. B. Henderson coll. (USNM E548, 1), No expedition data (MCZ 800, 2; removed from MCZ 755). BAHAMAS: *Alvin* dive 761 (USNM E19181, 1). YUCATAN CHANNEL: *Gerda* sta. 885 (USNM E19179, 1).

Type.—Carpenter (1881) mentioned a new species of *Antedon* undoubtedly referable to *Comatonia cristata* as occurring with *Antedon hagenii* (=*Coccometra hagenii*) in the Straits of Florida. Hartlaub (1912) described in detail a single specimen accompanied by the label "Com. 101, Stn. —" and suggested that it possibly came from the *Challenger* rather than from the *Blake* collection. At the end of his description (p. 475), he gave the locality as unknown.

A. H. Clark re-examined the specimen and reinterpreted the label as reading "Corw. Po. 1, Stn. __" which he identified as *Corwin* station 1P (5 mi. SSW of Sand Key, Florida, 164–183 m, 17 May 1867) (1931:292). He also wrote that Hartlaub had "a single specimen of this species without a locality label," a lapse resulting from Hartlaub's listing of the locality as unknown the *CORWIN* specimen, according to Clark, is in the MCZ (cat. no. 7), but I have not seen it.

Distribution.—Cape Lookout, North Carolina; Straits of Florida; Yucatán Channel. All but 3 specimens were collected on the Pourtalès Terrace south of the Florida Keys. Possible depth range: 14–580 m. Confirmed depth range: 14–580 m. For material collected on the Pourtalès Terrace, the ranges are 146–411 and 152–306 m, respectively. The Cape Lookout specimen was taken in 14 m and the specimen from Arrowsmith Bank, Yucatán Channel in 419–434 m. (Emended from Meyer et al., 1978:417.)

The specimen collected by *Alvin* in 580 m represents the only record from the insular margin of the Straits. Its greater depth relative to continental margin records parallels records for its frequent associate, *Coccometra hagenii.* The latter occurs primarily between 150 and 250 m on the Pourtalès Terrace (locality data for the 2 records in excess of 300 m here fall in less than 250 m on recent bathymetric charts) and as deep as 442 m off Cuba. Two records from the Blake Plateau are still deeper (805 and 1046 m) and one of these includes *Lophelia.*

Discussion.—A. H. Clark (1921, 1931) considered *Comatonia, Comatilia* and *Comatulides* as "primitive generalized" (1921:619) members of the family Comasteridae. He included *Comatonia* in the subfamily Capillasterinae because of its supposed resemblance to the small, 10-armed, monotypic genera *Comatilia* and *Microcomatula* and despite the absence of diagnostic, aboral, cirral processes. *Comatonia* and *Comatilia* both occasionally bear saccules along their ambulacra but the resemblance ends here. *Comatilia* appears to be paedomorphic; its ''generalized'' appearance (e.g., 10 arms, central mouth) along with other characteristics (e.g., large radials, deficient pinnulation, elongated cirrals and brachials) are the result, I believe, of accelerated sexual maturation and persistent juvenile morphology (progenesis *sensu* Gould, 1977) (Messing, unpublished). *Microcomatula mortenseni* A. H. Clark is known from a single, incompletely described specimen. Although discussion of its affinities must await re-examination of the type, the published description (A. H. Clark, 1931) also agrees with specimens of the comb-bearing antedonid *Ctenantedon kinziei* Meyer in some respects.

Comatonia agrees with the suborder Antedonacea and family Antedonidae in all diagnostic characters (Clark and Clark, 1967; Rasmussen, 1978). It also exhibits non-diagnostic traits, including its cirrus arrangement and morphology and prominent synarthrial swellings (Gislén, 1924:229, footnote), found in many antedonids but unknown in the Comasteridae. Its typically antedonid centrodorsal, almost covered with cirrus sockets, occurs in the Comasteridae only in *Microcomatula* which, as mentioned above, also may not belong in this family. Meyer (1972) noted that its radial articular facets and large centrodorsal cavity are characteristically macrophreatine (antedonacean) and agreed with Gislén that its affinities lay with this suborder rather than with the comasterids.

Following Gislén (1924:229, footnote), I believe *Comatonia* most closely approaches the antedonid subfamily Heliometrinae. Although the antedonid subfamilies are not uniformly well-defined, I here follow Clark and Clark's (1967) treatment. Some heliometrine species bear rudimentary or moderately developed combs on their oral pinnules, although these are never nearly as developed as in *Comatonia* and are weaker than in most comasterids. In the latter, comb tooth rudiments usually develop from the middle of the aboral side of the pinnular. In *Comatonia* and the heliometrines *Anthometra* and *Florometra,* the comb teeth develop as modifications of the spinose, distal, aboral margin of pinnulars proximal to the comb. As the teeth increase in size on more distal pinnulars, they expand proximally, occupying more and more of the aboral surface of the pinnular. In *Comatonia,* this derivation is most obvious in small specimens and on comb-bearing P_2 (Figs. 3f, j, k). It is obscured in larger specimens in which pinnulars proximal to the comb lack spinose, distal margins. Figures 4 and 5 show the close resemblance of rudimentary comb teeth and pinnular articular facets in *Comatonia* and the heliometrine *Anthometra adriani* (Bell) as well as the strong distinction between these characters in these two species and corresponding structures in the comasterid *Neocomatella alata* (Pourtalès). The arrow in Fig. 3e indicates an apparently regenerating, comb tooth-bearing pinnular in *Comatonia* that is similar to fully developed teeth in *Anthometra adriani*

Table 1.—Numerical data for 9 specimens of *Comatonia cristata* (Hartlaub) collected by R/V *Gerda*. Arms too broken to estimate total length. "DH" = ratio of basal diameter to height of centrodorsal. "Longest cirral LW" = ratio of greatest length to proximal width. "Arm LW" = ratio of arm width at Br_{3+4} to length from distal edge of radial to Br_{9+10} measured midradially.

Catalog number	CENTRODORSAL		CIRRI						ARMS		P_1		P_2		P_3	
	Diam. (mm)	DH (:1)	No.	Cirrals	Max. length (mm)	Longest cirral	Longest cirral length (mm)	Longest cirral LW (:1)	Width Br_{3+4} (mm)	LW (:1)	No. pinnulars: no. comb teeth	Length (mm)	No. pinnulars: no. comb teeth	Length (mm)	No. pinnulars: no. comb teeth	Length (mm)
USNM E19971	1.3	1.4	L	12	7.5	3–4	1.1	3.5	0.6	7.8	29:20	11	8:none	4 (P_b)	9:none	5.5
USNM E17863	1.7	1.7	LV	16	8	5	0.9	2.8	0.9	6.3	24:15	6	18:none	5.5	11:none	4
UMML 44-169	2.3	1.7	LXII	16	10	5	1.1	3.5	1.1	6.1	22+:14+	6+	—	—	—	—
USNM E17863	2.4	1.6	L	17	10	4	1.0	2.3	1.2	5.4	37:26	8	20:7	6.5	13:none	5
USNM E19177	~2.8	~1.8	LXI	16	10	5	1.0	2.4	1.2–1.3	5.9	35:24	9 (P_a)	10:none	4.5	10:none	5
USNM E19188	3.4	1.4	XC	21	15	5	1.3	3.1	1.7	5.1	52:41	13.5	12:none	6	—	—
USNM E17863	3.8	1.3	LXXX	19	14	5	1.1	2.7	1.7	5.4	47:37	13	—	—	—	—
USNM E19971	4.3	1.4	LXXXIV	22	20	5	1.8	4.0	1.8–2.1	—	44:32	12.5	—	—	—	—
											(regenerating)					
USNM E19971	4.4	1.5	LXXX	22	16	6	1.3	3.1	2.0	5.1	50:41	14	18:none	10	18:none	9

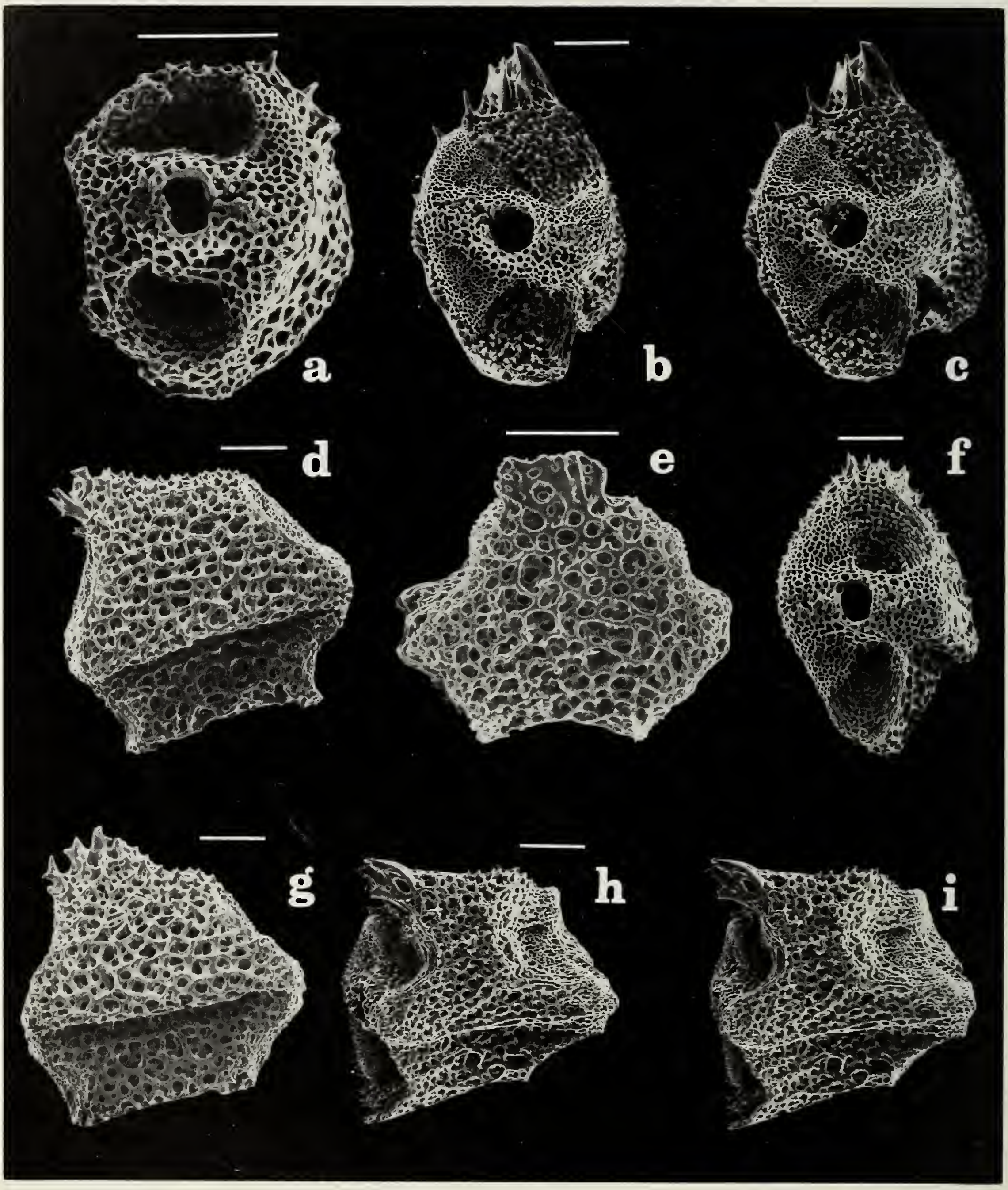

Fig. 4. **a,** Distal articular facet of proximal pinnular, *Neocomatella alata*; **b–c,** Same, *Comatonia cristata,* stereo pair; **d,** Middle pinnular with rudimentary comb tooth, ambulacral view, *Anthometra adriani*; **e,** Same, abambulacral view, *N. alata*; **f,** Distal articular facet of proximal pinnular, *A. adriani*; **g,** Middle pinnular with rudimentary comb tooth (same pinnule but slightly distal to d), ambulacral view, *A. adriani*; **h–i,** Same, *C. cristata,* stereo pair. Scales: 0.1 mm.

(Fig. 4h). In the heliometrine genus *Florometra,* comb teeth normally do not develop beyond the rudimentary, distal, spinose stage.*

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* A. M. Clark (personal communication) has brought to my attention the fact that another antedonid, *Annametra occidentalis* (A. H. Clark) (subfamily Antedoninae), may also bear

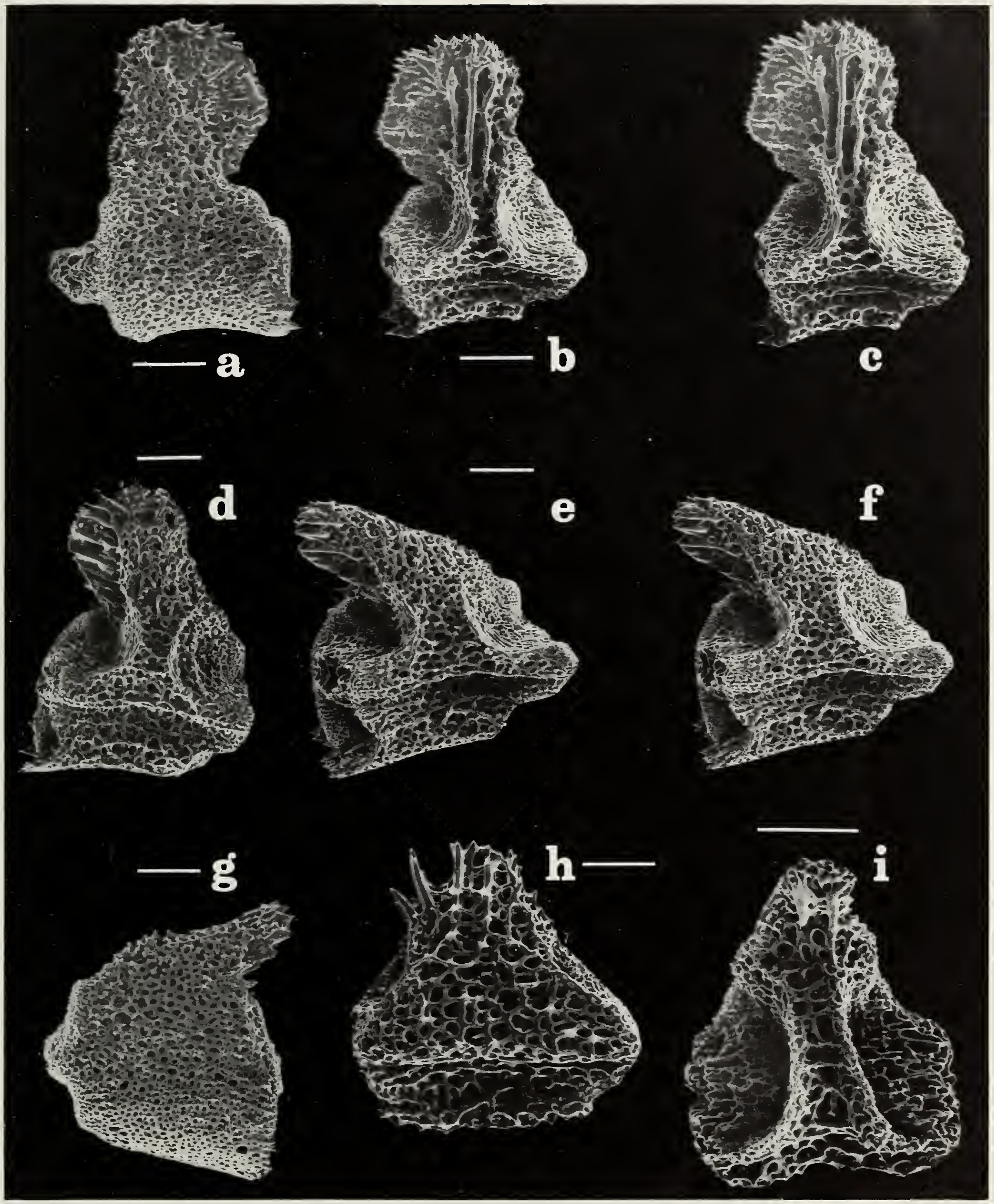

Fig. 5. **a–g,** *Comatonia cristata:* **a,** Distal pinnular with well developed comb tooth, abambulacral view; **b–c,** Same, ambulacral view, stereo pair; **d,** Middle pinnular with moderately developed comb tooth, ambulacral view; **e–f,** Middle pinnular (more proximal than d, with less well developed comb tooth), ambulacral view, stereo pair; **g,** Same, abambulacral view; **h,** *Anthometra adriani* (Bell), distal pinnular with well developed comb tooth, ambulacral view; **i,** *Neocomatella alata* (Pourtalès), same, obliquely ambulacral view. Scales: 0.1 mm.

rudimentary comb teeth on Pl. It appears from Figure 6 in Clark and Clark (1967:95) that these teeth are also derived from the distal aboral pinnular margin as discussed above. I have not yet examined specimens of this species.

Within the Heliometrinae as currently construed, *Comatonia* appears most similar to *Anthometra adriani*. Both bear a median, aboral knob or ridge on the proximal brachials, although these are more prominent and occur on more brachials in *Anthometra*. Both have only the first pair of pinnules modified (rarely, P_2 in *Comatonia*). The radial articular facets of the two species, and of another heliometrine, *Solanometra antarctica* (Carpenter), are also closely similar. The paired, irregular "septa" projecting distally (along the longtiudinal axis of the ray) from the sides of the intermuscular ridge in one specimen of *Comatonia* vary among the facets, appear to represent a secondary deposition of stereom and do not alter the basic architecture of the facet.

The relatively short, slender cirri of *Comatonia* differ from those of other heliometrine species although they do resemble those of juvenile *Anthometra* (centrodorsal diameter 1.5 mm). They are also similar, however, to cirri of the thysanometrine antedonid *Coccometra hagenii*. *Comatonia* and *Coccometra hagenii* have almost identical, restricted ranges: from the Mexican side of the Yucatán Channel to Cape Lookout, North Carolina. They occur sympatrically and in the greatest abundance on the Pourtalès Terrace (Clark and Clark, 1967; Messing, 1975; Meyer et al., 1978). The terrace is largely sediment-free, is subject to strong currents, exhibits some karst-like topography (Jordan, 1954; Jordan et al., 1964; Gorsline and Milligan, 1963) and apparently represents a distinctive, if not unique, environment in the tropical western Atlantic Ocean. That *Comatonia* and *Coccometra hagenii* are virtually the only crinoids ever collected here despite intensive dredging suggests that their cirrus morphology may be adaptively convergent.*

Comatonia conforms least to the Heliometrinae in terms of distribution. It occurs tropically and subtropically at moderate depths, whereas the remaining genera are found in polar, subpolar and cold, eastern Pacific waters. It is morphologically distinct enough, however, to suggest that it diverged from heliometrine stock before they became exclusively cold-water forms. The Bathymetrinae, allied to the Heliometrinae through *Anthometra* according to A. H. Clark (Clark and Clark, 1967), is a primarily deep and cold-water subfamily that includes species that enter warmer water, e.g., *Trichometra cubensis* (Pourtalès). Despite the relatively low latitudes at which it occurs, steep isothermal tilting across the Straits of Florida and Yucatán Channel indicates that *Comatonia* most likely occurs in water of less than 10°C.

Acknowledgments

I am grateful to Drs. Frederick M. Bayer of the Department of Invertebrate Zoology, National Museum of Natural History and Gilbert L. Voss of the University of Miami for making material collected by R/V *Gerda*

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* Despite these similarities, they do not appear to be closely related. In *C. hagenii*, the low hemispheric centrodorsal has a broad, smooth aboral pole; the cirri, though similar to those of *Comatonia*, are more delicate and are lost far more often; the arms, usually broken near the base in *Comatonia*, are far more often preserved in *C. hagenii*. Although P1 in both species is composed of many short pinnulars which may also be adaptively convergent, in *C. hagenii*, as in other thysanometrine species, the corners of the pinnulars are cut away giving the pinnule a distinctively beaded appearance.

available to me and, with Drs. Lowell P. Thomas and Donald R. Moore (both of the University of Miami), for supervising my master's thesis research, part of which is here included. I am indebted to Dr. David L. Pawson also of the Department of Invertebrate Zoology for supervising my postdoctoral research and, with Dr. Robert Woollacott of the Museum of Comparative Zoology, Harvard, for making available material from their respective institutions. The scanning electron micrographs were taken by Ms. Mary-Jacque Mann, of the National Museum of Natural History.

Literature Cited

Carpenter, P. H. 1881. Preliminary Report on the Comatulae.—Bull. Mus. Comp. Zool., Harvard 9(4):151–169; 1 pl.

Clark, A. H. 1916. Seven new genera of echinoderms.—J. Wash. Acad. Sci. 6(5):115–122.

———. 1921. A monograph of the existing crinoids 1(2).—Bull. U.S. Natl. Mus. 82:xxv + 795; 57 pls.

———. 1921. A monograph of the existing crinoids 1(3).—Bull. U.S. Natl. Mus. 82:vii + 816; 86 pls.

———, and A. M. Clark. 1967. A monograph of the existing crinoids 1(5).—Bull. U.S. Natl. Mus. 82:xiv + 860.

Clark, A. M. 1970. Marine Invertebrates of Scandinavia, 3. Echinodermata Crinoidea.—Universitetsforlaget, Oslo. 55 pp.

Clark, H. L. 1918. Report on the Crinoidea and Echinoidea collected by the Bahama Expedition from the Univ. of Iowa in 1893.—Univ. Iowa Monographs. Bull. Lab. Nat. Hist. 7(5):1–37; 5 pls.

Gislén, T. 1924. Echinoderm Studies—Zool. Bidr. Uppsala 9:iv + 316.

Gorsline, D. S., and D. G. Milligan. 1963. Phosphatic deposits along the margin of the Pourtalès Terrace, Fla.—Deep-sea Res. 10:259–262.

Gould, S. J. 1978. Ontogeny and Phylogeny.—Belknap Press, Cambridge, Mass. xvi + 501 pp.

Hartlaub, C. 1912. Reports on the results of dredging . . . by the U.S. Coast Survey Steamer "Blake" . . . XLV. Die Comatuliden.—Mem. Mus. Comp. Zool., Harvard 27(4):275–491; 18 pls.

Jordan, G. F. 1954. Large sinkholes in the Straits of Florida.—Bull. Am. Assoc. Petr. Geol. 38:1810–1817.

Jordan, G. F., R. J. Malloy, and J. W. Kofoed. 1964. Bathymetry and geology of Pourtalès Terrace, Florida.—Mar. Geol. 1(3):259–287.

Messing, C. G. 1975. The systematics and distribution of the Crinoidea Comatulida (exclusive of the Macrophreatina) collected by the R/V Gerda in the Straits of Florida and adjacent waters.—M.S. Thesis, Univ. of Miami, Coral Gables, Fla. 296 pp.

———. 1978. A revision of the comatulid genus *Comactinia* A. H. Clark (Crinoidea: Echinodermata).—Bull. Mar. Sci. 28:49–80.

Meyer, D. L. 1972. *Ctenantedon*, a new antedonid crinoid convergent with comasterids.—Bull. Mar. Sci. 22(1):53–66.

Meyer, D. L., C. G. Messing, and D. B. Macurda, Jr. 1978. Zoogeography of tropical western Atlantic Crinoidea.—Bull. Mar. Sci. 28:412–441.

Rasmussen, H. W. 1978. Articulata *in:* R. C. Moore and C. Teichert, eds., Treatise on Invertebrate Paleonotology, Part T, Echinodermata 2(3):T813–T937.

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A NEW SPECIES OF *TEGASTES* (COPEPODA: HARPACTICOIDA) ASSOCIATED WITH A SCLERACTINIAN CORAL AT ENEWETAK ATOLL

Arthur G. Humes

Abstract.—The harpacticoid copepod *Tegastes acroporanus,* new species, is associated with the scleractinian coral *Acropora florida* (Dana) at Enewetak Atoll. Until now only one harpacticoid species, *Tegastes georgei* Marcus and Masry, 1970, from *Stylophora* and *Pocillopora* in the Gulf of Elat, has been known to be associated with hard corals. The two species of *Tegastes* from corals resemble each other in the form of leg 5 in the female, but differ in the nature of the setae on the exopod of leg 4 and in the degree of sexual dimorphism in the first antenna of the male.

Although many cyclopoid copepods are associated with Scleractinia (Humes, 1979), harpacticoids have not developed associations with hard corals to the same extent. At present the only harpacticoid known to live with corals is *Tegastes georgei* Marcus and Masry, 1970. These authors found it with *Stylophora* and *Pocillophora* in the Gulf of Elat.

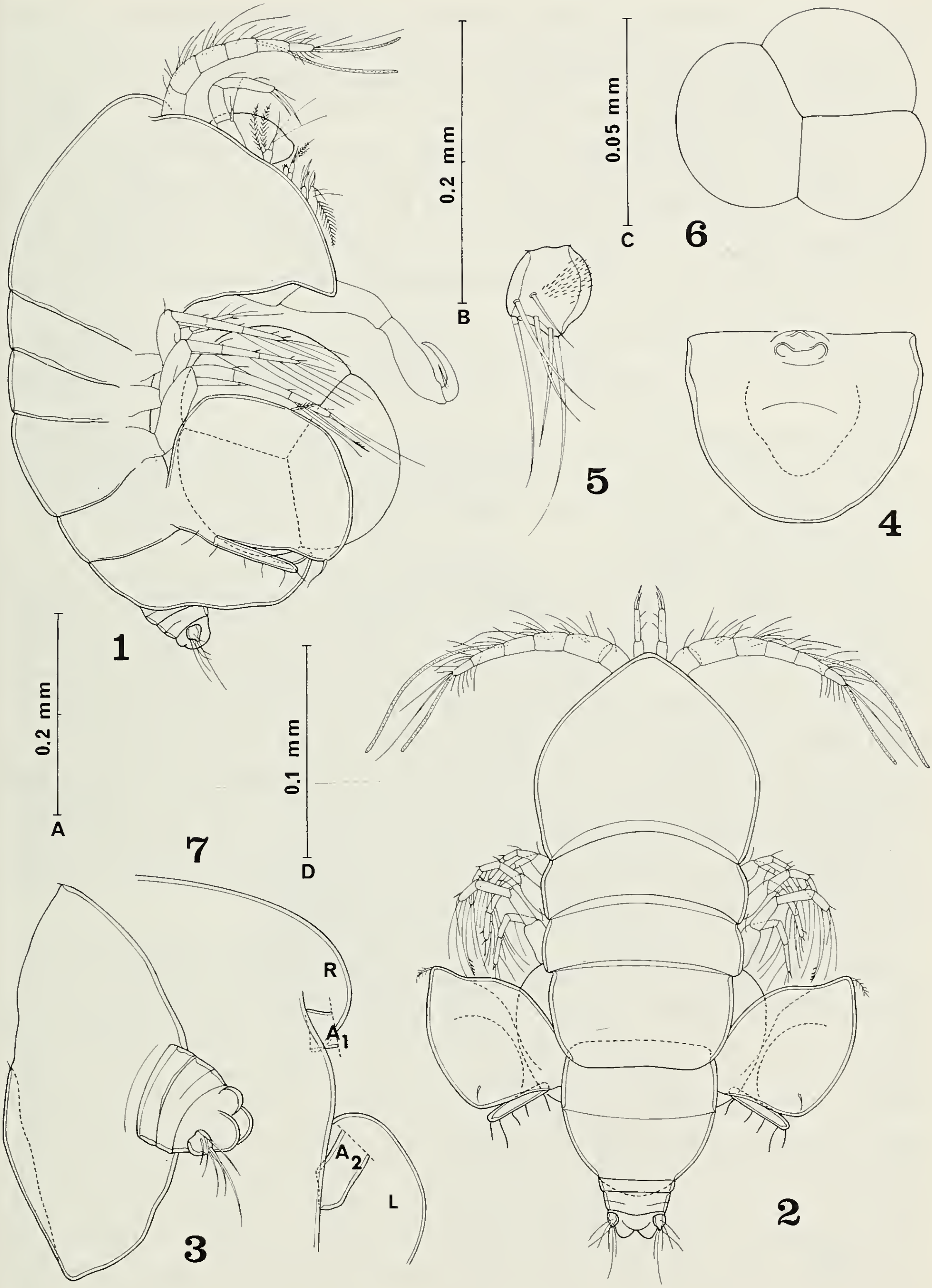
The specimens from the Marshall Islands reported here were collected by the author and Dr. Charles T. Krebs during field work made possible by the support and facilities of the Enewetak Marine Biological Laboratory, Enewetak. (The name of the atoll was formerly spelled Eniwetok.)

I thank Dr. John W. Wells, Department of Geological Sciences, Cornell University, who very kindly identified the coral host.

The observations and measurements were made on specimens cleared in lactic acid. All figures were drawn with the aid of a camera lucida. The letter after the explanation of each figure refers to the scale at which it was drawn. The abbreviations used are: R = rostrum, A_1 = first antenna, A_2 = second antenna, and L = labrum.

Harpacticoida G. O. Sars, 1903
Tegastidae G. O. Sars, 1904
Tegastes Norman, 1903
Tegastes acroporanus, new species
Figs. 1–26

Type-material.—109 ♀♀, 85 ♂♂ from *Acropora florida* (Dana), in 2 m, western end of Bogon Island, Enewetak Atoll, Marshall Islands, 23 June 1969. Holotype ♀, allotype, and 155 paratypes (90 ♀♀, 65 ♂♂) deposited



Figs. 1–7. *Tegastes acroporanus*, female. 1, Lateral (A); 2, Dorsal (A); 3, Genital and postgenital segments, lateral (B); 4, Genital segment, with outline of postgenital segments shown by broken line, ventral (B); 5, Caudal ramus, lateral (C); 6, Egg sac, lateral (A); 7, Rostrum and part of labrum, lateral (D).

in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.; the remaining paratypes in the collection of the author.

Female.—Body (Figs. 1, 2) relatively large. Length 0.54 mm (0.50–0.57 mm) and greatest dorsoventral thickness 0.32 mm (0.30–0.35 mm), based on 10 specimens. Greatest width at level of cephalosome approximately 0.20 mm. Segment of leg 1 fused with cephalosome. Genital segment (Fig. 3) produced ventrally with concave anterior surface. Greatest diagonal length of segment 265 μm. In ventral view genital segment 143 × 165 μm, a little wider than long (Fig. 4). Abdomen (postgenital segments) small, 80 μm long, and 3-segmented (Fig. 3).

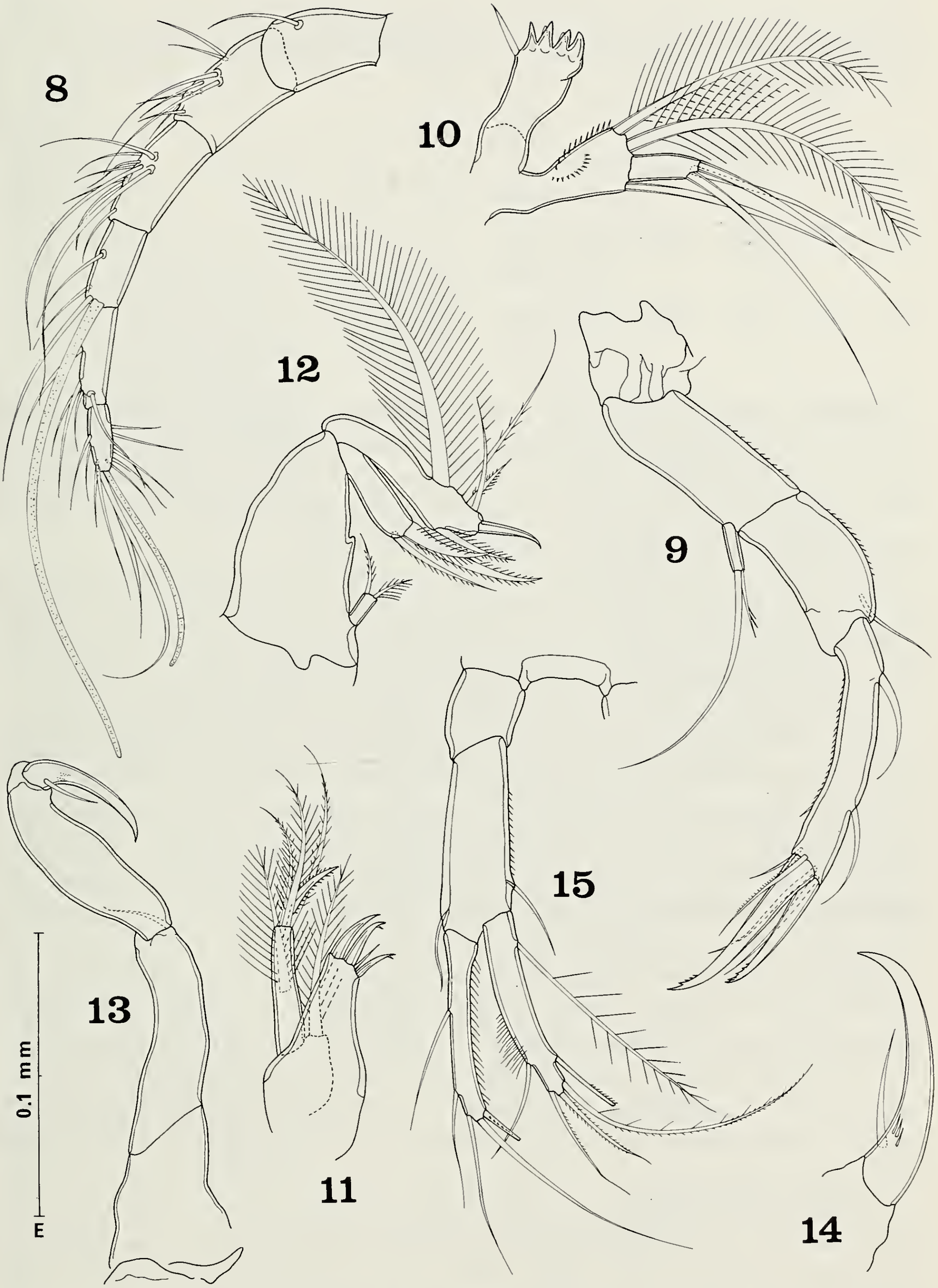
Caudal ramus (Fig. 5) minute, 20 × 20 μm, bearing six smooth setae, longest seta 52 μm. Portion of lateral surface of ramus with very small spinules.

Egg sac (Fig. 6) 240 × 212 μm, usually containing three eggs, each egg approximately 167 × 120 μm. Occasionally only two eggs in egg sac (Fig. 2). Egg sac held between large scooplike fifth legs and anterior concave surface of genital segment.

Rostrum (Fig. 7) a small prominence. First antenna (Fig. 8) 6-segmented and 196 μm long. Lengths of segments (measured along posterior margin): 31 (39 μm along anterior margin), 36, 34, 29, 34, and 24 μm respectively. Armature: 1, 8, 9, 3 + 1 aesthete, 5, and 10 + 1 aesthete. All setae naked.

Second antenna (Fig. 9) 3-segmented and 140 μm long not including terminal spines. Exopod 9 × 3.5 μm, bearing two unequal terminal setae. Endopod with first segment bearing one seta; second segment carrying two marginal setae and having terminally four slender setae and two stout slightly clawlike elements with small inner subapical teeth. Inner margin of basipod and first segment of endopod with row of small spinules; similar spinules along outer margin of second segment of endopod.

Labrum (Fig. 1) prominent. Mandible (Fig. 10) with precoxa armed terminally with a seta and four teeth (two middle teeth with double tips). Coxabasis ornamented with crescentic row of spinules, bearing distally two inner plumose setae and one outer smooth seta. Endopod with three terminal smooth setae. First maxilla (Fig. 11) with precoxa bearing three spines (two of them with a subapical tooth) and one small seta. Coxa with one plumose seta. Basipod with one plumose seta midway along its length and provided terminally with three plumose setae and a barbed spine. Second maxilla (Fig. 12) with syncoxa bearing proximally a small rectangular endite with two setae, followed by a marginal notch and finally by a larger endite bearing three setae. Basis elongate with a terminal smooth clawlike spine and having five setae, one very large with unusually long lateral hairs. Maxilliped (Fig. 13) elongate, approximately 255 μm including coxa. Endopod, or "hand," about 100 μm long. Claw 60 μm and bearing one seta and a few spinules (Fig. 13). Otherwise maxilliped without armature or ornamentation.



Figs. 8–15. *Tegastes acroporanus,* female. 8, First antenna, ventral (E); 9, Second antenna, outer (C); 10, Mandible, anterior (C); 11, First maxilla, posterior (C); 12, Second maxilla, posterior (C); 13, Maxilliped, inner (D); 14, Claw of maxilliped, outer (C); 15, Leg 1 and intercoxal plate, anterior (D).

Leg 1 (Fig. 15) with 1-segmented endopod and exopod. Legs 2–4 (Figs. 16, 18, 19) with 3-segmented rami. Formula for armature as follows:

P_1	coxa	0-0	basis	1-1	exp	2, 3		
					enp	1, 3, 1, 1		
P_2	coxa	0-0	basis	1-0	exp	1-1;	1-1;	1, 3, 2
					enp	0-1;	0-2;	1, 2, 2
P_3	coxa	0-0	basis	1-0	exp	1-1;	1-1;	1, 3, 3
					enp	0-1;	0-2;	1, 2, 3
P_4	coxa	0-0	basis	1-0	exp	1-0;	1-1;	1, 3, 2
					enp	0-1;	0-2;	1, 2, 1

Spinelike setae on all four legs with minutely truncate tips. Exopod and endopod of leg 1 (Fig. 15) about equal in length. Third endopod segment of leg 2 in one female with abnormal armature 2, 2 (Fig. 17). Exopod of leg 4 with distal of two inner setae on third segment enlarged, shaped like a curved blade, with subapical outer teeth (Fig. 19).

Leg 5 (Fig. 20) with greatly enlarged scooplike baseoendopod (Fig. 21) and elongate slender exopod. Baseoendopod approximately 218 × 130 μm, with an outer smooth seta, a plumose inner seta, and a smooth seta at distal outer corner. Exopod 105 × 18 μm, bearing five naked setae.

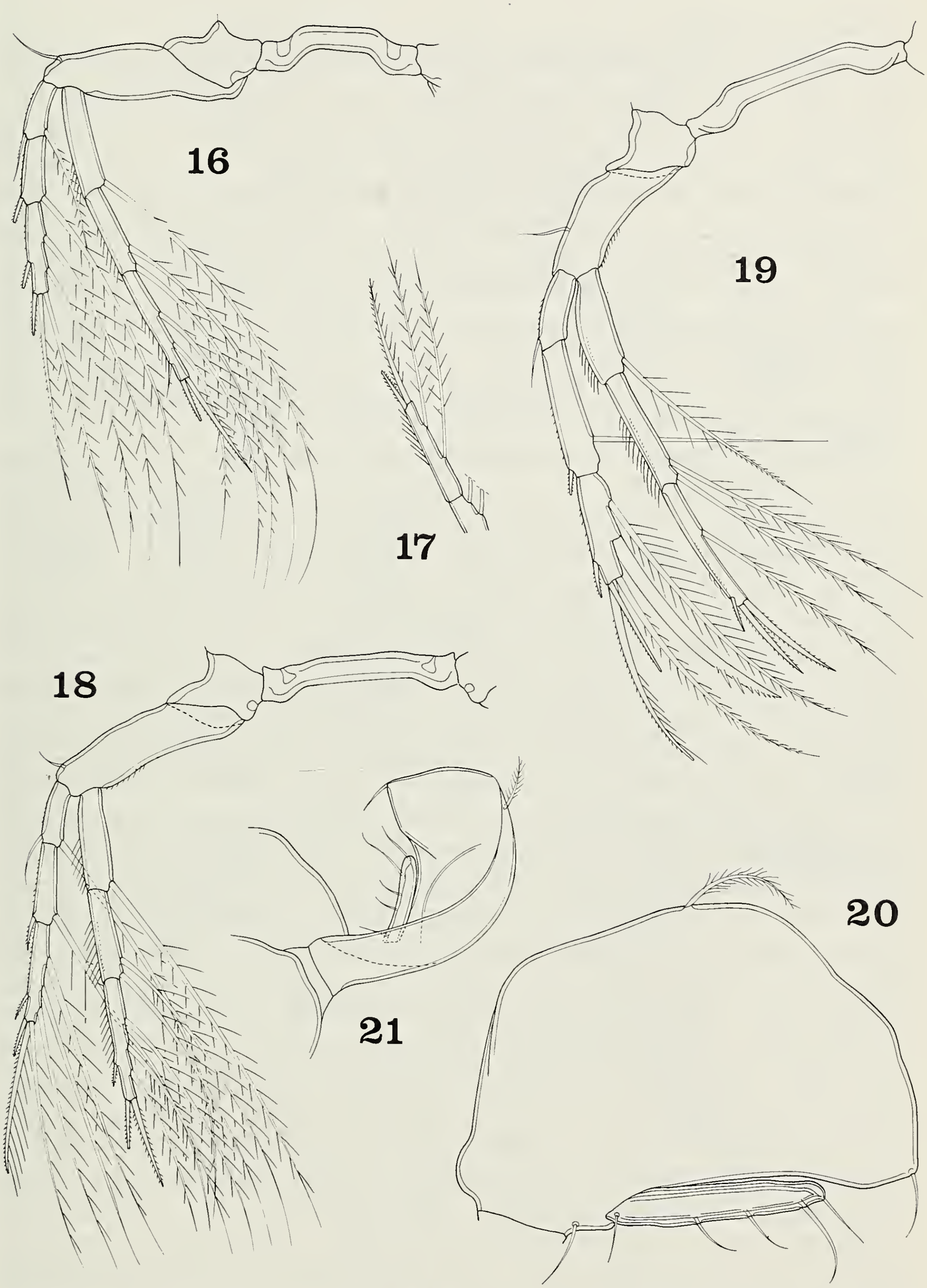
Living specimens in transmitted light opaque gray, eye red, eggs gray.

Male.—Body (Fig. 22) resembling in general form that of female. Length 0.47 mm (0.46–0.48 mm) and greatest dorsoventral thickness 0.28 mm (0.28–0.29 mm), based on 10 specimens. Greatest width at level of cephalosome approximately 0.18 mm. Genital segment produced ventrally, with spermatophore-reservoir divided into anterior foliose lappet concave posteriorly and posterior rounded lobe separated by smaller lobes (Fig. 23). Abdomen and caudal ramus similar to female.

Rostrum like that of female. First antenna (Figs. 24, 25) 7-segmented, 161 μm long, and showing strong sexual dimorphism. Lengths of segments (measured along posterior margin): 33 (36 μm along anterior margin), 31, 17.5, 45, 8, 40.5, and 14 μm respectively. Formula for armature: 1, 8, 6 + 1 aesthete, 9 + 1 aesthete, 1, 3, and 10 + 1 aesthete. All setae naked. Sixth segment with swollen proximal part and recurved, almost clawlike distal part.

Second antenna, labrum, mandible, first maxilla, second maxilla, maxilliped, and legs 1–4 similar to those in female. Abnormalities in armature of legs noted as follows: one male with 1, 2, 1, 1 on endopod of leg 1, and another male with 2, 3 on third segment of endopod of leg 3.

Leg 5 (Fig. 26) with a single seta on baseoendopod. Free segment elongate, 57 × 7 μm, bearing two smooth outer marginal setae and two long unilaterally barbed terminal setae.



Figs. 16–21. *Tegastes acroporanus,* female. 16, Leg 2 and intercoxal plate, anterior (D); 17, Third segment of endopod of leg 2, anterior (D); 18, Leg 3 and intercoxal plate, anterior (D); 19, Leg 4 and intercoxal plate, anterior (D); 20, Leg 5, antero-outer (D); 21, Leg 5, anterior (B).

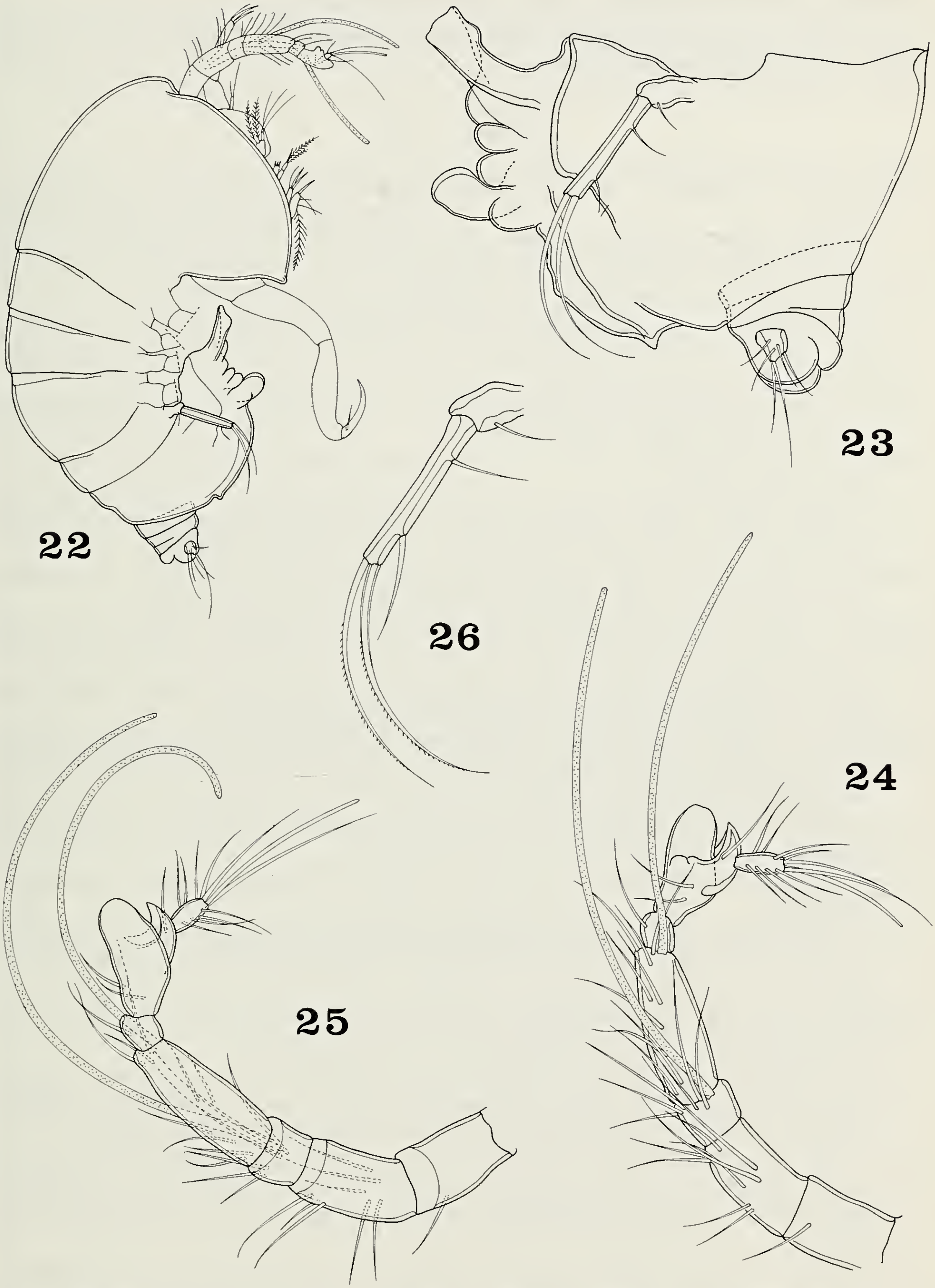
Color as in female.

Etymology.—The specific name *acroporanus* is a combination of the generic name of the host coral and the suffix *-anus,* signifying belonging to.

Remarks.—The genus *Tegastes* Norman, 1903, contains at present 25 valid species. In only 11 of these are both sexes known. In 12 species males are unknown and in two species females have not been described. Most species of *Tegastes* are free-living. However, three species (including the new species described above) are now known to be associated with invertebrates. *Tegastes knoepffleri* Médioni and Soyer, 1967, occurs with the bryozoan *Schizobrachiella sanguinea* (Norman) at Banyuls in southern France (Médioni and Soyer, 1967). *Tegastes georgei* Marcus and Masry, 1970, lives on the scleractinian corals *Stylophora* sp. and *Pocillopora* sp. in the Gulf of Elat, Red Sea (Marcus and Masry, 1970).

The expanded nature of the baseoendopod of the fifth leg in the female serves to distinguish *Tegastes acroporanus* from 15 species in which females are known and where the baseoendopod is not expanded and in some cases is triangular and tapered distally. These species are: *T. areolatus* Monard, 1935, *T. brasiliensis* Jakobi, 1953, *T. calcaratus* Sars, 1910, *T. clausi* Sars, 1904, *T. dalmatinus* Petkovski, 1955, *T. elenae* Marcus, 1963, *T. falcatus* (Norman, 1868), *T. flavidus* Sars, 1904, *T. grandimanus* Sars, 1904, *T. longimanus* (Claus, 1863), *T. nanus* Sars, 1904, *T. neapolitanus* (Claus, 1863), *T. pulcher* Pesta, 1932, *T. riedli* Pesta, 1959, and *T. tenuis* Pesta, 1932. The remaining 10 species may be separated from the new species on other grounds. In *T. andrewi* (T. Scott, 1894) the inner margin of the hand of the maxilliped has a curved spiniform process and a dilated appendage. In *T. chalmersi* Thompson and A. Scott, 1903, the length of the female is 0.3 mm and the hand of the maxilliped has spinules along the inner edge. In *T. georgei* Marcus and Masry, 1970, the third segment of the exopod of leg 4 bears a forked seta. In *T. knoepffleri* Médioni and Soyer, 1967, the maxilliped has several spines and a ciliated cup on the second segment. In *T. minutus* Sewell, 1940, the length of the female is 0.29 mm and the hand of the maxilliped is produced proximally. In *T. perforatus* Lang, 1935, the male first antenna is 8-segmented with the last 3 segments relatively unmodified. In *T. porosus* Petkovski, 1955, the female genital segment is drawn out into 2 spikes. In *T. satyrus* (Claus, 1860) the baseoendopod of the fifth leg in the female is narrow, of about equal length throughout, and rounded terminally. In *T. seurati* Monard, 1936, the baseoendopod of leg 5 in the female is quadrangular and the hand of the maxilliped is swollen proximally. In *T. edmondsoni* Pesta, 1932, the hand of the maxilliped bears spinules along the inner side.

A close relationship between *Tegastes acroporanus* and *T. georgei* is suggested by the nature of leg 5 in the female. *T. acroporanus* differs from the Red Sea species in having 6 apical setae on the endopod of the second



Figs. 22–26. *Tegastes acroporanus*, male. 22, Lateral, with legs 1–4 amputated (A); 23, Urosome, lateral (D); 24, First antenna, ventral (E); 25, First antenna, dorsal (E); 26, Leg 5, lateral (E).

antenna, in having 6 setae (none of them forked) on the third exopod segment of leg 4, and in showing strong sexual dimorphism in the sixth segment of the first antenna of the male.

Literature Cited

Claus, C. 1860. Beitraege zur Kenntniss der Entomostraken.—Erstes Heft, pp. 1–28. Marburg.

———. 1863. Die frei lebenden Copepoden mit besonderer Berücksichtigung der Fauna Deutschlands, der Nordsee und des Mittelmeeres.—pp. 1–230. Leipzig.

Humes, A. G. 1979. Coral-inhabiting copepods from the Moluccas, with a synopsis of cyclopoids associated with scleractinian corals.—Cah. Biol. Mar. 20:77–107.

Jakobi, H. 1953. Neue Tegastiden (Harpacticoida-Copepoda) von der Kueste Santa Catarinas (Brasilien).—Dusenia 4:173–180.

Lang, K. 1965. Copepoda Harpacticoidea from the Californian Pacific coast.—Kungl. Svenska Vetensk. Akad. Handl. 10(2):1–560.

Marcus, A. 1963. *Tegastes elenae* n. sp. harpacticoïde nouveau de la Mer Noire.—Vie et Milieu 14:561–569.

———, and D. Masry. 1970. *Tegastes georgei* n. sp. a new harpacticoid (Crustacea, Copepoda), found on corals in the Gulf of Elat.—Israel J. Zool. 19:169–174.

Médioni, A., and J. Soyer. 1967. Copépodes harpacticoïdes de Banyuls-sur-Mer. 6. Nouvelles formes associeés à des bryozoaires.—Vie et Milieu, ser. A, 18:317–343.

Monard, A. 1935. Les harpacticoïdes marins de la région de Salammbô.—Bull. Stat. Océanogr. Salammbô, no. 34, pp. 1–94.

———. 1936. Note préliminaire sur la faune des harpacticoïdes marins d'Alger.—Bull. Trav. Stat. d'Aquiculture et de Pêche de Castiglione, Alger, pp. 47–85.

Norman, A. M. 1869. Shetland final dredging report.—Part II. On the Crustacea, Tunicata, Polyzoa, Echinodermata, Actinozoa, Hydrozoa, and Porifera.—Rept. 38th Mtg. Brit. Assoc. Adv. Sci., 1868, pp. 247–336.

———. 1903. New generic names for some Entomostraca and Cirripedia.—Ann. Mag. Nat. Hist., ser. 7, 11:367–369.

Pesta, O. 1932. Marine Harpacticiden aus dem Hawaiischen Inselgebiet.—Zool. Jahrb. (Syst.) 63:145–162.

———. 1959. Harpacticiden (Crust. Copepoda) aus submarinen Höhlen und den benachbarten Litoralbezirken am Kap von Sorrent (Neapel).—Pubbl. Staz. Zool. Napoli 30 suppl.:95–177.

Petkovski, T. K. 1955. Weitere Beiträge zur Kenntnis der Grundwasser-Copepoden der adriatischen Küste.—Acta Mus. Maced. Sci. Nat. 3:209–225.

Sars, G. O. 1903. An account of the Crustacea of Norway with short descriptions and figures of all the species. V. Copepoda Harpacticoida. Parts I and II Misophriidae, Longipediidae, Cerviniidae, Ectinosomidae (part), pp. 1–28. Bergen Museum, Bergen.

———. 1904. An account of the Crustacea of Norway with short descriptions and figures of all the species. V. Copepoda Harpacticoida. Parts V and VI Harpacticidae (concluded), Peltidiidae, Tegastidae, Porcellidiidae, Idyidae (part), pp. 57–80. Bergen Museum, Bergen.

———. 1910. An account of the Crustacea of Norway with short descriptions and figures of all the species. V. Copepoda Harpacticoida. Parts XXIX and XXX Tachidiidae (concluded), Metidae, Balaenophilidae, Supplement (part), pp. 337–368. Bergen Museum, Bergen.

Scott, T. 1894. Report on the Entomostraca from the Gulf of Guinea, collected by John Rattray, B.Sc.—Trans. Linn. Soc. London, 2nd ser. zool., 6(1):1–161.

Sewell, R. B. S. 1949. The littoral and semiparasitic Cyclopoida, the Monstrilloida and Notodelphyoida.—John Murray Exped., 1933–1934, Sci. Repts., 9:17–199.

Thompson, I. C., and A. Scott. 1903. Report on the Copepoda collected by Professor Herdman, at Ceylon, in 1902.—Rept. Govt. Ceylon Pearl Oyster Fish. Gulf of Manaar, Suppl. Repts. 7:227–307.

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94(1), 1981, pp. 264–275

THREE NEW SPECIES OF THE *EVIOTA EPIPHANES* GROUP HAVING VERTICAL TRUNK BARS (PISCES: GOBIIDAE)

Susan J. Karnella and Ernest A. Lachner

Abstract.—Three new species of gobiid fishes of the genus *Eviota* Jenkins from Indo-Pacific marine waters are described, namely, *E. disrupta, E. fasciola,* and *E. irrasa.* These species are related to the *E. epiphanes* group, sharing a number of meristic and morphological characters, including the cephalic sensory pore system. They are distinguished from each other and from *E. epiphanes* by the presence, size, shape, and intensity of particular color marks, especially the dark mark or marks on the fleshy base of the pectoral fin, and the dark vertical bars on the trunk. The salient differences in the color patterns of preserved specimens of these four allopatric species are compared and illustrated, and their distributions are plotted on a map.

In this study we treat three new species that resemble *Eviota epiphanes* Jenkins in certain color characters and share many meristic and morphological characters (Group I, Lachner and Karnella, 1980). The shared characters are: complete sensory pore system for *Eviota*; branching of certain pectoral rays; male genital papilla nonfimbriate; vertebrae total 26; dorsal-anal fin ray formula 9/8; pelvic fin rays always I,4; interradial pelvic fin membrane reduced; segments between consecutive branches of the fourth pelvic fin ray usually 1; no elongation of the first dorsal fin; and five ventral midline spots. These four species may superficially resemble each other in preserved color pattern, depending upon the state of preservation or degree of development of particular color marks. These similarities may be observed in the following characters: the presence of bars dorsally on the head and nape; the presence of at least short bars or saddles along the dorsal midline of the trunk; the head, laterally and ventrally, having large scattered chromatophores, often arranged in clusters forming spots; caudal peduncle with a well developed dark subcutaneous spot that is integrated with a weak to strong subcutaneous vertical bar; and the first dorsal fin with a dark, irregularly mottled or barred pattern.

We find that meristic and morphometric characters are not useful in distinguishing these species. The discriminating characters segregating the species are specific color marks, primarily the type of mark on the fleshy base of the pectoral fin and the development, uniformity, and intensity of the vertical trunk bars. Color differences of the 3 new species and *E. epiphanes* are shown in Table 1.

Table 1.—Differences in color pattern among four species of the *Eviota epiphanes* group.

Character	*epiphanes*	*fasciola*	*disrupta*	*irrasa*
Development and description of mark on fleshy pectoral fin base	weak; few chromatophores on upper portion	well developed; single large spot; kidney shaped to semicircular	well developed; two spots; circular; discrete	well developed; two spots; oval to circular; not discrete
Intensity of pectoral base mark compared to other body pigmentation	equal to or less than	darker than	darker than	equal to
Development of trunk bars:				
length	reduced to saddles	to lower body	to lower body	at most, to lower body anteriorly, to upper body posteriorly
discreteness	not applicable	discrete	discrete	not discrete
uniformity	not applicable	uniform	interrupted anteriorly	uniform
Branchiostegal mark	absent	present	present	present
Scale pocket pigmentation	present; well developed	absent	absent	present; weakly developed
Pale area on posterior opercle and anterior pectoral base	absent	present	present	present

Methods

The methods of obtaining counts and measurements and the presentation of these data are given by Lachner and Karnella (1978, 1980). Detailed analysis of particular color marks was accomplished by recording pertinent data for each specimen. The specific color marks investigated were the following: dark mark on fleshy base of pectoral fin, its shape, intensity, if double or single, and relative size; transverse bars on head, dorsally, and nape, their intensity, density (whether less dense centrally than marginally), continuity over dorsal midline, if broken into spots laterally, or more intensely pigmented laterally; dark vertical bars on trunk, their discreteness (if sharply separated from pale interspaces), uniformity (if complete bars or broken laterally into vertical, oblong marks), continuity over dorsal midline, length of bars from dorsal midline ventrally, width of bars relative to pale interspaces, density of bars, and presence of two narrow bars at base of caudal fin; presence of pigmentation on the scale pockets, and the integration of this pigmentation with the trunk bars; presence of scattered chromatophores, clusters of chromatophores forming spots, or intermediate conditions, on cheek, opercle and ventral portion of head; dark mark on lower opercle and branchiostegal membranes, the degree of development and intensity relative to cheek pigmentation; and the nature of the pigmentation and its intensity on the anal and first and second dorsal fins.

The description of the cephalic sensory pore systems and the cutaneous papillae systems follow Lachner and Karnella (1978, 1980).

Eviota disrupta, new species

Fig. 1

Material examined.—229 specimens from several localities in eastern Oceania; total size range 8.1–16.1 mm; no gravid females found.

Holotype.—USNM 220912, (15.4), male; Society Is., Bora-Bora, south edge of Passe Teavanui, 6 Apr. 1970, C. L. Smith and R. Mathews, S70-13.

Paratypes.—All paratypes from same collection as holotype, originally consisting of 181 specimens (AMNH), distributed as follows: USNM 220567, 60 (8.8–16.1). ANSP 143060, 5 (12.9–15.3). AMS I.21421-001, 5 (11.1–14.8). BPBM 22891, 5 (11.8–15.3). CAS 45395, 5 (11.0–15.4). AMNH 39133, 100 (9.1–16.1).

Nontype material.—SOCIETY ISLANDS: Raiatea: USNM 220571, 1 (11.5). Huahine Nui: USNM 220570, 1 (14.7); AMNH 39134, 1 (14.6), S70-2; AMNH 39136, 1 (13.1), S70-3. Moorea: CAS 45397, 1 (12.5), sta. 67, GVF Reg. 1143; USNM 220569, 1 (12.4); CAS 45401, 4 (11.7–15.4), sta. 20, GVF Reg. 1352; AMNH 39135, 3 (8.1–13.7), S70-64. Maiao: CAS 45409, 2 (12.2, 13.4), sta. 21, GVF Reg. 1353. Tahiti: CAS 45411, 2 (13.3, 15.2), sta. 18, GVF Reg. 1350; CAS 45410, 1 (14.5), sta. 84, GVF Reg. 1160; BPBM

Fig. 1. *Eviota disrupta:* upper, USNM 220912, holotype, male, 15.4 mm SL, Bora-Bora; lower, USNM 220567, paratype, male, 15.3 mm SL, Bora-Bora.

8630, 4 (11.5–14.5). Raroia: CAS 45414, 4 (11.5–12.6), sta. 58, GVF Reg. 112. MANGAREVA: BPBM 13587, 2 (13.4, 13.5); BPBM 13556, 1 (14.7); BPBM 13546, 3 (10.0–11.8); BPBM 13548, 4 (13.9–14.0). SAMOA ISLANDS: Tutuila: USNM 220996, 10 (11.2–14.4); BPBM 11309, 1 (12.3). TONGA ISLANDS: USNM 220565, 1 (13.2), *Te Vega* Cr. 7, sta. 301.

Diagnosis.—Base of pectoral fin with two sharply defined, circular dark spots, clearly separated, of about equal size; pectoral spots intensely pigmented, more so than trunk bars; head (dorsally) and nape with large dark spots, usually arranged transversely and discontinuous along dorsal midline; trunk with dark, discretely outlined, vertical bars, some of which are almost always irregularly broken into elongate, oval or oblong shaped marks on the anterolateral portion of the body; trunk bars extending ventrally below midside of body and often discontinuous over dorsal midline on anterior part of trunk; scale pockets on trunk not pigmented.

Description.—Dorsal fin VI-I,8(1), VI-I,9(*14*); anal fin I,7(1), I,8(*14*); pectoral fin 16(4), 17(*11*); pelvic fin I,4(*14*); fourth ray of pelvic fin with 8–11 branches, average 9.4; number of segments between consecutive branches of fourth pelvic fin ray 0–2, average 1.1; pelvic fin membrane reduced; branched caudal fin rays 11(1), 12(3), 13(*4*), 14(1); segmented caudal fin rays 16(1), 17(*14*); scales highly deciduous, lateral scale rows 23(1), 24(1), 25(1); transverse scale rows 8(1); breast scaleless.

Spinous dorsal fin not elongate. Depressed pelvic fin rarely extending to origin of anal fin, never beyond.

Cephalic sensory pore system is pattern 1; cutaneous papillae system is pattern A.

Male genital papilla not fimbriate.

Vertebrae 10(7) precaudal, 16(7) caudal, total 26(7).

Color in preservative.—This species is similar in general color pattern to *E. fasciola* and *E. irrasa* except for the following characters: the pectoral base almost always has two discrete dark circular spots, the upper one larger or equal to the lower spot, and the spots are the most intense body pigmentation; in a few specimens the pectoral spots are weakly connected by less dense chromatophores; first and third transverse nape bars anterior to the dorsal fin origin are frequently separated along the midline forming spots laterally, the second bar often short and continuous over dorsal midline; trunk bars discretely outlined, irregularly interrupted anteriorly forming elongate vertical marks, and more regular posteriorly; bars usually extending below lateral midline, and sometimes discontinuous over dorsal midline; trunk bars sometimes with less dense or pale interiors; dark spot on lower opercle and branchiostegal membrane is conspicuous and often divided into two parts or nearly so; a small, sixth subcutaneous ventral midline spot may be present at the base of the procurrent caudal fin rays, but is never associated with a subcutaneous bar.

Color in life.—The following observations on color of a living specimen from Samoa (USNM 220996) were recorded by R. Wass: body greenish-yellow, operculum bluish-green, bars and spots brown.

Geographic distribution.—This species occurs in eastern Oceania (Figure 6) from the Samoa and Tonga Islands eastward to Mangareva.

Etymology.—The specific epithet, *disrupta* is Latin, meaning "broken up," in reference to the pattern of the vertical trunk bars.

Eviota fasciola, new species

Figs. 2 and 3

Material examined.—345 specimens from the Great Barrier Reef, Australia, and numerous localities in western Oceania; total size range 7.8–19.1 mm; smallest gravid female 13.6 mm SL.

Holotype.—USNM 220560, (18.0), male; One Tree Island, Queensland, Australia, 22 Nov. 1966, V. G. Springer, 66-7.

Paratypes.—All paratypes were collected from the Great Barrier Reef, Queensland, Australia. ONE TREE ISLAND: USNM 220564, 25 (10.2–19.1); CAS 45396, 5 (12.5–17.7); WAM P26843-001, 5 (11.2–16.8); previous three lots from same collection as holotype. USNM 220563, 31 (11.4–18.0), VGS 66-16; AMS I.15641-049, 1 (17.5). HERON ISLAND: LACM 32820-8,

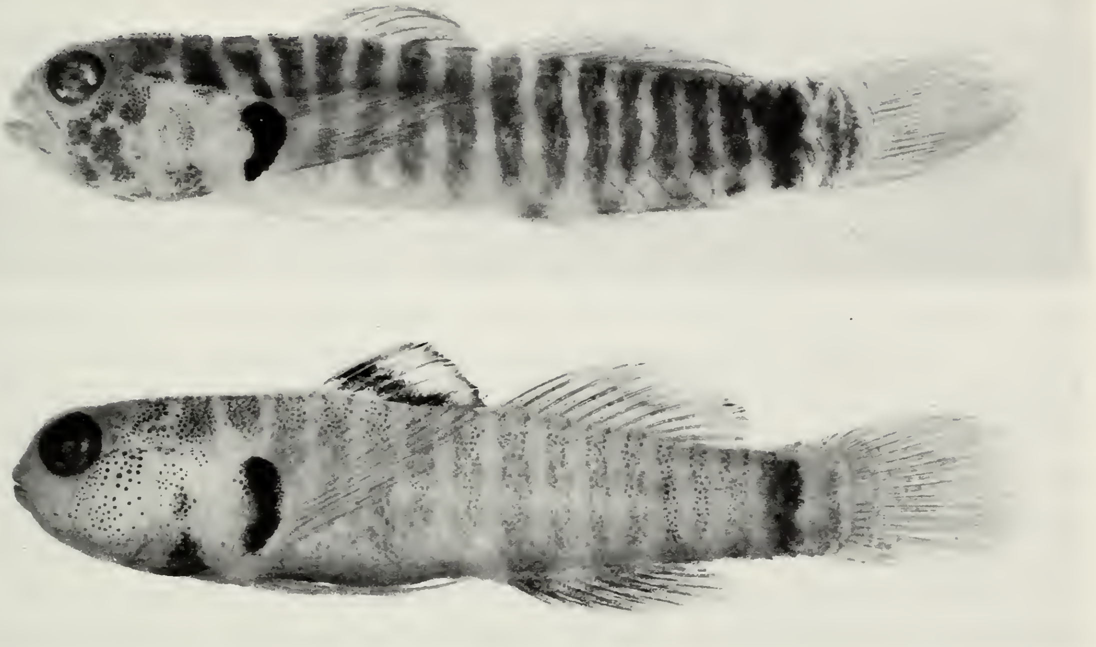

Fig. 2. *Eviota fasciola:* upper, USNM 220560, holotype, male, 18.0 mm SL, One Tree Island; lower, USNM 220559, paratype, female, 13.5 mm SL, Lizard Island.

2 (16.4–16.5). ENDEAVOUR REEF (collected by J. Tyler and C. L. Smith in 1969): ANSP 143059, 4 (13.5–15.3), TS,A-17; ANSP 143058, 11 (10.5–15.4), TS,A-13; ANSP 143057, 1 (12.4), TS,A-6; AMNH 39132, 1 (13.6), S69-19; LIZARD ISLAND (collected by Australian Museum team in 1975): AMS I.21422-001, 15 (10.2–17.6), DFH 75-14; AMS I.19473-177, 103 (9.3–16.9), LZ 75-60; USNM 220559, 11 (11.8–16.5), LZ 75-70; USNM 220955, 3 (10.4–12.4), LZ 75-17; AMS I.19483-071, 76 (10.2–17.8), LZ 75-71.

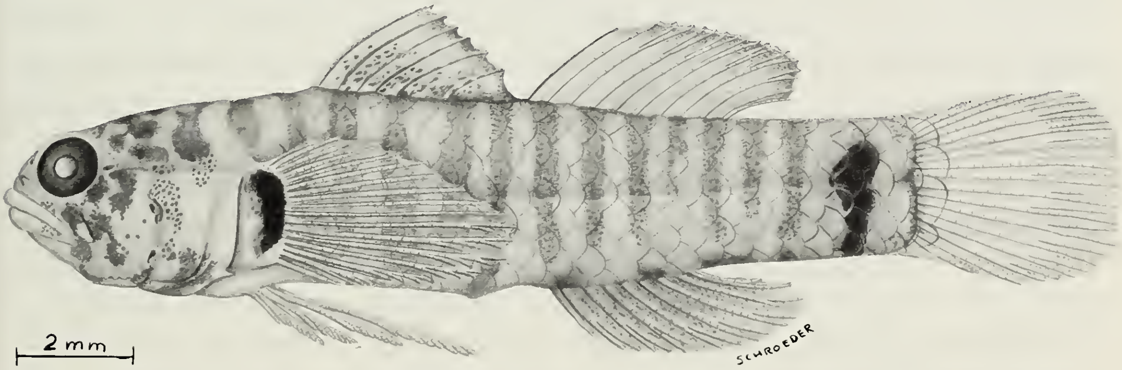

Fig. 3. *Eviota fasciola,* ANSP 143059, paratype, male, 15.3 mm SL, Endeavour Reef. (Drawn by J. R. Schroeder)

Other material.—PALAU ISLANDS: CAS 45407, 1 (12.1), Ngadarak Reef, sta. 106, GVF Reg. 612. ULITHI ATOLL: CAS 45400, 7 (11.5–13.8), sta. 178, GVF Reg. 975; CAS 45403, 10 (10.1–13.4), sta. 181, GVF Reg. 978; CAS 45412, 4 (11.5–12.9), sta. 179, GVF Reg. 976. IFALUK ATOLL: CAS 45402, 2 (11.9–12.5), sta. 76, GVF Reg. 379; CAS 45406, 1 (11.3), sta. 7, GVF Reg. 128; CAS 45413, 1 (9.1), sta. 109, GVF Reg. 230. MARIANAS ISLANDS: Saipan: CAS 45405, 7 (11.1–14.9), sta. 47, GVF Reg. 833; CAS 45399, 14 (9.2–16.0), sta. 46, GVF Reg. 832. USNM 149916, 13 (8.9–14.6); USNM 150022, 1 (12.0). Guam: CAS 45398, 8 (8.6–14.7), sta. 59-28, GVF Reg. 1856; UG 4512, 10 (8.7–15.6). AMS 18403-001, 2 (14.1, 15.3). MARSHALL ISLANDS: Enewetak Atoll: AMS I.18405-001, 1 (14.7); AMS 18401-003, 1 (14.5); USNM 220558, 2 (12.9, 13.7); BPBM 8241, 2 (13.5, 14.8); USNM 220562, 3 (13.3–14.7); LACM W63-281-2, 1 (14.8); LACM 6679-61, 6 (8.7–15.3); USNM 220568, 4 (10.4–15.5); LACM W63-283-4, 2 (10.9, 14.5). Majuro Atoll: AMS I.18399-001, 1 (14.0). GILBERT ISLANDS: Abaiang Atoll: AMS I.18052-001, 15 (8.9–15.5). TROBRIAND ISLANDS: AMS I.17102-052, 1 (15.4); USNM 220561, 2 (10.6, 14.2).

Tentative identifications.—KAPINGAMARANGI ATOLL: CAS 45408, 10 (7.8–11.9), sta. 62, GVF Reg. 365; CAS 45404, 2 (9.1, 9.5), sta. 8, GVF Reg. 311.

Diagnosis.—Base of pectoral fin with large dark kidney shaped to semicircular mark; intensity of pectoral mark greater than that of trunk bars; head (dorsally) and nape with dark transverse bars, usually complete over dorsal midline, occasionally one or more bars broken up into spots laterally, and about one-half of the specimens with spots or bars darker laterally than dorsally; trunk with prominent dark, discrete vertical bars, descending to ventral portion of body and continuous over dorsal midline; scale pockets on trunk not pigmented.

Description.—Dorsal fin VI-I,8(3), VI-I,9(*15*); anal fin I,8(*17*), I,9(1); pectoral fin 16(*7*), 17(11); pelvic fin I,4(*19*); fourth ray of pelvic fin with 6–12 branches, average 9.1; number of segments between consecutive branches of the fourth pelvic fin ray 0–2, average 1.1; pelvic fin membrane reduced; branched caudal fin rays 11(3), 12(*6*), 13(3); segmented caudal fin rays 17(*17*); lateral scale rows 23(1), 24(5), 25(*1*); transverse scale rows 6(*3*); breast scaleless.

Spinous dorsal fin not elongate. Depressed pelvic fin usually not extending to origin of anal fin, never beyond it.

Cephalic sensory pore system is pattern 1; cutaneous papillae system is pattern A.

Male genital papilla not fimbriate.

Vertebrae 10(*9*) precaudal, 16(*8*), 17(1) caudal, total 26(*8*), 27(1).

Color in preservative.—Specimens from Australia almost always have an intensely pigmented kidney-shaped spot, rarely a semicircular spot, extending over the height of the pectoral base, the upper portion usually wider. The pectoral spot is the most prominent mark on the body. In a few of the type specimens the pectoral spot is more heavily pigmented on the upper and lower portions than the middle portion, and rarely the mark is divided into upper and lower spots on specimens from Lizard Island. A pale area almost always lacking chromatophores is present on anterior part of base of pectoral fin and posterior portion of opercle. A dark circular spot occurs on the upper portion of the mesial surface of base of the pectoral fin. Head and trunk with prominent vertical dark bars, usually wider than the pale interspaces; 12–13 trunk bars from origin of spinous dorsal fin to midpeduncular spot, extending from dorsal midline to ventral portion of trunk, the last bar overlying the dark subcutaneous peduncle spot. Usually a small dark spot bordering upper procurrent rays just posterior to last bar and two narrow vertical bars at base caudal fin, the posterior one on bases of caudal fin rays; spot and bars are often undeveloped. The trunk bars may be reduced in size and intensity in some specimens, or they may have pale interiors, and the trunk pigmentation occasionally may be obscure, but the head and pectoral base marks persist. Three dark transverse bars on nape anterior to the origin of the spinous dorsal fin; a fourth, the anteriormost bar on the occipital area, usually present but often more irregular than other bars on nape and sometimes segmented into patches laterally and dorsally along the midline. A dark triangular mark is present immediately above and behind the eyes. One or more of the nape bars may be broken into spots and/or intensely pigmented laterally. Cheek with 6–7 large patches of chromatophores, a large diffuse patch on anterior part of opercle and a heavily pigmented patch on lower margin of opercle and overlapping branchiostegal membrane. Cheek, opercle and branchiostegal patches may be irregularly arranged in some specimens. Lower part of head and chin with patches of chromatophores similar to those on cheek. Five subcutaneous spots on ventral midline from origin of anal fin to end of caudal peduncle, associated with subcutaneous bars on lower part of trunk; bars absent from upper part of trunk. The fifth spot and lower subcutaneous bar are continuous with the caudal peduncle spot. Fins of the Australian specimens often pale, lacking prominent coloration. Spinous dorsal fin pale or with a diffuse dusky oblique band through the lower portion, the anterior basal portion, as well as the outer half, pale or dusky to brown, the margin sometimes darker. Second dorsal and anal fins dusky to pale. The remaining fins may have the rays bordered with fine chromatophores, otherwise they are pale.

The specimens from Trobriand Islands have a semicircular spot at the base of the pectoral fin, the anterior margin of which is nearly vertical. The nape and trunk bars may be discontinous along the dorsal midline.

Specimens from western Oceania, from the Palau to the Gilbert Islands (Fig. 6), have a more variable shaped pectoral spot, ranging from semicircular or oblong to somewhat kidney shaped; a specimen from the Gilbert Islands has the upper and lower portions of the spot enlarged with a central constriction, suggesting a two-spotted condition. The pectoral spot is less intense than in the Australian specimens, often equal in intensity to the trunk bars.

The only sexual dimorphism in coloration observed was that the females may be slightly paler.

Geographic distribution.—This species occurs in western Oceania from the Palau to the Gilbert Islands, the Trobriand Islands, and the Great Barrier Reef (Fig. 6).

Etymology.—The specific epithet is taken from the Latin word *fascia,* in reference to the bands nearly encircling the trunk.

Eviota irrasa, new species
Figs. 4 and 5

Material examined.—7 specimens from the Philippine Islands; total size range 12.3–17.6 mm; no gravid females found.

Holotype.—USNM 220566, (16.0), male; Philippine Is., Palawan Prov., Cocoro I. (Cuyo Is.); 25 May 1978, V. G. Springer and Smithsonian team, SP 78-26.

Paratypes.—USNM 220954, 5 (12.3–17.6); data as for holotype. USNM 220582, 1 (17.4), Philippine Is., Palawan Prov., Putic I. (Cuyo Is.), 22 May 1978, V. G. Springer and Smithsonian team SP 78-18.

Diagnosis.—Base of pectoral fin with two dark circular to oval spots, not sharply defined and often weakly connected, the upper spot somewhat larger than the lower; pectoral spots moderately pigmented, the intensity about equal to trunk bars; head (dorsally) and nape with dark, transverse bars continuous over dorsal midline, and somewhat more heavily pigmented laterally; trunk with regular dark, vertical bars, somewhat diffuse in outline, continuous over dorsal midline and usually not extending below midside anteriorly and much shorter posteriorly on peduncle; scale pockets dorsolaterally on trunk often weakly pigmented.

Description.—Dorsal fin VI-I,9(7); anal fin I,8(7); pectoral fin 16(3), 17(4); pelvic fin I,4(7); fourth ray of pelvic fin with 8–11 branches, average 9.9; number of segments between consecutive branches of fourth pelvic fin ray 1–2, average 1.2; pelvic fin membrane reduced; branched caudal fin rays 12(1), 13(1); segmented caudal fin rays 16(1), 17(6); lateral scale rows 24(2); transverse scale rows 6(1); breast scaleless.

Spinous dorsal fin not elongate. Depressed pelvic fin rarely extending to origin of anal fin, never beyond.

Cephalic sensory pore system is pattern 1; cutaneous papillae system is pattern A.

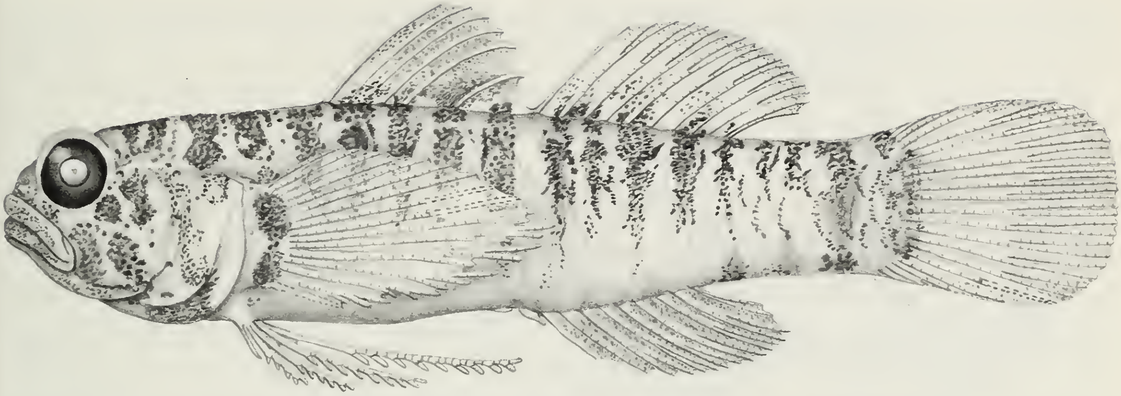

Fig. 4. *Eviota irrasa,* USNM 220566, holotype, male, 16.0 mm SL, Cuyo Islands. (Drawn by J. R. Schroeder)

Male genital papilla not fimbriate. Vertebrae 10(6) precaudal, 16(6) caudal, total 26(6).

Color in preservative.—This species is similar in the general color pattern to *E. fasciola* and *E. disrupta.* It differs in the following characters: *E. irrasa* has upper and lower dark, circular to oval, pectoral base spots that may be joined by scattered chromatophores, the upper spot somewhat larger; nape bars rarely broken up into spots; trunk bars mostly confined to dorsolateral portion, only the anterior bars extending to ventral area, the bars becoming shorter posteriorly and occurring only dorsolaterally; trunk bars sometimes diffuse, the pigmentation becoming irregular and outlining some of the scale pockets; dorsal and anal fins darker than in *E. fasciola,* the oblique band in the spinous dorsal fin dusky to black, wide, and some specimens with small intense black areas on membrane in middle portion of fin just posterior to first spine and in an oblique row following the next 3–4 spines; trunk bars may extend into basal portions of first and second dorsal fins; anal fin dusky to blackish.

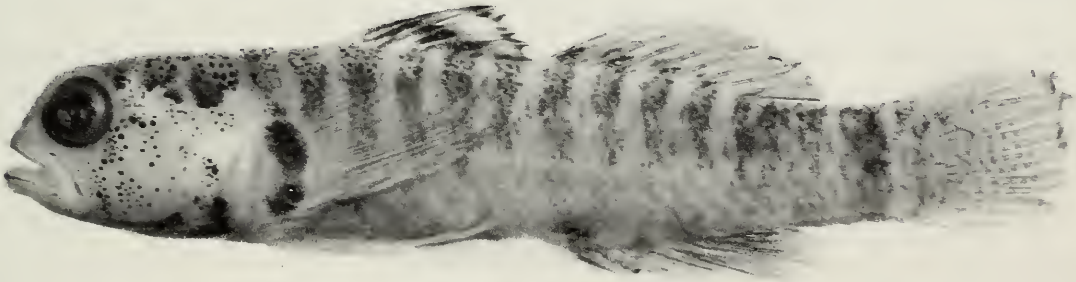

Fig. 5. *Eviota irrasa,* USNM 220954, paratype, female, 14.0 mm SL, Cuyo Islands.

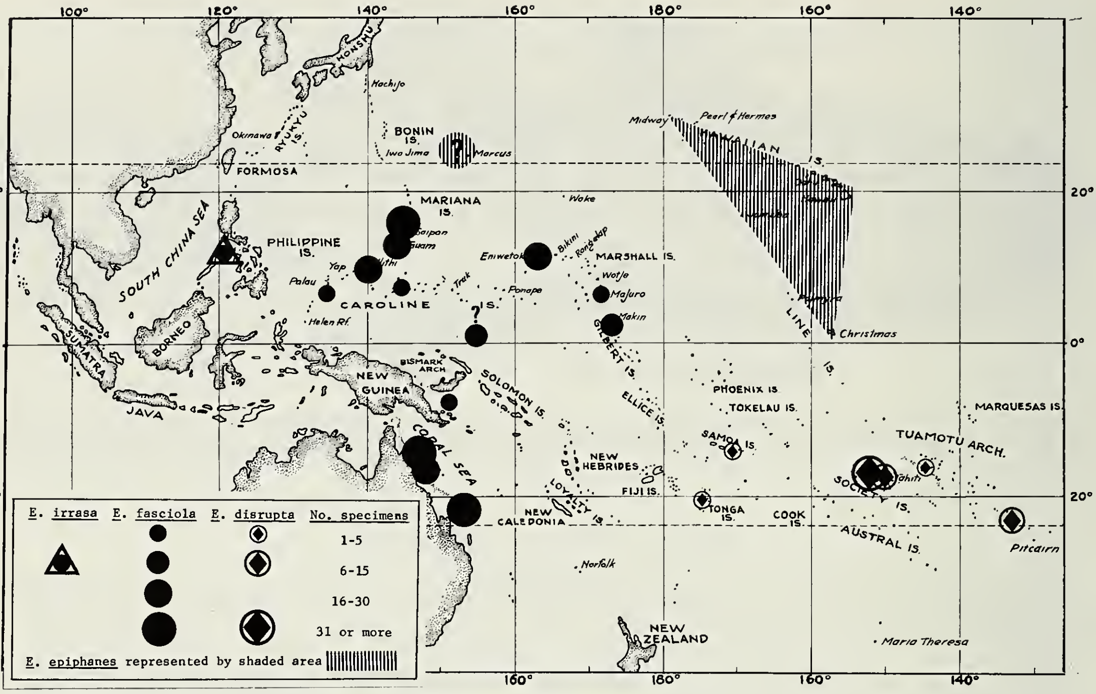

Fig. 6. Geographic distributions of *Eviota fasciola, E. disrupta, E. irrasa,* and *E. epiphanes,* based on material examined.

Geographic distribution.—Known only from the Cuyo Islands, Palawan Province, Philippine Islands (Fig. 6).

Etymology.—The specific name *irrasa* is Latin, meaning unpolished or unshaved, and is used in reference to the indiscrete nature of the pigmentation pattern of the head and trunk compared with *E. fasciola* and *E. disrupta.*

Discussion

Although *Eviota epiphanes, E. disrupta, E. fasciola,* and *E. irrasa* are superficially similar in many aspects, certain color marks are consistently different. The salient differences among these species are summarized in Table 1. No evidence of intergradation of these species is shown in our data. The four species occur in distinct geographical areas and are not so far known to be sympatric (Fig. 6). Because of the poor state of preservation of the specimens from Marcus Island (BPBM 7154, 23 spec.; BPBM 7155, 4 spec.) we identify these only tentatively as *E. epiphanes.*

Acknowledgments

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Natural Sciences of Philadelphia (ANSP), American Museum of Natural History, New York (AMNH), Australian Museum, Sydney (AMS), Bernice P. Bishop Museum, Honolulu (BPBM), California Academy of Sciences, San Francisco (CAS), Los Angeles County Museum of Natural History (LACM), and the University of Guam (UG). Our thanks also go to Richard C. Wass, Office of Marine Resources, Government of American Samoa, who donated a collection of *Eviota disrupta* from Samoa. We are especially indebted to C. L. Smith (AMNH) for allowing the generous exchange of type specimens of *Eviota disrupta* to various institutions, including the deposition of the holotype at the National Museum of Natural History, Washington, D.C. (USNM). The drawings (Figs. 3 and 4) were rendered by J. R. Schroeder.

The manuscript was reviewed by C. E. Dawson who provided valuable suggestions.

Literature Cited

Lachner, E. A., and S. J. Karnella. 1978. Fishes of the genus *Eviota* of the Red Sea with descriptions of three new species (Teleostei: Gobiidae).—Smithsonian Cont. Zool. 286:1–22.

———, and ———. 1980. Fishes of the Indo-Pacific genus *Eviota* with descriptions of eight new species (Teleostei:Gobiidae).—Smithsonian Cont. Zool. 315:1–127.

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TAXONOMY AND POSTMARSUPIAL DEVELOPMENT OF A DOMINANT DEEP-SEA EURYCOPID ISOPOD (CRUSTACEA)

George D. Wilson

Abstract.—*Eurycope iphthima* n. sp. is a valuable subject for studies of systematics and population biology in abyssal Crustacea because of it numerical dominance, size, and robustness. In this introductory paper, the species is described, and developmental variation is discussed for the following characters: pereopod VII, antennula, rostrum, uropods, oostegites, and male pleopods I and II. Some evidence indicates this species is facultatively hermaphroditic and its sexual development is partly independent of somatic growth.

Because deep-sea sampling is so difficult, the biology of few abyssal benthic Crustacea is known well enough to examine problems of ontogenetic and population variation. Yet a knowledge of variability is critical to a clear understanding of the systematics of a group. In order to make these types of analyses in an important deep-sea group, the Eurycopidae, this paper introduces *Eurycope iphthima* new species, a dominant abyssal isopod. This species has a large body allowing its retention by standard sampling techniques: the smallest post-marsupial individuals are greater than one millimeter in length. Of additional value, *E. iphthima* has a very robust body, insuring undistorted specimens that are relatively easy to measure. Furthermore, *E. iphthima* has potential ecological importance to deep-sea faunal assemblages because of its numerical dominance in some areas. In two large epibenthic sled samples collected during Woods Hole Oceanographic Institution (WHOI) cruise no. 106 (stations 326 and 328), this species is the most abundant isopod, accounting for 23% of the total individuals. This introductory paper describes *Eurycope iphthima* n. sp. and the post-marsupial development of a number of its systematically important characters. Subsequent papers will discuss the taxonomy, population biology, and zoogeography of this important species.

Terminology.—Hessler (1970) reviewed the terminology used for the development of asellote isopods and concluded that the most informative system is that of Zimmer (1926), introduced for cumacean development. In this paper, the updated system of Hessler (1970) is used, except that the juvenile stage is not directly associated with instars due to this species' complicated development (discussed below). Because three preparatory female stages before the brooding stage are recognized (Fig. 9D–F), the number after preparatory refers to the developmental stage, rather than the number of times the animal has entered that condition (as in Hessler, 1970), e.g., preparatory 3 female means the third and final preparatory female intermolt stage.

For structures on pleopods I and II of the male, the reader is referred to the excellent paper by Veuille (1978a), whose descriptive terms are used here with the exception that instead of his term, copulatory whip, stylet is used (Fig. 10K) as in past papers (Hessler, 1970). The small, thin distal projection on the protopod of the male pleopod II (Fig. 10K) is called the vermiform appendage after Menzies (1962).

Measurements.—Measurements are made as described in Wilson and Hessler (1980), with the following additions. Overhang is the ratio between the length of the rostral projection from the frons (Fig. 8D—a), and the rostral length (Fig. 8D—b). The length of the medial lobe of the antennular article one (Fig. 7C—ml) is measured from the insertion of article two to the lobe's distal tip. In the male pleopod I length–width ratio, the width is measured at the proximal edge of the dorsal orifice (Fig. 10K—do).

Family Eurycopidae
Subfamily Eurycopinae
Eurycope iphthima, new species
Figs. 1–5

Holotype.—Preparatory 3 female, 7.0 mm long, deposited in the United States National Museum (USNM), catalog number 181106.

Paratypes.—10 individuals, USNM 181107; 5 individuals, American Museum of Natural History, New York, catalog number 16253; 5 individuals, Zoological Museum of the University of Copenhagen; 273 individuals retained in the collection of Robert R. Hessler, Scripps Institution of Oceanography.

Type-locality.—WHOI station 326, R/V *Chain* cruise no. 106, 22 August 1973, 50°04.9–05.3′N, 14°23.8–24.8′W, 3859 meters, estimated bottom temperature (from Fuglister, 1960) 2.5°C.

Derivation of name.—iphthima is Greek, meaning strong or stalwart, referring to the robust nature of the species.

Other material.—See Table 1.

General distribution.—Abyssal Central North Atlantic and the rise and slopes of Northeastern Atlantic, 2379–5000 meters.

Diagnosis.—Body length approximately 2.1 times width, cephalon widest at level of pereopod I coxae. Rostrum (Fig. 8) almost always with some overhang, especially when rostrum narrow, width varies around 0.1 cephalon width, with u- or v-shaped anterior notch. Female and immature an-

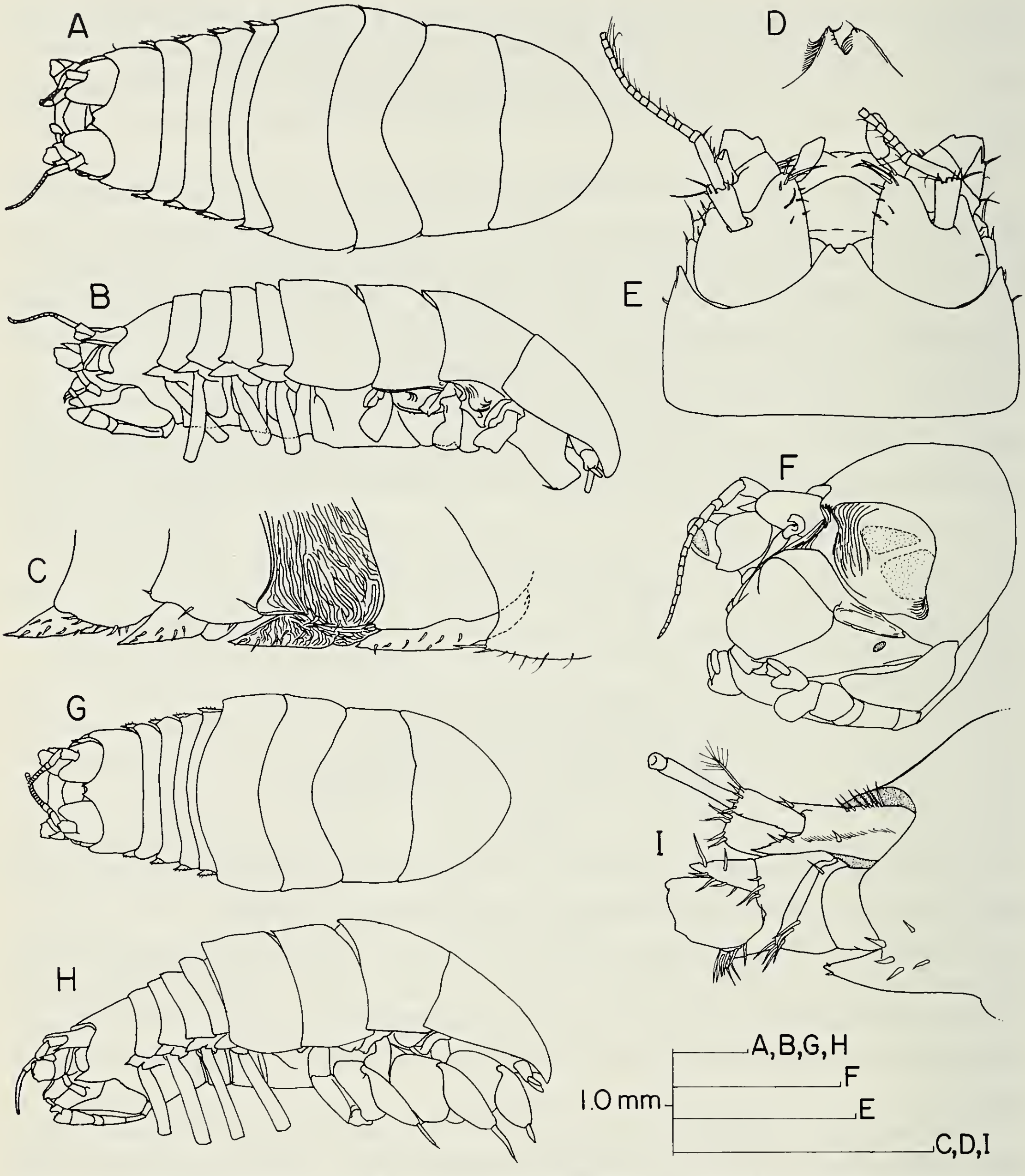

Fig. 1. *Eurycope iphthima*: A–E, I: holotype preparatory 3 female. A, Body, dorsal view; B, Body, lateral view; C, pereonites 1–4 and associated coxae, cuticular ridges shown only on pereonite 3; D, rostrum, left oblique view; E, Cephalon, dorsal view; F, Preparatory 2 female, cephalon, oblique frontal view, antennula and antenna removed on left side; G–H, Precopulatory adult male dorsal and lateral views; I, Cephalon, lateral view.

tennular third article (Fig. 7B) approximately same length as second article; basal article medial lobe slightly shorter than article 2; copulatory male antennular third article (Fig. 7B) slightly shorter than second article, basal article medial lobe around same length as second article, flagellar articles

Table 1.—Localities for *Eurycope iphthima* n. sp.

Station	Mean west latitude	Mean north longitude	Depth in meters	Number of samples	Number of individuals
*WHOI 326 (type locality)	50°05′	14°24′	3859	1	294
*WHOI 80	34°49′	66°34′	4970	1	3
WHOI 83?	34°46′	66°30′	5000	1	1 juv.
WHOI 121?	35°49′	65°10′	4800	1	2 frags.
WHOI 287?	13°16′	54°52′	4957	1	9 frags.
WHOI 288	11°03′	55°04′	4423	1	11
WHOI 318	50°27′	13°20′	2506	1	105
WHOI 321	50°12′	13°36′	2879	1	150
WHOI 323	50°08′	13°52′	3347	1	86
WHOI 328	50°05′	15°45′	4431	1	261
WHOI 330	50°43′	17°52′	4632	1	35
WHOI 334	40°43′	46°14′	4400	1	200
*Allen 50	43°46′	3°38′	2379	1	19
†INCAL 1.8	55°01′	12°36′	2890	4	18
INCAL 2.1	50°15′	13°12′	2641	4	108
INCAL 2.2	48°19′	15°23′	4829	1	12
INCAL 2.3	47°30′	9°34′	4284	11	96
INCAL 2.4	46°00′	10°21′	4802	1	1

* More information on these stations in Wilson and Hessler (in press).
† Expedition Intercalibration, described in Sibuet (1979).

after article 8 wider than long. Pleopod I of copulatory male (Fig. 10I–K) length 3.6 width, dorsal orifice position 0.68 medial length; distal tip truncate in ventral view, tapered medially, lateral lobes thin to ventrally-curving spines closely adpressed to medial lobe; medial lobe thick, rounded medially, thinning laterally to dorsal shelf. Pleopod II of copulatory male (Fig. 10K) with long vermiform process, 0.15 total pleopod length. Uropodal endopod length less than protopod width, exopod length greater than half endopod length (Fig. 9A–C).

Additional description and variation.—Body robust, natasome broadly rounded in dorsal view, vaulted, muscular. Lengths of mature adults greater than 4 to 5 mm, largest individuals may exceed 7 mm; females larger than males, median lengths (ranges) 5.5 mm (4.1–7.4) vs. 4.9 mm (4.0–6.3); mean stage 4 length 2.2 mm, standard deviation 0.1, range 2.0–2.5.

Rostral variability common (Fig. 8): median rostral length-cephalic width ratio 0.19, range 0.18–0.22; medial rostral width-length ratio 0.36, range 0.22–0.64; median overhang 0.28, range 0.0–0.33; rostrum rarely juts abruptly from frons; when rostrum narrow, overhang more distinct; median values vary from population to population.

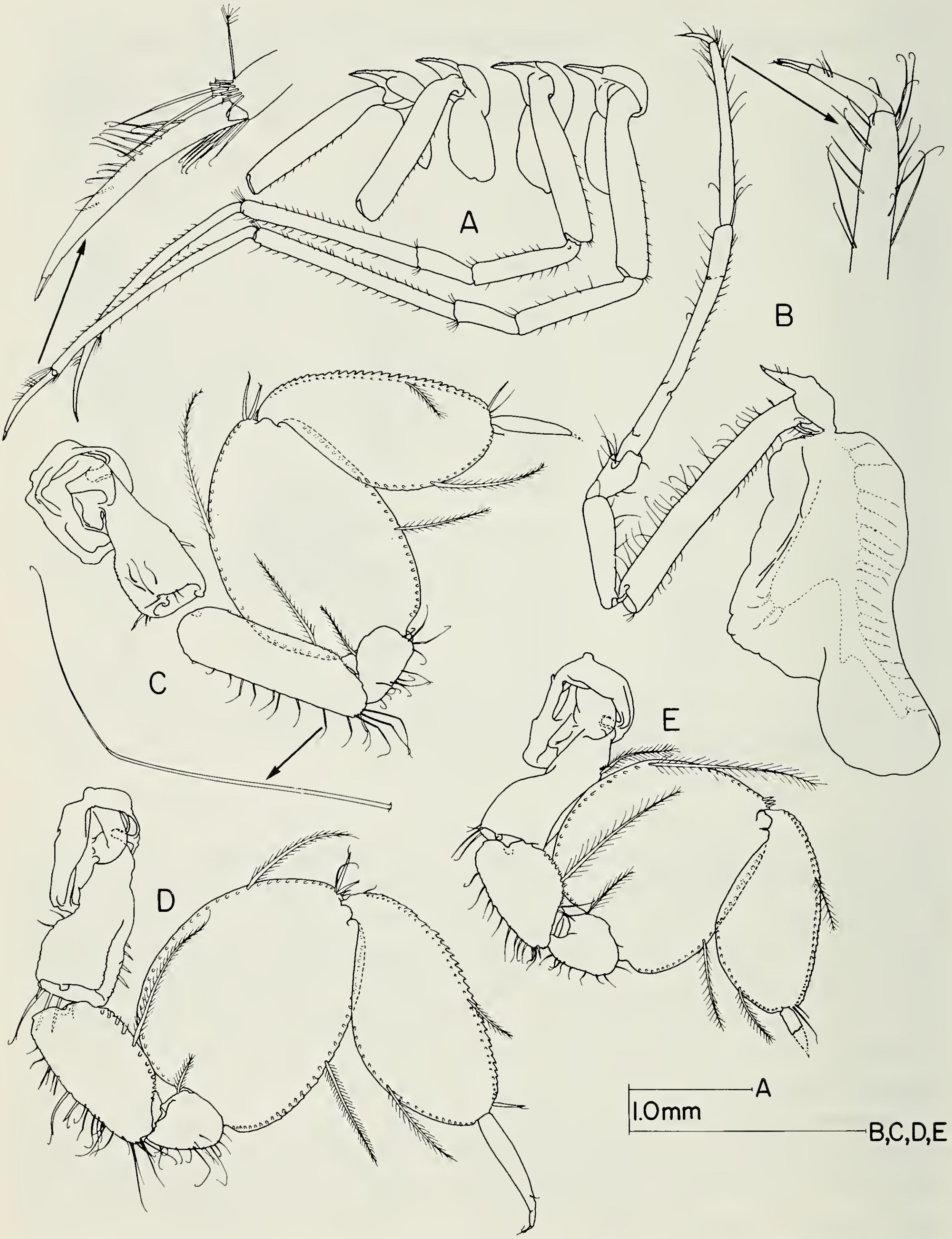

Fig. 2. Pereopods: A, Pereopods I–IV, III–IV intact, dactylus IV enlarged; B, Pereopod I with oostegite, dactylus enlarged; C–E, Left natapods from precopulatory male: pereopod V, whip seta from ischium enlarged; pereopod VI; pereopod VII. Plumose setal rows indicated by basal insertions and single representative setae.

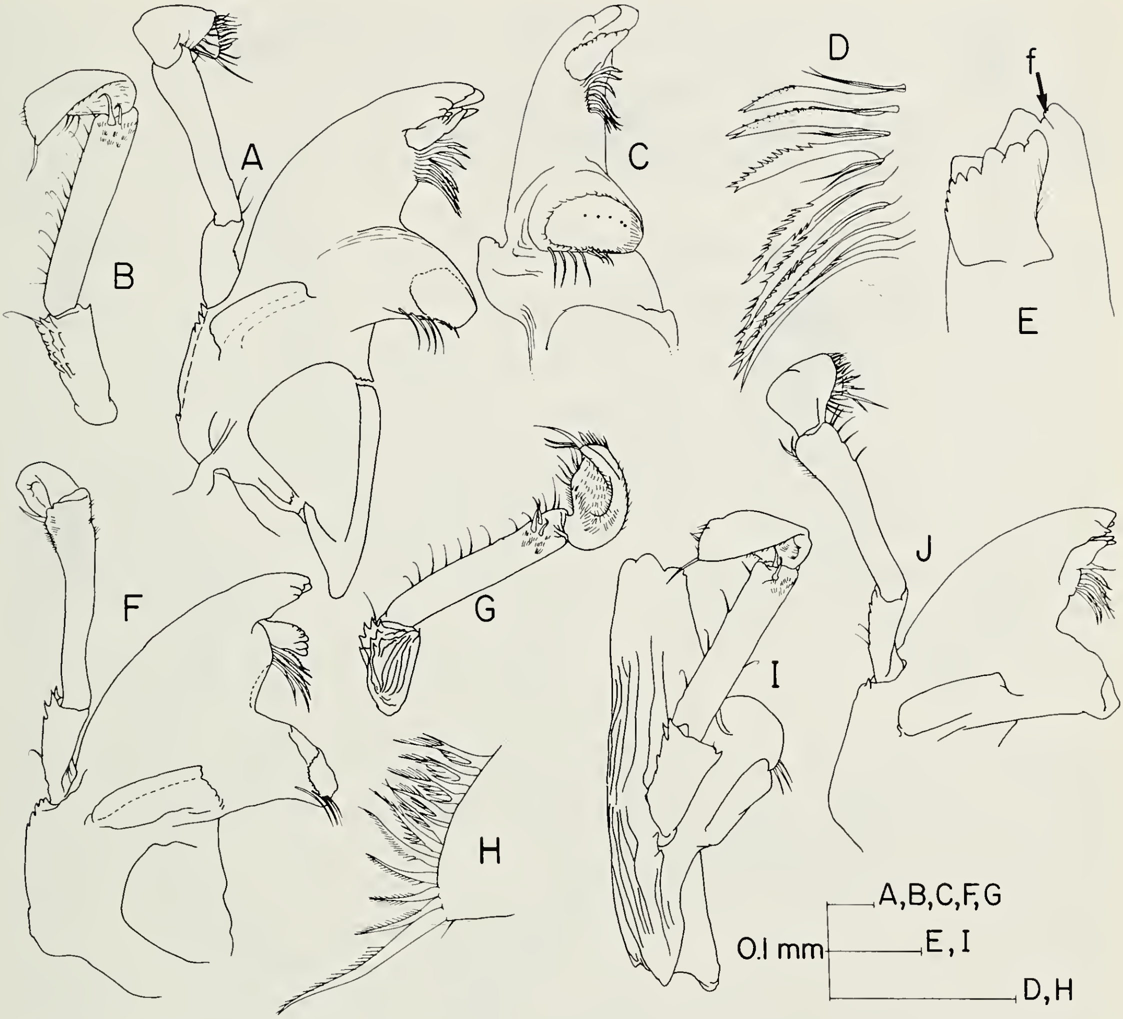

Fig. 3. Left mandibles: A–E, Preparatory 2 female. A, Dorsomedial view; B, Palp, lateral plan view; C, Medial view, plan view of triturative surface; D, Spine row, ventral view; E, Lacinia mobilis and incisor, posterior view, f—posterior fold in ventral tooth; F–H, Copulatory male. F, Dorsal view; G, Lateral view, palp in plan view; H, Setation of palp distal tip; I–J, stage 4 individual. I, Lateral view; J, Dorsal view.

Pereonite 7 medial length much greater than pereonite 5 or 6, pereonite 7 bulla enlarged and rounded; pereonites 5 and 7 subequal.

Antennula of copulatory male (Fig. 7D) with about 60 articles, length beyond proximal 2 articles 4.0 times length of article 1 medial margin; female antennula (Fig. 7B) values, 26 articles and 2.7 length ratio; basal article medial lobe with 5–7 unequally bifid setae in adults.

Left mandibular incisor (Fig. 3) with 3 large teeth, ventral tooth with fold in posterior surface (Fig. 3E—f), dorsal tooth with small tooth on dorsal side. Lacinia mobilis with 6 teeth on medial surface grading into 2–3 denticles on dorsal surface. Spine row with 7–9 spines having teeth or spinules

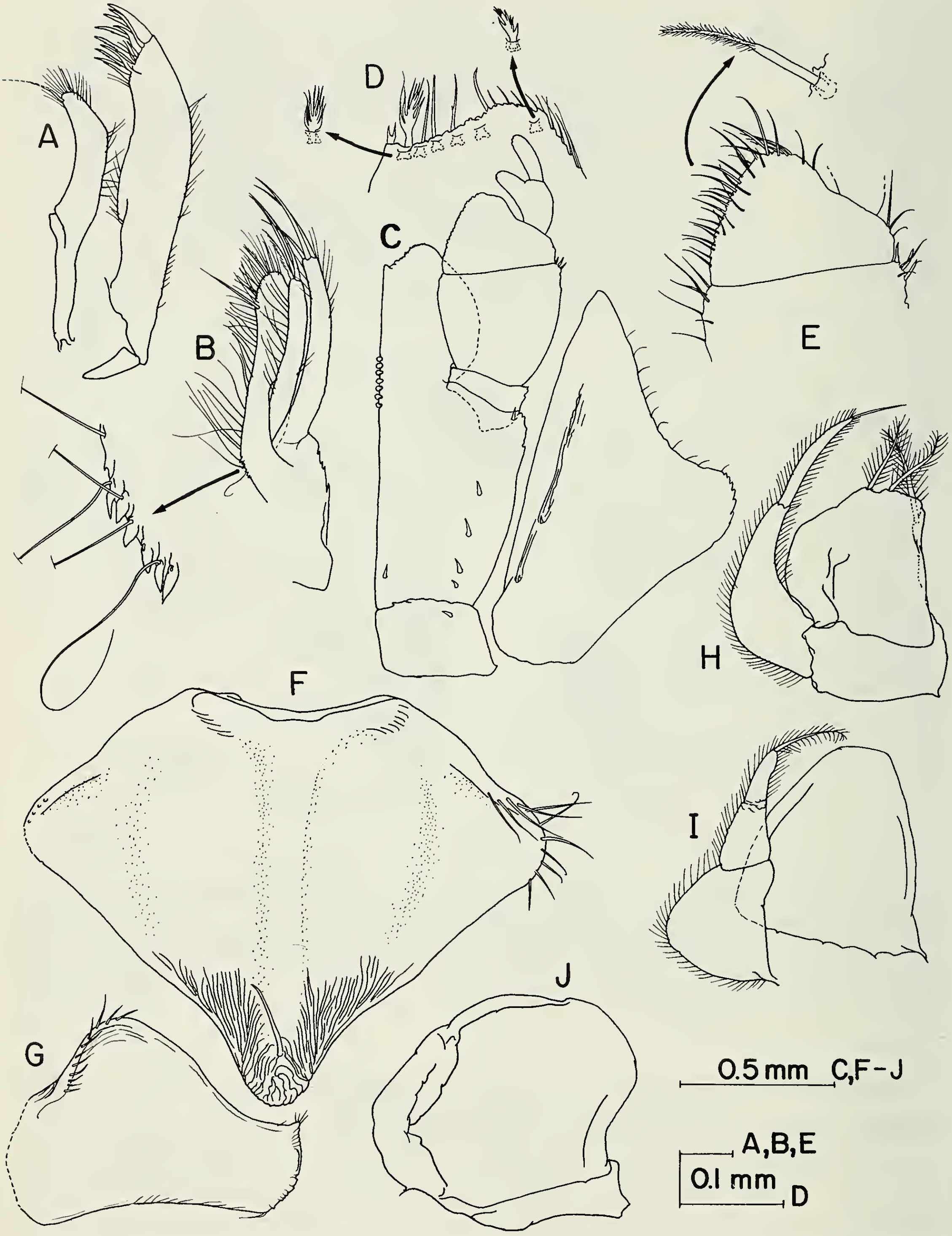

Fig. 4. Appendages from preparatory females: A, Maxillula; B, maxilla with enlargement of mediobasal denticles and setae; C–E, Maxilliped. C, Ventral view, epipod detached, setae not shown; D, Distal tip of endite, fan setae bases shown with examples to either side; E, Setation on palp articles 3 and 4; F, Pleopod II, ventral view, hemiplumose setae shown on left side, cuticular ridges shown only on apex and distal tip; G, Pleopod II, lateral view; H, Pleopod III; I, Pleopod IV; J, Pleopod V.

and very fine accessory setae on anteriormost 4–6 spines. Molar approximately same length as mandibular condyle; triturative surface oval, teeth on posterior and dorsal margins low and rounded, 6–8 setae on posterior margin. Mandibular palp shorter than mandibular body; male palp longer than female palp: male palp article 2 length 0.44 times mandible body length, female 0.38.

Maxilliped (Fig. 4C–E) in adults with 6–9 receptaculi, around 7 short thick unequally bifid setae on ventral face of coxa and basis; palp merus width 1.2 times endite width. Epipod broad with subquadrate lateral expansion, with 2–4 short thick setae on ventromedial ridge, length 1.8 times width.

Pereopod-body length ratios in pereopods I, III, IV: 0.74, 0.90, 1.05. Bases of pereopods I–II of copulatory male longer than in preparatory 3 female: copulatory male basis-body length ratios in first 4 pereopods 0.21, 0.20, 0.20, 0.22; for preparatory female 0.18, 0.19, 0.20, 0.20. Male pereopods (Fig. 2C–E) V–VII propodus width 0.51 times length, ventral setal row only on distal half of margin. Dactylus of pereopod VI largest of natatory limbs, pereopod VII dactylus smallest. Only one large seta at proximal posterior angle of pereopod VII basis.

Pleopod II of both sexes (Figs. 10K and 4F, G) with strongly recurved lateral margins. Male pleopods I (Fig. 10I–K) widest at insertion, with paired row of 9–10 hemiplumose setae. Male pleopod II (Fig. 10K) length 1.7 times width, depth 0.3 times length, with about 14 hemiplumose setae on each lateral margin. Stylet 0.69 times pleopod length. Female pleopod II (Fig. 4F–G) length 0.79 times width, depth 0.3 times length, with about 11 hemiplumose setae on lateral margins.

Uropodal protopod (Fig. 9A–C) strongly broadened medially, width greater than length, ventral and medial margins with dense row of long, thin unequally bifid setae.

Remarks.—*Eurycope iphthima* belongs to a speciose subgroup within the genus wherein the differences between the member species are small but definitive. Other described species in this subgroup are *E. complanata* Bonnier 1896, *E. hanseni* Ohlin 1901, *E. inermis* Hansen 1916, and *E. ratmanovi* Gurjanova 1946. These species are being revised and new species are being described in research now in progress.

Eurycope complanata is most similar to *E. iphthima* and occurs within the same geographic area although at much shallower depths. *E. complanata* is narrower in the body (l/w ratio 1.9) and has a narrower, less overhanging rostrum. Additionally, the antennular article 3 is distinctly longer than article 2 and the endopod of the uropod is longer than the width of the protopod.

Potential synonyms.—Menzies (1962, pp. 141–142) describes 4 individuals of *Eurycope complanata* collected by the R/V *Vema* in Lamont Geological Observatory Biotrawl no. 7 (5779 m 29°17.6′N, 57°20.3′W). The large male

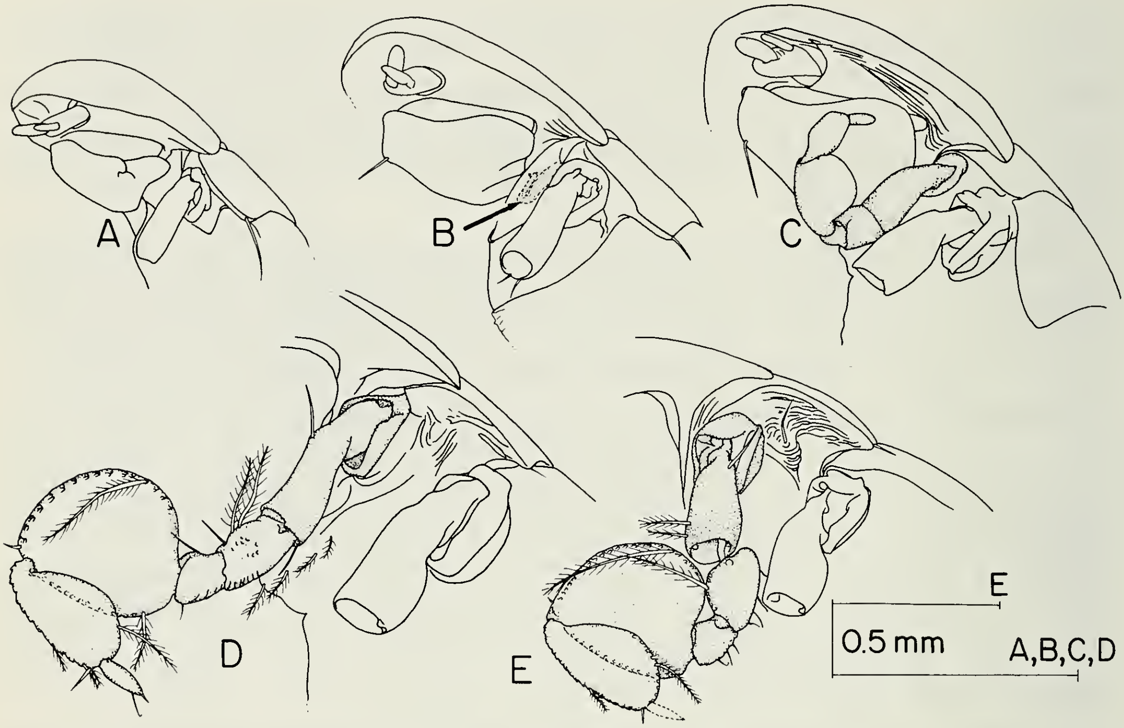

Fig. 5. Development of pereopod VII: Pereopod VII shown darkened in right lateral oblique view; basis of pereopod VI included for comparison; only representative setae in plumose setal rows shown. A, Manca 1; B, Manca 2, arrow indicates pereopod anlagen below cuticle; C, Manca 3; D, Stage 4; E, Stage 6.

figured by Menzies appears to be *E. iphthima,* but this cannot be determined with certainty because this material seems to be missing from the collections of the American Museum of Natural History (H. S. Feinberg, pers. comm.). Chardy (1979) lists *E. complanata* as occurring at stations 2000 meters and deeper in the Bay of Biscay. The present data and other information show that *E. iphthima* occurs in the Bay of Biscay in this depth range and *E. complanata* occurs shallower, 860–1920 meters (Bonnier, 1896; Wolff, 1962; unpublished data).

Postmarsupial Development

The postmarsupial development of deep-sea asellote isopods has been reviewed by Wolff (1962) and Hessler (1970). More recently Thistle and Hessler (1977), and Haugsness and Hessler (1979) provide developmental data for 2 abundant eurycopids. This section will describe the development of several taxonomically important characters and discuss the relationship between somatic growth and sexual maturation in *Eurycope iphthima* and in the species studied by the above authors.

Pereopod VII.—The first 5 stages can be recognized on the basis of the

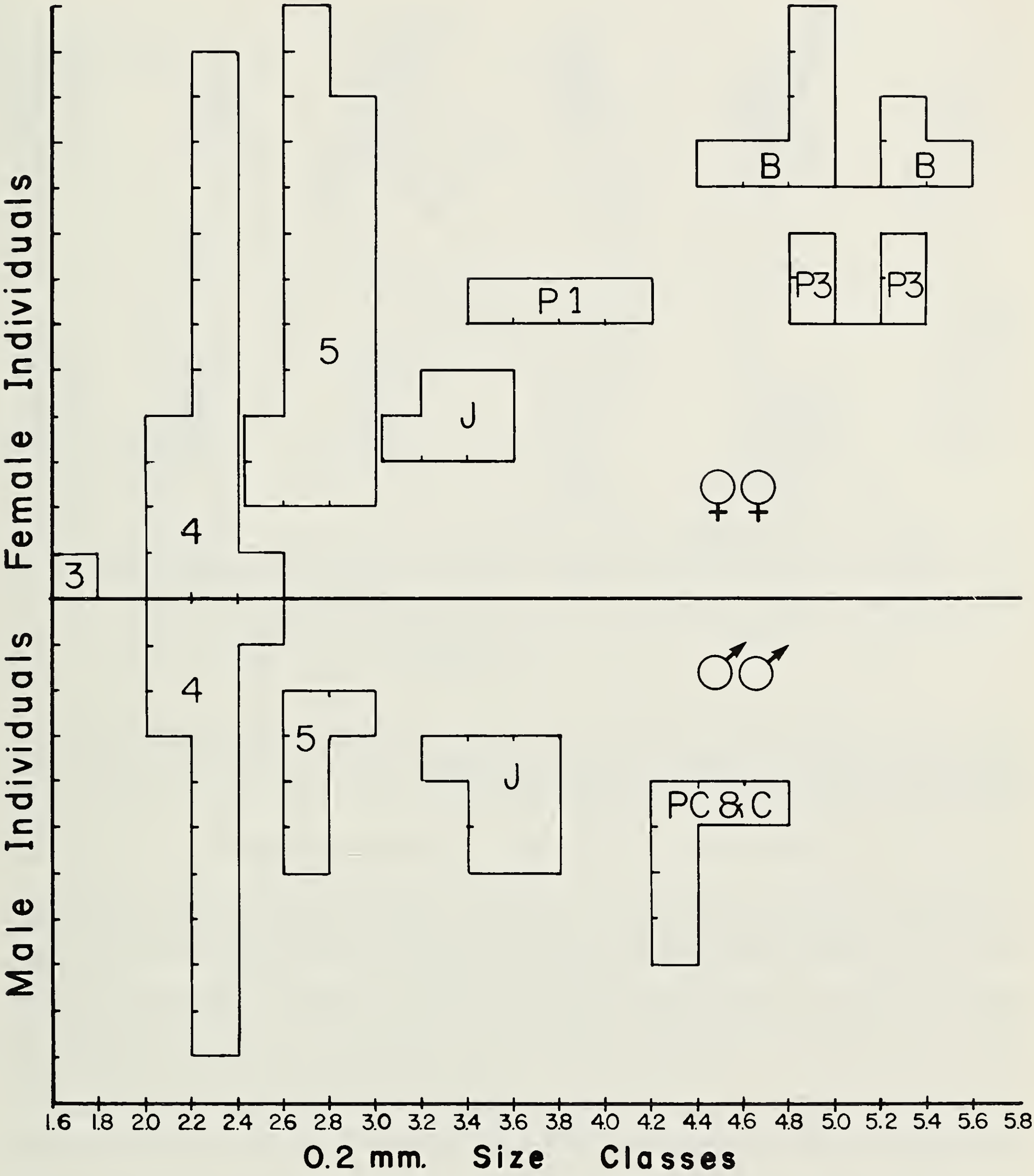

Fig. 6. Representative body length-frequency histogram of all intact individuals from WHOI 318. Stages three to five, *3–5*. Juveniles, *J*. Precopulatory and copulatory, *PC&C*. Preparatory one, *P1*. Preparatory three, *P3*. Brooding, *B*. Individuals outside of the 1.7–5.7 mm range and preparatory two females appeared in other samples.

development of the seventh pereopod and pereonite (Fig. 5). Manca 1 has no apparent pereopod VII and the corresponding segment appears dorsally as a triangular plate having no lateral margins. The manca 2 pereopod is a subcuticular primordium and the pereonite is somewhat larger but still with no lateral margins. In manca 3 the pereopod is external but rudimentary

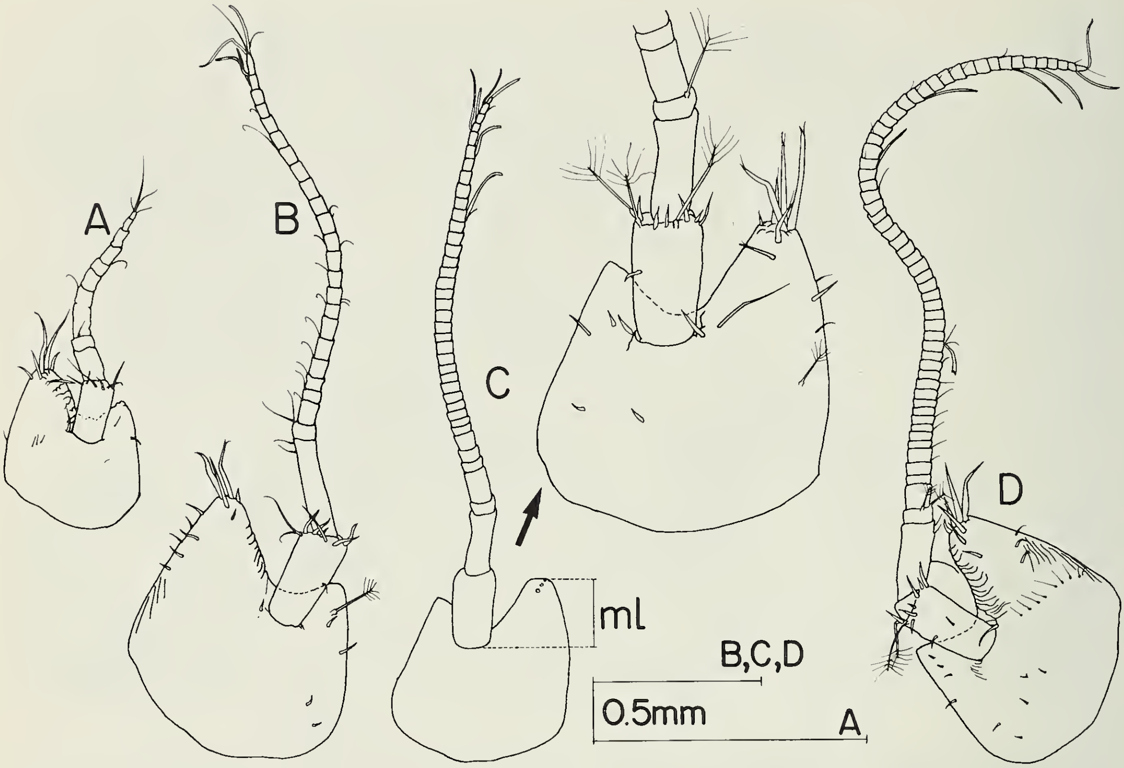

Fig. 7. Development of the antennula: A, Stage 4 individual; B, Preparatory 2 female; C, Precopulatory male, enlargement showing setal detail, distance *ml* illustrates medial lobe length; D, Copulatory male, not all aesthetascs present.

with no functional joints or setae. At this stage the seventh pereonite becomes part of the lateral margin but the anterolateral corner is not pointed. Similar to *Jaera a. albifrons* Bocquet (1953) the stage 4 pereopod VII becomes functional but is distinctly smaller, with fewer setae compared to the anterior natapods. In most specimens where the distal parts of the limb have been lost in sampling, stage 4 can be recognized by a basis which is smaller and much less robust than the basis of pereopod VI. In stage 5 the basis is the same length as pereopod VI but slightly less robust. In stage 6 and larger, pereopods VII and VI bases are of approximately equal size and robustness.

Instar size.—Figure 6 shows a representative size-frequency histogram from WHOI 318 which illustrates most of the instars discussed below. *Eurycope iphthima* increases in length by roughly 1 mm in 2 molts. This increase is less for mancas (with these stages falling between 1 and 2 mm) and perhaps greater for older individuals. Mancas 1–3 were approximately 1.1, 1.4 and 1.8 mm respectively. Stage 4 averaged 2.2 mm, varying only one or two tenths in either direction. Significantly, the mean length for stage 4, which was well represented at the localities studied in detail, did not vary

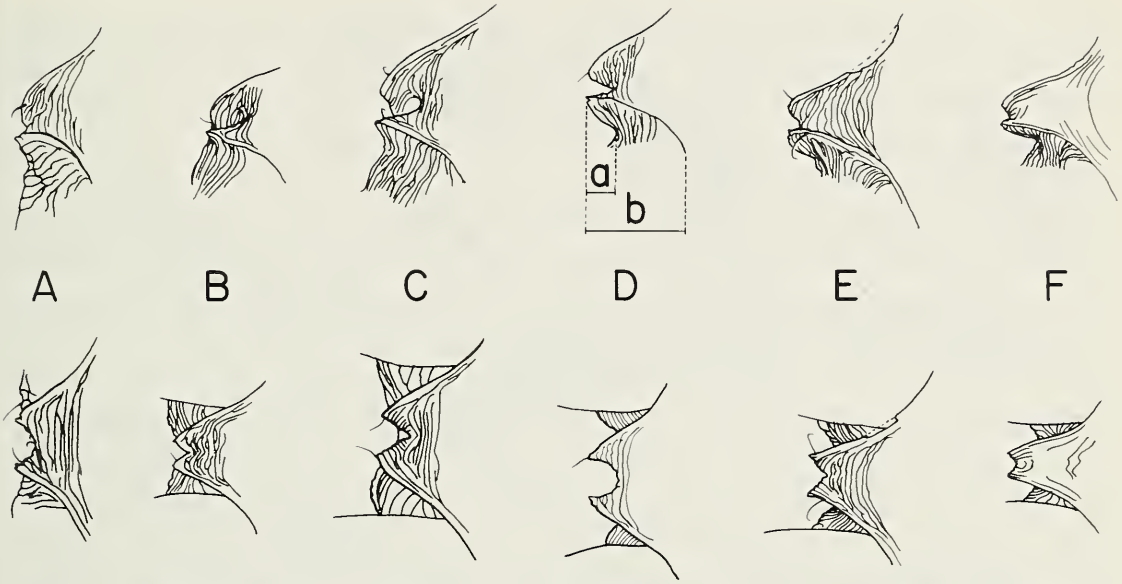

Fig. 8. Development and variation of the rostrum: Top illustrations, left oblique dorsal view; bottom illustrations, dorsal view; cuticular ridges shown. A, Stage 4 individual, 2.2 mm; B, Male, 5.1 mm; C, Preparatory 3 female, 6.7 mm; D, Preparatory 1 female, 5.8 mm, distance *a* is the rostral projection from the frons, distance *b* is the rostral length; E, Male, 6.5 mm; F, male, 5.1 mm. A–D, are common conditions; E–F are rare.

geographically. Stage 5 mean length at one abundant station (WHOI 318, Fig. 6) is 2.7 mm (SD = 0.14, N = 27, range = 2.4–2.9). Beyond stage 5 the molts are difficult to recognize, although at some localities they appear as modes in the size-frequency distribution. Sexual development cannot be used to recognize specific stages because it appears to be independent of size. Stage 6 is about 3.2–3.6 mm and stage 7 is at approximately 4.0–4.4 mm. Sexual maturity may occur at any stage after 7, the earliest being stage 8, roughly 4.4–5.0 mm. Beyond this stage the data do not allow a clear association between instar and size.

Antennula.—Besides the sexual pleopods, dimorphism is most apparent in the development of the antennula (Fig. 7). In mancas and stage 4, the flagellum has only a few articles, no aesthetascs and a more rounded medial lobe having 4 or 5 unequally bifid setae. One taxonomically diagnostic character, article 3 being subequal or shorter than article 2, is stable, even in these stages. As development proceeds, more articles are added to the flagellum with copulatory males achieving 50–60 articles and preparatory 3 females with only 20–25. Notably the females have aesthetascs only on the distal articles while in males they may occur on the full length of the flagellum. Male flagellar articles are wider than long and female articles are longer than wide. However, in spite of the shorter articles, the male antennula is longer. With increasing instar number the medial lobe becomes slightly more pointed and the distal setae increase to 6 or 7.

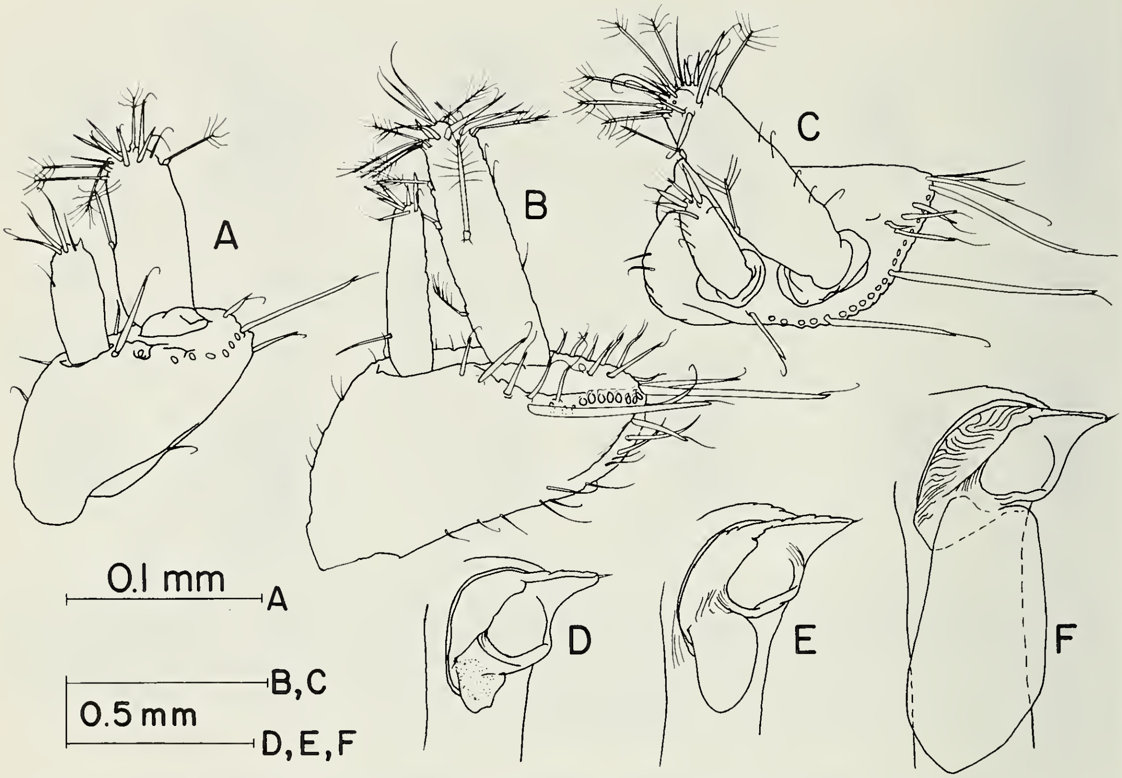

Fig. 9. A–C, Uropoda: A, Stage 4 individual; B, Preparatory 2 female; C, Copulatory male, posterior view. D–F, Developing oostegites: D, Preparatory 1 female; E, Preparatory 2 female; F, Preparatory 3 female.

Rostrum.—In spite of the variability associated with the rostrum, there are some developmental components that can be recognized (Fig. 8). In mancas and stage 4, the rostrum is fairly broad: rostral-cephalic width ratio around 0.15. With maturity, the rostrum narrows to a ratio of around 0.10, although in some males this can be as small as 0.05. The rostral-frons overhang can be seen to increase with age, ranging from 0.0 to 0.12 in the earliest stages to 0.10–0.33 at maturity. Mature males also tend to have greater overhang values than females. Between-individual variability in rostral shape also seems to increase with age such that all the manca and stage 4 individuals within a sample appear very similar while adults can be substantially different.

Uropoda.—On the uropod (Fig. 9A–C), key taxonomic characters remain relatively unchanged through the life cycle: the endopod is always shorter than the width of the protopod, and the exopod length is always greater than half the endopod length. However, in the mancas the rami are thicker than in the adults: the endopod-protopod width ratio is 0.35; in mature adults this decreases to around 0.31 and 0.24 for males and females respectively. Note that the males retain some width; they also have endopods that are slightly longer than females. The protopodal row of long, thin unequally bifid setae increases allometrically with size: in the manca 3, it has around 8–9 setae; in adults there are 20–22 setae, with no apparent dimorphism in this or other setal characters.

Oostegites and female maturation.—Four separate stages of development of the oostegites could be recognized in *Eurycope iphthima* (Fig. 9D–F). Wolff (1962) previously recognized a great variation in the sizes of developing oostegites in several eurycopids and munnopsids, but could not relate them to a developmental sequence for lack of data. The material of *E. iphthima* clearly shows that the increase in the size of the rudimentary oostegites is correlated with somatic growth and is a direct consequence of approaching maturation in females. The female juvenile phase, that is, individuals with no evidence of oostegite buds but not mancas, always spans stages 4 and 5, although it clearly goes into stages 6, 7 or larger in some individuals. Therefore one can find outwardly 'juvenile' females from 2.0 to an observed maximum of 5.6 mm. It is not known whether the large 'juveniles' represent totally non-reproductive individuals or females that have brooded once. These largest females are at least one stage larger than the smallest brooding females.

Preparatory 1 females are characterized by rudimentary oostegites which appear as small buds on the medial edge of the coxae of the first 4 pereopods (Fig. 9D). The tissue below these buds appears to be somewhat more dense and granular, thus aiding their identification. There was some interindividual variation in size of the buds but none approach the size of the next stage. Preparatory 1 females occurred at lengths from 3.5 mm (stage 6) up to 5.8 mm, well beyond stage 9.

A second rare state occurs where the rudimentary oostegite is approximately the same size as the coxa (Fig. 9E). Only one or two preparatory 2 females were found at each station, varying in length from 4.9 to 7.0 mm. The rarity of this state may be due to most females passing directly from preparatory 1 to preparatory 3 in one molt.

The preparatory 3 oostegite is much larger than the coxa but not extending to the midline (Fig. 9F). This condition was found in females as small as 4.6 mm (stage 8 or 9) to as large as 7.5 mm. The females in this state should be considered as being fully copulatory and sexually mature, because this is the final stage before brooding. In support of this assertion, Veuille (1978b) has shown that in *Jaera* the final preparatory females receive the males. Furthermore, several preparatory 3 females of *E. iphthima* which were dissected proved to have apparent cuticular organs and gonads full of oocyte material. In this state the oostegites were observed to vary from being thin, transparent lamellae to fat opaque pads. That these latter oostegites are in a premolt condition is shown by the presence of developing structures under the old cuticle.

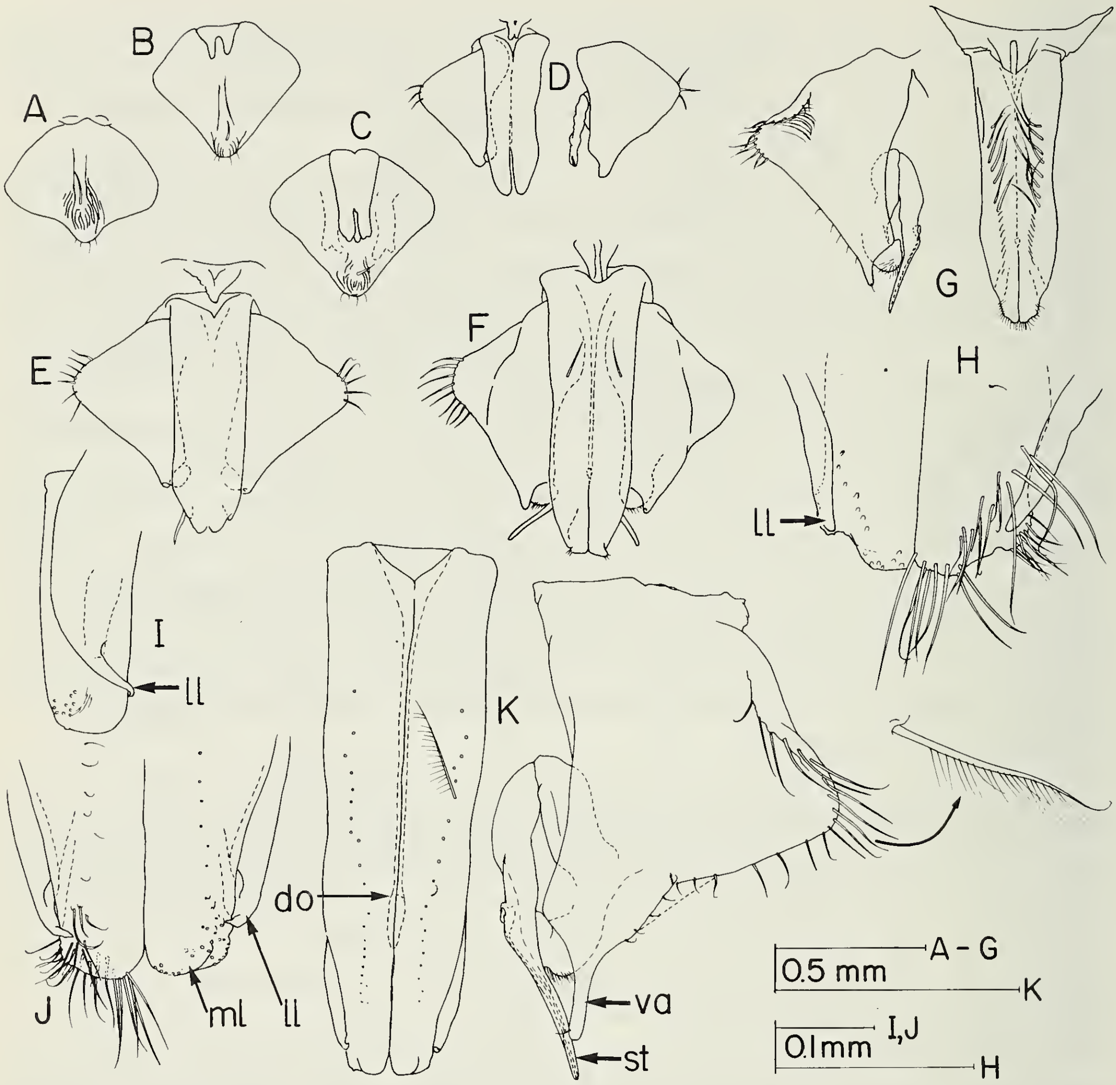

Fig. 10. Development of male pleopods I and II. A–C, Stage 4 individuals, all 2.2 mm long; D, Stage 5, 2.6 mm; left pleopod II detached to show developing stylet; E, Stage 7, 3.7 mm; F, Juvenile stage, 4.6 mm; G–H, Precopulatory male 4.4 mm; G, Pleopods separated; H, Enlargement of pleopod I distal tip, spines on lateral lobes straight, setae omitted from left side; I–K, Copulatory male, 5.4 mm, setae if omitted shown by their insertions; I–J, Pleopod I distal tip, lateral (showing curved spine) and ventral views, *ml*—medial lobe, *ll*—lateral lobe; K, Ventral view, pleopods separated, enlargement shows hemiplumose seta typically found in rows on venter of pleopod I and lateral margin of pleopod II, *st*—stylet, *va*—vermiform appendage, *do*—proximal edge of dorsal orifice.

In the final brooding condition, the oostegites become quite large and form the typical isopodan brood chamber. The oostegal lamella is very thin with an axial thickening for stiffness, and with several groups of fine sensory setae on the external surface. Brooding females were fairly rare in the collections and ranged in size from 4.5 to 5.8 mm. Because preparatory 3 females longer than 7 mm were found, it is reasonable to suppose that the brooding female can attain this size. The size-spread in mature and brooding females indicates that this species may reproduce at least twice in a life cycle. If this is the case for the eurycopid species examined by Wolff (1962), his data on oostegite and body size are easily explainable within the framework of the present study.

Male pleopods I and II.—Bocquet (1953) demonstrated that the male pleopod development in *Jaera* is not rigidly associated with particular instars. Similarly, these sexual characters of male *Eurycope iphthima* show considerable variation in their development. Two types of variation were recognized: the stage at which the pleopod begins to develop, and the degree of development of the pleopods at any one instar. Pleopod I appears in the manca 3, as in other deep-sea asellotes (Wolff, 1962; Hessler, 1970; Haugsness and Hessler, 1979), or later in stage 4 or 5. Males with developing pleopods were found over a broad range of sizes (2.0–4.9 mm). If the total variation in the development of pleopod I is considered, a gradual maturation is seen, although for each individual the pleopod growth is no doubt saltational. Consequently, it was not possible to classify the stages of male maturation other than to note when a male was fully copulatory.

At first appearance the first pleopod is a flat, bifurcate lobe of variable size above an undifferentiated pleopod II (Fig. 10A–C). In the degree of development shown in Fig. 10C the primordia of the endopod and exopod of pleopod II can be seen underneath the cuticle. As the instars proceed, the first pleopod extends to its full length relative to the pleotelson, and the second pleopod separates with the endopod and exopod becoming external, but undeveloped (Fig. 10D). Hemiplumose setae (Fig. 10K) appear in rows on the lateral margins of pleopod II and the ventral surface of pleopod I. The penile papillae enlarge and enter the anterior funnel of the first pleopods while the medial lobe separates from the lateral lobe and becomes more setose. At this point the stylet is fully elongated and its sperm duct is complete and open. During this development the distal tip of pleopod II becomes produced into a thin projection of variable length, the vermiform process, which in copulatory males (Fig. 10K) is nearly as long as the exopod. The pleopod I lateral lobe changes in the final molt from a straight spine (Fig. 10H) to a ventrally-curving spine (Fig. 10I).

Anomalous sexual development.—At WHOI 328 one 4.9 mm long individual was distinctly larger than stage 7, but had a developing male pleopod I on top of an undifferentiated female-like pleopod II. The second largest male (6.0 mm) at WHOI 326 was observed to have an antennula intermediate in development between mature males and females. Several of the largest males from these collections are only in the precopulatory stage, based on pleopod morphology, while smaller males are fully copulatory. Similar observations are found in other deep sea species. Hessler (1970) reports a very large preparatory male of *Chelator vulgaris* which exhibits feminine-like features, and the large illustrated male of *Eurycope ratmanovi* Gurjanova (1946) has immature pleopods. These anomalies may well represent manifestations of protogynous hermaphroditism, wherein a female may go through one brooding cycle and then changes into a male. Both in *E. iphthima* and in *C. vulgaris,* the unusual males are the same size or larger than the smaller modes of brooding females. Protogynous hermaphroditism has been reported for other janiroideans (Wolff, 1962) and is indicated by adult intersex individuals of Haploniscidae, Ishnomesidae, Pleurogoniidae, and other Eurycopidae (unpublished data). These latter individuals had both developing male pleopods and female characters, either oostegites or cuticular marks of the egg-laying organ (see Veuille, 1978b). It is important to note that some past reports of intersexes in deep-sea isopods, i.e., *Haploniscus percavix* Menzies (1962), are probably juvenile developing males. In spite of this possible confusion, the hermaphroditic condition may be much more prevalent in deep-sea isopods than previously thought. This certainly has proved to be the case in tanaids of the family Neotanaidae (Gardiner, 1975).

Discussion.—Hessler (1970) notes the development of most desmosomatid species appears to be rigidly scheduled as in *Haploniscus biscuspis* Wolff (1962). The size-frequency data on *Bellibos buzwilsoni* Haugsness and Hessler (1979) also seems to agree with this. However, Thistle and Hessler (1977), reporting on *Betamorpha characta* Hessler and Thistle (1975), describe some variability in the form of the immature male pleopods I and II, and could not discern any development of these male pleopods in the manca 3 stage.

Somatic growth in *E. iphthima,* at least for the earliest stages, is rigidly determined; stage 4 individuals always fall within a few tenths of a millimeter of 2.2 mm, regardless of the locality. In contrast to this, the stages of sexual development for both males and females have broad size ranges over several localities, clearly spanning a number of instars. Because the observed range of instars for levels of reproductive development is more restricted within localities, one possible function of this flexibility may be to allow a deme of the widespread *E. iphthima* more readily to adapt to local environmental conditions.

The results on this species indicate that there are 2 components to development that need to be considered: somatic growth, described as the succession of instars; and sexual development, described as the appearance of primary and secondary sexual characters. In most desmosomatids, the appearance of sexual features is closely coupled with somatic growth, while in *E. iphthima* and in the genus *Jaera* there is some independence between these two components.

However, observed variation of sexual development may require consideration of two different phenomena, decoupled sexual development, and hermaphroditism. Thus, *Chelator vulgaris* is an example of rigidly coupled sexual and somatic development with protogyny, *Jaera* shows some decoupling of sexual growth, and *Eurycope iphthima* displays characteristics of both influences on development.

Acknowledgments

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Literature Cited

Bocquet, C. 1953. Recherches sur le polymorphisme naturel des *Jaera marina* (Fabr.) (Isopodes Asellotes).—Arch. Zool. Exp. Gen. 90:187–450.

Bonnier, J. 1896. Edriophthalmes.—Ann. Univ. Lyon 1895:527–689.

Chardy, P. 1979. Structure of deep-sea asellota assemblages in the Bay of Biscay; relationships with the abyssal environment.—Ambio Special Report, no. 6, pp. 79–82.

Fuglister, F. 1960. Atlantic Ocean atlas of temperature and salinity profiles and data from the International Geophysical Year of 1957–1958.—Woods Hole Oceanographic Inst. Atlas Ser. 1:209 pp.

Gardiner, L. 1975. The systematics, postmarsupial development, and ecology of the deep-sea family Neotanaidae (Crustacea: Tanaidacea).—Smithsonian Cont. Zool. no. 170, 265 pp.

Gurjanova, E. 1946. New species of Isopoda and Amphipoda from the Arctic Ocean.—Comp. Results, Drifting Exp., Icebreaker "Sedov," 1937–1940. Moscow 3:272–297.

Hansen, H. 1916. Crustacea Malacostraca III.—Danish Ingolf Exped. 3(5):1–262.

Haugsness, J., and R. Hessler. 1979. A revision of the subfamily Syneurycopinae (Isopoda: Asellota: Eurycopidae) with a new genus and species (*Bellibos buzwilsoni*).—Trans. San Diego Soc. Nat. Hist. 19(10):121–151.

Hessler, R. 1970. The Desmosomatidae (Isopoda, Asellota) of the Gay Head–Bermuda Transect.—Bull. Scripps Inst. Oceanography 15:1–185.

———, and D. Thistle. 1975. On the place of origin of the deep-sea isopods.—Marine Biology 32:155–165.

Menzies, R. 1962. The isopods of abyssal depths in the Atlantic Ocean.—Abyssal Crustacea. Vema Res. Ser. 1:79–206.

Ohlin, A. 1901. Arctic Crustacea collected during the Swedish Arctic Expeditions 1898 and 1899 under the direction of Prof. A. G. Wathorst. I. Leptostraca, Isopoda, Cumacea.—Bih. Svensk. Vetensk. Aka. Handl. 26, 4(12):1–54.

Sibuet, M. 1979. Biologie. Connaissances générales sur les communautes benthiques abyssales dans l'Atlantique nord-est.—CNEXO 3:1–96.

Thistle, D., and R. Hessler. 1977. A revision of *Betamorpha* (Isopoda; Asellota) in the world ocean with three new species.—Zool. J. Linn. Soc. 60:275–295.

Veuille, M. 1978a. Biologie de la reproduction chez *Jaera* (Isopode Asellote) I.—Structure et fonctionnement des pièces copulatrices mâles.—Cah. Biol. Marine 19:299–308.

———. 1978b. Biologie de la reproduction chez *Jaera* (Isopode Asellote) II.—Évolution des organes reproducteurs femelles.—Cah. Biol. Marine 19:385–395.

Wilson, G., and R. Hessler. 1980. Taxonomic characters in the morphology of the genus *Eurycope* (Crustacea, Isopoda) with a redescription of *E. cornuta* Sars, 1864.—Cah. Biol. Marine 21:241–263.

Wolff, T. 1962. The systematics and biology of bathyal and abyssal Isopoda Asellota.—Galathea Rep. 6:1–320.

Zimmer, C. 1926. Northern and Arctic invertebrates in the collection of the Swedish State Museum. X, Cumaceen.—Kungl. Svenska Vetensk. Akad. Handl. ser. 3, 3(2):1–88.

Scripps Institution of Oceanography A-002, La Jolla, California 92093.

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94(1), 1981, pp. 295–313

THE AMPHIPOD GENERA *EOBROLGUS* AND *EYAKIA* (CRUSTACEA: PHOXOCEPHALIDAE) IN THE PACIFIC OCEAN

J. Laurens Barnard and Charline M. Barnard

Abstract.—*Eobrolgus* now contains 3 species, *spinosus* (Holmes) (type), *chumasi* n. sp. and *pontarpioides* (Gurjanova); *E. spinosus* appears to be a west Atlantic species introduced into lagoons and estuaries of the northeastern Pacific, whereas *E. chumasi* is a native eastern Pacific species and the possible ancestor of *spinosus*. Now that *spinosus* has returned to the Pacific, gene flow is perceived to occur with its parent *chumashi*.

Eyakia has 4 species, *robusta* (Holmes) (type) (? = *ochotica* (Gurjanova)), *calcarata* (Gurjanova), *uncigera* (Gurjanova) and *subuncigera* (Kudrjaschov). The first 2 are redescribed.

Introduction.—The genera *Eobrolgus* and *Eyakia* were recently carved out of the polytypic *Paraphoxus* Sars by J. L. Barnard (1979). The species of these genera are now presented and revised.

Of particular interest is the discovery of a new cryptic species of Phoxocephalidae near *Eobrolgus spinosus* (Holmes) (formerly *Paraphoxus spinosus*) which appears to be an endemic east Pacific species and which points to the possibility that east Pacific populations of *E. spinosus* are introductions from the Atlantic Ocean.

The taxonomy of American and North Pacific Phoxocephalidae is much more subtle than that found for Australian taxa by Barnard and Drummond (1978), so that generic distinctions are much finer and fewer.

The generic information of Barnard (1979) is not repeated here so as to save space for redescription of those species for which good material is available.

We thank Elizabeth B. Harrison, Janice M. Clark, Irene F. Jewett and Roland H. Brown for their help with this project. Dr. Janet Haig of the Allan Hancock Foundation kindly loaned us materials for this study. We thank John Chapman and Dr. James T. Carlton for their advice about introduced species.

Eobrolgus J. L. Barnard, 1979

This genus differs from Australian brolgins and *Paraphoxus* by the following factors: (1) proximal spines of article 4 on antenna 2 are thick and present (in brolgins they are thin or absent); (2) distal spines in the same locality are few; (3) inner plate of maxilla 1 with 4 setae (2 in other mentioned groups); (4) mandibular molar with 4+ spines (3 or fewer in brolgins); (5) inner plate of maxilliped with one main apical spine (none in brolgins); (6) maxillipedal dactyl with apical spine fused (not fused in brolgins except in *Elpeddo*); (7) epimeron 3 with 3+ long setae (3 or fewer usually short setae in brolgins); (8) right lacinia mobilis apical branch narrow or absent.

Key to the Species of *Eobrolgus*

1. Each lobe of telson with 2 apical spines .... *E. pontarpioides*
– Each lobe of telson with one apical spine 2
2. Epimeron 3 naked ventrally, right lacinia mobilis simple in female, outer plate of maxilla 1 with 9 spines .... *E. spinosus*
– Epimeron 3 with 1–2 ventral setae, right lacinia mobilis bifid in female, outer plate of maxilla 1 with 11 spines .... *E. chumashi*

Eobrolgus spinosus (Holmes)

Fig. 1f

Paraphoxus spinosus Holmes, 1905:477–478, fig. [unnumbered]; Kunkel, 1918:76–78, fig. 13; Shoemaker, 1925:26–27; J. L. Barnard, 1959:18; 1960:243–249, pls. 29–31; 1961:178; 1964a:105; 1966a:89; 1969a:197–198; 1969b:224; Reish and Barnard, 1967:18; Bousfield, 1973:125, pl. 34.1.

Description of female "f" of Atlantic Ocean.—Head about 18 percent of total body length, greatest width about 75 percent of length, rostrum unconstricted, broad, short, reaching middle of article 2 on antenna 1. Eyes large, mostly occluded with pigment, ommatidia ordinary. Article 1 on peduncle of antenna 1 about 1.35 times as long as wide, about 2.1 times as wide as article 2, ventral margin with about 9 setules, strongly produced dorsal apex with 2 setules, article 2 about 0.6 times as long as article 1, with 2 apicoventral rows of 4 and 2 setae and 3 lateral setae, primary flagellum with 7 articles, about 0.55 times as long as peduncle, bearing one short aesthetasc each on articles 3–6, accessory flagellum with 5 articles. Antenna 2 thin, not ensiform but article 1 enlarged, article 3 with one anterodorsal setule plus normal facial formula; spine formula on article 4 = 1-3-4, dorsal margin with notch bearing one seta and one spine, ventral margin with 5 groups of 2 long to medium setae, one ventrodistal long spine, article 5 about 0.8 times as long as article 4, facial spine formula = 2, dorsal margin bearing one apical set of short setae, ventral margin with 4 sets of 2 long to short setae, 3 ventrodistal long to medium spines set facially, flagellum as long as articles 4–5 of peduncle combined, with 8 articles.

Epistome with weak anterior knob. Mandibles with medium palpar hump, right incisor with 3 normal teeth, left incisor with 3 hump-teeth in 2 branch-

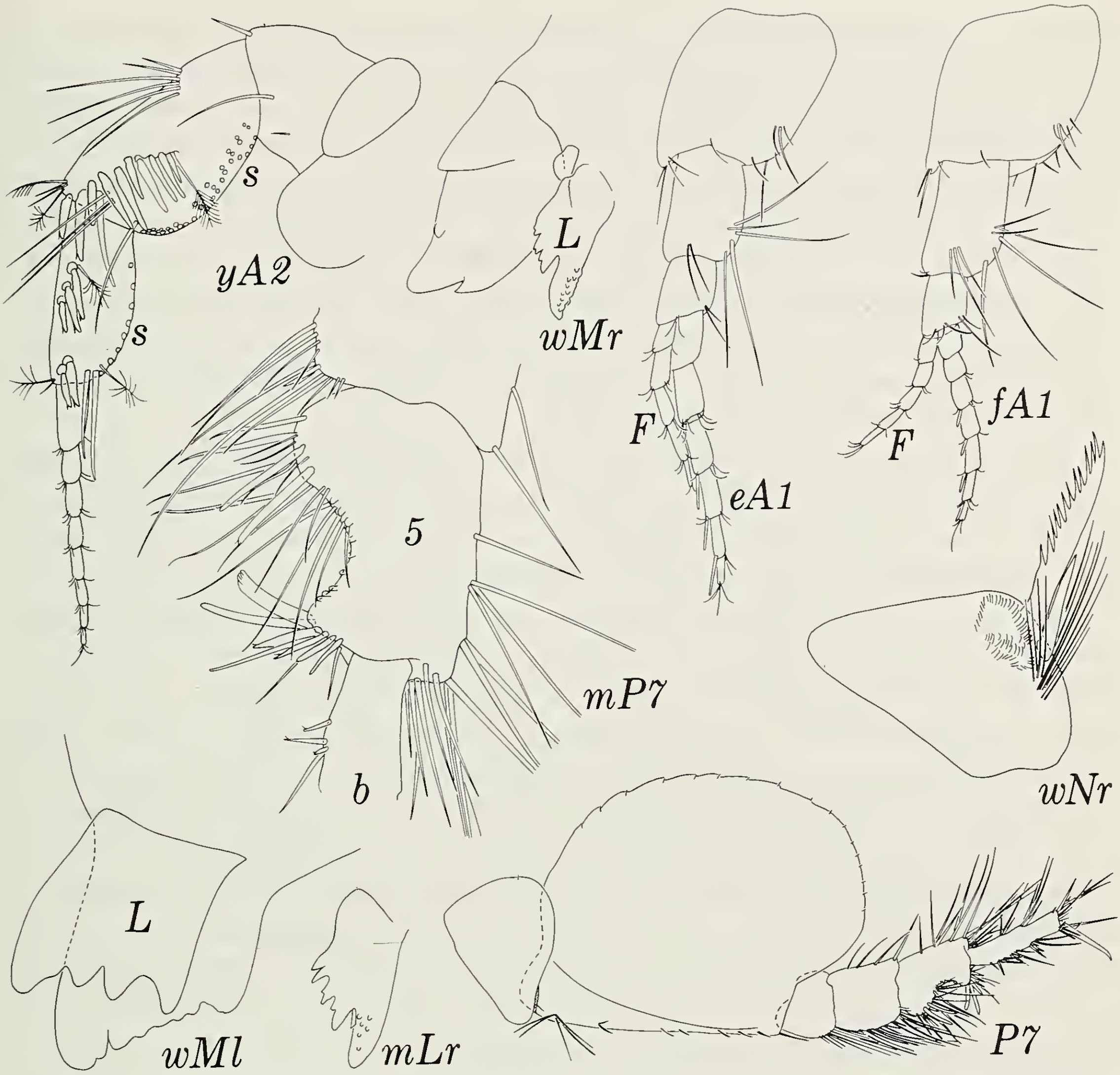

Fig. 1. *Eyakia robusta* (Holmes), m = male "m," w = female "w," y = female "y." *Eobrolgus chumashi,* new species, e = female "e." *Eobrolgus spinosus* (Holmes), f = female "f." Capital letters = A, antenna; F, accessory flagellum; L, lacinia mobilis; M, mandible; N, molar; P, pereopod; lower case letters to left of capitals refer to specimens described in text; lower case letters to right of capitals or freely placed in figures are as follows: b, broken; l, left; r, right; s, setae removed.

es, right lacinia mobilis simple, pointed, left lacinia mobilis with 4 teeth plus one accessory tooth, middle teeth not shortened, right rakers 6, left rakers 6 plus one rudimentary, molars composed of short bulbous protrusions, right molar with 4 primarily medium spines plus one short seta strongly disjunct, left molar with 4 primarily medium spines plus one short seta strongly disjunct, each molar with plume, palp article 1 short, article 2 with 2 long and short inner apical setae and one other short inner seta, article 3 about as long as article 2, oblique apex with 7–8 spine setae, basofacial formula = 0. Each outer lobe of lower lip with one cone. Inner plate of maxilla 1 ordinary, bearing one long apical pluseta, one similar apicomedial seta, 2 apicolateral much shorter setae, outer plate with 9 spines, palp thin, scarcely biarticulate, article 2 with one apical spine, one apicolateral and 2 medial setae. Plates of maxilla 2 extending equally, outer not broader than inner, outer with 2 apicolateral setae, inner with 2 medial setae. Inner plate of maxilliped with one large thin apical spine, 2 apicofacial setae, 4 medial setae, outer plate with 8 medial and apical spines, no apicolateral setae, palp article 1 without apicolateral seta, article 2 without lateral setae, medial margin weakly setose, article 3 with 4 facial setae, 2 lateral setae, nail of article 4 fused, with 2 accessory setules.

Coxa 1 scarcely expanded apically, anterior margin straight, main ventral setae of coxae 1–4 = 8-8-8-5, posteriormost seta of coxae 1–4 slightly shortened, anterior and posterior margins almost parallel, posterior margin convex, posterodorsal corner rounded, posterodorsal margin short, V-shaped, width-length ratio = 18:19. Gnathopods generally ordinary, width ratios on articles 5–6 of gnathopods 1–2 = 25:36 and 27:39, length ratios = 65:73 and 53:71, palmar humps ordinary, palms strongly oblique, article 5 of gnathopod 1 elongate, ovate, posterior margin rounded-flat, long, article 5 of gnathopod 2 ovate, posterior margin rounded, short, almost produced.

Pereopods 3–4 similar to each other, facial setae formulas on article 4 = 4 and 3, almost parallel to apex, on article 5 = 4 and 3, main spine of article 5 extending to M. 100 on article 6, article 5 with no proximoposterior spines, spine formula of article 6 = 4 + 5 and 4 + 5 plus middistal seta, some spines especially long, acclivity on inner margin of dactyls of pereopods 3–4 absent, emergent setule short, almost fully immersed, midfacial pluseta ordinary. Coxae 5–7 posteroventral setule formula = 2-1-1. Articles 4–5 of pereopods 5–6 narrow, facial spine rows sparse, facial ridge formula of article 2 on pereopods 5–7 = 0-1-1. Width ratios of articles 2, 4, 5, 6 on pereopod 5 = 53:33:30:13, of pereopod 6 = 68:26:16:9, of pereopod 7 = 80:17:16:8, length ratios of pereopod 5 = 78:32:40:38, of pereopod 6 = 90:56:45:43, of pereopod 7 = 100:23:22:27, article 2 of pereopod 7 reaching middle of article 4, posterior margin with 8 tiny serrations, only medial apex of article 6 finely and sparsely combed, bearing 1–2 weak digital processes.

Posteroventral corner of epimeron 1 rounded, posterior margin straight, naked, anteroventral margin with 2 medium setae, posteroventral face with one long seta. Posteroventral corner of epimeron 2 rounded, posterior margin weakly convex, naked, facial setae = 5, no pair set vertically. Posteroventral corner of epimeron 3 rounded, posterior margin straight, serrate, setose (4), with one dorsal setule notch, ventral margin naked.

Urosomite 1 with lateral setule at base of uropod 1, no ventral setae, articulation line short, urosomite 3 unprotuberant dorsally. Rami of uropods

1–2 with articulate but tightly fixed apical nails, outer ramus of uropod 1 with 3 dorsal spines, inner with 2, outer ramus of uropod 2 with 2 dorsal spines, inner with one dorsomedial spine, peduncle of uropod 1 with 4 basofacial setae and one apicolateral spine, medially with 4 marginal spines, apicalmost enlarged but not displaced. Peduncle of uropod 2 with 5 thin dorsal spines, medially with one medium apical spine, apicolateral corner of peduncles on uropods 1–2 with comb. Peduncle of uropod 3 with 4 ventral spines, dorsally with 2 lateral spines, one medial setule, rami feminine, inner extending to M. 50 on article 1 of outer ramus, apex with one long seta, medial and lateral margins naked, article 2 of outer ramus elongate, 0.25, bearing 2 short to medium setae, medial margin of article 1 with 4 setae, lateral margin with 3 acclivities, spine formula = 2-2-2-2, setal formula = 0. Telson especially long, length-width ratio = 35:29, almost fully cleft, each apex of medium width, rounded, scarcely protruding, lateral acclivity shallow, narrow, bearing ordinary lateral setule, spine next medial longer than setule; midlateral setules diverse, largest of medium size.

Young male "p" of Pacific Ocean (assumed transplant).—Like Atlantic *spinosus* in (1) presence of 9 spines on outer plate of maxilla 1; (2) simple right lacinia mobilis; (3) coxa 4 setose; (4) uropods 1–2 with comb; (5) rami of uropod 2 with one spine each; (6) apical setae on outer ramus of uropod 1 medium in length; (7) apical nails on rami of uropods 1–2 large; (8) no ventral setae on epimeron 3.

Female "u" of Pacific Ocean, possible hybrid.—Like Atlantic *spinosus* in items of paragraph above: 2, 3 (but coxa 4 with only 1 seta), 4, 5 (but only outer ramus with spine), 6, 7, 8; but outer plate of maxilla 1 with 11 spines like *chumashi*.

Male "b."—Article 2 of antenna 1 with 6–7 narrowly spread ventral setae, primary flagellum with 9 articles, one calceolus each on articles 1–5. Facial spine formula on article 4 of antenna 2 = 3-4-1, of article 5 = 2, latter with 4 dorsal sets of male setae and no calceoli, ventrodistal apex with 2 thin spines, flagellar calceolus formula = 2,3,5,7,9 . . . n.

Basofacial setal formula of article 3 on mandibular palp = 0-1, article 2 with 4 apical setae. Outer plate of maxilla 1 with 9 spines.

Coxa 4 more elongate than in female, width-length ratio = 4:5. Pereopods 3–4 thinner than in female; article 2 of pereopods 5–7 narrower than in female; article 5 of pereopod 7 with 1–2 male setae.

Epimera 1–3 broadened, posterior margin of epimeron 3 not shortened, setal formulae, epimeron 1 anteroventral = 2, posteroventral = 1, epimeron 2 facial = 3-4, epimeron 3 posterior = 4, facial = 0, ventral = 0. Spine formulae of uropods, uropod 1 peduncle apicolateral = 1, basofacial = 4, uropod 2 peduncle dorsal = 5, dorsal spines on outer ramus of uropod 1 = 2, of uropod 2 = 2, inner ramus of uropod 1 = 1, of uropod 2 = 1, ventral spines on peduncle of uropod 3 = 5, spine formula on article 1 of outer ramus = 1-2-2-2-2, setal formula = 1-1-1-1-1, setae on outer ramus of article 2 as in female.

Telson elongate, length-width ratio = 4:3, distal spines shortened, formula = setule, spine, setule, each lobe with long single denticle row.

Voucher material.—Male "b" 4.37 mm and male "c" 4.02 mm, Woods Hole, Massachusetts, USA, 9 July 1875, surface, A.E.V. [Verrill]; female "f" 4.58 mm, Amityville [Long Island, New York, USA], 6 July 1938, Acc. no. 149428; young male "p" 3.22 mm (no antenna 2), Friday Harbor, Washington, USA, 8896, 21 October 1920; female "u" 1.88 mm, Newport Bay, California, USA, station 50, 1964 January (see J. L. Barnard, 1959).

Remarks.—One presumes that this is an Atlantic species that has been introduced into estuaries, bays and lagoons of the northeastern Pacific Ocean, such as Friday Harbor and Newport Bay (and Morro Bay, San Francisco Bay, etc.) where it closely matches the endemic Pacific *E. chumashi*. Female "u" cited above is disturbing because it has 11 spines on the outer plate of maxilla 1 like *chumashi* yet has the *spinosus* morphology in other characters. Study on hybdridization is warranted. The two morphs may have been separated by Pleistocene closure of the Panamic isthmus and now have been rejoined by mankind without complete genetic isolation. Other explanations can be visualized and need not be discussed until the morphs are explored further.

Barnard (1960) did not detect this problem because finely drawn characters as now used had not been introduced. Most of the Allan Hancock Foundation materials will require reidentification, a task we leave to someone who wants to pursue the introduction problem.

Despite the amazing superficial resemblance of this species to *Paraphoxus oculatus,* the two taxa cannot be congeneric because of (1) the mandibular molar spine counts; (2) the spine distribution on article 4 of antenna 2; (3) the short article 1 of the mandibular palp; (4) the oblique apex of palp article 3 on the mandibular palp; (5) the non-foliate right lacinia mobilis; (6) the presence of 4 setae on the inner plate of maxilla 1; (7) the stout apical spine on the inner plate of the maxilliped; (8) the presence of basal armaments on article 5 of pereopods 3–4; (9) the presence of long setae on epimeron 3; and, in addition, the lesser values of setae on article 2 of antenna 1 not being fully apicad and the dactylar nail of the maxilliped being fused.

This species is also confusable with *Foxiphalus obtusidens* but the following characters distinguish *spinosus* from *obtusidens*: (1) the apicad position of the setae on article 2 of antenna 1; (2) the short head; (3) the non-ensiform antenna 2; (4) the simple right lacinia mobilis; (5) the thin apex of the palp on maxilla 1; (6) the tightly fixed apical nail on the inner ramus of uropod 1; (8) the lack of ventral setae on the urosome.

A few west American samples of "*Paraphoxus spinosus*" have been reexamined and some found to be the new species, *Eobrolgus chumashi,* a cryptic species similar to *spinosus.* But most of the material in the Allan Hancock Foundation needs to be reidentified and we have not examined the material from the Gulf of California, Carmen Island, identified by Shoemaker (1925) which is presumably in the American Museum of Natural History.

The open-sea character of *chumashi* and the estuarine-lagoon-shallow open-sea character of *spinosus* suggest the latter has been introduced onto the Pacific Coast from the western Atlantic. But more investigation of the two species is required.

Distribution.—Western Atlantic Ocean from Vineyard Sound to North Florida (*fide* Bousfield, 1973), depths unknown, no samples in Smithsonian collections with stated depths; eastern Pacific Ocean, confirmed localities, Friday Harbor and Newport Bay (lagoon), shallow water; much material to be reidentified in Allan Hancock Foundation.

Eobrolgus chumashi, new species
Fig. 1e

Description of female "e."—Body dwarfed. Head about 21 percent of total body length, greatest width about 67 percent of length, rostrum unconstricted, broad, short, almost reaching apex of article 2 on antenna 1. Eyes large, mostly occluded with pigment, ommatidia especially large. Article 1 of peduncle on antenna 1 almost 1.5 times as long as wide, about twice as wide as article 2, ventral margin with 7–8 setules, produced dorsal apex with 2 setules, article 2 about 0.55 times as long as article 1, with 2 apicoventral rows of 4 and 1 setae and 2 lateral setae, primary flagellum with 7 articles, about 0.8 times as long as peduncle, bearing one short aesthetasc each on articles 3–6, accessory flagellum with 5 articles. Antenna 2 not ensiform, article 3 dorsally naked but with normal facial setules, spine formula of article 4 = 1-3-5, dorsal margin with notch bearing 2 setae and one spine, ventral margin with 5 groups of 2 long to medium setae, one ventrodistal long spine, article 5 about 0.72 times as long as article 4, facial spine formula = 3, dorsal margin bearing one set of small setae apically, ventral margin with 4 sets of 1–2 long to short setae, 3 ventrodistal long to medium spines set facially; flagellum about 0.95 times as long as articles 4–5 of peduncle combined, with 7 articles.

Epistome unproduced. Mandibles with weak to medium palpar hump, right incisor with 3 teeth, left incisor with 3 hump-teeth in 2 branches, right lacinia mobilis bifid, distal branch not shorter than proximal, distal branch broad, proximal branch narrow, both branches simple, pointed, left lacinia mobilis with 4 teeth, middle teeth shortened, right rakers 7 plus 2 rudimentaries, left rakers 7 plus 3 rudimentaries, molars composed of elongate bulbous plaques, right molar with 5 primarily medium spines plus one short spine strongly disjunct, left molar with 6 primarily medium spines, no spine disjunct, each molar with plume, palp article 1 short, article 2 with one short inner apical seta and 2 other short inner setae, article 3 about 1.1 times as long as article 2, oblique apex with 9–7 spine-setae, basofacial formula = 0. Each outer lobe of lower lip with one cone. Inner plate of maxilla 1 ordinary, bearing one medium apical pluseta, one similar apicomedial seta, 2 apicolateral shorter setae, outer plate with 11 spines, no cusps, palp article 2 with one apical spine, one apicolateral, 2 apicomedial and 3 submarginal setae. Plates of maxilla 2 extending equally, outer broader than inner, outer with 3 apicolateral setae, inner with 2 medial setae. Inner plate of maxilliped with one large thick apical spine, 2 apicofacial setae, 3 medial setae, outer plate with 3 medial spines set apicad tightly, no apicolateral setae or cusp, palp article 1 without apicolateral seta, article 2 with one apicolateral seta, medial margin of article 2 moderately setose, article 3 with 4 facial setae, one lateral seta, nail of article 4 fused, with 2 accessory setules.

Coxa 1 scarcely expanded apically, anterior margin straight, main ventral setae of coxae 1–4 = 7-8-7-0, posteriormost seta of coxae 1–3 shortened, anterior and posterior margins parallel, posterior margin almost straight, posterodorsal corner sharp-rounded, posterodorsal margin short, concave, V-shaped, width-length ratio of coxa 4 = 13:17. Gnathopods ordinary, width ratios on articles 5–6 of gnathopods 1–2 = 25:33 and 26:33, length ratios = 65:56 and 49:52, palmar humps small, palms oblique, article 5 of gnathopod 1 elongate, ovate, posterior margin rounded-flat, long, article 5 of gnathopod 2 ovate, posterior margin rounded, short, almost produced.

Pereopods 3–4 similar to each other, facial setae formula on article 4 = 3 and 3, slightly oblique to apex, on article 5 = 4 and 4, main spine of article 5 extending to M. 90–100 on article 6, article 5 with no proximoposterior spines, spine formula of article 6 = 4 + 4 and 4 + 5 plus middistal seta, some spines especially long, acclivity on inner margin of dactyls of pereopods 3–4 obsolescent but sharp, emergent setule short, almost fully immersed, midfacial pluseta ordinary. Coxae 5–7 posteroventral setule formula = 1-1-1. Articles 4–5 of pereopods 5–6 narrow, facial spine rows sparse, facial ridge formula of article 2 on pereopods 5–7 = 0-1-1; width ratios of articles 2, 4, 5, 6 of pereopod 5 = 51:40:35:13, of pereopod 6 = 69:30:18:9, of pereopod 7 = 80:18:16:8, length ratios of pereopod 5 = 76:34:40:39, of pereopod 6 = 89:51:40:49, of pereopod 7 = 100:21:21:28, article 2 of pereopod 7 almost reaching middle of article 5, posterior margin with 10–11 tiny serrations, medial and lateral apices of article 6 deeply combed, lacking digital processes.

Posteroventral corner of epimeron 1 rounded, posterior margin weakly convex, with 2 setule-notches, anteroventral margin with 4–5 short setae, paired or not, posteroventral face with one medium seta. Posteroventral corner of epimeron 2 rounded, posterior margin weakly convex, with 2 setule notches, facial setae = 7, posteriormost seta disjunct posteriad. Posteroventral corner of epimeron 3 rounded, weakly protuberant, posterior margin straight, serrate, setose (2) and with 5 setule notches, ventral margin with 2 short spine-setae in posterior half.

Urosomite 1 with lateral setule at base of uropod 1, no ventral setae, articulation line short, urosomite 3 unprotuberant dorsally. Rami of uropods 1–2 with articulate but tightly fixed, deeply immersed and small apical nails, outer ramus of uropod 1 with one dorsal spine, inner with one, rami of uropod 2 naked, peduncle of uropod 1 with no basofacial setae and one small apicolateral spine, medially with 2 marginal spines, apicalmost enlarged but not displaced. Peduncle of uropod 2 with 4 dorsal spines, medially with one small apical spine, apicolateral corners of peduncles on uropods 1–2 without comb. Peduncle of uropod 3 with 4 ventral spines, dorsally with one lateral spine, one medial spine, rami feminine, inner extending to M. 65 on article 1 of outer ramus, apex with one tiny setule, medial and lateral margins naked, article 2 of outer ramus elongate, 0.40, bearing tiny immersed setule near pointed apex, apicomedial margin of article 1 naked, lateral margin with 2 acclivities, spine formula = 2-2-2, setal formula = 0. Telson especially long, length-width ratio = 42:33, almost fully cleft, each apex of medium width, rounded, scarcely protuberant, lateral acclivities shallow, narrow, bearing short lateral setule, spine next medial shorter than setule (thus very short), midlateral setules diverse, largest of medium size.

Male "d."—Ommatidia large. Article 1 of antenna 1 and articles 2–3 of antenna 2 with medial pubescence; length ratio of articles 1–2 on antenna 1 = 5:3; article 2 with 4 + 1 ventral setae narrowly confined and set apically, primary flagellum with 6 articles, one calceolus each on articles 1–3, aesthetascs moderately developed, accessory flagellum very short, 4-articulate. Article 4 of antenna 2 lacking dorsal notch, no dorsal spines and setae, other setae shortened, facial formula = 3-4-1, article 5 with 3 dorsal sets of male setae and one calceolus, 3 facial spines, ventrodistal apex with 2 thin spines; formula of calceoli on flagellum = 1,2,3,5,7,9 . . . n. Right lacinia mobilis broad and scarcely bifid, apices of lobes stubby and rounded, basofacial setal formula of article 3 on mandibular palp = 0-2.

Setae of coxae 1–3 shortened, coxa 4 not broadened, setae absent. Article 2 of only pereopod 7 narrower than in female. Epimera 1–3 broadened, posterior margin of epimeron 3 not shortened, setal formulae: epimeron 1 anteroventral = 4 (one set paired), posteroventral = 1, posterior = 3 setules, epimeron 2 facial = 6 (posterior one disjunct), posterior = 2 setules, epimeron 3 posterior = 3 + 3 setules, facial = 0, ventral = 2.

Spine formulae of uropods: uropod 1 peduncle apicolateral = 1, basofacial = 1 stout and short spine, medial peduncle = only one long apical spine not displaced, no others; uropod 2 peduncle dorsal = 4, not longer than in female, dorsal spines on outer ramus of uropod 1 = 1, of uropod 2 = 0-1, inner ramus of uropod 1 = 1, of uropod 2 = 1, ventral spines of peduncle of uropod 3 = 4, spine formula on article 1 of outer ramus = 2-2-2-2, setal formula = 0-1-1-1, apex of article 2 with 2 diverse medium setae. Telson elongate, distal spines not more shortened than already in female, with long denticle row on each lobe.

Male "g."—Nails on rami of uropods 1–2 enlarged but epimeron 3 with 2 ventral setae, rami of uropod 2 lacking spines, right lacinia mobilis bifid and outer plate of maxilla 1 with 11 spines. Possible hybrid with *spinosus.*

Holotype.—Allan Hancock Foundation No. 5746, female "e" 2.77 mm.

Type-locality.—*Velero IV* 4870, southern California, 33°30′33″N, 117°45′17″W, 10.7 m, benthic orange peel grab.

Voucher material.—Type-locality, male "d" 2.71 mm; male "g" J. L. Barnard station 38-C-4, Cayucos, California, 1 July 1961, intertidal, *Phyllospadix*-pelvetiid community (see J. L. Barnard, 1969a).

This cryptic species is generally similar to *E. spinosus* but differs in the following ways: (1) the ommatidia are enlarged; (2) the dorsal notch on article 4 of antenna 2 has one more seta; (3) the right lacinia mobilis is bifid; (4) the outer plate of maxilla 1 has 11 spines; (5) coxa 4 lacks setae; (6) epimeron 3 has 2 ventral setae; (7) uropods 1–2 lack peduncular comb; (8) the apical nails of uropods 1–2 are small; (9) uropod 1 has no basofacial setae; (10) the rami of uropods 1–2 lack dorsal or marginal spines; (11) article 2 on the outer ramus of uropod 3 is longer; and (12) has no significant setae in the female.

Just the sparse materials reexamined for this study indicate that characters 4, 5, 8 and possibly 10 are not very precise and that some hybridization or gene flow may be occurring between *chumashi* and *spinosus.* Nevertheless, the species seem to be justified; they appear to be vicariants now rejoined by human interference, *chumashi* appearing to be the native Pacific species and *spinosus* the Atlantic species that has been brought west.

Distribution.—Southern California, 0–11 m, probably more widespread (collections of *spinosus* in Allan Hancock Foundation requiring reidentification).

Eobrolgus pontarpioides (Gurjanova), revived

Pararpinia [sic] *pontarpioides* Gurjanova, 1953:229–230, figs. 11–12.

This species was synonymized with *obtusidens* by J. L. Barnard (1960:249) but is now recognized to be near or in the genus *Eobrolgus.* It is distinguished in the key to *Eobrolgus* but needs extensive redescription. No materials are available.

In the original depiction, antenna 1 is drawn as if the setae are apical on article 2 but possibly because of the deeply folded condition of article 3 the true condition of article 2 is obscured. If interpreted as apical, those setae suggest that *P. pontarpioides* belongs with *Eobrolgus,* but, if not, the species probably belongs to *Foxiphalus* or *Grandiphoxus.* Gurjanova drew only one seta on article 3 of antenna 2 suggesting that the species belongs with *Foxiphalus* and not with *Grandiphoxus* where at least 3 setae occur on article 3. The diversity in head of *Foxiphalus* and *Grandiphoxus* is intergraded by *Grandiphoxus robustus* Gurjanova so that the side view shown by Gurjanova for *P. pontarpioides* is useless for determination. J. L. Barnard (1960) considered *P. pontarpioides* to be a synonym of *Foxiphalus obtusidens* (Alderman) but now that *obtusidens* has been split into several species there may be cause to consider *P. pontarpioides* a good species. However, epimeron 3 as shown by Gurjanova is not typical of *obtusidens* nor of *Foxiphalus* in general. *Pontharpinia pontarpioides* must be reserved as a valid species of unknown genus until further study can be undertaken.

Eyakia J. L. Barnard, 1979

Four species are assigned to this genus; two of these are redescribed in the system of Barnard and Drummond (1978). These are *E. robusta* (Holmes) and *E. calcarata* (Gurjanova). The other two species, *E. uncigera* (Gurjanova) and *E. subuncigera* (Kudrjaschov) do not occur in Smithsonian collections.

The two analyzed species are alike in the extra spine on article 4 of antenna 2, the elongate spine on the molar, the taper on article 2 of pereopod 5, the facial setae on epimeron 3 and the widely spread basofacial setae on the peduncle of uropod 1.

Key to the Species of *Eyakia*

1. Epimeron 3 with large tooth .... *E. robusta* (=?*ochotica*)
– Epimeron 3 lacking tooth 2
2. Pereopod 7 article 2 ordinary, lacking spike .... *E. calcarata*
– Pereopod 7 article 2 with large spike 3
3. Coxa 2 without posteroventral tooth, outer ramus of uropod 1 without marginal spines .... *E. uncigera*
– Coxa 2 with posteroventral tooth, outer ramus of uropod 1 with marginal spines .... *E. subuncigera*

Eyakia robusta (Holmes)
Fig. 1m, w, y

Paraphoxus robustus Holmes, 1908:518–521, fig. 27.—J. L. Barnard, 1960:235–236, pl. 25; 1964b:244; 1966a:89; 1966b:29.

Description of female "w."—Head about 21 percent of total body length, greatest width about 70 percent of length, rostrum unconstricted, broad, elongate, almost reaching apex of article 2 on antenna 1. Eyes small, largely occluded with pigment, ommatidia ordinary. Article 1 of peduncle on antenna 1 about 1.4 times as long as wide, about 2.6 times as wide as article 2, ventral margin with about 11 setules, weakly produced dorsal apex with 2 setules, article 2 about 0.7 times as long as article 1, with midventral row of 8 setae, primary flagellum with 8 articles, about 0.45 times as long as peduncle, bearing one short aesthetasc each on articles 2–7, accessory flagellum with 6 articles. Antenna 2 not ensiform, article 3 with thin anterodorsal spine and normal facial armament, spine formula on article 4 = 5-5 (tightly compressed) plus offset thin spine midapically, dorsal margin with notch bearing 5 setae and one spine, ventral margin with 15 groups of 1–3 long to medium setae, one ventrodistal long spine, article 5 about 0.78 times as long as article 4, facial spine formula = 2-3, dorsal margin bearing one set of apical setae, ventral margin with 8 sets of one long seta each, 2 ventrodistal long to medium spines set facially; flagellum almost 0.7 times as long as articles 4–5 of peduncle combined, with 8 articles.

Epistome unproduced. Mandibles with weak palpar hump, right incisor with 3 teeth, third tooth placed distad, left incisor with 3 humps on 2 branches plus 3–4 weak teeth between, right lacinia mobilis bifid, distal branch much shorter than proximal, flabellate, tridentate, proximal branch simple, pointed, with marginal denticles and facial humps, left lacinia mobilis with 4 teeth, middle teeth not shortened, right rakers 11 plus 2 rudimentaries, left rakers 11 plus one rudimentary, molars composed of short bulbous humps, each with huge serrate spine, right molar with 2 additional primarily medium spines, left molar with 3 primarily medium spines, no spine disjunct, each molar with dense elongate plume; palp article 1 short, article 2 with 3 long to medium inner apical setae and 4 other long to short inner setae, article 3 about 1.2 times as long as article 2, oblique apex with 8–10 spine-setae, basofacial formula = 2-4. Each outer lobe of lower lip with one cone. Inner plate of maxilla 1 ordinary, bearing one long apical pluseta, one similar apicomedial seta, one shorter apicomedial seta and one apicolateral short seta, outer plate with 11 spines, palp article 2 with one apical spine, 2 apicolateral and 4–5 medial spines and 6 submarginal setae. Inner plate of maxilla 2 shorter than outer, outer not broader than inner, outer with 5 apicolateral setae, inner with 2 medial setae. Inner plate of maxilliped with 2 large thick apical spines, 2 apicofacial setae, 4 medial setae, outer plate with 12–14 medial and apical spines plus 3 apical cusps, 4 apicolateral setae, palp article 1 with one apicolateral seta, article 2 with one group of 4 apicolateral setae, medial margin of article 2 moderately setose, article 3 with 4 facial setae, 2 lateral setae, nail of article 4 distinct, short, with 2 accessory setules.

Coxa 1 not expanded apically, anterior margin weakly convex, main ventral setae of coxae 1–4 = 23:19:18:29, widely spread, posteriormost seta of coxae 1–2 shortest, of 3–4 slightly shortened, anterior and posterior margins of coxa 4 weakly divergent, posterior margin almost straight, posterodorsal corner rounded, posterodorsal margin ordinary, concave, width-length ratio = 15:18. Gnathopods generally ordinary but hands somewhat slender, width ratios on articles 5–6 of gnathopods 1–2 = 28:31 and 30:36, length ratios = 66:71 and 56:73, palmar humps ordinary, palms strongly oblique, article 5 of gnathopod 1 elongate, ovate, posterior margin flat, article 5 of gnathopod 2 ovate, posterior margin triangular.

Pereopods 3–4 similar to each other, facial setae formulas on article 4 = 12 and 12, parallel to apex, on article 5 = 13 and 12, main spine of article 5 extending to M. 100+ on article 6, article 5 with no proximoposterior spines but with numerous stout setae, spine formula of article 6 = 6 + 4 and 7 + 4 plus tiny middistal seta, one of spines in group of 4 really in middle, some spines especially long, acclivity on inner margin of dactyls of pereopods 3–4 absent, emergent setule short, midmarginal pluseta ordinary. Coxae 5–7 posteroventral seta formula = 11-6-1. Articles 4–5 of pereopods 5–6 narrow, facial spine rows sparse, facial ridge formula of article 2 on pereopods 5–7 = 0-1-1. Width ratios of articles 2, 4, 5, 6 of pereopod 5 = 42:23:21:11, of pereopod 6 = 69:22:17:10, of pereopod 7 = 84:23:17:8; length ratios of pereopod 5 = 74:28:35:37, of pereopod 6 = 92:50:60:53, of pereopod 7 = 100:25:22:33, article 2 of pereopod 7 not reaching middle of article 4, posterior margin with 6–8 medium serrations, anteroapical margins of articles 2–3 and anterior margins of articles 4–5 very densely setospinose, medial apex of article 6 smooth, bearing 6 digital processes; article 2 of pereopods 5–6 tapering distally, only setulose posteriorly, posteroventral lobe of pereopod 6 narrow, of pereopod 5 absent.

Posteroventral corner of epimeron 1 rounded, posterior margin weakly convex, with 4 widely spread setules, anteroventral margin densely setose, ventral face with 14+ long setae in irregular ranks (one row of 9 fairly uniform). Posteroventral corner of epimeron 2 rounded, posterior margin straight, with 4 widely spread setules, facial setae = horizontal rows of 16, 8 and 4. Posteroventral corner of epimeron 3 with large tooth, posterior margin straight, with 2 setule notches, ventral margin with 7 setae widely spread, face with almost horizontal row of 18 setae.

Urosomite 1 with lateral setule at base of uropod 1 and distoventral setae besides midventral setae, articulation line complete, urosomite 3 unprotuberant dorsally. Rami of uropods 1–2 with articulate but tightly fixed apical nails, outer ramus of uropod 1 with 3 tightly contiguous dorsal spines, inner with 2 also tight, outer ramus of uropod 2 with 3 dorsal spines also tight, inner with no dorsomedial spine, peduncle of uropod 1 with 10 basofacial setae extending along ventral margin and one apicoventral spine, medially with 10 thin marginal spines none displaced. Peduncle of uropod 2 with 17 thin dorsal spines, except apicalmost short and stout, medially with one small thin apical spine, apicolateral corners of peduncles on uropods 1–2 without comb. Uropod 3 shortened, peduncle with 8 ventral spines, dorsally with one lateral spine, one medial spine and one setule, rami feminine, inner extending to M. 50 on article 1 of outer ramus, apex with one seta, medial and lateral margins naked, article 2 of outer ramus short, 0.13, bearing 2 long setae, medial margin of article 1 with 5 spine-setae, lateral margin with 4 acclivities, short spine formula = 1-1-1-1-2, long spine formula = 0-1-1-1-1, setae = 0. Telson long, length-width ratio = 15:13, almost fully cleft, each apex wide, rounded, lateral acclivity broad, shallow, bearing ordinary lateral setule, thin spine next medial much longer than setule, midlateral setules diverse or not, largest of medium size.

Female "y".—Article 2 of antenna 1 actually with 2 rows of setae, 6 medial long and 8 laterals (3 long, 5 short), flagella with 10 and 7 articles each. Article 4 of antenna 2 with 10 spines in one row plus one displaced spine, formula of spines on article 5 = 2 + 2-2, [flagellum broken]. Right lacinia mobilis with 7 teeth on distal branch; rakers 12 plus 2 rudimentaries; each molar with 3 spines; basofacial formula on mandibular palp article 3 = 3-3. Inner plate of maxilla 1 normal. Apicolateral setae on outer plate of maxilla 2 = 7. Outer plate of maxilliped with 5 spines, 3 cusps and 9 lateral setae.

Setal formula on coxae 1–4 = 29-24-22-34. Epimeron 3 with 10 ventral setae mostly anterior, main facial row = 13. Uropod 1 peduncle with 3 apicolateral spines, inner ramus with only 1. Uropod 2 peduncle with 18 spines, apical four spines short and stout. Outer ramus of uropod 3 spine formula lateral = 1-2-2 only, inner ramus only half length of outer ramus article 1, length of article 2 = 0.07. Lateral setule of telson described for female "w" of spinal dimensions on this specimen.

Another female.—Article 1 outer ramus of uropod 3 spine formula = 1-2-2-2-2.

Male "m."—Article 1 of antenna 1 witn medial pubescence, article 2 with 4 lateral setae and ventral groups of 6 and 6. Articles 3–4 of antenna 2 with medial pubescence, article 4 lacking dorsal notch and spines, lateral formula on article 4 = 3-6-2, with one spine in group of 3 elongate and apparently representing displaced spine occurring on female; article 5 with 3 lateral spines, apex with only 2 spine-setules and one setule, dorsal margin with 8 sets of male setae and probably 7 calceoli [some broken], one flagellar calceolus each on articles 1,2,3,4,5,6,7,8 . . . n (generic character).

Spines on right mandibular molar = 2, shorter than in female, on left molar = 3, right lacinia mobilis illustrated.

Pereopods 5–6 like female, pereopod 7 illustrated, with odd article 5 as shown by Gurjanova (1938, 1951) for *calcarata,* article 2 narrower than in female.

Epimera 1–3 broadened, first 2 heavily setose as in female, ventral setae of epimeron 3 = 8, facial row = 11. Basofacial setae of uropod 1 = 11, position as in female, but ventral side of peduncle near base with 2–3 large setae not occurring in female, apicolateral spines of peduncle = 4, outer ramus = 4, inner = 1. Peduncle of uropod 2 with 25 dorsal spines, basals shorter than in female, 3 apicalmost short, outer ramus with 6 crowded spines. Peduncle of uropod 3 with 7 ventral spines, setal formula on article 1 of outer ramus (long and short together) = 1-1-2-2-1-2-1-1-2-2-2-3-3-3-3, length of article 2 = 0.025!!, with 2 long setae. Telson broadened, length-width ratio = 8:7, apical elements shortened, composed of one setule and one spine, each lobe with long row of denticles very densely packed.

Male "n."—Spine formula on article 4 of antenna 2 = 3-7-2.

Voucher material.—Female "w" 9.12 mm, Allan Hancock Foundation *Velero IV* 4772, southern California, 80.5 m; male "m" 12.0 mm and female "y" 15.0 mm, *Albatross,* Adakh Island [Alaska], July 1893, surface.

Other material.—Giant female, Port Etches, Alaska, 12–18 fm, 1874, W. H. Dall 669 (1140), mud; 2 males, Mitrofania Bay, Alaska, Acc. No. 157371, M.S. [Motorship] *Dorothy,* light shown over side [of vessel at] 7:30 P.M., from surface; giant male, Akun Island, Alaska, surface electric light, *Albatross,* 189?; one male, Old Harbor, Kodiak Island, Alaska, 11 August 1887–1888, *Albatross*; 2 males, Friday Habor, Washington, USA, 9 August 1950, L. Piternick, light off Oceanographic Lab.

Distribution.—Inner Aleutian Islands southward to Bahia de San Quintin, Baja California, Mexico, 4–221 m (bottom) and swimming at surface in neritic zone.

Eyakia calcarata (Gurjanova)

Parharpinia calcarata Gurjanova, 1938:271–272, 385, figs. 9, 9a, 9b.
Pararpinia [sic] *calcarata.*—Gurjanova, 1951:388–392, fig. 237.
Paraphoxus calcaratus.—J. L. Barnard, 1960:238–240, pl. 26; 1966a:88.

Description of female "n."—Head about 20 percent of total body length, greatest width about 70 percent of length, rostrum unconstricted, broad, elongate, exceeding middle of article 2 on antenna 1. Eyes medium to large, clear of pigment (aged in alcohol), ommatidia ordinary. Article 1 of peduncle on antenna 1 about 1.3 times as long as wide, about 2.3 times as wide as article 2, ventral margin with about 9 setules, unproduced dorsal apex with 2 setules, article 2 about 0.6 times as long as article 1, with 2 ventral rows of 5 and 4 setae, primary flagellum with 12 articles, about as long as peduncle, bearing one short aesthetasc each on articles 5–11, accessory flagellum with 10 articles. Antenna 2 not ensiform, article 3 with one anterodorsal spine (besides normal facial setules), spine formula on article 4 = 2-4 plus one long displaced midapical spine, dorsal margin with notch bearing 2 setae and 2 spines, ventral margin with 6 groups of 2–3 long to medium setae, one ventrodistal long spine, article 5 about 0.8 times as long as article 4, facial spine formula = 2-2, dorsal margin bearing one set of small apical setae, ventral margin with 4 sets of 1–2 long to short setae, 2 ventrodistal long spines set facially, flagellum proliferating.

Epistome unproduced. Mandibles with weak palpar hump, right incisor with 3 teeth, third set distad, left incisor with 3 humps on 2 branches and serrate between, right lacinia mobilis bifid, distal branch much shorter than proximal, flabellate, quadridentate, proximal branch simple, pointed, with marginal denticles and facial humps, left lacinia mobilis with 4 teeth plus one accessory tooth, middle teeth shortened, right rakers 9, left rakers 9 plus 2 rudimentaries, molars composed of bulbous humps, each with huge serrate spine, right molar with 3 additional medium spines, left with 2 additional medium spines, no spines disjunct, each molar with plume; palp article 1 short, article 2 with one long inner apical seta and 3–4 other long and short inner setae, article 3 about 1.2 times as long as article 2, oblique and narrow apex with 8 spine-setae, basofacial formula = 1-1. Each outer lobe of lower lip with one cone. Inner plate of maxilla 1 ordinary, bearing one long apical pluseta, one similar apicomedial seta, 2 apicolateral much shorter setae, outer plate with 11 spines, palp article 2 with one apical spine, one lateral and 2 medial spines, 3–4 submarginal setae. Plates of maxilla 2 extending equally, outer not broader than inner, outer with 3 apicolateral setae, inner with 2 medial setae. Inner plate of maxilliped with 2 large thick apical spines, 2 apicofacial setae, 5 medial setae, outer plate with 8 medial and apical spines, 4 apicolateral setae, palp article 1 with one apicolateral seta, article 2 with one group of 2 apicolateral setae, medial margin of article 2 moderately setose, article 3 with 7 facial setae, 2 lateral setae, nail of article 4 distinct, short, with 2 accessory setules.

Coxa 1 expanded apically, anterior margin convex, main ventral setae of coxae 1–4 = 14-9-9-12, posteriormost seta of coxae 1, 2, 4 shortest, of coxa 3 slightly shortened, anterior and posterior margins of coxa 4 parallel, posterior margin slightly convex, posterodorsal corner sharp-rounded, posterodorsal margin ordinary, concave, width-length ratio = 9:10. Gnathopods generally ordinary but gnathopod 2 significantly stouter than gnathopod 1. Width ratios on articles 5–6 of gnathopods 1–2 = 28:36 and 28:42, length ratios = 65:70 and 49:79, palmar humps ordinary, palms strongly oblique, article 5 of gnathopod 1 elongate, ovate, posterior margin flat, long, article 5 of gnathopod 2 subtriangular, posterior margin triangular, almost lobate.

Pereopods 3–4 similar to each other, facial setae formula on article 4 = 4 and 5, parallel to apex, on article 5 = 4 and 5, main spine of article 5 extending to M. 85–100 on article 6, article 5 with no proximoposterior spines, spine formula of article 6 = 4 + 3 and 5 + 3 plus middistal seta, one of spines in group of 3 situated in middle of posterior articular axis (not in the normal bilateral fashion), some spines especially long, acclivity on inner margin of dactyls of pereopods 3–4 absent, emergent setule short, midfacial pluseta ordinary. Coxae 5–7 posteroventral seta formula = 4-5-1. Articles

4–5 of pereopods 5–6 narrow, facial spine rows sparse. Facial ridge formula of article 2 on pereopods 5–7 = 0-1-1. Width ratios of articles 2, 4, 5, 6 of pereopod 5 = 45:22:22:13, of pereopod 6 = 75:27:21:11, of pereopod 7 = 88:22:21:11, length ratios of pereopod 5 = 74:28:41:49, of pereopod 6 = 95:58:55:70, of pereopod 7 = 100:25:28:40, article 2 of pereopod 7 reaching middle of article 4, posterior margin with 8 small serrations, articles moderately setose anteriorly, medial apex of article 6 sparsely and scarcely combed, bearing 3–4 short digital processes; article 2 of pereopods 5–6 tapering distally, only setulose posteriorly, posteroventral lobe of pereopod 6 broad, of pereopod 5 absent.

Posteroventral corner of epimeron 1 rounded, weakly protuberant, posterior margin deeply convex, with 3 setule notches, anteroventral margin with 9 short to medium setae, ventral face with 6 long setae in row running fully to posterior corner. Posteroventral corner of epimeron 2 rounded, weakly protuberant, posterior margin barely convex, with 4 setule notches, facial setae = 9, 2 middle pairs set vertically (setae scattered). Posteroventral corner of epimeron 3 weakly protuberant, with setule sinus, posterior margin straight, with 2 setule notches, ventral margin with one anterior seta, face with oblique row of 6 setae.

Urosomite 1 with lateral setule at base of uropod 1, scarcely any midventral setae, no ventrodistal setae, articulation line complete, urosomite 3 unprotuberant dorsally. Rami of uropods 1–2 with articulate but tightly fixed apical nails, outer ramus of uropod 1 with 3 dorsal spines, not crowded, inner with 2, outer ramus of uropod 2 with 2 dorsal spines, inner with none, peduncle of uropod 1 with 5 basofacial setae extending along ventral margin and 5 small apicolateral spines, medially with 6 marginal spines, apicalmost an ordinary spine, none displaced. Peduncle of uropod 2 with 8 dorsal spines, medially with one small apical spine, apicolateral corners of peduncles on uropods 1–2 without comb. Peduncle of uropod 3 with 4 short ventral spines, dorsally with one lateral spine, one medial spine and setule, rami submasculine, inner extending to M. 100+ on article 1 of outer ramus, apex with 2 small setae, medial and lateral margins with 7 and one setules, article 2 of outer ramus ordinary, 0.17, bearing 2 medium setae, medial margin of article 1 with one apical spine and 4–5 medial setules, lateral margin with 3 acclivities, spine formula = 1-1-1-1, short setal formula = 0-1-1-1. Telson long, length width ratio = 22:19, almost fully cleft, each apex wide, rounded, lateral acclivity broad, shallow, with very short lateral and short medial spine separated by setule, midlateral setules diverse, larger of medium size.

Voucher material.—Female "n" 6.41 mm, Allan Hancock Foundation *Velero III* 171-34, Islas Galapagos, east of Wreck Bay, Chatham Island, 32 fm, 21 January 1934.

Other material.—*Velero III* 224-34, Colombia, off Gorgona Island, 10 fm, 12 February 1934.

Distribution.—Japan Sea, 75 m; California, 324–695 m; Galapagos Islands, 46–73 m; Colombia, Gorgona Island, 18 m.

Eyakia ochotica (Gurjanova)

Pararpinia [sic] *ochotica* Gurjanova, 1953:225–229, figs. 9, 10.
Paraphoxus ochoticus.—J. L. Barnard, 1960:274.

A possible synonym of *E. robusta* but see J. L. Barnard (1960).

Distribution.—Okhotsk Sea.

Eyakia subuncigera (Kudrjaschov)

Paraphoxus subuncigerus Kudrjaschov, 1965:1776–1779, figs. 1, 2.

Article 5 of gnathopod 2 very short.

Distribution.—Okhotsk Sea, 207 m.

Eyakia uncigera (Gurjanova)

Parharpinia uncigera Gurjanova, 1938:267–269, 385, fig. 8.
Pararpinia [sic] *uncigera.*—Gurjanova, 1951:388, fig. 236.
Paraphoxus uncigerus.—J. L. Barnard, 1960:282.

Distribution.—Japan Sea; Okhotsk Sea.

Literature Cited

Barnard, J. L. 1959. Estuarine Amphipoda in: Ecology of Amphipoda and Polychaeta of Newport Bay, California.—Allan Hancock Foundation Publications, Occasional Paper 21:13–69, 14 plates.

———. 1960. The amphipod family Phoxocephalidae in the eastern Pacific Ocean, with analyses of other species and notes for a revision of the family.—Allan Hancock Pacific Expeditions 18:175–368, pls. 1–75, 1 chart.

———. 1961. Relationship of Californian amphipod faunas in Newport Bay and in the open sea.—Pacific Naturalist 2:166–186, 2 figs.

———. 1964a. Marine Amphipoda of Bahía de San Quintín, Baja California.—Pacific Naturalist 4:55–139, 21 figs., 17 charts, 13 tables.

———. 1964b. Los Anfipodos Bentonicos Marinos de la Costa Occidental de Baja California.—Revista de la Sociedad Mexicana de Historia Natural 14:205–274, 11 figs., 5 tables.

———. 1966a. Submarine canyons of southern California Part V Systematics: Amphipoda.—Allan Hancock Pacific Expeditions 27(5):1–166, figs. 1–46.

———. 1966b. Benthic Amphipoda of Monterey Bay, California.—Proceedings of the United States National Museum 119(3541):1–41, figs. 1–7.

———. 1969a. Gammaridean Amphipoda of the rocky intertidal of California: Monterey Bay to La Jolla.—United States National Museum Bulletin 258:1–230, figs. 1–65.

———. 1969b. A biological survey of Bahia de Los Angeles Gulf of California, Mexico, IV. Benthic Amphipoda (Crustacea).—Transactions of the San Diego Society of Natural History 15:175–228, figs. 1–30.

———. 1979. Revision of American species of the marine Amphipod Genus *Paraphoxus* (Gammaridea:Phoxocephalidae).—Proceedings of the Biological Society of Washington 92:368–379.

———, and M. M. Drummond. 1978. Gammaridean Amphipoda of Australia, Part III: The Phoxocephalidae.—Smithsonian Contributions to Zoology 245:1–551, figs. 1–269.

Bousfield, E. L. 1973. Shallow-water Gammaridean Amphipoda of New England.—Comstock Publishing Associates, a division of Cornell University Press, Ithaca & London. vii–xii, 1–312, figs. 1–13, pls. I–LXIX.

Gurjanova, E. F. 1938. Amphipoda, Gammaroidea of Siaukhu Bay and Sudzukhe Bay (Japan Sea).—Reports of the Japan Sea Hydrobiological Expedition of the Zoological Institute of the Academy of Sciences, USSR in 1934, 1:241–404, 59 text figs.

———. 1951. Bokoplavy morej SSSR i sopredel'nykh vod (Amphipoda-Gammaridea).—Akademiia Nauk SSSR, Opredeliteli po Faune SSSR 41:1029 pp., 705 figs.

———. 1953. Novye dopolnenija k dal'nevostochnoi faune morskikh bokoplavov.—Akademiia Nauk SSSR, Trudy Zoologicheskogo Instituta 13:216–241, 19 figs.

Holmes, S. J. 1905. The Amphipoda of Southern New England.—Bulletin of the United States Bureau of Fisheries 24:459–529, pls. 1–13, numerous text figs. [unnumbered].

———. 1908. The Amphipoda collected by the U.S. Bureau of Fisheries Steamer, "Albatross," off the west coast of North America, in 1903 and 1904, with descriptions of a new family and several new genera and species.—Proceedings of the United States National Museum 35:489–543, figs. 1–46.

Kudrjaschov, V. A. 1965. Novye vidy bokoplavov (Amphipoda, Gammaridea) iz vostochnoi chasti Okhotskogo Morja.—Zoologicheskii Zhurnal, Akademiia Nauk SSSR 44:1776–1789, figs. 1–10.

Kunkel, B. W. 1918. The Arthrostraca of Connecticut.—Connecticut Geological and Natural History Survey 6, Bulletin 26 (1) Amphipoda:15–181, figs. 1–55.

Reish, D. J., and J. L. Barnard. 1967. The benthic Polychaeta and Amphipoda of Morro Bay, California.—Proceedings of the United States National Museum 120(3565):1–26, fig. 1.

Shoemaker, C. R. 1925. The Amphipoda collected by the United States Fisheries Steamer "Albatross" in 1911, chiefly in the Gulf of California.—Bulletin of the American Museum of Natural History 52:21–61, 26 figs.

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CONTENTS

An historical synthesis of Mexican mammalian taxonomy José Ramírez-Pulido and Marie Claire Britton 1

Systematics and variation of the Aztec Shiner, *Notropis sallei*, a cyprinid fish from Central Mexico Barry Chernoff and Robert Rush Miller 18

Bernardichthys zorraquinosi, a new genus and species of salmoniform fish from the late Cretaceous of Oregon Richard W. Huddleston 37

A revision of the subspecies of *Sporophila* ("*Oryzoborus*") *angolensis* (Aves: Emberizinae) Storrs L. Olson 43

Comments on the osteology of balistoid fishes (Tetraodontiformes), with notes on the triodontid pelvis James C. Tyler and Keiichi Matsuura 52

A new poison-dart frog (Anura: Dendrobatidae) from the forest of southeastern Colombia William F. Pyburn 67

On Dorvilleidae and Iphitimidae (Annelida: Polychaeta) with a redescription of *Eteonopsis geryonicola* and a new host record Gary R. Gaston and David A. Benner 76

A new species of freshwater crab (Crustacea: Anomura: Aeglidae) from insular south Chile Carlos G. Jara and María T. López 88

Taxonomic observations on eastern Pacific *Antithamnion* species (Rhodophyta: Ceramiaceae) described by E. Y. Dawson David N. Young 94

A revision of the northern forms of *Euphonia xanthogaster* (Aves: Thraupidae) Storrs L. Olson 101

Spadella legazpichessi, a new benthic chaetognath from Enewetak, Marshall Islands Angeles Alvariño 107

Gorgoniscus incisodactylus, a new isopod of the epicaridean superfamily Cryptoniscoidea, parasitic on an ascothoracican cirriped from Hawaii Mark J. Grygier 122

Three new shrimps, and some interesting new records of decapod Crustacea from a deep-water coral reef in the Florida Keys Robert H. Gore 135

A new species of *Amastigos* (Polychaeta: Capitellidae) from the Chesapeake Bay and Atlantic coast of the United States with notes on the Capitellidae of the Chesapeake Bay R. Michael Ewing and Daniel M. Dauer 163

Uca marguerita, a new species of fiddler crab (Brachyura: Ocypodidae) from eastern Mexico Carl L. Thurman II 169

Additional acanthonotozomatid, paramphithoid, and stegocephalid Amphipoda from the Southern Ocean Les Watling and Heather Holman 181

A new genus and species of Spionidae (Annelida: Polychaeta) from the north and south Atlantic Nancy J. Maciolek 228

Reclassification and redescription of the comatulid *Comatonia cristata* (Hartlaub) (Echinodermata: Crinoidea) Charles Garrett Messing 240

A new species of *Tegastes* (Copepoda: Harpacticoida) associated with a scleractinian coral at Enewetak Atoll Arthur G. Humes 254

Three new species of the *Eviota epiphanes* group having vertical trunk bars (Pisces: Gobiidae) Susan J. Karnella and Ernest A. Lachner 264

Taxonomy and postmarsupial development of a dominant deep-sea eurycopid isopod (Crustacea) George D. Wilson 276

The amphipod genera *Eobrolgus* and *Eyakia* (Crustacea: Phoxocephalidae) in the Pacific Ocean J. Laurens Barnard and Charline M. Barnard 295

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THE TANAIDAE (CRUSTACEA; TANAIDACEA) OF CALIFORNIA, WITH A KEY TO THE WORLD GENERA

Jürgen Sieg and Richard N. Winn

Abstract.—Identification keys to the world genera and the California species of the family Tanaidae are presented. Diagnostic characters are discussed for *Sinelobus stanfordi* (Richardson), *Pancolus californiensis* Richardson, *Zeuxo normani* (Richardson), and *Zeuxo paranormani* Sieg. Two new species, *Synaptotanais notabilis* and *Anatanais pseudonormani* are described. Three additional species, *Zeuxo coralensis* Sieg, *Zeuxo maledivensis* Sieg, and *Zeuxo seurati* (Nobili), known to occur within the eastern Pacific region, are included in the identification keys. The distribution of all species are discussed.

Investigations in recent years have indicated that the tanaidacean Crustacea are among the more numerically abundant invertebrates of certain marine habitats (e.g. Livingston, 1977; Odum and Heald, 1972; Gage and Coghill, 1977). However, difficulties in identifying specimens to species or even family have impeded research on their biology. The identification keys to the suborders and families of the Tanaidacea by Sieg and Winn (1978) were an outcome of an examination of tanaids from benthic macrofaunal samples from the southern California borderland. It was stated then that additional identification keys, new species descriptions, and discussions of the families occurring along the California coast would be subsequently presented. The following is an examination of the members of the family Tanaidae from California.

Tanaidae Dana, 1849

Little is reported on the members of the family Tanaidae from California. *Tanais normani* Richardson and *Pancolus californiensis* Richardson, were originally described from Monterey Bay in northern California. Localities in southern California were noted for "*Anatanais normani*" by Miller (1968) at Catalina Island, Anacapa Island, Santa Barbara Harbor, and Moss Beach. Dillon Beach was mentioned as another locality for *Pancolus californiensis* by Lang (1961).

Miller (1968), and Miller and Menzies (1954) reported a *Tanais* sp., which was shown to be a male of *Sinelobus stanfordi* (Richardson) by Sieg (1980), who also showed that the type-material of *Tanais normani* Richardson actually consisted of 2 species of *Zeuxo,* one of which is now referred to *Zeuxo paranormani* Sieg (1979).

None of these previously known species was collected from the benthic sampling program (Bureau of Land Management 1976–1977) off southern California, which emphasized shallow subtidal regions (13 m) to deep shelf, slope, and basin soft-bottom regions (1886 m). Two new species within the family Tanaidae, *Synaptotanais notabilis* and *Anatanais pseudonormani,* were found and are described here.

Several shallow, near-shore studies recently completed or now in progress have indicated the frequent presence of tanaidaceans in great numbers, up to thousands per m^2 (Muscat, pers. comm.; Hammer and Zimmerman, 1979; Straughan 1977). The highest density with 140,000/m^2 has been reported for *Kalliapseudes crassus* by Barnard (1970).

There are currently 6 known species of Tanaidae from California: *Anatanais pseudonormani* n. sp.; *Pancolus californiensis* Richardson, *Sinelobus stanfordi* (Richardson), *Synaptotanais notabilis* n. sp., *Zeuxo normani* (Richardson), and *Zeuxo paranormani* Sieg (for futher details see Sieg, 1980). Three additional species known from the eastern Pacific region, *Zeuxo maledivensis* Sieg, *Z. seurati* (Nobili), and *Z. coralensis* Sieg are included in the following key to the California species of Tanaidae, since there is some possibility they may be found there also.

The terminology used is based on that suggested by Racovitza (1923) for the Isopoda, with modifications proposed by Sieg (1973, 1977, 1980), which includes a discussion of setae and spines of the Tanaidacea.

There has been much variation in the nomenclature applied to body segments and appendages for the Tanaidacea as discussed by Hansen (1913), Lang (1953), Wolff (1956, 1962) and Gardiner (1975). Gardiner summarized Wolff's terminology and suggested alternative terms to those used by Lang (1968). Lang's system is adopted here for the orientation of the appendages where: dorsal, ventral, medial, lateral are equivalent to tergal, sternal, rostral, and caudal, referring to limbs directed ventrally and laterally from the body, in their natural position. The abbreviations used for the figures are: A.1 (Antenna 1), A.2 (Antenna 2), L (Labrum), Md_l (left mandible), Md_r (right mandible), La (labium), Mx.1 (maxilla 1) Mx.2 (maxilla 2), Epi (epignath), Mxp (maxilliped), che (cheliped), P.1–P.6 (pereopod 1–6), Pl. 1–5 (pleopod 1–5), Plt (pleotelson) and Uro (uropod).

Key to the World Genera of the Family Tanaidae
(Modified from Sieg, 1980)
(*Not yet recorded from California)

1. Uropods long and slender, articles more than twice as long as broad (Fig. 1, Uro: 1) 2

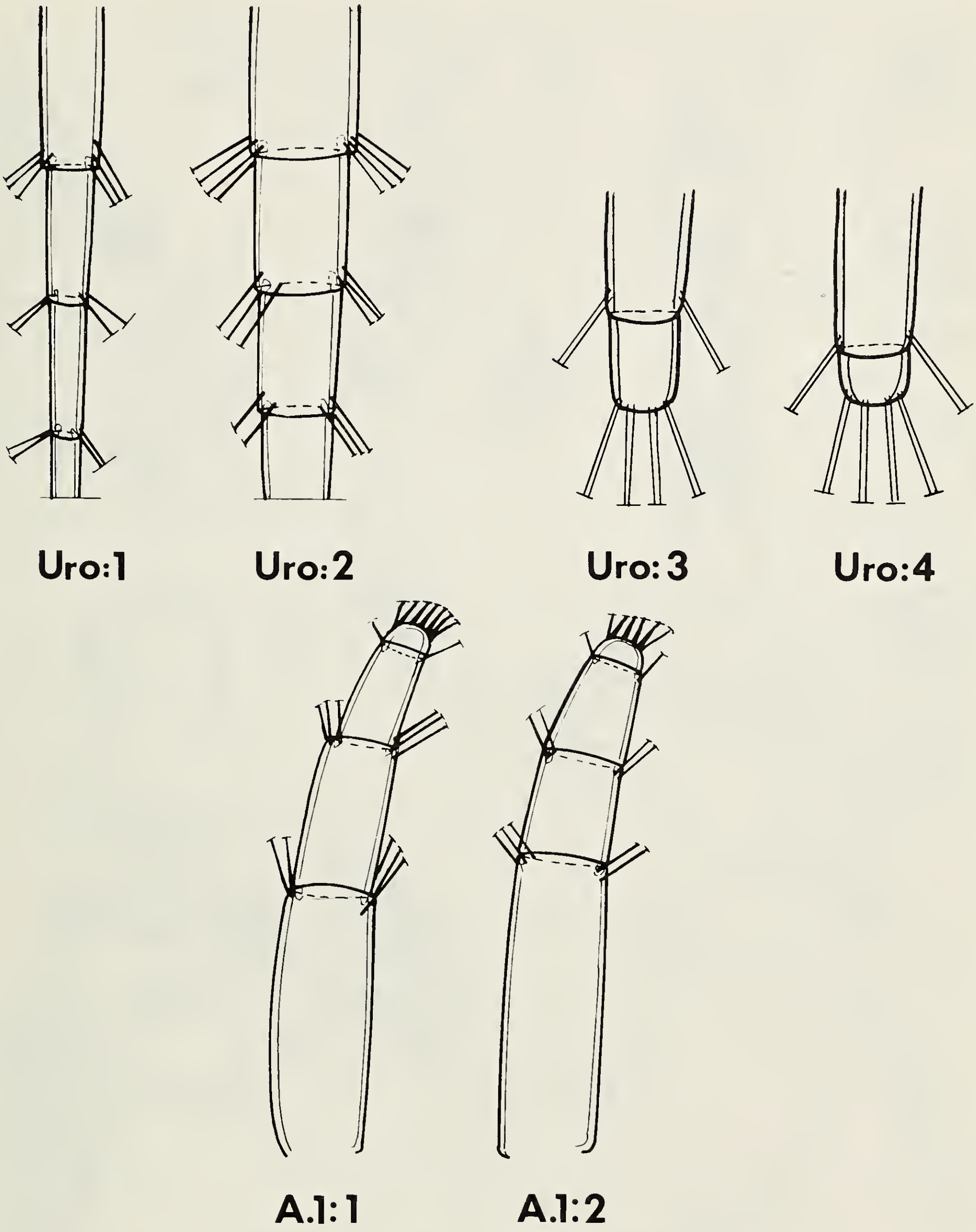

Fig. 1. Uropods and antenna 1 of different members of Tanaidae. Uro: 1—uropod long and slender, articles more than twice as long as broad; Uro: 2—uropod short, articles twice as long as broad; Uro: 3—uropod with terminal article normal; Uro: 4—uropod with terminal article greatly reduced; A.1: 1—antenna 1 with first article twice length of second article; A.1: 2—antenna 1 with first article more than 2.5 times length of second article.

– Uropods short, articles twice (rarely 3 times) as long as broad (Fig. 1, Uro: 2) 5

2. Antenna 1 of 5 articles, first and second article with many distal setae; cephalothorax broader than long . . . . *Archaeotanais* Sieg*

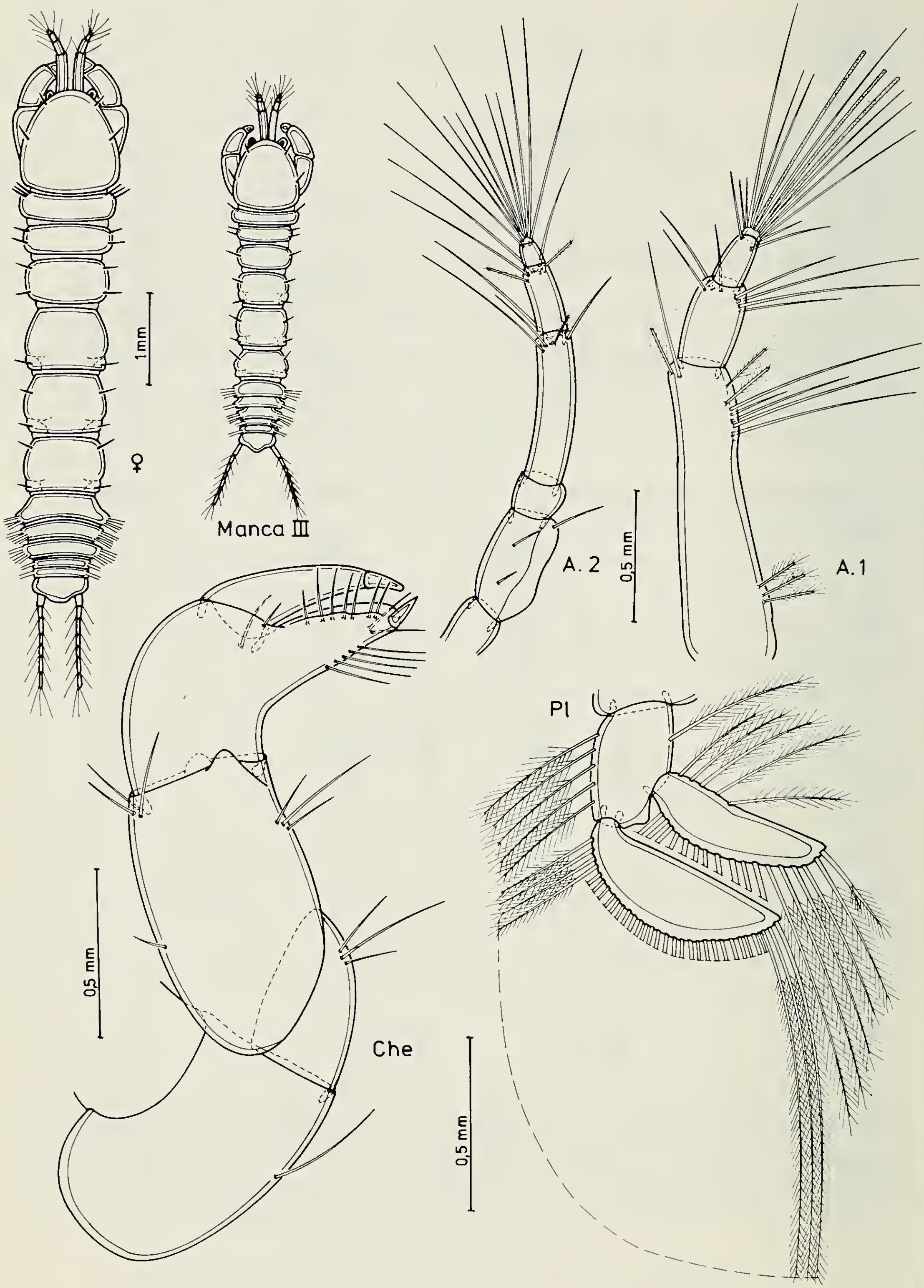

Fig. 2. *Synaptotanais notabilis*, female.

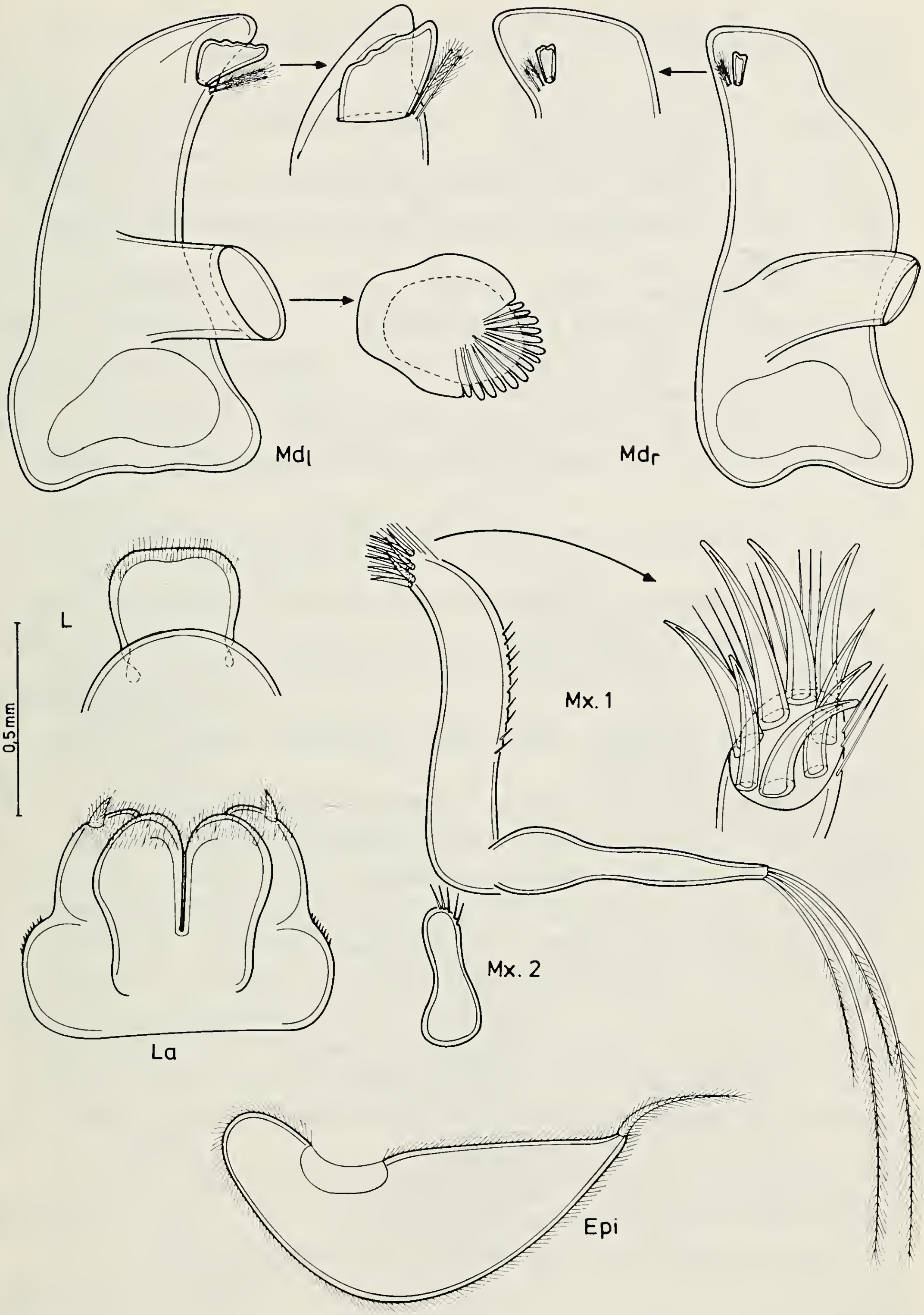

Fig. 3. *Synaptotanais notabilis*, female.

– Antenna 1 of 4 articles, first and second article with few distal setae; cephalothorax longer than broad (Uro about "6 to 11-jointed") 3
3. Endopod of uropods of at least 10 articles; antenna 2 of 8 articles; outer lobe of labium with spine .... *Langitanais* Sieg*
– Endopod of uropods of 5–6 articles; antenna 2 of 7 articles; outer lobe of labium without spine, with or without terminal article (Uro "6–7 jointed") 4
4. Outer lobe of labium without terminal article; tergite of fifth pleonite not distinctly separate from pleotelson .... *Protanais* Sieg*
– Outer lobe of labium with terminal article; tergite of fifth pleonite distinctly separate from pleotelson .... *Synaptotanais* Sieg
5. Terminal article of uropods greatly reduced (Fig. 1, Uro: 4) 6
– Terminal article of uropods normal, not reduced (Fig. 1, Uro: 3) 8
6. Pleopod 3 reduced; carpal spines of pereopods 2–4 strongly produced 7
– Pleopod 3 normal, not reduced; carpal spines of pereopods 2–4 normal, not strongly produced .... *Zeuxoides* Sieg*
7. Antenna 1 of 3 articles; pleon with 3 pleonites (tergites) visible dorsally .... *Pancolus* Richardson
– Antenna 1 of 4 articles; pleon with 5 pleonites (tergites) visible dorsally, plus pleotelson .... *Pancoloides* Sieg
8. Pleon with 4 pleonites (tergites) visible dorsally, plus pleotelson . 11
– Pleon with 5 pleonites (tergites) visible dorsally, plus pleotelson .. 9
9. Coxa of pereopod 1 without protuberance; pereonites 1–3 combined not longer than broad; terminal lobe of outer lobe of labium not well separated; chelae of male greatly enlarged, therefore, cephalothorax of males in cross-section nearly triangular .... *Hexapleomera* Dudich*
– Coxa of pereopod 1 with or without protuberance; pereonites 1–3 large, combined longer than broad; terminal lobe of outer lobe of labium well separated; chelae of male not greatly enlarged, therefore, cephalothorax of male normal 10
10. First article of antenna 1 greater than 2.5 times, often 3 times, length of second article (Fig. 1, A.1: 2) .... *Zeuxo* Templeton
– First article of antenna 1 twice length of second article (Fig. 1, A.1: 1) .... *Anatanais* Nordenstam
11. Uropods of 7 articles .... *Arctotanais* Sieg
– Uropods of 2–5 articles 12
12. Pleonites 1 and 2 with strong transverse rows of long plumose hairs 13

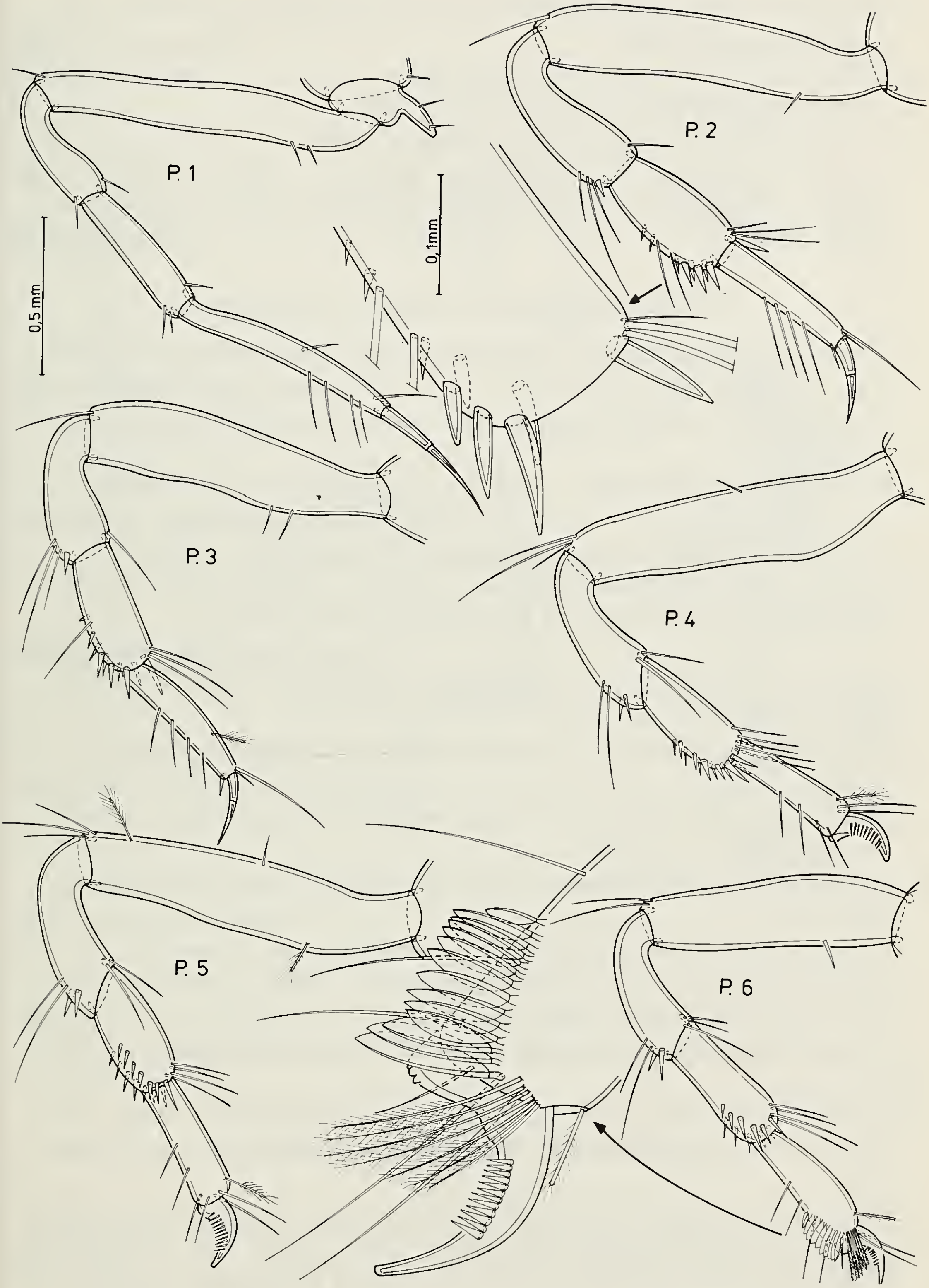

Fig. 4. *Synaptotanais notabilis,* female.

– Pleonites 1 and 2 without transverse rows of setae, but with a few lateral plumose hairs .... *Monoditanais* Sieg*
13. Outer lobe of labium with terminal lobe .... *Tanais* Latreille*
– Outer lobe of labium without terminal lobe 14
14. Fourth article of antenna 2 with circle of setae .... *Parasinelobus* Sieg*
– Fourth article of antenna 2 without circle of setae, but with few distal setae .... *Sinelobus* Sieg

Key to the Species of California Tanaidae

1. Uropods long and slender, articles more than twice as long as broad (Fig. 1, Uro: 1; Figs. 2–5; 12) .... *Synaptotanais notabilis* n. sp.
– Uropods short, articles twice as long as broad (rarely 3 times) (Fig. 1, Uro: 2) 2
2. Pleon of 3 pleonites plus pleotelson; pleopod 3 reduced (Fig. 7) .... *Pancolus californiensis* Richardson
– Pleon of 4–5 pleonites plus pleotelson; pleopod 3 not reduced 3
3. Pleon of 4 pleonites plus pleotelson; pleonites 1 and 2 each with well developed transverse row of long plumose setae (Fig. 6) .... *Sinelobus stanfordi* (Richardson)
– Pleon of 5 pleonites plus pleotelson; pleonites 1 and 2 with few lateral plumose setae 4
4. First article of antenna 1 2.0 times length of second article (Fig. 1, A.1: 1) .... *Anatanais pseudonormani* n. sp.
– First article of antenna 1 2.5 times length of second article, nearly 3.0 times (Fig. 1, A.1: 2) 5
5. Uropods of 4 articles (adults); coxa of pereopod 1 produced slightly (Fig. 15) .... *Zeuxo coralensis* Sieg*
– Uropods of 5–6 articles (adults) 6
6. Lacina mobilis of right mandible reduced to small projection (Fig. 17); coxa of pereopod 1 produced slightly .... *Zeuxo seurati* (Nobili)*
– Lacina mobilis of right mandible only slightly reduced (Figs. 13–16) 7
7. Coxa of pereopod 1 with strong, triangular protuberance (Figs. 13, 14); inner border of endopod of pleopods with more than 1 proximal setae 8
– Coxa of pereopod 1 with small, triangular protuberance (Fig. 16); endopod of pleopods with 1 proximal seta .. *Zeuxo maledivensis* Sieg*
8. Uropods of 6 articles (adults, Fig. 13); coxa of pereopod 1 with large protuberance (Fig. 13); carpus of pereopod 2 with 4 caudal and 2 rostral spines (Fig. 13) .... *Zeuxo normani* (Richardson)
– Uropods of 5 articles (adults, Fig. 14); coxa of pereopod 1 with less

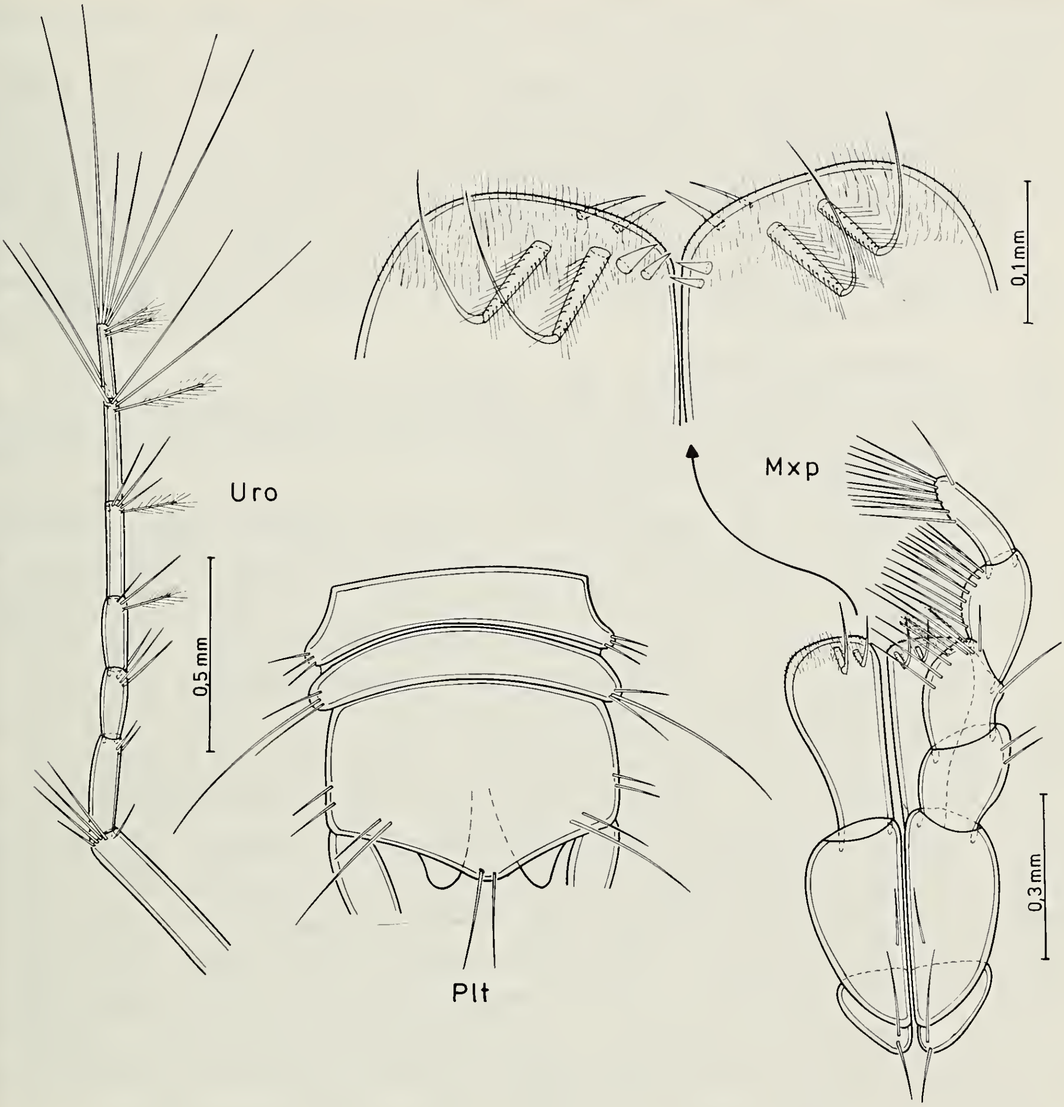

Fig. 5. *Synaptotanais notabilis,* female.

pronounced protuberance; carpus of pereopod 2 with 3 caudal and 2 rostral spines .... *Zeuxo paranormani* Sieg

Synaptotanais notabilis, new species
Figs. 2–5, 12

Description (females, neuters).—Body length of fully developed specimens about 7 mm.; manca stages and neuters smaller; slightly more than 4 times as long as broad.

Cephalothorax smoothly rounded; narrowing from posterior to anterior; 1.2 times longer than broad, with small rostral eye-lobes separated from cephalothorax by concave sutures; 1 small seta nearby, and additional lateral seta.

Pereon with first 3 pereonites laterally rounded in dorsal view. Last 3 pereonites with swollen region posteriorly. Pereonite 1 3.5 times broader than long; anterior border smoothly concave, with few setae anterolaterally near exhalent opening. Pereonite 2–3 times broader than long, lateral margin with 1 seta rostrally and 1 at the middle. Pereonite 3 twice as broad as long, bearing setae similar to pereonite 2. Pereonite 4 1.2 times broader than long, with 1 seta in each lateral corner. Pereonite 6 1.5 times broader than long, similar to pereonites 4 and 5.

Pleon with 5 distinct segments plus pleotelson visible in dorsal view. Last 2 segments smaller. Fifth pleonite (sternite) fused ventrally with pleotelson. Pleonites 1–3 with lateral plumose setae.

Antenna 1 (Fig. 2) of 4 articles. First article relatively large, 5.0 times longer than broad; inner border with 3 plumose hairs proximally, 5 setae and 2 plumose hairs distally; outer border with 1 seta and 1 plumose hair distally. Second article twice as long as broad; inner border with 4 distal setae; outer border with 3 distal setae. Third article small, but also twice as long as broad; inner border and outer border each with 1 distal seta. Fourth article minute, conical, with 3 short setae, 7 long setae and 3 esthetascs.

Antenna 2 (Fig. 2) of 7 articles. First article fused with cephalothorax, as long as broad, without setae. Second article twice as long as broad; outer border with flange, with distal seta; inner border with 2 setae. Third article small, as long as broad, without setae. Fourth article 4.0 times longer than broad; inner border with 3 distal setae; outer border with 1 seta and 2 plumose hair. Fifth article 2.5 times longer than broad; inner border with 2 setae and 1 plumose hair distally; outer border with 1 seta and 1 plumose hair. Sixth article as long as broad; inner and outer border with 1 distal seta. Seventh article minute, peak-like, with 4 short and 4 long setae.

Labrum (Fig. 3) hood-like, completely covered with fine hairs.

Mandible (Fig. 3) strongly produced. 0.33 of border of the terminal face of the pars molaris toothed. Lacinia mobilis of left mandible well developed, border distally crenulate, with 2 plumose membranous spines near articulation. Lacinia mobilis of right mandible distinctly smaller than left.

Labium (Fig. 3) with an inner and outer lobe, divided deeply in middle, distally covered with fine hairs. Outer lobe with terminal article and proximally with small lateral spines.

Maxilla 1 (Fig. 3) with uniarticulate palp bearing 4 fine, plumose terminal setae; endite with 8 spines surrounded by distal setae.

Maxilla 2 (Fig. 3) long, oval, with small terminal setae.

Maxilliped (Fig. 5) developed normally; coxa perpendicular to basis, with 2 mid-ventral setae; not fused medially. Basis not fused medially; also with 1 mid-dorsal seta. Palp of exopod of 4 articles. First article 1.5 times longer than broad, with 2 setae on outer border. Second article triangular; outer border concave, bearing 1 long seta; inner border bearing 3 plumose and 6 naked setae. Third article twice as long as broad; inner border slightly convex, with 2 rows of 8 and 4 setae. Fourth article 3.0 times longer than broad; outer border with 1 distal seta and inner border with 2 rows of 6 setae each. Endopod (inner lobe) not fused medially; with 2 oblique setae distally and 2 membranous spines medially (''coupling-hooks''*sensu* Lang, 1968).

Epignath (Fig. 3) kidney-shaped, with small appendix, completely covered with fine hairs.

Cheliped (Fig. 2) well developed, but slender. Basis twice as long as broad, with medial seta mid-ventrally. Merus triangular; ventrally with 3 medial setae. Carpus small, about twice as long as broad; ventrally with 3 medial setae on the distal third; mid-dorsally with 1 seta and distally with 3 medial setae. Propodus and fixed finger slightly shorter than carpus, with 1 medial and 1 lateral seta near articulation of dactylus. Fixed finger with spine at its tip and 2 lateral setae; dorsal border with 7, and ventral border with 5 setae. Dactylus with spine, curved slightly.

Pereopod 1 (Fig. 4) long and slender. Coxa having non-moveable articulation with sternite, with long prominent protuberance bearing 2 setae. Basis more than 6.0 times longer than broad; proximal third with 2 small sternal setae; distally with 1 tergal seta. Ischium absent. Merus 3.5 times longer than broad; sternally and tergally each with caudal seta distally. Carpus about 5.0 times longer than broad; tergally with 2 and sternally with 1 lateral setae distally. Propodus slender, more than 7.0 times longer than broad; middle with rostral seta sternally. Dactylus and spine combined slightly longer than 0.5 length of propodus.

Pereopod 2 (Fig. 4) with coxa fused with sternite, without protuberance. Basis 4.5 times as long as broad; sternally with 1 proximal seta; tergally with 1 distal seta. Ischium absent. Merus 3.5 times longer than broad; tergally with 3 caudal setae distally and 1 caudal spine; sternally with caudal seta. Carpus twice as long as broad; with 3 caudal setae distally and nearby medial spine sternally; distal tergal border with 3 caudal spines, 2 caudal setae and 5 rostral spines, 2 of which are very small. Propodus 4.5 times as long as broad; tergal row of 4 caudal setae and rostral seta distally; sternally with 1 caudal and 1 rostral seta distally. Dactylus and spine combined 0.5 as long as propodus.

Pereopod 3 (Fig. 4) proportions and armament mainly similar to pereopod 2. Carpus tergally with 4 caudal spines and caudal seta distally. Propodus tergally with 1 rostral spine.

Pereopod 4 (Fig. 4) coxa fused with sternite, with no distinguishing features. Basis 4.0 times longer than broad; middle and distal portions each with 3 tergal setae. Ischium absent. Merus 2.5 times longer than broad; distally with caudal and rostral seta sternally, and caudal and rostral spine tergally surrounding 2 setae. Carpus twice as long as broad, with ventral indenture for the propodus and 3 caudal and 2 rostral setae; distal row of dorsal spines consists of 6 caudal and rostral spines each. Propodus 3.5 times longer than broad; sternally with plumose hair and 1 rostral and 1 caudal seta; tergally with 2 setae near midlength and distally with 1 rostral and 1 caudal seta. Dactylus and spine coalesced to claw bearing row of membranous spines rostrally and caudally.

Pereopod 5 (Fig. 4) proportions and armament as in pereopod 4. Carpus sternally with 2 rostral and 2 caudal distal setae; tergally with row of 7 spines rostrally and caudally.

Pereopod 6 (Fig. 4) proportions and armament similar to 4 and 5. Carpus with 6 caudal and rostral spines distally. Propodus bears distal row of scalpelliform setae tergally; sternally with 7 plumose setae and plumose hair between long caudal and rostral setae.

Pleopods (Fig. 2) similar, not reduced. Outer border of basis with 5 setae, inner border with 1 seta. Exopod of 1 article, without setae on inner border and with many setae on outer border. Endopod of 1 article, with some setae on proximal inner border; outer border bears many setae, distal seta biciliated (specialized).

Pleotelson (Fig. 5) caudal point prominent, with 2 long setae; 1.5 times broader than long, with 2 long and 2 shorter caudal setae near articulation with uropods. Last pleonite partly fused with pleotelson; tergally well marked, sternally totally fused.

Uropods (Fig. 5) long and slender; consisting of basis and 6-articled endopod (Uro: "7-jointed"). Basis 5.0 times as long as broad, distally with 3 long and 2 short setae. Endopod with first article less than 4.0 times as long as broad, distally with 2 short setae. Second and third article less than 3.0 times as long as broad; second with 3 distal, third with 2 distal setae and a plumose hair. Fourth and fifth article 5.0 time as long as broad; fourth with 3 short setae and 1 plumose hair distally. Sixth article 4.0 times as long as broad, with 4 long and 2 short setae, and 2 plumose hairs distally.

Etymology.—The specific name is taken from the Latin word for "notable."

Material.—*Velero IV* sta. 23092/BLM 182 (33°39′0″N, 120°6′1″W), off Santa Rosa Island, California, 133 m: 5 ♀♀:1 ex. Senckenberg Museum Frankfurt SMF 8674, 2 sp. coll. Sieg, 2 ex. USNM 170654. *Velero IV* sta. 23093/BLM 183 (33°39′0″N, 119°58′0″W), off Santa Rosa Island, 133 m: 1 ♀, University of Southern California, Allan Hancock Foundation. *Velero IV* sta. 23187/BLM 79 (33°45′9″N, 120°03′0″W), off Santa Rosa Island, 133 m: 2 ♀♀, University of Southern California, Allan Hancock Foundation.

All specimens are syntypes, with *Velero IV* sta. 23092 designated as type-locality.

Discussion.—This species is readily distinguishable by its slender uropods

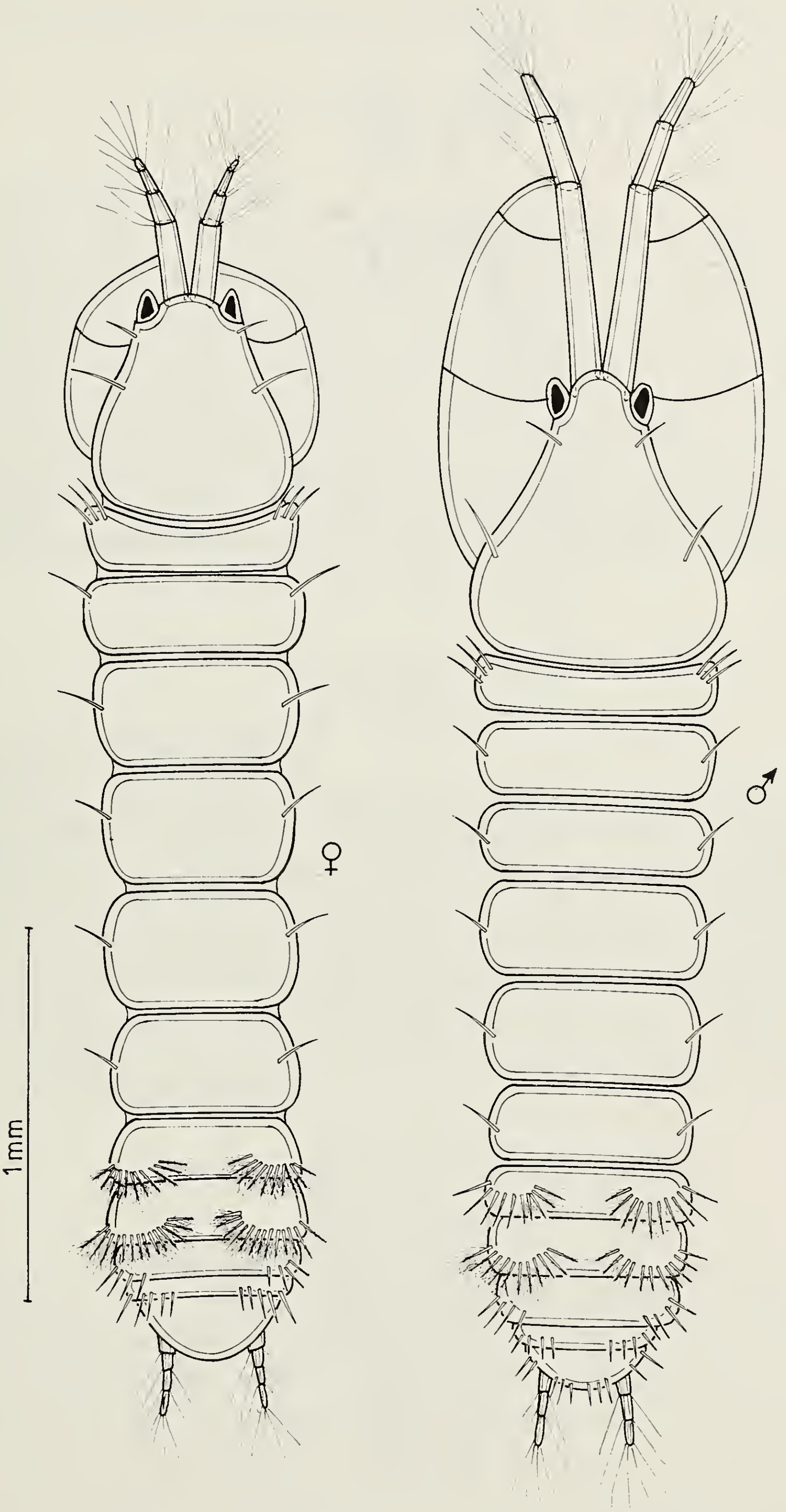

Fig. 6. *Sinelobus stanfordi,* female and male.

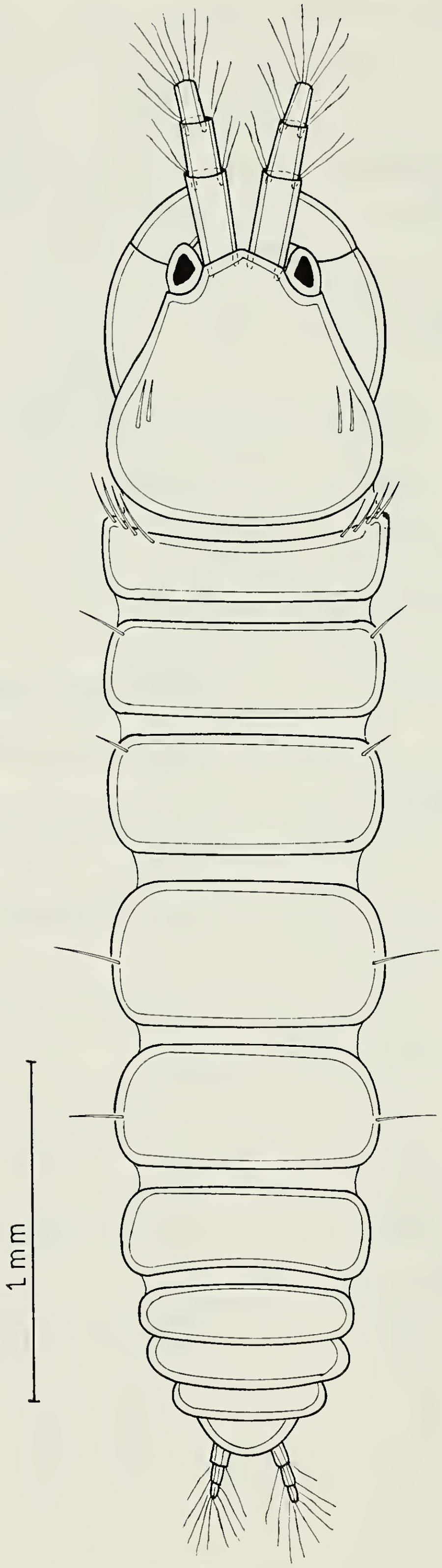

Fig. 7. *Pancolus californiensis*, female.

and relatively long first articles of antenna 1. Its present distribution is limited to the southern California borderland.

Sinelobus stanfordi (Richardson, 1901)
Fig. 6

Synonymy, see Sieg (1980).

Discussion.—The "Tanais" sp. mentioned by Miller (1968), and Miller and Menzies (1954) belongs to *Sinelobus stanfordi* as noted by Sieg (1980). The species may be recognized by the 5-segmented pleon (4 pleonites and the pleotelson), first and second pleonite with 2 curved rows of long, plumose vertical setae. The third pleonite also bears some plumose setae. *Sinelobus* is distinguished from the "true" *Tanais* by the loss of the terminal lobe in the labium and by the cephalothorax of males narrowing markedly from posterior to anterior (Fig. 6). The species is cosmopolitan and occurs in shallow intertidal and estuarine areas, including some records from fresh water.

Pancolus californiensis Richardson, 1905
Fig. 7

Synonymy, see Sieg (1980).

Discussion.—This species is easily recognized by its 4-segmented pleon (3 pleonites and the pleotelson). There appears to be no other species which share this character. Good descriptions and discussions of affinities have been given by Lang (1960) and Sieg (1980). The known distribution is from Monterey Bay in northern California (Richardson, 1905) to central California (although few records are available), and into southern California. In recent studies within southern California, *Pancolus californiensis* has been found mainly in intertidal and shallow subtidal areas associated with algae, or coarse-grained, sandy beaches.

Anatanais pseudonormani, new species
Figs. 8–11, 12

Description. (females, neuters).—Length of body 4–5 mm. Lateral margin of cephalothorax not rounded, slightly narrowed from posterior to anterior, 1.2 times longer than broad, with small rostral indentations separating eyelobes, with 2 small setae nearby and an additional lateral seta.

Pereonites similarily rounded laterally in dorsal view, with seta in anterolateral corners and occasionally in middle. Pereonite 1 4.5 times as broad as long; anterior border smoothly concave, with some setae near exhalent opening. Pereonite 2 3.0 times, and pereonite 3 2.3 times broader than long. Following 3 segments broaden posteriorly. Pereonites 4 and 5 1.8 times broader than long. Pereonite 6 twice as broad as long.

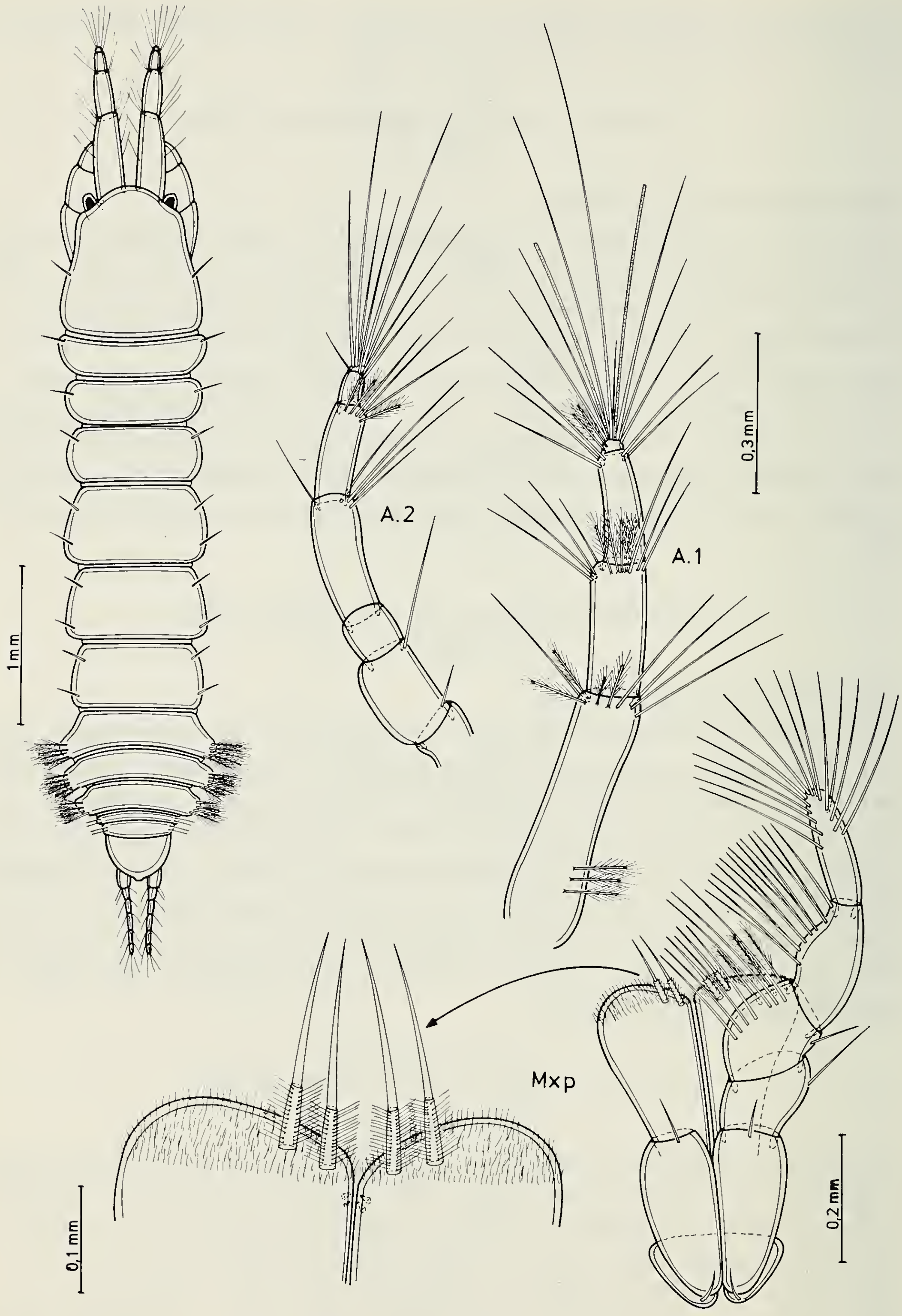

Fig. 8. *Anatanais pseudonormani,* female.

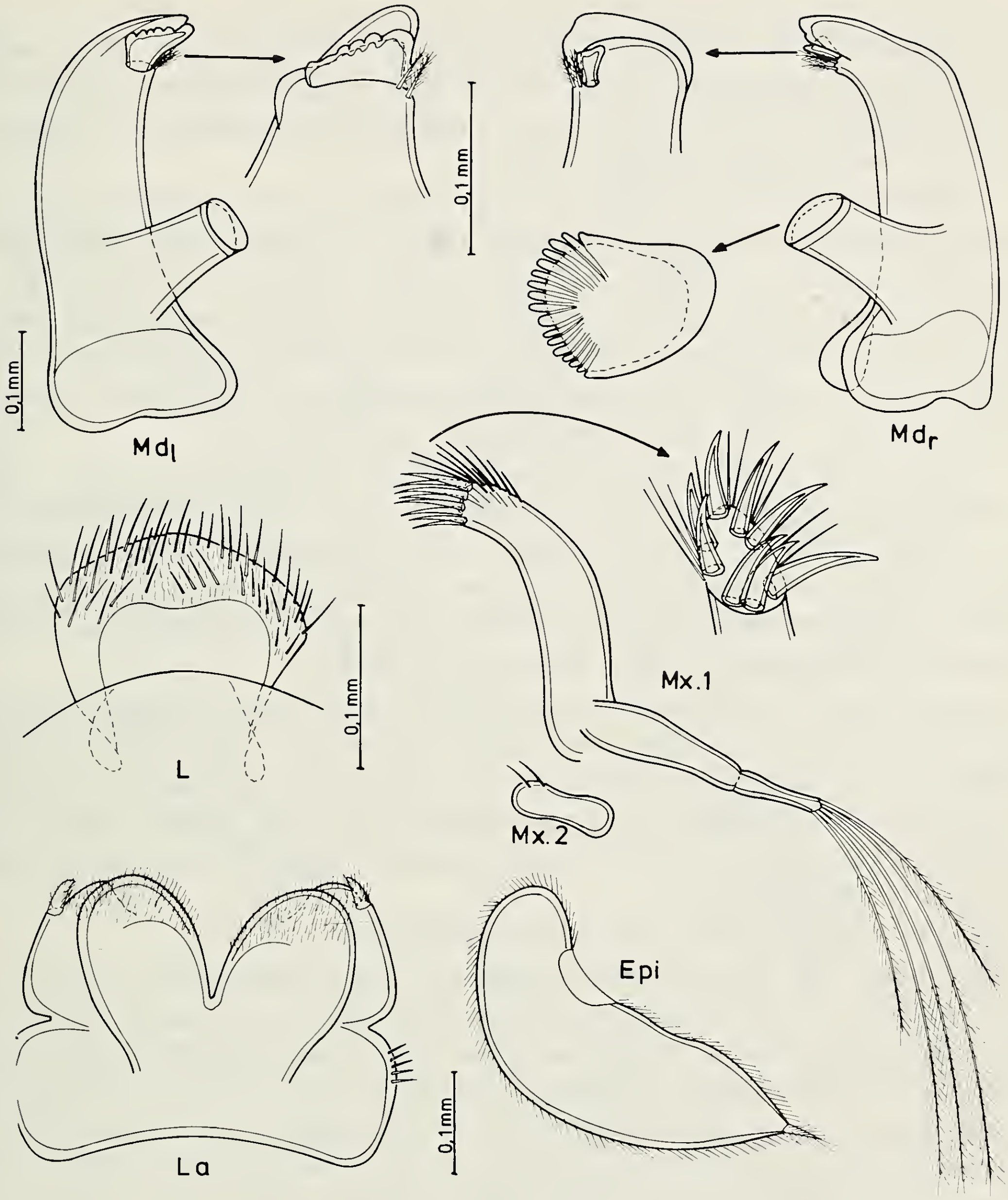

Fig. 9. *Anatanais pseudonormani,* female.

Pleon (Fig. 8) with 5 segments visible in dorsal view, plus pleotelson. First 3 pleonites relatively large, posterolaterally produced, bearing some plumose setae. Pereonites 1–3 (in dorsal view) 5.0 times broader than long; 4 and 5 small and compressed anterior to posteriorly; nearly 7.0 times broader than long, with 2 lateral setae.

Antenna 1 (Fig. 8) of 4 articles. First article 4.0 times longer than broad; proximal 0.33 of outer border with 2 plumose setae; outer border with 4 setae and inner border with 4 plumose setae and 1 normal seta distally.

Second article nearly 3.0 times longer than broad; outer border with 3 setae and 5 plumose setae distally; inner border with 4 distal setae. Third article also 3.0 times longer than broad; outer border with 2 and inner border with 3 setae distally. Fourth article minute, conical with 2 esthetascs, 2 plumose, 2 short, 2 very long and 4 other setae.

Antenna 2 (Fig. 8) of 7 articles. First article fused with cephalothorax; as long as broad, without setae. Second article 1.5 times longer than broad; inner border with 1 seta proximally and distally. Third article also small, as long as broad, without setae. Fourth article 2.7 times longer than broad; inner border with 4 setae; outer border with 3 normal and 3 plumose setae distally. Sixth article somewhat longer than broad, with 3 setae. Seventh article minute, conical, with 1 short and 5 long setae.

Labrum (Fig. 9) hood-shaped, completely covered with fine hairs.

Mandibles (Fig. 9) developed normally; 0.33 of border of terminal face of pars molaris toothed. Lacinia mobilis of left mandible well developed and distally with round teeth, with 2 plumose membranous spines near its articulation. Lacinia mobilis of right mandible reduced, but recognizable, bearing 2 plumose membranous spines near its articulation.

Labium (Fig. 9) with inner and outer lobes, both deeply incised in middle. Distal part of inner lobe with fine hairs. Outer lobe with terminal article, distally covered with fine hairs and row of small lateral spines proximally.

Maxilla 1 (Fig. 9) with endite and uniarticulate palp. Endite with 8 stout terminal spines surrounded by circle of setae. Palp as long as endite, with 5 very fine plumose setae.

Maxilla 2 (Fig. 9) long, oval with 2 small setae.

Maxilliped (Fig. 8) developed normally. Coxa perpendicular to basis, not fused medially, with 1 mid-ventral seta. Basis slender and small when compared with palp; twice as long as broad, not fused medially, with only 1 small seta near articulation of palp. Palp of 4 articles; first article with outer border convex, 1.5 times longer than broad, with 1 seta. Second article triangular; outer border concave, bearing 1 seta; inner border with 3 strong plumose setae, and 7 normal setae. Third article 2.0 times longer than broad, inner border slightly convex with 2 rows of 7 setae each. Fourth article nearly 4.0 times as long as broad; outer border with 1 distal seta; inner border with 2 rows of 7 setae. Endopod (inner lobe) not fused, distally covered with fine hairs and with 2 biciliated (specialized) setae on each side, as well as 3 small membranous projections (''coupling hooks,'' *sensu* Lang, 1968).

Epignath (Fig. 9) kidney-shaped, with small appendix, completely covered with fine hairs.

Cheliped (Fig. 11) slender; coxa behind proximal conjunction of basis, latter article more than twice as long as broad, distally with a rostral seta sternally. Merus triangular; distally with 2 rostral setae sternally. Carpus

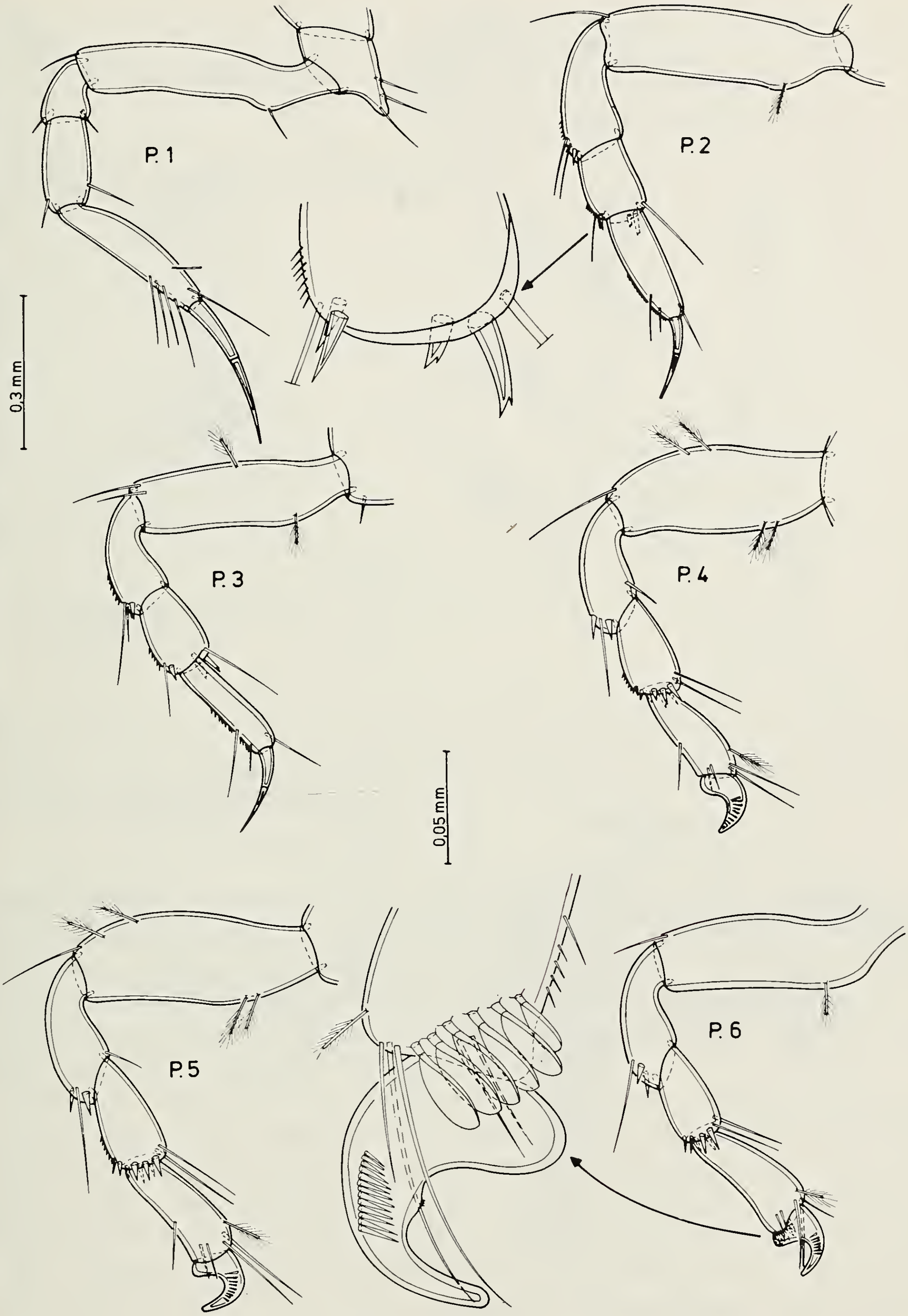

Fig. 10. *Anatanais pseudonormani*, female.

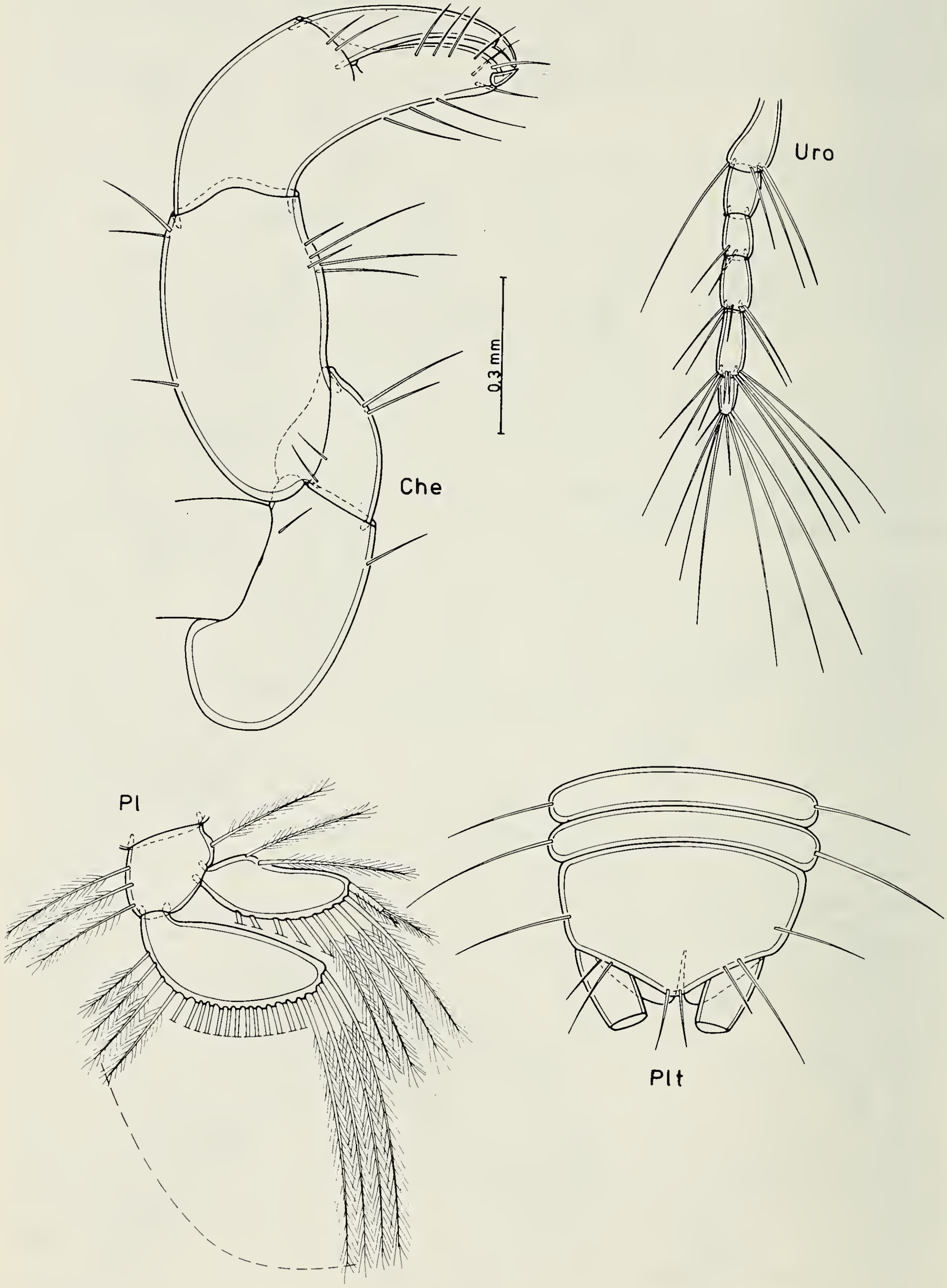

Fig. 11. *Anatanais pseudonormani*, female.

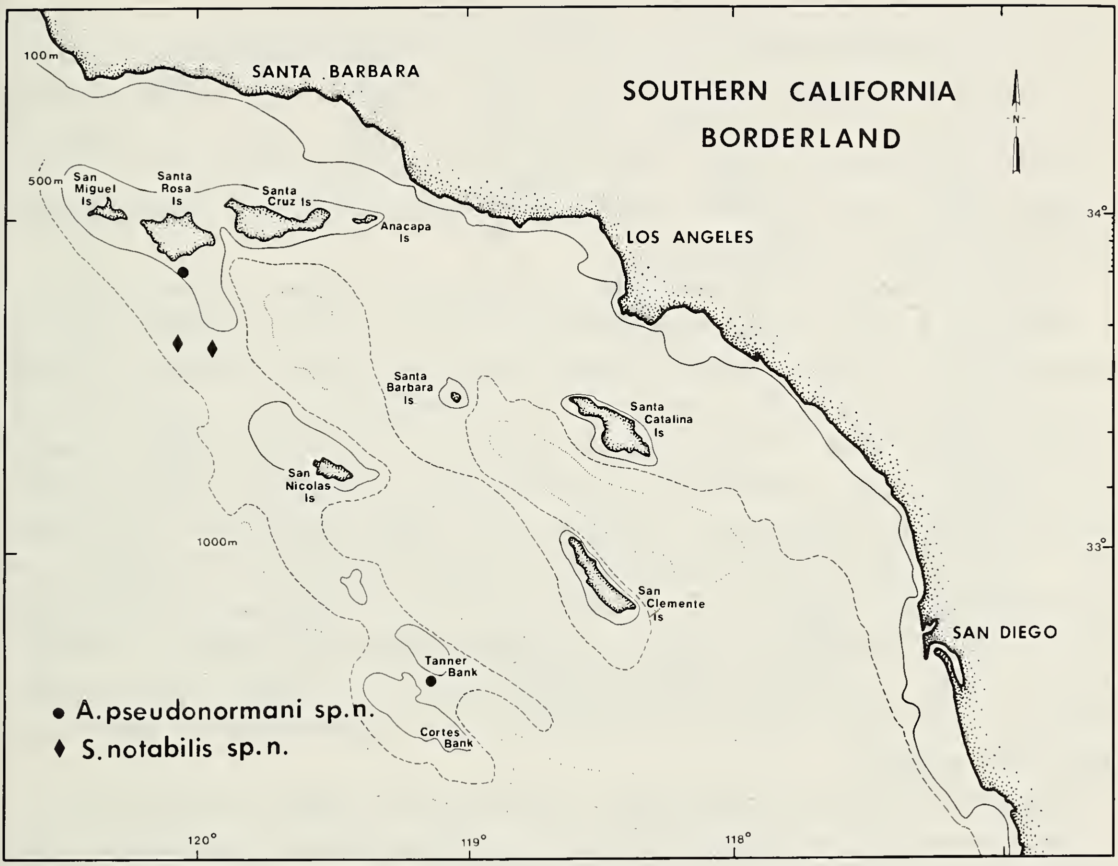

Fig. 12. Known distribution of *Synaptotanais notabilis* and *Anatanais pseudonormani* in the southern California borderland.

twice as long as broad, with 1 seta mid-tergally and 2 distal setae; sternally distal third bears group of 5 setae, inserting variously caudally or sternally. Propodus and fixed finger slender, as long as carpus, with 2 rostral setae near articulation of dactylus distally. Fixed finger with spine at tip and 2 caudal setae; dorsal border with 5 rostral and sternal border with 4 rostral setae. Dactylus with spine, slightly curved.

Pereopod 1 (Fig. 10) coxa fused with sternite, with prominent protuberance bearing 3 setae. Basis 5.5 times longer than broad, proximal third with 1 seta sternally, with another tergal seta distally. Ischium absent. Merus 1.5 times longer than broad; distally with 1 rostral seta tergally and sternally. Carpus twice as long as broad; distally with 1 caudal seta tergally and sternally. Propodus 4.7 times longer than broad, distal third with 4 tergal-caudal setae, some plumose hairs, and 1 caudal seta distal-sternally. Dactylus and spine combined as long as propodus.

Pereopod 2 (Fig. 10) with coxa fused to sternite, without specialized features. Basis 3.5 times longer than broad, proximal third with plumose hair distally and dorsal seta distally. Ischium absent. Merus twice as long as broad, with tergal-caudal spine, 1 caudal and 1 rostral seta distally. Carpus 1.5 times longer than broad; sternally with 1 caudal seta distally; tergally with 1 spine and 1 seta caudally and 3 rostral spines, first twice length of second. Propodus 3.5 times longer than broad, distal third with 2 setae tergally and 1 seta sternally. Dactylus and spine combined slightly longer than 0.66 length of the propodus.

Pereopod 3 (Fig. 10) proportions and armament similar to pereopod 2.

Pereopod 4 (Fig. 10) strongly produced. Coxa fused to sternite, with no characteristic features. Basis 2.5 times longer than broad; proximal half with 2 plumose hairs sternally; tergally with 2 feathered hairs and 1 seta. Ischium absent. Merus twice as long as broad, slightly curved sternally, with 1 caudal seta; distally with 1 caudal and 1 rostral spine surrounding 1 seta tergally. Carpus twice as long as broad; sternally with distal indentation for propodus and 1 caudal and rostral seta distally. Caudal and rostral distal rows of spines consist of 4 spines each. Propodus 2.7 times as long as broad; tergally with 1 seta mid-tergally as well as a small caudal and rostral seta distally; sternally with a plumose hair, 1 long caudal and 1 rostral seta distally. Dactylus and spine fused to claw bearing row of membranous spines rostrally and caudally.

Pereopod 5 (Fig. 10) proportions and armament similar to pereopod 4.

Pereopod 6 (Fig. 10) proportions and armament similar to pereopod 4 and 5, but with a distal row of only 4 caudal spines dorsally. Propodus with additional short row of scalpelliform setae distally: sternally with small seta between long caudal and rostral setae.

Pleopods (Fig. 11) similar. Outer border of basis with 3 setae, inner border with 1 seta. Exopod of 1 article; outer border bearing many setae. Endopod of 1 article; inner border with 2 plumose proximal setae, outer border with many plumose setae, most distal one oblique (specialized).

Pleotelson (Fig. 11) 1.5 times broader than long, caudal point prominent, with 2 long setae. Caudal border with 2 additional setae on each side of caudal point, 1 seta laterally. Last 2 pleonites fused with pleotelson; tergites small but well marked; sternites partly fused with pleotelson.

Uropods (Fig. 11) with basis (Uro: "6-jointed"), endopod of 5 articles. Basis 2.5 times longer than broad; outer border with 3 distal and inner border with 1 distal seta. First 3 articles 1.4 times longer than broad. First article without distal setae. Second article with 2 setae along inner border. Third article with 2 setae along outer border and 3 setae along inner border. Fourth article 2.5 times longer than broad, with 4 distal setae along outer border and 5 distal setae along inner border. Fifth article twice as long as broad, with 6 long and 2 short setae.

Etymology.—The name was chosen because of the close resemblance to *Zeuxo normani* (Richardson).

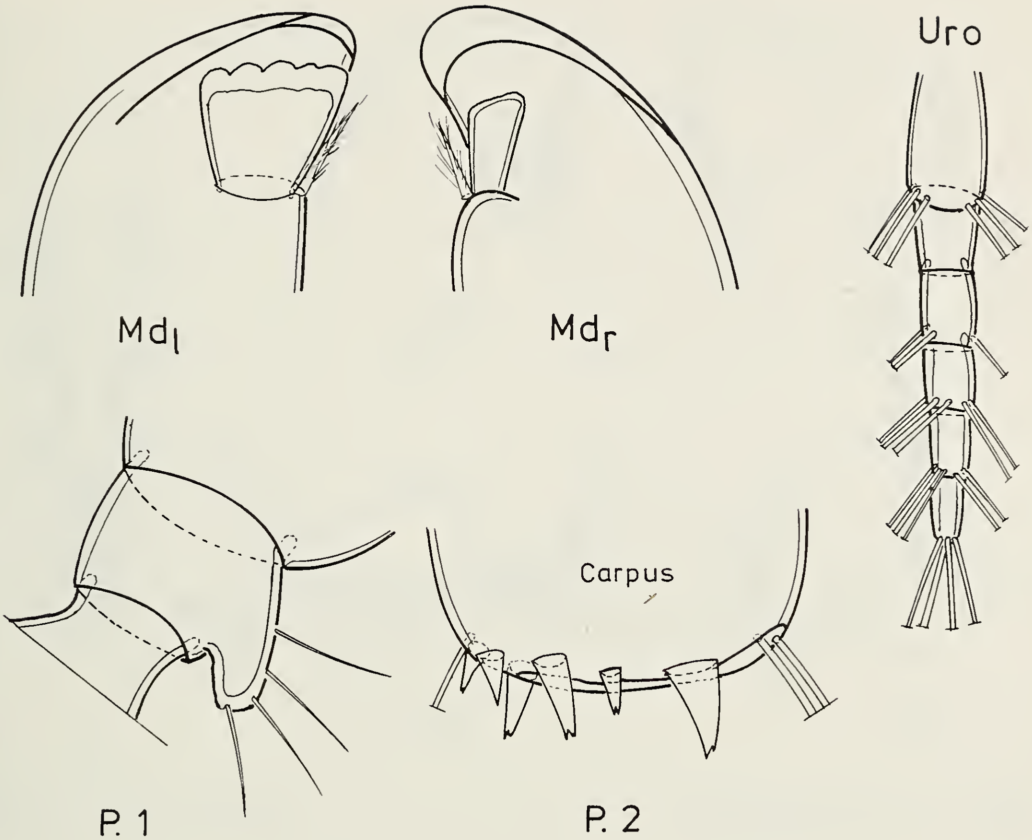

Fig. 13. *Zeuxo normani.*

Material.—*Velero IV* sta. 23045 (33°53′02″N, 120°06′01″W), off Santa Rosa Island, 55 m; 11 ♀♀: 2 ♀♀ coll. Sieg, 2 ♀♀ in Senckenberg Museum, Frankfurt, Germany; 7 ♀♀ in National Museum of Natural History, Washington: USNM 170655. *Velero IV* sta. 24358/BLM 636 (32°40′0″N, 119°9′49″W), Tanner Bank, southern California borderland, 120 m; 1 ♀ AHF, University of Southern California. Santa Cruz Island, Scorpio Harbour, California, 13 m; 1 ♀; Willis G. Hewatt coll. (USNM 86280). All specimens are syntypes.

Discussion.—This species closely resembles *Zeuxo normani* (Richardson), but can be distinguished by the relative proportions of the articles of antenna 1. The first article of *Anatanais* is twice the length of the second (rarely these proportions may vary from 3:1 to 2.5:1 in *Zeuxo*). There is also slight variation in some setae and plumose hairs, but they appear to be of no taxonomic value. The present distribution is only at the designated stations off Santa Cruz Island, Santa Rosa Island, and Tanner Bank within the southern California borderland.

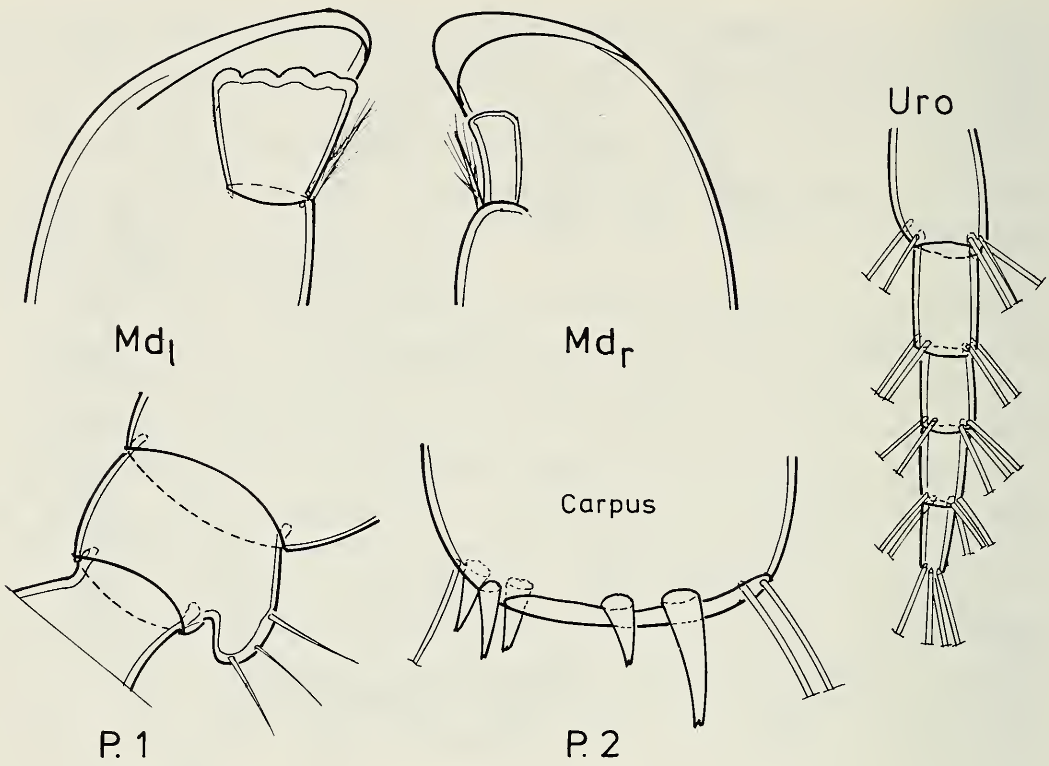

Fig. 14. *Zeuxo paranormani.*

Zeuxo normani (Richardson, 1901)
Fig. 13

Synonymy, see Sieg (1980).

Discussion.—In order to determine correctly the species of *Zeuxo* it is necessary to examine the coxa of pereopod 1 (Fig. 13), the carpus of pereopods 2–4, and the lacinia mobilis of the mandibles (Fig. 13). *Zeuxo normani* is characterized by the triangular protuberance extending from the coxa of pereopod 1, the 4 lateral and 2 medial spines borne distally on the carpus of pereopod 2 and the slightly reduced lacinia mobilis of the right mandible. In addition, the uropods (Fig. 13) of the adults consist of the basis and an endopod of 5 articles ("6-jointed"). A detailed redescription of the species is given, with figures, by Sieg (1980). The distribution of *Z. normani* is difficult to determine due to confusion with *Zeuxo paranormani*. At present it is reported from: Japan, without detailed locality (Shiino, 1951), and Tanabe Bay (Bieri and Tokioka, 1968); British Columbia, Nanoase Bay, False Narrows (Fee, 1927); Monterey Bay, California (type-locality, Richardson, 1905); Catalina Island, Anacapa Island, Santa Barbara Harbor, Moss Beach (Miller, 1968), and La Jolla (USNM 53846, det. Sieg).

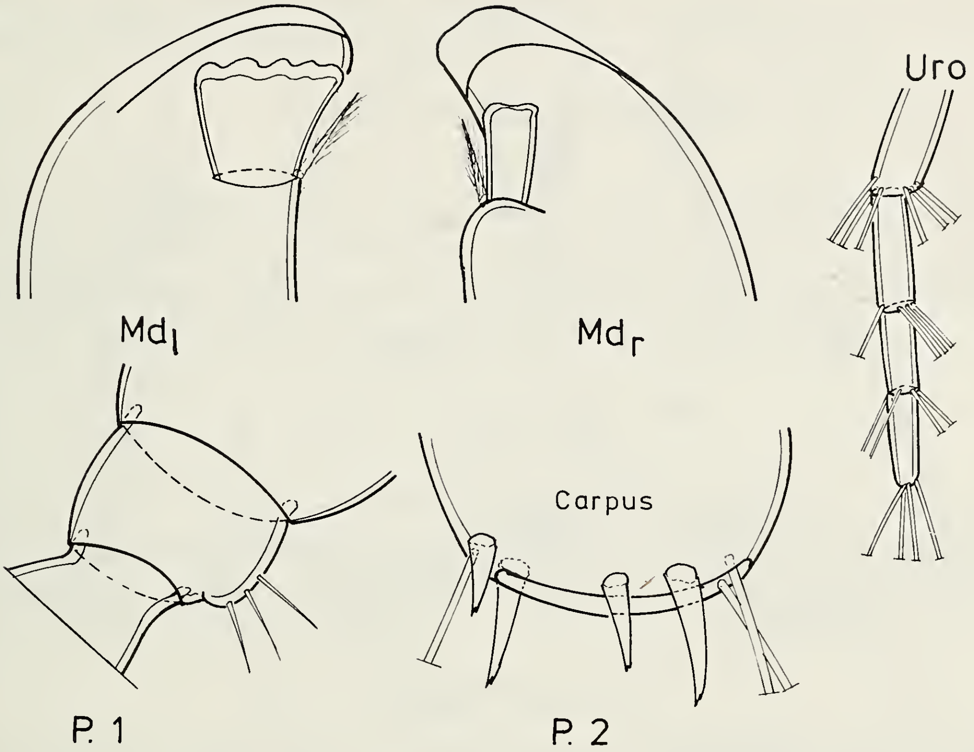

Fig. 15. *Zeuxo coralensis.*

Zeuxo paranormani Sieg, 1980
Fig. 14

A detailed description and discussion of this species, including figures, may be found in Sieg (1980).

Discussion.—*Zeuxo paranormani* has been confused with *Zeuxo normani*. The adults of *Z. paranormani* may be distinguished by the presence of uropods of 5 articles, while *Z. normani* have uropods of 6 articles ("6-jointed"). The protuberance of the coxa of pereopod 1 is somewhat less prominent in *Z. paranormani* than in *Z. normani,* and the carpus of pereopod 2 bears 2 medial and 4 lateral spines in *Z. normani*. The distribution of the species is presently known from scattered localities along the California coast: Humboldt Bay (USNM 66709), Santa Cruz Island (USNM 86281), La Jolla (USNM 53847), and Monterey Bay (USNM 30615), where it is noted as *Tanais normani* Richardson, 1905 type-material.

Zeuxo coralensis Sieg, 1980
Fig. 15

Discussion.—This species has been mentioned as occurring along the Pacific coasts of Japan and Panama Canal (Paitila, Sieg, 1980). It is included

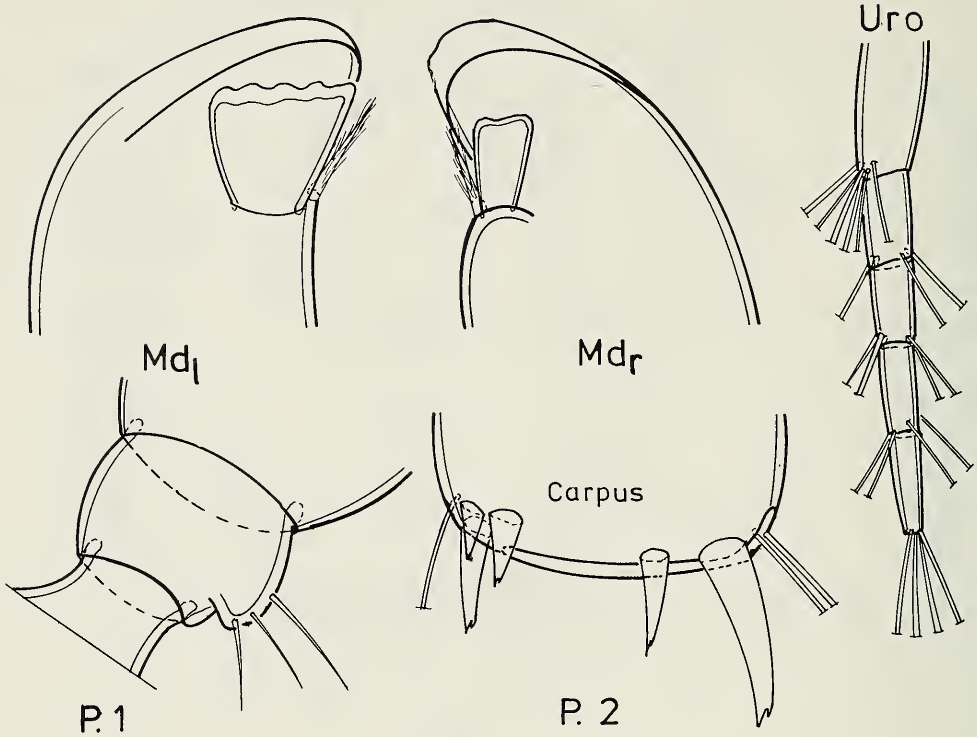

Fig. 16. *Zeuxo maledivensis.*

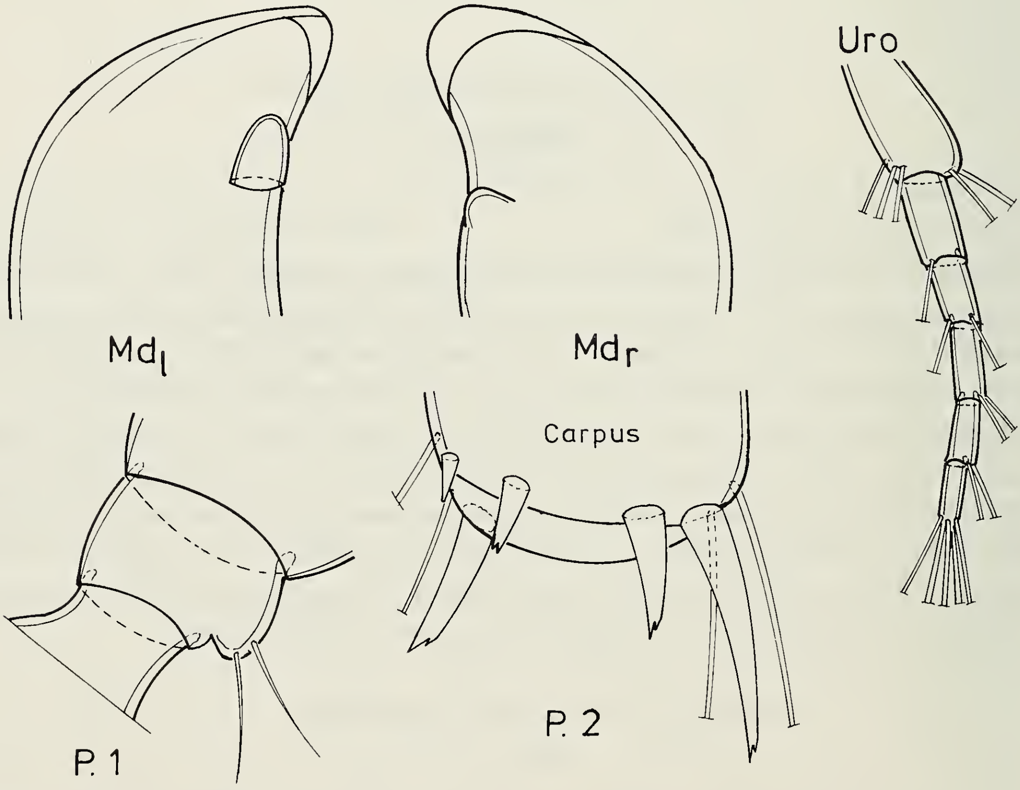

Fig. 17. *Zeuxo seurati.*

here because it possibly may occur along the California coast. For a discussion of the species see Sieg (1980).

Zeuxo maledivensis Sieg, 1980
Fig. 16

Discussion.—This species may also occur along the California coast, having been noted from the Maldives, Japan, and Florida. It may be distinguished from the other species in the Tanaidae by the figured details (Fig. 16). For a detailed description and discussion see Sieg (1980).

Zeuxo seurati Nobili, 1906
Fig. 17

Discussion.—*Zeuxo seurati* is recognized by the reduction of the left and right lacinia mobilis of the mandibles. It has been previously reported from the Tuamotu Islands, Japan (Nobili, 1906) and the Hawaiian Islands as *Anatanais insularis* (Miller, 1940).

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Literature Cited

Barnard, J. L. 1970. Benthic ecology of Bahía de San Quintin, Baja California.—Smith. Contrib. Zool. 44:1–60.

Bieri, R., and T. Tokioka. 1968. Dragonett, an opening-closing quantitative trawl for the study of microvertical distribution of zooplankton and the meio-epibenthos.—Publ. Seto Mar. Biol. Lab. 15(5):373–390.

Fauchald, K., and G. Jones. 1978. Southern California baseline study and analysis.—U.S. Bureau of Land Management and University of Southern California. 1976–1977.

Fee, A. R. 1927. The Isopoda of Departure Bay and vicinity with descriptions of new species, variations and colour notes.—Contrib. Canadian. Biol. Fish. 32:15–47, pl. I.

Gage, J. D., and G. G. Coghill. 1977. Studies on the dispersion patterns of Scottish Sea Loch benthos from contiguous core transects. Pp. 319–359 *in* Ecology of Marine Benthos, B. C. Coull, ed.

Gardiner, L. F. 1975. The systematics, postmarsupial development, and ecology of the deep-sea family Neotanaidae (Crustacea: Tanaidacea).—Smithsonian Contrib. Zool. No. 170, 266 pp.

Grassle, J. F., and H. L. Sanders. 1973. Life histories and the role of disturbance.—Deep-Sea Res. 20:643–659.

Hammer, R., and R. C. Zimmerman, 1979. Species of demersal zooplankton inhabiting a kelp forest ecosystem off Santa Catalina Island, California.—Bull. S. Calif. Acad. Sci. 78(3):196–206.

Jumars, P. A. 1976. Deep-sea species diversity: Does it have a characteristic scale?—Jour. Mar. Res. 34:217–246.

Lang, K. 1953. The postmarsupial development of Tanaidacea. Ark. Zool. (2)4:341–350.

———. 1960. The genus *Oosaccus* Richardson and the brood pouch of some tanaids.—Ark. Zool. (2)13:15–46.

———. 1961. Further notes on *Pancolus californiensis* Richardson.—Ark. Zool. (2)13:77–80.

Livingston, R. J., P. S. Sheridan, B. G. McLane, F. G. Lewis, III, and G. G. Kobylinski. 1977. The biota of the Apalachicola Bay system: functional relationships.—Florida Mar. Res. Publs. (Florida Dept. Nat. Res.) No. 26:75–100.

Menzies, R. J., and M. A. Miller. 1954. Key to the Chelifera and suborders of the Isopoda. *In:* Light, Smith, Pitelka, Abbott and Weesner; Intertidal invertebrates of the central California coast.—Berkeley, Univ. of Calif. Press. 446 pp.

Miller, M. A. 1940. The Isopoda Crustacea of the Hawaiian Islands. Chelifera and Valvifera.—Occ. Pap. B. P. Bishop Mus. 15:295–321.

———. 1968. Isopoda and Tanaidacea from buoys in coastal waters of the continental United States, Hawaii and the Bahamas.—Proc. U.S. Nat. Mus. 125:1–53.

Nobili, G. 1906. Diagnoses préliminaires de Crustacés, Décapodes et Isopodes nouveaux recueillis par M. le Dr. G. Seurat aux îles Touamotou.—Bull. Mus. Hist. Natur. 12:256–270.

Odum, W. E., and E. J. Heald. 1972. Trophic analysis of an estuarine mangrove community.—Bull. Mar. Sci. 22:671–738.

Racovitza, E. G. 1923. Notes sur les Isopodes. 10. Orientation de l'Isopode et essais de nomenclature pratique des bords et faces de son corps et de ses appendices. 11. Morphologie et phylogénie des péreiopodes et de leur phanères.—Arch. Zool. Exp. Gén. Notes et Revue 61:75–122.

Richardson, H. 1901. Papers from the Hopkins Stanford Galapagos expedition, 1898–1899. VI. The isopods.—Proc. Wash. Acad. Sci. 3:565–568.

———. 1901. Key to the isopods of the Atlantic coast of North America, with descriptions of new and little known species.—Proc. U.S. Nat. Mus. 23: 493–579.

———. 1905. Description of a new genus of Isopoda belonging to the family Tanaidae and of a new species of *Tanais,* both from Monterey Bay, California.—Proc. U.S. Nat. Mus. 28:367–370.

———. 1905. A Monograph on the Isopods of North America.—Bull. U.S. Nat. Mus. 54:1–727.

Shiino, S. M. 1951. On two species of the family Apseudidae found at Seto.—Rep. Fac. Fish. Pref. Univ. Mie. 1,1:12–25.

———. 1951. Notes on three species of Tanaidacea from Japanese coast.—Misc. Rep. Res. Inst. Nat. Resourc. 19:32–38.

Sieg, J. 1973. Ein Beitrag zum natürlichen System der Dikonophora Lang.—Diss. Kiel, 1973, 298 pp.

———. 1973a. Zum Problem der Herstellung von Dauerpräparaten von Klein-Crustaceen, insbesondere von Typusexemplaren.—Crustaceana 25:222–224.

———. 1977. Taxonomische Monographie der Pseudotanaidae.—Mitt. Zool. Mus. Berlin. 53:3–109.

———. 1980. Taxonomische Monographie der Tanaidae Dana 1849.—Abh. Senckenberg. Naturforsch. Ges. 537 (*In Press.*)

———, and R. N. Winn. 1978. Keys to suborders and families of Tanaidacea (Crustacea).—Proc. Biol. Soc. Wash. 91:840–846.

Straughan, D. 1977. Influence of power generating facilities on southern California coastal waters. Phase 3. Study of environmental conditions in King Harbor. April 1, 1976–1977. Report on the field biology.—Southern California Edison Research and Development Series 77-RD-5. 45 pp.

Wolff, T. 1956. Crustacea Tanaidacea from depths exceeding 6000 meters.—Galathea Reports 2:187–211.

———. 1962. The systematics and biology of bathyal and abyssal Isopoda Asellota.—Galathea Reports 6:7–320.

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A REDESCRIPTION OF *ECHINASTER MODESTUS* PERRIER, 1881 (ASTEROIDEA: SPINULOSIDA) FROM THE EASTERN GULF OF MEXICO AND THE WEST INDIES

Richard L. Turner and David B. Campbell

Abstract.—The seastar *Echinaster modestus* Perrier, 1881, is redescribed and a lectotype is designated. *Echinaster* spp. from the west coast of Florida used in recent experimental studies are not *E. modestus*.

During a morphological study of seastars of the genus *Echinaster* from the west coast of Florida, it was necessary for us to determine the identities of two common sibling species that have been called *E. spinulosus* (Ferguson, 1966, 1967, 1968), *E. echinophorus* (Ferguson, 1970, 1974; Atwood, 1973a, 1973b, 1973c; Atwood and Simon, 1973), *E. modestus* (Turner, 1976; Blake, 1978, 1980; Turner and Lawrence, 1979), and *Echinaster* (Ferguson, 1975a, 1975b, 1976, 1980). Based on the most recent monograph of seastars of the region (Downey, 1973), both forms must be assigned to *E. modestus* (Ferguson, 1975a, 1976; Turner, 1976; Turner and Lawrence, 1979); but a recent note (Campbell and Turner, 1979) gave three distinct morphological and meristic differences in the skeleton of the two forms. Examination of type-specimens by us has revealed that the two forms and Downey's (1973) material do not belong to *E. modestus*. Perrier's (1881, 1884) brief descriptions of *E. modestus* might have contributed to the present confusion, and Verrill's (1915) description of Perrier's specimens was equally brief. Walenkamp's (1979) detailed description seems to be based partly on material that differs from Perrier's type-specimens. Herein we redescribe *E. modestus* from the type material and designate a lectotype.

Family Echinasteridae Verrill, 1867
Genus *Echinaster* Müller and Troschel, 1840
Echinaster modestus Perrier, 1881
Figs. 1–2

Echinaster modestus Perrier, 1881:7, 1884:206–207, pl. 3, fig. 7 (part).—Verrill, 1915:43–44 (part).—Clark, 1941:55.—Walenkamp, 1979:74–79 (part).

Material.—MCZ 1080, Lectotype, 1 specimen (R = 34 mm, r = 8 mm), *Blake* Sta. 45 (101 fm, 25°33′N, 84°21′W).—MCZ 1119, Paralectotype, 1

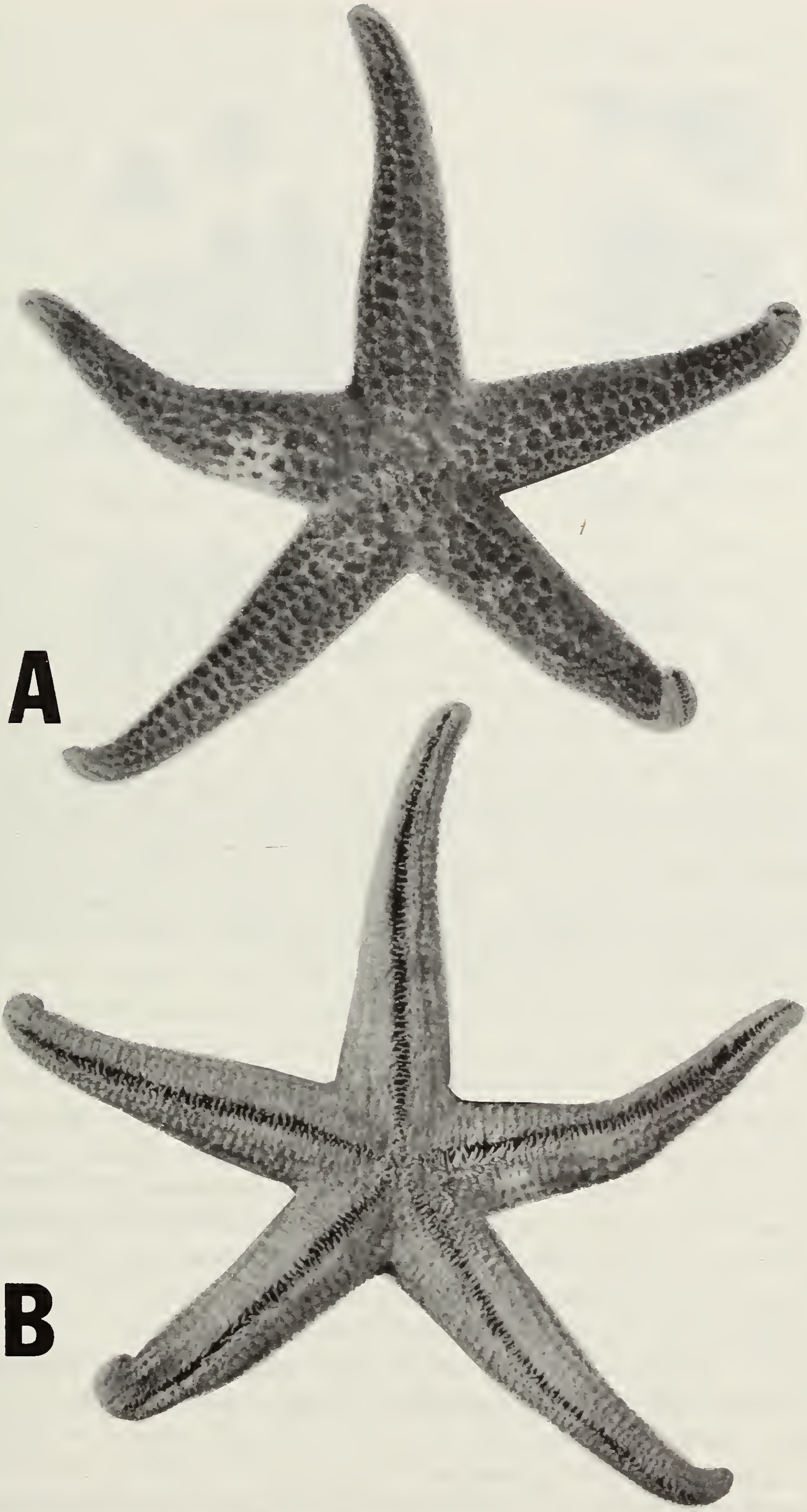

Fig. 1. *Echinaster modestus,* MCZ 1080, Lectotype. A, Aboral view; B, Adoral view.

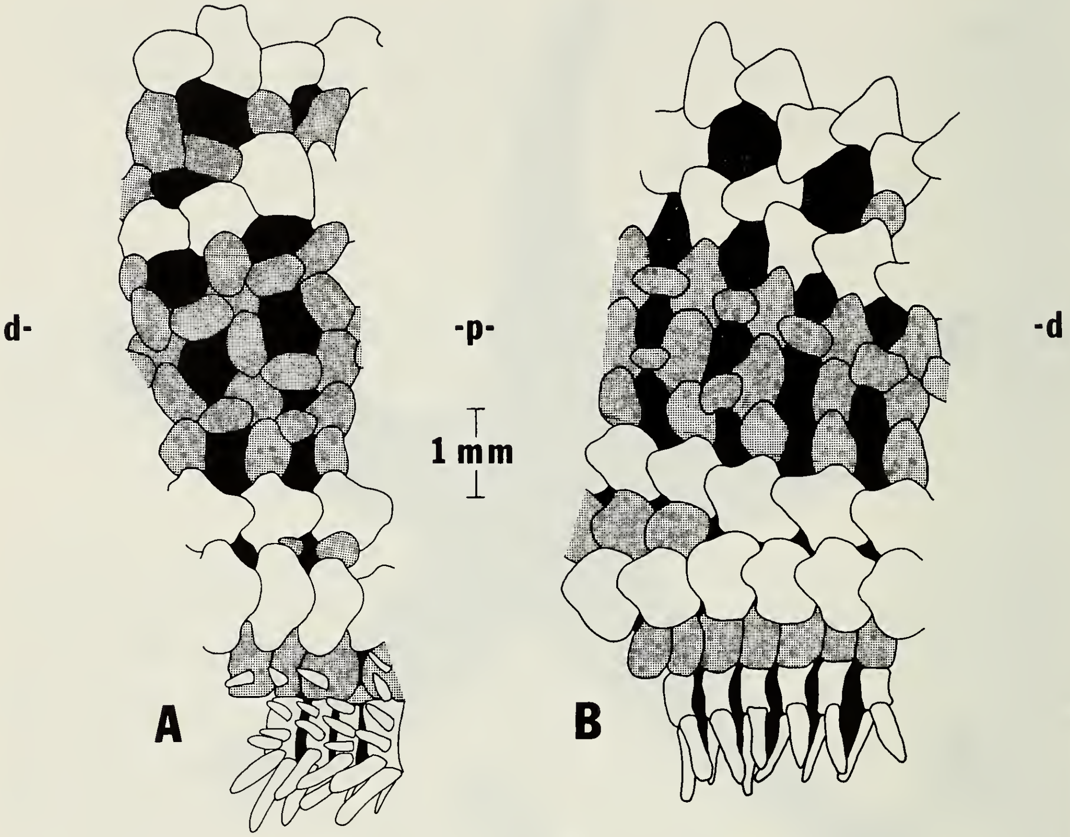

Fig. 2. *Echinaster modestus,* planar views of ray ossicles from midline of aboral surface (top) to the ambulacrum (bottom), near base of ray. Ossicles of primary skeleton unstippled; ossicles of secondary skeleton (except spines) stippled. Rows of ossicles, top to bottom: carinals, accessory ossicles, adradials, dorsolaterals, superomarginals, intermarginals, inferomarginals, actinolaterals, adambulacrals. Abbreviations: d, distal; p, proximal. A, MCZ 1080, Lectotype, full spination of adambulacrals 12–15 and actinolaterals shown; B, MCZ 1119, Paralectotype, only furrow spines of adambulacrals 12–17 shown.

specimen (R = 22 mm, r = 6 mm), *Blake* Sta. 157 (120 fm), Montserrat.—MCZ 4668, Paralectotype, 1 specimen (R = 26 mm, r = 8 mm), *Blake* Sta. 45 (101 fm, 25°33′N, 84°21′W).—MCZ 1081, 2 specimens (R = 9.5 mm, r = 2.7 mm; R = 8.1 mm, r = 2.9 mm), *Blake* Sta. 272 (76 fm) and 292 (56 fm), Barbados.—MCZ 1118, 1 specimen (R = 5.7 mm, r = 2.0 mm), *Blake* Sta. 276 (94 fm), Barbados.—MCZ 4001, 1 specimen (R = 56 mm, r = 11 mm), *Atlantis* Sta. 3303 (260 fm), Playa Baracoa, Cuba.

Diagnosis.—Rays 5, tapered, only slightly inflated at bases. Madreporite circular, with radiating gyri; peripheral spinules present. Aboral skeleton reticulate, with large papular areas. Adoral skeleton compact, with few papulae. Serial ossicles of rays: carinals, adradials, several rows of dorsolaterals, superomarginals, 1 short row of intermarginals, inferomarginals, 1–2 rows of actinolaterals, adambulacrals; all series except latter 2 with proximal imbrication; glassy tubercles present. Spines small, blunt, conical; generally 1 per ossicle, except for superomarginals (1–2), inferomarginals (2–4), adambulacrals (4–6), and mouth plates (6–7).

Description of type-material.—The following is based largely on MCZ 1080. Many details were confirmed in the two paralectotypes.

The rays taper uniformly to acute tips, with slight or no inflation near the bases. The smaller type-specimens are more robust (R:r, 3.7 and 3.3) than the larger (R:r, 4.3). The small, circular madreporite has a radiating system of sulci and gyri and bears 6–13 spinules on its periphery. Anal spinules number 8–14. The primary circlet has 1 (rarely 2) accessory ossicle between adjacent primary radials and interradials, but there is none between the madreporite and the primary radials of the bivium. Each primary radial bears 1–2 (usually 1) small, blunt spines. Other ossicles of the primary circlet and periproct bear 0–1 spine each.

The aboral skeleton is a loosely imbricating network. Papular areas are wider than or equal in diameter to the width of surrounding ossicles. Papulae are most abundant (3–7) between the carinals and adradials. The primary series of ossicles on the aboral surface are the carinals and adradials, each member of which bears a spine and overlaps the next proximal member (proximal imbrication). Members of the carinal series are triangular and alternate right and left of the midline; they are rarely separated by accessory ossicles. Accessory ossicles sometimes join the carinal and adradial series, which are otherwise directly joined. Members of the adradial series are triangular or quadrangular and are not separated by accessory ossicles. A few adradials have patches of glassy tubercles, but they appear eroded, perhaps from storage. The major secondary elements of the aboral skeleton are the dorsolaterals. Near the base of the ray, 3–5 dorsolaterals form a transverse series from each superomarginal to an adradial. The transverse series of dorsolaterals are joined by 1–2 longitudinal series of more superficial ossicles. A spine occurs on many members of the longitudinal series and on some of the transverse members, forming 1–2 irregularly spinous rows that extend $^4/_5$ the length of the ray.

The adoral skeleton is compactly imbricate, with few papulae. Superomarginals and inferomarginals are quadrangular ossicles with broadly rounded corners. They bear eroded patches of glassy tubercles and have proximal imbrication. The 2 marginal series are separated at the base of the ray by a few intermarginals, each of which has 0–1 spine. Intermarginals have proximal imbrication. The superomarginals define the ambitus; they bear 1–2 spines and are about as wide as they are long. The inferomarginals bear 2–4 spines and are wider than they are long. Each adambulacral bears a transverse row of 4–6 spines: 1 (rarely 2) slender, webbed spine deep in the ambulacral groove; 1 long, blunt spine at the margin of the groove (furrow spine); a slightly shorter, more distal furrow spine; and 1–2 (rarely 3) short subambulacral spines. Each mouth plate has 1 preoral spine, 3 furrow spines, 0–1 (usually 1) suboral spine, and 1–2 spines within the groove and hidden by the furrow spines. Actinolaterals form a distinct row between the inferomarginals and adambulacrals for less than half the ray length and then become hidden by the inferomarginals; each has 0–1 spine. A few additional actinolaterals sometimes occur in a short row next to the inferomarginals, but they are confined to the disc.

Description of other material.—Three other, small specimens from *Blake* stations 272, 276, and 279 also are *E. modestus*. Even the smallest has proximal imbrication, peripheral spinules (2) on the madreporite, 1–2 dorsolaterals in transverse series, a few interbrachial intermarginals, and a row of actinolaterals. The largest specimen is less than half the size of the smallest type-specimen, but it agrees with the description above in every detail except for the following: 3 peripheral spinules on madreporite; sulci and gyri of madreporite poorly developed; number of anal spinules and nature of primary circlet undetermined; few members of the longitudinal series of dorsolaterals present; proportion of ray length occupied by dorsolaterals undetermined; intermarginals not yet imbricate; superomarginals longer than wide; inferomarginals as wide as long; mouth plates with only 2 furrow spines. Most differences probably reflect ontogenetic variation. The third specimen has many superficial characteristics of *E. modestus,* but the skin was not removed for closer examination. As in the type-material, the smaller specimens are progressively more robust (R:r, 3.5, 3.0, 2.9).

Clark's (1941) large specimen from *Atlantis* Sta. 3303 seems to be *E. modestus* with a few differences that might only reflect growth of the rays: the carinal series and primary circlet have more accessory ossicles; the intermarginals and actinolaterals extend ⅔ the length of the ray; calcareous nodules lie free in the papular areas; rays are proportionately longer (R:r, 5.1).

Type-locality.—Southeastern Gulf of Mexico, northwest of Dry Tortugas.

Discussion.—Perrier (1881) did not specifically designate the type-material of *Echinaster modestus,* but he gave measurements for the larger specimen from *Blake* Sta. 45 and published a photograph of it in 1884. He later (1884, 1894) listed specimens from Gulf of Mexico, Montserrat, St. Vincent, and Guadeloupe stations of the *Blake* but not the specimens from Barbados. The material examined here represents all *E. modestus* held by the Museum of Comparative Zoology, Harvard University. We have not seen the specimens from St. Vincent and Guadeloupe. Because of the unsettled state of systematics of *Echinaster* (Downey, 1973; Tortonese and Downey, 1977; Tortonese and Madsen, 1979), we have designated the larger syntype from *Blake* Sta. 45 as lectotype and the other syntypes (MCZ 1119 and MCZ 4668) as paralectotypes.

Our observations confirm Perrier's (1881) brief diagnosis, but his description of spination around the ray did not reveal the kinds of underlying ossicles. The type-specimens differ from Downey's (1973) description by the presence of dorsolaterals, actinolaterals, proximal imbrication, and more spines on the mouth plates; examination of some of her material confirmed that it does not belong to *E. modestus*. Walenkamp (1979) examined some type-specimens of *E. modestus* as well as new material collected from the Guyana Shelf. His description included the lack of glassy tubercles, 3 rows of actinolaterals, a long row of intermarginals, and 4 mouth spines within the furrow; these characteristics are not found in the type-material. He did not describe the arrangement of dorsolaterals, but his description of "open areas" on the aboral surface probably reflects the arrangement of dorsolaterals and agrees with the type-material. Walenkamp (1979) assigned Downey's (1973) specimens of *Verrillaster spinulosus* to *E. modestus*. Our examination of her specimens, similar in size to the lectotype, revealed that they have no glassy tubercles, too many intermarginals, and 2–3 rows of actinolaterals. The identity of Downey's specimens of *V. spinulosus* remains unknown. *Echinaster* spp. on the west coast of Florida that have been used for experimental studies cited above lack actinolaterals, have a longer, less compact series of intermarginals, have fewer dorsolaterals and oral furrow spines, and have distal imbrication (proximal ossicles overlap distal ossicles); they are not *E. modestus*.

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Literature Cited

Atwood, D. G. 1973a. Larval development in the asteroid *Echinaster echinophorus*.—Biol. Bull. 144:1–11.

———. 1973b. Correlation of gamete shedding with presence of neurosecretory granules in asteroids (Echinodermata).—Gen. Comp. Endocrinol. 20:347–350.

———. 1973c. Histological comparison of asteroid neurosecretory granules before, during, and after natural spawning.—Trans. Amer. Micros. Soc. 92:277–280.

———, and J. L. Simon. 1973. Histological and histochemical analysis of neurosecretory granules in asteroids (Echinodermata).—Trans. Amer. Micros. Soc. 92:175–184.

Blake, D. B. 1978. The taxonomic position of the modern sea-star *Cistina* Gray, 1840.—Proc. Biol. Soc. Wash. 91:234–241.

———. 1980. On the affinities of three small sea-star families.—J. Nat. Hist. 14:163–182.

Campbell, D. B., and R. L. Turner. 1979. Comparative skeletal and ossicle morphology of sibling species of *Echinaster* (Echinodermata: Asteroidea) from the west coast of Florida.—Amer. Zool. 19:1009.

Clark, H. L. 1941. Reports on the scientific results of the *Atlantis* expeditions to the West Indies, under the joint auspices of the University of Havana and Harvard University. The echinoderms (other than holothurians).—Mem. Soc. Cubana Hist. Nat. 15:1–154.

Downey, M. E. 1973. Starfishes from the Caribbean and the Gulf of Mexico.—Smithson. Contrib. Zool. 126:1–158.

Ferguson, J. C. 1966. Mechanical responses of isolated starfish digestive glands to metabolic drugs, inhibitors and nutrients.—Comp. Biochem. Physiol. 19:259–266.

———. 1967. An autoradiographic study of the utilization of free exogenous amino acids by starfishes.—Biol. Bull. 133:317–329.

———. 1968. Transport of amino acids by starfish digestive glands.—Comp. Biochem. Physiol. 24:921–931.

———. 1970. An autoradiographic study of the translocation of amino acids by starfish.—Biol. Bull. 138:14–25.

———. 1974. Growth and reproduction of *Echinaster echinophorus*.—Fla. Sci. 37:57–60.

———. 1975a. The role of free amino acids in nitrogen storage during the annual cycle of a starfish.—Comp. Biochem. Physiol. 51A:341–350.

———. 1975b. Fatty acid and carbohydrate storage in the annual reproductive cycle of *Echinaster*.—Comp. Biochem. Physiol. 52A:585–590.

———. 1976. The annual cycle of fatty acid composition in a starfish.—Comp. Biochem. Physiol. 54B:249–252.

———. 1980. Fluxes of dissolved amino acids between sea water and *Echinaster*.—Comp. Biochem. Physiol. 65A:291–295.

Perrier, E. 1881. Reports on the results of dredging under the supervision of Alexander Agassiz, in the Gulf of Mexico, 1877–78, by the United States Coast Survey Steamer "Blake," Lieut.-Commander C. D. Sigsbee, U.S.N., commanding, and in the Caribbean Sea, 1878–79, by the U.S.C.S.S. "Blake," Commander J. R. Bartlett, U.S.N., commanding. 14. Description sommaire des Espèces nouvelles d'Astéries.—Bull. Mus. Comp. Zool., Harvard 9:1–31.

———. 1884. Mémoire sur les étoiles de mer recueillies dans la Mer des Antilles et le Golfe du Mexique durant les expéditions de dragage faites sous la direction de M. Alexandre Agassiz.—Nouv. Arch. Mus. Hist. Nat., ser. 2, 6:127–276.

———. 1894. Échinodermes. I, Stellérides.—Exped. Sci. Travailleur Talisman 3:1–432.

Tortonese, E., and M. E. Downey. 1977. On the genera *Echinaster* Mueller and Troschel and *Othilia* Gray, and the validity of *Verrillaster* Downey (Echinodermata: Asteroidea).—Proc. Biol. Soc. Wash. 90:829–830.

———, and F. J. Madsen. 1979. On the specific name *Echinaster sepositus*, its validity and authorship.—Natura 70:291–294.

Turner, R. L. 1976. Sexual difference in latent period of spawning following injection of the hormone 1-methyladenine in *Echinaster* (Echinodermata: Asteroidea).—Gen. Comp. Endocrinol. 28:109–112.

———, and J. M. Lawrence. 1979. Volume and composition of echinoderm eggs: implications for the use of egg size in life-history models.—pp. 25–40 *in* S. E. Stancyk, ed., Belle W. Baruch Library in Marine Science, vol. 9: Reproductive Ecology of Marine Invertebrates. Univ. S. Carolina Press, Columbia.

Verrill, A. E. 1915. Report on the starfishes of the West Indies, Florida, and Brazil, including those obtained by the Bahama Expedition from the University of Iowa in 1893.—Bull. St. Univ. Iowa 7:1–232.

Walenkamp, J. H. C. 1979. Asteroidea (Echinodermata) from the Guyana Shelf.—Zool. Verh. 170:1–97.

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THE MORPHOLOGY OF *TRIPOLYDORA SPINOSA* WOODWICK (POLYCHAETA: SPIONIDAE): AN APPLICATION OF THE SCANNING ELECTRON MICROSCOPE TO POLYCHAETE SYSTEMATICS

James A. Blake and Keith H. Woodwick

Abstract.—The morphology of *Tripolydora spinosa* Woodwick is reexamined using traditional light microscopy and the Scanning Electron Microscope (SEM). In addition to its already-known unique features, *T. spinosa* possesses modified spines on setiger 4, bristles on the major spines of setiger 5, unique "ribbed" notosetae on setigers 7–10, and neuropodial inferior sabre setae which accompany the hooded hooks. The setal arrangements, as revealed by SEM, permit a consideration of possible setal homologies of the modified spines of setigers 4 and 5. The position of *Tripolydora* among those genera having a modified fifth setiger is considered, relative to other genera of the subfamily Spioninae.

Tripolydora spinosa was first described from rocky intertidal habitats on Enewetak Atoll in the Marshall Islands by Woodwick (1964). Kohn and Lloyd (1964) subsequently reported the species from Easter Island where it occurred in rocky tidal pools with sand and algae.

In the original description, Woodwick (1964) found *T. spinosa* to possess an unusual combination of characteristics including a partially modified fifth setiger and branchiae on anterior setigers including the modified fifth. The species also has a characteristic unique for a member of the *Polydora*-complex, the presence of tridentate hooded hooks.

Because of this unusual combination of characteristics and the possible significance of *T. spinosa* in the evolution of the *Polydora*-complex (Blake, 1979), the species was selected to be the subject of a more complete morphological analysis. A detailed study of the morphology of *T. spinosa* using both the light and Scanning Electron Microscope (SEM) was initiated. For this work, it was possible to reexamine the Enewetak and Easter Island specimens, all of which are deposited in the National Museum of Natural History (USNM). In addition, new materials from Aitutaki in the Cook Islands, collected by the first author (JAB), Johnston Atoll, provided by the Naval Oceanographic Sorting Center (NOSC) in Hawaii, and from the Seychelles (Indian Ocean), deposited in the USNM were also examined.

The species is redescribed. A discussion considers the homologies of setal arrangements in forms having a modified fifth setiger and possible evolu-

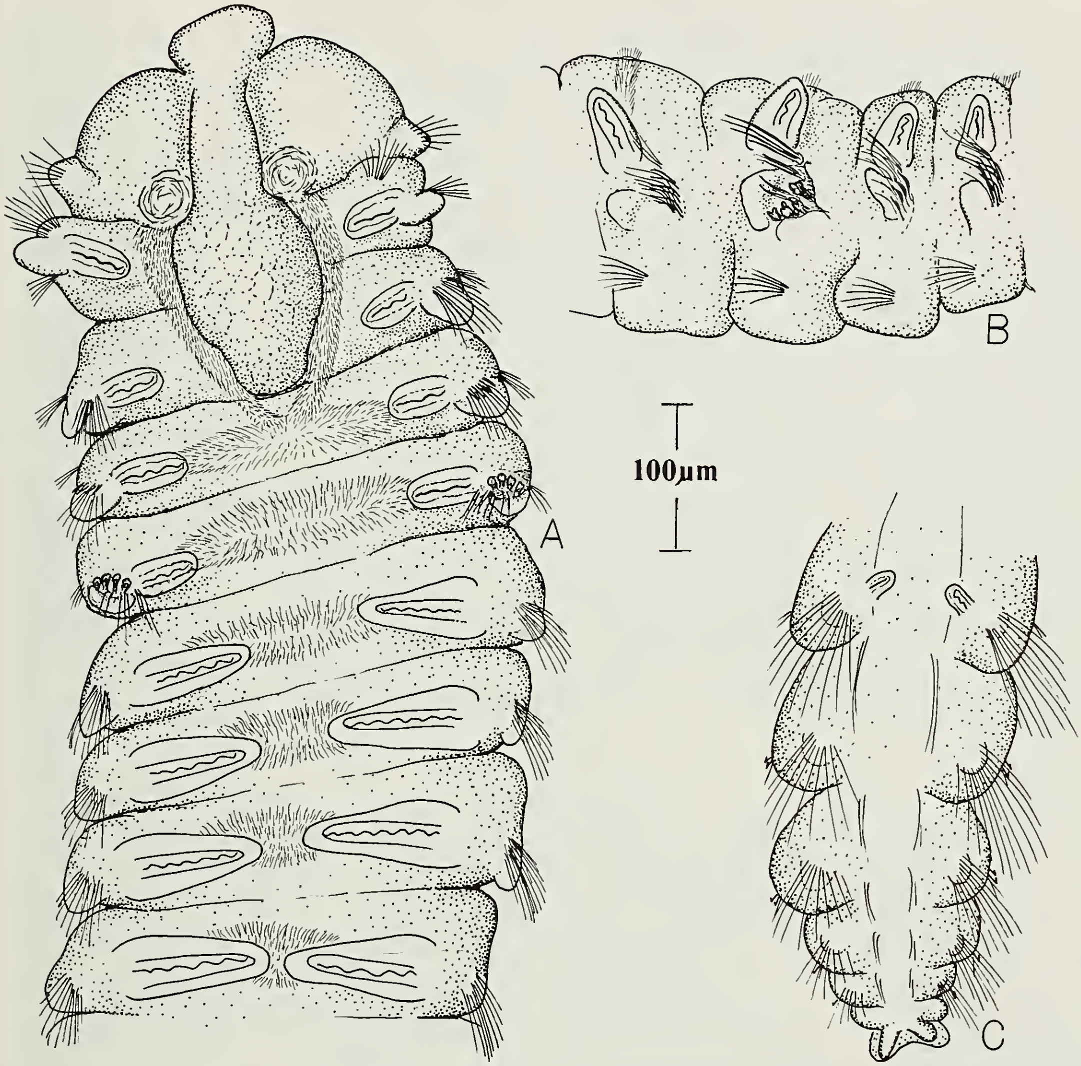

Fig. 1. *Tripolydora spinosa* (USNM 49530): A, Anterior end in dorsal view; B, Setigers 3–
 in right lateral view; C, Posterior end in dorsal view.

ionary significance of *T. spinosa* relative to its placement in the *Polydora*-
omplex of the subfamily Spioninae.

Methods

Nomarski Differential Interference Contrast (Zeiss RA) and Phase Con-
rast (Zeiss GFL) optics were used for light microscopy. SEM studies were
nade with a Zeiss Novascan 30 and JOEL JSM 35. SEM photographs were
roduced from negatives of Polaroid Type 55 film. The specimens were all
rom previously fixed museum specimens which are ordinarily fixed in formalin and preserved in 70% Ethanol. The specimens were dehydrated for
EM observation in a critical point drier and sputter coated with gold-paladium.

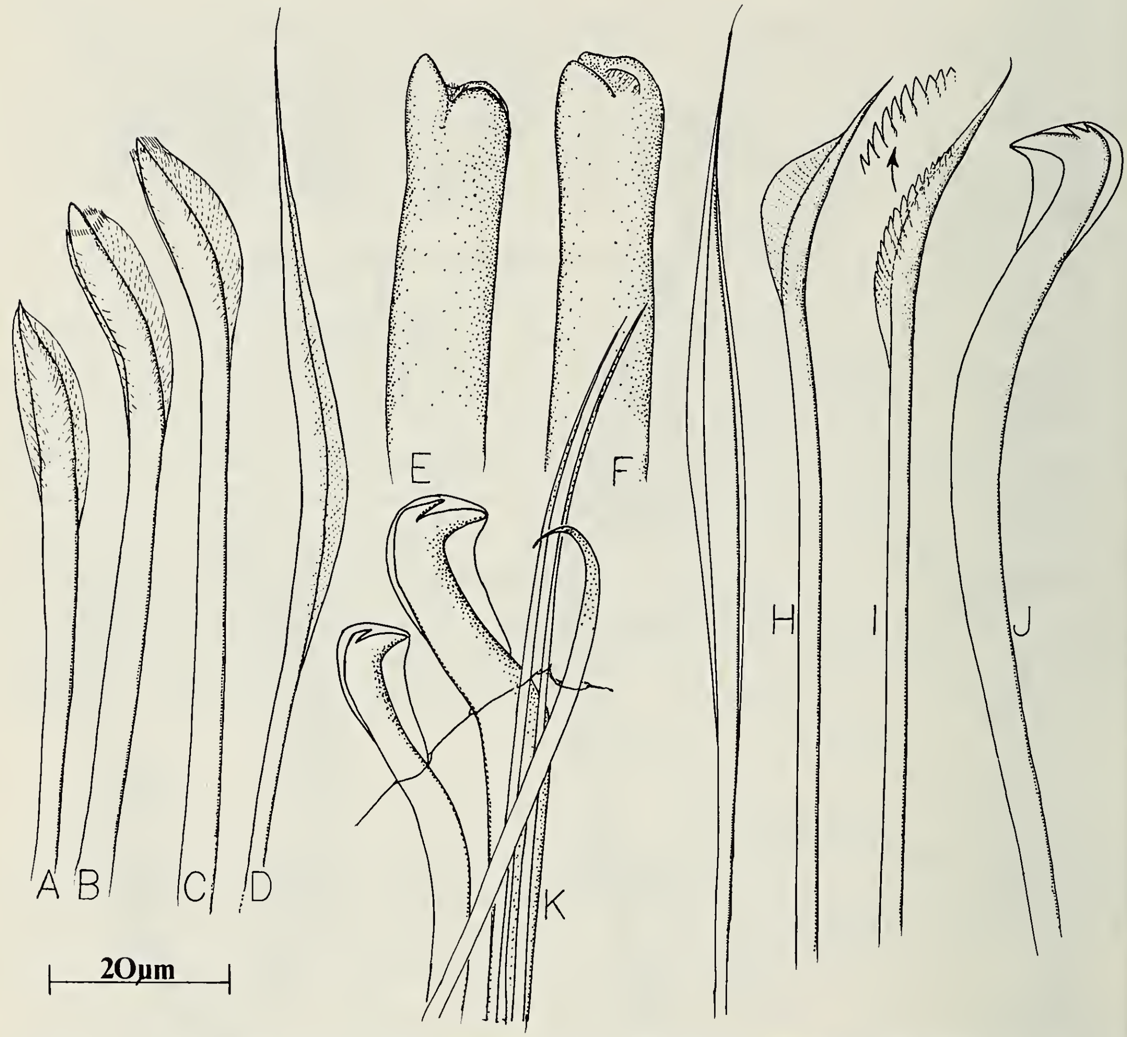

Fig. 2. *Tripolydora spinosa* (USNM 49530): A–C, Modified setae from setiger 4; D, Second tier capillary notoseta from setiger 3; E–F, Major spines from setiger 5; G, Companion bilimbate capillary setae from setiger 5; H, Anterior tier capillary notoseta from setiger 7; I, Posterior tier "ribbed" notoseta from setiger 7; J, Tridentate hooded hook; K, Fascicle of two bidentate hooded hooks, two capillary neurosetae and an inferior sabre seta.

Systematics

Tripolydora spinosa Woodwick, 1964
Figs. 1–5

Tripolydora spinosa Woodwick, 1964:155–156, fig. 4(6–9).—Reish, 1968:222.—Kohn and Lloyd, 1973:700.

Material examined.—MARSHALL ISLANDS: Enewetak Atoll, Bogambo, 2 July 1957, in beach rock, coll. D. J. Reish, holotype (USNM 32610).—EASTER ISLAND: between Hanga Roa and Hanga Piko, 15 Feb. 1969, in

Fig. 3. *Tripolydora spinosa* (USNM 49530): A, SEM of notopodia of setigers 4 and 5 in right lateral location; B, SEM of same in posterior view of setiger 5. Scale: Fig. 3A = 20 μm; 3B = 10 μm.

Fig. 4. *Tripolydora spinosa* (USNM 49530): A, SEM of modified notosetae (row I) and capillaries (row II) from setiger 4 in posterior view; B, Major spines of setiger 5 in lateral orientation. Scale: Fig. 4A = 10 μm; 4B = 10 μm.

rock in tide pool, coll. A. Kohn and M. Lloyd, 30 specimens (USNM 49537); same locality, in sand and algae, 125 specimens (USNM 49530).—COOK ISLANDS: Aitutaki, Akiami motu, south side, 1 Aug. 1978, boring into dead coral, coll. J. A. Blake, 3 specimens (JAB).—JOHNSTON ATOLL: Sta. 3, transect 6, 25 April 1976, coll. R. Brock, 11 specimens (NOSC 77003JI).—SEYCHELLES: Round Island, 19°45′S; 57°50′E, intertidal, from sponge, Dec. 1975, coll. K. Buchanan, 3 specimens (USNM 59926).

Description.—This is a small species, measuring up to 3.5 mm long and 0.4 mm wide for about 37 setigerous segments. In alcohol the color is opaque white to light tan with no body pigment. The prostomium is entire and broadly rounded on the anterior margin (Fig. 1A). The caruncle is broad and extends posteriorly over setigers 2 and 3 (Fig. 1A). There is no occipital tentacle and no eyes. Nuchal cilia occur in long tracts on both sides of the caruncle, merging posteriorly with the first dorsal sense organ on setiger 4. The peristomium is well developed and broad, but not inflated.

Setiger 1 is greatly reduced and lacks a notopodium and notosetae. The neuropodium is short, conical, and bears delicate capillary setae (Fig. 1A). Setigers 2–10 have elliptically shaped notopodial lamellae and indistinct neuropodial lamellae.

Setigers 2–10 bear notopodial fascicles of setae arranged in 2 rows (I and II), each running in a general dorso-ventral orientation, and a third group (III) of long superior capillaries located at a point near the uppermost setae of the second row. The setae vary in length and structure. The setae of the anterior row (I) are shortest, while those of the superior group (III) are the longest. The setae of setigers 2 and 10 are the least modified in the sequence, while those of setigers 4 and 5 are the most modified. There is a gradation of setal structure in setigers 3 and 4 leading to setiger 5 and a corresponding gradation in setigers 6–10 leading away from setiger 5.

The notosetae of setigers 2–3 and 6 are unilimbate capillaries (Fig. 2D) in which the setae of row I are shorter and have a broader sheath. In setigers 3 and 6 these setae are pennoned, with a long tapered tip. The enlarged portion of these setae is seen by SEM to be composed of free surface fibrils which are longest on one side of the seta. Varied lengths of these fibrils produce a tapered tip, which superficially resembles the acuminate setae of sabellids.

The notosetae of setiger 4 are arranged as on setigers 2 and 3 except that row I is modified and bears 3–4 setae having inflated sheaths, through which the tip of the shaft often protrudes (Figs. 2A–C; 3A–B; 4A). When observed with the SEM, the inflated sheath is seen to be a crest of bristles (Fig. 4A).

Setiger 5 appears only slightly modified superficially (Fig. 1A–B). The setae include a diagonal row of 3–4 major spines corresponding to row I and positioned anteroventral to 2 groups of 2–3 bilimbate companion capillaries (Fig. 2G) derived from row II, and a fascicle of dorsal capillaries (Fig. 3A–

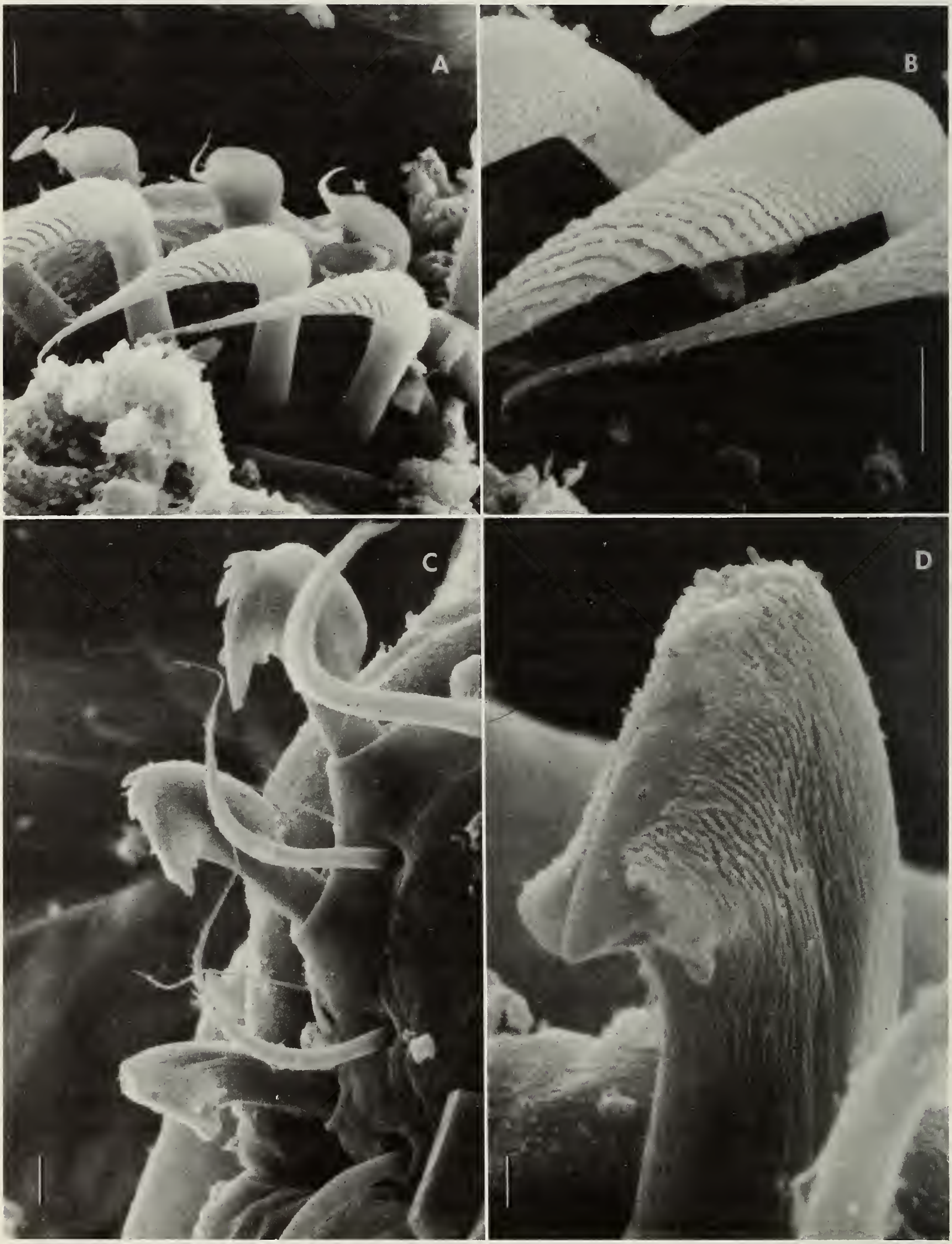

Fig. 5. *Tripolydora spinosa* (USNM 49530): A, SEM of "ribbed" row II capillary notosetae from setiger 7 in posterior view; B, Detail of same; C, SEM of tridentate hooded hooks in lateral view; D, Detail of individual hook in frontal orientation. Scale: Fig. 5A = 4 μm; 5B = 5 μm; 5D = 1 μm.

B) corresponding to row III. The major spines have a terminal tooth flanked on one side by 2 short knobs; the central depression between these prominences bears fine bristles (Fig. 2E; 3B; 4B). Worn spines have reduced knobs (Fig. 2F).

Setigers 7–10 have short unilimbate capillary notosetae in row I (Fig. 2H) similar to those of setigers 2–3 and 6 and long unilimbate capillaries with unusual riblike sculptured sheaths (Fig. 2I) in row II. The SEM reveals these ribs to consist of thickened whorls of minute bristle endings (Fig. 5A–B). The notosetae become longer and more slender in subsequent setigers, with those of the far posterior setigers being arranged as dense bundles of long needles which project posteriorly over the dorsum (Fig. 1C).

The neurosetae of setigers 2–8 consist of 4–5 unilimbate capillaries. Tridentate hooded hooks begin on setiger 9 and number 2–4 per neuropodium throughout the body. Initially, the hooks are accompanied by 4–5 unilimbate capillaries, but these are gradually replaced by 2–3 simple capillaries and a single large inferior sabre seta (Fig. 2K) bearing granulations near the distal end. The hooks have a large and a small apical tooth surmounting the main fang, to which the large apical tooth is closely applied (Fig. 2J). The small apical tooth is often worn and sometimes lacking, especially in posterior setigers (Fig. 2K). With the SEM, the hood is seen to have a fine microstructure, consisting of numerous minute bristle endings (Fig. 5C–D). In some cases, the hood is inflated (Fig. 5C). The hood opening is expanded near the tip of the main fang and flares somewhat laterally (Fig. 5D).

Branchiae occur from setiger 2, and continue without interruption to near the posterior end. The branchiae on setigers 2–5 are shorter than those of setiger 6 and subsequent setigers (Fig. 1A). Dorsal sense organs begin on setiger 4 and extend across the segments between the gills (Fig. 1A). The dorsal sense organs are difficult to see with light microscopy, but prominent with SEM. The pygidium is formed by 4 small lobes, the dorsal pair smaller (Fig. 1C).

Distribution.—Pacific Ocean: Marshall Islands, Johnston Atoll, Cook Islands, Easter Island.—Indian Ocean: Seychelles.

Discussion

The SEM reveals a significant number of details about setal structure and ciliary arrangement of *Tripolydora spinosa* that are not apparent with the light microscope. The SEM also demonstrates that it is possible to interpret setal homologies by considering setal arrangements over successive segments.

The arrangement of modified spines and capillaries on setigers 4 and 5 is clearly revealed in Fig. 3A. The modified spines of setiger 4 appear to be homologous to the shorter and thicker unilimbate capillaries occurring in row I of setigers 2–3 and 6–10. The same homology holds for the major spines of setiger 5. Here the 3–4 spines are aligned in a more anteroventral position. The long, thin capillaries of row II are also shifted on setigers 4 and 5. On setiger 4, the 2–3 ventralmost and shortest capillaries lie just posterior to the modified setae. This same relationship occurs on setiger 5, with the ventralmost capillaries becoming the companion setae.

The modified notosetae of setiger 4 are unusual. In some respects they resemble the major spines of setiger 5 found among some species of *Polydora* and *Boccardia* where the curved shaft is surmounted by a crest of bristles. In *T. spinosa* this crest is transparent when viewed with the light microscope, but is a solid feature in *Polydora caulleryi* Mesnil (see Blake, 1971). It is probable that the modified notosetae on setiger 4 of *T. spinosa* are transitional in degree of modification between unilimbate capillaries and the heavy crested spines of *P. caulleryi*.

The major spines of setiger 5 on *T. spinosa* are revealed by SEM to have a terminal tooth and 2 shorter knobs between which are located fine bristles. The terminal structure of this seta is very difficult to observe with light microscopy and the bristles are rarely seen. This emphasizes the difficulties of making accurate portrayals of setal structure using only the light microscope. The bristles had not been previously reported on the major spines of *T. spinosa*.

The ribbed nature of the capillary notosetae of setigers 7–10 of *T. spinosa* has not been previously described. With light microscopy these setae have a unilimbate appearance in which the ribs appear to be surface sculptures of the sheath. With SEM, it can be seen that each ''rib'' is part of a whorl of thickened fibril endings which completely cover the ends of these setae.

The fine details of the hoods of the hooded hooks are different in *T. spinosa* than we have observed using SEM in related species of *Polydora* and *Boccardia*. These differences manifest themselves in the degree of bristling apparent upon the hood, position and shape of the hood opening, and the number of teeth which project through the hood opening. These differences suggest that microarchitecture of the hooded hooks may prove to be useful in systematic studies of spionid polychaetes. Readers should be aware, however, that hood form will differ depending upon the drying technique employed during specimen preparation. If the specimens are air dried prior to coating and observation, the hoods tend to collapse, tear and more closely adhere to the shaft and teeth. The bristles also tend to be distorted with air drying. With critical point drying the hoods remain inflated, are seldom torn, and the bristles remain undistorted.

Among the genera of the *Polydora*-complex, *Tripolydora spinosa* is unique in many respects. It is the only species to have tridentate hooded hooks, prominent granulated inferior sabre setae, and unique "ribbed" notosetae on setigers 7–10. Moreover, with the exception of *Boccardiella limnicola* (Blake and Woodwick, 1976), it is the only species with gills from setiger 2 continuing uniformly to near the end of the body. The species has modified notosetae on setiger 4 *in addition to* the major spines on setiger 5. Modifications to notosetae on setiger 4 are known for some species of *Pseudopolydora* (see Woodwick, 1964), but are not known for other genera of the *Polydora*-complex. *Tripolydora spinosa* also resembles *Pseudopolydora* in the lack of major parapodial alteration to setiger 5 and in the reduced angle between the main fang and apical tooth (teeth) of the hooded hooks. The modified notosetae of setiger 4, the "ribbed" notosetae of setigers 7–10 and the inferior sabre setae were not reported by Woodwick (1964) because some of these setae were sheared off the holotype.

Blake (1979) proposed that *Tripolydora* exhibits a close relationship to the non-polydorid genus *Microspio*. This conclusion was originally based on similarities in branchial distribution, hooded hook structure, and the presence of inferior sabre setae in both genera. Additional support for this conclusion is the recent discovery that *Microspio granulata* Blake and Kudenov from Australia, the Hawaiian Islands, and Ifaluk Atoll in the Caroline Islands, and an undescribed species of *Microspio* from Ecuador have enlarged capillary notosetae on rows I and II over setigers 4–6 (Blake, unpublished). In addition, the setae of these 2 rows come together ventrally, close and form a loop. This arrangement is reminiscent of some species of *Polydora* where the modified spines of setiger 5 are positioned into a J-shape (see Blake, 1971). This trend in *Microspio* towards modification of setae in the corresponding modified region of polydorids occurs in no other member of the Spionidae. Blake (1979) emphasized that larval characters are also useful in interpreting relationships of the *Polydora*-complex; however, the larval morphology of *Tripolydora spinosa* has not been described.

From the information available, it would appear that *Microspio* is an appropriate genus to consider as having given rise to the *Polydora*-complex. In order to pursue this line of research SEM studies are being undertaken on selected species of *Microspio, Pseudopolydora,* and other genera of the *Polydora*-complex. Following completion of those studies it should be possible to describe more fully the interrelationships of the genera of the subfamily Spioninae.

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Literature Cited

Blake, J. A. 1971. Revision of the genus *Polydora* from the east coast of North America (Polychaeta: Spionidae).—Smithsonian Contrib. Zool. 75:1–32.

———. 1979. Evolutionary relationships of spionid polychaetes.—Amer. Zool. 19:887.

———, and K. H. Woodwick. 1976. A new species of *Boccardia* (Polychaeta: Spionidae) from two freshwater lakes in southeastern Australia.—Rec. Aust. Mus. 30:123–128.

Kohn, A. J., and M. C. Lloyd. 1973. Marine polychaete annelids of Easter Island.—Int. Rev. ges. Hydrobiol. 58:691–712.

Reish, D. J. 1968. The polychaetous annelids of the Marshall Islands.—Pacific Sci. 22:208–231.

Woodwick, K. H. 1964. *Polydora* and related genera (Annelida, Polychaeta) from Eniwetok, Majuro and Bikini Atolls, Marshall Islands.—Pacific Sci. 18:146–159.

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SYSTEMATIC NOTES ON CERTAIN OSCINES FROM PANAMA AND ADJACENT AREAS (AVES: PASSERIFORMES)

Storrs L. Olson

Abstract.—*Vireo gilvus disjunctus* Zimmer, 1941, is synonymized with *Vireo gilvus dissors* Zimmer, 1941, the range of which is extended to include both slopes of the northern end of the Western Andes of Colombia and Darién, Panama. The range of *Chlorospingus ophthalmicus novicius* Bangs, 1902, is restricted to the Boquete region and the east slope of Volcán de Chiriquí, Panama, the remainder of western Panama and Costa Rica being occupied by *C. o. regionalis* Bangs, 1906. *Chlorospingus punctulatus* Sclater and Salvin, 1869, should be regarded as a subspecies of *C. ophthalmicus* (Du Bus, 1847). *Chrysothlypis chrysomelas titanota* n. subsp. is named from Costa Rica, the nominate form being restricted to western Panama. *Icterus chrysater hondae* Chapman, 1914, is considered to be known from the holotype and paratype only, and all other specimens from Colombia and Panama are referred to *I. c. giraudii* Cassin, 1848. *Icterus mesomelas salvini* Cassin, 1867, extends only to the Almirante region of the Caribbean slope of western Panama, all other specimens from Panama being referable to *I. m. carrikeri* Todd, 1917. *Zonotrichia capensis orestera* Wetmore, 1951, is synonymized with *Z. c. costaricensis* Allen, 1891.

Vireonidae

Vireo gilvus

The collection of a specimen of *Vireo gilvus* from Darién, Panama, that is quite distinct from the population of western Panama and Costa Rica, *V. g. chiriquensis* (Bangs, 1903), necessitates a review of the subspecies known from Colombia. The last revision of these forms is that of Zimmer (1941). Material in the USNM collected by Carriker subsequent to Zimmer's revision requires changes to be made in the current nomenclature and published distributions of certain subspecies.

Two subspecies are recognized in eastern Colombia—*V. g. mirandae* Hartert, 1917, of the Santa Marta region and northern Venezuela, and *V. g. leucophrys* (Lafresnaye, 1844) in the Eastern Andes of Colombia, reportedly extending as far south as the eastern part of central Peru (Blake, 1968). As noted by Hellmayr (1935) and Meyer de Schauensee (1951), *mirandae* is poorly marked, but in series the 23 USNM specimens from Santa Marta, Sierra Perijá, and Sierra Negra, Colombia are seen to have paler underparts than *leucophrys,* although not all individuals would be separable.

The populations of the middle portions of the Central and Western Andes were recognized by Zimmer (1941) as a new race, *V. g. dissors* (type locality, Cerro Munchique, Cauca). This can be distinguished from *leucophrys* by the grayer, as opposed to warm brown, crown and the greener, less brown, dorsum. Although Meyer de Schauensee (1951) referred specimens from Huila to *leucophrys,* Carriker specimens from Huila (3 from Belén, 45 km SW of La Plata; 2 from La Candela, 10 miles SW of San Augustín) show a decided approach to *dissors* and can probably be regarded as intergrades. An older specimen from La Candela, presumably through foxing, appears more typical of *leucophrys* than those taken 40 years later.

On the basis of six specimens from the eastern slope of the northern end of the Central Andes, Zimmer (1941) described an additional race, *V. g. disjunctus* (type locality, Santa Elena, Antioquia). USNM specimens from the Central Andes in Antioquia include 4 from Hacienda Zulaiba, 17 miles NE of Santa Rosa de Osos, and 2 from La Bodega, S side of Río Negrito, on the road from Sonson to Nariño. Additional specimens from Antioquia definitely extend the range of the species to both slopes of the northern end of the Western Andes, whereas previously there had evidently been some doubt that the species occurred there (Blake, 1968). USNM specimens from the Western Andes include 7 from Hacienda Potreros, 15 miles SW of Frontino; 3 from Hacienda La Ilusión, Río Urrao, base of Páramo de Frontino, and 1 from Urrao.

Although Zimmer (1941:18) took some pains to distinguish *disjunctus* from the races in Ecuador and Peru, the only supposed difference from *dissors,* which is the nearest race geographically, was given as "darker upper parts." The characters he cites as differentiating *disjunctus* from *leucophrys* are exactly the same as those given for separating *dissors* from *leucophrys*. In the series I examined, which included topotypes of both *dissors* and *disjunctus,* there was only a tendency for darker coloration in the dorsum of more northern birds, but individual and seasonal variation made it impossible to separate specimens into two groups. Therefore, one of Zimmer's names, which were proposed simultaneously, should be suppressed. As first revisor, I select the name *dissors* to represent the subspecies of *Vireo gilvus* inhabiting the entire extent of the Western and Central Andes of Colombia, with *disjunctus* falling into synonymy.

A considerable extension of range for the species is provided by a single female taken 4 June 1963 by Pedro Galindo, 4 miles (6.4 km) W of the summit of Cerro Malí, Darién, Panama, at an elevation of 4800 feet (1463 m). This specimen (USNM 486488) has the pale underparts typical of Colombian birds and cannot, therefore, be referred to *chiriquensis* of western Panama. The coloration of the upperparts is unlike that of *leucophrys* and is most like that of *dissors,* to which I tentatively refer the specimen, although its preservation and state of wear do not permit a positive determination.

Both Hellmayr (1935) and Zimmer (1941) discuss a specimen of *V. gilvus* from Ricaurte, Nariño, southwestern Colombia, that Hellmayr referred to *v. g. josephae* Sclater, 1859, of Ecuador. In the USNM collections is an additional specimen, also from Ricaurte, taken by Carriker in 1950. I could detect no difference between this specimen and individuals of *dissors,* whereas it differs from *josephae* in the lighter crown and greener, less brownish, dorsum. For the present, the distribution of *V. g. josephae* probably should not be considered to include Colombia.

Thraupidae

Chlorospingus ophthalmicus

There are two races of this highly polymorphic species recognized in Costa Rica and Panama—*C. o. novicius* Bangs, 1902, and *C. o. regionalis* Bangs, 1906. Examination of extensive material from Panama shows that these two taxa are indeed valid, but their distribution and characters are not properly delimited at present. Zimmer (1947:3), for example, considered that "the separation of *novicius* and *regionalis* is not sharp and it is difficult to say where the line should be drawn." This idea results in part from ambiguous labeling of specimens but also from the fact that *novicius,* which is actually quite distinctive, has a peculiarly restricted range.

Bangs (1902) described *Chlorospingus novicius* from a series of specimens collected by W. W. Brown in Chiriquí, western Panama. Most of these were labeled as being from Boquete, but a few were labelled "Mt. Chiriqui" or "Caribbean Slope," meaning the Caribbean slope of Mt. Chiriquí (=Volcán de Chiriquí or Volcán Baru). The holotype is from "Mt. Chiriqui" at 7500 feet (2286 m). It is important to note that Brown worked out of Boquete and would therefore presumably have taken this, and other specimens so labeled, on the eastern slope of Volcán de Chiriquí. Bangs (1902) referred to Boquete as being "south" of Volcán de Chiriquí and considered most of Brown's collecting to have been done on the south slope, apparently to contrast it with the "northern" or Caribbean slope, whereas in fact, Boquete is more nearly east of Volcán de Chiriquí. Brown would have collected on the eastern as opposed to the western face of the volcano, which latter has been accessible only in more recent times. Because the birds from the western slope are referable to *regionalis,* the type locality of *novicius* should be restricted to the eastern slope of Volcán de Chiriquí.

The species *Chlorospingus ophthalmicus* was poorly known when Bangs (1902) described *novicius,* and he made his comparisons chiefly with the subspecies from Bolivia now known as *bolivianus* Hellmayr, 1921, noting particularly that the bill in *novicius* was larger. Bangs (1906) later described the birds of Costa Rica as a new form, *regionalis* (type locality, Cariblanco de Sarapiquí), distinguished by differences in color. Hellmayr (1936:402), in contrasting *novicius* with *regionalis,* regarded it as having a "much larger, thicker as well as longer bill." This is erroneous and was obviously adapted from Bangs' (1902) original comparison of *novicius* with the small-billed race *bolivianus.* Hellmayr further considered that two specimens from Urujás de Térraba, Costa Rica, were "identical with a topotypical series" of *novicius,* so that thenceforth (e.g. Storer, 1970), the range of *novicius* has been given as including western Panama and southwestern Costa Rica, with *regionalis* occupying the remainder of Costa Rica and Nicaragua.

In the process of arranging the USNM series of *C. ophthalmicus* from Panama by locality to check geographic variation, I found that birds from Boquete were markedly distinct from those taken elsewhere in Panama—so much so that I was easily able to pick out the remainder of the Boquete specimens before reading the labels. I could not distinguish birds from west of Volcán de Chiriquí from *regionalis* of Costa Rica. Much has been obfuscated by the apparent tendency of collectors to label specimens taken anywhere within sight of Volcán de Chiriquí as "El Volcán." Wetmore, for example, applied this term to such diverse localities as Cerro Picacho (7 km N of the peak), Silla de Cerro Pando (17 km WNW of the peak), and Lagunas (16 km WSW of the peak). Fortunately, he also supplied the more detailed locality information as well, which other collectors usually have not done. Many specimen labels of the past few decades apparently refer to the town of El Volcán (El Hato del Volcán or El Hato), west of the volcano, rather than to the peak itself.

From the available evidence, it appears that *C. o. novicius* has a much more restricted distribution than hitherto suspected, being known with certainty only from the Boquete area and extending from there to the Caribbean slope of Bocas del Toro. In addition to the USNM series of specimens from Boquete, I have examined the holotype of *C. o. novicius* and what remains at the MCZ of the original type series (Mt. Chiriquí, 3; Caribbean slope, 2; Boquete, 11), as well as the specimens recorded by Blake (1958) from the Boquete area, including the Caribbean slope of Bocas del Toro. All of these specimens are referable to *novicius.* Birds from the western slope of Volcán de Chiriquí through Costa Rica to Nicaragua are referable to *regionalis.*

C. o. novicius differs from *C. o. regionalis* as follows: crown and sides of head darker, decidedly brownish, not gray; dorsum more olivaceous, less yellow-green; pectoral band more intensely orangish, less yellow; light portions of throat more restricted, more heavily speckled, usually suffused with buff or even with the orangish of the breast, not whitish as in *regionalis.*

In these characters, as Zimmer (1947) noted, *novicius* shows a decided approach to the birds of Veraguas and Coclé, now known as *Chlorospingus* *punctulatus* Sclater and Salvin, 1869 (see Storer, 1970), in which the crown and sides of head are very dark brown, the throat is even more intensely speckled, and the pectoral band is deeper orange. Both Zimmer (1947) and Eisenmann (1955) rightly considered *punctulatus* to be but a subspecies of *C. ophthalmicus,* but Storer (1970:259, footnote) quoted Wetmore (in litt.) as believing it "closer to [*Chlorospingus*] *pileatus* but would maintain it as a full species until more is known about it in life." *C. punctulatus* has the white spot behind the eye characteristic of most subspecies of *C. ophthalmicus* and shows no approach whatever to *C. pileatus* Salvin, 1864, which has a broad white stripe extending from above the eye to the posterior margin of the crown. In its coloration, *punctulatus* differs only slightly from other dark-capped subspecies of *C. ophthalmicus,* such as *venezuelanus* Berlepsch, 1893, and clearly should be regarded as a subspecies of *C. ophthalmicus.* The fact that no specimens of *C. ophthalmicus* are known from the area between Boquete and the range of *punctulatus* in Veraguas, has no doubt contributed to the misunderstanding of the relationships of *punctulatus.*

There is some evidence of intergradation between *novicius* and *regionalis.* Three birds collected at Cerro Punta in 1932 show some buffiness in the throat, a somewhat more orangish pectoral band, and some brown in the crown, possibly due to intergradation with *novicius.* On the other hand, two birds from the same locality taken in 1955, and another taken in 1965, are clearly referable to *regionalis.*

USNM Panamanian specimens examined.—C. o. novicius: CHIRIQUI: "Mt. Chiriqui" (topotypical paratype) 1; Boquete (paratypes) 4; Boquete, Palo Alto, 1; Boquete, Río Caldera, 5; Boquete, Quiel, 18.

C. o. regionalis: CHIRIQUI: "Volcán," 2; El Volcán, Tisingal, 4; El Volcán, Silla de Cerro Pando, 5; El Volcán, Quebrada Zumbona, 2; El Volcán, Laguna Grande, 4; El Volcán, Lagunas, 2; El Volcán, Cerro Picacho, 1.

Chrysothlypis chrysomelas

Currently there are two subspecies recognized for this distinctive bird. The nominate form *C. c. chrysomelas* (Sclater and Salvin, 1869; type locality, Cordillera del Chucú, Veraguas, Panama) is stated to range through Costa Rica and western Panama, and *C. c. ocularis* Nelson (1912; type locality, Cana, Darién, Panama) has heretofore been known only from Darién, eastern Panama. Nelson (1912) distinguished *ocularis* from *chrysomelas* partly by the black loral spot of adult males, but mainly by what he supposed to be differences in the females. He was misled by comparing females of *ocularis,* which are entirely yellow underneath, with those from Costa Rica, which he regarded as "typical" and which are whitish below. Nelson had no specimens of true *chrysomelas* from western Panama, however; these birds are entirely yellow below, as in *ocularis*. This is clearly shown in Sclater and Salvin's (1869) plate accompanying the original description of *chrysomelas*. The Costa Rican birds thus represent an undescribed subspecies, as was mentioned in a footnote by Griscom (1935:377).

Chrysothlypis chrysomelas titanota, new subspecies

Holotype.—Female, USNM 209197, Bonilla, northern Cartago, Costa Rica. Collected 10 April 1908 by Francisco Basulto, original number 743.

Characters.—Adult males like *chrysomelas*; females with throat and belly suffused with white, leaving only a band across the breast yellowish, whereas females of *chrysomelas* are entirely bright yellow below; flanks grayish, not yellow-green as in *chrysomelas*.

Range.—Caribbean slope of Costa Rica. The great majority of specimens come from a limited area in central Costa Rica, but Slud (1964:366) records the species from "just south of Lake Arenal to the northern and eastern sides of the Cordillera Central and the approaches to the Talamanca Cordillera . . . ."

Etymology.—Greek, *titanotos,* whitened, from *titanos,* chalk or gypsum.

Specimens examined.—COSTA RICA. HEREDIA: Cariblanco de Sarapiquí (adult ♂: 1, MCZ; ♀: 1, MCZ; 1, AMNH). SAN JOSE: Carillo (adult ♂: 1, FM; 1, ANSP; 11, MCZ; immature ♂: 1, AMNH; 1, MCZ; 1, FM; ♀: 2, MCZ; 4, AMNH); La Hondura (adult ♂: 1, USNM). CARTAGO: Bonilla (adult ♂: 7, USNM; ♀: 4, USNM; 1, AMNH).

Remarks.—The three immature males listed above are more yellow below than any of the females. K. C. Parkes (in litt.) reports that of about 30 specimens in the Carnegie Museum of Natural History (all from Carillo), there are four non-juveniles sexed as females, two of which are whitish, as typical for *titanota,* one of which is all yellow below, and one of which is intermediate. One bird sexed as male that apparently is also a juvenile, is whitish below, as is an unsexed juvenile. Thus there seems to be some infrequent variation in the color of the underparts, but whether this can be correlated with age or sex cannot be determined with the material at hand. Regardless, virtually all Costa Rican females are instantly separable from all Panamanian females.

Chrysothlypis chrysomelas chrysomelas (Sclater and Salvin)

Tachyphonus chrysomelas Sclater and Salvin 1869, Proc. Zool. Soc. London 1869:440. Cordillera del Chucú, Veraguas, Panama.

Characters.—Females like *ocularis,* separable from *titanota* by the entirely yellow underparts. Males like *titanota,* separable from *ocularis* by the lack of a black loral spot.

Range.—Known with certainty only from Veraguas, Coclé, and western Panamá Province, Panama.

Specimens examined.—PANAMA. COCLE: Head of Río Guabal (adult ♂: 2, USNM; immature ♂: 2, USNM; ♀, 2 USNM). PANAMA PROVINCE: Cerro Campana (adult ♂; 1, USNM; 1, AMNH; ♀: 1, USNM).

Remarks.—The identity of 8 specimens (MCZ) from the Caribbean slope of Bocas del Toro, on the Boquete trail above Almirante (Kennard and Peters, 1928; Peters, 1931), remains in doubt. Five are adult males, two are immature males, and one is unsexed, but not an adult male. The last three birds are entirely yellow below, as in *chrysomelas,* but in the absence of any certain female specimens, the possibility remains that these birds may be referable to *titanota.*

Chrysothlypis chrysomelas ocularis Nelson

Chrysothlypis chrysomelas ocularis Nelson 1912, Smithsonian Misc. Coll. 60:19. Cana, eastern Panama.

Characters.—Exactly like *chrysomelas* except adult males with part of loral area black instead of yellow.

Range.—Eastern Panama in Darién and eastern Panamá Province.

Specimens examined.—PANAMA. PANAMA PROVINCE: Cerro Azul (adult ♂: 1, AMNH). DARIEN: Cana (adult ♂: 2, USNM; immature ♂: 1, USNM; ♀: 2, USNM); Tacarcuna Village (adult ♂: 1, USNM; ♀: 2, USNM); Cerro Tacaracuna (♂: 2, AMNH; ♀: 4, AMNH); Cerro Sapo (♂: 5, ANSP; ♀: 5, ANSP).

Remarks.—The supposedly greater width of the black orbital ring described by Nelson (1912) is too much affected by the preparation of the specimen to be of use. The specimen from Cerro Azul is the only one known outside of Darién. It has the black loral spot somewhat reduced, but no more so than certain individuals from Cerro Sapo.

Icteridae

Icterus chrysater

In the earlier literature, the southern populations of *I. chrysater* from Panama, Colombia, and Venezuela, were considered to represent a single subspecies, *I. c. giraudii* Cassin, 1898 (type locality ''Bogota''). On the basis of two (not three, *contra* Meyer de Schauensee, 1951) male specimens from Honda, Tolima, Colombia, Chapman (1914) described a new species, *Icterus hondae,* differentiated from *I. chrysater* by much deeper orange coloration and supposedly smaller size. Meyer de Schauensee (1951), while allowing that these specimens were more orange than in *giraudii,* considered *hondae* to be a subspecies of *chrysater*. He assigned all birds from Panama, the lowlands of western Colombia, and the Magdalena Valley to *hondae* on the basis of supposedly smaller size, reserving the name *giraudii* for the birds of the upper tropical and lower temperate zones of the remainder of Colombia and part of Venezuela. Blake (1968) followed this treatment.

According to Meyer de Schauensee (1951), the wing is 90–92 mm in the types of *hondae,* 89–94 mm in birds from the Pacific Coast of Colombia, and 86–94 mm in specimens from Panama. He considered the wing length of *giraudii* to range from 95.5 to 111 mm. Both the holotype and paratype of *hondae,* however, retain the primaries of the previous subadult plumage, which results in a shorter wing measurement. The wings in 32 males from Panama in the USNM range from 89 to 103 mm, and average 96 mm. Nine males from Magdalena and Norte de Santander, within the restricted range of *giraudii,* had wing lengths from 96.3 to 101.6 mm, averaging 98.4 mm. Overlap is thus far too great to permit separation of these birds, and there are no size differences within the remainder of the USNM series from Colombia and Panama that will permit the recognition of more than one subspecies in this area. Alexander Wetmore's unpublished notes and measurements of this series indicate that he considered all these specimens to be referable to *I. c. giraudii,* and I concur.

Although there is considerable variation in the intensity of coloration of specimens of *giraudii,* none is as deep orange as the type and paratype of *I. hondae,* which I examined at AMNH. Furthermore, the bills in these specimens are proportionately longer, more slender, and pointed than in *giraudii*; the mandibles in both are light horn color at the base, not bluish or blackish as in *giraudii*; and both have less black on the forehead and over the eye than *giraudii.* These characters were not noted in the original description or subsequently. For the present I regard *I. hondae* as a problematical subspecies of *I. chrysater* that is known so far only from the two original specimens. It is possibly confined to the upper Magdalena River Valley.

Icterus mesomelas

Four subspecies are recognized in *I. mesomelas,* of which the northernmost (*mesomelas* [Wagler, 1829]) and southernmost (*taczanowskii* Ridgway, 1901) are easily separated from the other two by the yellowish-white margins of their inner secondaries. Birds from eastern Panama and the Caribbean slope of western Panama through Nicaragua are presently (Blake, 1968) referred to *I. m. salvini* Cassin, 1867 (type locality, Costa Rica), whereas those from Colombia and western Venezuela are referred to *I. m. carrikeri* Todd, 1917 (type locality, Fundación, Santa Marta, Magdalena, Colombia). Todd (1917) merely compared *carrikeri* with *taczanowskii* of Ecuador and Peru and did not say how it differed from *salvini.* Hellmayr

(1937) diagnosed *carrikeri* as differing from *salvini* in having the black gular area more restricted, the bill smaller, and the general coloration slightly more orange.

In analyzing the specimens in the USNM, it quickly became evident that there were inaccuracies in the current concept of variation in this species, as the majority of Panamanian birds proved inseparable from those of Colombia. This at first suggested that the race *carrikeri* was invalid. Although poorly marked, *carrikeri* can be salvaged by redefining its range to include all of Panama east of the Canal Zone, extending west to Cerro Campana, western Panamá Province on the Pacific slope, and at least to El Uracillo, Coclé, on the Caribbean slope. The only specimens from Panama that are referable to *salvini* are from the Almirante area of Bocas del Toro (Almirante 2, USNM; 5, MCZ; Western River 2, MCZ; Fruitdale 1, MCZ; Changuinola River 2, MCZ). There is thus a considerable hiatus between *salvini* and *carrikeri* along the Caribbean coast of Panama. This is in large measure an artifact of collecting, but the pattern of distribution of these two subspecies, as redrawn here, is one commonly observed in other polytypic species of Panamanian birds.

Icterus m. salvini is separable from *I. m. carrikeri* by its larger bill (usually over 16.5 mm from anterior margin of nostril to tip) and more extensive black gular patch, although the latter is often considerably affected by the "make" of the skin. There is overlap in color characters; *salvini* seems never to be orangish, as are many individuals of *carrikeri,* but the more yellow examples of *carrikeri* could not be distinguished from *salvini.*

Fringillidae

Zonotrichia capensis

Although highly polytypic, *Zonotrichia capensis* shows an unusual lack of differentiation from Costa Rica through Panama, the Andes of Colombia, Ecuador, and western Venezuela. All specimens from these areas have in the past been assigned to the subspecies *Z. c. costaricensis* Allen, 1891. On the basis of nine specimens taken from Cerro Campana, western Panamá Province, Wetmore (1951) named a new subspecies, *Z. c. orestera,* distinguished from *costaricensis* by its supposedly darker coloration. In comparing these birds with the extensive series in the USNM from Costa Rica, Panama, and Colombia, I am unable to appreciate the distinction, however. Because all specimens in the type series of *orestera* were collected within a few days of each other in March, they are in a similar stage of molt and wear, causing them to exhibit a certain uniformity in appearance that one would not normally encounter in a more randomly selected series of specimens. This may have influenced Wetmore's conclusion. Nevertheless, there are numerous examples of *costaricensis* in the USNM collections that cannot be separated from those in the type series of *orestera*. I regard *Z. c. orestera* Wetmore, 1951 as a synonym of *Z. c. costaricensis* Allen, 1891. Considering the vast range through which *Z. c. costaricensis* shows no appreciable variation, it would indeed have been remarkable if the birds from Cerro Campana had differentiated.

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Literature Cited

Bangs, O. 1902. On a second collection of birds made in Chiriqui, by W. W. Brown, Jr.—Proceedings of the New England Zoological Club 3:15–70.

———. 1906. Notes on birds from Costa Rica and Chiriqui, with descriptions of new forms and new records for Costa Rica.—Proceedings of the Biological Society of Washington 19:101–112.

Blake, E. R. 1958. Birds of Volcán de Chiriquí, Panama.—Fieldiana: Zoology 36(5):499–577.

———. 1968. Family Vireonidae. Family Icteridae. *In* R. A. Paynter, Jr., ed. Check-list of Birds of the World. Volume 14.—Harvard University Press, Cambridge, Massachusetts.

Chapman, F. M. 1914. Diagnoses of apparently new Colombian birds, II.—Bulletin of the American Museum of Natural History 33(12):167–192.

Eisenmann, E. 1955. The species of Middle American birds.—Transactions of the Linnaean Society of New York 7:vi + 128 pages.

Griscom, L. 1935. The ornithology of the Republic of Panama.—Bulletin of the Museum of Comparative Zoology 78(3):261–382.

Hellmayr, C. E. 1935. Catalogue of birds of the Americas. Part 8.—Field Museum of Natural History Zoological Series 13(8):1–541.

———. 1936. Catalogue of birds of the Americas. Part 9.—Field Museum of Natural History Zoological Series 13(9):1–458.

———. 1937. Catalogue of birds of the Americas. Part 10.—Field Museum of Natural History Zoological Series 13(10):1–228.

Kennard, F. H., and J. L. Peters. 1928. A collection of birds from the Almirante Bay region of Panama.—Proceedings of the Boston Society of Natural History 38(10):443–465.

Meyer de Schauensee, R. 1951. The birds of the Republic of Colombia. Part 4.—Caldasia 5:873–1112.

Nelson, E. W. 1912. Descriptions of new genera, species and subspecies of birds from Panama, Colombia, and Ecuador.—Smithsonian Miscellaneous Collections 60(3):1–25.

Peters, J. L. 1931. Additional notes on the birds of the Almirante Bay region of Panama.—Bulletin of the Museum of Comparative Zoology 71(5):293–345.

Sclater, P. L., and O. Salvin. 1869. Descriptions of three new species of tanagers from Veragua.—Proceedings of the Zoological Society of London 1869:439–440.

Slud, P. 1964. The birds of Costa Rica, distribution and ecology.—Bulletin of the American Museum of Natural History 128:1–430.

Storer, R. W. 1970. Family Thraupidae. *In* R. A. Paynter, Jr., ed. Check-list of Birds of the World. Volume 13.—Harvard University Press, Cambridge, Massachusetts.

Todd, W. E. C. 1917. Preliminary diagnoses of apparently new birds from Colombia and Bolivia.—Proceedings of the Biological Society of Washington 30:3–6.

Wetmore, A. 1951. Additional forms of birds from Colombia and Panama.—Smithsonian Miscellaneous Collections 117(2):1–11.

Zimmer, J. T. 1941. Studies of Peruvian birds. 39.—American Museum Novitates 1127:1–20.

———. 1947. Studies of Peruvian birds. 52.—American Museum Novitates 1367:1–26.

National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

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SACCOGASTER MELANOMYCTER (OPHIDIIFORMES: BYTHITIDAE), A NEW FISH SPECIES FROM THE CARIBBEAN

Daniel M. Cohen

Abstract.—The ophidiiform bythitid fish *Saccogaster melanomycter,* the seventh known species of the genus, is described from a single, egg-bearing female taken at 7.5 m from the Caribbean coast of Colombia near Santa Marta. Other species have been trawled from 100–820 m. Differences from its congeners include a black nasal chamber, fewer anal fin rays (37 versus 46–64), and fewer vertebral centra (45 versus 51–57). It is closest to *S. normae* from Peru in having a partly restricted gill opening and in lacking a elongate fleshy pectoral peduncle.

A single small bythitid fish collected from shallow water on the Caribbean coast of Colombia and subsequently discovered in the Museum of Comparative Zoology is described well by the generic diagnosis for *Saccogaster,* a circumtropical genus of rarely encountered benthic fishes, presented by Cohen and Nielsen (1972). However, this specimen is so different from the six known species of *Saccogaster* that it cannot be identified with any of them and is named below. Terminology and methods follow Cohen and Nielsen (1972, 1978).

Saccogaster melanomycter, new species
Figs. 1, 2

Holotype.—The only known specimen, MCZ 47362, ♀, Colombia, Caribbean, Santa Marta, Gairaca Bay (Ensenada de Gayraca), 25 feet, coral reef environment; field no. RHCSM 77.

Diagnosis.—Nasal chambers sooty black, separated from the orbit by a white area; anal fin rays 37 (46 to 64 in other species); vertebrae 45 (51 to 57 in other species); no elongate, fleshy, pectoral peduncle; dorsal extent of gill opening at upper level of pectoral fin base; no scales on head or body.

Description.—Counts: dorsal 74; anal 37; pectoral 18; caudal 10; ventral 1-1; vertebrae 16 + 29 = 45; developed rakers on first arch 3. Measurements in mm: SL 66 (approximate, due to distorted nature of specimen), snout to dorsal fin origin 20.5, snout to anal fin origin 42.1, snout to ventral fin base 15.0, body depth at vent 10.6, head length 18.2, snout length 3.4, eye diameter 2.1, interorbital width 3.3, upper jaw length 9.5, maxilla depth

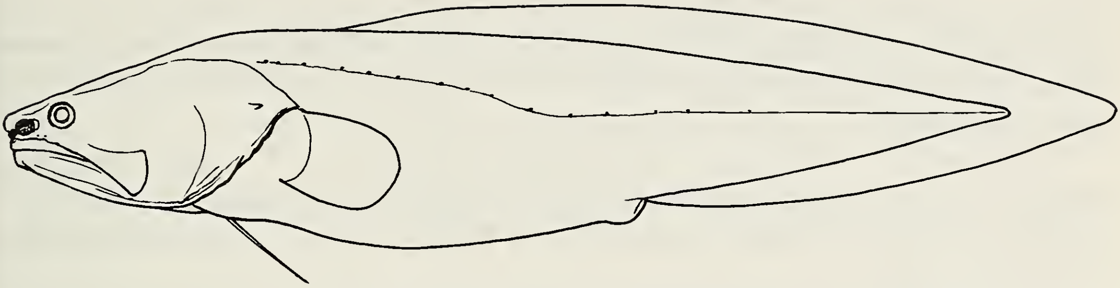

Fig. 1. *Saccogaster melanomycter*, holotype, MCZ 47362, 66 mm SL. Reconstructed view by Keiko Hiratsuka Moore.

3.3, symphysis of cleithra to ventral fin 3.6, ventral fin length 7.4, pectoral peduncle depth 4.8, pectoral fin length 7.1.

Body compressed, relatively short, greatest depth about 4.9 in SL. Preanal about 1.6 in SL. Head compressed, about 3.6 in SL. Skin relatively thick and opaque.

Lateral line continuous, originating above and anterior to upper angle of gill opening and descending to midline slightly beyond midpoint of body; its course marked by a narrow unpigmented line along which small papillae are widely spaced, about a dozen darkly pigmented ones to level of vent, beyond which they are pale and difficult to count.

Lateral canal head pores 1, well above angle of gill opening; supraorbital

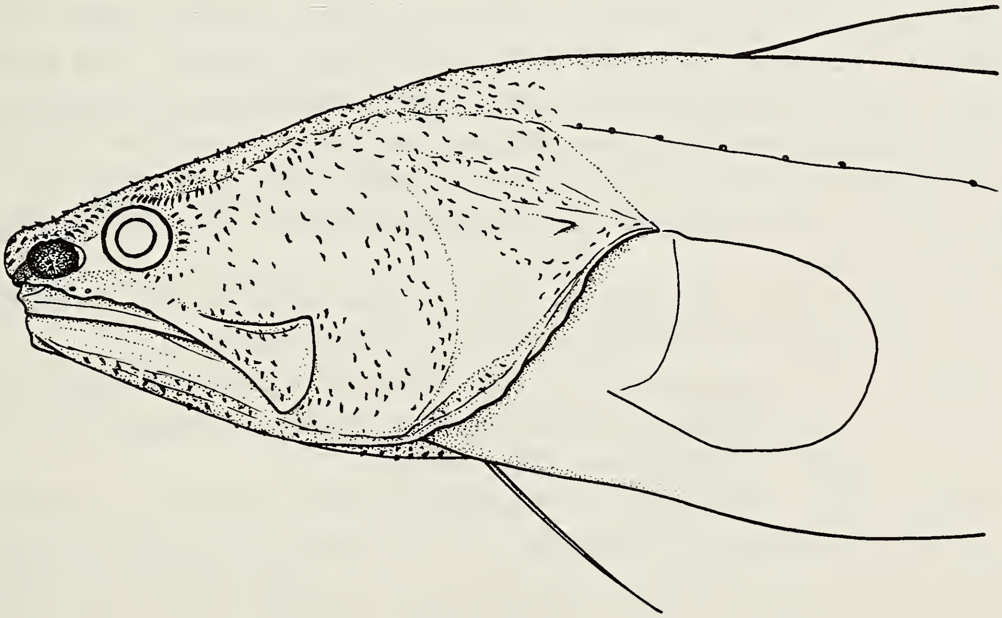

Fig. 2. *Saccogaster melanomycter*, holotype, MCZ 47362, 18.2 mm HL. Detailed view of head by Keiko Hiratsuka Moore.

pores 1, on upper lip medial to the tubular anterior nostril; infraorbital pores 3, 2 on upper lip below posterior nostril, 1 above posterior section of maxillary; mandibular pores 3, 2 large ones near tip of lower jaw, a small one near the angular.

Snout fleshy, with loose skin, perhaps inflated in life. Jaws subequal. Many small, dark filaments on the head, though absent from side of snout. A short, strong opercular spine present. Upper rear part of maxillary free and unsheathed.

Gill opening extending dorsally no farther than upper level of the pectoral fin base.

First gill arch with 3 spiny protuberances that are only slightly larger than the flat, spiny plates covering most of the arch. Gill filaments on first arch neither notably long nor short, closest to those of *S. maculata* (Cohen and Nielsen, 1972, fig. 1A). Pseudobranch of 2 filaments present.

Dentition on premaxillary a narrow, exterior band of granular teeth and an inner single row of enlarged, needle-like teeth. Vomer with a broadly U-shaped band of sharp-pointed teeth, the inner ones larger; a similar pattern continues on the palatine. Dentary with an irregular exterior row of small, slightly compressed teeth and an interior row of larger pointed teeth.

Dorsal fin originating over centrum 6, anal fin under 26 or 27. Adpressed pectoral fin extending about one-third of distance from insertion of pectoral fin rays to anus. Although the ossified pectoral radials are elongate as in other *Saccogaster* species, they lie in the body wall and are not enclosed in a long, free peduncle.

The type is a gravid female. The body cavity is nearly filled with two distended ovaries packed with unfertilized eggs of about 1 mm diameter. Pyloric caeca developed as two, small, slight hemispherical protuberances.

Color light brown, darker dorsally and on the caudal section. Dorsal and anal fins with a narrow pale rim. Nasal capsule lined with sooty black pigment, about equal in size to orbit; area between the eye and capsule immaculate white.

Abdominal centra 16; neural spines on the middle ones variously depressed and truncate. First parapophyses on centrum 6.

Habitat.—The capture of *S. melanomycter* at a depth of about 7.5 m in a reef area is surprising, as all previously reported examples have been trawled at depths ranging from 100 to 820 m.

Relationships.—Saccogaster melanomycter falls neatly into the scheme of possible relationships for species of *Saccogaster* proposed by Cohen and Nielsen (1972). Although *S. melanomycter* is readily distinguished from all species of the genus by its low anal fin and vertebral counts and its distinctive nasal pigmentation pattern, it fits in the *parva-tuberculata-normae* group of species because of its continuous lateral line and lack of scales. Within this group, *S. melanomycter* shares two specialized characters with

S. normae, a restricted gill opening and absence of a free pectoral peduncle for the elongate pectoral radials. *Saccogaster melanomycter* is, however, less specialized than *S. normae* in having a larger gill opening (although smaller than in other *Saccogaster* species) and in having the rear of the maxillary free.

Etymology.—The species name is taken from the Greek *melano-*, black, and *mykter,* nose.

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Literature Cited

Cohen, D. M., and J. G. Nielsen. 1972. A review of the viviparous ophidioid fishes of the genus *Saccogaster.*—Proc. Biol. Soc. Wash. 85:445–468.

———, and ———. 1978. Guide to the identification of genera of the fish order Ophidiiformes with a tentative classification of the order.—NOAA (Natl. Ocean. Atmos. Adm.) Tech. Rep. NMFS (Natl. Mar. Fish. Serv.) Circ. 417, 72 pp.

Systematics Laboratory, National Marine Fisheries Service—NOAA, National Museum of Natural History, Washington, D.C. 20560.

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FALSIPATELLINA, A NEW NAME FOR *PSEUDOPATELLINA* KENAWY AND NYÍRŐ, 1967 NON HAQUE, 1960 (FORAMINIFERIDA)

Drew Haman and Richard W. Huddleston

Haque (1960:28) established the genus *Pseudopatellina* (type-species *P. arthurcooperi* n. sp.) for specimens obtained from the middle to late Eocene shales underlying the Khirthar limestone at Ush Bul spring, Sor Range, West Pakistan. This group has been recorded in some systematic compilations (Tobias et al., 1970) but is absent from a number of leading works on foraminiferid systematics (Loeblich and Tappan, 1964a, b; 1974). Consequently, this genus is not well known.

Kenawy and Nyírő (1967:104) used the generic epithet *Pseudopatellina* (type-species *P. plana* n. sp.) for specimens obtained from upper Oligocene strata at Eger, Hungary.

Pseudopatellina Kenawy and Nyírő, 1967, is a junior homonym of *Pseudopatellina* Haque, 1960, and in accordance with ICZN Art. 53 is herein renamed *Falsipatellina*.

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Literature Cited

Haque, A. F. M. M. 1960. Some middle to late Eocene smaller Foraminifera from the Sor Range, Quetta District, West Pakistan.—Pakistan Geological Survey Memoirs, Palaeontologia Pakistanica 2(2):1–79.

Kenawy, A. I., and R. M. Nyírő. 1967. Zwei neue Foraminiferen aus dem Oberoligozän in Eger (Nordungarn).—Annales Historico-Naturales Musei Nationalis Hungarici, Pars Mineralogica et Palaeontologica 59:103–107.

Loeblich, A. R. Jr., and H. Tappan. 1964a. Sarcodina, chiefly "Thecamoebians" and Foraminiferida. Pp. C1–C900 *in* R. C. Moore, ed., Treatise on Invertebrate Paleontology, Part C, Protista 2.—Kansas University Press, xxxi + 900 pp.

———, and ———. 1964b. Foraminiferal classification and evolution.—Journal of the Geological Society of India 5:5–40.

———, and ———. 1974. Recent advances in the classification of the Foraminiferida. Pp. 1–53 *in* R. H. Hedley, and C. G. Adams, Foraminifera; vol. 1.—Academic Press, viii + 276 pp.

Tobias, M., E. Lilley, and M. Oxenham. 1970. Fossil Protozoa.—The Zoological Record, 1967, vol. 104, sec. 2, Protozoa, pt. II:145–198.

Chevron Oil Field Research Company, P.O. Box 446, La Habra, California 90631.

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THE NATURE OF THE VARIABILITY IN THE VARIABLE SEEDEATER IN PANAMA (*SPOROPHILA AMERICANA*: EMBERIZINAE)

Storrs L. Olson

Abstract.—Detailed examination of variation in *Sporophila americana* in Panama necessitates major changes in the stated ranges and nomenclature of the subspecies found there. The name *hicksii* (Lawrence, 1865) is revived for white-throated black and white birds on the Pacific coast of Panama from Veraguas east through Darién (skipping the Canal Zone), the Caribbean coast in San Blas, and south in western Colombia to Valle. The currently recognized name *chocoana* (Meyer de Schauensee, 1950) becomes a synonym of *hicksii*. It is suggested that the type locality of *hicksii* should be Buenaventura, Colombia, instead of Panama. Black-throated black and white birds from the Pacific slope of Costa Rica and Chiriquí may now be known under the resurrected name *hoffmanni* Cabanis, 1861. The nearly black subspecies *corvina* (Sclater, 1859) extends along the western Caribbean coast of Panama and in the Canal Zone intergrades with *hicksii* to form a hybrid zone in which no pure parental types occur. The long-used but dubiously applicable name "*aurita*" (Bonaparte, 1850) is tentatively applied to these intergrades and the specimens are analyzed by the use of a hybrid index.

As its name implies, the Variable Seedeater, *Sporophila americana,* has been regarded as being so variable in the adult male plumage, particularly in Panama, as to defy interpretation in terms of normal geographic variation. This idea became so fixed in the earlier literature that contrary information was often ignored. No recent attempts have been made to examine series of specimens from Panama to elucidate distributional patterns there. By current taxonomic practices there are three subspecies of *Sporophila americana* recognized in Panama: *S. a. corvina,* a nearly all black form found on the Carribean slope of western Panama north to Mexico; *S. a. aurita,* a supposedly extremely variable black and white form found on the Pacific slope of Costa Rica and Panama to the Canal Zone and on both slopes east of the Canal to Darién, where it is supposedly replaced by a more constant white-throated form, *S. a. chocoana,* inhabiting easternmost Panama and Pacific Colombia south to the Río Dagua. The development of this classification may be traced through the publications of Sclater (1871), Chapman

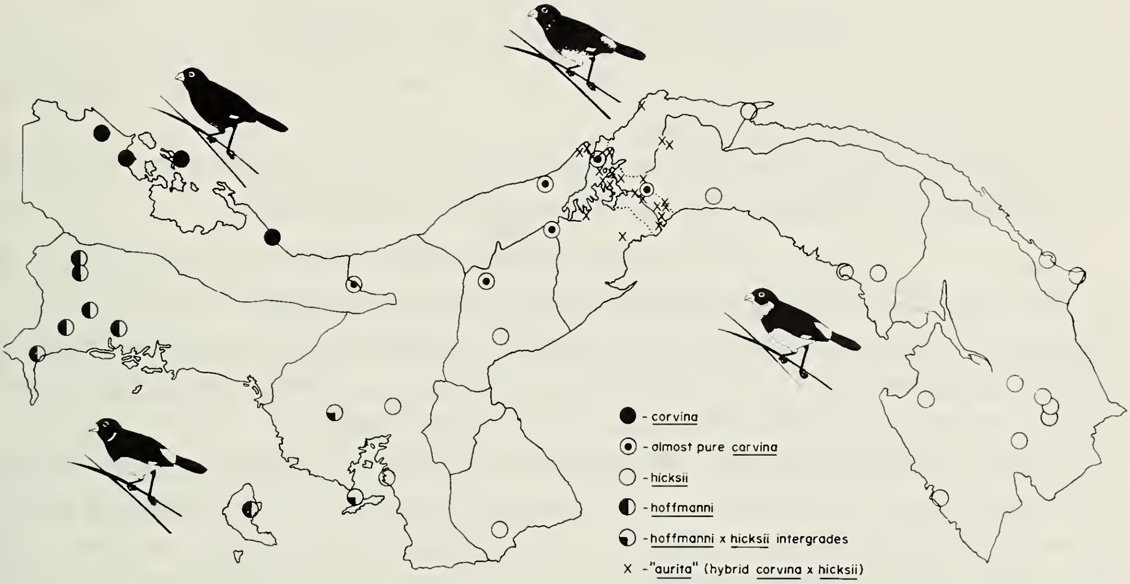

Fig. 1. Distribution of the forms of *Sporophila americana* in Panama, based on specimens examined in this study.

(1926), Hellmayr (1938), Meyer de Schauensee (1950, 1952) and Eisenmann (1957).

Not all of the observations below are entirely original, but their significance has not hitherto been appreciated. I shall not attempt to treat the history of each conclusion, as this may be found in the references just cited. The classification I shall propose differs considerably from that above. For this reason and because the nomenclatural changes I shall propose are rather intricate, I shall begin by presenting my conclusions first and documenting them beyond.

The revised distribution and nomenclature of *S. americana* in Panama is shown in Fig. 1. No change in status is required for the black populations from the western Caribbean coast, *S. a. corvina*. Much of the rest of the isthmus is occupied by a black and white subspecies, with a white rump and throat, which occurs in most of Panama east of the Canal Zone and west of the Canal Zone on the Pacific slope to central Veraguas. The name *hicksii* is resurrected for this subspecies, with *chocoana* falling into synonymy. A similar subspecies, but with a black throat, is found from western Veraguas, including Isla Coiba, west along the Pacific slope through Costa Rica. The name *hoffmanni* is revived for this form. The only birds showing great variability are restricted to the area of the Canal Zone, where populations consist entirely of intergrades between *corvina* and *hicksii,* and where no pure parental types occur. The name "*aurita,*" the application of which is dubious in any case, is tentatively used for these intergrades.

Sporophila americana corvina (Sclater)

Spermophila corvina Sclater, 1859, Proc. Zool. Soc. London 1859:379. Playa Vicente, Oaxaca, Mexico.

Spermophila badiiventris Lawrence, 1865, Ann. Lyc. Nat. Hist. N.Y. 8:172. Greytown, Nicaragua. Type re-examined for this study.

Characters.—Adult males almost entirely black, with only the speculum of the wing and midline of belly white. Speculum smaller than in *hicksii.* Females and subadult males are markedly darker and more sooty than in other subspecies, but have not been considered in determining the distribution or extent of intergradation in any of the forms.

Range.—Caribbean slope of southeastern Mexico, south through Bocas del Toro, Panama. The few specimens known from the Caribbean slope between Bocas del Toro and the Canal Zone are nearly pure *corvina,* but show faint traces of white on the sides of the neck. I have designated these as "0+" in the hybrid index discussed in the account of *S. a. "aurita,"* but have listed these specimens below under *corvina.*

Specimens examined (only specimens from Costa Rica and Panama are listed although others were examined).—COSTA RICA. GUANACASTE: ca. 3 miles E Tilarán, 950 m (1, LSU); Arenal, 500 m (1, LSU). ALAJUELA: Naranjo (1, USNM); Villa Quesada (1, USNM). HEREDIA: Puerto Viejo (1, LSU). CARTAGO: Bonilla (6, USNM; 4, AMNH); Guayabo (3, USNM); Tucurrique (1, AMNH); Aquiares (1, AMNH). SAN JOSE: Carillo (3, AMNH; 1, USNM). LIMON: Cariari (4, WFVZ); Finca La Lola, Río Madre de Dios (1, WFVZ); Jiménez (2, USNM); San Bernardo (1, USNM); Sipurio (2, USNM); Uva (1, USNM); Limón (3, AMNH); Guápiles (2, AMNH); Siquirres (1, AMNH); Atalanta (2, AMNH).

PANAMA. BOCAS DEL TORO: Almirante (5, USNM; 4, AMNH); Changuinola (1, USNM); Cocoplum (7, ANMH); "Bocas del Toro" (1, ANSP). The following were ranked "0+," or almost pure *corvina,* in the hybrid index discussed below: VERAGUAS: Río Calovévora, Caribbean slope (1, AMNH); COCLE: Tigre, head of Río Guabal (1, USNM); El Uracillo, Río Negro (1, USNM). COLON: Chilar, Río Indio (1, USNM). CANAL ZONE: Gatun (1, USNM); Gamboa Pipeline Road (1, USNM).

Sporophila americana hicksii (Lawrence)

Spermophila hicksii Lawrence, 1865, Ann. Lyc. Nat. Hist. N.Y. 8:171. "Panama" (probably = Buenaventura, Colombia, see below). Type re-examined for this study.

Spermophila aurita chocoana Meyer de Schauensee, 1950, Proc. Acad. Nat. Sci. Phila. 52:138, Nuquí, Chocó, Colombia.

Characters.—Adult males with throat, sides of neck, lower breast and abdomen, rump, undertail coverts, and speculum white; pectoral band and variable amount of chin black.

Range.—Pacific coast of Panama from central Veraguas and the Azuero Peninsula east (skipping the Canal Zone) through Panamá Province and Darién, the Atlantic slope in San Blas, south along the Pacific slope of Colombia to the vicinity of the Río Dagua, Valle.

Specimens examined.—PANAMA. VERAGUAS: Soná (5, USNM); La Colorada, Santiago (2, AMNH); E shore of Montijo Bay, 1 mile S of Angulo River mouth (2, CM); Isla Gobernadora (2, USNM; one of these is more similar to those from Isla Coiba). LOS SANTOS: Tonosí (1, USNM). COCLE: Gago (1, USNM). PANAMA PROVINCE: Pacora (1, USNM); Chiman, Río Chiman (1, USNM); Charco del Toro, Río Majé (2, USNM). SAN BLAS: Mandinga (2, USNM); Permé (2, MCZ); Puerto Obaldia (3, USNM, 1 MCZ). DARIEN: Cana (4, USNM; 3, MCZ); mouth of Río Paya, Río Tuira (1, USNM); Pucro, Río Pucro (1, USNM); Jaqué (5, USNM); El Real, Río Tuira (5, AMNH); Boca de Cupe, Río Tuira (3, AMNH); Río Sambú (1, ANSP).

COLOMBIA. CHOCO: Nuquí, Río Jurubidá (4, ANSP); Nuquí (2, USNM); Acandí (5, USNM); Juradó (1, AMNH; 1, ANSP); Río Baudonde (1, ANSP); Quibdo (1, ANSP); upper Río Baudó (1, ANSP); Andagoya (1, ANSP). ANTIOQUIA: Dabeiba, Río Sucio (1, AMNH); Villa Arteaga (2, USNM). CORDOBA: Socarré, Río Sinú (1, USNM). CALDAS: Santa Cecilia (3, ANSP). VALLE: Punta Muchimbo, Río San Juan, 1 mile S of mouth of Río Calima (2, USNM); San José (1, USNM); Buenaventura (2, USNM).

Remarks.—When Meyer de Schauensee (1950) described *chocoana,* he compared it with birds from Costa Rica, western Panama, and the Canal Zone, all of which were considered to represent *aurita* and all of which have black throats. He recognized that birds from Colombia and Darién differed in consistently possessing a white throat and he therefore segregated these under the name *chocoana.* A major problem arises here in the nature and orgin of the type specimen of *hicksii* Lawrence (USNM 40300). Meyer de Schauensee (1950:139) reported that "Mr. Herbert Deignan has kindly examined the type of *hicksii* for me and writes me that although it is a white-throated example, it was collected by Hicks 'probably not far from the city of Panama.' It therefore must be regarded as an aberrant example of *S. a. aurita.*"

The type of *hicksii,* which I have examined, is a perfectly typical example of *chocoana,* with a pure white throat and rump. It shows not a trace of the intergradation with *corvina* that marks "*aurita.*" The specimen is labelled simply "Panama," the implication being that it came from the vicinity of Panama City, on the Pacific slope. No such individuals with pure white throats from the vicinity of Panama City or the Canal Zone exist in any of the collections I have examined, although they have been taken on the Pacific slope both to the east and to the west of the Canal Zone area.

The type of *hicksii* was sent to S. F. Baird at the Smithsonian Institution by Fred Hicks in a lot of 54 specimens, all of which came from Panama except for 4 from Cali, Colombia, and 12 from Buenaventura, Colombia (letter of 27 December 1864 from Hicks to Baird; accession file 588, USNM). Not all of these specimens were catalogued. The type of *hicksii* was catalogued immediately following 3 specimens of the same species labelled as being from Buenaventura, one of which (USNM 40299) is now missing. These are the only other specimens of *Sporophila americana* among those collected by Hicks; the type of *hicksii* is the only one labelled as coming from Panama.

Hicks' original labels were for the most part more informative than usual for the period, and often included soft part colors and measurements, as well as locality, date, collector, and field number. Unfortunately, these were made of very fragile paper and in many instances appear to have been deliberately removed from the specimens, as is the case with the type of *hicksii*. Whoever copied the data onto the new labels often did not transfer all of the information that was on the originals and the transcriptions were also not without error. There is a specimen of the tanager *Ramphocelus flammigerus icteronotus* in the same lot as the type of *hicksii* that has ''Panama'' written on one side of the label and ''Buenaventura'' on the other.

Circumstantial evidence strongly suggests that the type specimen of *Spermophila hicksii* Lawrence came from Buenaventura, Colombia; it is unlikely to have been obtained in the vicinity of Panamá City. Even if the specimen did come from Panama, it can not be regarded as an abnormal specimen of ''*aurita,*'' since similar white-throated populations occur on the Pacific slope of Panama both to the west and to the east of the Panamá City–Canal Zone area. The name *Spermophila aurita chocoana* Meyer de Schauensee, 1950 therefore becomes a junior synonym of *Spermophila hicksii* Lawrence, 1865 and I recommend that Buenaventura, Valle, Colombia, be regarded as the type locality of *hicksii*.

Buenaventura is at or near the southern limit of the range of *hicksii*. Meyer de Schauensee (1950) correctly recognized the Río Dagua as the approximate line of demarcation between *chocoana* (=*hicksii*) and the subspecies *ophthalmica* (Sclater, 1860; type locality Babahoyo, Ecuador), which differs in having a narrower pectoral band and whiter chin. Colombian birds from Los Cisneros, Valle (3, AMNH), Guapi, Cauca (1, USNM), and from Nariño through Ecuador are referable to *ophthalmica*.

The discovery of white-throated individuals of *hicksii* west of the Canal Zone is significant (see discussion of ''*aurita*''). Although the amount of black in the chin is variable in *hicksii,* the birds from Coclé and the Azuero Peninsula stand out in having the chin almost totally white, thus contrasting markedly with the intergrades ("*aurita*") to the east and with the subspecies *hoffmanni* to the west.

Sporophila americana hoffmanni Cabanis

Sporophila hoffmanni Cabanis, 1861, Journ. Orn. 9:6. Costa Rica.

Spermophila collaris Lawrence, 1865, Ann. Lyc. Nat. Hist. N.Y. 8:177. Davíd, Chiriquí, Panama. (Not *Loxia collaris* Boddaert.) Type re-examined for this study.

Characters.—Similar to *hicksii* but adult males with throat black, with varying amounts of white, either as a narrow collar or as discontinuous patches, on either side of the neck.

Range.—Pacific slope of Costa Rica and Panama in Chiriquí and Isla Coiba, intergrading with *hicksii* in western Veraguas.

Specimens examined.—COSTA RICA. SAN JOSE: El General (7, MCZ). PUNTARENAS: Tambor, Nicoya (3, LACM); Las Agujas (1, LACM); Pigres (1, USNM); Pozo Azul (5, CM; 1, MCZ); El Pozo del Río Grande (de Térraba) (3, MCZ; 4, CM; 2, FM; 1, ANSP); Buenos Aires (3, CM; 4, FM; 4, AMNH); Puerto Jiménez, Peninsula de Osa (1, CM; 1, AMNH); Rincón de Osa (1, LSU; 1, WFVZ); Boruca (1, ANSP; 1, AMNH; 2, CM; 1, USNM; 1, ANSP; 7, MCZ); 13 km S of Palmar Sur (3, WFVZ); Helechales (7, WFVZ).

PANAMA. CHIRIQUI: Davíd (1, USNM; 1, MCZ); Divalá (1, MCZ; 1, USNM); El Volcán (4, USNM); Buena Vista (1, USNM); Puerto Armuelles (4, USNM); Boquerón (1, AMNH). VERAGUAS: Isla Coiba (7, USNM; 4, AMNH [collected by Batty, locality not reliable]).

Remarks.—Although Chapman (1926) recognized this subspecies (under the name *collaris*) and Hellmayr (1938) conceded that birds from Costa Rica and Chiriquí were generally separable from "*aurita,*" this western subspecies is not at present recognized, due to its similarity to certain of the intergrades from the Canal Zone and the fact that, hitherto, *hicksii* was not known to occupy the intervening area. Some of the intergrades of "*aurita*" are indeed very similar to the western birds, but they may usually be distinguished by the lesser amount of white in the rump. Within the populations from the Pacific slope of Costa Rica and Chiriquí, there is little variation in adult male plumage. Yet because of the confusion that has long attended the concept of variation in this species, Wetmore (1957) assigned a series of seven males from Isla Coiba, which closely resemble one another and show little variation, to the subspecies *aurita,* which was then considered to be extremely variable.

The earliest available name for the black-throated western birds is *hoff-*

manni Cabanis, 1861, the original description of which clearly pertains to this population. *S. a. hoffmanni* evidently intergrades with *S. a. hicksii* in Veraguas. A series of five males from Soná are closest to *hicksii* but have more black in the chin than typical of most individuals of that subspecies. The birds from Isla Coiba are like *hoffmanni* but show a slight tendency towards *hicksii* in having the white collar mostly continuous and a few white feathers on the chin. Of two adult males from Isla Gobernadora, Veraguas, one resembles the birds from Isla Coiba whereas the other could pass as typical *hicksii.*

Sporophila americana "*aurita*" (Bonaparte)

Spermophila aurita Bonaparte, 1850, Consp. Gen. Av. 1(2):497 "Bras. [il]" = Panama?

Spermophila semicollaris Lawrence, 1863, Ann. Lyc. Nat. Hist. N.Y. 8:10. Lion Hill, Panama Railroad. Type re-examined for this study.

Spermophila fortipes Lawrence, 1865, Ann. Lyc. Nat. Hist. N.Y. 8:172. Line of Panama Railroad. Type re-examined for this study.

Characters.—Extremely variable, ranging from individuals similar to *hicksii,* but with slightly more black in the rump, throat, or belly, to individuals nearly as black as *corvina*; see discussion of hybrid index below.

Range.—Essentially restricted to the Canal Zone area of central Panama; known as far west as La Chorrera, western Panamá Province, and as far east as Buenaventura Island, near Portobelo, Colón, and the Candelaria and Peluca Hydrographic Stations at the head of Madden Lake.

Specimens examined.—All are from the Canal Zone or immediately adjacent parts of Panamá or Colón provinces, except where indicated, and all are from the USNM, AMNH, and MCZ collections except 3 from Gatun (ANSP) and 1 from Barro Colorado Island (FM). Hybrid index (HI) is given first, followed by number of specimens in parentheses. Aspinwall, HI-1 (1); Balboa, HI-3 (2); Barro Colorado Island, HI-5 (1); Bas Obispo, HI-1 (1); Bohio HI-4 (1); Buenaventura Island, near Portobelo, Colón Province, HI-3 (1); Candelaria Hydrographic Station, HI-3 (3); Chiva Chiva, HI-4 (1); Colón, HI-1 (1), HI-2 (1); Corozal, HI-3 (2); Curundu HI-5 (1); Fort Lorenzo, HI-1 (1); Frijoles, HI-1 (1), HI-4 (1); Gamboa, HI-2 (1); Gatun, HI-1 (5), HI-2 (7), HI-3 (4), HI-4 (1); Juan Mina, HI-1 (1), HI-3 (2), HI-4 (1), HI-5 (2); La Chorrera, western Panama Province, HI-2 (1); Lion Hill (Loma del León), HI-1 (1), HI-2 (4); HI-3 (3); HI-4 (2); Miraflores, HI-3 (1), HI-5 (1); line of Panama Railroad, HI-5 (1); "near Panama," HI-2 (2), HI-3 (4), HI-4 (1), HI-5 (1); "Panama," HI-2 (3); Peluca Hydrographic Station, HI-3 (1); Tabernilla, HI-2 (1), HI-3 (1), HI-4 (1); Río Trinidad, Agua Clara, HI-2 (1); Savanna, HI-3 (1).

Remarks.—There is considerable doubt in my mind about the proper use of the name *aurita* Bonaparte, long applied to most of the specimens of this species from Panama and Pacific Costa Rica. Bonaparte's (1850:497) entire original description reads as follows: "*Sp. aurita,* Bp. Mus. Paris. ex Bras. Similis praecedenti [*Sporophila luctuosa*]; gula pectoreque nigerrimis: sed rostro nigro et macula utrinque auriculi alba." This description could apply to many individuals from the Canal Zone or equally well to *hoffmanni* of Costa Rica and Chiriquí. Sclater (1871:15) considered the specimens he examined from "Panama and Chiriqui" to represent a single species and stated that "the typical example of *S. aurita* in Mus. Paris clearly belongs to it, though the locality (Brazil) attributed to it in the 'Conspectus' is no doubt erroneous." It is not absolutely clear that Sclater actually examined the type; Hellmayr (1938:191) could not find it at the Paris Museum in 1935. Because of Sclater's action, the type locality of *aurita* has since been taken as Panama, but neither the true identity nor the provenance of the type has been positively determined.

Several nomenclatural resolutions suggest themselves. One could regard the name *aurita* Bonaparte as being of undeterminable application, or one could go on the assumption that the name was correctly applied to birds from the hybrid zone in the central part of the Panamanian isthmus. In the latter case, one might attempt to apply the name *aurita,* which is the earliest available for any of the Panamanian subspecies, to one or the other of the parental phenotypes, i.e. either to *corvina* or *hicksii.* To do this successfully, one would still need the holotype of *aurita* to determine to which parental type it was most similar. Were it to prove more similar to the black subspecies, then *corvina* would become a synonym of *aurita,* thus causing endless confusion, since *corvina* is the one name that has never been applied to the more variable populations in Panama. I have adopted a compromising course by applying the name "*aurita,*" in quotes, only to those individuals that are clearly intergrades between *corvina* and *hicksii.* Although this is not altogether a satisfactory resolution, this population has a circumscribed range in which neither parental phenotype occurs and in which virtually all individuals can be certainly identified as belonging to "*aurita,*" as opposed to some other population. This also prevents the sudden disappearance of the name under which the majority of Panamanian birds have appeared in most of the earlier literature.

To facilitate analysis of variation in "*aurita,*" I grouped adult male specimens according to the following hybrid index (HI).

HI 0.—Pure *corvina.* All black except for small white speculum and white along midline of belly. Individuals fitting this description but having faint traces of white "ears" I designated as "0+," shown in Fig. 1 as "almost pure *corvina.*"

HI 1.—More white in midline, particularly lower abdomen; some white in crissum. No, or almost no, white in rump. White "ears" present, but sometimes vestigial.
HI 2.—Like HI 1 but more white in belly and crissum and light tips to feathers on flanks away from midline. A few white-tipped feathers on rump.
HI 3.—White pattern of abdomen evident but suffused with black. White "ears" extending onto throat as a variable collar. Some white on chin and a little more on rump.
HI 4.—Belly mostly whitish, rump considerably white, but little white on chin.
HI 5.—Like *hicksii* but less white in rump.
HI 6.—Pure *hicksii*; black with white throat, white "ears," white lower breast and abdomen, white undertail coverts, speculum, and rump (but not upper tail coverts), chin variably black, pectoral band black.

Disregarding the few "0+" specimens from outside the area of the Canal Zone, I examined 80 specimens of "*aurita*." The number in each HI category was as follows:

HI 0^+	2	(3%)
HI 1	12	(15%)
HI 2	24	(30%)
HI 3	26	(33%)
HI 4	9	(11%)
HI 5	7	(9%)

Thus, 63% of the specimens could be regarded as more or less intermediate between the two parental types, 18% were more like *corvina* and 20% were more like *hicksii*. No specimens of pure parental stock occur in the area of intergradation, and this population thus constitutes a hybrid zone by Short's (1969) definition.

Eisenmann (1957:260) came close to a correct interpretation in hypothesizing that the variability of this species in Panama might be the result of "interbreeding between *aurita* and *corvina*" and that "nominate *aurita* is itself the product of some earlier contact between *corvina* and a population essentially like *ophthalmica*." It was not apparent at that time, however, that "*aurita*" was confined entirely to the Canal Zone area, nor that the "population essentially like *ophthalmica*," in the form of *hicksii*, still exists in Panama on the Pacific slope on either side of the hybrid "*aurita*" zone. Because the range of *hicksii* was obviously once continuous across the Pacific side of the isthmus, it is evident that the new development is the introgression by *corvina* genetic stock, thus creating a hybrid zone that has fragmented the distribution of *hicksii*.

The age of the establishment of the hybrid zone between *hicksii* and *corvina* is not certain, but Eisenmann's (1957:260) supposition that the forms in question "were probably not in contact" a century ago, may be doubted. The earliest specimens from the area of the Canal Zone are the types of *semicollaris* Lawrence and *fortipes* Lawrence, collected by McLeannen along the Panama Railroad in the mid-1800's. I have examined these and would classify both as HI 2 intergrades, with the type of *fortipes* having less white on the rump and more white on the chin than the type of *semicollaris*. Two other specimens collected by McLeannen I would classify as HI 2 and HI 5. Although I analyzed all the specimens of "*aurita*" from the hybrid zone by date and locality, I could detect no pattern of change through time. This may be due to lack of adequate samples taken in the 19th century. The hybrid zone has apparently been in existence for over a century and appears to be stable. The influence of *corvina* has not yet spread much beyond the Canal Zone on the Pacific slope. On the other hand, there is evidence, although slight, that the influence of *hicksii* may be spreading westward along the Atlantic slope.

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Literature Cited

Bonaparte, C. L. 1850. Conspectus Generum Avium. Part 1. E. J. Brill, Leyden.

Chapman, F. M. 1926. The distribution of bird-life in Ecuador.—Bulletin of the American Museum of Natural History 55:1–784.

Eisenmann, E. 1957. Notes on the birds of the Province of Bocas del Toro, Panama.—Condor 59(4):247–262.

Hellmayr, C. E. 1938. Catalogue of birds of the Americas. Part 11.—Field Museum of Natural History Zoological Series 13(11):1–662.

Meyer de Schauensee, R. 1950. Colombian zoological survey. Part VII. A collection of birds from Bolivar, Colombia.—Proceedings of the Academy of Natural Sciences of Philadelphia 102:111–139.

———. 1952. A review of the genus *Sporophila*.—Proceedings of the Academy of Natural Sciences of Philadelphia 104:153–196.

Sclater, P. L. 1871. A revision of the species of the fringilline genus *Spermophila*.—Ibis, series 3, 1(1):1–23.

Short, L. L. 1969. Taxonomic aspects of avian hybridization.—Auk 86(1):84–105.

Wetmore, A. 1957. The birds of Isla Coiba, Panama.—Smithsonian Miscellaneous Collections 134(9):1–105.

National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

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WESTERN ATLANTIC SEA CUCUMBERS OF THE GENUS *THYONE,* WITH DESCRIPTION OF TWO NEW SPECIES (ECHINODERMATA: HOLOTHUROIDEA)

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Abstract.—Current status of each of the several Western Atlantic holothurians referred to the genus *Thyone* s.l. is discussed. Two new species, *Thyone adinopoda* and *T. crassidisca,* from the southeastern United States are described.

Dendrochirotid holothurians of the genus *Thyone* s.l. are burrowing, U-shaped forms with tube feet scattered over the body wall and not restricted to the ambulacral radii. They usually occur in muddy to sandy habitats, and range from the subtidal zone to depths in excess of 200 meters. Systematic study of "Thyone" species is rendered difficult because in many species the diagnostic characters may change with growth, and in many the calcareous ossicles of the body wall tend to disappear with growth.

Thyone currently comprises a miscellany of approximately 40 species. Of the 14 Western Atlantic species referred to *Thyone* by Deichmann (1930), only 2 remain in that genus today. The other species are now scattered among several genera in 2 dendrochirotid subfamilies. Panning (1949, and later papers) has been largely responsible for the reassignment of these species. In her later papers, Deichmann (1954, 1957, 1963) ignored Panning's revision of the Cucumariidae, and attempted some revisions independently, thus further confusing an already complex situation.

In this paper we attempt to bring up-to-date the nomenclature of the Western Atlantic "Thyones" by listing the currently accepted names for all species. In addition, in the course of a monographic study of Western Atlantic holothurians, we have found two new species of *Thyone* s.s., and the opportunity is taken to describe these here.

Type-material is deposited at the National Museum of Natural History, Smithsonian Institution (USNM), the Indian River Coastal Zone Museum, Harbor Branch Foundation-Smithsonian Institution, Fort Pierce, Florida (IRCZM), and the Florida Department of Natural Resources, St. Petersburg, Florida (FSBC). This paper is Harbor Branch Foundation, Inc. Contribution to Science No. 199. Financial support for this study was received from the Harbor Branch Foundation, Inc. and from the Smithsonian Institution Fort Pierce Bureau.

We thank Dr. Thomas S. Hopkins for allowing one of us (DLP) to study holothurians collected under the auspices of the U.S. Bureau of Land Management, and the Florida Department of Natural Resources for giving us access to holothurians collected by the "Hourglass" Cruises and other investigations in the Gulf of Mexico.

Current Concept of the Genus *Thyone*

When Panning (1949:468) transferred species from *Havelockia* sensu Panning, 1949 to *Thyone* sensu Panning, 1949, he suggested that *Thyone* includes 2 groups of species; Group I comprising those species with tables but no rosettes in the introvert, and Group II comprising species with rosettes but no tables in the introvert. At least 3 Western Atlantic species, *pseudofusus* Deichmann, *inermis* Heller, and *crassidisca* n. sp. fall into yet another category, a Group III, where the introvert contains rosettes and tables.

A thorough revision of the "supergenus" *Thyone* is urgently needed, but is beyond the scope of this paper. While some species are well-defined, others appear to change greatly with growth, so that adults and young specimens may be referred to different species. Deichmann (1947) tended to dismiss Madsen's (1941) careful analysis of *T. fusus,* and his descriptions of new taxa. While Madsen's new species might not be valid, his detailed descriptions are excellent, and should form a model upon which a thorough revision of *Thyone* can be based.

Western Atlantic "Thyone" Species Listed or Described by Deichmann (1930, 1946)

Thyone briareus (Lesueur, 1824). Panning (1949) transferred this species to *Sclerodactyla.*

Thyone scabra Verrill, 1873. Panning (1949) transferred this species to *Havelockia.*

Thyone fusus (Müller, 1776). Deichmann (1930) described specimens of *Thyone* which she found to be very closely similar to *T. fusus* (Müller) from Northern Europe. In later papers, Deichmann (1946, 1947, 1954) concluded that the West Indian "fusus" and the Mediterranean "fusus" were identical, and that they differed in some respects from the typical northern European *T. fusus* (Müller). Deichmann applied the name *T. inermis* Heller to the Mediterranean-W. Atlantic species, and this name is accepted here.

Thyone pseudofusus Deichmann, 1930. Unchanged.

Thyone belli Ludwig, 1887. Panning (1949) transferred this species to *Pseudothyone.* Deichmann (1954) referred it to her (1941) genus *Neothyone.* Panning's action appears to be the more logical.

Thyone micropunctata Sluiter, 1910. Deichmann (1954) showed that this species is a junior subjective synonym of *Thyone belli* Ludwig, 1887.

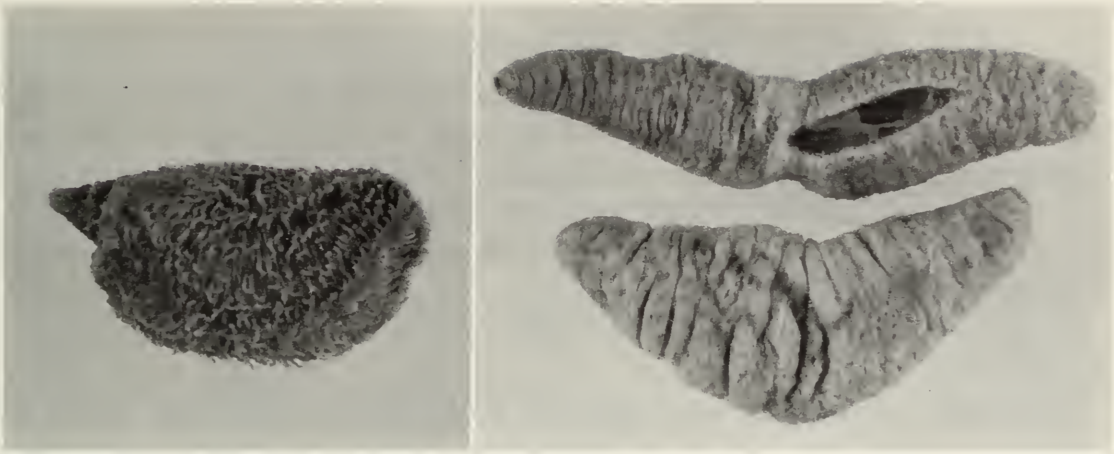

Fig. 1. Left, *Thyone adinopoda*, holotype, total length 26 mm; Right, *Thyone crassidisca*: upper, holotype, total length 51 mm; lower, paratype, total length 40 mm.

Thyone cognata (Lampert, 1885). Deichmann (1930) misspelled the species name as *cognita*. Referred to *Stolus* by Panning (1949). Referred unnecessarily to a new genus *Thyoneria* by Deichmann (1954). We prefer to accept the combination *Stolus cognatus*.

Thyone solida Deichmann, 1930. Referred to *Ludwigia* by Panning (1949). Mortensen (1925) and Pawson (1963) pointed out that *Ludwigia* is preoccupied, and is thus not available as a genus-name. Deichmann (1954) proposed *Euthyonacta* for this species, and we accept the combination *Euthyonacta solida*.

Thyone unisemita (Stimpson, 1851). Referred to *Stereoderma* by Panning (1949).

Thyone suspecta Ludwig, 1874. Referred to *Ocnus* herein. Panning (1949) had placed this species in his genus *Ludwigia* (see above).

Thyone surinamensis Semper, 1868. Referred to *Ocnus* by Panning (1949). Named as the type of a new genus *Parathyone* by Deichmann (1957). We accept the combination *Ocnus surinamensis*.

Thyone pervicax Theel, 1886. Referred to the preoccupied genus *Ludwigia* by Panning (1949). Referred to *Thyonella* by Deichmann (1954).

Thyone sabanillaensis Deichmann, 1930. In subsequent publications, Deichmann (1941, 1954) and Panning (1949) misspelled the species-name as *sabanillensis*. Referred to *Thyonacta* by Deichmann (1941) and by Panning (1949), then transferred to *Thyonella* by Deichmann (1954). We accept the combination *Thyonella sabanillaensis*.

Thyone gemmata (Pourtales, 1851). Referred to the preoccupied genus *Ludwigia* by Panning (1949), and to *Thyonella* by Deichmann (1954).

Thyone mexicana Deichmann, 1946. Referred herein to *Allothyone* Panning, 1949.

Genus *Thyone* Jaeger, 1833

Thyone Oken, 1815. (Oken's Lehrbuch der Naturgeschichte 1815–1816 was placed on the Official Index of Rejected Works by the International Commission on Zoological Nomenclature [Opinion 417, 1956]. As far as we can determine, Jaeger [1833:8] was the first to validate the genus-name *Thyone* in accordance with the requirements of the International Code of Zoological Nomenclature.)

Type-species.—*Holothuria fusus* Müller, 1776, by original designation of Jaeger, 1833.

Diagnosis.—Tentacles 10. Tube feet scattered on body wall, never restricted to ambulacral radii. Calcareous ring with long posterior projections, each made up of several pieces of calcite. Body wall ossicles tables with a spire of 2 pillars. Introvert may contain rosettes only, tables only, or tables and rosettes.

Remarks.—At the time of writing this paper, 3 species of *Thyone* were known from the Western Atlantic. They are *T. inermis* Heller, *T. pseudofusus* Deichmann, and *T. pawsoni* Tommasi. As *T. pawsoni* was described only briefly, illustrations of the calcareous ring and of ossicles from the introvert are given here (Fig. 2D, 2E). In this paper 2 further *Thyone* species are described.

Key to Western Atlantic Species of *Thyone* s.s.

1. Body wall tables with oval disc, 4 perforations and thick margins 2
– Body wall tables mostly irregular in outline, perforations few to numerous, margin thin 4
2. Spires of body wall tables terminate in several short teeth 3
– Spires of body wall tables terminate in a single blunt spine .... *Thyone crassidisca,* new species
3. Body wall tables with low, truncate spire. Ossicles in introvert tables and rosettes .... *Thyone pseudofusus* Deichmann, 1930
– Body wall tables with high tapering spire. Ossicles in introvert rosettes only .... *Thyone adinopoda,* new species
4. Disc of body wall tables with 4–9 perforations. Spire of supporting tables in tube feet abruptly tapering ... *Thyone pawsoni* Tommasi, 1972
– Disc of some body wall tables with 8–18 perforations. Spire of supporting tables in tube feet gently tapering ... *Thyone inermis* Heller, 1868

Thyone inermis (Heller)

Thyone inermis Heller, 1868:78.—Deichmann, 1946:3; 1947:87, pl. 1 figs. 7–13, pl. 2; 1954:397.—Panning, 1949:468.

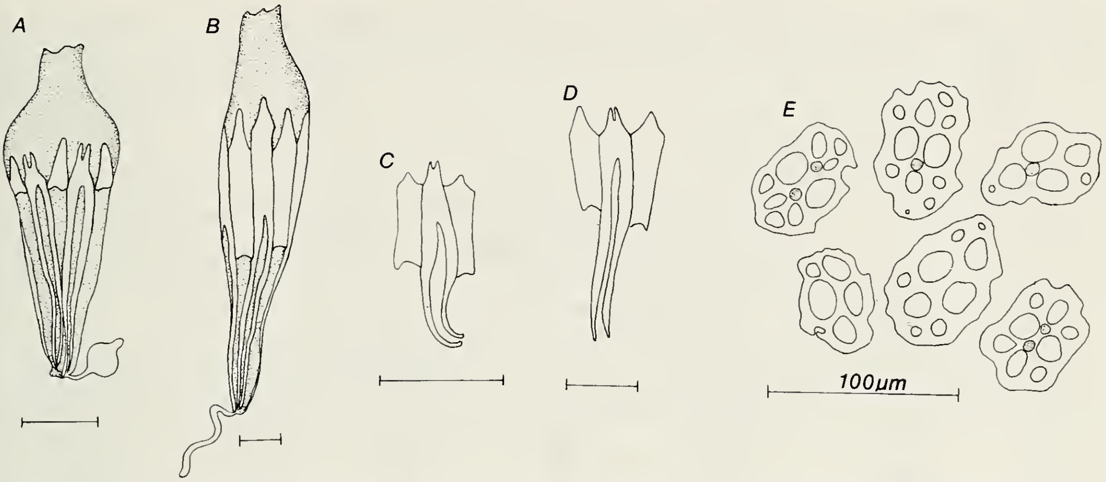

Fig. 2. A–D, calcareous rings of some species of *Thyone*. Scale line for all figures = 2 mm. A, *T. adinopoda*, radial and interradial pieces and single polian vesicle; B, *T. crassidisca*, radial and interradial pieces and single polian vesicle; C, *T. pseudofusus*, two interradial pieces and one radial; D, *T. pawsoni*, two interradial pieces and one radial; E, *T. pawsoni*, rudimentary tables from introvert.

Thyone fusus: Deichmann, 1930:167, pl. 14 figs. 1–5.—Domantay, 1958:196.
Thyone deichmannae Madsen, 1941:26.
Havelockia inermis: Panning, 1949:466.
Not: *Thyone fusus* (Müller, 1776).

Diagnosis.—Two ventral tentacles smaller than others. Interradial pieces of calcareous ring moderately long, extending posteriorly beyond union of tails of radial pieces. Body wall tables with thin margins and 4 perforations, although some have 8 or more. Spires of supporting tables in tube feet gently tapering. Introvert with tables and rosettes.

Remarks.—Deichmann either overlooked or ignored Madsen's new species *Thyone deichmannae,* a name he applied to the W. Atlantic material described as *T. fusus* by Deichmann in 1930. If future research determines that the Western Atlantic *Thyone* should be referred to a different species, *T. deichmannae* Madsen is available. In the Western Atlantic, reported from Tobago, British West Indies, and Florida (Deichmann, 1954).

Thyone pseudofusus Deichmann
Fig. 2C

Thyone pseudofusus Deichmann, 1930:168, pl. 14 figs. 6–9.—Clark, 1933:114.—Deichmann, 1941:107; 1946:4.—Panning, 1949:467.—Deichmann, 1954:395.—Domantay, 1958:197.—Tommasi, 1969:12, fig. 14.

Diagnosis.—Two ventral tentacles smaller than others. Interradial pieces

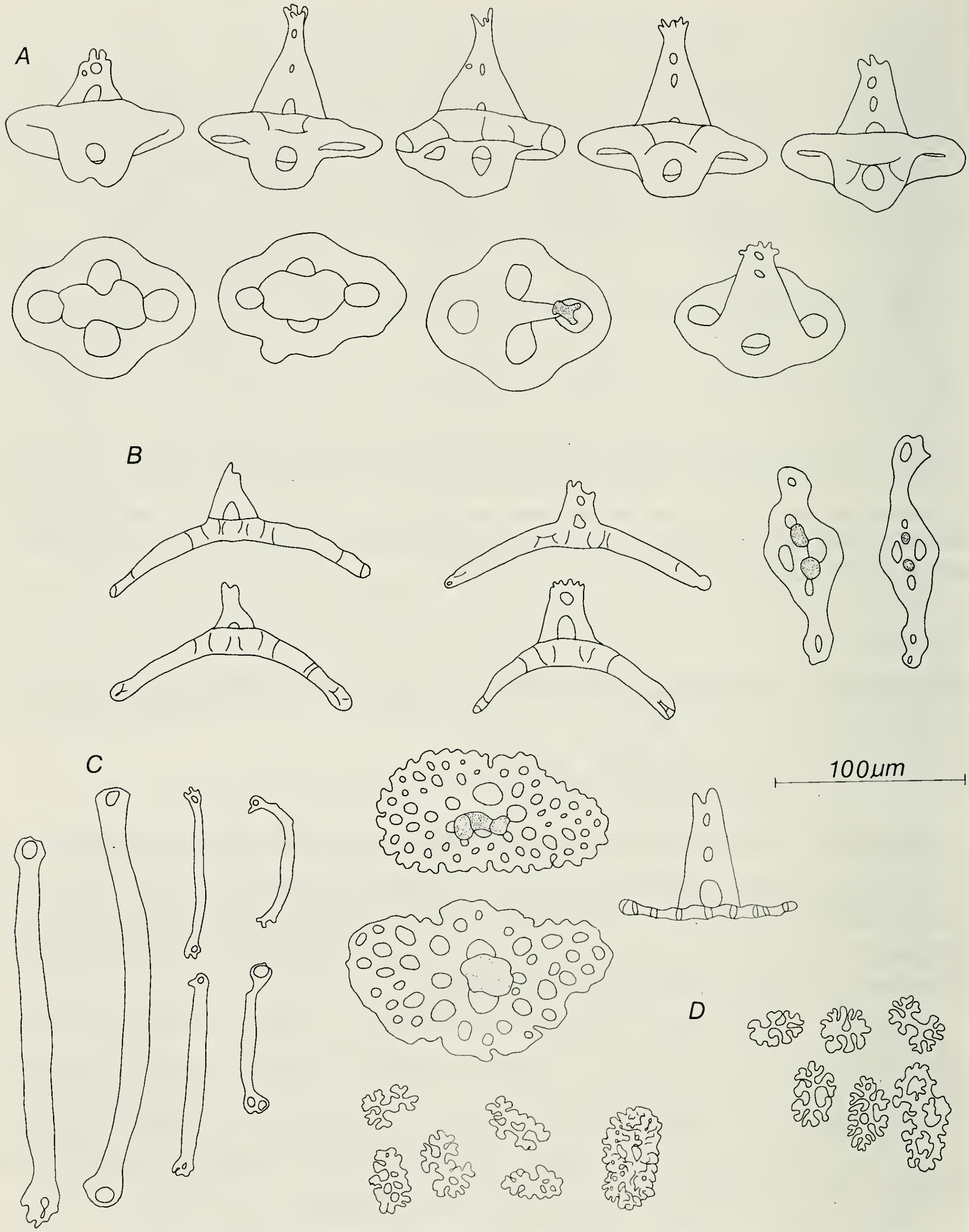

Fig. 3. *Thyone adinopoda*, ossicles. A, Tables from body wall; B, Tables from tube feet; C, Rods, rosettes and tables from tentacles; D, Rosettes from introvert.

of calcareous ring long, extending posteriorly well beyond union of tails of radial pieces. Body wall tables with 4 perforations, thick margins, and low truncate spire. Introvert with tables and rosettes.

Remarks.—The type-material was from Yucatan, in 45 meters depth.

Deichmann (1930) also noted that the species occurred in Tobago, British West Indies and in Florida. Tommasi reported *T. pseudofusus* from São Paulo, Brazil.

Table 1.—Average dimensions of tables from body wall and tube feet of *Thyone adinopoda*. n = 15. $\bar{x}$, mean; SD, standard deviation; SE, standard error.

	Tables from body wall					
	Height of table			Length of table		
Total length of specimen	$\bar{x}$ (μm)	SD	SE	$\bar{x}$ (μm)	SD	SE
16 mm	82.45	11.08	2.86	98.36	8.43	2.18
22 mm	77.65	6.63	1.71	90.45	5.83	1.51
25 mm	78.05	5.46	1.41	85.51	8.25	2.13
26 mm	80.25	9.69	2.50	88.59	9.59	2.48
39 mm	78.05	8.19	2.11	93.86	10.69	2.76
	Supporting tables from tube feet					
16 mm	62.70	8.58	2.22	119.73	9.04	2.33
22 mm	64.48	7.57	1.95	129.83	9.80	2.53
25 mm	64.02	10.69	2.76	107.45	10.44	2.70
26 mm	65.35	10.41	2.69	130.27	12.26	3.16
39 mm	60.08	6.58	1.68	117.53	8.93	2.31

Thyone pawsoni Tommasi

Fig. 2D, 2E

Thyone pawsoni Tommasi, 1972:19, figs. 12–15.

Diagnosis.—Two ventral tentacles smaller than others. Interradial pieces of calcareous ring large, extending posteriorly well beyond union of tails of radial pieces. Body wall tables with 4–9 perforations and thin margins. Spire of supporting tables in tube feet abruptly tapering. Introvert with tables; no rosettes.

Remarks.—The species was originally described from off the Gulf of Venezuela. Miller and Pawson (in preparation) describe material from off Georgia and off eastern and western Florida in 24–50 meters.

Thyone adinopoda, new species

Figs. 1, 2A, 3

Diagnosis.—Two ventral tentacles smaller than others. Interradial pieces of calcareous ring short, scarcely extending posteriorly beyond union of tails of radial pieces. Tables in body wall with oval disc, 4 perforations, thick margins and high tapering spires terminating in several short teeth. Ossicles in introvert rosettes only.

Etymology.—Species name derived from Greek, adinos = crowded, pous = foot, in reference to the numerous crowded tube feet on body wall.

Material examined.—Holotype USNM E21111, total length 26 mm, U.S. Bureau of Land Management, Sta. 13-45-VI-C(C-13), 19 July 1975, 29°30′45″N, 87°24′15″W, 63 meters. Paratypes: USNM E21112, 6 specimens, total lengths 12, 16, 18, 22, 25, 39 mm, same locality data as holotype; IRCZM 71:116, 2 specimens, total lengths 18, 22 mm, same locality data as holotype.

Description.—Body stout, more or less U-shaped, narrowing abruptly posteriorly to form a tail. Body wall thin but moderately stiff due to numerous ossicles. Tube feet numerous, apparently not completely retractile, in double rows anteriorly and posteriorly and scattered in radii and interradii elsewhere. Feet much more numerous in ventral interradii than in dorsal interradii.

Body wall and tentacles dirty white to light brown in alcohol. Tentacles 10, 2 ventral smaller than others. Calcareous ring tubular (Fig. 2); radials with very long posterior projections, each made up of numerous individual pieces of calcite. Interradials triangular, short, scarcely extending posteriorly beyond union of radial tails. Interradials rounded anteriorly, radials with anterior notch for insertion of retractor muscles. One Polian vesicle.

Body wall ossicles include tables, 60–90 μm high (from bottom of half-ring to top of spire), average 78 μm, and 72–118 μm long, average 91 μm. Disc oblong, swollen medially, with smooth thick margin and 4 equal-sized perforations. Occasionally 1–4 accessory perforations present. Spire composed of 2 strong pillars joined approximately ⅓ the way up their length and tapering to a blunt tip, armed with 2–7 short teeth. Opposite spire (on the inner part of disc), projects a distinct handle or half-ring with a large central perforation. Introvert with numerous rosettes 30–100 μm long, average 60 μm.

Tube feet with numerous supporting tables 50–85 μm high, average 63 μm and 92–158 μm long, average 120 μm. Disc elongate, strongly curved, with 4 central perforations and usually a single perforation at each end. Spire composed of 2 strong pillars, tapering to end in 0–6 small teeth. End plate well developed with several concentric rings of perforations, which increase in size from center of plate outwards.

Tentacles with numerous slender rods, rosettes and large tables. Rods 138–270 μm long, straight to slightly curved, with single perforation at each end. Tables (average 150 μm long by 80 μm wide) with flat disc, serrate margin and numerous perforations.

Remarks.—Thyone adinopoda shares with *T. crassidisca, T. pawsoni,* and *T. pseudofusus* the presence of handles or half-rings on tables from the body wall. Unlike *T. pseudofusus* and *T. crassidisca, T. adinopoda* has tables with a relatively thin disc, the spire is taller and gently tapering, and

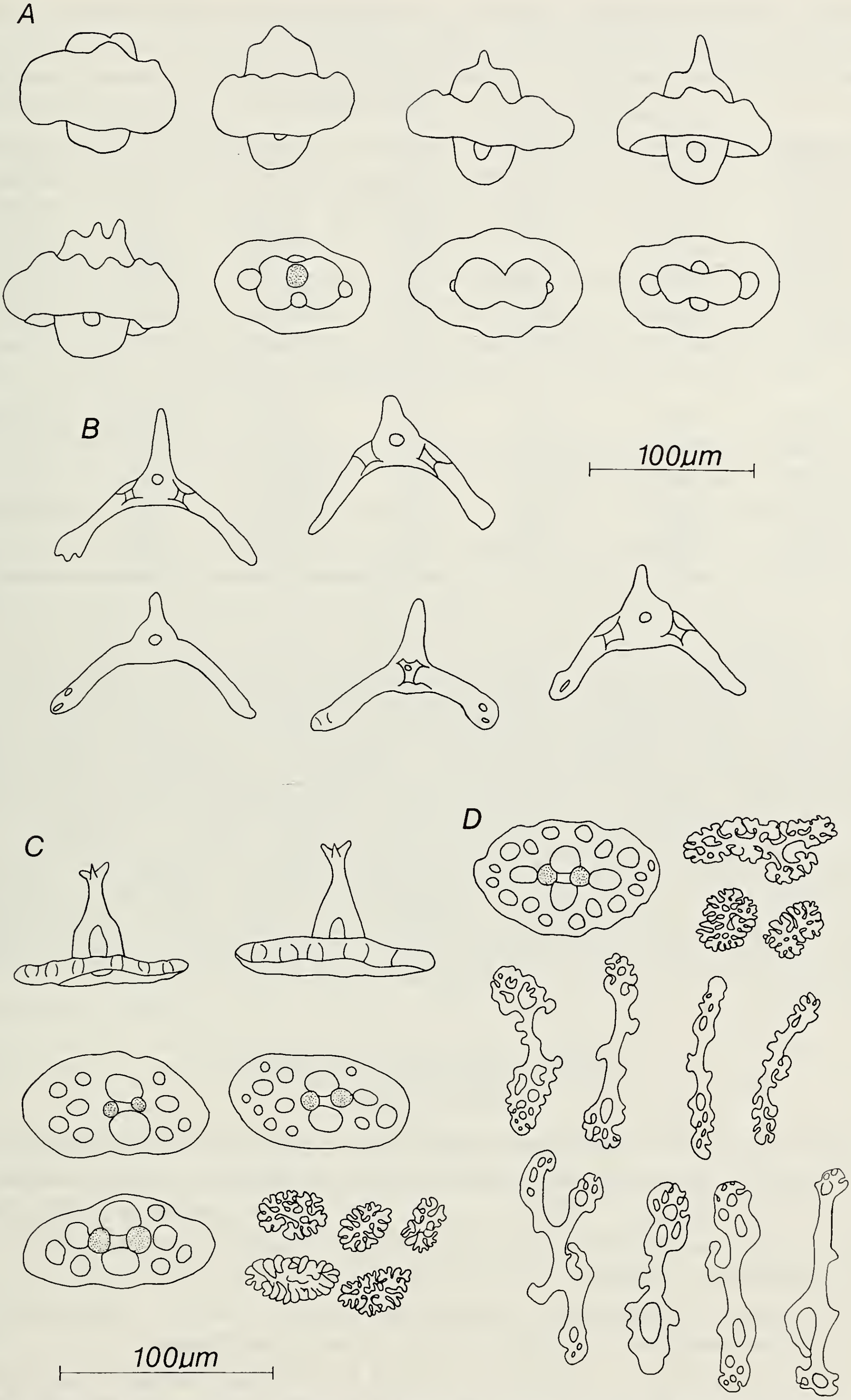

Fig. 4. *Thyone crassidisca*, ossicles. A, Tables from body wall; B, Tables from tube feet; C, Tables and rosettes from introvert; D, Table., rosettes and rods from tentacles.

Table 2.—Average dimensions of tables from body wall and tube feet of *Thyone crassidisca*. n = 15. $\bar{x}$, mean; SD, standard deviation; SE, standard error.

Total length of specimen	Tables from body wall					
	Height of table			Length of table		
	$\bar{x}$ (μm)	SD	SE	$\bar{x}$ (μm)	SD	SE
28 mm	67.11	7.13	1.84	81.55	4.16	1.07
30 mm	70.62	7.22	1.86	89.90	6.91	1.78
40 mm	68.42	7.77	2.01	96.48	10.75	2.77
41 mm	67.11	8.33	2.15	90.79	9.71	2.51
51 mm	78.07	11.62	3.00	94.31	8.50	2.20
60 mm	82.01	9.91	2.56	100.45	7.65	1.98
	Supporting tables from tube feet					
28 mm	78.95	13.39	3.46	145.61	13.11	3.39
30 mm	83.33	18.05	4.66	144.30	16.39	4.23
40 mm	74.11	11.52	2.97	130.71	10.52	2.72
41 mm	74.12	11.24	2.90	122.81	8.86	2.29
51 mm	91.67	9.80	2.53	134.21	12.87	3.32
60 mm	91.23	11.38	2.94	121.93	19.07	4.92

the perforations of the disc are conspicuous when viewed from above. In *T. pawsoni* the handles are much less common than in *T. adinopoda* and the spires of the tables are conspicuously different in both species. The supporting tables of the tube feet in *T. adinopoda* are similar to those of *T. pseudofusus*. Unlike *T. pseudofusus* and *T. crassidisca*, the introvert of *T. adinopoda* contains only rosettes and no tables. Like *T. crassidisca*, *T. adinopoda* appears to have no other close relatives in the genus *Thyone*.

The handles or half-rings on the body wall tables of the *Thyone* species discussed above are not unique to Western Atlantic species. For example, the Australian species *T. axiologa* H. L. Clark, 1938, also possesses this structure.

Thyone crassidisca, new species

Figs. 1, 2B, 4

Diagnosis.—Two ventral tentacles smaller than others. Interradial pieces of calcareous ring moderately long, extending posteriorly well beyond union of tail of radial pieces. Tables in body wall with oval disc, 4 perforations, thick margins, with short spires terminating in a single blunt spine. Introvert with tables and rosettes.

Etymology.—Species name derived from Latin, crassus = thick, discus = plate, in reference to the thick discs of the body wall tables.

Material examined.—Holotype, USNM E21113, total length 51 mm, R/V *Gosnold* Cruise 243, Station 621, 16 August 1974, 28°58.8′N, 79°58.8′W, 27 meters, pipe dredge, collected by D. K. Young. Paratypes: USNM E21114, 4 specimens, total lengths 28, 30, 40, 41 mm, R/V *Hernan Cortez,* Hourglass Project, Station I, Field No. EJ-66-364, 4 September 1966, 26°24′N, 82°06′W, 6 meters, box dredge, sand and shell, collected by B. Presley; USNM E21115, 1 specimen, total length 60 mm, U.S. Bureau of Land Management, Sta. HE-33-44, 18 June 1974, 28°26′30″N, 84°23′30″W, 45 meters; IRCZM 71:117, 1 specimen, total length 59 mm, R/V *Hernan Cortez,* Federal Clam Project, Station 805, Field No. EJ-71-364, 23 August 1971, 25°43.9′N, 81°42.2′W, 6.1 meters, Nantucket clam dredge, sand, 29.5°C, collected by C. Myhree; FSBC I 2400, 1 specimen, total length 16 mm, R/V *Hernan Cortez,* Hourglass Project, Station I, Field No. EJ-66-81, 9 March 1966, 26°24′N, 82°06′W, 6 meters, box dredge, mud and shell, 17.9°C, collected by B. Presley.

Description.—Body fusiform, with rounded anterior and posterior ends. Tube feet numerous, completely retractile, virtually invisible in contracted specimens. Feet scattered over body wall, with no obvious regular arrangement, although a tendency towards arrangement in double rows in radii is apparent anteriorly and posteriorly. Body wall slightly gritty to touch. Color whitish to light brown, with scattered light to dark brown patches of variable size and shape, up to 1 mm in diameter. Incidence of brown patches varies; some specimens have numerous patches, others have virtually none.

In some specimens calcareous ring, tentacles and associated structures have been autotomized. Calcareous ring tubular, radials with long anterior pieces and long posterior prolongations or tails. Interradial pieces also elongate, extending posteriorly slightly beyond point of junction of tails. Radials and interradials made up of a mosaic of small pieces of calcite.

Body wall ossicles include numerous tables 60–99 μm high (measured from bottom of half-ring to top of spire), average 72 μm, and 72–112 μm long, average 92 μm. Disc oval with 4 perforations, thick and strongly knobbed on margin. Spire robust, composed of 2 pillars, truncate or greatly tapered to a blunt tip. Inner surface of disc with distinct "handle" or half-ring. Introvert with large tables and rosettes. Tables 92–112 μm long, average 105 μm, 53–60 μm wide, average 56 μm and 66–92 μm high, average 79 μm. Disc oval with smooth margin, 4 central perforations and several accessory perforations at each end. Spire, composed of 2 pillars, tapers to a single acute spine with 1–4 minute teeth at the terminus. Rosettes scattered, 26–46 μm long.

Tube feet contain numerous supporting tables 53–105 μm high, average 82 μm and 99–165 μm long, average 133 μm. Disc elongate, strongly curved, with 4 central and 1–2 terminal perforations. Spire high, composed of 2 pillars greatly tapering to blunt or acute terminus. Endplates in tube feet composed of several pieces.

Tentacles with rods 79–118 μm long, average 90 μm with several perforations and undulate margins. Also rosettes and few tables like those found in the introvert.

Remarks.—*Thyone crassidisca* appears to be most closely related to *T. pseudofusus* Deichmann. They both possess robust 4-holed tables in the body wall, the tables with a handle or half-ring on the inner side of the disc. The species are sharply distinguished, however, on the basis of the ossicles in the body wall and elsewhere. In the body wall tables, the spire of *T. crassidisca* tends to terminate in a single point, the disc is very thick and, when viewed from above, the disc perforations are almost completely obscured by the robust spire. In *T. pseudofusus* the spires are low, with a series of (usually) 3 subequal teeth, the disc is not nearly so thick as in *T. crassidisca,* and the spire is not as robust when viewed from above, so that the disc perforations are clearly visible. The supporting tables in the tube feet of *T. crassidisca* have a spire which comes to a single blunt point, while in *T. pseudofusus* the spire ends in 3–5 blunt points.

Literature Cited

Clark, H. L. 1933. A handbook of the littoral echinoderms of Porto Rico and the other West Indian islands. Scientific Survey of Porto Rico and the Virgin Islands.—New York Acad. Sci. 16(1):1–147, 17 pls.

———. 1938. Echinoderms from Australia.—Mem. Mus. Comp. Zool. Harvard 55(8):1–596, 63 figs., 28 pls.

Deichmann, E. 1930. The holothurians of the western part of the Atlantic Ocean.—Bull. Mus. Comp. Zool. 71(3):41–226, 24 pls.

———. 1941. The Holothuriodea collected by the Velero III during the years 1932–1938. Part 1, Dendrochirota.—Allan Hancock Pacific Exped. 3(83):61–194, 21 pls.

———. 1946. A new species of *Thyone* s.s. from the Gulf of Mexico.—Occas. Pap. Mar. Biol. Lab., Louisiana State Univ., Baton Rouge, La. No. 4:1–4, 1 fig.

———. 1947. The fusus-like *Thyone* from the West Indian waters.—Proc. New England Zool. Club 24:83–90, 2 pls.

———. 1954. The holothurians of the Gulf of Mexico. *In* Gulf of Mexico, its origin, waters and marine life.—U.S. Fish Wildl. Serv. Fish. Bull. 89:381–410, 3 figs.

———. 1957. The littoral holothurians of the Bahama Islands.—American Mus. Novit. 1821:1–20.

———. 1963. Shallow-water holothurians known from Caribbean waters.—Stud. Fauna Curaçao 14(63):100–118.

Domantay, J. S. 1958. Some holothurians from Florida in the collection of the Allan Hancock Foundation.—Agra University J. Res. Sci. 7(2):181–202.

Heller, C. 1868. Die Zoophyten und Echinodermen des Adriatischen Meeres.—K.K. Zool.-Bot. Ges. Vienna: 1–88, 3 pls.

Jaeger, G. F. 1833. De Holothuriis. Turin. Pp. 1–42, 3 pls.

Lampert, K. 1885. Die Seewalzen. Weisbaden. Pp. 1–312, 1 pl.

Lesueur, C. A. 1824. Description of several new species of *Holothuria*.—Jour. Acad. Nat. Sci. Philad. 4:155–163.

Ludwig, H. 1874. Beitrage zur Kenntnis der Holothurien.—Arb. Zool. Zoot. Inst. Würzburg 3:77–120, 2 pls.

———. 1887. Die von G. Chierchia auf der Fahrt der Kgl. Corvette Vettor Pisani gesammelten Holothurien.—Zool. Jahrb. 2:1–36, 2 pls.

Madsen, F. J. 1941. On *Thyone wahrbergi* n.sp., a new holothurian from the Skagerrak, with remarks on *T. fusus* (O.F.M.) and other related species.—Goteborgs VetenskSamh. Handl. (6) 1B 1:1–31, 17 figs.

Mortensen, T. 1925. Echinoderms of New Zealand and the Auckland and Campbell Islands. Part IV. Holothurioidea.—Vidensk. Medd. Dansk Naturh. Foren. 79:322–386.

Müller, O. F. 1776. Prodromus Zoologiae Danicae seu animalium Daniae et Norvegiae Indigenarum Characters, Nanina et Synonyma. Imprimis Popularium Hauniae. [Holothurians p. 231–232.]

Panning, A. 1949. Versuch einer Neuordnung der Familie Cucumariidae. (Holothuroidea, Dendrochirota).—Zool. Jahrb. 78(4):404–470, 62 figs.

Pawson, D. L. 1963. The holothurian fauna of Cook Strait, New Zealand.—Zool. Publ. Victoria Univ. Wellington 36:1–38, 7 pls.

Pourtales, L. F. De. 1851. On the Holothuriae of the Atlantic coast of the United States.—Proc. Am. Assoc. Adv. Sci. :8–16.

Semper, C. 1868. Reisen in Archipel der Philippinen, Theil II. Wiss. Res. Bd. 1, Holothurien. Pp. 1–228, 40 pls.

Sluiter, C. P. 1910. Westindischen Holothurien.—Zool. Jahrb. f. Anat. und Syst. 11(2):331–341.

Stimpson, W. 1851. Pp. 7–8 in Proceedings of January 15, 1851.—Proc. Boston Soc. Nat. Hist. IV.

Theel, H. 1886. Report on the Holothuriodea of the Blake Expeditions 1887–1880.—Bull. Mus. Comp. Zool. 13(1):1–21, 2 pls.

Tommasi, L. R. 1969. Lista dos Holothurioidea recentes do Brasil. Contrcoes.—Inst. Oceanogr. Univ. S. Paulo, ser. Ocean. Biol. 15:1–29, 27 figs.

———. 1972. Equinodermes do Regiao Entre O Amapa (Brasil) E.A. Florida (E.U.A.).—Bolm. Inst. Oceanogr. S. Paulo 21:15–67, 27 figs.

Verrill, A. E. 1873. Brief contributions to Zoology. Results of recent dredging expeditions on the coast of New England.—Amer. Jour. Sci. 5:98–106.

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TWO LITTLE-KNOWN SPECIES OF *ELEUTHERODACTYLUS* (AMPHIBIA: LEPTODACTYLIDAE) FROM THE SIERRA DE LA MACARENA, COLOMBIA

William F. Pyburn and John D. Lynch

Abstract.—Two sympatric species of *Eleutherodactylus* occur in the cloud forest of La Macarena, Colombia. One is an undescribed species, herein named *Eleutherodactylus savagei.* This species resembles *E. fenestratus,* from which it differs in skin texture, in having a heel tubercle, and in throat pattern.

The other Macarena species is *Eleutherodactylus frater.* The species *E. savagei* and *E. frater* are morphologically similar and have similar breeding calls, but appear to be reproductively isolated from each other by differences in habitat, period of activity, and possibly by subtle differences in call.

A field party from the University of Texas at Arlington collected specimens and obtained voice recordings of two species of *Eleutherodactylus* in the cloud forest of the Macarena Mountains, Departamento del Meta, Colombia, in March 1971. The calls were recorded with a Uher 4000 Report L tape recorder and sound spectrograms were made from the tapes in the laboratory with a Kay Elemetrics Corporation "Sona-Graph."

One of the species is *Eleutherodactylus frater,* a small arboreal form whose relationships have been in doubt. The other species is unnamed. For it, we propose the name:

Eleutherodactylus savagei, new species
(Figs. 1, 2)

Holotype.—UTA 3535, an adult male taken on the Sierra de la Macarena, ca. 35 km WSW Vistahermosa, Depto. Meta, Colombia, 1097–1128 m, on 20 March 1971 by W. F. Pyburn.

Paratypes.—UTA 3525–29, 3536–38, 5608–18; USNM 218054–62; AMNH 107557–65; CM 76154–62; KU 187001–09; all topotypes collected 17–20 March by W. F. Pyburn, J. R. Glidewell, and J. Taulman.

Diagnosis.—1) Skin of dorsum finely shagreened becoming more coarse posteriorly, that of venter smooth; no dorsolateral folds; 2) tympanum prominent, its length about ⅓ eye length; 3) snout subacuminate in dorsal view,

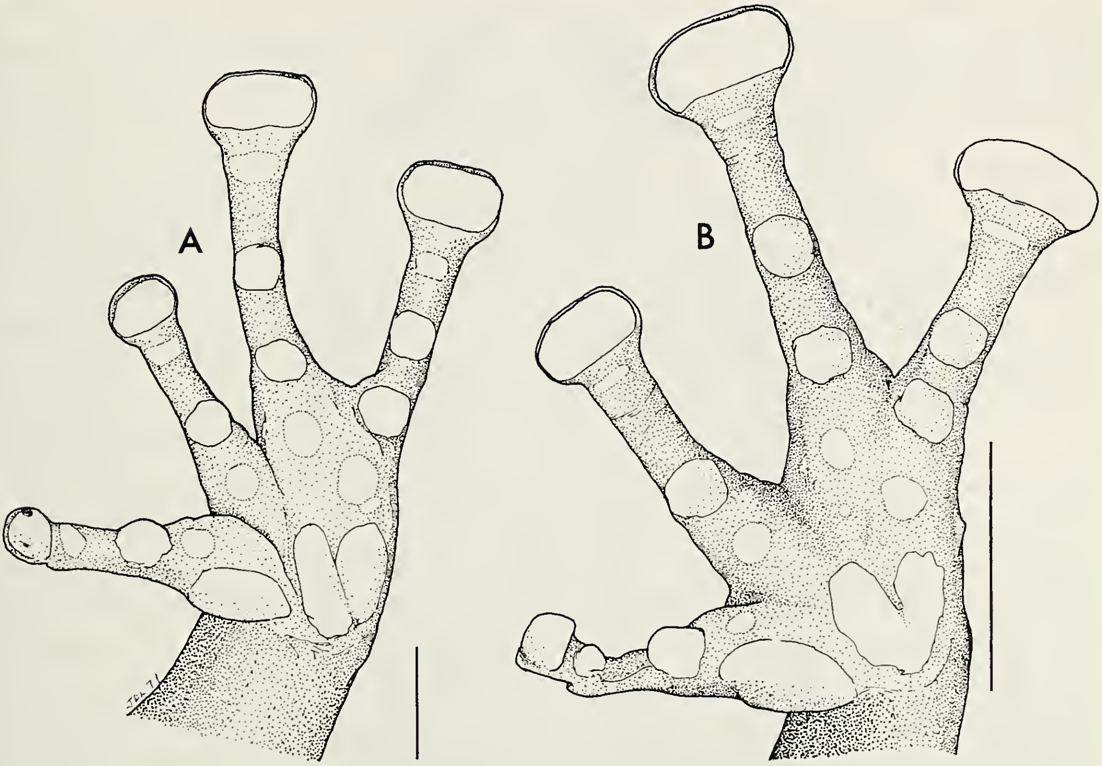

Fig. 1. Hands of (A) *Eleutherodactylus savagei* n. sp., UTA 5616, and (B) *E. frater,* UTA 3531. Lines equal 2 mm.

acutely rounded in lateral profile; snout long, E–N < eye length; 4) IOD broader than upper eyelid, flat; 5) vomerine odontophores triangular in outline; 6) males with vocal slits and white, non-spinous nuptial pads; 7) length of first and second fingers nearly equal; large pads on fingers III–IV; 8) fingers with slight lateral keels; 9) only antebranchial tubercle evident; 10) small tubercles on heel; no outer tarsal tubercles; inner edge of tarsus bearing ridge or series of tubercles; 11) two metatarsal tubercles, inner elongate, 4 times size of outer; supernumerary plantar tubercles at bases of toes; 12) toes bearing keels proximally; basally webbed (web not encroaching basal subarticular tubercles); 13) tan to brown with pattern vague except for black scapular spots and canthal-supratympanic stripe; throat peppered with brown, pigment extending onto chest as faint reticulation; groin and anterior and posterior surfaces of thighs uniform brown; shank bars oblique, narrower than interspaces; 14) adults moderate-sized, males 17.7–22.6 mm SVL ($\bar{x}$ = 20.2, N = 7), females 31.0–34.7 mm ($\bar{x}$ = 32.6, N = 17).

Most similar to *E. fenestratus* (Steindachner) but differing in skin texture (skin of dorsum finely shagreened *vs* with an interspersion of large warts), in having a small heel tubercle (none in *E. fenestratus*), and in having only faint marbling on the throat.

Description.—Head narrower than body, wider than long; HW in males

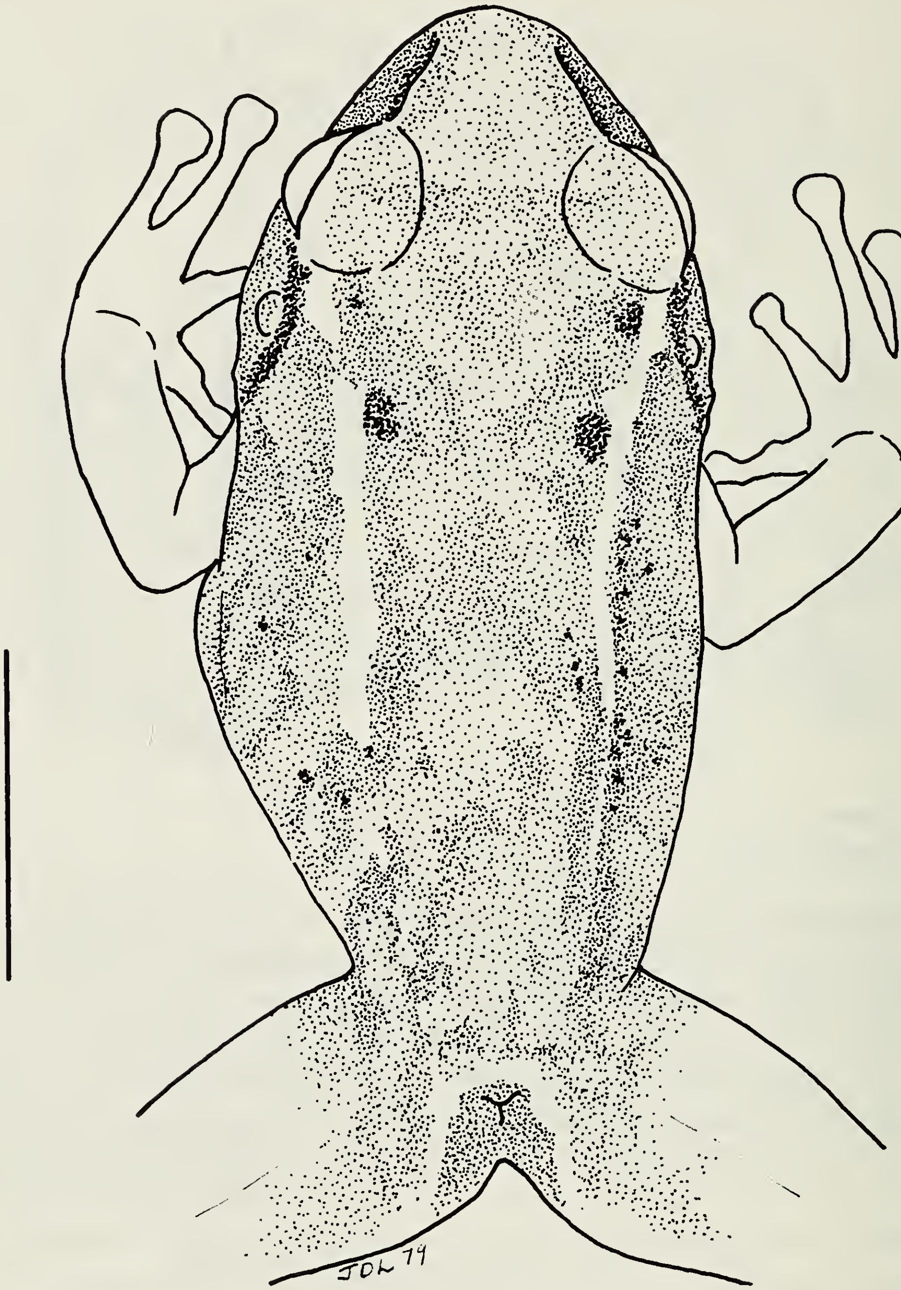

Fig. 2. Color pattern of *Eleutherodactylus savagei* n. sp., UTA 3527. Line equals 10 mm.

33.4–39.4 ($\bar{x}$ = 37.2, N = 5) percent SVL, in females 37.7–44.2 ($\bar{x}$ = 40.2, N = 18) percent; snout subacuminate in dorsal view, acutely rounded in lateral profile; snout long, E–N in males 73.5–75.8 ($\bar{x}$ = 74.4, N = 4) percent eye length, in females 79.5–95.0 ($\bar{x}$ = 86.9, N = 20) percent; nostrils weakly protuberant, directed laterally; canthus rostralis sharp, nearly straight (sinuous); loreal region flat (or very weakly concave), sloping abruptly to lip; some flaring of jaws posteriorly; interorbital region flat, no cranial crests; upper eyelid width in males 83.0–100.0 ($\bar{x}$ = 89.9, N = 4) percent IOD, in females 65.8–109.4 ($\bar{x}$ = 80.1, N = 8) percent; supratympanic fold thick, obscuring upper and posterior edges of tympanum which is higher than long, length of tympanum in males 29.3–33.3 ($\bar{x}$ = 32.1, N = 4) percent eye length, in females 27.5–35.7 ($\bar{x}$ = 32.3, N = 20) percent; postrical tubercles not prominent; choanae round, moderately large, not concealed by palatal shelf of maxillary arch; vomerine odontophores slightly smaller than a choana, triangular in outline, separated on midline by a distance equal to odontophore width, median and posterior to choanae, each bearing 4–5 teeth; tongue slightly longer than wide, not notched posteriorly, posterior ¼ not adherent to floor of mouth; males with vocal slits and a subgular vocal sac.

Skin of dorsum finely shagreened anteriorly, becoming more coarse posteriorly and very coarse with scattered tubercles on flanks; 1–2 small tubercles on upper eyelid; some evidence of a dorsolateral fold in scapular region but fading out in region of sacrum; large areolations below and posterolateral to vent, on posteroventral surfaces of thighs; no anal sheath or enlarged para-anal warts; skin of throat and venter smooth but with some suggestion of areolations encroaching from flanks; discoidal folds ill-defined; no ulnar tubercles except antebrachial; palmar tubercle bifid, much larger than oval thenar tubercle; supernumerary palmar tubercles relatively large (Fig. 1); subarticular tubercles subconical, round or slightly longer than wide; fingers bearing faint lateral keels; finger tips expanded forming pads (smallest on thumb), bearing broad discs on ventral surfaces; pads of III–IV largest (as large as tympanum) truncate, those of I–II round (Fig. 1); males bearing non-spinous nuptial pad; length of first and second fingers nearly equal.

One to two low round tubercles on heel, none on outer edge of tarsus; inner edge of tarsus bearing a long tubercle (sometimes one long and a short proximal one); inner metatarsal tubercle three times as long as wide; outer metatarsal tubercle round, ¼ size of inner; supernumerary plantar tubercles 4 (rarely 5), at bases of toes (some hint of others on rest of sole); basal toe webbing (not encompassing basal subarticular tubercles); lateral keels evident low on toes but indistinct distally; toes bearing pads and broad discs (smaller than those of outer fingers); heels of flexed hind legs overlap slightly; heel of adpressed hind leg reaches anterior edge of eye; shank of males 51.5–58.0 ($\bar{x}$ = 54.5, N = 5) percent SVL, of females 50.0–58.0 ($\bar{x}$ = 53.9, N = 20) percent.

Dorsum tan to brown with black scapular spots and nearly as dark canthal-supratympanic stripes; light brown sacral chevron, suprainguinal marks, interorbital bar, and flank bars (Fig. 2); anal triangle brown outlined with cream; 3–4 oblique bars on shank, less than to equal interspace width; a common variant has cream dorsolateral stripes along anterior $^3/_5$ body

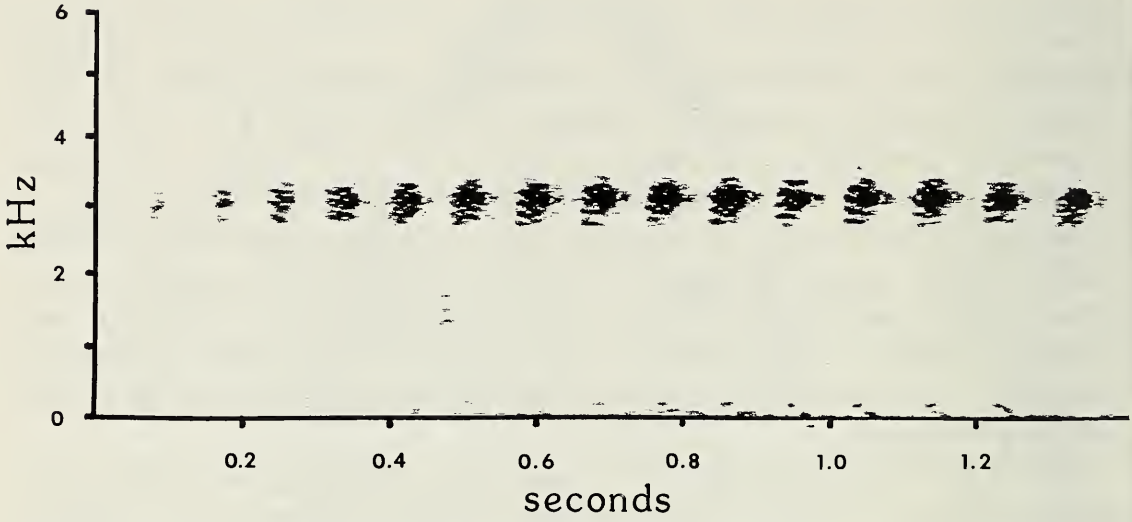

Fig. 3. Sound spectrogram of one complete call of *Eleutherodactylus savagei* (narrow band filter). Recorded 20 March 1971 at type locality (air temperature, 17.3°C).

(Fig. 2); throat lightly peppered with brown, sometimes extending onto chest as a reticulation; peppering on undersides of legs; groin and anterior and posterior surfaces of thighs uniform brown.

Measurements of holotype in mm.—SVL 21.2; shank 11.5; head width 7.8; head length 8.0; upper eyelid width 2.4; IOD 2.4; tympanum length 1.1; eye length 3.4; E–N 2.5.

Voice.—In the Macarena Mountains, *Eleutherodactylus savagei* began calling at dusk and choruses continued until well after midnight. The males called from low perches on leaves up to 50 cm above the ground. The call (Fig. 3) was a series of short closely spaced notes forming a dominant frequency band at 3000 Hz. Nineteen calls of 7 frogs recorded 20 March 1971 (air temperature, 17.3°C) had an average of 15 (range, 7–34) notes per call and a note repetition rate of 11.3 (10.2–12.2) notes per s. The duration of the call was 1.3 s (0.6–3.2) and the note duration was 0.05 s (0.04–0.09).

Etymology.—The new species is named for Jay M. Savage of the University of Southern California, in recognition of his contributions to understanding the biology of Neotropical *Eleutherodactylus*.

Distribution.—In addition to the type-series, we have seen the following (also from Depto. Meta, Colombia): Buenavista, 10 km NW Villavicencio, UTA 2723, 2725–26, 2741, 2743, 2748; Serrania de la Macarena, FMNH 81349–60, 81364.

Remarks.—Cochran and Goin (1970) confused this frog among what they called *E. terraebolivaris* Rivero (which occurs only in Venezuela). Lynch (1975) noted the presence of this frog but mistakenly termed it a member of the *unistrigatus* group. *Eleutherodactylus savagei* does not appear closely allied to the short-legged *fitzingeri* group of frogs of the Amazon Basin (*E. lanthanites* and *E. vilarsi*). It seems to be the northwestern replacement for *E. fenestratus* (Steindachner), which is replaced in northeastern South America by *E. gutturalis* Hoogmoed, Lynch, and Lescure.

Eleutherodactylus frater (Werner)

Hylodes frater Werner, 1899, Verh. zool.-bot. Gessell. Wien, 49:479 (type-locality, Peperital, near Villavicencio, Depto. Meta, Colombia, 1000 m).
Eleutherodactylus frater: Cochran and Goin, 1970, Bull. U.S. Nat. Mus. (288):433–34, pl. 54.

Diagnosis.—1) Skin of dorsum finely shagreened with scattered warts, that of venter coarsely areolate; no dorsolateral folds; 2) tympanum prominent, its length ¼–⅖ eye length; 3) snout subacuminate in dorsal view, round in lateral profile; canthus rostralis obtuse; 4) upper eyelid as wide as IOD; no cranial crests; tubercles on upper eyelid; 5) vomerine odontophores small, low; 6) males with vocal slits, subgular vocal sac; males bearing non-spinous nuptial pads on thumbs; 7) first finger shorter than second; large pads on outer fingers; 8) fingers with narrow lateral keels; 9) 2–3 conical ulnar tubercles present; 10) small tubercles on heel; inner edge of tarsus bearing short ridge, outer edge with 2–3 conical tubercles; 11) two metatarsal tubercles, inner oval, 8 times size round outer; supernumerary plantar tubercles present; 12) toes bearing lateral keels, enlarged pads; 13) pale brown with brown markings (reverse parentheses, suprainguinal blotches, narrow limb bars, supratympanic stripe and labial bars); no canthal stripe; venter finely peppered with brown (throat darker); concealed surfaces of thighs uniform brown; 14) adults small, males 17.2–21.6 mm SVL ($\bar{x}$ = 20.1, N = 7), one adult female 24.9 mm SVL.

Eleutherodactylus frater is most similar to *E. incomptus* Lynch and Duellman, *E. marmoratus* (Boulenger), and *E. martiae* Lynch, but differs from each in the arrangement of tarsal tubercles. It also differs from the smaller *E. martiae* in having vocal sacs in males and prominent tympani (concealed in *E. martiae*). *Eleutherodactylus incomptus* is probably the closest relative of *E. frater* but is slightly smaller (males 15.6–18.8 mm, females 23.7–25.9 mm SVL) and has the vomerine odontophores evident only in large females. *Eleutherodactylus marmoratus* is considerably larger (its males are larger than our only female *E. frater*).

Description.—Head as wide as body, wider than long; HW 35.4–38.4 ($\bar{x}$ = 36.8, N = 7) percent SVL; snout subacuminate in dorsal view, round in lateral profile; nostrils weakly protuberant, directed dorsolaterally; snout short, E–N 69.2–87.3 ($\bar{x}$ = 80.1, N = 7) percent eye length; canthus rostralis weakly defined, rounded; loreal region weakly concave, sloping to lips, lips not flared; upper eyelid width 93.3–113.6 ($\bar{x}$ = 101.6, N = 7) percent IOD; upper eyelid bearing 2–4 conical tubercles; no cranial crests; supratympanic fold concealing upper edge of tympanic annulus; tympanum prominent, round, its length 26.9–38.5 ($\bar{x}$ = 33.4, N = 7) percent eye length, separated from eye by slightly more than its diameter; postrictal tubercles subconical; choanae relatively small, round, not concealed by palatal shelf of maxillary arch; vomerine odontophores small, each ⅓–½ size of a choana, narrowly separated (by distance equal ⅔ width of an odontophore), bearing 2–3 teeth; tongue about as long as wide, posterior border feebly indented, posterior ²/₅ not adherent to floor of mouth; males with relatively long vocal slits and subgular, external vocal sac.

Skin of dorsum finely shagreened, overlain with larger granulations on lower back and with larger isolated tubercles on upper eyelid, between eyes, and in scapular region; flanks becoming coarsely areolate ventrally, skin of venter areolate, that of throat smooth; no dorsolateral folds or anal sheath; discoidal folds prominent; 2–3 ulnar tubercles; palmar tubercle bifid, much larger than oval thenar tubercle (Fig. 1); supernumerary palmar tubercles smaller than more pungent, round subarticular tubercles; fingers bearing slight lateral keel, most obvious along outside of palm and finger IV; pads truncate, smallest on I, that on II intermediate, largest on III and IV (more than 2 times width of digit below pad); pad of III as large as tympanum; discs broader than long, not indented, first finger shorter than second (Fig. 1); males with white, non-spinous nuptial pad on thumb.

Small tubercle on heel, 2–3 on outer edge of tarsus, inner edge of tarsus bearing tarsal ridge (distal ½) and a tubercle proximal to ridge; inner metatarsal tubercle twice as long as wide, outer minute (less than ⅛ size of inner), round; supernumerary plantar tubercles small, pungent, toward distal end of sole; subarticular tubercles round, weakly pungent; toes bearing lateral keel (more fringe-like than that on fingers) and pads (about same size as on fingers but seem smaller because of toe fringe); heels of flexed hind legs barely overlap; shank 46.8–50.0 ($\bar{x}$ = 48.9, N = 7) percent SVL.

Pale brown with slightly darker brown marbling over dorsum; still darker reverse parentheses in scapular region, slanted bars on upper flanks, and suprainguinal blotches; anal triangle dark brown; limb bars narrower than interspaces, oblique on shanks; no canthal stripe; supratympanic stripe dark brown, as are labial bars; diffuse brown area behind shoulder; ventral surfaces finely dusted with brown (most dense on throat) but appearing cream without magnification; groin peppered with brown, anterior and posterior surfaces of thighs uniform brown.

UTA 3531 has a black dorsolateral stripe continuing anteriad as a canthal stripe. There are 3 shorter brown stripes down the center of the back. Some specimens also have very pale snouts and, if so, the pale area defines an otherwise indistinct interorbital bar.

Voice.—During our 7-day camp in the cloud forest, choruses of *E. frater*

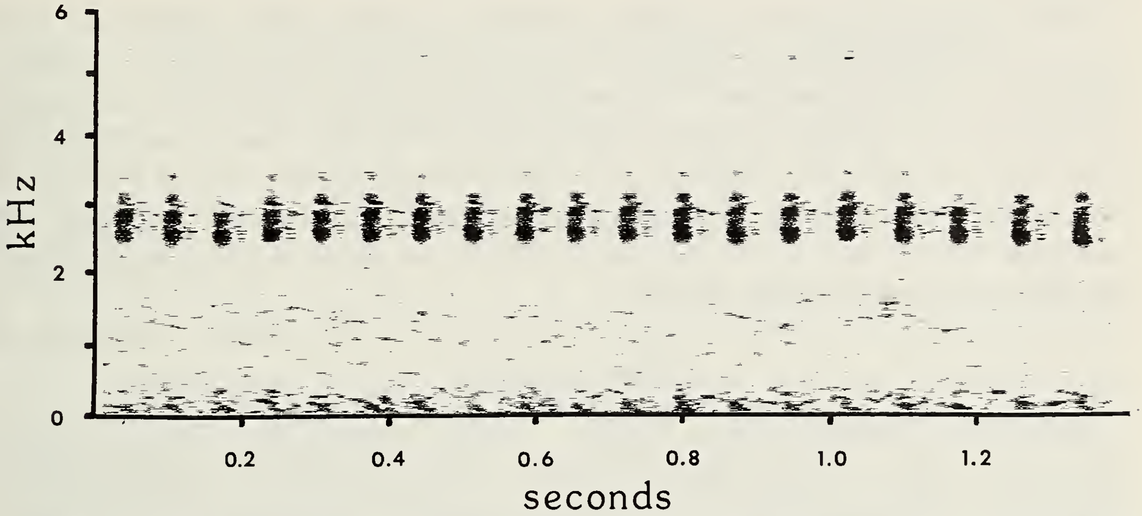

Fig. 4. Sound spectrogram of incomplete call (last 19 notes) of *Eleutherodactylus frater* (narrow band filter). Recorded 21 March 1971, Sierra de la Macarena, Colombia (air temperature, 19.7°C).

began each day at about 1500 h and continued through the evening until dark. Most individuals became quiet at dusk but a few frogs continued to call until about 1 hour after dark.

The call (Fig. 4) was a series of well-separated, short notes with a dominant frequency of about 2900 Hz. Thirteen calls of 4 individuals recorded 21 March 1971 (air temperature, 19.7°C) had a mean of 17.7 (11–32) notes per call and a note repetition rate of 16.7 (14.8–18.1) notes per s. The duration of the call was 1.1 s (0.7–2.2) and the note duration was 0.03 s (0.02–0.06).

Remarks.—Cochran and Goin (1970) confounded *E. frater* with the chocoan *E. taeniatus* (Boulenger). Lynch (1974) used the name *E. frater* for the chocoan species but subsequently redescribed *E. taeniatus* (Lynch, 1980). The eastern face of the Cordillera Oriental in Colombia is poorly known herpetologically but we anticipate *E. frater* and *E. incomptus* to replace one another somewhere between the Pasto-Mocoa road and the Bogota-Villavicencio road.

Discussion

Eleutherodactylus frater and *E. savagei* are similar enough in their morphology and breeding calls to make one suspect that cross matings could occur. *Eleutherodactylus savagei* begins calling at dusk, about 1 h before dark, so there is a 2 h interval in which the two species call at the same time. However, *E. frater* is almost entirely diurnal and *E. savagei* is essentially nocturnal, there being relatively few individuals of either species that call in the interval of temporal overlap. Furthermore, *E. frater* is arboreal whereas *E. savagei* males call from perches near the ground.

Both species produce a varying number of short notes with about the same dominant frequency, but calls of the two species can easily be distinguished by the human ear. The sound spectrograms show that the note duration of *E. savagei* averages nearly twice that of *E. frater* and that the notes of *E. savagei* are repeated at a slower rate than the notes of *E. frater*. We would expect these differences in habitat, breeding call, and time of vocalization to function as premating isolation mechanisms, making matings between the two species unlikely.

Abbreviations

Institutional abbreviations: AMNH, American Museum of Natural History, New York; FMNH, Field Museum of Natural History, Chicago; KU, University of Kansas Museum of Natural History, Lawrence; USNM, National Museum of Natural History, Washington, D.C.; UTA, University of Texas at Arlington, Arlington, Texas; CM, Carnegie Museum, Pittsburgh, Pennsylvania.

Acknowledgments

We thank Hymen Marx of the Field Museum of Natural History for the loan of specimens, and Wanda C. Pyburn, Jerry Glidewell, and James Taulman for assistance in the field. Travel by the senior author was made possible by a grant from the National Science Foundation in support of U.S. participation in the International Biological Program. Officials of the Instituto Nacional de Recursos Naturales (INDERENA) gave permission to collect specimens in the Sierra de la Macarena. Representative speimens and color transparencies of habitats were deposited in the collections of INDERENA.

Literature Cited

Cochran, D. M., and Goin, C. J. 1970. Frogs of Colombia.—U.S. Nat. Mus. Bull. (288):i–xii + 1–655, 68 pls.

Lynch, J. D. 1974. New species of frogs (Leptodactylidae: *Eleutherodactylus*) from the Amazonian lowlands of Ecuador.—Occ. Pap. Mus. Nat. Hist. Univ. Kansas (31):1–22.

———. 1975. The identity of the frog *Eleutherodactylus conspicillatus* (Gunther), with descriptions of two related species from northwestern South America (Amphibia, Leptodactylidae).—Contrib. Sci., Nat. Hist. Mus. Los Angeles Co. (272):1–19.

———. 1980. Systematic status and distribution of some poorly known frogs of the genus *Eleutherodactylus* from the chocoan lowlands of South America.—Herpetologica 36:175–189.

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THE SYSTEMATIC STATUS OF CENTRAL AMERICAN FROGS CONFUSED WITH *ELEUTHERODACTYLUS CRUENTUS*

Jay M. Savage

Abstract.—Eleutherodactylus cerasinus, E. cruentus, and *E. ridens,* three superficially similar species from lower Central America, are re-diagnosed. Direct comparisons of type material show that *E. peraltae* Barbour, 1928, and *E. tiptoni* Lynch, 1964, are synonyms of *E. cerasinus*; *Syrrhophus lutosus* Barbour and Dunn, 1921, *E. dubitus* Taylor, 1952, and *E. marshae* Lynch, 1964 are synonyms of *E. cruentus*; and *Syrrhopus molinoi* Barbour, 1928 is a synonym of *E. ridens.*

A series of three superficially similar species of *Eleutherodactylus* from lower Central America have caused confusion for all workers on the genus. The forms share the following features: finger II longer than I; no toe webbing; large finger and toe disks; disk pads round, never triangular; disk covers round, palmate or truncate, never pointed; and venter coarsely areolate. The earliest name applied to these frogs is *Hylodes cruentus* W. Peters, 1873. Since that time eleven different names, eight proposed as new taxa, have been applied to these forms.

In the course of studies on the genus in Middle America, I have had the opportunity to see extensive new living and preserved material of the problematic populations and have examined all extant types of names involved in the problem. The following sections summarize my findings as a basis for a more extensive treatment of all Middle American species in the genus in a subsequent paper. The clarification of the taxonomy and synonymy for these forms is required at this time so that other workers may use the correct names in their systematic and ecological treatments.

Eleutherodactylus cruentus (W. Peters)

1873 *Hylodes cruentus* W. Peters, Mon. Akad. Wiss. Berlin: 609.
1921 *Syrrhophus lutosus* Barbour and Dunn, Proc. Biol. Soc. Wash. 34:158 (Holotype: MCZ 8023; Costa Rica: Cartago: Canton de Cartago: Navarro, 1100 m).
1931 *Eleutherodactylus ventrimarmoratus:* Dunn, Occ. Paps. Boston Soc. Nat. Hist. 5:411.
Eleutherodactylus lutosus lutosus: Dunn (by implication), Occ. Paps. Boston Soc. Nat. Hist. 5:411.

1933 *Eleutherodactylus latidiscus:* Dunn, Occ. Paps. Boston Soc. Nat. Hist. 8:68–69.

1952 *Eleutherodactylus dubitus* Taylor, Univ. Kansas Sci. Bull. 35(5):707, Fig. 22 (Holotype: KU 24942; Costa Rica: Alajuela: Canton de Alajuela: SE slope Volcan Poas: Isla Bonita, 1476 m).

1964 *Eleutherodactylus marshae* Lynch, J. Ohio Herp. Soc. 4(3):67, Fig. 3 (Holotype: BYU 18819; Panama: Bocas del Toro: Rio Changena, 35 km W Almirante).

1965 *Eleutherodactylus cruentus:* Savage, Bull. South. Calif. Acad. Sci. 64(2):109.

Holotype.—Berlin 7811; Panama: Provincia de Chiriquí.

The confusion surrounding proper application of the name *cruentus* stems from several sources. Two of these are biological. The first is the result of extensive sexual dimorphism in which the males are much smaller (maximum size 28 mm) than the females (to 42 mm), and are also much more tuberculate and tend to have a truncate snout often with a slightly fleshy pointed tip (females are smoother and usually with a subovoid snout in dorsal outline). In addition, the tympanum in males is completely hidden by skin, whereas in females it is indistinct but definitely visible. The second involves the extremely high variability in coloration, ranging from markedly patterned to nearly uniform tan to black in dorsal color, often with light areas on back, flanks, and thighs green, bright yellow, orange or red; groin usually with one to several large yellow to orange spots. Nevertheless, all individuals assigned to this species agree in having a distinct, enlarged, pointed or flap-like supraocular tubercle; a well developed, distinct, pointed heel tubercle; greatly expanded, truncate, emarginate finger disks; and the subarticular tubercles raised but not pointed.

The holotype of this species is an adult female, 39.5 mm in length, collected by Ribbe somewhere in the Chiriquí region of western Panamá. It agrees in every respect (see key couplets 1 and 2 below) with examples now known from Costa Rica and Panama, although the extensive suffusion of the dorsum with red (the source of the species name) described by W. Peters (1873) is an unusual variant. Recently collected female examples from above Boquete, Chiriquí Province, Panama, are often colored in a similar fashion.

When the unusual coloration of the type of *cruentus* and the marked sexual dimorphism of the species are taken into account, it is not surprising that Barbour and Dunn (1921) described *Syrrhophus lutosus* based upon a juvenile male, 13 mm in length. This example agrees in all ways with male *cruentus*. Difficulty arose later, however, when Dunn (1931) allied *lutosus* with the nominal species *Syrrhopus* [sic] *molinoi* Barbour (1928), by reducing the latter to subspecies status under *lutosus*. As we shall see later, *molinoi* belongs with a very different species population.

While confused about the relationships of "*lutosus*" and *molinoi* Dunn (1931, 1933) was well aware that *molinoi* differed from the species here called *cruentus*. He referred material of the latter from central and western Panama, first to *Eleutherodactylus ventrimarmoratus* (an Amazonian form) and then to *E. latidiscus* (a western South American species). At the same time he recognized a relative of *cruentus, Eleutherodactylus cerasinus* (Cope, 1875), as occurring on Barro Colorado Island, Panama. *Eleutherodactylus cerasinus* is distinctive in having the groin, posterior thigh, and calf suffused with red pigment in life, a condition never found in *cruentus*.

Sometime between 1931 and 1951, Dunn (*in* Zetek and Wetmore, 1951) apparently became convinced that *cruentus* was an older name for *cerasinus*. He thus applied the former to *cerasinus,* while using *latidiscus* for *cruentus*. As a result almost all examples of *cerasinus* at most United States museums were re-labeled *cruentus* by Dunn. One suspects the change came about because Dunn wanted to apply the old name *cruentus* to some Panama form. Although he had examined the type of *cruentus* at Berlin in 1928, his notes may have been inadequate and his memory somewhat diminished by the 23 year gap. Very likely the red on the thighs of *cerasinus* and the name *cruentus* (= bloody) influenced him. As we shall see below, the two names apply to distinctive species.

Taylor (1952) in his classic work on Costa Rica recognized *lutosus* and *cerasinus* as distinct. In addition he described as new *Eleutherodactylus dubitus,* based on a large and variable series including males and females, but with a female holotype, 38.5 mm in length. Taylor's description covers a fair proportion of the variation in the species, but direct comparison of his type and the type of *cruentus* leaves no doubt as to their conspecificity.

Eleutherodactylus marshae Lynch, 1964 is a poorly fixed (the type and only known example appears to have died sometime well before preservation) adult male, 28 mm in length. The distinct black bars and bright yellow groin spots confirm the identification with *cruentus* made on the basis of direct comparison to Costa Rica and Panama material. The smooth venter and apparent tympanum mentioned in the original description are artifacts of death and desiccation prior to preservation. The type of *marshae* further agrees with adult male *cruentus* in having nuptial thumb pads and lacking vocal slits.

Eleutherodactylus cruentus differs from other Central American members of the genus with which it might be confused (exclusive of the two forms discussed in detail later in this paper) in having a well developed pointed to flap-like heel tubercle or calcar (absent in *E. altae* of Costa Rica and *E. pardalis* of Costa Rica and Panama); in having well developed accessory palmar tubercles and a series of 2–4 outer tarsal tubercles (absent in *E. caryophyllaceus* and *E. melanostictus* of Costa Rica and western Panama); and in having a distinct well developed pointed to flap-like supraocular tubercle (absent in *taeniatus* of Panama, Colombia, and northwestern Ecuador).

The known geographic range of this species may be stated as follows: primarily humid forests in the premontane zone on both slopes of Costa Rica and western Panama; scattered lowland records in eastern and southwestern Costa Rica into central Panama (40–1550 m).

Referral of eastern Panama and Colombia material to this species (Lynch 1979) is subject to question and requires a detailed study and comparison of samples before their status can be resolved.

Eleutherodactylus cerasinus (Cope)

1875 *Hylodes cerasinus* Cope, J. Acad. Nat. Sci. Phila. 2(8):112, pl. 26, Fig. 4.

1921 *Eleutherodactylus cerasinus:* Barbour and Dunn, Proc. Biol. Soc. Wash. 34:161; 1952, Taylor, Univ. Kansas Sci. Bull. 35(5):703, Fig. 21.

1928 *Eleutherodactylus peraltae* Barbour, Proc. N. Engl. Zool. Club 10:30, pl. 4, Fig. 1 (Holotype: MCZ 13601; Costa Rica: Cartago: Canton de Turrialba: Peralta, 386 m).

1964 *Eleutherodactylus tiptoni* Lynch, J. Ohio Herp. Soc. 4(3):65, Fig. 2 (Holotype: BYU 19146; Panama: Bocas del Toro: 35 km W Almirante).

1951 *Eleutherodactylus cruentus:* Dunn *in* Zetek and Wetmore, Ann. Rept. Smithson Inst. 1950:140.

Holotype.—USNM 32572: Costa Rica: Provincia de Limon: Canton de Talamanca: Cerro Ujam, 1524–2134 m.

This species was described by Cope (1875) based on material from the expedition of William More Gabb to Cerro Ujam in southeastern Costa Rica. The holotype, an adult female 33 mm in length, is still extant but is in very poor condition. The frog clearly was not collected at the elevation indicated in the original description (Savage, 1970). This specimen has all the distinctive features of *cerasinus*: a well developed heel tubercle; no enlarged supraocular or superciliary tubercles; some subarticular tubercles under toes III–IV pungent to pointed; tympanum clear, distinct; no discrete light and dark markings on groin. The presence of red in the groin, on the posterior surface of the thigh, and on the inner face of the calf as described by Cope (1875) confirms the facts of morphology as supported by the original figure. The species was independently described by Barbour (1928) as *Eleutherodactylus peraltae* based on a juvenile 26 mm in length. This individual agrees in all diagnostic features with the type of *cerasinus* and material from localities near Peralta on the Atlantic slope of Costa Rica.

The type and only known specimen of *E. tiptoni* is a young female 24 mm in length, that appears to have died and become desiccated before preservation. Its distinctive features include: a well developed heel tubercle, a series of subequal superciliary tubercles, outer finger disks expanded but not emarginate and some subarticular tubercles pungent or pointed. In these features the type of *tiptoni* agrees with *E. cerasinus* as defined in this paper and approaches closely examples referred to the latter form from the Almirante area of northwestern Panama.

Eleutherodactylus cerasinus differs from *E. cruentus* in the many features given in the key below (couplet 2). The types of *cerasinus, peraltae* and *tiptoni* conform closely with this character suite. Dunn (*in* Zetek and Wetmore, 1951) used the name *cruentus* for an *Eleutherodactylus* population from Barro Colorado Island, Panama. A re-examination of material in many museum collections from the island and other areas in Costa Rica and Panama, identified by Dunn as *cruentus,* shows that he consistently misapplied the latter name to examples of *E. cerasinus.* Although Myers and Rand (1969) continued to use *cruentus* for Barro Colorado Island examples with some question, the species is not known to occur on the island and all references to its occurrence there are based on *cerasinus.*

Among Central American *Eleutherodactylus* that might be mistaken initially for *E. cerasinus,* each (beside the two forms reviewed in greater detail in this paper) may be readily separated from it as follows (features for *cerasinus* in parentheses): *E. altae* and *E. pardalis* lack a well developed heel tubercle and have large discrete light groin and thigh spots (tubercle present, no discrete light spots); *E. caryophyllaceus* has an enlarged superciliary tubercle (no enlarged superciliary tubercle, although a row of equal sized small superciliary tubercles usually present); *E. melanostictus* has a well developed supraocular tubercle (absent); and *E. taeniatus* has distinct narrow finger fringes, lacks superciliary tubercles, lacks red in the groin and on legs in life, and adult males have nuptial thumb pads (no distinct finger fringes, a series of small superciliary tubercles, red present in the groin and on legs in life, no nuptial thumb pads).

The known geographic range for this species is: the Atlantic lowlands and premontane slopes of Nicaragua, Costa Rica, and Panama, onto both versants in western and central Panama (40–1300 m).

Eleutherodactylus ridens (Cope)

1867 *Phyllobates ridens* Cope, Proc. Acad. Nat. Sci. Phila. 18:131.
1885 *Hypodictyon ridens:* Cope, Proc. Amer. Philos. Soc. 22:383.
1888 *Syrrhophus ridens:* Boulenger, Proc. Zool. Soc. London: 206.
1900 *Syrrhophus ridens:* Günther, Biol. Centr. Amer.: 216.
1928 *Syrrhopus molinoi* Barbour, Proc. N. Engl. Zool. Club 10:28 pl. 2,

Fig. 2 (Holotype: MCZ 13051: Panama: Canal Zone: Barro Colorado Island, Panama).

1931 *Eleutherodactylus lutosus molinoi*: Dunn, Occ. Pap. Boston Soc. Nat. Hist. 5:411.

1952 *Eleutherodactylus ridens:* Taylor, Univ. Kansas Sci. Bull. 35(5):690, Fig. 18.

Holotype.—Lost; Nicaragua: Rio San Juan.

This species was originally described from Atlantic versant Nicaragua near the boundary with Costa Rica. The original account Cope (1867) emphasized the areolate venter, reddish dorsal color and dark supratympanic mark, characteristic of individuals associated with this name. Taylor (1952:690) subsequently was the first to apply the name *ridens* to this form, since Costa Rica examples agreed with Cope's original account. My examination of Honduras and Nicaragua specimens confirms their conspecificity with Costa Rica examples. Although the type is lost, the brief type description cannot be associated with any other species and I follow Taylor's use of the name *E. ridens* for this form.

Barbour's (1928) *Syrrhopus molinoi* is based on a 19 mm female that agrees in detail with Costa Rica specimens in: lacking a well developed heel tubercle, and having one to several enlarged pointed supraocular tubercles and the finger disks expanded and rounded. Lynch (1980) concurs with this allocation based on an independent study of the situation and the holotype of *molinoi*. Dunn's (1931) placement of the latter as a subspecies of *lutosus* is clearly incorrect as may be seen from the account of *cruentus,* above, and the key presented below. Although Taylor (1952) recognized *ridens* in Costa Rica he failed to associate it with the Panamanian frogs called *molinoi*. Myers and Rand (1969) continued to use *molinoi* for this form on Barro Colorado Island as a result. Of the three species treated in this paper, *cerasinus* and *ridens* occur on Barro Colorado Island; all three occur in the Panama Canal Zone.

Eleutherodactylus ridens may be separated from other Central American species in the genus with which it might be confused (except *cerasinus* and *cruentus*) as follows, with features for *ridens* in parentheses: *E. caryophyllaceus, E. melanostictus,* and *E. taeniatus* have a well developed heel tubercle (absent); and *E. altae* and *pardalis* have the groin and anterior thigh marked with large light spots (no spots).

Eleutherodactylus ridens has the following known geographic range: the Atlantic lowlands of extreme eastern Honduras, Nicaragua, Costa Rica, and Panama; premontane evergreen forests of Costa Rica and Panama on both Atlantic and Pacific versants; lowlands of southwestern Costa Rica, and in the Pacific versant evergreen forests of Panama, western Colombia, and northwestern Ecuador (15-1200 m).

The following key will distinguish the three species discussed in this report.

1. A distinct well developed pointed to flap-like heel tubercle (calcar) 2
– Heel smooth or with a few small warts all of about the same size and similar to others scattered over upper surface of hind limb; disks round; surface of upper eyelid with one to several enlarged pointed supraocular tubercles; anterior and posterior surfaces of thigh, calf and feet red in life; no nuptial pads; but vocal slits present in adult males; males to 19 mm, females to 25 mm .. *Eleutherodactylus ridens*
2. A distinct, enlarged, pointed or flap-like supraocular or superciliary tubercle; subarticular tubercles under fingers and toes not pungent nor pointed, although often raised; tympanum indistinct (females) or completely hidden (males) under skin; disks truncate; usually one to several bright golden-yellow to orange spots in groin and on front of thigh in life, each outlined by dark pigment; often a series of oblique black flank bars; nuptial thumb pads but no vocal slits in adult males; males to 28 mm, females to 42 mm .... *Eleutherodactylus cruentus*
– No distinct enlarged supraocular nor superciliary tubercle, although a series of small superciliary tubercles usually present along margin of eyelid and several small warts on upper eyelid surface; some subarticular tubercles, at least under toes III–IV, pungent or pointed; tympanum thin, distinct; disks truncate; posterior thigh surface brown with red in groin, on anterior and posterior thigh surfaces and underside of calf, in life; no discrete dark and light markings in groin; no nuptial thumb pads but vocal slits present in adult males; males to 23 mm, females to 35 mm .... *Eleutherodactylus cerasinus*

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Literature Cited

Barbour, T. 1928. New Central American frogs.—Proc. New Engl. Zool. Cl. 10:25–31, pls. 3.
———, and E. R. Dunn. 1921. Herpetological novelties.—Proc. Biol. Soc. Wash. 34:157–162.

Cope, E. D. 1867. Fourth contribution to the herpetology of tropical America.—Proc. Acad. Nat. Sci. Phila. 18:123–132.

———. 1875. On the Batrachia and Reptilia of Costa Rica.—J. Acad. Nat. Sci. Phila. (letterpress) ser. 2, (8):93–157.

Dunn, E. R. 1931. New frogs from Panama and Costa Rica.—Occ. Paps. Boston Soc. Nat. Hist. 5:385–401.

———. 1933. Amphibians and reptiles from El Valle de Anton, Panama.—Occ. Paps. Boston Soc. Nat. Hist. 8:65–79.

Lynch, J. D. 1964. A small collection of anuran amphibians from Panama, with the description of two new species of *Eleutherodactylus* (Leptodactylidae).—J. Ohio Herp. Soc. 4(3):65–68. 3 text-figs.

———. 1979. The amphibians of the lowland tropical forests.—Univ. Kansas Mus. Nat. Hist. Monogr. 7:189–215.

———. 1980. Systematic status and distribution of some poorly known frogs of the genus *Eleutherodactylus* from the Chocoan lowlands of South America.—Herp. 36(2):175–189.

Myers, C. W., and A. S. Rand. 1969. Checklist of amphibians and reptiles of Barro Colorado Island, Panama, with comments of faunal change and sampling.—Smithson. Contr. Zool. 10:1–11.

Peters, W. 1873. Über eine neue Schildkrotenart, *Cinosternun Effeldtii* und einige andere neue oder weniger bekannte Amphibien.—Mon. K. Akad. Wiss. Berlin 1873:603–618.

Savage, J. M. 1965. A new bromeliad frog of the genus *Eleutherodactylus* from Costa Rica.—Bull. So. Calif. Acad. Sci. 64(2):106–110.

Savage, J. M. 1970. On the trail of the golden frog; with Warszewicz and Gabb in Central America.—Proc. Calif. Acad. Sci. 38(14):273–388.

Taylor, E. H. 1952. A review of the frogs and toads of Costa Rica.—Univ. Kansas Sci. Bull. 35(5):577–942.

Zetek, J., and A. Wetmore. 1951. Report on the Canal Biological Area.—Ann. Rept. Smithson. Inst. 1950, App. 10:133–144.

Department of Biological Sciences and Allan Hancock Foundation, University of Southern California, Los Angeles, California 90007.

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PFLUGELLA, NEW NAME FOR *TRICELLARIA* PFLUG, 1965 (MICROPROBLEMATICA), *NON* FLEMING, 1828 (BRYOZOA)

Richard W. Huddleston and Drew Haman

Pflug (1965) established the new genus *Tricellaria* (type-species *T. delylensis* Pflug) from the Precambrian (Algonkian) of Montana. Pflug (1965:16) commented on the possible foraminiferal nature of this form and further added (1965:23) ''A problematic fossil is *Tricellaria delylensis* n. gen. n. sp. which exhibits several structures similar to Foraminifera.'' Edwards and Vevers (1975:347) listed *Tricellaria* Pflug under Rhizopoda, Protozoa, as did Tobias (1968:191) who also noted *Tricellaria* Pflug as ''a foraminiferan-like structure.''

The generic name *Tricellaria,* however was previously used by Fleming (1828:502) for a new genus of Recent scrupocellarid bryozoan (type-species *Cellaria ternata* Elliss, 1786).

Despite the qustionable foraminiferal affinity of *Tricellaria* Pflug as well as its possible removal from the animal kingdom, the taxon is nevertheless subject to the precepts of the International Code of Zoological Nomenclature (ICZN, Art. 2b). *Tricellaria* Pflug is a junior homonym of *Tricellaria* Fleming and must be replaced (ICZN, Art. 53).

The new name *Pflugella* is proposed to replace *Tricellaria* Pflug, 1965, *non Tricellaria* Fleming, 1828.

The name *Pflugella* is constructed in honor of Prof. Dr. Ing. H. D. Pflug, (Geologisch-Palaontologisches Institut, Liebig University, Giessen) for his contributions to micropaleontology.

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Literature Cited

Edwards, M. A., and H. G. Vevers. 1975. Nomenclator Zoologicus, vol. VII, 1956–1965.—Zool. Soc. London, 374 pp.

Fleming, J. 1828. History of British Animals. 502+ pp.

International Code of Zoological Nomenclature, 1964.—Intern. Trust Zool. Nomencl. London. 176 pp.

Pflug, H. D. 1965. Organische Reste aus der Belt-serie (Algonkium) von Nordamerika.—Palaeont. Zeitschr. 39:10–25.
Tobias, M. 1968. The Zoological Record, 1965, vol. 102, Sec. 2, Protozoa, pt. II:115–196.

Chevron Oil Field Research Company, P.O. Box 446, La Habra, California 90631.

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HETEROPTERA RECENTLY COLLECTED IN THE RAY MOUNTAINS IN ALASKA

Richard C. Froeschner and Libby Halpin

Abstract.—This report on a collection of Heteroptera from the Ray Mountains in Alaska includes a brief description of the areas collected, and contains a list of 18 species (in seven families), including 4 apparent "first records" for the state.

The Ray Mountains are located in interior Alaska, approximately 240 km (150 mi) northwest of Fairbanks and 80 km (50 mi) south of the Arctic Circle. The range is situated between the Yukon and Koyukuk Rivers. It trends northwest and is roughly 105 km long (65 mi) and 35 km wide (22 mi). The topography is diverse with most of the area between 457–1219 m (1500–4000 ft) elevation though several peaks exceed 1544 m (5000 ft) including Mount Tozi, the highest at 1682 m (5519 ft).

The range is well characterized as an "island" of subarctic alpine tundra surrounded by a "sea" of boreal forest. The study area was defined roughly to include all of the area above treeline (generally near 610 m [2000 ft]) as well as the forested floodplains and their adjacent forested slopes that finger up into the range.

The vegetation of the range represents a variety of arctic and alpine, and boreal forest communities. On floodplains of major streams open evergreen, deciduous, and mixed forests are present. At elevations above, treeline forests give way to willow scrub communities. Over the rolling lowlands of the range, tussock graminoid meadow and dwarf scrub tussock-graminoid meadow communities dominate. In the higher valleys, dwarf scrub communities are most prevalent, while in the highest parts of the range prostrate scrubs and barrens predominate (Brock and Burke, 1980; Schubert, 1980). See Table 1 for descriptions of localities in which collections were made.

During the summer of 1979 L. Halpin collected 39 specimens of terrestrial Heteroptera (including four unidentifiable nymphs of the family Miridae) in a study area in the Ray Mountains of Alaska. This collection of 18 species is of more than casual interest because it includes four species (indicated by asterisks) for which we have found no previous Alaskan records.

This paper treats the Heteroptera collected during a study of the Ray Mountains, Alaska, under National Science Foundation Grant No. SPI-795346.

Table 1.—Description of insect collecting localities.

Locality	Average elev.	Latitude, longitude	Ecosystem type(s)	Collecting dates (all in 1979)
Crash Creek	580 m 1900 ft	65°39′N 150°52′W	Lowland tundra	Aug. 12–13
Kilo Hot Springs	488 m 1600 ft	65°49′N 151°14′W	Boreal forest	Aug. 4–7
Lake 1485	452 m 1485 ft	65°52′N 151°24′W	Lowland tundra	July 18; Aug. 1
Lower Torment Cr.	580 m 1900 ft	65°49′N 151°26′W	Lowland tundra Boreal forest	June 24–July 26; July 19–23; Aug. 2–3
Moose Cr. Hdwtrs.	610 m 2000 ft	65°36′N 150°40′W	Lowland tundra Boreal forest	Aug. 15
Mt. Tozi Summit	1683 m 5519 ft	65°41′N 150°56′W	Alpine barren	Aug. 11
Spooky Valley	763 m 2500 ft	65°43′N 151°13′W	Upland tundra Alpine barren	July 8–11; Aug. 8–9
Tozitna River	580 m 1900 ft	65°38′N 150°46′W	Boreal forest	Aug. 14
Twilight Cr. Trib.	824 m 2700 ft	65°40′N 150°56′W	Upland/lowland tundra ecotone	Aug. 11
Upper Torment Cr.	854 m 2800 ft	65°46′N 151°31′W	Upland tundra Alpine barren	July 24–30

Acanthosomatidae

**Elasmucha lateralis* (Say). Lower Torment Creek, July 29, 1 ♂; Moose Creek Headwaters, August 15, 1 ♂, 1 ♀, 2 5th instar nymphs. Adults and nymphs are strongly infuscated, one male so much so that it appears almost totally black to the unaided eye. Several apparently previously unreported specimens from Fairbanks, Alaska, are in the National Museum of Natural History.

Anthocoridae

Anthocoris melanocerus Reuter. Spooky Valley, August 8, 1 ♂; Tozitna, August 14, 1 ♀.

Lygaeidae

**Geocoris bullatus* (Say). Moose Creek Headwaters, August 15, 1 ♀. Widely distributed in North America, this species was previously cataloged as far northwest as the Yukon in Canada.

Ligyrocoris sylvestris (Linnaeus). Kilo Hot Springs, August 16, 1 ♀.

Miridae

Calocoris fulvomaculatus (De Geer). Crash Creek, August 12, 1 ♂; Lower Torment Creek, August 3, 1 ♂.

Lygocoris contaminatus (Fallen). Lake 1485, July 18, 2 ♀♀; Lower Torment Creek, June 29, 1 ♂; Kilo Hot Springs, August 13, 1 ♀.

Lygus columbiensis Knight. Mt. Tozi Summit, August 11, 1 ♂, 1 ♀; Twilight Creek Tributary, August 11, 1 ♂.

Lygus varius Knight. Moose Creek Headwaters, August 15, 1 ♂; Twilight Creek Tributary, August 11, 1 ♂.

Mecomma gilvipes (Stal). Kilo Hot Springs, August 5, 1 ♂.

Orthotylus katmai Knight. Twilight Creek Tributary, August 11, 1 ♀.

Plagiognathus obscurus Uhler. Lower Current Creek, August 3, 1 ♀.

Polymerus unifasciatus (Fabricius). Tozitna River, August 14, 1 ♀. This is the color form with the entire clavus and much of the corium blackened.

Trigonotylus ruficornis (Geoffroy). Twilight Creek Tributary, August 11, 1 ♀.

Teratocoris caricis Kirkaldy. Twilight Creek Tributary, August 11, 1 ♀.

Nabidae

**Dolichonabis americolimbatus* (Carayon). Lake 1485, August 1, 1 ♂, 2 ♀♀, 1 nymph, latter determined by association with adults. These new records partially fill the gap between the formerly known North American range and the disjunct occurrence in eastern Asia as reported by Kerzhner (1969:521). Such a range suggests a natural migration through Beringia—whether eastward or westward is not yet clear.

Saldidae

Teloleuca pellucens (Fabricius). Lower Torment Creek, June 29, 1 ♀.

Scutelleridae

**Homaemus aeneifrons* (Say). Lower Torment Creek, June 29, 1 ♀; July 29, 1 nymph. Absence of a male prevents confident subspecies determination of these specimens, but they quite probably represent Walley's (1929:256) western subspecies *H. aeneifrons extensus* which was originally described from western North America from Canadian Northwest Territories south to Colorado.

Literature Cited

Brock, S., and I. Burke. 1980. Vegetation.—*In* N. Farquhar and J. Schubert (eds.), Ray Mountains, Central Alaska: Environmental Analysis and Resources Statement, Middlebury College Press. (In press.)

Kerzhner, I. M. 1969. New and little known Palearctic bugs of the family Nabidae (Heteroptera).—Entom. Review 47(4):517–525 [English Translation from the Russian, Entom. Oboz. 47(4):848–863].

Schubert, J. 1980. Ecosystems.—*In* N. Farquhar and J. Schubert (eds.), Ray Mountains, Central Alaska: Environmental Analysis and Resources Statement, Middlebury College Press. (In press.)

Walley, G. S. 1929. Notes on *Homaemus* with a key to the species (Hemip., Scutelleridae).—Canadian Entom. 61(11):253–256.

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CHRIOLEPIS VESPA, A NEW SPECIES OF GOBIID FISH FROM THE NORTHEASTERN GULF OF MEXICO

Philip A. Hastings and Stephen A. Bortone

Abstract.—*Chriolepis vespa* is described from the northeastern Gulf of Mexico. It is distinguished from the similar *Chriolepis benthonis* Ginsburg by its greater number of second dorsal-fin elements (10 vs. 9), greater degree of scale spination, longer pectoral fin, longer fourth and shorter fifth pelvic rays, tongue shape, and color pattern. The degree of branching of pelvic-fin rays one through four increases with growth in *C. vespa. Varicus* Robins and Böhlke has been distinguished from *Chriolepis* Gilbert on the basis of the degree of branching of the pelvic-fin rays (unbranched in *Varicus*) and other characters which prove to be inconsistent since the discovery of *C. vespa*. The systematics of this group of seven-spined gobies which lack sensory pores is in need of revision.

The gobiid fish genus *Chriolepis* Gilbert 1892, is presently poorly known in the western Atlantic. Only two species, *Chriolepis fisheri* Herre 1942, and *Chriolepis benthonis* Ginsburg 1953, have been described, each from a single specimen. Recent collecting on the offshore continental shelf in the northeastern Gulf of Mexico produced a series of specimens of a new goby referable to *Chriolepis*. Examination of other western Atlantic specimens of this genus indicates the presence of several other undescribed species, whose descriptions await the accumulation of additional specimens.

Methods.—All measurements were made with dial calipers to the nearest 0.1 mm. Meristic and morphometric data were recorded following the procedures of Böhlke and Robins (1968) with the following emendations and additions: fleshy interorbital width is the least distance between the fleshy portions of the supraorbital area; head depth at occiput is the vertical distance from the midline of the occiput to the ventral contour of the head; head depth at preoperculum is the vertical distance from the midline above the posterior edge of the preoperculum to the ventral contour of the head; head width is the maximum horizontal distance between the opercula; intermandibular width is the distance between the posterior mandible tips; body depth at anal-fin origin is the vertical distance from the anal-fin origin to the dorsal body contour; pelvic-fin spine length is the distance from the spine insertion to its tip; pelvic-fin ray length is the distance from the ray insertion to the tip of the longest branch.

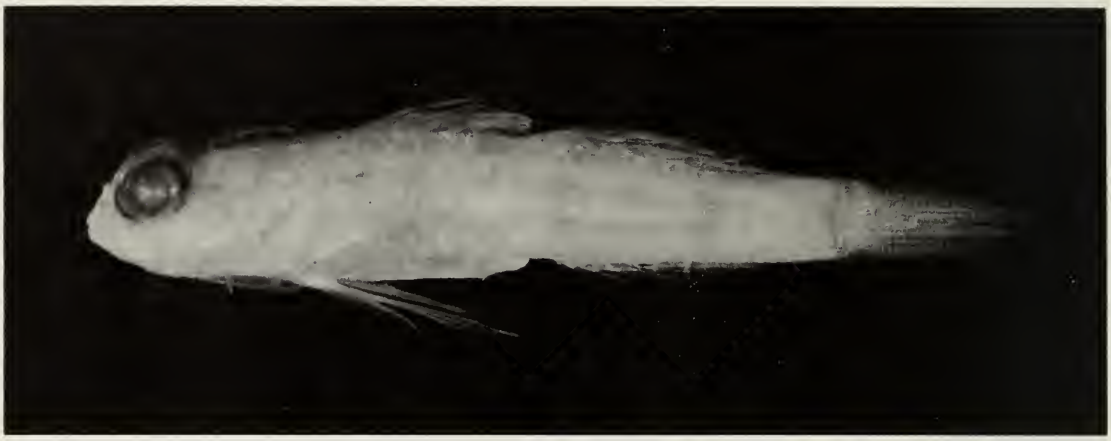

Fig. 1. Photograph of holotype of *Chriolepis vespa,* USNM 221523, 26.6 mm SL, female.

Institutional abbreviations are as follows: GCRL, Gulf Coast Research Laboratory, Ocean Springs, Mississippi; SU, Stanford University (collections now deposited at the California Academy of Sciences, San Francisco, California); USNM, United States National Museum of Natural History, Washington, D.C.; UF, Florida State Museum, University of Florida, Gainesville; UMML, University of Miami, Rosenstiel School of Marine and Atmospheric Sciences, Miami, Florida.

Chriolepis vespa, new species
Wasp goby
Figs. 1, 2, 3

Holotype.—USNM 221523, 26.6 mm SL female, northeastern Gulf of Mexico, 28°24′N, 85°15′W, R/V *BELLOWS* (cruise Bureau of Land Management, BLM 15, station III-C), collected with a 6.1 m semi-balloon trawl on 26 July 1975, depth 183 m, bottom composed of gray mud.

Paratypes.—USNM 221524, 7 (31.4–17.9 mm SL), collected with holotype; UF 28037, 1 (26.4 mm SL), 27°50′N, 84°42′W (R/V *BELLOWS* cruise BLM 15, station II-C), 27 July 1975, 183 m; UF 28038, 1 (34.1 mm SL),

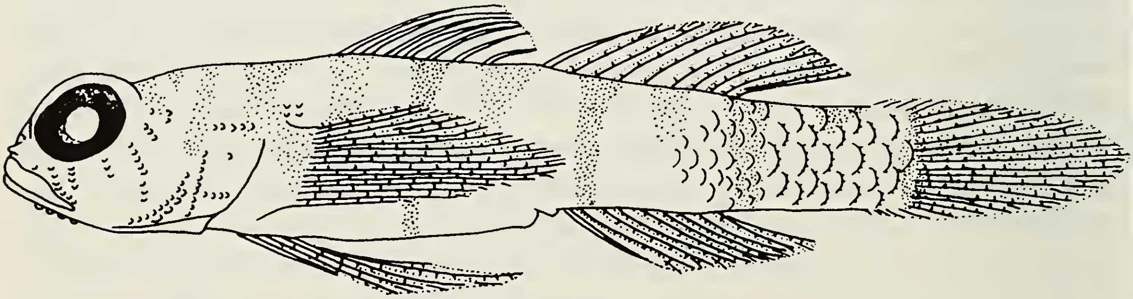

Fig. 2. Drawing of holotype of *Chriolepis vespa.*

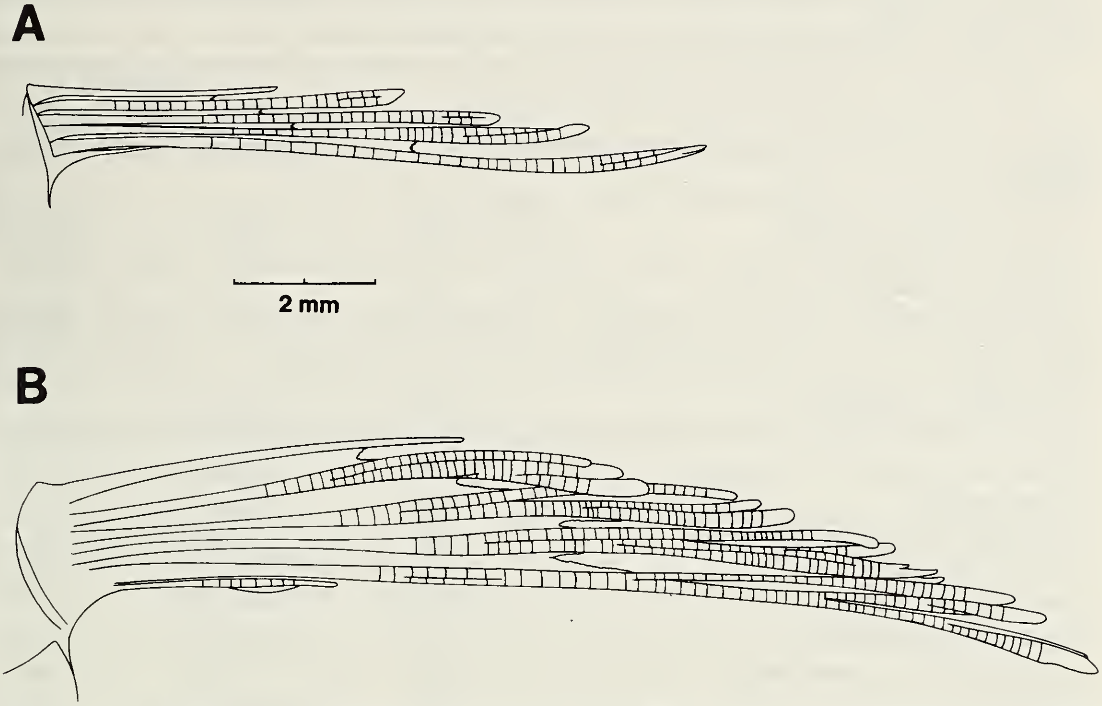

Fig. 3. Left pelvic fins of *Chriolepis vespa*. A, USNM 221524, 19.5 mm SL; B, UF 28038, 34.1 mm SL.

28°24′N, 85°15′W (R/V *BELLOWS* cruise BLM 13, station III-C), 29 August 1977, 183 m; GCRL 16972 (previously USAIC 05983), 1 (24.2 mm SL), northeastern Gulf of Mexico, 29°45.6′N, 87°46.2′W, 7 Feb. 1978, 35 m.

Diagnosis.—A plump-headed species of *Chriolepis* with 10 (I, 9) second dorsal-fin elements and 15–17 pectoral rays. Degree of branching of first through fourth pelvic-fin rays increasing with growth. Fifth pelvic-fin ray unbranched and short. Two to six rows of cycloid scales followed by six to nine rows of ctenoid scales on posterior third of body. Body pale yellowish with four olive bars with intervening olive saddles. Head with a yellow subocular bar in life.

Description.—Meristics and morphometrics of the type specimens are given below and in Table 1. Dorsal VII-10; anal 8 (7–9); pectoral 16 (15–17); vertebrae 27 (11 trunk + 16 caudal).

First through fifth spines of first dorsal fin closely spaced, sixth and seventh more widely spaced, none filamentous. Dorsal fins separate though closely spaced. First element of second dorsal fin a slender spine followed by nine branched rays (last two rays counted as one). First anal-fin element a slender spine followed by 6–8 (typically 7 or 8) branched rays (last two counted as one). Caudal fin truncate in largest specimens, rounded in others. Caudal fin composed of 16–17 total segmented rays (8–9 upper + 7–8 lower segmented rays); not all segmented rays are branched. Upper and lower

Table 1.—Meristics and morphometrics (expressed as thousandths of the standard length) of *Chriolepis vespa*.

	Holotype	Paratypes	
		Range	Mean
Meristics			
First dorsal-fin elements	VII	VII	VII
Second dorsal-fin elements	10	10	10
Anal-fin elements	8	7–9	8.2
Pectoral-fin rays	15 + 16	15–17	16.0
Morphometrics			
Standard length (mm)	26.6	17.9–34.1	25.4
Head length	305	293–354	327
Snout length	56	52–85	65
Maximum eye diameter	105	98–125	108
Interorbital width	9	8–15	11
Postorbital distance	162	147–192	169
Head depth at occiput	132	120–185	147
Head depth at preoperculum	165	155–226	167
Head width	214	196–273	232
Upper jaw length	109	111–123	116
Intermandibular width	132	112–170	149
Body depth at first dorsal-fin origin	180	130–187	163
Body depth at anal-fin origin	158	140–169	154
Caudal-peduncle depth	113	107–118	112
Caudal-fin length	263	265–308	280
Pectoral-fin length	323	284–364	322
Pelvic fin			
Spine length	124	110–128	115
Fourth ray length	293	271–365	312
Fifth ray length	90	41–87	77
Pelvic-fin base to anal-fin origin distance	327	282–371	327

caudal fin composed of 7–8 and 6–8 branched rays, respectively (13–16 total branched rays). Pectoral fin angulate (central rays longest), extending posteriorly to anal-fin origin when adpressed. Pelvic fin I, 5. Pelvic spine short (11–13% of SL). First through fourth pelvic rays increasing in length, the fourth being longest and extending past anus when adpressed (but falling short of the anal-fin origin). Fifth ray short, inconspicuous, adhering closely to the fourth and never branched (Fig. 3). First through fourth rays flattened slightly distally and branched in all specimens examined (Fig. 3); the extent of branching increases with fish length. In smaller individuals (Fig. 3A, 19.5 mm SL), the first through fourth rays with only one shallow branch. The largest specimen (Fig. 3B, 34.1 mm SL) with highly branched rays. In larger specimens, first ray with a secondary bifurcation near the tip of the medial branch of the primary bifurcation. Second, third, and fourth rays with both secondary and tertiary bifurcations. Typically secondary and tertiary bifurcations occur on the medial branch of the preceding bifurcation. Specimens of intermediate size show intermediate patterns of pelvic fin branching.

Pelvic-fin origin under pectoral-fin origin. Pelvic fins separate, with no interspinous membrane and no membrane connecting the fins medially; however, an inconspicuous low fleshy ridge between the inner bases of the pelvic fins is evident in some specimens.

Head plump, approximately one-third of SL. Eye large (maximum diameter about one-third of head length), slightly elevated and superior. Interorbit narrow. Frontals reduced to vestiges between orbits. Mouth terminal, inclined upward approximately 30° from the horizontal. Upper jaw extends posteriorly to below anterior edge of pupil. No head pores. Sensory papillae in rows between nostrils, on preorbit, suborbit, cheek, operculum, lower jaw symphysis, posterior edge of branchiostegal membrane, above pectoral-fin base, and along lateral midline of body anterior to scale rows (Fig. 2). Anterior nostril with a short tube, about one-half pupil diameter in length. Posterior nostril with a minute tube, about one-fourth length of anterior nostril tube. Tongue shallowly indented. Buccal valves well developed.

Posterior portion of body scaled. Scales somewhat caducous. Total scale rows 9–14: 2–6 rows of cycloid scales anteriorly; 6–9 rows of ctenoid scales posteriorly. Origin of cycloid scale rows variable, from under the fifth to the ninth element of the second dorsal fin (sixth in holotype). Origin of ctenoid scales also variable, from under seventh to below last element of second dorsal fin (tenth in holotype). Four enlarged basicaudal ctenoid scales present on upper and lower caudal fin, one upper and one lower on each side. Basicaudal scales missing from left side of holotype (Fig. 2). Ctenii on each basicaudal scale large, conspicuous, and variable in number (4–12). A few additional ctenoid scales on caudal fin between basicaudal scales.

Teeth in lower jaw in four rows anteriorly. Outermost row composed of widely-spaced, enlarged recurved canines. Innermost row composed of more closely-spaced, slightly smaller recurved canines. Inner and outer rows separated anteriorly by two rows of irregular low-pointed teeth. Laterally the outermost and central rows are lacking. Only the innermost row of canines present at angle of jaw. Teeth in upper jaw in about five rows anteriorly, outermost row composed of widely-spaced, enlarged recurved canines; four rows of irregular low-pointed teeth medial to outer row with a few slightly enlarged teeth irregularly spaced within medial rows. Innermost row close-set, with teeth not enlarged as in lower jaw. Outermost row extends to angle of jaw and tooth size decreases posteriorly. Inner rows decrease in number and size posteriorly until only two irregular rows of low teeth remain at angle of jaw. Modified or enlarged lateral canines lacking in either jaw. Teeth lacking on vomer and palatines.

Color notes taken from a fresh paratype (USNM 221524, 31.4 mm SL) supplemented by notes taken from a kodachrome of the same specimen are as follows: body pale yellowish, with pinkish tint anteriorly near pectoral base. Body translucent posteriorly (vertebral column visible through caudal peduncle). Four prominent olive, vertical bars on body; first bar under midspinous dorsal fin, second just posterior to second dorsal-fin origin, third connecting end of second dorsal fin with end of anal fin, fourth at caudal base. All bars extend to ventral outline of body and increase in intensity posteriorly. Two olive saddles on nape, first above preoperculum, second just anterior to pectoral-fin base. Four additional olive saddles on body, first at spinous dorsal-fin origin and one between each of the vertical bars; all saddles paler than vertical bars, and not extending below midline of body. Opercular region, lateral pectoral base, and chest cream-colored with a pink cast. Remaining body white ventrally. Head white from snout to preoperculum. Nape with an olive cast. Faint pink-orange pigment present on operculum. Bright yellow subocular bar extending vertically from orbit to angle of jaw. Lower jaw white. Branchiostegal membranes yellow. Iris golden. Spinous dorsal fin with a wide, yellow-olive band medially and a white band distally. Distal tips of spines yellow-olive. Second dorsal fin with three rows of yellow-olive spots separated by three white bands (yellow-olive proximally followed distally by alternating white and yellow-olive bands). Second dorsal-fin margin black. Anal fin yellow-olive medially, black distally. Distal black band occupies one-fifth of fin anteriorly and grades to occupy three-fifths of the fin posteriorly. Two vertical yellow bars on caudal fin followed distally by a white bar. Distal margin of fin with a black band. Lower caudal-fin rays pale yellow with sparsely scattered chromatophores. Pectoral fin yellow-orange. Pelvic fin yellow-orange proximally, gray distally.

Color of preserved (45% isopropynol) specimens (Figs. 1, 2) as follows: body pallid. Vertical bars and saddles clearly visible on body as clusters of chromatophores. Few chromatophores scattered elsewhere over dorsal and lateral aspects of body. Abdomen, thorax, ventral portion of lateral pectoral-fin base, branchiostegal membranes, and isthmus unpigmented. Nape with contracted chromatophores. Sparse chromatophores present on cheek, suborbit, preorbit, interorbit, and along upper and lower jaws. Iris black. Spinous dorsal fin with scattered chromatophores, most dense at tips of spines. Second dorsal fin with scattered chromatophores, most dense on distal margin. Anal fin unpigmented proximally, but with densely-spaced chromatophores on distal margin. Caudal fin with few scattered chromatophores centrally but with closely-spaced chromatophores peripherally on posterior and ventral margins. Upper portion of outer pectoral-fin base with chromatophores forming an irregular blotch. Few chromatophores on pectoral fin. Pelvic fin with few scattered chromatophores.

Comparisons.—Chriolepis vespa morphologically resembles *C. benthonis* Ginsburg 1953, described from a single specimen from off the Yucatan Peninsula in 154 m of water. The two species are similar in overall head and body shape, number of anal-fin rays (8 in *C. benthonis*), and pectoral-fin rays (16 in *C. benthonis*). They differ in number of second dorsal-fin rays (9 in *C. benthonis*) and in squamation. Although several scales are missing from the holotype of *C. benthonis,* salient differences are apparent in those that remain. In *C. benthonis* there are seven enlarged scales located mid-laterally on the caudal peduncle. Only the last three or four of these possess a few weakly developed ctenii. Small cycloid scales are present on the caudal peduncle above and below the central seven ctenoid scales. Cycloid scales also extend forward in a wedge to under the sixth element of the second dorsal fin. A few cycloid scales are present on the caudal-fin base. No enlarged basicaudal ctenoid scales are present, although these could have been lost. Ginsburg (1953) stated that modified scales were present on the caudal base but most were missing. In *C. vespa,* six to nine rows of well-developed ctenoid scales are present on the body posteriorly. Further, most scales above and below the mid-lateral series possess well-developed ctenii (as many as twelve on one scale), while the only cycloid scales present are those anterior to the mid-lateral ctenoid rows. The ctenii on most scales of *C. vespa* are larger than any of those that remain on the holotype of *C. benthonis*. In *C. vespa* a few ctenoid scales are present on the caudal fin between the modified basicaudal scales. *Chriolepis vespa* specimens and the holotype of *C. benthonis* also differ in some body proportions: *C. benthonis* has a shorter pectoral fin (248 thousandths of the SL), a shorter fourth pelvic-fin ray (247), and a longer fifth pelvic ray (105). Further, the two species differ in tongue shape (rounded in *C. benthonis,* indented in *C. vespa*).

R. S. Birdsong kindly allowed examination of a specimen of *Chriolepis* from Arrowsmith Bank off the Yucatan Peninsula (UMML uncat., R/V *PILLSBURY* station 584) which we believe represents the second known specimen of *C. benthonis*. It agrees with the holotype in dorsal-fin elements (VII-9) and anal-fin elements (8) and was taken relatively near (310 km SE) the type locality though in deeper water (approximately 350 vs. 154 m). Unfortunately, the scales are missing from the *PILLSBURY* specimen. A kodachrome taken of this specimen when initially captured reveals a pale yellow body and a vivid yellow wash on the head. No vertical bars are present on the body, although the head and body do have scattered chromatophores. Ginsburg (1953:22) described the color of the holotype of *C. benthonis* as ". . . a rather uniform light yellowish, probably faded . . ." and thus similar to the *PILLSBURY* specimen. If this uniform yellow color reflects the true coloration of *C. benthonis* and is not the result of fading, then *C. vespa* and *C. benthonis* differ markedly in color pattern, as vertical bars are prominent in *C. vespa*. Recent examination of the holotype of *C. benthonis* revealed no evidence of vertical bars.

According to the original description of the holotype (Herre, 1942), *C. fisheri* differs from *C. vespa* in several characters including head shape (more flattened in *C. fisheri*) and degree of squamation (body naked in *C. fisheri* with only one upper and one lower basicaudal scale present). Meristic differences between the two species include the number of anal-fin elements (10 in *C. fisheri*) and the number of second dorsal-fin elements (11 in *C. fisheri*), though a problematic specimen of *C. vespa* has 11 second dorsal-fin elements (see below). Further, the two species differ in coloration; six narrow crossbars, some of which extend upon the dorsal and anal fins, are present on the body of *C. fisheri* (Herre, 1942) while four are confined to the body of *C. vespa*.

Chriolepis vespa differs from the somewhat similar *Varicus bucca* Robins and Böhlke 1961, principally in the degree of branching of the pelvic-fin rays (unbranched in *V. bucca*), and in having fewer scale rows (27 in *V. bucca*). *Chriolepis vespa* differs from *Varicus marilynae* Gilmore 1979, which has slightly bifurcated pelvic-fin rays, in the number of second dorsal-fin elements (9 in *V. marilynae*), in having fewer scale rows (18–19 in *V. marilynae*), and in coloration (lower portion of head orange in *V. marilynae*).

Distribution and habitat.—The type specimens are from the northeastern Gulf of Mexico from off Mobile Bay, Alabama, to off Tampa Bay, Florida. One specimen was taken in 35 m while all others were from 183 m. Substrate at all localities was grey mud. An additional specimen which may be referable to this species (see below) was taken off Guyana (7°10′N, 53°36′W).

Etymology.—The name *vespa* is from the Latin "vespa," meaning wasp. This name is chosen to bring attention to the wasp-like olive banding of this species.

Discussion.—An additional specimen from off Guyana (UMML uncatalogued, R/V *PILLSBURY* station 658) which may represent *C. vespa* has apparently been lost (R. S. Birdsong and C. R. Robins, pers. comm.). A description of this specimen based on a black/white photograph and radiograph provided by Birdsong follows. Vertebrae 27; dorsal VII-11; anal 9. Ctenoid scales present on lateral portion of caudal peduncle. Enlarged ctenoid basicaudal scales (one upper and one lower) present on caudal-fin base. Chromatophores scattered over head and body, concentrated in four vertical bars on body. Light subocular bar present. Anal-fin margin and lower and distal caudal-fin margins black.

C. R. Robins, who examined this specimen and a kodachrome of a fresh paratype of *C. vespa,* indicated (pers. comm.) that the life colors of the *PILLSBURY* specimen closely resembled those of *C. vespa*. This record is tentatively referred to *C. vespa* because of its similar meristics (differs in having 11 instead of 10 second dorsal-fin elements) and color pattern. Considering the distance (approximately 3200 km) between collecting sites, this specimen needs further examination before positive identification can be made. If it is found and proves to be *C. vespa,* it would increase the species' known distribution considerably.

The genera *Chriolepis* Gilbert and *Varicus* Robins and Böhlke have been distinguished (Böhlke and Robins, 1968) by the following characters: state of pelvic-fin ray branching (branched in *Chriolepis,* unbranched in *Varicus*), presence or absence of a low fleshy membrane connecting the inner pelvic-fin rays (absent in *Chriolepis,* present in *Varicus*), and tongue shape (rounded in *Chriolepis,* bilobed in *Varicus*). Generic allocation of *C. vespa* is based on the extent of branching of the pelvic-fin rays. However, as the degree of pelvic-fin ray branching increases ontogenetically in *C. vespa,* this character may be of little value in distinguishing these genera. Further, the other two characters used to separate these genera are invalidated by the discovery of *C. vespa.* A low fleshy ridge is present between the inner pelvic rays of *C. vespa* (this ridge is also present on several eastern Pacific members of the genus *Chriolepis,* L. T. Findley, pers. comm.; Findley, 1975) and the tongue is not rounded but has a distinct indentation anteriorly.

The generic alignment of *Varicus marilynae* Gilmore 1979, which has slightly bifurcated pelvic rays, is open to question considering the variation of this character in *C. vespa* and the inconsistency of the other available generic distinctions. The western Atlantic members of this entire group of seven-spined gobies with divided pelvic fins and no head pores is in need of revision, as several apparently undescribed forms with both branched and unbranched pelvic-fin rays exist. Definitive generic allocation of these and previously described forms awaits further study.

Comparative material examined.—*Chriolepis* sp., tentatively identified as *Chriolepis vespa*: UMML uncatalogued, R/V *PILLSBURY* station 658, 07°10′N, 53°36′W, off Guyana, 4 July 1968, depth 126–135 m (specimen not examined, apparently lost, black/white photograph and radiograph examined). *Chriolepis benthonis*: USNM 47641, holotype, off the Yucatan Peninsula, Mexico; UMML uncatalogued, R/V *PILLSBURY* station 584, 21°02′N, 86°24′W, Arrowsmith Bank off the Yucatan Peninsula, Mexico, 23 May 1967, depth 347–353 m. *Chriolepis fisheri*: SU 37262, holotype, Barbados (radiograph only). *Varicus bucca*: UMML 7114, paratype, Caribbean Sea (cleared-and-stained). *Varicus marilynae*: USNM 218406, holotype, Atlantic Ocean, Florida east coast; UF 24757, paratype, Gulf of Mexico, Florida west coast.

Acknowledgments

We thank C. R. Robins and R. S. Birdsong for allowing us to describe this species, which they also recognized as undescribed. Birdsong kindly provided several specimens and radiographs, a photograph and radiograph of the apparently lost R/V *PILLSBURY* specimen, and helpful comments on the manuscript. L. T. Findley provided insight into *Chriolepis* systematics and a meticulous review of the manuscript. E. A. Lachner (USNM), C. R. Robins (UMML), and R. L. Shipp (USAIC) allowed examination of specimens in their care. T. Smoyer provided photographic assistance and C. Baker drew Fig. 3. Harbor Branch Foundation, Inc. contribution number 209.

Literature Cited

Böhlke, J. E., and C. R. Robins. 1968. Western Atlantic seven-spined gobies, with descriptions of ten new species and a new genus, and comments on Pacific relatives.—Proc. Acad. Nat. Sci. Philadelphia 120(3):45–174.

Findley, L. T. 1975. A new species of goby from Malpelo Island (Teleostei: Gobiidae: *Chriolepis*).—Smithsonian Contr. Zool. 176:94–98.

Gilbert, C. H. 1892. Scientific results of explorations by the U.S. Fish Commission steamer ALBATROSS, XXII: Descriptions of thirty-four new species of fishes collected in 1888 and 1889, principally among the Santa Barbara Islands and in the Gulf of California.—Proc. U.S. Natl. Mus. 14(880):539–566.

Gilmore, R. G. 1979. *Varicus marilynae,* a new gobiid fish from Florida.—Copeia 1979(1):126–128.

Ginsburg, I. 1953. Ten new American gobioid fishes in the United States National Museum, including additions to a revision of *Gobionellus*.—J. Washington Acad. Sci. 43(1):18–26.

Herre, A. W. C. T. 1942. Notes on a collection of fishes from Antigua and Barbados, British West Indies.—Stanford Univ. Publ., Biol. Sci. 7(2):285–305.

Robins, C. R., and J. E. Böhlke. 1961. A new gobioid fish from the Antilles and comments on *Ctenogobius fasciatus* and *C. curtisi*.—Copeia 1961(1):46–50.

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A NEW GENUS AND A NEW SPECIES OF HELMINTHOGLYPTID LAND SNAILS FROM THE MOJAVE DESERT OF CALIFORNIA

Walter B. Miller

Abstract.—A new genus, *Eremariontoides,* is erected for *Eremarionta argus* (Edson, 1912) because its anatomy differs significantly from that of *Eremarionta* Pilsbry, 1913. A new species of *Eremarionta, E. greggi,* is described for populations that had been considered conspecific with *E. argus* but whose anatomy reveals them to be typical *Eremarionta.*

In 1912, H. M. Edson described *Sonorella argus* from dead shells collected by A. M. Strong at the Iron Cap copper mine in Revenue Canyon, Argus Mts., California. Pilsbry (1939) assigned this species to the genus *Micrarionta* Ancey, 1880, subgenus *Eremarionta* Pilsbry, 1913, on the basis of shell characters only. *Eremarionta* was raised to generic rank by Bequaert and Miller (1973) because its anatomy and shell characters were sufficiently different from *Micrarionta* to render questionable the implied close phylogeny conferred by subgeneric status.

W. O. Gregg and I have dissected topotypes of *E. argus* and found that the anatomy of the reproductive system is considerably different from that of typical *Eremarionta.* There is no dart sac, no mucus glands, and the epiphallic caecum is reduced to a minute apical appendage on the epiphallus; furthermore, the penis and epiphallus are greatly shortened from the usual *Eremarionta* structures.

Over a period of years, Gregg and I have obtained specimens of *E. argus* from other localities in the Argus Mts., especially Homewood Canyon, at the southern end of the range, and we have found that all specimens dissected exhibit the same anatomy as the topotypes. More recently, specimens from the Slate Range, a spur of the Argus Range, have also revealed a similar anatomy.

By contrast, specimens from Johnson Canyon, in the Panamint Mts., which had been considered conspecific with *E. argus* on the basis of shell characters, have revealed a typical *Eremarionta* anatomy, with dart sac, mucus glands, long epiphallic caecum, and appropriate penial characteristics. Additional collecting in the eastern end of the Avawatz Mts., east of Fort Irwin, has yielded specimens similar to those found in the Panamint Mts., both in shell morphology and in reproductive anatomy.

It is apparent that the Argus and Slate populations have undergone major

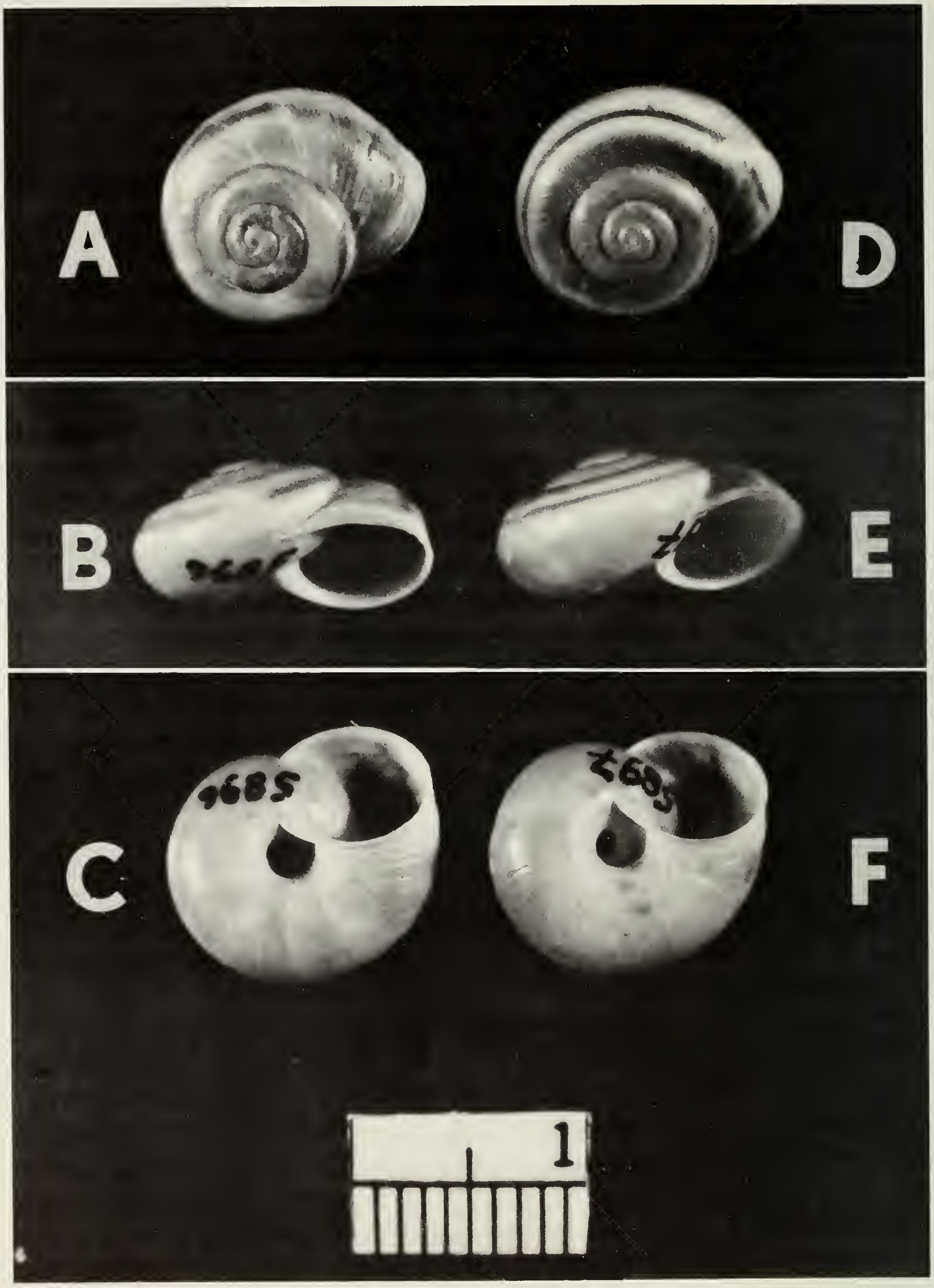

Fig. 1. A, B, C, Shell of *Eremariontoides argus*; D, E, F, Shell of *Eremarionta gregg*
holotype. Scale line, 1 cm.

genetic changes from the populations in the Panamint and Avawatz ranges, probably a form of saltational speciation by chromosomal rearrangement, along the lines of the probable evolution of *Mohavelix micrometalleus* (Berry, 1930) from a population of *Helminthoglypta micrometalleoides* Miller, 1970. Unfortunately, to date, Noorullah Babrakzai has been unsuccessful in attempts to stain for C-bands and G-bands on the relatively very small and numerous chromosomes of any of the Argus, Slate, Panamint, or Avawatz populations. Initial investigations on chromosome spreads of the Argus population, indicate a chromosome number of 2n = 60 (Babrakzai, personal communication). Babrakzai and I suspect that a comparison of chromosome bands would reveal the type of chromosomal rearrangement that has probably occurred.

Meanwhile, in order to reflect correctly the systematic positions of the different populations, it has become necessary to erect a new genus for *E. argus* and to describe a new species for the Panamint and Avawatz populations which, heretofore, have been considered conspecific with *E. argus*.

The following abbreviations for repositories of material are employed: ANSP = Academy of Natural Sciences of Philadelphia; CAS = California Academy of Sciences; CCC = Carl C. Christensen collection; FMNH = Field Museum of Natural History; USNM = U.S. National Museum of Natural History; UTEP = University of Texas at El Paso; WBM = Walter B. Miller collection.

Eremariontoides, new genus

Figs. 1A, B, C; 2A, B

Description.—Eremariontoides is a helminthoglyptid genus with shells similar to *Eremarionta* but with a reproductive anatomy characterized by the complete absence of dart apparatus and mucus glands. Additionally, the spermathecal duct and the spermathecal diverticulum are similar to those of *Eremarionta,* but the epiphallic caecum is reduced to a minute tip at the end of the epiphallus. The epiphallus is short and contains 3–4 longitudinal, anastomosing, thick pilasters which can protrude only slightly to form a minute, verge-like penis-papilla, into the short, saccular penial chamber.

Type-species.—Eremariontoides argus (Edson, 1912).

Distribution.—Eremariontoides is a monotypic genus which has been confirmed only in the Argus and the Slate Ranges of California.

Differential diagnosis.—Eremariontoides joins the list of the west North American helminthoglyptid genera that have lost the dart apparatus and mucus glands, namely *Sonorelix* Berry, 1943, *Sonorella* Pilsbry, 1900, *Mohavelix* Berry, 1943, *Greggelix* Miller, 1972, and *Tryonigens* Pilsbry, 1927. It is separated from *Sonorella* and *Mohavelix* by its substantial spermathecal diverticulum, its foreshortened and thick epiphallus, and its short

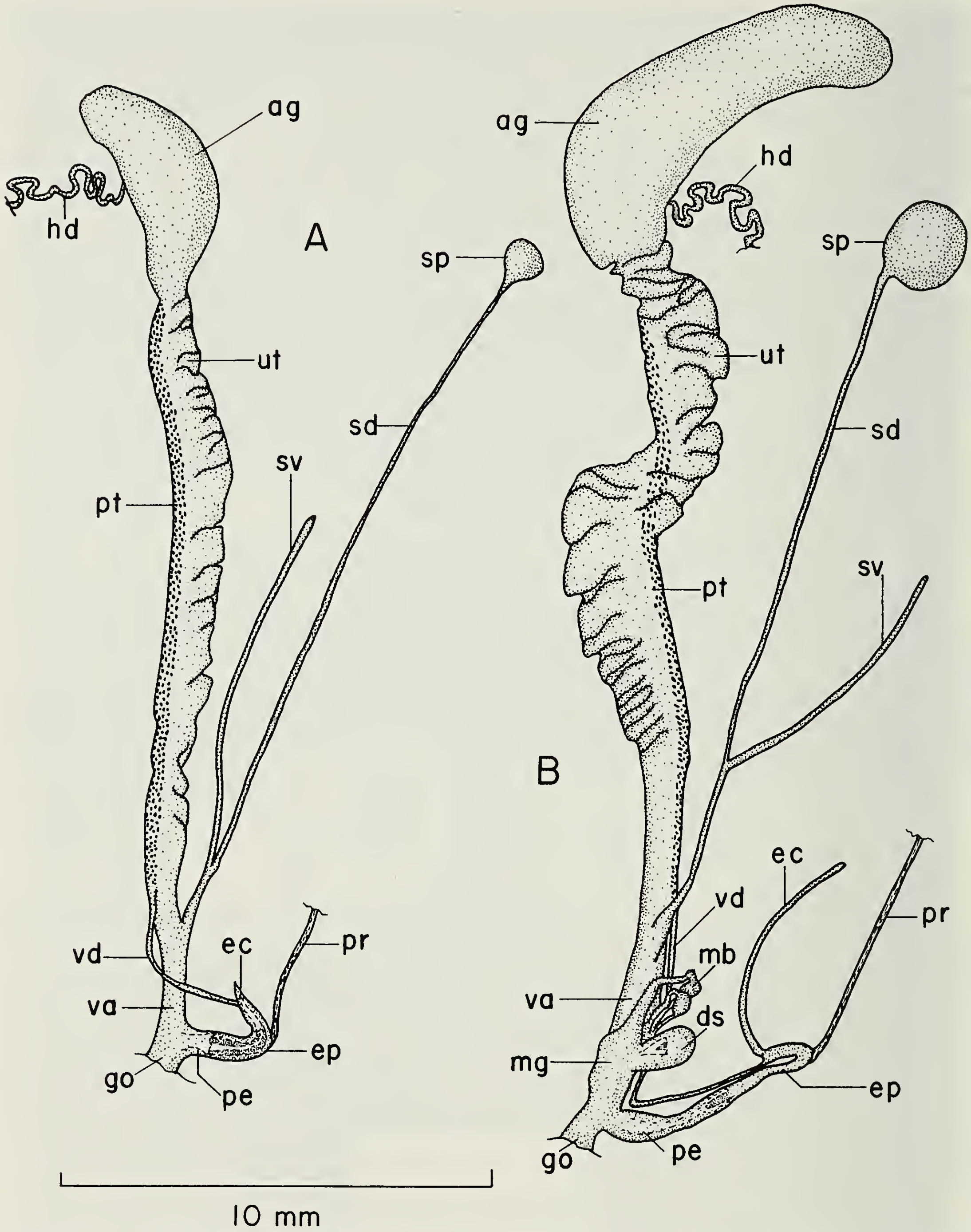

Fig. 2. A, Reproductive system of *Eremariontoides argus*; B, Reproductive system of *Eremarionta greggi*. Both figures to same scale; ovotestes omitted. ag, albumen gland; ds, dart sac; ec, epiphallic caecum; ep, epiphallus; go, genital orifice; hd, hermaphroditic duct; mb, mucus bulb; mg, mucus gland membrane; pe, penis; pr, penial retractor muscle; pt, prostate; sd, spermathecal duct; sp, spermatheca; sv, spermathecal diverticulum; ut, uterus; va, vagina; vd, vas deferens. A, WOG 7765-c stained whole mount, Revenue Canyon, Argus Mts. B, WBM 5897 stained whole mount, Johnson Canyon, Panamint Mts.

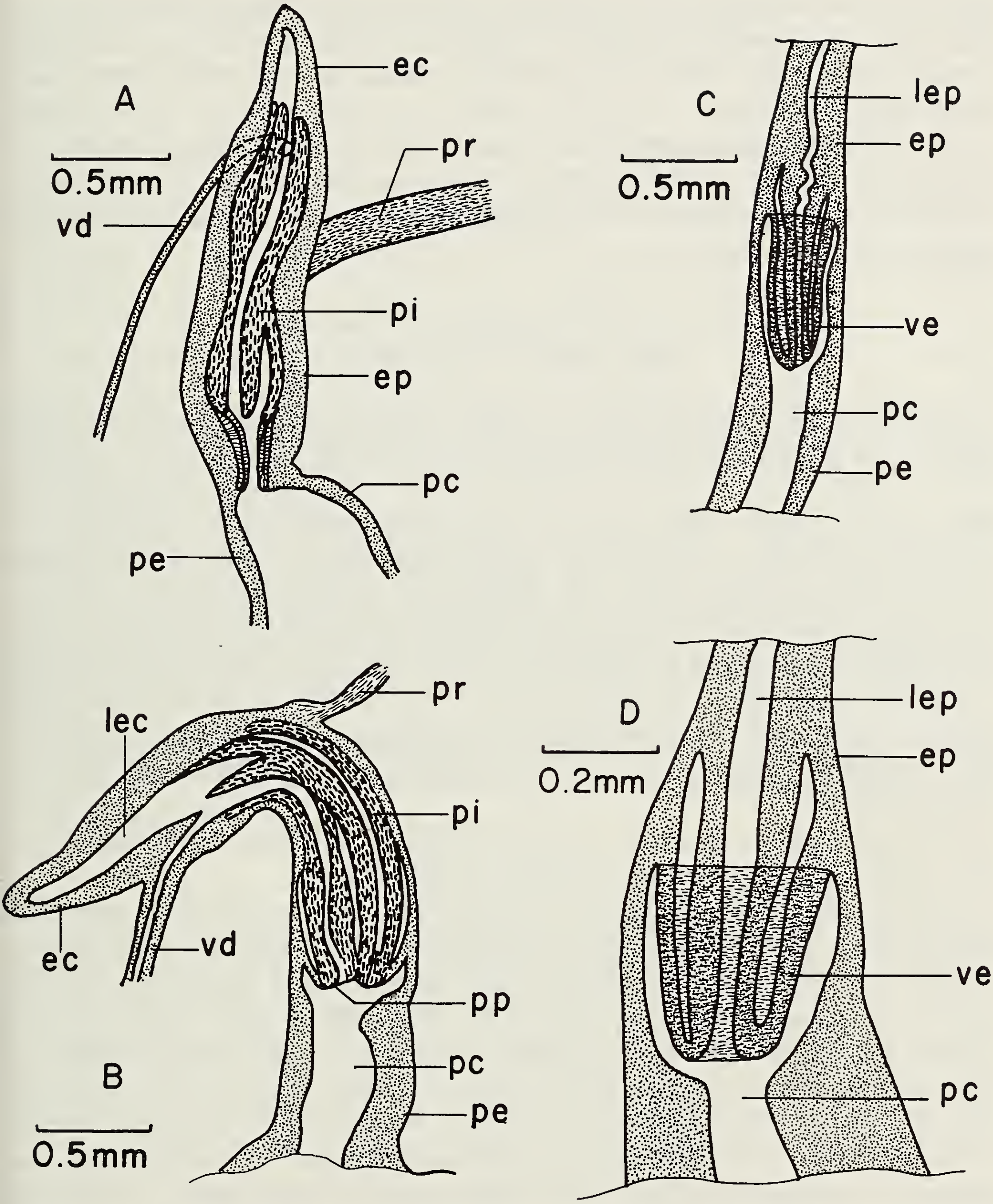

Fig. 3. A and B. Internal structures of male reproductive system of *Eremariontoides argus*. C and D. Internal structures of male reproductive system of *Eremarionta greggi*. All figures drawn from stained whole mounts as seen by camera lucida through compound microscope. A, WBM 5896; B, WOG 7765-c; both from Revenue Canyon, Argus Mts.; C, WBM 5897: D, WOG 7971-c; both from Johnson Canyon, Panamint Mts.; ec, epiphallic caecum; ep, epiphallus; lec, lumen of epiphallic caecum; lep, lumen of epiphallus; pc, penial chamber; pe, penis; pi, pilaster; pp, penis papilla; pr, penial retractor muscle; vd, vas deferens; ve, verge.

penis with occasionally a very slightly everted penis-papilla formed by the protruding distal ends of epiphallic pilasters. It is separated from *Sonorelix* and *Greggelix* by its very short epiphallic caecum and the absence of a true, non-invaginable verge. *Tryonigens* stands apart from all other genera by its extremely short spermathecal duct; otherwise, *Tryonigens* most closely resembles *Sonorella,* and differs from *Eremariontoides* by its sizeable, non-invaginable verge situated in the penial chamber, and by its lack of spermathecal diverticulum.

Eremarionta greggi, new species

Figs. 1D, E, F; 2B; 3C, D

Description of shell of holotype.—Shell small for the genus, with rounded whorls and moderately open umbilicus; color pale-brown, with a typical narrow, dark-brown band above the periphery, bordered on each side by a paler, whitish band. The body whorl descends sharply to the aperture bordered by a slightly expanded peristome. Embryonic shell of 1½ whorls initially glassy smooth, then with light radial wrinkles gradually superimposed with spirally arranged, elongate papillae. Beyond the embryonic shell, the papillae are present for about one more half whorl and then disappear completely; light radial wrinkles persist on all whorls to the aperture. The aperture is rounded-oval with margins converging to the thin parietal callus; the columellar margin of the aperture expanded and slightly reflexed over the umbilicus.

Measurements of holotype.—Shell diameter 12.4 mm, shell height 6.5 mm, unbilicus width 2.1 mm, number of whorls 4.

Reproductive system anatomy of holotype.—The reproductive system is typical for the genus, with a dart-containing dart sac inserted on the vagina, 2 mucus glands whose glandular tissues descend and spread around the vagina and whose ducts lead separately from each of the 2 bulbs into the vagina immediately above the opening of the dart sac. The spermathecal duct is typical for the genus and bears a moderately long spermathecal diverticulum. The penial retractor muscle is attached to the epiphallus which is equipped with a moderately long epiphallic caecum; at its distal end, the epiphallus consists of a short inner tube within an outer tube. The typical penial sac contains a verge at its proximal end which is formed by a partial eversion of the inner tube of the epiphallus.

Remarks.—The shell of *Eremarionta greggi* is in all respects similar to that of *Eremariontoides argus,* with which it has been considered conspecific. As stated by Pilsbry (1939): ''the depressed shape and very wide last whorl are its most prominent features.'' Adult shell measurements in the type lot vary from a minimum diameter of 10.7 mm to a maximum of 13.5 mm and from a minimum height of 5.7 mm to a maximum of 6.9 mm.

The reproductive anatomy is typical for the genus and is not diagnostically distinctive. The verge varies in length in different specimens depending on the degree of evagination of the distal inner epiphallic tube into the penial sac.

I have examined the reproductive system of most of the described species of *Eremarionta* and, in all specimens, I have noted a distinct verge formed by partial eversion of the inner epiphallic tube. Although the anatomy of this type of eversible verge indicated that a complete retraction should be possible, I have never observed such complete retraction. It is possible, however, that the ever-present partial eversion may be an artifact of preparation caused by the method of obtaining the body of the animal by drowning and heating to 60°C in order to avoid breaking the shell. Live, adult specimens of most species of *Eremarionta* are usually rare and difficult to obtain, so that every effort is made to preserve intact both the shell as well as the body of the animal.

Distribution.—*Eremarionta greggi* is known only from the Panamint Mountains and the Avawatz Mountains of California. It may be present in the Owl Head Mountains and possibly in other nearby ranges where *E. argus* had been said to occur; it will be necessary, however, to examine the anatomy of all such reported specimens before a definite diagnosis can be made.

Disposition of types.—Holotype, USNM 784583; Paratypes, USNM 784584; ANSP 353858; CAS 60745–60747; CCC 3949; FMNH 198998; UTEP 7958; WBM 5897.

Localities of Collections

Topotypes of *Eremariontoides argus* were collected from the following locality: Large, north-facing rockslide located 1.3 miles up Revenue Canyon from the limestone crusher plant, Argus Mts., Inyo Co., CA.

Additional collections of *E. argus* were made at the following localities: 1. Homewood Canyon, Argus Mts., in north-facing rockslides. 2. East side of Slate Mts. in rocks at base of ravines at south end of Panamint Dry Lake.

Type-locality for *Eremarionta greggi*: Johnson Canyon, Panamint Mts., in large north-facing rockslide at a point 6.5 road miles up Johnson Canyon road from the main west side road.

Populations of *E. greggi* were also confirmed in the Avawatz Mts., San Bernardino Co., CA, in north-facing rockslides along the Silver Lake-Fort Irwin road at the boundary of Fort Irwin.

Acknowledgments

The late Wendell O. Gregg introduced me to desert collecting in 1956. He was my constant companion and teacher for many years, and he has bequeathed to me a large number of undescribed populations of California land snails. His initial investigations in *Eremarionta* and *Eremariontoides* were responsible for the eventual preparation of this paper. I am also indebted for the assistance and camaraderie of Drs. Noorullah Babrakzai, Carl C. Christensen, and H. Lee Fairbanks in the course of several trips to field localities cited above. Their enthusiasm and encouragement contributed significantly to the successful elucidation of this perplexing problem of separating and identifying the many widespread populations of both species.

Literature Cited

Bequaert, J. C., and W. B. Miller. 1973. The mollusks of the arid Southwest.—University of Arizona Press: xvi + 271 pp.

Edson, H. 1912. Two new land shells from California.—Nautilus 26(4):37.

Miller, W. B. 1970. A new species of *Helminthoglypta* from the Mojave Desert.—Veliger 12(3):275–278.

Pilsbry, H. A. 1939. Land Mollusca of North America (north of Mexico).—Acad. Nat. Sci. Monogr. 3 (Vol. I, Pt. 1): xvii + 573 + i–ix pp.

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A NEW SPECIES OF *ASPIDOSIPHON* (SIPUNCULA) FROM THE WESTERN ATLANTIC OCEAN

Edward B. Cutler

Abstract.—A new species of Sipuncula, *Aspidosiphon* (*Aspidosiphon*) *gosnoldi*, is described. This form had earlier been identified erroneously as *Aspidosiphon spinalis* by Cutler (1973) and Cutler and Cutler (1979). It has been collected off the southeastern U.S., Bahamas, and Brazil at depths between 7 and 185 m.

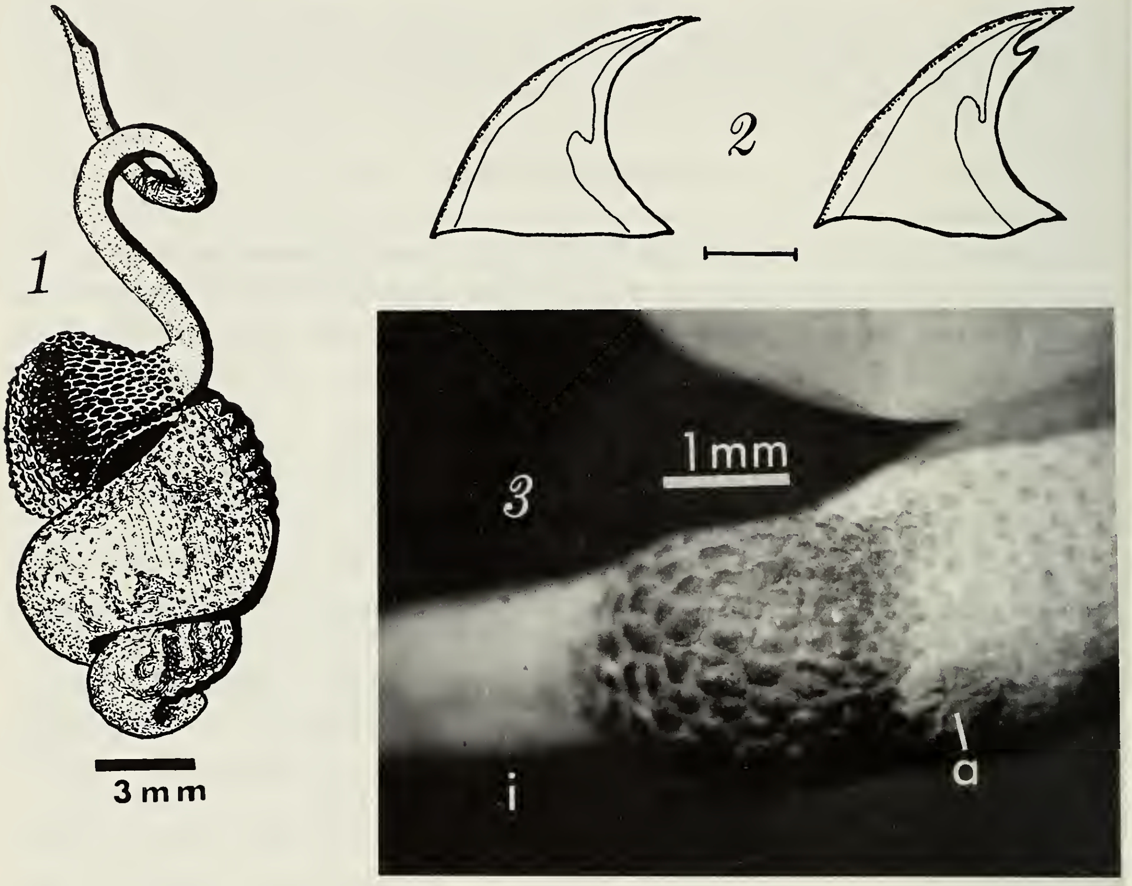
In Cutler (1973), and Cutler and Cutler (1979) the name *Aspidosiphon spinalis* Ikeda (1904) was used for two populations of western Atlantic Ocean worms. It was noted (Cutler, 1973:175), "This identification is made with some reservations because no specimens of Ikeda's material are available for comparison and his illustrations are not very clear." After spending several months in Japan examining that fauna and reevaluating the species described by Ikeda and Sato (Cutler and Cutler, 1981) it became clear to me that I had misused that name; i.e., the animals from the Atlantic Ocean were different from those Ikeda looked at. *Aspidosiphon spinalis* is now considered to be a junior synonym of *A. elegans*. Much of the confusion centered around the meaning of the term "spine." This is discussed in more detail in Cutler and Cutler (1981). The word spine has been used for two different kinds of structure: (A) large, conical, curved in side view, dark brown structures; (B) small, unpigmented, gently curved, single-pointed hooks. We have restricted our usage of spine to type A, such as those present in *A. elegans,* and call type B unidentate hooks, such as those present in this species. Consultation with Mary Rice (Smithsonian Institution) and examination of the existing literature has led me to conclude that these animals represent a new species.

Aspidosiphon (*Aspidosiphon*) *gosnoldi,* new species

Figs. 1—4

Aspidosiphon spinalis Ikeda.—Cutler, 1973:175–176, fig. 48–49.—Cutler and Cutler, 1979:107.

Description.—As almost all of these worms are coiled, having lived in gastropod shells, it is difficult to obtain accurate measurements (Fig. 1). They are commonly from 5–15 mm long but range from approximately 2–22 mm. The color is cream or pale tan with shields that vary from light to dark



Figs. 1–3. *Aspidosiphon gosnoldi*: 1, External view, introvert incomplete (from Cutler, 1973); 2, Unidentate and bidentate hooks from the introvert (scale 10 um); 3, Anterior end of trunk, showing anal shield (a, anus; i, introvert).

brown. In larger animals, the anterior third of the trunk appears brownish because of the development of darker cuticular plaques around the papillae. A few worms have commensal endoprocts, and others have commensal polychaetes living with them in the shells.

The introvert is 2–3 times the trunk length, and its diameter decreases near the end just behind the tentacular crown which is composed of 8–10 small, finger-shaped tentacles. No introvert was completely extended so no comment can be made about tentacle position. The distal 10–20% bears 25–60 complete rings of hooks followed by a short transition zone of incomplete rings, and eventually the hooks are scattered over most of the remainder of the introvert. The hooks near the distal end have secondary points while the remainder are unidentate (Fig. 2) and both are about 22–26 μm tall. The introvert also carries cylindrical papillae (15–17 μm tall) between the hook rings.

The anal shield is composed of large, brown, close-set, polygonal, randomly arranged, chitinous subunits (Fig. 3). In general, it has well-defined

Table 1.—A comparison of the known distribution of 3 similar *Aspidosiphon*.

Ocean	*A. gosnoldi* W. Atlantic	*A. misakiensis* W. Pacific	*A. gerouldi* E. and W. Atlantic
Latitudes	24–35°N and 23°S	25–35°N	8°S–16°N
Common depth	10–100 m	0–5 m	5–30 m

limits. The caudal shield, composed of scattered chitinous papillae is generally paler and less well defined. These papillae give a suggestion of a radial arrangement.

Internally the longitudinal musculature is continuous except that a few larger worms show a suggestion of separate bundles, particularly just behind the anal region. The 2 retractor muscles originate from the posterior end of the body at the border of the caudal shield and merge to form one muscle before inserting in the anterior end. These 2 muscles remain separate for about 35–50% of the total length. The coiled intestine is anchored at both ends by the spindle muscle but fixing muscles were not seen. The anterior attachment of the spindle muscle is on the body wall just anterior to the anus. The pale nephridia are about half the length of the body and are fixed to the body wall by connective tissue for much of their length.

Relationships.—This species is in the group of *Aspidosiphon* (*Aspidosiphon*) which have both bidentate and unidentate hooks, 2 retractor muscles originating near or on the posterior end of the trunk, an ungrooved anal shield, and lack dark, conical, spinelike papillae on the base of the introvert. This group now includes only *A. gerouldi* and *A. misakiensis*. *A. gosnoldi* differs from *A. gerouldi* in that its anal shield is much less compact, made up of units which are spread apart, while *A. gerouldi* has one which is compact and granular with the subunits fused. The caudal shield of *A. gerouldi* is also more distinct and grooved. The difference from *A. misakiensis* also lies in the nature of the anal shield (*A. misakiensis* being again more compact and coarse). The longitudinal muscle layer of *A. misakiensis* very often exhibits fractures or splits in it other than just in the anal region. These three species are geographically separate populations with some differences in habitat preference (Table 1). When one looks at representatives of these three populations, they do look different but it becomes difficult to articulate those differences precisely. It is possible that additional analyses with more sophisticated techniques will show these forms to be conspecific.

The name of this new species acknowledges the vessel used by the U.S. Geological Survey to collect most of these animals, the R/V *Gosnold*. The holotype is from Sta. 1692, 12 June 1964, 29°30′N, 80°29′W, 32 m, and is deposited at National Museum of Natural History, Smithsonian Institution, USNM 61624. Paratypes are from R/V *Eastward* St. 1439, collected by I.

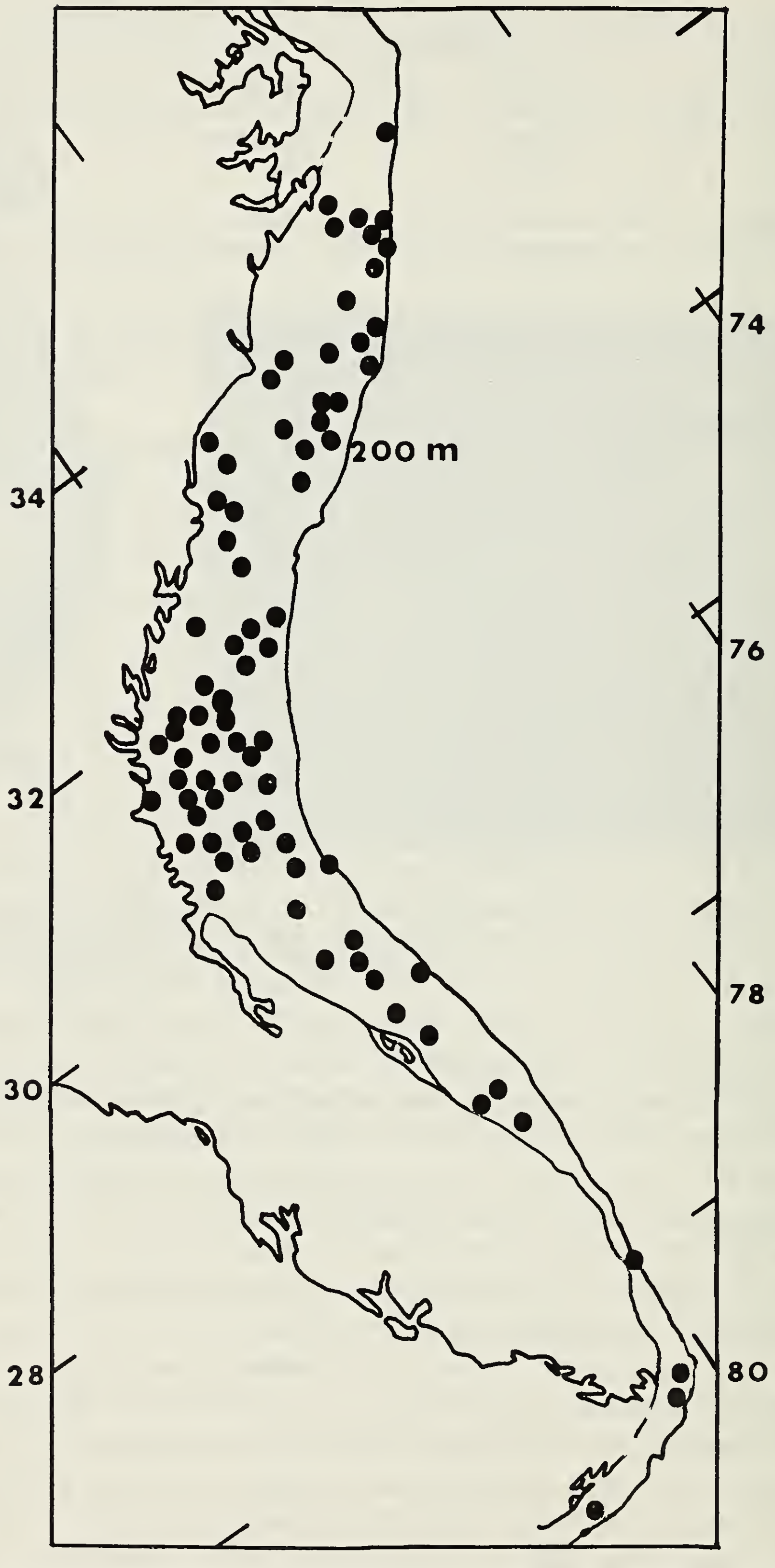


Fig. 4. Recorded occurrences of *Aspidosiphon gosnoldi* off the southeastern United States. For records in the Bahamas and Brazil, see text.

E. Gray and L. McCloskey, 21 May 1965, 34°59′N, 75°28′W, 100 m, USNM 61625.

Distribution.—In the Northern Hemisphere (Cutler, 1973, 287 specimens from 103 stations) this species inhabits the continental shelf from Cape Hatteras to the Florida Keys (Fig. 4). The known latitudinal range is from 24°27′ to 35°00′N. Seventy-one percent of the records are from depths less than 35 m, 17% between 35–85 m, and 12% greater than 85 m. The known depth range is 7–185 m; the temperatures range from 15–28°C. Most of these animals live in empty mollusk shells. One previously unpublished record is of 2 worms collected by B. Thomassin from the Bahamas in 1974, seaward reef slope in sand at 15 m. The southern population (Cutler and Cutler, 1979) is known from 2 stations off Brazil (23°S) at 103 m (11 specimens) and 25 m (1 specimen) collected by the *Calypso.*

Literature Cited

Cutler, E. B. 1973. Sipuncula of the Western North Atlantic.—Bull. American Mus. Nat. Hist. 152:105–204.

———, and N. J. Cutler. 1979. Campagnes de la *Calypso* au large des cotes Atlantiques Africaines (1956 et 1959) et Sud-Americaines (1960–1961). 23. Sipuncula.—Resultats Sci. Camp. de la Calypso 11:103–109.

———, and ———. 1981. A reconsideration of Sipuncula named by I. Ikeda and H. Sato.—Publ. Seto Mar. Biol. Lab. 26:51–93.

Ikeda, I. 1904. The Gephyrea of Japan.—Jour. Coll. Sci., Imp. Univ. Tokyo 20:1–87.

Utica College of Syracuse University, Utica, New York 13502.

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PSOLIDIUM PROSTRATUM, NEW SPECIES, FROM OFF THE EAST COAST OF THE U.S.A. (ECHINODERMATA: HOLOTHUROIDEA)

David L. Pawson and John F. Valentine

Abstract.—A new species of *Psolidium* is described. It was collected off the North Carolina and South Carolina coasts at depths ranging from 383 to 450 meters. This is the first record of the genus *Psolidium* from the Western North Atlantic.

The genus *Psolidium* Ludwig, 1886, as presently characterized includes approximately 25 species. *Psolidium* is widely distributed in the polar regions and the Pacific Ocean, to depths of approximately 3000 meters. Until now, only a single species, *P. arcuatum* (Herouard, 1912), from off the Azores, was known from the Atlantic Ocean. The present new species is, therefore, the first record of the genus from the Western North Atlantic.

As psolids usually attach themselves to hard substrata, such as rocks, it is obvious that they would be more plentiful in rocky habitats that are usually avoided by research vessels engaged in trawling and dredging. It is thus likely that several species of psolids, and especially *Psolidium,* remain to be discovered in rocky habitats in the Western North Atlantic.

The new species was collected off South Carolina by Texas Instruments Ecological Services during 1977, while undertaking the South Atlantic Benchmark Program for the Bureau of Land Management. An additional specimen collected from off North Carolina was found in the reference collection of the Duke University Marine Laboratory, Beaufort, North Carolina.

Family Psolidae Perrier, 1902

Psolidium Ludwig, 1886

Type-species.—*Psolidium dorsipes* Ludwig, 1886.

Psolidium prostratum, new species

Figs. 1, 2

Diagnosis.—Small species, probably not exceeding 20 mm in total length. Numerous tube feet scattered on dorsal surface. Oral and anal apertures sur-

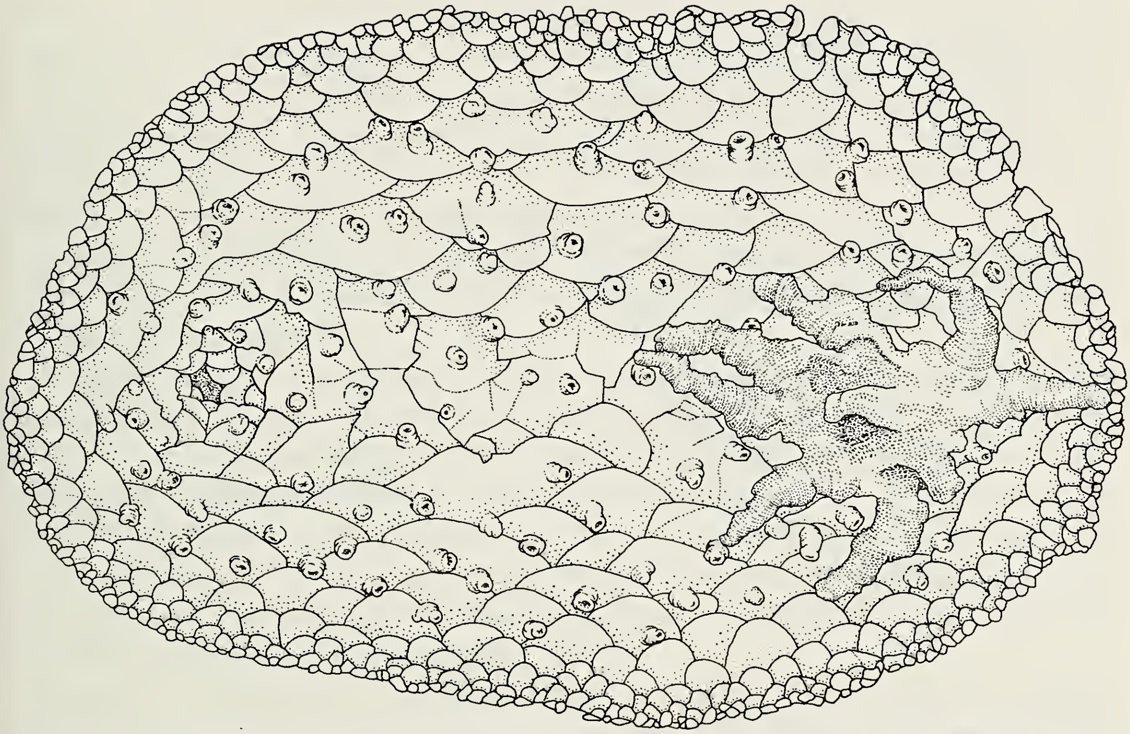

Fig. 1. *Psolidium prostratum*: Holotype, dorsal aspect. Drawing by C. G. Messing.

rounded by numerous scales; no identifiable oral or anal valves. Approximately 12–20 scales between oral and anal apertures. Mid-ventral radius with few (4–5) tube feet. Ossicles in sole exclusively knobbed plates, usually with more than 4 perforations; no cups.

Material examined.—10 specimens and 5 fragments from the following localities: HOLOTYPE.—USNM E20993, 32°20′06″N, 78°11′04″W, 412 meters, 15 February 1977, temperature 17.5°C, salinity 35.2‰, dissolved O_2 4.9 mg/liter (Sta. 159-2), total length 11.5 mm. PARATYPES.— USNM E20994, same data as Holotype, 2 specimens, 10.5, 3.5 mm; USNM E20995, 32°19′59″N, 78°10′39.06″W, 383 meters, 12 May 1977, temperature 8.79°C, salinity 35.3‰, dissolved O_2 4.7 mg/liter, 6 specimens and 5 fragments, total length 2–13 mm (Sta. 501-2 to 501-6). Other material: Duke University Marine Laboratory, 34°17.5′N, 75°49.5′W, 450 meters, 13 March 1965, 1 specimen, total length 6 mm.

Description.—Body very flattened, contorted to conform to shape of substrate. Total length 1.5–15 mm. Width approximately 50% of length. Dorsal surface with numerous thin, fragile scales; at least 12–20 scales between oral and anal apertures. Scales smooth, approximately equal-sized, averaging 1 mm in diameter. Scales decrease sharply in size towards ambitus. Tube feet scattered over dorsal surface, at least 100 feet in large specimens; feet emerge between and through dorsal scales (Fig. 2C). Oral and anal apertures similar, oral aperture larger. Both surrounded by numerous scales

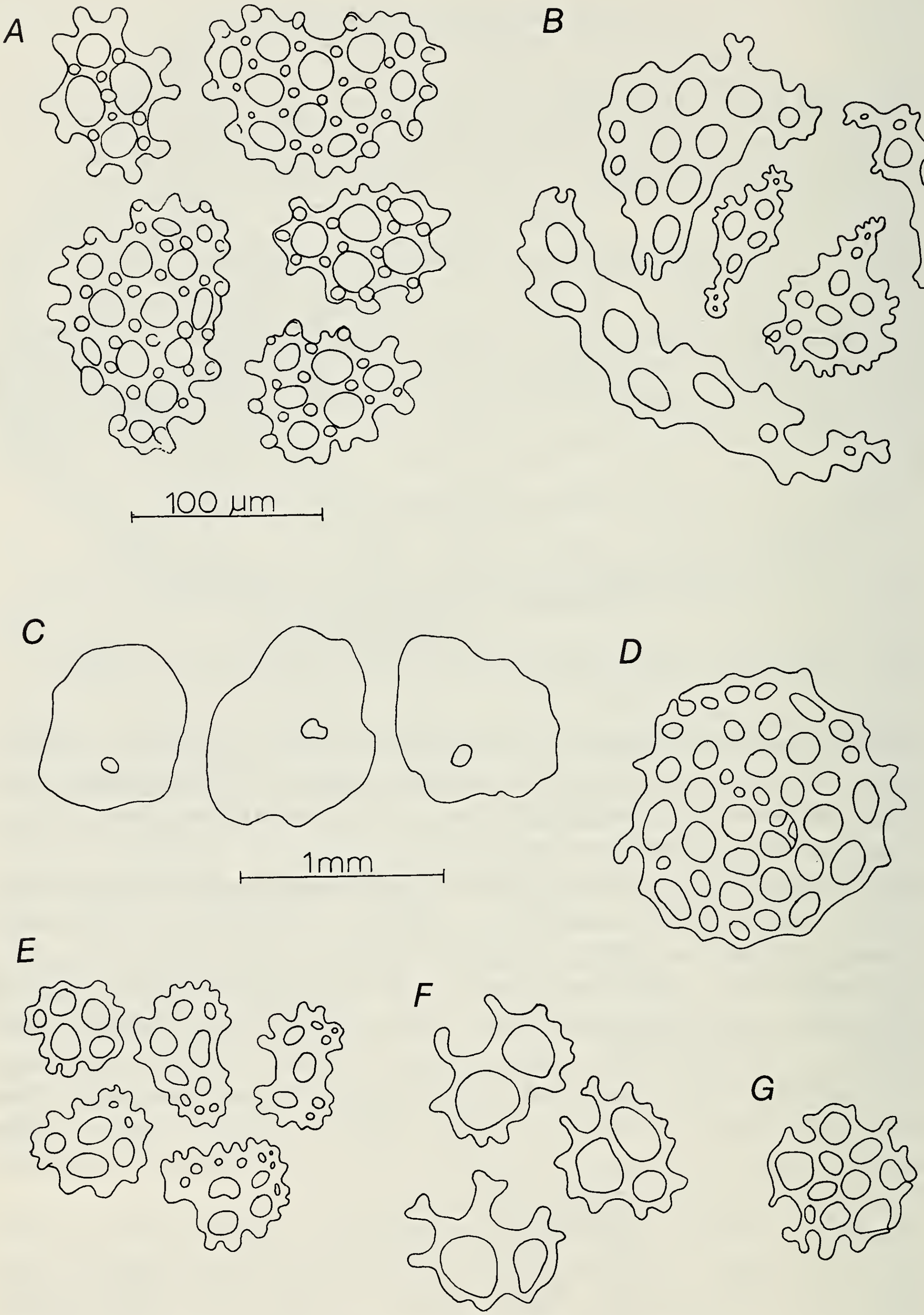

Fig. 2. *Psolidium prostratum*, ossicles: A, Knobbed buttons from sole; B, Perforated plates from tentacles; C, Outline drawings of dorsal plates, showing holes for passage of tube feet; D, Endplate from ventral tube foot; E, Plates from dorsal tube feet; F, Developing buttons from sole of 1.5 mm total length juvenile; G, Endplate from tube foot of 1.5 mm total length juvenile. The scale on Fig. 2A also applies to figs. 2B, D–G.

without regular arrangement. Anal aperture can be pushed outwards on a small anal cone. Boundary between dorsal and ventral surfaces marked by a sharp edge. Sole fragile, transparent, with scattered marginal tube feet. Midventral radius also with scattered tube feet, usually only 4–5 present. Tentacles weakly dendritic in larger specimens. Smaller specimens of less than 12 mm length often with unbranched tentacles; in these, primordial branches often evident. Tentacles 10, white, 2 ventral tentacles smaller than others. Color of body usually white, although in few specimens dorsal scales are light to dark brown.

Ossicles of sole exclusively knobbed buttons of average length 118 μm; usually there are more than 4 perforations (Fig. 2A). In sole of 1.5 mm long juvenile, ossicles smooth, with few perforations (Fig. 2F). Ventral tube feet with well developed endplates (Fig. 2D), even in juveniles (Fig. 2G). Dorsal feet lack endplates, but contain some curved simple plates, sometimes with a few small knobs (Fig. 2E). Tentacles contain small perforated plates and rods, often curved, of variable size, ranging from approximately 75 μm long to approximately 400 μm long (Fig. 2B).

Ecology.—Specimens were recovered from box core samples, in which they were found attached to pieces of volcanic agglomerate estimated to be between 1 million and 10 million years old. Other faunal elements included *Tharyx* sp., *Thelepus cincinnatus,* and several species of amphipods.

Relationships.—The only other known Atlantic congener, *P. arcuatum* Herouard, has smooth plates in the sole with few perforations. From the eastern Pacific, in the vicinity of Central America, 6 species are known. They differ from *P. prostratum* in the following ways: *P. gracile* Ludwig, 1894, has sole plates with fewer perforations and many fewer knobs. *P. panamense* Ludwig, 1894, has a higher, almost cylindrical body, much less conspicuous dorsal feet, and much larger sole plates. *P. ekmani* Deichmann, 1941, has pearl-like projections dorsally and 4-holed ossicles in the sole. *P. eubullatum* Deichmann, 1941, has heavy buttons and plates ventrally, and the dorsal feet have no ossicles. *P. dorsipes* Ludwig, 1886 and *P. planum* Deichmann, 1941, both have cups in addition to the other ossicles in the sole. The present new species appears to bear no close relationship with other known species in the genus.

Acknowledgments

We wish to thank Mr. J. Kevin Shaw and Ms. Debbie L. Blizzard for their help in many ways.

Literature Cited

Deichmann, E. 1941. The Holothurioidea collected by the *Velero III* during the years 1932 to 1938. Part I, Dendrochirota.—Allan Hancock Pacific Expeditions 8(3):61–194, pls. 10–30.

Herouard, E. 1912. Holothuries nouvelles des campagnes du yacht *Princesse-Alice*.—Bulletin de l'Institut Océanographique 239:1–9, figs. 1–7.

Ludwig, H. 1886. Die von G. Cheirchia auf der Fahrt der Kgl. Ital. Corvette "Vettor Pisani" gesammelten Holothurien.—Zoologische Jahrbucher 2:1–36, pls. 1–2.

———. 1894. The Holothurioidea.—Memoirs of the Museum of Comparative Zoology 17(3):1–183, pls. 1–19.

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A NEW SPECIES OF *HOMOCHAETA* (OLIGOCHAETA: NAIDIDAE) FROM THE WEST COAST OF CANADA

Peter M. Chapman

Abstract.—*Homochaeta raptisae* n. sp. is described from the lower Fraser River, British Columbia. The new species represents the first confirmation of the genus *Homochaeta* in North America.

The genus *Homochaeta* is distinguishable from other naidid genera by the fact that its dorsal setae start from segment II and hair setae are absent. The genus presently contains two recognized species identified from Eurasia and a third species, *H. lactea,* described from a single specimen collected in South America (Cernosvitov, 1937) and considered to be *species incerta sedis* (Brinkhurst and Jamieson, 1971). This paper describes a new species of *Homochaeta* from the North American west coast, *Homochaeta raptisae.*

Materials and Methods

Specimens of *Homochaeta raptisae* were identified from oligochaetes collected at several stations in the Tilbury Slough area of the lower Fraser River, B.C. (Chapman, 1980) during a baseline study by staff at the Habitat Protection Division of the Department of Fisheries and Oceans Canada (principal investigator, Mr. M. Nassichuk). Preserved worms were stained in paracarmine, and mounted whole in Canada balsam. The holotype and paratypes are deposited at the British Museum (Natural History) (BMHN). Additional material is deposited at the United States National Museum of Natural History (NMNH), and the National Museums of Canada (NMCIC).

Homochaeta raptisae, new species
Fig. 1

Material.—Holotype: BMNH 1980.47.1, whole mounted specimen. Paratypes: BMNH 1980.47.2–3, 2 specimens in alcohol. NMCIC 1980-1527, 2 specimens in alcohol; 1980-1528, whole mounted specimen. NMNH 062010, 2 specimens in alcohol; 062011, whole mounted specimen. Additional material: In the collection of P. M. Chapman, 30 specimens from various locations in the lower Fraser River, B.C.

Type-locality.—Lower Fraser River, B.C., Canada; subtidal silty sediment; 49°8.9′N, 122°59.7′W, collected 26 April 1977.

Etymology.—Named for my wife, Stavroula Raptis.

Description.—No pigment or eyes. Up to 15 segments, length (preserved) 0.5–1.0 mm. Prostomium elongate, triangular and upturned. All setae of

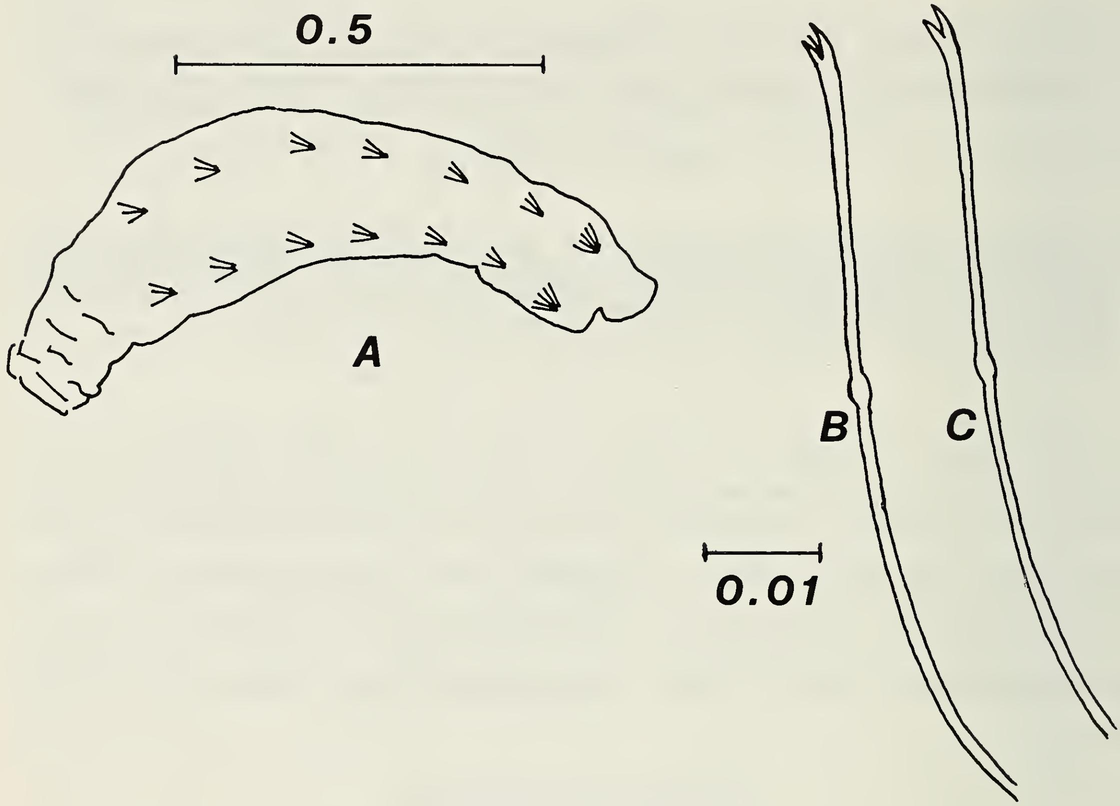

Fig. 1. *Homochaeta raptisae*: A, Outline of whole-mounted worm; B, Dorsal anterior setae; C, Ventral setae. All lengths in mm.

same shape, teeth of equal length, upper tooth thinner than lower, nodulus distal; dorsal anterior teeth with a single intermediate pectination; 5 setae per bundle in II, in other segments 3. Pharynx in II–III, stomach in V. Chloragogen from V. Coelomocytes absent. Evidence of budding.

Discussion

The genus *Homochaeta* is so distinctive, with bifid dorsals starting from II and lacking hair setae, that it cannot be confused with other naidids. With the discovery of *H. Raptisae* n. sp., the genus is now expanded to include four species, with the Eurasian forms (*H. naidina* and *H. setosa*) geographically separated from the South American species (*H. lactea*) and the present new species. A report of *H. naidina* from Virginia (Falls 1974) is unconfirmed, as voucher specimens were lost (Hiltunen and Klemm 1980).

H. raptisae can be distinguished from the other three species in the genus based on size, prostomial shape, and setal shape and number. Examination of the unique holotype of *H. lactea* (sent to the author courtesy of Mr. R. W. Sims of the British Museum) confirmed that *H. raptisae* is a new species. The other two species in the genus are sufficiently distinct that an examination of type-specimens was not necessary.

All specimens of *H. raptisae* examined contained large numbers of diatoms in their guts, but very little sediment, which suggests that they were feeding selectively on periphyton. All specimens were immature, a not unusual observation among the Naididae, which reproduce asexually by budding. Thus a description of sexually mature specimens must await the collection of further material.

H. raptisae was collected at the type-locality in numbers varying from <500 m^{-2} in winter and summer to $>10{,}000$ m^{-2} in spring. This seasonal abundance pattern, typical of many naidids, will be discussed elsewhere and is documented by Chapman (1980). The relatively large numbers of *H. raptisae* observed in the Fraser River suggest that this species will be identified from other areas in future. Its absence from previous taxonomic records may be due partly to the fact that inexperienced taxonomists could mistake the species for an immature tubificid, since its dorsals start on II. However, it is more probable that, due to its small size coupled with the common use of 0.5 mm sieves in benthic collections, previous workers have failed to collect or sort *H. raptisae* from sites where it might be abundant. The worms described in the present study were sorted using a 0.250 mm sieve; however, oligochaete collections made in 1972 and 1973 from the type-area (Westwater station 6—Northcote et al., 1976), sorted with a 0.5 mm sieve and examined by the author, did not include *H. raptisae.* This omission serves to emphasize the importance of sieve size in base-line benthic collections.

Acknowledgments

I am indebted to Dr. R. O. Brinkhurst for his assistance with the taxonomic descriptions, and I thank Ms. B. Piercey and Mr. M. Nassichuk who collected and made available the oligochaete material used in this study.

Literature Cited

Brinkhurst, R. O., and B. G. M. Jamieson. 1971. Aquatic Oligochaeta of the World.—U. of Toronto Press, Toronto. 860 pp.

Cernositov, L. 1937. Notes sur les Oligochaeta (Naididées et Enchytraeidées) de l'Argentine.—An. Museo Nac. Buenas Aires 39:135–157.

Chapman, P. M. 1980. Identification and analysis of oligochaete samples collected from the lower Fraser River, Feb.–Aug. 1977.—Report prepared for Habitat Protection, Fisheries and Oceans Canada. 13 pp.+ appendices.

Falls, E. Q. 1974. A taxonomic survey of freshwater oligochaetes from the Richmond Virginia area with reference to commensal ciliates.—Va. J. Sci. 25:25–29.

Hiltunen, J. K., and D. S. Klemm. 1980. A guide to the Naididae (Annelida: Clitellata: Oligochaeta) of North America.—EPA-600/4-80-031. 48 pp.

Northcote, T. G., N. T. Johnston, and K. Tsumura. 1976. Benthic, epibenthic and drift fauna of the lower Fraser River.—Westwater Technical Report 11, U. of British Columbia. 227 pp.

E.V.S. Consultants Ltd., 195 Pemberton Avenue, North Vancouver, B.C., V7P 2R4 Canada.

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FIRST DESCRIPTION OF THE MALE OPPOSUM SHRIMP, *HETEROMYSIS BERMUDENSIS BERMUDENSIS* (CRUSTACEA: MYSIDACEA)

Thomas E. Bowman

Abstract.—Some characters of *Heteromysis bermudensis bermudensis* are described and illustrated, from Bermudan specimens. Differences in the pleopod 4 support Bačescu's (1968) recognition of a subspecies, *H. b. cesari,* for Cuban specimens.

The opossum shrimp, *Heteromysis bermudensis* Sars, 1885, has been referred to by 6 different authors, but because of scanty material, it remains inadequately characterized. In particular, the ♂ of the typical subspecies is unknown. Sars (1885) had only a single ♀ with all the legs broken off. Verrill (1923) had an unspecified number of specimens, presumably collected by his students and him in 1898 and 1901, since the color in life was noted. Tattersall (1951) had 2 "rather badly damaged" ♀♀ (an understatement!), USNM 82388, collected in 1876–77 by G. Brown Goode. Clarke (1955) also examined these damaged ♀♀ in addition to unspecified "fresh material." Bačescu (1968) had 4 ♂♂ and Brattegard (1973) 1 ♀.

The Sars, Verrill, and Clarke specimens came from Bermuda. Bačescu's ♂♂, from Cuba, were assigned to a new subspecies, *H. b. cesari,* recently reported also from the Saba Bank by Brattegard (1980). Brattegard's (1973) ♀, from Colombia, was identified as *H. bermudensis,* and presumably belongs to the typical subspecies. The latter was called *H. b. typica* by Bačescu, but in accordance with ICZN Art. 47a the name should be *H. b. bermudensis*.

For the present study I have had available 41 ♂♀ from Hamilton Harbor, Bermuda, washed from algae and a sponge collected at depths of 2–6 feet by Lanelle W. Peterson, 13 August 1961.

Because the ♂ of *H. b. bermudensis* was unknown, Bačescu was unable to employ the useful ♂ secondary sexual characters in distinguishing the subspecies. In *Heteromysis,* as discussed in detail by Tattersall (1967), pleopods 2, 3, and especially 4 may be modified in the ♂, thereby providing valuable taxonomic characters. The characters used by Bačescu in a table comparing the subspecies are size, number of spines on the margin and in the sinus of the telson, color, length of the scale of antenna 2, and shape of eyes. A discussion of these follows:

Size: *H. b. cesari* is smaller (total length 4.0–4.2 mm) than *H. b. ber-*

mudensis. Sars' holotype measured 6 mm; Verrill and Clarke reported 6–8 and 7–9 mm respectively for their specimens. However, Brattegard's ♀ was only 4.6 mm, and the Peterson specimens are 4.5–4.8 mm, not much larger than *H. b. cesari*.

Marginal spines of telson: Including the 2 apical spines, *H. b. bermudensis* has 8 (Sars, Brattegard), 7–9 (Clarke), 8–9 (Peterson specimens); *H. b. cesari* has 8 (Bačescu listed 6, but did not include the 2 apical spines).

Spines in sinus of telson: *H. b. bermudensis* has 18 (Sars), 18–20 (Clarke), 16 (Brattegard), 15–16 (Peterson specimens); *H. b. cesari* has 14 (figures given in Bačescu's table are reversed).

Length of scale of antenna 2: According to Bačescu, in *H. b. bermudensis* the scale extends beyond the endopod peduncle and in *H. b. cesari* the scale is shorter than the peduncle. But Sars described the scale as "exceedingly small, scarcely as long as the antennular peduncle," I believe "antennular" is a lapsus for "antennal," for in Sars' pl. 38, figs. 1 and 2, the scale just reaches the end of the antennal peduncle, but is much shorter than the antennular peduncle. The apparent lengths of the antennal peduncle and scale depend to some extent upon the angle at which they are viewed and upon whether or not there is distortion from cover glass pressure.

Sars noted a distal segment in the antennal scale. Bačescu showed a distal segment in his figure of the head region but not in his more enlarged figure of antenna 2, and remarked, ". . . on ne distingue pas clairment d'article apical." Brattegard found no distal segment in his Colombian specimens, but it is clearly present in the Peterson specimens (Fig. 1c).

Eyes: Bačescu referred to the eyes of *H. b. bermudensis* as more or less cylindrical and to those of *H. b. cesari* as irregularly globular. This distinction is not clearly evident from a comparison of the figures of Sars, Bačescu, and Brattegard, but other differences are apparent. In *H. b. cesari* the cornea occupies nearly half of the eye, in *H. b. bermudensis* only ⅓. Also, the small concavity in the proximolateral part of the cornea in *H. b. cesari* has not been observed in *H. b. bermudensis*.

The above discussion suggests that most of the criteria used by Bačescu to distinguish the 2 subspecies either overlap or differ slightly, and hence are of questionable reliability. Because the ♂ of *H. b. bermudensis* was unknown, Bačescu was unable to use ♂ secondary sexual characters. However, we can now add to Bačescu's criteria the anatomy of the ♂ pleopod 4, which differs in the 2 subspecies as follows:

Spines/setae	*H. b. bermudensis*	*H. b. cesari*
Lateral margin	2	0
Medial margin, proximal to pseudobranchial lobe	1	0
Anterior surface	6	2
Distal margin	ca 35, with flagellum	26–30 without flagellum

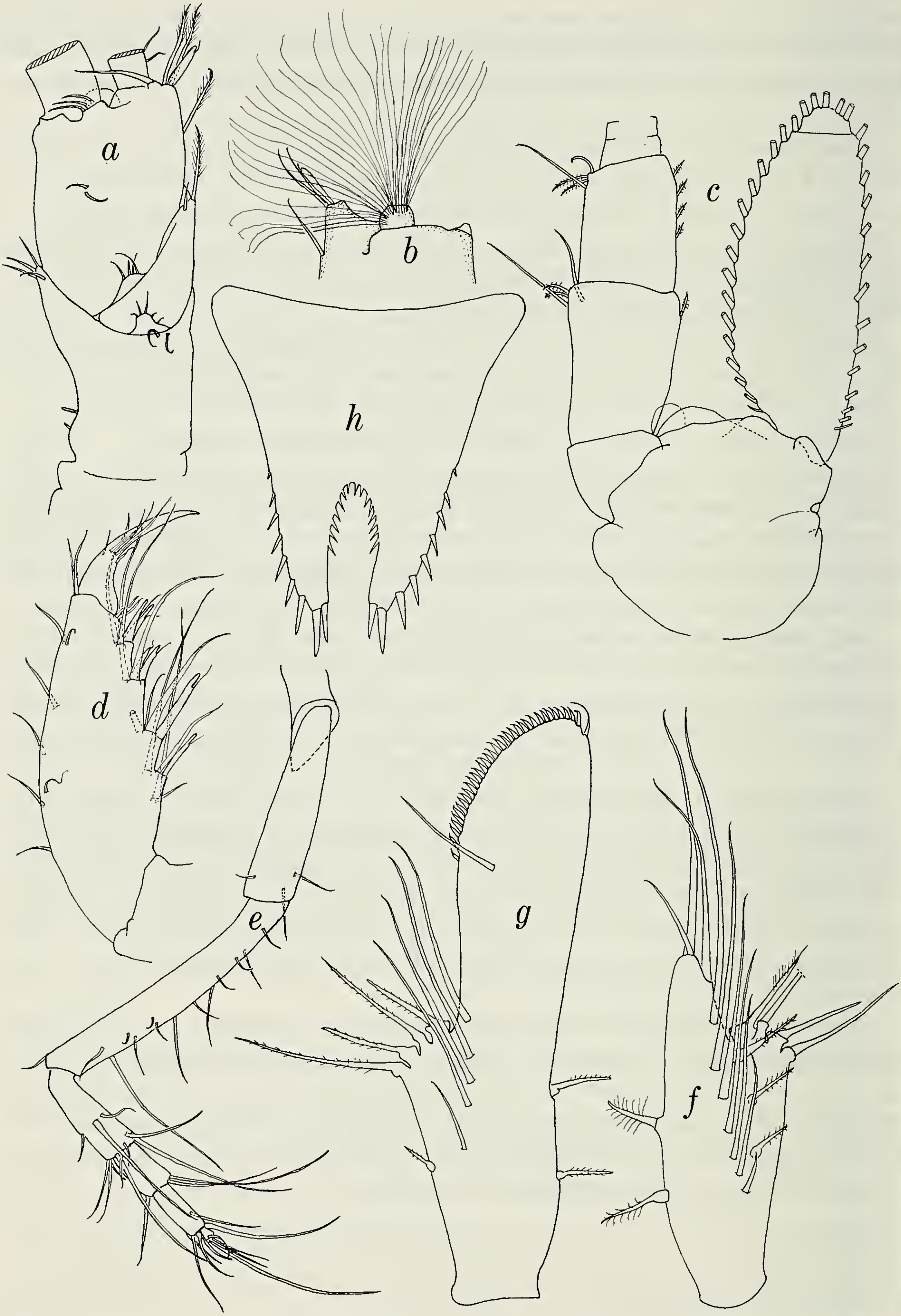

Fig. 1. *Heteromysis bermudensis bermudensis*: a, ♂ Antenna 1, sympod, dorsal; b, Distal end of antenna 1 sympod, ventral, showing ♂ lobe; c, ♂ antenna 2; d, Thoracic endopod 3, distal segments; e, Thoracic endopod 4; f, Pleopod 3, ♂; g, Pleopod 4, ♂; h, Telson.

These differences, together with those of the eyes, seem sufficient to support recognition of the 2 subspecies. Indeed, Bačescu remarked that if differences in the ♂ pleopod 4 should be found, the Cuban form would merit recognition as a full species. I quite agree, but believe this step should be deferred until pleopod 4 of ♂♂ of other populations can be examined for variability.

In other respects the Peterson specimens agree well with the Colombian ♀ described by Brattegard except for the presence of a distal segment in the scale of antenna 2. The ♂ lobe of antenna 1 is very short and densely covered with fine setae (Fig. 1b). The carpopropus of thoracic endopod 4 is 3–4 segmented (Fig. 1e); those of endopods 5–8 are 5–7-segmented. Sexual dimorphism of the pleopods is found only in pleopod 4 (Fig. 1g).

Acknowledgments

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Literature Cited

Bačescu, Mihai. 1968. *Heteromysini* nouveaux des eaux Cubaines: Trois espèces nouvelles de *Heteromysis* et *Heteromysoides spongicola* n.g. n. sp.—Revue Roumaine de Biologie, seria Zoologie (13)4:221–237.

Brattegard, Torleiv. 1973. Mysidacea from shallow water on the Caribbean coast of Colombia.—Sarsia 54:1–66.

———. 1980. *Platymysis facilis* gen. et sp. nov. (Crustacea: Mysidacea: Heteromysini) from the Saba Bank, Caribbean Sea.—Sarsia 65:49–52.

Clarke, William D. 1955. A new species of the genus *Heteromysis* (Crustacea, Mysidacea) from the Bahama Islands, commensal with a sea-anemone.—American Museum Novitates, No. 1716:1–13.

Sars, G. O. 1885. Report on the Schizopoda collected by H. M. S. Challenger during the years 1873–76.—Report on the Scientific Results of the Voyage of H. M. S. *Challenger* during the Years 1873–76, Zoology 13(37):1–228, pls. 1–38.

Tattersall, Olive S. 1967. A survey of the genus *Heteromysis* (Crustacea: Mysidacea) with descriptions of five new species from tropical coastal waters of the Pacific and Indian Oceans, with a key for the identification of the known species of the genus.—Transactions of the Zoological Society of London 31:157–193.

Tattersall, Walter M. 1951. A review of the Mysidacea of the United States National Museum.—United States National Museum Bulletin 201:I-X + 1–292.

Verrill, A. E. 1923. Crustacea of Bermuda. Schizopoda, Cumacea, Stomatopoda and Phyllocarida.—Transactions of the Connecticut Academy of Arts and Sciences 26:181–211, pls. 49–52.

Division of Crustacea, Smithsonian Institution, Washington, D.C. 20560.

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94(2), 1981, pp. 462–463

COMMENTS ON THE TAXONOMIC STATUS OF *TOMMOTIA* MISSARZHEVSKY 1970 (TOMMOTIIDAE: MICROPROBLEMATICA)

Richard W. Huddleston

Missarzhevsky in Rozanov and Missarzhevsky (1966) established the genera *Camena* and *Camenella* for problematic microfossils of lower Cambrian age. The generic name *Camena* Missarzhevsky in Rozanov and Missarzhevsky 1966 was preoccupied by Camena Hewitson 1865 and subsequently Missarzhevsky (1970) proposed the replacement name *Tommotia* for the junior homonym. *Camena* Missarzhevsky in Rozanov and Missarzhevsky had been made the type-genus of the family Camenidae by Missarzhevsky in Rozanov et al. (1969).

Bengtson (1970) pointed out that *Tommotia* and *Camenella* were congeneric, representing separate parts of the same organism. Bengtson (1970) corrected the family name from Camenidae to Tommotiidae based on the new name *Tommotia,* citing authorship to Missarzhevsky 1970. Bengtson (1970:369–370) commented, "Since *Tommotia* is the replacement name for the type-genus of a family, it will—contrary to what is normally the case—take the date of the name replaced, *Camena* (article 39 of the International Code of Zoological Nomenclature), and thus be able to compete in priority with *Camenella,* . . . Accordingly, the generic name *Tommotia,* because of its status as type-genus for the family, is here selected as the valid name for the combined genera." However, ICZN article 39 only indicates that the family name Camenidae is invalid because of the junior homonym status of its type-genus, *Camena*. Further, ICZN article 60(b) indicates that *Tommotia* must compete with *Camenella* with its 1970 date rather than the date of the name it replaced, 1966. Regardless of the fact that *Tommotia* is the replacement name for the type-genus it is a junior subjective synonym of *Camenella* and must be treated as such by all who recognize the synonymy. (ICZN article 60).

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Literature Cited

Bengtson, S. 1970. The lower Cambrian fossil *Tommotia*.—Lethaia 3:363–392.

Missarzhevsky, V. V. 1970. Renaming of an early Cambrian genus of phosphatic problematic organisms.—Paleont. Zhur. 1970(4):100.

Rozanov, A. Yu., and V. V. Missarzhevsky. 1966. Biostratigraphy and fauna of the oldest Cambrian horizons.—Akad. Nauk SSR. Geol. Inst. Trudy, 148, 126 pp.

Rozanov, A. Yu. et al. 1969. The Tommotian stage and the Cambrian lower boundary problem.—Akad. Nauk. SSR. Geol. Inst. Trudy 206, 380 pp.

Chevron Oil Field Research Company, P.O. Box 446, La Habra, California 90631.

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94(2), 1981, pp. 464–478

NOTES ON WEST AFRICAN PIPEFISHES (SYNGNATHIDAE), WITH DESCRIPTION OF *ENNEACAMPUS*, N. GEN.

C. E. Dawson

Abstract.—*Syngnathus pellegrini* Fowler, described from Gabon, is based on mislabeled specimens from the western north Atlantic and is a junior synonym of *S. fuscus* Storer. The name *Enneacampus* is proposed for a new syngnathine (tail-pouch) genus characterized, in part, by a 9-ray caudal fin and by the presence of an anal fin, pouch-protective plates, and everted pouch-closure. The type-species (*Syngnathus ansorgii* Boulenger 1910) and its only congener, *Enneacampus kaupi* (Bleeker) are rediagnosed and illustrated; *Syngnathus pulchellus* Boulenger and *S. olssoni* Johnels are junior synonyms of *Enneacampus ansorgii. Oostethus brachyurus aculeatus* (Kaup) and the two species of *Enneacampus* are the only pipefishes known to occur commonly in shallow coastal or inland waters of west Africa between Sénégal and Angola (*ca.* 16°N–18°S); all are known to breed in fresh water.

The genus *Syngnathus* Linnaeus (type-species *S. acus* L.) has long been a catchall for pipefishes of varying lineages or uncertain taxonomic status. The number of nominal species is variously estimated at 40–50 or more, but the number of valid species more closely approaches 30. Studies on western African pipefishes currently referred to *Syngnathus* show that one name is a junior synonym of an extralimital species and that four nominal species, apparently freshwater forms, are not referrable to *Syngnathus* s.s. I here clarify the identity of *S. pellegrini* Fowler, propose a new genus for the accommodation of *S. ansorgii* Boulenger and *S. kaupi* Bleeker, and refer two nominal species (*S. pulchellus* and *S. olssoni*) to the synonymy of *S. ansorgii.*

In addition to species rediagnosed here (*ansorgii* and *kaupi*), preliminary studies indicate that only one other pipefish [*Oostethus brachyurus aculeatus* (see Dawson, 1979)] occurs commonly in the shallow coastal and inland waters of western Africa between Sénégal and Angola (*ca.* 16°N–18°S). Compared to the western Atlantic, with 14 coastal and inland species known from the same latitudes, western Africa supports a depauperate pipefish fauna.

Methods and Materials

Measurements (mm) are of total length (TL), standard length (SL) or head length (HL). Unless otherwise noted, color descriptions are from specimens preserved in alcohol; the term "venter" refers to the ventral surface of the head or body; other methods follow Dawson (1977). Abbreviations for repositories of material examined are: AMNH, American Museum of Natural History; ANSP, Academy of Natural Sciences, Philadelphia; BMNH, British Museum (Natural History), London; CAS-SU, Stanford University collections, how housed at California Academy of Sciences; GCRL, Gulf Coast Research Laboratory Museum; IRSNB, Institut Royal des Sciences Naturelles de Belgique, Brussels; MCZ, Museum of Comparative Zoology, Harvard University; MNHN, Muséum National d'Histoire Naturelle, Paris; NRM, Naturhistoriska Riksmuseet, Stockholm; RMNH, Rijksmuseum van Natuurlijke Historie, Leiden; UMMZ, Museum of Zoology, University of Michigan; USNM, National Museum of Natural History, Smithsonian Institution; ZMUC, Zoological Museum, University of Copenhagen.

Syngnathus pellegrini Fowler

Fowler (1919) described this species from four specimens (88–113 mm TL), reportedly collected in Gabon by P. B. DuChaillu. The name was listed by Fowler (1922) and he later (1936) gave the type locality as "coast of the French Congo." Additional specimens referrable to *S. pellegrini* have not been taken along the African coast. The validity of this species was questioned by Blache (1962) but it was included in a recent key to eastern Atlantic fishes (Blache et al., 1970).

The original description gives counts of 18 + 38 rings, 38 dorsal-fin rays and 4 + 6 subdorsal rings for the holotype (ANSP 975) and 18–20 + 37–38 rings and 35–37 dorsal-fin rays for the three paratypes (ANSP 976–978). My counts from these juveniles (now 83–107 mm SL) follow: rings 19 + 37–38; dorsal-fin rays 36, 37, 41, 42; pectoral-fin rays 13 (6 counts), 14 (2); caudal-fin rays 10; subdorsal rings 5–4 + 4.5–5.5. The configuration of principal head and body ridges is that of the genus *Syngnathus,* and the anal fin is present. Pertinent proportional values are: HL in SL 8.1–8.4, snout length in HL 2.1–2.2, snout depth in snout length 4.5 (in holotype), length of dorsal-fin base in HL 0.8–0.9.

These specimens are conspecific with *S. fuscus* Storer, a common species along the Atlantic coast of the United States. There have been a number of labeling problems with material thought to belong to the DuChaillu (or Duchaillu) west African collection and mislabeling of these western Atlantic pipefishes is not surprising. Fowler (1936) noted that *Ischnomembras gabunensis* Fowler 1903 is conspecific with the American atherinid *Menidia*

menidia (Linnaeus), and I am advised (in litt.) by Mrs. Eugenia Böhlke (ANSP) that at least three other species, treated as west African by Fowler (1919), are based on misidentified specimens of western Atlantic origin.

Enneacampus, new genus

Type-species.—*Syngnathus ansorgii* Boulenger 1910.

Diagnosis.—Superior trunk and tail ridges discontinuous near rear of dorsal fin, inferior trunk and tail ridges continuous, lateral trunk and tail ridges discontinuous below dorsal-fin base; venter of trunk clearly V-shaped, the median longitudinal ridge with or without a prominent fleshy keel. Snout length 1.8–2.8 in HL; median dorsal snout ridge not strongly elevated, usually ending on interorbital but sometimes continued to frontal ridge, its margin entire to finely denticulate in subadults and adults; interorbital depressed mesially but flared dorsolaterad toward orbits; median dorsal head ridges a little elevated; supraopercular ridge usually distinct; opercle with a complete, straight, longitudinal ridge, otherwise smooth or ornamented with fine striae; pectoral-fin base with superior and inferior ridges. Principal body ridges distinct but not strongly elevated, indented between rings, the margins finely denticulate to entire; posterior angles of tail rings not produced to spine-like points; scutella without longitudinal keels. Head and body devoid of dermal flaps, spines or prominent denticulations. Trunk rings 12–14 (mostly 13), total rings 44–50, dorsal-fin rays 22–29, pectoral-fin rays 12–17 (mostly 12–16), anal-fin rays 2–3, caudal-fin rays typically 9, the fin rounded distally. Dorsal-fin origin on last trunk ring or first tail ring, the fin-base not elevated, total subdorsal rings 5.0–6.5. Brood pouch below 12–18 tail rings; pouch plates present, angled a little laterad in brooding males; pouch-closure the everted type of Herald (1959); without odontoid processes in jaws (Dawson and Fritzsche, 1975) or bony inclusions in gill membranes (Dawson, 1978). Maximum size at least 173 mm TL.

Comparisons.—The principal body ridge configuration of *Enneacampus* (Fig. 1) is shared with several other syngnathine (tail-pouch) genera, but *Enneacampus* clearly differs in having 9 rather than 10 caudal-fin rays. In general appearance, species of *Enneacampus* (Figs. 2, 3) are most similar to those of *Bryx* Herald, *Parasyngnathus* Duncker, and *Syngnathus* s.s. *Enneacampus* also differs from *Bryx* in having an anal fin, and from *Parasyngnathus* in having well-developed pouch plates. *Enneacampus* has a complete opercular ridge, a supraopercular ridge, and everted pouch-closure, whereas species of *Syngnathus* lack the supraopercular ridge, lack a complete opercular ridge in subadults and adults, and pouch-closure is inverted. Furthermore, species of *Enneacampus* (2 specimens examined) lack the 3rd epibranchial and have one infrapharyngobranchial, whereas the 3rd epibranchial and two infrapharyngobranchials are present in *Syngnathus* (Fritzsche 1980).

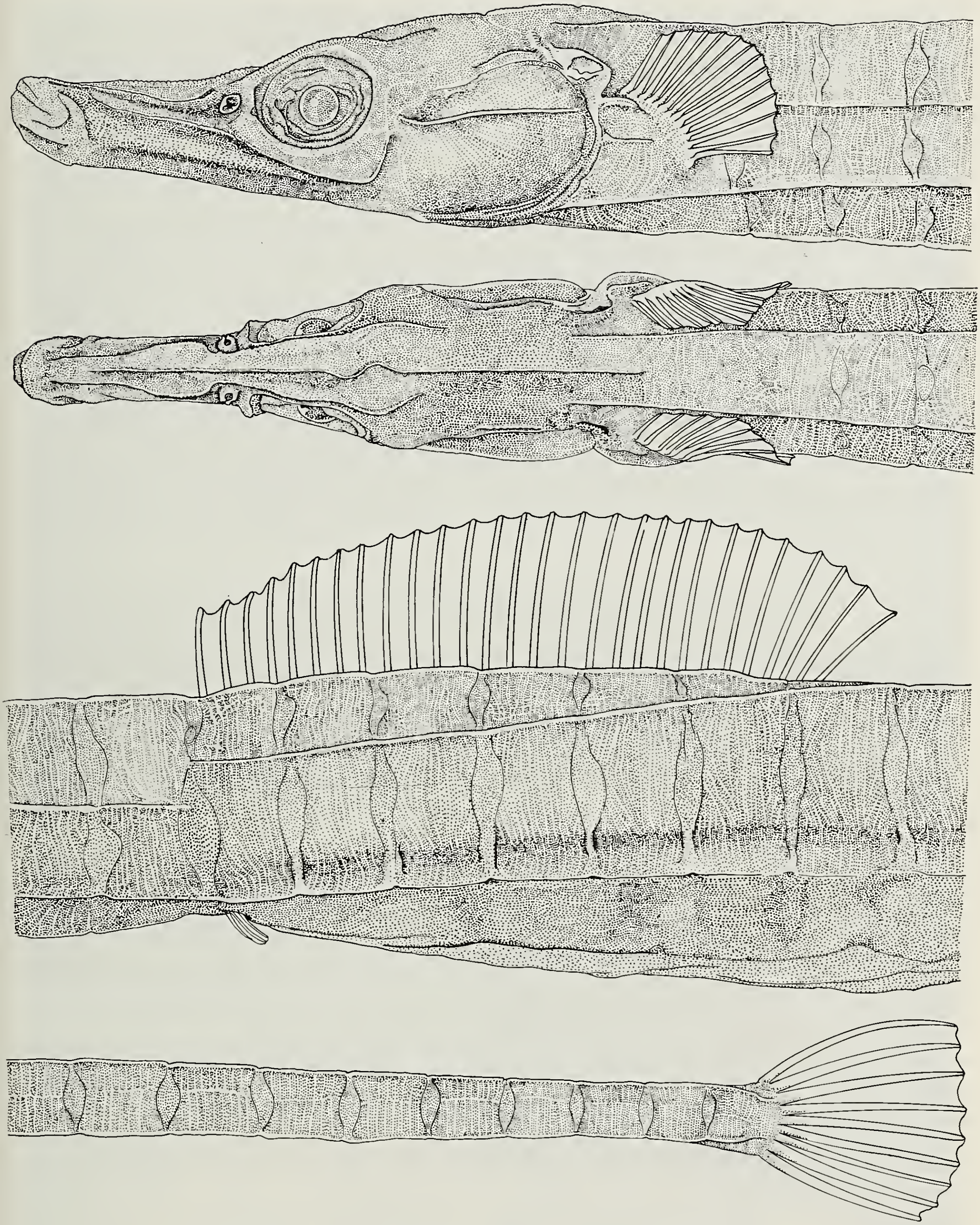
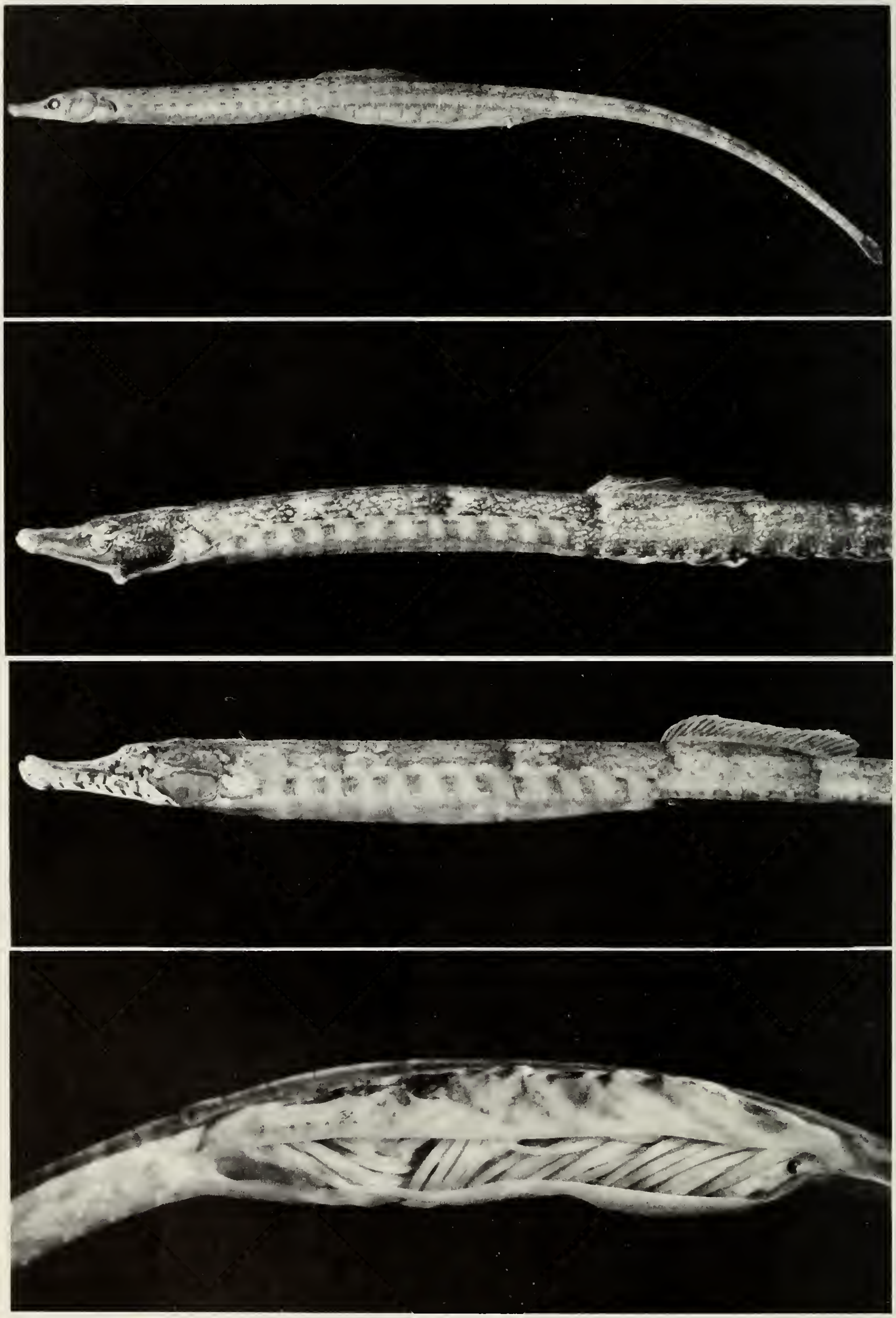


Fig. 1. *Enneacampus ansorgii*. Upper pair.—Lateral and dorsal aspects of head and anterior trunk rings. Lower pair.—Top: posterior trunk and anterior tail rings, together with dorsal and anal fins and anterior portion of brood pouch. Bottom: posterior tail rings and caudal fin. From 110.5 mm SL holotype (BMNH 1911.6.1.129).



The *Enneacampus* body ridge configuration is also shared with two gastrophorine (trunk-pouch) genera, the monotypic Australian *Leptoichthys* Kaup and the Indo-Pacific *Doryichthys* Kaup. Compared to the former, *Enneacampus* has fewer anal- and caudal-fin rays (respectively, 2–3 and 9 against 5 and 11) and lacks the very elongate snout and caudal fin characteristic of *Leptoichthys*. *Enneacampus* shares the 9-ray caudal fin with *Doryichthys* but differs from this trunk-pouch genus in having fewer anal-fin rays (4 rays in *Doryichthys*) and in having rounded pectoral fins (usually emarginate in *Doryichthys*).

Etymology.—From the Greek *ennea* (nine) and *kampos* (sea-animal), in allusion to the characteristic 9-ray caudal fin; gender, masculine.

Remarks.—Among pipefishes which retain the caudal fin from postlarva to adult, the number of caudal-fin rays is a highly conservative character useful in defining genera, and the typical number of rays ranges from 8 to 11 (except when damaged or regenerated). The majority of syngnathine and some gastrophorine genera have 10 caudal-fin rays, whereas the 9-ray fin is less common. Nine caudal-fin rays are characteristic of several trunk-pouch genera (e.g. *Doryichthys, Oostethus* Hubbs) but, among tail-pouch forms, the 9-ray fin is found only in *Enneacampus* and some Indo-Pacific species currently referred to *Trachyrhamphus* Kaup and *Yozia* Jordan and Snyder. In Atlantic waters, the 9-ray caudal fin is found only in the two species of *Enneacampus* and in eastern and western Atlantic populations of the widespread doryrhamphine *Oostethus brachyurus* (Bleeker).

Most pipefishes with the 9-ray caudal fin (except those referred to *Trachyrhamphus* or *Yozia*) are known to breed in fresh water. Although some with a 10-ray fin may also breed in fresh water (e.g. *Syngnathus scovelli* (Evermann and Kendall) and species of *Pseudophallus* Herald), the majority of pipefishes with other than 9 caudal-fin rays breed in estuarine or marine habitats.

Enneacampus ansorgii (Boulenger)
Figs. 1–2

Syngnathus ansorgii Boulenger, 1910:559 (orig. descr.; Quanza (= Cuanza) River, Angola); Boulenger, 1915:86, fig. 73 (in key, descr.); Clausen, 1956:227 (comparisons); Daget and Iltis, 1965:185 (in key); Thys, 1965:317 (listed, Fernando Póo); Thys, 1967:82, fig. 24 (descr., comparisons).
Syngnathus pulchellus Boulenger, 1915:88, fig. 74 (orig. descr., Gabon and

←
Fig. 2. *Enneacampus ansorgii*. Top to bottom: BMNH 1911.6.1.129 (110.5 mm SL, male, holotype). UMMZ 187910 (94 mm SL, male). GCRL 15532 (110 mm SL, adult female). GCRL 15485 (ventral aspect of brood pouch of 82.5 mm SL male, illustrating disposition of pouch-young and brood-pouch folds).

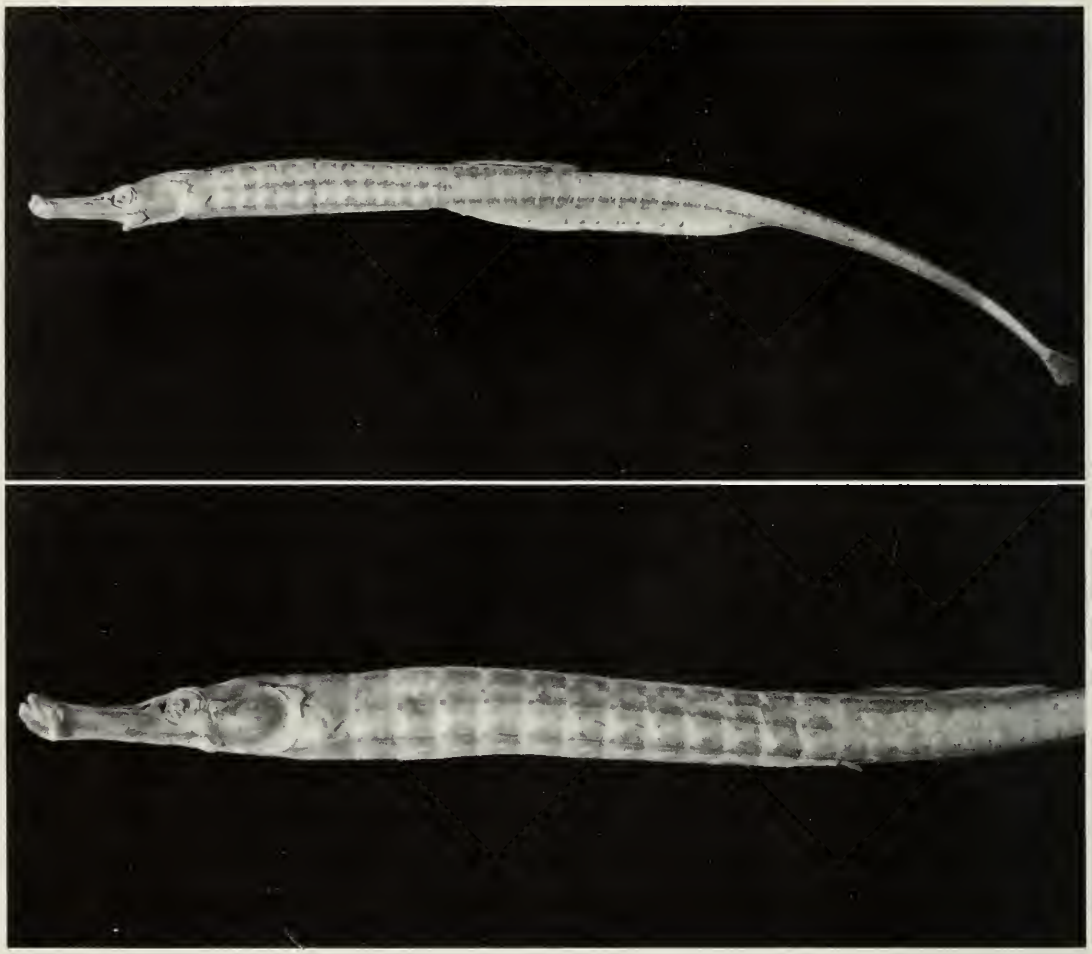


Fig. 3. *Enneacampus kaupi*. CAS-SU 63059: Top.—141 mm SL, brooding male. Bottom.—132 mm SL, adult female.

Cameroon); Clausen, 1956:227, pl. 1, figs. 1–2 (comparisons, Nigeria); Sterba, 1959:613, figs. (descr.; European aquarium trade import); Kähsbauer, 1962:159 (listed, Nigeria); Daget and Iltis, 1965:185 (in key; range); Thys, 1967:83 (in key, comparisons, possibly conspecific with *ansorgii*); Roman, 1970:147, 149, fig. 66 (in key, descr., Rio Muni); Wheeler, 1975:344, text fig. only (aquarium fish; West Africa).

Syngnathus (*Parasyngnathus*) *Ansorgei:* Duncker, 1915:85 (n. comb., misspelling, descr.).

Table 1.—Frequency distributions of trunk, tail, and total rings in species of *Enneacampus*.

	Trunk rings		Tail rings							Total rings						
Species	12	13	31	32	33	34	35	36	37	44	45	46	47	48	49	50
ansorgii	6	98	1	6	6	7	28	52	4	2	6	6	7	29	50	4
kaupi		18		5	12	1					5	12	1			

Table 2.—Frequency distributions of dorsal- and pectoral-fin rays and total subdorsal rings in species of *Enneacampus*.

	Dorsal-fin rays								Pectoral-fin rays						Subdorsal rings						
Species	22	23	24	25	26	27	28	29	12	13	14	15	16	17	5.00	5.25	5.50	5.75	6.00	6.25	6.50
ansorgii	1	5	5	14	42	25	6	2	28	86	43	8			5	18	40	29	17	2	1
kaupi					11	4	3				3	10	19	1			1	6	10	2	

Syngnathus olssoni Johnels, 1954:348, 399, fig. 18 (orig. descr.; Farida and Alikiama swamps, Gambia River); Clausen, 1956:227 (comparisons).
Syngnathus olsonni: Daget and Iltis, 1965:185 (misspelling, in key, Gambia and Guinea); Thys, 1967:83 (in key, possibly conspecific with *ansorgii*).

Diagnosis.—Rings 12–13 + 31–37 = 44–50; dorsal-fin rays 22–29; pectoral-fin rays 11–15 (14 or less in 95% of counts); total subdorsal rings 5.0–6.5; dorsal-fin origin from middle of last trunk ring to origin of 2nd tail ring, usually at anterior margin of 1st tail ring (70% of specimens examined). Proportional data based on 48 specimens 54–118.5 ($\bar{x}$ = 87.7) mm SL follow: HL in SL 8.4–10.8 (9.4), snout length in HL 2.1–2.8 (2.5), snout depth in snout length 2.4–4.0 (3.2), length of dorsal-fin base in HL 0.9–1.3 (1.1), anal ring depth in HL 2.7–4.7 (3.6), trunk depth in HL 2.2–3.3 (2.6), pectoral-fin length in HL 4.4–6.2 (5.2), length of pectoral-fin base in pectoral-fin length 1.2–1.7 (1.4). Median dorsal snout ridge of subadults and adults finely denticulate under ×30 magnification. See Tables 1–3 for additional counts.

Coloration.—Snout with or without irregular brown bars or blotches (Fig. 2); opercle with pale stripe along longitudinal ridge, with brownish diagonal bars below the ridge or mottled throughout; eye usually with short brown

Table 3.—Geographical variation in frequencies of dorsal-fin rays in *Enneacampus ansorgii*.

	Dorsal-fin rays							
Locale	22	23	24	25	26	27	28	29
Gambia		2	2					
Sierra Leone	1	1						
Ghana			2	4	2			
Nigeria			1	9	38	24	6	
Cameroon		1		1		1		
Gabon					2			
Zaire								1
Angola								1

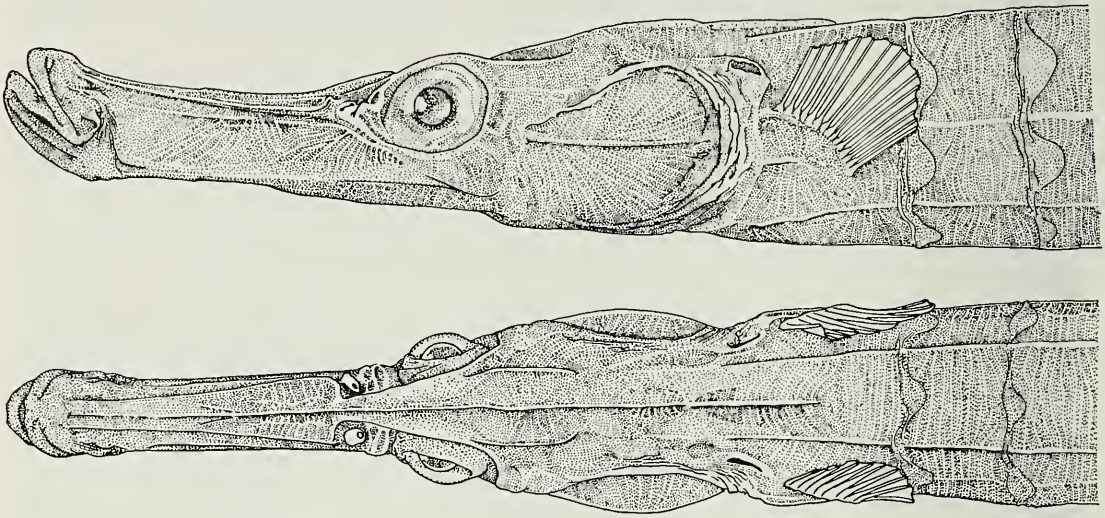


Fig. 4. *Enneacampus kaupi.* Lateral and dorsal aspects of head and anterior trunk rings. From 132 mm SL female (CAS-SU 63059).

bars radiating from pupil; head otherwise plain, mottled or blotched with brown. Body usually with indications of irregular, diffuse, pale bars crossing dorsum and upper part of sides on every 4th–5th ring; lower half of side of trunk usually with a rectangular brown blotch on each ring; side of trunk and tail otherwise variously mottled, blotched or shaded with brown. Dorsal fin hyaline distally, the proximal third or more of each fin-ray shaded with brown; proximal third of pectoral fin blotched or shaded with brown, otherwise hyaline; caudal fin irregularly blotched with brown, the margin usually pale.

Brood pouch and young.—The brood pouch is developed below 12–17 tail rings in 26 adult males (69.5–128.5 mm SL). One (75.5 mm SL) has a total of 17 eggs in a single 2-row layer through 12 or 14 pouch-rings, another (94 mm SL) has one layer of 35 eggs through 14 of 16 pouch-rings. Brood-pouch young (prolarvae and postlarvae sensu Hubbs, 1943) are unusually large, and one, representative of 32 postlarvae in an 82.5 mm SL male (GCRL 15485), measured 17.8 mm TL. When best developed, young completely fill the brood pouch, the pouch-folds fail to meet on the ventral midline, and the young are partly exposed (Fig. 2).

Comparisons.—The two species of *Enneacampus* overlap in meristic features (Tables 1–2) but *E. ansorgii* usually has fewer pectoral-fin rays (modally, 13 against 16 in *kaupi*). *Enneacampus ansorgii* has higher values for ratios of HL in SL ($\bar{x}$ = 9.4 against 7.1) and snout length in HL ($\bar{x}$ = 2.5 against 2.0) and these species also differ in other proportional features (see diagnoses). The median dorsal snout ridge is finely denticulate in subadult and adult specimens of *E. ansorgii* (typically entire in *kaupi*) and the quadrate dark blotches on the trunk rings are replaced by arcuate or semicircular ocellate spots along the inferior trunk ridge in well-marked specimens of *E. kaupi*.

Limited observations suggest that these species also differ in reproductive capacity and in the size of brood-pouch young. Seven brooding males of *E. ansorgii* (75.5–94 mm SL) contained 17 to 36 brood-pouch eggs or postlarvae, whereas there were over 800 prolarvae in a male *E. kaupi* (141 mm SL). Several prolarvae and postlarvae from different males of *E. ansorgii* measured about 11–18 mm TL; prolarvae of *E. kaupi* are about 4.4 mm TL.

For practical purposes, these species are most readily distinguished by obvious differences in relative length of the snout (compare Figs. 1 and 4).

Types.—The holotype of *Syngnathus ansorgii* (BMNH 1911.6.1.129) has the following counts and measurements (mm): rings 13 + 36, dorsal-fin rays 29, pectoral-fin rays 14 × 15, subdorsal rings 0 + 6.5, brood-pouch rings 17, anal-fin rays 3, caudal-fin rays 9, SL 110.5, HL 11.4, snout length 4.9, snout depth 1.5, length of dorsal-fin base 12.1, anal ring depth 4.2, trunk depth 4.8, pectoral-fin length 2.3, length of pectoral-fin base 1.9. The nares open through a single pore bilaterally, the lateral trunk ridge ends without deflection on the left side but the distal extremity is deflected a little ventrad on the right, and some larvae are retained in the brood pouch. Boulenger's (1910) original counts of 15 + 37 rings and subdorsal rings are in error, but his illustration (Fig. 73) of the holotype shows 13 trunk rings and about 6.5 subdorsal rings.

The syntypes of *Syngnathus pulchellus,* conspecific with the holotype of *S. ansorgii,* consist of a 128.5 mm SL male (BMNH 1874.6.8.20) and a dried female (BMNH 1888.12.13.41) with an estimated TL of 100 mm. The dorsal fin is missing in the male and an accurate count of dorsal-fin rays cannot be obtained from the female. There are 5.75 subdorsal rings in the male, about 5.5 in the female; both have 9 caudal-fin rays; there are 13 + 34 rings in both, rather than the described count of 13 + 35. Lateral trunk and tail ridges are discontinuous on both sides of the male and on the left side of the female; lateral trunk ridges are not deflected distally. The right side of the female is anomalous in that the lateral trunk and tail ridges are confluent and this is the ridge configuration described for the species by Boulenger (1915). In addition to employing this atypical ridge pattern as a principal character distinguishing *S. pulchellus* from *S. ansorgii* and *S. kaupi,* Boulenger illustrated this configuration (Fig. 74) on the left side of the female syntype, although it is present only on the right.

Johnels' (1954) description of *S. olssoni* was based on six specimens, including one male with developed brood pouch, 63–73 mm TL. Four of these, including the illustrated male "type" (now 69.5 mm SL), are cataloged as NRM 11151; the fate of the others is unknown. These fish, conspecific with *S. ansorgii,* have discontinuous lateral trunk and tail ridges, the lateral trunk ridge is deflected ventrad only on the right side of a 67.5

mm SL female, and all have 9 caudal-fin rays. The specimen described as having confluent lateral trunk and tail ridges on the right side is missing. Johnels reported 14 trunk rings in all of his material but I count 13 in the four extant fish. My counts of other meristic features fall within the described range.

Variation.—Johnels (1954) and Clausen (1956) noted variation in the lateral body ridges in this species and Clausen questioned the reliability of the lateral ridge configuration as a taxonomic character. Among 199 configurations examined here, the typical pattern of discontinuous lateral trunk and tail ridges (Fig. 1) occurred in 196 and these ridges were confluent in two cases. The lateral trunk ridge was straight in 186, whereas it was deflected distally to end between the lateral midline and the inferior ridge in 11. In one instance, the superior trunk and tail ridges were confluent rather than discontinuous. Unilateral or bilateral variation is rather common in some pipefishes (e.g. *Syngnathus acus, S. schlegeli*), but in *Enneacampus ansorgii,* as in most species, ridge configuration varies in less than 10 percent of those examined and constitutes an important primary character.

The nares are typically 2-pored bilaterally in most pipefishes but the majority of *E. ansorgii* examined have a single opening on each side. This condition appears similar to that reported for *Corythoichthys schultzi,* an Indo-Pacific marine species (Dawson, 1977).

Available data (Table 3) suggest a north-south increase in frequencies of dorsal-fin rays from Gambia to Angola.

Distribution.—*Enneacampus ansorgii* is known from rivers, streams, and swamps from the Gambia River drainage to the Cuanza River, Angola. There are apparently no definite records of its occurrence in estuarine or marine habitats.

Material examined.—One hundred and thirteen specimens, 40.5–128.5 mm SL, excluding pouch-larvae.

Holotype.—BMNH 1911.6.1.129 (110.5 mm SL, adult male), Angola, Quanza (= Cuanza) River at Dondo, cast net, 13 July 1910, W. J. Ansorge.

Other material.—GAMBIA: NRM 11151 (4, 61.5–69.5), including holotype (male) and 3 paratypes of *Syngnathus olssoni*). SIERRA LEONE: UMMZ 187910 (2, 55–94). GHANA: CAS-SU 63060 (3, 56–76), CAS-SU 63061 (1, 63), CAS-SU 63062 (2, 40.5–70), CAS-SU 64635 (1, 88.5), MCZ 48079 (1, 105). NIGERIA: GCRL 15408 (1, 99.5), GCRL 15485 (3, 81.5–88), GCRL 15486 (2, 93–100), GCRL 15531 (2, 78–99), GCRL 15532 (2, 101–109.5), ZMUC P.39478–84 (7, 66–87), ZMUC P.39485 (1, 102), ZMUC P.39486–90 (5, 83–99), ZMUC P.39491–92 (2, 72–72.5), ZMUC P.39493–94 (2, 68–76.5), ZMUC P.39495–96 (2, 76–95.5), ZMUC P.39497–99 (3, 58–84), ZMUC P.39500–04 (5, 70.5–95.5), ZMUC P.39505–06 (2, 78–107), ZMUC P.39507–09 (3, 72–85.5), ZMUC P.39510 (1, 88), ZMUC P.39511 (1, 80), ZMUC P.39512–17 (6, 54–100), ZMUC P.39518 (1, 70), ZMUC P.39519–21

(3, 57.5–99), ZMUC P.39522–28 (7, 49.5–93), ZMUC P.29529–42 (14, 70.5–92.5), ZMUC P.39543–49 (7, 80–95.5), ZMUC P.39550–51 (2, 75.5–98.5), ZMUC P.39552–53 (2, 99.5–105), ZMUC P.39554–55 (2, 95–105.5), ZMUC P.39556 (1, 94). CAMEROON: BMNH 1874.6.8.20 (128.5, syntype of *S. pulchellus*), MNHN 29.91 (1, 84), MCZ 48149 (2, 66–81). GABON: BMNH 1888.12.13.41 (ca. 100, dried syntype of *S. pulchellus*), GCRL 16280 (1, 49), MNHN 06-211 (2, ca. 77–95). ZAIRE: IRSNB 19412 (1, 118.5).

Enneacampus kaupi (Bleeker)
Figs. 3–4

Syngnathus spicifer (not of Rüppell): Kaup, 1856:34 (misident. in part, Guinea sp. only).

Syngnathus Kaupi Bleeker, 1863:24, pl. 4, fig. 2 (orig. descr., Guinea); Duméril, 1870:542, 547 (in key, descr. compiled).

Syngnathus kaupi: Günther, 1870:174 (descr. compiled); Lönnberg, 1895 (Cameroons); Boulenger, 1912:23 (freshwater lagoon at Chiloango, Bas-Congo); Boulenger, 1915:86, fig. 72 (in key; descr.; Degama and Chiloango, Congo); Metzelaar, 1919:217 (listed); Fowler, 1936:556 (in key, descr. compiled, Liberia to Congo); Cadenat, 1950:300 (listed; Guinea, Sierra Leone, Dahomey); Poll, 1953:251, fig. 102 (descr., Liberia to Congo); Clausen 1956:227 (comparisons; Boulenger's (1915) "Degama" should be Degema, Lower Niger); Kähsbauer, 1962:159 (listed, Nigeria); Daget and Iltis, 1965:185, fig. 114 (in key; descr.; Ivory Coast; type loc. given incorrectly as Ghana); Blache et al., 1970:242, fig. 656 (in key); Roman, 1970:147, fig. 65 (in key; descr.; Rio Muni).

Syngnathus kaupii: Büttikofer, 1890:480 (emendation, Liberia).

Syngnathus Kaupii: Steindachner, 1894:89 (Liberia).

Syngnathus (*Parasyngnathus*) *Kaupi:* Duncker, 1915:85 (n. comb.; descr.; Liberia to Gabon); Monod, 1927:680 (food item of *Galeoides decadactylus*; Souelaba, Cameroon).

Diagnosis.—Rings 13–14 + 32–34 = 45–47; dorsal-fin rays 26–28; pectoral-fin rays 14–17 (15 or more in 91% of counts); total subdorsal rings 5.5–6.25; dorsal-fin origin from anterior margin to middle of 1st tail ring, usually at anterior margin (90% of specimens examined). Proportional data based on 15 specimens 55–141 ($\bar{x}$ = 91.1) mm SL follow: HL in SL 6.7–7.5 (7.1), snout length in HL 1.8–2.1 (2.0), snout depth in snout length 3.2–5.4 (4.5), length of dorsal-fin base in HL 1.2–1.6 (1.4), anal ring depth in HL 3.4–5.3 (4.4), trunk depth in HL 2.8–3.7 (3.2), pectoral-fin length in HL 5.9–8.0 (6.7), length of pectoral-fin base in pectoral-fin length 1.1–1.5 (1.3). Median dorsal snout ridge usually entire under ×30 magnification. See Tables 1–2 for additional counts.

Coloration.—Roman (1970) described recently collected material as generally dusky with a brick-red abdomen; the head plain in males but with black bars below eye and on lower part of opercle in females; lower part of side (of trunk) greyish-yellow, with a golden, black-margined, ocellus on each ring; tail rings black spotted, sprinkled with gold; caudal fin black, edged with pale. Somewhat faded specimens (CAS-SU 17148) have the dorsum and upper parts of sides of body crossed by about 10 narrow and diffuse pale bars (spaced ca. 4–5 rings apart); each trunk ring with a dark-margined arcuate or semicircular brown spot extending dorsad from the inferior ridge; pouch-plates of male with an alternating series of short pale and brownish bars; dorsal-fin rays and pectoral fins shaded lightly with brown microchromatophores; caudal fin brown, with narrow pale margin.

Brood pouch and young.—The brood pouch is developed below 16–18 tail rings in four brooding males (83–141 mm SL) and an immature male (71 mm SL) has evidence of pouch development below 15 rings. None of the available males have eggs, but pouch-young are present in three. The largest and best preserved male (141 mm SL) has coiled prolarvae (ca. 4.4 mm TL), arranged in about four transverse rows and in two layers, through 15 of the 17 pouch-rings; the number of young is conservatively estimated at 850–900.

Comparisons.—See under *E. ansorgii.*

Holotype.—Bleeker (1863) recorded 14 + 34 rings, 26 dorsal-fin rays, 16 pectoral- and 10 caudal-fin rays for the 173 mm TL, female, holotype of *E. kaupi*. This specimen (RMNH 3874) now lacks the caudal fin and part of the tail, the dorsal fin originates at the anterior margin of the 1st tail ring and there are 6.25 subdorsal rings. Other counts and measurements (mm) follow: trunk rings 13, remaining tail rings 28, dorsal-fin rays 26, pectoral-fin rays 16 × 16, head length 21.4, snout length 10.9, snout depth 2.0, length of dorsal-fin base 16.2, trunk depth 7.1. Bleeker's atypical count of 10 caudal-fin rays suggests an error in enumeration or a regenerated fin.

Variation.—Atypical body ridge configurations were not noted in material examined and meristic data show no evidence of geographic variation. Five specimens examined had 2-pored nares bilaterally, whereas one had a single pore on the right side and two on the left. Roman (1970) recorded 14 trunk rings for two of 16 specimens from the Rio Muni region. This count was 13 in the remainder of Roman's material and in all specimens examined here.

Distribution.—Present materials show that *E. kaupi* ranges from Guinea to Zaire where it has been taken with *E. ansorgii* in the Banana River. There is a record from the Loemé River estuary (Congo) and Boulenger noted the occurrence of this species in brackish water, but most collections are apparently from freshwater. The only record of *E. kaupi* from marine waters is apparently that of Bas (1974) and Lloris and Rucabado (1979). I have been unable to obtain this specimen, trawled in 24 meters off Punta Durnford (23°12′N, 16°20′W), and its identity requires verification.

Material examined.—Nineteen specimens, 55– ca. 165 mm SL, excluding pouch-larvae.

Holotype.—RMNH 3874 (now 152.5 [orig. ca. 165 mm SL], damaged female), Guinea.

Other material.—LIBERIA: CAS-SU 48408 (3, 55–77), RMNH 5401 (1, 79.5). GHANA: CAS-SU 63059 (2, 132–141), USNM 219173 (2, 78–99.5). NIGERIA: BMNH 1902.11.10.301 (1, 68.5). CAMEROON: CAS-SU 17148 (2, 73.5–101), GCRL 17011 (1, 98.5). CONGO: MNHN 1967-185 (1, 110.5), MNHN 1967-186 (1, 63.5). ZAIRE: AMNH 17135 (1, 83), BMNH 1912.4.1.475–6 (2, 97–119), IRSNB 8701 (1, 84.5).

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Literature Cited

Bas, C. 1974. Distribución de especies dermersales recogidas durante la expedición oceanográfica "Sahara I."—Res. Exp. Cient. B/O Cornide 3:187–247.

Blache, J. 1962. Liste des poissons signalés dans l'Atlantique tropico-oriental sud du Cap des Palmes à Mossamédès (province guinéo-équatoriale).—Cah. ORSTOM, ser. Pte. Noire. 2:13–102.

Blache, J., J. Cadenat, and A. Stauch. 1970. Clés de détermination des poissons de mer senegalés dans l'Atlantique oriental (entre 20°N et 15°S).—Faune Tropicale, ORSTOM. 18:1–479.

Bleeker, P. 1863. Mémoire sur les poissons de la côte de Guinée.—Nat. Verh. Holl. Maatsch. Wetensch. 2(18):1–136.

Boulenger, G. A. 1910. On a large collection of fishes made by Dr. W. J. Ansorge in the Quanza and Bengo Rivers, Angola.—Ann. Mag. Nat. Hist., 8th ser. 6:537–561.

———. 1912. Poissons recueillis dans la région du Bas-Congo par M. le Dr. W. J. Ansorge.—Ann. Mus. Congo Belge, Zool. ser. 1. 2:1–27.

———. 1915. Catalogue of the fresh-water fishes of Africa in the British Museum (Natural History).—London. 3:1–526.

Büttikofer, J. 1908. Reisebilder aus Liberia.—E. J. Brill, Leiden. 2:480.

Cadenat, J. 1950. Poissons du mer du Sénégal.—Initiations Afr., IFAN 3:1–345.

Claussen, H. S. 1956. Biological and taxonomical notes on Nigerian fresh-water *Syngnathus* (Linné 1758) Kaup 1856, with remarks on the taxonomic value of crista media trunci and c. superior caudae.—Vidensk. Medd. fra Dansk naturh. Foren. 118:225–234.

Daget, J., and A. Iltis. 1965. Poissons de Côte d'Ivoire (eaux douces et saumatres).—Mem. IFAN 74:1–385.

Dawson, C. E. 1977. Review of the pipefish genus *Corythoichthys* with description of three new species.—Copeia 1977:295–338.

———. 1978. Review of the Indo-Pacific pipefish genus *Bhanotia,* with description of *B. nuda* n. sp.—Proc. Biol. Soc. Wash. 91:392–407.

———. 1979. Review of the polytypic doryrhamphine pipefish *Oostethus brachyurus* (Bleeker).—Bull. Mar. Sci. 29:465–480.

Dawson, C. E., and R. A. Fritzsche. 1975. Odontoid processes in pipefish jaws.—Nature 257:390.

Duméril, A. 1870. Histoire naturelle des poissons ou ichthyologie générale. Tome second. Ganoides, dipnés, lophobranchs.—Paris. 624 pp.

Duncker, G. 1915. Revision der Syngnathidae.—Mitteil. Naturh. Mus. Hamburg 32:9–120.

Fowler, H. W. 1919. The fishes of the United States Eclipse Expedition to West Africa.—Proc. U.S. Nat. Mus. 56:195–292.

———. 1922. Notes on hemibranchiate and lophobranchiate fishes.—Proc. Acad. Nat. Sci. Phila. 73:437–448.

———. 1936. The marine fishes of West Africa.—Bull. Amer. Mus. Nat. Hist. 70:1–605.

Fritzsche, R. A. 1980. Revision of the eastern Pacific Syngnathidae (Pisces: Syngnathiformes), including both recent and fossil forms.—Proc. Cal. Acad. Sci. 42:181–227.

Günther, A. 1870. Catalogue of the fishes in the British Museum.—Taylor and Francis, London. Vol. 8, 549 pp.

Herald, E. S. 1959. From pipefish to seahorse—a study of phylogenetic relationships.—Proc. Cal. Acad. Sci. 29:465–473.

Hubbs, C. L. 1943. Terminology of early stages of fishes.—Copeia 1943:260.

Johnels, A. G. 1954. Notes on fishes from the Gambia River.—Arkiv. f. Zool., Stockholm 6:327–411.

Kähsbauer, P. 1962. Beitrag zur kenntnis der Fischfauna von Nigeria.—Ann. Naturhist. Mus. Wien 65:139–165.

Kaup, J. 1856. Catalogue of lophobranchiate fish in the collection of the British Museum.—Taylor and Francis, London. 76 pp.

Lloris, D., and J. Rucabado. 1979. Especies ictiológicas de las expediciones pesqueras realizadas en el platforma del NW de Africa (1971–1975).—Res. Exp. Cient. B/O Cornide 8:3–151.

Lönnberg, E. 1895. Notes on fishes collected in the Cameroons by Mr. Y. Sjöstedt.—Öfvers. svenska Vetensk Akad. Handl. 3:179–195.

Metzelaar, J. 1919. Report on the fishes collected by Dr. J. Boeke in the Dutch West Indies 1904–1905, with comparative notes on marine fishes of tropical west Africa.—A. H. Kruyt, Amsterdam. 315 pp.

Monod, T. 1927. Contribution a la faune du Cameroun. Pisces I.—Faune Col. Fr., Paris. 1:643–742.

Poll, M. 1953. Poissons III. Téléostéens malacoptérygiens.—Res. Sci. Exped. oceanogr. Belg. eaux côt. afr. Atl. Sud (1948–49) 4(2):1–258.

Roman, B. 1970. Peces de Rio Muni, Guinea Ecuatorial (Aguas dulces y salobres).—Fund. La Salle Sci. Nat., Barcelona. 295 pp.

Steindachner, F. 1894. Die Fische Liberia's.—Notes Leyden Mus. 16:1–96.

Sterba, G. 1959. Freshwater fishes of the world. Revised edn.—Longacre Press, London. 878 pp.

Thys van der Audenaerde, D. F. E. 1965. List of the freshwater fishes presently known from the Island of Fernando Poo.—Bonn. Zool. Beitr. 16:316–317.

———. 1967. The freshwater fishes of Fernando Poo.—Verh. Kon. v. Acad. Wetens., Belge 29:1–167.

Wheeler, A. C. 1975. Fishes of the world.—MacMillan Publ. Co., Inc., New York. 366 pp.

Gulf Coast Research Laboratory Museum, Ocean Springs, Mississippi 39564.

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GONODACTYLUS SIAMENSIS, A NEW STOMATOPOD CRUSTACEAN FROM THAILAND

Raymond B. Manning and Marjorie L. Reaka

Abstract.—The third shallow water member of the *G. falcatus* group of species from Thailand is recognized. It can be distinguished in the field by its color pattern.

Among the stomatopods collected by one of us (M.L.R.) in Thailand in 1973 was a small species of the *Gonodactylus falcatus* group which could be distinguished in the field from the two more common species of the group found there, *G. mutatus* Lanchester, 1903, and *G. ternatensis* De Man, 1902 (see Dingle, Caldwell, and Manning, 1977; Manning, 1978). This species is described here.

We thank Roy L. Caldwell for help in collecting these specimens; studies in Thailand were carried out under NSF grant GB-36046. The illustrations were prepared by Lilly King Manning. All of the specimens have been deposited in the collections of the Smithsonian Institution under USNM catalog numbers.

Gonodactylus siamensis, new species
Fig. 1

Gonodactylus falcatus.—Reaka, 1979a:238, 252, fig. 1; 1979b:330, 333, fig. 3. [Not *Gonodactylus falcatus* (Forskål, 1775).]

Material.—Thailand: Gulf of Thailand, Sattahip [12°40′N, 100°52′E]; intertidal coral rubble reef flat exposed at low tide; 2, 4 July 1973; M. L. Reaka, and R. L. Caldwell, leg.: 10 ♂, 21–39.5 mm, 13 ♀, 16–38 mm (♀, 36 mm long, holotype, USNM 181673; remainder of specimens are paratypes, USNM 181674).

Description.—Rostral plate longer than broad, median spine relatively long; anterior margin of plate sloping anteriorly or perpendicular to body line; basal part of plate short, lateral margins divergent, anterolateral angles acute but broadly rounded. Ocular scales small, breadth of each no greater than width of rostral spine at base. Anterior 5 abdominal somites lacking transverse grooves, sixth somite with 6 carinae, variously inflated, usually unarmed posteriorly in females, occasionally unarmed in small males also; median carinule absent. Small black spot faintly indicated on each side of sixth somite between submedian and intermediate carinae. Abdominal width/carapace length index ranging from 875 in smallest to 780 in largest

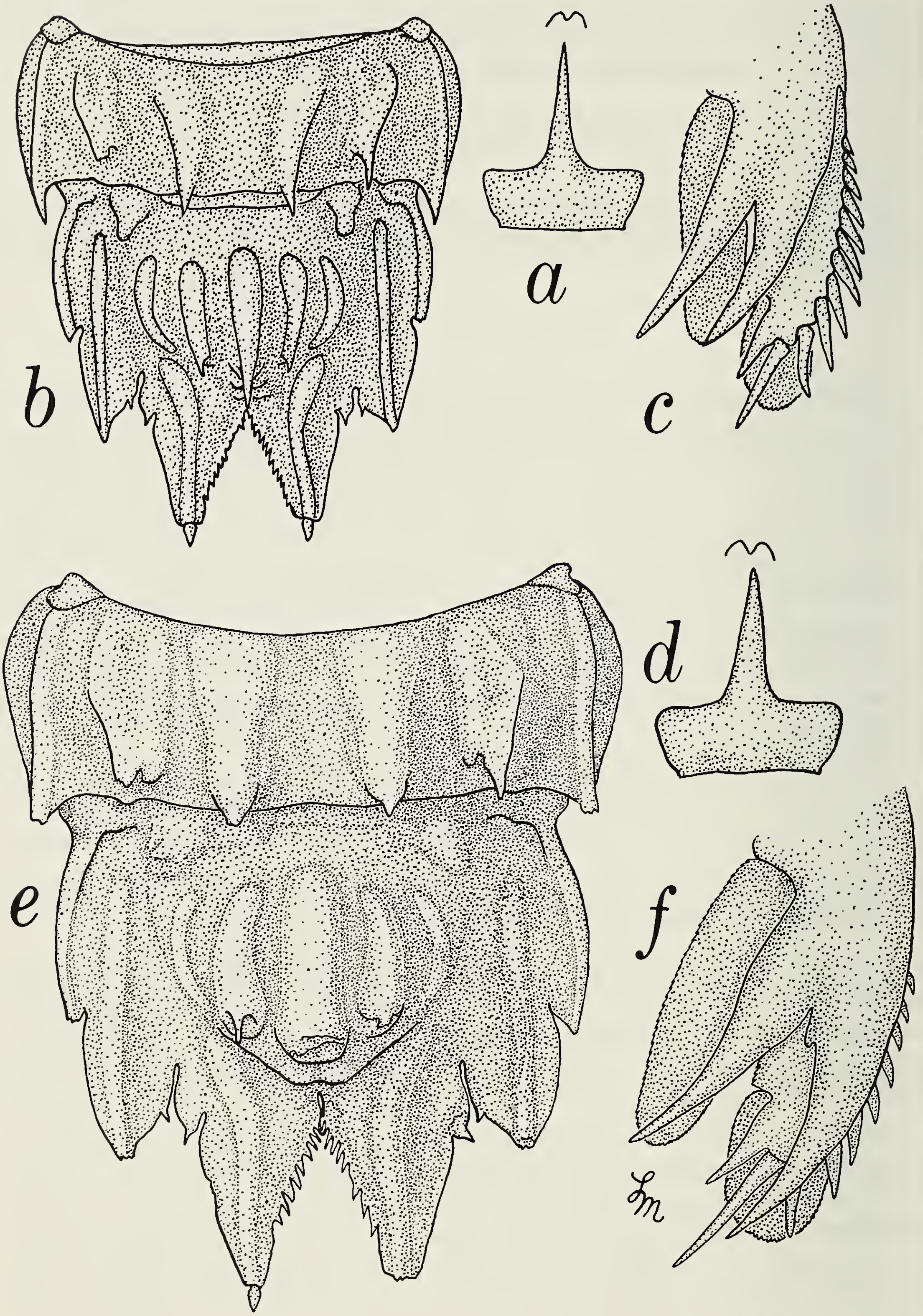

Fig. 1. *Gonodactylus siamensis*: *a–c,* Female, 25 mm long; *d–f,* female, 36 mm long. *a, d,* Rostral plate and ocular scales; *b, e,* Sixth abdominal somite and telson; *c, f,* Uropod, ventral view.

specimens. Telson with length and width subequal or length greater. Dorsal carinae of telson inflated, especially in males, median and accessory medians each usually with apical spinule flanked ventrally by rounded excavation; dorsal carinae slender in juveniles, more inflated in adults. Knob distinctly bilobed. 3 pairs of marginal teeth present, all relatively slender in females, submedians with movable apices, intermediates and laterals usually with slender, sharp apices. Intermediate denticles sharp, distinct. Anterior surface of telson with faint indication of dark spot on each side anterior to anterior submedian carina. Ventral surface of telson with low postanal ridge and longer, sharper carina on each submedian tooth. Uropodal endopod with single line of marginal setae, exopod with 10–13, usually 11, graded movable spines on outer margin of proximal segment; basal prolongation with 1 lobe proximally on inner margin of outer spine.

Color in life.—Females uniform olive or chocolate brown, or green, frequently speckled; meral spot yellow with light brown infusion; 4 black spots on sixth abdominal somite and telson. Males black, dark green, or olive green, with red posterior edges on abdominal somites. Antennal scales blue; setae blue proximally, red distally.

Measurements.—Total lengths of males 21 to 39.5 mm, of females 16 to 38 mm. Other measurements, in mm, of female holotype: carapace length 9.0; rostral plate length 2.8, width 2.6; fifth abdominal somite width 7.3; telson length 6.3, width 6.0.

Remarks.—Two other species of the *G. falcatus* group of species are known to occur in Thailand (Dingle, Caldwell, and Manning, 1977; Naiyanetr, 1980). *Gonodactylus ternatensis,* the largest of the three species, attaining a total length in Thailand of 87 mm, can be distinguished immediately from *G. mutatus* and *G. siamensis* by its long rostral spine and, slender, sharp carinae as well as an undivided knob on the telson. In life it agrees with *G. siamensis* and differs from *G. mutatus* in having red intersegmental bands on the body as well as blue antennal scales in the male; it differs from both species in having an orange rather than a yellow meral spot. *Gondactylus siamensis* and *G. mutatus* are of similar size and are superficially similar morphologically. In life, they can be distinguished immediately by the blue antennal scale in the former, a red, orange, or yellow antennal scale in the latter; in addition, *G. mutatus* lacks the posterior red bands on the body segments.

Gonodactylus siamensis differs from *G. mutatus* in the shape of the rostral plate, with the apical spine longer and the basal portion shorter, and the telson is usually longer, with longer, slenderer marginal teeth in the new species.

In these specimens, the abdominal width/carapace length index shows a wide variation between young and old specimens, as follows:

Carapace length, mm	No. of specimens	Index	
		Range	Mean
4	1	—	875
5	3	833–860	844
6	2	833–841	837
7	6	819–877	854
8	1	—	852
9	7	778–826	808
10	2	776–784	780

Many of the specimens of *G. siamensis* have damaged spines and carinae on the sixth abdominal somite and telson (Fig. 1*e*), suggesting that they are somewhat aggressive.

Etymology.—The specific epithet is derived from the old name for Thailand, Siam.

Literature Cited

Dingle, Hugh, Roy L. Caldwell, and Raymond B. Manning. 1977. Stomatopods of Phuket Island, Thailand.—Phuket Marine Biological Center, Research Bulletin 20:1–20, figures 1–11.

Manning, Raymond B. 1978. Notes on some species of the *Falcatus* Group of *Gonodactylus* (Crustacea: Stomatopoda: Gonodactylidae).—Smithsonian Contributions to Zoology 258:1–15, figures 1–13.

Naiyanetr, Phaibul. 1980. Stomatopoda of Thailand.—95 pages, plates 1–35. Chulalongkorn University, Bangkok.

Reaka, Marjorie L. 1979a. The evolutionary ecology of life history patterns in stomatopod Crustacea, pages 235–260. *In* S. E. Stancyk, editor, Reproductive Ecology of Marine Invertebrates.—Belle W. Baruch Library of Marine Science, University of South Carolina Press.

———. 1979b. Patterns of molting frequencies in coral-dwelling stomatopod Crustacea.—Biological Bulletin 156:328–342, figures 1–3.

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A NEW DEEP-SEA LEECH, *BATHYBDELLA SAWYERI,* N. GEN., N. SP., FROM THERMAL VENT AREAS ON THE GALÁPAGOS RIFT

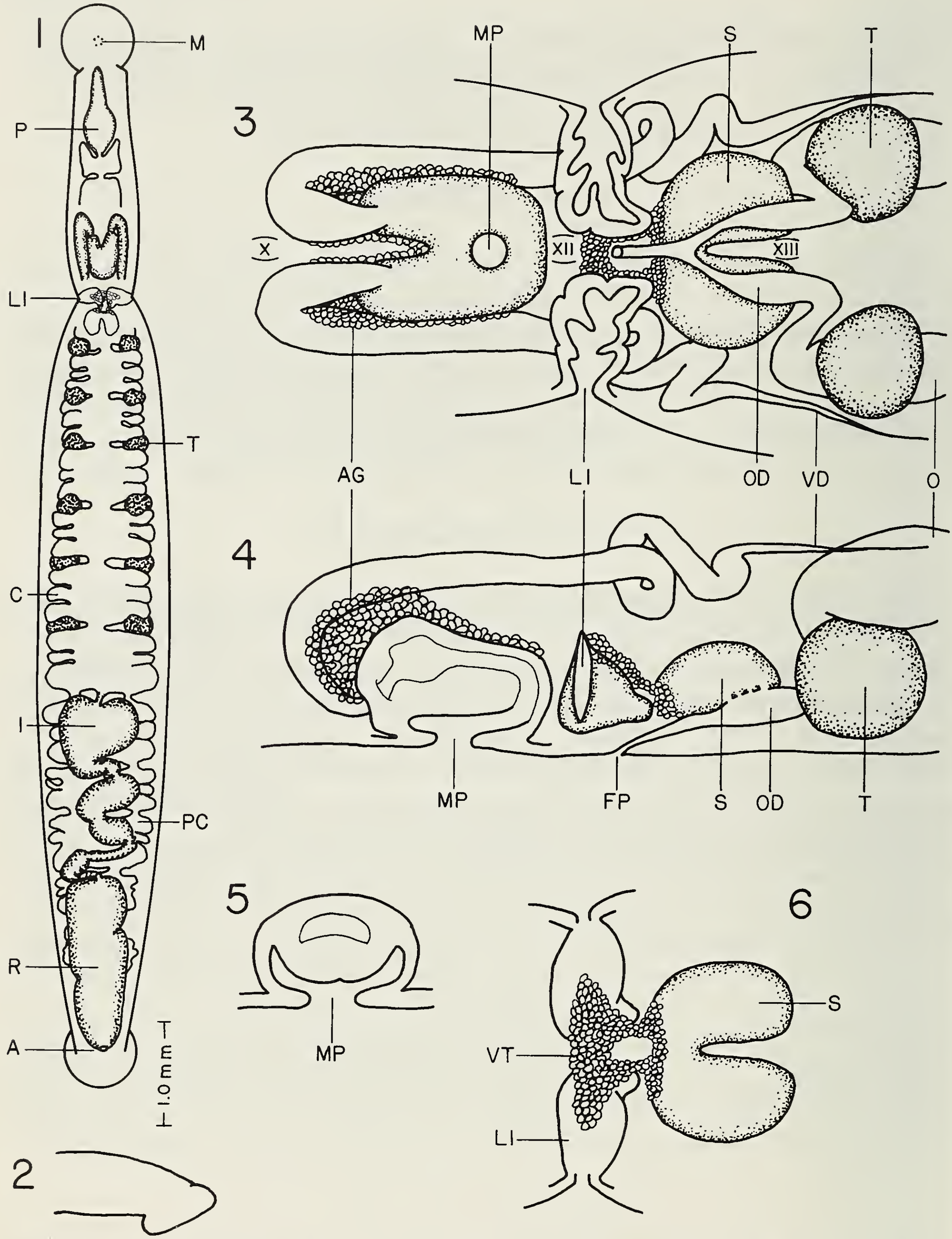
Eugene M. Burreson

Abstract.—*Bathybdella sawyeri* was common in samples of invertebrates collected by DSRV *Alvin* from 2400 meters at 00°48.3′N, 86°13.5′W during February 1979. The leech is not known to exceed 11 mm in length and has the following morphological characteristics: tegument smooth, lacking gills and pulsatile vesicles; eyes and ocelli absent; caudal sucker small; 6 pairs of testisacs; deep, paired lateral invaginations in XII connected via vector tissue to large bilobed spermatheca in XII; postceca present.

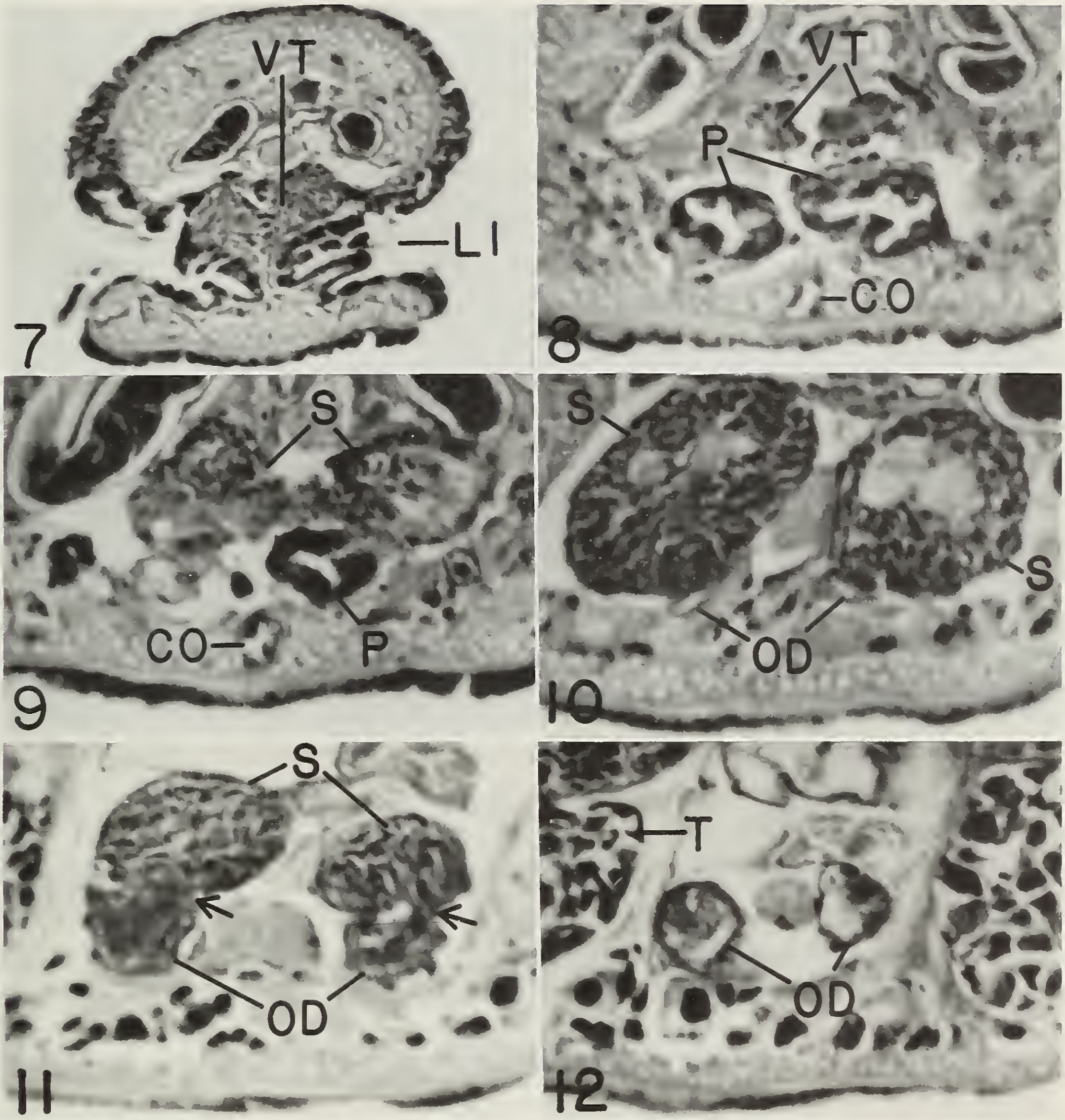
The discovery of unique biological assemblages near submarine thermal vents during the first DSRV *Alvin* expedition to the Galápagos Rift in 1977 (Corliss and Ballard, 1977; Lonsdale, 1977; Corliss et al., 1979) inspired the Galápagos Rift Biology Expedition in early 1979 (Ballard and Grassle, 1979; Grassle et al., 1979). Included in the material collected on this expedition was a small species of piscicolid leech. None of the specimens collected was from a fish, but the crop of most individuals was filled with red blood cells indicating that the leech is a fish parasite. Specimens examined include 10 individuals preserved in situ on the outer surface of a single vestimentiferan tube collected on *Alvin* dive 884 (00°47.7′N, 86°07.7′W, 2482 m, 2°C, 25 January 1979), and 46 specimens, ranging from 3 to 11 mm in length, from the bottom of a small aquarium used to temporarily hold a clump of mussels collected on *Alvin* dive 890 (00°48.3′N, 86°13.5′W, 2447 m, 2°C, 15 February 1979). Five individuals were sectioned (frontal, entire ×2; sagittal, entire; transverse, entire; transverse, anterior half), two wholemounts were prepared and stained with Semicohn's acetocarmine, and two specimens were prepared for examination under the scanning electron microscope.

Bathybdella, new genus

Diagnosis.—Size small, not known to exceed 11 mm; body elongate, cylindrical; paired deep, lateral pits in XII giving appearance of distinct trachelosome/urosome division; tegument smooth, lacking papillae, tubercles, gills, and pulsatile vesicles; caudal sucker slightly subterminal, not wider than maximum body width; oral sucker well developed; midbody segments 3(9?) annulate; crop strongly compartmented, postceca present; intestine



Figs. 1–6. *Bathybdella sawyeri*: 1, Reconstruction of digestive system, reproductive system, body shape and sucker shape from dorsal aspect; 2, Caudal sucker, lateral view; 3, Male and female reproductive systems, ventral view; 4, Male and female reproductive systems, lateral view; 5, Transverse section of terminal portion of male reproductive system at level of male gonopore; 6, Spermatheca system, dorsal view. A, anus; AG, accessory gland cells; C, crop cecum; FP, female gonopore; I, intestine; LI, lateral invagination; M, mouthpore; MP, male gonopore; O, ovisac; OD, oviduct; P, proboscis; PC, postceca; R, rectum; S, spermatheca; T, testisac; VD, vasa deferentia.



Figs. 7–12. Transverse paraffin sections of *B. sawyeri* illustrating female reproductive system. 7, ×75; 8–12, ×110. 7, Immediately posterior to ganglion in XII showing large lateral invaginations, LI, and mass of vector tissue, VT; 8, Posterior portion of XII, ventral ⅔ of body, illustrating cords of vector tissue, VT, posterior extensions of lateral invaginations, P, and common oviduct. CO; 9, Anterior portion of XIII showing bilobed spermatheca, S, with connecting element, terminal portion of posterior extension of left lateral invagination, P, and common oviduct, CO; 10, Anterior portion of XIII with paired oviducts, OD, in contact with ventral portion of spermathecal lobes, S; 11, At ganglion in XIII showing enlarged oviducts, OD, packed with sperm, and connections (arrows) between oviducts and spermathecal lobes, S; 12, Posterior portion of XIII illustrating oviducts, OD, and testisacs, T.

lacking symmetrical diverticula; 6 pairs of testisacs; bursa moderately large; deep, paired lateral invaginations immediately posterior to ganglion in XII opening externally into lateral pits; posterior margins of invaginations covered by vector tissue with short, paired cords leading to large bilobed sper-

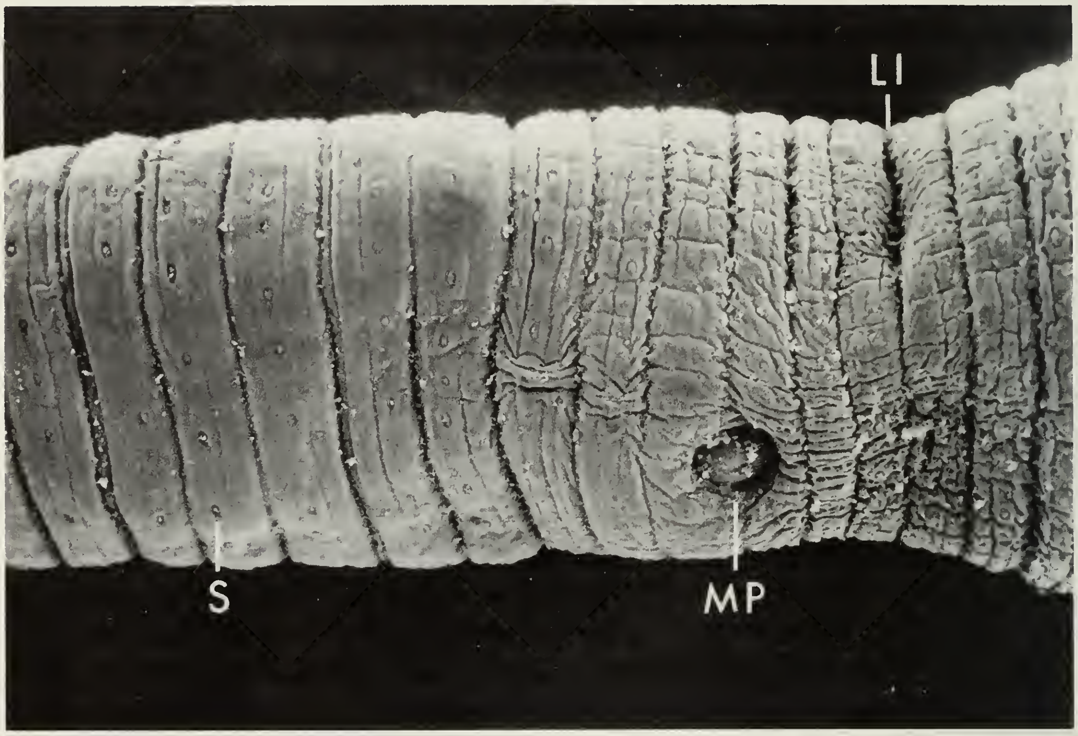


Fig. 13. Scanning electron micrograph of *B. sawyeri,* ×120. LI, lateral invagination; MP, male gonopore; S, sensillae.

matheca (seminal receptable) in XIII; oviducts in contact with ventral surface of spermatheca; marine.

Type-species.—Bathybdella sawyeri n. sp.,

Etymology.—From the Greek, *bathy,* deep + *bdella,* a leech.

Bathybdella sawyeri, n. sp.

Figs. 1–13

Diagnosis.—With the characters of the genus; average total length of mature individuals including suckers, 8 mm (range 6–11 mm); no eyes or ocelli on either sucker or on body; no pigmentation apparent on body or suckers; minute sensillae dorsally and ventrally on primary annuli of each segment on trachelosome and urosome; mouthpore centrally located in oral sucker; posterior portion of proboscis bulbous; esophageal diverticula absent; crop ceca trilobed; postceca fused with 4 wide fenestrae; intestine sinuous with small chambers, rectum large; accessory gland cells covering dorsal portions of ejaculatory ducts, artrial conua and bursa; bursa confluent ventrally with specious cavity opening through large male gonopore.

Holotype.—USNM 65773; *Paratypes.*—USNM 65774, 65775.

Type-locality.—Galápagos Rift, Eastern Pacific Ocean, 00°48.3′N, 86°13.5′W, 2,447 m.

Hosts.—Unknown, but assumed to be deep-sea demersal fishes.

Etymology.—Named in honor of Dr. Roy T. Sawyer in recognition of his many contributions to hirudinology.

External characters (Figs. 1, 2, 13, measurements of holotype).—Body elongate, cylindrical, and indistinctly divided into trachelosome and urosome, although deep lateral pits at ganglion in XII giving appearance of distinct separation. Average total length of mature individuals including suckers 8.0 mm (range 6–11 mm, holotype 9.0 mm). Mouthpore centrally located in well-developed discoid oral sucker 0.8 mm in diameter eccentrically attached to trachelosome. Oral sucker devoid of eye spots and pigment. Trachelosome tapering slightly toward anterior end where first 2 nuchal annuli constricted. Lateral margins otherwise roughly parallel except for deep lateral pits at level of ganglion in XII where invaginations open externally. Trachelosome width here narrowing to 0.5 mm (Figs. 1, 13). Posterior to lateral pits trachelosome widening abruptly into prominent shoulders, especially when crop is full, and merges with urosome. Male gonopore a large spherical opening 0.1 mm in diameter (Fig. 13) separated by 3 annuli from openings to invaginations in lateral pits (Fig. 13). Female gonopore never observed with certainty even under scanning electron microscope, but based upon sectioned material should be in same annular furrow as lateral invaginations or slightly caudad. Urosome widest (1.3 mm) at midlength of body and tapering to 0.7 mm at caudal sucker, lacking papillae, tubercles, gills, pulsatile vesicles, pigment and ocelli. Midbody segments basically 3-annulate, each deeply furrowed primary annulus further subdivided such that there appear to be 3 or 4 secondary annuli in each primary annulus. Minute sensillae (Fig. 13) dorsally and ventrally on each primary annulus of urosome and trachelosome. Caudal sucker small (0.8 mm diameter), slightly subterminal, not wider than greatest body width, and lacking pigmentation and ocelli.

Coelomic system.—Material inadequate for detailed characterization. Lateral extensions of ventral sinus at ganglia and of dorsal sinus intersegmentally in testicular region. Presence of lateral sinuses unconfirmed. Pulsatile vesicles absent.

Central nervous system.—Central nervous system typical of that of other piscicolid leeches with ventral nerve cord consisting of anterior ganglionic mass, 21 segmental ganglia in VII though XXVII, and posterior ganglionic mass.

Digestive system (Fig. 1).—Mouthpore approximately centrally located in oral sucker. Proboscis, 530 μm in length, extending to ganglion in IX; anterior portion about 100 μm in diameter, expanding somewhat abruptly about mid-length into bulbous portion 210 μm in diameter (Fig. 1). Bulbous portion appearing too large to pass through anterior ganglionic mass, unless quite compressible. Salivary glands located between ganglia in VII and IX. Crop divided into 2 compartments in trachelosome; first with 2 short anterior projections around base of proboscis. No esophageal diverticula present. Crop lumen expanding between testisacs into large trilobed ceca (Fig. 1). Intestine and postceca originating immediately posterior to ganglion in XIX. Intestine a large chamber with short anterior pouches at XIX/XX, narrowing abruptly at ganglion in XX, becoming tubular, sinuous, with small pouches in anterior portion of XX, XXI and XXII, the latter displaced laterally to left. Intestine entering a large, uniformly tubular rectum at XXIII/XXIV. Posteca fused with 4 wide fenestrae immediately posterior to ganglia from XX to XXIII. Trilobed nature of crop persisting in postceca to XXIII; postceca terminate at XXVI.

Reproductive System.—(Figs. 4–13). Six pairs of large testisacs located intersegmentally in XIII/XIV through XVIII/XIX. Vasa deferentia enlarged in XIII and entering loosely coiled epididimides in anterior portion of XIII, continuing cephalad and becoming confluent with ejaculatory bulbs as walls of ducts become increasingly thicker and more glandular. Immediately posterior to ganglion in X, ducts bending ventrad and lumina becoming very small. Ejaculatory ducts entering atrial cornua on their anteroventral margin (Figs. 3, 4). Lumina of atrial cornua merging into small common atrium which opens into moderately large bursa. Bursa continuing caudad to near ganglion in XII, bending ventrad and entering a spacious chamber between body wall and elongated glandular mass of atrium (Figs. 4, 5). This chamber opening externally through large male gonopore in anterior portion of XII. Region between ventral surface of ejaculatory bulbs and dorsal surface of ejaculatory ducts, atrium and bursa covered with large mass of accessory gland cells (Fig. 3, 4).

Female system having paired, deep, lateral invaginations immediately posterior to ganglion in XII (Figs. 3, 4, 6). Openings to invaginations appearing externally as long vertical slits (Fig. 13) in lateral depressions or pits. These invaginations being spacious, epithelial-lined cavities penetrating almost to midline of body (Figs. 3, 7). Posterior projections from each invagination terminating near anterior margin of large, bilobed spermatheca (Fig. 9) located in anterior portion of XIII (Figs. 3, 4, 8, 9). Compact mass of vector tissue covering dorsal and posterior margins of each lateral invagination and filling area between them (Figs. 6, 7). Vector tissue narrowing abruptly and bifurcating into 2 short cords of cells prior to merging with lobes of spermatheca at XII/XIII (Figs. 6, 8). Vector tissue cords without lumina or surrounding epithelium. Spermatheca, situated in anterior portion of XIII, consisting of 2 broadly elongate lobes with a narrow anterior connection. Spermatheca a loose cellular mass bounded by an epithelium except at extreme anterior portion where a proliferation of vector tissue cord cells not covered by an external epithelium (Fig. 6). Unlined cavity present in each spermatheca lobe (Fig. 10). Sperm present in spermatheca of all sectioned leeches, but never present in lateral invaginations.

Ovisacs situated dorsally at XIII/XIV. Left and right oviducts bending ventrad near first pair of testisacs and continuing anteriorly near body midline (Fig. 12). Oviducts, when contacting ventral surface of spermatheca, expanding and filled with sperm (Figs. 3, 11). In sectioned material, epithelium of dorsal surface of oviducts and ventral surface of spermatheca becoming diffuse such that there are many places where lumina of oviducts are confluent with spermatheca and sperm can be seen in the process of entering oviducts (Fig. 11). Oviducts continuing cephalad, still in contact with spermatheca, then becoming very small tubes (Figs. 3, 10). Oviducts eventually fusing into common oviduct then bending ventrad and cephalad to female gonopore somewhat posterior to lateral invaginations (Figs. 4, 8, 9).

Discussion

Bathybdella sawyeri is remarkable for depth of collection, abundance, and the unique anatomy of the female reproductive system. The depth of collection is exceeded only by *Galatheabdella bruuni* from 4400 m and 3880 m in the Tasman Sea (Richardson and Meyer, 1973), and by an unidentified leech from the deep-sea fish *Bassozetus* from 3570 m in the Pacific off Costa Rica listed in the same report. It is likely that the latter leech is *Bathybdella sawyeri*. The collection location (9°23′N, 89°32′W) is near the Galápagos Rift region and the brief description provided by Richardson and Meyer (1973), from a single poorly preserved specimen, resembles that of *B. sawyeri*. This suggests that *B. sawyeri* may not be endemic to vent areas, but rather may be a parasite of widely distributed deep-sea benthopelagic fishes such as *Bassozetus*. The unusually high abundance of the leech in vent areas may be the result of an abundance of fish hosts attracted by a rich food supply, and also the presence of hard substrate for cocoon deposition. According to Cohen (pers. comm.) approximately 16 species of mainly benthopelagic fishes have been photographed, observed, or captured in the thermal vent areas. Most, including *Bassozetus,* are rare, but some Macrouridae (benthopelagic) and two species of Zoarcidae (secretive, sedentary benthic fishes) are apparently common in the vent area.

Bathybdella sawyeri has one of the most complex arrangements known in the Piscicolidae for conducting spermatozoa from the external copulatory zone near the gonopores to the ova. The spermatozoa are apparently introduced into or near the lateral invaginations, migrate through the epithelial layer of the invaginations to the surrounding vector tissue, and then along the narrow cords to the spermatheca where they are stored until they pass into the oviducts. Neither copulation nor attached spermatophores have been observed in *B. sawyeri,* however, and it is not known how, or for certain if, spermatozoa enter the lateral invaginations. An unpaired ventral invagination, histologically identical to those of *B. sawyeri* and surrounded by vector tissue, occurs in *Mysidobdella borealis* (Johansson). This structure often contains spermatozoa and was termed a spermatheca by Burreson and Allen (1978). It is unlikely that the lateral invaginations in *B. sawyeri* function as spermathecae since other structures serve that purpose, and thus the histologically identical invagination in *M. borealis* may not function as a spermatheca either. These deep pouches probably hold the spermatozoa only temporarily. A deep, ventral invagination and a shallow ventral depression are reported by Brumpt (1900) in *Branchellion torpedinis* and *Cystobranchus respirans* respectively. While it may be tempting to interpret these invaginations as relict structures derivable from the paired ectodermal spermathecae of oligochaetes, it is also possible that they are advanced characters derived by invagination of the piscicolid copulatory zone into the ventral vector tissue mass. The true spermatheca in *B. sawyeri* is similar histologically and in segmental position to those of other piscicolids but has unique features as well. It is strongly bilobed whereas in most piscicolids spermathecae (used in the broad sense of any large well-defined mass of vector tissue) are unpaired. These include *Marsipobdella sacculata* Moore, *Hemibdella soleae* Van Beneden & Hesse, *Johanssonia arctica* (Johansson), *Calliobdella vivida* (Verrill), and *Piscicola salmositica* Meyer, among others. However, the basic bilateral nature of the spermatheca in other species may be reflected by the paired cords of conductive tissue from the spermatheca to the ovisacs present in *H. soleae, C. vivida, P. salmositica,* and others. The primitive leech, *Acanthobdella peledina* Grube does have a bilobed spermatheca in XIII and, interestingly, a shallow ventral invaginated pit at XII/XIII (Brumpt, 1900). The most unique feature of the spermatheca in *B. sawyeri* is its position dorsal to the oviducts. In all other piscicolids the spermatheca or vector tissue mass is situated ventral to the ovisacs, immediately behind the female gonopore, and closely associated with the copulatory zone of the ventral body wall. This facilitates transfer of spermatozoa from spermatophores affixed to the copulatory zone to the spermatheca. In such arrangements the oviducts usually pass through the anterior portion of the spermatheca. Even in *Marsipobdella sacculata* the elongate, more dorsally situated spermatheca terminates in vector tissue near the ventral body wall posterior to the female gonopore. In *B. sawyeri* the spermatheca is located more in the middle of the body away from the ventral body wall.

The closest relatives of *Bathybdella* n. gen. may be *Mysidobdella* Selensky and *Hemibdella* van Beneden and Hesse, although neither is really very similar. *Mysidobdella* has a single deep invagination bordered by vector tissue (Burreson and Allen, 1978), but it is located posterior to the female pore in XIII while those of *B. sawyeri* are anterior to the female pore in XII. *Hemibdella* possesses a spermatheca and accessory gland cells around the atrium and lacks eyes and ocelli (Selensky, 1931). *Mysidobdella* and

Hemibdella are both small marine leeches with small caudal suckers, but, unlike *B. sawyeri,* both have only five pairs of testisacs.

The combination of paired, lateral invaginations; bilobed spermatheca dorsal to the oviducts; six pairs of testisacs; small caudal sucker, and lack of pulsatile vesicles clearly separates *Bathybdella* from all other previously described genera.

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Literature Cited

Ballard, R. D., and J. F. Grassle. 1979. Return to oases of the deep.—Nat. Geog. Mag. 156:689–705.

Brumpt, E. 1900. Reproduction des hirudinees.—Mém. Soc. Zool. France 13:286–400.

Burreson, E. M., and D. M. Allen. 1978. Morphology and biology of *Mysidobdella borealis* (Johansson) comb. n. (Hirudinea: Piscicolidae), from mysids in the western North Atlantic.—J. Parasitol. 64(6):1082–1091.

Corliss, J. B., and R. D. Ballard. 1977. Oases of life in the cold abyss.—Nat. Geog. Mag. 152:441–453.

Corliss, J. B., J. Dymond, L. I. Gordon, J. M. Edmond, R. P. von Herzen, R. B. Ballard, K. Green, D. Williams, A. Bainbridge, K. Crane, and T. H. van Andel. 1979. Submarine thermal springs on the Galápagos Rift.—Science 203:1073–1083.

Grassle, J. F., C. J. Berg, J. J. Childress, J. P. Grassle, R. R. Hessler, H. J. Jannasch, D. M. Karl, R. A. Lutz, T. J. Mickel, D. C. Rhoads, H. C. Sanders, K. L. Smith, G. N. Somero, R. D. Turner, J. H. Tuttle, P. J. Walsh, and A. J. Williams. 1979. Galápagos '79: initial findings of a deep-sea biological quest.—Oceanus 22:2–10.

Lonsdale, P. 1977. Clustering of suspension-feeding macrobenthos near abyssal hydrothermal vents at oceanic spreading centers.—Deep-Sea Res. 24:857–863.

Richardson, L. R., and M. C. Meyer. 1973. Deep-sea fish leeches (Rhynchobdellae: Piscicolidae).—Galathea Rept. 12:113–126.

Selensky, W. D. 1931. Ueber die Gattung *Hemibdella* nebst einigen allgemeinen Bemerkungen über die Organisation der Ichthyobdelliden.—Pubb. Staz. Zool. Napoli 11:1–21.

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A NEW DWARF CRAYFISH FROM THE PACIFIC VERSANT OF MEXICO (DECAPODA: CAMBARIDAE)

Alejandro Villalobos-Figueroa and Horton H. Hobbs, Jr.

Abstract.—*Cambarellus prolixus* is described from Lago de Chapala, in the State of Jalisco, Mexico. It shares the lake with two of its closest relatives, *Cambarellus chapalanus* (Faxon) and *C. montezumae* (Saussure), but appears to occupy a different niche. The new species may be distinguished from all other members of the genus by the length of the acumen, which is at least 0.8 as long as, and usually greater in length than, the remainder of the rostrum.

Introduction

The new crayfish described herein was discovered during the course of studies on Lago de Chapala, State of Jalisco, conducted by the Instituto de Ingeniería of the Universidad Nacional Autónoma de México. Among the organisms collected in the vicinity of Ajijic were several specimens of a crayfish (acocil) of the genus *Cambarellus* which were readily recognized as being different from *Cambarellus chapalanus* (Faxon, 1898:661), the common crayfish inhabiting much of the littoral zone of the lake. In subsequent collecting efforts, one of us (AV-F) obtained numerous specimens of this unique crayfish, verifying its restricted habitat and limited distribution within the lake.

Cambarellus prolixus, new species
Figs. 1, 2

Diagnosis.—Pigmented, eyes well developed. Rostrum with margins subparallel to concave and bearing spines, acumen at least 0.8 as long as basal part. Carapace without cervical spine. Areola 3.0 to 4.8 (average 3.7) times as long as broad and constituting 22.6 to 27.7 (average 26.1) percent of total length of carapace (39.0 to 48.2, average 44.2, percent of postorbital carapace length). Suborbital angle broadly obtuse to subacute. Branchiostegal spine absent. Postorbital ridge with acute cephalic extremity, spine often overreaching posterior margin of orbit. Antennal scale approximately 3 times as long as wide, broadest proximal to midlength. Merus of cheliped with 0–2 dorsal, 1–3 ventral, and 1 distolateral spines. Hooks on ischia of second and third pereiopods of male, form I, simple, neither overreaching basioischial articulation nor opposed by tubercle on corresponding basis; coxa of fourth pereiopod with well developed cephalomesial and caudomesial bosses, that of fifth pereiopod subtuberculiform. First pleopods of first

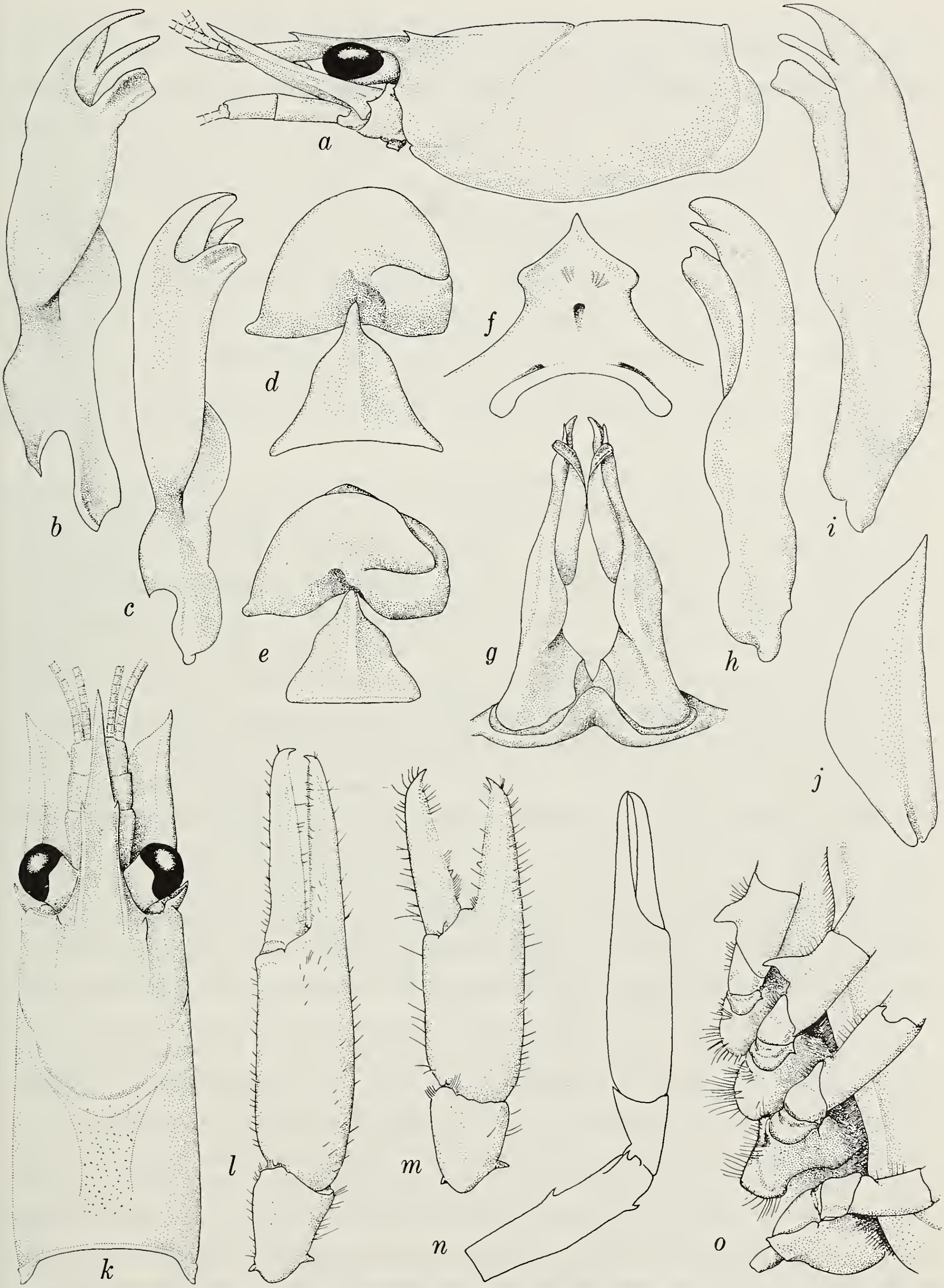

Fig. 1. *Cambarellus prolixus* (all illustrations are of holotype except *c* and *h* of morphotype, *d, e,* and *m* of allotype, and *g* of paratypic male, form I): *a,* Lateral view of carapace; *b, c,* Mesial view of first pleopod; *d, e,* Annulus ventralis; *f,* Epistome; *g,* Caudal view of first pleopods; *h, i,* Lateral view of first pleopod; *j,* Antennal scale; *k,* Dorsal view of carapace; *l, m,* Dorsal view of distal podomeres of right cheliped; *n,* Lateral view of distal podomeres of left cheliped; *o,* Proximal podomeres of second through fifth pereiopods.

form male symmetrical, very weakly arched at distal end of proximal third, lacking both subapical setae and shoulder on cephalic surface; terminal elements corneous, subparallel in lateral aspect, and directed at about 40 degree angle to main shaft of appendage: mesial process with troughlike groove mesially, truncate distally, and directed somewhat distolaterally; central projection tapering from base, its apical part slightly inclined mesially; and slender caudal process extending caudodistally beyond other 2 elements. Annulus ventralis about 1.5 times as broad as long, caudal face with conspicuous median concavity at base receiving postannular sclerite when annulus rotated posteriorly; prominent undulating horizontal sinus cutting sinistral anterior, lateral, and caudal surfaces. Postannular sclerite campanulate in outline, 1.2 to 1.3 times as broad as long, and base more than 0.75 times as broad as greatest width of annulus ventralis. First pleopod lacking in female.

Holotypic male, form I.—Cephalothorax (Fig. 1*a, k*) subovate, slightly compressed. Greatest width of carapace little more than height at caudodorsal margin of cervical groove. Areola about 3.0 times as long as wide with 5 or 6 punctations across narrowest section, its length constituting 26.1 percent of entire length of carapace (43.4 percent of postorbital carapace length). Surface of carapace weakly punctate, many punctations bearing simple setae. Rostrum with slender lateral carinae weakly concave laterally and terminating in well developed spines overreaching basal segment of antennule; acumen conspicuously long, overreaching antennal scale, and extending beyond antennular peduncle by distance subequal to length of ultimate podomere of latter; dorsal surface concave with usual submarginal rows of setiferous punctations and scattered ones between. Subrostral ridges rather weak but evident in dorsal aspect along almost basal third of rostrum. Left suborbital angle well defined and, although forming obtuse angle, with small slightly eccentric subacute apex; angle on right side injured. Brachiostegal spine lacking, cephalic extremity of branchiostegite rounded. Cervical spine absent.

Abdomen slightly narrower than carapace (5.1 and 5.5 mm). Pleura of third through fifth segments truncate ventrally and lacking angles. Cephalic section of telson with 1 spine in each caudolateral corner. Cephalic lobe of epistome (Fig. 1*f*) broadly joined to main body, subtriangular, apex of anterior angle produced; main body with distinct fovea; epistomal zygoma rather strongly arched. Proximal podomere of antennule with conspicuous spine on ventromesial border at about midlength. Antennal peduncle with well developed spine on distolateral surface of basis; ischium with small ventral tubercle: flagellum extending caudally to almost midlength of telson. Antennal scale (Fig. 1*j*) 7.4 times as long as broad, widest proximal to midlength; mesial margin of lamellar area with 2 subangular bends, proximal one at widest part of scale and other at about base of distal fourth; disto-

Table 1.—Measurements (mm) of *Cambarellus prolixus*.

	Holotype	Allotype	Morphotype
Carapace:			
Entire length	16.1	14.2	16.9
Postorbital length	9.7	9.0	9.3
Width	5.5	5.5	5.5
Height	5.3	5.6	4.9
Areola:			
Width	1.4	1.1	1.1
Length	4.2	3.9	4.3
Rostrum:			
Width	1.8	1.8	1.7
Length	7.0	5.6	8.3
Length of acumen	3.7	2.5	5.2
Chela:			
Length, palm mesial margin	5.6	3.8	4.0
Palm width	2.8	2.6	2.0
Length, lateral margin	11.3	8.0	9.1
Dactyl length	5.1	4.0	4.7
Abdomen:			
Width	5.1	5.7	5.2
Length	16.8	14.5	16.0

lateral spine overreaching antennular peduncle but falling short of apex of acumen.

Third maxilliped extending cephalically to slightly beyond basal segment of antennular peduncle; mesial half of ischium with broad band of stiff simple setae, single row of plumose setae flanking ventromesial side of lateral costa, and few between row and mesial band, distolateral angle not produced; exopod reaching midlength of propodus.

Right chela (Fig. 1*l*) subovate in cross-section, not strongly depressed; surface, except for opposable margins of fingers, lacking tubercles and spines but studded with setiferous punctations, those with short setae much more numerous than those with long ones; latter more abundant along lateral surface of fixed finger, on mesial surface and flanking low submedian longitudinal ridge on dorsal surface of dactyl, and along opposable margins of both fingers. Opposable margin of both fingers with band of minute denticles extending along almost entire length; in addition, fixed finger with tubercle near base, and dactyl with corneous cusp slightly beyond distal end of basal third of finger (in dorsal aspect, tubercles hidden by minute denticles).

Carpus of cheliped about 1.3 times as long as broad, bearing setiferous punctations; distal ventrolateral articular area produced in strong acute spine. Merus of cheliped (Fig. 1*n*) likewise with setiferous punctations, longest setae ventrally and proximolaterally, those situated on latter forming row of 6 conspicuously long ones; dorsal margin with strong preterminal spine, ventral surface with 1 at about midlength, and lateral surface with 1 at distal extremity. Ischium also with setiferous punctations, but without spines or tubercles; sufflamen clearly defined.

Hooks on ischia of second and third pereiopods (Fig. 1*o*) simple, not overreaching basioischial articulation and not opposed by tubercle on corresponding basis; that on third more tapering and clawlike. Coxa of fourth pereiopod with conspicuous setiferous caudomesial and cephalomesial bosses, latter directly cephalolaterally; coxa of fifth pereiopod with less conspicuous tuberculiform caudomesial boss bearing few setae. Sternum between second, third, and fourth pereiopods rather deep; lateral margins not strongly produced ventrally but setae borne on them conspicuous.

First pleopods (Fig. 1*b, g, i*) as described in "Diagnosis." Lateral lobe of proximal podomere of uropod broadly rounded, mesial lobe with distinct spine; distomedian spine on mesial ramus premarginal.

Allotypic female.—Differing, other than in secondary sexual features, from holotypic male in following respects: rostral margins subparallel to level of marginal spines, latter more divergent than in holotype, acumen distinctly shorter, not overreaching antennal scale, dorsal surface with number of long setae between submarginal rows; in dorsal aspect, subrostral ridges disappearing beneath lateral carinae on basal fourth of rostrum; suborbital angle lacking subacute apex; abdomen slightly broader than carapace (5.7 and 5.5 mm); cephalic section of telson with 2 spines in each caudolateral corner; cephalic lobe of epistome triangular, cephalic angle not produced; mesial borders of antennal scale rounded, 2 subangular bends not so evident (Fig. 2*i*), distolateral spines reaching level of apex of acumen; both fingers of chela (Fig. 1*m*) with tuft of setae at ventral opposable base, opposable margin of fixed finger with tooth at end of proximal third, dactyl with 2 teeth in corresponding position, minute denticles arranged in single row on both fingers. See Table 1 for differences in proportions of chelae and other body regions.

Annulus ventralis (Fig. 1*e*) as described in "Diagnosis." First pleopods absent. Basal podomere of uropod as in holotype.

Morphotypic male, form II.—Differing from holotype in following respects: section of rostrum posterior to marginal spines shorter than in holotype, acumen overreaching antennular peduncle by almost 3 times length of ultimate podomere of latter, setae on dorsal surface less numerous than in holotype; cephalic section of telson with 2 spines in each caudolateral corner; epistome triangular, cephalic angle not produced; tubercle on ischium of antenna acute; flagellum of antenna overreaching caudal margin of telson; antennal scale with mesial margin of lamella more rounded, sub-

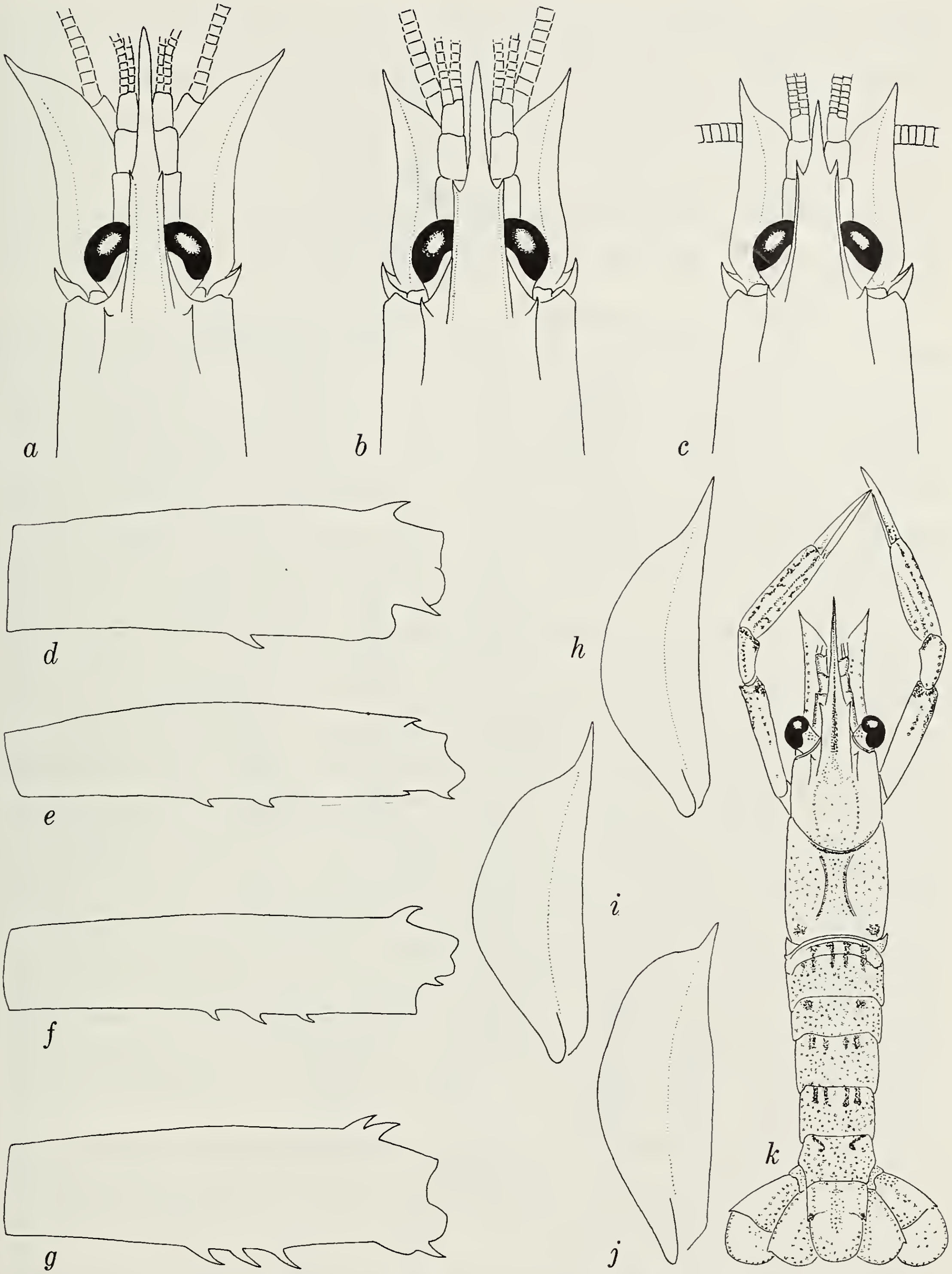

Fig. 2. *Cambarellus prolixus*: *a–c*, Dorsal view of cephalic region of paratypic males, form I; *d–g*, Lateral view of right merus of paratypic males, form I: *h*, *j*, Dorsal view of right antennal scale of paratypic males, form I; *i*, Same of allotype; *k*, Diagrammatic representation of color pattern. Note: Acumen probably regenerated in *c*.

angular bends obscured; third maxilliped extending cephalically to base of ultimate podopere of antennule; opposable margin of fixed finger of chela lacking tooth, that of dactyl situated on proximal tenth of finger; hooks on ischia of second and third pereiopods much reduced in size and that on third tuberculiform rather than clawlike; cephalomesial boss on fourth pereiopod represented by ridge and not so well defined; first pleopod (Fig. 1*c, h*) less inclined caudally, caudal process and central projection disposed as in holotype but shorter and more robust, mesial process also shorter, and none of 3 corneous.

Color notes.—The general coloration of this crayfish is grayish brown, pale to translucent in areas where the chromatophores are widespread or absent, and dark where they occur in clusters (Fig. 2*k*). Almost all of the markings are bilaterally distributed except for the median line on the rostrum and the broader median cluster on the telson. The dorsomedian line on the rostrum extends from the apex caudally beyond the base of the orbit. Paired, laterally convex lines mark the gastric region, and subparallel ones flank the dorsal part of the cervical groove, that posterior to the groove being darker than that anterior to it. Concave lines abut the mesial margins of the branchiocardiac grooves, and a pair of conspicuous splotches are present near the dorsal posterolateral borders of the carapace. Two pairs of short, longitudinal, darker markings occur on either side of the median line of the terga of the first and second abdominal segments. The chromatophores on the third abdominal tergum are, for the most part, rather evenly distributed but a pair of subcircular spots are present anterolaterally. On the fourth and fifth terga there are repetitions of the pattern on the first and second, and the sixth tergum exhibits an anterior dorsolateral pair of curved markings. The most conspicuous elements of the color pattern on the telson are the dark clusters at the caudolateral extremities of the cephalic section; the general distribution of the chromatophores on the remainder of the telson and uropods is as illustrated. Color on the first pereiopods is concentrated toward the dorsodistal end of the merus, along the dorsomesial distal part of the carpus, on and flanking the mesial surface of the propodus, and on the proximal part of the fingers.

Size.—The largest specimen available is a female having a carapace length of 17.2 (postorbital carapace length 9.8) mm. Corresponding lengths of the smallest first form male are 9.9 (6.0) mm, and of the smaller of the two ovigerous females 11.9 (7.3) mm.

Type-locality.—Lago de Chapala (Fig. 3), 500 meters from the north levee at Ajijic, State of Jalisco, Mexico, at depths of 4 to 5 meters. (See "Ecological Notes.")

Disposition of types.—The holotypic male, form I, allotypic female, and morphotypic male, form II, are deposited in the National Museum of Natural History, Smithsonian Institution, nos. 177206, 177207, and 177208, re-

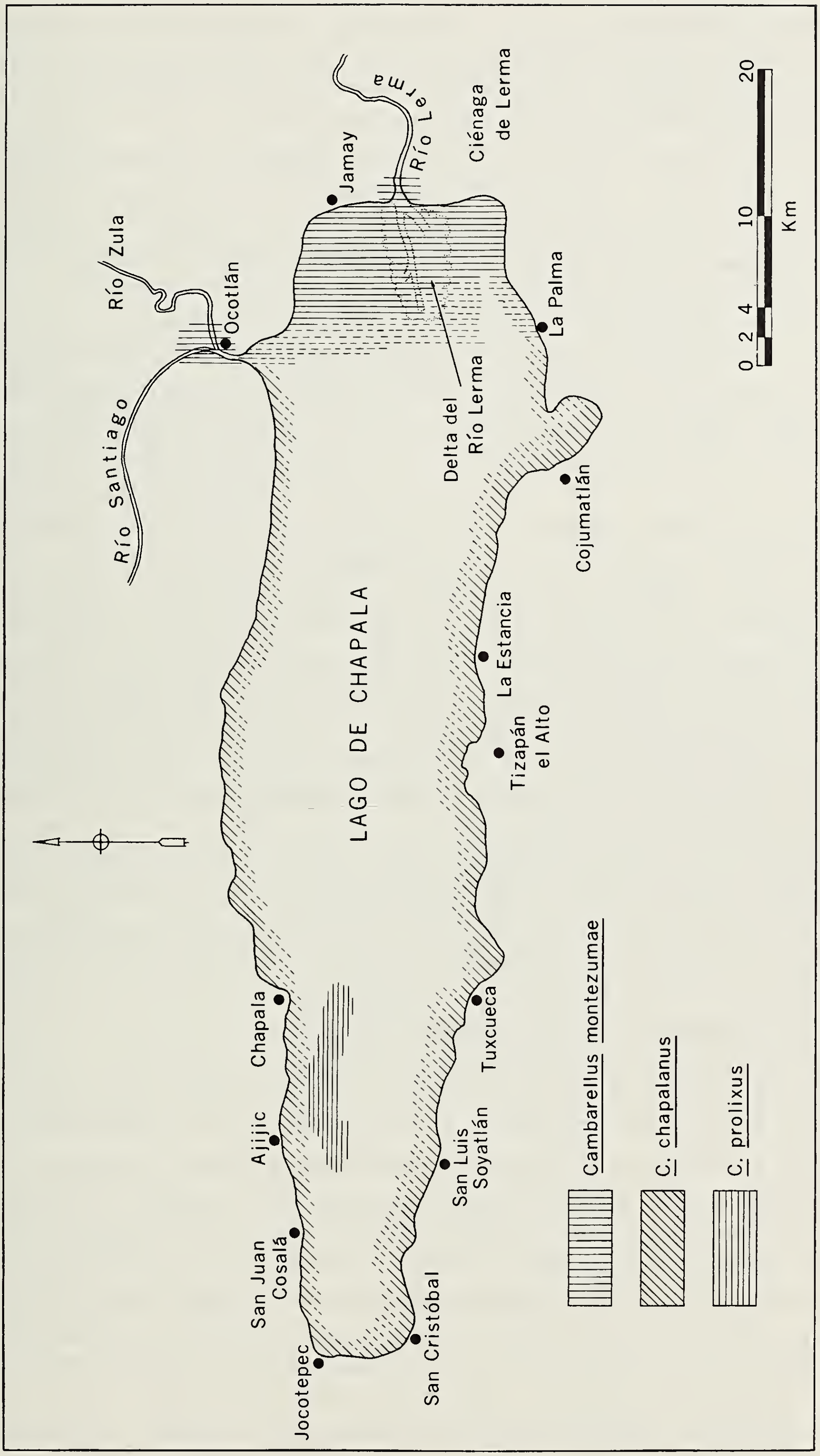

Fig. 3. Lago de Chapala, depicting the distribution of the three crayfishes inhabiting the lake.

spectively. Of the paratypes, 2 ♂I, 2 ♂II, and 2 ♀ are deposited in each of the following: Texas Memorial Museum, University of Texas at Austin; British Museum (Natural History); and Rijksmuseum van Natuurlijke Historie. Of the remaining paratypes, 57♂I, 41♂II, 45♀, 19 j♂, 15 j♀, 2 ovig ♀, and 1♀ with young are deposited in the National Museum of Natural History and 25♂I, 24♂II, 27♀, 45 j♂, 36 j♀ in the Instituto de Biología, Universidad Nacional Autónoma de México. All except one of the first form males were collected by the first author and M. E. Zamora on 20 November 1977; the single male was obtained by C. D. Barbour on 9 December 1979.

Range.—Known only from Lago de Chapala, Jalisco, Mexico.

Variations.—The greatest range of variation noted occurs in the shape of the rostrum and relative length of the acumen (Fig. 2*a–c*); the margins may be subparallel, slightly convergent, or concave, and the acumen ranges in length from 0.8 to 1.9 times as long as the basal part of the rostrum. Perhaps most of those rostra in which the acumen is shorter than the basal section have been injured. The shape of the antennal scale is also variable (Fig. 12*h–j*), the lateral margin may be almost straight or bowed mesially or laterally; the mesial margin of the lamellate area may exhibit two subangular bends or be gently rounded in an almost continuous curve. The teeth on the opposable margins of the fingers of the chelae may vary from 0 to 2 and be positioned at different levels along the proximal third of the finger. On the merus of the cheliped (Fig. 2*d–g*) there may be none to two well developed premarginal spines dorsally and one to three ventrally. The cephalic section of the telson bears one or two spines in each caudolateral corner. For other variations see Table 1 and "Diagnosis."

Ecological notes.—Lago de Chapala forms a part of the basin of the Río Lerma and Río Santiago which drain some 130,000 km². It is the largest lake in Mexico, having an area of 1100 km², and, in addition to receiving the waters of the two rivers, it is also fed by runoff from lakeside dwellings, municipalities, farms, and industries; consequently evidence of eutrophication and contamination is almost always present.

Prior to the discovery of *Cambarellus prolixus, C. chapalanus* was the only crayfish known to occur in the lake (the presence of a third species, *C. montezumae* (Saussure, 1857:102), at the eastern end was disclosed during the study mentioned in the introductory paragraph above). As shown on the accompanying map, all three species frequent the marginal or submarginal zone of this body of water; however, *C. prolixus* does not share the littoral biotope, but lives at depths of three or four meters where the bottom is littered with plant debris; some individuals invade depths of seven or eight meters. The temperature at these depths varies between 18 and 20.5°C; the pH exhibits values of 8.3 to 8.6; the transparency ranges from 1.2 to 1.4 m; and the oxygen concentration varies from 4.44 to 4.66 ml/l.

Among the animal components of the biocenosis to which *C. prolixus* belongs are *Anodonta* sp. and *Pisidium* sp. (bivalve mollusks belonging to the families Unionidae and Sphaeridae, respectively), *Planorbis* sp. (snails of the family Planorbidae), larvae and nymphs of various insects including members of the orders Odonata (Zygoptera and Anisoptera), Hemiptera, Trichoptera, and Coleoptera (Dytiscidae).

Life history notes.—First form males have been collected on November 20 and December 9. On the former date, two ovigerous females and another carrying second instar young were obtained. One of the ovigerous females had a carapace length of 14.6 (postorbital carapace length 9.1) mm and carried 70 eggs with diameters ranging from 0.8 to 0.9 mm. Corresponding measurements of the other were 11.9 (7.3) mm and her brood of eggs consisted of 54 with diameters of 0.9 to 1.0 mm. Twenty-one young were found on a female with lengths of 14.2 (8.4) mm. Inasmuch as the young were in the second instar, many or a few could have escaped prior to or during capture and preservation.

Relationships.—*Cambarellus prolixus* is without doubt more closely allied to the other Mexican members of the genus than to any of those species occurring in the United States, and shares as much in common with *C. chapalanus,* a species described from the same lake, as with any other member of the genus. The most striking similarities are in the spination, the first pleopod of the male, and in the annulus ventralis of the female. More distantly related are *C. montezumae, C. patzcuarensis* Villalobos (1943:607), and *C. zempoalensis* Villalobos (1943:601). It may be distinguished most readily from all other members of the genus in possessing an acumen that is no less than 0.8 as long as, and usually greater in length than, the remainder of the rostrum. The spines on the dorsal and ventral surfaces of the merus of the cheliped (Figs. 1*n,* 2*d–g*) are strikingly more strongly developed than in any of the four species mentioned except in the "giant females" (unusually large individuals) of *Cambarellus chapalanus.* The ventral spine (never multiple except in *C. prolixus* and the giant females) is absent in most *C. montezumae,* in all *C. zempoalensis* that we have examined, and poorly developed in *C. patzcuarensis,* and the dorsal one is small to rudimentary in the latter three, and not much better developed in males and most females of *C. chapalanus.* The annulus ventralis of *C. prolixus* is proportionately broader than in the other four species mentioned, but that of *C. chapalanus* is more similar than are the strikingly more elongate ones of the remaining three. The mesial process of the first pleopod of *C. prolixus* is more robust than that of *C. zempoalensis* and not so far removed from the caudal process; also it is shorter than that of *C. montezumae.* Whereas *C. chapalanus* is known to occur in a number of localities in Jalisco and Michoacan, *C. prolixus* has been found only in Lago de Chapala.

Remarks.—*Cambarellus prolixus* is infested with the same entocytherid ostracod, *Ankylocythere heterodonta* (Rioja, 1940), as are all of its relatives mentioned in the discussion of its relationships (see Hobbs, 1971:33).

Etymology.—Prolixus (L.), stretched out, long; so named because of the exceedingly long rostrum.

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Literature Cited

Faxon, Walter. 1898. Observations on the Astacidae in the United States National Museum and in the Museum of Comparative Zoology, with descriptions of new species.—Proceedings of the United States National Museum 20 (1136):643–694, plates 62–70.

Hobbs, Horton H., Jr. 1971. The entocytherid ostracods of Mexico and Cuba.—Smithsonian Contributions to Zoology 81:55 pages, 31 figures.

Rioja, Enrique. 1940. Estudios carcinológicos. V. Morfología de un ostrácodo epizario observado sobre *Cambarus* (*Cambarellus*) *montezumae* Sauss. de México, *Entocythere heterodonta* n. sp. y descripción de algunos de sus estados larvarios.—Anales del Instituto de Biología, Universidad Nacional Autónoma de México 11 (2):593–609, figures 1–33.

Saussure, Henri de. 1857. Note carcinologique sur la famille des Thalassides et sur celle des Astacides.—Revue et Magasin de Zoologie Pure et Appliquée, series 2, 9:99–102.

Villalobos Figueroa, Alejandro. 1943. Estudios de los Cambarinos Mexicanos. I. Observaciones sobre *Cambarellus montezumae* (Saussure) y algunas de sus formas con descripción de una subspecie nueva.—Anales del Instituto de Biología, Universidad Nacional Autónoma de México 14 (2):587–611, 2 plates.

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CORALANTHURA AND *SAURANTHURA*, TWO NEW GENERA OF ANTHURIDEANS FROM NORTHEASTERN AUSTRALIA (CRUSTACEA: ISOPODA: ANTHURIDAE)

Gary C. B. Poore and Brian Kensley

Abstract.—Two new anthurid genera, *Coralanthura* for *C. endeavourae* n. sp. and *C. ardea* n. sp., and *Sauranthura* for *S. goldmanorum* n. sp., are described from the Great Barrier Reef and the Coral Sea. *Coralanthura* is characterized by a 7-articulate maxilliped, non-operculiform pleopods, and triangular carpi on the posterior pereopods. *Sauranthura* lacks the seventh pereopod, has a 3-articulate maxilliped, and triangular carpi on the posterior pereopods.

The anthuridean fauna of temperate southeastern Australia has only recently been the subject of intensive study and has been found to contain numerous new species and genera (Poore, 1975, 1978). It is not surprising, therefore, that the fauna of tropical Australia is largely unknown as is the case for the tropical Pacific (Kensley, 1979). This contribution reports on two new anthurid genera, one represented by two species. The material comes from small collections made on reefs in the Coral Sea and on the Great Barrier Reef. Material is deposited in the National Museum of Victoria, Melbourne (NMV), the Queensland Museum, Brisbane (QM), and the United States National Museum of Natural History (USNM).

Family Anthuridae

Coralanthura, new genus

Diagnosis.—Eyes present. Antenna 1 flagellum of 3–5 articles. Antenna 2 flagellum of 6–11 articles. Mandibular palp of 3 articles. Maxilliped of 7 articles, long endite present. Pereopod 1 subchelate, propodus expanded, larger than pereopods 2 and 3. Pereopods 4–7 with triangular carpi having short free anterior margins. Pleopod 1 exopod barely operculiform, not indurate. Pleonites 1–5 free, short, subequal in length; 6 fused with telson. Telson lacking statocysts.

Etymology.—The generic name derives from 'coral' for the Coral Sea, where it was first taken, plus the frequently used name 'anthura.'

Type-species.—*Coralanthura endeavourae,* new species.

Remarks.—Only two other genera of anthurids share with *Coralanthura* a maxilliped of 7 articles, viz. *Neohyssura* Amar, and *Ocsanthura* Kensley.

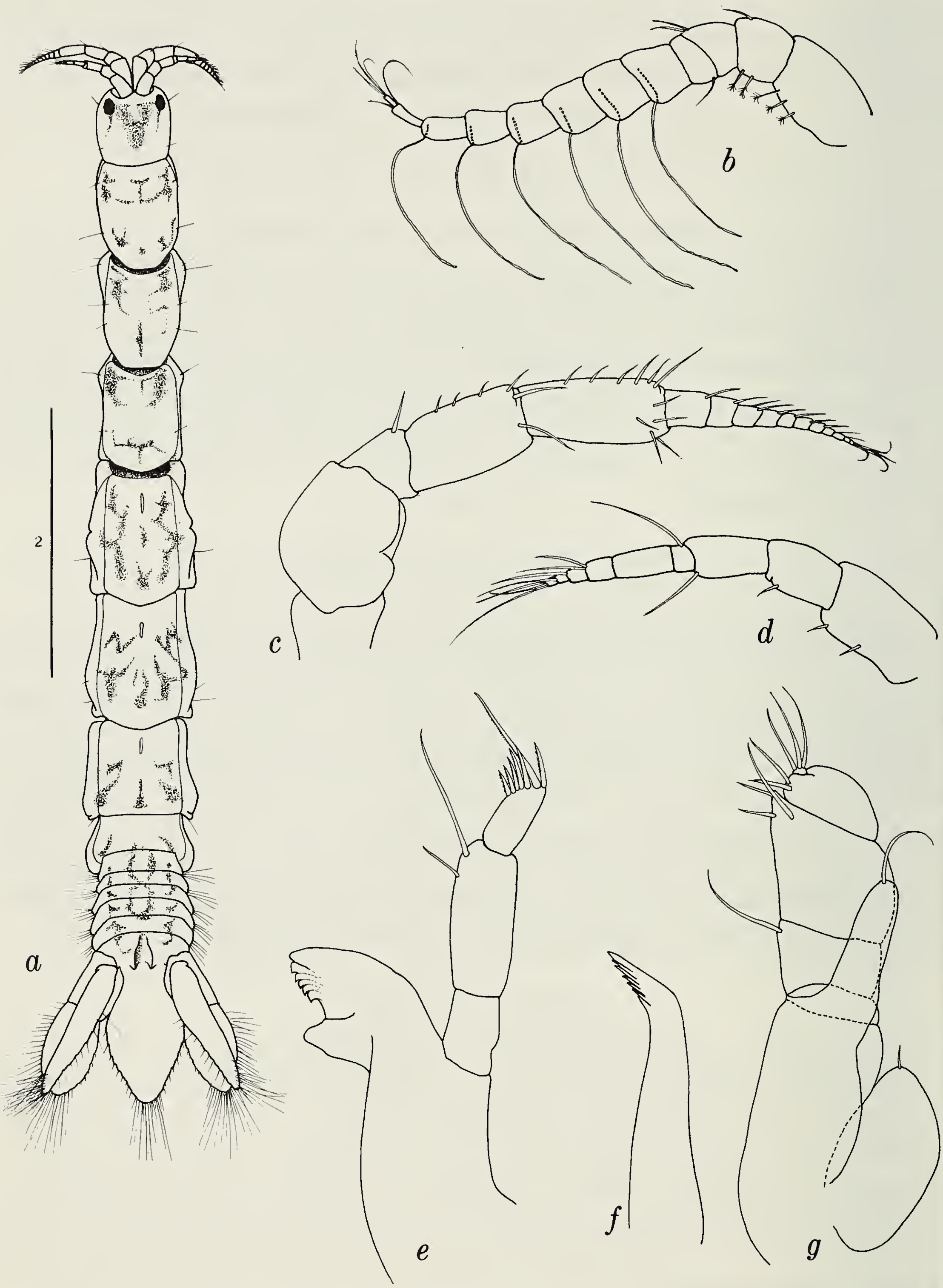

Fig. 1. *Coralanthura endeavourae*: a, Holotype in dorsal view (scale in mm); b, Antenna 1 ♂; c, Antenna 2; d, Antenna 1 ♀; e, Mandible; f, Maxilla; g, Maxilliped.

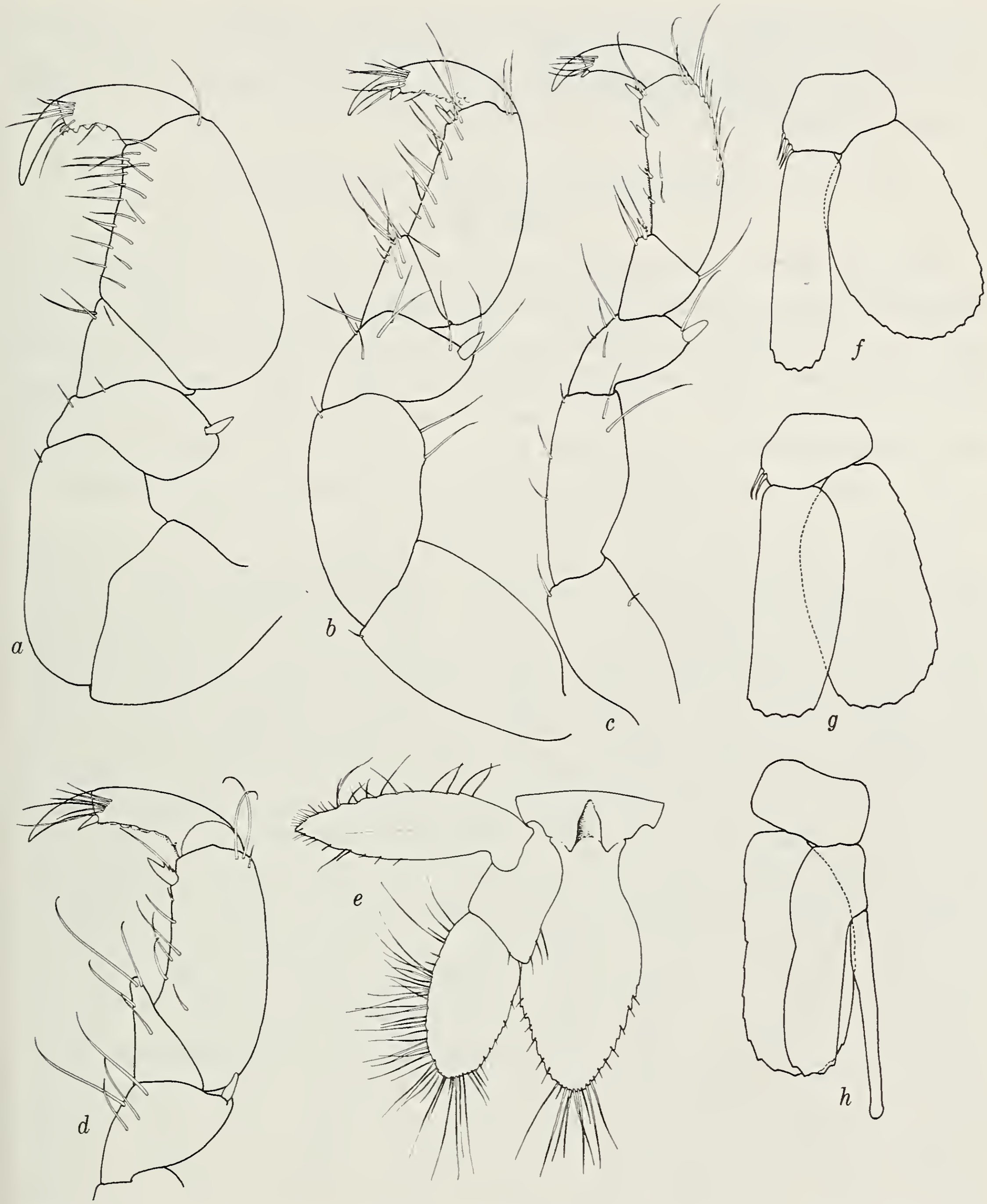

Fig. 2. *Coralanthura endeavourae*: a, Pereopod 1 ♀; b, Pereopod 2; c, Pereopod 7; d, Pereopod 1 ♂; e, Fused pleonite 6, telson, and left uropod; f, Pleopod 1; g, Pleopod 2 ♀; h, Pleopod 2 ♂.

Neohyssura is also similar to *Coralanthura* in having pleonites 1–5 free, and pleonite 6 fused with the telson, but differs in being blind, and in having a poorly developed maxillipedal endite, poor setation on the mandibular palp, well developed, i.e. expanded pereopods 2 and 3, and a broad propodus on the posterior pereopods. The blind genus *Ocsanthura* has relatively more elongate pleonites, a quadrate carpus of the posterior pereopods, a less strongly developed maxillipedal endite, a slender acute mandibular molar and broad lamina dentata, and pleonite 6 free.

Coralanthura endeavourae, new species

Figs. 1, 2

Description.—♀. Integument not indurate; with dorsal pigmentation patches on head, pereon, and pleon. Body proportions: $C < 1 = 2 = 3 < 4 > 5 > 6 > 7$. Head with blunt rostrum as long as rounded anterolateral lobes; eyes well pigmented. Pereonites 4–6 each with shallow, elongate middorsal pit. Pleonites 1–5 free, short, subequal, pleonite 6 fused to telson, with strong middorsal excavation in posterior margin. Telson proximally narrow, widest at midlength, tapering evenly to rounded apex, margins unevenly serrate, with short lateral setae, and elongate distal setae.

Antenna 1 flagellum of 5 articles, equal in length to second and third articles of peduncle together. Antenna 2 peduncle with articles 4 and 5 relatively elongate; flagellum of 11 articles, shorter than 2 proximal peduncle articles. Mandibular palp of 3 articles, second as long as first and third together; article 3 with comb of 7 fringed spines, penultimate spine longest; incisor with single cusp; lamina dentata with 5 serrations; molar bluntly rounded. Maxilliped of 7 articles, third article short; seventh minute, subterminal; narrow distally rounded endite reaching to middle of maxillipedal article 5. Pereopod 1 subchelate, stout; merus with blade-like spine on anterior margin; propodus inflated, as deep as long, with straight setose cutting edge; dactylus strongly hooked, shorter than palm, unguis almost half length of dactylus. Pereopods 2 and 3 similar, less robust than first, propodi not inflated, with blade-like anterior spine; propodus stoutly cylindrical, with setae and distal spine on palm; unguis one-third length of curved dactylus. Pereopods 4–7 similar, merus with blade-shaped anterior spine; carpus triangular, but with short free anterior margin; propodus with 4 evenly-spaced spines on posterior margin; dactylus with short unguis. Pleopods subequal in length and form. Pleopod 1 non-operculiform, endopod as long as exopod, but less than half width, both rami with distal plumose setae. Uropodal peduncle short, half as long as telson; exopod lanceolate-acute, about one-third as wide as long; endopod reaching to end of telson, subovate, both rami with setose margins.

♂. Head with large swollen eyes; antenna 1 flagellum of 6 articles bearing dense whorls of aesthetascs. Pereopod 1 palm setose; pereopod 2 as in female; pereopod 3 with distally produced carpus. Pleopod 2 with club-shaped stylet little longer than rami.

Etymology.—The species is named for H.M.S. *Endeavour,* the ship in which Captain James Cook visited Northern Australia in 1770.

Material.—Holotype: NMV J821 and J822 (slide), ovigerous ♀, TL 7.4 mm: Coral Sea, cay north of Long Island, Chesterfield Reefs, 19°48′S, 158°17′E; 10 m from reef edge; coll. N. L. Bruce, 10 May 1979.

Paratypes: NMV J823, 1 non-ovigerous ♀ 6.0 mm, 1 manca 3.0 mm, 1 ♂ 4.4 mm; QM W8096, 1 ♂ 4.5 mm; QM W8106, 1 non-ovigerous ♀ 7.3 mm, 1 manca 3.0 mm; from type locality. NMV J824 and J825 (slide), 1 ♂ 4.6 mm; USNM 181712, 3 non-ovigerous, ♀, 4.2 mm, 4.9 mm, 5.8 mm; Long Island, Chesterfield Reefs, seaward edge of reef, 15 m; coll. N. L. Bruce, 6 May 1979. NMV J826, head and pleon only; Queensland, Lizard Island, 14°40′S, 145°28′E, Great Barrier Reef, outer barrier reef near platform, 1 m, coral rubble with red encrusting algae; coll. B. Kensley, 29 May 1980.

Coralanthura ardea, new species
Figs. 3, 4

Description.—♀. Integument not indurate, with small dorsal spots of pigment on head, posterior margin of pereonites 2–6, and pleonite 6. Body proportions: $C < 1 > 2 > 3 < 4 = 5 < 6 > 7$. Head with broad rostrum as long as rounded anterolateral lobes; eyes small, well pigmented. Pereonites 4–6 with very shallow dorsal pits. Pleonites 1–5 free, pleonite 6 fused with telson, with strong middorsal excavation in posterior margin. Telson narrow proximally, widest at midlength, tapering to rounded apex; distal margins unevenly serrate; short setae laterally, elongate setae distally.

Antenna 1 peduncle with second and third articles subequal in length, flagellum of 3 articles, equal in length to last article of peduncle. Antenna 2 peduncle with fifth article twice length of fourth, flagellum of 6 articles, shorter than last peduncle article. Mandibular palp of 3 articles, second as long as first and third together; article 3 with comb of 7 spines, distalmost longest; incisor with 3 cusps; lamina dentata with 5 serrations; molar obsolete. Maxilliped of 7 articles, third short, seventh minute, terminal; narrow apically acute endite reaching almost to end of maxillipedal article 5. Pereopod 1 subchelate, stout; ischium and basis with deep flanges on anterior margins; propodus almost as deep as long, inflated, palm with 2 proximal teeth plus setae; dactylus curved, as long as palm, unguis one-quarter length of dactylus. Pereopod 2 less well developed than first; ischium and basis with flanges on anterior margin; propodus with large proximal and smaller distal tooth on palm; unguis one-third length of curved dactylus. Pereopod 3 similar to 2, but toothed palm of propodus shorter. Pereopods 4–7 similar; carpi triangular, with free anterior margin considerably shorter than posterior margin; propodus with row of about 9 spines along posterior margin; dactylus with short unguis. Pleopod 1 approaching operculiform condition, not indurate; exopod almost twice length of pleopod 2, distally setose; endopod small, triangular, less than half length of exopod, with 2 terminal

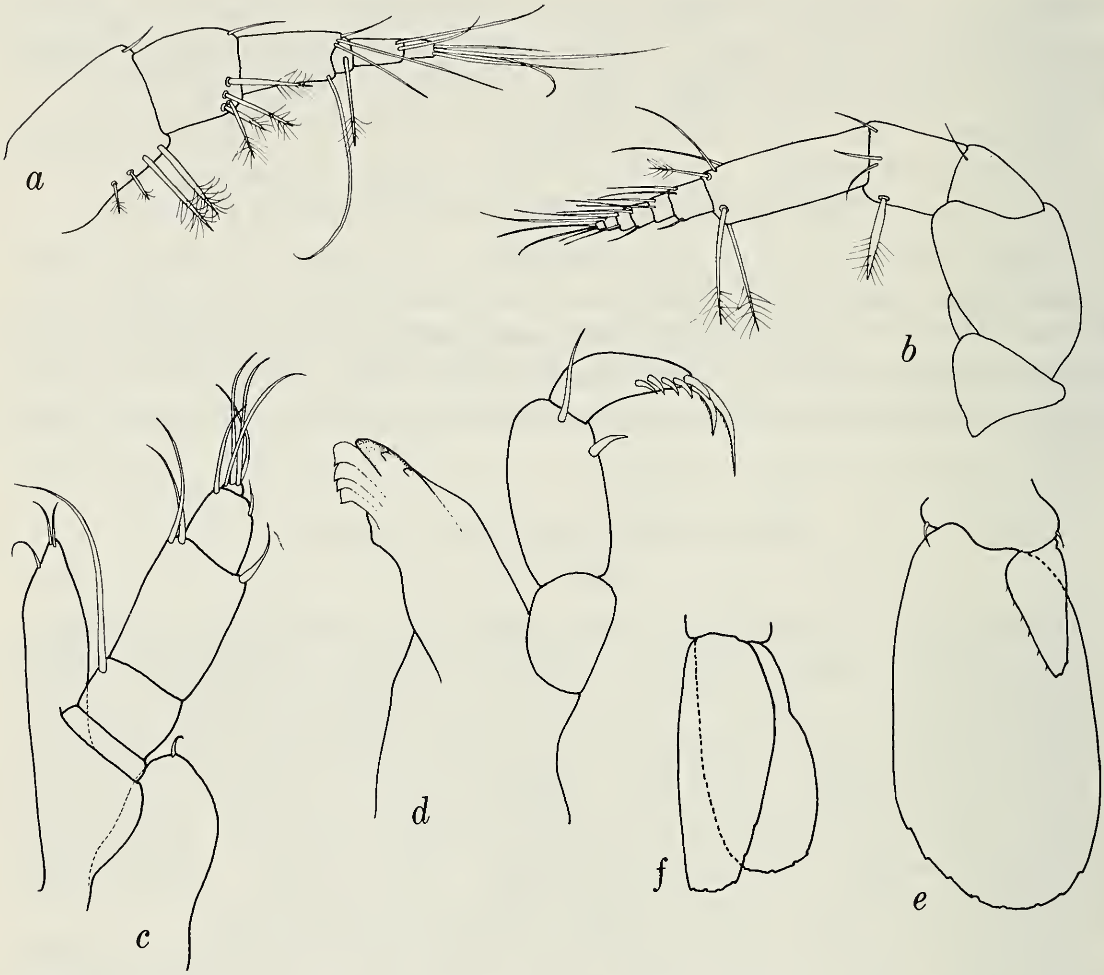

Fig. 3. *Coralanthura ardea*: a, Antenna 1; b, Antenna 2; c, Maxilliped; d, Mandible; e, Pleopod 1; f, Pleopod 2.

setae. Pleopod 2 with subequal rami, distally setose. Uropodal peduncle short, half length of telson; exopod broadly lanceolate, about twice as long as greatest width; endopod reaching to end of telson, widest basally, tapering to rounded apex; both rami with setose margins.

Etymology.—The species, taken from Heron Island, is named for *Ardea*, a genus of heron.

Material.—Holotype: NMV J827, ovigerous ♀, TL 4.8 mm; Queensland, Heron Island, Great Barrier Reef 23°27′S, 151°55′E; reef flat, coll. N. L. Bruce, 15 Jan. 1979. Paratypes: NMV J828, 2 non-ovigerous ♀, 3.2 mm, 3.9 mm; NMV J829, J830 (slide), 1 ♀ 4.3 mm, QM W8671, 3 non-ovigerous ♀, 2.0 mm, 3.5 mm, 3.6 mm; USNM 181713, 2 non-ovigerous ♀, 3.5 mm, 4.3 mm; all from type-locality.

Remarks.—*C. endeavourae* and *C. ardea* are placed in the same genus as they show a similar structure in the pleonal condition, maxilliped, mandible, and pereopods. The structure of pleopod 1 (along with the number of

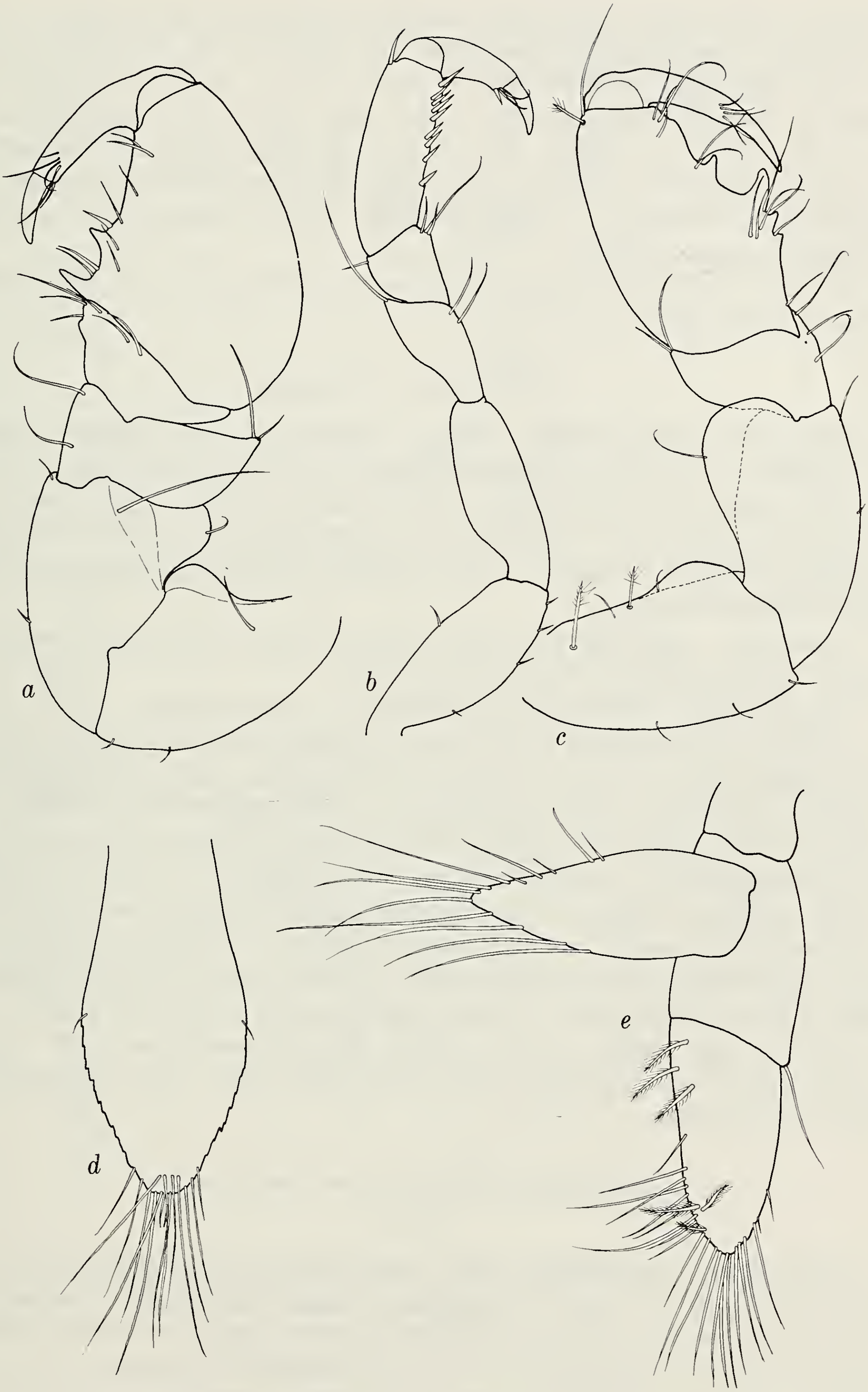

Fig. 4. *Coralanthura ardea*; a, Pereopod 1; b, Pereopod 7; c, Pereopod 2; d, Telson; e, Uropod.

articles in the first and second antennae, propodus of pereopod 1, and maxillipedal palp) serve to separate the species, with *C. ardea* showing a more advanced condition than *C. endeavourae.* In the latter, the endopod of pleopod 1 is as long as, but only about half the width of the exopod, which is broader than in the following subequal pleopods. In *C. ardea,* however, pleopod 1 is longer than the following pleopods, the endopod is reduced to a short triangular ramus, while the broad exopod is becoming operculiform.

C. ardea is known only from the type-locality at 23.5°S, considerably further south than *C. endeavourae.*

Sauranthura, new genus

Diagnosis.—Eyes present. Antenna 1 flagellum of 1 or 2 articles. Antenna 2 flagellum of 2 articles. Mandibular palp of 3 articles. Maxilliped of 3 articles, endite present. Pereopod 1 subchelate, propodus expanded, larger than pereopods 2 and 3. Pereopods 4–6 with carpus triangular. Pereopod 7 lacking. Pleonites 1–5 fused, 6 free. Pleopod 1 exopod operculiform. Telson with 2 basal statocysts.

Etymology.—The generic name is derived from the Greek "sauros"—a lizard, the type locality being Lizard Island.

Type-species.—*Sauranthura goldmanorum,* new species.

Remarks.—Among the Anthuridae two genera lack pereopods on the seventh pereonite, viz. *Hyssura* Norman and Stebbing, 1886, and *Exallanthura* Kensley, 1980. The former possesses a 5- or 6-segmented maxilliped, pleonites 1–5 free, pleonite 6 fused with the telson, and the exopod of pleopod 1 non-operculiform. The latter genus, with pleonites 1–5 fused, an operculiform exopod of pleopod 1, and a 3-segmented maxilliped, resembles *Sauranthura* more closely, but the single-segmented mandibular palp immediately separates the Indian Ocean genus from the present material. In general body form, maxillipedal, antennal, uropodal, and telsonic structure, *Sauranthura* is very similar to *Pendanthura* Menzies and Glynn, 1967, but the single-segmented mandibular palp of this latter genus again distinguishes it from *Sauranthura.*

Sauranthura goldmanorum, new species

Fig. 5

Description.—Integument thin, non-indurate. Body proportions: C > 1 > 2 = 3 = 4 = 5 > 6 > 7; pereonite 7 about half length of pereonite 6. Head with rounded rostrum extending beyond rounded anterolateral lobes; band of red-brown pigment between well-pigmented dorsolateral eyes. Pleonites 1–5 fused, with lateral slits indicating segmentation; pleonite 6 free,

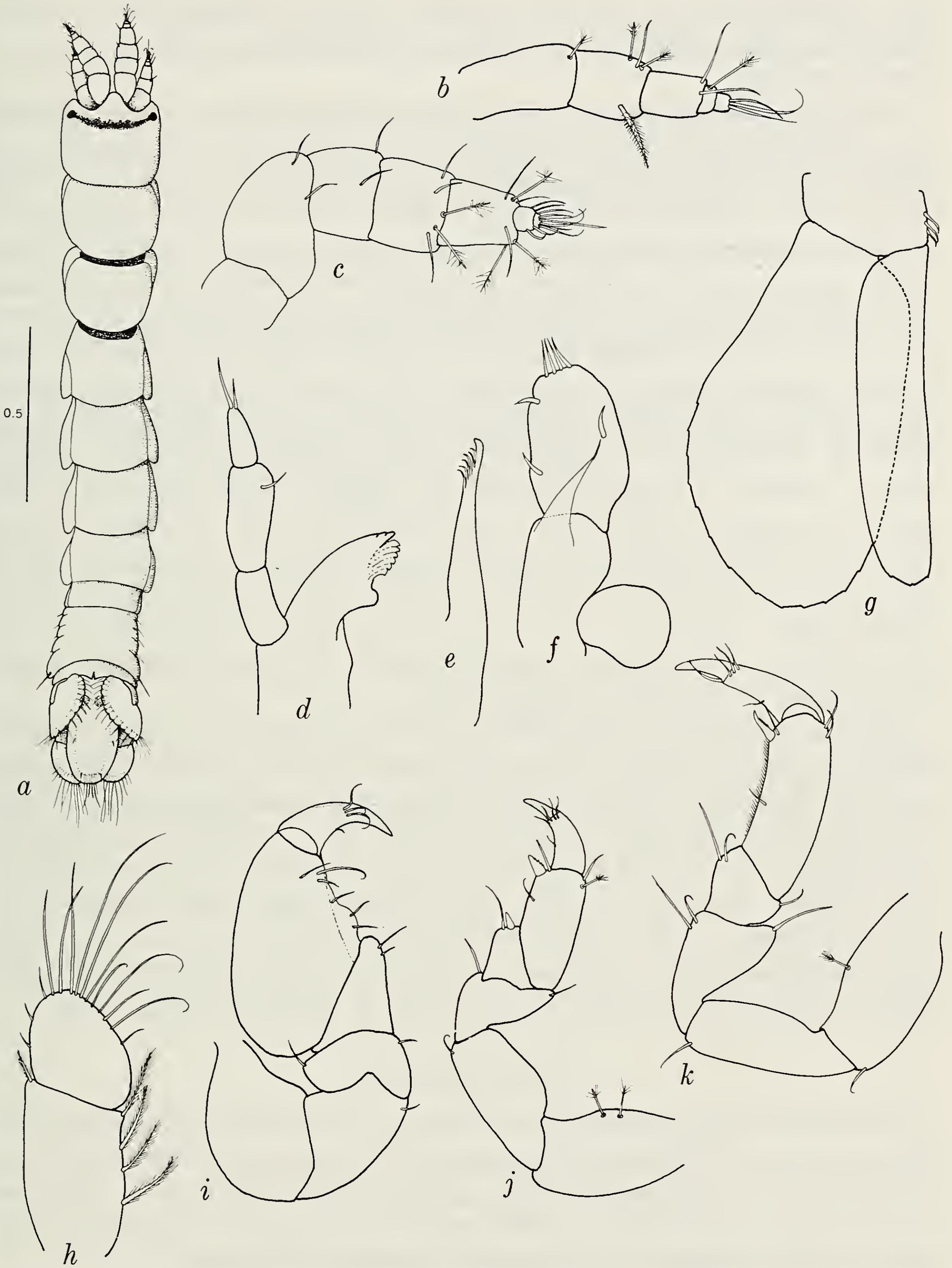

Fig. 5. *Sauranthura goldmanorum*: a, Paratype in dorsal view (scale in mm); b, Antenna 1; c, Antenna 2; d, Mandible; e, Maxilla; f, Maxilliped; g, Pleopod 1; h, Uropodal basis and endopod; i, Pereopod 1; j, Pereopod 2; k, Pereopod 6.

with middorsal slit in posterior margin. Telson elongate/ovate, distally broadly rounded, with 6 terminal setae, broad hyaline margin; 2 statocysts in proximal half.

Antennal peduncle with first article subequal in length to second and third articles together, 2 articles of flagellum very short, setose. Antenna 2 peduncle with 3 distal articles subequal in length; flagellum of 2 very short setose articles. Mandibular palp of 3 articles; middle article longer than first or third, last with 2 terminal setae; molar rounded, incisor of 3 blunt cusps; lamina dentata with 6 serrations. Maxilliped of 3 articles, 2 distal articles subequal in length; thin-walled, narrowly-tapering endite on inner surface. Pereopod 1 carpus distally rounded; propodus expanded, palm with thin hyaline margin bearing few short setae. Pereopods 2–6 essentially similar; carpus with anterior margin shorter than posterior; propodus becoming progressively more elongate posteriorly, bearing strong serrate spine posterodistally. Pleopod 1 exopod operculiform, slightly longer than and 3 times width of endopod; latter with 3 distal plumose setae. Uropodal exopod ovate, with scalloped hyaline margin bearing plumose setae and few simple setae, just reaching base of endopod; latter ovate, bearing several elongate simple setae.

Etymology.—The species is named for Barry and Lois Goldman of Lizard Island, Great Barrier Reef, Queensland.

Material.—Holotype: NMV J831, 1 non-ovigerous ♀ 2.0 mm; between Palfrey and South islands, off Lizard Island, 14°40′S, 145°28′E, Great Barrier Reef, from algal turf growing on large dead coral fragments, 3 m, coll. B. Kensley, 30 May 1980. Paratypes: NMV J832, J833 and J834 (slide), 4 non-ovigerous ♀, 1.9–2.2 mm, crest between Palfrey and South Island, off Lizard Island, 14°40′S, 145°28′E, Great Barrier Reef, coral rubble, 0.5 m, coll. B. Kensley, 31 May 1980. USNM 181714, 1 non-ovigerous ♀ 1.8 mm, lagoon between Palfrey and South islands, off Lizard Island Great Barrier Reef; *Acropora* coral rubble, 8–10 m, coll. B. Kensley, 28 May 1980.

Acknowledgments

Our sincere thanks are due to Niel Bruce, University of Queensland, for collecting some of the material mentioned in this paper; to Barry and Lois Goldman of Lizard Island, for their assistance and hospitality to the second author during a short visit in 1980; and to Dr. Thomas E. Bowman of the Smithsonian Institution for his helpful criticism of the paper.

Literature Cited

Kensley, B. 1979. New species of anthurideans from the Cook and Fiji islands. (Crustacea: Isopoda: Anthuridea).—Proceedings of the Biological Society of Washington 92:814–836.

———. 1980. Anthuridean Isopod Crustaceans from the International Indian Ocean Expedition, 1960–1965, in the Smithsonian Collections.—Smithsonian Contributions to Zoology 304:1–37.

Menzies, R. J., and P. W. Glynn. 1968. The common marine isopod Crustacea of Puerto Rico.—Studies on the Fauna of Curaçao and other Caribbean Islands 27:1–133.

Norman, A. M., and T. R. R. Stebbing. 1886. On the Crustacea Isopoda of the 'Lightning', 'Porcupine,' and 'Valorous,' Expeditions.—Transactions of the Zoological Society, London 12:77–141.

Poore, G. C. B. 1975. Australian species of *Haliophasma* (Crustacea: Isopoda: Anthuridae).—Records of the Australian Museum 29:503–533.

———. 1978. *Leptanthura* and new related genera (Crustacea, Isopoda, Anthuridea) from eastern Australia.—Memoirs of the National Museum of Victoria 39:135–169.

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CERATOCOLAX MYKTERNASTES, NEW SPECIES (COPEPODA, BOMOLOCHIDAE) PARASITIC IN THE NASAL SINUS OF *HAEMULON SCIURUS* (PISCES, POMADASYIDAE) FROM BELIZE

Hillary Boyle Cressey

Abstract.—*Ceratocolax mykternastes*, n. sp., is described from the nasal sinus of *Haemulon sciurus* from off Belize. Descriptions of both the female and male are given. The males differ in one respect from the generic diagnosis of *Ceratocolax*. Placement in the genus *Ceratocolax* is based primarily on female structures.

During fieldwork in Belize in March 1980, I discovered a new species of *Ceratocolax* Vervoort in the nasal sinuses of the bluestriped grunt, *Haemulon sciurus* (Shaw). The only other species of *Ceratocolax* known thus far is *C. euthynni* Vervoort, parasitic in the nasal sinuses of the scombrid fishes *Euthynnus alleteratus* and *Sarda sarda* (Vervoort, 1965; Cressey and Cressey, 1980).

The illustrations were made with the aid of a Wild Drawing Tube. All measurements are of the holotype or allotype. All material is in the collections of the Smithsonian Institution.

Ceratocolax mykternastes, new species

Material examined.—Holotype ♀ (USNM 181890), allotype ♂ (USNM 181891), and 11 ♀, 3 ♂ paratypes (USNM 181892) collected from the nasal sinuses of 24 *Haemulon sciurus* from off Carrie Bow Cay, Belize, 4–9 March 1980. In addition, one female and one male were dissected and illustrated and 2 females were prepared for examination with a scanning electron microscope; these additional specimens were from the same collection as the type-material.

Female.—Body form as in Figure 1. Total length 1.94 mm, greatest width 1.16 mm (measured at widest part of cephalon), length of cephalon 0.58

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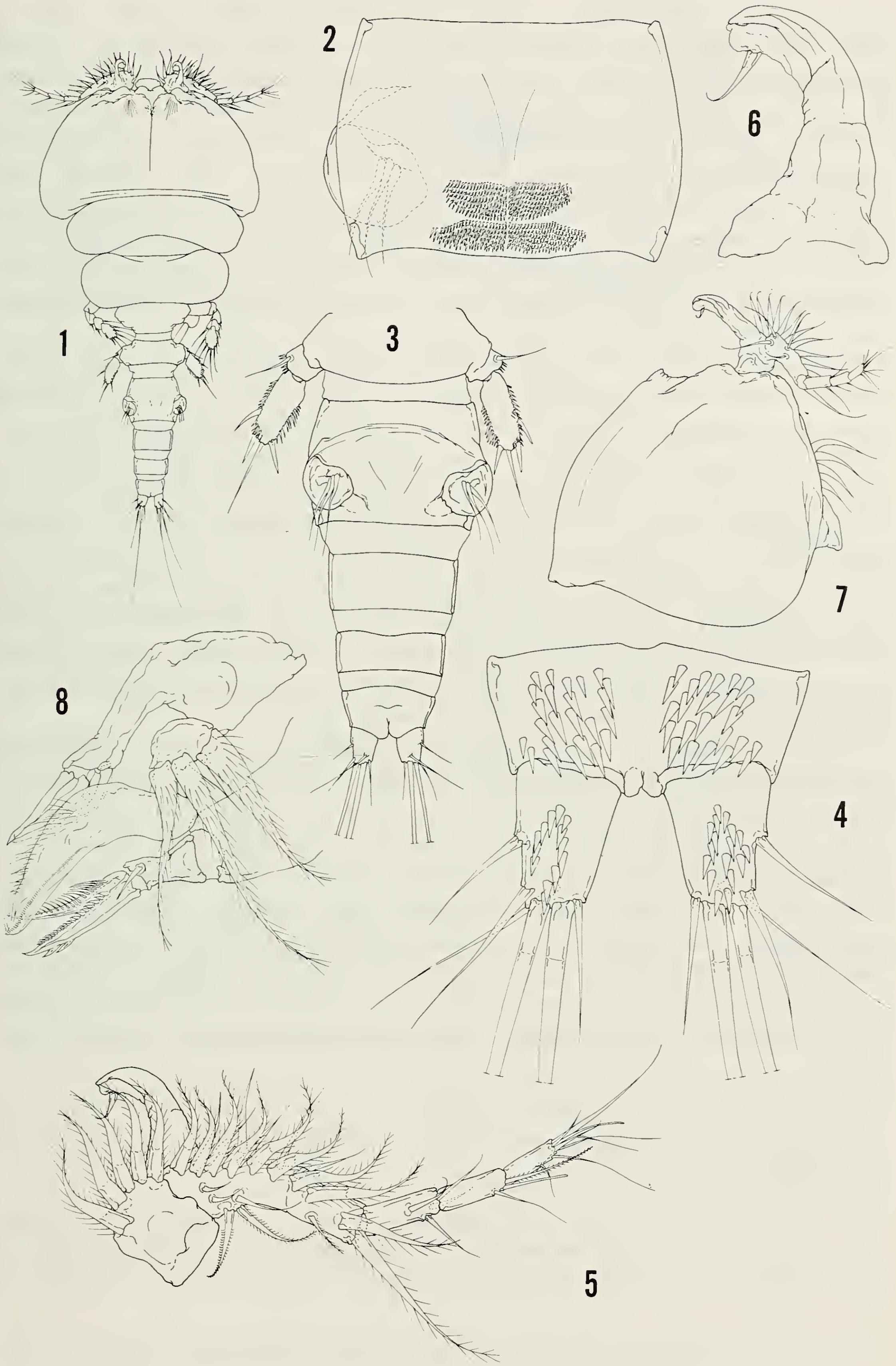
Figs. 1–8. *Ceratocolax mykternastes*, female: 1, Dorsal; 2, Genital segment, ventral; 3, Genital segment and abdomen, dorsal; 4, Last abdominal segment and caudal rami, ventral; 5, First antenna; 6, First antenna spine; 7, Cephalon and first antenna, lateral; 8, Mandible, paragnath, first maxilla, second maxilla.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mm; cephalon with median, longitudinal groove. Genital segment (Fig. 2) wider than long (265 × 324 μm), ventrally with prominent patches of spinules as indicated in figure; spinules may appear as one patch, or there may be more or less distinct areas between patches; in all specimens examined, however, outline of spinulose area was similar. Abdomen (Fig. 3) 3-segmented, segments measure (l × w) 123 × 188 μm, 118 × 165 μm, and 106 × 153 μm respectively; last segment (Fig. 4) ventrally with 2 prominent patches of large spinules. Caudal rami (Fig. 4) slightly longer than wide (70 × 53 μm); each ramus with 6 setae, 2 much longer than other 4, and ventral patch of spinules similar to those on last abdominal segment; longest seta measures 613 μm.

First antenna (Fig. 5) 5-segmented (second segment incompletely divided), first and second segments together bearing row of 15 stout, plumose setae, last 2 segments each with one aesthete. Arising dorsally near juncture of first and second segments is a long, curved, sclerotized spine bearing a small, naked seta; seta is embedded in membrane reaching from tip of spine to midlength of edge; tip of spine curves mediad toward crenulate cephalic knob (Figs. 6, 7, 27). Rostrum with 2 ventral hooks (Fig. 28). Second antenna similar to that of *C. euthynni,* with numerous rows of small, closely spaced hooklets, 4 hooked spines, and 2 apical setae. Mandible, paragnath, first maxilla and second maxilla as in Figure 8; labrum with 2 large patches of stout spinules. Maxilliped (Fig. 9) with one naked and 3 plumose setae; maxilliped hook with outer accessory tooth.

Legs 1–4 biramous, rami 3-segmented except leg 1 exopod. Legs 2–4 all segments, except leg 2 endopod third segment, with patches or rows of stout spinules along outer or distal edges, as indicated in figures. Leg 1 (Fig. 10) coxopod distolateral corner heavily haired, distal edge with short row of spinules; basipod with long, stout, plumose seta on distolateral corner, ventral surface with large patch of spinules near insertion of endopod, and smaller rows and patches of spinules as indicated in figure; exopod 2-segmented, second segment incompletely divided, first segment with outer crenulate spine, second segment with 4 outer spines and 6 terminal to inner setae; endopod 3-segmented, first and second segments each with one inner

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Figs. 9–14. *Ceratocolax mykternastes,* female: 9, Maxilliped; 10, Leg 1; 11, Leg 2; 12, Leg 3; 13, Leg 4; 14, Leg 5.

Figs. 15–22. *Ceratocolax mykternastes,* male: 15, Dorsal; 16, Genital segment and abdomen, ventral; 17, Last abdominal segment and caudal rami, ventral; 18, First antenna; 19, Second antenna; 20, Mandible, paragnath, first maxilla, second maxilla; 21, Maxilliped; 22, Leg 1.

Figs. 23–26. *Ceratocolax mykternastes,* male: 23, Leg 2; 24, Leg 3; 25, Leg 4; 26, Leg 5.

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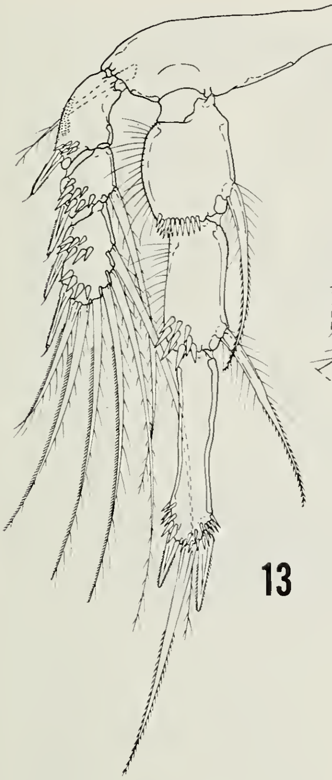

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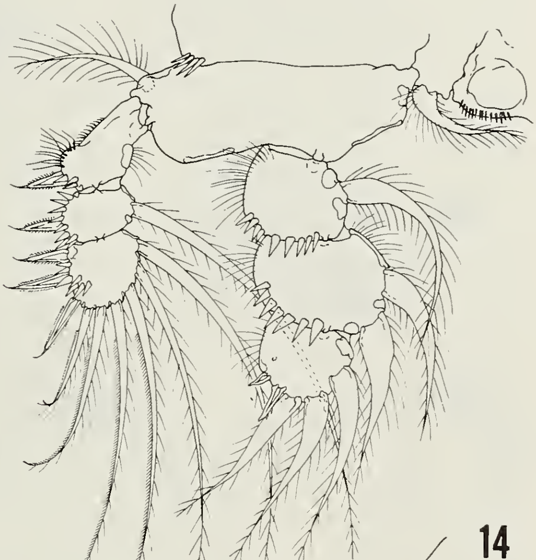

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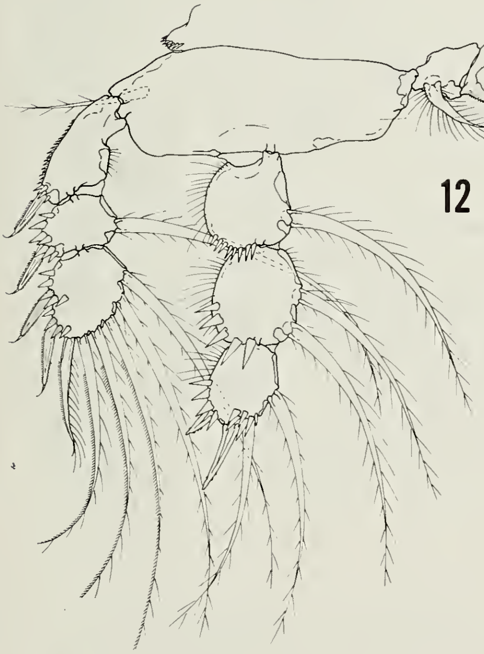

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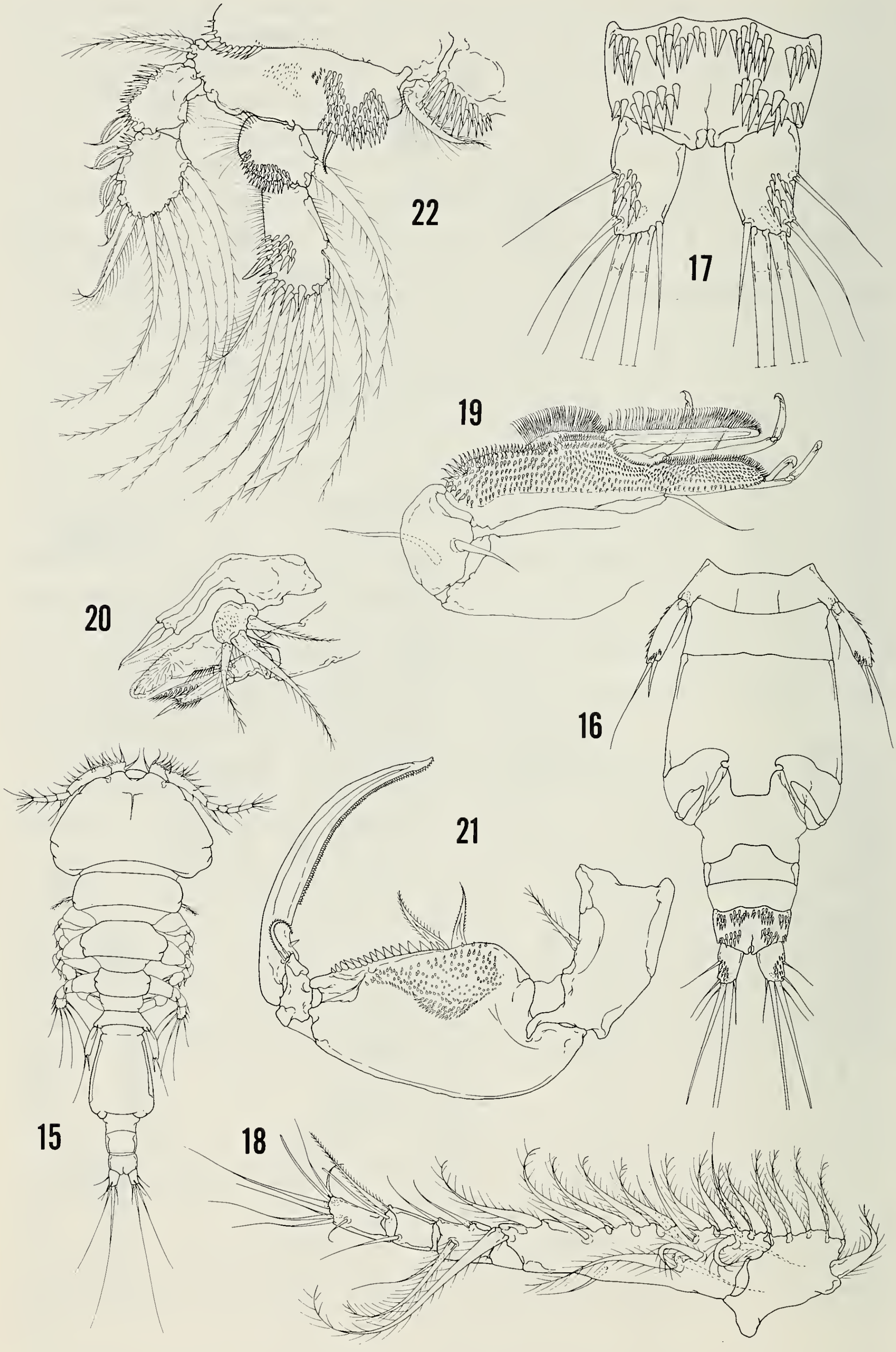
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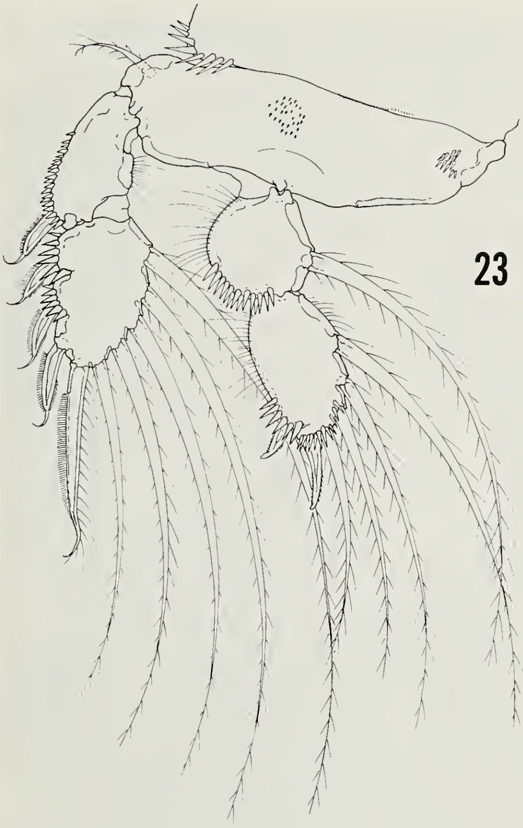
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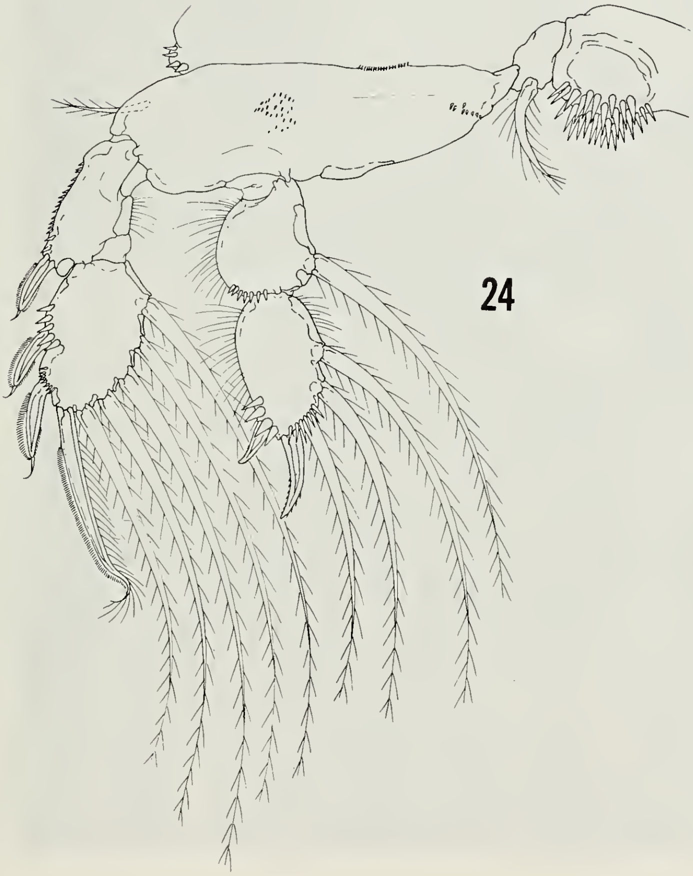
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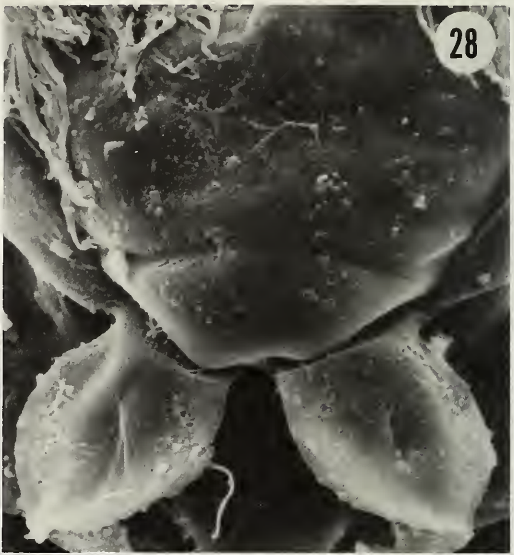
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seta and row of short hairs along distolateral edge; third segment with one small spine on outer corner, and 5 setae (all setae plumose); interpodal plate (Fig. 29) with flattened, overlapping spinules. Leg 2 (Fig. 11) coxopod with short row of spinules on distolateral corner; basipod with slender, plumose seta on distolateral corner; exopod first segment with outer spine, outer and inner edge of segment haired, second segment with outer spine and inner seta, third segment with 3 outer spines and 6 setae, 4 outermost setae with long plumes on inner edge, short hairs on outer edge (see Fig. 30), all spines with short hairs along margins and flagellum at tip (see Fig. 31); endopod somewhat inflated, first segment with stout, inner seta, second segment with 2 inner setae, third segment with 3 inner to terminal setae and 2 outer, sclerotized spines. Leg 3 (Fig. 12) similar to leg 2 with following exceptions: exopod first segment outer edge spinulose, third segment with 2 outer spines and 6 setae; endopod not inflated, last segment with 2 setae and 2 spines, spines larger than those on leg 2. Leg 4 (Fig. 13) exopod similar to leg 3 except more slender and patches of spinules larger; endopod elongate (especially third segment), extending well beyond exopod; first and second segments each with short, inner seta, proximal half of each seta plumose, distal half spinulose, third segment with distal seta flanked by 2 spinulose spines. Leg 5 (Fig. 14) uniramous, first segment with outer plumose seta and outer patch of long, slender spinules; free segment with 3 long, slender, spinulose spines and one naked seta, segment with several patches of long, slender spinules. Leg 6 represented by 3 naked setae on genital segment near area of egg sac attachment (Figs. 2, 3).

Male.—Body form as in Figure 15. Total length 1.25 mm, greatest width 0.50 mm, length of cephalon 0.32 mm. Genital segment (Fig. 16) slightly longer than wide (230 × 206 μm). Abdomen 2-segmented, segments measure (l × w) 88 × 94 μm, and 64 × 88 μm respectively; last segment (Fig. 17) ventrally with several patches of stout spinules. Caudal rami (Fig. 17) longer than wide (47 × 29 μm), each ramus with 6 setae (2 much longer than other 4), and ventral patch of stout spinules; longest seta 460 μm.

First antenna (Fig. 18) 5-segmented with anterior row of 15 stout, plumose setae on first and second segments; last 2 segments each with one aesthete; no spines or modified setae. Rostral hooks absent. Second antenna (Fig. 19) similar to that of female, but rows of spinules not so closely spaced. Mandible, paragnath, first and second maxillae as in Figure 20. Mouthparts very small, and accessory mandibular blade, present in female, could not be seen in male specimen dissected and illustrated; first maxilla with minute spinules

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Figs. 27–32. *Ceratocolax mykternastes,* female: 27, First antenna spines, lateral, ×750; 28, Ventral rostral hooks, ×1050; 29, Leg 1 interpodal plate, ×775; 30, Leg 2 exopod seta, ×1600; 31, Leg 2 exopod spine, ×1500; 32, Leg 3 exopod, tip of last segment, ×1000.

or hairs on basal segment; paragnath with short row of slender spinules along distal edge. Maxilliped (Fig. 21) basal segment with one plumose seta; second segment with patch of short spinules, 2 plumose setae, and row of stout, triangular spinules; last segment clawlike, with plumose seta and smaller, naked setule, inner edge with row of small, toothlike spinules.

Legs 1–4 biramous, rami 2-segmented; all segments with patches or rows of stout spinules along outer or distal edges as indicated in figures. Leg 1 (Fig. 22) coxopod with row of stout spinules along distolateral edge, and plumose seta on distomedial corner; basipod with long, outer plumose seta, a somewhat horseshoe-shaped patch of spinules on inner surface and short, spinulose seta medial to insertion of endopod; exopod first segment with outer spine; second segment with 4 outer spines, and 4 inner to terminal plumose setae; proximal 4 spines haired on margins, with flagellum at tip; distal spine elongate, tapered and sickle-shaped at tip, inner edge plumose, outer edge with short, closely spaced hairs; endopod first segment with inner seta, second segment somewhat elongate, with short, outer spine and 6 inner to terminal plumose setae, outer margins of endopod segments heavily haired; interpodal plate with long, stout spinules. Leg 2 (Fig. 23) coxopod with row of spinules on outer distal corner; basipod with outer seta smaller than that on leg 1, small patch of spinules on inner surface; exopod similar to leg 1 except second segment with 2 rows of spinules on outer edge, and 5 plumose setae; also, distal spine more elongate than that of leg 1; endopod first segment with inner seta, second segment with 2 outer to terminal spines and 4 inner to terminal plumose setae. Leg 3 (Fig. 24) similar to leg 2 with following exceptions: exopod second segment with only 2 short, flagellated, outer spines; endopod second segment with only 3 plumose setae. Leg 4 (Fig. 25) exopod similar to leg 3 except proximal 3 outer spines slightly more elongate and serrate rather than haired on margins, second segment with only 4 plumose setae; endopod first segment with inner seta, second segment elongate with terminal spinulose seta flanked by 2 elongate spinulose spines. Leg 5 (Fig. 26) uniramous, basal segment with sparsely plumose seta, free segment with stout spinules along outer and distal margins, distally with stout inner spine and outer seta.

Etymology.—The specific name is from the Greek, *mykter* (nostril), and *nastes* (dweller), referring to the habitat of this parasite.

Remarks.—The females of *C. mykternastes* agree with Vervoort's (1965) generic diagnosis of *Ceratocolax,* especially in the unusual structure of the first antenna. *Ceratocolax mykternastes* can be distinguished from *C. euthynni* by a number of features: *C. mykternastes* has a prominent spinulose area on the ventral surface of the genital segment, this is lacking in *C. euthynni,* the adults of which have prominent lateral processes on the genital segment; the dorsal antennal spine of *C. mykternastes* has an accessory seta near the tip, this seta is not present on *C. euthynni*; leg 2 endopod first and second segments of *C. mykternastes* have stout spines along the distal edges, rather than tufts of hairs as in *C. euthynni*; *C. mykternastes* leg 4 exopod last segment has 2 spines, 6 setae, while *C. euthynni* has 3 spines, 4 setae. In addition, there are several other, minor points of difference between the two species.

Male *C. mykternastes* differ from Vervoort's generic diagnosis of *Ceratocolax* in one respect; that is, the number of segments of legs 1–4. The rami of legs 1–4 of *C. euthynni* are 3-segmented (except leg 4 endopod 2-segmented); those of *C. mykternastes* are all 2-segmented. A comparison of the spine and seta formulae of these two species shows that both species have the same total number of spines on leg 1 endopod and on both rami of legs 2–4. The total number of setae has been reduced by 1 in *C. mykternastes* on both rami of legs 2 and 3, and leg 4 exopod; the total number of spines and setae is the same for both species for legs 1 and 4 endopods. In all other respects, males of the present species agree with the generic diagnosis of *Ceratocolax*.

In spite of this apparently major difference between the males, I have placed this species in *Ceratocolax* principally on the basis of the female morphology. Many copepod species (and genera) are known only from females, therefore, it would not seem wise, at this time, to erect a new genus on the basis of a male character alone. Collections of more members of this genus will perhaps lead to modifications of the generic diagnosis, or to the establishment of a new genus.

In addition to *H. sciurus,* two other species of *Haemulon* were caught and examined for copepods: 20 specimens of the French grunt, *H. flavolineatum* (Desmarest), and one specimen of the smallmouth grunt, *H. chrysargyreum* Gunther; none of these specimens were found to have any copepod parasites.

In 1980, Cressey and Cressey misspelled *Ceratocolax* as "*Ceratacolax*" when redescribing *C. euthynni,* and throughout the manuscript; we regret this error.

Acknowledgments

I would like to thank Dr. Robert Karl Johnson of the Field Museum, Chicago for the fish identifications; Mr. Walter Brown of the Smithsonian Institution for the scanning electron micrographs; Dr. Roger Cressey, Smithsonian, for patient advice and assistance; and Dr. Thomas E. Bowman, Smithsonian, for reading and commenting on the manuscript. This paper is contribution number 68 of the Smithsonian Institution's Investigations of Marine Shallow-Water Ecosystems Program, Reef and Mangrove Study—Belize, supported in part by the Exxon Corporation. Special thanks to Dr. Klaus Rützler, of the Smithsonian, for bringing this program to my attention, and for many kindnesses.

Literature Cited

Cressey, R., and H. B. Cressey. 1980. Parasitic copepods of mackerel- and tuna-like fishes (Scombridae) of the world.—Smithsonian Contributions to Zoology 311: iv + 186 pages, figures 1–139.

Vervoort, W. 1965. Three new species of Bomolochidae (Copepoda, Cyclopoida) from tropical Atlantic tunnies.—Zoologische Verhandelingen 76:3–40, figures 1–22.

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A REDESCRIPTION OF *OCTOPUS ORNATUS* GOULD, 1852 (OCTOPODA: CEPHALOPODA) AND THE STATUS OF *CALLISTOCTOPUS* TAKI, 1964

Gilbert L. Voss

Abstract.—*Octopus ornatus* is redescribed based on specimens from Hawaii, Bikini Atoll, and Kenya. Variations of mantle shape and color patterns are described and illustrated as well as internal anatomical features. *Callistoctopus arakawai* is placed in the synonymy of *Octopus ornatus*. Taki's statement that his specimen exhibited luminescence is refuted by observations of living specimens in Hawaii. As the original type-material is lost, a large male specimen from Oahu, Hawaii, the type-locality, is designated the neotype.

Among the cephalopods collected from the R/V *Anton Bruun* during United States participation in the International Indian Ocean Expedition was a series of octopus from East Africa having long dorsal arms and conspicuous buff-colored stripes and spots. These animals were at first thought to belong to *Octopus macropus* Risso, 1826, but were later considered to be conspecific with *Callistoctopus arakawai* Taki, 1964, from Japanese waters. Examination of material in the United States National Museum of Natural History disclosed specimens of *Octopus ornatus* Gould, 1852, that appeared to be the same. This latter material was received on loan along with other specimens from Oceania. Finally, two specimens were received from Hawaii along with color notes made when they were alive. Study of all of this material leads to the conclusion that *Octopus ornatus* is a widely distributed species of which *Callistoctopus arakawai* Taki is a synonym. The evidence is presented below.

The measurements and indices used are those of Voss (1963, p. 11) except for the designation HAI which is the length of the hectocotylized arm as a percentage of its fellow arm on the opposite side.

Octopus ornatus Gould, 1852
Figs. 1–3

Octopus ornatus Gould, 1852:476, fig. 590, 590a.—Tryon, 1879:112, pl. 30, figs. 29–30.—Robson, 1929:108.
Polypus ornatus.—Berry, 1909:418; 1914:294, pl. XLVI, figs. 1–2.
Callistoctopus arakawai Taki, 1964:292, pls. 2–3, text-figs. 34–41.
Octopus arakawai.—Dong, 1979:72, pl. 1, fig. 2.

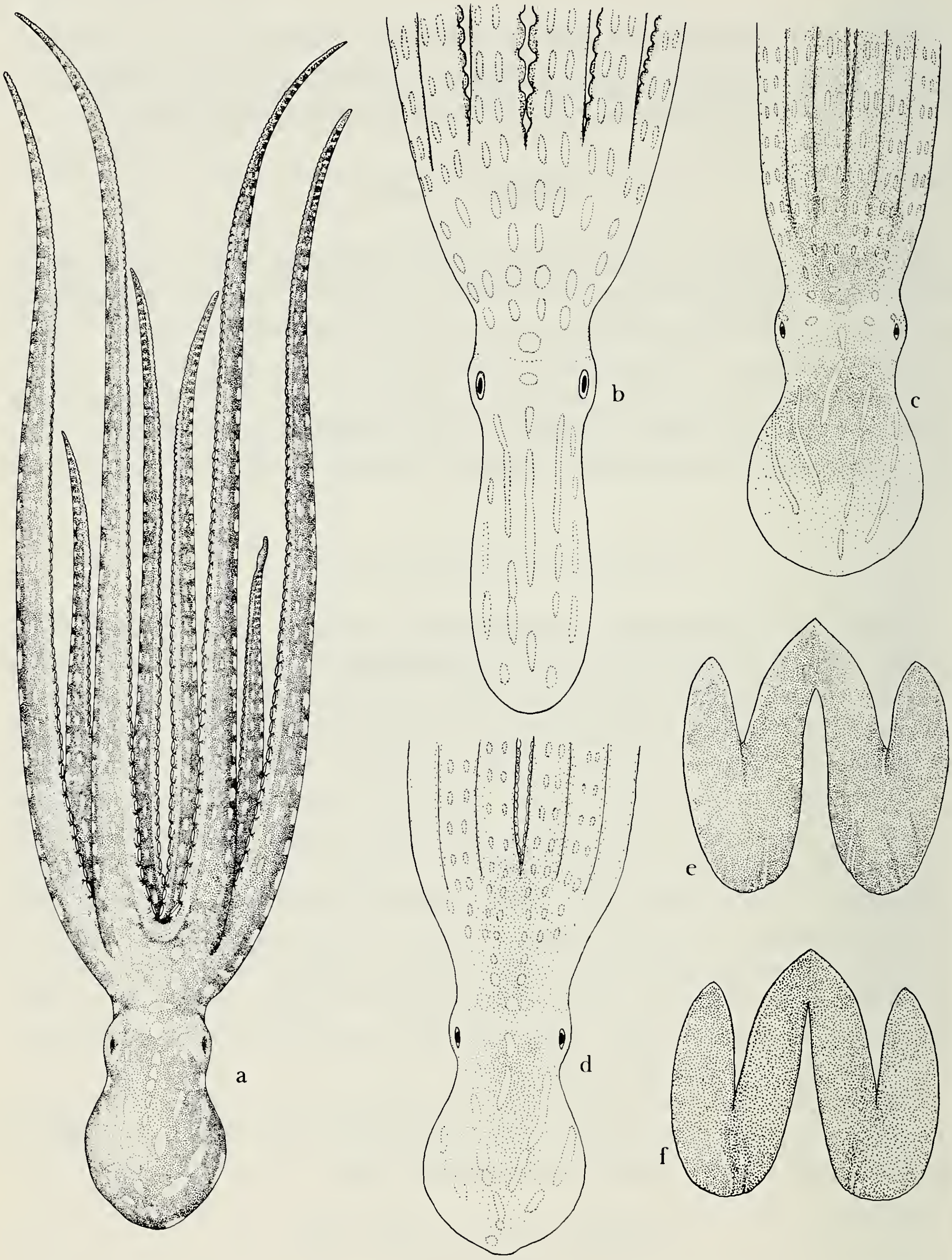

Fig. 1. *Octopus ornatus*: a, Dorsal view of neotype (88 mm ML); b, Color pattern and shape of 101 mm ML male from East Africa; c, Same of 47 mm ML male from East Africa; d, Same of 66 mm ML male from East Africa; e, Funnel organ of 101 mm ML male from East Africa; f, Funnel organ of 74 mm ML female from Hawaii.

Material examined.—Neotype, male, mantle length 88 mm, from Black Point, Oahu, Hawaii, collected by Stephen Kempf, 11 January 1976, USNM 730020.—1 female, mantle length 74 mm, Oahu, Hawaii, collected by C. F. E. Roper and R. E. Young, UMML 1756.—1 male, mantle length 83 mm, Market, Hawaii (*Albatross*) S.S.B. #382, USNM 214609.—1 male, mantle length 98 mm, Enyu Island, entrance to lagoon, Bikini Atoll, Marshall Islands, Schultz leg. 16 March 1946, USNM 574184.—4 females, mantle lengths 22–65 mm, USNM 730022.—1 male, mantle length 66 mm, USNM 730023, R/V *Anton Bruun*, cruise 9, sta. HA-1, Andromache Reef just south of entrance to Port Kalindi, Mombasa Harbor, Kenya in 0–1 meter, 15 November 1964.—2 males, mantle lengths 47–101 mm, same data as above, UMML 1756.—3 males, mantle lengths 44–104 mm, R/V *Anton Bruun*, cruise 9, sta. HA-2, Andromache Reef, just south of entrance to Port Kalindi, Mombasa Harbor, Kenya, in 0–1 meter, 16 November 1964, USNM 730021.

Description.—The description is based upon 15 specimens ranging in distribution from Hawaii to Bikini Atoll and East Africa. While the characters are consistent and show little variation over the species' range, some difficulties arise from the ability of the animals to elongate or contract the mantle. Round and tubular shaped mantles are found in the material and can have drastic effects upon indices. In the elongate stage the mantle length is greatly increased resulting in low indices in some characters and high ones in others. This problem should be borne in mind when using the indices.

The description is based primarily upon the large male from Oahu designated as the neotype.

The mantle is round, bulbular, smooth posteriorly or with a small terminal point, or it may be greatly elongate and tubular (MWI—males, 31–*62.1*–83; females, 27–*60.7*–70). It is muscular and thick-walled with a moderately wide aperture. The funnel is muscular, stout, and free for about half of its length. The funnel organ is W-shaped with the outer limbs a little shorter than the median ones.

The head is narrower than the mantle with (HWI—males, 32–*45.9*–57; females, 31–*46.2*–55) and in the specimens with round mantles there is a distinct neck region. In those with tubular mantles no neck region is found. The eyes are of moderate size and are somewhat protuberant.

The arms are long and stout (MAI—males, 15–*18.2*–23; females, 14—*18.8*–26; ALI—males, 82–*84.8*–87; females, 80–*84.5*–88), but taper to slender tips. The arm order in nearly all cases is I.II.III.IV with I the longest (two exceptions). The suckers are biserial and large (SIn—males, 7.9–*11.4*–15; females, 5–*10*–14) and there are no specially enlarged suckers in the males. The web is shallow (WDI—males, 9–*11.4*–14; females, 8–*10.3*–12).

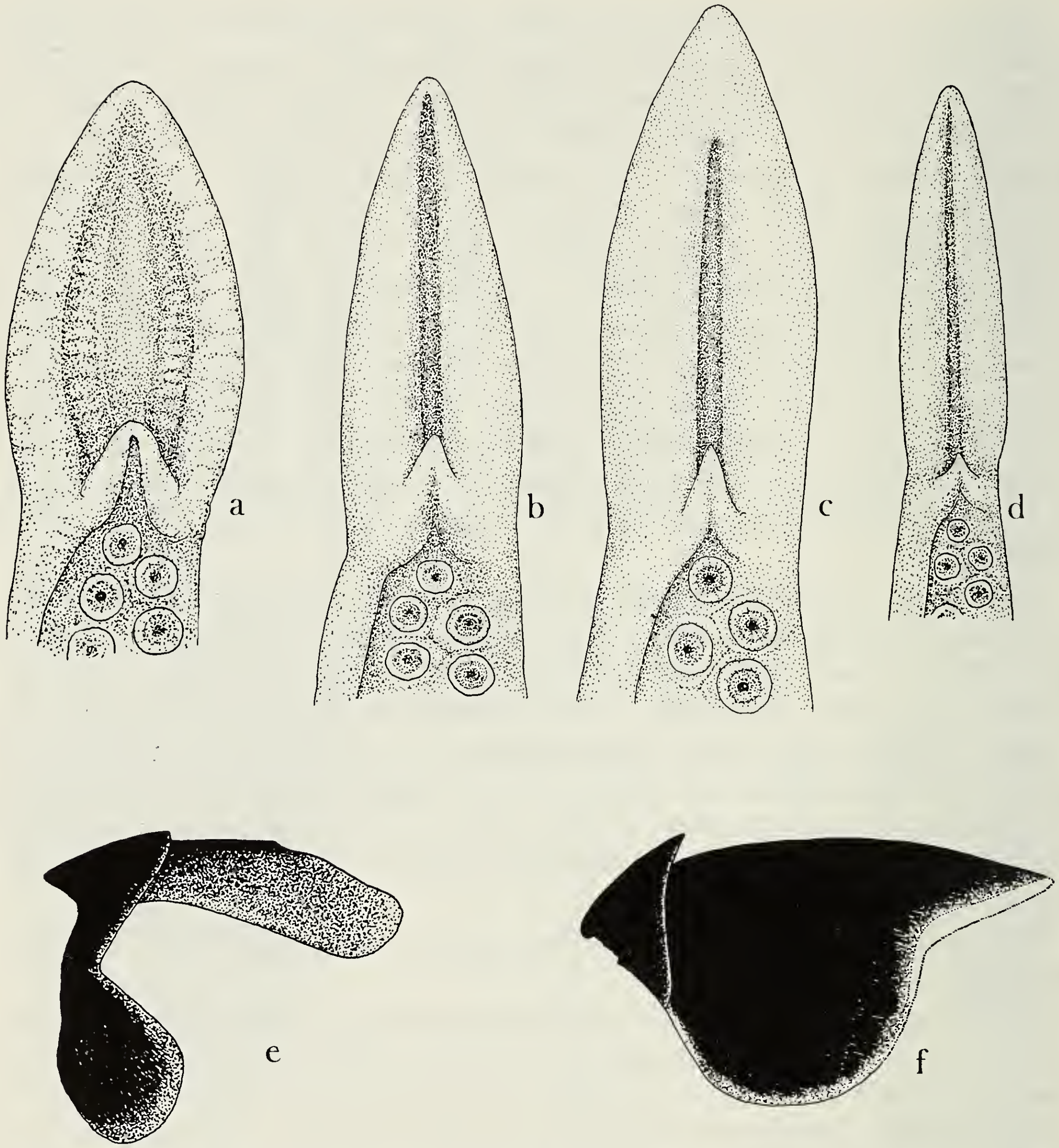

Fig. 2. *Octopus ornatus*: a, Hectocotylus of 47 mm ML male from East Africa; b, Hectocotylus of neotype (88 mm ML); c, Hectocotylus of 98 mm ML male from Bikini; d, Hectocotylus of 101 mm ML male from East Africa; e, Lower beak, f, Upper beak, of 101 mm ML male from East Africa.

The web formula is very variable but sector B is usually the deepest and sector E is usually the shallowest.

The third right arm is hectocotylized and is shorter than its fellow arm (HAI 59–*68.7*–82) (Fig. 2a–d). There is a distinct well-formed spermatophoral groove. The ligula is small (LLI—2.3–*5.4*–6.9) and is elongate with strongly inrolled lateral margins completely enclosing the deep, smooth longitudinal groove on the oral face. In small specimens the ligula is more open while in the specimen from Bikini the distal fifth of the ligula margins is

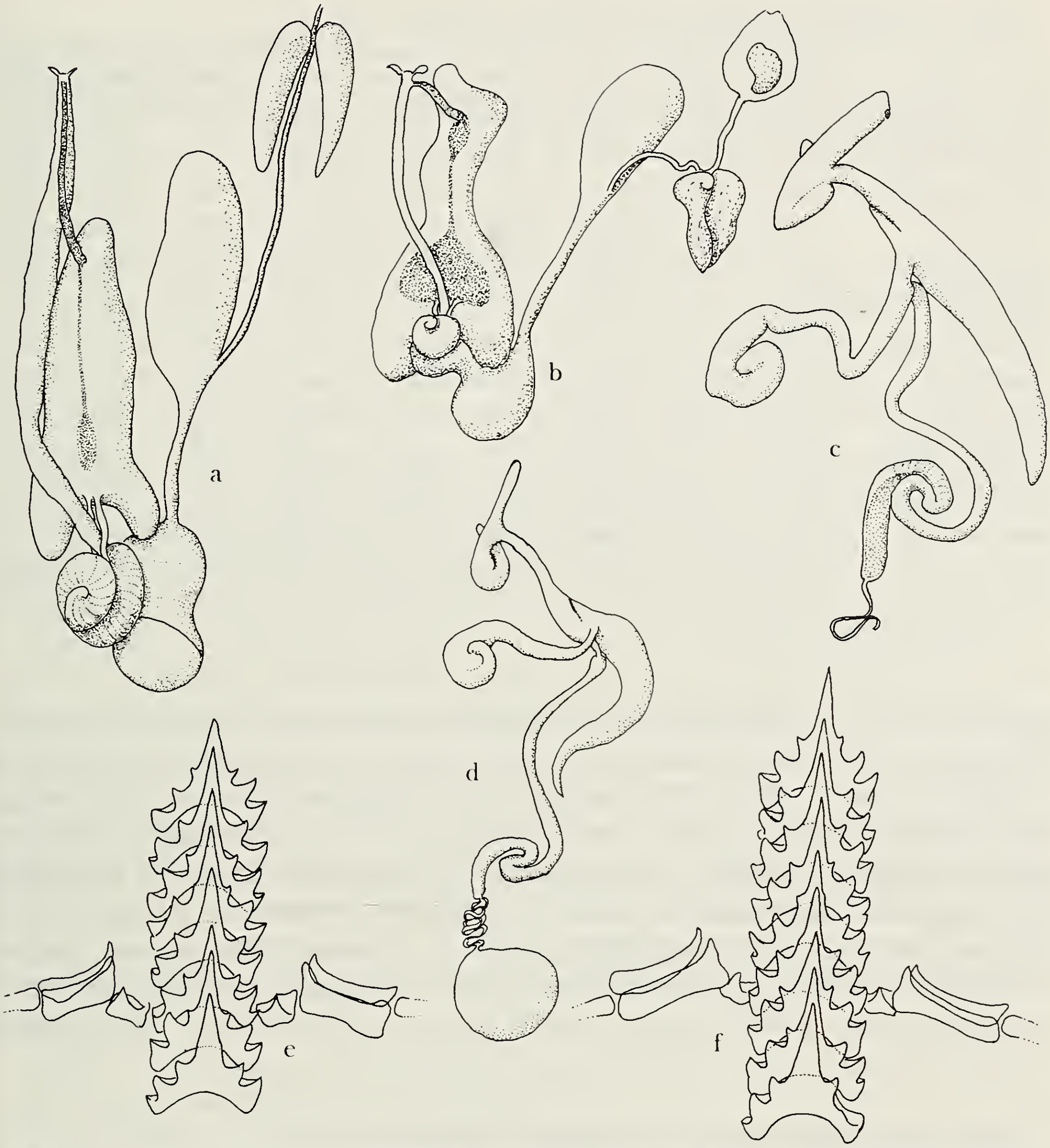

Fig. 3. *Octopus ornatus*: a, Digestive tract from 101 mm ML male from East Africa; b, Digestive tract from 74 mm ML female from Hawaii; c, Genitalia from 98 mm ML male from Bikini; d. Genitalia from 101 mm ML male from East Africa; e, Radula from 101 mm ML male from East Africa; f, Radula from 83 mm ML male from Hawaii.

fused together as shown in figure 2c. The calamus is small (CLI—13.6–*23.7*–39) and set flush with the margins of the ligula.

There are 12–14, more often 14, lamellae on the outer demibranch of the gills.

Several specimens were dissected to permit description of the digestive and reproductive tracts. The beaks are distinctive. The upper beak has a well-marked long notch in the cutting edge while the lower beak has a sharp ridge medially in the lamella which is divided in the posterior half. The

Table 1.—Indices and other data of 9 males of *Octopus ornatus*.

Index	Africa	Africa	Africa	Hawaii	Hawaii	Africa	Bikini	Africa	Africa
Mantle length	44	47	66	83	88	98*	98	101*	104*
Mantle width I	68	83	77	67	78	45	77	33	31
Head width I	50	53	53	42	57	35	56	32	35
Mantle arm I	15	16	17	15	16	22	18	22	23
Arm length I	87	86	86	87	86	82	85	82	82
Arm width I	25	22	23	17	24	18	—	17	13
Web depth I	11	11	11	12	9	14	—	12	—
Sucker Index normal	13	13	13	10	15	10	12	9	7.9
Hect. arm I	67	73	82	59	79	60	—	61	—
Ligula length I	2.8	2.3	6.9	4.6	6.6	4.9	6.0	6.2	—
Calamus length I	39	30	13.6	25	18.8	22.7	—	16.7	—
Arm formula	1.2.3.4	1.2.3.4	1.2.3.4	1.2.4.3	1.2.4.3	1.2.3.4	——	1.2.3.4	1.2.??
Web formula	BDCAE	BACDE	BCADE	ACBDE	BACDE	ACBDE	DBCEA	BACDE	?
Gills	12	13	13	13	14	14	14	13	14

* indicates elongate forms.

radula from both Hawaiian and East African specimens are very similar. Both have a symmetrical seriation of A^{6-8} with an average of A^7, with about 2 cusps on each side of the rachidian. The digestive tract is very similar between the Hawaiian and East African specimens. Both show elongate posterior salivary glands, an enormous crop, large stomach and separated spiral caecum. The digestive gland of the Hawaiian female is elongate in the anterior part but wide posteriorly and has a 2-parted ink sac, the largest posterior. The East African specimen has an elongate gland (it is from a specimen with a tubular mantle) and a small posterior ink sac. Both glands

Table 2.—Indices and other data of 6 females of *Octopus ornatus*.

Index	Africa	Africa	Africa	Africa	Africa	Hawaii
Mantle length	22	33	47	64*	65	74
Mantle width I	68	70	66	27	63	70
Head width I	55	48	43	31	45	55
Mantle arm I	14	18	16	26	18	21
Arm length I	88	85	86	80	85	83
Arm width I	20	19	14	9	17	32
Web depth I	8	10	10	10	12	12
Sucker Index normal	9	14	11	5	9	12
Arm formula	1.2.3.4	1.2.3.4	1.2.3.4	1.2.3.4	2.1.3.4	2.1.3.4
Web formula	ABCDE	BACDE	BCDAE	A=CBDE	BCDA=E	BCD=AE
Gills	14	14	14	14	14	12

* indicates elongate forms.

are obviously modified for elongation. The posterior end of the glands is strongly bilobed.

The female genitalia are not illustrated as none of the specimens with viscera in good condition were adult. However, the ovary is not posterior but median and ventral in position, oval or squarish, with very long slender proximal and distal oviducts with small oviducal glands.

The male genitalia are very similar in all specimens. The one from Bikini has a long penis but over half of it is composed of a posterior diverticulum that is folded under itself and projects forward. The penial apparatus from an East African specimen conforms to this same general pattern but is longer and more slender, coming from an elongate-mantled specimen. The spermatophores of all the males were too incomplete to measure or illustrate.

The skin of the mantle, head and aboral surface of the arms and web is finely to roughly granulose, resembling that of *Octopus vulgaris* in some forms. There are a few large contracted papillae over each eye but not large enough to be classed as ocular cirri.

The color of the more recently preserved material at my disposal is purplish red dorsally on the mantle, head and arms. In long-preserved specimens the background color is reddish brown. Ventrally and on the oral surface of the arms and web the skin is a pale flesh color. The pattern of splotches, spots and stripes is very similar in all of the specimens and is well shown in the figures. Variations of mantle shape and color pattern are shown in the outline drawings. These spots and stripes are pale to bright buff. In some specimens, particularly those from East Africa, the spots and stripes have a raised ridge or crest or fleshy mound in their centers, the latter, especially on the arms, reminiscent of those found in *Octopus macropus*.

Type.—The original type-material has been lost. The neotype, a male, mantle length 88 mm is USNM 730020.

Type-locality.—Sandwich Islands, collected by the U.S. Exploring Expedition.

Discussion

The original specimens were from the Wilkes expedition "obtained at the Sandwich Islands at Oahu and Mauii." None of these specimens have been located in any of the museums where they might be expected to have been deposited, and all of these specimens in alcohol must be assumed to be lost (personal communication, Richard I. Johnson, Museum of Comparative Zoology, Harvard). The most important part of the original description is the following (Gould, 1852, p. 477): "The ground color is deep orange; beneath somewhat clouded with white; above variegated with five longitudinal buff stripes, the median one extending to between the eyes, the two lateral ones curving on each side, like median lines, and extending only to the neck;

between these lines, around the middle of the sac, are deep brown patches, and also between the bases of the arms; there are also brown mottlings along the back of the arms. These, with the pale, bubble-like patches around the base of the sac and along the arms, give a very gay and diversified coloring."

This description of the color pattern almost exactly suffices for a description of the colors of the specimens from East Africa and of Taki's *Callistoctopus arakawai* (Taki, 1964: pl. 2).

An apparent discrepancy is the extremely narrow and elongate body of the African specimens. Some of these have narrower mantles than are known for adults of any other species of octopod. This is variable, however, and several specimens of normal mantle shape are in the series.

Examination of the digestive and reproductive tracts of both normal and elongated specimens shows that this species is especially adapted for shape change. This is seen in the elongated digestive gland (Taki, 1964, p. 295, noted that it nearly filled the mantle), the very long ink sac duct, and the long convoluted oviducts and anteriorly located ovary.

The two radulas figured, one from Bikini and the other from East Africa, are nearly exactly the same with symmetrically placed cusps on the rachidian and in a series of 7 to 8. Taki (1964, p. 294, figure 39) also shows a symmetrical series of 7 rather than 6 as he states in the text.

A variable feature requiring further study is the hectocotylus. Unfortunately, the hectocotylus described and figured by Berry (1914, pl. XLVI, fig. 2) is from an immature specimen and resembles that of immature specimens in the present material. The single male from Hawaii available to me has a long, slender but fully excavated ligula. The male from Bikini collected by Schultz has a narrow hectocotylus with a strongly inrolled ligula whose margins are fused together along the terminal fifth of its length. The question arises: does this represent an abnormality or a geographic variation? The African specimens are very similar to Taki's specimens from Japan and may represent the more "typical" condition.

Taki erected the genus *Callistoctopus* for his new species *arakawai* and *magnocellatus*. The characters by which he differentiated the genus from *Octopus* are "(1) large size, (2) robust construction, (3) characteristic color pattern, (4) reduction of ink-sac." The size and robustness of construction are no greater than in many other species of *Octopus,* nor is the reduction in size of the ink sac of particular note. All of the specimens described here have a distinctive color pattern, in some ways resembling that of *Octopus macropus* (i.e. pale spots on body and arms). Certainly *magnocellatus* should not have been included as its color pattern is very dissimilar to that of *arakawai* and should be included among the regular ocellated species of *Octopus*. There is no valid basis for the retention of the genus *Callistoctopus* and it is placed in the synonymy of *Octopus*. *C. arakawai* is considered to be a synonym of *O. ornatus* Gould, 1852, a widely distributed Indo-West Pacific species.

Dong (1979: 72) has reported the occurrence of *arakawai* from off Xisha, Guandong Province, China, placing it correctly in the genus *Octopus*. A photograph of the specimen (pl. 1, fig. 2) shows that it is a long-bodied specimen resembling the elongate animals from East Africa.

A final question needs to be examined. Taki (1964:296–298, 301–304) stated that the living animal, although not personally seen by him, emitted "bluish phosphorescent light when stimulated; the light is emitted from the pink stripes and spots which are scattered all over the body surface except the ventral surface of body and arms; at that time the colour pattern looks thin-coloured than ordinary time." Taki's examination of the cellular structure of these "phosphorescent" areas revealed deeply-buried cells that he interpreted to be light producing cells but that seemed to me to be iridocytes or reflecting cells, especially as the latter are not mentioned in his histological comments. To verify this, I requested that Drs. Roper and Young, both with extensive knowledge of cephalopod luminescence, examine living specimens in Hawaii, if such could be found.

In a letter from Roper dated 20 November 1975 he wrote "The so-called luminescence surely is not true luminescence. Dick (R. E. Young) and I saw it and the girl (graduate student using the specimen for behavioral studies) saw it repeatedly under fairly well lit conditions. The animal pulls back its chromatophores and exposes the long patches of iridophores which exhibit iridescence and shimmer. It is vivid enough to be mistaken for luminescence—if you didn't look too carefully." The statement "pulls back its chromatophores" corresponds to Taki's "the colour pattern looks thin-coloured than ordinary time."

Roper and Young's observations amply refute the existence of bioluminescence in this species and to date no octopod is known to possess luminescent organs (Thomas, 1977, p. 386, has shown that the supposed light organs in *Tremoctopus lucifer* Akimushkin, 1963, are not light organs). The specimen from which Roper and Young's observations were made died shortly thereafter and was sent to me. It is a female and corresponds to the others in all particulars.

There is a complex of species in the Indo-West Pacific region characterized by the possession of long arms I. These animals have generally been assigned, without critical study, to *Octopus macropus*. In the light of the situation with regards to *Octopus ornatus*, other members of this complex need reexamination to determine their specific relationships.

Acknowledgments

I wish to thank Clyde F. E. Roper of the United States National Museum of Natural History for the loan of material from that institution, for reading the manuscript, and both Roper and Richard E. Young, University of Hawaii, for kindly producing specimens from Hawaii and for providing notes on the colors of the living animal. Michael Sweeney of the USNM kindly assisted me on a visit to Washington and gave unsparingly of his time. The illustrations of color patterns and ligulas are the work of Banjong Mianmanus, the full view of the neotype is by Laura Sartucci. The others are my own. I also wish to thank the National Science Foundation for its continued support of my research by Grant DEB-7603456 for which this is a report. This paper constitutes a scientific contribution from the Rosenstiel School of Marine and Atmospheric Science, University of Miami.

Literature Cited

Akimushkin, I. I. 1963. Cephalopods of the Seas of the U.S.S.R. (1965 English translation of Golovonogie mollyuski morei SSSR).—Izdatil'stvo Akademii Nauk SSSR, Moskva, 223 pp.

Berry, S. Stillman. 1909. Diagnoses of new cephalopods from the Hawaiian Islands.—Proc. U.S. Natl. Mus. 37:407–419, text-figs. 1–9.

———. 1914. The Cephalopoda of the Hawaiian Islands.—Fish. Document No. 789:257–362, 11 pls., 40 text-figs.

Dong, Zhengzhi. 1979. A preliminary report of the cephalopods from the Xisha waters, Guangdong Province, China.—Studia Marina Sinica, no. 15:71–74, pl. 1.

Gould, Augustus A. 1852. United States Exploring Expedition etc., under the command of Charles Wilkes. Volume 12, Mollusca and shells. 1–510 pp., atlas of 52 pls. Philadelphia.

Robson, G. C. 1929. A monograph of the recent Cephalopoda. Part I. Octopodinae.—British Museum (Natural History) London, pp. 1–236, 7 pls., 89 text-figures.

Taki, Iwao. 1964. On eleven new species of the Cephalopoda from Japan, including two new genera of Octopodinae.—J. Fac. Fish. Animal Husb., Hiroshima Univ. 5(2):277–330, 7 pls., 68 text-figs.

Thomas, Ronald F. 1977. Systematics, distribution, and biology of cephalopods of the genus *Tremoctopus* (Octopoda: Tremoctopodidae).—Bulletin of Marine Science 27(3):353–392.

Tryon, George W. 1879. Manual of conchology. Vol. i, Cephalopoda. Philadelphia, 316 pp., 112 pls.

Voss, Gilbert L. 1963. Cephalopods of the Philippine Islands. U.S. Natl. Mus. Bull. 234, 180 pp., 4 pls., 36 text-figs.

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94(2), 1981, pp. 535–560

A REVISION OF THE NETTASTOMATID EEL GENERA *NETTASTOMA* AND *NETTENCHELYS* (PISCES: ANGUILLIFORMES), WITH DESCRIPTIONS OF SIX NEW SPECIES

David G. Smith, James E. Böhlke, and P. H. J. Castle

Abstract.—The genera *Nettastoma* Rafinesque and *Nettenchelys* Alcock form an easily recognized group within the family Nettastomatidae. The posterior nostril is displaced dorsally to the top of the head or behind it. The body is deepest in the middle and tapers at both ends. *Nettastoma* has a longer snout and 11–14 pores along the upper jaw; *Nettenchelys* has a shorter snout and 8–10 pores along the upper jaw. The position of the posterior nostril varies greatly among species of the two genera. The larva in both genera is deep-bodied anteriorly and tapers sharply toward the tail. *Nettastoma* contains four species. *Nettastoma melanura* Rafinesque (Atlantic), *N. syntresis* n. sp. Smith and Böhlke (Atlantic), and *N. solitarium* n. sp. Castle and Smith (Indo-Pacific) have the posterior nostril above the anterior edge of the eye. They are distinguished *inter alia* by the number of supraorbital and lateral-line pores and the relative size of the median vomerine teeth. *Nettastoma parviceps* Günther has the posterior nostril over the posterior edge of the eye. *Metopomycter denticulatus* Gilbert is synonymized with *Nettastoma parviceps,* and the genus *Metopomycter* is synonymized with *Nettastoma*. *Nettenchelys* contains five species. *Nettenchelys pygmaeus* n. sp. Smith and Böhlke (Atlantic) and *N. gephyra* n. sp. Castle and Smith (Indo-Pacific) have an enlarged median series of anterior vomerine teeth, and the posterior nostril is slightly behind the posterior edge of the eye; *N. pygmaeus* is mature at 150–200 mm TL, *N. gephyra* at about 400 mm. *Nettenchelys inion* n. sp. Smith and Böhlke, (Atlantic), *N. exorius* n. sp. Böhlke and Smith (Atlantic), and *N. taylori* Alcock (Indo-Pacific) lack the enlarged anterior vomerine teeth and have the posterior nostril at or behind the occiput. In *N. inion* the posterior nostril is just in front of the supratemporal canal, in *N. exorius* slightly behind the occiput, and in *N. taylori* between the dorsal-fin origin and the anus.

The Nettastomatidae are a rather poorly known family of eels inhabiting the outer continental shelf and the continental slope of the world's tropical and warm temperate oceans. Closely related to the Congridae, nettastomatids are characterized primarily by an elongation and narrowing of the head and snout and an enlargement of the mouth. The teeth are generally small and in multiserial bands. The body is elongate and the tip of the tail is greatly attenuated. Pectoral fins are usually absent. The distinction between the Congridae and the Nettastomatidae is not clear, and further study may lead to the union of the two families.

One readily distinguishable group within the Nettastomatidae is composed of the nominal genera *Nettastoma* Rafinesque, *Metopomycter* Gilbert, and *Nettenchelys* Alcock. In this group the posterior nostril is displaced dorsally to the top of the head or even farther back in some species. The body is deepest in the middle and tapers toward both ends. The larva in these forms is deep bodied anteriorly and narrows sharply toward the tail (Smith 1979:11).

This group was known for many years from a single Atlantic species of *Nettastoma, N. melanura* Rafinesque, and two poorly defined Pacific species of *Metopomycter, M. parviceps* (Günther) and *M. denticulatus* Gilbert. These two genera were distinguished by the position of the posterior nostril, near the anterior margin of the eye in *Nettastoma* and near the posterior margin of the eye in *Metopomycter. Nettenchelys* was so poorly known that no attempt had been made to determine its relationships; its omission from Jordan's Genera of Fishes (Jordan 1917–1920) may have contributed to its obscurity.

We have recently discovered several additional species of this group in both the Atlantic and Indo-Pacific. The holotype and only known specimen of *Nettenchelys taylori* Alcock was reexamined and determined to belong to the group. The position of the posterior nostril is now seen to form a graded series among the species, and the basic distinction between *Nettastoma and Metopomycter* has largely disappeared. However, a character that does divide these species clearly into two groups is the length of the snout and the number of pores along the upper jaw. *Nettastoma melanura, N. syntresis* n. sp., *N. solitarium* n. sp. and *N. parviceps* have 11 to 14 pores in this series and a correspondingly longer snout. The remaining species have a shorter snout and eight to ten pores. We recognize these two groups as genera, *Nettastoma* and *Nettenchelys. Metopomycter* becomes a synonym of *Nettastoma.*

Methods

Head length is measured to the upper corner of the gill opening. The upper jaw is measured from the tip of the snout to the posterior end of the maxilla. Interbranchial distance is measured between the lower end of the gill openings across the ventral midline. Depth is measured at the anus. Head pores are designated as in Smith and Kanazawa (1977) except that there is no postrictal pore in the infraorbital canal; infraorbital pores are

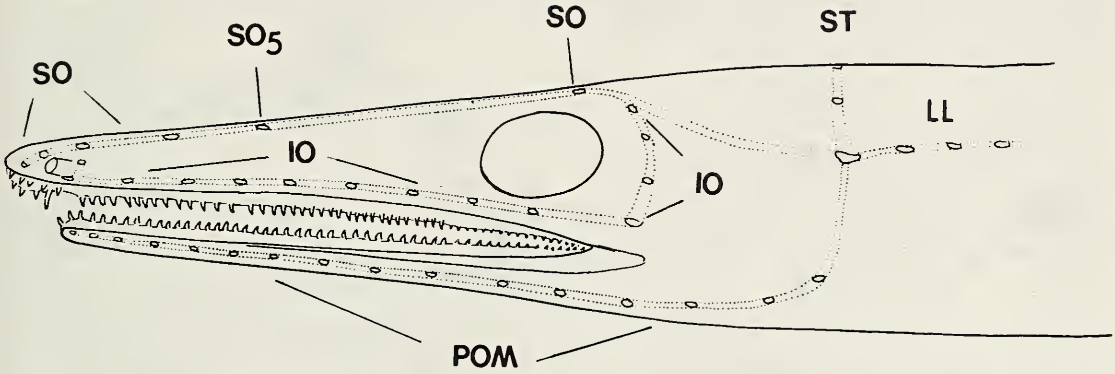

Fig. 1. Diagrammatic view of head of a nettastomatid to show sensory canals and pores. Abbreviations explained in text.

given as those along the upper jaw plus those behind the eye. The presence or absence of the fifth supraorbital pore (SO_5) is diagnostic in the species of *Nettastoma,* and its position is indicated in Fig. 1. The anteriormost lateral-line pore is located at the junction of the lateral-line and the supratemporal and preoperculomandibular canals. We call this a lateral-line pore throughout, although in the holotype of *Nettenchelys taylori* it is located below the level of the lateral-line canal. Lateral-line pores counted are those anterior to the anus. In the descriptions, the number of specimens that each count or measurement was based upon is given in parentheses following that value. Unless otherwise stated, lengths are total lengths (TL).

Abbreviations for pores are as follows: LL = lateral-line, POM = preoperculomandibular, IO = infraorbital, SO = supraorbital, ST = supratemporal.

Abbreviations for museums are as follows: AM, Australian Museum, Sydney; ANSP, Academy of Natural Sciences of Philadelphia; BMNH, British Museum (Natural History), London; BPBM, Bernice P. Bishop Museum, Honolulu; MB, Museu Bocage, Lisbon; MNHN, Muséum National d'Histoire Naturelle, Paris; RUSI, Rhodes University, Grahamstown, South Africa; SAM, South African Museum, Capetown; TM, Tasmanian Museum, Hobart; UMML, Rosenstiel School of Marine and Atmospheric Science, University of Miami, Florida; USAIC, Ichthyological Collection, University of South Alabama, Mobile; USNM, National Museum of Natural History, Washington, D.C.; ZMUC, Zoological Museum, University of Copenhagen; ZSI, Zoological Survey of India, Calcutta.

Genus *Nettastoma* Rafinesque, 1810

Nettastoma Rafinesque, 1810:66 (type-species *Nettastoma melanura* Rafinesque, 1810, by monotypy).

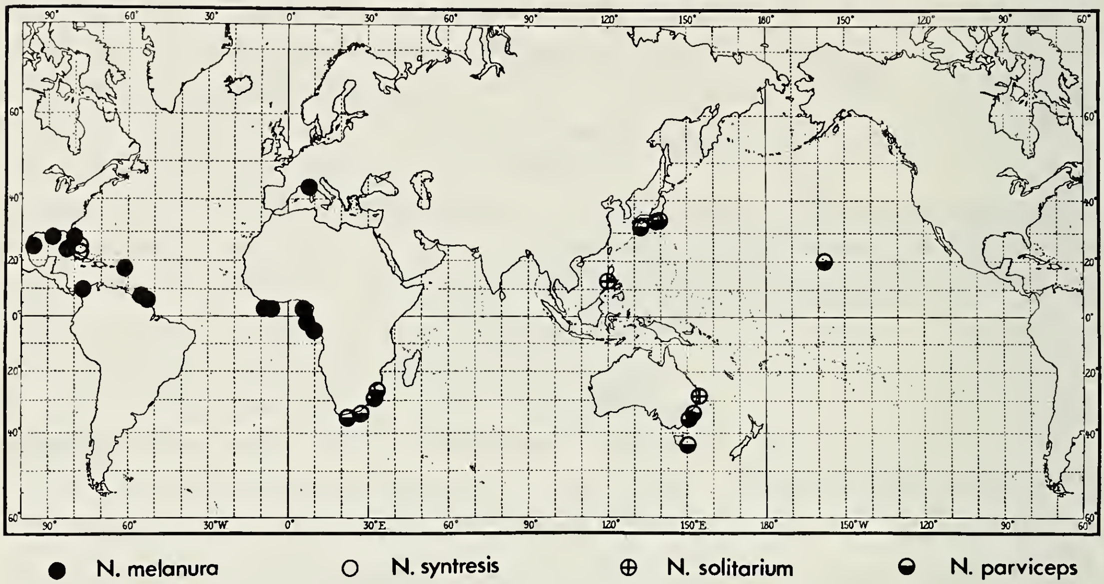

Fig. 2. Distribution of the species of *Nettastoma*.

Hyoprorus Kölliker, 1854:101 (type-species *Hyoprorus messinensis* Kölliker, 1854, by monotypy).

Metopomycter Gilbert, 1905:585 (type-species *Metopomycter denticulatus* Gilbert, 1905, by original designation).

Muraenosaurus Osorio, 1909:14 (type-species *Muraenosaurus Güntheri* Osorio, 1909, by monotypy). Preoccupied by *Muraenosaurus* Seeley, 1874, Reptilia.

Osorina Whitley, 1951:68 (type-species *Muraenosaurus Güntheri* Osorio, 1909, by original designation). To replace *Muraenosaurus* Osorio.

Description.—Body elongate, round in cross section, deepest in middle and tapering at both ends. Tail slender and attenuate, tip delicate and easily damaged. Pectoral fin absent. Dorsal fin originates above gill opening. Head elongate, slightly depressed, snout length about 35–49% head length; anterior nostrils tubular, opening laterally just behind tip of snout; posterior nostrils displaced dorsally near anterodorsal or posterodorsal margin of eye; tip of snout soft, flexible, extending a short distance in front of the premaxillary teeth. Teeth relatively small, in multiserial bands or patches. Maxillary and mandibular teeth in bands, innermost teeth somewhat enlarged; premaxillary tooth patch short, continuous with maxillary teeth; vomerine tooth patch elongate, reaching level of eye, median teeth sometimes enlarged. Eleven to fourteen infraorbital pores along upper jaw, the second one slightly elevated in short ascending branch of infraorbital canal immediately behind anterior nostril (Fig. 1); five or six supraorbital pores including one near posterior end of canal above eye; third supraorbital pore slight-

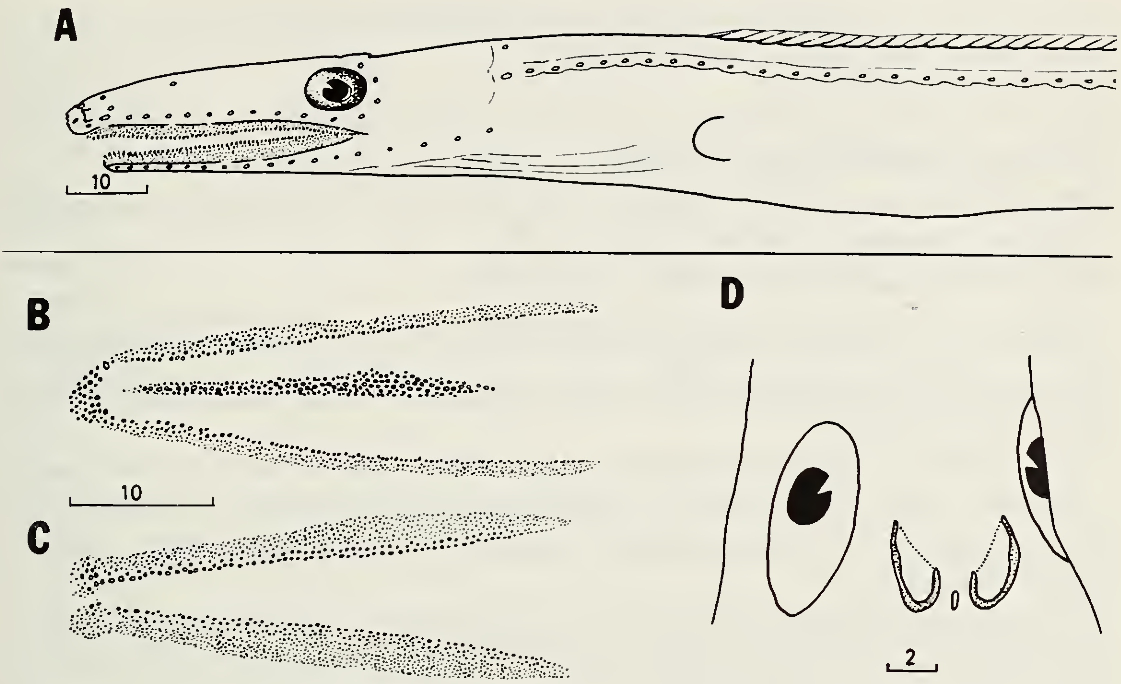

Fig. 3. *Nettastoma parviceps,* AM I.20452-003 (634 mm incomplete). A, Head. B, Upper dentition. C, Lower dentition. D, Dorsal view of a portion of head to show posterior nostrils and posteriormost supraorbital pore. Scales in mm; a single scale applies to B and C.

ly posterior to second infraorbital pore (i.e., the one in ascending branch of infraorbital canal); three supratemporal pores. Viscera: stomach pale, reaching near level of vent; intestine pale. Maximum TL probably 800–1000 mm.

Range.—Eastern and western tropical Atlantic, including Mediterranean; Indo-Pacific from East Africa to Hawaii, Australia to Japan (Fig. 2).

Etymology.—Gr. *netta,* duck; Gr. *stoma,* mouth. The gender is neuter.

Note.—*Nettastoma elongatum* Kotthaus, 1968 is a species of *Saurenchelys* Peters.

Key to the Species of *Nettastoma*

1. Posterior nostril near posterior margin of eye (Indo-Pacific) . . . . *N. parviceps* Günther
– Posterior nostril near anterior margin of eye 2
2. SO$_5$ pore usually absent; median vomerine teeth slightly enlarged; LL pores 44–49 (Atlantic) . . . . *N. melanura* Rafinesque
– SO$_5$ pore usually present; LL pores 45 or fewer 3
3. LL pores 38–41; median vomerine teeth not enlarged (western Atlantic) . . . . *N. syntresis* n. sp.
– LL pores 43–45; median vomerine teeth somewhat enlarged (Indo-Pacific) . . . . *N. solitarium* n. sp.

Nettastoma parviceps Günther, 1877
Figs. 2, 3

Nettastoma parviceps Günther, 1877:446 (original description, Yedo, Japan, holotype BMNH 1879.5.14.440).

Metopomycter denticulatus Gilbert, 1905:585, fig. 233 (original description, Hawaii, holotype USNM 52191).

Metopomycter parviceps: Gilbert, 1905:585.

Diagnosis.—SO_5 pore normally absent (Fig. 3A). LL pores 49–58. Median vomerine teeth not enlarged (Fig. 3B). Posterior nostril above posterodorsal corner of eye (Fig. 3D).

This species has appreciably more lateral-line pores than *N. melanura, N. syntresis,* and *N. solitarium,* and differs from these species in having the posterior nostril over the posterior margin of the eye rather than over its anterior corner.

Description.—Meristic characters: Total vertebrae unknown but at least 230. Pores: LL 49–58 (33); POM 15–20 (23), IO 11–14 (24) + 3 (29); SO 5–6 (24); ST 3 (23; one specimen had 4).

Morphometric characters: Predorsal length 25–32% preanal length (37); head 27–34% preanal (37); snout 36–49% head (36); eye 9–14% head (37); upper jaw 50–66% head (36); gill opening 3–9% head (37); interbranchial 7—17% head (35); depth 4–10% preanal (32).

Dentition (Fig. 3B, C): Maxillary and mandibular teeth in bands, the inner teeth slightly larger; premaxillary tooth patch short, continuous with maxillary teeth; vomerine tooth patch elongate, reaching level of eye, median teeth not enlarged.

Color: A freshly caught specimen (AM I.20452-003) was gray; vertical fins black-edged; snout gray-black; iris and opercular regions silver.

Size: The largest specimen examined was 815 mm TL, 335 mm preanal. Females with large eggs were about 500–600 mm TL.

Variation.—*Nettastoma parviceps* is known from four widely separated areas: Japan, Hawaii, Australia, and South Africa. These four populations differ from each other in four characters (Table 1). In addition, the two northern hemisphere populations differ from the two southern hemisphere populations in the nature of the posteriormost supraorbital pore (the one between the posterior nostrils). In the former this pore is paired, whereas in the latter the pores of the right and left sides are fused into a single median pore (Fig. 3D).

Specimens of *N. parviceps* almost invariably have damaged tails, making it impossible to give accurate vertebral counts. Several specimens in which the caudal region seemed to be intact or nearly so yielded counts of about 230. The holotype of *N. parviceps* (from Japan) has approximately 234 vertebrae with 53 preanal; that of *Metopomycter denticulatus* (from Hawaii)

Table 1.—Geographic variation in *Nettastoma parviceps*.

Predorsal length as percentage of preanal length	25	26	27	28	29	30	31	32
Japan	1	0	2	3	1			
Hawaii				3	5	3	4	
South Africa		2	3	3	1	1	2	1
Australia	1	2						

Head length as percentage of preanal length	27	28	29	30	31	32	33	34
Japan		2	2	3				
Hawaii					1	3	5	6
South Africa			2	2	4	4	1	
Australia	1	1	0	1				

Snout length as percentage of head length	36	37	38	39	40	41	42	43	44	. . .	49
Japan					3	1	3				
Hawaii		1	3	6	3	1	1				
South Africa	2	0	1	3	3	1	1	0	1	. . .	1
Australia				1	1	0	0	0	1		

Preanal lateral-line pores	49	50	51	52	53	54	55	56	57	58
Japan						1	5	0	1	
Hawaii	2	4	2	4	2					
South Africa					3	1	4	1	0	2
Australia					1	2				

has 158 with 50 preanal, but the caudal region is obviously incomplete. Myomere counts from nine larvae (all southern hemisphere) ranged from ca. 220 to 236.

Range.—This species (Fig. 2) has been recorded from Japan, Hawaii, eastern Australia from New South Wales to Tasmania, and southeastern Africa from southern Mozambique to near the Cape of Good Hope. Depth 60–1,190 m (mean 575 m). It has a bitemperate distribution, being rare or absent in equatorial waters.

Study material.—JAPAN: BMNH 1879.5.14.440 (holotype of *Nettastoma parviceps*: 665), CHALLENGER 232, 35°11′N, 139°28′E, 630 m, 12 May 1875. USNM 112037 (1:546), ALBATROSS D5059, 33°05′30″N, 138°39′50″E, 13 Oct. 1906. USNM 148872 (1:458) and USNM 149779 (1:518), ALBATROSS D4957, 32°36′N, 132°23′E, 799 m, 23 Aug. 1906. USNM 149786 (1:495), ALBATROSS D4971, 33°23′30″N, 135°34′E, 1,187 m, 30 Aug. 1906. USNM 149787 (2:495–537), ALBATROSS D4972, 35°25′45″N, 135°33′E, 805

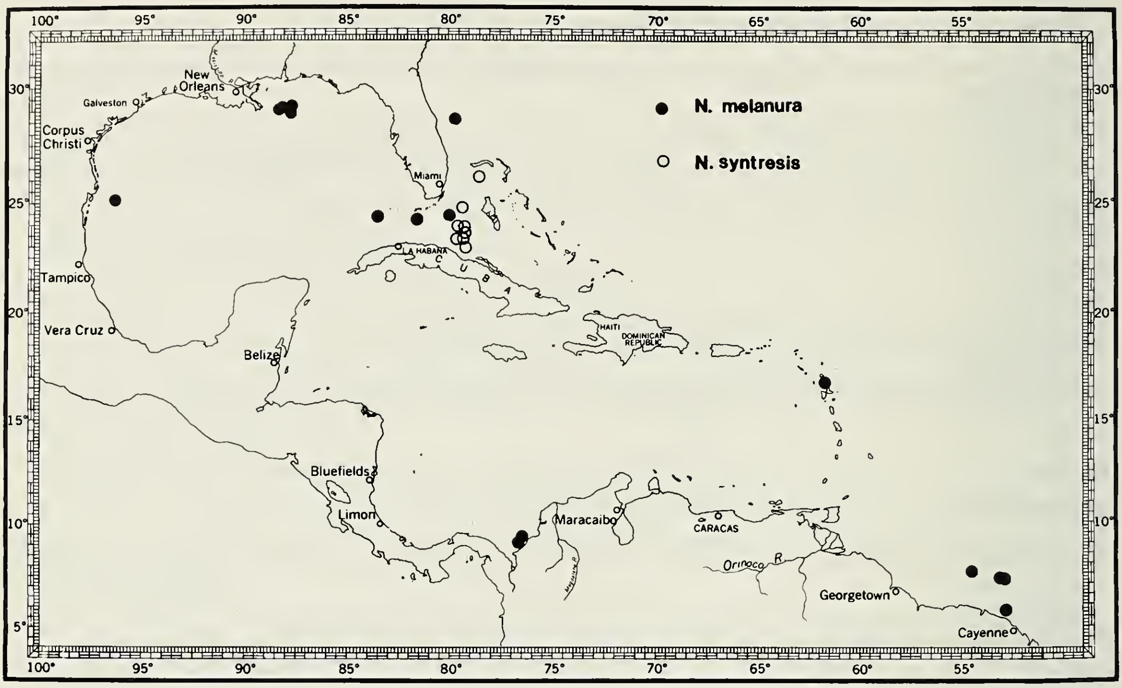

Fig. 4. Distribution of *Nettastoma melanura* and *N. syntresis* in the western North Atlantic.

m, 30 Aug. 1906. USNM 164157 (1:590), ALBATROSS 5067, 35°05′50″N, 138°41′15″E, 15 Oct. 1906.

HAWAII: BPBM 24856 (12:487–755), TOWNSEND CROMWELL 61–66, 21°01′N, 156°08′W, 860 m, 26 Oct. 1972. BPBM 25073 (1:487), TOWNSEND CROMWELL 52–87, Hawaiian Islands, Pailolo Channel, mid-channel, 650 m, 10 March 1971. BPBM 25081 (1:602), TOWNSEND CROMWELL 59–20, 21°09′N, 156°11′W, 100–800 m, 11 July 1972. USNM 52191 (holotype of *Metopomycter denticulatus*: male, 765), Hawaii, 1899.

EASTERN AUSTRALIA: AM I.19376-002 (1:200 incomplete), KAPALA, 35°44′S, 150°38′E, 550 m, 10 Nov. 1976. AM I.20452-003 (2:575–634 incomplete), KAPALA 75-05-05, 33°32′S, 152°00′E, 823 m, 19 Aug. 1975. AM I.20452-004 (1:370 incomplete), KAPALA, 33°31′S, 152°00′E, 822 m, 19 Aug. 1975. TM D1649 (1:480), 43°57′S, 150°23′E, 730–940 m, 30 Dec. 1979.

SOUTHEASTERN AFRICA: ANSP 123528 (1:231), 25°29′S, 33°35′E, 450 m, 28 Sept. 1964. RUSI uncatalogued (1:915), off Limpopo River, Mozambique, 485 m, 17 Jan. 1968. SAM-12785 (1), PIETER FAURE, off Cape St. Blaize, South Africa, 60 m. SAM-12786 (1:256), PIETER FAURE, off East London, South Africa, 357 m. SAM-12787 (3:137–297), PIETER FAURE, off East London, South Africa, 732 m. SAM-12788 (1:259), PIETER FAURE, off East London, South Africa, 549 m. SAM-24372 (2:349 and incomplete), Division of Sea Fisheries, off Durban, South Africa, 406 m 26 July 1964.

Etymology.—L. *parvus,* little, and L. *caput,* head; the significance is not obvious, although the head of this species is slightly smaller than that of *N. melanura,* the only other species of the genus known to Günther.

Nettastoma melanura Rafinesque, 1810
Figs. 2, 4, 5A, 6A

Nettastoma melanura Rafinesque, 1810:66 (original description, Sicily, holotype lost).

Muraenophis saga Risso, 1810:370 (original description, Nice, Holotype MNHN B-849).

Murenophis saga: Risso 1826:193.

Muraena saga: Costa 1844:10.

Hyoprorus messinensis Kölliker, 1854:102 (original description, Messina). Larva.

Leptocephalus longirostris Kaup, 1856:150 (original description, North Atlantic). Larva.

Nettastoma melanurum Günther, 1870:48 (unjustified emendation).

Nettastoma mendax Facciolà, 1893:147 (original description, Mediterranean).

Nettastoma saga: Facciolà, 1899:31.

Muraenosaurus Güntheri Osorio, 1909:14, pl. 1, Fig. 2–4 (original description, Portugal, holotype MB 2066).

Leptocephalus urosema Lea, 1913:39 (original description, near Azores, two syntypes at Natural History Museum, Bergen). Larva.

Osorina guentheri: Whitley 1951:68.

Not *Nettastoma melanura* Rafinesque of Facciolà 1893:144, 1899:30, Poll 1953:129.

Diagnosis.—Usually five supratemporal pores, SO_5 absent (Fig. 5A). LL pores 43–49. Median vomerine teeth somewhat enlarged (Fig. 6A). Posterior nostril near anterodorsal margin of eye.

Description.—Meristic characters: Total vertebrae ca. 190–210. Branchiostegal rays 9 (1). Pores: LL 43–49 (32); POM 18–21 (27); IO 12–14 (29) + 3 (30); SO 5 (29); 6 (4); ST 3 (28; one specimen had 5).

Morphometric characters: Predorsal 33–40% preanal (31); head 35–42% preanal (31); snout 35–44% head (30); eye 8–11% head (30); upper jaw 51–62% head (29); gill opening 2–8% head (26); interbranchial 13–29% head (17); depth 5–12% head (28).

Dentition (Fig. 6A): Maxillary and mandibular teeth in bands, the inner teeth largest; premaxillary tooth patch short, continuous with maxillary teeth; vomerine tooth patch elongate, reaching level of eye, median teeth usually enlarged somewhat, but not forming a single row.

Osteology: Supraoccipital absent. Upper pharyngeals divided. Epicentral processes on caudal vertebrae.

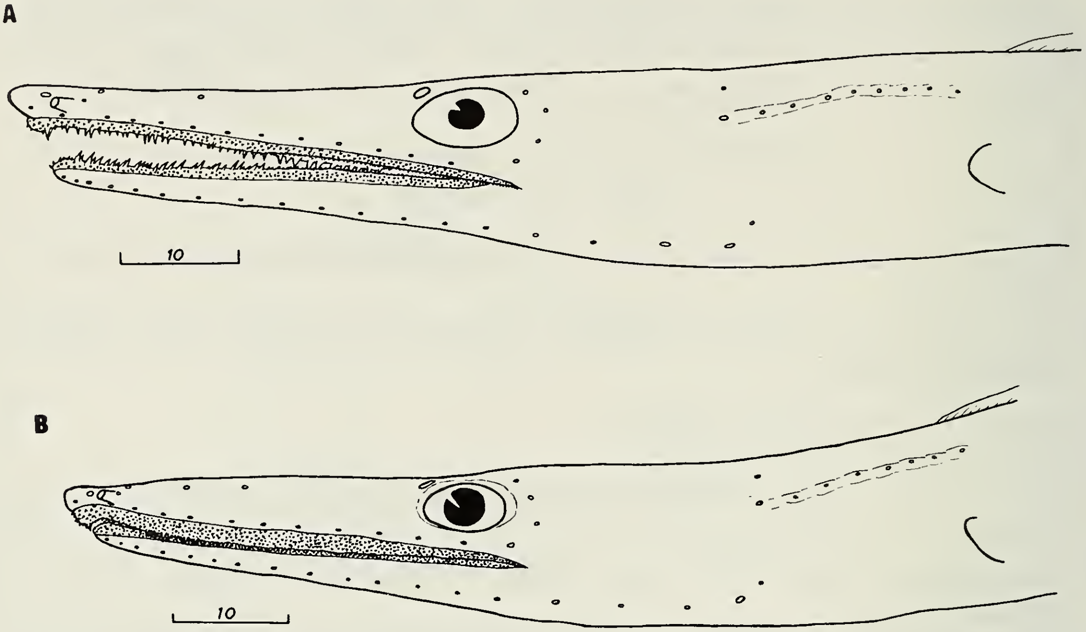

Fig. 5. A, Head of *Nettastoma melanura*, ANSP 117074 (581 mm). Note absence of SO_5 pore. B, Head of *Nettastoma syntresis*, ANSP 114965 (433 mm). Note presence of SO_5 pore. Scales in mm.

Color: In preservative, brown or gray; vertical fins black-edged.

Size: The largest specimen examined was 773 mm TL, 303 mm preanal.

Variation.—The frequency of regenerated tails makes it difficult to obtain complete vertebral counts. The few x-rayed specimens that appeared to be intact yielded counts of slightly over 200. Myomere counts from 15 larvae ranged from 186 to 211.

Of 33 specimens examined, 29 lacked the SO_5 pore. Three specimens had this pore on one side but not the other. One specimen had the pore on both sides, but they were not directly opposite each other. The presence of the SO_5 pore is an anomalous condition in this species.

Despite its wide range, we find no evidence of geographic variation in *Nettastoma melanura.*

Nomenclatural note.—During much of the nineteenth century *Nettastoma melanura* was confused with the other nettastomatid inhabiting the Mediterranean, the species now known as *Facciolella physonema* (Facciolà), which is characterized by the posterior nostril opening through a slit in the upper lip. Facciolà (1893:147) recognized this and concluded that Rafinesque's *Nettastoma melanura* referred to the species with the labial nostril; he proposed *Nettastoma mendax* for the species with the superior nostril. He later (1899) elaborated on this but decided that the species with the superior nostril should be known as *Nettastoma saga* (Risso, 1810). Still later (Facciolà, 1911, 1914) he reversed his opinion and decided that *N. melanura* Rafinesque really referred to the species with the superior nostril.

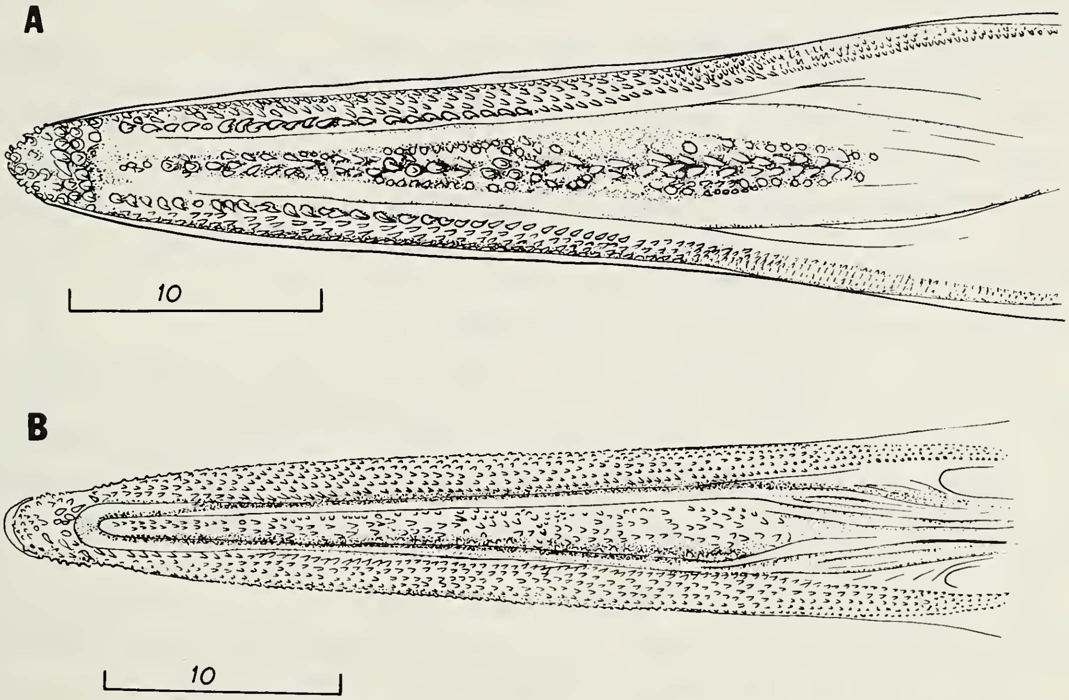

Fig. 6 A, Upper dentition of *Nettastoma melanura,* ANSP 117074 (581 mm), showing enlarged median vomerine teeth. B, Upper dentition of *Nettastoma syntresis,* ANSP 158936 (482 mm). Note median teeth not enlarged. Scales in mm.

This made *N. saga* and *N. mendax* synonyms of *N. melanura* and left the species with the labial nostril without a name. Facciolà (1911:275) gave the generic name *Nettastomella* (preoccupied and later replaced by *Facciolella* Whitley) and later (Facciolà, 1914:47) the specific name *physonema* to the latter. Thus at different times Facciolà used the name *Nettastoma melanura* to refer to two distinct species of eel.

Range.—Widely distributed on both sides of the Atlantic, from the Mediterranean to the Gulf of Guinea and from the northern Gulf of Mexico and east coast of Florida through the Caribbean to the Guianas (Figs. 2, 4). Depth 37–1647 m (mean 730 m). *Nettastoma melanura* appears to be absent from the Santaren and Nicholas Channels, and the Bahamas. It is replaced there by *Nettastoma syntresis* n. sp.

Study material.—GULF OF MEXICO: ANSP 117066 (2:567–660), OREGON 4815, 25°05′N, 96°27′W, 732 m, 12 Apr. 1964. ANSP 117074 (1:581), OREGON 4076, 28°33′N, 86°27′W, 458 m, 3 Dec. 1962. USNM 178997 (2:616, incomplete), OREGON 4149, 29°12′N, 87°48′W, 732 m, 17 Dec. 1962. USNM 179069 (3:440–773), OREGON 4006, 29°03′N, 88°20′W, 641 m, 23 Oct. 1962. USNM 195898 (2:339–544), OREGON 2822, 28°55′N, 87°49′W, 1647 m, 16 July 1960. USNM 198051 (1:666), OREGON 4580, 29°06′N, 88°06′W, 732 m, 11 Dec. 1963.

STRAITS OF FLORIDA: UMML 13212 (1:606), OREGON 4374, 24°21′N, 83°36′W, 732 m, 7 Aug. 1963. UMML 13727 (1:373), OREGON 4373, 24°26′N, 83°31′W, 549 m, 7 Aug. 1963. UMML 15648 (1:473), GERDA 362, 24°10′N, 81°42′W, 631 m, 15 Sept. 1964. USNM 185651 (1:294), SILVER BAY 449, 28°42′N, 79°48′W, 512–576 m, 11 June 1958. USNM 197341 (1:626), SILVER BAY 3516, 24°24′N, 80°00′W, 732–860 m, 9 Nov. 1961.

CARIBBEAN: ANSP 126445 (1:635), OREGON 11231, 8°56′N, 76°53′W, 622 m, 2 Nov. 1970. USNM 198754 (1:727), OREGON 4902, 9°02.4′N, 76°31.5′W, 732 m, 28 May 1964. USNM 219848 (1:780), OREGON 6703, 16°53′N, 61°53′W, 750–842 m, 21 May 1967.

GUIANAS: ANSP 114844 (1:655), OREGON 10800, 7°20′N, 53°04′W, 692 m, 17 Nov. 1969. USNM 158933 (1:482), OREGON 2039, 5°47′N, 52°55′W, 37 m, 11 Nov. 1957. USNM 158934 (1: incomplete), OREGON 2011, 7°46′N, 54°36′W, 732 m, 7 Nov. 1957. USNM 158935 (1:659), OREGON 2030, 7°10′N, 52°55′W, 549 m, 10 Nov. 1957. USNM 185639 (1:606), OREGON, off Surinam, Sept. 1958.

GULF OF GUINEA: UMML 15145 (4:469–555), PILLSBURY 74, 4°20′N, 9°26′W, 732 m, 4 June 1964. UMML 16940 (1:224), PILLSBURY 51, 4°56′N, 5°01′W, 329–494 m, 31 May 1964. UMML 20903 (3:200–420), PILLSBURY 256, 3°45′N, 8°03′E, 408–485 m, 14 May 1965. USNM 198619 (1:337), GERONIMO 199, 1°26.4′W, 8°24′E, 3 Sept. 1963. USNM 198629 (1:406), GERONIMO 2-247-VIII, 4°38′S, 11°01′E, 9 Sept. 1963. USNM 199537 (1:460), GERONIMO 206, 2°00′S, 8°47′E.

MEDITERRANEAN: USNM 49345 (1:602), Nice, France.

Etymology.—Gr. *melan,* black, dark, and Gr. *oura,* tail, referring presumably to the dark edges of the posterior part of the dorsal and anal fins. The correct form of the name would seem to be *melanura* and not the emended form *melanurum,* despite the fact that *Nettastoma* is neuter. The Greek "*oura*" is a feminine noun, and *melanura* could legitimately stand as an appositional noun. There is nothing in the original description to indicate whether Rafinesque intended it as an adjective or a noun. The amended article 30(i) of the International Code of Zoological Nomenclature states clearly that in such cases the name is to be treated as a noun in apposition, hence no justification exists for emending it to *melanurum*.

Nettastoma syntresis, new species, Smith and Böhlke

Holotype.—USNM 219849 (male: 442), SILVER BAY 2458, Santaren Channel, 23°40′N, 79°18′W, 531 m, 5 Nov. 1960.

Diagnosis.—Normally six supraorbital pores, SO_5 present (Fig. 5B). LL pores 38–41. Median vomerine teeth not enlarged (Fig. 6B). Posterior nostril near anterodorsal margin of eye.

Description.—Meristic characters: total vertebrae 201 (1). Branchiostegal rays 7/8 on one paratype (USNM 158936). Pores: LL 38–41 (14); POM 18–19 (5); IO 12–13 + 3 (11); SO 5–7 (16); ST 3 (12).

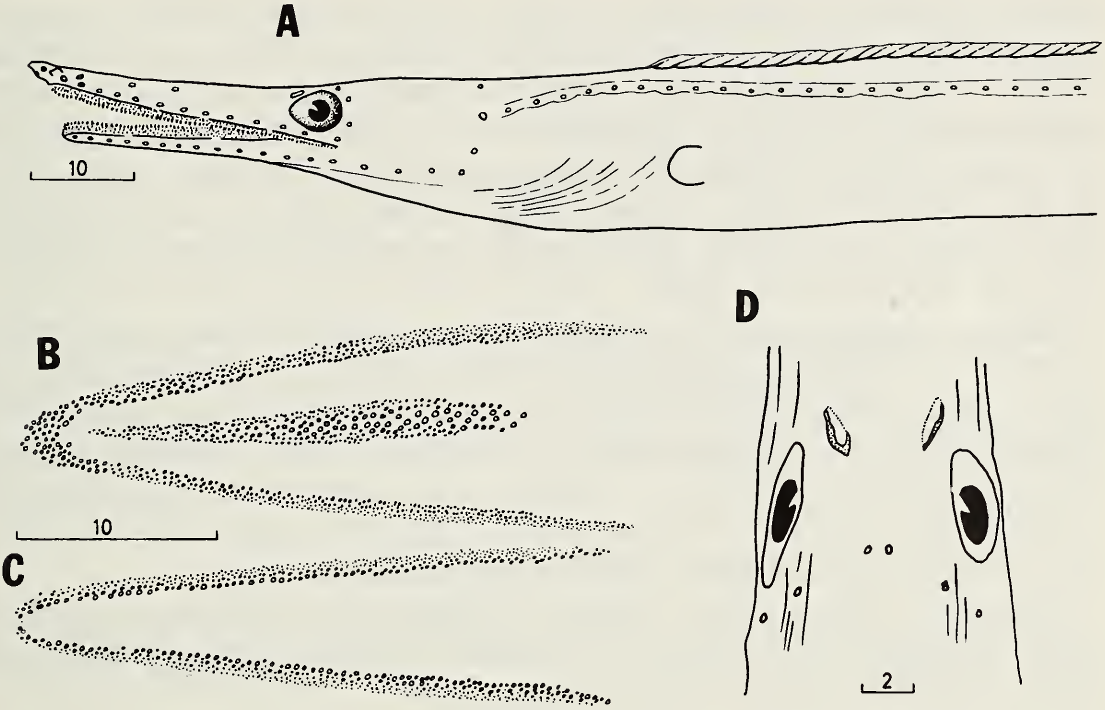

Fig. 7. *Nettastoma solitarium,* holotype (457 mm). A, Head. B, Upper dentition. C, Lower dentition. D, Dorsal view of a portion of head showing posterior nostrils. Scales in mm; a single scale applies to B and C.

Morphometric characters: Preanal 35% TL (1); predorsal 37–41% preanal (13); head 39–43% preanal (13); snout 41–44% head (13); eye 8–11% head (13); upper jaw 57–63% head (12); gill opening 4–7% head (12); interbranchial 10–22% head (9); depth 7–13% preanal (11).

Dentition (Fig. 6B): Maxillary and mandibular teeth in bands, the inner teeth larger; premaxillary tooth patch short, continuous with maxillary teeth; vomerine tooth patch elongate, reaching level of eye, median teeth not enlarged.

Color: In preservative, brown or gray; vertical fins edged in black.

Size: The largest specimen examined was 482 mm TL, 184 mm preanal.

Variation.—Of 16 specimens examined, 12 had six supraorbital pores on both sides. One specimen had six on one side and five on the other. Three specimens had six on one side and seven on the other. In no specimen was the SO_5 pore absent on both sides.

Range.—This species has been collected only in the Santaren Channel (between the Cay Sal Bank and the Great Bahama Bank), the Nicholas Channel (between Cuba and the Cay Sal Bank), and the Northwest Providence Channel, Bahamas. Depth 458–641 m. *Nettastoma syntresis* and *N. melanura* appear to have disjunct distributions (Figs. 2, 4).

Study material.—Paratypes: ANSP 114965 (1:433), 23°25′N, 79°40′W, 458 m, 16 Dec. 1969. UMML 31525 (3:320–409), COLUMBUS ISELIN 137, 26°07′N, 78°34.1′W, 560–591 m, 27 Sept. 1973. USNM 157939 (1: incomplete), OREGON 1341, 22°55′N, 79°16′W, 439 m, 16 July 1955. USNM 158936 (1:482), COMBAT 450, 23°59′N, 79°43′W, 641 m, 24 July 1957. USNM 197127 (2:270–360), SILVER BAY 2469, 23°59′N, 79°17′W, 531–549 m, 7 Nov. 1960. USNM 197342 (1: incomplete), SILVER BAY 2475, 24°48′N, 79°17′W, 549 m, 8 Nov. 1960. USNM 197345 (6:251–453), same data as holotype. USNM 202953 (1:260), SILVER BAY 3514, 23°20′N, 79°27′W, 549 m, 8 Nov. 1961.

Others (relatively poor condition, not designated as paratypes): MCZ 38780 (1: ca. 370, in two pieces), ATLANTIS 2982A, 22°48′N, 78°50′W, 384 m, 11 March 1938. MCZ 38781 (1: 122), ATLANTIS 2987A, 23°22′N, 79°56′W, 521 m, 13 March 1938. MCZ 38803 (1: 298), ATLANTIS 2984, 23°16′N, 79°10′W, 439–458 m, 12 March 1938. MCZ 38811 (1: 179), ATLANTIS 3434, 23°10′N, 79°35′W, 476 m, 1 May 1939. MCZ 38814 (1: 250), ATLANTIS 3438, 23°05.5′N, 79°37′W, 485 m, 2 May 1939.

Etymology.—Gr. *syntresis,* channel, passage, strait, referring to the Santaren, Nicholas, and Northwest Providence Channels, the only places the species has been found. A noun in apposition.

Nettastoma solitarium, new species, Castle and Smith
Figs. 2, 7

Holotype.—MNHN 1979-187 (female: 457), MUSORSTOM Philippines 50, 13°49.2′N, 120°01.8′E to 13°48.2′N, 120°02.5′E, 415–510 m, 25 Mar. 1976.

Diagnosis.—Six supraorbital pores, SO_5 present (Fig. 7A). LL pores 42–45. Median vomerine teeth somewhat enlarged (Fig. 7B). Posterior nostril above anterodorsal corner of eye.

This species is intermediate between *N. melanura* and *N. syntresis* in the number of lateral-line pores. It shares enlarged vomerine teeth with *N. melanura* and the presence of the SO_5 pore with *N. syntresis.*

Description.—Meristic characters: Number of vertebrae unknown. Pores: LL 42–45 (3); POM 19 (3); IO 13 + 3 (3); SO 6 (3); ST 3 (3).

Morphometric characters: Predorsal 35–36% preanal (3); head 37–39% preanal (3); snout 40–41% head (3); eye 9–11% head (3); upper jaw 51–54% head (3); gill opening 6–8% head (3); interbranchial 14–16% head (3); depth 9–11% preanal (3).

Dentition (Fig. 7B, C): Maxillary and mandibular teeth in bands, the inner teeth larger; premaxillary tooth patch short, continuous with maxillary teeth; vomerine tooth patch elongate, reaching level of eye, median teeth somewhat enlarged, but not forming a single row.

Color: In preservative, brown or gray; opercular region darker; vertical fins black-edged to wholly black at tip of caudal region.

Size: The largest specimen was 465 mm TL, 179 mm preanal.

Range.—This species (Fig. 2) has been collected off the Philippine Islands at 415–610 m and off New South Wales, Australia at 502 m, but we know of it also in the western Indian Ocean (C. Karrer, pers. comm.).

Study material.—Paratypes, PHILIPPINES: MNHN 1979-188 (1:465 incomplete), MUSORSTOM Philippines 43, 13°50.5′N, 120°28.0′E to 13° 52.3′N, 120°28.6′E, 484–448 m, 24 Mar. 1976. MNHN 1978-189 (1:405 incomplete), MUSORSTOM Philippines 44, 13°46.9′N, 120°29.5′E to 13°46.2′N, 120°29.8′E, 610–592 m, 24 Mar. 1976.

Paratype, AUSTRALIA: AM I.20301-016 (1:320 incomplete), KAPALA, 29°52′S, 153°42′E to 29°55′S, 153°41′E, 502 m, 23 Aug. 1977.

Etymology.—L. *solitarius,* solitary, alone, lonely, in reference to the isolated and widely scattered distribution of this species in the Indo-Pacific. An adjective.

Nettenchelys Alcock, 1898

Nettenchelys Alcock, 1898:149 (type-species *Nettenchelys taylori* Alcock, 1898, by monotypy).

Description.—Body elongate, round in cross-section, deepest in middle and tapering at both ends. Tail slender and attenuate, tip delicate and easily damaged. Pectoral fin absent. Dorsal fin originates above or slightly behind gill opening. Head moderately elongate, slightly depressed; snout length about 33–37% head length; anterior nostrils tubular, opening laterally just behind tip of snout; posterior nostrils located on top of head or body behind posterior margin of eye, degree of posterior displacement varying greatly among the known species (Fig. 8); tip of snout soft, flexible, extending a short distance in front of premaxillary teeth. Maxillary and mandibular teeth in bands, innermost teeth somewhat enlarged; premaxillary tooth patch short, continuous with maxillary teeth; vomerine tooth patch elongate, reaching about to anterior margin of eye, sometimes several enlarged median teeth anteriorly. Eight or nine infraorbital pores along upper jaw including one in short ascending branch of infraorbital canal immediately behind anterior nostril; five supraorbital pores all well anterior to eye; third supraorbital pore slightly anterior to second infraorbital pore; two or three supratemporal pores. Viscera: stomach pale, posterior end near level of vent; intestine pale. Maximum size probably no more than 550 mm TL.

Discussion.—The species within the genus *Nettenchelys* as defined here fall into two groups. *Nettenchelys pygmaeus* n. sp. and *N. gephyra* n. sp. have an enlarged median series of teeth at the anterior end of the vomer (Figs. 10B, 11B). The posterior nostrils in these species are located on top of the head behind the posterior edge of the eye (Fig. 8A, B). In *N. taylori* Alcock, *N. exorius* n. sp., and *N. inion* n. sp. the anterior vomerine teeth are not enlarged (Fig. 12B) and the posterior nostrils are located at or behind

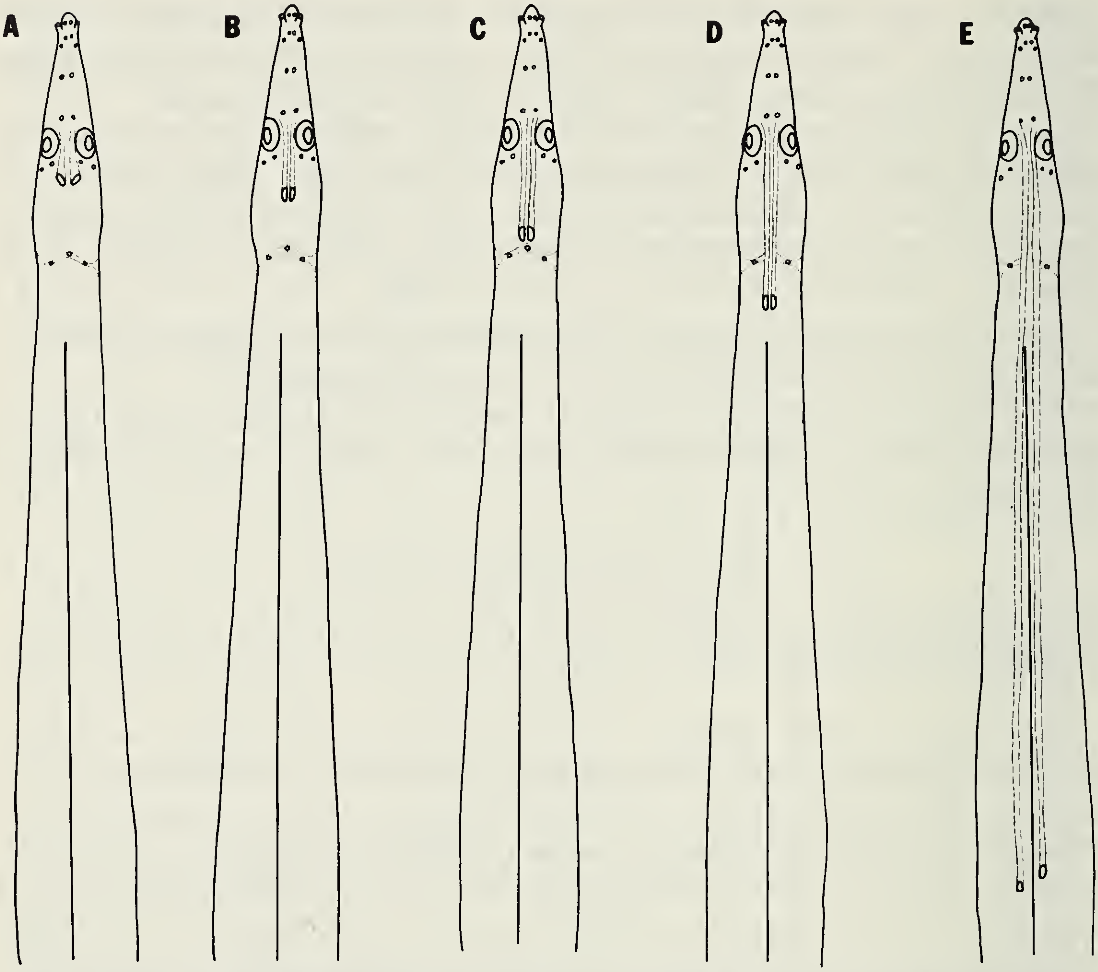

Fig. 8. Semidiagrammatic dorsal view of the five species of *Nettenchelys* showing position of posterior nostrils. A, *N. pygmaeus*. B, *N. gephyra*. C, *N. inion*. D, *N. exorius*. E, *N. taylori*.

the occipital region (Fig. 8C–E). Nevertheless, these two groups are closer to each other than they are to the species of *Nettastoma,* and we feel that this is best expressed by placing them in one genus.

Range.—Western North Atlantic and tropical Indo-Pacific. All of the species are known from very few individuals.

Etymology.—Gr. *netta,* duck, and Gr. *enchelys,* eel. The Greek *enchelys* can apparently be either masculine or feminine. Alcock did not indicate the gender in his description, and it cannot be inferred from the name of the type species. Article 30(a)(i)(2) of the International Code of Zoological Nomenclature dictates that in such circumstances the name is to be considered masculine.

Key to the Species of *Nettenchelys*

1. Anterior vomerine teeth forming an enlarged median series; posterior nostrils on top of head slightly behind eye 2

Fig. 9. Distribution of the three species of *Nettenchelys* in the western North Atlantic.

- Anterior vomerine teeth not enlarged, posterior nostrils at or behind occiput 3
2. Very small, mature at 150–200 mm TL; posterior nostril just behind posterior margin of eye (Western Atlantic) . . . . . . *N. pygmaeus,* n. sp.
- Mature at about 400 mm TL; posterior nostril about midway between posterior margin of eye and occiput (Indo-Pacific) . . . . *N. gephyra,* n. sp.
3. Posterior nostril just in front of supratemporal canal; median supratemporal pore present (western Atlantic) . . . . *N. inion,* n. sp.
- Posterior nostril behind supratemporal canal; median supratemporal pore absent 4
4. Posterior nostril between occiput and dorsal-fin origin (western Atlantic). . . . . *N. exorius,* n. sp.
- Posterior nostril about midway between dorsal-fin origin and anus (Indo-Pacific) . . . . *N. taylori* Alcock

Nettenchelys pygmaeus, new species, Smith and Böhlke

Figs. 8A, 9, 10

Holotype.—ANSP 142277, formerly part of USAIC 03460 (male: 175), Gulf of Mexico, 29°52′N, 87°06.5′W, 128 m, 28 Aug. 1976.

Diagnosis.—Anterior median vomerine teeth enlarged (Fig. 10B). Posterior nostril on top of head just behind posterior margin of eye (Fig. 8A). Mature at 150–200 mm TL.

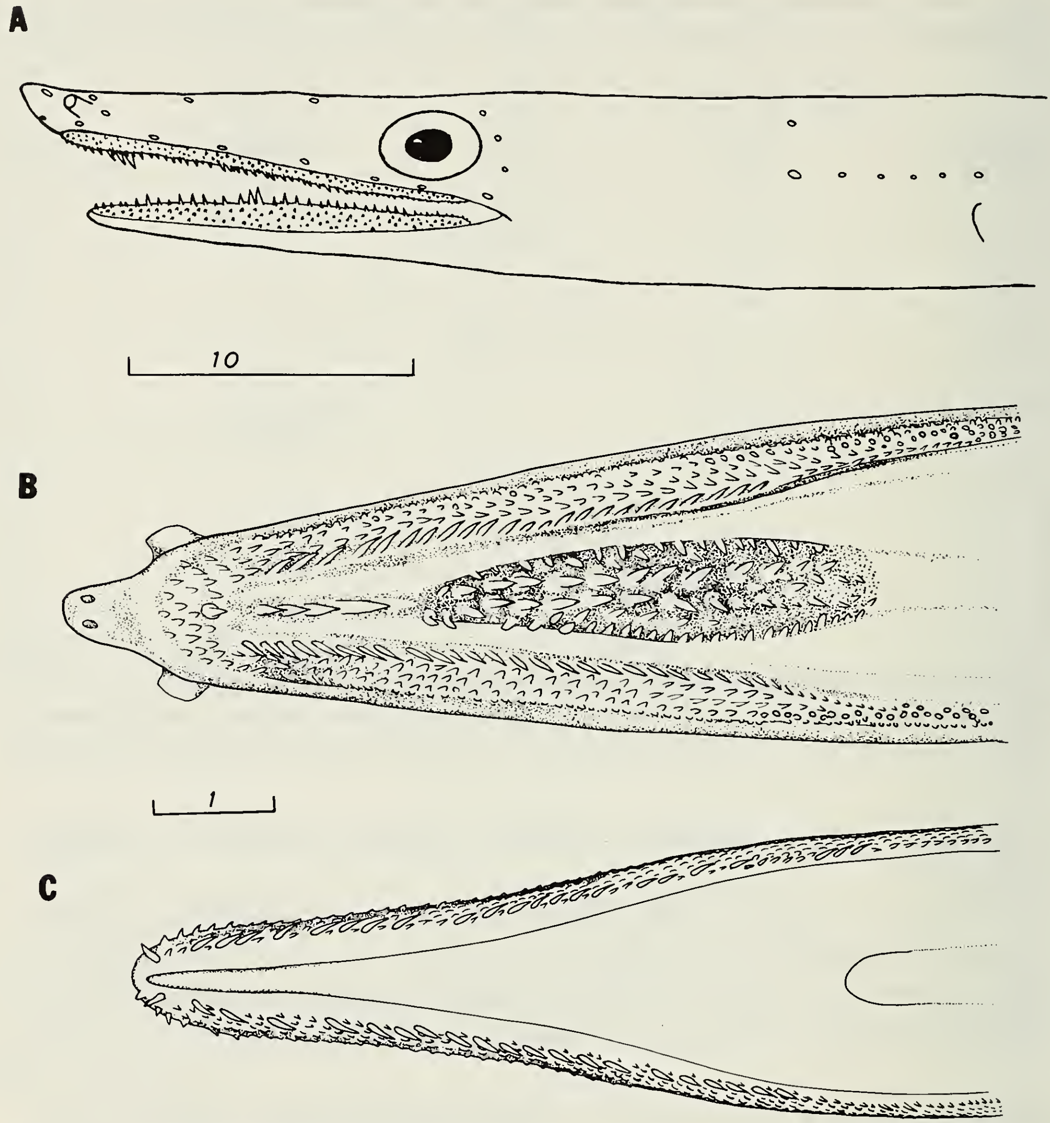

Fig. 10. *Nettenchelys pygmaeus*, ANSP 130812 (167 mm, incomplete). A, Head. B, Upper dentition. C, Lower dentition. Scales in mm; a single scale applies to B and C.

Description.—Meristic characters: Pores: LL ca. 40–42 (2); IO 8 + 3 (3); SO 5 (3); ST 3 (3). Number of vertebrae unknown.

Morphometric characters: Preanal ca. 35–36% TL (4); predorsal 33–35% preanal (4); head 30–33% preanal (4); snout 34–37% head (4); eye 8–10% head (4); upper jaw 53% head (2); gill opening 6–7% head (3); depth 7–8% preanal (4).

Dentition (Fig. 10B, C): Maxillary teeth in bands, teeth of innermost series somewhat enlarged. Mandibular teeth in bands, those of innermost series markedly enlarged. Premaxillary tooth patch short, continuous with maxillary teeth. Vomerine tooth patch elongate, reaching about to level of anterior margin of eye, anteriormost part consisting of a single series of enlarged teeth medially.

Color: In preservative brown, darker above than below. One specimen had a distinct bicolored appearance, dark above and pale below.

Size: This is a dwarf species. The largest specimen measured only 201 mm TL, 71 mm preanal. The smallest specimen, a female 151 mm TL, 54 mm preanal was filled with large eggs. Because of the small size, we were unable to obtain satisfactory radiographs or to count the brachiostegal rays and the POM pores.

Relationships.—This species is closest to *N. gephyra* of the Indo-Pacific, and the differences are discussed under that species.

Range.—Two of the four known specimens came from off western Venezuela, the other two from the northern Gulf of Mexico (Fig. 9). This suggests that the species is probably fairly widely distributed in the western Atlantic. Its small size and relatively deepwater habitat may make it difficult to collect. It would easily slip through the mesh of most nets. Other small eels usually are collected by divers using rotenone, and *Nettenchelys pygmaeus* lives too deep for this. Depth 128–280 m.

Study material.—Paratypes, CARIBBEAN: ANSP 130812 (1: 167 incomplete), PILLSBURY 739, 10°54.7′N, 66°17.8′W, 234–280 m, 23 July 1968. USNM 200779 (1: 151), OREGON 5628, 10°42′N, 67°56′W, 210 m, 28 Sept. 1965.

Paratype, GULF OF MEXICO: USAIC 03460 (1:201), same data as holotype.

Etymology.—From Gr. *pygmaios*: small, dwarf, referring to the small size of the adults. An adjective.

Nettenchelys gephyra, new species, Castle and Smith

Figs. 8B, 11

Holotype.—MNHN 1979-150 (female: 431), Bulari Pass (western reef of New Caledonia), 400 m, 1 April 1978.

Diagnosis.—Anterior median vomerine teeth enlarged (Fig. 11B). Posterior nostril on top of head about midway between posterior margin of eye and occiput (Figs. 8B, 11D). Mature at 430 mm TL.

Description (from holotype).—Meristic characters: Total vertebrae 158 (incomplete). Brachiostegal rays 5 on right side. Pores: LL 44; POM 17; IO 9 + 3; SO 5; ST 3.

Morphometric characters: Preanal ca. 39% TL; predorsal 31% preanal; head 29% preanal; snout 36% head; eye 12% head; upper jaw 51% head; gill opening 6% head; depth 9% preanal.

Dentition (Fig. 11B, C): Maxillary teeth in bands, those of innermost series distinctly enlarged; mandibular teeth in bands, those of innermost series markedly enlarged; premaxillary tooth patch short, continuous with maxillary teeth; vomerine tooth patch elongate, reaching to level of anterior margin of eye, anteriormost part isolated from remainder and consisting of 3 enlarged teeth in a single row.

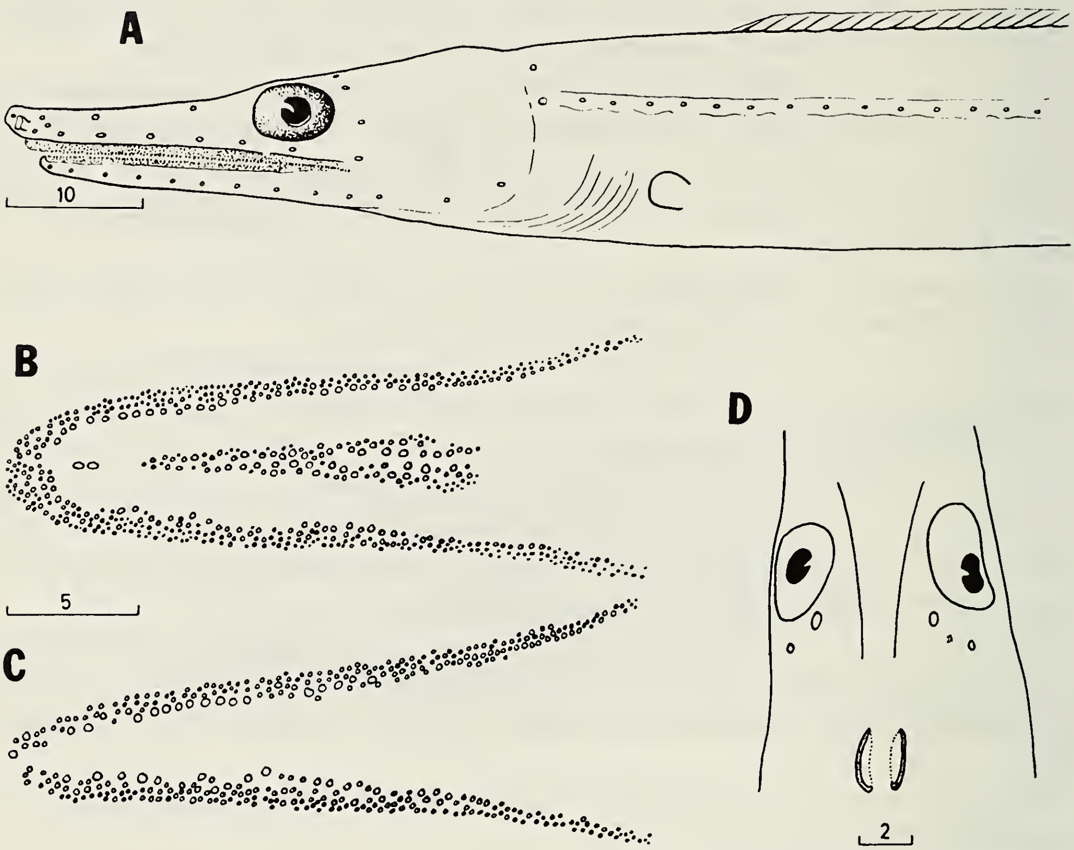

Fig. 11. *Nettenchelys gephyra,* holotype (431 mm). A, Head. B, Upper dentition. C, Lower dentition. D, Dorsal view of a portion of head showing posterior nostrils. Scales in mm; a single scale applies to B and C.

Color: In preservative light brown, darker on head; posterior portions of dorsal and anal fins black.

Size: The holotype, a female of 431 mm TL, 167 mm preanal, had eggs of approx. 0.9 mm diameter. The species probably does not grow much larger.

Relationships.—This species most closely resembles the Atlantic *N. pygmaeus.* The principal differences are the size at maturity and the position of the posterior nostril. Whereas the largest *N. pygmaeus* was 201 mm TL, and another specimen of 151 mm also contained large eggs, the holotype of *N. gephyra* measured 431 mm. The posterior nostril is located more posteriorly in the holotype of *N. gephyra* than in *N. pygmaeus. Nettenchelys gephyra* has slightly more preanal lateral-line pores, one more infraorbital pore, and a slightly lesser upper jaw length than *N. pygmaeus,* but these are based on so few specimens that their significance is uncertain.

The second specimen, USNM 134972, is much smaller, but it is badly damaged and neither the sex nor the state of maturity can be determined. Its dentition is identical to that of the holotype, and its posterior nostril is about a third of the way between the posterior margin of the eye and the occiput. We assume it is *N. gephyra,* although because of its poor condition we do not designate it as a paratype.

Range.—The two specimens were collected off New Caledonia and the Philippines. Depth about 400 m.

Study material.—USNM 134972 (1: 93 incomplete), ALBATROSS D5187, 9°16′45″N, 123°21′15″E, 412 m, 31 March 1908.

Etymology.—Gr. *gephyra,* a bridge, in reference to the link that this species provides between *Nettenchelys pygmaeus* and *Nettenchelys inion,* which has the posterior nostrils farther back. A noun in apposition.

Nettenchelys inion, new species, Smith and Böhlke

Figs. 8C, 9

Holotype.—ANSP 142274 (male: 423), GERDA 242, 25°36′N, 79°21′W, 458–531 m, 30 Jan. 1964.

Diagnosis.—Posterior nostril at occiput, just in front of supratemporal canal (Fig. 8C). Median supratemporal pore present. Anterior vomerine teeth not enlarged. Predorsal 37% preanal, head 38% preanal.

Description (from holotype).—Meristic characters: Vertebrae 210 (complete?). Brachiostegal rays 6 on right side. Pores: LL 41; POM 14; IO 9 + 3; SO 5, ST 3.

Morphometric characters: Predorsal 37% preanal; head 38% preanal; snout 37% head; eye 10% head; upper jaw 55% head; depth 10% preanal.

Dentition: Maxillary teeth in bands, innermost teeth somewhat enlarged. Mandibular teeth in bands, inner teeth enlarged. Premaxillary tooth patch short, continuous with maxillary teeth. Vomerine tooth patch elongate, reaching about to eye, anterior teeth not enlarged.

Color: In preservative brown; vertical fins dark-edged posteriorly.

Size: The only known specimen is 423 mm TL, 127 mm preanal.

Relationships.—The single known specimen most closely resembles *N. exorius* n. sp. The principal difference is the position of the posterior nostril. In *N. inion* the supratemporal canal is unobstructed, and the median pore is present. The holotype of *N. inion* has slightly greater predorsal, head, and snout lengths than any of the four specimens of *N. exorius.* Since the specimens of *N. exorius* include both males and females, these differences cannot be sexual. There is no evidence elsewhere among the Nettastomatidae that the position of the posterior nostril varies greatly within a species, and we conclude that the specimen described here represents a distinct species.

Range.—The single known specimen was collected just south of Bimini at the eastern edge of the Straits of Florida, depth 458–531 m (Fig. 9).

Etymology.—Gr. *inion,* back of head, occiput, referring to the position of the posterior nostril. A noun in apposition.

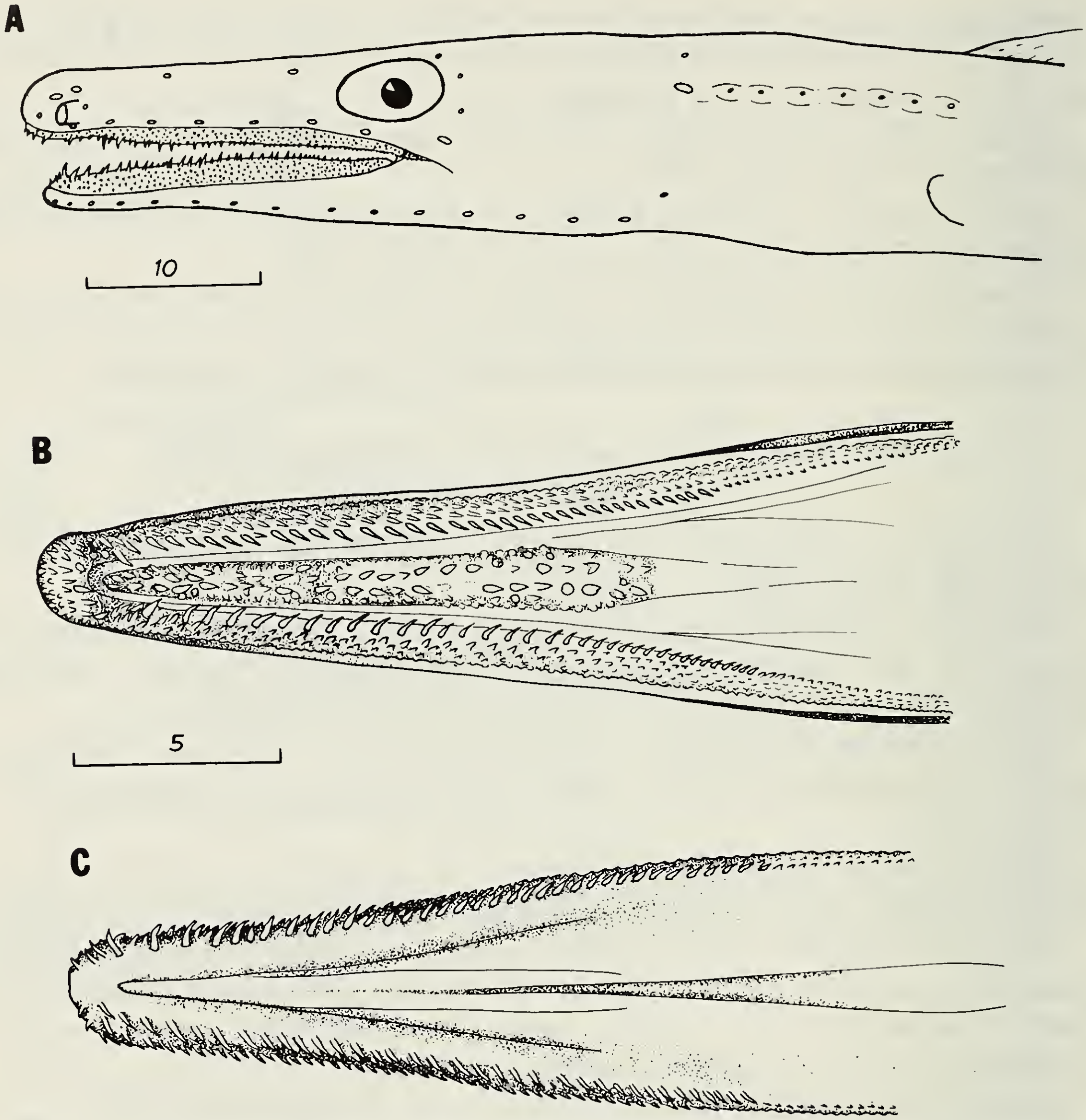

Fig. 12. *Nettenchelys exorius,* ANSP 130813 (429 mm). A, Head. B, Upper dentition. C, Lower dentition. Scales in mm; a single scale applies to B and C.

Nettenchelys exorius, new species, Böhlke and Smith

Figs. 8D, 9, 12

Holotype.—ANSP 142275 (female: 467), SILVER BAY 3685, 29°41′N, 80°11′W, 347 m, 22 Jan. 1962.

Diagnosis.—Posterior nostril behind occiput, between supratemporal canal and dorsal-fin origin (Fig. 8D). Median supratemporal pore absent, apparently obliterated by nasal tube. Anterior vomerine teeth not enlarged (Fig. 12B). Predorsal 32–34% preanal, head 31–34% preanal.

Description.—Meristic characters: Number of vertebrae unknown; all specimens have regenerated tails. Branchiostegal rays 6 on right side in one paratype (ANSP 130813). Pores: LL 40–43 (4); POM 14–16 (3); IO 8–10 + 3 (4); SO 5 (4); ST 2 (4)

Morphometric characters: Predorsal 32–34% preanal (4); head 31–34% preanal (4); snout 34–36% head (4); eye 9–11% head (4); upper jaw 45–51% head (3); gill opening 5–7% head (3); interbranchial 15–19% head (2); depth 8–12% preanal (4).

Dentition (Fig. 12B, C): As in *N. inion.*

Osteology: Supraoccipital absent. Upper pharyngeals divided. First basibranchial ossified, closely articulated with glossohyal. Second basibranchial cartilaginous. Very small epicentral processes on caudal vertebrae.

Color: In preservative, brown; vertical fins dark-edged posteriorly.

Size: The largest specimen was 467 mm TL, 163 mm preanal.

Range.—Three of the four known specimens were collected off the northeast coast of Florida. The fourth came from the junction of the Northwest and Northeast Providence Channels in the Bahamas. Depth 277–494 m.

Study material.—Paratypes: ANSP 130813 (1: 429), OREGON 5745, 29°40′N, 80°03′W, 458 m, 18 Nov. 1965. ANSP 131739 (1: 329), OREGON 11703, 30°28′N, 79°51′N, 494 m, 19 Jan. 1972.

Other: UMML 20867 (1:253—cleared and stained), GERDA 867, 25°52′N, 77°54′W, 277 m, 20 July 1965.

Etymology.—Gr. *exorios,* beyond the frontier, in reference to the posterior nostrils, which have migrated beyond the occiput and are located behind the head. An adjective.

Nettenchelys taylori Alcock, 1898
Fig. 8E

Nettenchelys taylori Alcock, 1898:150 (original description, off the Travancore coast, India, holotype listed below); 1899, pl. 25 (Fig. 5).

Diagnosis.—Posterior nostril far behind occiput, posterior to midpoint between snout tip and anus (Fig. 8E). Median supratemporal pore absent. Anterior vomerine teeth not enlarged. Predorsal 34% preanal, head 33% preanal.

Description.—Meristic characters: Pores: LL 48; POM 15; IO 9 + 3/8 + 3; SO 5; ST 2. Vertebrae: Tail tip regenerated, 48 vertebrae before anal fin.

Morphometric characters: Predorsal 34% preanal; head 33% preanal; snout 33% head; eye 8% head; upper jaw 47% head; gill opening 12% head; interbranchial 15% head; depth at gill opening 8% preanal; depth at anus 10% preanal; snout to posterior nostril 71% of preanal on left side; 68% on right.

Dentition: Maxillary tooth patches irregularly six teeth across at their widest, the teeth of the innermost row moderately enlarged anteriorly but not posteriorly; teeth gradually increasing in size from lateral to medial.

Premaxillary tooth patch irregularly five or six teeth deep (from front to rear) at its broadest, the teeth gradually increasing in size from front to rear; those of posteriormost series enlarged like the anteriormost inner maxillary teeth and, like them, with arrow-shaped tips. Premaxillary and maxillary patches continuous without a space between them.

Vomerine tooth patch twelve rows across at its widest, none of the teeth enlarged, patch terminating posteriorly far short of maxillary and mandibular patches. Teeth largest medially, decreasing in size in both directions laterally. A rather wide separation anteriorly between premaxillary and vomerine patches.

Mandibular tooth patches irregularly about nine teeth across at widest, the teeth increasing in size from outside inward, those of the innermost series moderately enlarged except posteriorly; patches distinctly separated from each other anteriorly. Mandibular patches continue posteriorly to rictus, while maxillary patches extend back beyond that point laterally.

Color: In preservative, brown; vertical fins pale, dusky marginally.

Size: The only known specimen, the holotype, is 533 mm TL. It is a female with eggs.

Range.—The only specimen was collected at a depth of 786 m off the Travancore coast, a region in the State of Kerala at the southwestern tip of India.

Study material.—Holotype: ZSI F 3171/1 (female: 533 incomplete), INVESTIGATOR Sta. 232, 7°17′30″N, 76°54′30″E, 786 m, 19 Oct. 1897.

Etymology.—"Named after Commander A. Dundas Taylor, late Indian Navy, who, in the year 1874 was chiefly instrumental in reviving the Marine Survey of India" (Alcock, 1898:151).

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Literature Cited

Alcock, A. 1898. XXII.—Natural history notes from H. M. Indian Marine Survey Ship 'Investigator,' Commander T. H. Heming, R. N., commanding.—Series II, No. 25. A note on the deep-sea fishes, with descriptions of some new genera and species, including another probably viviparous ophidioid.—Ann. Mag. nat. Hist., (7):136–156.

———. 1899. Illustrations of the zoology of the Royal Indian Marine Survey Ship Investigator, under the command of Commander T. H. Heming, R. N./Fishes.—Part VI, Plates XXV–XXVI. Crustacea.—Part VII, Plates XXXVI–XLV.—Calcutta.

Costa, O. G. 1844. Fauna de Regno di Napoli . . . Pesci, Pt. 1, Fasc. 48–49, Genere Murena; Muraena Thunb. (non Artedi):1–10.

Facciolà, L. 1893. Sull'esistenza di forme di passaggio da alcune specie di leptocefalidi agli adulti corrispondente.—Naturalista Sicil., 12:144–148.

———. 1899. Sull'esistenza di due specie di *Nettastoma* nel Mare di Messina.—Riv. Ital. Sci. Nat., 19(2–3):29–32.

———. 1911. Generi di vertebrati ittioidi del mare di Messina.—Boll. Soc. Zool. Ital., (2)12:268–287.

———. 1914. Su di un nuovo tipo dei Nettastomatidi.—Boll. Soc. Zool. Ital., (3)3:39–47.

Gilbert, C. H. 1905. II. The deep-sea fishes of the Hawaiian Islands. *In*: Jordan, D. S., and B. W. Evermann, The aquatic resources of the Hawaiian Islands.—Bull. U.S. Fish. Commn., 23 (for 1903), Part 2:575–713, pls. 66–101.

Günther, A. 1870. Catalogue of the fishes in the British Museum, 8:xxv + 549 p.

———. 1877. Preliminary notes on new fishes collected in Japan during the expedition of H.M.S. 'Challenger.'—Ann. Mag. nat. Hist., (4)20:433–446.

Jordan, D. S. 1917–1920. The genera of fishes . . . in four parts.—Stanford University, University Series: 576 pp. (+ total of 55 pp. variously paged in Roman numerals). [Part I, 1917, pp. 1–161; Part II, 1919, pp. 163–284; Part III, 1919, pp. 285–410; Part IV, 1920, pp. 411–576].

Kaup, J. J. 1856. Catalogue of apodal fish, in the collection of the British Museum.—London: British Museum, viii + 163 p., 19 pls.

Kölliker, A. 1854. Weitere Bemerkungen über die Helmichthyiden.—Verh. Phys.-med. Ges. Würzb., 4:100–102 (A. Kölliker in this paper although given as Rudolph Albert von Kölliker in Dean's *Bibliography of Fishes*).

Kotthaus, A. 1968. Fische des Indischen Ozeans. Ergebnisse der ichthyologischen untersuchungen . . . "Meteor" . . . A. Systematischer Teil, III, Ostariophysi und Apodes.—Meteor Forsch. (D) 3:14–56.

Lea, E. 1913. Muraenoid larvae from the "Michael Sars" North Atlantic deepsea expedition 1910.—Rep. sci. Res. "Michael Sars" N. Atl. Deep Sea Exped. 1910, 3 (1), Zoology:1–59, 6 pls.

Osorio, B. 1909. Contribuição para o conhecimento da fauna bathypelagica visinha das costas de Portugal/Prefacio.—Mems. Mus. Bocage, 1:1–35, 3 pls.

Poll, M. 1953. Poissons: Téléostéens malacoptérygiens.—Res. sci. Exped. océanogr. belg. eaux côt. afr. Atl. Sud., 4(2)3:258 p., 104 figs., 8 pl.

Rafinesque, C. S. 1810. Caratteri di alcuni nuovi generi e nuove specie di animali e piante della Sicilia, con varie osservazioni sopra i medisimi.—Palermo: 105 p., 20 pls.

Risso, A. 1810. Ichthyologie de Nice, ou histoire naturelle des poissons du département des Alpes maritimes.—Paris, Schoell: xxxvi + 388 p.

———. 1826. Histoire naturelle des principales productions de l'Europe méridionale et particulièrement de celles des environs de Nice et des Alpes maritimes. Vol. 3.—Paris and Strasbourg: xvi + 480 p., 16 pls.

Seeley, H. G. 1874. On *Muraenosaurus Leedsii,* a plesiosaurian from the Oxford clay.—Quart. J. Geol. Soc. Lond., 13(21):197–208, pl. 21.

Smith, D. G. 1979. A guide to the leptocephali (Elopiformes, Anguilliformes, and Notacanthiformes).—NOAA tech. Rep. nat. mar. Fish. Serv. Fish. Circ. 424: iv + 39 pp.

———. and R. H. Kanazawa. 1977. Eight new species and a new genus of congrid eels from the western North Atlantic with redescriptions of *Ariosoma analis, Hildebrandia guppyi* and *Rhechias vicinalis.*—Bull. mar. Sci. 27(3):530–543.

Whitley, G. P. 1951. New fish names and records.—Proc. R. Zool. Soc. N.S.W., 1949–50:61–68.

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94(2), 1981, pp. 561–563

A NEW GONIASTERID SEASTAR, *EVOPLOSOMA SCORPIO* (ECHINODERMATA: ASTEROIDEA), FROM THE NORTHEASTERN ATLANTIC

Maureen E. Downey

Abstract.—*Evoplosoma scorpio,* a new species of starfish (Family Goniasteridae) from the western approaches to the English Channel, is described. It is chiefly characterized by its complete covering of irregular granules and acute, conical spines, and by tall, spatulate, denticulate pedicellariae.

A new goniasterid starfish collected by the *Sarsia* in the western approaches to the English Channel (48°N, 10°W) in ca. 1600 meters represents a genus hitherto unknown from the Atlantic. Of the two species previously described in this genus, *Evoplosoma forcipifera* Fisher (1906) is known from Hawaii, and *E. augusti* (Koehler (1909) from the Indian Ocean.

The genus *Evoplosoma,* described by Fisher in 1906, belongs to the subfamily Hippasteriinae, of the family Goniasteridae. The other Atlantic genus in this subfamily, *Hippasteria,* is abundant north of ca. 40° in both the eastern and western Atlantic.

Evoplosoma scorpio, new species
Fig. 1

Holotype.—Deposited in the British Museum (Natural History).

Type locality.—*Sarsia* Station 2/19, 48°28.6′N, 10°20.1′W, in western approaches, west of English Channel and south of Ireland; 1600 m.

Description.—Disc pentagonal, inflated; arms 5, long, narrow, cylindrical; abactinal plates small, irregularly circular, flat, of varying sizes, completely covered by irregular, tumid granules (usually with 1 or more tiny conical "pimples") and bearing each 1–2 short, acute, conical spines, often accompanied by a small feliped pedicellaria; granules covered with thin skin; abactinal disc surface larger than actinal surface, marginals not visible from above; marginal plates corresponding throughout length of arm, moderate, broader than long, rectangular, covered with granules and bearing 1–5 conical spines slightly longer than those on abactinal plates; actinal areas rather small, with ca. 6 rows of actinal plates, row adjacent to adambulacrals extending more than halfway out arm; actinal plates irregularly polygonal, armed as abactinals but with larger, more abudant pedicellariae; adambulacral plates more or less square, furrow margin straight or slightly curved,

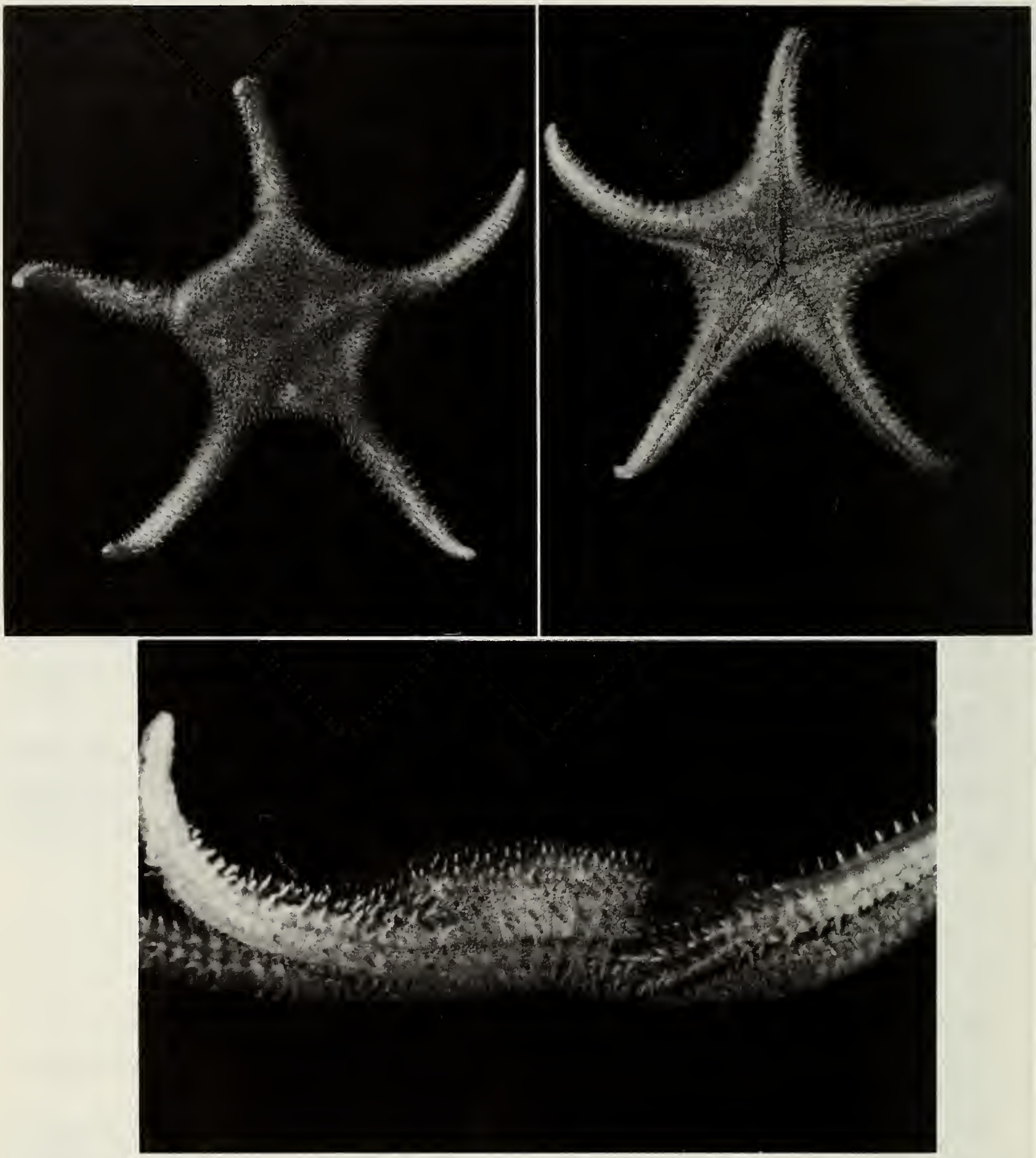

Fig. 1. *Evoplosoma scorpio,* abactinal, actinal, and lateral views.

bearing 5–6 stout, blunt furrow spines, somewhat flattened laterally; behind furrow spines, 1 large conical subambulacral spine, 1 pedicellaria, several granules; mouth plates large, rhomboid, bearing ca. 5 large, sturdy, flattened oral spines on each half, first spine largest, and ca. 2 rows of angular granules on either side of furrow; pedicellariae taller than broad, spatulate, felipedal, bearing blunt, spaced teeth across apex and down each side of valves; madreporite ordinary, of moderate size, closer to margin of disc than center. R = 110 mm, r = 33 mm, height of disc = 20 mm, number of superomarginals = 33.

Color.—Bright orange-red, center of disc paler, madreporite white.

Etymology.—Named for the constellation Scorpio.

Discussion.—The form of this species is exactly that of *Evoplosoma forcipiferum* Fisher, from Hawaii, with an abrupt demarcation between the pentagonal disc and the narrow arms. It differs from that species in having a much thinner, less conspicuous membrane, in having fairly uniform abactinal spines (not "spines and spinelets," as Fisher describes *E. forcipifera*), and the adambulacral spines are straight, slightly flattened, of the ordinary goniasterid type, not "remarkably thin and compressed . . . with expanded chisel-like tips" as in *E. forcipifera.* The marginal plates, though not large, are quite distinct, the opposite being true for *E. forcipifera.* There are twice as many superomarginal plates in *E. scorpio,* but this may be due to the difference in size. The valves of the pedicellariae, somewhat fluted and with irregular denticulation in Fisher's species, are much smoother and more regular in *E. scorpio.* The actinal interradial areas are smaller, but the first row of actinal plates extends further out on the arm in *E. scorpio* than in *E. forcipifera.*

Evoplosoma augusti Koehler, from the Indian Ocean, differs in form from the other two species, being of the more conventional stellate shape, without the inflated disc; Koehler says (1909:96): "edge of disc notably thinner than center." The abactinal plates bear fat tubercles, rather than conical spines, and there is a bare space between the tubercles and the surrounding granules. As in *E. forcipifera,* the actinal areas are larger than in *E. scorpio. Evoplosoma augusti* has ca. 8 truncate, lamelliform adambulacral spines; the pedicellariae are exactly like those of *E. forcipifera.* The peculiar body form of *Evoplosoma scorpio* is also not uncommon in north Atlantic specimens of *Hippasteria phrygiana,* to which the genus *Evoplosoma* is closely related.

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Literature Cited

Fisher, W. K. 1906. The starfishes of the Hawaiian Islands.—Bull. U.S. Fish Comm. 1903, 23(3):987–1130, pls. 1–49.

Koehler, R. 1909. Astéries recueillies par l'Investigator dan l'Ocean Indien. I. Les Astéries de Mer profonde.—Calcutta: Indian Museum, Pp. 5–143, pls. I–XIII.

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A REDESCRIPTION OF *TUBIFICOIDES HETEROCHAETUS* (MICHAELSEN) (OLIGOCHAETA: TUBIFICIDAE)

H. R. Baker

Abstract.—*Tubificoides heterochaetus* (Michaelsen, 1926) (Oligochaeta: Tubificidae) is redescribed from type-material and is compared to new material of this species from North Carolina. Oversights in the original description and recent literature are corrected.

Access to one of the syntypes of *Tubificoides heterochaetus* (originally described as *Limnodrilus heterochaetus* Michaelsen, 1926), and to mature material of this species from North Carolina has necessitated a redescription as the original description and recent literature have been found to be lacking in some respects.

This species is now seen to possess a thin but distinct penis sheath and both bifid and simple-pointed setae posteriorly.

The syntype described here is accorded lectotype status.

Methods and Materials

One of the syntypes of *Limnodrilus heterochaetus* Michaelsen, 1926 was loaned to Dr. R. O. Brinkhurst, courtesy of Dr. M. Dzwillo, Zoologisches Institut and Zoologisches Museum (ZIZM), Universität Hamburg, W. Germany. Mr. Brian Woodard sent several specimens of *T. heterochaetus* from North Carolina for identification. All material was stained in paracarmine and mounted whole in Canada Balsam. Some of the North Carolina material has been deposited in the Smithsonian Institution, United States National Museum of Natural History (USNM), Washington, D.C.

Systematic Description

Tubificoides heterochaetus (Michaelsen, 1926)
Figs. 1, 2

Limnodrilus heterochaetus Michaelsen, 1926:22, fig. A (a–d); 1927:17, fig. 19.

Limnodrilus heterochaetus Michaelsen.—Bülow, 1957:99.—Popescu-Marinescu et al., 1966:1963.

Peloscolex heterochaetus (Michaelsen).—Marcus, 1942:156.—Marcus, 1950:4.—Cekanovskaya, 1962:279, figs. 176, 177.—Brinkhurst, 1963a:44,

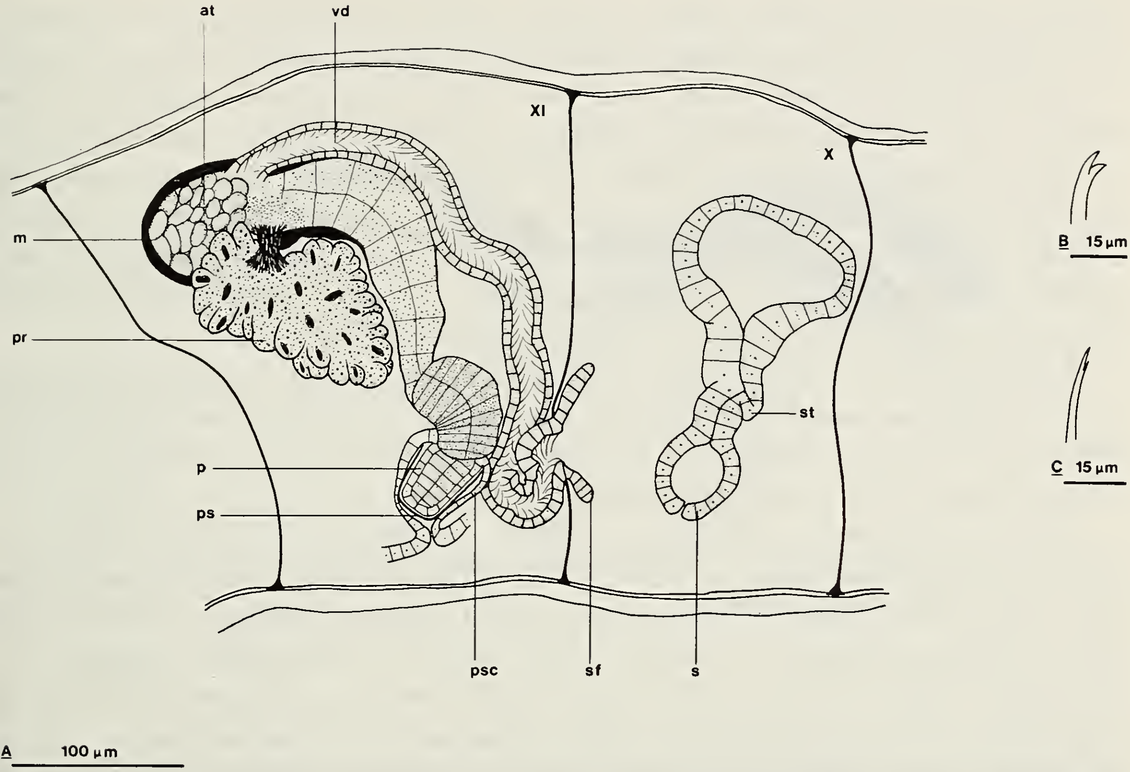

Fig. 1. *Tubificoides heterochaetus*: A, Male duct and spermatheca of lectotype, notation as in description, penis sheath thickened slightly to show form; B, Dorsal anterior bifid seta; C, Dorsal posterior bifid seta.

fig. 31; 1963b:713.—Hrabé, 1964:109.—Brinkhurst and Jamieson, 1971:521, figs. 8, 14 (G–I).

Tubificoides heterochaetus (Michaelsen).—Brinkhurst and Baker, 1979:1556.

Description (lectotype).—Length 5.1 mm, width at X 380 μm (in fixed, slightly compressed specimen), 29 segments (incomplete). Prostomium shorter than broad at peristomium, conical. Clitellum weak over ½X–½XII. Body wall slightly papillate posteriorly with foreign material adhering. Segments II–VIII short, segment IX longer, gut enlarged in IX.

Anteriorly 4, 5 bifid setae per bundle, upper tooth about as long and thick as lower (Fig. 1B); 1, 2 setae per bundle posteriorly, one ventral bundle of X with 1 seta (other side missing seta), no ventral setae in XI. No modified genital setae. From XIV–XV posteriorly ventral setae sharply simple-pointed; some (all?) posterior dorsal bundles with bifid and simple-pointed setae, bifid setae with upper tooth longer and much thicker than the very thin lower tooth (Fig. 1C). Male and spermathecal pores in setal line, spermathecal pores open anterior to ventral setae of X.

Male genitalia (all structures paired) (Fig. 1A): sperm funnel (sf) moderate in size, vas deferens (vd) 35.5 μm wide behind sperm funnel narrowing to 16.9 μm just before entry into atrium (at); vas deferens about as long as atrium with wide ciliated lumen. Atrium with enlarged muscular (m) head, vas deferens and prostrate (pr) enter nearly opposite each other just below swollen head; prostate small, stalked. Atrium apparently tripartite with swollen head being composed of large (vacuolated?) cells, middle tubular portion composed of large granular cells, lower (distal) portion composed of small granular cells. Atrium narrows basally and then widens just before joining penial bulb. Atrium terminates in true penis (p) with thin cuticular sheath; penis sheath (ps) short (46 μm long) and wide (approx. 36 μm wide at base), slightly cone shaped, in short penial sac (psc).

Spermathecae (s) short (Fig. 1A) (approx. 200 μm in length) with thick walled ampullae and distinct ducts (approx. 35 μm wide), sperm traps (st) apparently present; basal end of duct bulbous (46 μm in diameter) with distinct lumen. No spermatozeugmata observed.

Material examined.—ZIZM cat. V9920. Lectotype of *T. heterochaetus*, whole mounted specimen.—USNM 62805, 62806, 2 whole mounted specimens from Cape Fear River (32 miles from coast), North Carolina. Sample from 25 ft, locality estuarine, medium sands with silt and organic detritus. B. Woodard coll., 28 Feb. 1980. Found with *Dero* sp., *Paranais* sp., *Nais communis, Nais variabilis* (all naidid oligochaetes), *Scolecolepides viridis* (a spionid polychaete) (B. Woodard, pers. comm.).—Baker collection, 5 whole mounted specimens, locality and collector as for USNM specimens.—Woodard collection, 3 whole mounted specimens, locality and collector as for USNM specimens.

Distribution.—Europe, North Carolina, Virginia, U.S.A.

Discussion

The description of *Tubificoides heterochaetus* given here differs from the original (Michaelsen, 1926) in one important respect. In the original description the dorsal posterior setae were described as being sharply simple pointed. The lectotype of *T. heterochaetus* has some posterior dorsal setae which are clearly bifid (Fig. 1C). The lower tooth of these setae is very thin, rather short, and is not visible if the setae are not properly oriented.

Some of the recent literature (Brinkhurst and Jamieson, 1971; Brinkhurst and Baker, 1979) reported *T. heterochaetus* to be without a penis sheath. Although Michaelsen (1926:27, 28) did recognize that *T. heterochaetus* had a slightly thickened cuticular penis sheath he felt that it was not thick or stiff enough to be called a true penis sheath. *T. heterochaetus* is recognized here as possessing a true penis sheath.

The specimens of *T. heterochaetus* from North Carolina agree for the most part with the above description. These specimens reach a maximum length of 9 mm with up to 31 segments. There may be up to 3 setae per bundle posteriorly. Sperm traps (*sensu* Brinkhurst and Baker, 1979) are

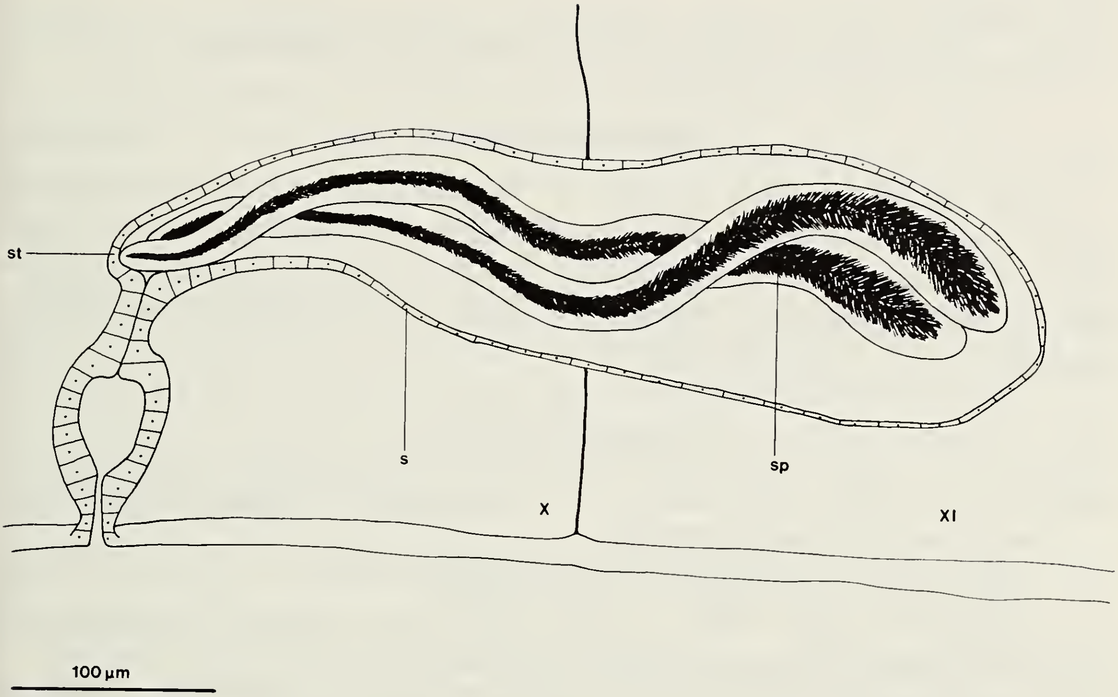

Fig. 2. *Tubificoides heterochaetus*: Spermathecae of a North Carolina specimen, notation as in description, sperm trap clearly present, basal portion of spermathecal duct bulbous with distinct lumen.

present in the North Carolina specimens (Fig. 2). As the lectotype had not yet mated (shown by lack of spermatozeugmata in the spermathecae) this feature was not as apparent. The spermatozeugmata (sp) in the North Carolina *heterochaetus* are elongate in shape (Fig. 2). One or both of the spermathecal ampullae often penetrate the sperm sac into XI. In most of the North Carolina *heterochaetus* there is 1 seta present per ventral bundle of X.

In the North Carolina specimens the atrial muscle layer below the head of the atria does not thin out as fast and remains slightly thicker than does the muscle layer in the lectotype (Fig. 1A). This may be due to different fixing procedures in the material from the two locations.

The North Carolina *heterochaetus* also have bifid dorsal setae posteriorly which are of the same form as those of the lectotype. This is a very unusual characteristic in the Tubificinae as the upper tooth is usually the tooth which undergoes reduction. The presence of this feature in both the lectotype and the North Carolina *heterochaetus* is a very strong indication that the North Carolina material is indeed *T. heterochaetus*. Many of these dorsal posterior bundles consist of 1 bifid seta with the other setae being sharply simple-pointed setae.

The North Carolina *heterochaetus* are similar to the lectotype in their degree of papillation.

All members of the genus *Tubificoides* (*sensu* Brinkhurst and Baker, 1979) are now known to possess a penis sheath of some form.

Acknowledgments

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Literature Cited

Brinkhurst, R. O. 1963a. Taxonomical studies on the Tubificidae (Annelida, Oligochaeta).—Int. Revue Ges. Hydrobiol. 48:7–89.

———. 1963b. Notes on the brackish-water and marine species of Tubificidae (Annelida, Oligochaeta).—J. Mar. Biol. Ass. U.K. 43:709–715.

———, and H. R. Baker. 1979. A review of the marine Tubificidae (Oligochaeta) of North America.—Canadian J. Zool. 57:1553–1569.

———, and B. G. M. Jamieson. 1971. Aquatic Oligochaeta of the World.—Oliver and Boyd, Edinburgh. 860 pp.

Bülow, T. 1955. Oligochaeten aus den Endgebieten der Schlei.—Kieler Meeresforsch. 11:253–263.

Cekanovskaya, O. V. 1962. The aquatic Oligochaete fauna of the USSR.—Opred. Faune SSSR 78:1–411. [in Russian]

Hrabé, S. 1964. On *Peloscolex svirenkoi* (Jaroschenko) and some other species of the genus *Peloscolex*.—Spisy Prír. Fac. Univ. Brne 450:101–112.

Marcus, Ernesto. 1942. Sôbre algumas Tubificidae do Brasil.—Bolm. Fac. Filos. Cienc. Univ. São Paulo 25:153–228.

Marcus, Eveline du B.-R. 1950. A marine tubificid from Brazil.—Commun. Zool. Mus. Hist. Nat. Montevideo 3(59):1–8.

Michaelsen, W. 1926. Oligochaeten aus dem Ryck bei Greifswald und von benachbarten Meeresgebieten.—Mitt. Hamb. Zool. Mus. Inst. 42:21–29.

———. 1927. Clitellata: Oligochaeta.—*In:* Grimpe and Wagler, Die Tierwelt der Nord- und Ostsee (chap. VI c:1–44), Leipzig.

Popescu-Marinescu, V., F. Botae, and G. Brezeanu. 1966. Untersuchungen über die Oligochaeten im rümanischen Sektor des Donaubassins.—Arch. Hydrobiol. Suppl. 30:161–179.

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THE GENERIC STATUS AND DISTRIBUTION OF *MONODELLA TEXANA* MAGUIRE, THE ONLY KNOWN NORTH AMERICAN THERMOSBAENACEAN

Jan H. Stock and Glenn Longley

Abstract.—Although the original description of *Monodella texana* Maguire, 1965, attributes several peculiar features, notably in the maxillipeds, to the sole North American representative of the Thermosbaenacea, a reexamination of material from the San Marcos area (Texas) revealed a close morphological similarity to European and West Indian taxa of *Monodella,* with which it clearly is congeneric.

Maguire's (1964, 1965) discovery of the first thermosbaenacean outside the Mediterranean area awoke considerable interest by biogeographers and stygobiologists. Maguire attributed his material without comments to the genus *Monodella,* at that time only known from groundwaters in Italy, Yugoslavia, and Israel. Presently, the genus is known also from Spain, the Balearic Islands, France, and Greece, and outside the Mediterranean area from the British and U.S. Virgin Islands, Culebra (E. of Puerto Rico), Haiti, Cuba (references in Stock, 1976, and Stock, in press), Puerto Rico (unpublished personal observations) and Somalia (Messana, 1979).

In the years following the description of the Texan thermosbaenacean, but preceding the discovery of extra-Mediterranean taxa, several carcinologists wondered whether Maguire had been right in considering the New World taxon congeneric with the Old World species. When Stock (1976) described a second New World species, found in St. Croix (U.S. Virgin Islands), it became clear that true *Monodella*s existed outside the Mediterranean, but at the same time doubt was cast on the correctness of Maguire's morphological observations. According to the original description, the Texan *Monodella* had a 2-segmented mandibular palp (versus 3-segmented in the other species), was devoid of endo- and exopodites on the 2nd maxilla (versus present), and fused coxo- and basipodal endites in the maxilliped (versus separate), and lacked maxillipedal epipodites (versus present). The most conspicuous difference between Maguire's description of *M. texana* and the other members of *Monodella* was the alleged presence, in the female, of a 2-segmented maxillipedal endopodite, whereas the normal female condition is characterized by the absence (or reduction to a vestigial setule) of an endopodite. The male maxillipedal exopodite of *M. texana* was described as 4-segmented, whereas 2-segmented is the normal situation.

None of these differences materialized in a new study based on 15 specimens from an artesian well in San Marcos, Hays County, Texas, not far from the type-locality. Since the original description obviously is wanting, and since the accompanying illustrations are on much too small a scale to make recognition of details possible, *Monodella texana* is completely redescribed in the sequel.

The artesian well from which the present specimens came is at an old Federal Fish Hatchery, deeded to the Southwest Texas State University as an Aquatic Station in 1964. It derives its water and very interesting hypogean fauna from the underlying Edwards Aquifer. More details and an illustration of the artesian well can be found in the recent paper on the Amphipoda of the well (Holsinger and Longley, 1980).

The specimens have been collected by the junior author and his team at the Edwards Aquifer Research and Data Center, Southwest Texas State University, San Marcos, Texas. The senior author is indebted to Dr. John R. Holsinger, Old Dominion University, Norfolk, Virginia, for bringing the existence of freshly collected material to his notice.

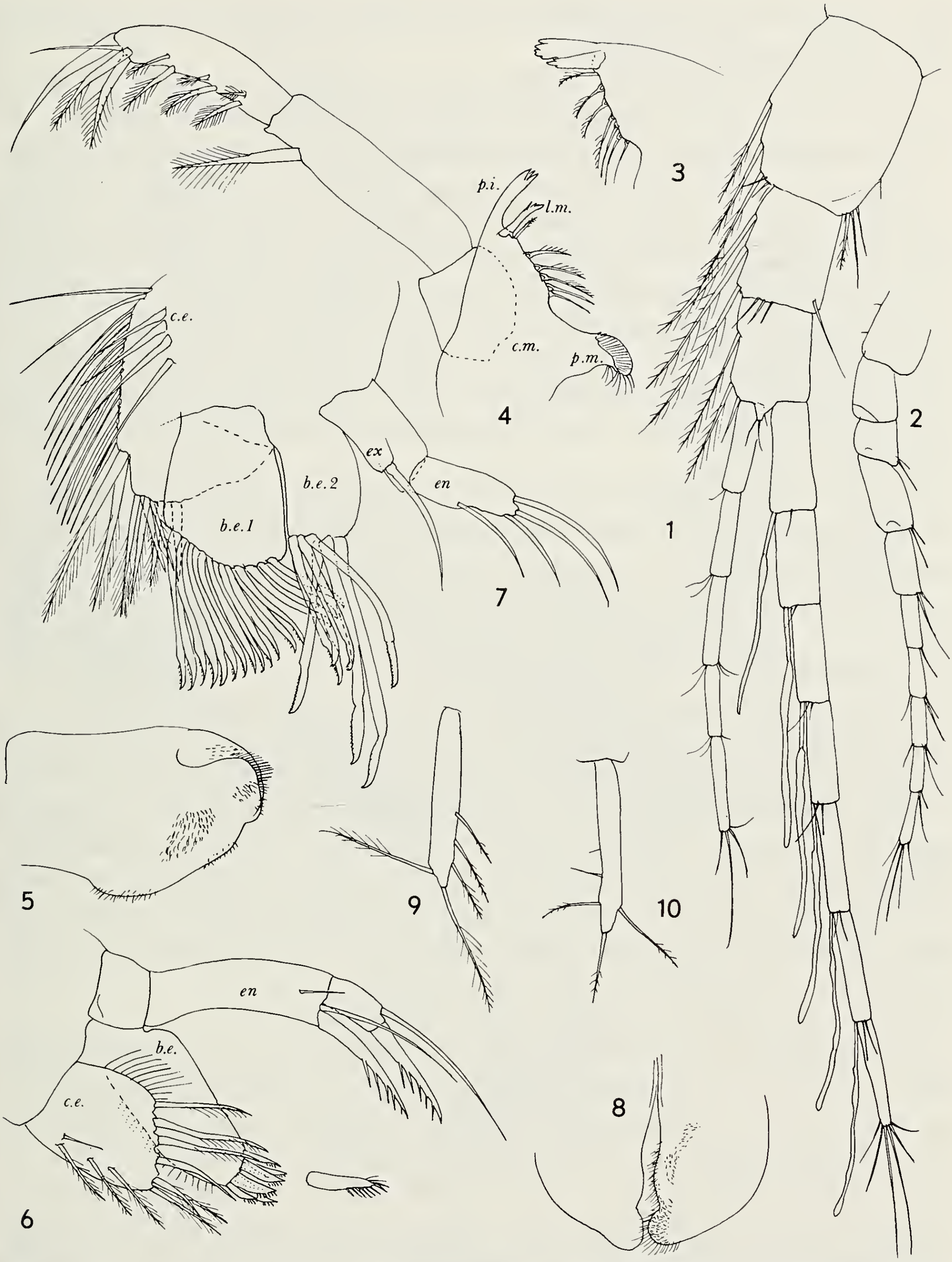
Monodella texana Maguire, 1965

Monodella: Maguire, 1964:931–932, fig. 1.
Monodella texana Maguire, 1965:149–154, figs. 1–3, pl. III; Karnei, 1978:38, fig. 15.
Monadella (lapsus calami) *texana:* Longley, 1978:23.

Body length 1.6–2.0 mm (♂) or 1.7–2.2 (♀). Females differ in external morphology from males in only a few characters: (1) the maxilliped is devoid of an endopod; (2) a penis on pereiopod 7 is absent; (3) the proximal flagellum segments of the first antenna are devoid of aesthetes; (4) in certain phases of life, a dorsal brood pouch is present.

The animal is similar in body shape to other members of the genus *Monodella* and its appendages are remarkably similar to those of the only other Eastern Hemisphere species named so far, *M. sanctaecrucis* Stock, 1976. In the following description, *M. texana* will be compared with *M. sanctaecrucis*.

The first antenna (Fig. 1) has a 3-segmented peduncle (protopodite) and 2 flagellae; the main flagellum (exopodite) is 7- to 8-segmented, the accessory flagellum (endopodite) is about ⅔ the length of the main flagellum and consists of 5 segments. All segments of the main flagellum in ♂ bear very long, stalked, aesthetes; in ♀ the proximal flagellum segments are devoid of aesthetes. The peduncle segments in *M. texana* are only slightly longer than wide (versus at least twice as long as wide in *M. sanctaecrucis*). The peduncle is armed with several long, plumose setae and some short, naked



Figs. 1–10. *Monodella texana*: 1, First antenna, ♂ (scale AB); 2, Second antenna, ♂ (AB); 3, Left corpus manibulae, ♀ (AC); 4, Right mandible, ♀ (AC); 5, Paragnath, ♀ (AC); 6, First maxilla, ♂ (AD); 7, Second maxilla, ♂ (AD); 8, Labium, ♀ (AC); 9, First pleopod, ♂ (AB); 10, Second pleopod, ♀ (AB). (For scales see Figs. 11–15.) *b.e.* = basipodal endite, *b.e.1, b.e. 2* = first and second basipodal endite; *c.e.* = coxopodal endite; *c.m.* = corpus mandibulae; *en* = endopodite; *ex* = exopodite; *l.m.* = lacinia mobilis; *p.i.* = pars incisiva; *p.m.* = pars molaris.

setae. The third peduncle segment bears a distal, triangular process armed with 3 short setules.

The second antenna of *M. texana* (Fig. 2) is similar to that of *M. sanctaecrucis*. It consists of 5 peduncle segments and 5 flagellum segments.

The mandible consists of a corpus mandibulae and 3-segmented palp (Fig. 4). Palp segment 1 is squarish and unarmed; segment 2 is elongate and bears 1 subdistal, plumose seta; segment 3 is slightly curved and bears 2 distal plumose setae, 1 thin and 1 heavy distal naked setae, and a varying number (3 to 6) lateral plumose setae. In the corpus mandibulae one can distinguish a pars incisiva, a lacinia mobilis and a pars molaris; the latter two are separated by a row of 3–4 plumose and 2 (right mandible) or 3 (left mandible) naked setae. The lacinia mobilis bears 5 fine teeth (right) or 3 coarse teeth (left), and the pars incisiva bears 3 pointed teeth (right) or 5 obtuse teeth (left) (Figs. 3 and 4).

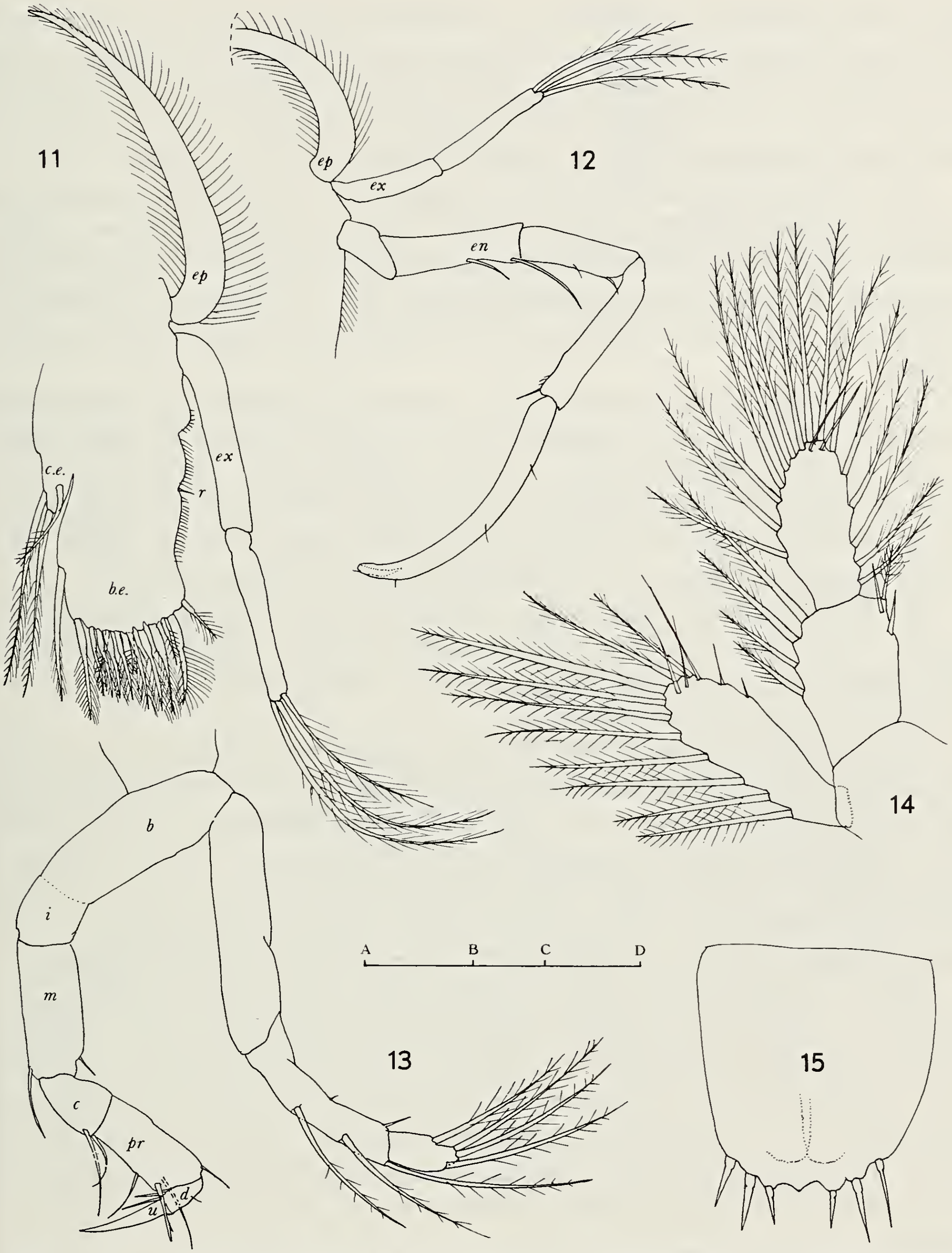
The first maxilla (Fig. 6) shows (1) a coxopodal endite, armed with 3 medial, plumose and 1 medial, naked setae, 6 plumose distal setae, and a lateral row of cilia; (2) a basipodal endite, distally armed with 6, sawlike spines, and (3) a ''palp'' (endopodite) consisting of 3 articles, the second armed with 2 setae and 1 large toothed spine, the third with 1 seta and 1 large toothed spine.

As usual in the genus, the second maxilla (Fig. 7) is complexly built: (1) a coxopodal endite with 2 medial rows of naked setae and a distal row of 8 plumose setae; (2) a first basipodal endite armed with a distal row of about 16 long, slightly S-shaped spines, distomedially provided with a grasping edge; (3) a second basipodal endite armed with 7 similar, transformed, though longer and heavier, spines; and (4) a palp of 2 segments, the basal one of which carries a rudimentary, bud-like exopodite armed with 1 seta, and a unimerous endopodite armed with 4 setae. In *M. sanctaecrucis* the endopodite is 2-segmented and carries 7 setae.

The labium (Fig. 8) is a deeply cleft, ciliated lobe.

The maxilliped is sexually dimorphic. In the male, a 5-segmented endopodite is present; in the female this is reduced to a single setule (Figs. 11, 12). Furthermore, the appendage shows (1) a small coxopodal endite armed with 3 plumose setae; (2) a large basipodal endite armed with a row of 4 shorter plumose setae and a row of 8 to 9 longer plumose setae; (3) a 2-segmented exopodite armed with 3 distal plumose setae; and (4) a ciliated epipodite. In *M. sanctaecrucis* the exopodite is armed with 3 distal, 1 lateral and 1 medial setae.

The first pereiopod (Fig. 13) has a 3-segmented exopodite; in some specimens, the segmentation line between the second and third segments tends to become indistinct. The second exopodal segment bears 3 medial, plumose setae; the third segment bears 2 terminal and 2 subterminal plumose setae;



Figs. 11–15. *Monodella texana*: 11, Maxilliped, ♀; 12, Maxilliped, ♂; 13, First pereiopod, ♀; 14, Uropod, ♂; 15, Telson, ♂ (all to scale AB). *b* = basis; *b.e.* = basipodal endite; *c* = carpus; *c.e.* = coxopodal endite; *d* = dactylus; *en* = endopodite; *ep* = epipodite; *ex* = exopodite, *i* = ischium; *m* = merus; *pr* = propodus; *r* = rudiment of endopodite; *u* = ungulus.

the lateral armature is reduced to 2 vestigial setules. (In *M. sanctaecrucis* the lateral armature consists of 2 plumose setae.) The ischial segment of the endopodite is almost completely fused with the basipodite (articulated in *M. sanctaecrucis*). The shape and armature of the merus, carpus, propodus, dactylus and ungulus are very similar to that of *M. sanctaecrucis*.

The second pereiopod (Fig. 16) has a 2-segmented exopodite, lacking any lateral armature (in *M. sanctaecrucis* it carries 2 plumose setae). Club-shaped spines occur on the first exopodite segment (2 spines), the endopodal propodus (5 spines) and dactylus (5 spines). Fig. 17 shows an aberrant appendage in which the ungulus and the subterminal dactylar spine are subequal.

The third pereiopod resembles the second; the number of club-shaped spines on the endopodal propodus and dactylus are 11 and 9, respectively.

The fourth pereiopod is rather similar, too (Fig. 18), but bears 12 club-shaped spines on the endopodal propodus and 7 such spines on the dactylus. In *M. sanctaecrucis* the dactylus bears only 2 spines, and the lateral exopodal armature (absent in *M. texana*) consists of 1 plumose seta.

The fifth pereiopod (Fig. 19) has a relatively short second exopodite segment, armed with 5 plumose setae (6 in *M. sanctaecrucis*). The endopodal propodus bears 16, and the dactylus 8 club-shaped spines (6 and 2 spines, respectively, in *M. sanctaecrucis*).

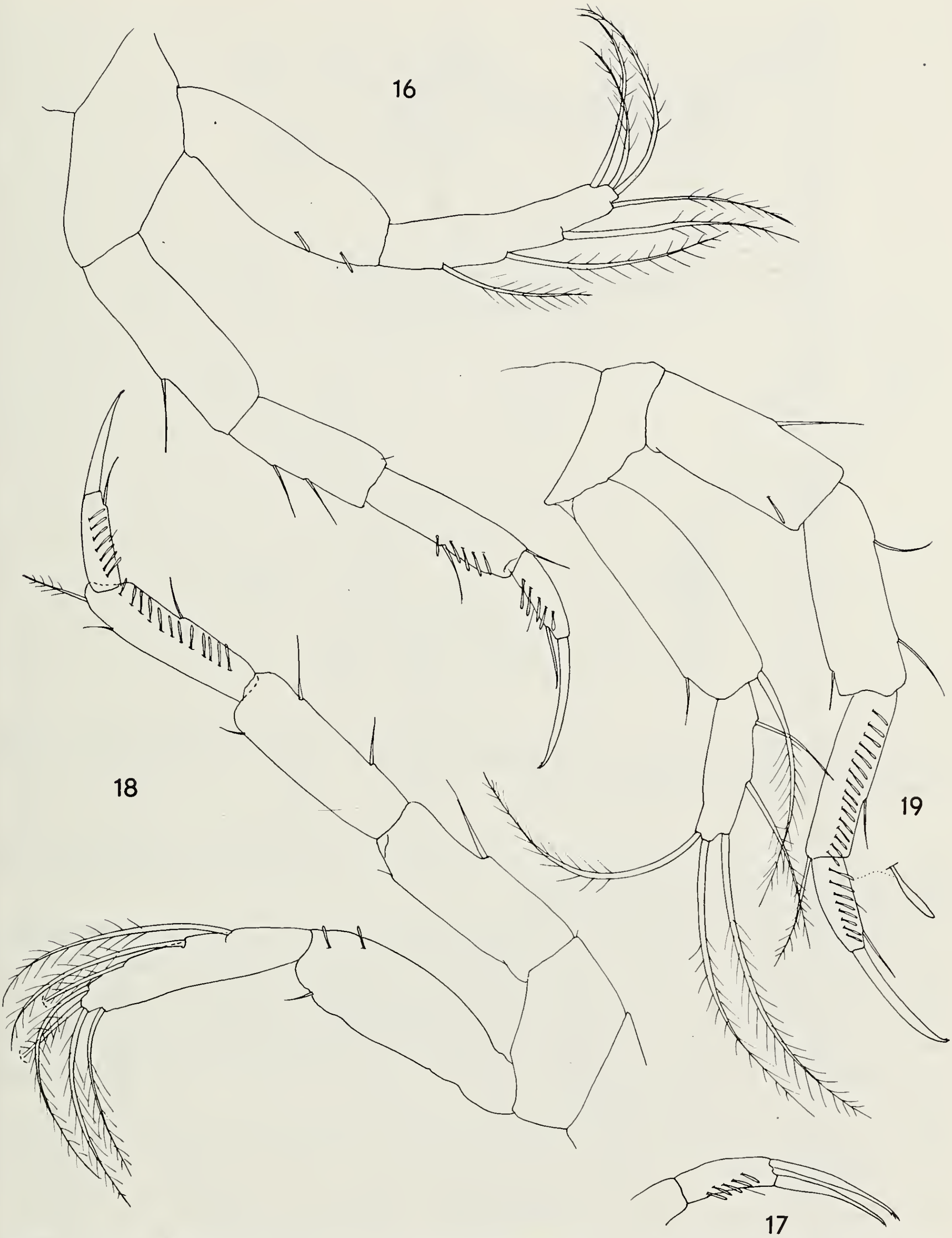
In the sixth pereiopod (Fig. 20), the exopodite is reduced to a single segment, armed with 4 medial club-shaped spines, 2 medio-subdistal plumose setae, 1 distal rudimentary seta, and 1 lateral rudimentary seta. The distal and subdistal elements are placed on a low projection (''socle''), which is lacking in *M. sanctaecrucis*. The endopodal carpus bears usually 2, sometimes 1, medial setae. The propodus bears 19–20, the dactylus 5–6 club-shaped spines (in *M. sanctaecrucis* the dactylus bears only 2 spines).

The seventh pereiopod (Fig. 21) has a thin, one-segmented exopodite, armed as in P6. The endopodal carpus bears 1 medial seta. The armature of the propodus and dactylus is as in P6. This appendage differs from that of *M. sanctaecrucis* in the presence of socles for the (sub)distal exopodal elements, and in the higher number of endopodal dactylus spines. In the male, the coxopodite carries a lateral, curved, finger-shaped appendage, the penis, which is almost as long as the exopodite (shorter in *M. sanctaecrucis*).

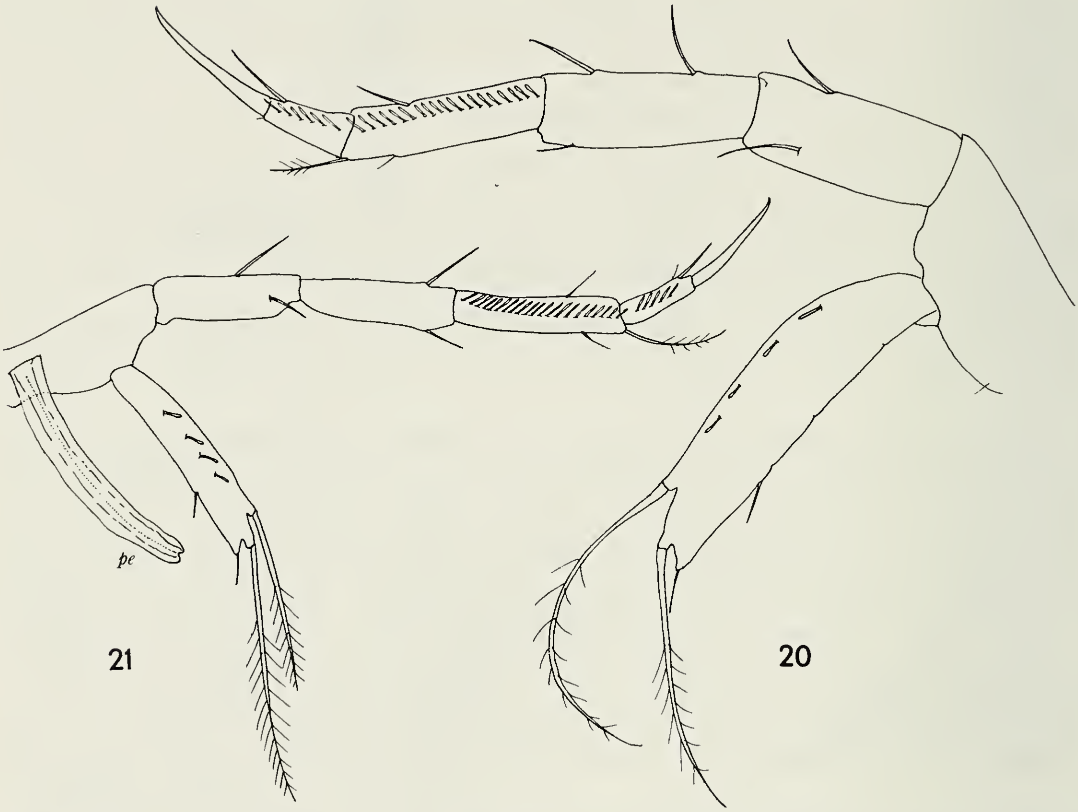
The first and second pleopods (Figs. 9, 10) are small, finger-shaped, one-segmented appendages, armed with 5 setae.

The uropod (Fig. 14) has a 2-segmented exopodite and a 1-segmented endopodite and is very similar in morphology to that of *M. sanctaecrucis*.

The telson (Fig. 15) bears 2 longer and 1 shorter spine on either side, and a triangular mid-distal lobe in between the two groups of spines. The anus is



Figs. 16–19. *Monodella texana*: 16, Second pereiopod, ♀; 17, Endopodal dactylus of aberrant second pereiopod, ♀; 18, Fourth pereiopod, ♀; 19, Fifth pereiopod, ♀. (All to scale AB, see Figs. 11–15.)



Figs. 20–21. *Monodella texana*: 20, Sixth pereiopod, ♀; 21, Seventh pereiopod, ♂ (both to scale AB, see Figs. 11–15.) *pe* = penis.

subterminal. In *M. sanctaecrucis,* the anus is terminal and the distal triangular lobe appears to be lacking.

Remarks.—As the above description shows, *M. texana* is morphologically very similar to *M. sanctaecrucis*. The main differences are (1) the degree of elongation of the peduncular segments of antenna 1; (2) the number of setae on the 2nd exopodite segment of the maxilliped; (3) the shorter endopodite of maxilla 2 in *M. texana*; (4) the absence of plumose lateral setae in the exopodite of pereiopods 1 to 5 in *M. texana*: (5) the shape of the exopodite of pereiopods 6 and 7; (6) the length of the penis in relation to the length of the 7th pereiopodal exopodite; (7) the number of spines on the dactylus of the posterior pereiopods; and (8) the shape of the telson.

The overall resemblance, even in the finer details, to the Old World species (see, for instance, Rouch, 1965, for good illustrations of *Monodella argentarii* Stella, 1951) is likewise striking.

In conclusion, it can be said that the members of the genus *Monodella,* notwithstanding their occurrence in several isolated areas of the world, have retained a remarkable morphological uniformity. So far, no marine representatives referable to *Monodella* are known, although marine Thermosbaenacea belonging to other genera have recently been found in the West

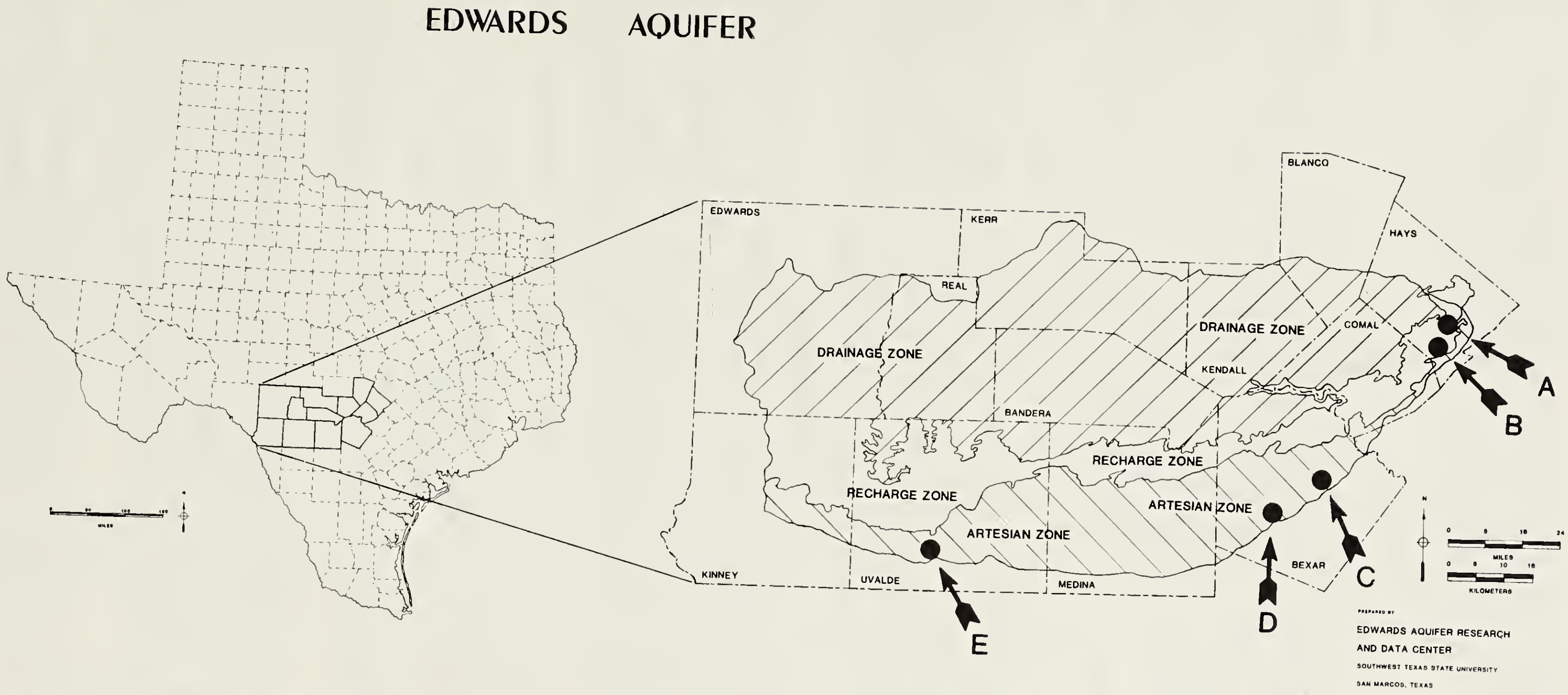


Fig. 22. Distribution of *Monodella texana*: A, Artesian Well, Southwest Texas State University, San Marcos, Texas; B, Ezell's Cave, San Marcos, Texas; C, Artesia Pump Station Well (City Water Board), San Antonio, Texas; D, Verstraeten Well No. 1, 2.85 km North of Von Ormy, Texas; E, George Ligocky Farm Well, No. H-5-158, near Uvalde, Texas.

Indies (Stock, 1976, and unpublished). The absence of marine Thermosbaenacea in the Mediterranean, the only other area in the world where they have been actively looked for, may be explained by the late Miocene hydrographic history of that basin (Stock, 1980; Danielopol, 1980). The sea level dropped very considerably and much of the remaining water was temporarily transformed into brine. It is conceivable that many marine ancestors of the actual stygofaunal elements became extinct in the Mediterranean during the late Miocene. In the West Indies, where no such drastic salinity crisis took place, marine Thermosbaenacea could and did, in fact, survive.

Distribution.—The type-locality of *M. texana* is Ezell's Cave, in San Marcos, Hays County, Texas (Maguire, 1964, 1965). Karnei (1978) records the species also from the Verstraeten Well No. 1 and the City Water Board Artesia Pump Station Well (both in Bexar Co., Texas). Longley (1978) records the species from the artesian well of the Southwest Texas State University Aquatic Station in San Marcos (Hays Co.). Material of the latter well has been used for the above redescription. Moreover, 7 specimens from the George Ligocky Farm Well No. H-5-158 (Uvalde Co., Texas) were studied, but, unfortunately, all these specimens were heavily damaged. As far as could be ascertained, this material appears to be identical to that of San Marcos. The known distribution is shown in Fig. 22.

Literature Cited

Danielopol, D. 1980. An essay to assess the age of the freshwater interstitial Ostracoda of Europe.—Bijdr. Dierk., Amsterdam 50(2):V243–291.

Karnei, H. 1978. A survey of subterranean aquatic fauna of Bexar County, Texas.—M.Sc. Thesis, Southwest Texas State University, San Marcos: 1–118.

Longley, G. 1978. Status of *Typhlomolge* (=*Eurycea*) *rathbuni,* the Texas Blind Salamander.—Endangered Species Rep., U.S. Fish & Wildlife Serv., Albuquerque, New Mexico 2:i–vi, 1–45.

Maguire, B., Jr. 1964. Crustacea: A primitive Mediterranean group also occurs in North America.—Science 146:931–932.

———. 1965. *Monodella texana* n. sp., an extension of the range of the crustacean order Thermosbaenacea to the Western Hemisphere.—Crustaceana 9(2):149–154, pl. III.

Messana, G. 1979. Groundwater research by the "Centro di Studio per la Faunistica ed Ecologia tropicali" in Somalia.—Stygo News 2(2):5–8.

Rouch, R. 1965. Contribution à la connaissance du genre *Monodella* (Thermosbaenacés).—Ann. Spéléol. 19(4):717–727.

Stock, H. H. 1976. A new genus and two new species of the crustacean order Thermosbaenacea from the West Indies.—Bijdr. Dierk., Amsterdam 46(1):47–70.

———. 1980. Regression model evolution, as exemplified by the genus Pseudoniphargus (Amphipoda).—Bijdr. Dierk., Amsterdam 50(1):V105–144.

———. The influence of Hadziid Amphipoda on the occurrence and distribution of Thermosbaenacea and Cyclopoid Copepoda in the West Indies.—Int. J. Speleol. 10(4) [in press].

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CAECIDOTEA SALEMENSIS AND *C. FUSTIS*, NEW SUBTERRANEAN ASELLIDS FROM THE SALEM PLATEAU (CRUSTACEA: ISOPODA: ASELLIDAE)

Julian J. Lewis

Abstract.—Two species of *Caecidotea* belonging to the asellid *Hobbsi* Group are described from the Salem Plateau Section of the Ozark Plateau Province. *Caecidotea salemensis* is a widespread and common inhabitant of subterranean habitats in the central part of the Salem Plateau in both Arkansas and Missouri. *Caecidotea fustis* is known only from subterranean habitats in the northeastern part of the plateau.

The Salem Plateau is a section of the Ozark Plateau physiographic province, which comprises parts of southern Missouri, northern Arkansas and western Illinois (Fig. 1). Several thousand caves and springs are known from the Ordovician limestones and dolomites prevalent in the region (Bretz, 1956; Bretz and Harris, 1961; Vineyard and Feder, 1974), from which four subterranean species of *Caecidotea* are currently known: *C. antricola* Creaser (1931), *C. dimorpha* Mackin and Hubricht (1940), *C. extensolinguala* (Fleming, 1972) and *C. serrata* (Fleming, 1972). Records of *Caecidotea stiladactyla* Mackin and Hubricht (1940) from the central Missouri part of the Salem Plateau are probably erroneous determinations of *C. fustis*. Two subterranean species are added to the list of the Salem Plateau isopod fauna herein, an accomplishment made possible largely by the collections of Leslie Hubricht (LH), James E. Gardner (JEG) and John L. Craig (JLC).

Caecidotea salemensis, new species
Figs. 2–5

Asellus tridentatus.—Fleming, 1972:254 (in part). *A.* spp.—Craig, 1977:83, 85, 87 (in part).

Material examined.—ARKANSAS: Lawrence Co., Imboden, deep cistern, 29 Aug. 1925, Byron C. Marshall, 61 ♂♂, 12 ♀♀ (USNM 59263). MISSOURI: Boone Co., stream in Hunter Cave, 5 mi NNW Ashland, 4 Aug. 1940, LH, 4 ♂♂, 20 ♀♀. Carter Co., Norris Cave, small quiet pools, 10 mi NW Van Buren, 29 Jan. 1979, JEG, 2 ♂♂. Dallas Co., Saltpeter Cave, 22 Nov. 1974, O. Hawksley, 4 ♂♂, 7 ♀♀. Douglas Co., seep, on bluff above North Fork of White River, W. of Roosevelt, 1 May 1940, LH, 19 ♂♂, 22 ♀♀; small spring on bluff near North Fork of White River, 7 mi E Richville, 1 June 1935, LH, 3 ♂♂, 3 ♀♀. Franklin Co., drip pools and stream, Mushroom Cave, 2.5 mi E. Sullivan, 5 Apr. 1942, LH, 25 ♂♂, 11 ♀♀; same locality, 1 June 1974, JLC, 1 ♂, 1 ♀. Hickory Co., seep 5 mi W Urbana, 16 Mar. 1975, JLC, 21 juv, 3 ♀♀; same locality, 23 Mar. 1975, 3 ♀♀. Pettis Co., Hughesville, cistern, 20 Aug. 1932, A. Gurloff, 6 ♂♂, 5 ♀♀ (USNM 67700). Phelps Co., Lane Cave, small quiet pools, 1 mi N Yancy Mills, 17 Jan. 1979, JEG, 11 ♂♂, 8 ♀♀; Little Piney Cave, 7 mi SW Rolla, 15 May 1980, JEG, 1 ♂, 2 ♀♀; Zorumski Cave, 5 mi WSW Newburg, 17 Mar. 1980, JEG, 9 ♂♂, 2 ♀♀. Pulaski Co., Little Cave, beneath stones in riffles, 1 mi E. Devils Elbow, 6 Dec. 1978, JEG, 9 ♂♂, 6 ♀♀; same locality, 6 Aug. 1979, Julian J. Lewis, Teresa M. Lewis, JEG, 4 ♂♂, 2 ♀♀; York Cave, drip pools, 1.5 mi N Hanna, 28 Mar. 1942, LH, 5 ♂♂, 1 ♀; same locality, 21 May, 1978, JLC, 1 ♂, 1 ♀; McCann Cave #1, 4 mi W Waynesville, 6 Mar. 1976, JLC, 5 ♂♂, 7 ♀♀. Texas Co., Bat Cave, in small stream, 7 mi NE Success, 5 July 1940, LH, 1 ♂, 4 ♀♀ (USNM 108585); Unnamed Cave #15, 12 mi W Licking, 21 Apr. 1980, JEG, 9 ♂♂, 5 ♀♀. Washington Co., Hamilton Cave, drip pool, 5.5 mi SE Sullivan, 20 July 1940, LH, 6 ♂♂, 2 ♀♀.

A 12.5 mm male from Imboden, Arkansas is the holotype (USNM 59263), the other specimens from this locality are paratypes (USNM 181300). All of the material examined has been deposited in the National Museum of Natural History, Smithsonian Institution.

Description.—Eyeless, unpigmented. Longest male, 16.0 mm, body slender, linear, about 6.9× as long as wide, coxae visible in dorsal view; longest female, 9.8 mm. Margins of head, pereonites and telson very setose. Head about 1.8× as wide as long, anterior margin concave, rostrum lacking; postmandibular lobes moderately produced. Telson about 1.4× as long as wide, sides subparallel, caudomedial lobe moderately produced, broadly rounded.

Antenna 1 reaching middle of last segment of antenna 2 peduncle, flagellum of male of about 17–18 segments, esthete formula 3-0-1-0-1 (Fig. 2d); flagellum of female shorter, of about 11–12 segments. Antenna 2 reaching pereonite 7, last segment of peduncle about 1.3× length preceding segment, flagellum of about 70–84 segments.

Mandibles with 4-cuspate incisors and lacinia mobilis; spine row with about 14 spines in left, 17 spines in right mandible. Palp with plumose setae on distal segments. Maxilla 1, apex of outer lobe with 13 robust spines, inner lobe with 5 apical plumose setae. Maxilliped with about 7 retinacula.

Male pereopod 1 propus about 1.3× as long as wide; palm proximally with 1–2 small, robust spines, medial process subtriangular, separated from smaller rounded or slightly bicuspid distal process by U-shaped cleft (Figs. 3a; 5a–f); dactyl flexor margin with up to 5–6 spines, decreasing to 0–1 in mature individuals, and rounded process (Fig. 3d). Female pereopod 1 propus more slender, about 1.4× as long as wide, palm with 2 proximal spines, processes lacking; dactyl flexor margin with about 5 spines. Pereopod 4 more robust in male than female.

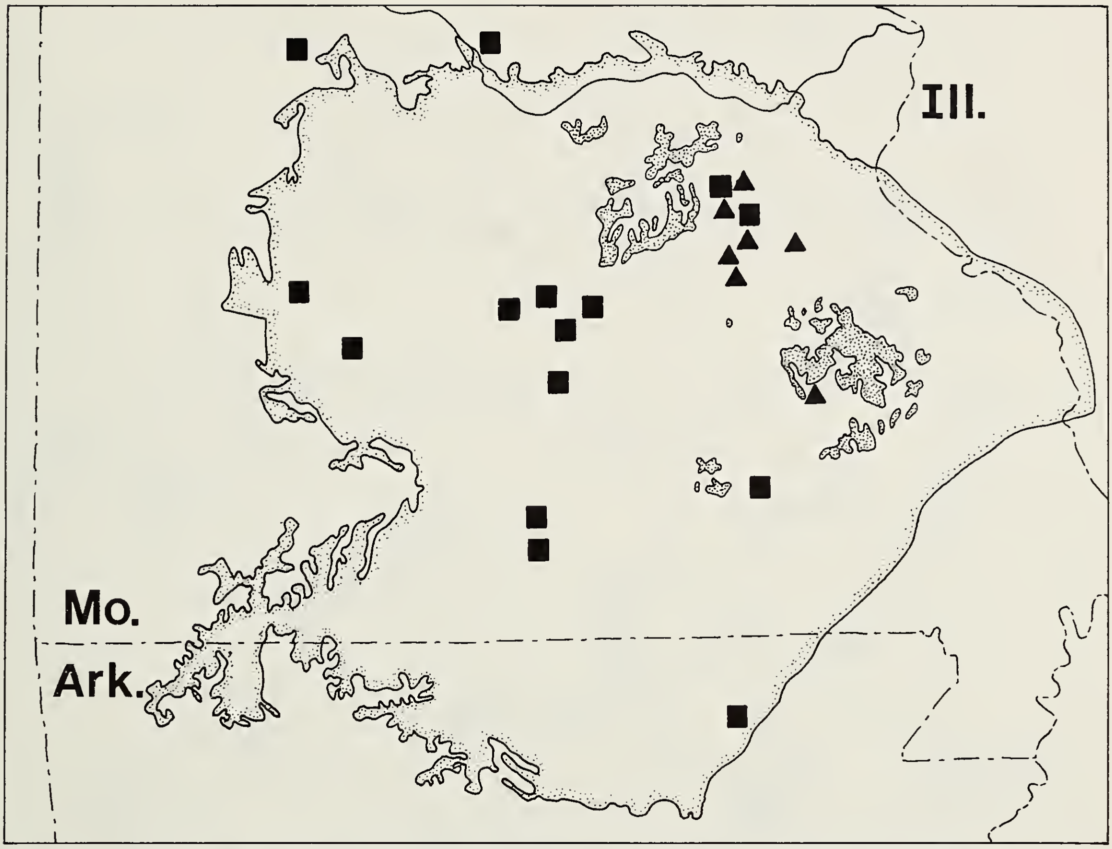

Fig. 1. The Salem Plateau Section (stippled around margins) of the Ozark Plateau Province, showing the ranges of *Caecidotea salemensis* (squares) and *C. fustis* (triangles); stippled areas within the Salem Plateau indicate areas where non-cavernous rocks occur.

Male pleopod 1 larger than pleopod 2; protopod about 0.7× length of exopod, with 3–4 retinacula; exopod about 2× as long as wide, with long plumose setae on distal margin and short setae on concave distal part of lateral margin. Male pleopod 2 exopod, proximal segment with 0–4 setae, distal segment suboval, bearing about 15 plumose setae along lateral and distal margins and about 7 non-plumose setae along mesial margin; endopod with prominent basal apophysis, tip with 3 processes: caudal process broadly rounded, forming a lateral shoulder; cannula short, cylindrical, endopodial groove prominent; mesial process distally curved, rectangular, obscuring cannula. Female pleopod 2 with 9–12 plumose setae along lateral and distal margins, anterior surface with numerous setae.

Pleopod 3 about 2× as long as wide, distal segment about 1.6× length of proximal segment, distal margin with about 20 long, plumose setae. Pleopod 4, exopod with setae along proximal lateral margin and single oblique sigmoid suture. Pleopod 5 exopod with setae along proximal lateral margin, and weak transverse suture.

Uropods of male very spatulate in mature specimens, slightly longer than telson. Uropods of female cylindrical, equal or subequal to length of telson.

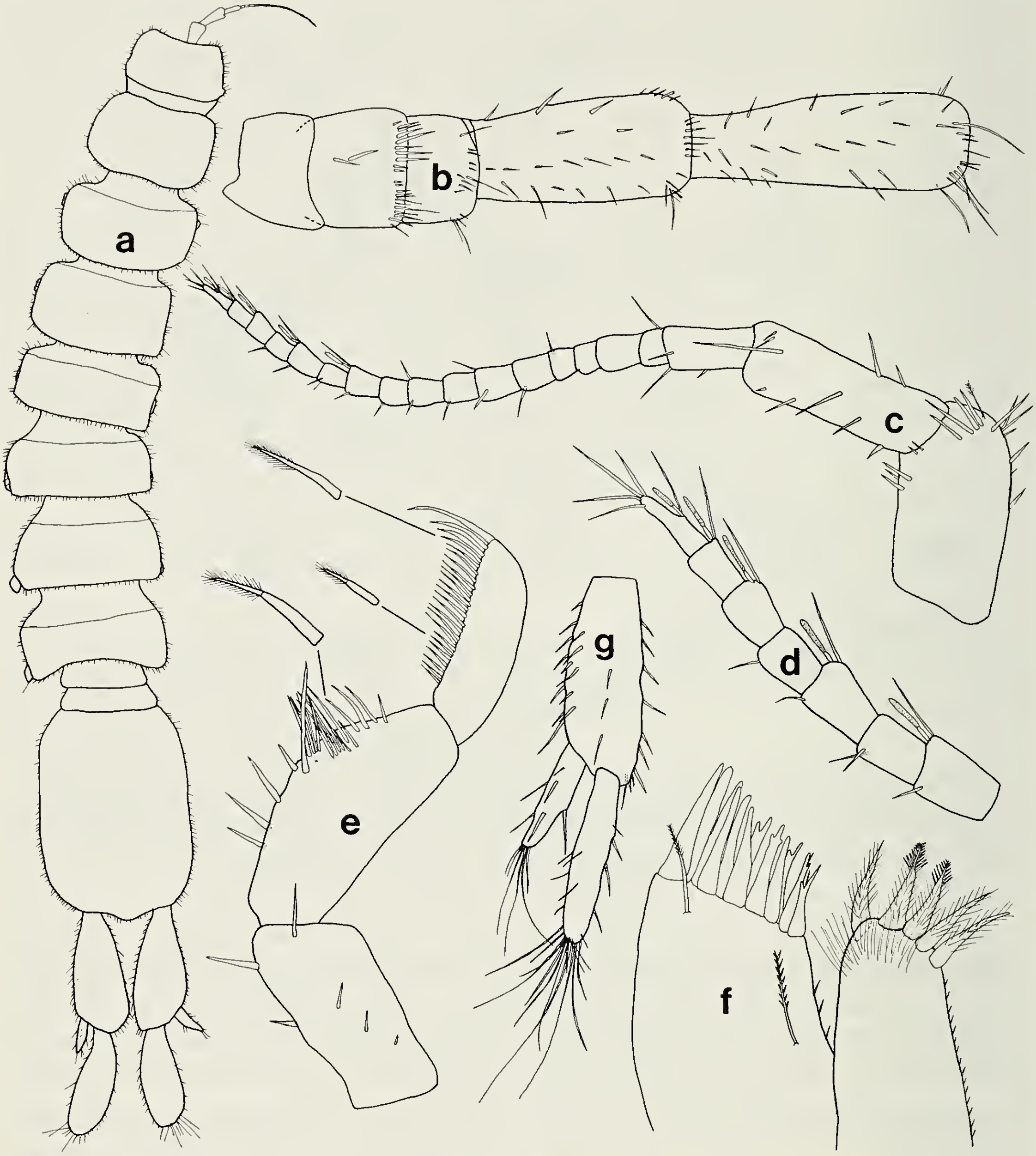

Fig. 2. *Caecidotea salemensis*: a–f from male paratype, g from female paratype: a, Habitus, dorsal; b, Antenna 2, proximal segments; c, Antenna 1; d, Same, distal segments; e, Mandibular palp; f, Maxilla 1; g, Uropod, dorsal.

Etymology.—Named after the Salem Plateau.

Relationships.—*Caecidotea salemensis* is closest morphologically to *C. tridentata* and two undescribed species from drain tiles in Missouri and Illinois (Lewis and Bowman, in press), and Floyd County, Indiana (Lewis, in prep.), referred to here as *Caecidotea* sp. #1 (Ill./Mo.) and *Caecidotea* sp. #2 (Ind.). *Caecidotea salemensis* is readily separated from these species

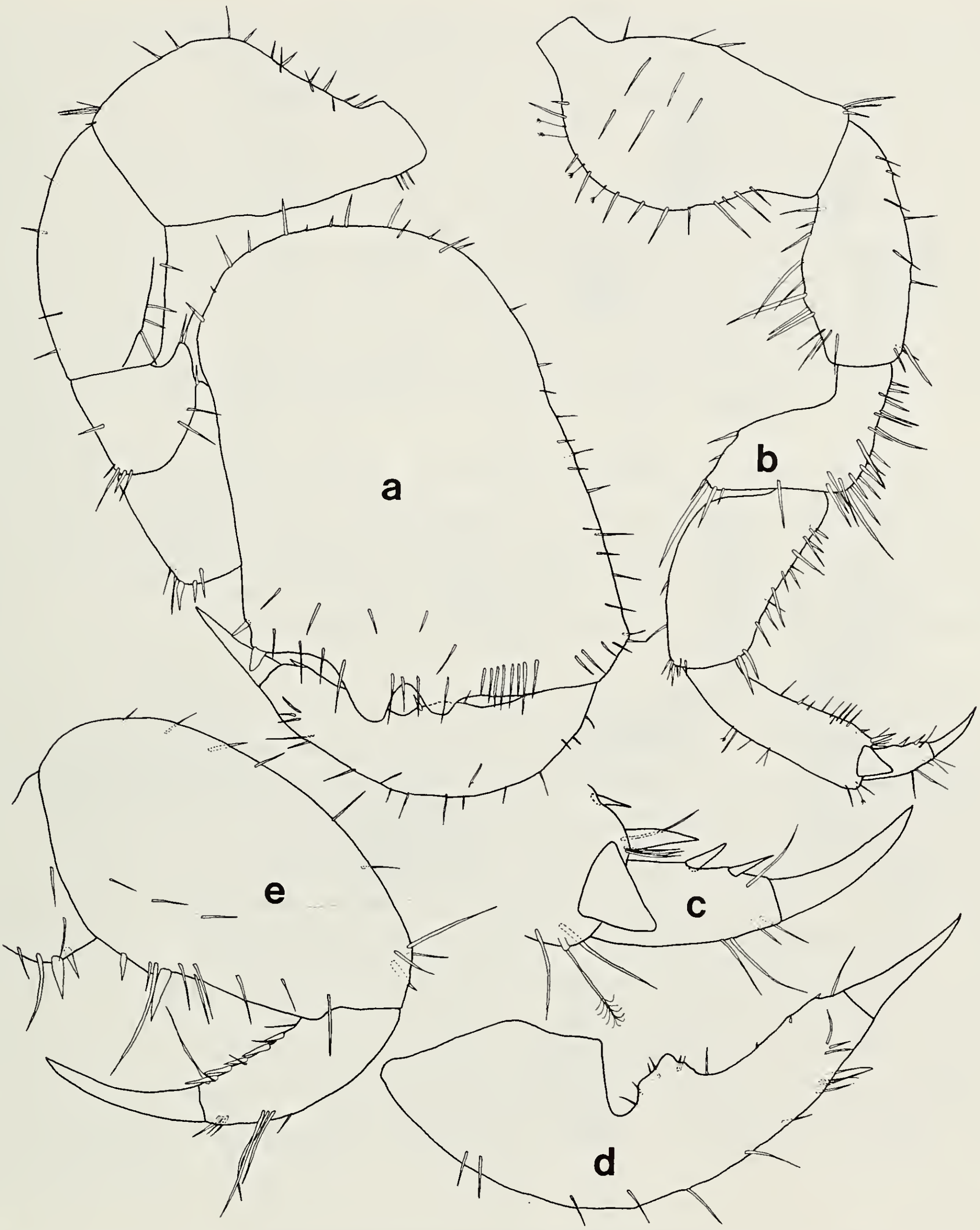

Fig. 3. *Caecidotea salemensis*: a–d from male paratype, e from female paratype: a, Pereopod 1; b, Pereopod 4; c, Same, dactyl; d, Pereopod 1, dactyl; e, Pereopod 1.

by the possession of a single sigmoid suture in pleopod 4; in the other three species two sutures are present. The palmar margins of the male pereopod 1 propus in *C. salemensis* and *C.* sp. #1 each bear one or two proximal spines, a subtriangular median process and a bicuspid distal process. *C. tridentata* differs in having a distinct fingerlike proximal process, while *C.* sp. #2 has a shorter, triangular proximal process.

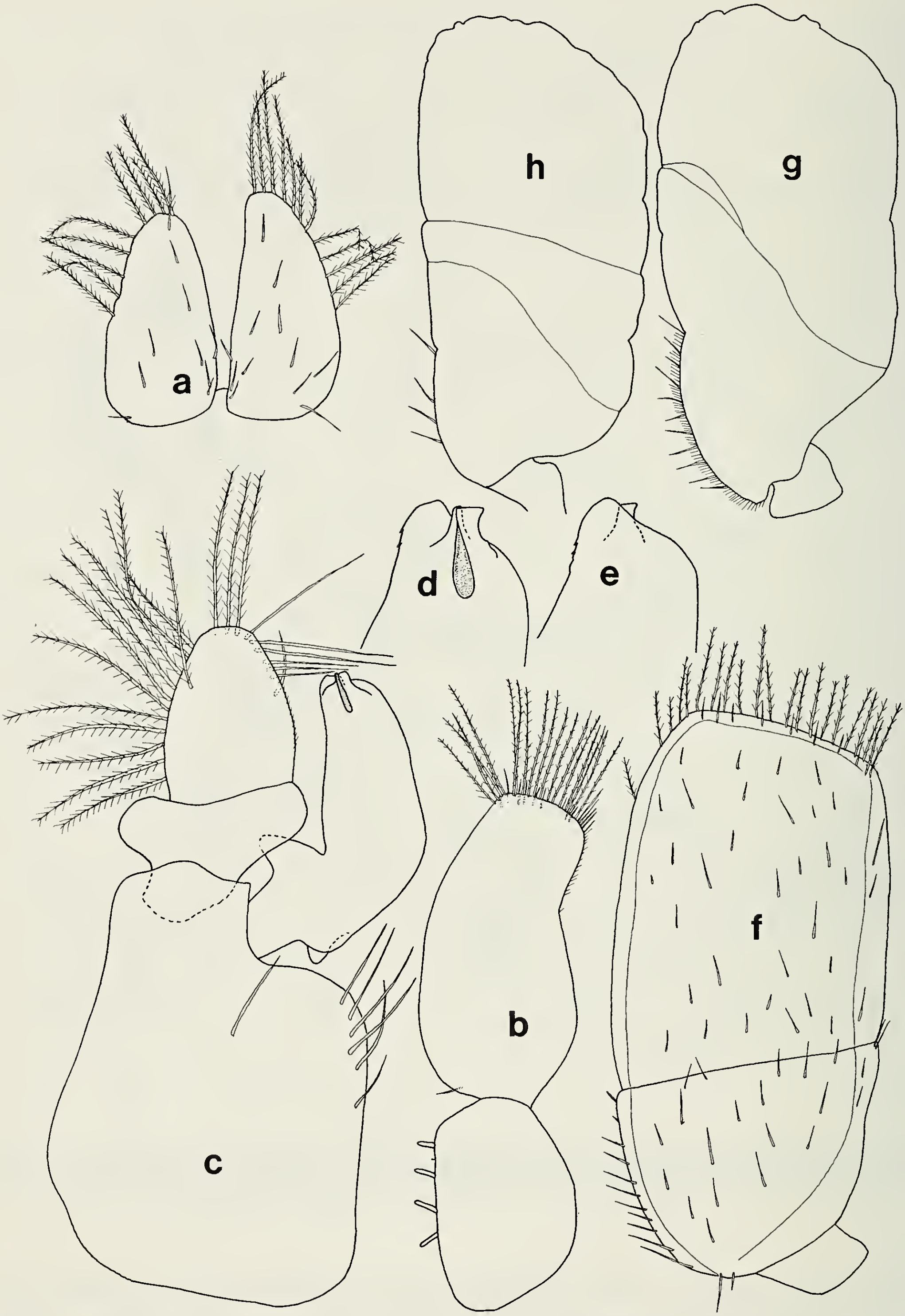

Fig. 4. *Caecidotea salemensis*: a from female paratype, b–h from male paratype: a, Pleopod 2; b, Pleopod 1; c, Pleopod 2; d, Same, tip of endopod, anterior; e, Same, posterior; f, Pleopod 3; g, Pleopod 4; h, Pleopod 5.

The male pleopod 1 of all 4 species is similar in having long setae only along the distal margin of the exopod. The male second pleopod endopod tips are also very similar, although the placement of the endopodial groove differs from one species to the next, and the relative sizes of the tip processes also help to characterize the species. In *C. salemensis, C.* sp. #1 and *C.* sp. #2, the groove is on the lateral side of the mesial process, but in *C. tridentata* it is on the mesial side of this process. The cannulas of *C. salemensis, C. tridentata* and *C.* sp. #2 differ from that of *C.* sp. #1 in being slender and low, mostly obscured from both the anterior and posterior aspects. In *C.* sp. #1 the cannula protrudes beyond the mesial and caudal processes, visible from both anterior and posterior aspects, and is recurved mesially.

The low, partially obscured cannula, extending in a line parallel to the axis of the endopod, plus the shape and setation of the male pleopod 1 of *Caecidotea salemensis,* are typical of the morphology of the species of Steeves' (1964) *Hobbsi* Group. Within this group *C. tridentata, C. salemensis, C.* sp. #1 and *C.* sp. #2 comprise an assemblage of closely related, allopatric species.

Habitat and distribution.—Caecidotea salemensis is known from the groundwater of caves, seeps, springs and cisterns. In caves it is usually taken from streams and drip pools. These habitats are markedly different from *C. tridentata, C.* sp. #1 and *C.* sp. #2, which are known only from drain tiles and wells in areas where caves do not occur. Thus, *C. salemensis* is a troglobite, whereas the other 3 species are phreatobites. *C. salemensis* occurs widely in the Salem Plateau and is also known from a few other localities near the edge of the plateau. Through much of its range *C. salemensis* is sympatric with *C. antricola,* a species which is distinct morphologically from *C. salemensis* (Steeves, 1966; Lewis and Bowman, in press).

Remarks.—Ovigerous females were present in collections taken in March, April and May with typically between 16 and 27 immatures present in the brood pouches.

Caecidotea fustis, new species
Figs. 6, 7

Asellus stiladactylus.—Fleming, 1972:254 (in part).

Material examined (all deposited in the National Museum of Natural History, Smithsonian Institution).—MISSOURI: Crawford Co., Bat Cave, 7 mi SE Leasburg, 16 Dec. 1973, JLC, 2 ♂♂; 24 May 1974, 2 ♂♂, 4 ♀♀; Bear Cave, 8.5 mi NE Steelville, 6 Aug. 1980, JEG, 5 ♂♂, 11 ♀♀; Nameless Cave, 16 Feb. 1974, JLC, 1 ♂, 1 ♀; Onondaga Cave, 4 mi SE Leasburg, 30 May 1974, JLC, 1 ♂, 4 ♀♀; Pool in Onyx Cave, on bluff above Brazil Creek,

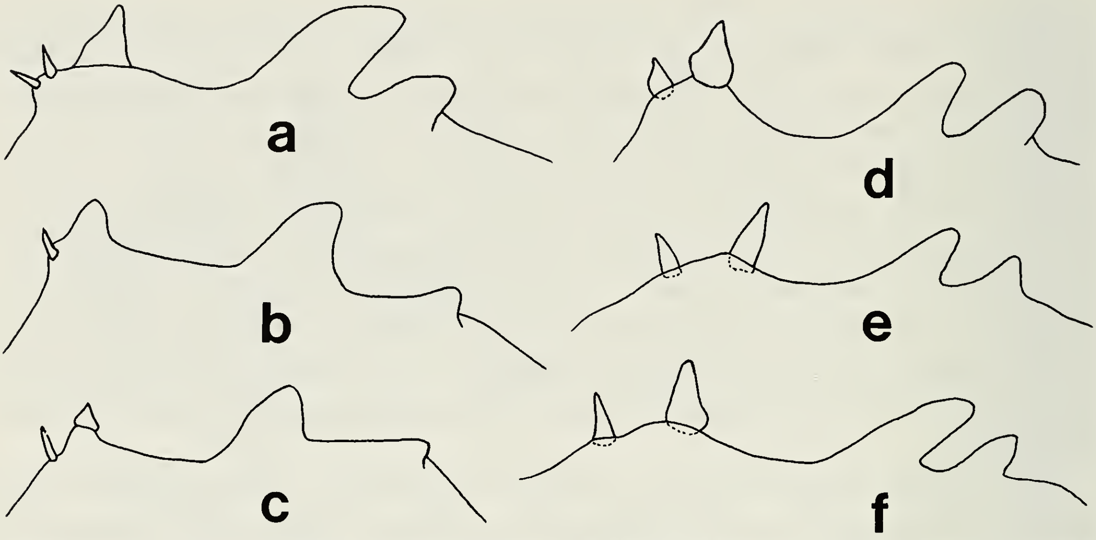

Fig. 5. *Caecidotea salemensis*: Variation of male pereopod 1 palmar margin (setae omitted): a, Little Cave; b, Cistern, Imboden; c, Same; d, Cistern, Hughesville; e, Texas Cave; f, Lane Cave (locality data in text).

3 mi N Campbell Bridge, 8 mi SE Bourbon, 20 July 1940, LH, 14 ♂♂, 4 ♀♀. Franklin Co., Copper Hollow Sink Cave, 8 Feb. 1958, O. Hawksley, 2 ♂♂, 6 ♀♀; Meramec Caverns (type-locality), drip pools, 2.5 mi SE Stanton, 16 Dec. 1939, LH, 11.5 mm ♂ holotype, USNM 181301 and 13 ♂♂ paratypes, USNM 181302; Seeps, 0.5 mi NW Mushroon Cave, 2.5 mi E Sullivan, 5 Apr. 1942, LH, 32 ♂♂, 22 ♀♀. Iron Co., seep, base of Taum Sauk Mountain, near Mina Sauk Falls, 5 mi NW Hogan, 18 Jan. 1942, LH, 9 ♂♂, 5 ♀♀. Washington Co., Corral Cave, 18 mi E Steelville, 21 Aug. 1980, JEG, 3 ♂♂, 9 ♀♀.

Description.—Eyes vestigial or absent; pigment absent or lightly scattered on dorsum. Longest male, 11.0 mm; body slender, linear, about 6.0× as long as wide; coxae visible in dorsal view. Margins of head, pereonites and telson moderately setose. Head about 1.3× as wide as long, anterior margin concave, postmandibular lobes slightly produced. Telson about 1.8× as long as wide, sides subparallel, caudomedial lobe low, poorly defined.

Antenna 1 reaching to middle of distal segment of antenna 2 peduncle; flagellum of about 13 segments, esthete formula 3-0-1-0-1 (Fig. 6b). Antenna 2 reaching about to anterior margin of telson; distal segment of peduncle about 1.3× length of preceding segment; flagellum of about 63 segments.

Mandibles with 4-cuspate incisors and lacinia mobilis; spine row with about 10 spines in left, 11 spines in right mandible. Palp with plumose setae on distal segments. Maxilla 1, apex of outer lobe with 13 robust spines; inner lobe with 5 apical plumose setae. Maxilliped with about 4 retinacula.

Male pereopod 1 propus about 1.5× as long as wide; palm with proximal spine, triangular medial process and bicuspid distal process; dactyl flexor margin with up to about 6 small spines, rounded process present in mature

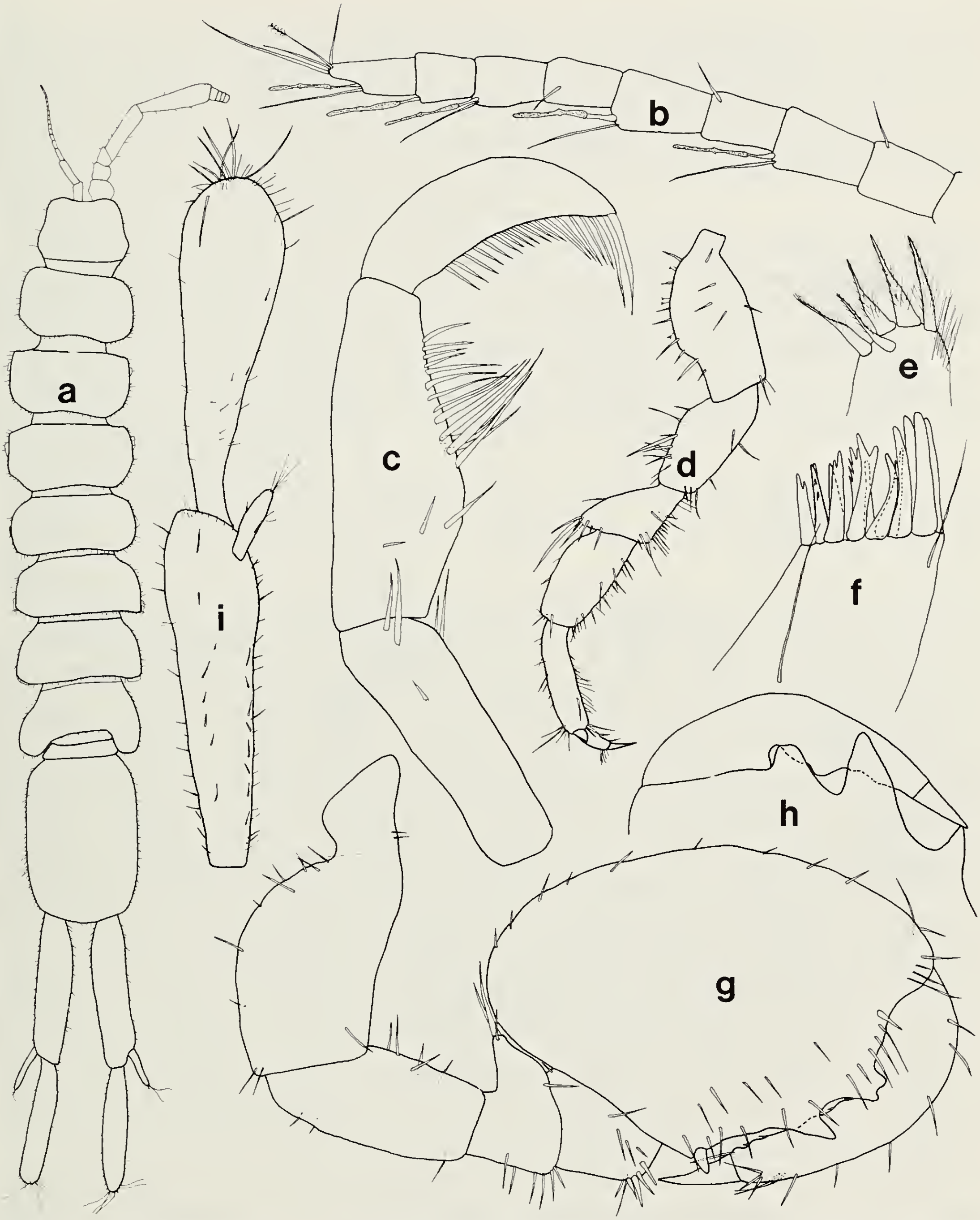

Fig. 6. *Caecidotea fustis*: a–g from male paratype, Meramec Caverns; h, i from male from Taum Sauk Mountain: a, Habitus, dorsal; b, Antenna 1, distal segments; c, Mandibular palp; d, Pereopod 4; e, Maxilla 1, inner lobe; f, Same, outer lobe; g, Pereopod 1; h, Pereopod 1, propus and dactyl, setae omitted; i, Uropod, dorsal.

specimens. Female pereopod 1 propus more slender, about 2× as long as wide, palm with proximal spine, processes lacking; dactyl flexor margin with about 3 spines. Pereopod 4 more robust in male than female.

Male pleopod 1 larger than pleopod 2; protopod about 0.6× length of exopod, with 4–5 retinacula; exopod about 2× as long as wide, with about

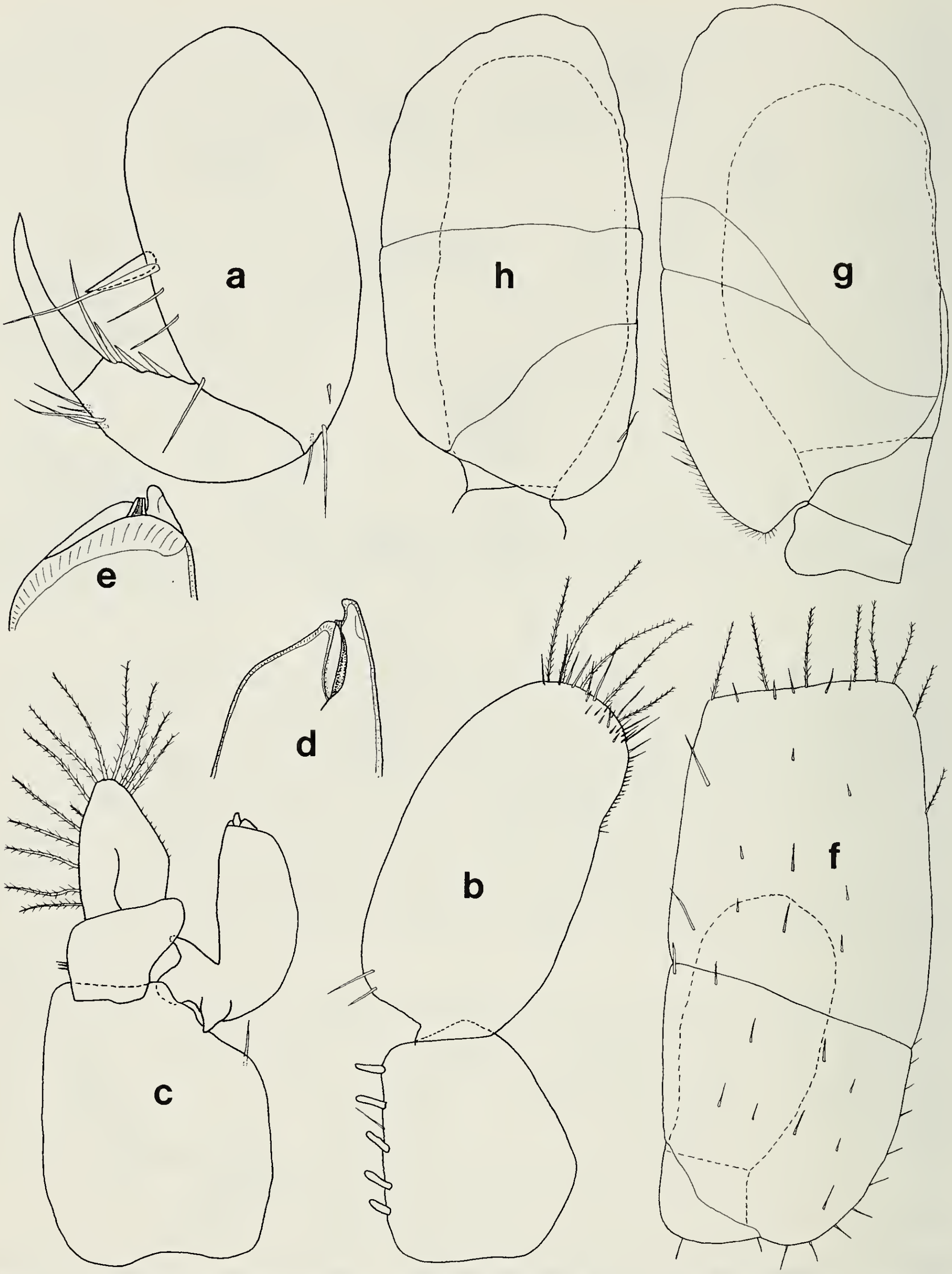

Fig. 7. *Caecidotea fustis*: a from ovigerous female, Taum Sauk Mountain; b–h from male paratype, Meramec Caverns: a, Pereopod 1; b, Pleopod 1; c, Pleopod 2; d, Same, tip of endopod, anterior; e, Same, posterior; f, Pleopod 3; g, Pleopod 4; h, Pleopod 5.

5 plumose setae on distal margin and short setae on concave distal part of lateral margin. Male pleopod 2 exopod, proximal segment with about 3 lateral setae, distal segment subtriangular, bearing about 13 plumose setae along lateral and distal margins; endopod with prominent basal apophysis,

tip with 4 processes: (1) cannula obscured by other processes, forming low truncate conical extension of endopodial groove; (2) mesial process broad, suboval, distally rounded; (3) lateral process high, digitiform, slightly recurved laterally, with low subtriangular flange on caudal surface; and (4) caudal process forming heavily sclerotized band, broadening laterally, across posterior distal part of endopod.

Pleopod 3 about 2.1× as long as wide, distal segment about 1.3× length of proximal segment, distal margin with about 6–7 long, plumose setae. Pleopod 4, exopod with setae along proximal lateral margin, single oblique sigmoid suture present. Pleopod 5 with proximal seta, 2 weak sutures.

Uropods of male spatulate, about 1.7× length of telson, exopod distinctly club-shaped in mature males. Uropods of female cylindrical, equal or subequal to length of telson.

Etymology.—The name, proposed as a noun, is derived from the Latin "fustis" (=club), referring to the appearance of the uropods of mature males.

Relationships.—The general morphological affinities of *Caecidotea fustis* are with the members of the *Hobbsi* Group, sharing with other members of this group the shape and distal setation of the male pleopod 1, and the low, truncate distally extending cannula. Specifically, *C. fustis* may be related to *C. stiladactyla.* The male pereopod 1 of these species is quite similar in most specimens, although in large specimens of *C. fustis* the proximal spine present on the palmar margin of the propus in both species is replaced by a large, triangular process. The endopod tips of *C. fustis* and *C. stiladactyla* are similar in that each possesses a truncate, conical cannula which is nearly obscured by other, somewhat digitiform processes. However, *C. stiladactyla* exhibits a phenomenon which has not been reported to occur in other asellids, i.e., the cannula has both recumbent and erect positions, and apparently is capable of a telescoping motion within the tip of the endopod. Fleming (1972) illustrated both positions, but the recumbent position appears to be the endopod tip of *C. fustis* (reported from Onyx Cave, Missouri by Fleming) rather than that of *C. stiladactyla.* Besides the lack of the telescoping cannula, *C. fustis* is pigmented in some collections, while pigmentation is unknown in *C. stiladactyla,* and the male pleopod 1 of *C. fustis* bears distal plumose setae which are absent in *C. stiladactyla.*

Habitat and distribution.—Caecidotea fustis is known only from caves and seeps in a narrow north-south band lying between Washington and Iron counties, Missouri. This area, on the western flank of the St. François Mountains, is within the northeastern part of the Salem Plateau. *Caecidotea fustis* is allopatric with *C. stiladactyla,* which is apparently known authentically only from localities in Arkansas which are adjacent to the edge of the Salem Plateau.

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I would like to thank Dr. Thomas E. Bowman for both reading the manuscript and expediting the loan of material from the collections of the National Museum of Natural History, including all of the specimens donated to the museum by Mr. Leslie Hubricht. Mr. James E. Gardner donated many specimens collected during his work on a cooperative cave inventory by the Missouri Department of Conservation, the Mark Twain National Forest, and the North Central Forest Experiment Station, and provided field assistance to me on a collecting trip through Missouri in August 1979. Mr. John L. Craig also donated his large collection of Missouri cave asellids, which added many localities for the new species described herein. Dr. Stuart Neff both read the manuscript and made travel funds available through the Water Resources Laboratory, University of Louisville. The Research Advisory Committee of the National Speleological Society provided grant funds partially used for travel expenses incurred during a collecting trip through the Ozarks. Finally, Mrs. Teresa M. Lewis provided field assistance and moral support during the preparation of this paper.

Literature Cited

Bretz, J. H. 1956. Caves of Missouri.—Missouri Division of Geological Survey and Water Resources, volume 39, 2nd series, 490 pp.

———, and S. Harris. 1961. Caves of Illinois.—Illinois State Geologic Survey, Report of Investigations 215, 87 pp.

Craig, J. L. 1977. Invertebrate faunas of caves to be inundated by the Meramec Park Lake in eastern Missouri.—National Speleological Society Bulletin 39(3):80–89.

Creaser, E. P. 1931. A new blind isopod of the genus *Caecidotea* from a Missouri cave.—Occasional Papers of the Museum of Zoology, University of Michigan 222:1–7.

Fleming, L. E. 1972. The evolution of the eastern North American isopods of the genus *Asellus* (Crustacea: Asellidae).—International Journal of Speleology 4:221–256.

Lewis, J. J., and T. E. Bowman. The subterranean asellids of Illinois.—Smithsonian Contributions to Zoology 335. [in press.]

Mackin, J. G., and L. Hubricht. 1940. Descriptions of seven new species of *Caecidotea* (Isopoda: Asellidae) from the central United States.—Transactions of the American Microscopial Society 59(3):383–397.

Steeves, H. R. 1964. The troglobitic asellids of the United States: The *Hobbsi* group.—American Midland Naturalist 71(2):445–451.

———. 1966. Evolutionary aspects of the troglobitic asellids of the United States: the *Hobbsi, Stygius* and *Cannulus* Groups. American Midland Naturalist 75(2):392–403.

Vineyard, J. D., and G. L. Feder. 1974. Springs of Missouri.—Missouri Geological Survey and Water Resources, Report 29, 266 pp.

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94(2), 1981, pp. 591–597

A REVIEW OF THE *PLATYSQUILLA* COMPLEX (CRUSTACEA, STOMATOPODA, NANNOSQUILLIDAE), WITH THE DESIGNATION OF TWO NEW GENERA

Raymond B. Manning and David K. Camp

Abstract.—*Platysquilla* Manning, 1967, is redefined, with *P. eusebia* (Risso, 1816) as its only species. The other species previously assigned to *Platysquilla, Lysiosquilla enodis* Manning, 1962, and *Platysquilla horologii* Camp, 1971, are removed and made the type-species of two new, monotypic genera, *Platysquilloides* and *Mexisquilla,* respectively. The three genera are defined, and the type-species are re-illustrated.

The nomenclatural histories of *Squilla eusebia* Risso, 1816, and *Lysiosquilla enodis* Manning, 1962, were briefly summarized by Camp (1971:21). Both had been transferred to *Heterosquilla* (Manning, 1963) and later to *Platysquilla* (Manning, 1967), with *S. eusebia* designated as type-species of the latter genus.

When *Platysquilla horologii* Camp, 1971, was described, the three known specimens did not fully agree with the definition of the genus, although it was recognized that they agreed more closely with *Platysquilla* than with any other established genus. Therefore, a very conservative approach was taken, and the generic description was emended to allow the inclusion of *P. horologii* in *Platysquilla.* With the discovery of additional specimens of *P. horologii* (R. W. Heard and D. K. Camp, in prep.), and after further consideration of the relationships between the three species, we believe the latter are sufficiently different from one another to warrant their separation into three monotypic genera.

Platysquilla Manning, 1967

Platysquilla Manning, 1967:238.—Holthuis, 1967:26.—Manning, 1968:111; 1969:90.—Camp, 1971:120.—Manning, 1977:93; 1980:368 [In part].

Definition.—Size moderate, total length 75 mm or less; body smooth, depressed, loosely articulated; eye of moderate size, cornea expanded but not bilobed, set obliquely on stalk; rostral plate subquadrate with apical spine, lateral margins straight, anterolateral corners rounded; antennal protopod with 2 mesial and 2 ventral papillae; carapace narrowed anteriorly, without carinae or spines, cervical groove indicated on lateral plate only; thoracic somites without dorsal carinae, lateral margins truncate; eighth

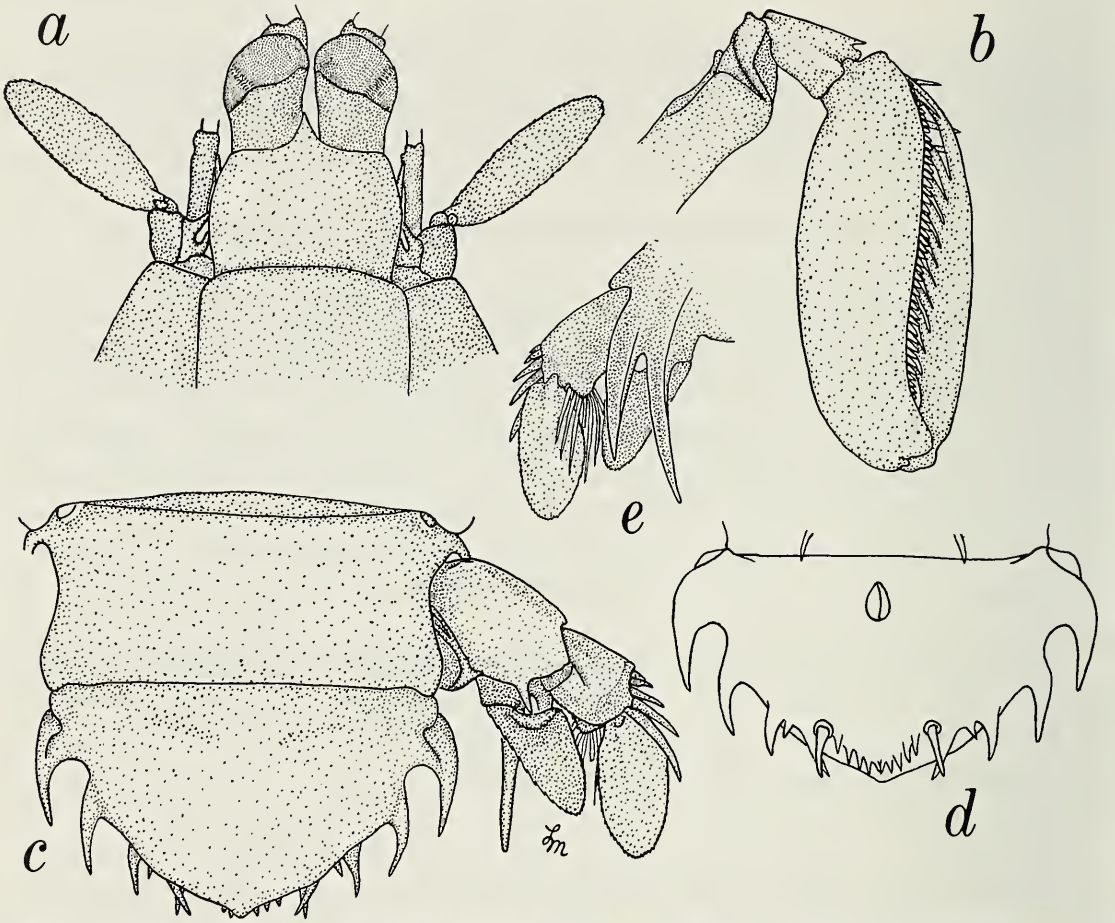

Fig. 1. *Platysquilla eusebia*, female, 44.5 mm, Naples, Italy, USNM 23207: *a*, Front; *b*, Claw; *c*, Sixth abdominal somite, telson, and uropod; *d*, Telson, ventral view; *e*, Uropod, ventral view.

thoracic somite without low, inconspicuous tubercle on midline of ventral surface; 5 epipods present; mandibular palp absent; raptorial claw slender, dactylus not inflated basally; outer margin of dactylus faintly notched basally; propodus fully pectinate with 4 movable spines at base, first longest, second shortest; carpus with distal, dorsal spine; ischiomeral articulation terminal; merus slender, elongate, longer than ischium; endopods of walking legs 2-segmented, distal segment of first 2 legs ovate, that of last leg slenderest; abdomen depressed, loosely articulated, anterolateral plates with complete suture; sixth abdominal somite without posterolateral spines, with curved, ventrally directed process present on each side in front of articulation of uropod, with 2 strong spines on ventral, posterior margin; telson broad, with obtuse, triangular, wide median posterior projection; marginal armature of telson consisting of row of slender submedian denticles, 1 movable submedian tooth, and 4 sharp, fixed lateral teeth, usually with slender denticle or tubercle between fixed teeth; basal segment of uropod with 2 dorsal carinae, inner terminating in slender spine; proximal segment of exopod with short dorsal carina, outer margin armed with slender, movable, sharp spines; endopod triangular, with proximal portion of outer edge folded over dorsally; spines of basal prolongation triangular in cross-section, inner spine longer. [Modified from Manning, 1969:90.]

Type-species.—*Squilla eusebia* Risso, 1816, by original designation. See Figure 1.

Gender.—Feminine.

Number of species.—One.

Distribution.—Mediterranean Sea and adjacent North Atlantic, off Portugal, France, and the west coast of Ireland (Manning, 1977).

Platysquilloides, new genus

Platysquilla Manning, 1967:238.—Holthuis, 1967:26.—Manning, 1968:111; 1969:90.—Camp, 1971:120.—Manning, 1977:93; 1980:368 [In part].

Definition.—Size moderate, total length 70 mm or less; body smooth, depressed, loosely articulated; eye of moderate size, cornea faintly bilobed, set obliquely on stalk; rostral plate subquadrate with apical spine, lateral margins slightly convex, anterolateral corners rounded; antennal protopod with 1 mesial and 2 ventral papillae; carapace narrowed anteriorly, without carinae or spines, cervical groove indicated on lateral plate only; thoracic somites without dorsal carinae, lateral margins truncate; eighth thoracic somite with low, inconspicuous tubercle on midline of ventral surface; 4 epipods present; mandibular palp absent; raptorial claw slender, dactylus not inflated basally; outer margin of dactylus strongly notched basally; propodus fully pectinate, with 4 movable spines at base, first longest, second shortest; carpus with distal, dorsal spine; ischiomeral articulation terminal; merus slender, elongate, longer than ischium; endopods of walking legs 2-segmented, distal segment of first 2 legs ovate, that of last leg slenderest; abdomen depressed, loosely articulated, anterolateral plates with complete suture; sixth abdominal somite with sharp posterolateral spines, with curved, ventrally directed process present on each side in front of articulation of uropod, without spines on ventral, posterior margin; telson broad, with obtuse, subtriangular, narrow median posterior projection; marginal armature of telson consisting of row of slender submedian denticles, 1 movable submedian tooth, and 4 fixed lateral teeth, mesial 2 spatulate, with slender denticle between fixed teeth; basal segment of uropod with 2 dorsal carinae, inner terminating in slender spine; proximal segment of exopod with short dorsal carina, outer margin armed with spatulate, movable spines; endopod triangular, with proximal portion of outer edge folded over dorsally; spines of basal prolongation triangular in cross-section, inner spine longer.

Type-species.—*Lysiosquilla enodis* Manning, 1962. See Figure 2.

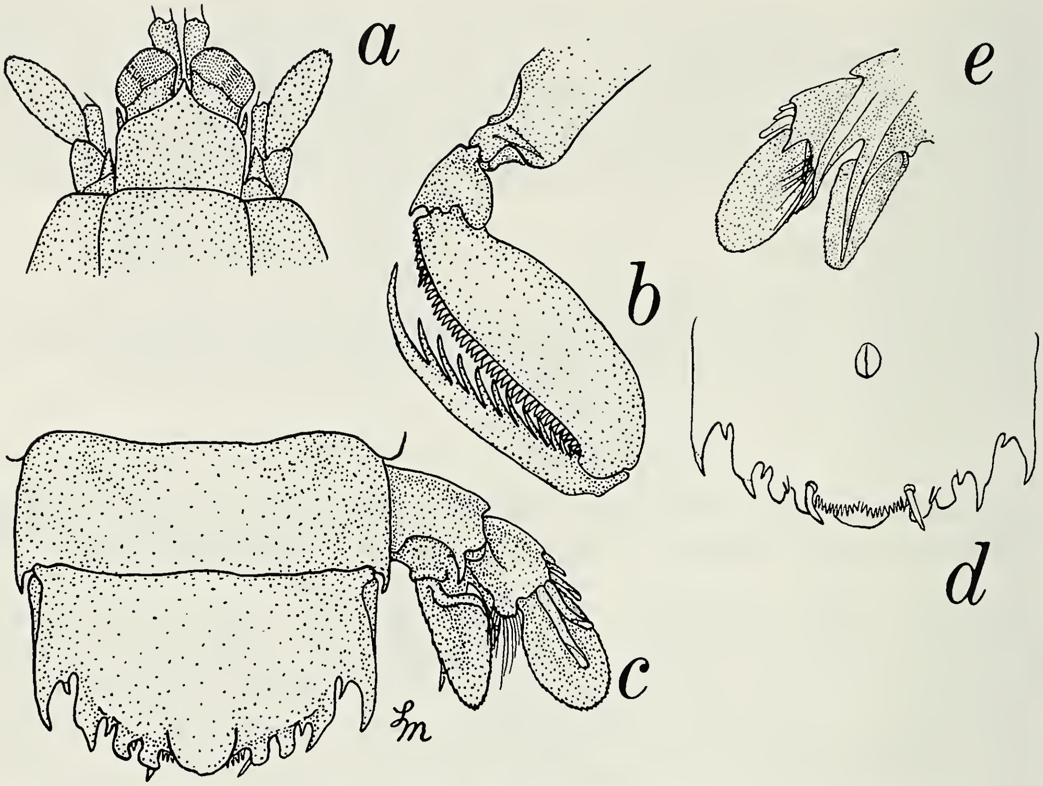

Fig. 2. *Platysquilloides enodis,* male, 48 mm, off New Jersey, USNM 172218: *a*, Front; *b*, Claw; *c*, Sixth abdominal somite, telson, and uropod; *d*, Telson, ventral view; *e*, Uropod, ventral view.

Etymology.—The name is composed of the generic name *Platysquilla* with the Latin suffix "*-oides,*" meaning "resembling."

Gender.—Masculine.

Number of species.—One.

Remarks.—This new genus differs from *Platysquilla* in having 4, rather than 5, epipods and in having 1 mesial papilla on the antennal peduncle, rather than having 2 mesial papillae. It shares other, less significant, characteristics with the other western Atlantic genus described below which further separate them from the eastern Atlantic *Platysquilla.* These include the presence of a strong, rather than faint, proximal notch on the dactylus of the raptorial claw, the lack of submedian spines on the ventral, posterior margin of the sixth abdominal somite, the presence of posterolateral spines on the sixth abdominal somite, a narrow, rather than broad, posterior median projection on the dorsum of the telson, and spatulate, rather than sharp, movable spines on the outer margin of the exopod of the uropod.

Distribution.—Northwestern Atlantic, from scattered localities between Massachusetts and North Carolina (Manning, 1969), including 16 km N of Atlantic City, New Jersey, and off Maryland and Virginia (Howells, Karp, and Langton, 1980).

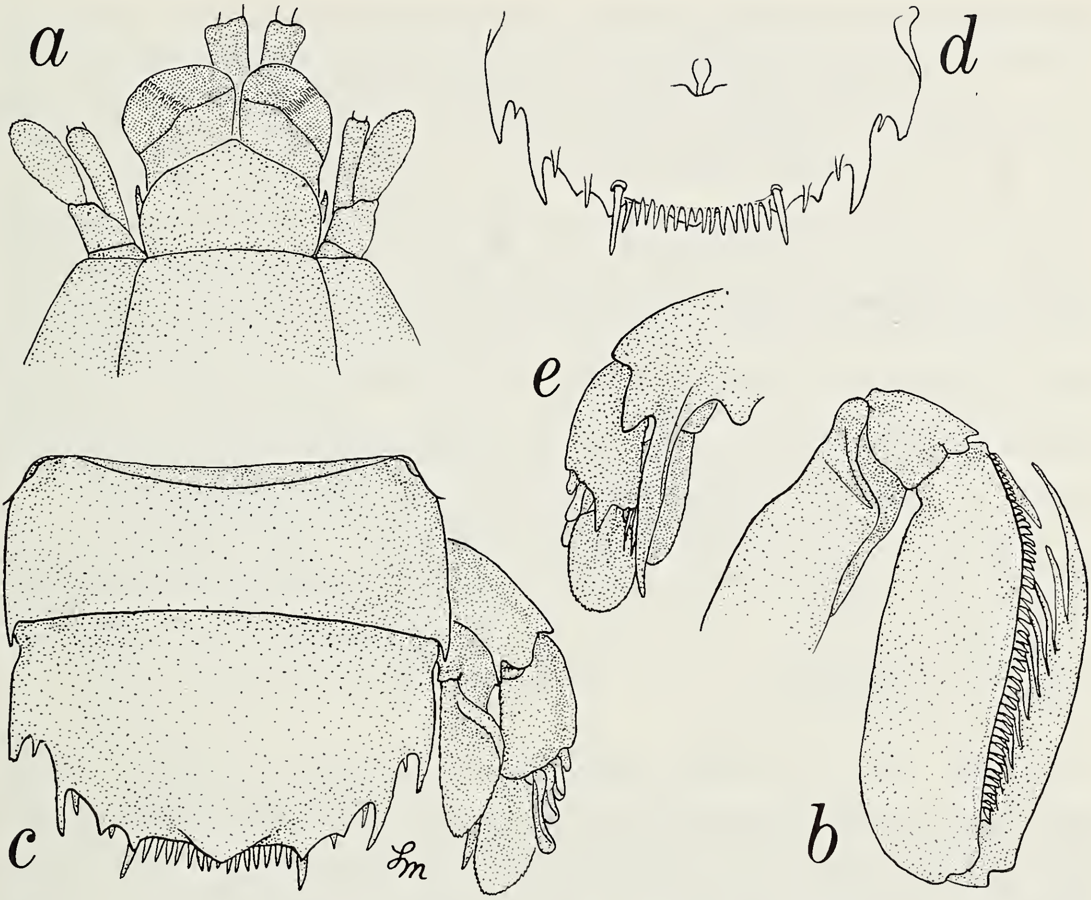

Fig. 3. *Mexisquilla horologii,* female paratype, ca. 16 mm, west of Egmont Key, Florida, USNM 128832: *a*, Front; *b*, Claw; *c*, Sixth abdominal somite, telson, and uropod; *d*, Telson, ventral view; *e*, Uropod, ventral view.

Mexisquilla, new genus

Platysquilla.—Camp, 1971:120 [In part].

Definition.—Size small, total length 20 mm or less; body smooth, depressed, loosely articulated; eye of moderate size, cornea faintly bilobed, set obliquely on stalk; rostral plate cordiform, lateral and anterolateral margins broadly rounded, sloping to obtuse apex; antennal protopod without mesial papillae, with 2 ventral papillae; carapace narrowed anteriorly, without carina or spines, cervical groove indicated on lateral plate only; thoracic somites without dorsal carinae, lateral margins truncate; eighth thoracic somite with low, inconspicuous tubercle on midline of ventral surface; 3 epipods present; mandibular palp absent; raptorial claw slender, dactylus not inflated basally; outer margin of dactylus strongly notched basally; propodus fully pectinate, with 4 movable spines at base, first longest, second shortest; carpus with distal, dorsal spine; ischiomeral articulation terminal; merus slender, elongate, longer than ischium; endopods of walking legs 2-

segmented, distal segment of first 2 legs ovate, that of last leg slenderest; abdomen depressed, loosely articulated, anterolateral plates with complete suture; sixth abdominal somite with sharp posterolateral spines, with curved, ventrally directed process present on each side in front of articulation of uropod, without spines on ventral, posterior margin; telson broad, with obtuse, subtriangular, narrow median posterior projection; marginal armature of telson consisting of row of slender submedian denticles, 1 movable submedian tooth, and 4 fixed lateral teeth, mesial 2 sharp, with slender denticle between fixed teeth; basal segment of uropod with 2 dorsal carinae, inner terminating in slender spine; proximal segment of exopod with short dorsal carina, outer margin armed with spatulate, movable spines; endopod triangular, with proximal portion of outer edge folded over dorsally; spines of basal prolongation triangular in cross-section, inner spine longer.

Type-species.—*Platysquilla horologii* Camp, 1971. See Figure 3.

Etymology.—*Mexisquilla* is derived from Gulf of Mexico and the generic name *Squilla*. It alludes to the apparent restriction of members of the genus to the Gulf of Mexico.

Gender.—Feminine.

Number of species.—One.

Remarks.—This new genus differs from *Platysquilla* in having 3, rather than 5, epipods and in having no mesial papillae on the antennal peduncle rather than having 2 such papillae. Other characteristics which differ from those of *Platysquilla,* but which are shared with *Platysquilloides,* are discussed under the latter genus.

Mexisquilla also differs from *Platysquilloides* in having fewer epipods and fewer antennal papillae than are present on the latter genus.

Mexisquilla differs from both *Platysquilla* and *Platysquilloides* in its overall size and degree of development. *Mexisquilla horologii* is relatively much smaller than the type-species of the other two genera. It also shows reduction in development of the telson characters relative to such development in *Platysquilla eusebia* and *Platysquilloides enodis*. The possibility of neotenic origin of *M. horologii* was discussed by Camp (1973:18).

Distribution.—Eastern Gulf of Mexico (Camp, 1971, 1973).

Acknowledgments

We thank F. A. Chace, Jr., L. B. Holthuis, and W. G. Lyons for commenting on the manuscript, Lilly King Manning for preparing the illustrations, and R. W. Heard for offering specimens of *M. horologii* for study.

Literature Cited

Camp, D. K. 1971. *Platysquilla horologii* (Stomatopoda, Lysiosquillidae), a new species from the Gulf of Mexico, with an emendation of the generic definition.—Proceedings of the Biological Society of Washington 84(15):119–128.

———. 1973. Stomatopod Crustacea.—Memoirs of the Hourglass Cruises 3(2):1–100.

Holthuis, L. B. 1967. Fam. Lysiosquillidae et Bathysquillidae. *In* H. E. Gruner and L. B. Holthuis, eds., Crustaceorum Catalogus 1:1–28. W. Junk, The Hague.

Howells, R. G., C. Karp, and R. W. Langton. 1980. Occurrence of a rare mantis shrimp, *Platysquilla enodis* (Manning, 1962), in the Middle Atlantic Bight area (Stomatopoda).—Crustaceana 38(1):101–104.

Manning, R. B. 1962. Seven new species of stomatopod crustaceans from the northwestern Atlantic.—Proceedings of the Biological Society of Washington 75:215–222.

———. 1963. Preliminary revision of the genera *Pseudosquilla* and *Lysiosquilla* with descriptions of six new genera (Crustacea: Stomatopoda).—Bulletin of Marine Science of the Gulf and Caribbean 13(2):308–328.

———. 1967. Preliminary account of a new genus and a new family of Stomatopoda.—Crustaceana 13(2):238–239.

———. 1968. A revision of the family Squillidae (Crustacea, Stomatopoda), with the description of eight new genera.—Bulletin of Marine Science 18(1):105–142.

———. 1969. Stomatopod Crustacea of the western Atlantic.—Studies in Tropical Oceanography, No. 8: viii + 380. Institute of Marine Sciences, University of Miami.

———. 1977. A monograph of the West African stomatopod Crustacea.—Atlantide Report No. 12:25–181.

———. 1980. The superfamilies, families, and genera of Recent stomatopod Crustacea, with diagnoses of six new families.—Proceedings of the Biological Society of Washington 93(2):362–372.

Risso, A. 1816. Histoire naturelle des Crustacés des environs de Nice, pp. 1–175, 3 pls. Paris.

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ANATOMY OF *DIASTOMA MELANIOIDES* (REEVE, 1849) WITH REMARKS ON THE SYSTEMATIC POSITION OF THE FAMILY DIASTOMATIDAE (PROSOBRANCHIA: GASTROPODA)

Richard S. Houbrick

Abstract.—*Diastoma melanioides* is the living survivor of a long lineage of snails in the Family Diastomatidae that occurred in the Tethys Sea during the Tertiary. Study of the anatomy shows that this species has open pallial gonoducts, and aphallic males, which establishes it in the superfamily Cerithiacea. A large ovipositor on the right side of the foot extends into the mesopodium. The radula is taenioglossate; the alimentary tract has paired salivary glands that run through the nerve ring and a stomach with style sac, gastric shield and reduced spiral caecum. The cephalic cavity is large and accommodates a small buccal mass and lengthy buccal and labial nerves. The nervous system is moderately condensed. Living animals occur subtidally in shallow water where they burrow in sandy bottoms and graze on algae and detritus. Development appears to be direct. *Diastoma melanioides* most closely resembles members of the Cerithiidae in anatomy and ecology. Anatomical and shell characters, and the fossil record indicate that *Diastoma* should be given familial status. The family is placed close to the Cerithiidae, the Potamididae, and the freshwater Melanopsidae.

Introduction

Diastoma melanioides (Reeve) is a relatively unknown cerithiacean prosobranch of moderate size which is restricted to a limited area of the coastline of the Great Australian Bight. It is the sole survivor of the *Diastoma* lineage, Family Diastomatidae. The taxonomic limits of this family have been poorly defined; consequently, a number of heterogenous groups have been referred to the Diastomatidae by numerous authors, and the family has been expanded well beyond the original concept. The living relict, *Diastoma melanioides,* heretofore known only from its shell, is rare in most museum collections and unfigured in most publications. Recently, some well-preserved specimens collected at Esperance, Western Australia, were sent to me through the kindness of Mr. Alan Longbottom. This material has provided information about the operculum, radula, and anatomy of *Diastoma melanioides* which unequivocally establishes that it is a cerithiacean.

The account that follows presents a description of the shell and internal anatomy, reviews the literature, and sets definite systematic limits to the family by providing familial and generic descriptions and a synonymy.

Material and Methods

Fourteen specimens of *Diastoma melanioides* were sent to me for examination by Mr. Alan Longbottom of Esperance, Western Australia. Eight of these were well-preserved animals and were dissected under a Wild M-5 stereo dissecting microscope. A one percent Methylene Blue aqueous solution was used as a stain. Protoconchs, shell ultrastructure, radula and periostracum were studied with a Nova-Scan SEM. All measurements are relative to average-sized snails (see Table 1). There was not sufficient material for statistical measurements of the soft parts.

Although anatomical observations are substantially accurate, the limited material and its preserved state may not have shown all the details of the fragile pallial gonoduct, stomach and smaller nerves. My work should be reconfirmed by the study of living snails.

Description

List of abbreviations.—*a*—anus; *bg*—buccal ganglion; *bm*—buccal mass; *bt*—buccal tensor; *cbc*—cerebral-buccal connective; *cc*—cerebral cavity; *cg*—cerebral ganglion; *cme*—cut mantle edge; *ct*—ctenidium; *d*—dialyneury; *dg*—digestive gland; *dln*—dorsal labial nerve; *es*—esophagus; *exh*—exhalant siphon; *f*—foot; *ff*—fold emerging from spiral calcum; *ga*—glandular area; *gs*—gastric shield; *hg*—hypobranchial gland; *i*—intestine; *il*—inner lamina; *inh*—inhalant siphon; *j*—jaws; *k*—kidney; *lln*—lateral labial nerve; *lmn*—left mantle nerve; *lpg*—left pleural ganglion; *lsg*—left salivary gland; *m*—mouth; *mn*—mantle nerve; *mp*—mantle papillae; *mpg*—mesopodial ganglion; *ng*—nerve ganglion; *nr*—nerve ring; *od*—oviduct; *odd*—opening of digestive diverticula; *og*—oviducal groove; *ol*—outer lamina; *on*—optic nerve; *op*—operculum; *ovp*—ovipositor; *os*—osphradium; *osd*—opening of salivary duct; *ov*—ovary; *pes*—posterior esophagus; *pg*—pedal ganglion; *pod*—proximal end of pallial oviduct; *ppg*—propodial groove; *psg*—proximal end of salivary gland; *r*—rectum; *rd*—radula; *rcg*—right cerebral ganglion; *rpg*—right pleural ganglion; *rsg*—right salivary gland; *sa*—sorting area; *sbg*—subesophageal ganglion; *sbn*—subvisceral nerve; *sbv*—subvisceral connective; *sc*—spiral caecum; *sd*—sperm duct; *sec*—supraesophageal connective; *sg*—salivary gland; *sn*—snout; *spg*—supraesophageal ganglion; *sp*—spermatophore receptacle; *sr*—seminal receptacle; *ss*—style sac; *st*—stomach; *t1*—typhlosole 1; *t2*—typhlosole 2; *tn*—tentacle nerve; *wcc*—wall of cerebral cavity.

Specimens examined.—Abbreviations: AMS = Australian Museum, Sydney; USNM = United States National Museum; WAM = Western Australian Museum.

Western Australia: Cheyne Beach, 40 mi E of Albany, 34°47′S, 118°25′E (AMS); Cheyne Beach, near Posidonia, 34°47′S, 118°25′E (WAM); Cape Riche, 70 mi E of Albany, 34°37′S, 118°46′E (AMS); North Side of High Island, Duke of Orleans Bay, 33°55′S, 122°37′E (WAM); Esperance Bay, Esperance (USNM, 806583, 801614); Mississippi Bay, 30 mi E of Esperance, 34°00′S, 122°17′E (AMS); Eyre Highway, 65 mi E of Madura, 31°55′S, 127°00′E (AMS).

South Australia: Port Sinclair, 32°06′S, 133°00′E (AMS); Smokey Bay, 32°20′S, 133°47′E (AMS); Streaky Bay, 32°32′S, 134°08′E (AMS).

Shell (Table 1; Fig. 1A–D, G–J).—Shell elongate, length 30–50 mm, turreted, having apical angle of 25 degrees and comprising 10–13 convex whorls. Protoconch (Fig. 1I) has two convex, smooth whorls. Transition from protoconch to teleoconch sharply defined by straight lip of protoconch and sudden change in sculpture. First two whorls of teleoconch sculptured with 3 weak spiral cords which increase to 4 on the third whorl. Spiral cords weak, increasing in number but diminishing in intensity on each successive whorl. Slanting axial ribs appear on fourth teleoconch whorl and are most pronounced and numerous (12–18) on median whorls of shell but become weaker and nearly lost on penultimate and body whorls. Overall fine cancellate sculpture results from intersection of axial ribs and spiral cords. Varices occasionally present as low flat axial ridges. Suture straight, deeply incised, forming ramp at posterior of each whorl that becomes most pronounced on body whorl where outer lip of aperture is slightly detached from body whorl to form anterior apertural notch. Aperture (Fig. 1H) tear-shaped, wide at base and a little over one-third the length of shell. Anterior siphonal canal virtually absent but distinguishable as shallow, depressed curve of apertural basal lip. No anal canal present. Columella slightly convex with slight but distinct median oblique fold originating from base of outer apertural lip and continuing into aperture of the shell where it ends about halfway up body whorl. Slight columellar callus present. Outer lip of aperture continuous, not broken by anterior canal, thin, smooth and slightly curved. Shell color white, flecked with small, spirally arranged, light brown spots and blotches. Largest blotches at posterior of each whorl, adjacent to suture.

Periostracum (Fig. 3D–F) thin and tan colored, covering entire shell and with spiral rows of tiny hair-like projections that correspond to underlying spiral sculpture of shell. Periostracum on live collected specimens has overall fuzzy appearance but flakes off easily when dry.

Operculum (Fig. 1J, K) dark brown, ovate and paucispiral with nucleus near the columellar edge. Operculum closes aperture when animal withdrawn.

Fig. 1. A–D. Dorsal, ventral and side views of the shell of *Diastoma melanioides* (49.7 mm long). Shell in A has been whitened with Ammonium chloride to enhance shell sculpture; E–F, Shells of the Eocene fossil *Diastoma costellata,* from the Paris Basin. Note the pronounced sutural ramp at aperture. (52 mm long). G–H. Shell apex (G), and adult whorls and aperture (H) of *Diastoma melanioides* showing details of shell sculpture; I, SEM micrograph of protoconch of *Diastoma melanioides* showing change from embryonic to juvenile shell sculpture; J–K. Operculum showing free surface (J) and attached side with muscle scar (K).

Animal: external features (Fig. 2A, B, D).—Base color white to flesh with a few tiny flecks of brownish pigment on head-snout. Head with a large, highly extensible, spade-shaped snout (*sn*) deeply incised with transverse wrinkles. Cephalic tentacles short, about one-third the length of snout, and widening to a peduncle where attached to head. A tiny black eye present

Table 1.—Analysis of shell characters of *Diastoma melanioides*. (Measurements in mm.)

Character (n = 10)	$\bar{x}$	SD	Range
Length	38.58	5.93	30–49.68
Width	11.73	1.34	9.48–14.08
No. of whorls	11.7	0.95	10–13
No. axial ribs per whorl	16.1	1.97	12–18
Aperture length	11.06	1.28	9.25–13.44
Aperture width	4.87	0.45	4.20–5.82

on outer edge of each peduncular stalk. The relatively large foot (*f*) has a propodial grove (*ppg*) (anterior pedal mucous gland). A furrow emerges from the exhalant siphon and runs down the right side of the foot. In females, a large, bulbous, vermiform ovipositor emerging from a deep pit is present on the median right side of the foot (Fig. 2B, C). Mantle edge thick, characterized by a sharply defined ridge at the exhalant siphon (*exh*). Upper margin of mantle edge bifurcate, with thin, membranous fringe from which emerges another papillated fringe (*mp*). Mantle papillae are short and fused with each other at their bases. Inhalant siphon (*inh*) marked by a thickening of mantle wall and by papillae wider than those at dorsal mantle edge. No papillae on ventral edge of mantle. Mantle thin, unpigmented, forming dorsal fold that begins at exhalant siphon and extends back for one-half of the first whorl. Major mantle organs visible through mantle wall. Tan colored, single-lobed kidney (*k*) of moderate size present. Digestive gland (*dg*) dark brown. Gonads occupy dorsal parts of upper whorls.

Mantle cavity and associated organs (Fig. 2D).—The deep, spacious mantle cavity occupies the last two whorls of the animal. A thick glandular area (*ga*) lies on the inner side of the mantle edge adjacent to the tip of the inhalant siphon. The bipectinate osphradium (*os*) is a thin brown ridge comprising about 140 thick filaments and is about 13.5 mm long and 0.2 mm wide. It lies adjacent to the ctenidium but is separated from it by a narrow margin of thin mantle tissue. The osphradium curves away from the ctenidium at its distal end and twists toward the inhalant siphon. The monopectinate ctenidium (*ct*) is large, about 17 mm long, 2.3 mm wide, and comprises 195 thin leaflets. A long, wide hypobranchial gland (*hg*) lies adjacent to the ctenidium and excretes much mucus. It is composed of thick transverse folds which become darker and wider at the distal end, adjacent to the anus and exhalant siphon. The osphradium, ctenidium and hypobranchial glands do not extend the length of the mantle cavity but end about a third of the way from its proximal end. The rectum (*r*) is filled with ovoid fecal pellets comprised of sand grains, detritus, and algal fragments. The pallial gonoducts extend the length of the mantle cavity, and are open in both sexes. The

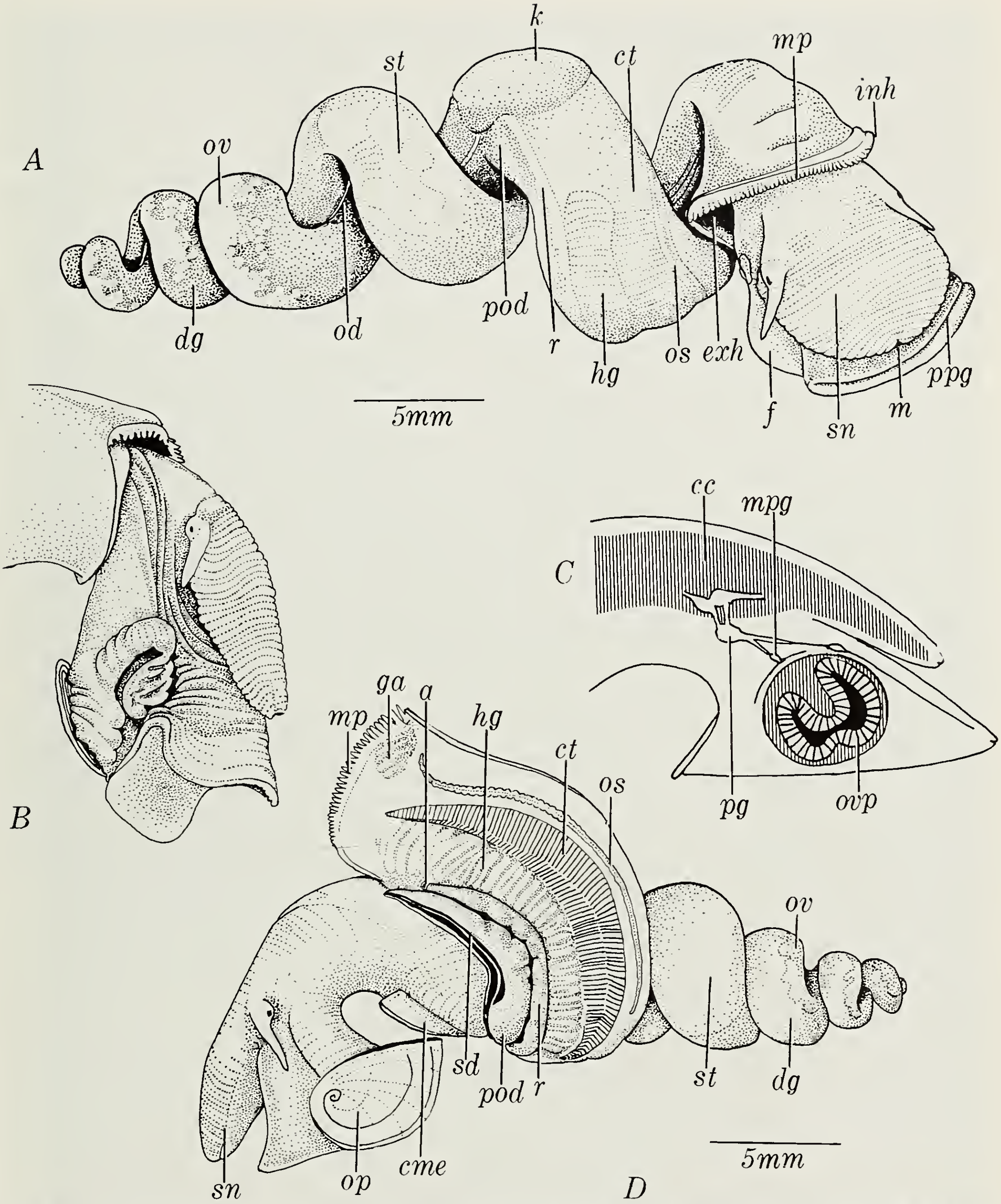

Fig. 2. A, *Diastoma melanioides,* female removed from shell and viewed from right dorsal side; B, Female showing large bulbous ovipositor on right side of foot and ciliated groove leading to it from exhalant siphon; C, Midsagittal section through head-foot showing interior of ovipositor with mucus gland, central cavity and innervation by nervous system; D, Female removed from shell, mantle cavity opened along left side and mantle folded to right.

spacious proximal mantle cavity contains a large pericardial sac that accommodates a large auricle and ventricle. The single-lobed kidney (Fig. 2A, *k*) has a large slit-like opening on its ventral surface that leads into the mantle cavity.

Alimentary system (Fig. 4).—*Diastoma* has a spacious cephalic cavity (hemocoel). The highly extensible snout is dominated by bundles of circular muscle. The mouth (*m*) is deeply recessed between the two lobes of the snout apex. The jaws (*j*) are thin and brittle, each about 1.3 mm long. Under the microscope, they appear scale-like near their cutting edges. The radular ribbon (Fig. 3A–C) is tiny, about 3.8 mm long, 0.6 mm wide and comprising 50 rows of teeth. It is about one-eleventh the length of the shell and is typically taenioglossate (2 + 1 + 1 + 1 + 2), not unlike those of some *Cerithium* species. Rachidian tooth quadrate in shape, concave laterally and convex basally. Cutting edge of rachidian has spade-shaped, pointed, central cusp flanked on each side with 2–4 smaller blunt denticles. Basal plate of rachidian tooth has pair of basolateral projections. Lateral tooth rhombiodal in shape, laterally elongate where it is attached onto the basal radular membrane. Top of lateral tooth has cutting edge with tiny inner denticle, a large, triangular, pointed cusp and 2–3 tiny denticles, respectively. Base of lateral tooth straight. Basal plate with centrally located, small, blunt peg. Marginal teeth long, slender, swollen centrally, curving and with spatulate tips. Cutting edge of inner marginal tooth has 2 sharp inner denticles, a long, pointed, central cusp and a short blunt outer denticle. Outer marginal tooth identical but lacks outer denticle.

The buccal mass (*bm*) is relatively small, about 3 mm long, and is attached anteriorly to the inner tip of the cephalic cavity by numerous, thin muscular tensors (*bt*). Originating at the center of the ventral buccal mass is a long, post-median retractor muscle that inserts on the ventral wall of the cephalic cavity. It is flanked by 2 smaller retractors. The radula sac originates at the central posterior part of the buccal mass and extends dorsally.

The esophagus (*es*) is long, narrow and loosely connected to the base and sides of the buccal body cavity by several long, thin muscles. The largest of these extend from the esophagus to the nerve ring and then to the walls of the cephalic cavity (*m*). The esophagus may thus be partially pulled through the nerve ring when the snout is extended. Attached to the dorsal surface of the anterior esophagus are a pair of long tubular, convoluted salivary glands (*sg*) which pass through the nerve ring and end on the mid-esophagus, where they are twisted to its left side (Fig. 5D). Each salivary gland empties into a side of the median buccal cavity (Fig. 4, *osd*). The

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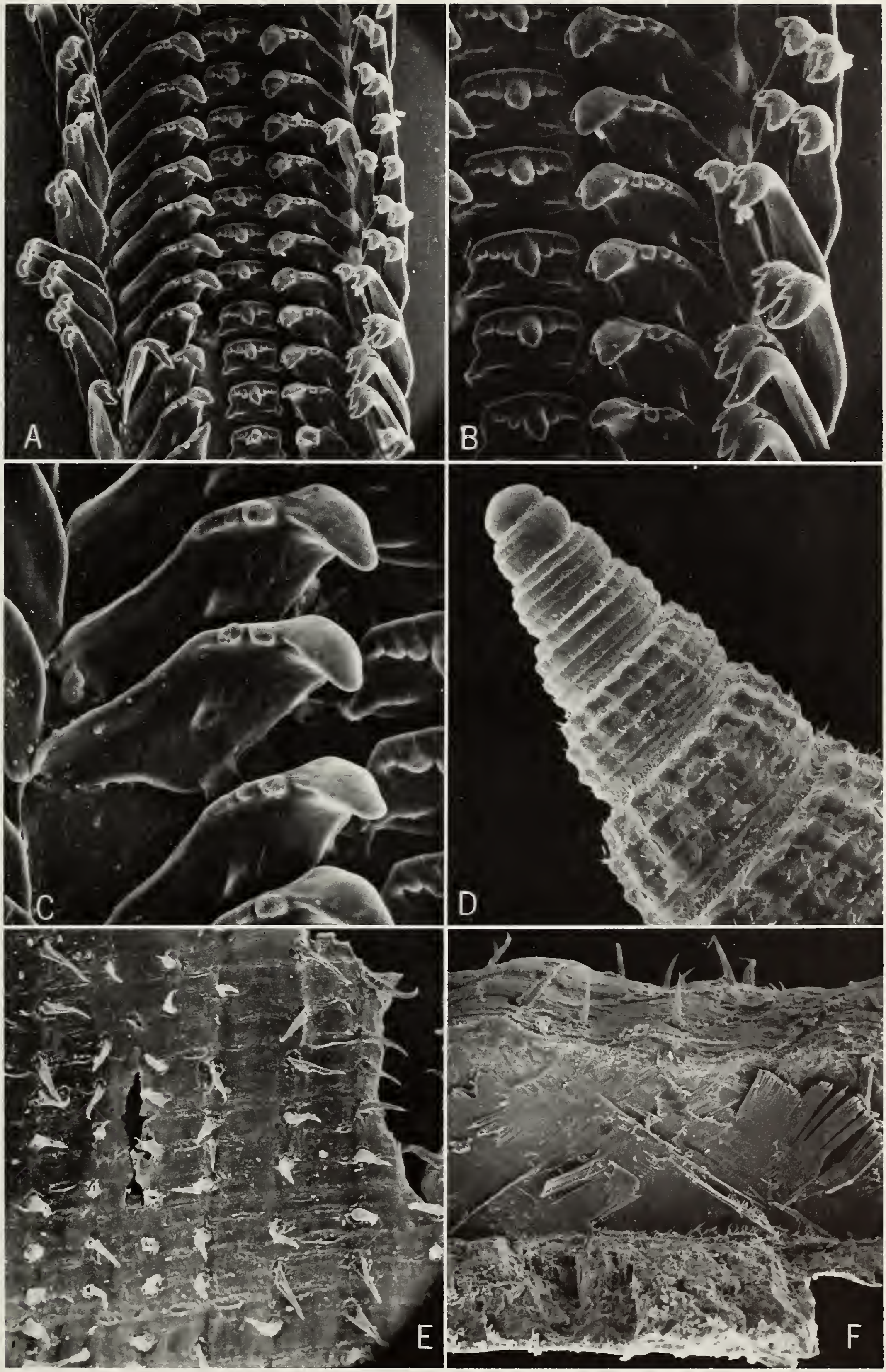
Fig. 3. SEM micrographs: A, Radula of *Diastoma melanioides* showing unworn portion of radular ribbon (0.6 mm wide); B, Details of rachidian, lateral and marginal teeth (0.3 mm wide); C, Close up of lateral tooth (0.15 mm long) showing its insertion on basal radular membrane; D, SEM micrograph of protoconch and juvenile whorls of shell to show early sculpture and periostracum (15×); E, SEM of periostracum illustrating microscopic periostracal hairs (50×); F, Cross section of shell showing periostracum at top and lamellar aragonite below (50×).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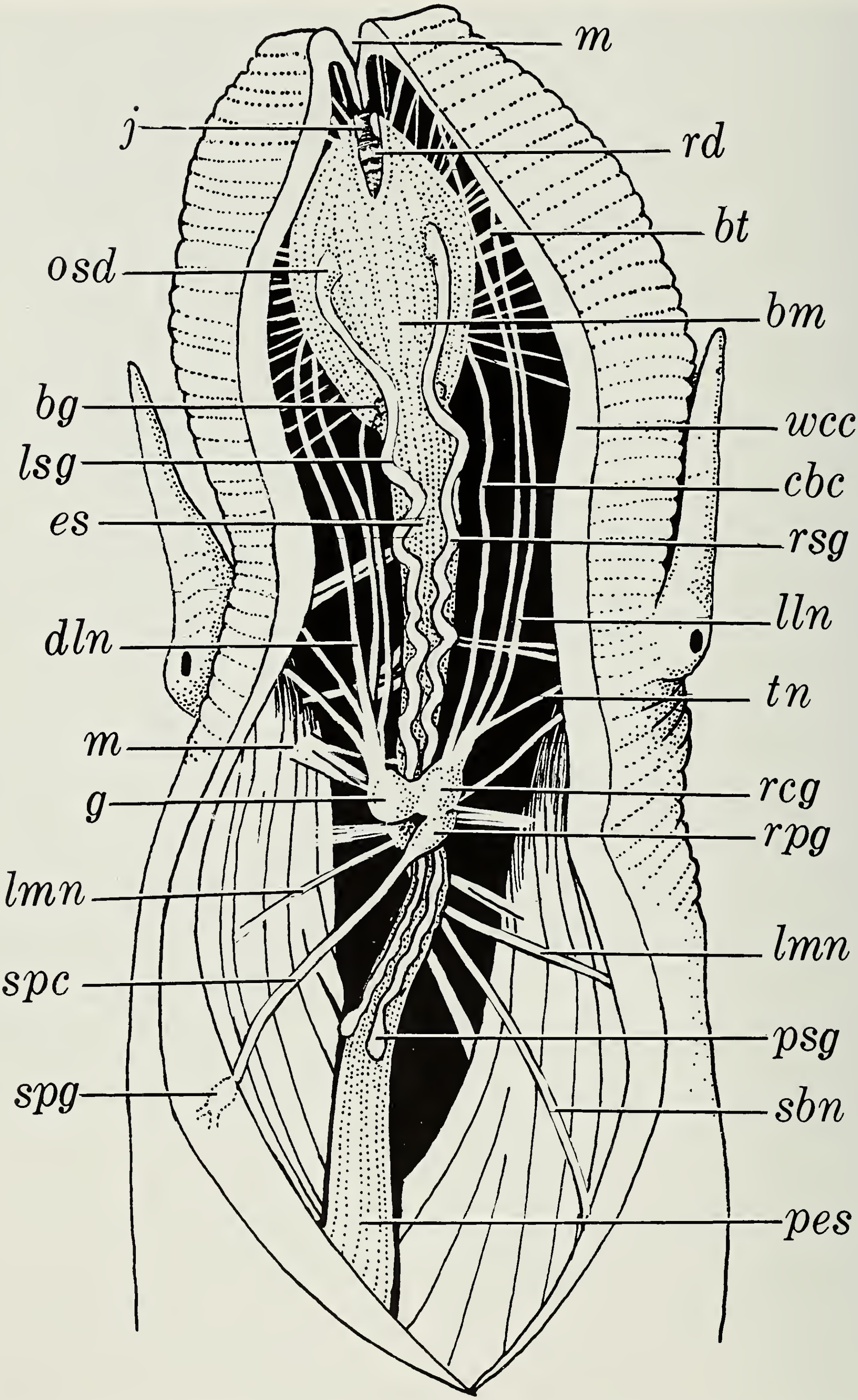

Fig. 4. Dissection of head of *Diastoma melanioides* opened by a dorsal longitudinal cut to expose cephalic cavity and anterior alimentary tract (buccal mass 3 mm long).

anterior esophagus has a dorsal food groove and two dorsal ridges (Fig. 5E) which become ventral-lateral (Fig. 5F) as they pass through the nerve ring. The mid-esophagus is flattened dorso-ventrally and the dorsal food ridges become more laterally placed.

The stomach (Fig. 5G) is typically cerithiacean and is a large organ almost one and a half whorls in length. It has a well-defined sorting area (*sa*) comprised of transverse lamellae-like folds, a style sac (*ss*), a large cuticular gastric shield (*gs*) and 2 liver ducts (*odd*). Posterior to the gastric shield is a large pad-like area (*ff*) of uncertain function which arises from the reduced spiral caecum (*sc*). No crystalline style was found but this was probably due to the preserved state of the animals.

Reproductive system (Fig. 5A).—The presence of open pallial gonoducts, aphallic males, spermatophores, and the location of the seminal receptacle are typically cerithiacean. Males are smaller than females and easily distinguished from them by the lack of an ovipositor on the right side of the foot. The narrow laminae of the pallial gonoducts are thin walled and glandular at the proximal end of the gonoduct where the outer lamina becomes thickened and white along its base. This area is probably the prostate and spermatophore-forming organ. The white testis overlays the digestive gland on the dorsal surface of each upper whorl.

The long pallial gonoduct of females is a larger, wider organ than in males (Figs. 2D, 5A). The deep slit-like oviducal groove (*og*) formed by the 2 laminae of the open duct is lined with numerous transverse folds of glandular tissue which become thick and more opaque at the proximal end of the duct. This is the albumen gland (*ag*). The pallial oviduct ends just anterior to the anus. A narrow slit, the sperm-collecting gutter (*sd*), lies along the free edge of the outer lamina (*ol*) enlarging to form a pouch-like seminal receptacle (*sr*) which is located in the post-median section of the lamina. The seminal receptacle is a flattened, kidney-shaped structure with a spongy interior that initially receives the spermatophore and also serves to hold the sperm. A central axial flap of tissue divides it into 2 chambers that join at the end. I extracted the remains of what appeared to be a disintegrating spermatophore from the inner chamber. The seminal receptacle is narrow at its proximal end and becomes a blind tube (*sr*) in the proximal part (*pod*) of the outer lamina of the oviduct. No opening from the receptacle to the oviducal groove was found.

The ovary (Fig. 2A, *ov*) lies on the dorsal surface of the digestive gland (*dg*) and is light tan. Oocytes are about 0.4 mm in diameter and are shaped like rounded triangles.

One of the most unusual structures associated with the female reproductive tract of *Diastoma* is the large ovipositor (Fig. 2B, C) on the right median part of the mesopodium. This ball-like pad has a crescent-spiral configuration that sinks into a deep pit at its center (Fig. 2C, *ovp*). The pit leads into

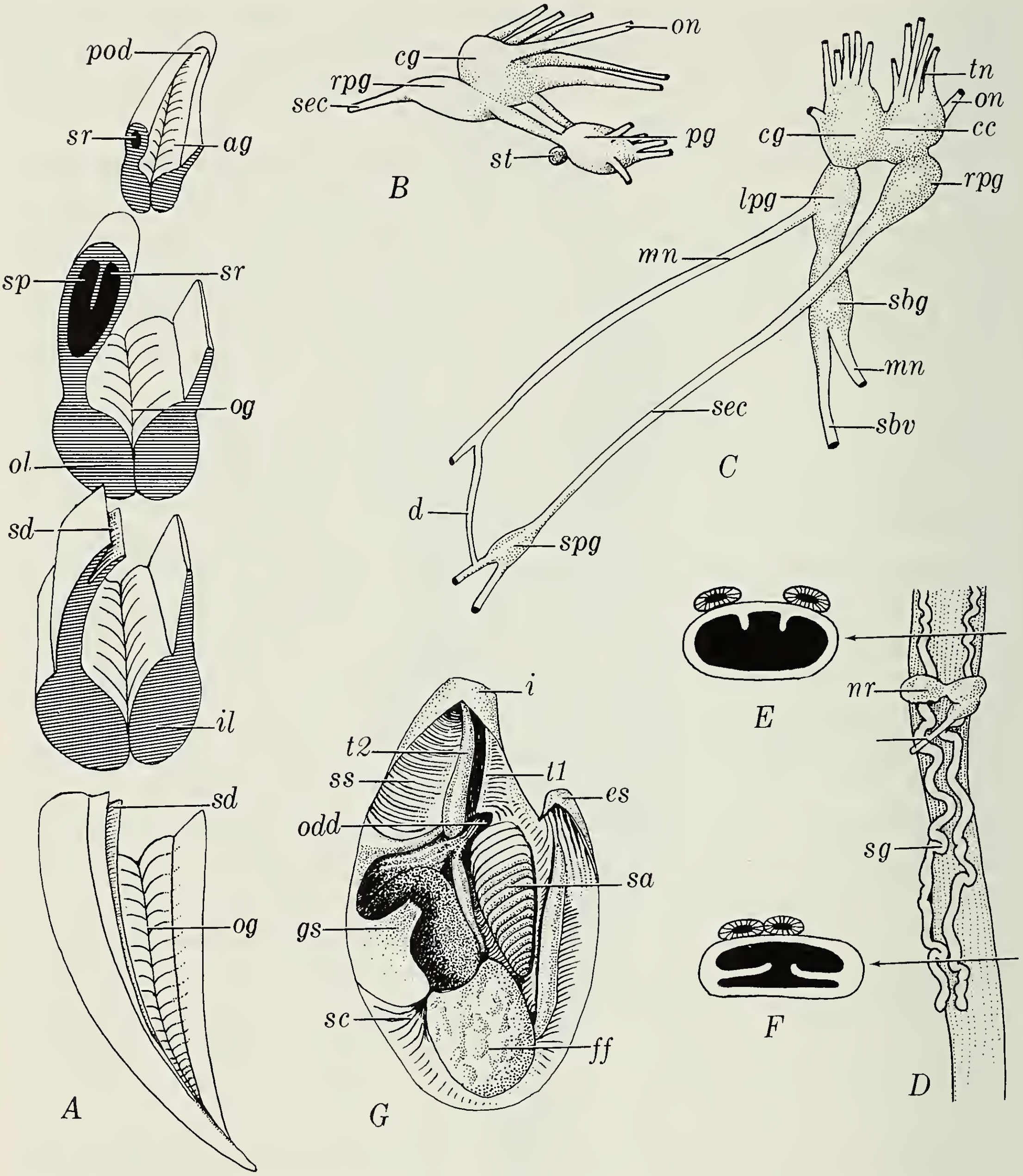

Fig. 5. A, Diagrammatic representation of pallial oviduct with sections of duct cut away to show arrangement of laminae and associated ducts, spermatophore and seminal receptacles. Pallial oviduct is 10 mm long and oriented with distal end at bottom of figure; B, Lateral view of cerebropedal complex; C, Dorsal view of nerve ring and associated nerves; D, Anterior and mid-esophagus with nerve ring and salivary glands; E, Section through anterior esophagus showing dorsal folds and salivary ducts; F, Section through mid-esophagus showing ventral-lateral (dorsal) folds and salivary ducts; G, Stomach opened with a mid-dorsal longitudinal cut to expose inner anatomy.

a large cavity in the center of the foot. The cavity is lined with thick glandular tissue embedded in the muscular mesopodium and is connected with the pedal hemocoel. The organ and cavity taper toward the left side of the foot. The ovipositor is innervated by a pair of nerves originating from the metapodial ganglia (*pg*). Although the exact function of the ovipositor was not observed, it is undoubtedly associated with the formation of the jelly egg mass. In preserved specimens the cavity is filled with a viscous mucus and continues to emit mucus when placed in water. There is no evidence that it is a brood sac.

Nervous system (Fig. 4, 5B, C).—*Diastoma* has an epiathroid nervous system that is moderately condensed with a layout typical of cerithiaceans. The RPG ratio of Davis et al. (1976:263) (length of the pleurosupra–esophageal connective divided by the sum of the lengths of the supraesophageal ganglion, pleuro-supraesophageal connective and right pleural ganglion) is 0.69, a median value between those observed in members of the Cerithiidae and the Potamididae. The most characteristic features of the nervous system are the long labial (Fig. 4, *lln, dln*) and proboscis nerves which emerge from the cerebral ganglia (*rcg, lcg*). These lie free within the cephalic cavity in a "loose" state and are surrounded with little connective or muscular tissue. The large cerebral ganglia (Fig. 5B, C, *cg*) are almost fused to each other. Each of the pleural ganglia (*rpg, lpg*) are joined to the cerebral ganglia with short thick connectives. The right pleural ganglion (*rpg*) gives rise to a long supraesophageal connective (*sec*) that ends in the supraesophageal ganglion (*spg*) which is embedded in the left body wall. This ganglion emits a nerve that is connected to the left mantle nerve by a long dialyneury (*d*). The left pleural ganglion (*lpg*) is joined to the subesophageal ganglion by a short thick connective. A long visceral nerve (*sbv*) and a typical visceral loop are present. The 2 pedal ganglia (*pg*) are joined to the cerebral and pleural by moderately short, slender connectives. The pedal commissure is short and thick. A large statocyst (*st*) containing numerous statoliths lies at the posterior base of each pedal ganglion. Two long major connectives run from each pedal ganglion to the propodial and mesopodial ganglia (Fig. 2C, *mpg*). The mesopodial ganglia give rise to the nerves that innervate the ovipositor. All ganglia are pink in color.

Systematics

Diastomidae Cossmann, 1894:322; 1906:173–174.—Wenz, 1940:749–750.—Pchelintsev and Korobkov, 1960:159.—Franc (*in* Grassé) 1968:281.—Gründel, 1976:71–75.—Ladd, 1972:27.—Wilson and Gillett, 1979:61.—Rehder, 1980:33 (*non* Diastomidae Cossmann).

Diastomatidae (emend. *pro* Diastomidae) Ludbrook, 1971:31; 1978:112.

This family comprises many fossil species and one Recent one. It is characterized by individuals having turreted, elongate shells with convex whorls and ovate apertures with continuous outer lips and wide shallow anterior canals. Former varices are normally present. A paucispiral operculum, taenioglossate radula, paired salivary glands, stomach with style sac and gastric shield, a deep mantle cavity with open pallial gonoducts, and the absence of a penis are characteristic of the living animal.

Remarks.—The family, as originally proposed by Cossmann (1894:322–323), included a group of fossil genera (*Sandbergeria* Bosquet, *Cryptaulax* Tate, *Exelissa* Piette, *Teliostoma* Harris and Burrows, *Aurelianella* Cossmann) centered around the genus *Diastoma* Deshayes. Cossmann (1906:173) subsequently treated the family in more detail and added the genera (subgenera) *Aneurychilus* Cossmann and *Cerithidium* Monterosato. With the exception of *Cerithidium* and *Diastoma,* all of these taxa represent fossil groups. Cossmann appears to have been unaware that *Diastoma* is still extant in southern Australia, represented by *Diastoma melanioides* Reeve. This is probably due the the fact that Reeve (1849) originally placed it in *Mesalia,* a turritellid genus.

The original concept of the family is somewhat heterogenous, exemplified by Cossmann's (1906:174) division of the family into "cerithid," "rissoid" and "bacilliform" groups. The subsequent expansion of the family by the inclusion of various other small-shelled groups has distorted the family concept into an unnatural polyphyletic group. This is reflected in the literature and has been recently acknowledged by Ludbrook (1971) and Gründel (1976). A brief summary of the history of the family concept follows.

Initially, the family was expanded to include other genera of small-shelled mesogastropods by Dall (1889:258), who, misled by Deshayes' (1861:413) statement of an affinity between *Diastoma* and the rissoids, also suggested that *Diastoma* was related to *Alaba* and a *Bittium* species. It is likely that Dall had never seen the fossil *Diastoma* species from the Paris Basin and merely compared the figures of them with *Alaba* and the common southeastern Atlantic species, *Bittium varium* Pfeiffer. He was also unaware of the existence of the living relict, *Diastoma melanioides.* Dall's (1889) assignment of *Bittium varium* to *Diastoma* probably led other workers such as Bartsch (1911), Wenz (1940) and Franc (1968) to equate cerithiacean species of the genera *Finella, Alaba,* and *Alabina,* all having small shells with shallow anterior canals which superficially resemble those of the large fossil *Diastoma* species, with the Diastomatidae. Both Wenz (1940) and Franc (1968) synonymized the Finellidae and the Alabinidae with the Diastomatidae. Neither worker was aware that a living species of *Diastoma* existed. This led more recent authors such as Ladd (1972:27), Kensley (1973:281), and Abbott (1974:107) incorrectly to assign other small-shelled cerithiacean snails of the genera *Bittium, Alabina, Obtortio,* and *Diala* to the Diastomatidae.

Tate (1894:176–177), Finlay and Marwich (1937:42), Marwick (1957:163), and Ludbrook (1971) were the only authors to point out that *Diastoma* has a living representative. Ludbrook (1971) also noted that many of the small cerithiids referred to *Diastoma* should be excluded from that group. Her treatment of the family, although brief, is substantially in agreement with my findings.

Gründel (1976) suggested that the Diastomatidae was a primitive group which arose in the Triassic and gave rise to the Cerithiacea. He believed that the Cerithiidae split off from the Diastomatidae in the Cretaceous and that *Diastoma* was a short-lived unsuccessful side branch of mainstream cerithiacean evolution. Within his classificatory scheme, Gründel (1976:75) divided the Diastomatidae into two subfamilies, the Diastominae, which included the Bittiinae and Diastomiinae, and the Finellinae to which he assigned the tribes Finellini and Scaliolini. Thus he included within the subfamily Finellinae genera such as *Sandbergeria, Eufinella, Obtortio, Fesandella,* and *Scaliola*. Gründel did not cite Ludbrook's (1971) paper and made no mention of the living species, *Diastoma melanioides*. His treatment of the family placed much emphasis on sculptural characters of the protoconch and early teleoconch; moreover, he grouped genera solely on the basis of morphological similarity. I thus find his conclusions unsatisfactory. For instance, his assignment of *Bittium* to the Diastomatidae is incorrect because anatomical evidence shows that *Bittium* is closely related to *Cerithium* and falls within the Cerithiidae (see my recent remarks on this subject, Houbrick, 1980:4–5). The *Finella* group is also more properly assigned to the Cerithiidae (Houbrick, 1980:4), and species in the *Scaliola* group are anatomically unknown. Thus Gründel's (1976) subfamily Fenellinae is a polyphyletic group and should be excluded from the Diastomatidae.

The family name Diastomidae was correctly changed to Diastomatidae by Ludbrook (1971:31) and the latter will be used throughout this paper. Abbott (1974:107), Gründel (1976:71), and Rehder (1980:33) all incorrectly dated the family name from 1895, but Cossmann's original proposal of the family was published in 1894.

Gründel (1976:76), in a rather lengthy treatment of the Diastomatidae, concluded that the genus *Diastoma* is closely related to *Bittium,* due to similarity in shell features. His lack of acquaintance with the living species and excessive reliance on ontogenetic characters derived from protoconch and sculpture render his conclusions inadequate. Too much is known of the plasticity of developmental modes of cerithiaceans to accept protoconch shape and sculpture as conservative characters for phylogenetic speculation. Gründel's (1976:88) judgement that the presence of a well-defined anterior siphonal canal in *Bittium* species constitutes only a trivial difference ignores the functional significance of such a difference. *Bittium* species are tiny snails that live on algae or hard substrata and represent a completely different adaptive radiation from the *Diastoma* lineage, which is adapted for burrowing in a sandy substrate.

Study of the living species, *Diastoma melanioides,* has supplied additional characters derived from the radula and anatomy which more tightly define the family limits. It is apparent that several of the small-shelled cerithiacean taxa discussed above should be excluded from the Diastomatidae and that the family as defined herein, comprises an extinct Tethyan group with a sole survivor living in south Australia. The exact status and placement of *Obtortio* and *Alaba* remain unknown until more is known of their anatomy.

Diastoma Deshayes, 1850

Diastoma Deshayes, 1850:46; 1861:411–413 (Type-species, by monotypy, *Melania costellata* Lamarck, 1804).—Tate, 1894:176–177.—Fischer, 1884:682–683.—Harris, 1897:231–232.—Cossmann, 1889:34–35; 1906:175–176.—Bartsch, 1911:581 (*non Diastoma* Deshayes).—Grant and Gale, 1931:758 (*non Diastoma* Deshayes).—Olsson, 1929:22 (*non Diastoma* Deshayes).—Wenz, 1940:749–750 (in part).—Ludbrook, 1957:22 (in part).—Pchelintsev and Korobkov, 1960:159.—Keen, 1963:32–86. (*non Diastoma* Deshayes).—Abbott, 1974:107 (*non Diastoma* Deshayes).—Emerson and Jacobson, 1976: (*non Diastoma* Deshayes).—Gründel, 1976:73–74, 76.—Houbrick, 1977:102; 1980a:3–4.—Ludbrook, 1978:112.

Neodiastoma Cotton, 1932:541 (Type-species, by original designation, *Mesalia melanioides* Reeve, 1849).—Finlay and Marwick, 1937:42.—Marwick, 1957:162–163.—Götting, 1974:129.

Description.—Shell turreted, elongate, of moderate size with inflated whorls and ovate aperture that is broad at base and narrow posteriorly where the outer apertural lip joins the body whorl to form a sutural notch. Sculpture consists of axial ribs, thin spiral cords and occasional varices. Suture deeply incised. Columella concave with slight median, oblique fold. Anterior siphonal canal wide and shallow, not distinct from base of outer apertural lip. Outer lip of aperture thin and slightly sinuous. Operculum ovate, corneous, paucispiral, and with eccentric nucleus. Periostracum with tiny hairs. Radula taenioglossate (2 + 1 + 1 + 1 + 2). Mantle cavity deep. Ctenidium and osphradium do not extend length of mantle cavity. Salivary glands tube-like and extending through the nerve ring. Style sac and gastric shield present. Pallial gonoducts open in both sexes, males aphallate; seminal receptacle and spermatophore pouch in outer lamina of pallial oviduct. Females have a large ovipositor on right median part of mesopodium extending into center of foot and innervated by mesopodial ganglion. Nervous system epiathroid, moderately condensed with long labial and proboscis nerves and left dialyneury. Reproduction dioecious; spermatophores present; spawn and larvae unknown.

Remarks.—This genus comprises a compact group of relatively large-shelled, distinctive looking mesogastropods most of which are extinct. It is now represented by a single living species in a very restricted area along the coast of southern Australia (Fig. 6). Proposed by Deshayes in 1850, the genus is best known from the Eocene of the Paris Basin. The original generic citation in the *Atlas* of the *Traité Élémentaire de Conchyliologie* mentioned only the name, *Diastoma*. The type-species is *Melania costellata* Lamarck, 1804, by monotypy. Deshayes (1861:411) later described the genus in considerable detail from four Paris Basin species and discussed his reasons for transferring *Melania costellata* to *Diastoma*. Deshayes (1861) further remarked that *Diastoma* only superficially resembled the melanians and that the genus was closer to the Rissoidae. This has unfortunately led to confusion about the generic limits and has resulted in a polyphyletic familial concept, as discussed previously.

Tate (1894:176–177) was first to note that an Australian fossil, *Diastoma provisi* Tate, 1894, was congeneric with the living Australian snail, *Diastoma melanioides*. The latter was originally assigned by Reeve (1849) to *Mesalia* Gray, a turritellid genus. Tate (1894) noted that it superficially resembled *Mesalia,* but differed from other species in that genus by having a columellar plait, a straight outer lip, and varices. He thus transferred *Mesalia melanioides* to the genus *Diastoma*. Finlay and Marwick (1937:42) assigned *Diastoma* to the Melaniidae (=Thiaridae Troschel).

Cotton (1932:541) proposed the genus *Neodiastoma* which he assigned to the Cerithiidae to accommodate the recent species, *Diastoma melanioides*. He noted that this species differed from fossil *Diastoma costellata* by the "anterior notch of the outer lip" in the latter. Ludbrook (1971:31–32) pointed out that not all specimens of *Diastoma costellata* have the aperture separated at the suture to the same degree; thus, the presence of a sutural ramp in association with the outer lip of the anterior aperture is a variable feature. Moreover, examination of a series of Recent *Diastoma melanioides* shows that this species also has a sutural ramp at the anterior aperture although it is not as pronounced as in *Diastoma costellata*. I have figured specimens of *D. costellata* with pronounced ramps (Fig. 1E–F). A single variable shell character which is present in both fossil and Recent species does not constitute a reasonable generic character. I concur with Ludbrook (1971) that *Neodiastoma* is a synonym of *Diastoma*. Cossmann (1889:34) originally suggested that the genus was similar to *Semivertagus* Cossmann and *Fastigiella* Reeve in the placement of the median columellar fold, but I think this is more easily explained by convergence. Cossmann (1906:175) later remarked that the genus was an "ambiguous" one and noted the superficial similarity between *Diastoma* and the freshwater genus *Melania*. He did not agree with Dall's (1889) referral of *Bittium varium* Pfeiffer to *Diastoma* and considered it a true *Bittium* species with a rudimentary canal which superficially resembled that of *Diastoma*.

Fossil record.—According to Cossmann (1906:176), this genus may date back to the Cretaceous (Senonian) but the assignment of fossils from this Period to *Diastoma, s.s.,* is unlikely. The genus, as defined herein, was present in the Paleocene but is best known from the Eocene and Oligocene of the Paris Basin. *Diastoma* species [Cossmann (1906) recorded 12] were widespread in the Tethys Sea. Ludbrook (1971:31) recorded the genus from Egypt, the East Indies, and North and South America, but gave no citations to support this statement. Although I have made a literature search, I have been unable to confirm the presence of *Diastoma* fossils in these areas. The genus is found in the Australian Miocene, early Pliocene, and Pleistocene where it is represented by three fossil species (Ludbrook 1971:31; 1978:112), one of which, *Diastoma melanioides,* survives to the present.

Diastoma melanioides (Reeve, 1894)

Mesalia melanioides Reeve, 1849: *Mesalia,* fig. 3, sp. 3 (Holotype: BM(NH); Type-locality, here selected: (Esperance, Western Australia).
Diastoma melanioides (Reeve), Ludbrook, 1971:32; 1978:112.
Diastoma melanoides Tate, 1894:177 (err. *pro melanioides* Reeve).
Mesalia exilis Sowerby, 1913:236, pl. 3, fig. 9 (Holotype: BM(NH); Type-locality: "West Australia."
Neodiastoma melanioides (Reeve), Cotton, 1832:541.

Synonymic remarks.—Reeve (1849) first described this species from an unknown locality and remarked that "the generic pecularities of *Mesalia* are well represented in this species." This observation does not conform to the facts: *Mesalia* species are anatomically unknown but are thought to be members of the family Turritellidae and do not have the median columellar fold seen in *Diastoma melanioides.* Sowerby later (1913:3, 236) described the same species, naming it *Mesalia exilis,* but remarked that he was uncertain of its generic allocation. He cited West Australia as the habitat but Cotton (1932:541) noted that the type of Sowerby's *Mesalia exilis* came from Esperance Bay, Western Australia. Sowerby (1913) was either unaware of Reeve's (1849) previous description of *Mesalia melanioides* or did not regard Reeve's species to be conspecific with *Mesalia exilis.* These two taxa are, nevertheless, conspecific. Tate (1894) was the first to transfer Reeve's species from *Mesalia* to *Diastoma* and his decision was reconfirmed by Cotton (1932:541) who elected to give the living form a different generic name, *Neodiastoma.*

Ecology

Nothing has been recorded about the ecology of this species. Museum data and observations made by Mr. A. Longbottom (pers. comm.) have supplied the sparce information presented below. *Diastoma melanioides* lives subtidally in depths of 1–5 meters where it burrows in clean white sand

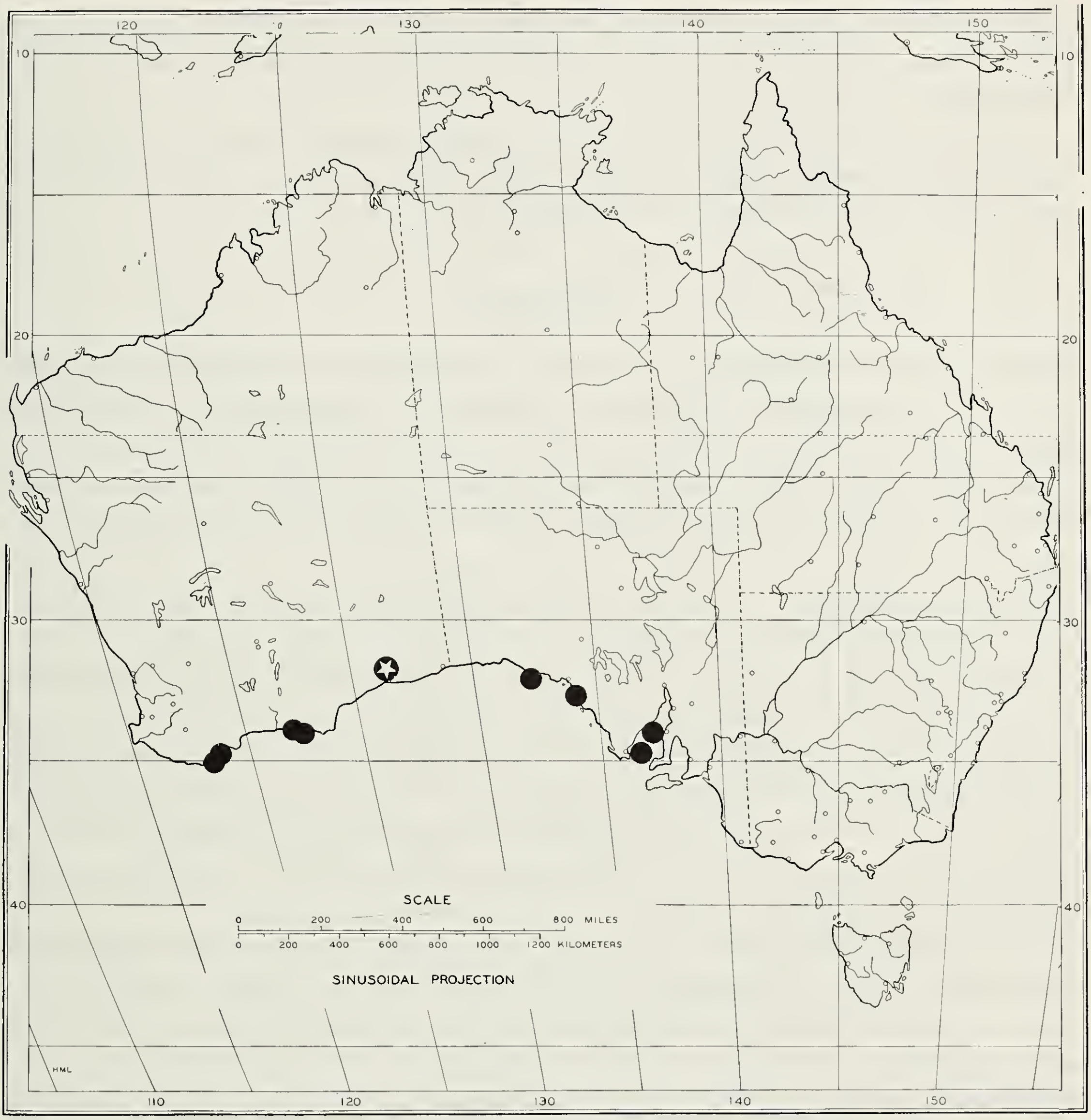

Fig. 6. Geographic distribution of *Diastoma melanioides* based on museum specimens and records cited by Ludbrook (1957). Star represents a fossil from the Ecula Basin.

associated with grass beds and algae. Its presence may be detected by long trails in the sand. The large gastric shield and style sac indicate an herbivorous mode of feeding; moreover, the tiny jaws, small taenioglossate radula, stomach contents, and fecal pellets comprised of fine sand grains and detritus suggest that *Diastoma* feeds on microalgae and detrital particles found in the sandy substrate. Repaired shells indicated that this species is attacked by crabs. Although no drilled shells were seen, the sandy habitat also suggests possible predation by naticid snails. Paired snails were collected in June (Longbottom, pers. comm.) and large ova were found in the ovaries of preserved animals collected in July. This may indicate an early winter breeding season. The spawn is undescribed, but the presence of a large ovipositor and associated mucoid-jelly gland suggests a jelly-like spawn mass not unlike those described for other cerithiacean snails. The bulbous, smooth protoconchs and restricted distribution are indicative of direct development.

Ludbrook (1971:30) presented a map showing the summer isotherms of the Great Australian Bight. These indicate that *Diastoma* lives well within the warm temperature 19–20°C isotherms.

Conclusions

The shell and anatomy of *Diastoma melanioides* establish beyond doubt that it is the superfamily Cerithiacea. Features common to the superfamily are the open pallial gonoducts, aphallic males, and general layout of the alimentary tract which includes a taenioglossate radula, paired salivary glands and stomach with a style sac, gastric shield, and reduced spiral caecum.

Distinctive features which establish the familial status of the group are the elongate shell with its wide aperture, indistinct inhalant siphonal canal, and deeply impressed suture and ramp. The shell shape is much like those of the freshwater melanians. The thick, slightly hairy periostracum is an unusual trait for a burrowing snail. I know of no other cerithiacean having a similar periostracum although *Campanile symbolicum,* which is sympatric with *Diastoma,* has a strange calcified periostracum (Houbrick, 1981*a*).

The anatomy of *Diastoma* differs markedly from other cerithiaceans by a number of diagnostic features:

1) The highly extensible snout and large cephalic cavity are notable characters. The snout of *Diastoma* is wider and longer in relation to body size than in most cerithiaceans but there is some resemblance to burrowing, sand-dwelling cerithiid snails such as *Rhinoclavis fasciata* (Bruguiere), *R. vertagus* (Linnaeus) and *R. aspera* (Linnaeus) (Houbrick, 1978). The relatively small buccal mass, jaws, and generalized taenioglossate radula are not diagnostic at the familial level.

2) The paired worm-like salivary glands extend through the nerve ring, are unusually long and simple, and constitute a distinctive character. In contrast to *Diastoma,* the salivary glands of all observed cerithiid and modulid snails are spongy masses of tissue having long, thin ducts and, with the exception of a small part of the left salivary gland, lie anterior to the nerve ring (Houbrick, 1980:124). Some members of the Potamididae, such as *Cerithidea scalariformis* (Say) and *Batillaria minima* (Gmelin) have more simple, worm-like salivary glands like *Diastoma* but the greater part of these glands lies well anterior to the nerve ring (personal observation).

3) An unusual feature of the anterior and mid-esophagus of *Diastoma* is its loose connection to the walls of the spacious cephalic cavity by numerous, long muscular strands. The muscles are inserted on the esophagus

where it passes through the nerve ring and are also loosely connected to the ganglia. The esophagus is thus able to move somewhat through the nerve ring when the snout is extended. I have not seen this kind of anatomical flexibility in the anterior esophagus of any other cerithiacean.

4) The pallial gonoduct of *Diastoma* has a simple, generalized arrangement. The spermatophore pouch and seminal receptacle are located in the outer lamina of the pallial oviduct and comprise a simple, bifurcate chamber. Other cerithiaceans, such as the cerithiids, modulids, melanians, and turritellids, while having a similar ground plan to the pallial oviduct, display greater complexity in the internal structures associated with the seminal receptacle, spermatophore pouch and sperm collecting gutters.

5) An unusual diagnostic character of *Diastoma* is the large, complex ovipositor which is found on the mesopodium of females. Although ovipositors have been noted in other marine cerithiacean snails such as *Cerithium* (Marcus and Marcus, 1964:500) and *Modulus* (Houbrick, 1980b:121), I know of no other marine snail in which there is a large mucus-producing gland located within the center of the mesopodium and connected to the external ovipositor. It is assumed that this gland contributes to the formation of the egg mass, which is probably very gelatinous. Belgin (1973:390, fig. 7) has shown a very similar ovipositor in *Zemelanopsis,* a freshwater melanian snail, but gave no details about its internal structure other than to say that it was a deep pit bordered by a muscular lobe.

6) A diagnostic feature of the nervous system of *Diastoma* is the length of the labial and buccal nerves and the innervation of the ovipositor organ by the mesopodial ganglion and its ancessory nerves. The nervous system is moderately concentrated having an RPG ratio which lies between the values observed in members of the Cerithiidae and Potamididae.

7) In *Diastoma,* the proximal ends of the osphradium, ctenidium, and hypobranchial gland are not located at the posterior end of the mantle cavity. Instead they begin anterior to it, which is an unusual feature. In members of the Cerithiidae, Potamididae, Modulidae, and Turritellidae, these organs extend the length of the mantle cavity, but in freshwater melanian species of *Zemelanopsis* they appear to be shortened as in *Diastoma* (Belgin, 1973:390, fig. 7).

While taxonomic criteria for the familial status of a group are ill-defined and somewhat arbitrary, I believe that the characters derived from the shell and anatomy of *Diastoma* are of sufficient diagnostic weight to establish the group as a distinct family. To these I add the additional evidence of a long fossil record which shows that these species comprised a distinct group since the early Tertiary. It may be argued that the overall resemblance of *Diastoma* to the cerithiids is quite close and that the evidence for familial status is not convincing. Nevertheless, the observed differences indicate to me a higher taxonomic category for the group than a generic one.

The shell and anatomy of *Diastoma* are most like those observed in members of the Cerithiidae and Potamididae and very much like those of some species of the freshwater family Melanopsidae H. and A. Adams. It is possible that *Diastoma* is the marine branch of that family, but not enough comparative material has been analyzed to say more on this subject. Although this resemblance may be due to convergence, it is likely that the Diastomatidae are closely related to these cerithiacean families. The shell of *Diastoma,* in contrast to those of members of the above-mentioned families, lacks a distinct anterior canal and its aperture is more like those seen in smaller-shelled members of the Dialidae. There may be a relationship between these two groups but nothing is now known of the anatomy of *Diala*.

The relationship between *Diastoma melanioides* and the Australian fossil *Diastoma* species is clearly a close one (Ludbrook, 1971:131). There is no way to demonstrate with certainty that this Australian assemblage belongs to the same lineage as the Tethyan group of European fossils which bears the same generic name. As is so often the case, the type-species of the genus, *Diastoma costellata,* is rather atypical of the group. The axial ribs are more pronounced and the sutural ramp, formed where the outer lip meets the body whorl, is more exaggerated than in most *Diastoma* species (see illustrations in Fig. 1E–F). Examination of a number of specimens of this species shows that this character varies in intensity and is most pronounced in older specimens. Moreover, other Tethyan *Diastoma* species do not have this feature in so pronounced a state. It should also be noted that a similar, but weaker sutural ramp is present in the living species and was figured by Ludbrook (1971:fig. 13).

The main conchological difference between the Australian and European fossils is the presence of the median columellar fold in species of the former. This fold does not extend up the shell axis but appears to be merely a thickening of the columellar callus. Cotton (1932), noting this difference between the living species and the European fossils, considered it to be of generic significance. I do not believe a simple character should be so heavily weighted. Although the two assemblages may constitute different generic taxa, I regard them as being of the same lineage and prefer to retain all species with the genus *Diastoma* until more detailed analysis of the fossil species is made.

Members of the Diastomatidae probably lived throughout the Tethys Sea during the Tertiary. Other Tethyan survivors are found in the Australian region and include prosobranchs such as *Campanile symbolicum* Iredale (Houbrick, 1981a), *Gourmya gourmyi* (Crosse) (Houbrick, 1981b), and the bivalve genus *Neotrigonia,* family Trigoniidae, which became largely extinct in the Cretaceous. These relict species probably remained in the Australian area after the closure of the Tethys in the Miocene.

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Literature Cited

Abbott, R. T. 1974. American Seashells. The Marine Mollusca of the Atlantic and Pacific Coasts of North America, 2nd Ed. New York, 663 pp., 24 pls.

Bartsch, P. 1911. The Recent and fossil mollusks of the genus *Diastoma* from the west coast of America.—Proceedings of the United States National Museum 39:581–584.

———. 1911. The Recent and Fossil Mollusks of the Genus *Alabina* from the west coast of America.—Proceedings of the United States National Museum 39:409–418, pls. 61–62.

Belgin, F. H. 1973. Studies on the functional anatomy of *Melanopsis praemorsa* (L.) and *Zemelanopsis trifasciata* (Gray). Proceedings of the Malacological Society of London 40(5):379–393.

Cossmann, M. 1889. Catalogue illustré des Coquilles Fossiles de l'Éocène des environs de Paris.—Annales de la Société Royale Malacologique de Belgique 24:3–381, pls. 1–9.

———. 1894. Revision sommaire de la faune du Terrain oligocene marin aux environs d'Etampes.—Journal de Conchyliologie 41:297–363.

———. 1906. Essais de Paleoconchologie Comparee 7:261. Paris.

Cotton, B. C. 1932. Notes on Australia Mollusca with descriptions of new genera and new species.—Records of the South Australian Museum 4(4):537–547.

Dall, W. H. 1889. Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico (1877–78) and in the Caribbean Sea (1879–80), by the U. S. Coast Survey Steamer "Blake," Lieut.-Commander C. D. Sigsbee, USN, and Commander J. R. Bartlett, USN, commanding. Report on the Mollusca. Part 2 Gastropods and Scaphopoda.—Bulletin of the Museum of Comparative Zoology 18(29):1–492, 40 pls.

Deshayes, G. P. 1850. Traité Élémentaire de Conchyliologie, Atlas, 80 pp., 132 pls.

———. 1861–1864. Description des Animaux sans Vertebrés découverts dans la Bassin de Paris. Paris. vol. 2, text: Mollusques, Acéphales monomyaires et Branchiopodes.—Mollusques Céphalés, premiere partie, 968 pp., atlas, 64 pls.

Emerson, W. K., and M. K. Jacobson. 1976. The American Museum of Natural History Guide to Shells: Land, Freshwater, and Marine, from Nova Scotia to Florida.—New York. i–xviii + 482 pp., 17 pls.

Finlay, H. J., and J. Marwick. 1937. The Wangaloan and associated Molluscan Faunas of Kaitangata—Green Island Subdivision.—New Zealand Geological Survey Branch. Palaeontological Bulletin No. 15:1140, 17 pls.

Franc, A. 1968. Classe des Gastéropodes (Gastropoda Cuvier, 1798) [*in*] Grassé, P. P. (ed.), Traité de Zoologie, Anatomie, Systématique, Biologie. Vol. 5, Mollusques Gastéropodes et Scaphopodes (Fascicule III).—Paris, 1083 pp.

Fretter, V., and A. Graham. 1962. British prosobranch molluscs: their functional anatomy and ecology.—Ray Society, London. 775 pp., 317 figs.

Götting, K. 1974. Malakozoologie, Grundriss der Weichtierkunde.—Stuttgart, 320 pp.

Grant, U. S., and H. R. Gale. 1931. Catalogue of the Marine Pliocene and Pleistocene Mollusca of California and Adjacent Regions.—Memoirs of the San Diego Society of Natural History 1:1–1036, 32 pls.

Gründel, J. 1976. Zur Taxonomie und Phylogenie der *Bittium*-Gruppe (Gastropoda, Cerithiacea).—Malakologische Abhandlungen Staatlisches Museum für Tierkunde in Dresden 5(3):33–59, 15 figs.

Harris, G. F. 1897. Catalogue of Tertiary Mollusca in the Department of Geology, British Museum (Natural History). Part 1, The Australasian Tertiary Mollusca.—London, British Museum (Natural History) 1–407, pls. 1–8.

Houbrick, R. 1977. Reevaluation and new description of the genus *Bittium* (Cerithiidae).—The Veliger 20(2):101–106.

———. 1978. The family Cerithiidae in the Indo-Pacific, Part I: The genera *Rhinoclavis, Pseudovertagus* and *Clavocerithium*.—Monographs of Marine Mollusca 1:1–130, 98 pls.

———. 1980a. Review of the Deep-Sea Genus *Argyropeza* (Gastropoda: Prosobranchia: Cerithiidae).—Smithsonian Contributions to Zoology, No. 321:1–30, 12 figs.

———. 1980b. Observations on the anatomy and life history of *Modulus modulus* (Prosobranchia: Modulidae).—Malacologia 20(1):117–142.

———. 1981a. Anatomy, biology and systematics of *Campanile symbolicum* Iredale with reference to adaptive radiation of the Cerithiacea (Gastropoda: Prosobranchia).—Malacologia (in press).

———. 1981b. Anatomy and Systematics of *Gourmya gourmyi* (Prosobranchia: Cerithiidae), a Tethyan Relict from the south west Pacific.—The Nautilus 95(1):2–11.

Keen, A. M. 1963. Sea Shells of Tropical West America. 2nd Ed.—Stanford, 1064 pp., 22 pls.

Kensley, B. 1973. Sea Shells of Southern Africa.—Gastropods.—Cape Town. 236 pp.

Ladd, H. 1972. Cenozoic Fossil Mollusks from Western Pacific Islands; Gastropods (Turritellidae through Strombidae).—Geological Survey Professional Paper, 532:iii+79 pp., 20 pls.

Lamarck, J. B. P. A. de. 1804. Suite des Mémoires sur les fossiles des environs de Paris, Genre XXXVIII. Mélanie.—Annales du Muséum National d'Histoire Naturelle 3:429–436.

Ludbrook, N. H. 1957. The Molluscan Fauna of the Pliocene Strata underlying the Adelaide Plains. Part IV—Gastropoda (Turritellidae to Struthoilariidae).—Transactions of the Royal Society of South Australia 80(4):17–58, 4 pls.

———. 1971. Large gastropods of the families Diastomidae and Cerithiidae (Mollusca: Gastropoda) in southern Australia.—Transactions of the Royal Society of South Australia 95(1):29–42, pls. 1–6.

———. 1978. Quaternary Mollusks of the western part of the Eucla Basin. Geological Survey of Western Australia.—Bulletin 125:1–286, 24 pls.

Marwick, J. 1957. Generic Revision of the Turritellidae.—Proceedings of the Malacological Society of London 32(4):144–166.

Marcus, E., and E. Marcus. 1964. On *Cerithium atratum* (Born, 1778).—Bulletin of Marine Science 14:494–510.

Olsson, A. A. 1929. Contributions to the Tertiary Paleontology of Northern Peru: Part 2, Upper Eocene Mollusca and Branchiopoda.—Bulletins of American Paleontology 15(57):4–36, 8 pls.

Pchlintsev, V. F., and I. A. Korobkov. 1960. Molliuski-Briukhonogie. *In* Y. A. Orlov (ed).—Osnovy Paleontologii, Moskva, 359 pp.

Reeve, L.A. 1849. Conchologia Iconica, 5, *Mesalia,* 1 pg, 1 pl.

Rehder, H. A. 1980. The Marine Mollusks of Easter Island (Isla de Pascua) and Sala y Gomez.—Smithsonian Contributions to Zoology No. 289:1–167, 14 pls.

Sowerby, G. B. 1913. Descriptions of New Species of Mollusca.—Annals and Magazine of Natural History, 8th series, 12:233–239, pls. 3.

Tate, R. 1894. Unrecorded genera of the older Tertiary Fauna of Australia, including diagnoses of some new genera and species.—Journal of the Royal Society of New South Wales 28:167–198, pls. 10–13.

Wenz, W. 1938–1944. Gastropoda, Teil 1, Allgemeiner Teil und Prosobranchia. [*in*] Schindewolf, Handbuch der Paläozoologie, vol. 6.—Borntraeger, Berlin. vii+1639 pp.

Wilson, B., and K. Gillett. 1979. A Field Guide to Australian Shells.—Prosobranch Gastropods. 287 pp., 67 pls. Sydney.

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PSEUDOPLUMARELLA ECHIDNA, A NEW SPECIES OF PRIMNOID OCTOCORAL FROM QUEENSLAND (COELENTERATA: OCTOCORALLIA)

Frederick M. Bayer

Abstract.—A new primnoid octocoral, *Pseudoplumarella echidna,* from the southern coast of Queensland, is described and illustrated by scanning electron micrography. The species is compared with the related *Pseudoplumarella corruscans* (Thomson and Mackinnon, 1911) from New South Wales, which also is illustrated. A possibly distinct variant is reported but not established as a distinct taxon.

A brief examination of octocorals in the collections of the Queensland Museum, made possible through the kindness of Dr. L. R. G. Cannon, revealed an interesting new species of the primnoid genus *Pseudoplumarella* allied to *P. corruscans* (Thomson and Mackinnon, 1911). As the octocoral fauna of Australia is still inadequately known, it is desirable to put on record descriptions of new species such as this in order to facilitate a comprehensive marine faunal inventory for Australia at some time in the future.

Pseudoplumarella Kükenthal, 1915

Plumarella (part) Thomson and Mackinnon, 1911:682.
Pseudoplumarella (part) Kükenthal, 1915:143, 145; 1924:263.

Diagnosis (emend.).—Primnoids with uniplanar, alternately pinnate branching. Polyps small, directed obliquely upward, biserial or on all sides of twigs; lateral and adaxial rows of body scales greatly reduced, adaxials absent in some species; opercular scales tall isosceles triangles, of nearly uniform size, only the adaxials being somewhat smaller, fitting closely together without overlapping, forming a prominent conical operculum; marginal scales fewer than 8, not folding over operculars; coenenchymal sclerites scalelike, sometimes with a deeper layer of small, tuberculate spheroids.

Type-species.—*Plumarella thetis* Thomson and Mackinnon, 1911; by original designation.

Remarks.—Although Kükenthal (1915, 1924) included *Plumarella plumatilis* (Milne Edwards and Haime, 1857) in his genus *Pseudoplumarella,* Versluys (1906:39) had already established the subgenus *Pterostenella* for that species. Therefore, were it not for the fact that *P. plumatilis* and *P.*

Fig. 1. *Pseudoplumarella echidna,* colonies: **A,** Holotype, Queensland Mus. Reg. No. G4710; **B,** Paratype, Queensland Mus. Reg. No. GL1; **C,** Paratype, Queensland Mus. Reg. No. GL2; **D,** Paratype, USNM 59823; **E,** Variant, Queensland Mus. Reg. No. GL3.

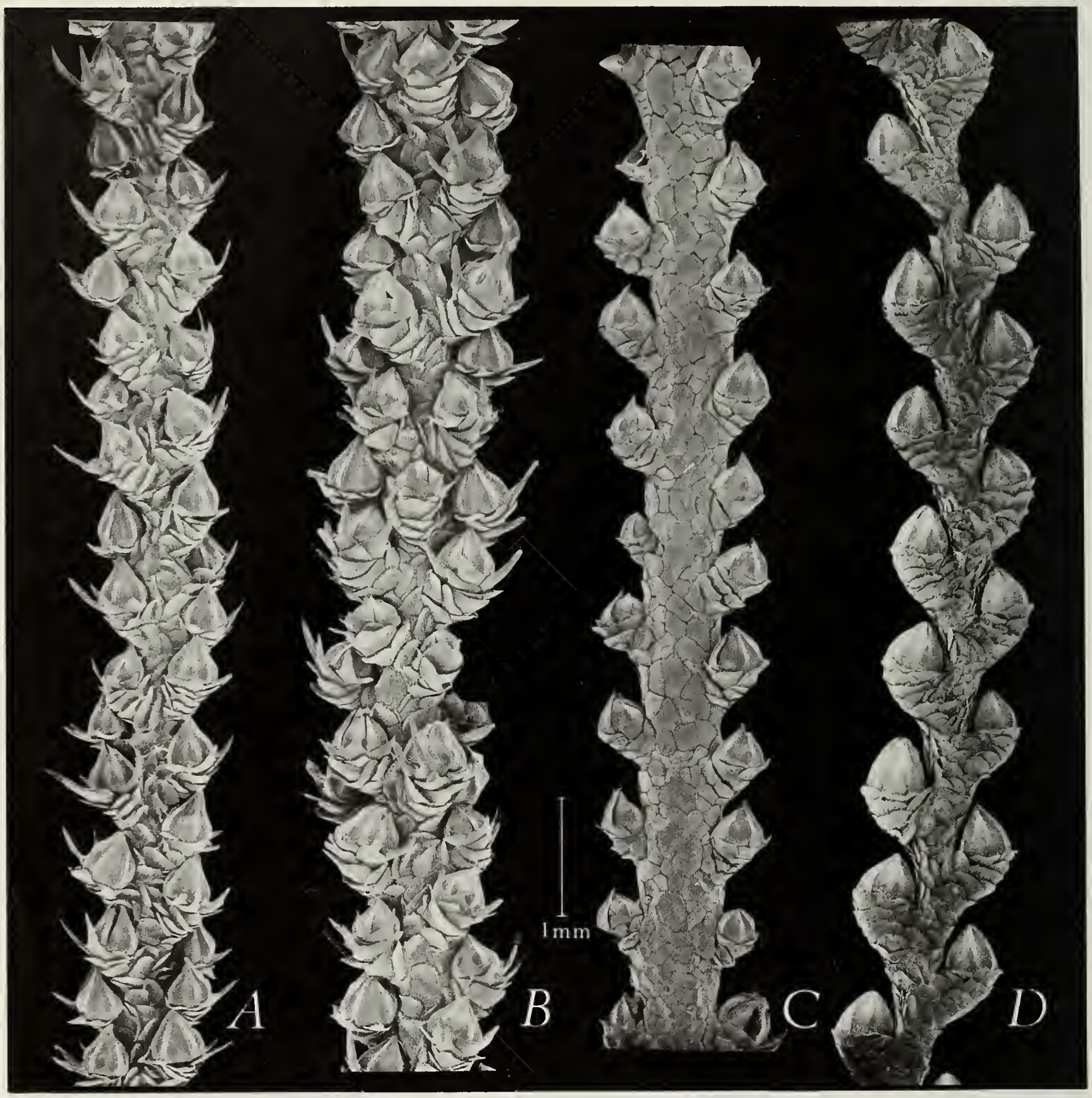

Fig. 2. **A,** *Pseudoplumarella echidna,* holotype; **B,** *P. echidna,* paratype, GL1; **C,** *P. echidna,* variant GL3; **D,** *P. corruscans,* syntype, BM(NH) 1933.3.13.73. Parts of branches with polyps; all SEM micrographs.

thetis are generically distinct, *Pseudoplumarella* would be a junior synonym. The most conspicuous distinguishing character of *Pseudoplumarella* is the tall, conical operculum composed of tightly fitting triangular scales the margins of which abut but do not overlap; the polyps may be in close spirals all around the twigs, or biserial, but not in whorls as in *Pterostenella.* The operculum of *Pterostenella* is very low, often almost flat, and is composed of overlapping scales; the polyps, which have a complete adaxial covering of scales, stand almost vertically and are arranged in widely spaced whorls.

In addition to the new species here described, the genus *Pseudopluma-*

Fig. 3. *Pseudoplumarella echidna:* Lateral and abaxial views of polyp; SEM stereomicrographs, 50×.

rella includes four species: *P. thetis, P. corruscans, P. filicoides,* and *P. versluysi,* all of Thomson and Mackinnon (1911) and all from the coast of New South Wales, Australia. Unfortunately, ambiguities in the original descriptions and discrepancies between descriptions and illustrations preclude the construction of a reliable key for their separation. However, the new species is easily distinguished from the others as it is the only one that has spines on the abaxial marginal scales.

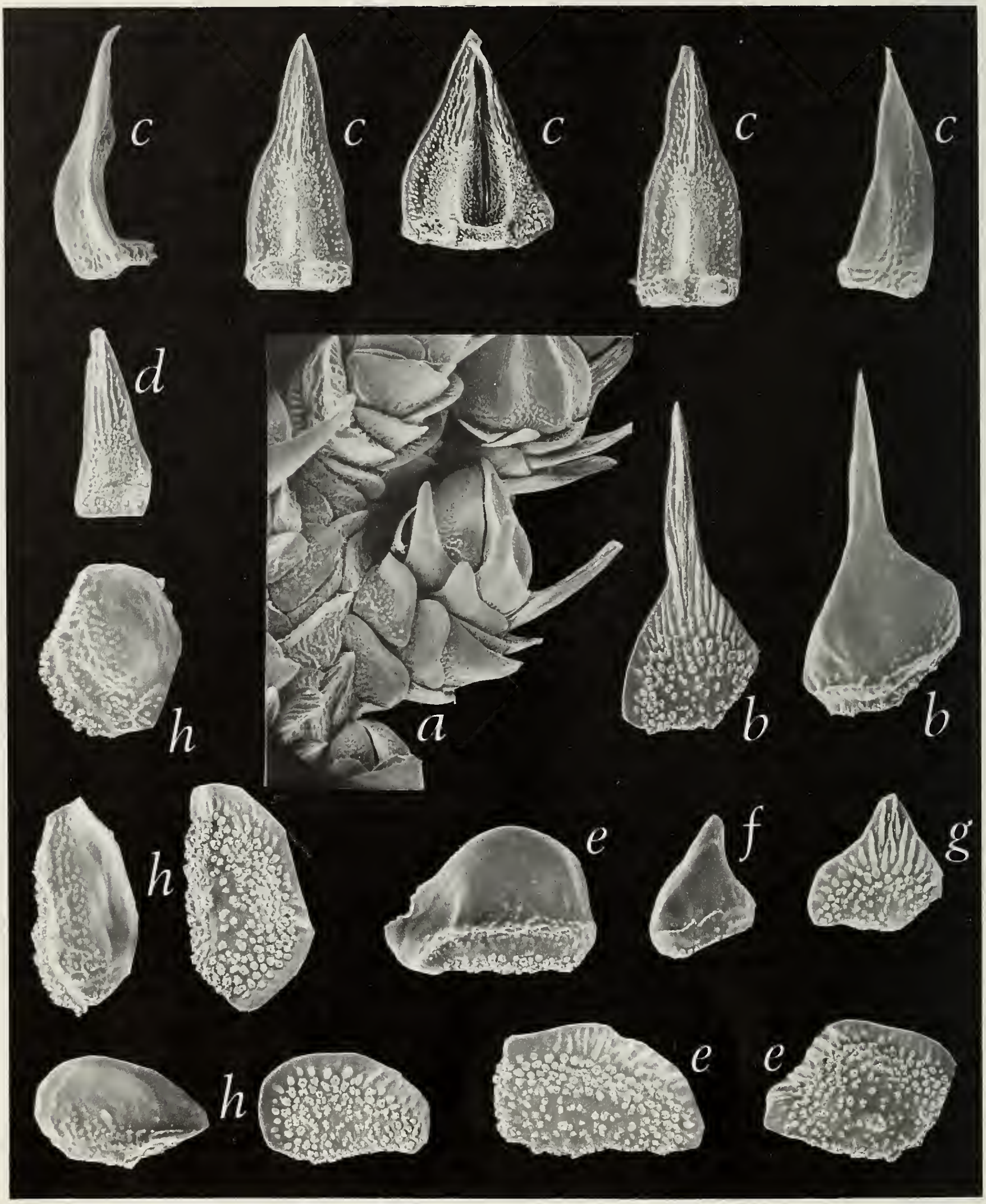

Fig. 4 *Pseudoplumarella echidna:* **A,** Lateral view of intact polyp; **B,** Marginal scales, inner and outer surfaces; **C,** Opercular scales; **D,** Adaxial opercular scale; **E,** Body scales; **F,** Submarginal scale, outer surface; **G,** Submarginal scale, inner surface; **H,** Coenenchymal scales. **A,** 38×; **B–H,** 63×.

Pseudoplumarella echidna, new species
Figs. 1a–d; 2a–b; 3–4

Material.—Four colonies, dredged amongst fan corals, Jumpin Pin, between North Stradbroke and South Stradbroke Islands, Queensland, where

Fig. 5. *Pseudoplumarella corruscans,* syntype, BM(NH) 1933.3.13.73; lateral and abaxial views of polyp; SEM stereomicrographs, 50×.

southern Moreton Bay enters the ocean; 47 fathoms (86 m); coll. Prof. William Stephenson and student party, 1 July 1961.

Diagnosis.—Pseudoplumarella with distal edge of marginal scales produced into strong spine.

Description.—Colonies (Fig. 1a–d) closely and alternately pinnate, 18–21 twigs in 5 cm along one side of branch; fully developed twigs generally of rather uniform length throughout colony or within major branches, from 1.5 to 3 cm long, decreasing in length abruptly toward tips of branches. Polyps small, about 0.75 mm tall, closely biserial on unbranched twigs; operculum of one polyp often overlapping base of next polyp above; 17–20 in 1 cm along one side of twigs (Fig. 2a). Operculum tall, conical, composed of triangular scales closely fitting but not overlapping (Fig. 3), size nearly uniform (Fig. 4c) except for adaxial pair, which are somewhat smaller than the others (Fig. 4d). Marginal scales usually 4, in abaxial and outer lateral rows only, rarely a small scale below one or both inner lateral operculars; free edge of marginal scales produced as a sharp spine, that of abaxial marginals

Fig. 6. *Pseudoplumarella echidna,* variant; lateral and abaxial views of polyp; SEM stereomicrographs, 50×.

stronger (Figs. 3, 4b) that of the outer laterals shorter and usually not so acute. Usually 5 (sometimes 4, rarely 6 or 3) body scales in abaxial rows, usually only 1 or 2 in outer lateral rows; body scales (Fig. 4e) oval; distal edge of submarginals sometimes produced as a low, blunt spine or rounded angle (Fig. 4f); body scales externally smooth except for some low, simple granulations on proximal part, internally tuberculated, distal edge with several sharp radial ridges (Fig. 4g). Tentacles devoid of sclerites. Coenenchy-

Table 1.—Comparison of measurements of *Pseudoplumarella curruscans* and *P. echidna*.

	Height of colony (cm)	No. of twigs in 5 cm	Length of twigs (cm)	Polyps in 1 cm	Length of polyp (mm)	No. of body scales in abax. rows
P. corruscans	44	13	4	10	1	6
P. echidna G4710	24.5	18	3	17	0.75	3–6
P. echidna GL1	22	20	1.5–2.5			
P. echidna GL2	14.5*	21	2.5–3.0	20	0.75	3–4
P. echidna 59823	11.5	21	2	20	0.75	3–6
P. echidna var.	5.5*	31	1.5	14	0.75	3–4

* Broken off at top and lacking holdfast.

mal sclerites (Fig. 4h) scalelike, rounded, squarish, broadly or narrowly oval, imbricate, their free edges upturned and outer face more or less concave, thus resembling shallow, lopsided bowls with tuberculate bottoms. Tuberculate spheroids were not observed.

Types.—Queensland Museum Register No. G4710 (holotype, Fig. 1a); GL1 (paratype, Fig. 1b); and GL2 (paratype, Fig. 1c). USNM 59823 (paratype, Fig. 1d).

Variant.—Queensland Museum Register No. GL3 (Fig. 1e).

Comparisons.—In gross colonial aspect, *Pseudoplumarella echidna* most closely resembles *P. corruscans* (Thomson and Mackinnon), but in that species the colonies are larger and the lateral twigs not so closely crowded. Although Kükenthal (1924:263) separated *P. corruscans* from *P. thetis* because "Die abaxialen Schuppen sind schmaler und haben einen freien gezahnelten Rand," this character must have been based on Thomson and Mackinnon's pl. 65, fig. 4, which does not agree with the syntype (Fig. 5) deposited in the British Museum (Nat. Hist.). Moreover, the original description makes no mention of a toothed margin on the body scales, nor does the drawing of sclerites (pl. 68, fig. 6) illustrate such a feature. Possibly, the "strongly-marked radiating ridges" on the inside border of the body scales (which are visible in the intact polyps as can be seen in Fig. 5) led to the erroneous drawing of the polyps.

Pseudoplumarella echidna also resembles the Japanese *Plumarella spinosa* Kinoshita, 1908. That species has similar, closely pinnate branching and small, biserial polyps with spinous marginal scales, but there are 8 marginals, 6 of them with spines, and the operculars overlap in such a way that the operculum forms only a low cone or is nearly flat.

The polyps of *P. corruscans* are mostly about 1 mm tall (Fig. 5) and they do not overlap one another along the branch (Fig. 2d), so about 10 occur in 1 cm along one side of a branch, compared with 17–20 in *P. echidna*.

The measurements of *Pseudoplumarella corruscans* as presented by Thomson and Mackinnon (1911:684) are compared with those of the present specimens in Table 1.

A single specimen from the haul that yielded the holotype and paratypes of *P. echidna* differs in features that may be of specific importance, but the lack of additional specimens precludes establishing it as a new species at this time. It differs from *P. echidna* in the following ways: the colony (Fig. 1e) is smaller (a little over 5 cm tall, but in damaged condition), the twigs shorter (1.5 cm) and more crowded (31 in 5 cm along one side of a branch), and the polyps less crowded (14 in 1 cm along one side of twig) (Fig. 2c); in many polyps the abaxial body scales are reduced to a single row of 3 or 4, the marginal spines are not so strong, and the coenenchymal scales fit tightly, with little or no overlap (Fig. 6). Differences of this magnitude would ordinarily be considered of specific importance. However, the size differences could be related to the immediate environment of that colony, and the reduction of the abaxial body scales to a single row could be an individual anomaly, so this specimen is treated as a possible variant of *Pseudoplumarella echidna* pending the study of adequate material.

Acknowledgments

I am grateful to Dr. L. R. G. Cannon of the Queensland Museum, who made these specimens available for study, and to the Queen Elizabeth Fellowship Program, and especially to Drs. J. T. Baker, John Pollard, and Shirley Dryden, who made it possible for me to carry out a highly productive research program in Australia during June–September 1980.

The scanning electron micrographs reproduced herein were made by Walter R. Brown, Chief of the S.E.M. Laboratory, Smithsonian Institution, and the photographs of colonies were made by Michael R. Carpenter, who also assisted in the final preparation of the plates.

This paper has benefitted from the criticisms of my colleagues Drs. W. Duane Hope and Raymond B. Manning, to whom I am grateful for time spent in my behalf.

Literature Cited

Kinoshita, K. 1908. Primnoidae von Japan.—Journal of the College of Science, Imperial University of Tokyo 23(12):1–74, pls. 1–6.

Kükenthal, W. 1915. System und Stammesgeschichte der Primnoidae.—Zoologischer Anzeiger 46(5):142–158.

———. 1924. Gorgonaria.—Das Tierreich 47:i–xxviii + 1–478, 209 figs. Berlin and Leipzig, Walter de Gruyter & Co.

Thomson, J., and D. L. Mackinnon 1911. The alcyonarians of the "Thetis" Expedition.—Australian Museum, Sydney, Memoir 4:661–695, pls. 41–82.

Versluys, J. 1906. Die Gorgoniden der Siboga Expedition II. Die Primnoidae.—Siboga-Expeditie Monographie 13a:1–187, figs. 1–178, pls. 1–10, chart.

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SOLENOCERA ALFONSO, A NEW SPECIES OF SHRIMP (PENAEOIDEA: SOLENOCERIDAE) FROM THE PHILIPPINES

Isabel Pérez Farfante

Abstract.—A new species of penaeoid shrimp, *Solenocera alfonso,* is described and illustrated from specimens collected in the waters of the Philippines at depths between 176 and 547 m. This species possesses a spine on the dorsal midline of the carapace posterior to the cervical sulcus, a feature which distinguishes it from all of its congeners. It is compared with the Indo-West Pacific *S. australiana, S. halli,* and *S. melantho.*

Among the interesting materials encountered during a current study of the extensive collections of penaeoid shrimps obtained in the Philippines by the U.S. steamer *Albatross,* 1907–10, were representatives of a previously unknown species of *Solenocera.* This shrimp, which is now known to occur on the upper slope of the island platforms to depths of 547 m, is described and illustrated here. It is characterized by the presence of a spine on the dorsal midline of the carapace posterior to the level of the dorsal end of the cervical sulcus, a feature unique within the genus. This character, together with the hepatic and branchiocardiac sulci being curved in opposing arcs and the peculiar terminal armature of the ventromedian lobule of the petasma, make this species stand out from its relatives. In recent years, large collections of penaeoids have been assembled from Indonesia and the Philippines, and I hope that specimens of this shrimp will be discovered among these collections, thus expanding our knowledge of its geographical and ecological distribution.

Type-material is deposited in the National Museum of Natural History, Smithsonian Institution (USNM), and the Rijksmuseum van Natuurlijke Historie (RMNH), Leiden. The method of measuring the specimens and the terminology used below are described by Pérez Farfante (1969), and Pérez Farfante and Bullis (1973). In the captions of the figures, carapace length and total length are abbreviated cl and tl, respectively. The illustrations of the petasma were made from a specimen stained with methyl green.

Solenocera alfonso, new species
Figs. 1–5

Material (all from the Philippines).—Holotype: ♀, USNM 184022, 31.5 mm carapace length, about 114 mm total length, 10 mm rostrum length;

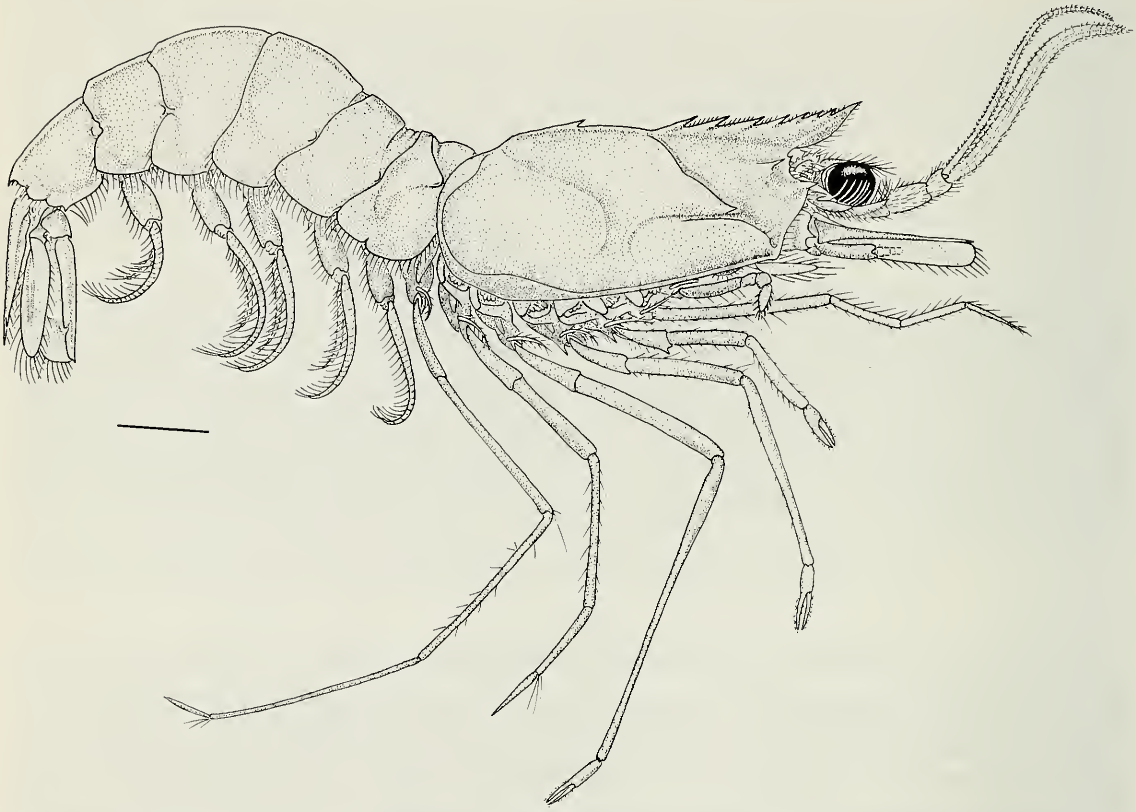

Fig. 1. *Solenocera alfonso,* holotype, USNM 184022, ♀ 31.5 mm cl, off Capitancillo I, W of Leyte, Philippines: Lateral view. Scale = 10 mm.

type-locality, off Capitancillo I, W of Leyte, 10°38′00″N, 124°13′08″E, 346 m, 18 March 1909, *Albatross* stn 5409. Allotype: ♂, USNM 184023, 26 mm carapace length, about 109 mm total length, 8.5 mm rostrum length, Macajalar Bay, N Mindanao, 8°37′37″N, 124°35′00″E, 391 m, 4 August 1909, *Albatross* stn 5501.

Paratypes: 1 ♀, USNM 184024, Balayan Bay, Luzon, 329 m, 20 February 1909, *Albatross* stn 5363. 1 ♂, USNM 184025, Tayabas Bay, SE Luzon, 357 m, 24 April 1908, *Albatross* stn 5222. 1 ♀, USNM 184026, SE of San Andrés Is, NW of Marinduque, 91–353 m, 24 April 1908, *Albatross* stn 5221. 1 ♀, USNM 184027, NE of Cebu, 130–271 m, 3 April 1908, *Albatross* stn 5194. 2 ♂ 1 ♀, USNM 184028, off Palompon, W Leyte, 344 m, 16 March 1909, *Albatross* stn 5402. 2 ♂ 1 ♀, USNM 184029, off Palompon, W of Leyte, 333 m, 16 March 1909, *Albatross* stn 5403. 1 ♂ 1 ♀, RMNH, N of Ponson I, W of Leyte, 348 m, 17 March 1909, *Albatross* stn 5404. 1 ♀, USNM 184030, N of Capitancillo I, W of Leyte, 291 m, 18 March 1909, *Albatross* stn 5408. 1 ♂, USNM 184031, S of Panay I, 176 m, 30 March 1908, *Albatross* stn 5183. 1 ♂ 2 ♀, USNM 184032, NE of Pescador I, E of Negros, 547 m, 1 April 1908, *Albatross* stn 5189. 3 ♂ 1 ♀, USNM 184033, NE of Pescador I, E of Negros, 549 m, 1 April 1908, *Albatross* stn 5188. 1

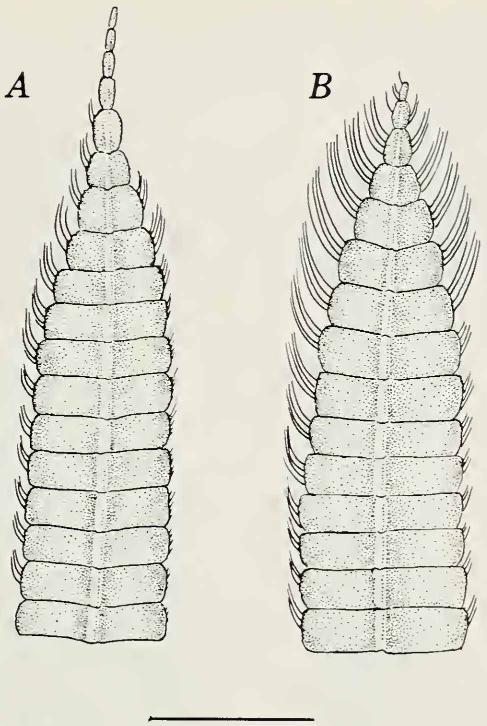

Fig. 2. *Solenocera alfonso*, paratype, USNM 184026, ♀ 40 mm cl, SE of San Andrés Is, NW of Marinduque, Philippines: Terminal parts of right antennular flagella—**A**, Dorsal; **B**, Ventral. Scale = 2 mm.

♂ 1 ♀, USNM 184034, S of Dumalag I, Davao Gulf, 247 m, 18 May 1909, *Albatross* stn 5247.

Description.—Body glabrous (Fig. 1) except for elongate patch of setae, typical of members of the genus, covering rostrum immediately dorsal to adrostral carina and continuing posteriorly to epigastric tooth. Rostrum almost reaching distomesial margin of eye, horizontal or tilted upward, deep, ventral margin convex along basal 0.7–0.8, apically almost straight. Number of rostral plus epigastric teeth 6–8 (usually 7), teeth progressively smaller and closer together from epigastric to ultimate, latter distinctly postapical; apex of fourth tooth in line with orbital margin. Adrostral carina, extending from orbital margin to or slightly beyond ultimate tooth. Postrostral carina well marked but comparatively low, and weakly depressed at level of dorsal extremity of cervical sulcus, bearing tooth slightly anterior to or at midlength between depression and midposterior margin of carapace; carina progressively lower behind tooth, and followed by minute dorsal tubercle located on depressed posteromedian portion of carapace. Median sulcus varying from well marked and almost continuous to being represented only by few pits. Marginal ridge of carapace narrow anteriorly, broadening and forming ventral lobe at about midlength of branchial region, and broadening again forming posterolateral lobe, finally becoming slender along midposterior section. Orbital spine small; postorbital spine longest of lateral cara-

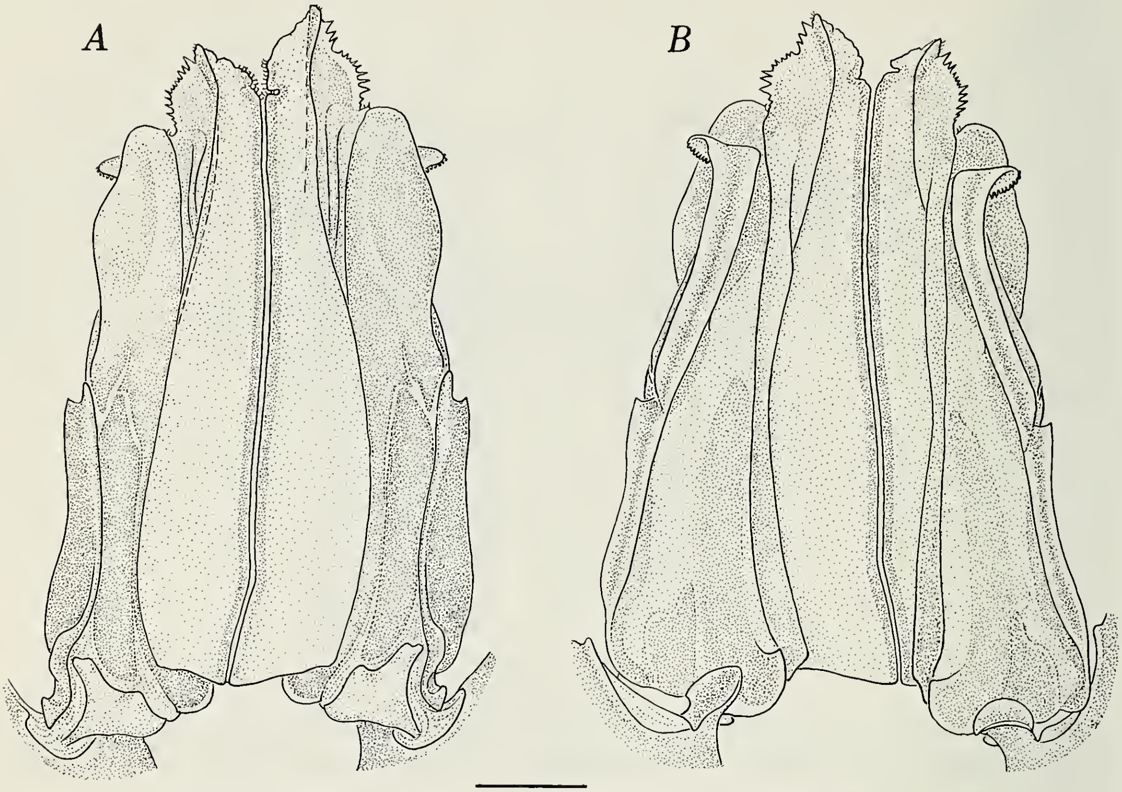

Fig. 3. *Solenocera alfonso,* allotype, USNM 184023, ♂ 26 mm cl, Macajalar Bay, N Mindanao, Philippines: **A,** Dorsal view of petasma; **B,** Ventral view of same. Scale = 2 mm.

pace spines, strong and continuous with conspicuous buttress; antennal spine slender; hepatic spine sharp. Pterygostomian and branchiostegal spines lacking. Orbito-antennal sulcus weakly defined. Cervical carina raised, sharp, with distinct bend just dorsal to hepatic region, its posterodorsal extremity ending at lateral base of epigastric tooth; cervical sulcus deep, merging ventrally with anterodorsally directed shallow groove and hepatic sulcus, junction forming deep depression just anterior to hepatic spine. Hepatic sulcus with posterior part, relatively shallow but well defined, turning ventrally in arc; anterior part deep and extending anteroventrally to pterygostomian pit; hepatic carina sharp anteriorly, its anteroventral extremity making sharp bend ventrally extending along posterior margin of tear shaped pterygostomian pit. Branchiocardiac sulcus and carina strongly defined, forming broad anterior arc and extending posterodorsally to near margin of carapace.

Antennular peduncle about 0.6 as long as carapace; prosartema reaching or almost reaching distomesial margin of eye, but its long setae attaining proximal third of second antennular article. Stylocerite relatively short, length equivalent to 0.65 that of first antennular article, and ending in inconspicuous spine; distolateral spine slender and sharp. Dorsal flagellum slightly longer than ventral, about 1.6 times carapace length while ventral flagellum 1.4 times carapace length in shrimp 23 mm cl; in shrimp 37 mm cl dorsal 0.9 and ventral 0.7 times carapace length; terminal part of dorsal flagellum gradually tapering distally over 9 to 24 (latter in young) articles (Fig. 2A), that of ventral flagellum over 8 to 12 (Fig. 2B), in both flagella last few articles forming filament.

Scaphocerite overreaching antennular peduncle by 0.1 to 0.2 of its own length; lateral rib ending in strong, sharp spine, reaching or almost reaching distal margin of lamella. In available specimens, antennal flagellum as much as 4.1 times total length of shrimp.

Third maxilliped surpassing antennular peduncle by length of dactyl and about half that of propodus; ratio of dactyl/propodus 0.8–0.9.

First pereopod extending to distal end of carpocerite or exceeding it by as much as 0.8 length of propodus. Second pereopod overreaching antennular peduncle by at least 0.75 length of propodus and at most by propodus and extreme distal part of carpus. Third pereopod surpassing antennular peduncle by length of propodus and 0.3 to 0.5 that of carpus. Fourth pereopod overreaching peduncle by at least half length dactyl and at most by dactyl and 0.1 length of propodus. Fifth pereopod overreaching antennular peduncle by length of dactyl and almost entire propodus or by dactyl, propodus, and extreme distal part of carpus. Order of pereopods in terms of their maximum anterior extensions: first (shortest), fourth, second, fifth, and third—latter exceeding fifth only slightly if at all. Third maxilliped barely overreaching second pereopod. First pereopod armed with long, slender mesial spine on basis and slightly shorter one on ischium. Second pereopod bearing short spine on basis. In male, fifth pereopod bearing flattened, scale-like tooth on distomesial margin of coxa; in female short tooth borne on distomesial extremity of coxal plate.

Abdomen with middorsal carina from second through sixth somites, carina on second somite low and rounded (sometimes almost indistinct), that on third to sixth, high and sharp. Posterodorsal margin of third through fifth somites with median incision; sixth somite bearing conspicuous sharp spine at posterior end of carina and pair of small posteroventral spines. Telson tapering caudally to acute apex and bearing pair of small, fixed, lateral spines. Mesial ramus of uropod approaching apex of telson; lateral ramus reaching or barely surpassing distal border of mesial ramus, its marginal ridge ending in well developed spine. All sternites armed with laterally compressed, strong median tooth on posterior border, teeth decreasing in size posteriorly.

Petasma (Fig. 3A–B; Fig. 4B) with distal part of ventromedian lobule tapering rapidly and extending conspicuously beyond dorsolateral lobule, latter surpassing distally and overlapping ventral costa dorsally. Terminal margin of dorsomedian lobule unarmed, that of ventromedian lobule sinuous and bearing 10 to 18 irregular spinules of variable length. Distal part of dorsolateral lobule with lateral margin weakly biconcave, its terminal margin

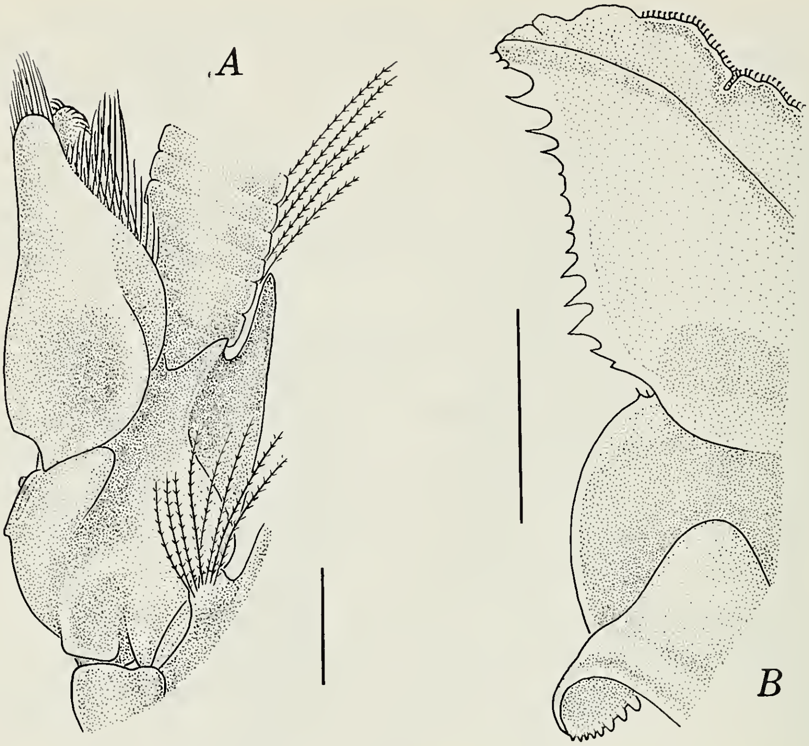

Fig. 4. *Solenocera alfonso,* allotype: **A**, Dorsolateral view of right appendix masculina; **B**, Dorsolateral view of distal part of left half of petasma. Scales = 1 mm.

armed with 1 or 2 well developed spinules at mesial extremity, and row of very minute ones (usually lost) extending onto lateral margin; lobule with stiff ridgelike thickening running obliquely from distal to proximolateral margins; thickening becoming obliquely truncate proximally, abutting distomesial border of proximal part of ventral costa. Ventral costa bent strongly outwardly, resulting flap, broadest mesially, and bearing 15 to 20 short spines on terminal margin. Junction of distal and proximal parts of ventral costa marked by deep emargination.

Appendix masculina (Fig. 4A) broadening from base to about midlength then tapering gradually to blunt apex, and bearing dorsolateral, strongly curved rib proximally; distal part of lateral margin armed with elongate patch of long setae, and apex with tuft of shorter ones. Appendix interna considerably narrower but extending as far as or slightly farther than appendix masculina, bearing apically closely set short setae. Basal sclerite with subvertical lateral wall projecting distally in blunt ventrolateral spur.

Thelycum (Fig. 5) with subquadrangular posterior depression delimited laterally by raised margins of sternite XIV and anteriorly by transverse ridge, sometimes interrupted, situated somewhat anterior to midlength of sternite; pair of slender, fusiform, submesial protuberances placed relatively far apart, immediately anterior and subperpendicular to transverse ridge (protuberances almost indistinguishable in young). Sternite XIII with high

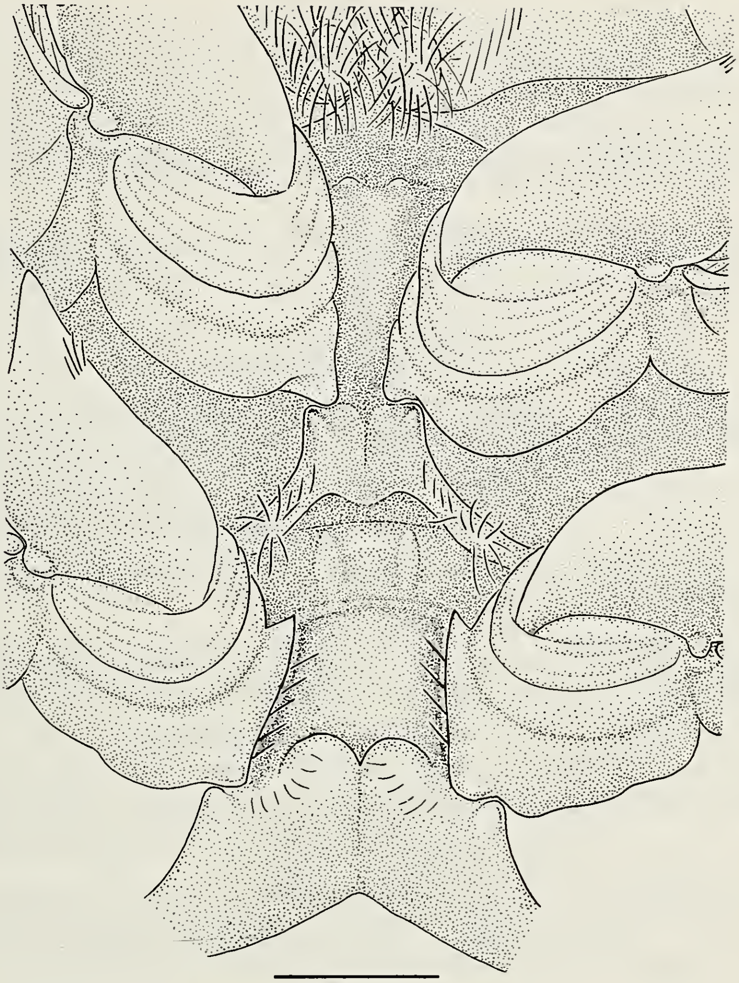

Fig. 5. *Solenocera alfonso,* holotype: Thelycum. Scale = 2 mm.

vertical posterior shelf divided by median slit and bearing pair of strong, acute, anterolateral tubercles; base of anterior third of sternite XIII crossed by transverse elevation continuous with caudomedian ridge. Posterior thoracic ridge with thick, setose, strongly biconvex anterior border.

Size.—Carapace lengths of males examined 15 to 29 mm, of females, 18 to 40 mm.

Geographic and bathymetric ranges.—This species has been found only in the waters of the Philippines: from Balayan Bay, SW Luzon, to Davao Gulf, SE Mindanao. It inhabits the upper slope of the island shelves, at depths of 176 to 547 m, and occurs on substrates of mud—mostly green mud—and at least occasionally on a mixture of fine sand and mud on which one of the 14 samples available was collected.

Remarks.—*Solenocera alfonso* is unique among the members of the genus in possessing a spine on the postrostral carina posterior to the cervical sulcus, about midway between the latter and the caudal margin of the carapace. In this species both the posterior part of the hepatic sulcus and the anterior part of the branchiocardiac sulcus turn ventrally forming opposing arcs which are neither so well defined nor present together in any of its congeners. Also distinctive is the marginal carina of the carapace, which is expanded in two lobes on each side: one situated posteroventrally about midlength of the branchial region, the other posterolaterally near middorsum.

This species closely resembles members of a homogeneous group of Indo-west-Pacific species comprising *S. australiana* Pérez Farfante and Grey, 1980, *S. halli* Starobogatov, 1972, and *S. melantho* De Man, 1907. This group, like *S. alfonso,* may be characterized by lacking branchiostegal and pterygostomian spines, possessing a hepatic carina ending at the pterygostomian region (not recurving posteriorly), and having a relatively low postrostral carina that is only slightly depressed at the level of the cervical sulcus. *Solenocera alfonso* may be distinguished from the other three species not only by the peculiar features cited in the previous paragraph, but also by thelycal and petasmal characters.

In *S. alfonso* the distal part of the ventromedian lobule of the petasma tapers rapidly instead of gradually or being truncate, its free margin is sinuous and bears spinules of various lengths the number of which ranges from 10 to 18. In *S. australiana, S. halli,* and *S. melantho* the free margin of the ventromedian lobule is armed with numerous spinules which in the former two species increase in length laterally and in *S. melantho* are all about the same length, except for the lateralmost three or four that may be smaller. In *S. alfonso* the distal margin of the dorsolateral lobule at its mesial extremity bears only 1 or 2 readily distinguishable spinules continuous with a row of very minute ones which extend along the lateral margin (these spinules are missing in most of the specimens available, there remaining only the raised points where they were inserted). In *S. australiana* and *S. halli* the dorsolateral lobule bears numerous spinules (18 to 40) which decrease in length proximolaterally, and in *S. melantho,* although the margin may be armed with only 1 or 2 spinules at its mesial extremity—much like in *S. alfonso*—there are usually more, as many as 13; furthermore, the lobule itself is not stiffened by a ridgelike thickening as it is in *S. alfonso.*

The thelycum of *S. alfonso* differs mainly from that of the other three species in lacking lateral protuberances and possessing only one pair of submesial protuberances on the anterior part of sternite XIV, which are very slender and set relatively far apart. In the other three species the thelycum bears two pairs of protuberances or often three in *S. melantho,* and the submesial ones are usually rounded or oblong, or if slender, roughly fusiform and disposed transversely.

Etymology.—This species is named for my brother, Dr. Alfonso Pérez Farfante, my companion during my first explorations of the seashore. The specific name is to be treated as a noun in apposition.

Acknowledgments

Thanks are due Horton H. Hobbs, Jr., and Fenner A. Chace, Jr., of the Smithsonian Institution, and Bruce B. Collette, of the National Marine Fisheries Service, Systematics Laboratory, for their criticisms of the manuscript. María M. Diéguez prepared all of the illustrations except those of the antennular flagella which were drawn by Keiko Hiratsuka Moore; to both I am most grateful.

Literature Cited

Man, J. G., de. 1907. Diagnoses of new species of macrurous decapod Crustacea from the "Siboga-Expedition." II.—Not. Leyden Mus. 29:127–147.

Pérez Farfante, I. 1969. Western Atlantic shrimps of the genus *Penaeus*.—U.S. Fish Wildl. Serv., Fish. Bull. 67:461–591.

———, and H. R. Bullis, Jr. 1973. Western Atlantic shrimps of the genus *Solenocera* with description of a new species (Crustacea: Decapoda: Penaeidae).—Smithson. Contrib. Zool. 153, 33 pp.

———, and D. L. Grey. 1980. A new species of *Solenocera* (Crustacea: Decapoda: Solenoceridae) from northern Australia.—Proc. Biol. Soc. Wash. 93(2):421–434.

Starobogatov, Y. I. 1972. Penaeidae (Crustacea Decapoda) of Tonkin Gulf.—*In* Fauna Tonkinskogo zaliva i usloviya ee sushchestvovaniya. Issled. Fauny Morey 19(18), Acad. Sci., USSR, Zool. Inst., Nauka, Lenningrad: 359–415. [Translated by the Office of International Fisheries, National Marine Fisheries Service.]

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(Contents continued from back cover)

A new Goniasterid seastar, *Evoplosoma scorpio* (Echinodermata: Asteroidea), from the northeastern Atlantic Maureen E. Downey 561

A redescription of *Tubificoides heterochaetus* (Michaelsen) (Oligochaeta: Tubificidae) H. R. Baker 564

The generic status and distribution of *Monodella texana* Maguire, the only known North American Thermosbaenacean Jan H. Stock and Glenn Longley 569

Caecidotea salemensis and *C. fustis,* new subterranean Asellids from the Salem Plateau (Crustacea: Isopoda: Asellidae) Julian J. Lewis 579

A review of the *Platysquilla* complex (Crustacea, Stomatopoda, Nannosquillidae), with the designation of two new genera Raymond B. Manning and David K. Camp 591

Anatomy of *Diastoma melanioides* (Reeve, 1849) with remarks on the systematic position of the family Diastomatidae (Prosobranchia: Gastropoda) Richard S. Houbrick 598

Pseudoplumarella echidna, a new species of Primnoid octocoral from Queensland (Coelenterata: Octocorallia) Frederick M. Bayer 622

Solenocera alfonso, a new species of shrimp (Penaeoidea: Solenoceridae) from the Philippines Isabel Pérez Farfante 631

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CONTENTS

The Tanaidae (Crustacea; Tanaidacea) of California, with a key to the world genera
Jürgen Sieg and Richard N. Winn 315

A redescription of *Echinaster modestus* Perrier, 1881 (Asteroidea: Spinulosida) from the eastern Gulf of Mexico and the West Indies
Richard L. Turner and David B. Campbell 344

The morphology of *Tripolydora spinosa* Woodwick (Polychaeta: Spionidae): an application of the scanning electron microscope to Polychaete systematics
James A. Blake and Keith H. Woodwick 352

Systematic notes on certain oscines from Panama and adjacent areas (Aves: Passeriformes) Storrs L. Olson 363

Saccogaster melanomycter (Ophidiiformes: Bythitidae), a new fish species from the Caribbean Daniel M. Cohen 374

Falsipatellina, a new name for *Pseudopatellina* Kenawy and Nyírõ, 1967 *non* Haque, 1960 (Foraminiferida) Drew Haman and Richard W. Huddleston 378

The nature of the variability in the variable seedeater in Panama (*Sporophila americana*: Emberizinae) Storrs L. Olson 380

Western Atlantic sea cucumbers of the genus *Thyone*, with description of two new species (Echinodermata: Holothuroidea) David L. Pawson and John E. Miller 391

Two little-known species of *Eleutherodactylus* (Amphibia: Leptodactylidae) from the Sierra de la Macarena, Colombia William F. Pyburn and John D. Lynch 404

The systematic status of Central American frogs confused with *Eleutherodactylus cruentus* Jay M. Savage 413

Pflugella, new name for *Tricellaria* Pflug, 1965 (Microproblematica), *non* Fleming, 1828 (Bryozoa) Richard W. Huddleston and Drew Haman 421

Heteroptera recently collected in the Ray Mountains in Alaska
Richard C. Froeschner and Libby Halpin 423

Chriolepis vespa, a new species of Gobiid fish from the northeastern Gulf of Mexico
Philip A. Hastings and Stephen A. Bortone 427

A new genus and a new species of Helminthoglyptid land snails from the Mojave Desert of California Walter B. Miller 437

A new species of *Aspidosiphon* (Sipuncula) from the western Atlantic Ocean
Edward B. Cutler 445

Psolidium prostratum, new species, from off the east coast of the U.S.A. (Echinodermata: Holothuroidea) David L. Pawson and John F. Valentine 450

A new species of *Homochaeta* (Oligochaeta: Naididae) from the west coast of Canada
Peter M. Chapman 455

First description of the male opposum shrimp, *Heteromysis bermudensis bermudensis* (Crustacea: Mysidacea) Thomas E. Bowman 458

Comments on the Taxonomic Status of *Tommotia* Missarzhevsky 1970 (Tommotiidae: Microproblematica) Richard W. Huddleston 462

Notes on west African pipefishes (Syngnathidae), with description of *Enneacampus*, n. gen. C. E. Dawson 464

Gonodactylus siamensis, a new Stomatopod Crustacean from Thailand
Raymond B. Manning and Marjorie L. Reaka 479

A new deep-sea leech, *Bathybdella sawyeri*, n. gen., n. sp., from thermal vent areas on the Galápagos Rift Eugene M. Burreson 483

A new dwarf crayfish from the Pacific versant of Mexico (Decapoda: Cambaridae)
Alejandro Villalobos-Figueroa and Horton H. Hobbs, Jr. 492

Coralanthura and *Sauranthura*, two new genera of Anthurideans from northeastern Australia (Crustacea: Isopoda: Anthuridae) Gary C. B. Poore and Brian Kensley 503

Ceratocolax mykternastes, new species (Copepoda, Bomolochidae) parasitic in the nasal sinus of *Haemulon sciurus* (Pisces, Pomadasyidae) from Belize
Hillary Boyle Cressey 514

A redescription of *Octopus ornatus* Gould, 1852 (Octopoda: Cephalopoda) and the status of *Callistoctopus* Taki, 1964 Gilbert L. Voss 525

A revision of the Nettastomatid eel genera *Nettastoma* and *Nettenchelys* (Pisces: Anguilliformes), with descriptions of six new species
David G. Smith, James E. Böhlke, and P. H. J. Castle 535

(Contents continued inside back cover)