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Guide to the Parasites of Fishes of Canada

Part II – Crustacea

Edited by L. Margolis and Z. Kabata

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GUIDE TO THE PARASITES OF FISHES OF CANADA

PART II — CRUSTACEA

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Part II — Crustacea

Copepoda and Branchiura

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Contents

Guide to the Parasites of Fishes of Canada
Part II — Crustacea

INTRODUCTION

In presenting the second part of the "*Guide to the Parasites of Fishes of Canada,*" we would like to make a few brief comments on this contribution to the series. To begin with, the fact that the part "Crustacea" follows "Monogenea and Turbellaria" is purely fortuitous, having been determined by the timing of its completion. As stated in our introduction to the series (Margolis and Kabata 1984), this publication is intended primarily as an aid to identification of parasites of fishes and its format is generally that of an expanded key.

This part of the "*Guide*" is devoted exclusively to the crustacean parasites of fishes. In all, four major crustacean taxa are represented (Copepoda, Branchiura, Amphipoda, and Isopoda). At the time of writing, 163 species of crustacean parasites (131 Copepoda, 10 Branchiura, 11 Isopoda, and 11 Amphipoda) are known to infect Canadian fishes. They occur on 232 species of fish. Since the fish fauna of Canada comprises currently 1,008 species (D. E. McAllister, National Museum of Natural History, Ottawa, Ontario, K1A OM8, personal communication), slightly fewer than a quarter of them (23 %) have been found to be parasitized by Crustacea. Somewhat fewer than a half of these fishes (43.3 %) are known to harbour only one species of crustacean. As many as 84.5 % carry 1–5 species, 14.6 % carry 6–10 species. Two (0.9 %) carry more than 10 species.

The majority (80.4 %) of the crustacean parasites recorded from Canadian fishes belong to Copepoda. These figures are far from definitive. New discoveries and new locality records continue to raise the number of parasite species. It is to be expected that many more species, particularly of the higher Crustacea (Isopoda and Amphipoda) will be discovered.

Three authors were invited to cover the broad range of crustacean species parasitizing Canadian fishes: Z. Kabata deals with Copepoda and Branchiura, Fahmida Rafi with Isopoda, and E. L. Bousfield and Z. Kabata with Amphipoda. This multiple authorship imposes some slight differences in the manner of treatment of the three sections, although we have tried to keep these differences to a minimum. The authors have produced their own separate lists of literature cited. For the readers' convenience, however, a combined host–parasite list is appended at the end. The host list is arranged taxonomically, in accordance with the order adopted by Robins et al. (1980). An index to hosts (p. 179) helps to locate each species without difficulty. The capital letters behind names of parasites denote their taxonomic affinity: Copepoda (C), Branchiura (B), Isopoda (I), and Amphipoda (A).

The descriptions of Copepoda, a group of great morphological diversity, could be compressed without detracting from the facility with which they can be identified. Morphologically more uniform Amphipoda and Isopoda required somewhat longer descriptions. In all instances, however, only features salient for the taxa have been included.

In presenting records of localities and host affiliations, the authors used as their baseline the Synopsis of Margolis and Arthur (1979). In the copepod section all records for which no citation is given were taken from this synopsis. Full citations are given only for those records that are either subsequent to the publication of the synopsis or were not included in it. Since no records of Amphipoda and only a few of Isopoda were included in the synopsis, all records are treated in full in the accounts of these groups.

The Synopsis was also followed in designating geographical locations of the records shown in the keys. The following abbreviations were used: For marine areas, Arctic (Arc), Atlantic (Atl), East Arctic (E Arc), Pacific (Pac), and West Arctic (W Arc). For inland waters, Alberta (Alta), British Columbia (BC), Labrador (Lab), Manitoba (Man), New Brunswick (NB), Newfoundland (Nfld), Northwest Territories (NWT), Nova Scotia (NS), Ontario (Ont), Prince Edward Island (PEI), Quebec (Que), Saskatchewan (Sask), and Yukon Territory (YT).

The first task of any reader trying to identify a specimen of a crustacean parasite will be to determine to which of the four major taxa his specimen belongs. He can then move to the appropriate section of this volume.

To facilitate this first step, a key to the major taxa is given below.

Key to major taxa

1 Two prominent circular suckers (modified from first maxillae) present on ventral surface of cephalothorax ..... Branchiura

Suckers absent from ventral surface of cephalothorax 2

2 Legs, when present, represented by not more than four pairs of fully developed limbs, at least some of them biramous; no appendages on abdominal segments ..... Copepoda

Seven pairs of uniramous, ambulatory legs invariably present; appendages present also on abdominal segments 3

3 Body usually flattened dorsoventrally, first pair of legs subchelate, six pairs of abdominal appendages present (five modified pleopods, one unmodified uropod) ..... Isopoda

Body usually compressed side to side, first two pairs of legs subchelate, abdominal appendages represented by three pairs of pleopods (modified) and three pairs of uropods (unmodified) Amphipoda

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THE EDITORS

COPEPODA AND BRANCHIURA

Z. KABATA

ABSTRACT

KABATA, Z. 1988. Copepoda and Branchiura, p. 3-127. *In* L. Margolis and Z. Kabata [ed.] Guide to the parasites of fishes of Canada. Part II. Crustacea. Can. Spec. Publ. Fish. Aquat. Sci. 101: 184 p.

Keys to identification of all 131 species of Copepoda and 10 species of Branchiura known to parasitize Canadian fishes are provided, with brief descriptions and illustrations of all salient morphological features of each species. An appendix to the Copepoda describes the most common larval stages of these parasites occurring on Canadian fishes.

Achtheres corpulentus is transferred to the genus *Salmincola* and *S. extumescens* is relegated to synonymy with it. *Achtheres micropteri* and *A. ambloplitis* are synonymized with *A. pimelodi*. *Clavella insolita* is recognized as a synonym of *C. stichaei* and a suggestion is put forward that *C. pinguis* might also be a synonym of that species. *Argulus canadensis* is tentatively treated as a junior synonym of *A. stizostethii*.

RÉSUMÉ

KABATA, Z. 1988. Copepoda and Branchiura, p. 3-127. *In* L. Margolis and Z. Kabata [ed.] Guide to the parasites of fishes of Canada, Part II. Crustacea. Can. Spec. Publ. Fish. Aquat. Sci. 101: 184 p.

On trouvera dans le présent document des clés d'identification des 131 espèces de Copepoda et des 10 espèces de Branchiura parasites des poissons des eaux canadiennes. Chaque espèce est brièvement décrite et toutes les caractéristiques morphologiques importantes sont illustrées. À l'annexe sur les Copepoda, on décrit les stades larvaires les plus souvent observés chez les poissons des eaux canadiennes.

Achtheres corpulentus est maintenant classé dans le genre *Salmincola* et il est mis en synonymie avec *S. extumescens*. De plus, *Achtheres micropteri* et *A. ambloplitis* sont mis en synonymie avec *A. pimelodi*. *Clavella insolita* est reconnu comme un synonyme de *C. stichaei* et, selon l'auteur, *C. pinguis* pourrait être un synonyme de cette dernière espèce. Pour l'instant, *Argulus canadensis* est traitée comme un synonyme récent de *A. stizosterhii*.

INTRODUCTION TO COPEPODA

Although it is difficult to determine with precision the number of copepod species parasitic on fishes, rough estimates (Kabata 1984a) place that number between 1,600 and 1,800. A large proportion of them belongs to the suborder Siphonostomatoida (75 %), some 20 % to Poecilostomatoida, and only about 5 % to Cyclopoida. The members of the first two major taxa are predominantly marine, whereas those of the third one are exclusively freshwater.

The copepods and their fish hosts form a great variety of associations, reflecting the diversity in type and extent of adaptation of copepods to a parasitic mode of life. At one extreme, copepods like *Ergasilus* (Fig. 42A) show only slight structural departure from the ancestral free-living condition, at the other, copepods like *Lernaea* (Fig. 46F) or one of the members of the family Pennellidae (Fig. 36G) have lost all semblance of crustacean habitus, becoming vermiform, or assuming irregular and almost bizarre shapes. Although some copepods are fairly loosely associated with their hosts and able — like *Caligus* (Fig. 3A) — to move freely over the surface of the fish, others — like Pennellidae — are permanently anchored, some penetrating deep into the tissues of the host. Others still have become endoparasitic.

Similar diversity exists in the extent of harmful influence exerted by copepods on fishes. The severity of damage is a function of host–parasite relationships. Kabata (1976a) divided copepods by the type of this relationship into (i) ectoparasites, (ii) mesoparasites, and (iii) endoparasites. The ectoparasites, associated with the external surfaces of their hosts, tend to be small and, unless present in very large numbers, relatively harmless. The mesoparasites, which are partly external, are, on the other hand, rather large and exert a profound negative influence on their hosts, regardless of their abundance. Endoparasites, totally enclosed in the host's tissues, are rare among Copepoda and their effects on the fish are as yet not well known.

The fishes of Canada are parasitized by copepods belonging to all three suborders mentioned above. Sixteen families are represented. As in the world fauna, so also in Canada, Siphonostomatoida are in the majority, comprising 67 % of the species. Poecilostomatoida account for 31.5 % and Cyclopoida for only 1.5 % of the species. As many as 85 % of copepod species are marine, the remaining ones being euryhaline, brackish, or freshwater.

(It should be noted that although subordinal rank was adopted for these three major taxa by Kabata (1979), some current investigators accord to them ordinal status. The possible change of rank does not, however, affect mutual relationships among these taxa.)

In compiling this account of Copepoda parasitic on fishes of Canada, I used the Synopsis of the parasites of fishes of Canada (Margolis and Arthur 1979) as my baseline. Records of copepods enumerated in that synopsis are summarized here without reference to their original sources. Literature citations are given only to records subsequent to the publication date of the synopsis, or those not included in it. As in the synopsis, synonyms listed here are only those that appeared in Canadian literature.

I wish to thank all those colleagues who helped me in the preparation of this account by providing me with specimens or literature, in particular Dr. R. Cressey, Smithsonian Institution, Washington, D.C.; Dr. T. A. Dick, University of Manitoba, Winnipeg, Manitoba; Dr. A. Fréchet, Université Laval, Sainte-Foy, Québec, Dr. G. L. Hoffman, Leetown, West Virginia; Dr. K. Rohde, University of New England, Armidale, N.S.W., Australia; and Dr. W. E. Hogans, Huntsman Marine Laboratory, St. Andrews, New Brunswick. Without their kindness, my work would have been much more difficult.

KEYS TO COPEPODA

As mentioned above, copepods parasitizing Canadian fishes belong to three suborders, distinguishable from one another mainly by their mouth parts. The members of these three suborders can be distinguished with the aid of the key below.

Key to suborders

1 Mouth forming a short, subcylindrical tube (Fig. 2), sometimes situated at the apex of a more or less prominent cone; mandible rod-shaped, with flat distal part, usually, though not invariably, bearing a row of teeth (Fig. 1A, B) ..... Siphonostomatoida

Mouth and mandible not as above 2

2 Mouth not forming a tube, more or less gaping (Fig. 39B); mandible falcate (Fig. 1C) Poecilostomatoida

Mouth not forming a tube, more or less gaping; mandible small, with unciform, unarmed distal segment (Fig. 1D) ..... Cyclopoida

SIPHONOSTOMATOIDA

As mentioned above, the members of this suborder comprise a significant majority of copepods parasitic on fishes, infecting them in both freshwater and marine habitats. Their success as fish parasites has been attributed to two characteristic adaptations: their buccal apparatus that has been claimed to facilitate exploitation of fish tissues and, for many species, their possession of the frontal filament. Many siphonostomatoids are equipped with this larval attachment organ, which assures security of contact with the host at the time when the copepod undergoes extensive morphological changes and is in danger of being swept away. Some successful genera, however, are devoid of this device, apparently without adverse effect on their efficiency as parasites.

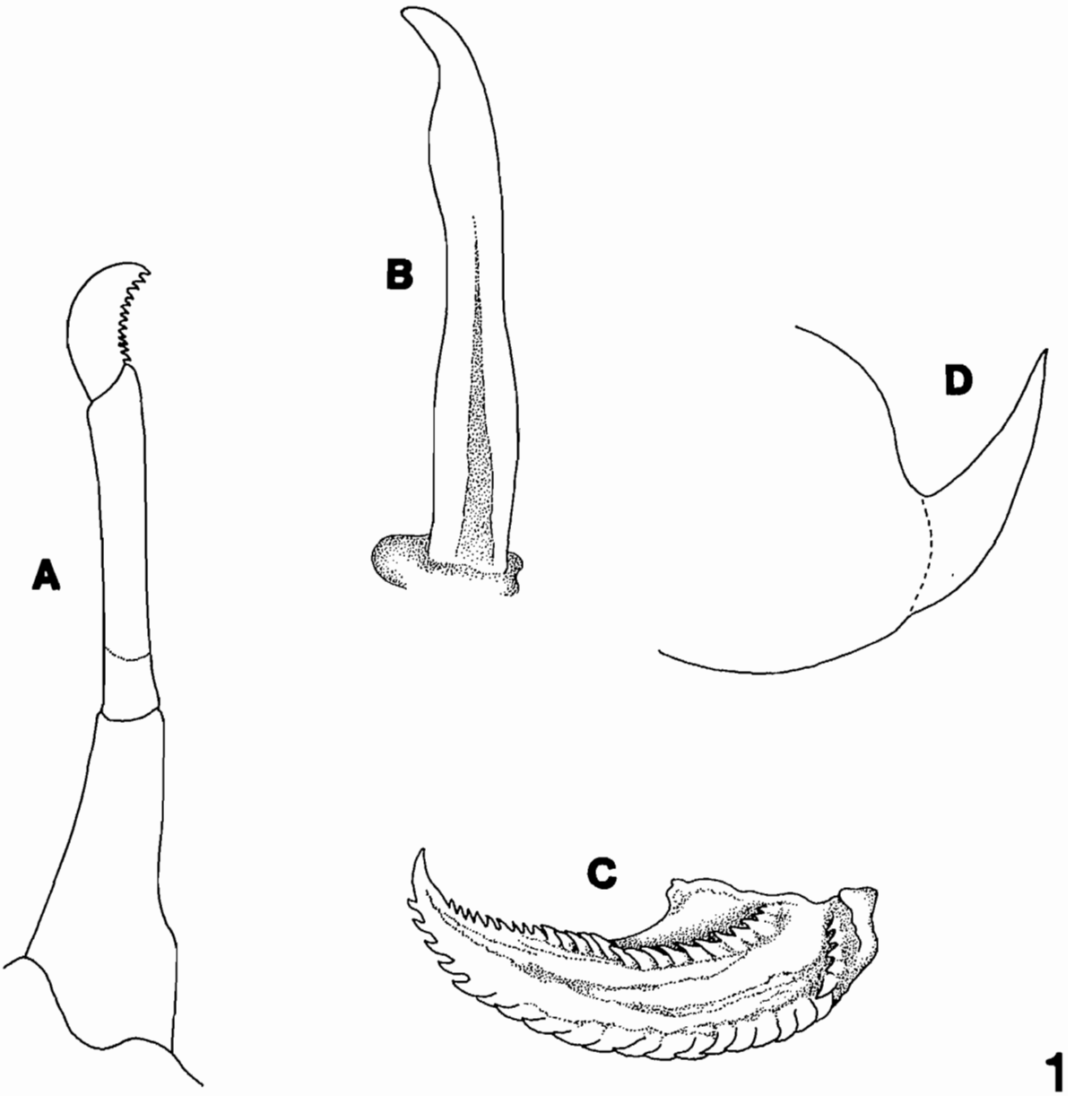

FIG. 1. Types of copepod mandibles. A,B. Siphonostomatoida; C. Poecilostomatoida; D. Cyclopoida. (Semidiagrammatic)

The great morphological variety of Siphonostomatoida makes their general diagnosis very difficult. The only feature common to all members of this group, and its hallmark, is the structure of the buccal apparatus, in which labrum and labium form together a tube, more or less fused and enclosing a pair of stylet-like mandibles (Fig. 1A,B).

The abundance of siphonostomatoid copepods is reflected in an extraordinary variety of their morphology and their modes of life. In the Canadian fauna they are represented by 11 families. The members of these families can be distinguished from one another with the aid of the following key:

Key to families of Siphonostomatoida

1 Body dorsoventrally flattened, cephalothorax covered by dorsal shield 2

Body not as above 4

2 Only one free segment present between cephalothorax and genital complex (Fig. 3G) ..... Caligidae

More than one free segment present between cephalothorax and genital complex 3

3 Frontal plates clearly delimited from dorsal shield, egg sacs visible in dorsal aspect (Fig. 13E) ..... Pandaridae

Frontal plates fused with dorsal shield, egg sacs concealed in dorsal aspect (Fig. 14G) ... Cecropidae

4 Attachment to host by means of second antennae and/or maxillipeds 5

Attachment by organs other than above 7

5 Body segmentation largely retained, attachment by both second antennae (Fig. 16E) and maxillipeds (Fig. 16H) (auxiliary attachment by first leg in *Nemesis*) ..... Eudactylinidae

Body with segmentation partly or completely lost 6

6 Three or four segments present between cephalothorax and genital complex; maxillipeds present in female ..... Dichelesthiidae

Not more than two segments present between cephalothorax and genital complex; maxillipeds absent in female ..... Hatschekiidae

7 Attachment by modified second maxillae 8

Attachment by holdfast buried in host tissues 10

8 Second maxillae ribbon-like, clasping gill filaments ..... Naobranchiidae

Second maxillae not ribbon-like 9

9 Second maxillae fused at tips only (Fig. 22A), partially along their length (Fig. 33F), or along their entire length (Fig. 30A); bulla present or absent; cephalothorax well developed (except in *Nectobrachia*) (Fig. 33F) ..... Lernaeopodidae

Second maxillae completely fused, much reduced cephalothorax vestigial; trunk with aliform lateral expansions curving ventrally (Fig. 34A) ..... Tanypleuridae

10 Holdfast of one pair (Fig. 35H), more than one pair (Fig. 37A), or numerous dendritic or simple outgrowths (Fig. 36B); egg sacs uniseriate (Fig. 36E) ..... Pennellidae

Holdfast more or less compact (Fig. 34E); egg sacs multiseriate (Fig. 34G) ..... Sphyriidae

Family CALIGIDAE

This exclusively parasitic family consists of species living predominantly on outer surfaces of marine fishes (only one freshwater species is currently known). Some caligids are capable of living in buccal and branchial cavities of their hosts. Although most of them are freely mobile on their hosts and are capable of moving from one host individual to another, some have adopted more stationary habits. Partial burrowing under the skin surface or semi-permanent attachment to the gills are not unknown.

The morphology of Caligidae is exemplified by *Caligus curtus* Müller, 1785, shown in Fig. 4B. The arrangement and structure of cephalothoracic appendages are diagrammatically illustrated in Fig. 2. Sexual dimorphism is manifest in differences between the shapes and sizes of the genital complex and abdomen and in the structure of the second antenna. These differences are not extensive enough to require separate familial diagnoses for the two sexes. The diagnosis is as follows:

Body of four tagmata: cephalothorax, fourth leg-bearing segment, genital complex, and abdomen. Cephalothorax including first three leg-bearing segments, covered by flat dorsal shield. Fourth leg-bearing segment small. Genital complex of two fused segments, with vestiges of fifth legs (in female) and fifth and sixth legs (in male), dorsoventrally flattened and of varied shape and size. Abdomen dorsoventrally flattened, of one or more segments and of varied length. Frontal plates present, well defined, with or without lunules. First antennae two-segmented, short; second antennae hamate. Postantennary processes present or absent. Mouth cone short, blunt, enclosing mandibles. First maxillae small, consisting of short process and separate setiferous papilla. Second maxillae long, slender, brachiform. Maxilliped, prehensile, subchelate. First leg with vestigial endopod; second leg biramous; third leg fused with its opposite number, biramous; fourth leg uniramous. Fifth leg vestigial. Sixth leg usually absent in female, vestigial in male. Uropods flat, setiferous.

The family is represented in the Canadian fauna by two genera, distinguishable by the following key:

Key to genera of Caligidae

Lunules (lun, Fig. 2) present on frontal plates ..... *Caligus*

Lunules absent ..... *Lepeophtheirus*

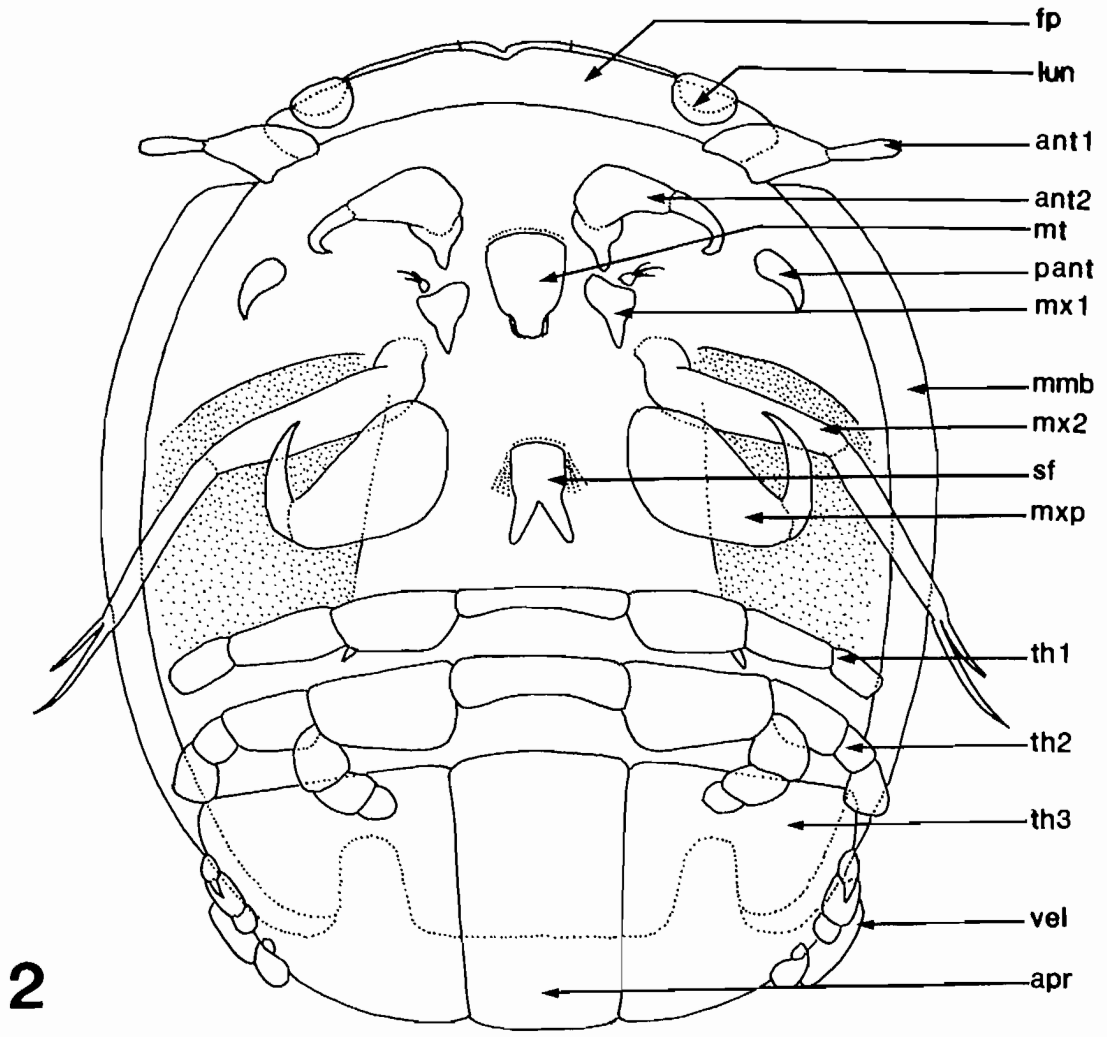

FIG. 2. Ventral surface of a caligid cephalothorax. (Diagrammatic) (Modified from Kabata 1979).
ant1 — first antenna; ant2 — second antenna; apr — apron of third leg; fp — frontal plate; lun — lunule; mmb — marginal membrane; mt — mouth tube; mx1 — first maxilla; mx2 — second maxilla; mxp — maxilliped; pant — postantennary process; sf — sternal furca; th1–th3 — first to third leg; vel — velum.

Genus *Caligus* Müller, 1785

The genus *Caligus* is among the most successful genera of the marine parasitic copepods, numbering more than 200 species and occurring in all geographic areas. Its known species vary greatly in abundance, in the range of host species, and in the extent of deleterious influence exerted.

The generic diagnosis is the same as that of Caligidae, with lunules present. The key below can be used to identify both males and females of the five *Caligus* species known from Canadian fishes.

Key to species of *Caligus*

1 Cephalic zone of dorsal shield divided by transverse suture behind eyes (Fig. 3G); postantennary process much reduced or absent ..... *C. coryphaenae* Steenstrup and Lütken, 1861

Female (Fig. 3G): Dorsal shield suboval, frontal plates well developed,relatively small, posterior tips of lateral zones of shield not projecting beyond margin of thoracic zone. Genital complex longer than thoracic zone of shield, with posteriorly diverging margins and rounded posterolateral lobes. Abdomen with indistinct segmentation (3–5 segments indicated by partial sutures), about as long as genital complex. Total length 5–8 mm. Sternal furca (Fig. 3I) flanked by scale-like sclerites. Fourth leg with three-segmented exopod (Fig. 3K) and full complement of five spines.

Male (Fig. 3H): Genital complex subcircular, shorter than thoracic zone of shield. Abdomen two-segmented, about as long as genital complex. Total length 4.5–6 mm. Claw of second antenna (Fig. 3J) simple, with one secondary tine.

Marine. Skin of *Thunnus thynnus*. (Atl) (Hogans 1985a).

Cephalic zone of dorsal shield not divided by transverse suture; postantennary process well developed 2

2 Distal segment of exopod of fourth leg with three apical and one lateral spine (Fig. 3E) 3

Distal segment of exopod of fourth leg with three apical spines; lateral spine absent (Fig. 4G) 4

3 Seta 4 of distal segment of exopod of first leg semipinnate (with membrane along one margin (Fig. 3D); corpus of maxilliped unarmed in both sexes (Fig. 3C) .. *Caligus elongatus* Edwards, 1840

Female (Fig. 3A): Dorsal shield slightly longer than wide, with posterior margin of thoracic zone projecting beyond tips of lateral zone. Genital complex about as long as thoracic zone of shield. Abdomen one-segmented, more than 1/2 length of genital complex. Exopod of first leg two-segmented, distal segment with terminal spine 1 simple, spines 2 and 3 bifid, spine 4 longer than other three, pinnate. Total length 5–6 mm.

Male (Fig. 3B): Genital complex oval, slightly shorter than thoracic zone of dorsal shield. Abdomen two-segmented, about as long as genital complex. Second antenna with bifid terminal claw (Fig. 3F). Total length 4–5 mm.

Marine. Skin and fins of *Clupea harengus harengus*, *Conger oceanius*, *Cyclopterus lumpus*, *Gadus morhua*, *Hippoglossus hippoglossus*, *Macrozoarces americanus*, *Melanogrammus aeglefinus*, *Merluccius bilinearis*, *Microgadus tomcod*, *Pollachius virens*, *Raja laevis*, *Raja* sp., *Salmo gairdneri*, *Salvelinus fontinalis*, *Urophycis tenuis*, and unspecified flounder. (Atl). Additional record: *Gadus morhua*. (Atl) (Appy and Burt 1982).

Seta 4 of distal segment of exopod of first leg unarmed (Fig. 5E); male maxilliped with denticulated flange on inner margin of corpus (Fig. 5D); female maxilliped with two spinules on inner margin of corpus (Fig. 5C) ..... *Caligus clemensi* Parker & Margolis, 1964

Female (Fig. 5A): Dorsal shield tapering anteriorly, posterior margin of its thoracic zone slightly projecting beyond tips of lateral zones. Genital complex with rounded anterolateral corners and transversely truncated posterior margin, length equal to that of thoracic zone of dorsal shield. Abdomen one-segmented, more than 1/2 length of genital complex. Apical armature of exopod of first leg (Fig. 5E) with seta 4 long, unarmed. Exopod of fourth leg two-segmented, lateral spine present on second segment (Fig. 5F). Total length 4–5 mm.

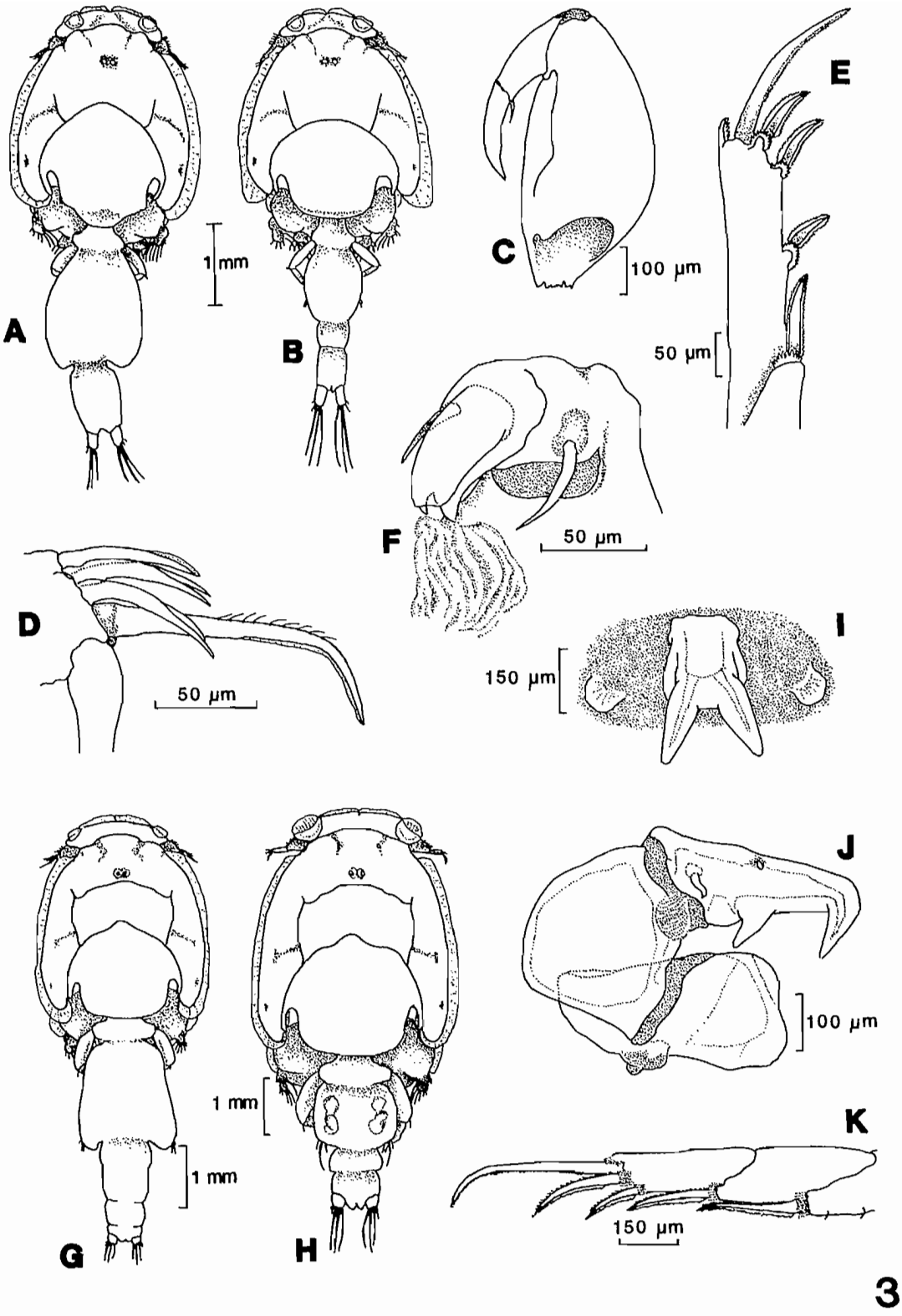

FIG. 3. A. *Caligus elongatus*, female, dorsal; B. Same, male, dorsal; C. Female, maxilliped; D. Tip of exopod of first leg; E. Exopod of fourth leg; F. Male, claw of second antenna; G. *Caligus coryphaenae*, female, dorsal; H. Same, male, dorsal; I. Sternal furca; J. Male, second antenna; K. Exopod of fourth leg. (Modified from Kabata 1979).

Male (Fig. 5B): Genital complex less than 1/2 length of thoracic zone of dorsal shield. Abdomen two-segmented, slightly shorter than genital complex. Maxilliped with denticulated flange and two spines on inner margin of corpus (Fig. 5D). Total length 4–5 mm.

Marine. External surfaces of *Clupea harengus pallasi*, *Gasterosteus aculeatus*, *Hexagrammos* sp., *Hydrolagus colliei*, *Oncorhynchus gorbuscha*, *O. keta*, *O. kisutch*, *O. nerka*, *Oncorhynchus* sp., *Salmo gairdneri*, *Sebastes caurinus*, *Sebastes* sp., and *Theragra chalcogramma*. (Pac). Additional records: *Clupea harengus pallasi*. (Pac) (Arthur and Arai 1980a); *Gasterosteus aculeatus*. (Pac) (Z. Kabata, unpublished).

4 Terminal armature of exopod of first leg with setae 1–3 simple, subequal, partly denticulated, seta 4 slightly longer, unarmed (Fig. 4F) ..... *Caligus curtus* Müller, 1785

Female (Fig. 4A): Dorsal shield subovoid, posterior margin of thoracic zone projecting beyond tips of lateral zones. Genital complex of equal length with thoracic zone of shield. Abdomen one-segmented, less than 1/2 length of genital complex. Maxilliped slender, with small, rounded prominence on median margin of corpus (Fig. 4D). Exopod of fourth leg two-segmented, no spine on lateral margin (Fig. 4G). Total length 5–10 mm.

Male (Fig. 4B): Genital complex roughly circular, with protruding posterolateral corners, more than 1/2 length of thoracic zone of dorsal shield. Abdomen one-segmented, more than 1/2 length of genital complex. Maxilliped with broad corpus, its inner margin with two pointed processes (Fig. 4E). Second antenna with bifid terminal claw (Fig. 4C). Total length 5–12 mm.

Marine. External surfaces of *Gadus morhua*, *Melanogrammus aeglefinus*, *Merluccius bilinearis*, *Microgadus tomcod*, and *Pollachius virens*. (Atl). Additional record: *Gadus morhua*. (Atl) (Appy and Burt 1982).

Terminal armature of exopod of first leg with setae 2 and 3 bifid; seta 4 about twice length of others (Fig. 5K) ..... *Caligus macarovi* Gusev, 1951

Female (Fig. 5G): Dorsal shield longer than wide, narrower anteriorly. Genital complex subcircular, with slightly re-entrant posterior margin, longer than thoracic zone of dorsal shield. Abdomen indistinctly 2-segmented (second segment ca. 20% abdomen length), about as long as genital complex. Maxilliped with slender, unarmed corpus (Fig. 5I). Sternal furca with digitiform tines (Fig. 5L). Terminal segment of exopod of first leg with three long, semipinnate setae on posterior margin; lateral margin with setae 2 and 3 bifid and subequal; seta 4 simple, apparently unarmed, twice length of other setae (Fig. 5K). Total length 5–6.5 mm.

Male (Fig. 5H): Genital complex oval, with posterolateral protrusions for fifth and sixth leg, more than 1/2 length of thoracic zone of dorsal shield. Abdomen two-segmented, longer than genital complex. Maxilliped with prominent corrugated flange on inner margin of corpus (Fig. 5J). Sternal furca with slightly spatulate tines (Fig. 5M). Total length 3.5 mm.

Marine. External surfaces of *Cololabis saira*. (Pac).

In addition to the species included in the key, unidentified *Caligus* species have been recorded from *Gadus morhua* on the Atlantic coast and from *Merluccius productus* on the Pacific coast.

Lepeophtheirus von Nordmann, 1832

The species belonging to this genus currently number about 100. Resembling *Caligus* in most morphological details, they can be fairly readily distinguished from members of that genus by the absence of lunules (lun, Fig. 2) from their frontal plates. Biological similarities between these two genera are also very close, as are their host–parasite relationships. *Lepeophtheirus* is exclusively marine and cosmopolitan in distribution.

The generic diagnosis of *Lepeophtheirus* is the same as the familial diagnosis of Caligidae, with lunules absent. Twelve species of the genus are presently known in Canadian waters. The sexual dimorphism displayed by the members of the genus necessitates the use of separate keys for males and females. The sexes can be best distinguished from each other by the structure of the second antennae, uniformly hamate in females, but varying in males, especially in their distal part.

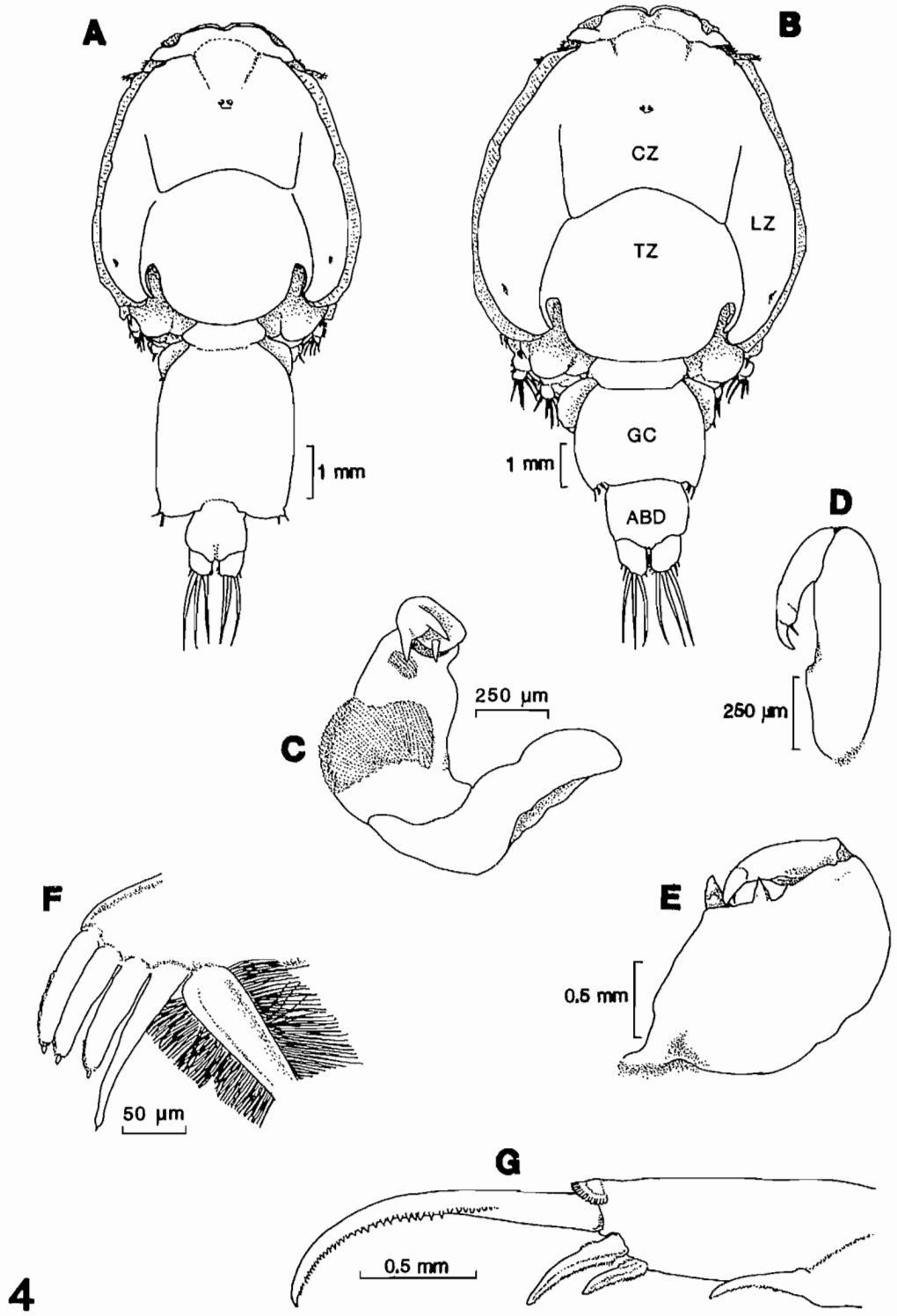

FIG. 4. *Caligus curtus*. A. Female, dorsal; B. Male, dorsal; C. Male, second antenna; D. Female, maxilliped; E. Male, maxilliped; F. Tip of exopod of first leg; G. Tip of exopod of fourth leg. (Modified from Kabata 1979).
ABD — abdomen; CZ — cephalic zone; GC — genital complex; LZ — lateral zone; TH — thoracic zone.

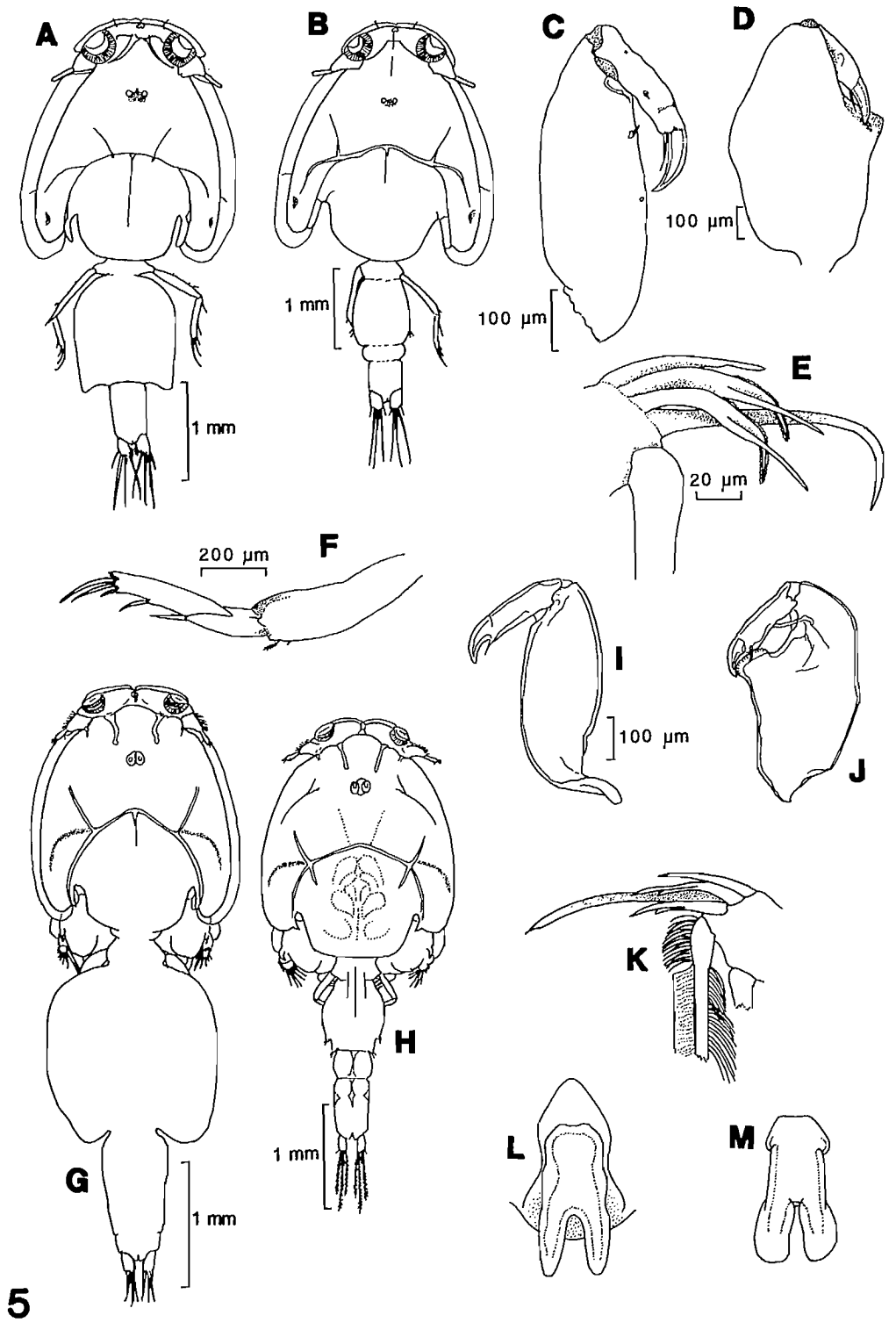

FIG. 5. A. *Caligus clemensi*, female, dorsal; B. Same, male, dorsal; C. Maxilliped, female; D. Same, male; E. Tip of exopod of first leg; F. Fourth leg; G. *Caligus macarovi*, female, dorsal; H. Same, male, dorsal; I. Female, maxilliped; J. Male, maxilliped; K. Tip of exopod of first leg; L. Sternal furca, female; M. Same, male. (A,B modified from Parker and Margolis 1964; C–F redrawn from Kabata 1972; G–I redrawn from Gusev 1951; J,L,M modified from Shiino 1954; K redrawn from Shiino 1956).

Key to females of species of *Lepeophtheirus*

1 Sternal furca with bifid tines (Fig. 6C) 2

Sternal furca with single tines (Fig. 7F) 3

2 Fifth leg with subtriangular distal half (Fig. 6G) ..... *L. bifidus* Fraser, 1920

Dorsal shield with shallow posterior sinuses (Fig. 6A). Genital complex subcircular, longer than thoracic zone of shield. Abdomen one-segmented, less than 1/2 length of genital complex. First maxilla with subequal tines. Distal margin of exopod of first leg with seta 1 simple, setae 2 and 3 bifid, seta 4 short, pinnate (Fig. 6E). Spine of exopod of third leg at some distance from basal swelling (Fig. 6F). Total length 5 mm.

Marine. Skin of *Lepidopsetta bilineata* and *Parophrys vetulus*. (Pac). Additional record: *Pleuronichthys decurrens*. (Pac) (Z. Kabata, unpublished).

Fifth leg subquandrangular, with deeply indented outer margin (Fig. 6L) ..... *L. hippoglossi* (Krφyer, 1837)

Dorsal shield subcircular (Fig. 6H). Genital complex suboval, with posterolateral lobes, longer than thoracic zone of shield. Abdomen one-segmented, less than 1/4 length of genital complex. Sternal furca with bifid tines (Fig. 6J). Terminal setae of first exopod with flanges along margins (Fig. 6K). Total length 12 mm.

Marine. Skin of *Hippoglossus hippoglossus*. (Atl). Additional records: *Hippoglossus hippoglossus* and *Reinhardtius hippoglossoides*. (Atl) (Zubchenko 1980).

3 Sharp triangular sclerite on both sides of sternal furca on ventral surface of cephalothorax (Fig. 7C) ..... *L. nordmanni* (Edwards, 1840)

Dorsal shield subcircular (Fig. 7A). Genital complex suboval, longer than thoracic zone of shield, with small lobes in posterolateral corners. Abdomen one-segmented, less than 1/2 length of genital complex. Cephalothoracic appendages long, slender. First maxilla with two subequal tines. Fifth leg subtriangular. Total length 10 mm.

Marine. Skin of *Mola mola*. (Atl) (Pac).

No sclerites on sides of sternal furca 4

4 Exopod spine of third leg some distance from basal swelling (Fig. 7G) ..... *L. parviventris* Wilson, 1905

Dorsal shield suboval (Fig. 7D). Genital complex rounded, longer than thoracic zone of shield, with margins re-entrant at base of abdomen. Latter one-segmented, less than 1/2 length of genital complex. First maxilla with two subequal tines. Sternal furca (Fig. 7F) broad, with short tines. Fifth leg subtriangular. Total length 5–8 mm.

Marine. Skin of *Anoplopoma fimbria*, *Enophrys bison*, *Eopsetta jordani*, *Gadus macrocephalus*, *Hexagrammos decagrammus*, *Lepidopsetta bilineata*, *Myoxocephalus polyacanthocephalus*, *Raja binoculata*, *R. rhina*, *Scorpaenichthys marmoratus*, *Sebastes pinniger*, and *Xiphister atropurpureus*. (Pac). Additional record: *Theragra chalcogramma*. (Pac) (Arthur 1984).

Exopod spine of third leg at distal end of basal swelling (Fig. 7J) 5

5 Second terminal spine of fourth leg longer than other two (Fig. 7K) 6

Second terminal spine of fourth leg shorter than first (Fig. 9G) 7

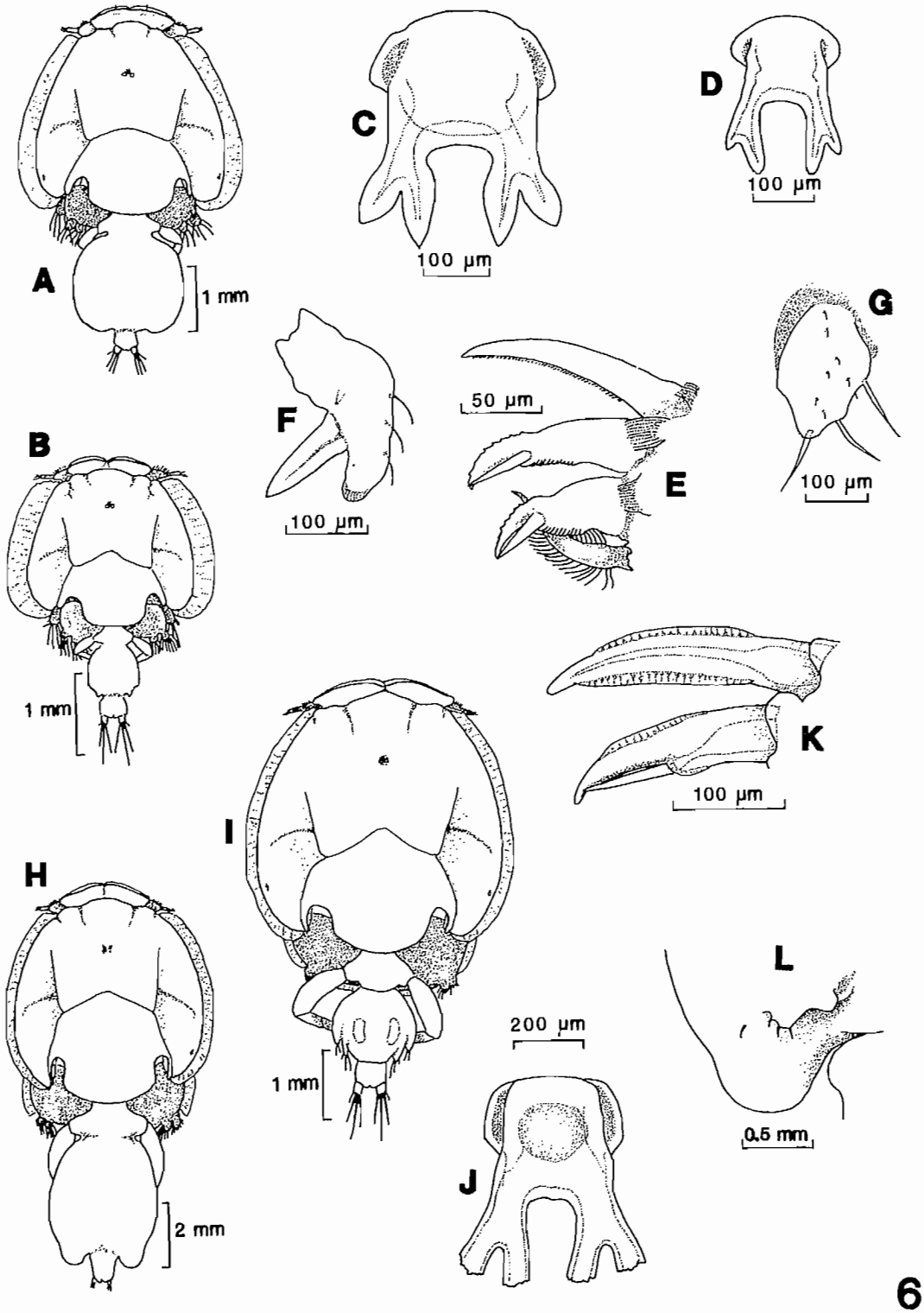

FIG. 6. A. *Lepeophtheirus bifidus*, female, dorsal; B. Same, male, dorsal; C. Sternal furca, female; D. Same, male; E. Tip of exopod of first leg; F. Basal spine of exopod of third leg; G. Fifth leg; H. *Lepeophtheirus hippoglossi*, female, dorsal; I. Same, male, dorsal; J. Sternal furca; K. First two spines of exopod of first leg; L. Fifth leg, female. (A–G modified from Kabata 1973; H–L redrawn from Kabata 1979).

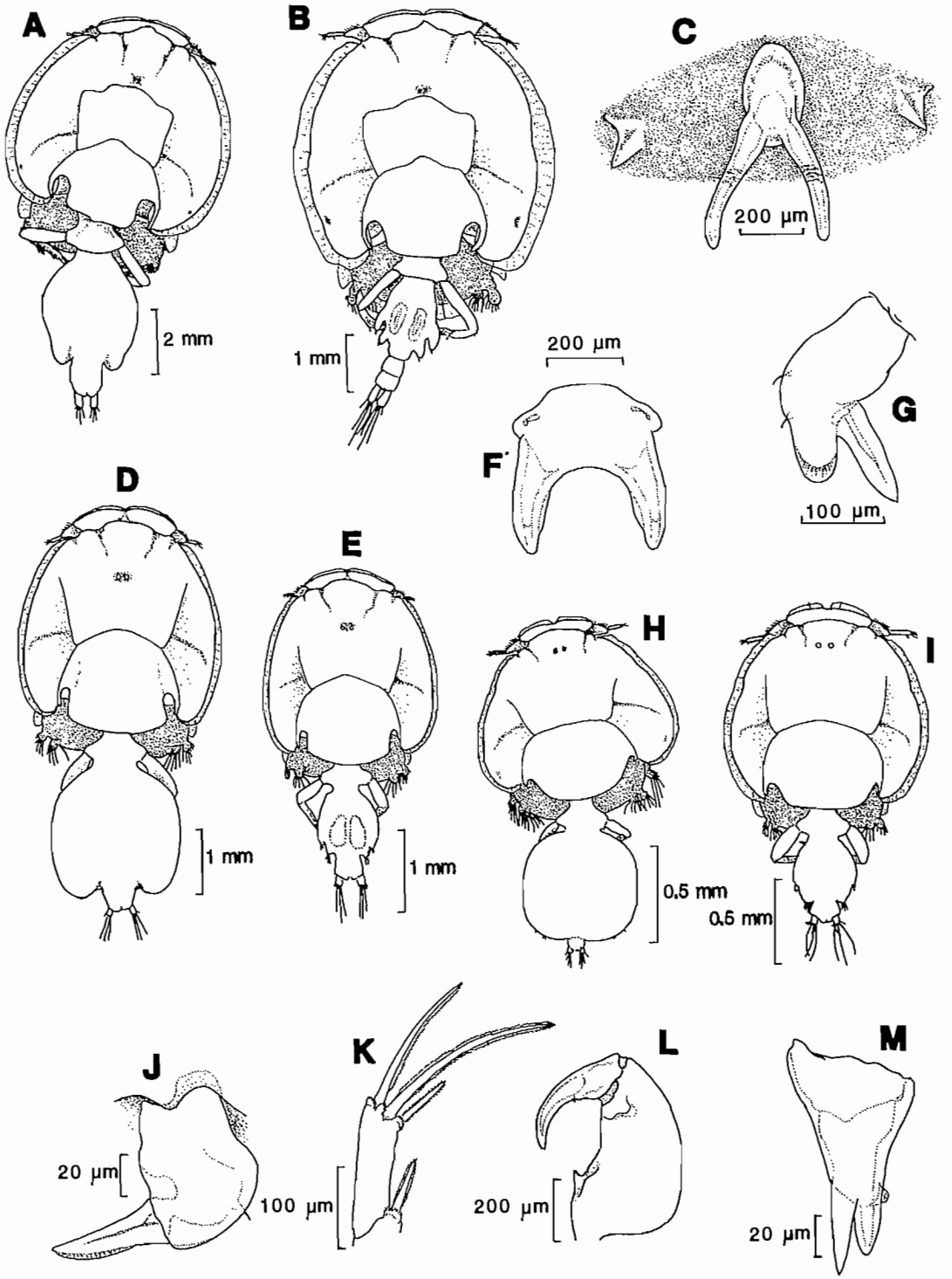

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FIG. 7. A. *Lepeophtheirus nordmanni*, female, dorsal; B. Same, male, dorsal; C. Sternal furca; D. *Lepeophtheirus parviventris*, female, dorsal; E. Same, male, dorsal; F. Sternal furca; G. Spine of exopod of third leg; H. *Lepeophtheirus pauhis*, female, dorsal; I. Same, male, dorsal; J. Spine of exopod of third leg; K. Tip of exopod of fourth leg; L. Maxilliped, female; M. First maxilla, male. (A–C redrawn from Kabata 1979; D–M redrawn from Kabata 1973).

6 Maxilliped with pointed outgrowth on medial margin (Fig. 7L) ..... *L. paulus* Cressey, 1969

Dorsal shield broader posteriorly (Fig. 7H), with very shallow posterior sinuses. Genital complex subcircular, longer than thoracic zone of shield. Abdomen one-segmented, very small, less than 1/2 length of genital complex. First maxilla with two subequal tines. Exopod spine of third leg (Fig. 7J) at tip of basal swelling. Fifth leg subquadrangular. Total length 1–4 mm.

Marine. Buccal cavity of *Sebastes flavidus*, *S. maliger*, *S. nigrocinctus*, and *S. ruberrimus*. (Pac). Additional record: *Theragra chalcogramma*. (Pac) (Arthur 1984).

Maxilliped without pointed outgrowth on medial margin (Fig. 8E) ..... *L. breviventris* Fraser, 1920

Dorsal shield with very shallow posterior sinuses (Fig. 8A). Genital complex subcircular, about as long as thoracic zone of shield. Abdomen one-segmented, diminutive. First maxilla with one tine much smaller than other. Sternal furca with blunt, nearly parallel tines (Fig. 8C). Exopod spine of third leg at distal end of basal swelling (Fig. 8D). Second terminal spine of fourth leg longer than other two (Fig. 8G). Fifth leg subquadrangular. Total length 3–4 mm.

Marine. Buccal cavity of *Ophiodon elongatus*. (Pac).

7 Fifth leg trifid (Fig. 8M) or subrectangular (Fig. 9F) 8

Fifth leg subtriangular (Fig. 9L) 9

8 Fifth leg trifid (Fig. 8M) ..... *L. parvicruris* Fraser, 1920

Dorsal shield subcircular, with very shallow posterior sinuses (Fig. 8H). Genital complex about as long as shield. Abdomen indistinctly two-segmented (first segment much shorter than second), about as long as genital complex. First maxilla with two subequal tines. Sternal furca (Fig. 8J) with flanges on blunt tines. Exopod spine of third leg (Fig. 8K) at distal end of basal swelling. Exopod of fourth leg two-segmented (Fig. 8L). Total length 5–6 mm.

Marine. Skin of *Platichthys stellatus*. (Pac).

Fifth leg subrectangular (Fig. 9F) ..... *L. pravipes* Wilson, 1912

Dorsal shield narrower anteriorly (Fig. 9A). Genital complex rounded, about as long as shield, with pointed posterolateral lobes. Abdomen one-segmented, diminutive. First maxilla with two subequal tines. Sternal furca (Fig. 9D) with divergent, tapering tines. Exopod spine of third leg at tip of basal swelling (Fig. 9E). Exopod of fourth leg three-segmented (Fig. 9G). Total length 4–5 mm.

Marine. Skin of *Hippoglossus stenolepis*, *Ophiodon elongatus*, and *Raja binoculata*. (Pac).

9 First maxilla with one tine much smaller than other (Fig. 9J) ..... *L. nanaimoensis* Wilson, 1912

Dorsal shield narrower anteriorly (Fig. 9H). Genital complex about as long as thoracic zone of shield, with prominent, usually rounded posterior lobes. Abdomen one-segmented, less than 1/4 length of genital complex. Sternal furca with divergent, inward curving tines (Fig. 9I). Exopod spine of third leg at tip of basal swelling (Fig. 9K). Fifth leg long, subtriangular (Fig. 9L). Male unknown. Total length 4 mm.

Marine. Skin of unspecified flounder. (Pac). Additional record: *Citharichthys sordidus*. (Pac) (Leighton and Bergey 1983).

First maxilla with two subequal tines (Fig. 10E) 10

10 Sternal furca with spatulate tines (Fig. 10D) ..... *L. salmonis* (Krøyer, 1837)

Dorsal shield suborbicular (Fig. 10A). Genital complex subquadrangular, longer than thoracic zone of shield, with rounded posterior lobes. Abdomen one-segmented, cylindrical, about as long as genital complex. Exopod spine of third leg at tip of basal swelling (Fig. 10F). Exopod of fourth leg three-segmented, two distal segments fused (Fig. 10G). Fifth leg subtriangular (Fig. 10H). Total length 7–18 mm.

Marine. Skin of *Acipenser transmontanus*, *Ammodytes hexapterus*, *Oncorhynchus gorbuscha*, *O. keta*, *O. kisutch*, *O. nerka*, *O. tshawytscha*, *Ophiodon elongatus*, *Salmo clarki*, *S. gairdneri*, *S. salar*, and *Salvelinus fontinalis*. (Atl) (Pac). Additional record: *Salmo salar*. (Atl) (Pippy 1980).

Sternal furca with tapering tines (Fig. 10M) 11

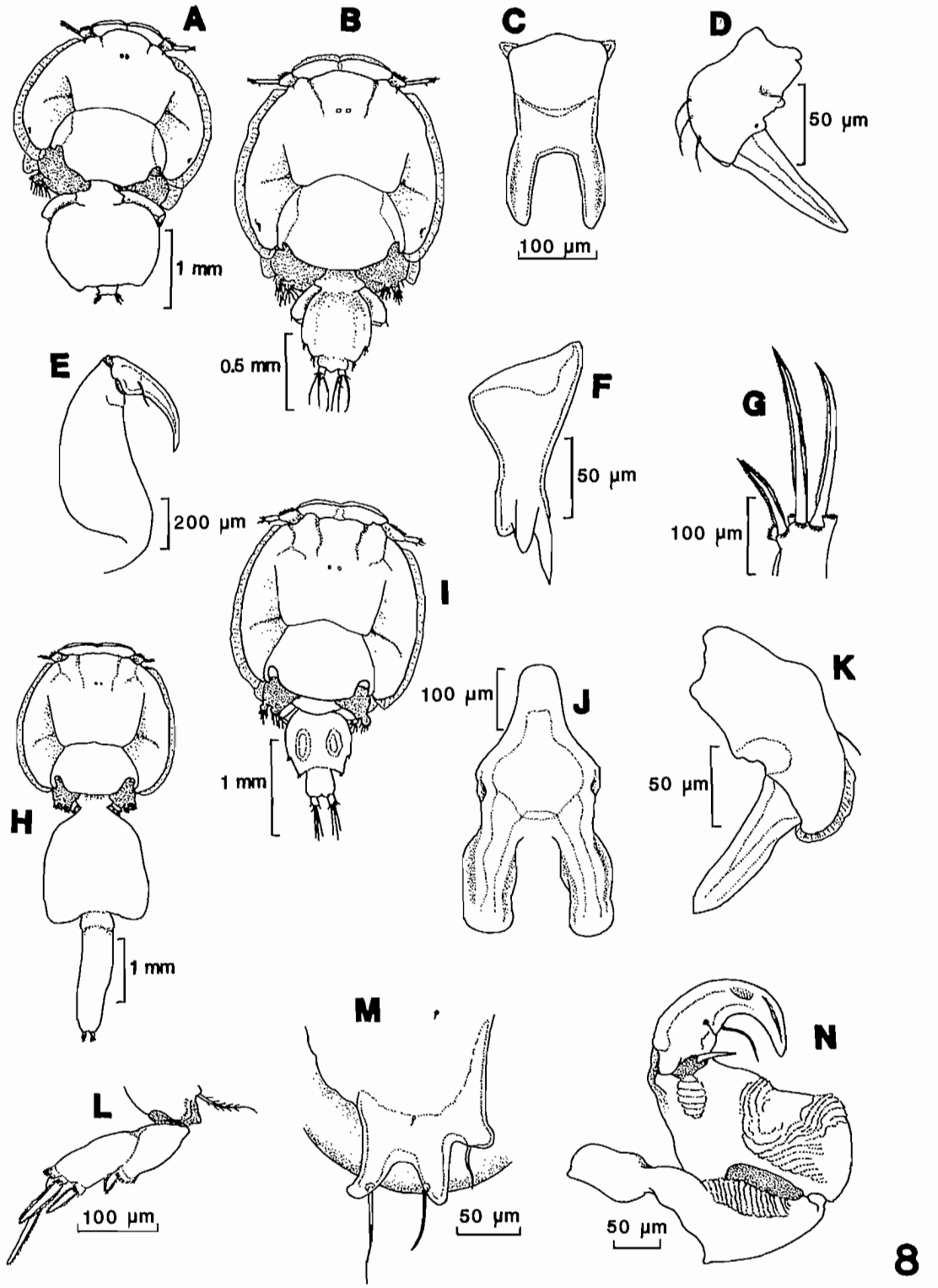

FIG. 8. A. *Lepeophtheirus breviventris*, female, dorsal; B. Same, male, dorsal; C. Sternal furca; D. Spine of exopod of third leg; E. Maxilliped, female; F. First maxilla, male; G. Tip of exopod of fourth leg; H. *Lepeophtheirus parvicruris*, female, dorsal; I. Same, male, dorsal; J. Sternal furca; K. Spine of exopod of third leg; L. Exopod of fourth leg; M. Fifth leg, female; N. Second antenna, male. (Redrawn from Kabata 1973).

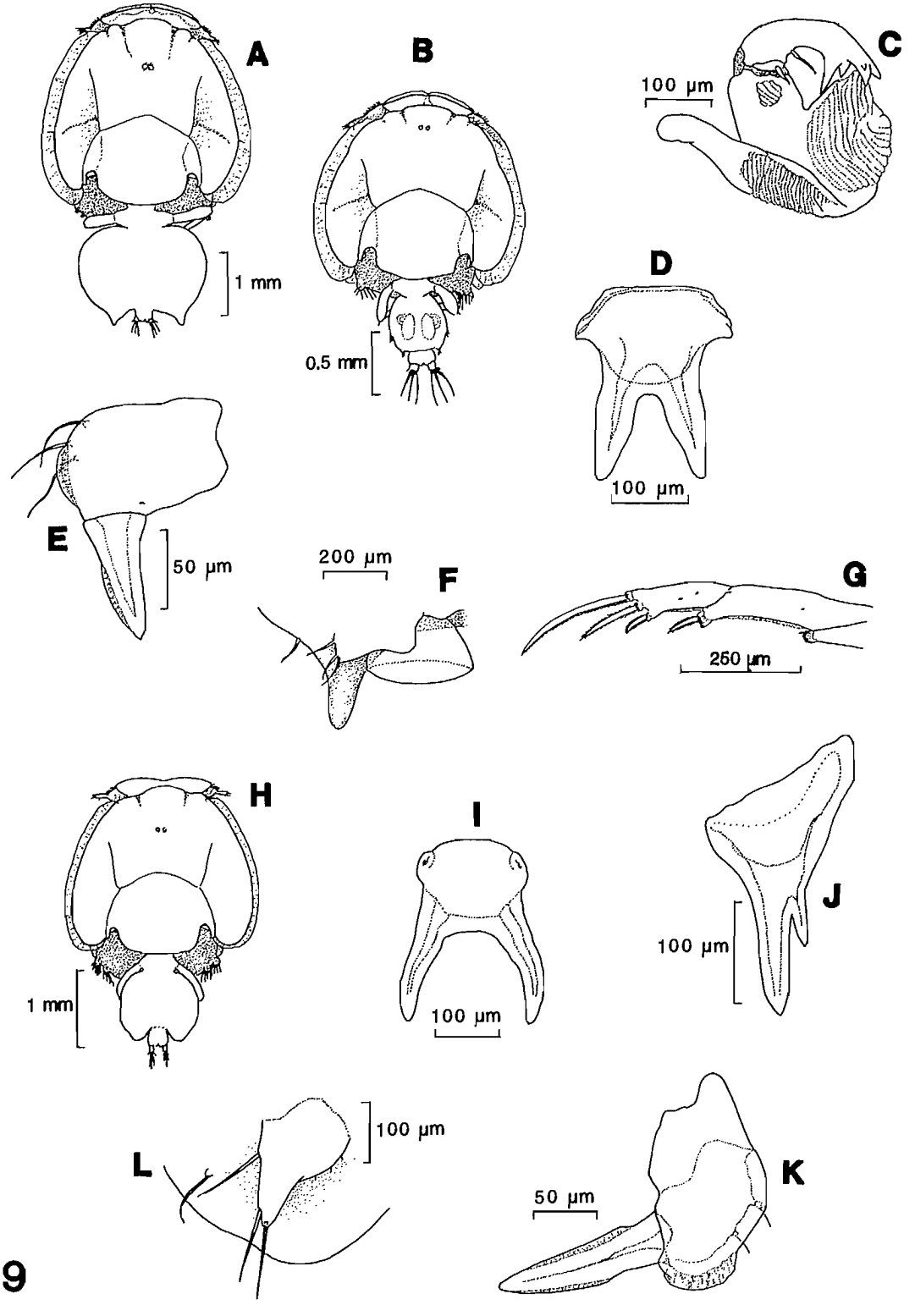

FIG. 9. A. *Lepeophtheirus pravipes*, female, dorsal; B. Same, male, dorsal; C. Male, second antenna; D. Sternal furca; E. Spine of exopod of third leg; F. Female, fifth leg; G. Fourth leg; H. *Lepeophtheirus nanaimoensis*, female, dorsal; I. Sternal furca; J. First maxilla; K. Spine of exopod of third leg; L. Fifth leg. (Redrawn from Kabata 1973).

11 Tines of sternal furca with convex inner (sometimes also outer) margins (Fig. 10M) ..... *L. hospitalis* Fraser, 1920

Dorsal shield suborbicular to ovoid (Fig. 10I), with fairly deep posterior sinuses. Genital complex suborbicular, slightly longer than thoracic zone of shield. Abdomen one-segmented, less than 1/2 length of genital complex. First maxilla with two subequal tines (Fig. 10L). Exopod spine of third leg at tip of basal swelling (Fig. 11B). Exopod of fourth leg three-segmented, with terminal spines decreasing in size by about equal increments (Fig. 11A). Fifth leg subtriangular (Fig. 11C). Total length 3.5–5.5 mm.

Marine. Skin of *Gadus macrocephalus*, *Lepidopsetta bilineata*, *Parophrys vetulus*, *Platichthys stellatus*, and *Pleuronichthys coenosus*. (Pac). Additional record: *Hexagrammos* sp. (Pac) (Z. Kabata, unpublished).

Tines of sternal furca with margins more or less straight (Fig. 11J) ..... *L. oblitus* Kabata, 1973

Dorsal shield slightly ovoid (Fig. 11D). Genital complex subcircular, about as long as thoracic zone of shield, with rounded lobes on posterior margin. Abdomen indistinctly two-segmented, less than 1/2 length of genital segment. First maxilla with two subequal tines (Fig. 11H). Exopod spine of third leg at tip of basal swelling (Fig. 11K). Exopod of fourth leg three-segmented (Fig. 11L). Fifth leg subtriangular (Fig. 11M). Total length 4.8–5.8 mm.

Marine. Skin and branchial cavity of *Hexagrammos decagrammus*, *H. stelleri*, *Sebastes* sp., *S. alutus*, *S. caurinus*, and *S. maliger*. (Pac).

Key to males of species of *Lepeophtheirus*

(Male of *L. nanaimoensis* not included in key)

1 Sternal furca with bifid tines (Fig. 6D) 2

Sternal furca with simple tines (Fig. 7F) 3

2 Terminal setae of exopod of first leg with partly serrated margins (Fig. 6E) ..... *L. bifidus* Fraser, 1920

Genital complex oval, shorter than thoracic zone of dorsal shield, with fifth and sixth leg at apices of small lobes (Fig. 6B). Abdomen one-segmented, less than 1/2 length of genital complex. Second antenna with inflated middle segment and simple claw. First maxilla with two tines and accessory process, all subequal. Total length 3 mm.

Terminal setae of exopod of first leg with flanges on margins (Fig. 6K) ..... *L. hippoglossi* (Krøyer, 1837)

Genital complex subcircular, shorter than thoracic zone of dorsal shield, with prominent lobes bearing fifth and sixth legs (Fig. 6I). Abdomen one-segmented, less than 1/2 length of genital complex. Claw of second antenna simple. First maxilla with two subequal tines and accessory process. Total length 5 mm.

3 Sharp triangular sclerites on both sides of sternal furca on ventral surface of cephalothorax (Fig. 7C) ..... *L. nordmanni* (Edwards, 1840)

Genital complex oblong, as long as thoracic zone of dorsal shield, with prominent lobes bearing fifth and sixth legs (Fig. 7B). Abdomen two-segmented, about 1/2 length of genital complex. Claw of second antenna with lateral tine near midlength. Single tine of first maxilla with two small secondary outgrowths. Total length 6 mm.

No sclerites flanking sternal furca (Fig. 7F) 4

4 Exopod spine of third leg at some distance from tip of basal swelling (Fig. 7G) *L. parviventris* Wilson, 1905

Genital complex suboval, shorter than thoracic zone of dorsal shield, with small lobes bearing fifth and sixth legs (Fig. 7E). Abdomen one-segmented, very small, less than 1/4 length of genital complex. Claw of second antenna simple. First maxilla with two subequal tines and accessory process. Total length 3–4.5 mm.

Exopod spine of third leg at distal end of basal swelling (Fig. 7J) 5

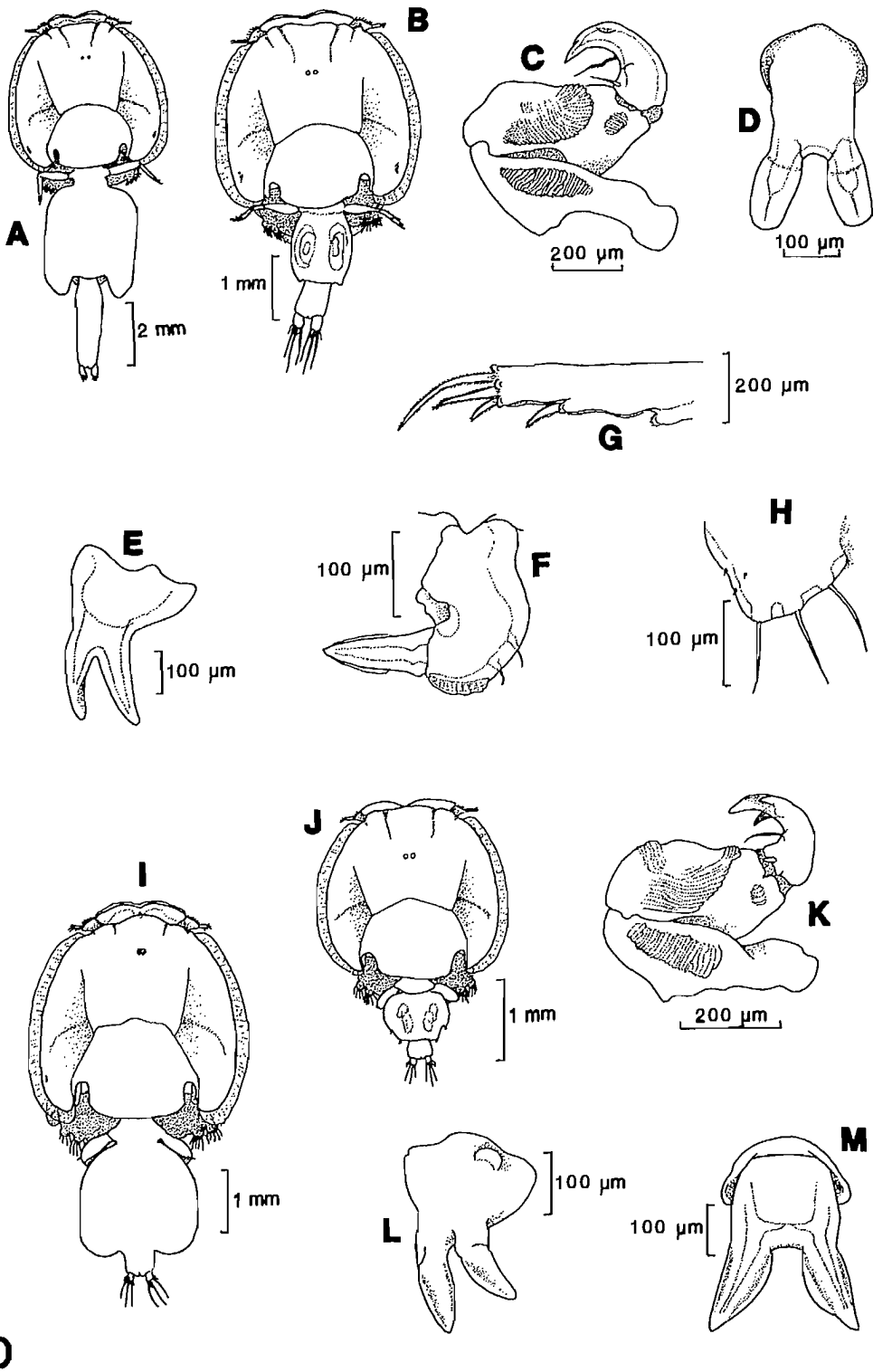

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FIG. 10. A. *Lepeophtheirus salmonis*, female, dorsal; B. Same, male, dorsal; C. Male, second antenna; D. Sternal furca; E. Female, first maxilla; F. Spine of exopod of third leg; G. Exopod of fourth leg; H. Female, fifth leg. I. *Lepeophtheirus hospitalis*, female, dorsal; J. Same, male, dorsal; K. Male, second antenna; L. Female, first maxilla; M. Sternal furca, female. (Redrawn from Kabata 1973).

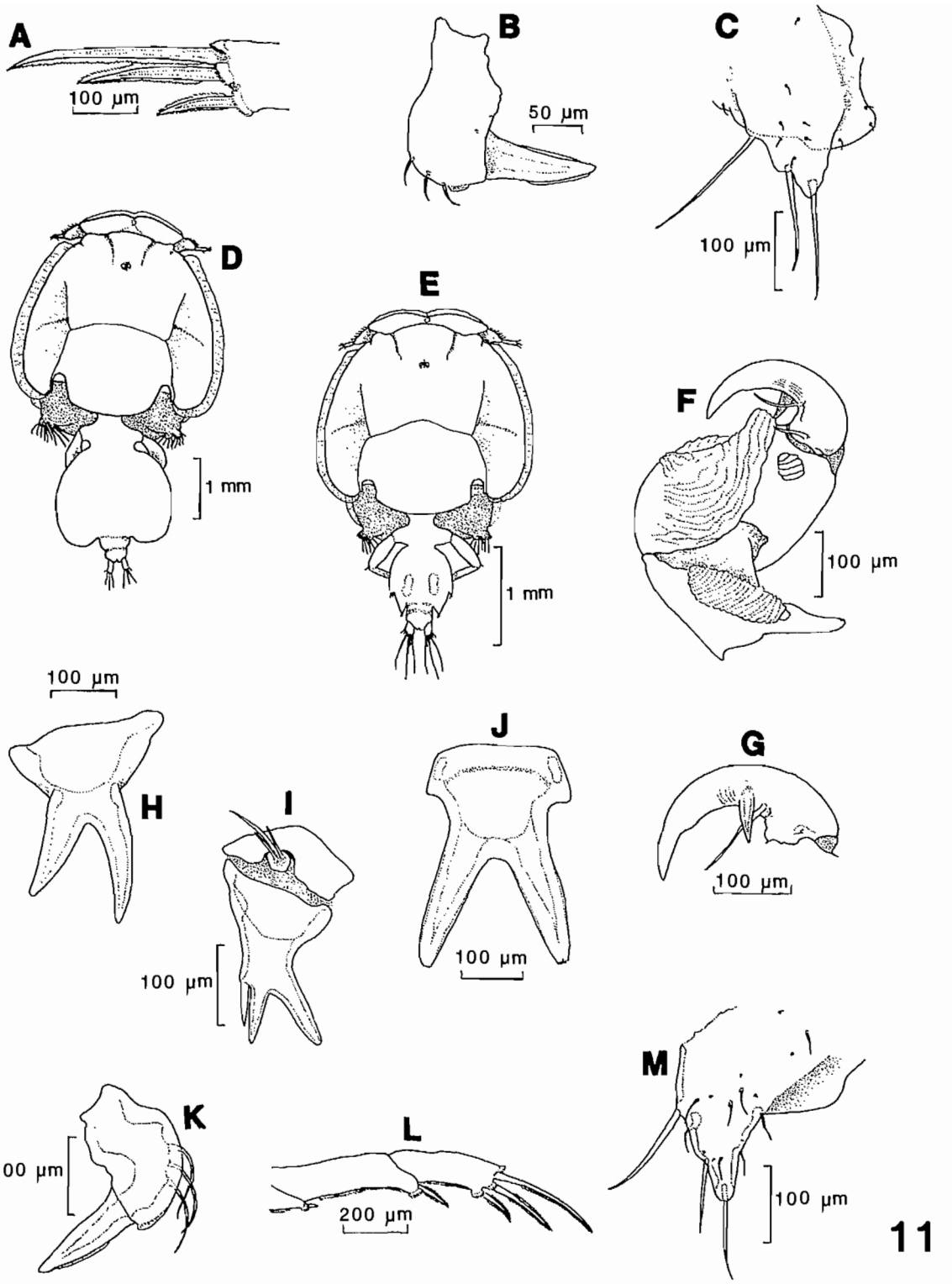

FIG. 11. A. *Lepeophtheirus hospitalis*, tip of exopod of fourth leg; B. Spine of exopod of third leg; C. Fifth leg, female; D. *Lepeophtheirus oblitus*, female, dorsal; E. Same, male, dorsal; F. Male, second antenna, entire; G. Same, terminal claw; H. Female, first maxilla; I. Male, first maxilla; J. Female, sternal furca; K. Spine of exopod of third leg; L. Exopod of fourth leg; M. Female, fifth leg. (Redrawn from Kabata 1973).

5 Second terminal spine of exopod of fourth leg longer than other two (Fig. 7K) 6

Second terminal spine of exopod of fourth leg shorter than first (Fig. 10G) 7

6 First maxilla with two very short, blunt tines and much longer accessory process (Fig. 8F) .... *L. breviventris* Fraser, 1920

Genital complex suboval, shorter than thoracic zone of dorsal shield (Fig. 8B). Abdomen one-segmented, less than 1/4 length of genital complex. Claw of second antenna with three secondary tines. Total length 2 mm.

First maxilla with single tine (flange at base) and with longer accessory process (Fig. 7M) .... *L. paulus* Cressey, 1969

Genital complex suboval, shorter than thoracic zone of dorsal shield (Fig. 7I). Abdomen one-segmented, less than 1/2 length of genital complex. Claw of second antenna with small secondary tine about midlength. Total length 1–2 mm.

7 Claw of second antenna simple, with flanges of membrane on each side (Fig. 8N, 10C) 8

Claw of second antenna not simple 9

8 Exopod of fourth leg two-segmented (Fig. 8L) ..... *L. parvicruris* Fraser, 1920

Genital complex shorter than thoracic zone of dorsal shield, with prominent posterolateral lobes (Fig. 8I). Abdomen one-segmented, about 1/2 length of genital complex. First maxilla with two subequal tines and shorter accessory process. Total length 2–3 mm.

Exopod of fourth leg three-segmented (second and third segments fused but spine of second segment present) (Fig. 10G) ..... *L. salmonis* (Krφyer, 1837)

Genital complex oval, about as long as thoracic zone of dorsal shield (Fig. 10B). Abdomen one-segmented, shorter than genital complex. First maxilla with one tine 1/2 length of other and with short accessory process. Total length 5–7 mm.

9 Claw of second antenna with one lateral tine in proximal part (Fig. 11G) ... *L. oblitus* Kabata, 1973

Genital complex subcircular to oval, shorter than thoracic zone of shield, with prominent posterolateral processes (Fig. 11E). Abdomen indistinctly two-segmented, about 1/4 length of genital complex. Second antenna with moderately inflated middle segment (Fig. 11F). First maxilla with two subequal tines and shorter accessory process (Fig. 11I). Total length 2.6 mm.

Claw of second antenna other than above 10

10 Claw of second antenna with two secondary tines in distal half (Fig. 10K) .... *L. hospitalis* Fraser, 1920

Genital complex subcircular, about 1/2 length of thoracic zone of dorsal shield (Fig. 10J). Abdomen one-segmented, less than 1/2 length of genital complex. First maxilla with two subequal tines and accessory process. Total length 1.5–3.5 mm.

Claw of second antenna ending in four large tines, with small fifth tine present (Fig. 9C) .... *L. pravipes* Wilson, 1912

Genital complex oval, shorter than thoracic zone of dorsal shield (Fig. 9B). Abdomen one-segmented, less than 1/2 length of genital complex. Second antenna with inflated middle segment (Fig. 9C). First maxilla with two blunt subequal tines and longer accessory process. Total length 2.5 mm.

In addition to the species listed in the keys above, unidentified *Lepeophtheirus* spp. have been recorded from the skin and gills of various fishes off the Pacific coast (*Ammodytes hexapterus*, *Lepidopsetta bilineata*, *Merluccius*

productus, *Microgadus proximus*, *Mola mola*, *Myoxocephalus polyacanthocephalus*, *Parophrys vetulus*, *Platichthys stellatus*, and *Raja binoculata*). Additional records: *Theragra chalcogramma*. (Pac) (Arthur 1984); *Merluccius productus*. (Pac) (Sankurathri et al. 1983); Chalimus stages on *Eopsetta jordani*, *Gadus macrocephalus*, *Gasterosteus aculeatus*, *Sebastes maliger*, and *Parophrys vetulus*. (Pac) (Z. Kabata, unpublished).

Lewis (1964) listed *Lepeophtheirus dissimulatus* Wilson, 1905, as occurring in British Columbia on *Gadus macrocephalus*. This record resulted apparently from mislabelling of material (Lewis, personal communication). *L. dissimulatus* has never been found in Canadian waters.

Family PANDARIDAE

All members of this family are ectoparasitic on elasmobranch hosts, often occurring in large, dense colonies on the fins of sharks, although they can be found also scattered at other sites. They are capable of altering their position on the host but appear to do so only rarely.

Being generally similar to Caligidae, Pandaridae are characterized by possession of accesssory attachment organs, the adhesion pads (A-pad, Fig. 12A). The pads are hard, flat structures with rough surfaces (usually due to the presence of numerous fine, parallel grooves), facilitating strong attachment to the host. Another typically pandarid feature is the length of the mouth tube, which makes it impossible for the mouth to assume a position perpendicular to the substrate. Consequently, the mouth always points obliquely backwards and its labrum is shorter than its labium, to enable it to remain flush with the substrate. The family diagnosis is as follows:

Females: Dorsoventrally flattened, with caligiform dorsal shield. First pedigerous segment incorporated into cephalothorax. Second pedigerous segment with or without paired dorsal plates. Adhesion pads present on ventral surface of cephalothorax, associated with various appendages or separate from them. Abdomen one- or two-segmented, with or without dorsal plates. Legs 1–4 biramous, legs 5 vestigial.

Males: Similar to females, but without dorsal plates. Legs 1–4 with long pinnate setae, legs 5 and 6 present.

Pandaridae are represented in the Canadian fauna by three genera, identifiable with the aid of the following key:

Key to genera of Pandaridae

1 Second free segment with paired dorsal plates ..... *Pandarus*

Second free segment without dorsal plates 2

2 Female abdomen two-segmented ..... *Dinemoura*

Female abdomen one-segmented ..... *Echthrogaleus*

Pandarus Leach, 1816

Eleven species of this genus are currently recognized as valid, although many more have been described, to be later consigned to synonymy. All species of *Pandarus* live on external surfaces of sharks, on which they tend to form densely crowded colonies. Such colonies are often located on the trailing margins of the host's pectoral fins. The generic diagnosis of *Pandarus* is as follows:

Female: Pandaridae. Cephalothoracic shield without subdividing sutures, but frontal plates clearly delimited. Dorsal plate of first free segment equal to, or longer than, those of second. Plates of third free segment fused at base, extending over part of genital complex. Abdomen one-segmented, with dorsal plate. First antenna with large adhesion pad at base (Fig. 12A), second four-segmented, prehensile, also with adhesion pad at base. Mouth

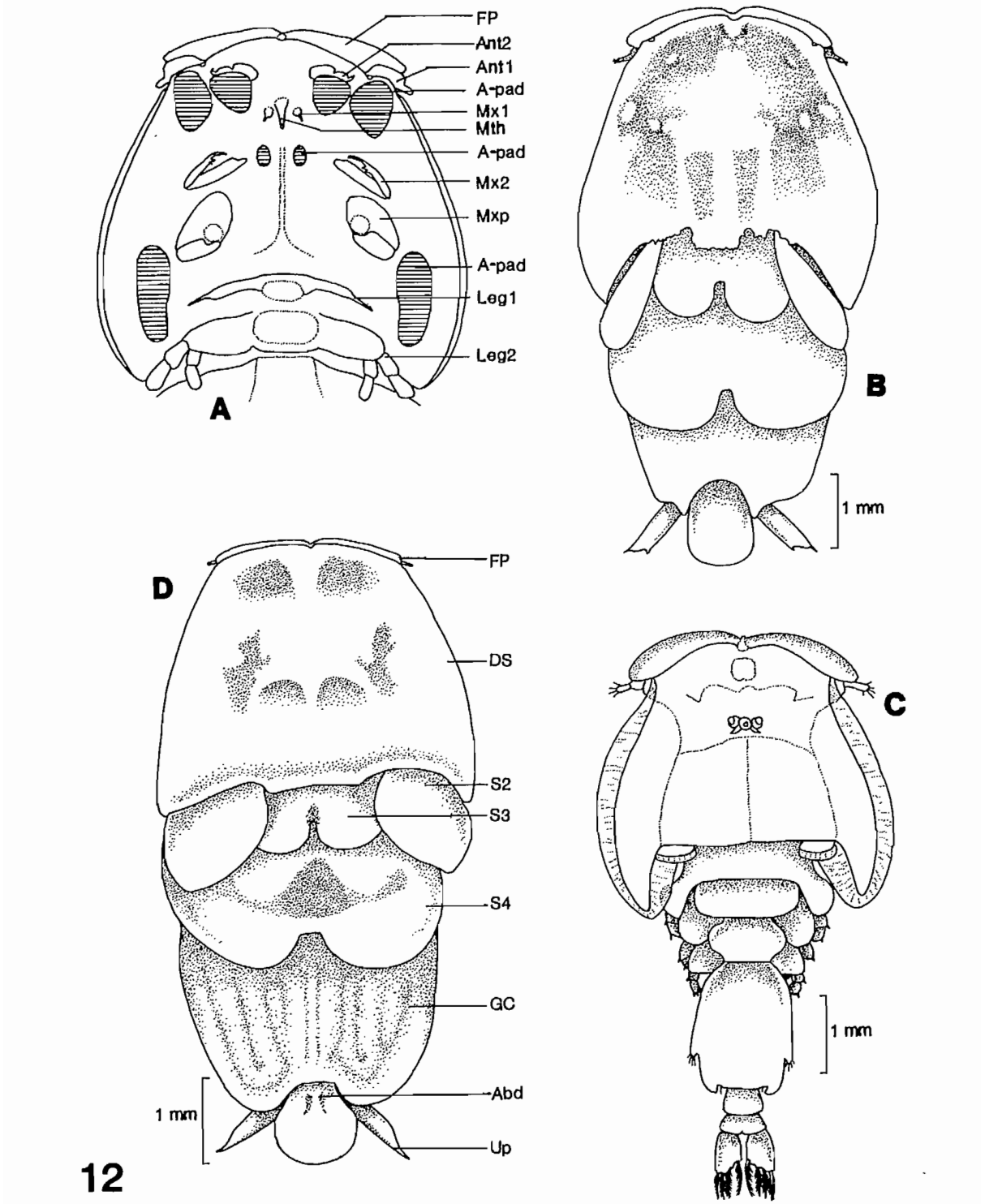

FIG. 12. A. *Pandarus sinuatus*, female, cephalothorax, ventral (diagrammatic); B. female, entire, dorsal; C. Male, dorsal; D. *Pandarus floridanus*, female, dorsal; (A,B,D original, C redrawn from Wilson 1907a).
Abd — abdomen; Ant1 — first antenna; Ant2 — second antenna; A-pad — adhesion pad; DS — dorsal shield; FP — frontal plates; GC — genital complex; Leg1, Leg2 — first and second legs; Mth — mouth tube; Mxp — maxilliped; Mx1 — first maxilla; Mx2 — second maxilla; S2-S4 — second to fourth pedigerous segments; Up — uropod.

tube long, slender. Oral appendages similar to those of Caligidae. Claw of maxilliped spatulate. Adhesion pads at bases of first maxillae, between first legs and in posterolateral corners of ventral surface of shield (Fig. 12A). Three pairs of legs biramous, rami two-segmented; fourth biramous, rami one-segmented; fifth vestigial. Uropods prominent. Egg sacs filiform, straight, uniserial.

Male (Fig. 12C): Similar to female, but without dorsal plates. Abdomen 2-segmented. Rami of legs 1–4 two-segmented; endopod of third leg not modified. Fifth and sixth legs vestigial.

One, possibly two, species of *Pandarus* occur in Canadian waters. They can be distinguished from each other with the aid of the following key:

Key to species of *Pandarus*

Body darkly pigmented, but eye spots connected by median posterior line ..... *Pandarus sinuatus* Say, 1817

Female (Fig. 12B): Dorsal shield with rounded anterior and divergent lateral margins, latter with narrow marginal membranes; no sutures on dorsal surface of shield. Dorsal plates of first free segment distinctly longer than those of second. Genital complex with re-entrant posterior margin. Abdomen completely covered by dorsal plate. Uropods projecting posterolaterally from below abdominal dorsal plate. Total length 6–7 mm.

Male (Fig. 12C): As in generic diagnosis. Total length 7 mm.

Marine: External surfaces of *Carcharias taurus*. (Atl). Additional record: *Carcharodon carcharias*. (Atl) (Hogans and Dadswell 1985a).

Body slightly pigmented, with pigment usually confined to anterior portion of cephalothorax and plate of fourth thoracic segment ..... *Pandarus floridanus* Cressey, 1967

Both female (Fig. 12D) and male closely resemble *P. sinuatus*, with the exception of characteristics mentioned above.

The presence of *P. floridanus* in Canadian waters is attested by a single find, on the skin of *Torpedo nobiliana*, off the Atlantic coast (W. E. Hogans, unpublished). The female specimens found on that fish are virtually indistinguishable from *P. sinuatus*, but their identity was confirmed by Dr. R. Cressey of the Smithsonian Institution. According to his description (Cressey 1967), in addition to differences in coloration indicated in the key, *P. floridanus* has a dorsal abdominal plate that is much longer than the uropods, and the plate of the second segment extends in this species further than the middle of the plate of the fourth segment. Comparison of Fig. 12B with 12D shows that of those characteristics only the relatively lighter pigmentation allows to distinguish between *P. floridanus* and the more heavily pigmented *P. sinuatus*. It would appear that the differences between these two nominal species require corroboration.

Dinemoura Latreille, 1829

The most recent reviewer of this genus (Kabata 1979) accepted only four species of *Dinemoura* as valid, with one *species inquirenda* that probably could be reduced to synonymy on closer examination. All four species are parasitic on external surfaces of sharks and resemble *Pandarus* in their host–parasite relationships. The generic diagnosis of *Dinemoura* is as follows:

Female: Dorsal shield with lateral zones marked off by sutures; posterior tips of lateral zones reaching end of second free segment; frontal plates distinct. First free segment with dorsolateral plates, second unarmed, third with large plates overlapping part of genital complex. Latter with or without small dorsal plates. Abdomen two-segmented; first segment short, with paired dorsal plates fused at base and with or without posteroventral plates; second segment with single dorsal plate. Uropods prominent. Appendages similar to those of *Pandarus*. Legs 1–4 biramous, rami of first two-segmented, second and third three-segmented, fourth one-segmented, foliolate; legs 5 and 6 vestigial.

Male: Cephalothorax and first two free segments similar to those of female; plates of third free segment reduced or absent. Genital complex small, oval, with or without posterolateral processes. Abdomen two-segmented,

unarmed, but uropods present. Rami of legs 1–4 two-segmented, terminal segment of endopod of third leg modified. Legs 5 and 6 vestigial.

Only two species recorded from Canadian waters. Their females can be distinguished from each other as follows:

Key to species of *Dinemoura*

Dorsal plates of third free segment longer than wide, with rounded tips (Fig. 13A) .... *Dinemoura producta* (Müller, 1785)

Female (Fig. 13A): Pandaridae. Dorsal shield suborbicular; lateral margins partly delimited by sutures, with well developed marginal membranes and tips reaching posterior margin of second free segment; frontal plates separate. First free segment with posterolateral plates reaching posterior margin of unarmed second segment. Third free segment with narrow neck and prominent dorsal plates. Genital complex width usually less than half length, with prominent posterolateral lobes. First segment of abdomen with large ventrolateral plates (vlp, Figs. 13B,C) extending well past posterior margin of second segment and often visible in dorsal aspect; paired dorsal plates (dpl, Fig. 13B) also present; second segment with single dorsal plate (dp2, Fig. 13B) largely covered by plates of first segment. Length 13–18 mm.

Male (Fig. 13D): Anterior part similar to that of female. Third free segment with dorsolateral plates fused and forming nearly straight margin. Genital complex longer than wide, with smooth lateral margins. Abdomen two-segmented, second segment slightly longer than first. Length 10–14 mm.

Marine. External surfaces of *Isurus glaucus*. (Pac) (Z. Kabata, unpublished.)

Dorsal plates of third free segment wider than long, often with re-entrant posterolateral margins (Fig. 13E)..... *Dinemoura latifolia* (Steenstrup & Lütken, 1861)

Female (Fig. 13E): Similar to that of *D. producta*, but with relatively larger cephalothorax and genital complex width more than half length. Ventrolateral plates of first abdominal segment (Fig. 13F) not reaching posterior margin of second segment and not visible in dorsal aspect. Length 15 mm.

Male (Fig. 13G): Anterior part similar to that of female. Third free segment with dorsolateral plates not fused in mid-dorsal line. Genital complex wider posteriorly, with concavities in posterior halves of lateral margins. Length 8 mm.

Marine. External surfaces of *Carcharodon carcharias*. (Atl) (Hogans and Dadswell 1985a).

Echthrogaleus Steenstrup and Lütken, 1861

This genus, comprising at present five species (with one possible species inquirenda in addition) is also almost exclusively associated with the outer surfaces of sharks. Only one of its species (*E. torpedinis* Wilson, 1907) was ever found on elasmobranchs other than sharks. The generic diagnosis of *Echthrogaleus* is as follows:

Female: Pandaridae. Dorsal shield suborbicular, tips of lateral zones reaching second free segment; frontal plates distinctive. First free segment with dorsolateral plates, second unarmed, border between them sometimes indistinct; third free segment with paired dorsal plates covering large part of genital complex. Latter with very large posterolateral lobes covering abdomen in dorsal aspect. Abdomen one-segmented, with well developed uropods. Oral appendages siphonostome. Legs 1–4 biramous, rami one- to three-segmented; fifth and sixth legs vestigial.

Male: Similar to female, but with dorsolateral plates (other than those of first free segment) reduced or absent. Genital complex much smaller, without posterolateral lobes. Abdomen two-segmented.

Only one species has been reported from Canadian waters.

Echthrogaleus coleoptratus (Guerin-Meneville, 1837)

Female (Fig. 14A): General description as in generic diagnosis. Dorsal plates of third free segment covering most of first half of genital complex, their posterolateral margins sometimes (not always) slightly concave. Abdomen (Fig. 14B) subquadrangular, with uropods about as long as abdomen. Length 10–14 mm.

Male (Fig. 14C): As in generic diagnosis. Length 6–8 mm.

Marine. External surfaces of *Lamna nasus* and an unspecified shark. (Pac).

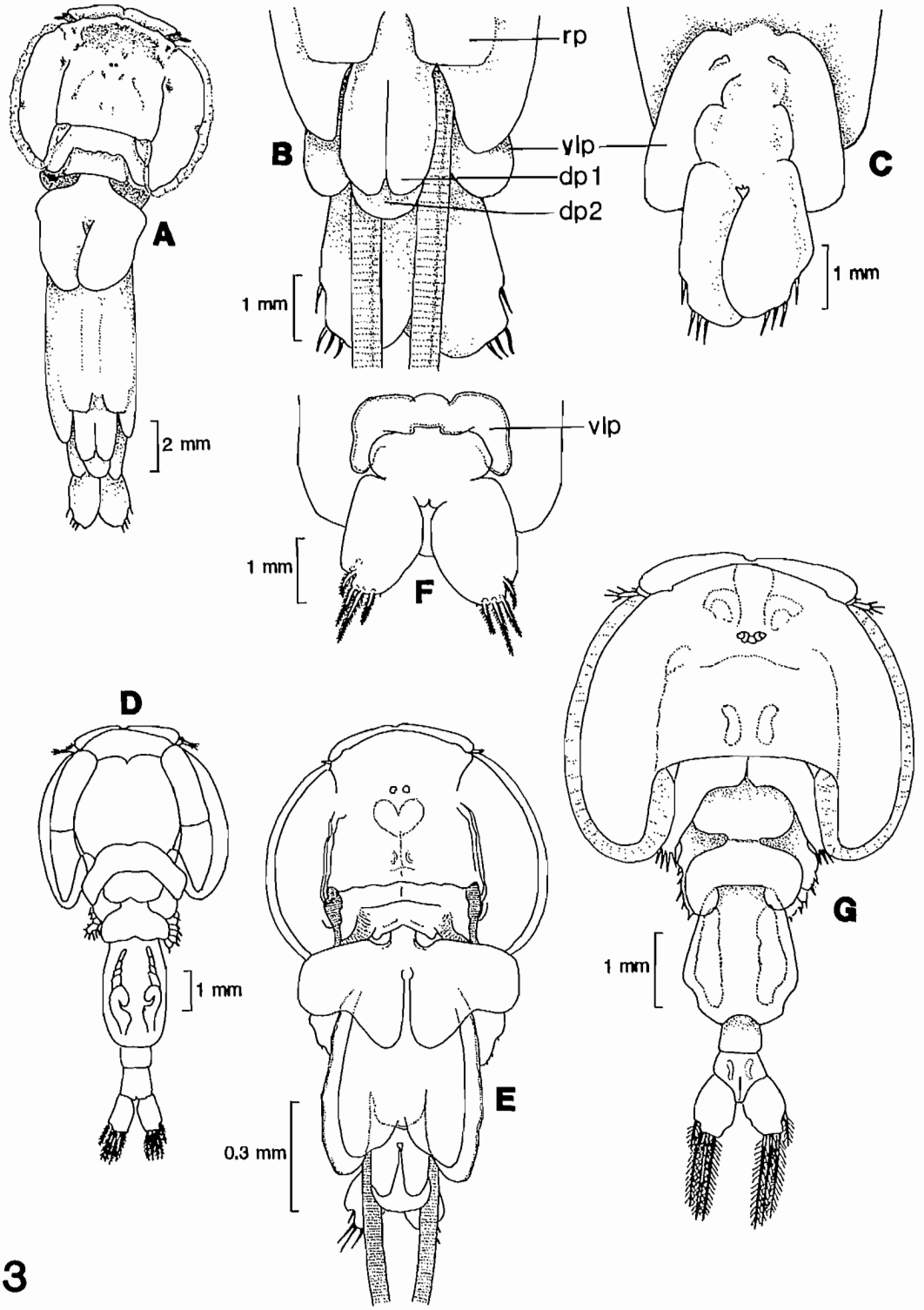

FIG. 13. A. *Dinemoura producta*, female, dorsal; B. Same, posterior end, dorsal; C. Same, ventral; D. Male, dorsal; E. *Dinemoura latifolia*, female, dorsal; F. Posterior end, ventral; G. Male, dorsal. (A–C redrawn from Kabata 1979; D redrawn from Wilson 1923; E,F redrawn from Yamaguti 1936; G redrawn from Wilson 1907a).
dp1 — dorsal plate, paired; dp2 — dorsal plate, median; rp — rudimentary plate; vlp — ventrolateral plate.

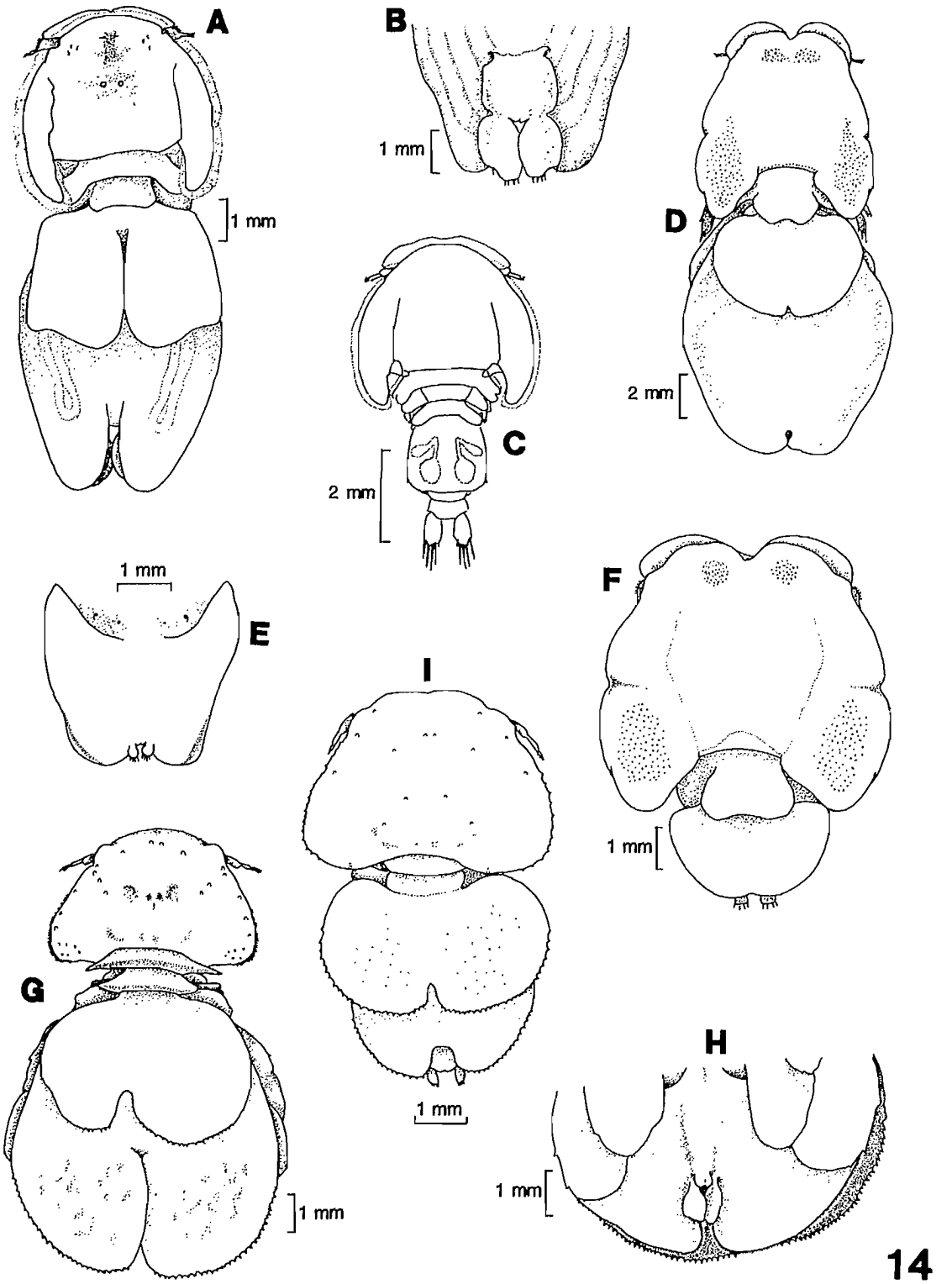

FIG. 14. A. *Echthrogaleus coleoptratus*, female, dorsal; B. Same, posterior extremity, ventral; C. Male, dorsal; D. *Cecrops latreilli*, female, dorsal; E. Same, abdomen, ventral; F. Male, dorsal; G. *Orthagoriscicola muricatus*, dorsal; H. Same, posterior extremity, ventral; I. Male, dorsal. (A,B,D-H redrawn from Kabata, 1979; C redrawn from Cressey 1967).

Family CECROPIDAE

This small family consists of five genera, the best known three of which (*Cecrops*, *Orthagoriscicola*, and *Philorthagoriscus*) occur on the same host species, *Mola mola*. The other two (*Entepherus* and *Luetkenia*), which live on fishes other than *Mola*, have a more tenuous claim on the membership of the family. Only the cecropids parasitic on *Mola* have been recorded from Canadian waters. The family diagnosis is as follows:

Female: Caligiform. Dorsal shield either without subdividing sutures, or with only partial delimitation of lateral zones; frontal plates partly delimited from, or completely fused with, shield. First pedigerous segment incorporated into cephalothorax. First and second free thoracic segments separate (*Orthagoriscicola*) or fused together (*Cecrops* and *Philorthagoriscus*); first free segment with dorsolateral plates, third with partly fused dorsal plates covering part of genital complex. Latter with large, plate-like extension entirely covering one-segmented abdomen. Egg sacs uniseriate, convoluted, not visible in dorsal aspect. Appendages siphonostome. Four pairs of biramous appendages; rami of legs 1–3 two-segmented in *Cecrops* and *Philorthagoriscus*, those of leg 3 one-segmented in *Orthagoriscicola*, those of leg 4 one-segmented in all three genera.

Male: Similar to female, but with less well developed dorsal plates and with abdomen partly uncovered in dorsal aspect.

The members of these three genera can be identified with the help of the following keys, separate for males and females. Sexual dimorphism of the members of this family necessitates separate keys for the two sexes.

Keys to genera of Cecropidae

Females

1 First and second free thoracic segments separate, third with large, fused dorsal plates (Fig. 14G) ..... *Orthagoriscicola*

First and second free thoracic segments fused together 2

2 First free thoracic segment with dorsolateral plates, second unarmed (Fig. 15A) .... *Philorthagoriscus*

First free thoracic segment with dorsolateral plates, second with small dorsal plate (Fig. 14D) ..... *Cecrops*

Males

1 Margins of cephalothoracic shield and dorsal plates smooth ..... *Cecrops*

Margins of cephalothoracic shield and of dorsal plates serrated 2

2 Surface of dorsal shield with noticeable tubercles, without sutures, margin of genital complex serrated ..... *Orthagoriscicola*

Surface of dorsal shield smooth, with longitudinal and oblique sutures, two subtriangular processes on both lateral margins of genital complex ..... *Philorthagoriscus*

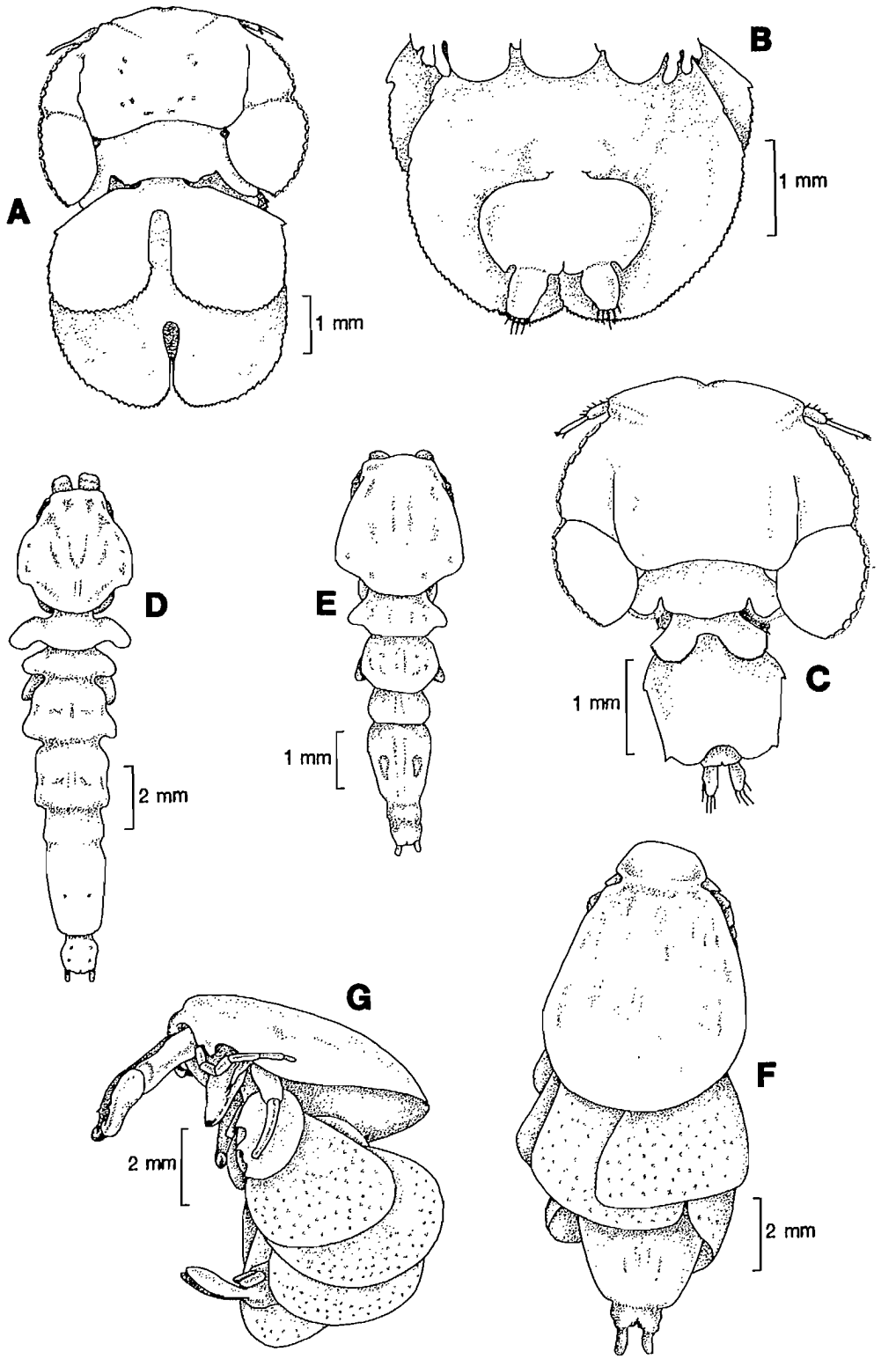

FIG. 15. A. *Philorthagoriscus serratus*, female, dorsal; B. Same, posterior extremity, ventral; C. Male, dorsal; D. *Dichelesthium oblongum*, female, dorsal; E. Same, male, dorsal; F. *Anthosoma crassum*, female, dorsal; G. Male, lateral. (Redrawn from Kabata 1979).

Cecrops Leach, 1816

According to the most recent reviewer, "Only one incontrovertibly valid species can be placed in this genus" (Kabata 1979). The generic diagnosis, therefore, is the same as that of the sole species of *Cecrops*.

Cecrops latreilli Leach, 1816

Female (Fig. 14D): Dorsal shield without subdividing sutures, lateral lobes projecting to level of posterior end of dorsal plate of second free segment. First and second free segments fused together, first with lateral plates, second with dorsal plate; third free segment much larger than preceding two, with large dorsal plate. Genital complex with dorsal plate covering posterior half of body. Abdomen one-segmented, with protruding anterolateral corners (Fig. 14E). Four pairs of biramous legs. Egg sacs convoluted, not visible in dorsal aspect. Length 20–30 mm.

Male (Fig. 14F): Cephalothorax as in female. Third free segment with large dorsal plate covering most of posterior half of body. Part of abdomen visible in dorsal aspect. Length 14–17 mm.

Marine. Gills of *Mola mola*. (Atl) (Pac).

Orthagoriscicola Poche, 1902

This genus, like the preceding one, is monotypic. Although two new species were described some 30 years ago, they were found synonymous with *O. muricatus* by subsequent reviewers (Kabata 1979). The diagnosis of the only known valid species can be accepted also as the generic diagnosis.

Orthagoriscicola muricatus (Krφyer, 1837)

Female (Fig. 14G): Dorsal shield without subdividing sutures, but with scattered tubercles and spines, and with spinules on posterolateral margins. First and second free segments with short lateral plates, third with large bilobed plate. Genital complex with paired plates covering abdomen. Latter broad, with pedunculate base and deeply cleft posterior margin (Fig. 14H). Four pairs of biramous legs, rami of first two pairs two-segmented, second two one-segmented. Length 20 mm.

Male (Fig. 13I): Similar to female, but with abdomen exposed in dorsal aspect. Length 10–15 mm.

Marine. Body surface of *Mola mola*. (Atl). (The only Canadian record was that of Threlfall (1967), who identified this species as *O. wilsoni* Schuurmans Stekhoven and Shuurmans Stekhoven, 1956. This taxon was subsequently reduced to synonymy with *O. muricatus* by Kabata (1979).)

Philorthagoriscus Horst, 1897

This genus is monotypic. Its generic diagnosis is the same as that of its only species, *P. serratus*.

Philorthagoriscus serratus (Krφyer, 1863)

Female (Fig. 15A): Dorsal shield with sutures delimiting lateral zones; latter extending well beyond posterior margin of thoracic zones; margins of shield serrated. First and second free segments fused, with prominent lateral plates. Third free segment with large, paired plates fused at base, and with serrated margins. Genital complex with similar but larger plates covering abdomen in dorsal view. Abdomen one-segmented, wider than long (Fig. 15B). Four pairs of biramous legs. Rami of pairs 1–3 two-segmented, those of pair 4 one-segmented. Length 7–8 mm.

Male (Fig. 15C): Cephalothorax similar to that of female. Third free segment with dorsal plates much smaller than those of corresponding segment of female. Plates of genital complex rudimentary, exposing abdomen in dorsal view. Length 4–5 mm.

Marine. Body surface of *Mola mola*. Pacific and Atlantic. (Margolis and Arthur (1979) did not mention Wilson's (1922) record of this species taken at "Newfoundland." The record is somewhat suspect, as it mentions *P. serratus* occurring on *Squalus acanthias*. Although Wilson claims to have found three samples, each of several specimens, at least two samples were juvenile and could have been misidentified. There are no other records of *P. serratus* from hosts other than *Mola*.)

Family DICHELESTHIIDAE

The most recent reviewer (Kabata 1979) included in this family, in addition to its type genus, *Dichelesthium*, only *Anthosoma*. These two monotypic genera, previously placed in two separate families, share unique segmentation and the structure of the second antenna that separate them from all other genera, with which they were previously associated. Although the differences in their host–parasite relationships caused them to evolve along divergent paths and to acquire very different characteristics, they are linked by the similarity of the underlying structural plan. Both genera are of ancient origin, as indicated for one of them (*Dichelesthium*) by similarities to a fossil form and for both of them by the antiquity of their hosts. The family diagnosis is as follows:

Female: Cephalothorax more or less completely fused with the first pedigerous segment, dorsal shield well developed. Three (or four) rather indistinct segments between cephalothorax and genital complex. Dorsolateral plates on second pedigerous segment in *Anthosoma*, absent in *Dichelesthium*. Abdomen one- or two-segmented. First antenna six-segmented, second antenna subchelate and retractile, indistinctly segmented. Buccal region siphonostome. Second maxilla with prehensile apex, maxilliped subchelate. Three pairs of modified legs, with foliaceous sympods (*Anthosoma*) or without them (*Dichelesthium*), with or without reduced rami.

Male: Similar to female, abdomen indistinctly two-segmented in *Dichelesthium*, dorsolateral plates always absent from second pedigerous segment.

Key to genera of Dichelesthiidae

Females

Dorsolateral plates present on second pedigerous segment; legs with aliform sympods forming skirt around posterior half of body (Fig. 15F) ..... *Anthosoma*

No plates on pedigerous segments, no skirt around posterior half of body (Fig. 15D) .... *Dichelesthium*

Males

Dorsal shield covering about half of body; legs with aliform sympods overlapping one another along lateral sides of body (Fig. 15G)..... *Anthosoma*

Dorsal shield less than half of body length; legs not overlapping one another along lateral sides of body (Fig. 15E) ..... *Dichelesthium*

Dichelesthium Hermann, 1804

Dichelesthium oblongum (Abildgaard, 1794)

Female (Fig. 15D): Dorsal shield without subdividing sutures. Intersegmental boundaries indistinct. Second and third pedigerous segments short and broad. Abdomen indistinctly two-segmented, first segment nearly obscured in dorsal view. Three pairs of legs: first two biramous, rami short, unarmed; third without rami, larger than other two. Uropods suboval, unarmed. Length 12 mm.

Male (Fig. 15E): Similar to female, with dorsal shield forming about 1/3 of body length. Intersegmental boundaries more distinct than in female. Length 7–12 mm.

Marine. Gill cavity of *Acipenser brevirostrum* and *A. oxyrhynchus*. Estuary of St. John River (N.B.) (Appy and Dadswell 1978).

Anthosoma Leach, 1816

Anthosoma crassum (Abildgaard, 1794)

Female (Fig. 15F): Dorsal shield usually with central part darkly pigmented, no subdividing sutures. Three ill-defined segments between cephalothorax and genital segment. Dorsolateral plates on second pedigerous segment overlapping with aliform legs to form skirt-like cover round posterior end of body. Three pairs of legs modified into subcircular aliform plates; rami absent. Abdomen one-segmented. Uropods cylindrical, apparently unarmed. Length 8–15 mm.

Male (Fig. 15G): Similar to female but without dorsolateral plates on second pedigerous segment. Length 7–10 mm.

Marine. External surfaces of unspecified shark. (Pac). Additional record: *Carcharodon carcharias*. (Atl) (Hogans and Dadswell 1985a).

Family EUDACTYLINIDAE

This small family, currently numbering less than 50 species, comprises six genera of copepods parasitic exclusively on elasmobranchs. Like their hosts, many of them have wide-ranging distribution. In the Canadian fauna only two of these genera have been recorded. The family diagnosis given below combines, therefore, only the characters of these genera.

Female: Cephalothorax incorporating one pedigerous segment, dorsal shield present. Four segments following cephalothorax with well developed terga. Abdomen two- or three-segmented. Maxilliped chelate or subchelate. Four pairs of biramous legs, rami two- or three-segmented. First leg modified in *Nemesis*, exopod of second sometimes modified in *Eudactylina*, armature of rami reduced. Fifth leg one-segmented.

Male: Similar to female but smaller and with three or four-segmented abdomen. Maxilliped always subchelate. Armature of thoracopod rami well developed, first leg and endopods of third and fourth modified in *Nemesis*.

Key to genera of Eudactylinidae

Maxilliped chelate in female (Fig. 16H), subchelate in male; first leg not modified ..... *Eudactylina*

Maxilliped subchelate in both sexes (Fig. 17B); first leg modified for prehension..... *Nemesis*

Eudactylina van Beneden, 1853

The genus *Eudactylina* consists of about 27 species (inadequacies of description consign some to the status of *species inquirendae*, so that an exact count is not possible). All are parasitic on gills of elasmobranchs, a habitat to which their chelate maxillipeds are particularly well adapted. The generic diagnosis is as follows:

Female: Eudactylinidae. Cephalothorax covered by dorsal shield, four following thoracic segments with well-developed, shield-like terga. Abdomen two-segmented. Maxilliped chelate (Fig. 16H). Four pairs of biramous legs, with rami two- or three-segmented; second leg with or without modified exopod; fifth leg one-segmented.

Male: Similar to female, but abdomen three- or four-segmented. Maxilliped subchelate. Exopod of second leg never modified; leg armature better developed.

The Canadian copepod fauna contains three species of *Eudactylina*, identifiable with the aid of the key below.

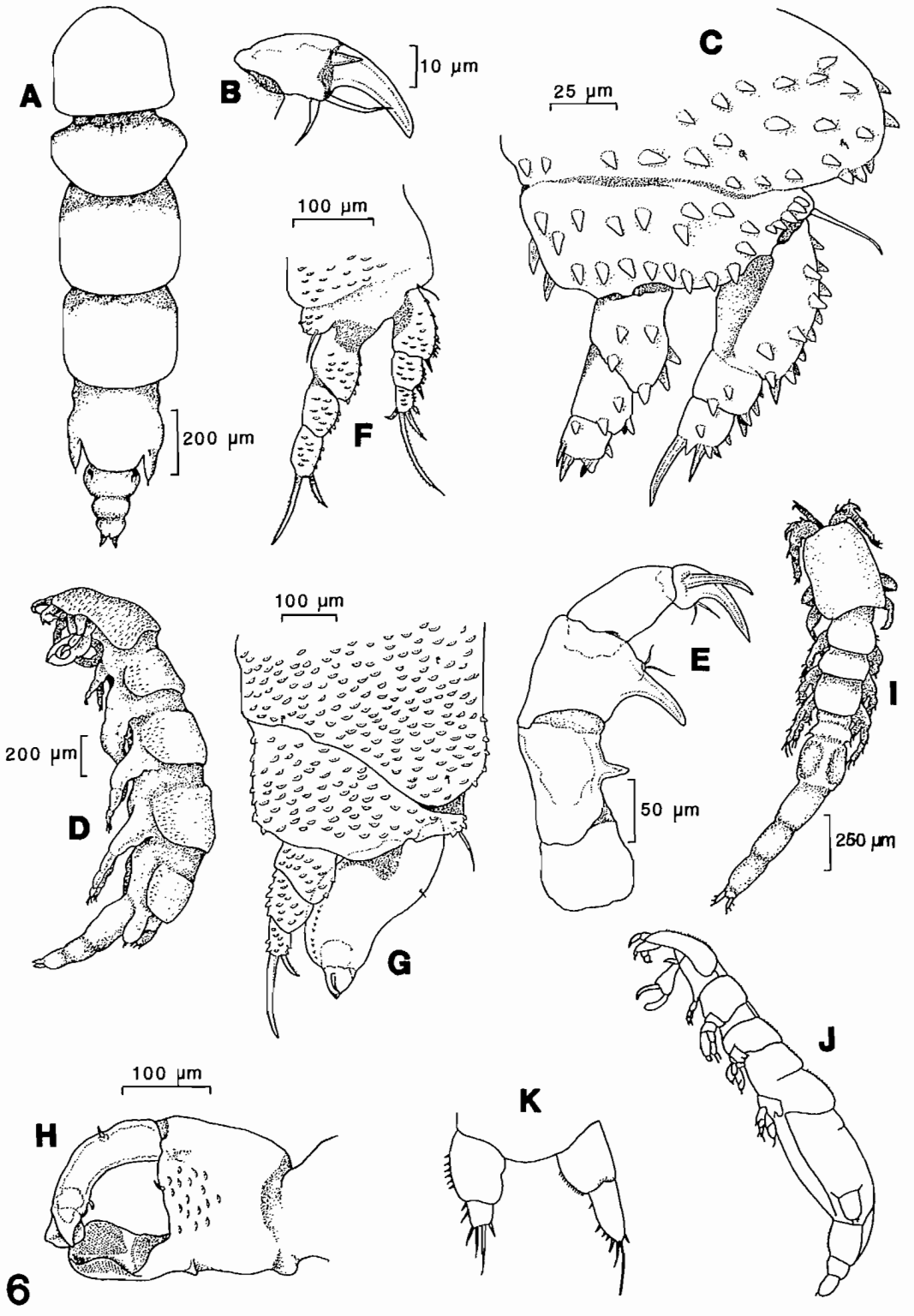

FIG. 16. A. *Eudactylina acanthii*, female, dorsal; B. Same, tip of second antenna; C. Same, second leg; D. *Eudactylina similis*, female, lateral; E. Same, second antenna; F. First leg; G. Second leg; H. Maxilliped; I. Male, dorsal; J. *Eudactylina corrugata*, female, lateral; K. First leg. (A–I redrawn from Kabata 1979; J,K redrawn from Bere 1930a).

Key to species of *Eudactylina*

1 Female (Fig. 16A): Exopod of second leg not modified (Fig. 16C) ..... *E. acanthii* A. Scott, 1901
Dorsal shield and terga without cuticular ornamentation; spine at base of terminal claw of second antenna short (Fig. 16B). Length 2 mm.
Male: Unknown.
Marine. Gills of *Squalus acanthias*. (Atl) (Pac).
Additional record: *Squalus acanthias* (Pac) (Kabata 1979).

Female: Exopod of second leg modified (Fig. 16G) 2

2 Female (Fig. 16D): First leg with three-segmented rami (Fig. 16F) ..... *E. similis* T. Scott, 1902
Dorsal shield and terga with cuticular ornamentation; spine at base of terminal claw of second antenna long (Fig. 16E). Length c. 3 mm.
Male (Figs. 16I): Similar to female, but narrower and with fourth free segment reduced. Abdomen three-segmented. Exopod of second leg not modified. Length 2 mm.
Marine. Gills of *Raja rhina* and *R. stellulata* (Pac) (Kabata 1979).

Female (Fig. 16J): First leg with two-segmented rami (Fig. 16K) ..... *E. corrugata* Bere, 1930
Dorsal shield and terga covered with hair-like setules; apparently no spine at base of terminal claw of second antenna. Length not recorded.
Male: Unknown.
Marine. Gills of *Raja erinacea* and *R. radiata*. (Atl).

Nemesis Risso, 1826

This widespread genus of eudactylinid copepods, now including some 11 species, differs from *Eudactylina* by the obviously larger size of its members. The size of *Nemesis* brings with it a set of problems of living on the gills that calls for particularly strong attachment. Lacking efficient chelate maxillipeds, it evolved a unique, prehensile first leg, which is its most characteristic feature and which aids in maintaining a hold on the host's gills. The generic diagnosis of *Nemesis* is as follows:

Female: Cephalothorax with well developed dorsal shield, followed by four free thoracic segments and a genital segment, small and subspherical. Abdomen two- or three-segmented. Buccal apparatus siphonostome. Maxilliped subchelate. Four pairs of biramous legs, rami two-segmented; first leg modified for prehension. Fifth leg vestigial.

Male: Similar to female, but elongate and slender. Abdomen three- or four-segmented. First two pairs of legs similar to those of female, third and fourth often with very large endopod spines. Sixth leg occasionally present.

Only one species recorded from Canadian waters.

Nemesis robusta (van Beneden, 1851)

Female (Fig. 17A): Cephalothorax with well developed shield, broad. Following thoracic segments as broad as cephalothorax, covered with shield-like terga. Fifth pedigerous segment much narrower. Abdomen three-segmented. Maxilliped subchelate (Fig. 17B). Four pairs of biramous legs, rami two-segmented; first leg modified for prehension, fifth one-segmented. Length 5 mm.

Male (Fig. 17C,D): Similar to female, but slender. Abdomen four-segmented. Maxilliped subchelate. Legs with armature better developed than in female; third and fourth pair with long, spiniform, apical processes on endopods. (Note that Fig. 17B represents an appendage of *Nemesis lamna*, which is closely similar to that of other species.) Length 3 mm.
Marine. Gills of *Carcharias taurus*. (Atl).

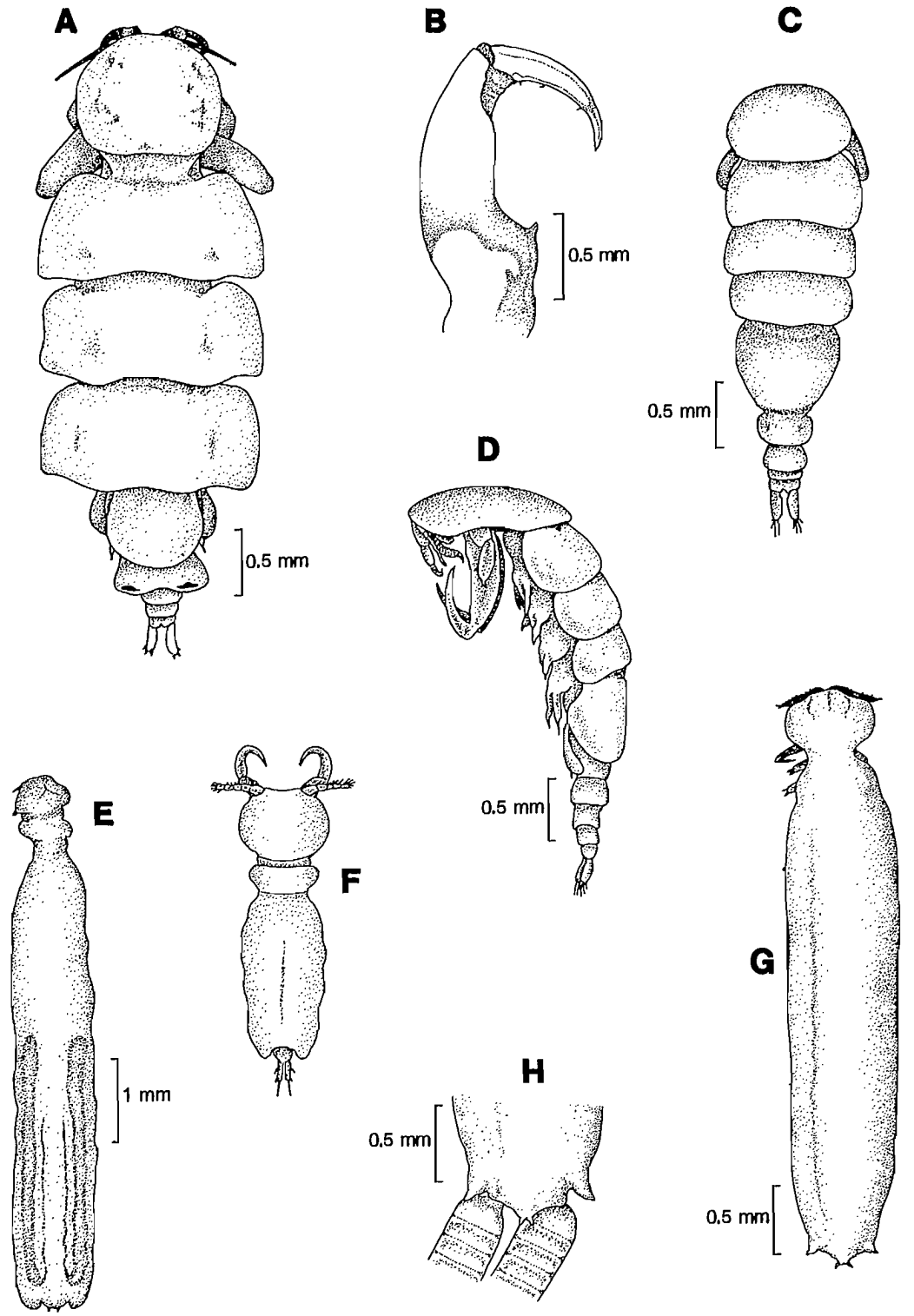

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FIG. 17. A. *Nemesis robusta*, female, dorsal; B. *Nemesis lamna*, maxilliped; C. *Nemesis robusta*, male, dorsal; D. Same, lateral; E. *Hatschekia hippoglossi*, female, dorsal; F. Same, male, dorsal; G. *Hatschekia conifera*, female, dorsal; H. Same, posterior extremity, ventral. (A–E redrawn from Kabata 1979; F redrawn from Scott and Scott 1913; G,H redrawn from Kabata 1981).

Family HATSCHEKIIDAE

This abundant family of teleost gill parasites consists of five genera, jointly numbering nearly 100 species. Its main characteristics are the small size of its members, rarely exceeding a length of 2 mm, and the small number of eggs produced by its females. At the same time, the members of the family are often capable of producing large populations on the gills of their hosts. The familial diagnosis is as follows:

Female: Cephalothorax usually separated from trunk by neck-like constriction; latter ill-defined, sometimes absent. Trunk subcylindrical to subspherical. Abdomen one-segmented, partly or completely incorporated in trunk. Second antenna prehensile. Maxilliped absent. Two pairs of biramous legs, other pairs vestigial or absent. Male: Similar to female but usually smaller and with relatively smaller trunk.

Only one genus, *Hatschekia*, present in Canadian waters.

Hatschekia Poche, 1902

Hatschekia is among the most successful genera of siphonostomatoid copepods. It comprises over 80 species, all living on gills of teleosts. The genus is especially abundant in warm waters and diminishes in number of species in higher latitudes. Only two species recorded in Canadian waters.

The generic diagnosis is as that for the family. Rami of first two pairs of legs one- or two-segmented; third and fourth consisting of one or more setae. Uropods present.

Key to species of *Hatschekia*

Posterior extremity of trunk forming rounded lobes in lateral corners (Fig. 17E) .... *H. hippoglossi* (Krøyer, 1837)

Female (Fig. 17E): relatively long and slender. Second pedigerous segment often separated from cephalothorax and trunk by constrictions. Trunk dorsoventrally flattened. Abdomen not clearly delimited from trunk. First two pairs of legs with rami clearly two-segmented, with denticulation on basal segments of exopods. Length 3–6 mm.

Male (Fig. 17F): similar to female, but with relatively shorter trunk. Length 1.5 mm.

Marine. Gills of *Hippoglossus hippoglossus*. (Atl).

Additional record: *H. hippoglossus* and *Reinhardtius hippoglossoides*. (Atl) (Zubchenko 1980).

Posterior extremity of trunk with pointed conical processes in lateral corners (Fig. 17H) .... *H. conifera* Yamaguti, 1939

Female (Fig. 17G): Abdomen not clearly delimited from trunk, latter subcylindrical. No spinulation on exopods of first two legs, rami without distinct segmental boundaries. Length 2–4 mm.

Male: Unknown.

Marine. Gills of *Brama japonica*. (Pac) (Kabata 1981).

Family LERNAEOPODIDAE

This family comprises at present about 250 species and undoubtedly belongs to the most successful families of Siphonostomatoida. It is cosmopolitan in the oceans of the world and in the fresh waters of the northern hemisphere. Its members live on most diverse fishes, from the most primitive elasmobranchs to the most advanced teleosts. Their phylogeny was discussed in detail by Kabata (1979).

The success of Lernaeopodidae is chiefly due to the unique mode of their attachment, which combines a high degree of security with relative freedom of movement within a circle, the radius of which is determined by the length of their second maxillae. These appendages have evolved into arm-like connections between the bulla, an organ of attachment securely embedded in the tissues of the fish (see Kabata and Cousens 1972), and the body of the parasite.

To be able to identify Lernaeopodidae, some familiarity with their gross morphology is indispensable. The body of lernaeopodid females consists of three easily distinguishable parts: cephalothorax, second maxillae and trunk (Fig. 18B,D). The relative sizes of these parts and the manner in which they are assembled constitute the most significant characteristics of the lernaeopodid genera. Kabata (1979) distinguished six types of lernaeopodid structure, but they can be reduced to two variants: short cephalothorax (Fig. 18A) and long cephalothorax type (Fig. 18C), the former being more primitive than the latter.

The buccal apparatus of Lernaeopodidae (Fig. 18E) is typically siphonostome, except for the unusual function and structure of the second maxillae, greatly modified and spatially divorced from the remaining mouthparts.

The males of Lernaeopodidae are ephemeral dwarfs, usually found attached to young but sexually mature females. They die and drop off after the process of fertilization has been accomplished. (For detailed discussion see Kabata 1979.) They can be disregarded for the purposes of identification. The diagnosis of the family is as follows:

Female: Cephalothorax short and at angle to long axis of trunk, or long and deflected from that axis either dorsally or ventrally (greatly reduced in *Nectobrachia*). Trunk of varying shape, with or without modified uropods and posterior processes; lateral and/or dorsal swellings sometimes present. Cephalothoracic appendages siphonostome, except for second maxillae modified into arm-like structures, sometimes much reduced (completely reduced in *Clavellopsis*). Attachment by bulla or by branching tips of second maxillae. Legs absent.

Male: Dwarf, resembling larval stage of female, or abbreviated and suboval. Appendages similar to those of female, but second maxillae not modified. Vestigial legs sometimes present.

Out of 38 genera now included in the family, 14 have been recorded in Canadian waters. They can be distinguished from one another with the aid of the key below. It should be noted that the females of the genera *Albionella* and *Lernaeopoda* are indistinguishable from one another. Only the males of these genera (usually absent) can provide definite clues to their identity (Kabata 1979).

Key to genera of Lernaeopodidae

1 Cephalothorax reduced to small conical process at anterior end of trunk; second maxillae fused in distal halves (Fig. 33F) ..... *Nectobrachia*

Cephalothorax not reduced 2

2 Cephalothorax flat, suboval or subtriangular, inclined ventrally at obtuse angle to long axis of trunk (Fig. 20A) 3

Cephalothorax subcylindrical, often dorsally deflected along trunk, but sometimes in other position (Fig. 30I) 9

3 Modified uropods and posterior processes absent 4

Modified uropods and posterior processes present (Fig. 30A) 6

4 Two short, digitiform processes present near tip of second maxillae (Fig. 19D); mandible with three secondary teeth (Fig. 19C) ..... *Ommatokoita*

Second maxillae without digitiform processes near tip; mandible with not more than one secondary tooth 5

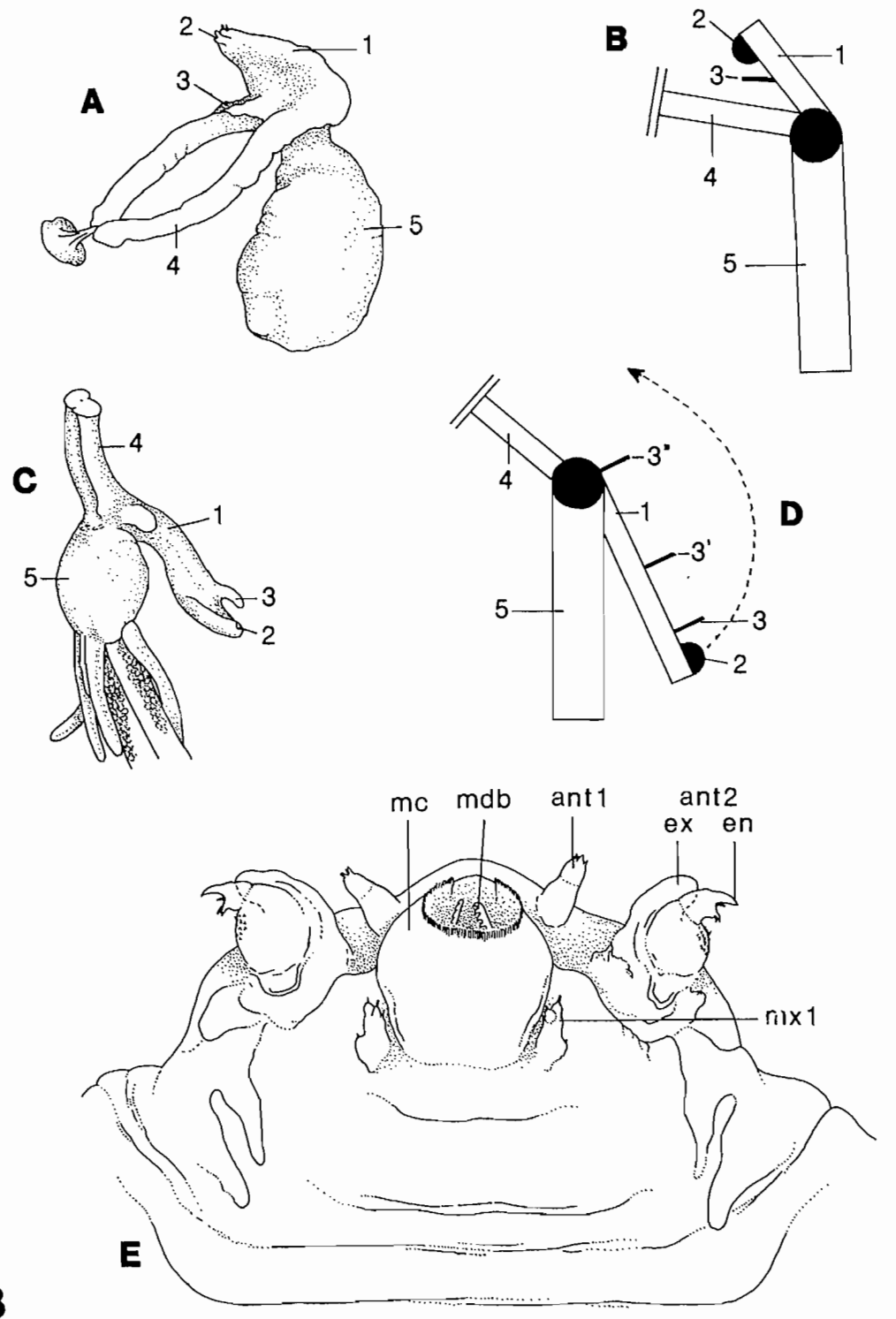

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FIG. 18. Morphology of Lernaeopodidae. A. Short cephalothorax type; B. Same, diagrammatic; C. Long cephalothorax type; D. Same, diagrammatic; E. Buccal region of *Salmincola*. (Redrawn from Kabata 1979).
1 — cephalothorax; 2 — mouth; 3 — maxillipeds; 4 — second maxillae; 5 — trunk; ant1 — first antenna; ant2 — second antenna; en — endopod; ex — exopod; mc — mouth cone; mdb — mandible; mx1 — first maxilla.

5 Posterior extremity of trunk pointed, protruding well beyond openings of oviducts (Fig. 20C); mandible with one secondary tooth ..... *Achtheres*

Posterior extremity rounded, not protruding far beyond openings of oviducts (Fig. 21F); mandible without secondary teeth ..... *Salmincola*

6 Bulla well developed in mature female (Fig. 26E) 7

Bulla vestigial or absent 8

7 Uropods dorsal to eggs sacs ..... *Lernaeopodina*

Uropods ventral to egg sacs (Fig. 25A) ..... *Lernaeopoda* and *Albionella*

8 Tips of second maxillae with two long undivided processes each (Fig. 28A)..... *Schistobrachia*

Tips of second maxillae branching into large dendritic holdfast (Fig. 28I) ..... *Dendrapta*

9 One or more pairs of posterior trunk processes present in fully mature females (Fig. 28E) 10

Posterior trunk processes absent 12

10 Maxillipeds situated at midlength of long, cylindrical cephalothorax, distant from mouth cone (Fig. 27A) ..... *Charopinus*

Maxillipeds close to mouth cone (Fig. 27F)..... 11

11 First maxillae with three setiferous papillae on endopod; exopod lateral (Fig. 27H). Uropods dorsal to egg sacs. Parasitic on elasmobranchs ..... *Pseudocharopinus*

First maxillae with two setiferous papillae on endopod; exopod ventral (Fig. 30B). Uropods ventral to egg sacs. Parasitic on teleosts..... *Neobrachiella**

12 Base of cephalothorax near centre of dorsal surface of trunk, distant from bases of second maxillae (Fig. 30G) ..... *Clavellisa*

Bases of cephalothorax and second maxillae close together at anterior end of trunk (Fig. 31E) 13

13 Second maxillae reduced to sessile collar (Fig. 33A); first maxillae with two long and one short papilla on endopod (Fig. 33C) ..... *Clavellodes*

Second maxillae not reduced to collar; first maxillae with either two or three long terminal papillae 14

*Note: There is one exception to this rule. *Neobrachiella robusta* has uropods *dorsal* to egg sacs. It parasitizes exclusively teleost fishes, however, unlike all other lernaeopodids with dorsal uropods.

14 Second antenna with large exopod and reduced endopod (Fig. 32K)..... *Clavellomimus*

Second antenna with large endopod; exopod reduced or absent (Fig. 31G) ..... *Clavella*

Ommatokoita Leigh-Sharpe, 1926

The only known species of this genus, *O. elongata*, occurs most commonly attached to the cornea of *Somniosus microcephalus*, although some records from other sharks have also been published. The generic description is the same as that of the type and only species.

Ommatokoita elongata (Grant, 1827)

Female (Fig. 19A): Cephalothorax short, flat, with not very well defined dorsal shield. Trunk much longer than broad, usually with more or less parallel lateral margins; no armature on posterior margin, but perianal area distinctly set off (Fig. 19B). Second antennae prehensile. Mandible (Fig. 19C) with three secondary teeth. First maxilla with lateral exopod and three terminal papillae on endopod (Fig. 19E). Second maxillae fused at tips, with two apical digitiform processes each (Fig. 19D). Bulla plano-convex, without manubrium. Corpus maxillipedis with abundantly spinulated inner margin (Fig. 19F). Total length (without second maxillae) 20–25 mm.

Male (Fig. 19G): Cephalothorax longer than trunk and at obtuse angle to its long axis; ventral surface bearing large second maxillae and maxillipeds. Posterior extremity of trunk with external genitalia and uropods. Two pairs of vestigial legs on anterior part of ventrolateral surface of trunk. Total length 2.5 mm.

Marine. Cornea of *Somniosus microcephalus*. (E Arc).

In addition to *O. elongata*, a specimen obviously belonging to this genus was recently found (Hogans and Brattey 1986) off St. Pierre Bank, Scotian Shelf, on *Etmopterus princeps*. An ovigerous female was attached immediately posterior to the second dorsal fin of its host. Although all the appendages of this copepod were unmistakably similar to those of *O. elongata*, its general appearance (Fig. 19H) differed noticeably from that species, as did its size (6 mm without second maxillae). This find seems to represent a new addition to the hitherto monotypic genus. In absence of sufficient material, however, positive identification and description is as yet impossible.

Achtheres von Nordmann, 1832

The most recent reviewer (Kabata 1969a, 1979) postulated the existence of only six nominal species in this genus, apparently derived from *Salmincola*. All but one of them (*A. percarum*) are Nearctic, four having been recorded from Canada. Kabata (1979) pointed out the existence of a close similarity among all of them. The degree of similarity suggested that at least some of them may be spurious taxa, synonymous with those described earlier. Doubts about validity of one species were recorded by Huggins (1959), who quoted a personal communication from Dr. T. E. Bowman, Smithsonian Institution, mentioning the possibility that *A. ambloplitis* might be "a small form of *A. pimelodi*." Kabata (1969a, 1979) strongly suggested that *A. corpulentus* might be identical with *Salmincola extumescens*, though he stopped short of making an outright proposal of a change in its systematic status, claiming insufficient evidence.

Canadian records comprise *Achtheres ambloplitis* Kellicott, 1880, *A. micropteri* Wright, 1882, *A. pimelodi* Krøyer, 1863, and *A. corpulentus* Kellicott, 1880. The original descriptions of all four are sketchy and cannot be used for comparative purposes. It was necessary to examine authenticated material of all four species and to carry out direct comparisons. Regrettably, Kellicott's specimens were not available, but samples identified, among others, by the leading copepodologist of the day, C. B. Wilson, were examined. As the result of these examinations, I can now postulate the following:

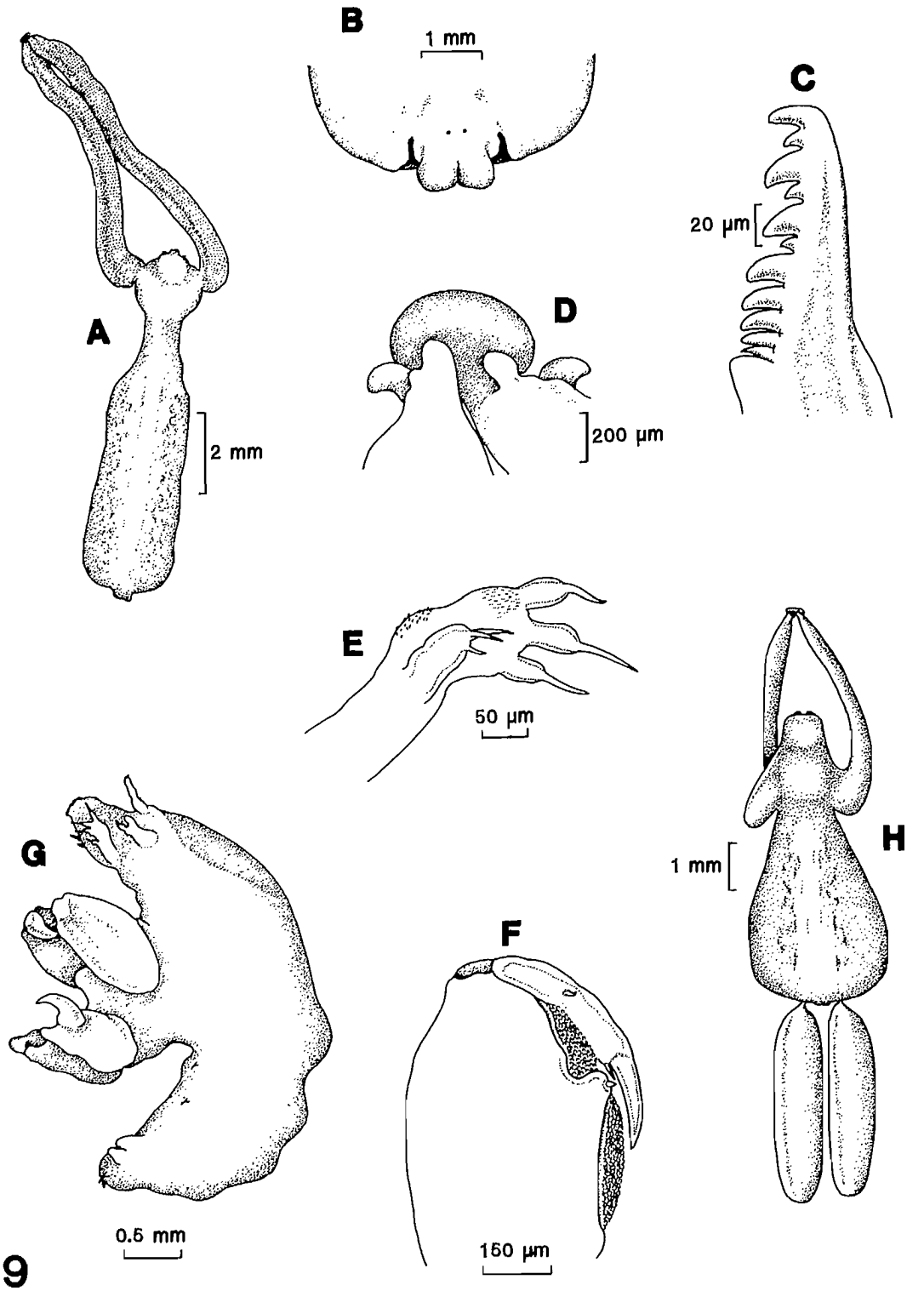

FIG. 19. A. *Ommatokoita elongata*, female, dorsal; B. Same, posterior extremity, ventral; C. Mandible, distal part; D. Tips of second maxillae; E. First maxilla; F. Maxilliped; G. Male, lateral; H. *Ommatokoita* sp., female, dorsal. (A–G redrawn from Kabata 1979; H redrawn from Hogans and Brattey 1986).

(a) *Achtheres corpulentus* is, indeed, identical with *Salmincola extumescens*. Both taxa possess a bulla with unique orbicular anchor of very large diameter and the egg sacs of both exhibit characteristic forward and dorsad curl, not found in any related species. Their gross morphology and the structure of their appendages provide no grounds for retaining them in separate taxa. I propose, therefore, to alter the status of *A. corpulentus* by transferring it to the genus *Salmincola* (q.v.). Since *Salmincola extumescens* (Gadd, 1901) is chronologically junior to *A. corpulentus*, its specific name must become a junior synonym. The proper binomen for it will be *Salmincola corpulentus* (Kellicott, 1880).

(b) The three remaining species are identical with one another. Close examination of specimens of *A. pimelodi* (Fig. 20D), *A. micropteri* (Fig. 20C), and *A. ambloplitis* (Fig. 20A) did not reveal any morphological differences that would necessitate their assignment to separate taxa. On the other hand, many significant similarities were found linking them together, like the armature of the subchela of the maxilliped (Fig. 20E). As regards host affinities, two of them have overlapping host ranges. *Achtheres ambloplitis* and *A. micropteri* parasitize members of the teleost family Centrarchidae. On the other hand, the hosts of *Achtheres pimelodi* belong to Ictaluridae, a family belonging to an order different from that containing Centrarchidae. However, this difference is also insufficient to support retention of *A. pimelodi* in a taxon separate from the other two nominal species.

The first of these three nominal species to be described was *A. pimelodi*. Consequently, the other two binomina become its junior synonyms. With their relegation to synonymy, the Canadian records of *Achtheres* are reduced to a single species, *A. pimelodi*. The generic diagnosis of *Achtheres* is the same as that of its sole Canadian representative.

Achtheres pimelodi Krøyer, 1863
SYN.: *Achtheres ambloplitis* Kellicott, 1880
Achtheres micropteri Wright, 1882

Female (Fig. 20A–D): Cephalothorax short, dorsoventrally flattened, at obtuse or right angles to long axis of trunk, separated from it by neck-like constriction (partly or completely obliterated in contracted specimens) (Fig. 20D). Trunk longer than wide, its posterior extremity subconical, protruding well beyond level of oviduct orifices (Fig. 20B). Abdomen completely incorporated in trunk. Second maxillae subcylindrical, about as long as trunk (length depending on degree of contraction), without apical expansions. Bulla with short manubrium and flat, subcircular anchor. Claw of maxilliped well developed, with elaborate armature at base, on inner margin of subchela (Fig. 20E). Total length 1.6–3.0 mm.

Male (Fig. 20F): Body straight. Cephalothorax less than half of total length, ventral surface with prominent second maxillae and maxillipeds. Trunk ovoid, with ventral plates at posterior extremity. Total length 1.0–2.0 mm.

> Freshwater. Gills and buccal and branchial cavities of *Ambloplites rupestris*, *Coregonus clupeaformis*, *Ictalurus nebulosus*, *I. punctatus*, *Lepomis gibbosus*, *Micropterus dolomieui*, and *M. salmoides*. (Ont). Additional records: *Lepomis gibbosus* and *Ambloplites rupestris*. (Ont) (Hanek 1974; Hanek and Fernando 1978a,b,c,d,e).

An unidentified species of *Achtheres* was recorded in Alberta on *Prosopium williamsoni* by Thomson (1974, MS), cited in McAllister and Mudry (1983).

Salmincola Wilson, 1915

Circumpolar in distribution, this genus is confined to freshwater habitats of the northern hemisphere, its range largely coincidental with that of its most common hosts, Salmonidae and their relatives. *Salmincola* contains at present 17 species, at least eight of which occur in Canada. A recent record of a ninth species is still in need of confirmation and will be mentioned at the end of the key to species.

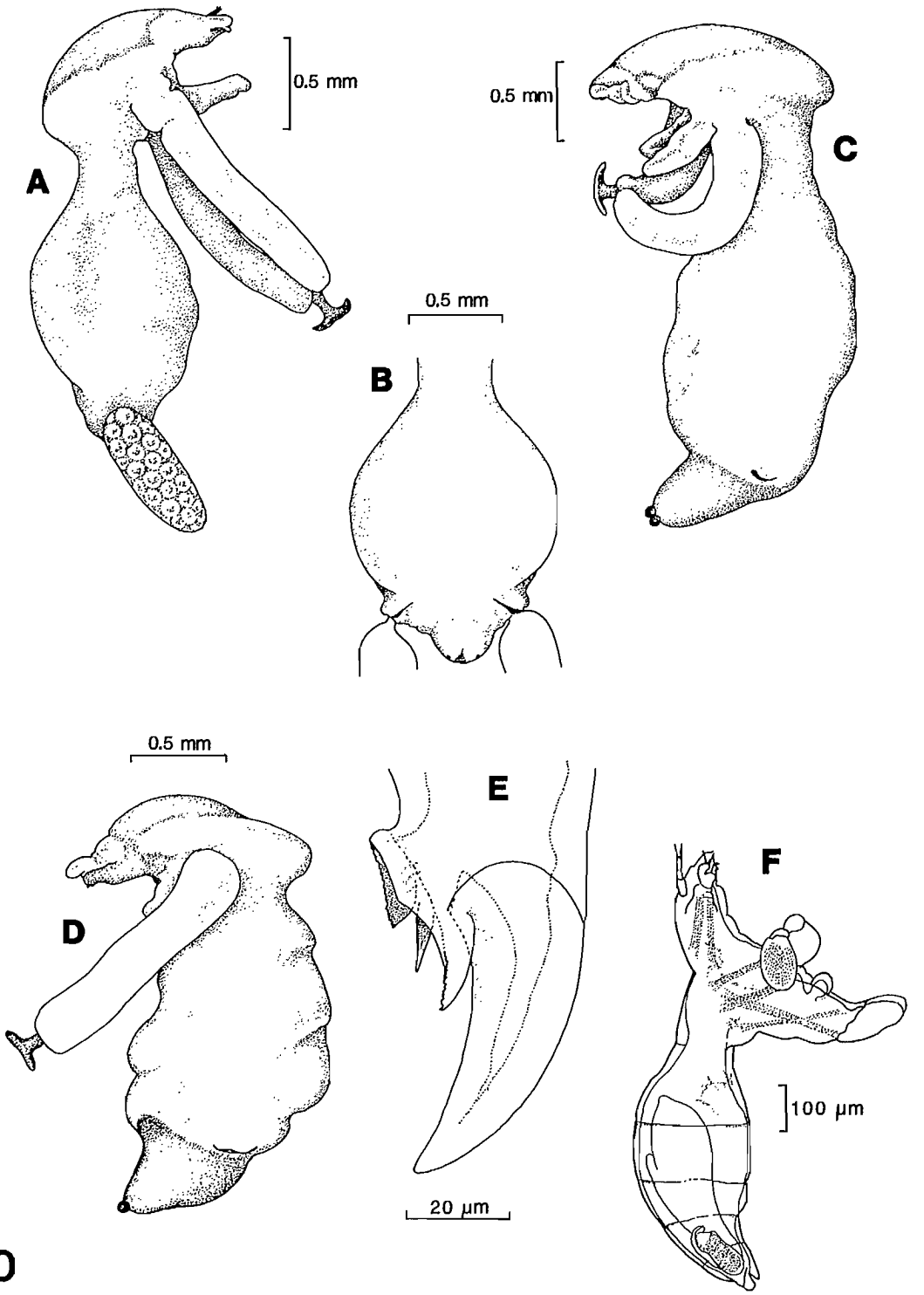

FIG. 20. A. *Achtheres pimelodi*, female, lateral (originally identified as *A. ambloplitis*); B. Same, trunk; C. Female, lateral (originally identified as *A. micropteri*); D. Female, lateral; E. Same, maxilliped, claw, dorsal; F. Male, lateral. (A–E original; F redrawn from Wilson 1915).

The identification of *Salmincola* must be based on its females. The diminutive males are not readily distinguishable from species to species. In appearance they resemble the males of *Achtheres* (Fig. 20F); they seldom measure more than 2 mm in length. The generic diagnosis of the female *Salmincola* is as follows:

Cephalothorax short, dorsoventrally flattened, obliquely ventral to long axis of trunk and separated from trunk by distinct constriction. Trunk oval to subcircular in outline, its rounded posterior end not protruding far beyond level of oviduct orifices. Second maxillae subcylindrical, attached distally to bulla. Latter of various shapes, moderately or very large. Maxilliped with palp on corpus; claw of maxilliped well developed or reduced, without elaborate armature at base.

Key to species of *Salmincola*

1 Maxilliped with normally developed claw (1/5–1/4 length of rest of subchela) (Fig. 21E) 2

Maxilliped with greatly reduced claw (Fig. 24J) 7

2 Length of maxilliped palp between 1/3 and 1/2 length of subchela (exclusive of claw) and more than twice palp's diameter at base (Fig. 21E) ..... *S. thymalli* (Kessler, 1868)

Cephalothorax subtriangular, longer than wide; trunk varying from elongate to suborbicular (Fig. 21A). Endopod of second antenna (Fig. 21B) with crenated tubercle 4, exopod armature varying from sparse, fairly prominent, to numerous minute spinules. Mandible (Fig. 21C) with seven teeth. First maxilla (Fig. 21D) with ventral papilla much smaller than other two, exopod reduced to simple spine. Maxilliped (Fig. 21E) short and squat, with long and slender palp. Bulla clavate, of varying lengths. Total length 3–4 mm.

Freshwater. Fins of *Prosopium cylindraceum*, *Prosopium* sp., and *Thymallus arcticus*. (NWT) (YT) (Lab). Additional records: *Prosopium williamsoni*. (Anon. 1978, 1981, 1984; Arai and Mudry 1983) (BC); *Thymallus arcticus*. (Anon. 1978, Arai and Mudry 1983) (BC); *Coregonus clupeaformis* (Anon., 1984). (BC).

Length of maxilliped palp not greater than 1/3 length of subchela (exclusive of claw) and equal or slightly greater than palp's diameter (Fig. 21K) 3

3 Terminal segment of endopod of second antenna with one ventral process as large as, or larger than, dorsal hook, and another much smaller process (Fig. 21G) ..... *S. edwardsi* (Olsson, 1869)

Cephalothorax with broad base, narrowing towards apex, greatly varying in length, trunk roughly oval, with rounded margins and usually convex dorsum (Fig. 21F). Exopod of second antenna armed with sparse but prominent and slender spinules (Fig. 21H). Mandible (Fig. 21I) with 6–7 teeth. First maxilla (Fig. 21J) with stubby papillae carrying very short apical spines. (Sometimes only middle papilla well developed, others greatly reduced.) Maxilliped (Fig. 21K) with patch of spinules near base of claw; papilliform palp often bearing one or two apical processes. Bulla with short manubrium and subcircular anchor. Total length 2.5 mm.

Freshwater. Gill chamber, gills, fins and skin of *Salvelinus alpinus*, *S. fontinalis*, *S. malma*, and *S. namaycush*. (Doubtful records also from *Salmo gairdneri* and *S. clarki*.) Records from all parts of Canada, except for Manitoba, Saskatchewan and Alberta. Additional records: *Salvelinus alpinus*. (NWT) (Beverley-Burton 1978); *S. fontinalis*. (Lab) (Chinniah and Threlfall 1978); *S. malma*, *S. namaycush*, and *Prosopium williamsoni*. (BC) (Anon. 1978); *Salvelinus alpinus*. (NWT) (Que) (Curtis 1979, 1984); *S. fontinalis*. (Man) (Kooyman and Gaboury cited in Lubinsky and Loch 1979); *S. alpinus*. (NWT) (Dick and Beloserik 1981); *S. alpinus* and *S. fontinalis*. (Ont) (Que) (Black 1981, 1982); *S. alpinus*, *S. malma*, *S. namaycush*, and *Prosopium williamsoni*. (BC) (Arai and Mudry 1983); *S. fontinalis*. (Nfld) (Cone and Ryan 1984). [Syn. *Salmincola exsanguinata* Sandeman and Pippy, 1967; *Lernaeopoda arcturi* Miers, 1877; *L. edwardsii* Olsson, 1869.]

Terminal segment of endopod of second antenna not as above 4

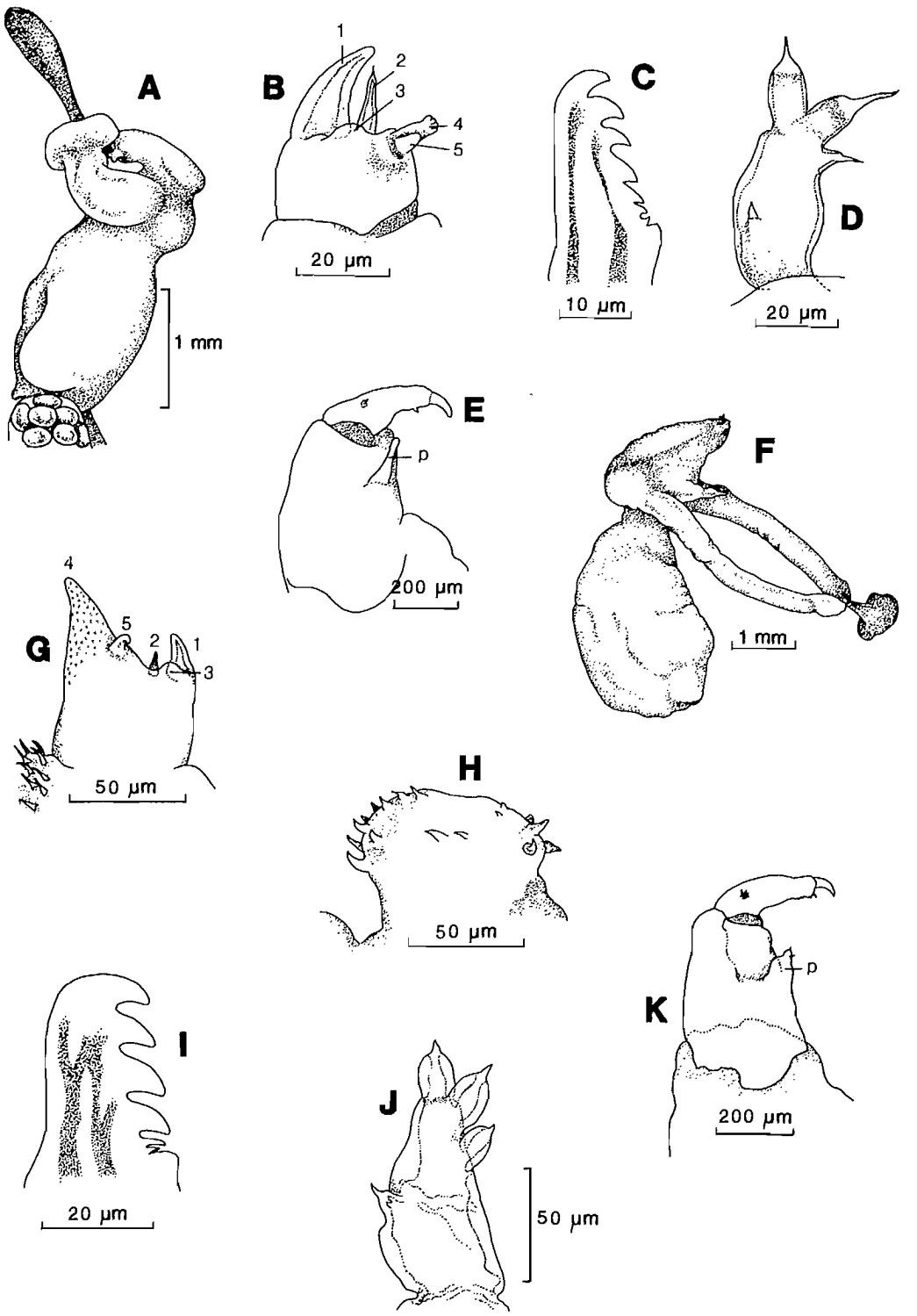

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FIG. 21. A. *Salmincola thymalli*, female, lateral; B. Same, endopod of second antenna; C. Mandible, tip; D. First maxilla; E. Maxilliped; F. *Salmincola edwardsi*, female, lateral; G. Same, endopod of second antenna; H. Exopod of second antenna; I. Mandible, tip; J. First maxilla; K. Maxilliped. (Redrawn from Kabata 1969a).
p — palp; other explanations in text.

4 Terminal segment of endopod of second antenna with very large ventral semispherical swelling topped by two small conical processes (Fig. 22B) ..... *S. siscowet* (Smith, 1874)

Cephalothorax elongated, often with noticeable dorsal prominence, trunk fairly long (Fig. 22A). Exopod of second antenna with sparse spinulation. Mandible (Fig. 22C) with 6–7 teeth. First maxilla (Fig. 22D) with reduced ventral papilla. Maxilliped similar to that of *S. edwardsi*. Manubrium of bulla long, anchor mushroom-shaped, with curling rim. Total length up to 5 mm.

Freshwater. Gills, fins and skin of *Salvelinus malma* and *S. namaycush*. (Que) (Ont) (Sask) (NWT). Questionable records also from (W Arc). Additional records: *Salvelinus namaycush*. (Lab) (Chinniah and Threlfall 1978); *S. namaycush*. (BC) (Anon. 1984).

Terminal segment of endopod of second antenna with two ventral processes, often arising from common base and either equal or subequal in size (Fig. 22F) 5

5 Bulla ovate, with one side flat or somewhat concave (Fig. 22J) ..... *S. salmoneus* (L.)

Cephalothorax subtriangular, relatively short; trunk varying from slender to suborbicular (Fig. 22E). Exopod of second antenna with apical patch of small, densely packed denticles and two more prominent tubercles (Fig. 22G). Mandible with seven teeth. First maxilla (Fig. 22H) with subequal papillae bearing long setae. Maxilliped (Fig. 22I) with prominent, robust palp. Bulla with short manubrium and ovoid anchor. Total length 7–8 mm.

Freshwater. Gill chamber and gills of *Salmo salar*. (Lab) (Nfld) (NS) (NB) (Que). Found also on the same host in the Atlantic. Additional records: *Salmo salar*. (Atl) (Lab) (NB) (Nfld) (NS) (Que) (Pippy 1980); *S. salar*. (Nfld) (Cone and Ryan 1984).

Bulla not ovate, with one side flat or concave 6

6 Tip of exopod of second antenna with many large spines (Fig. 23C) ... *S. californiensis* (Dana, 1852)

Cephalothorax from narrow to broad and short, trunk short, orbicular (Fig. 23A). Endopod of second antenna (Fig. 23B) resembling that of *S. salmoneus*. Mandible (Fig. 23D) with six, rarely five, teeth. First maxilla (Fig. 23E) with subequal, often reduced, papillae. Maxilliped (Fig. 23F) with prominent, robust and squat palp. Bulla with long manubrium and subcircular anchor. Total length 3.5–7 mm.

Freshwater. Gill chamber, gills, fins, and skin of *Oncorhynchus kisutch*, *O. nerka*, *Salmo clarki*, *S. gairdneri*, and *Salvelinus malma*. (BC) (NWT) (W Arc) (Pac). Additional records: *Oncorhynchus gorbuscha*, *O. keta*, *O. kisutch*, *O. nerka*, *O. tshawytscha*, *Salmo gairdneri*, *Salvelinus namaycush*, and *Prosopium williamsoni*. (Anon. 1978, 1981, 1984); *Oncorhynchus tschawytscha*, *Salmo gairdneri*, and *Salvelinus namaycush*. (Arai and Mudry 1983); *Oncorhynchus nerka*. (Groot, Margolis and Bailey 1984). (BC). [Syn.: *Salmincola bicauliculata* (Wilson, 1908); *S. carpenteri* (Packard, 1874); *S. falculata* (Wilson, 1908).]

Tip of exopod of second antenna unarmed, save for two papillae (Fig. 23I) ..... *S. carpionis* (Krφyer, 1837)

Cephalothorax ovoid, wider posteriorly, trunk with distinct, narrow anterior neck (Fig. 23G). Endopod of second antenna (Fig. 23H) resembling that of *S. salmoneus*. Mandible (Fig. 23J) with seven teeth. First maxilla (Fig. 23K) with short, subconical papillae. Maxilliped (Fig. 23L) with small palp of irregular shape. Bulla with fairly long manubrium and mushroom-like anchor. Total length 8–9 mm.

Freshwater. Buccal cavity, gills, fins and skin of *Oncorhynchus nerka*, *Salvelinus alpinus*, *S. fontinalis*, and *S. malma*. (Que) (Lab) (W Arc) (NWT) (BC) (Atl). [Syn.: *Salmincola gibber* (Wilson, 1908); *S. salvelini* Richardson, 1938.]

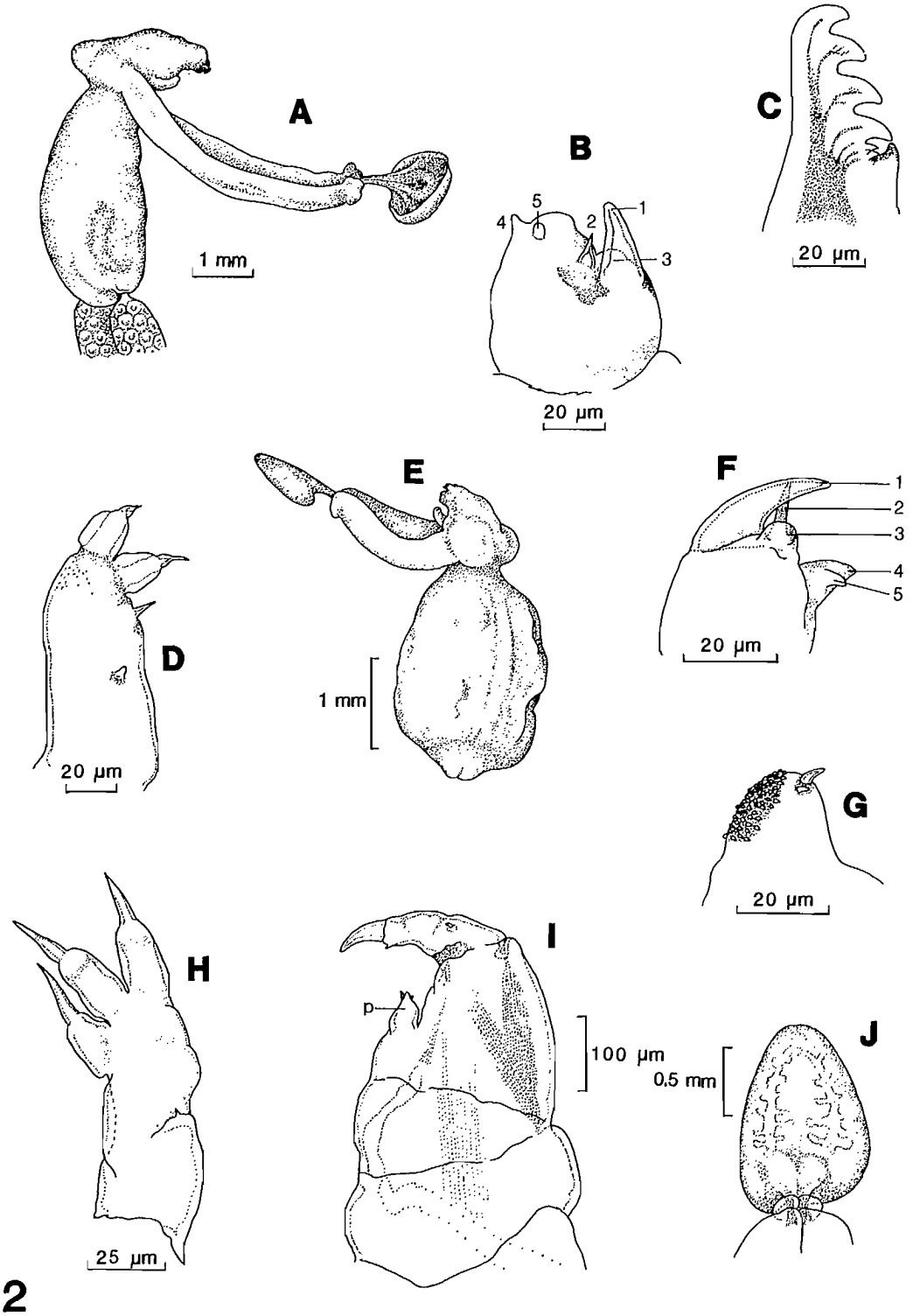

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FIG. 22. A. *Salmincola siscowet*, female, lateral; B. Same, endopod of second antenna; C. Mandible, tip; D. First maxilla; E. *Salmincola salmoneus*, female, dorsolateral; F. Same, endopod of second antenna; G. Exopod of second antenna; H. First maxilla; I. Maxilliped; J. Bulla, anchoral surface. (Redrawn from Kabata 1969a).
p — palp; other explanations in text.

7 Bulla with wide discoidal anchor, no spinulation on terminal segment of endopod of second antenna (Fig. 24B) ..... *S. corpulentus* (Kellicott, 1880)

Cephalothorax long, resembling inverted letter T, trunk with convex dorsum, egg sacs reflected anteriorly in curving lines (Fig. 24A). Exopod of second antenna profusely spinulated. Mandible with 7–8 teeth (Fig. 24C). First maxilla (Fig. 24D) with ventral papilla reduced and spiniform, apical setae of other two papillae short. Maxilliped (Fig. 24E) with greatly reduced claw of subchela and diminutive palp. Manubrium of bulla long, anchor discoidal, with very wide diameter. Total length 4.5–8.5 mm.

Freshwater. Gills and gill chamber of *Coregonus artedii*, *C. clupeaformis*, *C. hoyi*, *C. kiyi*, *C. reinhardi*, and *Coregonus* sp. (NWT) (Alta) (Ont) (Que). Additional records: *Salmo salar* and *Coregonus clupeaformis*. (Lab) (Chinniah and Threlfall 1978); *Coregonus clupeaformis*. (Man) (Watson and Dick 1979; Watson, cited in Lubinsky and Loch 1979); *Coregonus clupeaformis*. (Alta) (Leong and Holmes 1981; Hobbs, cited in McAllister and Mudry 1983). [Syn.: *Salmincola extumescens* (Gadd, 1901); *S. inermis* (Wilson, 1911).]

Bulla subspherical (Fig. 24F), spinulation present on ventral surface of terminal segment of endopod of second antenna (Fig. 24G) ..... *S. extensus* (Kessler, 1868)

Cephalothorax relatively long, slender, trunk narrow anteriorly, increasing in girth posteriorly (Fig. 24F). Exopod of second antenna armed with scattered but numerous strong spinules. Mandible (Fig. 24H) with seven teeth. First maxilla similar to that of *S. corpulentus*. Subchela of maxilliped (Fig. 24I) with greatly reduced claw and with patch of spinules near base of claw (Fig. 24J). Total length up to 5 mm.

Freshwater. Skin and fins of *Coregonus artedii*, *C. clupeaformis*, *C. hoyi*, *Prosopium cylindraceum*, and *P. williamsoni*. (YT) (BC) (Alta) (Ont) (Lab). Additional records: *Prosopium williamsoni*. (BC) (Anon. 1978, 1981, 1984; Arai and Mudry 1983); *Coregonus artedii*, *C. clupeaformis*, and *Esox lucius*. (Man) (Watson and Dick 1980; Watson, cited in Lubinsky and Loch 1979); *Coregonus artedii* and *C. clupeaformis*. (Alta) (Leong and Holmes 1981).

Chinniah and Threlfall (1978) reported occurrence of *Salmincola coregonorum* (Kessler, 1868) on *Coregonus clupeaformis* in Labrador, without giving details of identification. Kabata (1969) considered *S. coregonorum* a Palearctic species, in absence of any previous records from the Nearctic. This first North American record should be confirmed before the distribution range of *S. coregonorum* is extended to the New World.

Some unidentified species of *Salmincola* have been recorded. These records refer to *Salmincola* sp. on gills, fins, and skin of *Cottus asper*, *Oncorhynchus gorbuscha*, *O. nerka*, *Prosopium cylindraceum*, *P. williamsoni*, *Salvelinus fontinalis*, *S. namaycush*, and *Stenodus leucichthys*. (BC) (NWT) (Man) (Ont) (Que). Additional records: *Salvelinus namaycush*. (Man) (Stewart-Hay, cited in Lubinsky and Loch 1979); *Salvelinus namaycush*. (BC) (Anon. 1984).

Lernaeopoda de Blainville, 1822

In commenting upon this genus, Kabata (1979) contended that out of 16 nominal species of this genus only two (*L. galei* Krφyer, 1837, and *L. bidiscalis* Kane, 1896) can be accepted without reservations. To this number can be added *L. bivia* Leigh-Sharpe, 1930, recently re-examined by the present author. Kabata's (1979) review established a new genus, *Albionella*, whose females are indistinguishable from those of *Lernaeopoda*, but whose males are clearly not identical with those of that genus. The differences in the morphology of the males are quite sufficient to draw a border line between these two genera. Unfortunately, male lernaeopodids are not often encountered, so that in practice one can be left in uncertainty as to the generic identity of possible *Lernaeopoda* and *Albionella*.

Members of the genus *Lernaeopoda* are parasitic mainly on sharks and tend to display site specialization.

The generic diagnosis below is illustrated with details of *L. galei* and *L. bidiscalis*.

Female: Cephalothorax short, dorsoventrally flattened, ventrally inclined to long axis of trunk. Latter of various shapes, without posterior processes but with inflated uropods, ventral to oviduct orifices (Fig. 25A). Second antenna (Fig. 25B) with large exopod and small endopod. Mandible (Fig. 25C) with three secondary teeth. First maxilla (Fig. 25D) with lateral exopod and three apical papillae on endopod. Second maxillae separate from each other, long. Maxilliped with secondary denticles at base of claw (Fig. 25E).

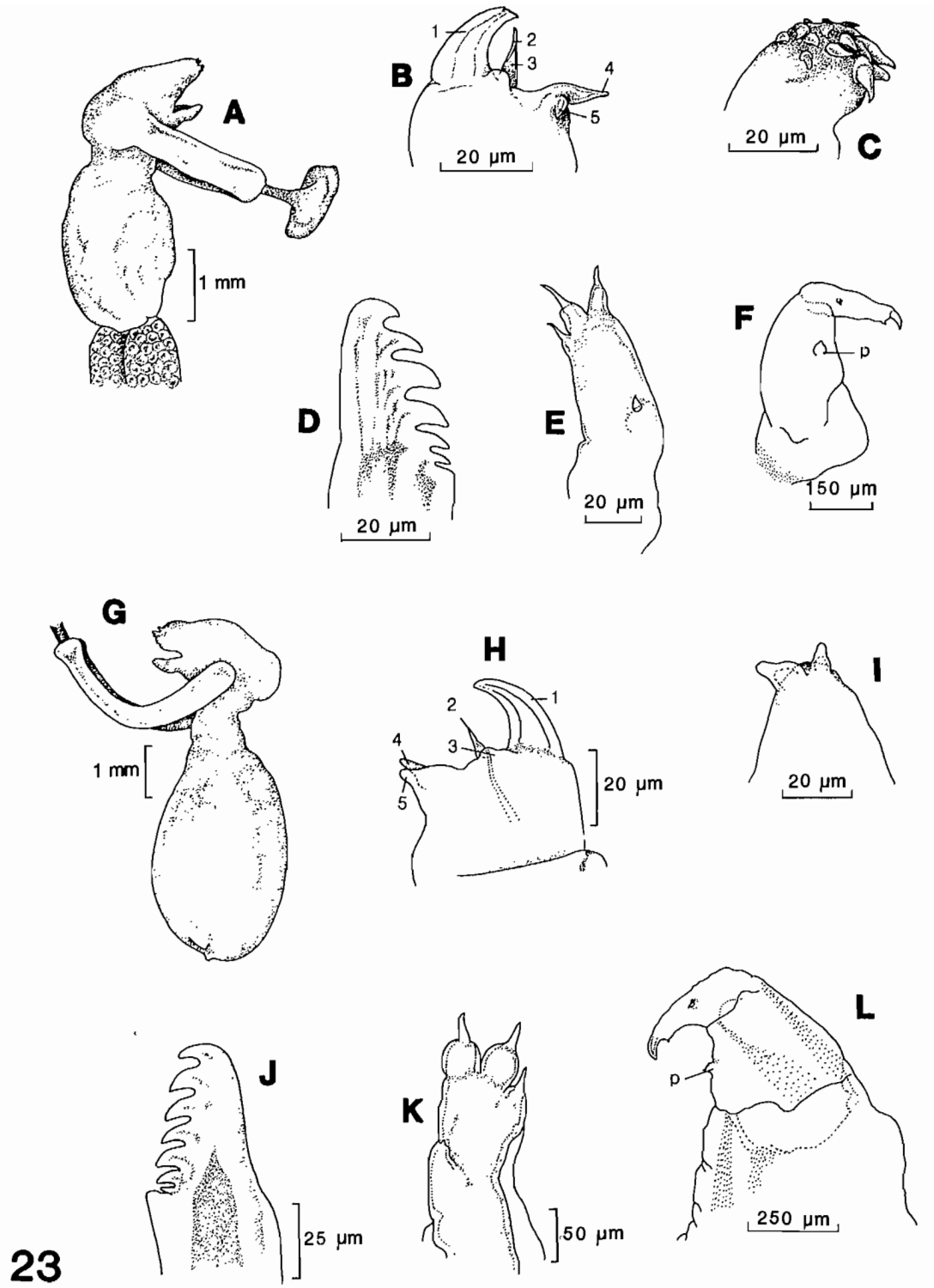

FIG. 23. A. *Salmincola californiensis*, female, lateral; B. Same, endopod of second antenna; C. Exopod of second antenna; D. Mandible, tip; E. First maxilla; F. Maxilliped; G. *Salmincola carpionis*, female, lateral; H. Same, endopod of second antenna; I. Exopod of second antenna; J. Mandible, tip; K. First maxilla; L. Maxilliped. (Redrawn from Kabata 1969a).
p — palp; other explanations in text.

Male: Cephalothorax with prominent posterodorsal swelling, less than half body length, obliquely ventral to long axis of, and clearly separated from, trunk. Prominent, inflated uropods pointing posteriorly (Fig. 25F). Two pairs of vestigial legs. External genitalia (Fig. 25G) present.

Only one record of *Lernaeopoda* has been registered in the Canadian fauna. Templeman (1965) reported finding an unspecified *Lernaeopoda* in the cloacal region of *Raja jenseni* off Newfoundland. The specimen was identified, from a photograph, by Z. Kabata. The record must be viewed with caution, because *Lernaeopoda* usually does not occur on hypotrematous hosts. Indeed, the literature dealing with this genus contains only four records of occurrence on hosts other than sharks. Van Beneden (1870) claimed to have found *L. galei* on *Trygon pastinaca* and Kurz (1877) on *Myliobatis aquila*. Russo (1975) reported a find of *L. stellicola* (= *L. galei*) on *Raja binoculata*. Dollfus (1946) was surprised to find *L. bidiscalis* on a teleost fish, *Mola mola*. All those references are, at best, records of aberrant host–parasite association.

Albionella Kabata, 1979

This recently established genus consists of four species, all parasitic on sharks. As mentioned above (p. 00), the females of *Albionella* are virtually indistinguishable from those of *Lernaeopoda*. Only one minor morphological detail can serve as a clue to their identity. The claw of the maxilliped of *Albionella* (Fig. 25I) carries normally only one simple secondary denticle on the proximal part of its inner margin. The corresponding claw of *Lernaeopoda* usually has at least two (up to four) such denticles. It is the male, however, that supplies the most important characters for identification of *Albionella*.

Only one species of this genus has been recorded in Canadian waters and its diagnosis suffices to characterize the genus.

Albionella centroscyllii (Hansen, 1923)

Female: Cephalothorax short, dorsoventrally flattened, ventrally inclined to long axis of trunk (Fig. 25H). Trunk elongate, wider posteriorly, with prominent, club-shaped uropods. Appendages similar to those of *Lernaeopoda*, but claw of maxilliped (Fig. 25I) with only one secondary denticle on inner margin. Total length 3 mm.

Male (Fig. 25J): Cephalothorax about as long as trunk, without posterodorsal swelling, not clearly separated by constriction from trunk; uropods not inflated, pointing posteriorly.

Marine. Gills of *Centroscyllium fabricii*. (Atl). [Syn.: *Lernaeopoda centroscyllii* Hansen, 1923.]

Lernaeopodina Wilson, 1915

This genus comprises five species, all parasitic on elasmobranchs, although one holocephalan host has also been recorded. Two of these species have been found on small sharks (*Etmopterus*), but the records overwhelmingly point to Hypotremata, and especially Rajidae, as the preferred hosts of *Lernaeopodina*. The typical sites of attachment of *Lernaeopodina* are the gills and outer surfaces of their hosts, but at least one record from the corneal surface has been published. On two occasions, *Lernaeopodina* was found on holocephalan hosts.

Ho (1985) described *Lernaeopodina pectinata*, which he considered a new species, the first of the genus to parasitize a teleost host. The structure of the male of this species, however, does not allow its inclusion in *Lernaeopodina*. It belongs, in fact, to an unknown genus of Lernaeopodidae. In the same paper, Ho suggested that Bere's (1930) record of *Lernaeopodina longimana* (Olsson, 1869) from Passmaquoddy Bay might be conspecific with *L. relata* Wilson, 1915. More detailed examination is required to settle this issue. The generic diagnosis is as follows:

Female: Cephalothorax short, dorsoventrally flattened, ventrally inclined to long axis of trunk. Latter elongate, without posterior processes but with fusiform or subcylindrical uropods dorsal to orifices of oviducts. Second antennae with both rami well developed. First maxilla with lateral exopod and two or three terminal papillae on endopod. Second maxillae separate from each other, long; bulla small, with subcircular anchor.

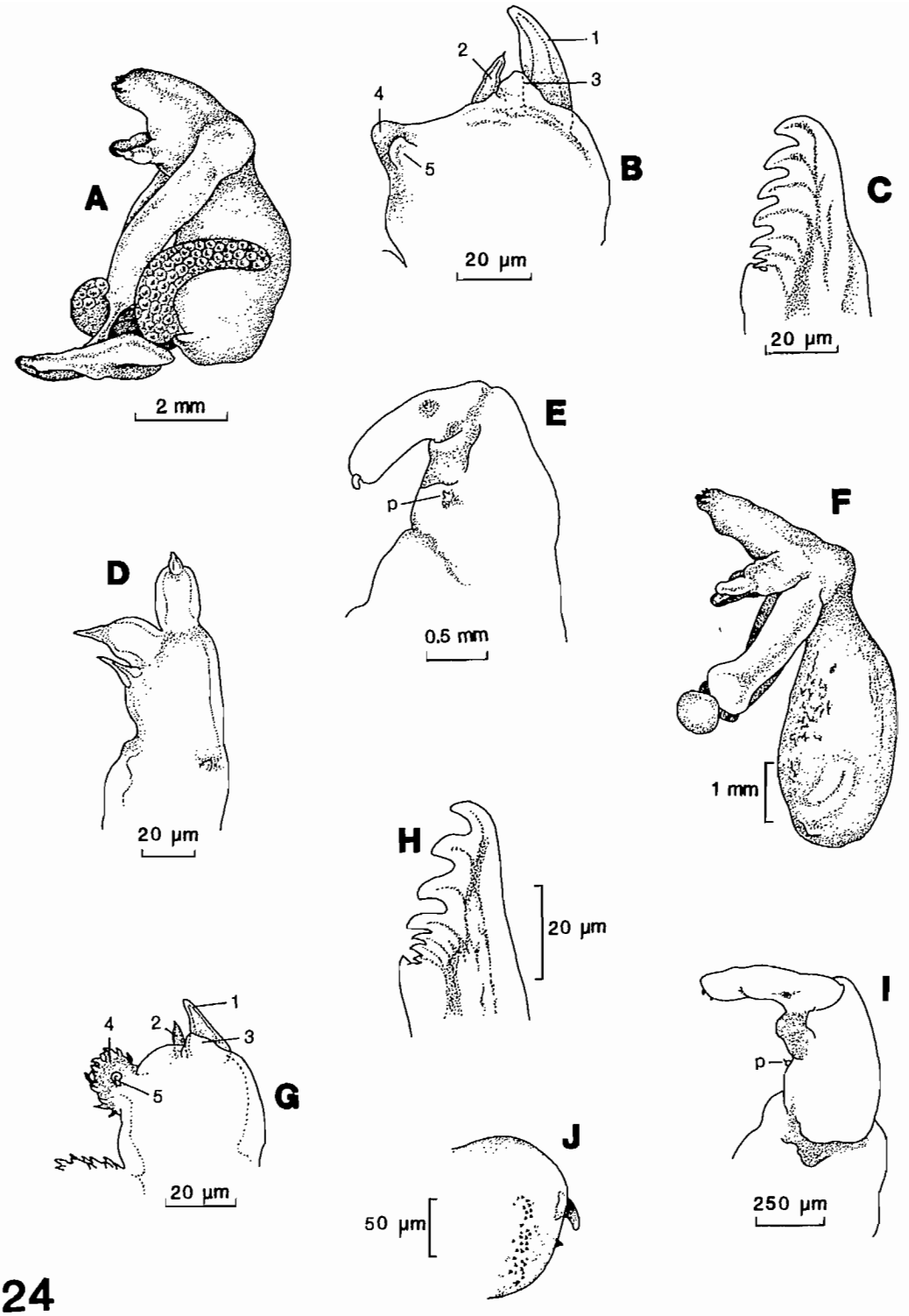

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FIG. 24. A. *Salmincola corpulentus*, female, ventrolateral; B. Same, endopod of second antenna; C. Mandible, tip; D. First maxilla; E. Maxilliped; F. *Salmincola extensus*, female, lateral; G. Same, endopod of second antenna; H. Mandible, tip; I. Maxilliped, entire; J. same, tip of subchela. (Redrawn from Kabata 1969a).
p — palp; other explanations in text.

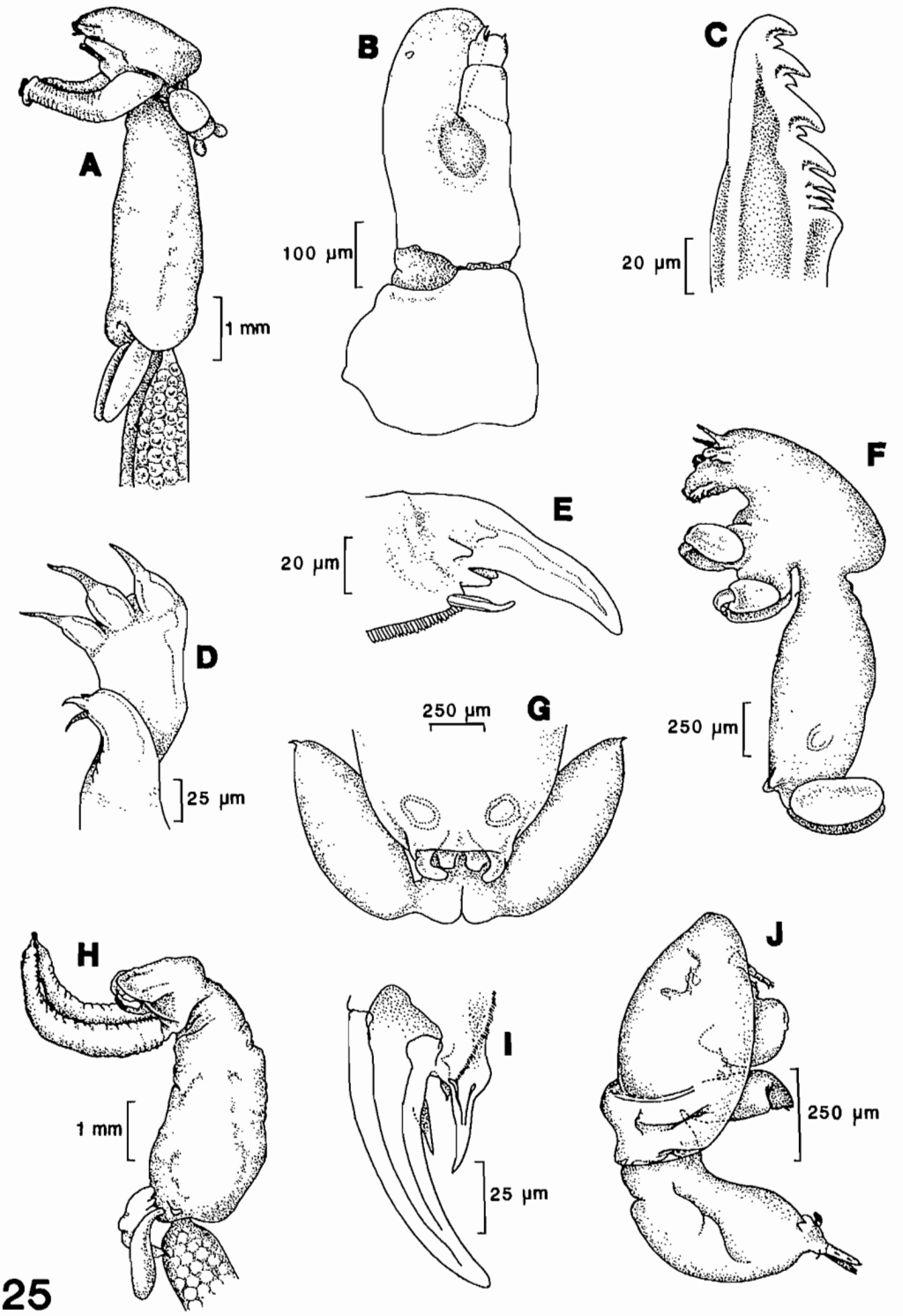

FIG. 25. A. *Lernaeopoda galei*, female, lateral (with male attached); B. *Lernaeopoda bidiscalis*, second antenna; C. *Lernaeopoda galei*, female, tip of mandible; D. First maxilla; E. Claw of maxilliped; F. Male, lateral; G. *Lernaeopoda bidiscalis*, male, posterior extremity, ventral; H. *Albionella centroscyllii*, female, lateral (with male attached); I. Claw of maxilliped; J. Male, lateral. (A–G redrawn from Kabata 1979; H-J redrawn from Kabata 1964a).

Male (Fig. 26I): Anterior part of cephalothorax ventrally inclined to, posterior in line with, long axis of trunk. Latter subcylindrical, shorter than cephalothorax, obscurely segmented and tapering. Two pairs of vestigial legs present. Uropods well developed, pointing posteriorly. External genitalia absent.

Three of five species of this genus occur in Canadian waters.

Key to species of *Lernaeopodina*

1 Second maxillae more than twice length of trunk (Fig. 26A) ..... ***L. longibrachia*** (Brian, 1912)
Trunk elongate, wider posteriorly, with subcylindrical uropods (Fig. 26A,B). First maxilla with three subequal terminal endopod papillae, without denticulation (Fig. 26C). Claw of maxilliped without secondary denticles (Fig. 26D). Total length of body 12 mm, length of second maxillae 28–100 mm.
Marine. Eyes of *Hydrolagus affinis*. (Atl).

Second maxillae less than twice length of trunk 2

2 Anterior part of cephalothorax with distinct dorsal swelling (Fig. 26E); first maxilla with two terminal papillae (Fig. 26F) ..... ***L. longimana*** (Olsson, 1869)
Trunk elongate, wider posteriorly, with fusiform uropods less than 1/4 length of trunk. Genital process absent. Second maxillae shorter or longer than trunk; bulla subspherical. Claw of maxilliped without secondary denticles. Total length 5–8 mm.
Marine. Gills of *Bathyraja richardsoni*, *Raja erinacea*, *R. laevis*, and *R. radiata*. (Atl) [Syn.: *Lernaeopodina cluthae* (T. Scott, 1900).]

Anterior part of cephalothorax more or less flat (Fig. 26G); first maxilla with only one endopod papilla well developed, two reduced (Fig. 26H) ..... ***L. pacifica*** Kabata and Gusev, 1966
Trunk elongate, wider posteriorly, with fusiform uropods less than 1/4 length of trunk (Fig. 26G). Second maxillae about as long as trunk (longer in immature specimens), bulla discoidal. Claw of maxilliped without secondary denticles. Length 5–6 mm.
Marine. Gills of *Raja rhina* . (Pac).

Charopinus Krφyer, 1863

Only three species are included in this genus, one of them with some uncertainty. Two others have been described as *Charopinus* from male specimens only. Since the male is quite alike for several genera in the *Charopinus*-branch of Lernaeopodidae, the affiliation of those two species to *Charopinus* must be considered not proven. The morphology of the male (Fig. 27E) is distinctive, but it can be used only to determine the suprageneric position within the family.

One species of *Charopinus* was recorded from Canada, somewhat tentatively. A record of *Brachiella parkeri* (Thomson, 1890) by Bainbridge (1909) was seen by Kabata (1979) as possibly referring to *Charopinus dubius*. Although the record has not been confirmed by subsequent finds, the presence of this species in Canadian waters is quite likely. The generic diagnosis is identical with that of the Canadian species.

Charopinus dubius T. Scott, 1900

syn.: ?*Brachiella parkeri* (Thomson, 1890); of Bainbridge (1909)

Female: Cephalothorax subcylindrical, about as long as trunk, deflected posteriorly along dorsal wall of trunk (Fig. 27A). Trunk of about equal length and width, with subcylindrical uropods, dorsal to oviduct orifices and about as long as trunk; small tubercular genital process present (Fig. 27B). First maxilla (Fig. 27C) with lateral exopod and three terminal papillae on endopod. Second maxillae long, separate from each other; characteristic boat-shaped bulla (Fig. 27A). Maxilliped (Fig. 27D) reduced, distant from buccal region.
Marine. Spiracles of *Raja laevis*. (Atl).

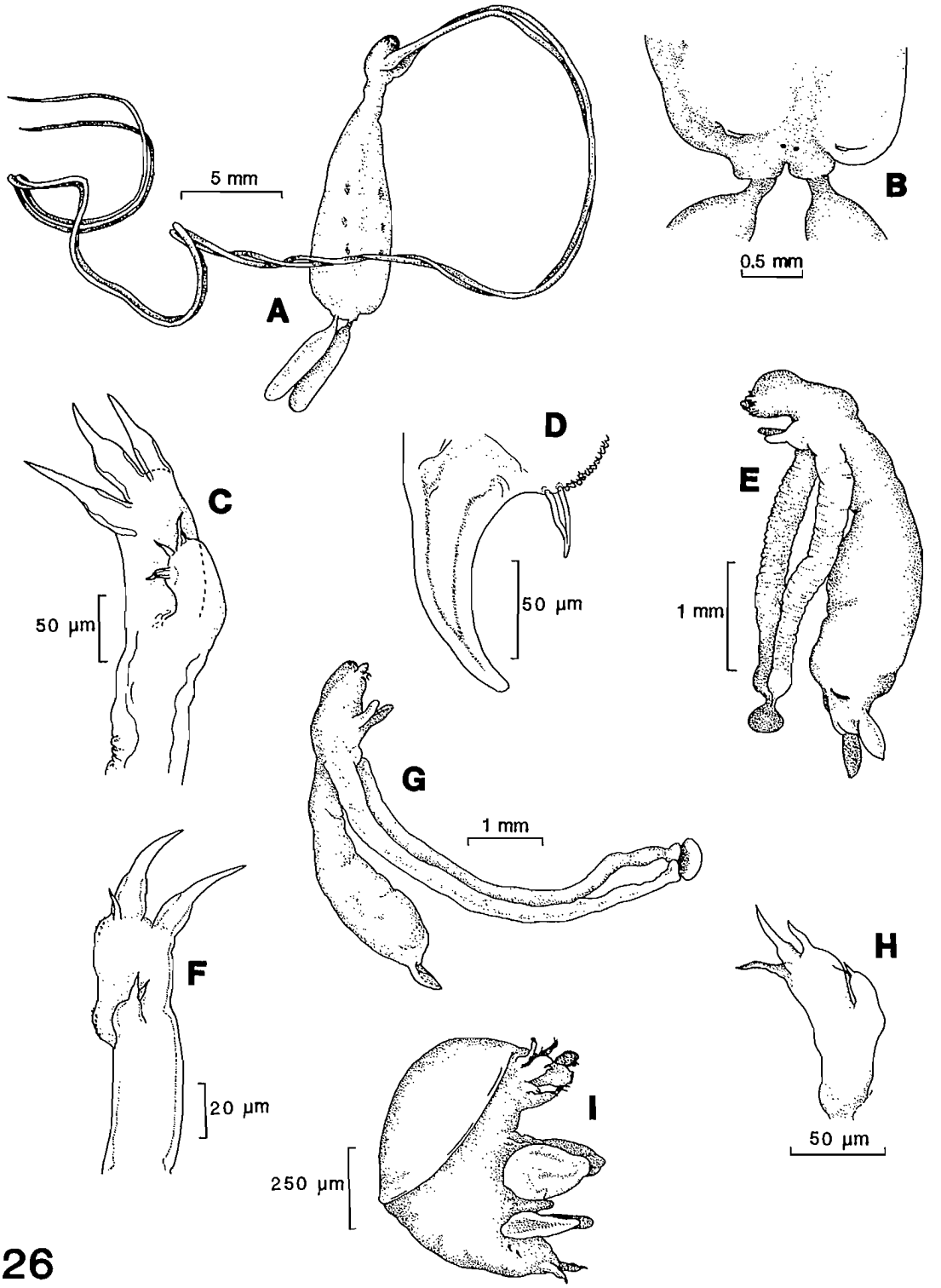

FIG. 26. A. *Lernaeopodina longibrachia*, female, ventrolateral; B. Same, posterior end of trunk, ventral; C. First maxilla; D. Claw of maxilliped; E. *Lernaeopodina longimana*, female, lateral (second maxillae contracted); F. First maxilla; G. *Lernaeopodina pacifica*, young female, lateral; H. Same, first maxilla; I. Male, lateral. (A–D redrawn from Kabata 1969b; E,F redrawn from Kabata 1979; G–I redrawn from Kabata 1970a).

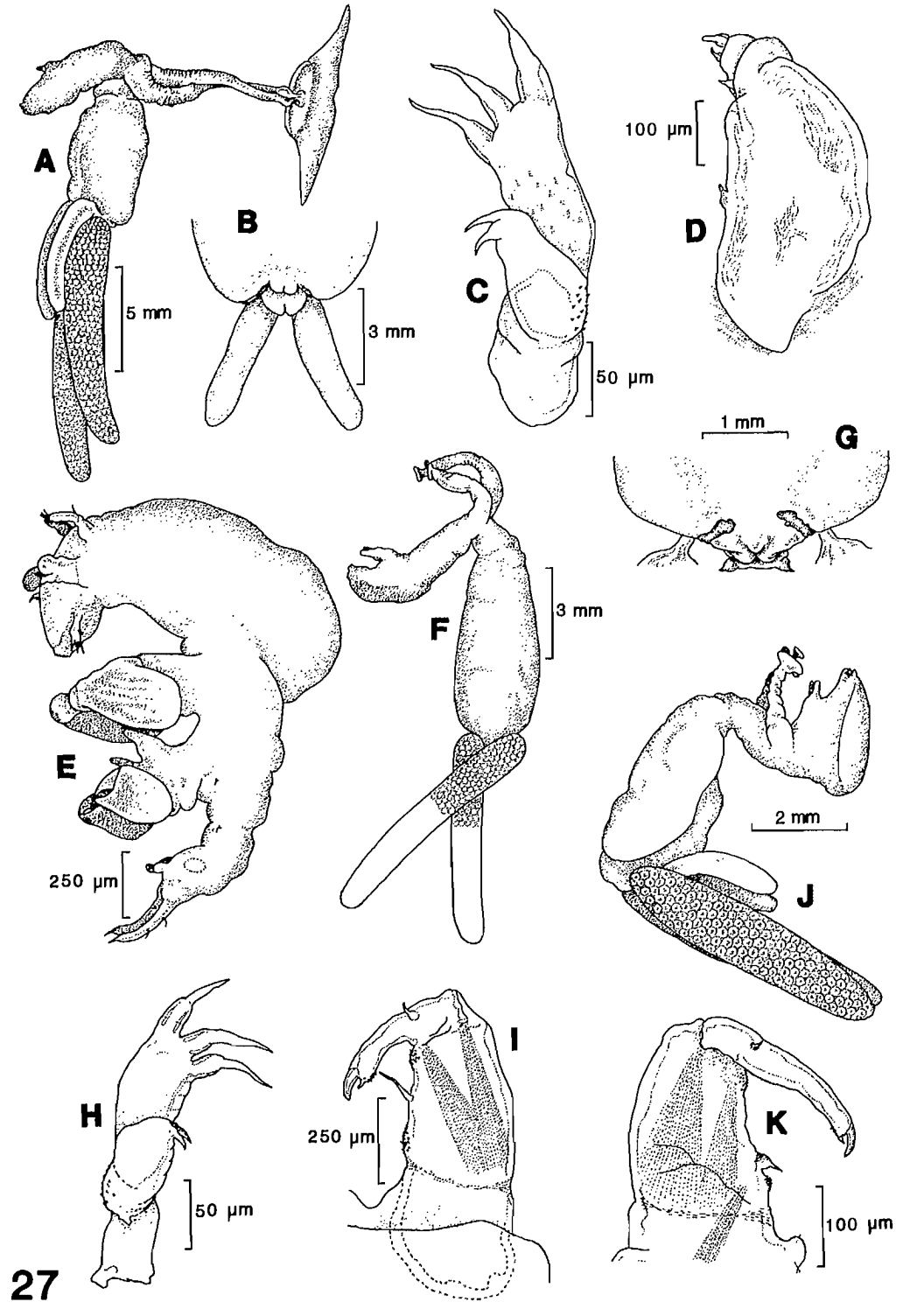

FIG. 27. A. *Charopinus dubius*, female, lateral; B. Same, posterior extremity, ventral; C. First maxilla; D. Maxilliped; E. Male, lateral; F. *Pseudocharopinus dentatus*, female, lateral; G. Same, posterior extremity, ventral; H. First maxilla; I. Maxilliped; J. *Pseudocharopinus bicaudatus*, female, lateral; K. Same, maxilliped. (A–D, F–K redrawn from Kabata 1964b; E redrawn from Kabata 1979).

Pseudocharopinus Kabata, 1964

Apparently closely related to *Charopinus*, but retaining more primitive features, this genus consists of 11 species, parasitizing elasmobranchs in all regions of the world. The full range of distribution of these copepods is not yet known, but there are grounds to believe that at least some of them are cosmopolitan.

Pseudocharopinus belongs to the *Charopinus*-branch of the family and its males are similar to other males of that branch. The differences between the females of these genera are clear from the generic diagnosis of *Pseudocharopinus*.

Female: Cephalothorax subcylindrical, shorter than trunk, with well delimited head, deflected posteriorly along dorsal surface of trunk (except in *P. bicaudatus*). Trunk usually longer than wide, dorsoventrally flattened. Uropods usually cylindrical, dorsal to oviduct orifices. First maxilla with lateral exopod and three terminal papillae on endopod. Second maxillae separate from each other; bulla usually small, with lenticular anchor. Maxilliped well developed, functional, close to buccal region.

Male: Similar to that of *Charopinus*.

Two species of *Pseudocharopinus* have been recorded from Canadian waters.

Key to species of *Pseudocharopinus*

Dorsal shield nearly in line with long axis of cephalothorax, latter subcylindrical, deflected along dorsal wall of trunk (Fig. 27F) ..... *P. dentatus* (Wilson, 1912)

Cephalothorax not greatly expanding anteriorly, shorter than trunk. Latter elongate (Fig. 27F). Uropods very small, tuberculate (Fig. 27G). First maxilla (Fig. 27H) with denticulation near base of exopod. Myxal area of maxilliped (Fig. 27I) with proximal denticulated swelling and distal long, slender seta; claw with single secondary denticle. Total length 10 mm.

Marine. Gills, gill cavity, body surface, and claspers of *Raja binoculata* and *R. rhina*. (Pac).

Dorsal shield at about right angles to long axis of cephalothorax, latter not deflected posteriorly (Fig. 27J) ..... *P. bicaudatus* (Krφyer, 1837)

Cephalothorax greatly expanded anteriorly. Trunk with anterior neck-like part and posterior subquadrangular, dorsoventrally flattened. Uropods digitiform, prominent, about half length of quadrangular part of trunk (Fig. 27J). Second maxillae separate from each other, with collars at apices. Myxal area of maxilliped (Fig. 27K) with small proximal denticulated swelling and distal setiferous tubercle; claw with single secondary denticle. Total length 5.5–6 mm.

Marine. Spiracles of *Squalus acanthias*. (Pac). [Syn.: *Brachiella dentata* Wilson, 1912; *Charopinus dentatus* (Wilson, 1912).]

Schistobrachia Kabata, 1964

Only three species have been assigned to this genus, two of them parasitic on the genus *Raja*, the third, *S. chimaerae* (Yamaguti, 1939), found on a species of *Chimaera* in Japan. *Schistobrachia*, a member of the *Charopinus*-branch of Lernaeopodidae, belongs to a small group of lernaeopodid genera distinguished by almost complete disappearance of the bulla as the organ of attachment of adult females. The role of that organ is taken over by outgrowths, developing near the tips of the second maxillae and producing an anchoring holdfast in the tissues of the host. The generic diagnosis of *Schistobrachia* is as follows:

Female: Cephalothorax small, subtriangular, dorsoventrally flattened, ventrally inclined to long axis of trunk. Latter elongate, without genital or posterior processes; uropods subcylindrical. Second antenna biramous, with rami equally well developed. First maxilla with lateral exopod and three terminal papillae on endopod. Second maxillae separate from each other, long, fused at tips and provided with pair of slender processes each.

Male: Similar to that of *Charopinus*.

Two species have been found in Canadian waters.

Key to species of *Schistobrachia*

Uropods small (Fig. 28B) ..... *S. ramosa* (Krøyer, 1863)
Trunk narrow anteriorly, expanding posteriorly (Fig. 28A), with uropods on sides of anal tubercle (Fig. 28B). First maxilla with dorsal spinulation (Fig. 28C). Second maxilla with long and slender, subequal terminal processes (Fig. 28A). Myxal area of maxilliped inflated (Fig. 28D), with proximal small setiform tubercle and distal subconical process; claw with single secondary denticle. Total length 8 mm.
Marine. Gills of *Raja radiata*. (Atl). [Syn.: *Charopinus ramosus* Krøyer, 1863.]

Uropods more than half length of trunk (Fig. 28E) ..... *S. tertia* Kabata, 1970
Similar to *S. ramosa* but relatively shorter and thicker second maxillae; terminal processes of second maxillae short; subterminal conical swelling present (Fig. 28E). Myxal area of maxilliped (Fig. 28F) not markedly inflated, with conical swelling and digitiform setiferous papilla; claw with single secondary denticle. Total length 7–10 mm.
Marine. Gills and buccal cavity of *Raja binoculata* and *R. rhina*. (Pac).

Dendrapta Kabata, 1964

This monotypic genus is a typical member of the *Charopinus*-branch of Lernaeopodidae, together with the preceding genus characterized by the complete absence of a bulla in the adult female (young post-metamorphosis females still retain vestigial bullae). The holdfast produced by the profusely branching maxillary outgrowths becomes in *Dendrapta* an intricate bush of rhizoid branches, sometimes permeating a volume of host tissue larger than the parasite itself.

The description of the only species of this genus can serve as the generic diagnosis.

Dendrapta cameroni (Heller, 1949)

Female (Fig. 28G): Cephalothorax small, subtriangular, of about equal length and width, ventrally inclined to long axis of trunk. Latter wider than long, with small genital process. Uropods present, dorsal to oviduct orifices. Second antenna (Fig. 28H) with rami equally well developed. Mandible with three secondary teeth. First maxilla with lateral exopod and three terminal papillae on endopod. Second maxillae separate, tips branching repeatedly to produce holdfast (Fig. 28I). Claw of maxilliped with notch in inner margin (Fig. 28J).

Male: Similar to that of *Charopinus*.

[Syn.: *Charopinus cameroni* Heller, 1949.]

Kabata and Gusev (1966) recognized two subspecies of this species, both present in Canadian waters and distinguishable from each other as follows:

Key to subspecies of *Dendrapta cameroni*

Uropods clavate, about half length of trunk (Fig. 28G) .....
..... *Dendrapta cameroni cameroni* (Heller, 1949)
Total length 7 mm, uropod length 3.5 mm.
Marine. Body surface of *Raja radiata*. (Atl). Additional record: *Raja radiata*. (Atl) (Khan et al. 1980).

Uropods clavate, much longer than trunk (Fig. 28K) .....
..... *Dendrapta cameroni longiclavata* Kabata and Gusev, 1966
Total length 7 mm, uropod length 13 mm.
Marine. Body surface of *Raja inornata*. (Pac).

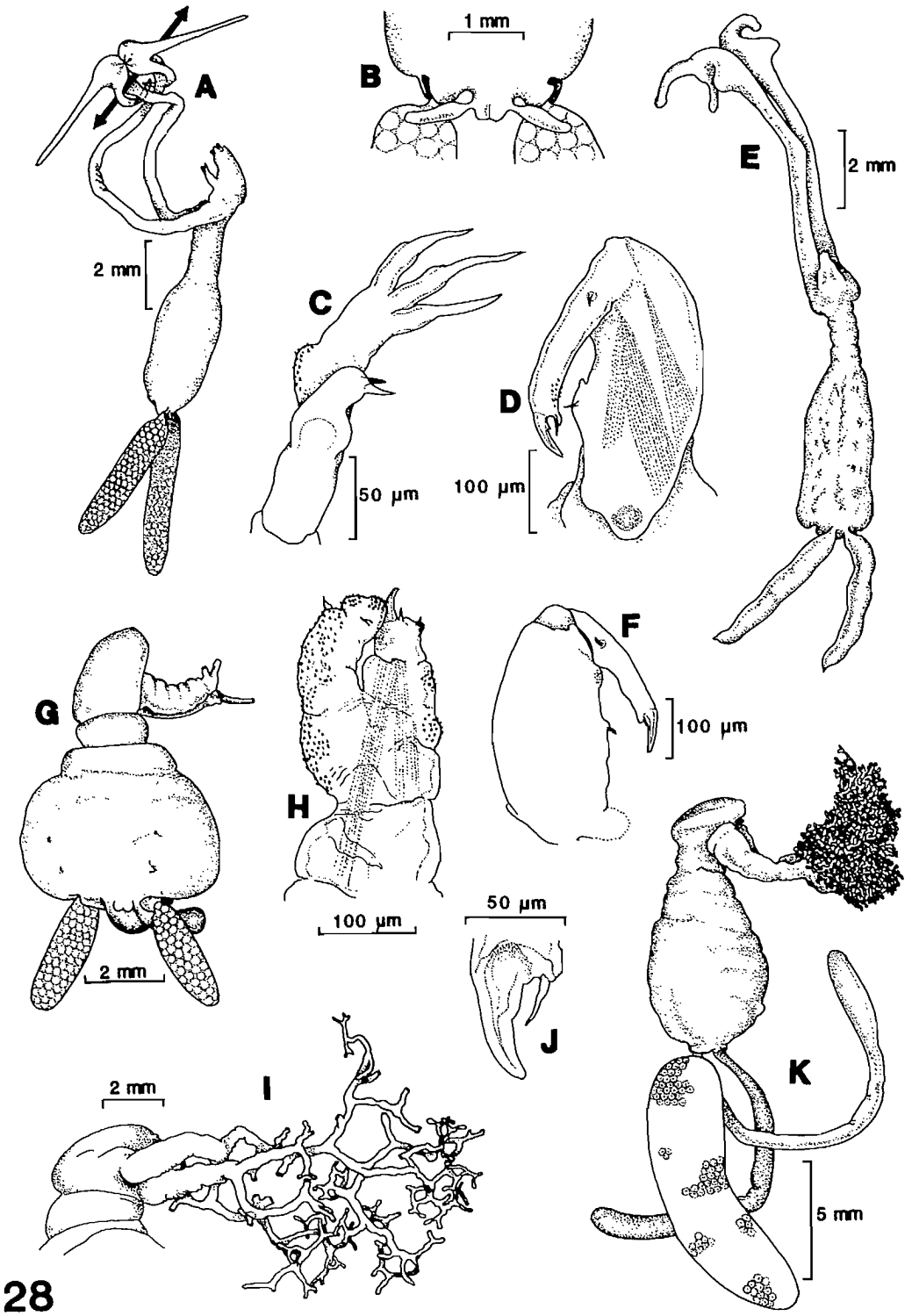

FIG. 28. A. *Schistobrachia ramosa*, female, lateral; B. Same, posterior extremity, dorsal; C. First maxilla; D. Maxilliped; E. *Schistobrachia tertia*, female, dorsal; F. Same, maxilliped; G. *Dendrapta cameroni cameroni*, female, dorsal; H. Second antenna; I. Second maxillae; J. Claw of maxilliped; K. *Dendrapta cameroni longiclavata*, female, lateral. (A–D redrawn from Kabata 1979; E,F redrawn from Kabata 1970a; C,H,J redrawn from Kabata 1964b; I redrawn from Kabata 1970b; K redrawn from Kabata and Gusev 1966).

Neobrachiella Kabata, 1979

This very successful genus contains the largest number of species among Lernaeopodidae. More than 50 have been described and new ones are being added every year. The females of the genus exhibit considerable morphological diversity, but its males are quite uniform, all closely resembling that shown in Fig. 30F.

Neobrachiella is widely distributed in all the oceans and seas of the world, all its species parasitizing teleost fishes. The generic diagnosis is as follows:

Female: Cephalothorax cylindrical, long. Trunk of varying shape, with or without dorsal, lateral, and ventral outgrowths. One to several pairs of posterior processes present, ventral to oviduct orifices (with few exceptions, e.g., *N. robusta*, in which they are dorsal); genital processes present or absent. Second antenna with endopod much smaller than exopod. First maxilla with ventral or ventrolateral exopod and two terminal papillae on endopod; third, reduced papilla sometimes present. Second maxillae short or long, fused or separate; bulla present.

Male (Fig. 30F): Cephalothorax slightly shorter than trunk, with constriction separating two tagmata. Posterior extremity of trunk with uropods but without external genitalia. Legs absent.

Three species have been recorded in Canada.

Key to species of *Neobrachiella*

1 Tips of second maxillae with five digitiform lobes (Fig. 29C) ..... *N. insidiosa f. pacifica* (Kabata, 1979)

Cephalothorax subcylindrical, shorter than trunk (Fig. 29A). Latter elongate, dorsoventrally flattened, with digitiform uropods and small posterior processes (rudimentary or absent in very young adults). First maxilla with large spiniform seta at base of dorsal terminal papilla of endopod (Fig. 29B). Myxal area of maxilliped denticulated (Fig. 29D), in addition to small papilla surmounted by spiniform seta; claw (Fig. 29E) with three secondary denticles. Total length 6 mm.

Marine. Gills of *Merluccius productus*. (Pac). Additional record: *Merluccius productus*. (Pac) (Sankurathri et al. 1983). [Syn.: *Brachiella lageniformis* Szidat, 1955; of Kabata (1970c).]

Tips of second maxillae without lobes or subdivisions 2

2 Second maxillae separate, longer than half length of cephalothorax (Fig. 29F) ..... *N. rostrata* (Krøyer, 1837)

Cephalothorax subcylindrical, usually not deflected posteriorly along dorsal surface of trunk. Latter with small, conical genital process; posterior processes absent (Fig. 29F). First maxilla with small setiferous papilla at base of dorsal terminal papilla of endopod (Fig. 29G). Myxal area of maxilliped (Fig. 29I) with proximal denticulated swelling and distal spiniferous papilla; claw with three secondary denticles (Fig. 29J). Total length up to 15 mm.

Marine. Gills of *Hippoglossus hippoglossus*. (Atl). Additional records: *Reinhardtius hippoglossoides*. (Atl) (Reimer 1981; Rokicki 1982). [Syn.: *Parabrachiella rostrata* (Krøyer, 1837).]

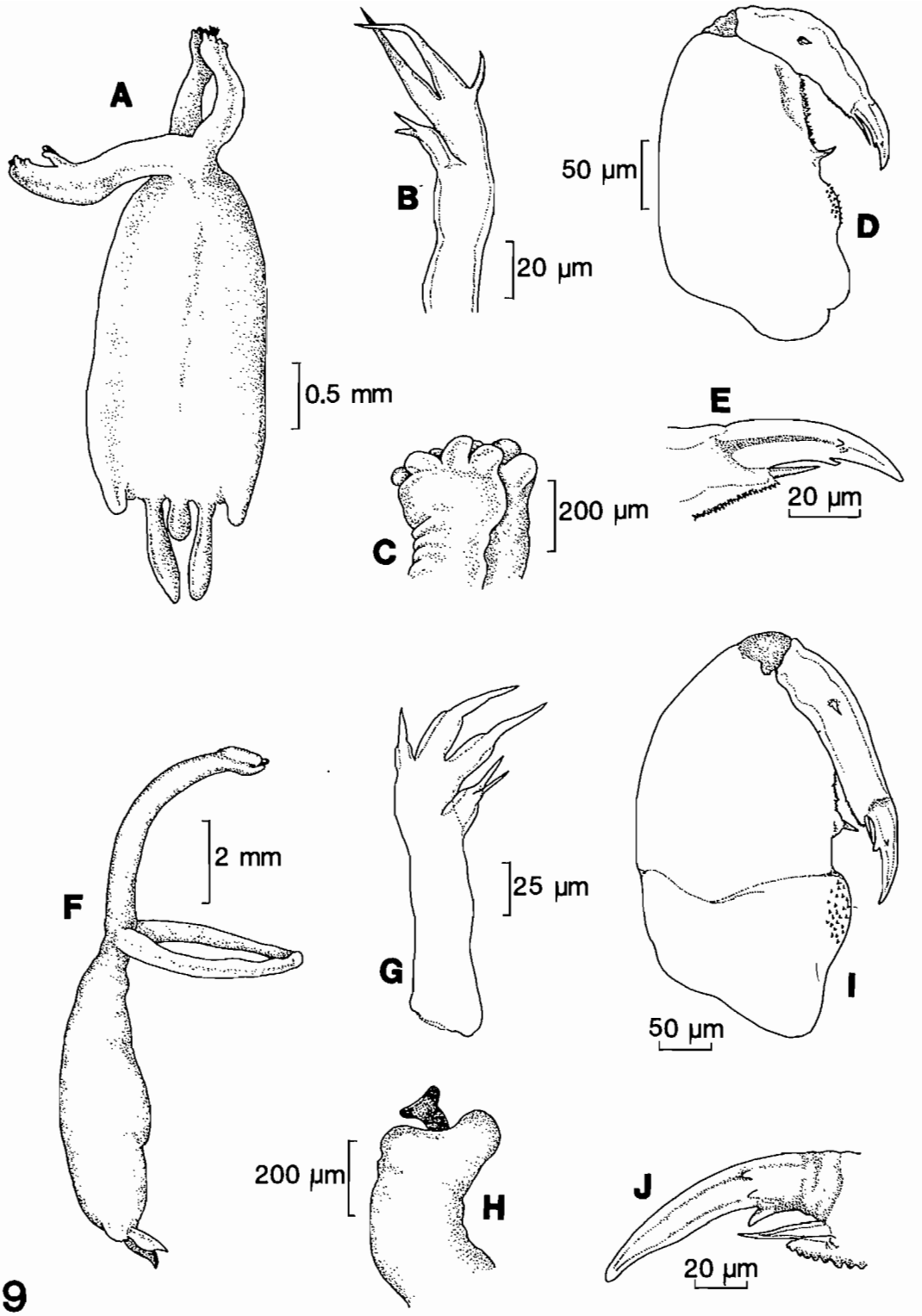

FIG. 29. A. *Neobrachiella insidiosa f. pacifica*, female, dorsal; B. Same, first maxilla; C. Tips of second maxillae; D. Maxilliped, entire; E. Claw of maxilliped; F. *Neobrachiella rostrata*, female, lateral; G. Same, first maxilla; H. Tips of second maxillae; I. Maxilliped, entire; J. Claw of maxilliped. (A original; B–E redrawn from Kabata 1970c; F,G,I,J redrawn from Kabata 1979; H modified from Kabata 1979).

Second maxillae shorter than quarter length of cephalothorax (Fig. 30A) .....
..... *N. robusta* (Wilson, 1912)

Cephalothorax subcylindrical, anteriorly expanded, often longer than trunk, with marked transverse welt on dorsal side some distance from base (Fig. 30A). Trunk of varying shape, usually of about equal length and width; uropods digitiform, posterior processes absent or two pairs present, of different lengths. Genital process present, from tuberculate to digitiform. First maxilla with spiniform seta at base of dorsal terminal papilla of endopod (Fig. 30B). Myxal area of maxilliped (Fig. 30C) as in preceding species; claw with two secondary denticles (Fig. 30D). Total length 5–6 mm.

Marine. Gills and gill rakers of *Sebastes aleutianus*, *S. alutus*, *S. auriculatus*, *S. aurora*, *S. babcocki*, *S. borealis*, *S. brevispinis*, *S. caurinus*, *S. crameri*, *S. diploproa*, *S. entomelas*, *S. flavidus*, *S. maliger*, *S. melanops*, *S. pinniger*, *S. proriger*, *S. reedi*, *S. ruberrimus*, *S. rubrivinctus*, and *S. zacentrus*. (Pac). Additional record: *Sebastes alutus*, *S. babcocki*, *S. maliger*, and *S. pinniger*. (Pac) (Z. Kabata, unpublished). [Syns.: *Clavella robusta* Wilson, 1912; *Clavellopsis robusta* (Wilson, 1912); *Brachiella robusta* (Wilson, 1912).]

In Canadian waters this species exists in two morphological forms: *f. robusta* and *f. longidigita*. The former is either devoid of posterior processes or has two pairs of very small ones (Fig. 30E); the latter has two pairs of long posterior processes (Fig. 30A), its uropods and genital process are also long.

Clavellisa Wilson, 1915

This genus comprises currently 13 nominal species, but some of them have been poorly described and are of doubtful validity. All but two of these species parasitize clupeiform fishes. Six species were described from India, five from the Atlantic Ocean, and two from the western North Pacific. Only one species was found in Canada and its description can serve as the generic diagnosis.

Clavellisa cordata Wilson, 1915

Female (Fig. 30G): Cephalothorax cylindrical, much longer than trunk, base near centre of dorsal surface of trunk, apex tapering. Trunk cordiform, dorsoventrally flattened, widening posteriorly and with deeply re-entrant posterior margin. Second maxillae less than half length of trunk, apposed distally, without apical expansions. Cephalothorax length 3.5 mm, trunk length 2 mm.

Male (Fig. 30H): Cephalothorax longer than trunk, its entire ventral surface occupied by appendages. Trunk reduced, rounded, with ventral papilliform outgrowth. Total length 0.2 mm.

Marine and brackish water. Gills of *Alosa aestivalis*, *A. pseudoharengus*, and *A. sapidissima*. (Atl) (Rubec and Hogans, in press).

Clavella Oken, 1816

The number of species constituting this genus cannot be accurately determined at present, because several of them have been poorly described and their status is uncertain. It can be estimated at between 20 and 25. The members of the genus are characterized by a unique type of second antenna, the longitudinal axis of which runs through the sympod and endopod, with the exopod displaced to one side, often reduced, sometimes absent. They all have long, subcylindrical cephalothoraces and tend to have short second maxillae, often partially fused together. The males of *Clavella* (Fig. 31J) are abbreviated in a jack-knife fashion, so that the original posterior extremity is brought forward, to a position close behind the maxillipeds, on the ventral side of the body.

The members of the genus are all parasitic on the gills, in the branchial and buccal cavities, or on external surfaces (preferably fins) of advanced teleosts. The generic diagnosis is as follows:

Female: Cephalothorax cylindrical, of different lengths, usually deflected posteriorly along dorsal surface of trunk. Latter dorsoventrally flattened, of various shapes, with or without genital process, without prominent uropods and without posterior processes. Second antenna with large endopod and reduced or absent exopod. First maxilla with ventral exopod and two terminal papillae on endopod. Second maxillae short, separate or partly fused.

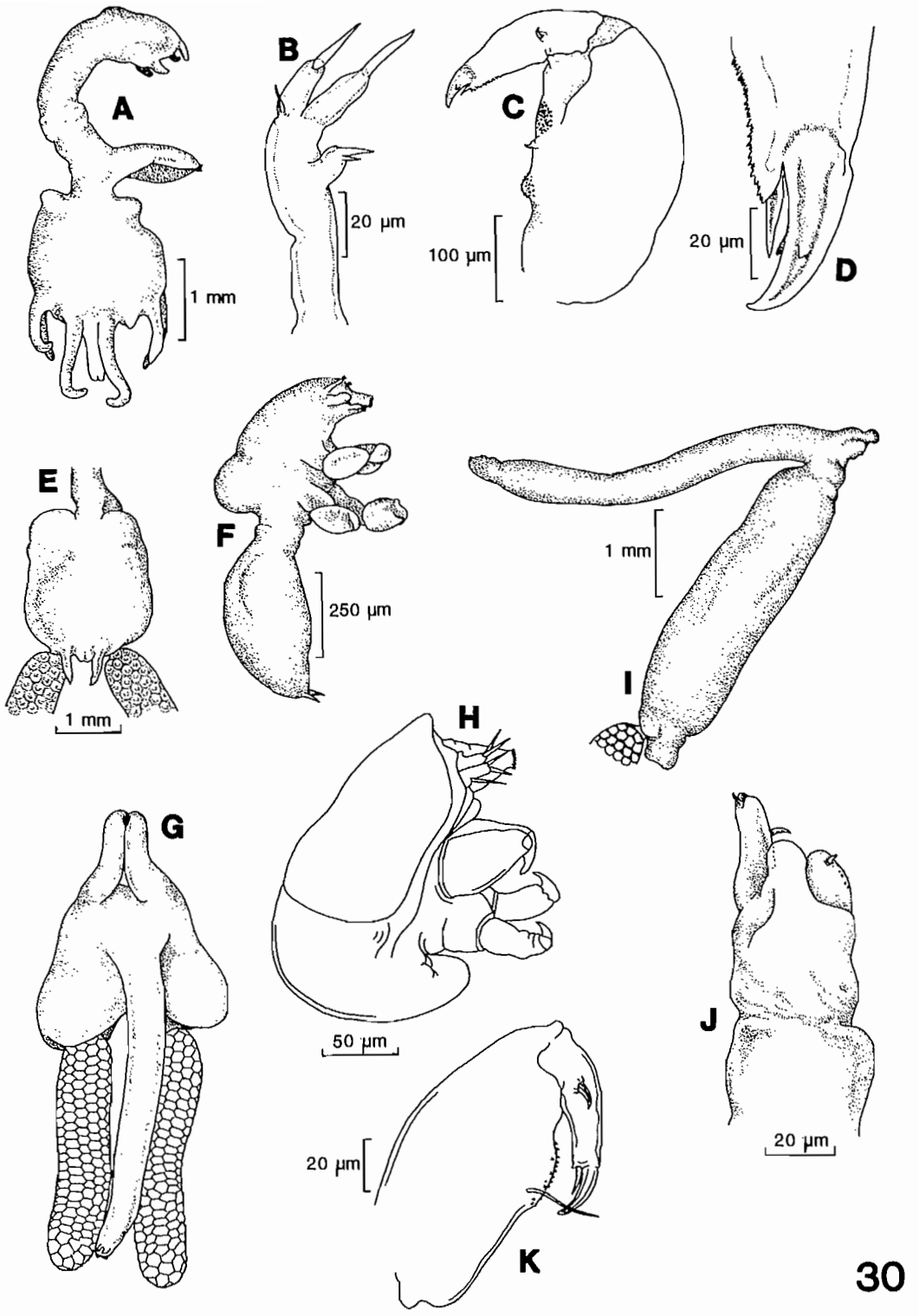

FIG. 30. A. *Neobrachiella robusta f. longidigita*, female, dorsal; B. Same, first maxilla; C. Maxilliped, entire; D. Claw of maxilliped; E. *Neobrachiella robusta f. robusta*, trunk, dorsal; F. Male, lateral; G. *Clavellisa cordata*, female, dorsal; H. Male, lateral; I. *Clavella pinguis*, female, lateral; J. Same, second antenna; K. Maxilliped. (A–F redrawn from Kabata 1979; G redrawn from Ho 1977; H redrawn from Wilson 1915; I–K redrawn from Kabata 1969b).

Male: Ephemeral dwarf, with oval, unsegmented body and appendages (other than second maxillae) similar to those of female.

The Canadian fauna of parasitic Copepoda contains at present six nominal species of *Clavella*.

Key to species of *Clavella*

1 Genital process absent (Fig. 31A) 2

Genital process present (Fig. 31E) 3

2 Trunk length 4 mm, trunk length:width ratio 2.5 ..... *C. pinguis* Wilson, 1915*
Cephalothorax as long as, or longer than, trunk, both long, subcylindrical (Fig. 30I). Second antenna with prominent endopod and small exopod (Fig. 30J). Myxal area of maxilliped with denticulated patch and long, slender seta (Fig. 30K). Cephalothorax length 4–5 mm, trunk length 4 mm.
Marine. Fins of *Lycodes atlanticus* and *L. terranovae*. (Atl).

Trunk length not more than 2 mm, trunk length:width ratio 1.5 ..... *C. stichaei* (Krφyer, 1863)*
Cephalothorax subcylindrical, about as long as trunk (Fig. 31A). Latter elongated oval, with slightly protruding perianal area; genital process absent. Endopod of second antenna with bifid apex and slender seta. First maxilla with sparse dorsal spinulation. Second maxillae short, fused; bulla small, subsphaerical. Myxal area of maxilliped with patch of denticles and long, slender seta. Cephalothorax length 2 mm, trunk length 2 mm.
Marine. Fins of *Lycodes vahlii*. (Atl). Additional record: *Lycodes polaris*. (Arc) (L. Bernier, unpublished).

3 Genital process small, not protruding, or only slightly protruding beyond anal orifice .....
..... *C. parva* Wilson, 1912
Cephalothorax longer than trunk. Latter subquadrangular, slightly longer than wide (Fig. 31B). Exopod of second antenna vestigial (Fig. 31C). Spiniform seta on myxal area of maxilliped (Fig. 31D). Cephalothorax length 1.5 mm, trunk length 1 mm.
Marine. Fins of *Artedius harringtoni*, *Chitonotus pugetensis*, *Embiotoca lateralis*, *Phanerodon furcatus*, *Rhacochilus vacca*, *Sebastes alutus*, *S. auriculatus*, *S. babcocki*, *S. caurinus*, *S. diploproa*, *S. elongatus*, *S. flavidus*, *S. maliger*, and *S. pinniger*. (Pac). Additional record: *Rhacophilus vacca*. (Pac) (Z. Kabata, unpublished).

Genital process usually prominent, projecting well beyond anal orifice 4

4 Dorsal shield of cephalothorax broader anteriorly (Fig. 31F) ..... *C. adunca* (Strφm, 1762)
Cephalothorax as long as, or longer than, trunk. Latter of varying proportions, dorsoventrally depressed (Fig. 31E). Exopod of second antenna absent (Fig. 31G). First maxilla with denticulation on dorsal margin (Fig. 31H). Myxal area of maxilliped with patch of denticles and short spiniform seta (Fig. 31I).
Marine. Gills, branchial cavity, fins, anal region of *Gadus macrocephalus*, *G. morhua*, *Melanogrammus aeglefinus*, *Microgadus proximus*, and *Pollachius virens*. (Atl) (Pac). Additional records: *Gadus morhua*. (Atl) (Redkozubova 1976); *Pollachius virens* and *Melanogrammus aeglefinus*. (Atl) (Khan et al. 1980); *Coryphenoides rupestris* and *Macrourus berglax*. (Atl) (Zubchenko 1981); *Melanogrammus aeglefinus*. (Atl) (Scott 1981); *Gadus morhua*. (Atl) (Appy and Burt 1982); *Lycenchelys paxillus*. (Atl) (Hogans, unpublished); *Gadus macrocephalus* and *Hexagrammos* sp. (Pac) (Z. Kabata, unpublished).

Dorsal shield of cephalothorax narrower anteriorly (Fig. 32B) 5

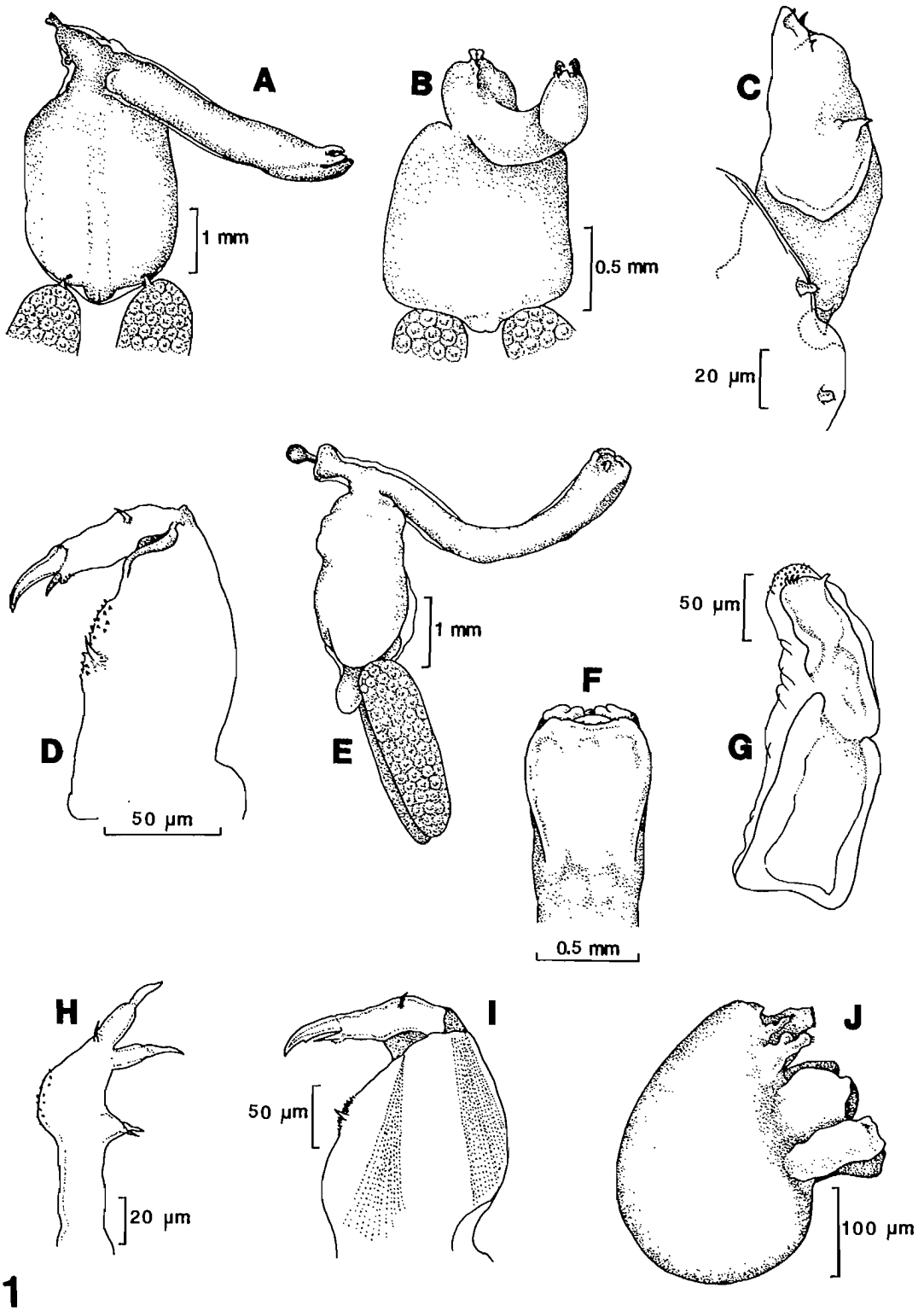

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FIG. 31. A. *Clavella stichaei*, female, dorsal; B. *Clavella parva*, female, dorsal; C. Same, second antenna; D. Maxilliped; E. *Clavella adunca*, female, lateral; F. Same, dorsal shield; G. Second antenna; H. First maxilla; I. Maxilliped; J. Male, lateral. (A original; B–D redrawn from Kabata 1969b; E–J redrawn from Kabata 1979).

5 Trunk usually longer than wide (Fig. 32A); second antenna with small exopod (Fig. 32C) .... *C. irina* Wilson, 1915

Cephalothorax longer than trunk. First maxilla without dorsal spinulation or small spine near base of dorsal papilla of endopod (Fig. 32D). Myxal area with patch of robust spinules and short spiniform seta (Fig. 32E). Cephalothorax length 7 mm, trunk length 5–6 mm.

Marine. Gills of *Gadus macrocephalus*. (Pac) (Z. Kabata, unpublished).

Trunk usually wider than long (Fig. 32F); second antenna without exopod (Fig. 32G) .... *C. perfida* Wilson, 1915

Cephalothorax longer than trunk, with pedunculate papillae on both sides of base (Fig. 32F). First maxilla without dorsal spinulation, but with small spine present near base of dorsal papilla of endopod (Fig. 32H). Myxal spinulation weak (Fig. 32I). Cephalothorax length 5–6 mm, trunk length 3 mm.

Marine. Gills of *Merluccius productus* and *Theragra chalcogramma*. (Pac). Additional records: *Theragra chalcogramma*. (Pac) (Arthur 1984; Z. Kabata, unpublished).

*NOTE: All Canadian records of *C. stichaei* prior to Margolis and Arthur (1979) appear as *C. insolita* Wilson, 1915. Closer inspection of these two species shows them to be morphologically identical. Their host ranges also overlap, both nominal taxa being parasitic on fishes of the families Stichaeidae and Zoarcidae, though *C. stichaei* has also been observed on one occasion on a cottid host. Under the circumstances, there does not appear to be any reason for maintaining their separate identity and the author proposes to relegate *C. insolita*, a chronologically later taxon, to synonymy with *C. stichaei*.

Ho (1977) suggested that *C. insolita* is synonymous with *C. pinguis* Wilson, 1915. There exists a fairly close similarity between these species. Indeed, the most striking difference between them is their size, *C. stichaei* being much larger than *C. insolita*. Dimensions by themselves are not a reliable clue to identity. The possibility that *C. pinguis* does belong to the same species as the two above-mentioned taxa cannot be dismissed. Clearer evidence is, however, required before it is merged with them.

In addition to species of *Clavella* identified in the key, an unspecified *Clavella* sp. was recorded from *Gadus morhua*, *Melanogrammus aeglefinus*, and *Pollachius virens*. (Atl). Additional record: *Clavella* sp. and *Hexagrammos stelleri*. (Pac) (Z. Kabata, unpublished).

Clavellodes Wilson, 1915

It is now accepted that *Clavellodes* is a monotypic genus, its only species being *C. rugosus* (Krφyer, 1837). It is a typical member of the *Clavella*-branch of Lernaeopodidae, its unusual features being reduced second maxillae and the structure of the first maxilla. The male (Fig. 33E) resembles that of *Clavella* but tends to be longer in proportion to its width.

The hosts of *C. rugosus* all belong to the genus *Anarchichas*. The generic diagnosis is the same as that of the species.

Clavellodes rugosus (Krφyer, 1837)

Female (Fig. 33A): Cephalothorax subcylindrical, as long as, or longer than, trunk, usually transversely wrinkled; head set off, dorsal shield with trilobed anterior margin (Fig. 33B). Trunk subquadrangular, with anal tubercle in centre of posterior margin; no genital process or posterior processes. Second antenna with large, spinulated exopod and reduced endopod. First maxilla (Fig. 33C) with lateral exopod and reduced third papilla of endopod. Second maxillae reduced to sessile collar. Myxal area of maxilliped (Fig. 33D) with two conical outgrowths. Cephalothorax length 5 mm, trunk length up to 4 mm.

Male (Fig. 33E): Abbreviated as in *Clavella*.

Marine. Gills of *Anarchichas lupus* and *A. minor*. (Atl) (Zubchenko 1980).

Clavellomimus Kabata, 1969

This author includes four species in *Clavellomimus*, all transferred from other genera of the *Clavella*-branch. Three are relatively poorly known and, on closer examination, might undergo a revision of their status. The fourth occurs in Canadian waters. Its description can serve as the generic diagnosis.

Clavellomimus macruri (Hansen, 1923)

Female (Fig. 32J): Cephalothorax subcylindrical, usually longer than trunk, with poorly developed dorsal shield. Trunk elongate, with very small genital process, absent in some specimens. Second antenna (Fig. 32K) with

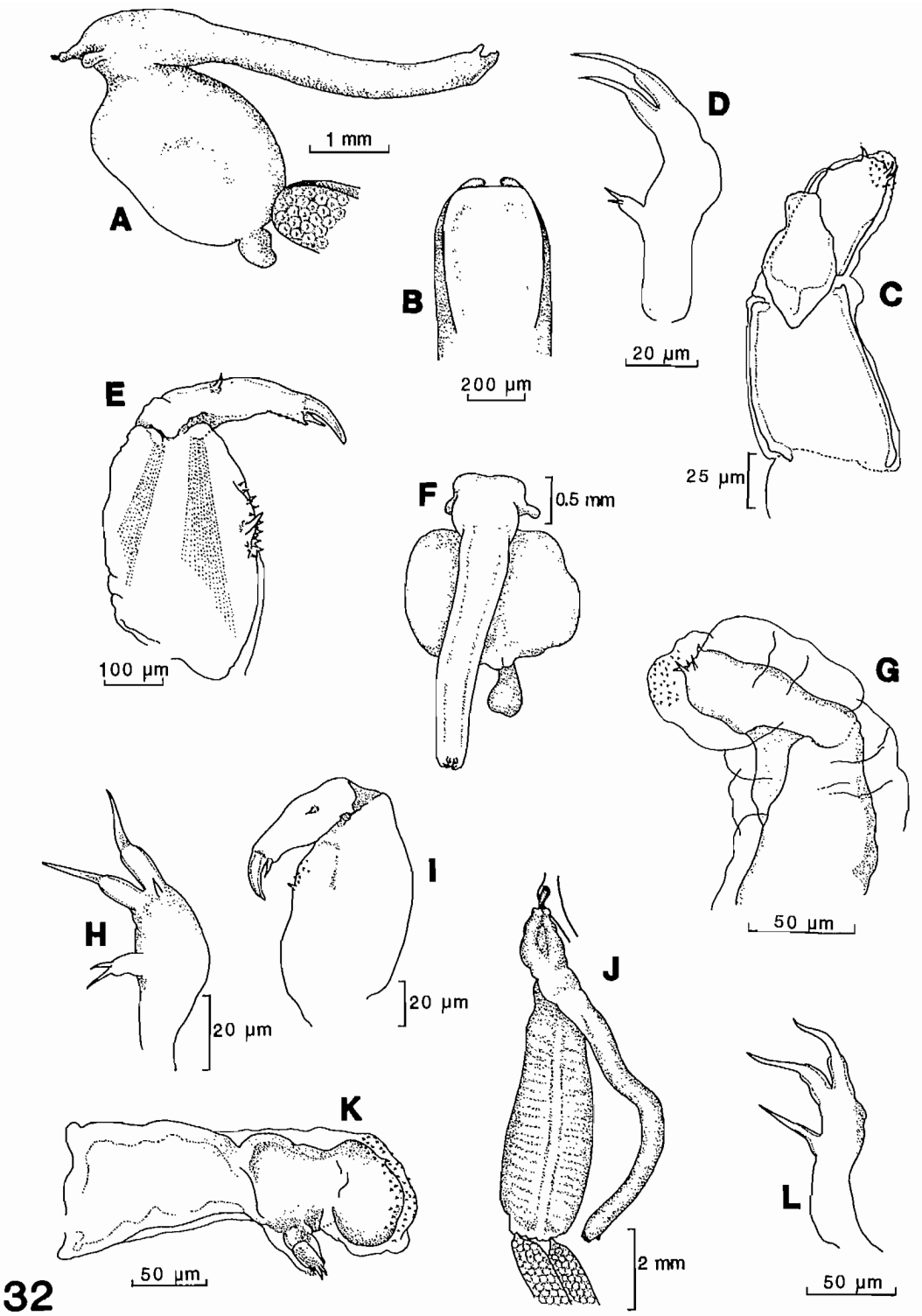

FIG. 32. A. *Clavella irina*, female, dorsolateral; B. Same, dorsal shield; C. Second antenna; D. First maxilla; E. Maxilliped; F. *Clavella perfida*, female, dorsal; G. Same, second antenna; H. First maxilla; I. Maxilliped; J. *Clavellomimus macruri*, female, dorsal; K. Same, second antenna; L. First maxilla. (A,B,D,E original; C redrawn from Kabata 1963; F–I redrawn from Kabata 1979; J–L redrawn from Kabata 1969b).

reduced endopod. First maxilla (Fig. 32L) with ventral exopod bearing single seta; endopod with two terminal papillae, spinulation absent. Second maxillae separate but in common cuticular sheath. Maxilliped apparently without myxal denticulation. Cephalothorax length 6–8 mm, trunk length 5–7 mm.

Male: Intermediate between those of *Clavella* and *Clavellodes*.

Marine. Fins of *Macrourus berglax*. (Atl). Additional record: *M. berglax*. (Atl) (Zubchenko 1981).

Nectobrachia Fraser, 1920

This genus is unique among Lernaeopodidae in the extreme reduction of its cephalothorax, present as a small tubercle on the anterior margin of the trunk. Several other morphological features separate it from all other genera of the family. Only two species of *Nectobrachia* are known at present, one of which has been recorded in Canadian waters. The generic diagnosis is the same as that of the Canadian representative of the genus.

Nectobrachia indivisa Fraser, 1920

Female (Fig. 33F): Cephalothorax greatly reduced, conical, on anterior margin of trunk. Latter subquadrangular, without posterior processes or uropods; small genital process present. Second antenna (Fig. 33G) with exopod smaller than endopod. First maxilla with two terminal papillae on endopod (Fig. 33H), exopod absent. Second maxillae fused in distal halves, often longer than trunk, with terminal inflated parts. Bulla with octoradiate anchor. Maxilliped (Fig. 33I) at apex of protuberance larger than itself. Length of trunk 1.3–2.6 mm.

Male (Fig. 33J): Oval dwarf, abbreviated in clavelline fashion but with subconical vestigial trunk present on posterior part of ventral surface.

Marine. Gills of *Lepidopsetta bilineata* and *Platichthys stellatus*. (Pac). Additional record: *L. bilineata*. (Pac) (Z. Kabata, unpublished).

In addition to all the identifiable lernaeopodid copepods, another record of a presumed lernaeopodid was published by Stock (1915) under the name of Lernaeopodae sp. [sic]. This copepod was found on *Raja laevis* (Atl).

Family NAOBRANCHIIDAE

Comprising only one genus, *Naobranchia* Hesse, 1863, this family is clearly related to Lernaeopodidae. The salient characteristics uniting these two families is their use of second maxillae as the attachment organs. The way in which the attachment is effected is, however, quite different. Whereas Lernaeopodidae attach themselves by becoming anchored in the host tissues, usually with the aid of the bulla, *Naobranchia* embraces gill filaments with its second maxillae. To act in this capacity, these appendages became transformed into flat, ribbon-like limbs that form loops around the filaments and are firmly fused by their tips, to assure a permanent grip on the host. The second unique characteristic of *Naobranchia* is its possession of brood pouches, for storage and incubation of eggs. The males resemble those of the *Clavella*-branch of Lernaeopodidae and, in particular, those of *Nectobrachia*.

Naobranchia currently numbers 21 species, all parasitic on gill filaments of teleost hosts in various parts of the world. Only one representative of the genus has been recorded in Canada.

Naobranchia Hesse, 1863

The characteristics of this genus are the same as those of its family.

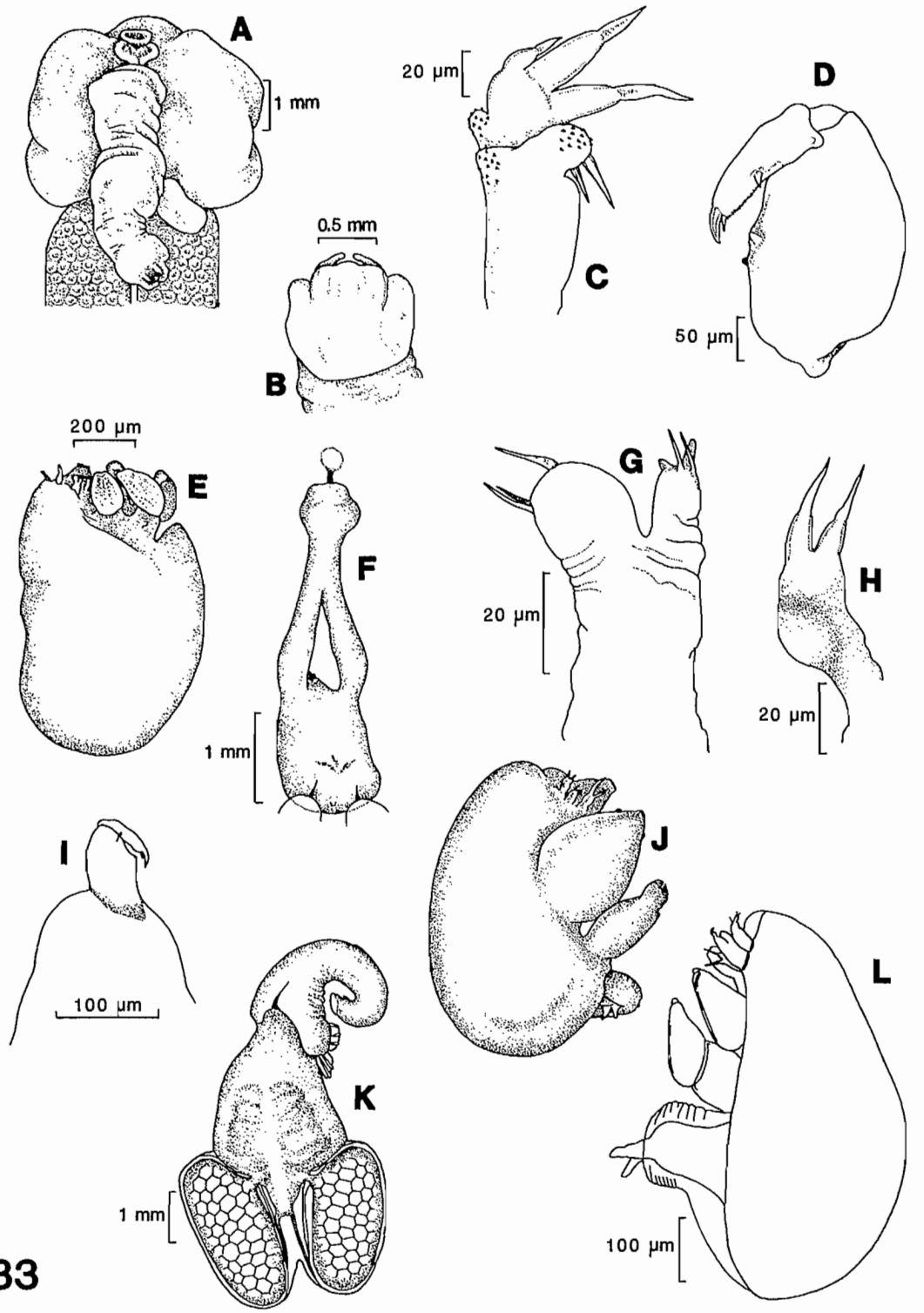

FIG. 33. A. *Clavellodes rugosus*, female, dorsal; B. Same, dorsal shield; C. First maxilla; D. Maxilliped; E. Male, lateral; F. *Nectobrachia indivisa*, female, ventral; G. Same, second antenna; H. First maxilla; I. Maxilliped; J. Male, lateral; K. *Naobranchia occidentalis*, female, dorsal; L. Male, lateral. (A–E redrawn from Kabata 1979; F–I redrawn from Kabata 1970a; J redrawn from Markevich 1946; K,L redrawn from Wilson 1915).

Naobranchia occidentalis Wilson, 1915

Female (Fig. 33K): Cephalothorax subcylindrical, about as long as trunk, usually with pronounced ventral flexion; dorsal shield small; prominent subspherical swellings on both sides of head. Trunk dorsoventrally flattened, wider posteriorly, with conical posteromedian projection and brood chambers in posterolateral corners. Appendages similar to those of Lernaeopodidae, but second maxillae flat, narrow, each with three parallel muscle strands, forming complete loops. Length of cephalothorax 4 mm, length of trunk 4 mm.

Male (Fig. 33L): Similar to those of Lernaeopodidae.

Marine. Gill filaments of *Lepidopsetta bilineata*, *Myoxocephalus polyacanthocephalus*, *Parophrys vetulus*, *Sebastes aleutianus*, *S. alutus*, *S. borealis*, *S. caurinus*, *S. diploproa*, *S. maliger*, *S. nigrocinctus*, *S. paucispinis*, *S. pinniger*, and *S. proriger*. (Pac). Additional record: *Anoplopoma fimbria*, *Citharichthys sordidus*, *Glyptocephalus zachirus*, *Hippoglossoides elassodon*, *Lepidopsetta bilineata*, *Parophrys vetulus*, *Sebastes babcocki*, *S. brevispinis*, and *S. pinniger*. (Pac) (Z. Kabata, unpublished).

Family TANYPLEURIDAE

This family was established by Kabata (1969b) to accommodate a single species, *Tanypleurus alcicornis* Steenstrup and Lütken, 1861. Because of its extreme and unique modification, this species had presented a puzzle and its familial status had undergone several changes prior to that date.

T. alcicornis resembles Lernaeopodidae in using second maxillae as the organs of attachment to the host. Here, however, resemblance ends. The cephalothorax is so greatly reduced that it escaped the notice of earlier observers. The structure of the appendages, particularly that of the second antenna, is different from those of all other siphonostomes and does not permit inclusion of this copepod in any siphonostome family.

Both familial and generic diagnosis are the same as that of the only species known.

Tanypleurus has not been found outside the western North Atlantic.

Tanypleurus Steenstrup and Lütken, 1861

Tanypleurus alcicornis Steenstrup and Lütken, 1861

Female (Figs. 34A): Cephalothorax reduced to diminutive tubercle on anterior margin of trunk. Latter much wider than long, its lateral thirds flexing wing-like ventrad; two series of papilliform processes, both simple and branching, on dorsal surface; lateral margins lobate; small genital process present. Second antenna (Fig. 34B) uniramous, with apical armature. Mandible siphonostome, without secondary teeth. First maxilla (Fig. 34C) uniramous. Second maxillae fused into short, stalk-like structure and profusely branching at apices to form holdfast. Maxillipeds absent. Length of trunk 4–5 mm, width up to 10 mm.

Male: Unknown.

Marine. Gills of *Lycodes lavalaei* and *L. reticulatus*. (Atl).

Family SPHYRIIDAE

This small group of copepods, parasitic mainly on deep-water marine teleosts, has become adapted to a sessile mode of life that involves deep penetration of the host tissues. A large part of the copepod is embedded in the host and surrounded by a connective tissue capsule. The body of a sphyriid female consists of three easily discernible parts: anterior, more or less expanded cephalothorax, posterior, flat and enlarged genital complex and an intervening neck-like, subcylindrical part of lesser or greater length. At the posterior extremity one finds

processes, sometimes referred to as respiratory cylinders in acknowledgment of their presumed function. Varying from simple to very elaborate, those cylinders provide important diagnostic clues for female Sphyriidae. Males of the family are little known. Those that have been described bear distinct resemblance to the males of Lernaeopodidae, suggesting relationship between these two families. The diagnosis of the family is as follows:

Female: Cephalothorax with holdfast of various shapes and positions. Long, subcylindrical neck, genital complex of varying shapes, dorsoventrally flattened, with two rows of sclerotized pits on flat surfaces in some genera. Posterior processes simple, subdivided or elaborately branching. Appendages greatly reduced.

Male: Resembling males of Lernaeopodidae.

Sphyriidae comprise at present seven genera, jointly numbering over 20 species. Representatives of three genera have been recorded in the Canadian fauna.

Key to genera of Sphyriidae

1 Cephalothorax with transversely expanded holdfast (Fig. 34E) ..... *Sphyrion*

Cephalothorax without transversely expanded holdfast 2

2 Neck without secondary holdfast; posterior processess profusely branching, with central stalk (Fig. 34G) ..... *Lophoura*

Neck with branching secondary holdfast; posterior processes simple, cylindrical (Fig. 35A) .... *Paeonocanthus*

Sphyrion Cuvier, 1830

Morphological variability of the embedded part of the female resulted in the description of several species of *Sphyrion* that cannot be accepted as valid and, at best, can be accorded the status of *species inquirenda*. Only two species have been accepted by the most recent reviewer (Kabata 1979). Only one of them is represented in the Canadian fauna. The diagnosis of the genus, in addition to characters mentioned in the key above, includes presence of branching posterior processes without a central stalk.

Sphyrion lumpi (Krφyer, 1845)

Female (Fig. 34D): Cephalothorax with holdfast of two long, bluntly-ending lateral lobes (Fig. 34E). Neck subcylindrical, without secondary outgrowths. Genital complex suborbicular or pyriform. Posterior processes repeatedly branching, their complexity increasing with age of female. Appendages reduced to simple papilliform or digitiform outgrowths. Total length 45-60 mm.

Male (Fig. 34F): Resembling males of *Clavella*-branch of Lernaeopodidae. Length 2 mm.

Marine. Embedded in musculature, posterior part protruding externally. Hosts: *Anarchichas denticulatus*, *A. lupus*, *Macrourus berglax*, *Sebastes marinus*, and *S. mentella*. Additional records: *Reinhardtius hippoglossoides*. (Atl) (Rokicki 1982); *Glyptocephalus cynoglossus* and *Sebastes marinus*. (Atl) (Tomasiewicz 1982); *Coryphenoides rupestris*, *Sebastes marinus*, and *Sebastes mentella*. (Atl) (Gaevskaya and Kovaleva 1984): *Sebastes mentella*. (Atl) (Bourgeois and Ni 1984); *Antimora rostrata* and *Gairdropsaurus ensis*. (Atl) (W. E. Hogans, unpublished).

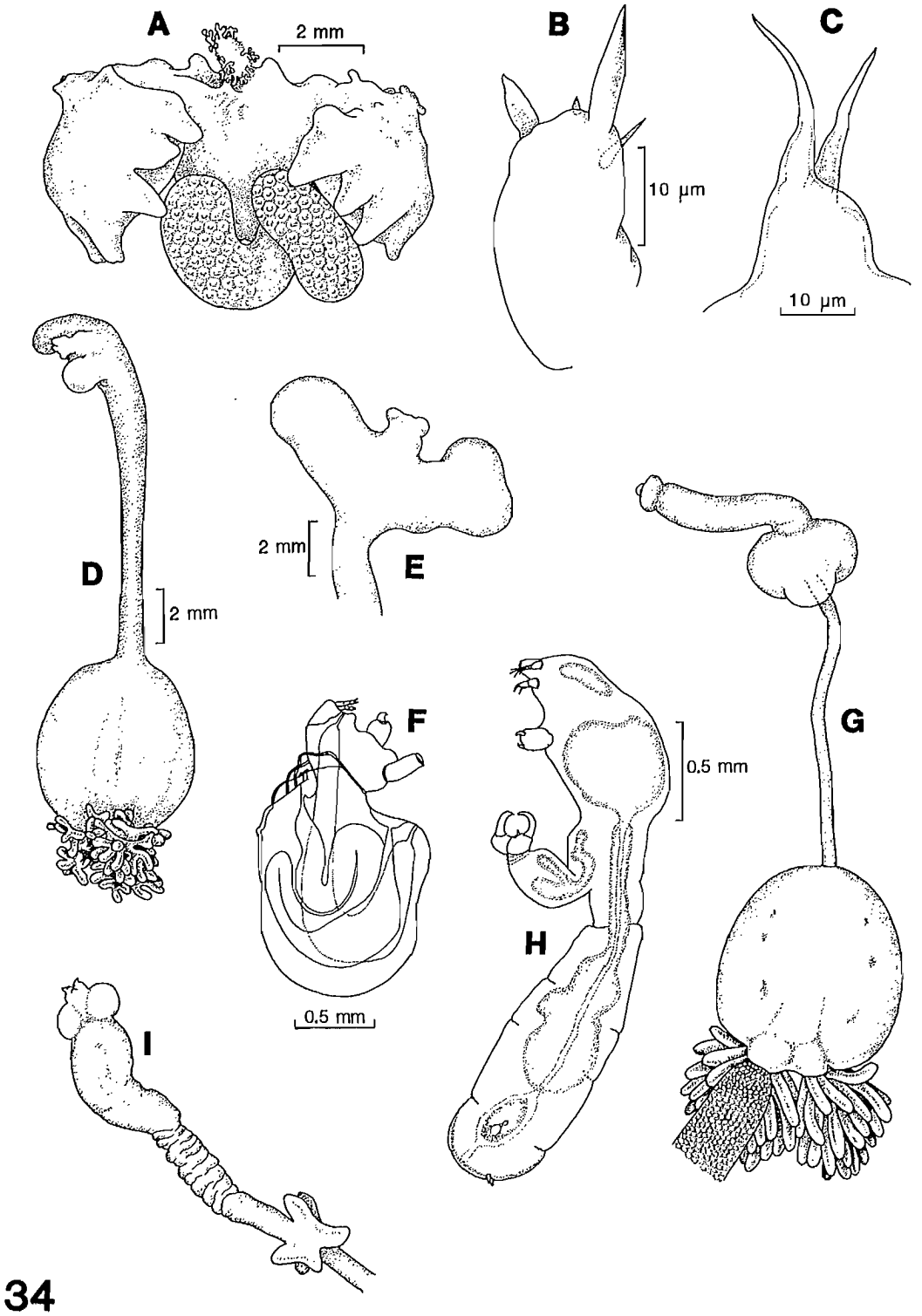

FIG. 34. *Tanypleurus alcicornis*, female, ventral; B. Same, second antenna; C. First maxilla; D. *Sphyrion lumpi*, female; E. Same, holdfast, dorsal; F. Male, lateral; G. *Lophoura bouvieri*, female; H. Male, lateral; I. *Lophoura gracilis*, anterior end. (A–C redrawn from Kabata 1969c; D–F redrawn from Kabata 1979; G modified from Ho 1977; H redrawn from Wilson 1919; I redrawn from Ho 1977).

Lophoura Kölliker, 1853

This most abundant genus of Sphyriidae comprises 12 nominal species, or about half of the total number of known sphyriids. They are mainly distinguishable from one another by the shape of their holdfasts. The systematics of the genus are somewhat confused at present; a review is needed. It is quite possible that several of the nominal species now listed in the genus will have to be relegated to synonymy. The generic diagnosis is as follows:

Female: Cephalothorax with holdfast of various shapes at its posterior end. Neck subcylindrical, long and thin. Genital complex suborbicular, ovoid or pyriform. Posterior processes with multiple clavate outgrowths of central stalk.

Male: Resembling those of non-abbreviated males of Lernaeopodidae, but with maxillipeds and second maxillae fused in pairs.

Two species of *Lophoura* are known to occur in the Canadian fauna. They can be identified with the aid of the following key:

Key to species of *Lophoura*

Holdfast consisting of up to five subspherical lobes, sometimes on narrow peduncles, but usually sessile ..... *L. bouvieri* (Quidor, 1912)

Female (Fig. 34G): Cephalothorax with anterior part set off by constriction, subcylindrical. Neck subcylindrical, thin and long. Genital complex suborbicular, with two longitudinal rows of three sclerotized pits each on flat surfaces. Length (without posterior processes) 30–35 mm.

Male (Fig. 34H): As in generic diagnosis. Length 3 mm.

Marine. Musculature of *Macrourus berglax*. (Atl) (Zubchenko 1981); *Nezumia bairdi*. (Atl) (W. E. Hogans, unpublished). [Syn.: *Rebelula bouvieri* Quidor, 1912.]

Holdfast consisting of several digitiform, partially fused outgrowths ..... *L. gracilis* (Wilson, 1919)

Female: Cephalothorax (Fig. 34I) with anterior part set off by constriction, gradually narrowing posteriorly, smooth or partially transversely wrinkled. Otherwise similar to *L. bouvieri*.

Male: Unknown.

Marine: Musculature of *Synaptobranchus kaupi*. (Atl) (Hogans and Dadswell 1985b).

Paeonocanthus Kabata, 1965

This monotypic genus has been known from only a few records, all from a deep-sea teleost, *Bathylagus antarcticensis*, all taken from the southern hemisphere. The only representative of this genus, *P. antarcticensis*, was originally described (Hewitt 1965) as a member of *Periplexis*. The difference in the structure of the posterior processes (cylindrical versus lobate) prompted Kabata (1965) to place it in a separate genus. Aleshkina (1978) suggested that the posterior processes of *Periplexis* might range in structure from multilobate to cylindrical, claiming that she had found transitional forms. If that were true, the reason for the existence of *Paeonocanthus* would have to be questioned. Aleshkina's evidence indicates that the number of lobes on the posterior processes of *Periplexis* is, indeed, variable. It does not, however, prove that *Periplexis* can have cylindrical, undivided processes. Pending more information, I prefer to retain *Paeonocanthus* as distinct from *Periplexis*.

The diagnosis of the genus is the same as that of its only species.

Paeonocanthus antarcticensis has been found recently in Canadian waters.

Paeonocanthus antarcticensis (Hewitt, 1965)

Female (Fig. 35A): Cephalothorax small, compact, with diffuse, branching holdfast. Very long neck, posteriorly expanding into trunk. Latter oblong, wider posteriorly, with two dorsolateral, longitudinal rows of depressions

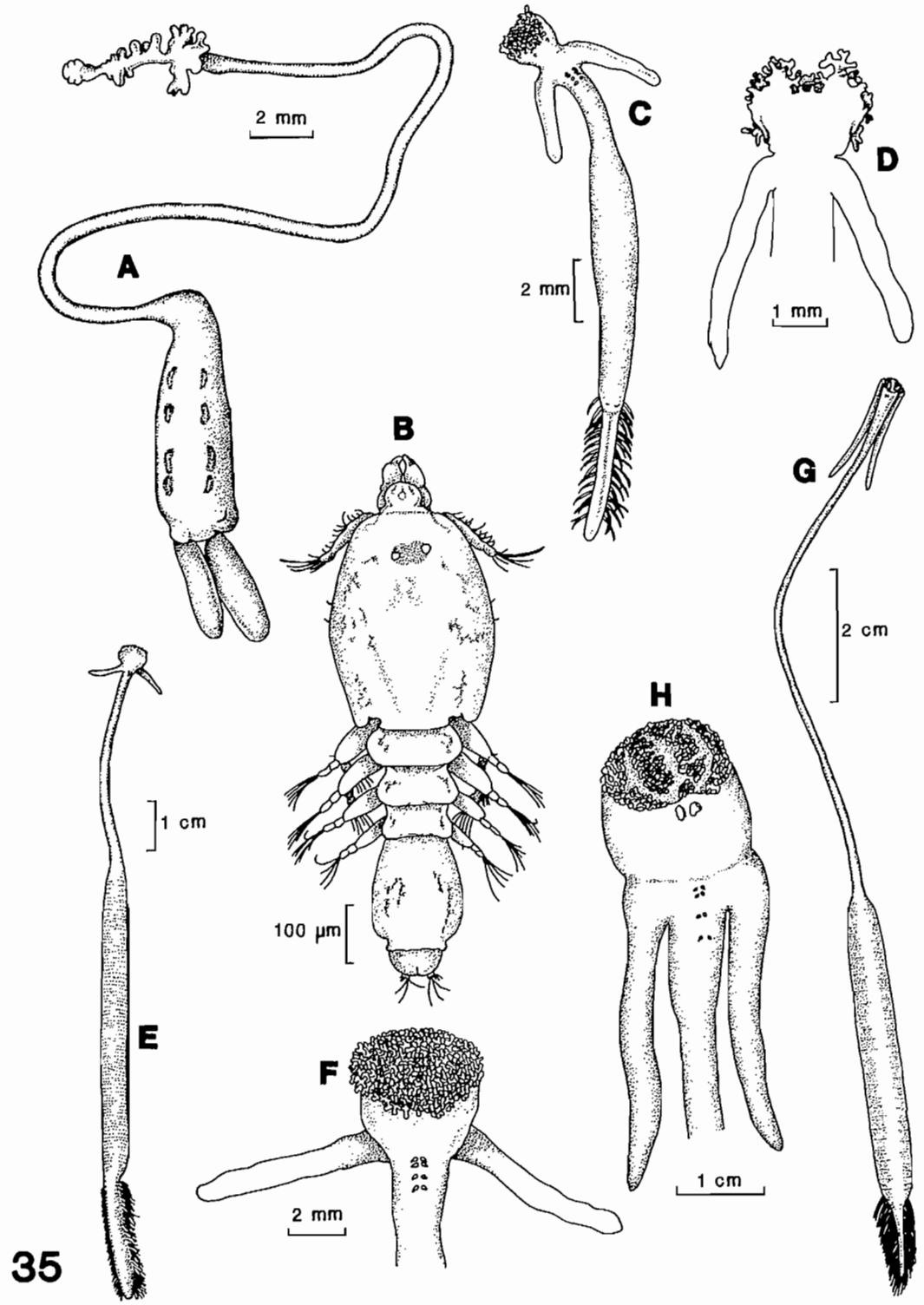

FIG. 35. A. *Paeonocanthus antarcticensis*, female; B. Pennellid male (*Haemobaphes*), dorsal; C. *Pennella sagitta*, female, ventral; D. Same, cephalothorax, dorsal; E. *Pennella filosa*, female, ventral; F. Same, cephalothorax, ventral; G. *Pennella instructa*, female, dorsal; H. Same, cephalothorax, ventral. (A redrawn from Hogans 1986b; B redrawn from Kabata 1967a; C–F redrawn from Kabata 1979; G,H redrawn from Hogans 1986a).

on dorsal surface and small lateral lobes on posterior margin. Posterior processes cylindrical, dorsal to egg sacs. Total length 35–50 mm.

Male: Unknown.

Marine. Musculature of *Bathylagus euryops*. (Atl) (Hogans 1986b).

Family PENNELLIDAE

Their large size and their mesoparasitic way of life (Kabata 1979) have attracted a disproportionately large share of attention to Pennellidae. Penetrating deeply the tissues of their hosts, they have long been perceived as extremely harmful to them. The most recent account and discussion of their effects on the fish has been published by Kabata (1984a).

The extensive metamorphosis, which female Pennellidae undergo in the course of their ontogeny, modified them to the point where it is difficult to recognize them as belonging to Copepoda. The difficulties of a systematist are further compounded by the great morphological plasticity of the females, whose definitive body shape is greatly influenced by the identity of the host and the parasite's location on it. Pennellidae display a strong tendency to development of outgrowths, mainly at the anterior end of the body, where they form more or less elaborate holdfasts (the main organs of attachment), but also near the posterior extremity. In the latter location they form what has been termed "abdominal brush." Individual variability of all these structures also adds to the difficulties in specific identification.

Pennellidae are also unique among Siphonostomatoida in having life cycles involving intermediate hosts, either invertebrate or fish. The males are found mainly in association with young females during the process of impregnation, or free-swimming in plankton.

The biological success of Pennellidae is attested by their abundance. These parasites of teleost fishes number about 140 species, grouped in 18 genera (two *genera inquirenda* have also been proposed), distributed throughout the oceans of the world.

This account will deal only with the metamorphosed female, which is the usually encountered stage. The family diagnosis will also include the male, though males will be omitted from the descriptions of individual genera and species. They are sufficiently similar throughout the family to be recognized as pennellid males on those rare occasions when encountered. They are also similar to pre-metamorphosis females, which differ from them in the relatively longer genital complex fused with the abdomen.

Female (post-metamorphosis): Cephalothorax oval or subspherical, in line with or perpendicular to, trunk, with or without dendritic cephalic processes, with or without dendritic or lobiform posterolateral and/or posterodorsal processes. Trunk of several types: (a) subcylindrical, with or without narrower anterior part, with or without secondary outgrowths on that part, with or without midlength constriction; (b) plano-convex, with inclined narrow anterior part; (c) straight, narrower posteriorly, its thin anterior part subterminal; (d) irregularly sigmoid. Abdomen unsegmented, subcylindrical or subconical, with or without brush. Appendages siphonostomatoid, maxillipeds absent.

Male (Fig. 35B): Cephalothorax longer than wide, with rounded anterior and truncated posterior margin. Three free thoracic segments, followed by oval or subquadrangular genital complex. Abdomen one-segmented, small. Appendages as in female, maxillipeds present, subchelate.

Up to now 11 species of Pennellidae have been recorded in Canada, representing six genera, identifiable with the aid of the key below.

Key to genera of Pennellidae

1 Trunk straight, subcylindrical (Fig. 35C) 2

Trunk with sigmoid flexion (Fig. 37A) 5

2 Trunk with abdominal brush (Fig. 35C) ..... *Pennella*

Trunk without abdominal brush 3

3 Large dendritic holdfast present (Fig. 36B) ..... *Phrixocephalus*

Holdfast not dendritic 4

4 Holdfast of one pair of lateral lobes (Fig. 36D) ..... *Sarcotretes*

Cephalothorax compact, without holdfast (two pairs of digitiform process in *P. asinus*) (Fig. 36H) ..... *Peniculus*

5 Holdfast of one dorsal and two lateral antlers, all repeatedly branching; egg sacs irregularly looped round central stalk (Fig. 37A) ..... *Lernaeocera*

Holdfast of one or several pairs of lobes; egg sacs spirally coiled (Fig. 37C) ..... *Haemobaphes*

Pennella Oken, 1816

Taking into account all nominal species of *Pennella*, one can see this genus as the most abundant in the family. About 30 species have been described. The difficulties in finding reliable morphological criteria for determining specific identity have resulted, however, in creating confusion and uncertainty, so that the validity of many species must be questioned. A thorough revision of the genus is long overdue.

The copepods of this genus live on teleost fishes, one or more parasitizing cetaceans. The depth to which they penetrate their hosts varies from species to species, although it is also subject to individual variations. Some perforate the body wall and anchor in the internal organs. The generic diagnosis is as follows:

Female (post-metamorphosis): Cephalothorax subspherical, with holdfast consisting of two or three unbranched processes; well developed cephalic processes present on the anterior margin. Trunk subcylindrical, straight, usually slender. Abdomen also subcylindrical, in line with trunk, provided with lateral rows of fine processes forming abdominal brush. Four pairs of legs, close together behind cephalothorax.

Three species of *Pennella* have been found in Canadian waters. They can be identified with the aid of the key below.

Key to species of *Pennella*

1 Cephalothorax forming cup with more or less marked dorsolateral lobes around profuse cephalic processes (Fig. 35D) ..... *P. sagitta* (L.)

Holdfast of two lateral branches of various lengths, extending posterolaterally from cephalothorax (Fig. 35C). Neck relatively short and thick, sometimes difficult to separate from trunk. Abdominal brush of two rows of processes, simple or branching into two. Total length 200 mm.

Marine. Musculature of *Histrio histrio*. (Atl) (W. E. Hogans, unpublished).

Cephalothorax not as above 2

2 Holdfast of two lateral branches, running parallel to long axis of trunk; cephalic processes in four dorsoventral bands (Fig. 35H) ..... *P. instructa* Wilson, 1917

Trunk long, slightly thicker in its posterior, transversely striated third (Fig. 35G). Abdominal brush similar to that of *P. filosa*. Total length 225 mm.

Marine. Musculature and internal organs or blood vessels of *Xiphias gladius*. (Atl) (Hogans et al. 1985; Hogans 1986a).

Holdfast not as above, cephalic processes in one undivided patch (Fig. 35F) ..... *P. filosa* (L.)

Holdfast of two lateral branches extending posterolaterally from cephalothorax; third, dorsal branch present or absent. Trunk long, gradually expanding in girth posteriorly, with fine transverse striation for most of its length. Abdominal brush of two rows of repeatedly branching processes (Fig. 35E). Total length 200 mm.

Marine. Musculature of *Mola mola* (Pac) and *Xiphias gladius* (Atl). Additional records: *Xiphias gladius*. (Atl) (Hogans et al. 1985); *Mola mola*. (Atl) (Hogans 1987). [Syn.: *P. orthagorisci* Wright, 1870.]

Phrixocephalus Wilson, 1908

The salient feature of the members of this genus is its powerfully developed holdfast, spreading perpendicularly from the body of the copepod in luxuriant profusion of intricately branching dendrites. The volume of host tissue permeated by them is comparatively large and the damage inflicted correspondingly extensive.

Thirteen species of *Phrixocephalus* have been described, 11 of them from the seas around Japan. This interesting distribution appears to suggest that the centre of the origin of this genus is situated near Japan. It is entirely possible, however, that the number of species is smaller than that recorded to the present time. More than one species have been described from the same host. Given the morphological plasticity of Pennellidae, some of the descriptions might apply to more than one phenotype of the same species. The generic diagnosis is as follows:

Female: Cephalothorax with dendritically branching, luxuriant holdfast; neck with one or more secondary holdfasts. Trunk subcylindrical or saccular, abdomen vestigial. Appendages pennellid, four pairs of legs present. Egg-sacs spirally coiled.

Male: Typical for the family (Fig. 35B).

Only one species has been found in Canadian waters.

Phrixocephalus cincinnatus Wilson, 1908

Female (post-metamorphosis) (Fig. 36A): Cephalothorax subspherical, imperceptibly narrowing into cylindrical neck, anterior surface bearing papilliform cephalic processes, holdfast of varying number of branches, all branching into complex system of dendrites (Fig. 36B). Neck gradually tapering posteriorly, with two sets of secondary holdfasts (Fig. 36A). Trunk abruptly expanding, subcylindrical, somewhat narrower anteriorly, with posteriorly protruding perianal area. Length 30 mm.

Marine. Eye of *Atheresthes stomias* and *Citharichthys* sp. (Pac). Additional records: *Atheresthes stomias*. (Pac) (Ronald 1959); *Hippoglossus stenolepis*. (Pac) (Z. Kabata, unpublished).

Sarcotretes Jungersen, 1911

This small pennellid genus consists currently of six species, all parasitic on small, deep-sea teleosts. It can be diagnosed by its simple holdfast, consisting of a single pair of lateral lobes. Another typical characteristic is the position of the narrowest part of the body near its midlength. The egg sacs are straight and uniseriate.

The parasites of this genus attach themselves to the host by burrowing in the musculature, usually near the top of the dorsum but sometimes also close to the mid-ventral line, especially near the anus. They are capable of reaching, and anchoring to, internal organs of the host.

Only one species has been found in Canadian waters.

Sarcotretes scopeli Jungersen, 1911

Female (post-metamorphosis)(Fig. 36C): Cephalothorax with holdfast consisting of single pair of oval lobes, sometimes with nipple-like posterior tips. Oral region at apex of subcylindrical, proboscis-like outgrowth (Fig. 6D). Thoracic neck area behind cephalothorax retaining three terga of original segments; neck narrowing posteriorly, then expanding, either abruptly or imperceptibly, into trunk. Latter subcylindrical. Appendages siphonostome; maxillipeds absent; only three pairs of legs present. Length 20–25 mm.

Marine. Dorsal musculature of *Benthosoma glaciale*. (Atl) (W. E. Hogans, unpublished).

Peniculus von Nordmann, 1832

As many as 15 species of this widespread pennellid genus have been described, parasitic on many unrelated teleost fishes. The members of the genus do not penetrate the host tissues to an appreciable depth, often being associated with the fins of their hosts. Their harmful effects are correspondingly slight. The most characteristic feature of *Peniculus* is the compact cephalothorax. The generic diagnosis is as follows:

Female (post-metamorphosis): Cephalothorax subovoid, short, with or without digitiform lateral processes, bearing prominent mouth cone. Narrow neck separating cephalothorax from trunk. Latter subcylindrical, without posterior processes. Appendages siphonostome, four pairs of legs: two bi- and two uniramous.

Two species of this genus have been found in Canadian waters. They can be identified with the aid of the key below.

Key to species of *Peniculus*

Cephalothorax without lateral digitiform processes (Fig. 36E) ..... *P. clavatus* (O. F. Müller, 1779)

Mouth tube protruding posteroventrally from, and longer than, cephalothorax. Neck cylindrical, narrow and short (Fig. 36F). Trunk with two semispherical swellings on ventral surface of anterior end (arrow in Fig. 36E). First two pairs of legs close together at anterior end of neck, third at posterior end, fourth behind ventral swellings of trunk. Rami of legs often missing. Length 10 mm.

Marine: Fins of *Sebastes marinus*, *S. mentella*, and *Triglops pingeli*. (Atl).

Cephalothorax with two pairs of digitiform lateral processes (Fig. 36H) ..... *P. asinus* Kabata and Wilkes, 1977

Anterior pair of processes projecting well beyond margin of cephalothorax (Fig. 36H), posterior pair shorter than anterior. Neck slender, often bent. Small anterior part of trunk marked off by shallow constriction (Fig. 36G). Position of three pairs of legs as in *P. clavatus*, fourth in shallow constriction on ventral surface of trunk. Latter similar to that of *P. clavatus*. Length 8–12 mm.

Marine. Fins of *Sebastes alutus*, *S. babcocki*, *S. brevispinis*, *S. crameri*, *S. flavidus*, *S. proriger*, and *S. reedi*. (Pac). [Syn.: *Peniculus* sp. of Sekerak and Arai (1977).]

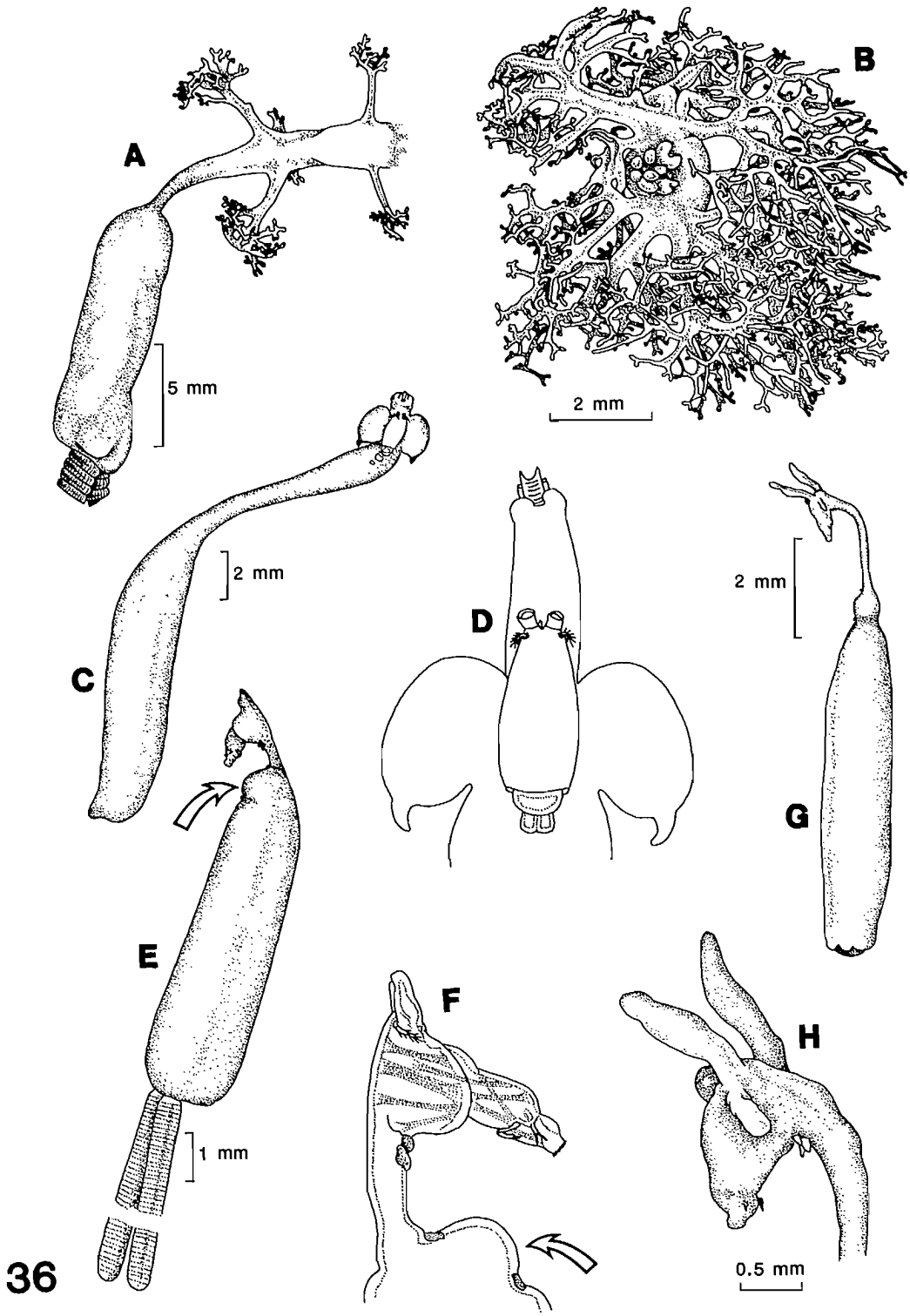

FIG. 36. A. *Phrixocephalus cincinnatus*, female, trunk, lateral; B. Same, holdfast, anterior; C. *Sarcotretes scopeli*, female, dorsal; D. Same, cephalothorax, dorsal; E. *Peniculus clavatus*, female, lateral; F. Same, cephalothorax, lateral; G. *Peniculus asinus*, female, lateral; H. Same, cephalothorax, lateral. (A,B redrawn from Kabata 1967b; C–F redrawn from Wilson 1917; G,H redrawn from Kabata and Wilkes 1977). Arrow in 36E points to semispherical swellings of trunk.

Lernaeocera de Blainville, 1822

Established more than 1 1/2 centuries ago, this genus is the best known and, at the same time, the most confusing member of Pennellidae. The reason for the difficulties encountered in identifying *Lernaeocera* are due to the fact that the degree of morphological variability it displays is much greater than in most other genera of the family. This variability, in its turn, is prompted by the constraining impact of the confined habitat of *Lernaeocera*. The species of this genus live on the gills and their relatively large size calls for the most efficient use of the limited space in the branchial chambers. This need results in the sigmoid folding of the trunk and hitching up of the egg sacs to an axial rod. The head of the parasite embeds in a major blood vessel of the host and often in its heart. The effects on the host were last discussed by Kabata (1984e).

The generic diagnosis of *Lernaeocera* is the same as that of its type species, *L. branchialis*.

Although many species of *Lernaeocera* have been described, the most recent reviewer (Kabata 1979) accepted only three as incontrovertibly valid, all from the North Atlantic. Only one of them has been found in Canadian waters.

Lernaeocera branchialis (L.)

Female (post-metamorphosis)(Fig. 37A): Cephalothorax with holdfast of one dorsal and two lateral antlers, usually profusely branching. Narrow cylindrical neck of varying length, abruptly expanding into trunk. Latter, jointly with abdomen, showing more or less pronounced sigmoid flexion. Abdomen unsegmented, subcylindrical. Egg sacs connected in irregular loops to central hyaline rod by fine membrane, uniseriate. Appendages siphonostome, maxillipeds absent. Four pairs of legs, close together behind cephalothorax on ventral surface. Length (straight line from anterior to posterior end) up to 60 mm.

Marine. Gills of *Cyclopterus lumpus*, *Gadus morhua*, *G. ogac*, *Hippoglossoides platessoides*, unspecified cod, and unspecified fish. (Atl). Additional records: *Cyclopterus lumpus* and *Gadus morhua*. (Atl) (Sherman and Wise 1961); *Gadus morhua*. (Atl) (Appy and Burt 1982); *Cottunculus thompsoni*. (Atl) (W. E. Hogans, unpublished).

Haemobaphes Steenstrup and Lütken, 1861

The females of the genus *Haemobaphes* resemble superficially those of *Lernaeocera*, from which they are usually distinguishable by the length of their neck region and by the type of their holdfasts. The latter are never dendritic, but consist of lobes, usually multiple, sometimes subdivided. It is the holdfasts that provide the main distinguishing features of *Haemobaphes* also at the specific level.

The genus contains nine species, although some of them might have to be relegated to synonymy on careful review. Kabata (1967a), for example, expressed doubts as to the validity of *H. theragrae*. Without an extensive review, however, it is impossible to determine whether *H. theragrae* is valid or, as Kabata speculated, is a synonym of *H. diceraus*. In the absence of such a review, it is prudent to leave the taxonomic status of *H. theragrae* undisturbed. The generic diagnosis of *Haemobaphes* is as follows:

Female (post-metamorphosis): Cephalothorax with more or less elaborate, multilobate holdfast. Neck thin, U-shaped, usually with secondary holdfast (one pair of lateral processes) at point of flexion. Trunk sigmoid, with or without outgrowths over bases of egg sacs. Latter in tight, spiral coil. Appendages siphonostome, maxillipeds absent. Four pairs of legs, two close together, third and fourth at greater intervals from each other and first two.

Key to species of *Haemobaphes*

1 Third and fourth pedigerous segments not discernible ..... *H. theragrae* Yamaguti, 1939

Holdfast wider than long, with pair of blunt anterior processes and smaller pair of dorsal processes; small, flat posterodorsal prominence in median line. Trunk with one pair of lateral prominences over bases of egg sacs (Fig. 37B). Length 65 mm.

Marine. Gill cavity of *Sebastes alutus* and *S. zacentrus*. (Pac). Additional records: *Theragra chalcogramma*. (Pac) (Kabata, unpublished).

Third and fourth pedigerous segments separated by more or less distinct transverse constrictions (Fig. 37H) 2

2 Processes present directly behind fourth legs (Fig. 37D) 3

No processes directly behind fourth legs 4

3 Pair of large, digitiform lateral processes and pair of smaller, bifid processes behind fourth legs (Fig. 37D) ..... *H. cyclopterina* (Fabricius, 1780)

Holdfast (Fig. 37D) with pair of large, longitudinal, lateral processes and pair of smaller, anteroventral processes. Trunk (Fig. 37C) with two pairs of conical processes over bases of egg sacs. Length 30 mm.

Marine. Gill cavity of *Artediellus uncinatus*, *Lumpenus lampetraeformis*, *Lycenchelys verilli*, *Lycodes vahlii* and *Myoxocephalus scorpioides*. (Atl) (E Arc).

Two pairs of small, subconical lateral processes and one pair of laterodorsal processes behind fourth legs (arrow in Fig. 37E) ..... *H. internedius* Kabata, 1967

Holdfast (Fig. 37F) with one pair anterolateral, one large posterolateral, and two ventral lobes. Neck very short. Trunk with two pairs of prominent outgrowths over bases of egg sacs. Length 25 mm.

Marine. Gill cavity of *Artedius harringtoni*, *Oligocottus maculosus*, and unspecified smelt. (Pac).

4 Holdfast (Fig. 37H) with two lateral subspherical lobes and two ventral swellings. Trunk (Fig. 37G) without processes over bases of egg sacs. Length 30 mm ..... *H. disphaerocephalus* Grabda, 1976

Marine. Gill cavity of *Thaleichthys pacificus*. (Pac) (Z. Kabata, unpublished).

Holdfast (Fig. 37J) with two longitudinal, lateral, pyriform lobes, wider posteriorly, and two oval ventral swellings. Trunk with two pairs of conical outgrowths over bases of egg sacs (Fig. 37I). Length 30 mm ..... *H. diceraus* Wilson, 1917

Marine. Gill cavity of *Cymatogaster aggregata*, *Thaleichthys pacificus*, and unspecified bass. (Pac).
Additional records: *Merluccius productus*. (Pac) (Sankurathri et al. 1983); *Gadus macrocephalus*. (Pac) (Z. Kabata, unpublished).

NOTE: *T. pacificus* was recorded as host of this species, before *H. disphaerocephalus* was recognized as a separate species.

In addition to the above species, unspecified *Haemobaphes* were recorded on the Pacific coast from the following hosts: *Agonus acipenserinus*, *Ammodytes hexapterus*, *Blepsias cirrhosus*, *Hexagrammos decagrammus*, *Lepidopsetta bilineata*, *Oligocottus maculosus*, *Syngnathus griseolineatus*, and *Triglops pingeli*. Additional records: larval stages, *Eopsetta jordani*. (Pac) (Z. Kabata, unpublished); *Theragra chalcogramma*. (Pac) (Arthur 1984).

POECILOSTOMATOIDA

Although not as numerous as the siphonostomatoids, the members of this suborder constitute some 20% of the entire fauna of copepods parasitic on fishes. Within the subordinal boundaries they enclose species representing a very wide range of adaptations to parasitic life, beginning with forms like Bomolochidae and their relatives,

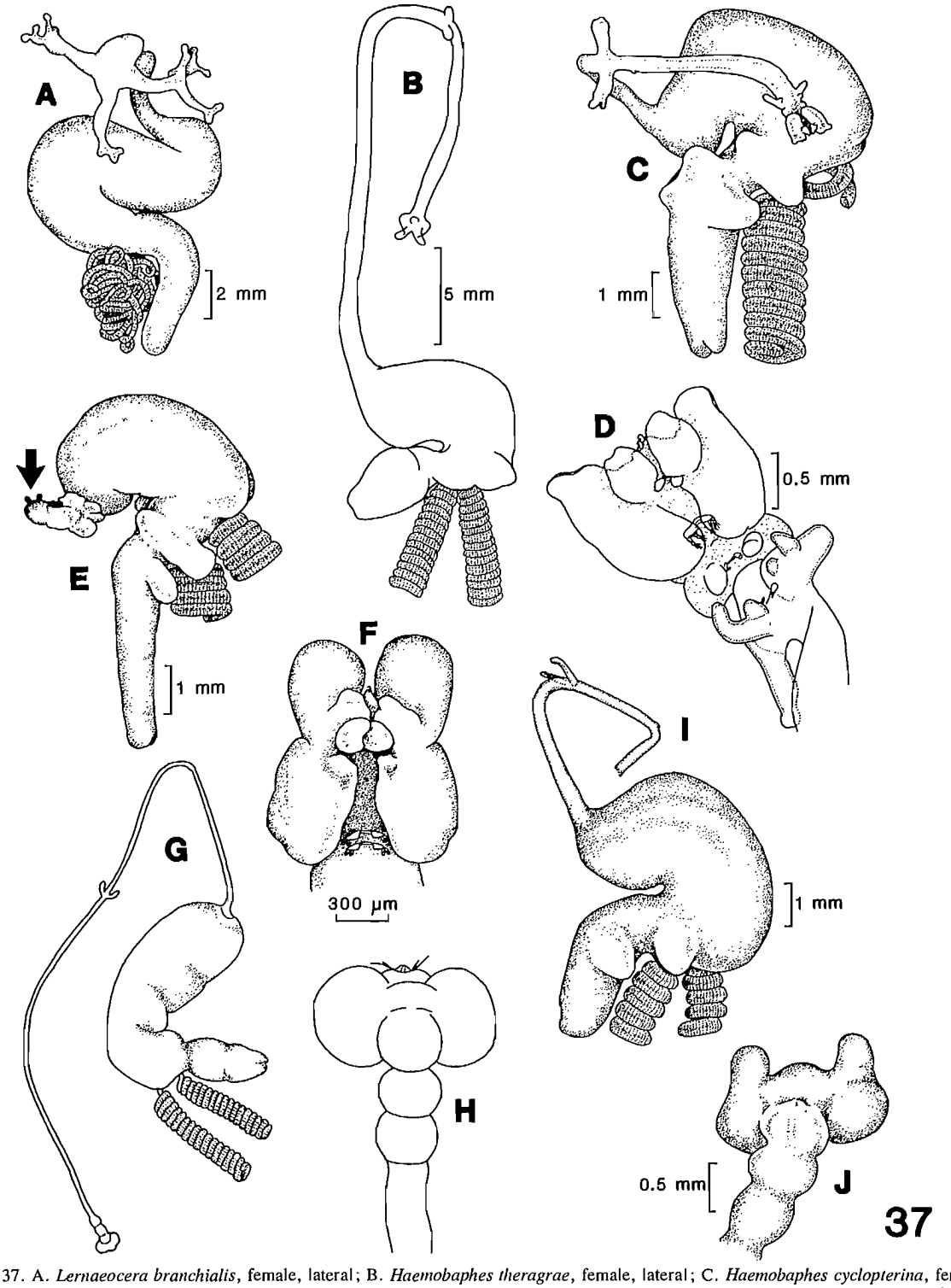

FIG. 37. A. *Lernaeocera branchialis*, female, lateral; B. *Haemobaphes theragrae*, female, lateral; C. *Haemobaphes cyclopterina*, female, lateral; D. Same, holdfast, ventral; E. *Haemobaphes intermedius*, female, lateral; F. Same, holdfast, ventral; G. *Haemobaphes disphaerocephalus*, female, lateral; H. Same, holdfast, dorsal; I. *Haemobaphes diceraus*, female, lateral (decapitated); J. Same, holdfast, dorsal. (A,C,D redrawn from Kabata 1979; B redrawn from Yamaguti 1939; E,F,I,J redrawn from Kabata 1967a; G,H redrawn from Grabda 1976).
Arrow in 37E points to secondary holdfast.

which are only slightly modified from the ancestral free-living condition, and ending with Chondracanthidae, strongly metamorphosed under the impact of parasitism. Both ectoparasites and endoparasites can be found among them.

Poecilostomatoids as a group are less deleterious to their hosts than members of the other two suborders. Most of them are small and tend to be more or less mobile and less prone to cause extensive tissue damage. Only Chondracanthidae and some Philichthyidae, due to their relatively large size and intimate, prolonged contact with the host, inflict injuries comparable in extent to those caused by many siphonostomatoid and cyclopoid copepods. Some small poecilostomatoids, however, when present in sufficiently large numbers, especially on the gills of fishes in small freshwater habitats, are capable of causing mass kills.

Four families are represented among the poecilostomatoids recorded in the Canadian fauna.

Key to families

1 Endoparasites, inhabiting mucous ducts or pouches in body wall or viscera ..... Philichthyidae

Ectoparasites, on external surfaces or in branchial cavity 2

2 Attached permanently by short, unciform second antenna; external segmentation obscure ..... Chondracanthidae

Not attached permanently (mobile or able to change place of attachment) 3

3 Attached to host with powerful, subchelate second antennae; external segmentation largely retained ..... Ergasilidae

Mobile, with second antennae reflected upon themselves; external segmentation largely retained ..... Bomolochidae

Family PHILICHTHYIDAE

The members of this family are endoparasitic. They inhabit subcutaneous mucous ducts of teleosts and/or their lateral line canals, or form pouches invaginated in the wall of the rectum or abdominal wall. An externally visible swelling is sometimes present.

The present number of about 50 known species probably represents only a small part of philichthyid copepods. Their secluded habitat causes them to be overlooked by all but the most determined searchers. The main characteristic of the adult female philichthyids is their partial or complete loss of external segmentation, often accompanied by many outgrowths, processes or papillae that impart to the copepod a strange appearance. The family diagnosis is as follows:

Female: Body vermiform, saccular, or subspherical, often with many papilliform, digitiform or complex outgrowths. External segmentation largely obsolete. Cephalothoracic appendages reduced, difficult to observe. Legs absent.

Male: Body elongate, with external segmentation largely obsolete. Third thoracic segment with pairs of lateral, backward-pointing processes. Uropods well developed, sometimes very long. Cephalothoracic appendages fully developed. Two or three pairs of legs present.

Only two genera recorded from fishes of Canada. They can be distinguished with the aid of the key below.

Key to genera of Philichthyidae

Body saccular, encrusted with transverse bands of papilliform tubercles (Fig. 39A). Inhabiting pouches in body wall or rectum ..... *Sarcotaces*

Body elongate, with long and prominent dorsal and lateral processes (Fig. 39C). Inhabiting subcutaneous mucous ducts of host's head ..... *Colobomatus*

Sarcotaces Olsson, 1872

The shapelessness of the females of this genus creates an uncertainty about its intrageneric systematics. Although six nominal species have been described (two as recently as 1974), the validity of some of them at least is a matter of controversy. The biology of these copepods is still largely unknown. Inhabiting in pairs (male and female) large pouches, up to 9 cm in length, they cause some displacement of the internal organs of the host. No demonstrable ill-effects, however, have been documented so far. Only one species of *Sarcotaces* has been found in Canadian waters. The generic diagnosis is the same as that of the Canadian species.

Sarcotaces arcticus Collett, 1874

Female (Fig. 38A): Body saccular, without clear external segmentation, tapering posteriorly to narrow, pointed, tail-like extremity; small, anteroventral plaque (oral disc) marking position of oral region. Small, sclerotized protuberances covering most of body surface, arranged in ill-defined transverse bands, often interrupted on ventral side; posterior half of body covered by smaller, more densely packed tubercles, except for naked posterior extremity. No anal orifice. Mouth parts and other appendages obsolete, but uniramous first antennae present. Length reaching 90 mm.

Male (Fig. 38B). Cephalothorax small, well delimited from rest of body. Trunk elongate, with prominent lateral processes projecting caudad from third thoracic segment; segmentation obscure; flagelliform uropods nearly 3/4 length of trunk. No anal orifice. Length 3 mm (without uropods).

First antenna four-segmented, apical armature well developed. Second antenna four-segmented, uniramous, with strong spines on two distal segments. Mandible relatively large, ending in strong geniculate claw. Maxilla (probably second maxilla) of broad basal segment and unciform denticulated terminal segment. Two pairs of biramous legs with two-segmented sympods and one-segmented rami; latter bearing several subtriangular denticles each.

Marine. Pouches in body wall and rectum of *Sebastes aleutianus*, *S. alutus*, *S. brevispinis*, and *S. ruberrimus*. (Pac).

Colobomatus Hesse, 1873

The small size and secretive habits of the members of this genus make them difficult to find. It is entirely possible that the real number of species belonging to it is much higher than 38 hitherto recorded from various parts of the world. To find *Colobomatus*, one must strip the skin from the cranium and the lower jaw of the fish. Understandably, only determined and thorough searchers can expect to uncover these endoparasites. The generic diagnosis of *Colobomatus* is as follows:

Female: Body divided into cephalic, thoracic and genito-abdominal parts by constrictions, all with variously shaped and arranged processes; abdomen two-, or three-segmented, caudal furca well developed. Antennae and oral appendages simplified and reduced, legs vestigial or absent.

Male: Body divided into head, five thoracic and five abdominal segments. Antennae and oral appendages better developed than those of female. Three pairs of legs present, first two biramous, third uniramous; vestigial fourth leg sometimes present.

The biology of *Colobomatus* and its effects on the host fish are virtually unknown. Only one species has been found in Canada.

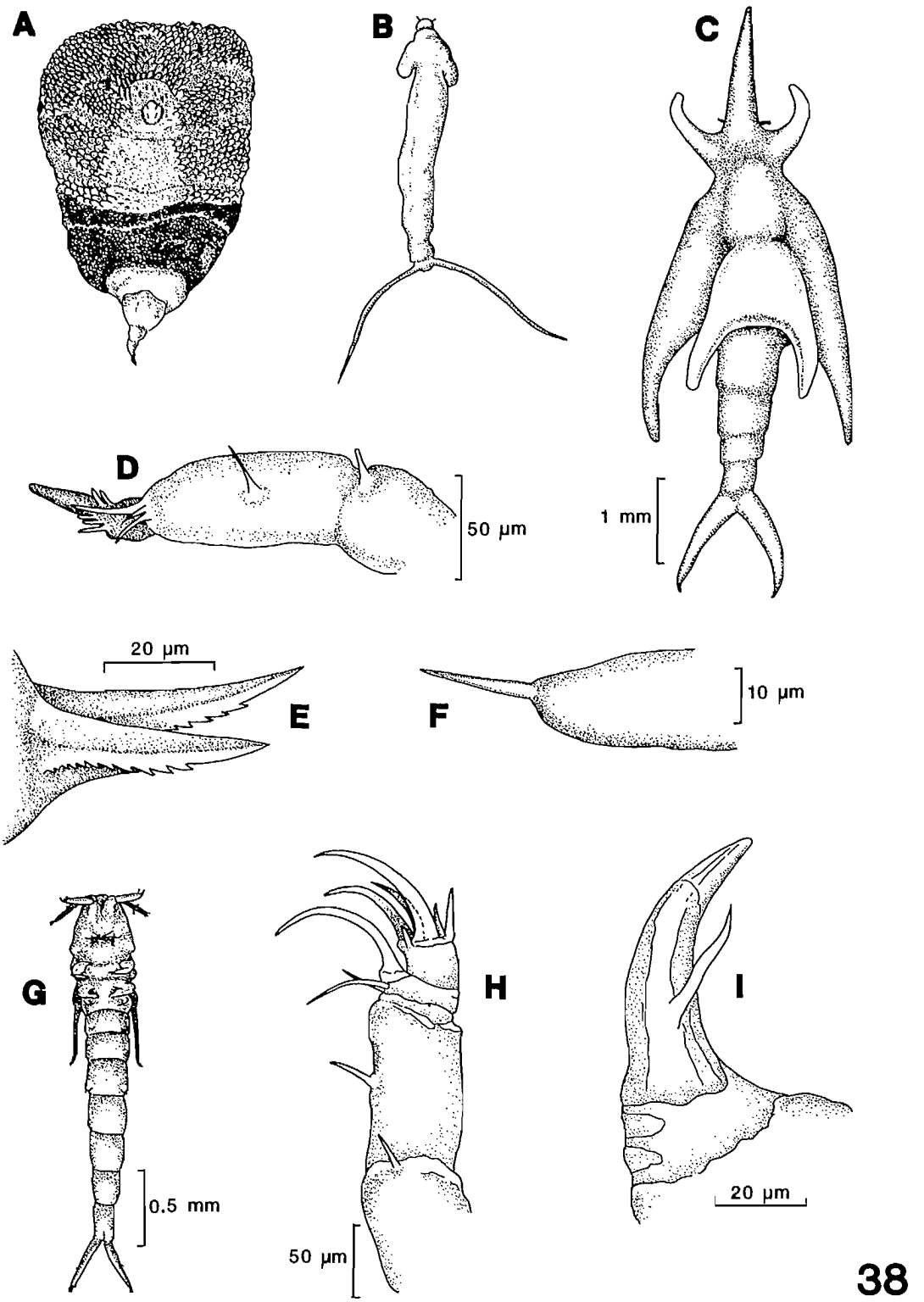

FIG. 38. A. *Sarcotaces arcticus*, female, ventral; B. Male, dorsal; C. *Colobomatus kyphosus*, female, dorsal; D. Same, second antenna, ventral; E. Second maxilla, lateral; F. Maxilliped, lateral; G. Male, ventral; H. Same, second antenna, ventral; I. Mandible, posterior. (A,B redrawn from Kabata 1970b; C–I redrawn from Sekerak 1970).

Colobomatus kyphosus Sekerak, 1970

Female (Fig. 38C): Cephalic area with elongated, pointed pre-antennary process and two lateral processes directed obliquely anteriorly, separated from thoracic area by definite constriction. Thoracic area with dorsal swelling bearing pair of posterolateral processes and with lateral aliform expansions produced into posteriorly directed processes. Genito-abdominal area partly divided into five segments (mainly on ventral surface), with oviduct orifices on second segment. Uropods prominent, 2/3 length of genito-abdominal area. Total length (without uropods) 4.6–7.0 mm.

First antenna apparently three-segmented, with well developed armature. Second antenna (Fig. 38D) with obscure segmentation, poorly armed. Mandible and first maxilla not observed. Second maxilla (Fig. 38E) with two serrated terminal blades. Maxilliped (Fig. 38F) bearing single terminal spine. Two pairs of vestigial legs.

Male (Fig. 38G): Body elongated, definitely segmented, narrowing posteriorly, with prominent uropods; stylet-like lateral processes on third thoracic segment. Total length 2.0–2.6 mm.

First antenna five-segmented, with well developed armature. Second antenna (Fig. 38H) four-segmented, two terminal segments with claw-like spines. Mandible (Fig. 38I) unciform, with secondary seta. First maxilla broad-based, carrying two seta. Second maxilla and maxilliped similar to those of female. Legs 1 and 2 biramous, both rami and sympod two-segmented; leg 3 with rami one-segmented; leg 4 of two short setae.

Marine. Cephalic sensory canal of *Sebastes aleutianus*, *S. alutus*, *S. babcocki*, *S. borealis*, *S. brevispinis*, *S. caurinus*, *S. crameri*, *S. diploproa*, *S. elongatus*, *S. entomelas*, *S. flavidus*, *S. maliger*, *S. nigrocinctus*, *S. pinniger*, *S. proriger*, *S. reedi*, *S. ruberrimus*, *S. variegatus*, and *S. zacentrus*. (Pac).

Family CHONDRACANTHIDAE

Among the parasitic copepods belonging to Poecilostomatoida, the family Chondracanthidae occupies a prominent place. It comprises presently between 150 and 160 species, grouped in 36 genera. The members of their family can be found predominantly on teleost fishes, though they also occur on holocephalans and elasmobranchs. They are all highly adapted to a parasitic mode of life and remain fixed semipermanently on the surfaces of their hosts, usually ensconced in protected habitats within the gill chamber, in nasal cavities, or in the cloacal region. They are greatly modified morphologically and exhibit sharp sexual dimorphism, their males being dwarfs attached to the genital region of the female. The morphology of a chondracanthid female and homology of its individual parts with those of an unmodified poecilostome copepod are shown in Fig. 39A. The body of most female chondracanthids consists of three tagmata: the cephalothorax, accommodating most of the appendages, the large trunk, containing alimentary canal and uteri, and a small genito-abdomen, usually clearly articulated into its two components. The cephalothorax and trunk may carry outgrowths and processes, often prominent and numerous. Some females develop long neck-like structures from premandibular segments of the cephalothorax or anterior part of the trunk. The mouthparts of the chondracanthids are shown in Fig. 39B. The mouth is a gaping orifice, overhung by the labrum. The labium, on the other hand, is greatly reduced. The mandible is equipped with pliable falciform blade, a hallmark of the family. Other mouth parts, from the paragnath to the brachiform maxilliped, are equally characteristic of the family. The legs are usually reduced to peg-like stumps, often bifid and most commonly comprising only two pairs. The males (Fig. 39C) appear morphologically ill-balanced, with relatively large cephalothoraces and small, narrow trunks.

The biology of Chondracanthidae is little known, but we do know that their mode of feeding involves extrabuccal digestion, resulting in lysis of sizeable portions of musculature. Frequently observed vigorous response of the host tissue at the sites of feeding and attachment may lead to hyperplasia and hypertrophy, resulting in covering of the head of the parasite with tissue growth and its imprisonment for life. The diagnosis of the family is as follows:

Female: Body consisting of three tagmata: cephalothorax, trunk, and genito-abdomen (in *Diocus* third tagma poorly developed, especially its abdominal component). Cephalothorax and trunk with or without outgrowths and processes, trunk in most instances with at least one pair of posterolateral processes. Mouth parts poecilostome. Usually (not always) two pairs of modified thoracopods present.

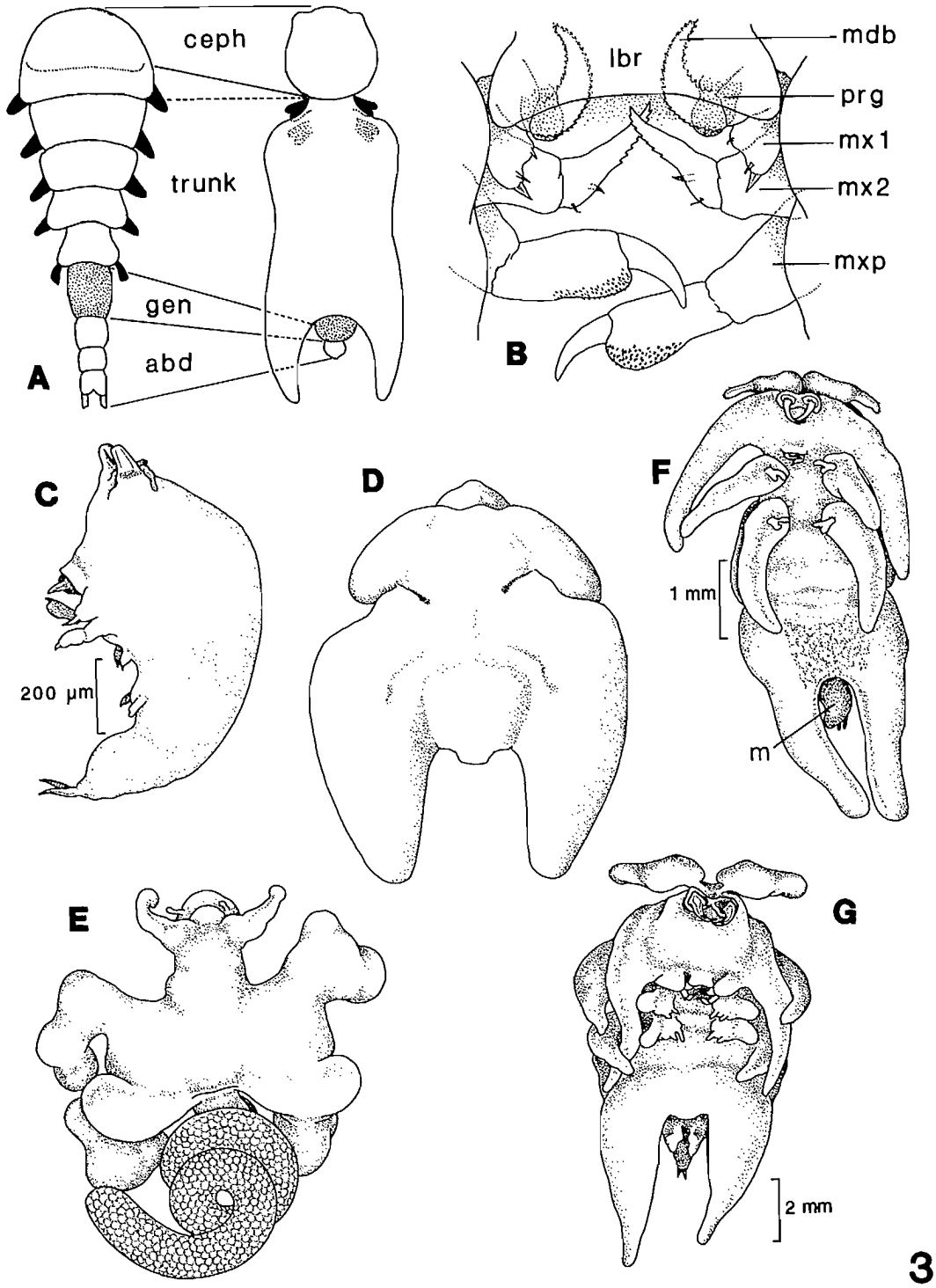

FIG. 39. A. Chondracanthid metamorphosis (diagrammatic); B. Mouth parts of Chondracanthidae; C. Chondracanthid male; D. *Diocus frigidus*, female, dorsal; E. *Diocus gobinus*, female, dorsal; F. *Lateracanthus quadripedis*, female, ventral; G. *Chondracanthodes radiatus*, female, ventral. (A–C redrawn from Kabata 1979; D redrawn from Hansen 1923; E redrawn from Ho 1970; F redrawn from Kabata and Gusev 1966; G redrawn from Ho 1971).
abd — abdomen; ceph — cephalothorax; gen — genital complex; lbr — labrum; m — male; mdb — mandible; mx1 — first maxilla; mx2 — second maxilla; mxp — maxilliped; pgr — paragnath.

Male: Dwarf, attached to the genital area of female. Cephalothorax markedly larger than trunk, latter indistinctly segmented. Cephalothoracic appendages similar to those of female. Two pairs of modified legs present.

Representatives of six genera have been recorded in Canadian waters. They can be distinguished with the aid of the following key:

Key to genera of Chondracanthidae

1 Second antennae T-shaped; abdomen very small or indistinct ..... *Diocus*

Second antennae unciform; abdomen well developed 2

2 Trunk with lateral, with or without posterolateral, dorsal and ventral processes (Fig. 40J); cephalothorax with or without processes 3

Trunk with posterolateral processes only (Fig. 41F); cephalothorax without processes 5

3 Two pairs of lateral processes at anterior end of trunk, arising under bases of legs; cephalothorax with long lateral processes (Fig. 39F) ..... *Lateracanthus*

Processes not as above 4

4 Cephalothorax with or without posterolateral processes, trunk with two pairs of lateral, one of posterolateral and single, more or less developed anterodorsal processes (Fig. 39G) ..... *Chondracanthodes*

Cephalothorax with or without posterolateral processes; trunk with or without posterolateral processes, other processes not as above (Fig. 40H) ..... *Chondracanthus*

5 Legs bifid (Fig. 41B) ..... *Acanthochondria*

Legs undivided (Fig. 41I) ..... *Acanthochondrites*

Diocus Krφyer, 1863

Female: Cephalothorax with or without processes. Trunk of narrow anterior and wide posterior parts, both with lateral processes. Genital segment wider than long. Abdomen poorly developed or indistinct. First antenna slender, clearly segmented. Second antenna T-shaped. Two pairs of small, vestigial legs present.

Male: Typical for Chondracanthidae, with fairly well segmented trunk. The Canadian fauna contains two species of *Diocus* identifiable with the aid of the key below.

Key to species of *Diocus*

Posterior part of trunk with one pair of posterolateral processes (Fig. 39D) ..... *D. frigidus* Hansen, 1923

Cephalothorax without obvious outgrowths (Fig. 39D). Anterior part of trunk with wide-based, distally rounded processes; posterolateral processes not distinctly delimited from trunk, smooth and distally rounded. Egg sacs more or less curved. Length 3.4–5.7 mm.

Marine. Gill chamber of *Lycodes lavalaei* and *L. vahlii*. (Atl) (Khan 1978; Khan et al. 1980).

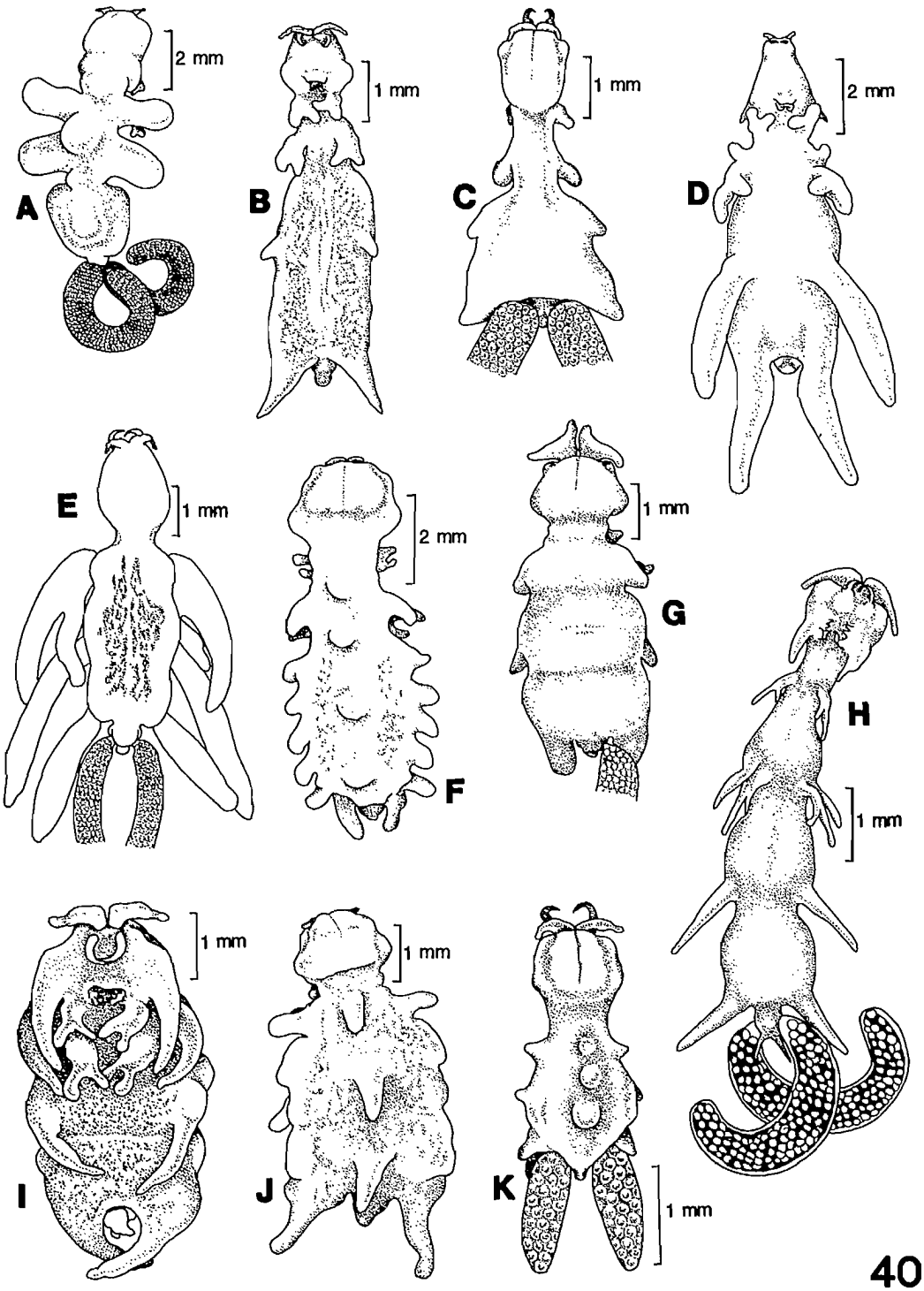

FIG. 40. A. *Chondracanthus narium*, female, dorsal; B. *Chondracanthus gracilis*, female, ventral; C. *Chondracanthus deltoideus*, female, dorsal; D. *Chondracanthus merluccii*, female, ventral; E. *Chondracanthus palpifer*, female, dorsal; F. *Chondracanthus nodosus*, female, dorsal; G. *Chondracanthus cottunculi*, female, dorsal; H. *Chondracanthus triventricosus*, female, ventral; I. *Chondracanthus pinguis*, female, ventral; J. *Chondracanthus irregularis*, female, dorsal; K. *Chondracanthus pusillus*, female, dorsal. (A redrawn from Kabata 1969d; B,I–K redrawn from Kabata 1968; C redrawn from Kabata 1984; D,F redrawn from Kabata 1979; E redrawn from Wilson 1912; G modified from Ho 1971; H redrawn from Sekerak 1970).

Posterior part of trunk with one pair of lateral and one of posterolateral processes (Fig. 39E) . . . . . *D. gobinus* (Müller, 1776)

Cephalothorax with one pair of small posterolateral processes (Fig. 39E). Anterior part of trunk with one pair of narrow-based processes; processes of posterior part irregularly twisted, each with several swellings. Egg sacs spirally coiled. Length 10 mm.

Marine. Fins of *Gymnocanthus tricuspis*. (Atl).

Lateracanthus Kabata and Gusev, 1966

This genus, widespread on deep-water macrurid fishes, has been discovered in Canadian waters quite recently. The generic diagnosis is the same as that of its type species, *L. quadripedis*.

Lateracanthus quadripedis Kabata and Gusev, 1966

Female (Fig. 39F): Cephalosome with one pair of long, tapering posterolateral processes. Two pairs of long anterolateral trunk processes arising under bases of bifid legs; posterolateral processes present. Genito-abdomen well developed. Egg sacs straight. Length 6 mm.

Male: Typical for Chondracanthidae.

Marine. Gill cavity of *Macrourus berglax*. (Atl). (Khan et al. 1980; W. E. Hogans, unpublished).

Chondracanthodes Wilson (in Oakley, 1930)

This genus, distinguished by the constancy in the arrangement of its trunk processes (two pairs of lateral, one of posterolateral and a single anterodorsal), consists of four species. It is very closely related to the genus *Chondracanthus*, both morphologically and biologically. Its generic diagnosis is the same as that of its only species occurring in Canadian waters.

Chondracanthodes radiatus (Müller, 1776)

Female (Fig. 39G): Cephalothorax with prominent digitiform posterolateral processes. Lateral processes of trunk situated at level of legs, long, with rounded apices; posterolateral processes robust, projecting far beyond posterior extremity of abdomen; anterolateral process well developed, with subspherical distal part. Legs with bases expanding laterally; rami slender, well delimited. Total length 7 mm.

Male. Typical for Chondracanthidae.

Marine: Gill cavity of *Coryphenoides rupestris* and *Macrourus berglax*. (Atl) (Zubchenko 1981, 1985; Ho 1985; W. E. Hogans, unpublished). [Syn.: *Chondracanthus radiatus* of Zubchenko 1981, 1985.]

Chondracanthus Delaroche, 1811

This successful genus comprises nearly a third of all members of the family; over 40 species of *Chondracanthus* have been described. Morphologically distinctive by the possession of processes on their trunks and sometimes on the cephalosomes, the species of *Chondracanthus* do not differ biologically from most other genera of this family. They are all marine, almost all live in sheltered areas of the surfaces of teleost fishes (branchial and buccal cavities) and all are strongly attached by means of their uncinate second antennae. Their effects are also similar to those resulting from infection with other chondracanthids. The diagnosis of the genus is as follows:

Female: Cephalosome with or without processes. Trunk with or without posterolateral processes and with varying numbers of lateral, mid-dorsal and midventral processes. Cephalic appendages of chondracanthid type. Two pairs of bifid legs.

Male: Typical for Chondracanthidae.

The Canadian fauna contains at present 11 species of *Chondracanthus*, the females of which can be identified with the aid of the key below.

Key to species of *Chondracanthus*

1 Trunk without posterolateral processes (Fig. 40A) ..... *Ch. narium* Kabata, 1969

Cephalosome irregularly triangular, with buccal orifice at posterior end of ventral surface. Trunk with two pairs of digitiform lateral processes and three median dorsal swellings (middle swelling much more prominent than other two); posterior end of trunk expanded, narrowing towards extremity. Abdomen small, subconical. Egg sacs usually with circular curves. Length 7 mm.

Marine. Nasal cavities of *Ophiodon elongatus*. (Pac).

Trunk with posterolateral processes 2

2 Trunk with single pair of lateral processes (Fig. 40E) 3

Trunk with more than one pair of lateral processes (Fig. 40F) 6

3 Single small dorsal process ..... *Ch. gracilis* Fraser, 1920

Cephalosome wider posteriorly, with buccal orifice at posterior end of ventral surface; no outgrowths or processes. Trunk with one pair of small lateral processes at about midlength (Fig. 40B); dorsal process slightly posterior to lateral pair; posterolateral processes present. Egg sacs straight. Length 7–8 mm.

Marine. Gill cavity of *Hexagrammos decagrammus* and *Scorpaenichthys marmoratus*. (Pac).

Dorsal processes absent 4

4 Lateral processes small, subconical (Fig. 40C) ..... *Ch. deltoideus* Fraser, 1920

Cephalosome with two pairs of ventrolateral tubercles. Trunk with narrow anterior and broader posterior part (Fig. 40C); single pair of small tuberculiform lateral processes and divergent posterolateral processes. (In contracted specimens lateral processes often not discernible.) Egg sacs straight. Length 6 mm.

Marine. Gill cavity of *Hexagrammos decagrammus*, *H. stelleri*, and *Sebastes melanops*. (Pac). Additional record: *H. decagrammus*. (Pac) (Kabata 1984b). [Syn.: *Acanthochondria deltoidea*.]

Lateral processes large, digitiform 5

5 Cephalosome with small, pointed posterolateral processes; second legs not reaching base of lateral trunk processes (Fig. 40D) ..... *Ch. merluccii* (Holten, 1802)

Cephalosome broader posteriorly. Trunk with small tubercles in anterolateral corners; lateral processes long, arising at midlength and extending beyond bases of equally long posterior processes. Second legs not much longer than first. Egg sacs straight. Length 12 mm.

Marine. Gills and gill cavity of *Merluccius bilinearis*. (Atl).

Cephalosome without posterolateral processes, second legs extending beyond bases of lateral trunk processes (Fig. 40E) ..... *Ch. palpifer* Wilson, 1922

Very similar to *Ch. merluccii* but without anterolateral trunk tubercles. Second leg large, reaching posterior quarter of trunk. Egg sacs straight. Length 6–7 mm.

Marine. Gill and buccal cavities of *Merluccius productus* and *Gadus macrocephalus**. (Pac). (The author found *Ch. palpifer* on several occasions on external surfaces of the former host, usually near head, or at base of dorsal fin.) Additional record: *Merluccius productus*. (Pac). Sankurathri et al. (1983). [Syn.: *Acanthochondria palpifera*.]

* *Gadus macrocephalus* was recorded as a host for this parasite by Fraser (1920), as well as being mentioned by Markevich (1956). The author has not been able to find it on this host, in spite of extensive searches.

6 Trunk with six lateral and one ventrolateral processes, four mid-dorsal and one midventral tubercle (Fig. 40F) ..... *Ch. nodosus* (Müller, 1776)

Cephalosome broader posteriorly, without outgrowths or processes. Trunk with narrow anterior part (when relaxed), all processes subconical. Bases of legs with lobate medial and lateral expansions. Egg sacs straight. Length 8 mm.

Marine. Gills of *Sebastes marinus* and *S. mentella*. (Atl). Additional record: *S. fasciatus*, *S. marinus*, and *S. mentella*. (Atl)(Bourgeois and Ni 1984). [Syn.: *Chondracanthopsis nodosus*.]

Trunk with two pairs of lateral processes 7

7 No processes on dorsal surface of trunk (Fig. 40G) 8

Processes or tubercles on dorsal surface of trunk (Fig. 40K) 9

8 No processes on cephalosome; prominent subtriangular outgrowth on proximal part of first antenna (Fig. 40G) ..... *Ch. cottunculi* Rathbun, 1886

Cephalosome without outgrowths or processes. Trunk with two pairs of small lateral processes (Fig. 40G) and one posterolateral pair; latter short and stout. Egg sacs straight. Length 6 mm.

Marine. Gills of *Cottunculus microps*. (Atl). Additional record: *C. thompsoni*. (Atl) (W. E. Hogans, unpublished).

Cephalosome with long posterolateral processes; first antenna without prominent outgrowths (Fig. 40H) ..... *Ch. triventricosus* Sekerak, 1970

Trunk subdivided into three parts by transverse constrictions, with two pairs of lateral processes (one at bases of second legs, other in front of second constriction) and posterolateral processes. Egg sacs with semilunar curves. Length 6–10 mm.

Marine. Nasal capsules of *Sebastes aleutianus*, *S. alutus*, *S. babcocki*, *S. brevispinis*, *S. caurinus*, *S. crameri*, *S. diploproa*, *S. flavidus*, *S. helvomaculatus*, *S. maliger*, *S. proriger*, *S. reedi*, *S. ruberrimus*, *S. variegatus*, and *S. zacentrus*. (Pac).

9 Cephalosome with long posterolateral processes (Fig. 40I) ..... *Ch. pinguis* Wilson, 1912

Cephalosome wider than long, its processes as long as those of trunk (Fig. 40I). Latter with two pairs of long, digitiform processes and equally long posterolateral processes; four subconical tubercles in mid-dorsal line. Egg sacs straight. Length 3–5 mm.

Marine. Gill cavity of *Hexagrammos decagrammus*, *Scorpaenichthys marmoratus*, *Sebastes aleutianus*, *S. alutus*, *S. auriculatus*, *S. babcocki*, *S. borealis*, S. *brevispinis*, *S. caurinus*, *S. crameri*, *S. diploproa*, *S. emtomelas*, *S. flavidus*, *S. maliger*, *S. melanops*, *S. pinniger*, *S. proriger*, *S. reedi*, *S. ruberrimus*, *S. zacentrus*, and *Xiphister atropurpureus*. (Pac). Additional records: *S. alutus*, *S. babcocki*, *S. brevispinis*, *S. flavidus*, *S. maliger*, and *S. pinniger*. (Pac) (Z. Kabata, unpublished).

Cephalosome without posterolateral processes 10

10 Cephalosome 1/3 length of total length; posterolateral trunk processes not protruding beyond tip of abdomen (Fig. 40K) ..... *Ch. pusillus* Kabata, 1968

Cephalosome of equal length and width. Trunk with two pairs of lateral papilliform processes, posterolateral processes, and three sub-conical swellings in mid-dorsal line. Egg sacs straight. Length 2.5 mm.

Marine. Gills and gill cavity of *Apodichthys flavidus*. (Pac).

Cephalosome usually less than 1/4 total length; posterolateral trunk processes protruding well beyond tip of abdomen (Fig. 40J) ..... *Ch. irregularis* Fraser, 1920

Cephalosome wider than long. Trunk with three pairs of lateral processes (middle process usually slightly subdivided) and three digitiform or elongate subconical mid-dorsal processes. Egg sacs straight. Length 5–9 mm.

Marine. Gills and gill cavity of *Enophrys bison* and *Myoxocephalus polyacanthocephalus*. (Pac).

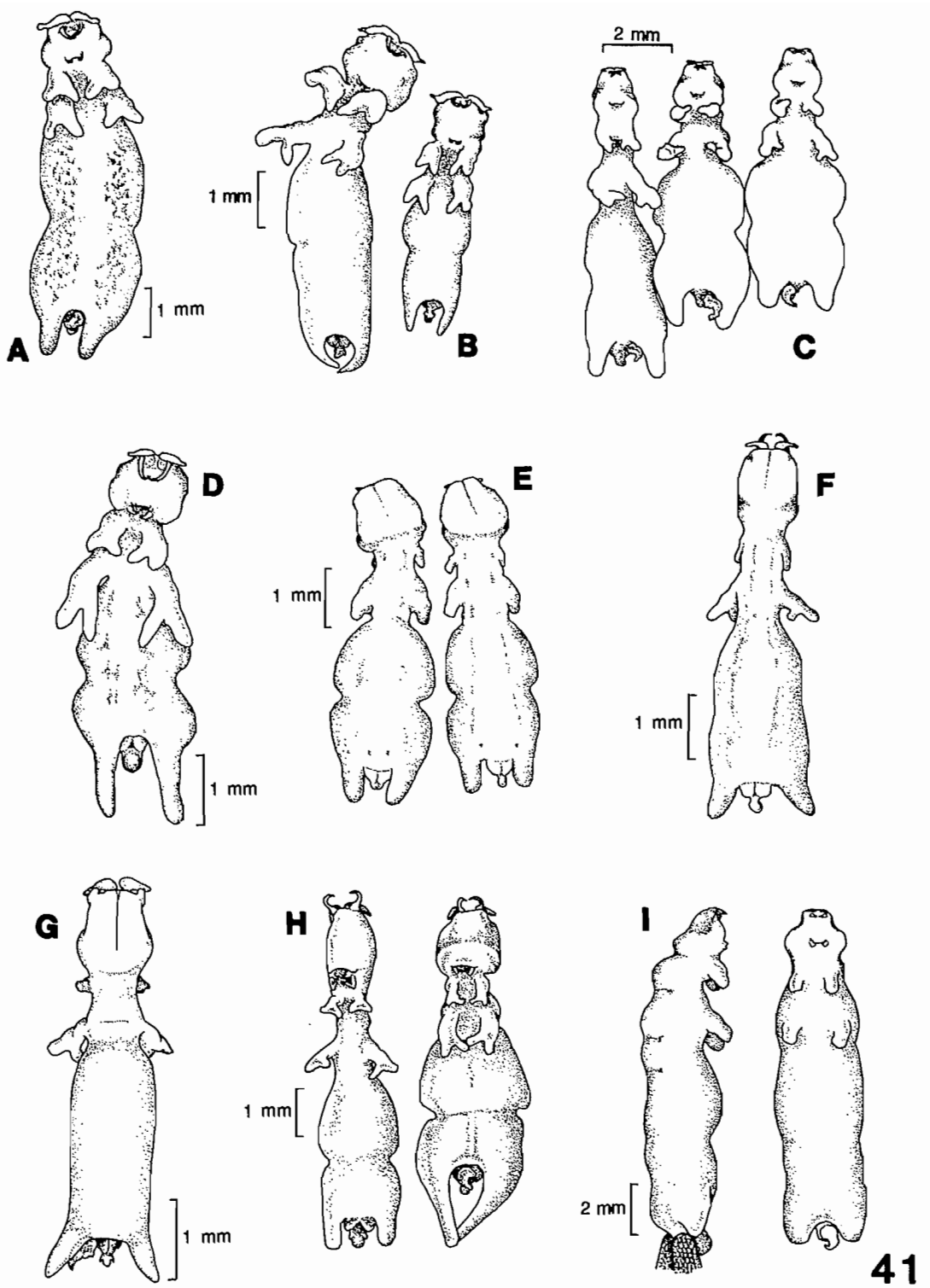

FIG. 41. A. *Acanthochondria cornuta*, female, ventral; B. *Acanthochondria rectangularis*, two females, ventral; C. *Acanthochondria epachthes*, three females, ventral; D. *Acanthochondria margolisi*, female, ventral; E. *Acanthochondria dojirii*, two females, dorsal; F. *Acanthochondria vancouverensis*, female, dorsal; G. *Acanthochondria fraseri*, female, dorsal; H. *Acanthochondria hippoglossi*, two females, ventral; I. *Acanthochondrites annulatus*, two females, lateral (left) and ventral (right). (A,I redrawn from Kabata 1979; B,D–F redrawn from Kabata 1984b; C redrawn from Kabata 1968; G redrawn from Ho 1972; H redrawn from Kabata 1987).

In addition to the 11 species listed in the key above, an unspecified *Chondracanthus* was recorded from a "sea perch" on the Atlantic coast (Stock 1915).

Acanthochondria Oakley, 1927

Unlike *Chondracanthus*, *Acanthochondria* is characterized by the absence of outgrowths and processes of the cephalosome and trunk. This paucity of morphological features makes intrageneric systematics quite difficult. The structure of the appendages is fairly uniform within the genus and provides little help in identification. The difficulties in identifying *Acanthochondria* were discussed recently by Kabata (1984b).

Acanthochondria is biologically quite successful, as can be seen in the fact that it comprises over 50 species, ectoparasitic on various teleosts and even on holocephalans. It is capable of producing infections of high intensities. The generic diagnosis is as follows:

Female: Cephalosome dorsoventrally flattened, of various lengths and widths, without any outgrowths or processes. Short anterior part of trunk narrow, posterior two to six times longer than cephalosome, often subdivided by more or less marked transverse constriction near midlength; posterolateral processes present, other processes absent. Two pairs of bilobed legs.

Male: Typical for Chondracanthidae.

Eight species of this genus are currently known in Canadian waters. The key to their females follows:

Key to species of *Acanthochondria*

1 First antenna with proximal part inflated and projecting mediad from base; distal part subcylindrical, clearly delimited ..... *A. cornuta* (Müller, 1776)

Cephalosome (Fig. 41A) wider posteriorly, with buccal orifice at posterior end of ventral surface. Trunk varying in shape, but with distinct constriction near midlength; posterolateral processes long and stout. Abdomen not inflated at base, its greatest width about midlength. Total length 5–9 mm.

Marine. Gill cavity of *Glyptocephalus cynoglossus*, *Hippoglossoides platessoides*, *Pseudopleuronectes americanus*, and an unspecified flounder. Additional record: *Hippoglossoides platessoides*. (Atl) (Zubchenko 1980). [Syn.: *Chondracanthus cornutus*.]

First antenna not as above 2

2 First antenna with proximal part not inflated, but distal subcylindrical part clearly delimited ... . *A. rectangularis* (Fraser, 1920)

Cephalosome (Fig. 41B) with more or less parallel lateral margins, with buccal orifice at posterior end of ventral surface. Trunk with roughly parallel lateral margins, slightly notched at about midlength; posterolateral processes slender, digitiform, projecting some distance beyond tip of abdomen. Latter inflated near base, with deep constriction between it and genital segment. Total length 4.5–7 mm.

Marine. Gill cavity of *Hydrolagus colliei*, *Parophrys vetulus*, *Platichthys stellatus*, and *Pleuronichthys caenosus*. (Pac). Additional record: *Platichthys stellatus*. (Pac) (Z. Kabata,unpublished). [Syn.: *Chondracanthus rectangularis*.]

First antenna with distal part not clearly delimited, gradually tapering 3

3 Second legs twice the size of first, or larger (Fig. 41D) 4

Second legs not markedly larger than first (Fig. 41A) 5

4 Cephalosome wider than long, or of equal length and width (Fig. 41D) ... *A. margolisi* Kabata, 1984

Buccal orifice at posterior end of ventral surface. Trunk (Fig. 41D) with pronounced constriction near midlength, subcylindrical or clavate posterolateral processes protruding far beyond tip of abdomen. Latter ovoid, separated by deep constriction from genital segment. First antenna profusely spinulated. Total length 5–6 mm.

Marine. Gill cavity of *Microstomus pacificus*. (Pac) (Kabata, 1984b).

Cephalosome longer than wide (Fig. 41H) 5

5 Head to trunk length ratio less than 1:5. First antenna not markedly tapering. Claw of maxilliped with secondary denticle ..... *A. hippoglossi* Kabata, 1987

Cephalosome sometimes wider posteriorly (Fig. 41H), with buccal orifice near posterior end of ventral surface. Trunk with shallow constriction at about midlength; posterolateral processes of variable length. Total length 5.4–6.6.

Marine. Buccal cavity of *Hippoglossus stenolepis* and *Hippoglossoides elassodon*. (Pac) (Kabata 1987).

Head to trunk ratio greater than 1:5. First antenna with markedly tapering apex. Claw of maxilliped with secondary denticle ..... *A. epachthes* (Wilson, 1908)

Cephalosome small, wider posteriorly (Fig. 41C), with buccal orifice in posterior half of ventral surface. Trunk with shallow constriction at midlength; posterolateral processes short, subconical, not projecting much beyond tip of abdomen. Total length 7–9 mm.

Marine. Claspers of male *Hydrolagus colliei*. (Pac). Additional record: *Hydrolagus colliei*. (Pac) (Z. Kabata, unpublished). [Syn.: *A. holocephalarum*.]

6 First maxilla with terminal and subterminal process only ..... *A. dojirii* Kabata, 1984

Cephalosome wider posteriorly (Fig. 41E). Trunk with narrow pedigerous segments, definite constriction between posterior two thirds; posterolateral processes blunt, level with, or only slightly protruding beyond, tip of abdomen. Latter somewhat inflated at base, ovoid. Total length 5.6–6.4 mm.

Marine. Gill cavity of *Parophrys vetulus*. (Pac) (Kabata, 1984b).

First maxilla with additional, third process on medial margin 7

7 Process on medial margin of first maxilla much smaller than other two, unarmed ..... *A. vancouverensis* Kabata, 1984

Cephalosome (Fig. 41F) with roughly parallel lateral margins, buccal orifice in centre of posterior half of ventral surface; posterolateral processes tapering, only slightly projecting beyond tip of abdomen. Latter subspherical, with shallow constriction between it and genital segment. Total length 6 mm.

Marine. Nasal capsules of *Scorpaenichthys marmoratus*. (Pac) (Kabata, 1984b).

Process on medial margin of first maxilla spinulated, subequal in length to other two processes ..... *A. fraseri* Ho, 1972

Cephalosome wider posteriorly (Fig. 41G). Trunk with roughly parallel lateral margins (no constriction), posterolateral processes usually divergent, pointed, protruding some distance beyond tip of abdomen. Latter ovoid, with shallow constriction between it and genital segment. Total length 3–6 mm.

Marine. Gill cavity of *Pleuronichthys decurrens*. (Pac) (Z. Kabata, unpublished).

Acanthochondrites Oakley, 1930

This genus is monotypic. A second species, *A. japonicus*, had been described but was subsequently relegated to synonymy. *Acanthochondrites* is widespread and is known to occur on elasmobranch hosts both in the Atlantic and the Pacific. The generic diagnosis is the same as that of the only species of the genus.

Acanthochondrites annulatus (Olsson, 1869)

Female (Fig. 41I). Cephalosome with narrow antennary region and broad posterior end. Trunk with more or less parallel lateral margins, posterolateral processes short, conical. Abdomen very small, conical. Second antennae much reduced. Two pairs of peg-like legs. Total length 5–16 mm.

Male: Typical for Chondracanthidae.

Marine. Gills of *Raja laevis*. (Atl).

Family ERGASILIDAE

A group of copepods that can be considered as relatively recently adapted to parasitism, this family comprises 130 species articulated into 15 genera. The recent origin of their parasitism is evident in the fact that only their females are parasitic. The males remain free-swimming through the entire life cycle and the process of mating occurs in water, before the females find and settle on their hosts. The other indication of the recent abandonment of the free-swimming life is the slight degree of morphological adaptation to parasitism. Only two concessions to this mode of life are of note in their morphology: greatly developed second antennae that act as the attachment organs and a large, pregenital trunk, often merging imperceptibly with the cephalothorax, disrupting the original segmentation and providing storage space for the reproductive products.

As suggested by their powerfully developed second antennae, Ergasilidae have a great capacity for prehension, a capacity they use to the full. Living in habitats where firmness of prehension is vital (gills, exposed surfaces), they tend to be rather stationary, once attached. They even show a tendency to permanent attachment and in some genera to the fusion of the second antennae into a solid ring embracing a gill filament. Most of them, however, are able to change their position on the host and do so, to the host's detriment. Ergasilidae are unusal in comprising two genera parasitic on invertebrates (*Ostrincola* Wilson, 1933 and *Teredophilus* Harding, 1964). In their overwhelming majority (93 %), however, they parasitize freshwater and marine fishes. One species of *Ergasilus* (*E. chautaquaensis* Fellows, 1888) has never been found on a host. The diagnosis of the family is as follows:

Female: Cephalothorax slender or moderately to greatly inflated, of various shapes. Leg-bearing free segments usually well delimited, except for the segment bearing fifth legs, sometimes fused with genital segment to form two- or three-segmented genital complex. Latter small, subspherical. Abdomen three-segmented. First antenna five- or six-segmented, setiferous; second antenna subchelate, three-segmented (claw of subchela not considered segment by author). Mandible two-segmented, falcate, with palp. First maxilla very small, suborbicular; second maxilla falcate, two-segmented. Maxilliped absent. Four pairs of biramous legs, rami one- to three-segmented. Fifth leg uniramous, one- or two-segmented.

Male: Generally resembling female, but never with trunk and with abdomen consisting of one segment more than that of female. Appendages similar to those of female, but maxilliped present.

Two genera of Ergasilidae present in Canadian waters can be distinguished from each other with the aid of the key below.

Key to genera of Ergasilidae

Cephalothorax slightly flattened dorsoventrally, its longest axis in anteroposterior plane .... *Ergasilus*

Cephalothorax subspherical, with longest axis in dorsoventral plane ..... *Thersitina*

Ergasilus von Nordmann, 1832

The most abundant genus of Ergasilidae, *Ergasilus* comprises 68 % of its species (the next most abundant genus, *Paraergasilus* Markevich, 1937, has only about 9 %). All the comments applicable to Ergasilidae above apply also to *Ergasilus*. The diagnosis of the genus is also similar.

Female: Cephalothorax of various shapes, longer than wide or inflated into massive trunk, broader than long. Four free thoracic segments well delimited from one another, gradually diminishing in size in posterior direction. Genital segment small, subspherical. Abdomen three-segmented. First antennae five- or six-segmented, second antennae subchelate, with single terminal claw. Mouthparts and other appendages ergasilid.

Male: As in family diagnosis.

Females of 12 species of *Ergasilus* have been found on Canadian fishes. They can be identified with the aid of the key below.

Key to species of *Ergasilus*

1 Endopod of first leg two-segmented (Fig. 42C) ..... *E. versicolor* Wilson, 1911

Cephalothorax (Fig. 42A) often with deep transverse furrow at midlength. First three thoracic segments with small subconical dorsolateral swellings. Second antenna (Fig. 42B) without inflation between first and second segments, with papilliform outgrowth on inner margin of second; subchela with papilla on proximal and setule on distal part of inner margin of shaft, that of claw unarmed. Total length 1.0–1.3 mm.

Freshwater. Gills of *Ictalurus nebulosus*, *I. punctatus*, and *Noturus flavus* (or *N. gyrinus*). (Ont). Additional record: *I. nebulosus*. (Ont) (Welch cited in Lubinsky and Loch, 1979). [Syn.: *Ergasilus elegans* Wilson, 1916.]

Endopod of first leg three-segmented 2

2 No inflation between first and second segments of second antenna (Fig. 42G) .. *E. lizae* Krφyer, 1863

Cephalothorax (Fig. 42F) retaining trace of segmental border between cephalosome and first leg-bearing segment, entire tagma violin-shaped, narrower posteriorly. Second antenna (Fig. 42G) slender, with small outgrowth on inner margin of second segment; subchela with one proximal and one distal setule on inner margin of shaft, that of claw unarmed. Total length 1.1 mm.

Freshwater. Gills of *Fundulus diaphanus*. (NS).

Moderately or greatly inflated membrane between first and second segment of second antenna (Fig. 42K) 3

3 Inflated membrane between first and second segment of second antenna extending to distal end of second segment (Fig. 42I) ..... *E. cyprinaceus* Rogers, 1969

Cephalothorax (Fig. 42H) with antennary area projecting anteriorly and sharply delimited by suture lines. Conical dorsolateral swellings on first free thoracic segment; fourth free thoracic segment reduced and difficult to observe. Second antenna (Fig. 42I) without armature on inner margin of second segment and subchela. Total length 0.6–1.0 mm.

Freshwater. Gills of *Pimephales notatus* and *P. promelas*. (Ont).

Inflated membrane between first and second segments of second antenna smaller than above 4

4 Subchela of second antenna without protuberances on inner margin of shaft (Fig. 42K) 5

Subchela of second antenna with protuberances on inner margin of shaft (Fig. 43D) 7

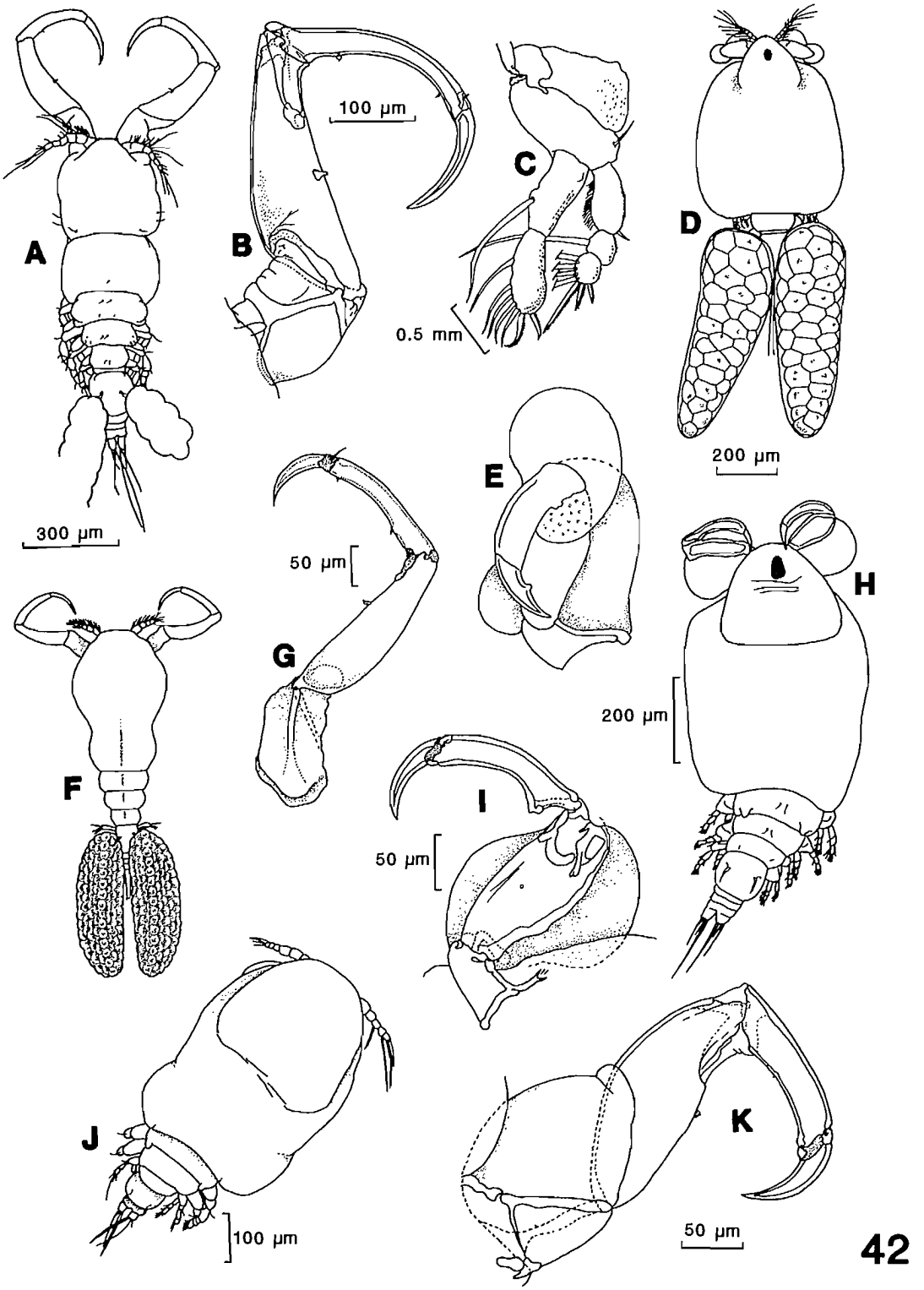

FIG. 42. A. *Ergasilus versicolor*, female, dorsal; B. Same, second antenna; C. First leg; D. *Ergasilus manicatus*, female, dorsal; E. Same, second antenna; F. *Ergasilus lizae*, female, dorsal; G. Same, second antenna; H. *Ergasilus cyprinaceus*, female, dorsal; I. Same, second antenna; J. *Ergasilus centrarchidarum*, female, dorsal; K. Same, second antenna. (A,C redrawn from Roberts 1969; B,I–K redrawn from Roberts 1970; D,E modified from Wilson 1911; F redrawn from Scott and Scott 1913; G redrawn from Kabata 1979; H redrawn from Rogers 1969).

5 Subchela of second antenna without protuberance on inner margin of claw (Fig. 42K) .... *E. centrarchidarum* Wright, 1882

Cephalothorax (Fig. 42J) with antennary area broad, extending nearly to midlength of tagma, delimited by distinct suture. First free thoracic segment with small, conical, dorsolateral swellings. Moderate inflation between first and second segment of second antenna (Fig. 42K); subchela with tiny setule on proximal part of inner margin of shaft. Total length 0.8–0.9 mm.

Freshwater. Gills of *Ambloplites rupestris*, *Catostomus catostomus*, *Lepomis auritus*, *L. gibbosus*, *L. macrochirus*, *Micropterus dolomieui*, *M. salmoides*, *Perca flavescens*, *Stizostedion canadense*, *S. vitreum vitreum*, and *S. vitreum glaucum*. All records from Ontario except for that from *Catostomus catostomus*, which was reported also from Quebec. Bere (1930a) reported this species also from *Microgadus tomcod*, a marine fish, most likely a misidentification. Additional records: *Ambloplites rupestris* and *Lepomis gibbosus*. (Ont) (Hanek 1974; Hanek and Fernando 1978a,b,c,d,e).

Subchela of second antenna with protuberance or protuberances on inner margin of claw 6

6 Balloon-like cuticular inflation at base of subchela of second antenna (Fig. 42E) .... *E. manicatus* Wilson, 1911

Cephalothorax (Fig. 42D) with protruding antennary area, subovate, but with transversely truncated posterior margin. Claw of second antenna (Fig. 42E) with single subconical tubercle on inner margin. Total length 1 mm.

Marine and brackish-water. Gills of *Menidia menidia* and *Osmerus mordax*. (Atl).

No cuticular inflation at base of subchela of second antenna (Fig. 43B) ..... *E. nerkae* Roberts, 1963

Cephalothorax (Fig. 43A) with antennary area protruding anteriorly but not delimited by sutures, lateral margin with shallow indentations. First free thoracic segment with small conical dorsolateral swellings. Second antenna (Fig. 43B) with moderate inflation between first and second segment, latter with small protuberance on inner margin. Total length 0.9–1.1 mm.

Freshwater. Gills of *Catostomus catostomus*, *C. macrocheilus*, *Couesius plumbeus*, *Mylocheilus caurinus*, *Oncorhynchus kisutch*, *O. nerka*, *Prosopium williamsoni*, *Ptychocheilus oregonensis*, *Richardsonius balteatus*, *Salmo gairdneri*, *Salvelinus namaycush*, and unidentified Salmonidae. (BC) (Alta). Additional records: *Catostomus commersoni*, *C. macrocheilus*,*Coregonus artedii*, *C. clupeaformis*, *Mylocheilus caurinus*, *Oncorhynchus nerka*, *Ptychocheilus oregonensis*, *Salmo gairdneri*,*Thymallus arcticus*. (BC) (Anonymous 1978); *Coregonus clupeaformis*. (Man) (Watson and Dick 1979); *Coregonus artedii* and *C. clupeaformis*. (Man) (Watson cited in Lubinsky and Loch 1979); *Catostomus catostomus*. (BC) (Anonymous 1981); *Coregonus artedii*, *C. clupeaformis*, *Oncorhynchus kisutch*, and *Salvelinus namaycush*. (Alta) (Leong and Holmes 1981); *Coregonus commersoni*, *C. macrocheilus*, *C. clupeaformis*, *Mylocheilus caurinus*, *Oncorhynchus nerka*, *Ptychocheilus oregonensis*, *Salmo gairdneri*, and *Thymallus arcticus*. (BC) (Arai and Mudry 1983); *Catostomus catostomus* and *Salmo gairdneri*. (BC) (Anonymous 1984). [Syn.: *Ergasilus caeruleus* of Bangham and Adams, 1954 (partim); *Ergasilus* sp. of Bangham and Adams, 1954 (partim).]

7 Inner margin of second segment of second antenna with pronounced curvature (Fig. 43D) .... *E. caeruleus* Wilson, 1911

Cephalothorax (Fig. 43C) with antennary area distinctly protruding anteriorly, 2/3 width of tagma, delimited by suture line. Small, conical, dorsolateral swellings on first free thoracic segment. Second antenna (Fig. 43D) with protuberance on inner margin of second segment; subchela with knob-like distal outgrowth on shaft, that of claw uneven, with at least one outgrowth. Total length 0.8 mm.

Freshwater. Gills of *Ambloplites rupestris*, *Anguilla rostrata*, *Carpiodes cyprinus*, *Coregonus artedii*, *C. clupeaformis*, *Cyprinus carpio*, *Esox masquinongy*, *Lepomis gibbosus*, *Lota lota*, *Micropterus dolomieui*, *Moxostoma anisurum*, *M. erythrurum*, *Notropis cornutus*, *Oncorhynchus nerka*, *Perca flavescens*, *Percina caprodes*, *Percopsis omiscomaycus*, *Petromyzon marinus*, *Pomoxis annularis*, *P. nigromaculatus*, *Prosopium cylindraceum*, *Salvelinus fontinalis* × *S. namaycush*, *Semotilus atromaculatus*, *S. corporalis*, *Stizostedion canadense*, *S. vitreum glaucum*, and *S. vitreum vitreum*. (Ont). *Catostomus catostomus* and *C. commersoni*. (Ont) (Lab). *Acrocheilus alutaceus*. (BC). Additional records: *Ambloplites rupestris* and *Lepomis gibbosus*. (Ont) (Hanek 1974; Hanek and Fernando 1978a,b,c,d,e); *Catostomus catostomus*, *C. commersoni*, *Perca flavescens*, and *Salvelinus fontinalis* × *S. namaycush*. (Ont) (Dechtiar and Berst 1978); *Catostomus*

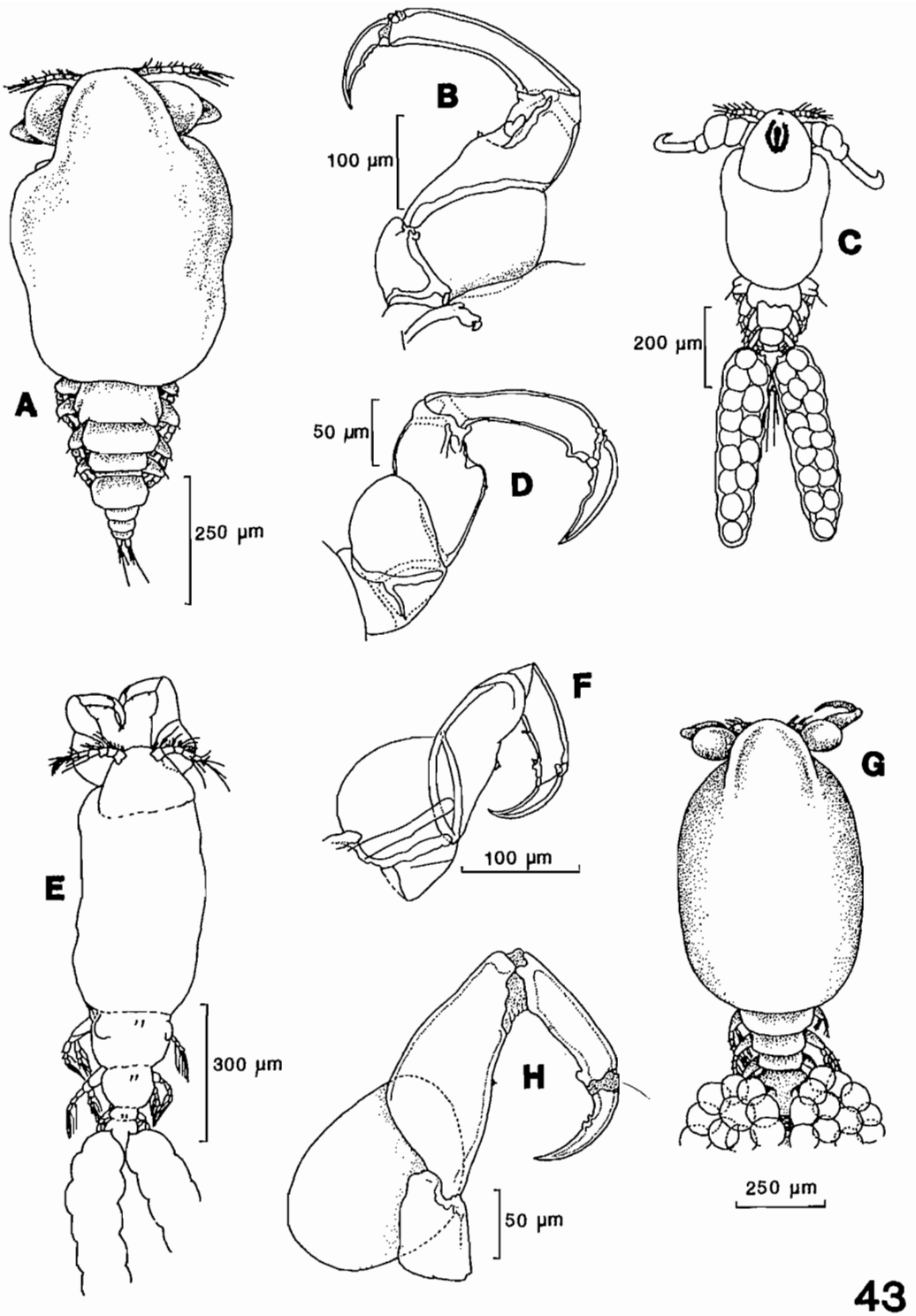

FIG. 43. A. *Ergasilus nerkae*, female, dorsal; B. Same, second antenna; C. *Ergasilus caeruleus*, female, dorsal; D. Same, second antenna; E. *Ergasilus celestis*, female, dorsal; F. Same, second antenna; G. *Ergasilus labracis*, femal, dorsal; H. Same, second antenna. (A,G,H original; B,D,F redrawn from Roberts 1970; C redrawn from Wilson 1911; E redrawn from Roberts 1969).

catostomus. (Lab) (Chinniah and Threlfall 1978). As pointed out by Margolis and Arthur (1979), due to the confusion in the taxonomy of this species, some other *Ergasilus* species were on occasions misidentified as *E. caeruleus*.

Inner margin of second segment of second antenna without pronounced curvature 8

8 Second segment of endopod in all four legs with only one seta on medial margin .... *E. celestis* Mueller, 1936

Cephalothorax (Fig. 43E) much longer than wide, with projecting antennary area delimited by indistinct sutures. First two free thoracic segments large, third much smaller; border between cephalothorax and first free thoracic segment indistinct. Second antenna (Fig. 43F) with only moderately inflated membrane between first and second segment, latter with protuberance on inner margin; subchela with two setules on inner margin of shaft, claw unarmed.

Freshwater. Gills of *Lota lota* and unspecified fishes. (Ont). *Anguilla rostrata*. (Que). [Syn.: *Ergasilus osburni* Tidd and Bangham, 1945.]

Second segment of endopod in legs 2-4 with two seta on medial margin 9

9 Claw of second antenna with two outgrowths close together on proximal part of inner margin (Fig. 43H) ..... *E. labracis* Krφyer, 1864

Cephalothorax (Fig. 43G) with antennary area protruding anteriorly but without posterior delimiting suture. Moderately large inflation between first and second segment of second antenna (Fig. 43H), protuberance on inner margin of second segment; subchela with prominent knob-like process on inner margin of shaft, at base of claw. Total length 1.0 mm.

Brackish water. Gills of *Osmerus mordax*. (Nfld) (Que) (Fréchet et al. 1983); *Morone saxatilis*. (NB) (Hogans 1985b). [Syn.: *Ergasilus funduli* of Fréchet et al., 1983.]

Claw of second antenna with only one outgrowth on proximal part of inner margin (Fig. 44D) 10

10 Cephalothorax (Fig. 44A) with trunk strongly inflated, broad, with two dorsal humps divided by transverse depression ..... *E. auritus* Markevich, 1940

Antennary area of cephalothorax projecting anteriorly, usually with pronounced ventral flexion. Fourth free thoracic segment often overlapped by third and difficult to observe. Second antenna (Fig. 44B) with very large, almost spherical inflation between first and second segment, latter with protuberance on inner margin; subchela with knob-like outgrowth on inner margin of shaft, that of claw with one outgrowth on proximal part. Total length 0.7 mm.

Euryhaline. Gills, fins and skin most commonly of *Gasterosteus aculeatus*. (Pac) (BC) (Lab) (Nfld). *Oncorhynchus kisutch* and unspecified Salmonidae. (Alta). *O. nerka* and *Salvelinus fontinalis*. (Que). Additional records: *Osmerus mordax*. (Nfld) (Threlfall 1981); *Coregonus artedii*, *C. clupeaformis*, *Salvelinus namaycush*, *Oncorhynchus kisutch*, and *Pungitius pungitius*. (Alta) (Leong and Holmes 1981). [Syn.: *Markewitschia aurita* (Markevich, 1940).]

Cephalothorax not as described above..... 11

11 Short spine on distolateral corner of first exopod segment of first leg only .. *E. turgidus* Fraser, 1920

Cephalothorax (Fig.44C) with antennary area not distinctly delimited. Second antenna (Fig. 44D) with large, subspherical inflation between first and second segment, latter with protuberance on inner margin; subchela with proximal setule and distal large knob-like outgrowth on inner margin of shaft, that of claw with one proximal outgrowth. Total length 0.8 mm.

Marine and brackish water. Gills of *Chitonotus pugetensis*, *Cymatogaster aggregata*, and *Gasterosteus aculeatus*. (Pac) (BC). Additional record: *Cymatogaster aggregata*. (BC) (Z. Kabata, unpublished).

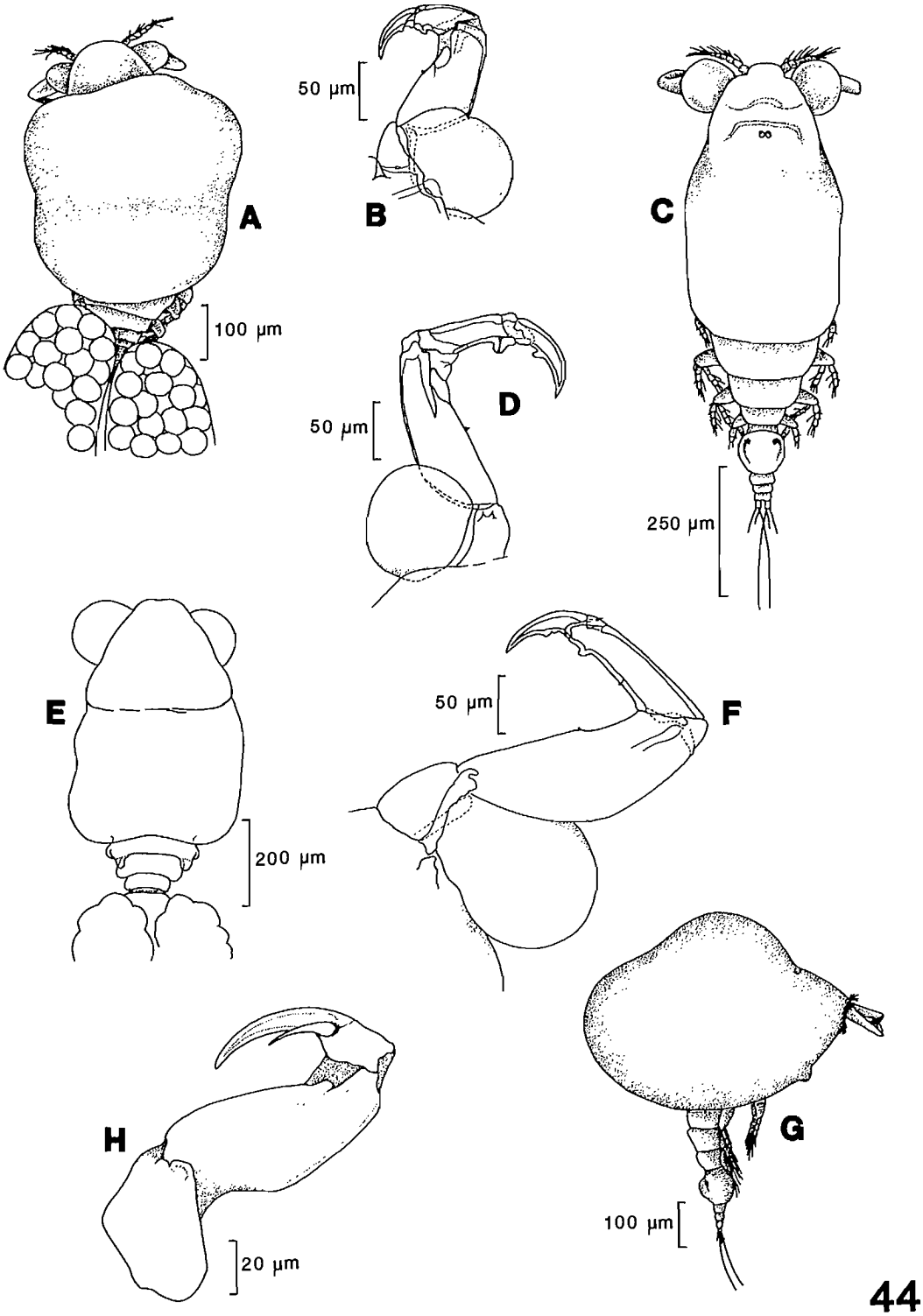

FIG. 44. A. *Ergasilus auritus*, female, dorsal; B. Same, second antenna; C. *Ergasilus turgidus*, female, dorsal; D. Same, second antenna; E. *Ergasilus luciopercarum*, female, dorsal; F. Same, second antenna; G. *Thersitina gasterostei*, female, lateral; H. Same, second antenna. (A,C original; B,D–F redrawn from Roberts 1970; G,H redrawn from Kabata 1979).

Short spines on distolateral corners of first exopod segments of legs 1–4 .....
..... *E. luciopercarum* Henderson, 1926

Cephalothorax (Fig. 44E) forming trunk, anteriorly narrower and rounded, antennary area not clearly delimited, posterior margin often re-entrant. Second antenna (Fig. 44F) with ovoid inflation between first and second segment, protuberance on inner margin of second segment reduced to small setiform process; subchela with proximal setule and distal knob-like outgrowth on inner margin of shaft, that of claw proximally uneven, with one small outgrowth. Total length 0.8 mm.

Freshwater. Gills of *Morone americana*, *Perca flavescens*, *Prosopium cylindraceum*, *Salvelinus fontinalis*, *Stizostedion vitreum vitreum*. (Lab) (Nfld) (Ont) (Que). Additional records: *Perca flavescens* and *Stizostedion vitreum*. (Ont) (Anthony 1978); *Perca flavescens*, *Stizostedion vitreum*, *S. canadense*, *Percopsis osmiscomaycus*, and *Esox lucius*. (Man) (Welch, Watson, cited in Lubinsky and Loch 1979); *Esox lucius*. (Man) (Watson and Dick 1980). [Syn.: *Ergasilus confusus* Bere, 1931.]

In addition to the species included in the above key, unidentified species of *Ergasilus* have been recorded in Canada from the following fish species: *Anguilla rostrata*, *Salmo trutta*, and *Salvelinus fontinalis* (Nfld) (Lab); *Ambloplites rupestris*, *Coregonus artedii*, *C. clupeaformis*, *Ictalurus nebulosus*, *Lepomis gibbosus*, *Micropterus dolomieui*, *Moxostoma erythrurum*, and *Notropis hudsonius* (Ont); *Hiodon alosoides*, *Notropis hudsonius*, *Notropis* sp., *Perca flavescens*, *Pungitius pungitius*, and *Stizostedion vitreum* (Man); *Coregonus artedii* (Alta) and *Cottus asper* (BC). Additional records: *Notropis hudsonius*, *Pungitius pungitius*, *Perca flavescens*, and *Stizostedion vitreum*. (Man) (Stewart-Hay and McLeod cited in Lubinsky and Loch 1979); *Catostomus catostomus* and *C. commersoni*. (Alta) (Leong and Holmes 1981); *Gasterosteus aculeatus*, *Salmo salar*, and *Salvelinus fontinalis*. (Nfld) (Cone and Ryan 1984).

Thersitina Norman, 1905

The genus *Thersitina* has been considered monotypic, its only species, *T. gasterostei*, being widespread and well known. Percival (1937) described another species, *T. inopinata*, from New Zealand, but that species has never been found again. (Hewitt and Hine (1972) do not mention it in their checklist of parasites of New Zealand fishes.) The generic diagnosis is the same as that of *T. gasterostei*, its species occurring in Canadian waters. As in *Ergasilus*, only the diagnosis of the female is given.

Thersitina gasterostei (Pagenstecher, 1861)

Female (Fig. 44G): Cephalothorax greatly inflated, its long axis at right angles to anteroposterior axis of body, often with prominent bump on anterior surface; antennary region situated ventrally. Free thoracic segment often not clearly defined, diminishing in size posteriorly. Genital complex subquadrangular, or narrower posteriorly. Abdomen three-segmented. Second antenna (Fig. 44H) subchelate. Maxilliped absent. Four pairs of biramous legs with rami three-segmented (except for two-segmented exopod of fourth leg).

Fresh or brackish water. Gill cavity or gills of *Gasterosteus aculeatus*, *G. wheatlandi*, and *Pungitius pungitius*. (Atl) (BC) (Lab) (Nfld) (Que).

Family BOMOLOCHIDAE

The copepods belonging to this family have not become greatly modified on assuming their parasitic way of life. In particular, their segmentation has remained largely intact (Fig. 45A) and their natatory appendages appear as functional as those of their free-living relatives.

The family contains currently 19 genera and 112 species, but more than half of these species are grouped in only three genera: *Bomolochus* von Nordmann, 1832, *Holobomolochus* Vervoort, 1969, and *Nothobomolochus* Vervoort, 1962.

The main reason for the bomolochids' lack of morphological adaptation is their motility on the host. They tend to inhabit relatively sheltered surfaces (e.g., inner surfaces of opercula), where they scurry around, maintaining precarious hold on the host by applying the concave sides of their cephalothoraces to the substrate, the entire cephalothorax acting as a sucker. The security of the grip is enhanced by the second antennae, capable of hooking

into the tissue of the host. Kabata (1979) pointed out the convergent similarity between this poecilostomatoid family and the siphonostomatoid Caligidae, whose mode of life bears many resemblances to that of the bomolochids. The diagnosis of the family is as follows:

Female: Cephalothorax often broader than long, with concave ventral surface; posterior margin sometimes overlapping following segment or being overlapped by it. Free, leg-bearing segments diminishing in size in posterior direction, usually (not always) distinctly delimited. Genital complex small, subcircular. Abdomen distinctly three-segmented. First antenna uniramous, setiferous. Second antenna uniramous, with endopod reflected over sympod. Oral appendages poecilostome. Maxilliped lateral to oral region. Four pairs of biramous legs, first with rami very broad and capable of closing off posterior margin of cephalothoracic suction pad; fifth leg uniramous, two-segmented.

Male: Generally resembling female, but smaller, with two-segmented abdomen.

Only two genera are present in Canadian waters and can be distinguished from each other as follows:

Key to genera of Bomolochidae

First antenna of female with fourth seta from base hooked and sclerotized (Fig. 45B) .... *Bomolochus*

No modified setae on first antenna of female ..... *Holobomolochus*

Bomolochus von Nordmann, 1832

The current number of species in this genus is 25, constituting 22 % of all bomolochid species. Small and mobile, these copepods are obviously successful parasites, though they rarely build up infections of high intensity and have not been implicated in serious damage to their hosts.

The generic diagnosis of *Bomolochus* is much the same as that of the family. As indicated in the key, its hallmark is the presence of a sharply hooked and sclerotized fourth seta on the first antenna of the female. The male has no such modified setae.

Only one identifiable species has been recorded in Canadian waters.

Bomolochus cuneatus Fraser, 1920

Female (Fig. 45A): Cephalothorax wider than long, constituting widest part of body. Fourth leg-bearing segment much smaller than third. Claw of maxilliped sigmoid, with small secondary tine on distal half and two plumose setae on proximal half. Exopod spines of legs bearing apical flagellae. Total length 1.5 mm.

Male: Similar to female, with differences as described in familial diagnosis.

Marine. Gill cavity of *Clupea harengus pallasi*, *Cymatogaster aggregata*, *Gasterosteus aculeatus*, and *Rhacochilus vacca*. (Pac). Additional records: *Clupea harengus pallasi*. (Pac) (Arthur and Arai 1980a, 1980b); *Clupea harengus pallasi*, *Cymatogaster aggregata*, *Hexagrammos stelleri*, *Leptocottus armatus*, *Rhacochilus vacca*, and *Syngnathus griseolineatus*. (Pac) (Z. Kabata, unpublished). [Syn.: *Parabomolochus cuneatus* (Fraser, 1920).]

Bere (1930b) listed names of two species of *Bomolochus* (*B. longisetosus* and *B. varians*) that she found on fishes in the Canadian Pacific. The descriptions of these species were never published, hence Bere's names must be considered nomina nuda.

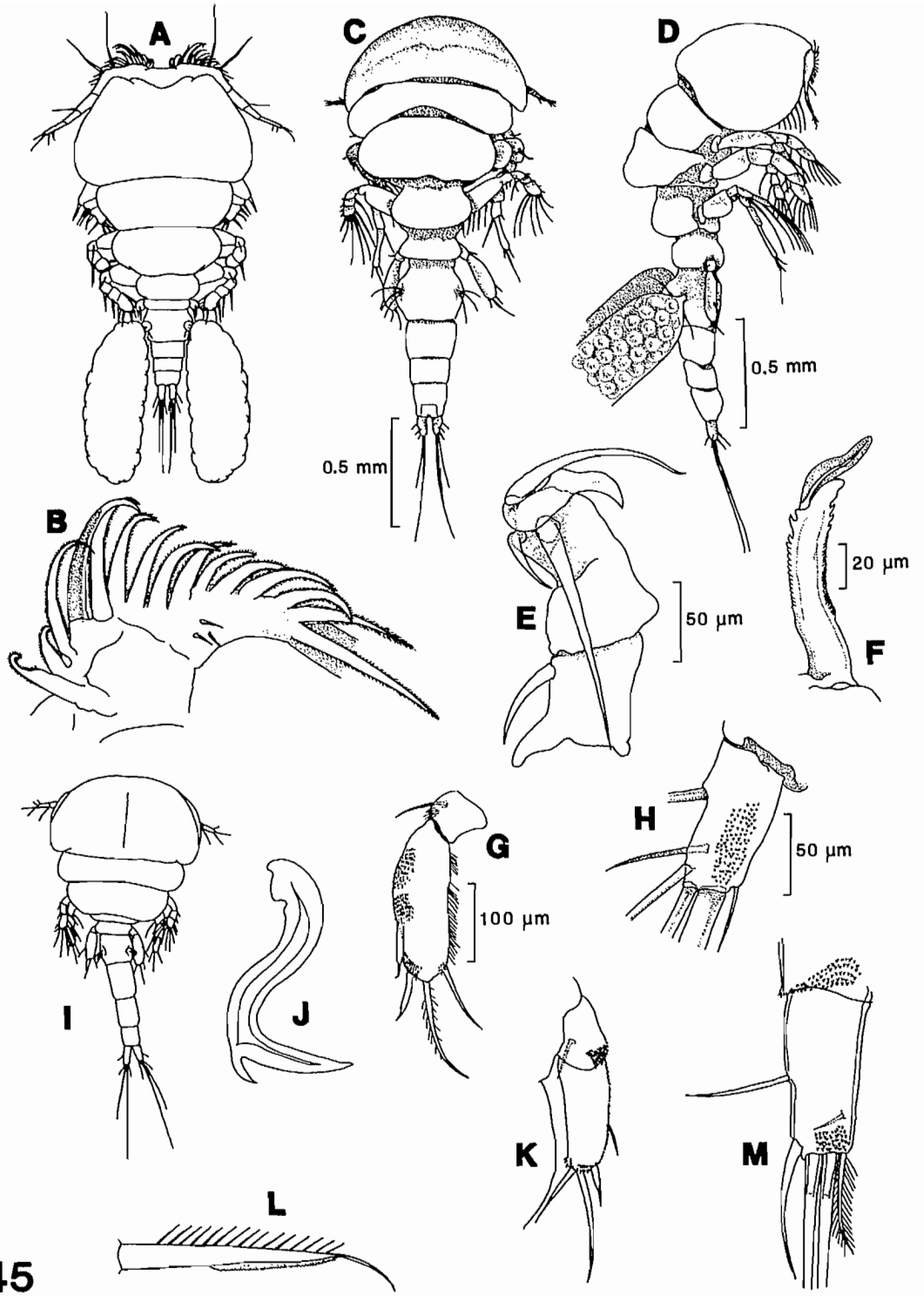

FIG. 45. A. *Bomolochus cuneatus*, female, dorsal; B. Same, proximal part of first antenna; C. *Holobomolochus venustus*, female, dorsal; D. Same, lateral; E. Maxilliped; F. Exopod spine; G. Fifth leg; H. Uropod; I. *Holobomolochus spinulus*, female, dorsal; J. Same, claw of maxilliped; K. Fifth leg; L. Exopod spine; M. Uropod. (A,B redrawn from Vervoort 1964; C–H redrawn from Kabata 1979; I–M redrawn from Cressey 1969).

Holobomolochus Vervoort, 1969

With the exception of the difference in the armature of the female first antenna, this genus does not differ from *Bomolochus*. The similarity between them is close enough to obviate the need for a separate generic diagnosis. Of 17 species of *Holobomolochus* now known, three have been found in Canadian waters. They can be recognized with the aid of the key below. The key includes only females.

Key to species of *Holobomolochus*

1 Maxilliped claw without secondary tine (Fig. 45E) ..... *H. venustus* Kabata, 1971

Cephalothorax (Fig. 45C) wider than long. Third pedigerous segment with distinct dorsal swelling (Fig. 45D), fourth narrower than third. Terminal flagella of exopod spines with membranes on two margins (Fig. 45F). Fifth leg (Fig. 45G) with one plumose and one naked seta and two spines: two or three batches of spinules on lateral planar surface of distal segment. Uropod with patch of denticles (Fig. 45H).

Marine. Gill cavity of *Scorpaenichthys marmoratus*, *Sebastes caurinus*, *S. elongatus*, *S. maliger*, *S. pinniger*, and *S. ruberrimus*. (Pac). Additional records: *Hexagrammos stelleri*. (Pac) (Z. Kabata, unpublished).

Maxilliped claw with distinct secondary tine (Fig. 45J) 2

2 Distal segment of fifth leg with four slender setae and large spinulated patch (Fig. 45K); spinulated patch on distal half of uropod (Fig. 45M) ..... *H. spinulus* (Cressey, 1969)

Cephalothorax (Fig. 45I) slightly more than one-third of body length, wider than long; fourth pedigerous segment much smaller than and partly covered by third; genital segment narrower or of equal width with fourth pedigerous segment; abdominal segments longer than wide. Distal part of maxilliped claw at right angles to proximal (Fig. 45J). Exopod spines with simple terminal flagella (Fig. 45L).

Marine. Gill cavity of *Leptocottus armatus* and *Oligocottus maculosus*. (Pac).

Distal segment of fifth leg (Fig. 46D) with one plumose seta and three flange-rimmed spines bearing simple, short terminal flagella; uropod not spinulated (Fig. 46E)..... *H. occultus* Kabata, 1971

Cephalothorax (Fig. 46A) wider than long, fourth pedigerous segment of about equal size with fifth, without dorsal prominence; genital segment larger than fourth pedigerous; abdominal segments wider than long. Maxilliped claw bent at right angles, with prominent seta near base (Fig. 46B). Exopod spines with broad flanges on two margins and short, simple flagella (Fig. 46C).

Marine. Gill cavity of *Hippoglossoides elassodon* and *Lyopsetta exilis*. (Pac). Additional records: *Hemilepidotus spinosus* and *Rhacochilus vacca*. (Pac) (Z. Kabata, unpublished).

Unidentified *Holobomolus* were collected by Dr. K. Rohde from *Cymatogaster aggregata* and *Gasterosteus aculeatus* in 1982 off the coast of British Columbia.

CYCLOPOIDA

Cyclopoida, the third suborder of Copepoda that contains many species parasitic on fishes, contribute much less to the parasite fauna of this group of hosts than the two suborders reported upon above. According to Kabata (1979), only about 5 % of copepods parasitizing fish belong to this suborder. Except for one unconfirmed record of a cyclopoid found on a fish in the Red Sea, all species are freshwater. Most of them belong to the family Lernaeidae. The only representatives of Cyclopoida reported from the Canadian fishes are members of that family.

Family LERNAEIDAE

This intriguing and important family of freshwater cyclopoids consists in its entirety of parasites of fishes. It contains about 75–85 species, belonging to 13 genera. Due to the current taxonomic confusion existing in the genus *Lernaea*, the exact number is not possible to determine. The modern approach to systematics, taking into account characteristics other than morphological, has put in doubt some long-established species.

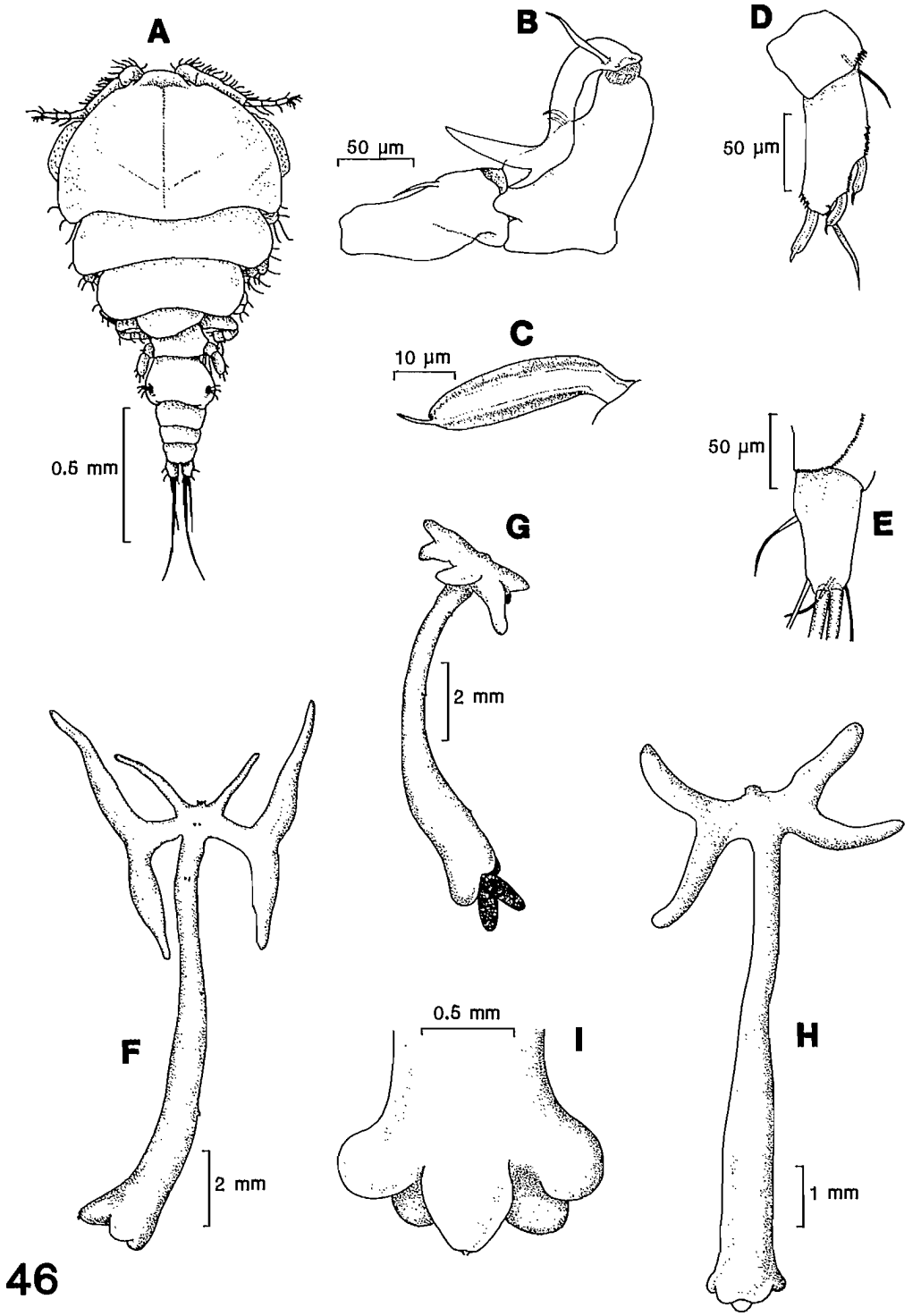

FIG. 46. A. *Holobomolochus occultus*, female, dorsal; B. Same, maxilliped; C. Exopod spine; D. Fifth leg; E. Uropod; F. *Lernaea cyprinacea*, female, ventral; G. Same, ventrolateral; H. *Lernaea cruciata*, ventral; I. Same, posterior extremity, dorsal. (A–E from redrawn Kabata 1971; F,G redrawn from Kabata 1979; H,I original).

The family is rather unevenly divided into two groups of species, the first of them not overly modified and still retaining most, or at least some, of their segmentation (40 %), the second highly metamorphosed and usually possessed of a more or less well developed holdfast as an attachment organ (60 %). Only one genus, *Lernaea*, has species living on Canadian fishes. For this reason the diagnosis of the family will be dispensed with in this account.

Lernaea L.

As mentioned above, the systematics of *Lernaea* are at present in a state of flux. It is not certain which of the over 40 nominal species of this genus will remain valid, after the period of revision initiated more than a decade ago in the USSR is finally over.

The genus has long attracted attention of scientists and fish farmers because of the devastating effects its members are capable of exerting on their hosts. Penetrating deep into the tissues of the fish and developing within them a large, though comparatively simple, holdfast, *Lernaea* causes extensive tissue damage and has been known to bring about mass kills of valuable fish stocks.

Although the free-swimming larval stages of *Lernaea* are quite similar to the related free-living cyclopoids, the adult females are changed out of all recognition by a process of metamorphosis seldom equalled among Copepoda. The extent of the change can be gauged from the generic diagnosis.

Post-metamorphosis female: Diminutive, semispherical cephalothorax followed by well developed holdfast. Latter consisting of simple, or dividing branches. Neck, following holdfast, subcylindrical, gradually expanding posteriorly into trunk ending in terminal swelling or swellings and subconical abdomen. Appendages cyclopoid, minute, difficult to observe.

The males of *Lernaea* are not parasitic; they die after mating without undergoing metamorphosis. They will not be included in this account.

It should be noted that *Lernaea* displays a fair degree of variability in the structure of its holdfast and posterior extremity. Spurious small outgrowths might occur on the branches of the holdfast, or some parts of it might be missing. The posterior extremity might also vary in the number and shape of its lobes.

Two species of *Lernaea* occurring in Canada can be distinguished from each other as follows:

Key to species of *Lernaea*

Holdfast (Fig. 46F) of two pairs of branches: larger pair T-shaped, smaller pair simple, usually short and thin ..... *L. cyprinacea* L.

Branches of holdfast either in anteroposterior plane or perpendicular to long axis of body. Trunk ending in bilobed prominence ventrally, with subconical abdomen displaced obliquely dorsad (Figs. 46F,G). Total length 10–20 mm.

Freshwater. Anterior part embedded in musculature, posterior protruding. *Carassius auratus*, *Cyprinus carpio*, *Lepomis gibbosus*, *L. macrochirus*, and *Semotilus atromaculatus*. (Ont).

Holdfast (Fig. 46H) of single pair of Y-shaped branches..... *L. cruciata* (Le Sueur, 1824)

Trunk ending in bilobed ventral prominence; pair of subspherical dorsolateral lobes flanking subconical abdomen (Fig. 46I). Total length 8–15 mm.

Freshwater. Anterior part embedded in musculature, posterior protruding. *Ambloplites rupestris*. (Que) (Lewis and Doucet 1981; Lewis and Fairchild 1984); *Lepomis gibbosus*. (Que) (Lewis, Doveau and Doucet 1984).

Appendix to Copepoda

In addition to adult copepods parasitizing fishes, early stages of these parasites are sometimes encountered, attached to fish or even free-swimming in plankton. These small, immature copepods are usually very difficult to identify, unless they occur in association with identifiable adults. The younger the age the greater is the degree of morphological similarity. This state of affairs is not surprising. The variety in the morphology of parasitic copepods is a reflection of differences in the degree of adaptation to parasitism and the type of the host-parasite relationship. These features develop gradually in the course of ontogeny. Their absence during early life means that the very young copepods display mainly characteristics masked in later life, inherited from their free-living ancestors.

Although it is next to impossible to identify these early stages to the specific level, they usually can be placed in a family taxon without undue difficulty. Knowing which adult copepods of that family parasitize a particular fish species, one can then deduce the identity of the juveniles with a fair measure of certainty.

Juvenile copepods most frequently encountered on Canadian fishes belong to three families: Caligidae, Pennellidae, and Lernaeopodidae. All of them pass through a copepodid stage, followed by several so-called chalimus stages. The copepodids initiate the association with the fish. Attaching themselves at first with their second antennae, aided by the maxillipeds, they make their hold on the fish secure by extruding from their frontal region and implanting in the tissues of the host a unique structure known as the frontal filament. All chalimus stages are attached, while they undergo extensive morphogenesis that transforms them eventually into pre-adults whose structure foreshadows the definitive habitus of the adult copepod. This appendix will give characteristic features of the copepodids and early chalimus stages of all three above-mentioned families, adding some later stages likely to be encountered on Canadian fishes.

The Copepodid Stage

The copepodids bear a close resemblance to one another. A caligid copepod is shown in Fig. 47A, a pennellid in Fig. 47D, and a lernaeopodid in Fig. 47G. All of them have well-developed cephalothoraces, usually suboval or obovate, and a thoraco-abdominal posterior part, usually four-segmented, the last segment representing the abdomen. All of them also have two pairs of well-armed, biramous legs. The best way to place a copepodid in an appropriate family is to examine its second antenna. To do this, one must mount it on a slide ventral side up and look at it at a low to medium magnification. The second antenna of caligid copepodids (Fig. 47B) is recognizable by being folded upon itself. Pointing mediad from its base, it flexes so that its apex is far on the lateral side of the base. The second antenna of the pennellid copepodid (Fig. 47E) is typically subchelate, with a very strong, opposable claw. The lernaeopodid second antenna at this stage (Fig. 47H) is biramous, its exopod often sporting three long setae and its endopod ending in a uniform claw.

The Chalimus

The number of chalimus stages differs from genus to genus, but the most common number is four. Chalimi appear as simplified versions of copepodids, their segments much less definite or absent, their appendages less efficient, their legs with reduced armature. The caligid chalimus (Fig. 47C) can be recognized by the fact that its frontal filament is always attached to the margin of its frontal region and is usually quite long. At later stages one can distinguish between the chalimus of *Caligus* and *Lepeophtheirus*, the former showing rudiments of lunules through the cuticle of its anterolateral margins. The pennellid chalimus is also attached by the frontal margin, but its frontal filament is short, sometimes completely embedded in the tissues of the fish. In contrast, the lernaeopodid chalimus (Fig. 47I) holds its frontal filament in its second maxillae. The filament itself is fairly long.

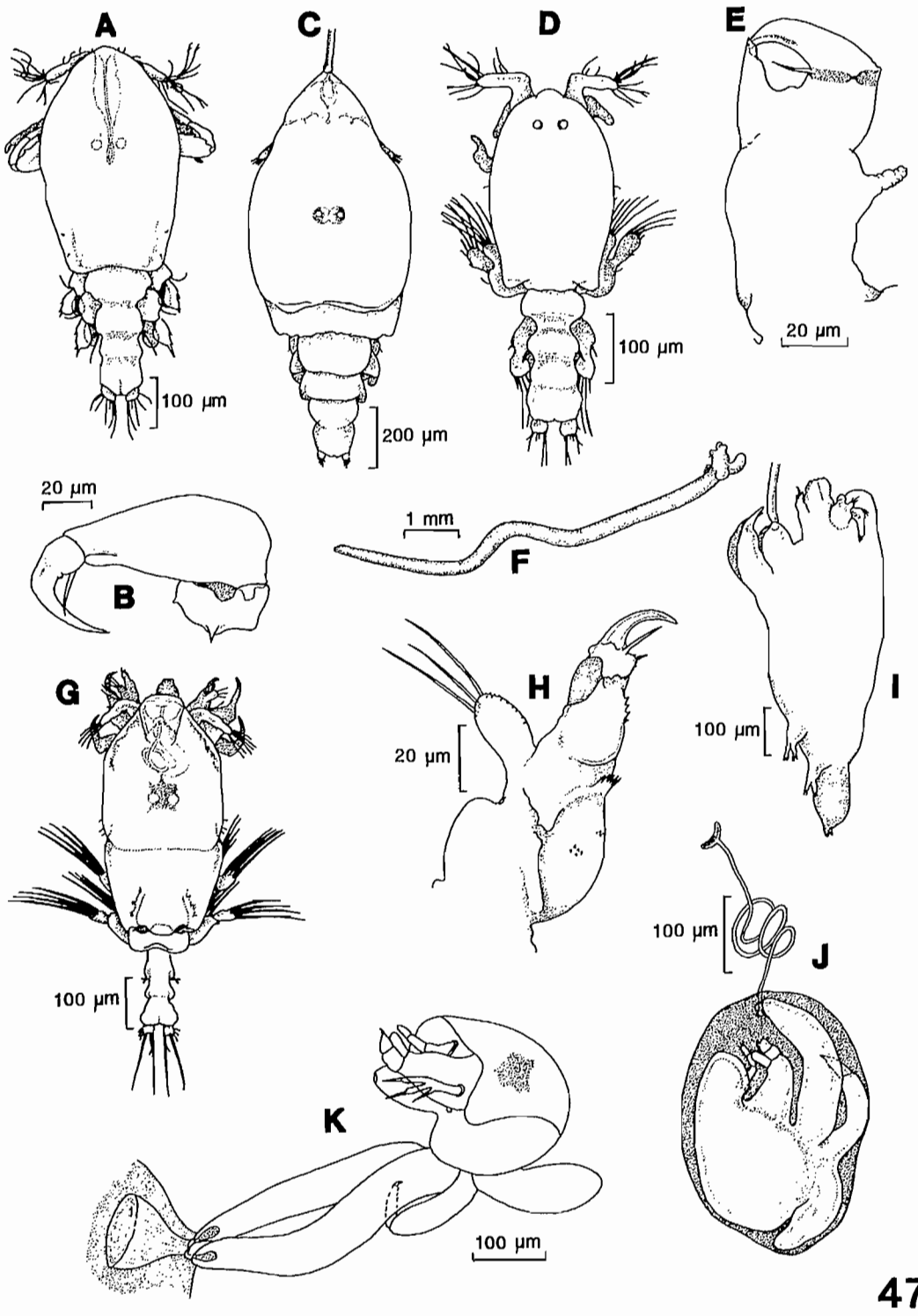

FIG. 47. A. *Caligus clemensi*, copepodid, dorsal; B. Same, second antenna; C. Same, second chalimus stage; D. *Haemobaphes diceraus*, copepodid, dorsal; E. Same, second antenna; F. *Lernaeocera lusci*, juvenile female; G. *Salmincola californiensis*, copepodid, dorsal; H. Same, second antenna; I. Same, first chalimus stage; J. *Clavella adunca*, "pupa"; K. Same, juvenile female. (A-C redrawn from Kabata 1972; D,E redrawn from Kabata 1976b; F redrawn from Kabata 1979; G–I redrawn from Kabata and Cousens 1973; J,K redrawn from Heegaard 1947).

Some Post–Chalimus Stages

While the chalimus of Caligidae gives rise to the pre-adults resembling the adults in most respects, those of the other two families undergo a profound transformation. The post-chalimus females of Pennellidae elongate and assume a vermiform habitus (Fig. 47F), later becoming either long and straight or sigmoid. Their holdfasts develop at the same time. Some Lernaeopodidae (*Clavella* and its relatives) pass through a "pupal stage" (Fig. 47J), which is followed by a juvenile stage still different from the final adult condition. At that stage (Fig. 47K) they have well-developed second maxillae acting as a part of the attachment organ, well formed though not yet elongate cephalothoraces and diminutive trunks. The final shape will be assumed by gradual elongation of the cephalothorax and growth of the trunk.

INTRODUCTION TO BRANCHIURA

A rather small group of crustacean parasites, comprising fewer than 150 species grouped in five genera, Branchiura are more important than their relatively small numbers would suggest. They are particularly important in freshwater aquaculture, where their harmful impact upon fish can assume devastating proportions.

Although unequivocally parasitic, Branchiura are capable of spending prolonged periods without a host. They mate while free-swimming and deposit their eggs in characteristic clusters on various submerged objects. They are also capable of moving from fish to fish. Most species are only loosely specific.

The main features of branchiuran morphology are illustrated in Fig. 48, depicting the ventral surface of *Argulus alosae*, a member of the most common genus of the group. The hallmark of the group is the dorsal shield, reminiscent of a somewhat similar structure in Caligidae (p. 9). It varies in shape from orbicular to oval and covers all appendages, except one or two posterior pairs of legs. Near its anterior margin, the ventral surface carries two pairs of antennae, with accessory spines immediately posterior to them. In the genus *Argulus* (though not in other genera) a preoral stylet and mouth are situated in the midventral line some distance behind the antennae. At about the same level are found the most prominent of the branchiuran appendages, the first maxillae, in the genus *Argulus* modified to form cup-like suckers with strongly reinforced walls and with margins of membrane. Posterior to them are the second maxillae, uniramous appendages with three powerful spines and variously armed plates on their bases. Two pairs of accessory spines are located in the space between the second maxillae and the bases of the first pair of legs. Along both lateral margins of the shield, the ventral surface bears outlines of two enclosed spaces, known as the respiratory areas, their name indicating their presumed function. The dorsal surface of the shield bears a pair of compound eyes. The abdomen, largely or completely visible from the dorsal aspect, is bilobed, its shape being fairly characteristic for each species, though varying somewhat from individual to individual. Its shape differs also between the sexes. Four pairs of legs are arranged between the accessory spines of the second maxillae and the base of the abdomen.

KEY TO BRANCHIURA

The Canadian fauna contains only one genus of Branchiura, *Argulus*. Its diagnosis will serve for identification of the entire group.

Argulus O.F. Müller, 1785

This genus is far and away the largest among Branchiura, comprising over 120 species, i.e., about 85 % of their entire number. Roughly a quarter of them are marine, the remaining ones parasitize freshwater teleosts. As pointed out above, the characteristic features of *Argulus* are the sucker-like, modified first maxillae and the preoral stylet. *Argulus* is slightly dimorphic sexually, but the differences between sexes are not significant enough to preclude determination of the specific identity of either sex. This account, therefore, will be limited to the females of the species. The generic diagnosis of *Argulus* is as follows:

Branchiura. Dorsal shield flat, orbicular to oval, with posterolateral lobes. Abdomen of variable size and shape but invariably bilobed. Two pairs of antennae and preoral stylet present. Mouth tubular, enclosing strongly denticulated mandibles. First maxilla modified into sucker, second uniramous, with strong plate and three spines on base. Maxilliped absent. Four pairs of legs present.

The identification key below is largely based on a small number of highly diagnostic characters, the same for both sexes: the shape and position of the respiratory areas, the number and shapes of sclerites forming supporting rods of the membranous rims of the maxillary suckers and the armature of the basal plate of the second maxilla.

Ten species of *Argulus* have been recorded from Canadian fishes.

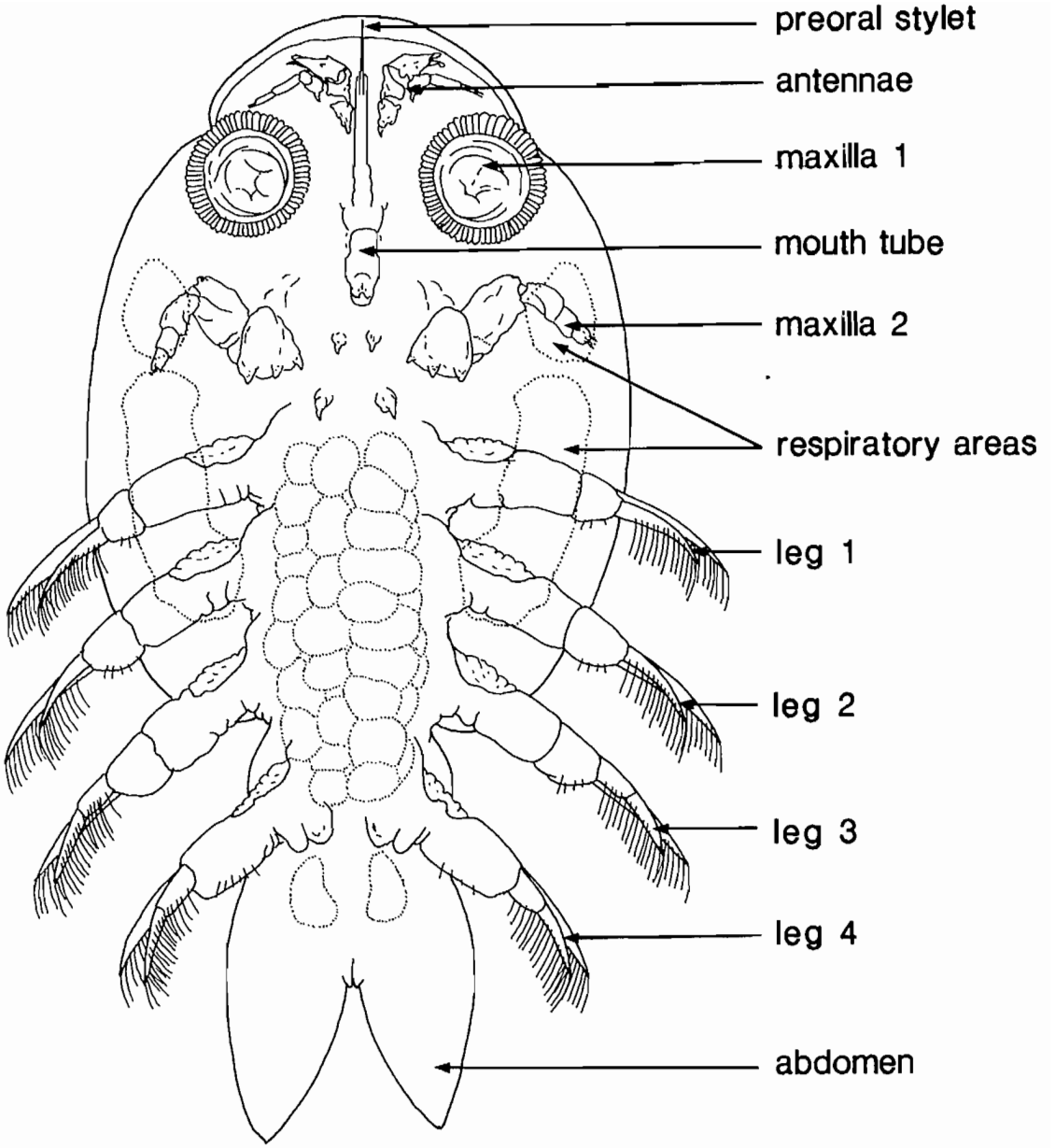

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FIG. 48. *Argulus alosae*, ventral surface. (Modified from Cressey 1978).

Key to species of *Argulus*

1 Smaller respiratory area entirely or in part medial to larger area (Fig. 49B) 2

Smaller respiratory area entirely anterior to larger area (Fig. 51H) 5

2 Postantennary spine bifid (Fig. 49C) ..... *A. versicolor* Wilson, 1902

Shield suborbicular (Fig. 49A), cleft between posterolateral lobes half length of shield. Abdomen almost completely exposed in dorsal aspect, long and narrow, cleft between lobes extending close to its base. Smaller respiratory area (Fig. 49B) entirely medial to larger area, near its anterior end. Antennary spines short and blunt (Fig. 49C). No armature on base of mouth tube. Supporting rods of maxillary sucker (Fig. 49D) comprising 4–7 sclerites. Basal spines of second maxilla (Fig. 49E) of subequal size, plate with few ctenoid scales and long, almost transparent setae. Total length: female 6 mm, male 4.5 mm.

Freshwater. Fins of *Percopsis omiscomaycus* and *Stizostedion vitreum vitreum*. (Ont).

Postantennary spine single 3

3 Smaller respiratory area club-shaped, only partly overlapping larger area (Fig. 49G) ..... *A. stizostethii* Kellicott, 1880

Shield (Fig. 49F) suboval, much longer than wide, with shallow indentations of margins at ocular level; posterolateral lobes about 1/3 length of shield, not overlapping abdomen. Latter longer than wide, cleft between lobes about half length of abdomen, lobes pointed. Antennary and postantennary spines short but pointed (Fig. 49H). Base of mouth tube with few ctenoid scales (Fig. 49I). Supporting rods of maxillary cup comprising 11–16 sclerites (Fig. 49J). Basal spines of second maxilla subequal, slender; plate with many sparsely set scales with even margins (Fig. 49K). Total length: female 12 mm, male 8.5 mm.

Freshwater. Fins and body surface of *Acipenser fulvescens*, *Catostomus commersoni*, *Coregonus artedii*, *Coregonus* sp., *Gasterosteus aculeatus*, *Notropis hudsonius*, *Perca flavescens*, *Salmo salar*, *Salvelinus fontinalis*, *Stizostedion vitreum vitreum*, unspecified stickleback, and unspecified sucker. (Man) (Nfld) (NS) (Ont). Additional records: *Coregonus artedii* and *C. clupeaformis*. (Man) (Watson and Dick 1979); *Coregonus artedii*, *C. clupeaformis*, and *Esox lucius*. (Man) (Watson cited in Lubinsky and Loch 1979); *Catostomus commersoni* and *Stizostedion vitreum*. (Man) (Stewart-Hay cited in Lubinsky and Loch 1979); *Esox lucius*. (Man) (Watson and Dick 1980). [Syn.: *Argulus canadensis* Wilson, 1916.]

Smaller respiratory area entirely medial to larger area 4

4 Supporting rod of maxillary cup consisting of two long sclerites only (Fig. 50D) ..... *A. appendiculosus* Wilson, 1907

Shield suborbicular, often slightly longer than wide (Fig. 50A), cleft between posterolateral lobes about 1/4 length of shield. Abdomen slightly longer than wide, cleft between lobes more than 1/2 length of abdomen, lobes broad but pointed, completely exposed in dorsal aspect. Smaller respiratory area (Fig. 50B) roughly rounded, entirely medial to larger area; latter expanding mediad posteriorly. Antennary spines reduced or absent, postantennary long and slender (Fig. 50C). Mouth tube without spines or scales near base. Basal spines of second maxilla broad and blunt, subequal, plate with sparse, large scales and few short setae near margin (Fig. 50E). Total length: female 7–15 mm, male up to 10 mm.

Freshwater. Fins of *Cyprinus carpio*, *Ictiobus cyprinellus*, and *Stizostedion canadense*. (Ont) (Sask). Additional records: *Catostomus commersoni* and *Stizostedion vitreum*. (Ont) (T. A. Dick, unpublished).

Supporting rods of maxillary cups consisting of 7–11 sclerites (Fig. 50H) ..... *A. catostomi* Dana and Herrick, 1837

Shield suborbicular (Fig. 50F), cleft between posterolateral lobes less than 1/3 length of shield, lobes barely reaching base of abdomen. Latter suborbicular, only slightly longer than wide, cleft between lobes shallow (less than 1/5 length of abdomen), lobes with rounded apices. Smaller respiratory area (Fig. 50G) roughly rounded, mediad to larger area. Latter with posterior part expanding inwards. Basal spines of

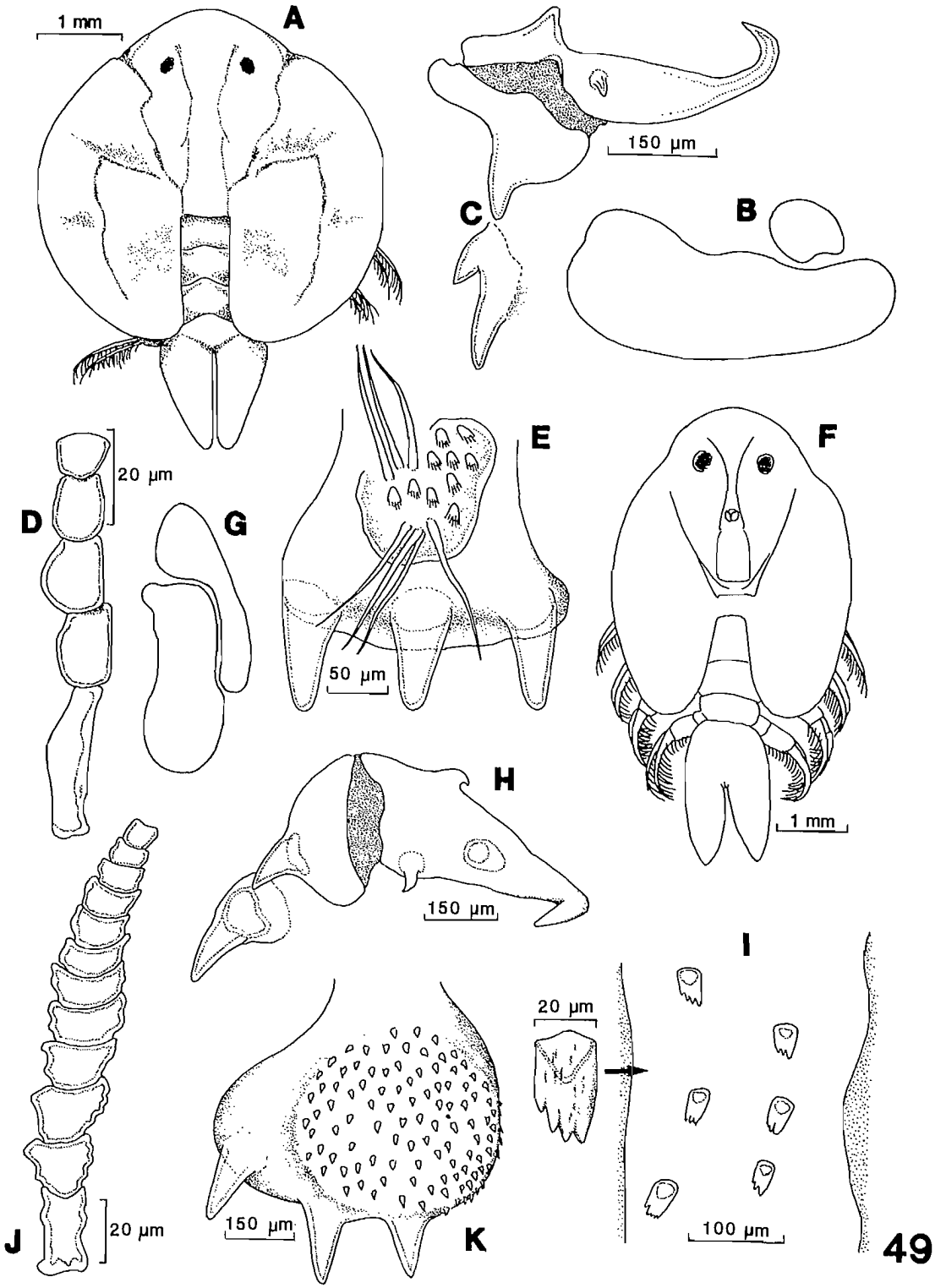

FIG. 49. A. *Argulus versicolor*, female, dorsal; B. Respiratory areas; C. Antennary and postantennary spines; D. Maxillary supporting rod; E. Base of second maxilla; F. *Argulus stizostethii*, female, dorsal; G. Respiratory areas; H. Antennary and postantennary spines; I. Scales on base of mouth tube; J. Maxillary supporting rod; K. Base of second maxilla. (B,G redrawn from Cressey 1978; F redrawn from Wilson 1902; other figures original).

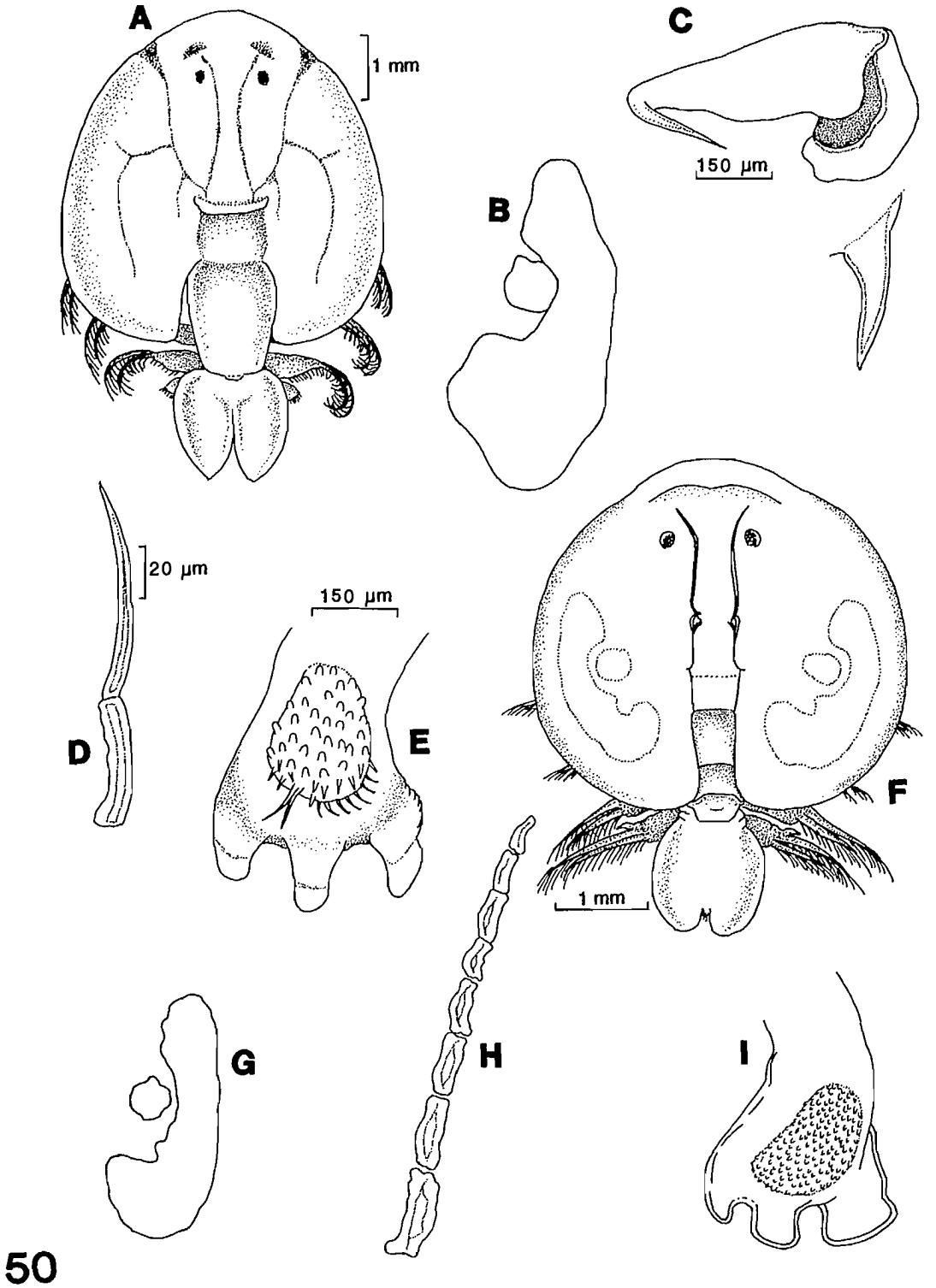

FIG. 50. A, *Argulus appendiculosus*, female, dorsal; B. Respiratory areas; C. Antennary and postantennary spines; D. Maxillary supporting rod; E. Base of second maxilla; F. *Argulus catostomi*, female, dorsal; G. Respiratory areas; H. Maxillary support rod; I. Base of second maxilla. (F modified from Wilson 1907b; G,H redrawn from Cressey 1978; I redrawn from Cressey 1972; other figures original).

second maxilla broad and somewhat spatulate, lateral wider than other two (Fig. 50I); plate with numerous, closely set scales. Total length: female up to 12 mm, male up to 6 mm.

Freshwater. Fins of *Catostomus commersoni*, *Etheostoma exile*, *E. nigrum*, *Ictalurus melas*, and *Semotilus atromaculatus*. (Ont).

5 Mouth tube with spines or scales on basal half (Fig. 51D) 6
Mouth tube with basal half unarmed 9

6 Basal teeth of second maxilla very short, broad, with irregularly denticulated margins and narrow strips of membrane (Fig. 51F) ..... *A. funduli* Krøyer, 1863

Shield suborbicular (Fig. 51A), with marked concavities in anterolateral margins; cleft between posterolateral lobes about 1/4 of length of shield, lobes not reaching base of abdomen. Latter distinctly longer than wide, cleft between lobes about 1/4 length of abdomen, lobes rounded. Smaller respiratory area (Fig. 51B) roughly oval, anterior to larger, gap between them about equal to diameter of smaller area. Antennary and postantennary spines blunt, latter with broad base (Fig. 51C). Base of mouth tube with cluster of ctenoid scales (Fig. 51D). Supporting rods of maxillary cups consisting of 15–22 sclerites (Fig. 51E). Basal plate of second maxilla armed with closely set ctenoid scales (Fig. 51F). Total length: female 5 mm, male 3.5 mm.

Marine. Skin and fins of *Fundulus heteroclitus*, *Menidia menidia*, *Pseudopleuronectes americanus*, and *Pungitius pungitius*. (Atl).

Basal teeth of second maxilla not as above 7

7 Armature of basal part of mouth tube consisting of spines (Fig. 51J) ..... *A. alosae* Gould, 1841

Shield oval (Fig. 51G), with indentations in anterolateral margins, cleft between posterolateral lobes with divergent inner margins, 1/3 length of shield; lobes not reaching base of abdomen. Latter longer than wide, cleft between lobes less than 1/2 length of abdomen, lobes pointed. Smaller respiratory area (Fig. 51H) anterior to larger, with small gap between them. Postantennary spines (Fig. 51I) broad-based, short, and blunt. Supporting rod of maxillary cup consisting of 8–11 sclerites (Fig. 51K). Basal spines of second maxilla (Fig. 51L) slender and pointed, subequal; plate with numerous spines similar to those on mouth tube. Total length: female up to 12 mm, male up to 6 mm.

Marine and brackish water. Skin of *Microgadus tomcod*. Found also free swimming. (Atl). (Wilson (1920) suggested also *Gasterosteus wheatlandi*.) Additional record: *Acipenser brevirostrum*. (NB) (Appy and Dadswell 1978).

Armature of basal part of mouth tube consisting of scales 8

8 Fewer than 10 scales on basal part of mouth tube (Fig. 52D); sclerites of maxillary rods narrow (Fig. 52E) ..... *A. borealis* Wilson, 1912

Shield roughly oval (Fig. 52A), with slight depressions in anterolateral margins, cleft between posterolateral lobes 1/4 length of shield; lobes not reaching base of abdomen. Latter oval, with very shallow cleft between lobes. Smaller respiratory area (Fig. 52B) anterior to, and widely separated from, larger area. Antennary and postantennary spines (Fig. 52C) long and slender. Supporting rods of maxillary cups consisting of 5–9 sclerites (Fig. 52E). Basal spines of second maxillae subequal, long and pointed; plate with sparse spatulate scales and tuft of setae (Fig. 52F). Total length: female up to 8.5, male up to 4 mm.

Marine. Body surface of *Hippoglossoides elassodon*, *Lepidopsetta bilineata*, and *Sebastes caurinus*. (Pac). Additional record: *Cymatogaster aggregata*. (Pac) (Z. Kabata, unpublished).

Large part of anterior wall of mouth tube covered with spatulate scales (Fig. 52J); sclerites of maxillary supporting rods short and broad (Fig. 52K) ..... *A. megalops* Smith, 1874

Shield elliptical (Fig. 52G), with deep indentations in anterolateral margins and subtriangular posterior sinus about 1/3 length of shield; posterolateral lobes reaching third pair of legs. Abdomen oval, cleft between broad abdominal lobes less than 1/4 length of abdomen. Smaller respiratory area (Fig. 52H) anterior to larger, with narrow gap between them. Antennary and postantennary spines long, slender and

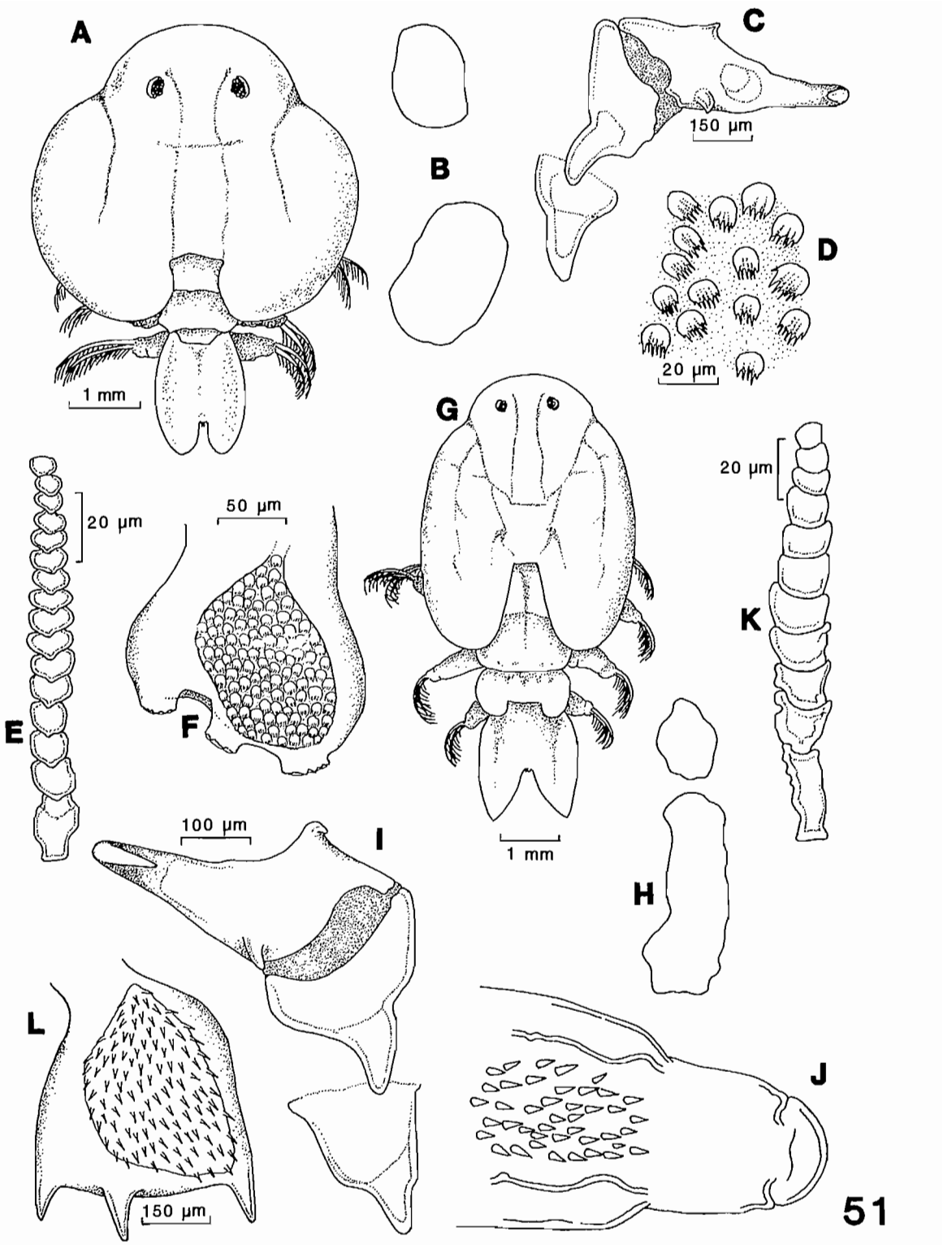

FIG. 51. A. *Argulus funduli*, female, dorsal; B. Respiratory areas; C. Antennary and postantennary spines; D. Cluster of spines from base of mouth tube; E. Maxillary supporting rod; F. Base of second maxilla; G. *Argulus alosae*, female, dorsal; H. Respiratory areas; I. Antennary and postantennary spines; J. Mouth tube; K. Maxillary supporting rod; L. Base of second maxilla. (B,H,J redrawn from Cressey 1978; other figures original).

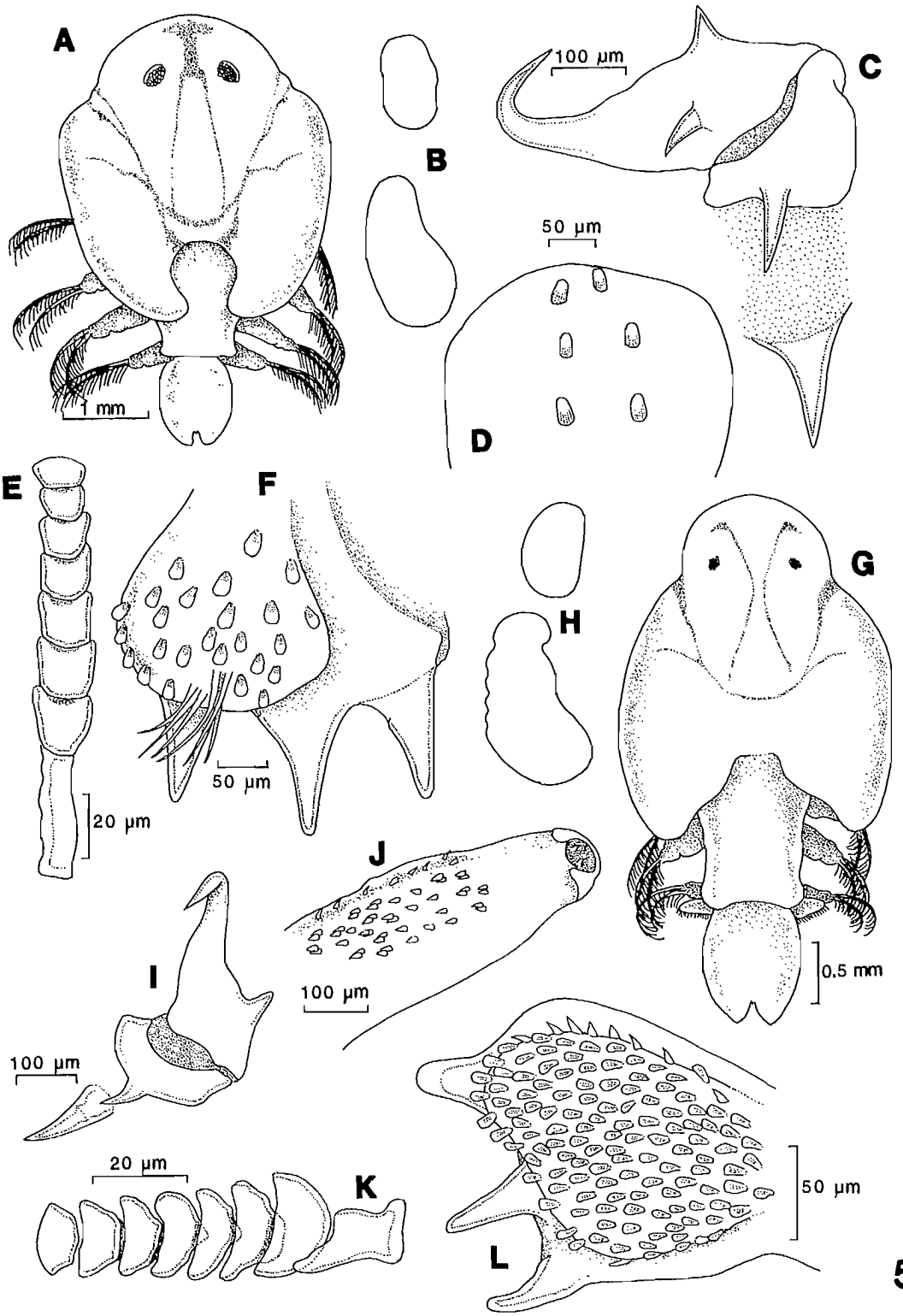

FIG. 52. A. *Argulus borealis*, female, dorsal; B. Respiratory areas; C. Antennary and postantennary spines; D. Base of mouth tube; E. Maxillary supporting rod; F. Base of second maxilla; G. *Argulus megalops*, female, dorsal; H. Respiratory areas; I. Antennary and postantennary spines; J. Mouth tube; K. Maxillary supporting rod; L. Base of second maxilla. (B redrawn from Meehan 1940; H redrawn from Cressey 1972; other figures original).

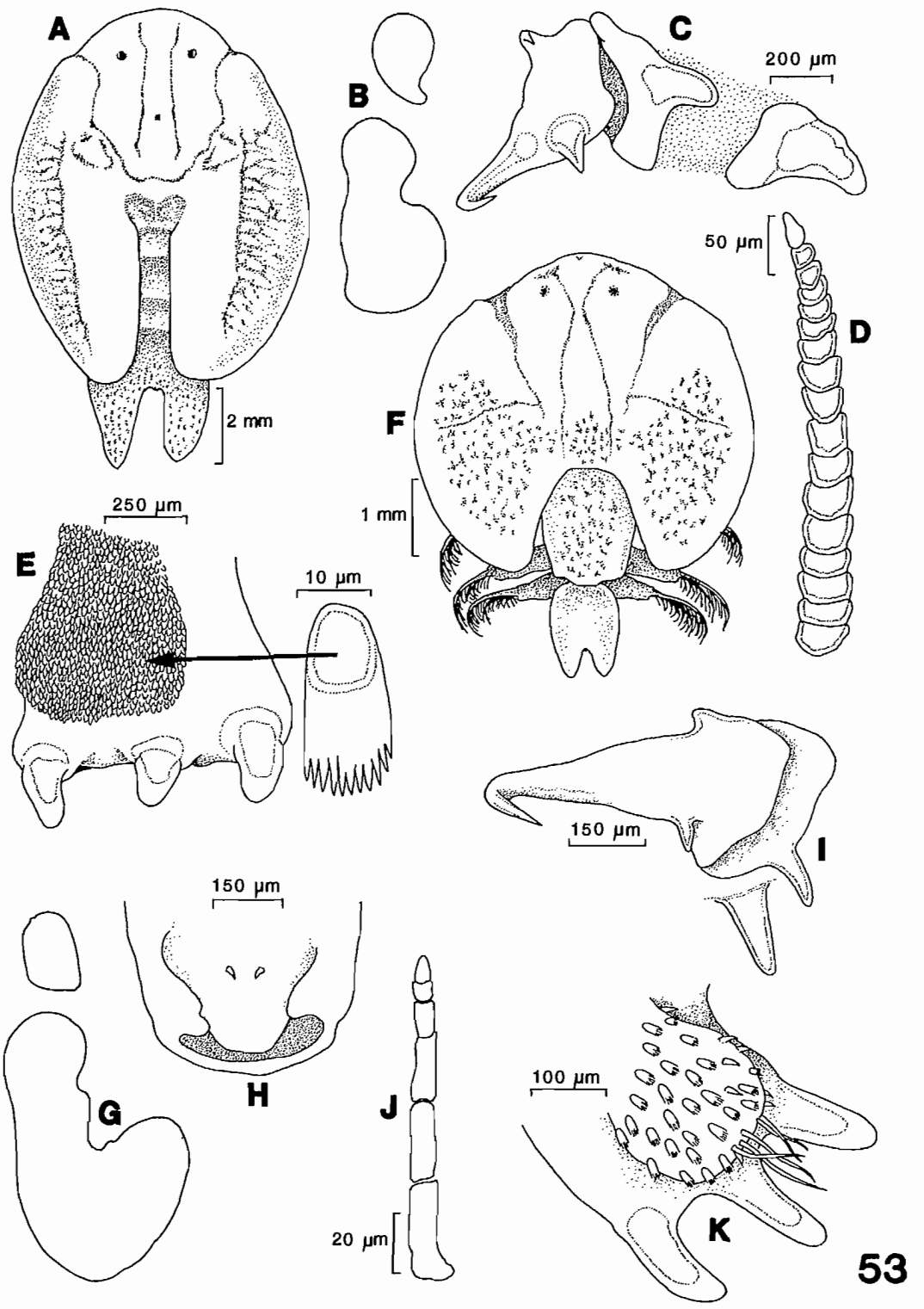

FIG. 53. A. *Argulus pugettensis*, female, dorsal; B. Respiratory areas; C. Antennary and postantennary spines; D. Maxillary supporting rod; E. Base of second maxilla (single scale enlarged); F. *Argulus flavescens*, female, dorsal; G. Respiratory areas; H. Tip of mouth tube; I. Antennary and postantennary spines; J. Maxillary supporting rod; K. Base of second maxilla. (G redrawn from Meehan 1940; other figures original).

sharp (Fig. 52I). Supporting rods of maxillary cups consisting of 4–9 sclerites (Fig. 52K). Basal spines of second maxilla digitiform (Fig. 52L), lateral spine thicker than other two; plate with numerous spatulate scales. Total length of both sexes 5–7 mm. [Syn.: *Argulus megalops* var. *spinosus* Wilson, 1944.]

Marine. Body surface of *Pseudopleuronectes americanus*. (Atl).

9 Supporting rods of maxillary cups with more than 10 sclerites (16–18 in female, 7–10 in male)(Fig. 53D) ..... *A. pugettensis* Dana, 1852

Shield oval (Fig. 53A), with small notches in anterolateral margins, cleft between posterolateral lobes less than 1/2 length of shield, lobes overlapping nearly half of abdomen. Latter longer than wide, cleft between lobes about half length of abdomen, lobes irregularly shaped, pointed. Smaller respiratory area (Fig. 53B) anterior to larger, with narrow gap between them; medial margin of larger lobe indented. Antennary and postantennary spines short, blunt and stout (Fig. 53C). Base of mouth tube unarmed. Basal spines of second maxilla (Fig. 53E) short and blunt; plate with numerous, crowded, ctenoid scales. Total length: female up to 18 mm, male up to 8 mm.

Marine. Body surface of *Cymatogaster aggregata*, *Embiotoca lateralis*, *Phanerodon furcatus*, *Rhacochilus vacca*, *Salmo gairdneri*, and *Sebastes caurinus*. (Pac). Additional record: *Hexagrammos stelleri*. (Pac) (Z. Kabata, unpublished).

Supporting rods of maxillary cups with fewer than 10 (usually 4–6) sclerites (Fig. 53J) ..... *A. flavescens* Wilson, 1916

Shield suborbicular (Fig. 53F), cleft between posterolateral lobes about 1/3 length of shield, lobes reaching base of abdomen. Latter oval, cleft between lobes about 1/4 length of abdomen. Smaller respiratory area (Fig. 53G) anterior to larger, with narrow gap between them, larger area with medial expansion posteriorly. Antennary and postantennary spines long, digitiform (Fig. 53I). Base of mouth tube unarmed but two denticles present near tip of upper lip (Fig. 53H). Basal spines of second maxilla long, robust, with rounded tips (Fig. 53K); plate with sparse ctenoid scales and tuft of setae. Total length: female up to 6 mm, male up to 4 mm.

Freshwater. Found free swimming. (NS). [Syn.: *Argulus piperatus* Wilson, 1920.]

In addition to the species listed in the key, unspecified *Argulus* have been reported from unspecified small fishes in the Atlantic and from *Coregonus artedii* and *Percopsis omiscomaycus* in Ontario. In the foregoing account *Argulus canadensis* has been treated as a junior synonym of *Argulus stizostethii*, on the authority of Meehan (1940) and Cressey (1972, 1978). The latter author did not include *A. canadensis* in his keys and implicitly considered it synonymous with *A. stizostethii*. (Dr. R. Cressey kindly confirmed this in a personal communication.) However, the matter is not definitively resolved. Further studies might prove the validity of *A. canadensis*.

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ISOPODA

FAHMIDA RAFI

ABSTRACT

RAFI, F. 1988. Isopoda, p.129–148. *In* L. Margolis and Z. Kabata [ed.] Guide to the parasites of fishes of Canada. Part II. Crustacea. Can. Spec. Publ. Fish. Aquat. Sci. 101: 184 p.

This account gathers together information on Isopoda either known to be parasitic on fishes in Canadian waters, or strongly suspected of occurring on them. Together with isopods recorded in Canada, it includes those known to occur close to the Canadian borders, or straddling them in distribution (i.e., known to occur both to the north and south of Canada). In all, 11 species of Isopoda qualify for inclusion. They are all members of the suborder of Flabellifera and belong to two families: Aegidae (3 genera, 9 species) and Cymothoidae (1 genus, 2 species).

This first comprehensive account of Isopoda parasitic or presumed to be parasitic on Canadian fishes provides an introduction to isopod morphology and keys to identification of all species, with illustrations sufficient to facilitate their use.

RÉSUMÉ

RAFI, F. 1988. Isopoda, p.129–148. *In* L. Margolis and Z. Kabata [ed.] Guide to the parasites of fishes of Canada. Part II. Crustacea. Can. Spec. Publ. Fish. Aquat. Sci. 101: 184 p.

Le présent travail regroupe des données sur les Isopoda parasites des poissons des eaux canadiennes ou considérés capables d'être présent sur ces poissons. En plus des espèces d'Isopoda signalées au Canada, il contient de l'information sur les espèces présentes dans les eaux frontalières ou dont les aires de répartition se chevauchent (espèces présentes au nord et au sud du Canada). Au total, 11 espèces d'Isopoda sont décrites. Elles appartiennent toutes au sous-ordre Flabellifera et sont réparties dans deux familles, soit Aegidae (3 genres, 9 espèces) et Cymothoidae (1 genre, 2 espèces).

Cette première vue d'ensemble des espèces d'Isopoda parasites ou considérés parasites des poissons des eaux canadiennes fournit une introduction à la morphologie des Isopoda et des clés d'identification de toutes les espèces accompagnées d'illustrations.

INTRODUCTION

The order Isopoda belongs to the superorder Peracaridae, subclass Malacostraca, class Crustacea of the phylum Arthropoda (Table 1). Its species are commonly known as sow-bugs, pill-bugs, woodlice, water slaters, and gribbles. Isopods can easily be distinguished from other peracarids by having a dorsoventrally flattened body, the head fused to the first (rarely second) thoracic somite to form a cephalothorax; no carapace; eyes sessile; antenna 1 always uniramous; thorax with six or seven somites, each bearing a pair of uniramous appendages; abdomen composed of six somites, usually one or more somites fused with the telson to form a pleotelson; five pairs of biramous abdominal appendages; and a pair of biramous uropods attached to the telson laterally or ventrally.

More than 10,000 species of isopods occur worldwide. The majority of them occur in the marine environment from littoral to abyssal zones. Others occur in estuarine and fresh water, and a few are wholly terrestrial. The majority of isopods are free-living although some are commensals or parasites. All of the species in one suborder, Epicaridea, are parasitic on Crustacea.

The parasitic isopods found on fishes all belong in the suborder Flabellifera G.O. Sars, 1899 (Table 1). They are well adapted to their parasitic way of life and can cause considerable damage to the host tissues at the infection site.

TABLE 1. Classification of isopods parasitic on Canadian fishes.

Phylum: Arthropoda
Subphylum: Crustacea
Class: Malacostraca
Superorder: Peracarida
Order: Isopoda
Suborder: Flabellifera
Family: Aegidae
Genus: *Syscenus*
Rocinela
Aega
Family: Cymothoidae
Genus: *Lironeca*

Flabellifera are isopods with the body usually flattened and possessing seven peraeonal somites and six pleonal somites inclusive of the pleotelson. There are seven pairs of peraeopods and five pairs of pleopods. The uropods are situated laterally and form a tail-fan with the pleotelson. Mouthparts are developed for biting, chewing, slicing, or piercing. The suborder Flabellifera is composed of two dissimilar groups: the sphaeromid type, in which the pleon consists of minute pleonite 1, a large pleonite 2 formed by fusion of the remaining pleonites, and a swollen pleotelson; and the cirolanid type with a pleon of five clearly visible pleonites plus the pleotelson. The parasitic isopods of fishes belong to the latter group.

The general structure of a parasitic isopod is illustrated in Fig. 1, depicting the morphology of *Rocinela*, a common genus of the family Aegidae. The body is divided into three regions: the cephalon (head), peraeon (thorax) and pleon (abdomen).

The cephalon bears anteriorly a pair of antennules (antenna 1) and a pair of, usually larger, antennae (antenna 2), each consisting of a proximal peduncle and distal flagellum. The mouthparts are paired appendages found in a large buccal mass ventral to the cephalon. They are the mandibles and maxillae (maxilla 1 and maxilla 2). These appendages are shielded below by a pair of maxillipeds. The mouth opening is bordered anteriorly by the labrum, posteriorly by the bilobed paragnath, and laterally by the mandibles. The mouthparts are modified for piercing and sucking. The mandibles lack a lacinia mobilis and the incisor is blade-like. Maxilla 1 consists of a single, slender stylet with apical and subapical spines. Maxilla 2 is bilobed with terminal and lateral spines. The maxilliped palp is 2- to 5-segmented, the distalmost segment bears strong recurved or slightly curved spines.

The peraeon has well defined coxal plates on peraeonites 2–7. The paired uniramous legs of each peraeonite, the peraeopods, consist of seven articles. All seven pairs of peraeopods are prehensile in the family Cymothoidae, whereas in Aegidae only peraeopods 1–3 are prehensile. The terminal article (dactyl) of the prehensile peraeopods is as long as or longer than the penultimate (propod) segment. The tip of the dactyl has very sharp claws for clinging to the body of the host.

The abdomen consists of five free pleonites; the sixth pleonite is fused with the telson to form a pleotelson. Each pleonite bears a pair of biramous, lamelliform appendages, the pleopods. These typically serve as gills and as swimming appendages. The pleotelson bears a pair of uropods, each of which bears an inner (endopod) and outer (exopod) ramus arising from the peduncle.

The flabelliferan parasitic isopods of fishes are found throughout the world, virtually in all habitats, though by far the greatest number are marine. They are important parasites in certain freshwater environments of South America and Africa, where they infect fishes used locally for food (Brusca 1981). In North America they are restricted to brackish and marine waters; no freshwater occurrences have ever been reported.

Records of parasitic isopods from fishes in Canada are few. Of a total of 47 genera and 360 species of Flabellifera only 4 genera and 11 species are so far recorded from Canada or adjacent waters. The present work contains keys to these genera and species, and their diagnoses and illustrations. The records include those mentioned in Margolis and Arthur (1979) and papers published up to the end of 1985. Numbers in parentheses after each host name correspond with the numbers assigned to the references. Some isopods, known to be parasitic, have been found in Canadian waters not associated with any host fish. They, too, have been included in this account, as potential parasites of Canadian fishes.

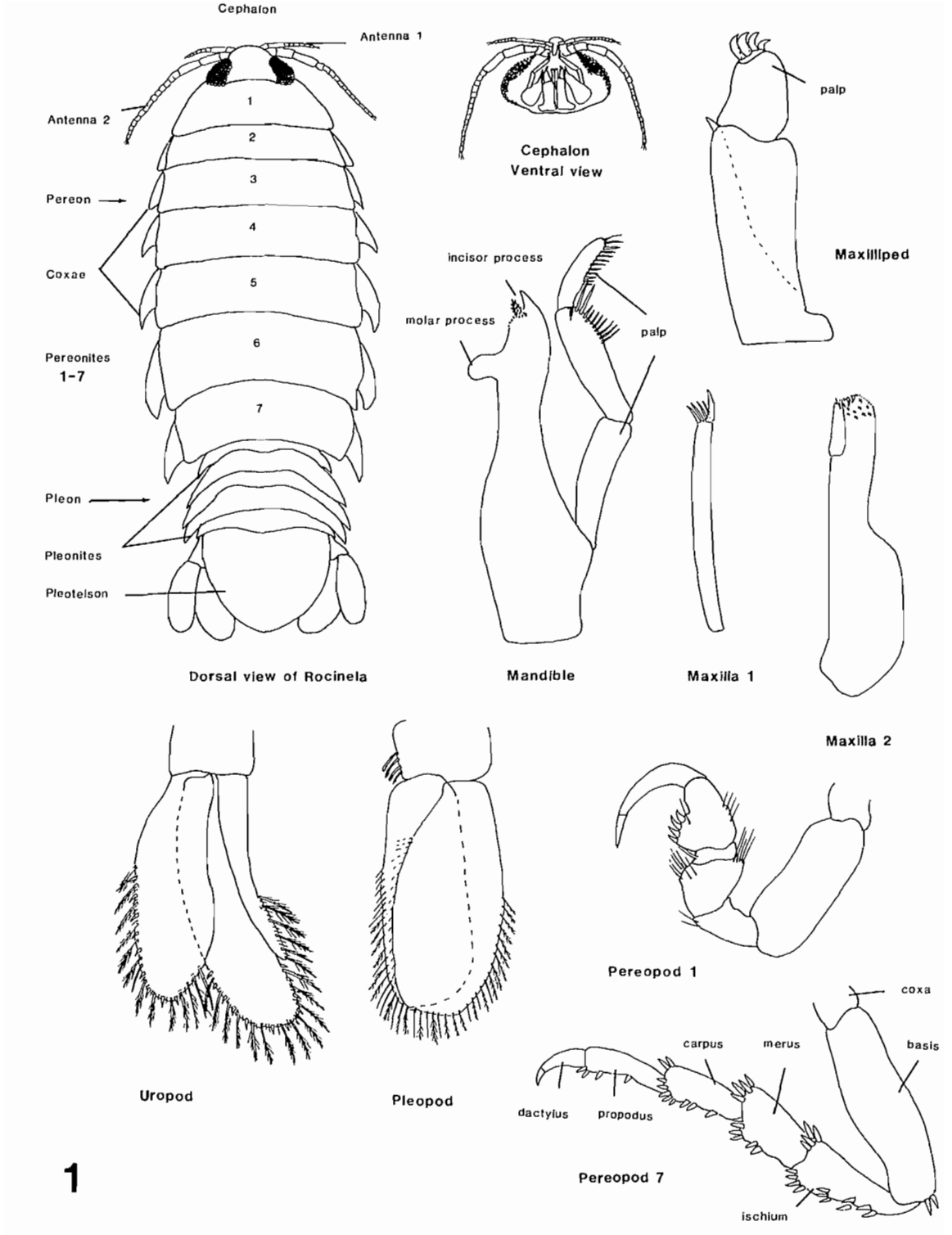

FIG. 1. General structure of Flabellifera.

KEYS TO ISOPODA

Key to families of parasitic Flabellifera

Peduncle and flagellum of antennae well developed; peraeopods 1–3 prehensile; pleotelson and uropods marginally spinose and setose ..... Aegidae Leach, 1815

Segments of antennary peduncle not distinguishable from those of flagellum; peraeopods 1–7 prehensile; pleotelson and uropods without marginal setae and spines ..... Cymothoidae Dana, 1852

Family AEGIDAE Leach, 1815

Body of cirolanid facies (see p. 000), but large and robust. Peduncle of both antennae well defined. Peraeopods 1–3 distinctly prehensile; dactyls longer than propods and somewhat recurved; all peraeopods spinose or setose. Pleotelson and uropods with marginal setae and spines.

Sexual dimorphism is not prominent. Members of this family are "temporary parasites," not known to display host specificity. There are five valid genera of Aegidae in the world (Brusca and Iverson 1985), of which three are known to occur in Canada (*Syscenus, Rocinela,* and *Aega*).

Key to genera of Aegidae

1 Pleon abruptly narrower than peraeon; eyes wanting; peraeopods 1–3 lacking spines ..... *Syscenus* Harger, 1880

Pleon not narrower than peraeon; eyes present; peraeopods 1–3 spinose or setose 2

2 Maxilliped palp two-segmented, terminal segment with recurved spines; mandible with palp segments 1 and 2 subequal; propod of peraeopod 1 with spine-bearing lobe .... *Rocinela* Leach, 1818

Maxilliped palp five-segmented, with straight or recurved spines; mandible with palp segment 2 longer than segment 1; propod of peraeopod 1 without spine-bearing lobe ..... *Aega* Leach, 1818

Syscenus Harger, 1880

Body elongated, pleon narrower than peraeon. Frontal margin of cephalon not forming a rostrum. Maxilliped palp two-segmented. Mandibular palp with proximal (first) segment longer than middle (second) segment. Peraeopods 1–3 without expanded propod; dactyl strongly curved and terminating in very sharp point.

One species in Canadian waters.

Syscenus infelix Harger, 1880

Frontal margin of cephalon forming median triangular process with concavity at each side of base; eyeless; posterolateral margins of head rounded; anterolateral angles of peraeonite 1 forming notch. Coxae of peraeonites 4–7 extending outward with pointed posterior angles (Fig. 2A). Antenna 1 peduncular segments robust, with few setae (Fig. 2B). Antenna 2 peduncular segments 4–5 and flagellum laterally setose (Fig. 2C). Distal segment of maxilliped with 2 curved spines at apex (Fig. 2D). Maxilla 1 with 1 large apical spine and 5 subapical and lateral small spines on each lobe (Fig. 2F). Peraeopod 1 with few setae but no spines (Fig. 2H). Uropod rami marginally setose; protopod not expanded (Fig. 2K).

Host: Unknown. (Atl). Records: Brunel (1961, 1970); Ledoyer (1975).

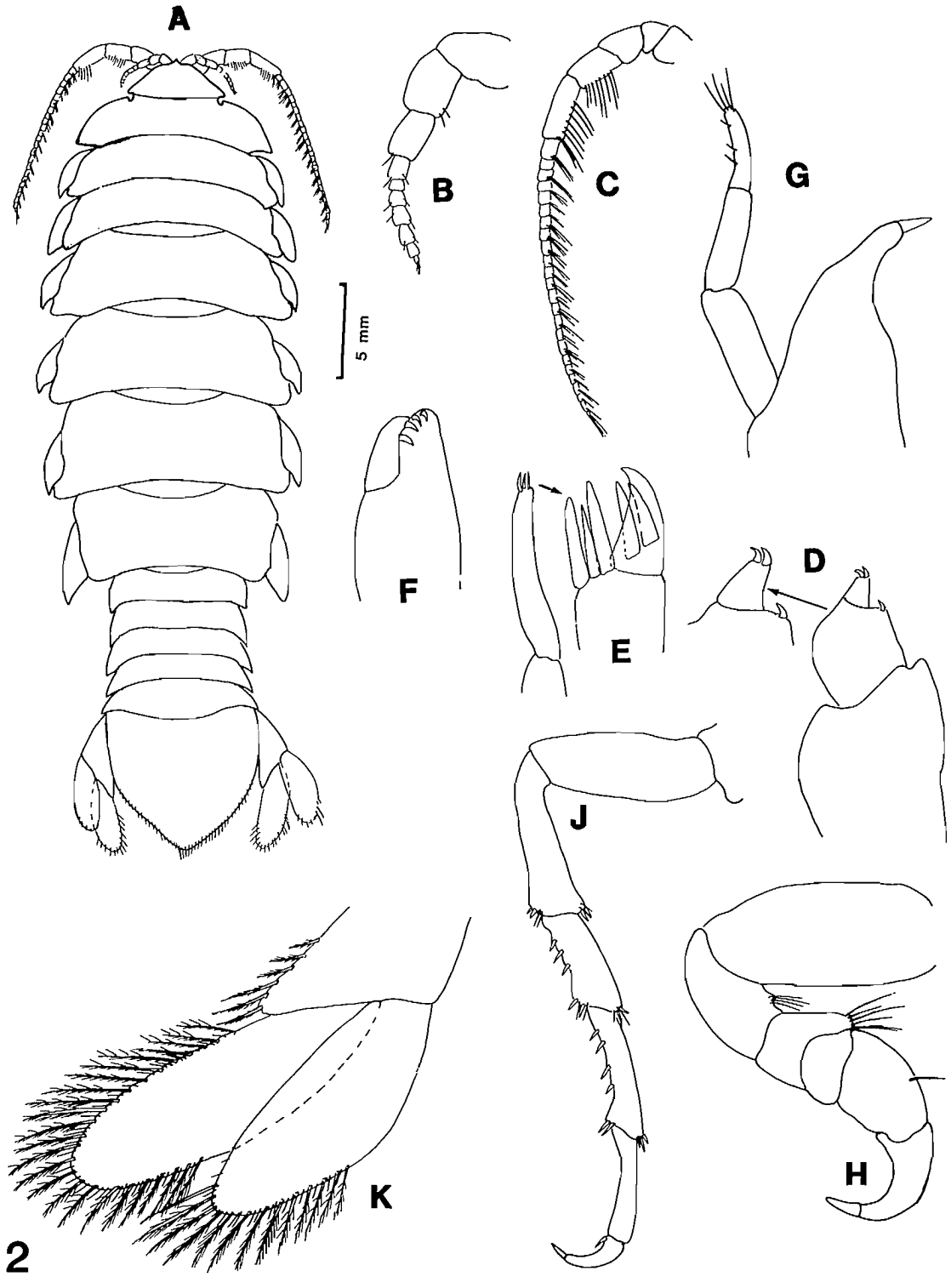

FIG. 2. *Syscenus infelix*. A. Dorsal view; B. Antenna 1; C. Antenna 2; D. Maxilliped; E. Maxilla 1; F. Maxilla 2; G. Mandible; H. Pereopod 1; J. Pereopod 7; K. Uropod.

Rocinela Leach, 1818

Body depressed, pleon not much narrower than peraeon. Eyes well developed. First two segments of antennary peduncle not expanded. Mandible with linguiform lamella. Propod of peraeopods 1–3 more or less expanded and spinose, dactyl very large, unciform. Peraeopods 4–7 with propod short.

Six species of *Rocinela* have been recorded in Canadian waters or in areas closely adjacent to them

Key to species of *Rocinela*

1 Frontal margin of cephalon produced anteriorly to form a large rostrum 2

Frontal margin of cephalon rounded or triangular, not forming a rostrum 4

2 Frontal margin of cephalon trifid, with large subspatulate rostrum and subquadrate basal protuberance (Fig. 3) ..... *Rocinela tridens* Hatch, 1947

Posterolateral angles of coxae acute. Terminal segment of maxilliped palp with 4 slightly recurved apical spines (Fig. 3D) Maxilla 1 distally bearing 2 slender spines and strong claw-like tooth (Fig. 3E). Median margin of maxilla 2 with row of setae; outer lobe broadly rounded, with denticle, inner lobe apically produced as triangular tooth (Fig. 3F). Incisor process of mandible claw-like, with bidentate accessory lobe (Fig. 3G). Propod of peraeopod 1 with strong arcuate lobe bearing 6–7 spines at distal inner margin; merus with 5 sucker-like spines (Fig. 3H).

Host: Unknown. (Pac). Records: Hatch (1947); George and Stromberg (1968); Kozloff (1974). Although the above records are not, strictly speaking, Canadian, they all came from an area only a few miles distant from the Canadian border. It can be assumed that *R. tridens* is present also in Canadian waters. The figures of mouthparts and appendages were taken from George and Stromberg (1968).

Cephalon with simple median rostrum with rounded apex 3

3. Anterolateral angles of peraeonite 1 greatly expanded to form projections parallell to rostrum (Fig. 4) ..... *Rocinela cornuta* Richardson, 1898

Frontal margin of cephalon forming elongate median rostrum with lateral convexity. Coxae or peraeonites 5–7 with posterior angles barely pointed (Fig. 4A). Terminal segment of maxilliped palp with 4 small and 1 large apical spines (Fig. 4D). Maxilla 2 with 1 long apical spine on inner lobe and 2 small apical spines on outer lobe (Fig. 4F). Propod of peraeopod 1 with 3 blunt spines at inner distal margin (Fig. 4H). Inner margin of peraeopod 7 with small spines (Fig. 4J). Uropod rami heavily setose and spinose (Fig. 4K).

Host: Unknown. (Atl). Record: Brinkhurst et al. (1976). This species has been recorded from Alaska by Richardson (1899, 1905) and its presence off the Pacific coast of Canada cannot be excluded.

Anterolateral angles of peraeonite 1 forming no projections parallel to rostrum (Fig. 5) ..... *Rocinela angustata* Richardson, 1898

Frontal margin of cephalon forming broad median rostrum with truncate apex; posterior angles of coxae 4–7 acute (Fig. 5A1). Maxilliped palp with 6 recurved and straight apical and subapical spines on terminal segment (Fig. 5D). Maxilla 1 with apical claw-like spine and 5 lateral setae (Fig. 5E). Inner and outer lobes of maxilla 2 with 2 recurved spines and few semilunar scales dorsally (Fig. 5F). Mandibular molar process extending outward to form a lobe (Fig. 5G). Propod of peraeopod 1 with 4 curved lateral spines (Fig. 5H). Inner margin of peraeopod 7 with long spines and setae (Fig. 5J). Uropod rami setose, exopod spinose (Fig. 5K).

Hosts: *Raja binoculata* (2,3,4); unspecified halibut (2,3,4); no host mentioned (1,5) (Pac). Records: (1) Richardson (1905); (2) Hatch (1947); (3) George and Stromberg (1968); (4) Kozloff (1974); McDaniel et al. (1978).

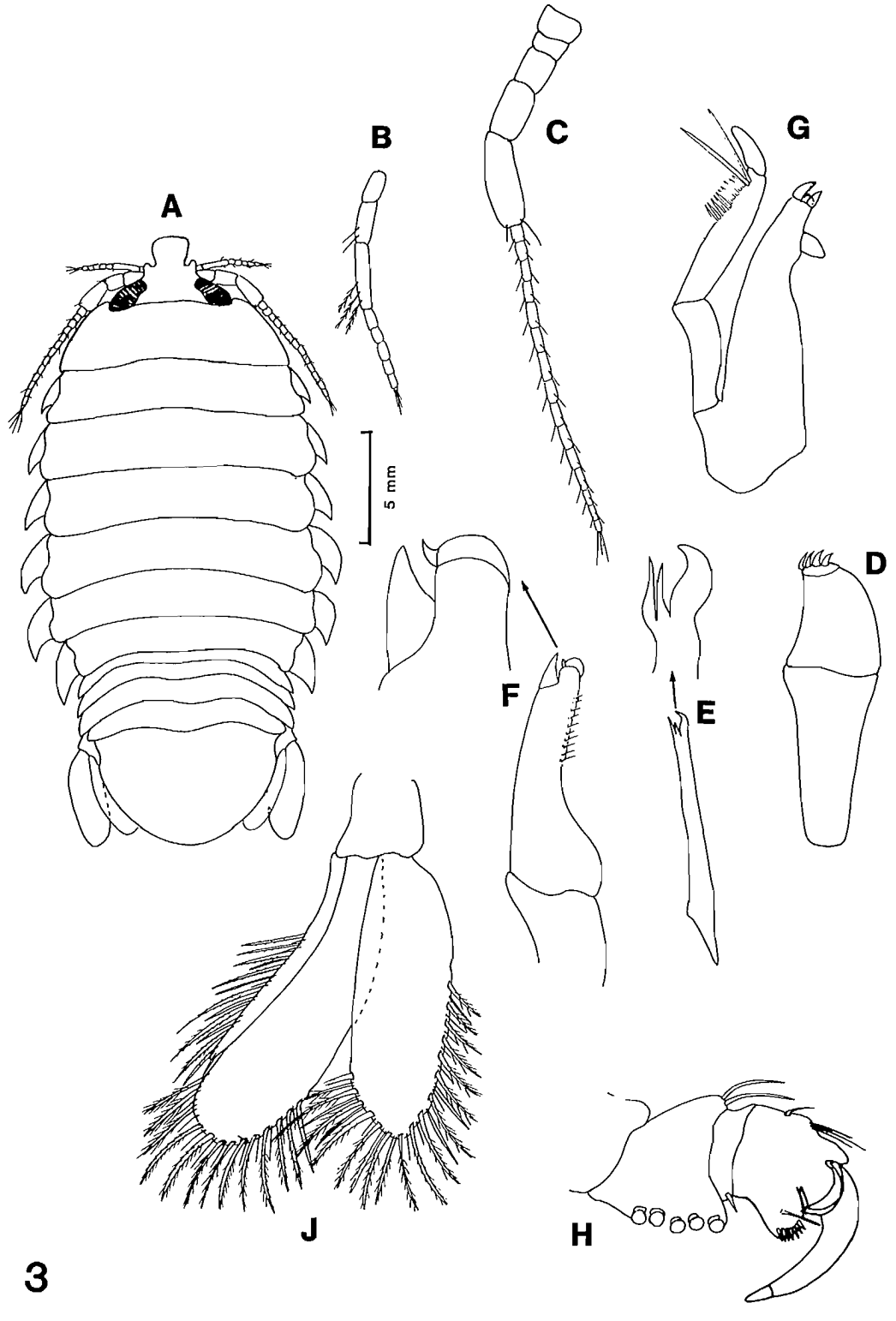

FIG. 3. *Rocinela tridens*. A. Dorsal view; B. Antenna 1; C. Antenna 2; D. Maxilliped; E. Maxilla 1; F. Maxilla 2; G. Mandible; H. Pereopod 1; J. Uropod. (Mouthparts and appendages from Georges and Stromberg 1968.)

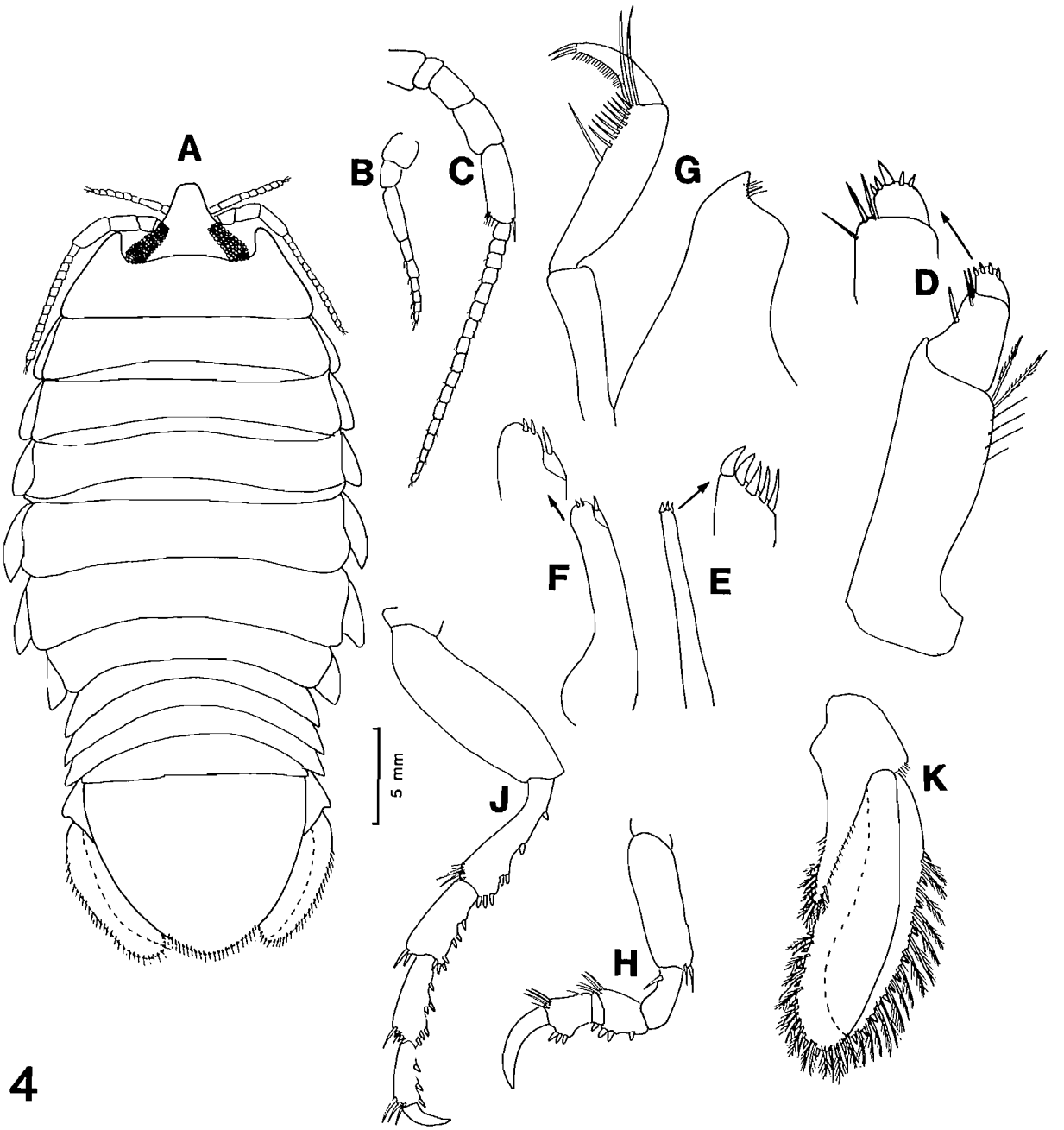

FIG. 4. *Rocinela cornuta*. A. Dorsal view; B. Antenna 1; C. Antenna 2; D. Maxilliped; E. Maxilla 1; F. Maxilla 2; G. Mandible; H. Pereopod 1; J. Pereopod 7; K. Uropod.

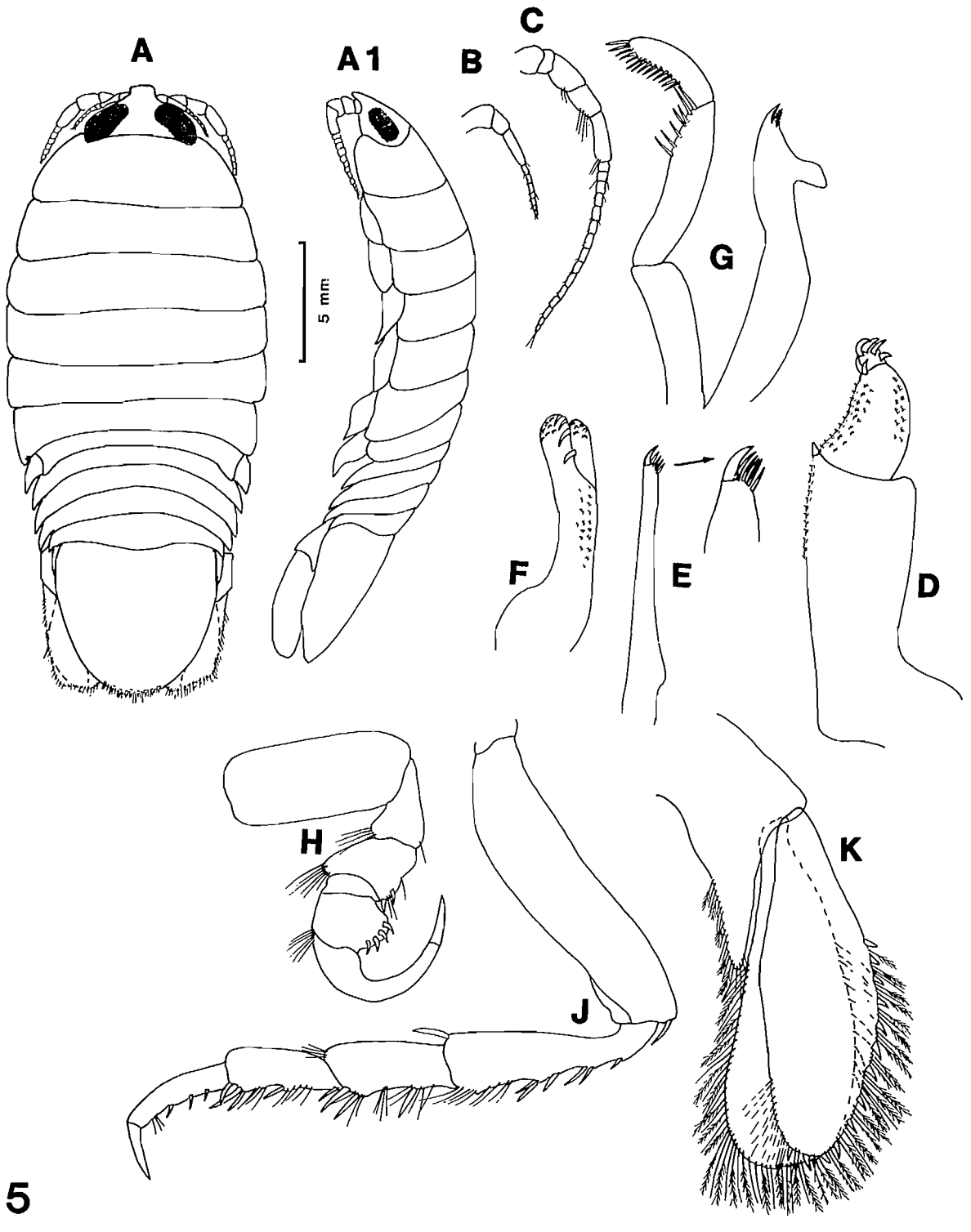

FIG. 5. *Rocinela angustata.* A. Dorsal view; Al. Lateral view; B. Antenna 1; C. Antenna 2; D. Maxilliped; E. Maxilla 1; F. Maxilla 2; G. Mandible; H. Pereopod 1; J. Pereopod 7; K. Uropod.

4. Peraeopod 1, propod with strong arcuate distal lobe and bearing 8 marginal spines (Fig. 6) ..... *Rocinela propodialis* Richardson, 1905

Frontal margin of cephalon broad and round. Peduncular segments of antenna 1 broad (Fig. 6B). Terminal segment of maxilliped palp with 4 stout curved apical spines (Fig. 6D). Maxilla 1 with 1 large claw-like apical spine and 5 lateral setae (Fig. 6E). Outer lobe of maxilla 2 with 2 apical spines, inner lobe with 1 terminal spine (Fig. 6F). Terminal segment of mandibular palp laterally setose, with saw-tooth setae (Fig. 6G). Merus of peraeopod 1 with 5 sucker-like spines and 4 long setae at outer distal margin (Fig. 6H). Peraeopod 7 with many short spines (Fig. 6J).

Hosts: *Raja binoculata* (3,4,5); *Hippoglossus stenolepis* (2); *Hippoglossus* sp. (3,4); *Sebastes* sp. (3,4); unspecified rock cod (3,5); host not mentioned (1) (Pac). (1) Richardson (1905); (2) Fee (1926); (3) Hatch (1947); (4) George and Stromberg (1968); (5) Kozloff (1974).

Propod of peraeopod 1 without distal lobe, bearing 3 proximal spines 5

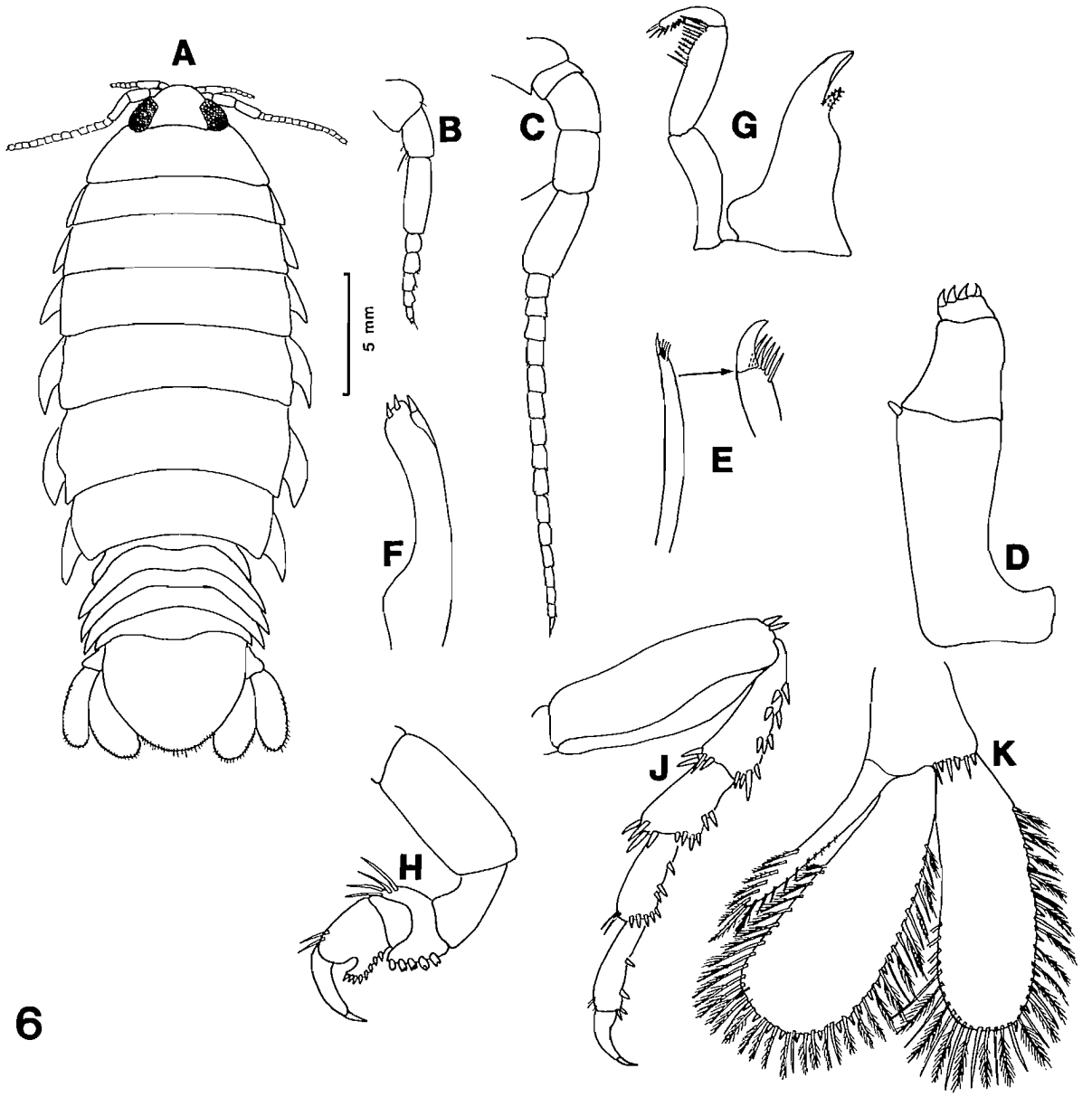

FIG. 6. *Rocinela propodialis*. A. Dorsal view; B. Antenna 1; C. Antenna 2; D. Maxilliped; E. Maxilla 1; F. Maxilla 2; G. Mandible; H. Pereopod 1; J. Pereopod 7; K. Uropod.

5 Peraeon slightly longer than broad; pleonites and pleotelson with dark pigmentation (Fig. 7) ..... *Rocinela belliceps* (Stimpson, 1864)

Coxae of peraeonites 5–7 with weak oblique carinae, posterior angles acute (Fig. 7A). Terminal segment of maxilliped palp with 2 recurved and 2 small apical spines (Fig. 7D). Outer lobe of maxilla 2 with 2 small recurved apical spines and dorsal pectinate scales; inner lobe bearing 2 large recurved apical and lateral spines and few dorsal pectinate scales, along with lateral setae (Fig. 7F). Propod of peraeopod 1 with proximal small, blunt spines; merus with 3 sucker-like marginal spines (Fig. 7H). Peraeopod 7 with slender marginal spines (Fig. 7J).

Hosts: *Gadus macrocephalus* (3,6); *Hydrolagus colliei* (2,8); *Hydrolagus* sp. (7); *Raja* sp. (8); *Sebastes maliger* (4); unspecified cod (2,8); unspecified halibut (6,8); unspecified rockfish (6,8); unspecified sculpin (2,3); unspecified skate (6); host not mentioned (1). (Pac). Records: (1) Rathbun (1909); (2) Richardson (1899, 1905, 1909); (3) Boone (1920); (4) Fee (1926); (5) Fraser (1932); (6) Hatch (1947); (7) George and Stromberg (1968); (8) Kozloff (1974).

Peraeon three times as long as broad; pleonites and pleotelson devoid of pigmentation (Fig. 8) ..... *Rocinela americana* Schioedte and Meinert, 1879

Frontal margin of cephalon narrow and round; coxae of peraeonites 4–7 broad, with acute posterior angles (Fig. 8A). Distal segment of maxilliped palp with 4 robust, slightly recurved spines (Fig. 8D). Maxilla 2 with very small apical spines on outer lobe; lobes with dorsal semilunar scales (Fig. 8F). Mandibular molar process protruding outward, forming lobe with denticulated margin (Fig. 8G). Propod of peraeopod 1 with proximal lobe bearing 3 stout spines; merus with 3 lateral spines (Fig. 8H). Peraeopod 7 with few slender marginal spines (Fig. 8J).

Host: Unknown. (Atl). Record: Harger (1878).

Aega Leach, 1818

Body compact, pleon not much narrower than pereon. Eyes usually large, often contiguous. First two segments of peduncle for first antenna somewhat expanded, flagellum of many segments. Mandible without molar process. Palp of maxilliped five-segmented. Propod of peraeonites 1–3 cylindrical, not expanded, dactyl sharply curved. Propod of peraeonites 4–7 short.

Two species of *Aega* have been found in Canadian waters.

Key to species of *Aega*

Eyes large, elongated, nearly touching anteriorly; uropods not extending beyond pleotelson, outer margin of endopod with deep median notch (Fig. 9) ..... *Aega psora* L., 1761

Posterior margin of coxae narrowly rounded (Fig. 9A). Basal segment of antenna 1 square, second projecting to midlength of third segment (Fig. 9B). Distal segment of maxilliped palp bearing 5 recurved apical spines (Fig. 9D). Maxilla 2 bearing 4 lateral recurved spines on outer lobe; inner lobe with 1 apical, 3 lateral spines and 1 brush seta (Fig. 9F). Merus of peraeopod 1 with 2 small blunt spines on distal margin (Fig. 9H). Endopod of uropod with deep median notch (fig. 9J).

Hosts: *Gadus morhua* and *Hippoglossus hippoglossus* (1,7); cod and halibut (2,3,4,5,6,9); no host mentioned (8) (Atl). Records: (1) Boone (1920); (2) Brunel (1961); (3) Halkett (1907); (4) Harger (1878); (5) Johansen (1930); (6) Rathbun (1881); (7) Richardson (1905); (8) Schultz (1969); (9) Wallace (1919).

Richardson (1905) and Boone (1920) mention other species as hosts of *A. psora*. Although these species have not been found to harbour this isopod in Canadian waters, it is quite possible that they serve as its host there. The species are: *Gadus ogac, Molva molva, Myoxocephalus scorpius, Reinhardtius hippoglossoides, Somniosus microcephalus,* and unspecified skate.

Eyes small, markedly separated from each other; uropods extending beyond pleotelson, endopod margin without notch (Fig. 10) ..... *Aega symmetrica* Richardson, 1905

Coxae large, subquadrate, not visible dorsally (Fig. 10A1). Peduncle segments of antenna 1 not dilated (Fig. 10B). Distal segment of maxilliped palp with 2 large and 2 small apical spines (Fig. 10D). Maxilla 2 with 3 straight apical spines on outer lobe and 1 seta on inner lobe (Fig. 10F). Propod of peraeopod 1 with 3 large spines on inner margin (Fig. 10H). Endopod of uropod lacking notch (Fig. 10J).

Host: Unknown. (Pac). Records: Stimpson (1864); Richardson (1905).

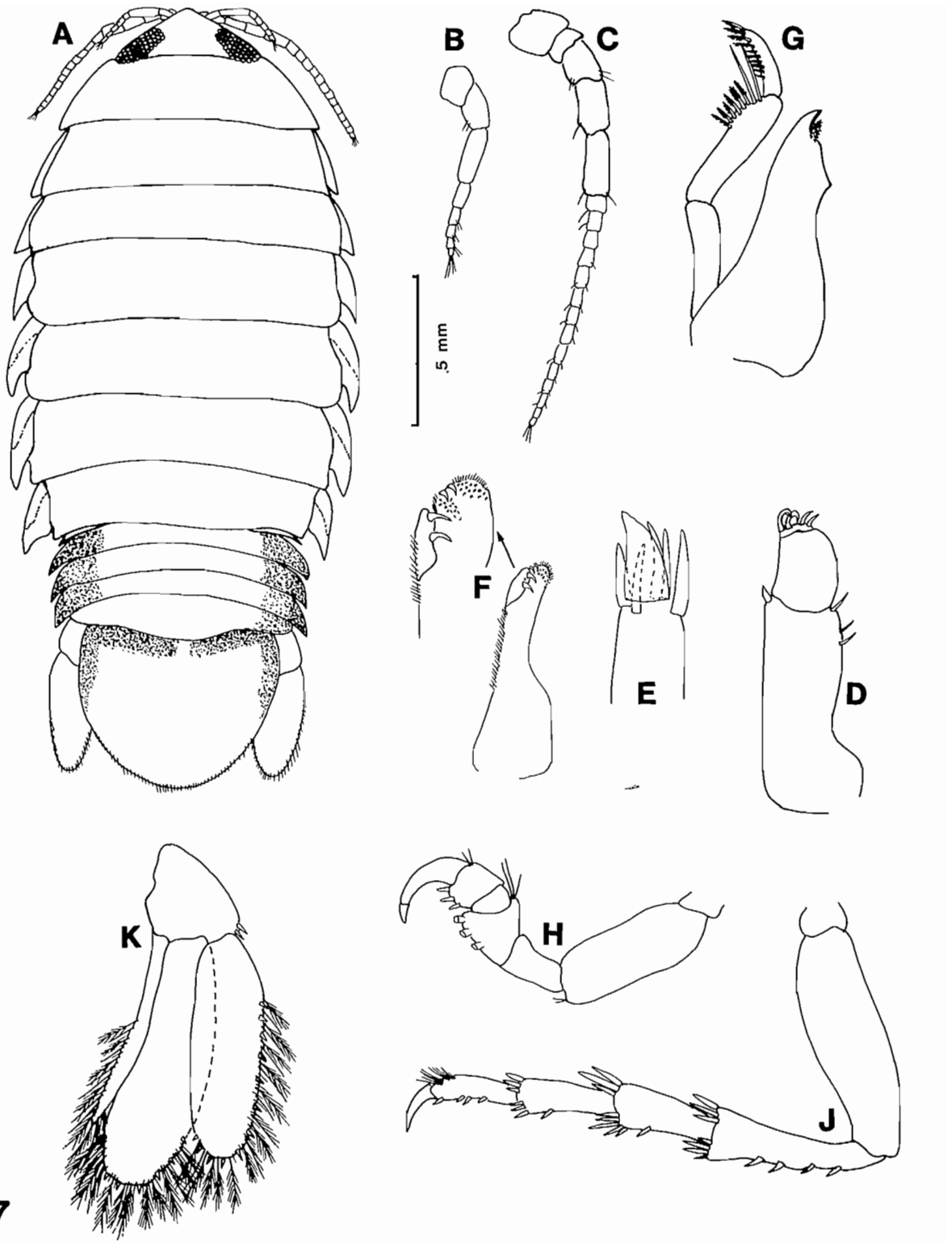

FIG. 7. *Rocinela belliceps*. A. Dorsal view; B. Antenna 1; C. Antenna 2; D. Maxilliped; E. Maxilla 1; F. Maxilla 2; G. Mandible; H. Pereopod 1; J. Pereopod 7; K. Uropod.

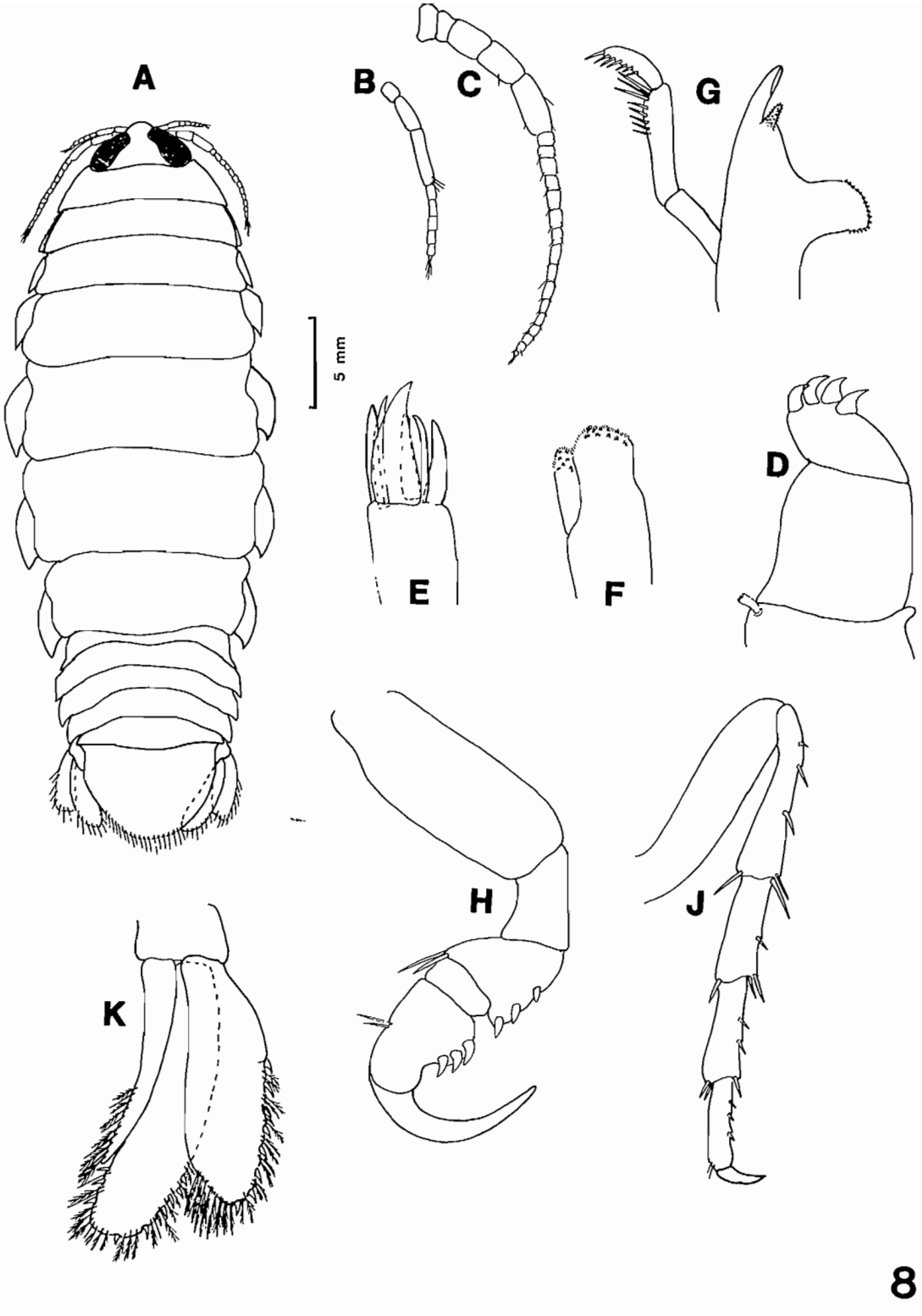

FIG. 8. *Rocinela americana*. A. Dorsal view; B. Antenna 1; C. Antenna 2; D. Maxilliped; E. Maxilla 1; F. Maxilla 2; G. Mandible; H. Pereopod 1; J. Pereopod 7; K. Uropod.

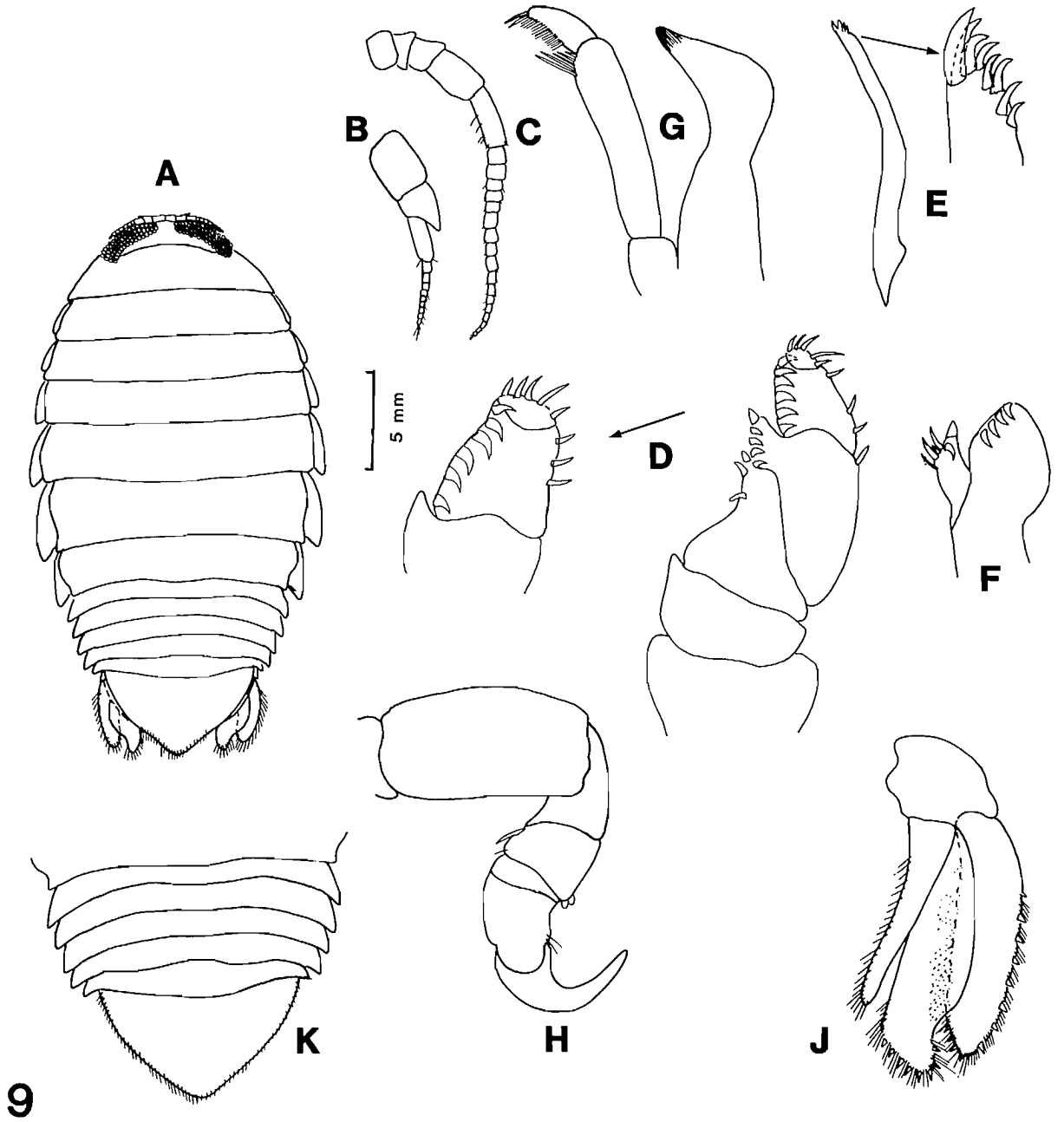

FIG. 9. *Aega psora*. A. Dorsal view; B. Antenna 1; C. Antenna 2; D. Maxilliped; E. Maxilla 1; F. Maxilla 2; G. Mandible; H. Pereopod 1; J. Uropod; K. Pleon.

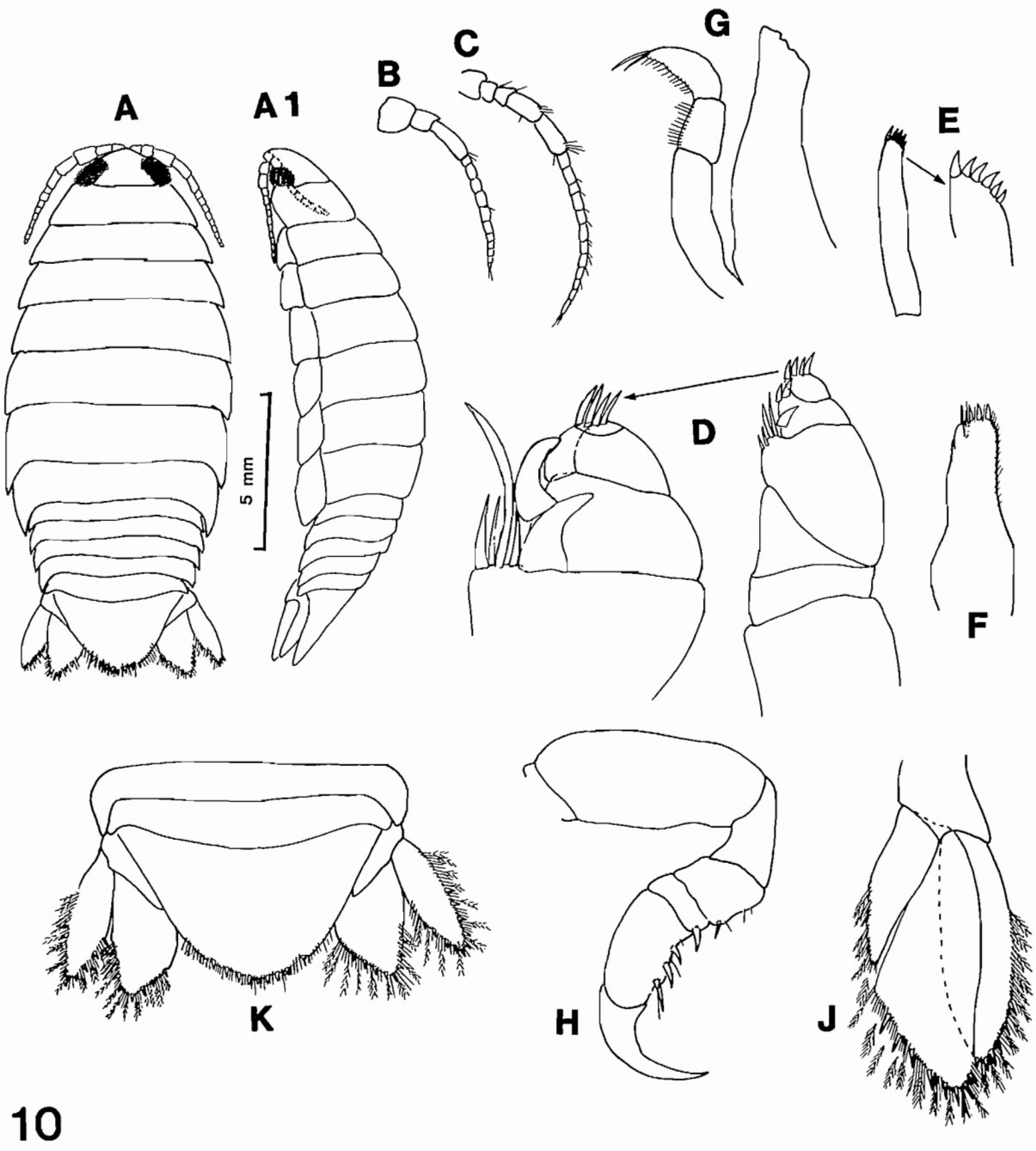

FIG. 10. *Aega symmetrica*. A. Dorsal view; Al. Lateral view; B. Antenna 1; C. Antenna 2; D. Maxilliped; E. Maxilla 1; F. Maxilla 2; G. Mandible; H. Pereopod 1; J. Uropod; K. Telson.

Family Cymothoidae Dana, 1852

Body usually twisted to one side. Antennae reduced, no clear distinction between peduncle and flagellum. Mandible lacking molar process and lacinia mobilis; incisor blade-like. Maxilliped palp 2-segmented. Peraeopods prehensile, with dactyl longer than propod. Pleopods and uropods without marginal setae.

Cymothoids are protandrous hermaphrodites and are permanent parasites of fishes. Host specificity is strong in some species. This is a large family, of which only one genus, *Lironeca*, has been reported from Canada.

Lironeca Leach, 1818

Body suboval, more or less twisted. Cephalon usually immersed in pereonite 1; anterior margin of pereonite 1 widely sinuate in the middle and incised at anterolateral angles. First antennae widely separate at base; peduncular segments not expanded. Pleonites subequal.

Two species are known to occur in Canadian waters.

Key to species of *Lironeca*

Dorsolateral surface of each peraeonite with several rugosities in transverse row; peraeopods 4–7 with carina on basis (Fig. 11) ..... *Lironeca vulgaris* Stimpson, 1857

Frontal margin of cephalon broadly rounded; eyes small (Fig. 11A). Terminal segment of maxilliped palp with 3 recurved apical apines (Fig. 11D). Maxilla 1 with large and 2 small apical spines (Fig. 11E). Maxilla 2 with 2 small apical spines on outer lobe and 2 lateral recurved spines on inner lobe (Fig. 11F). Pleonites subequal in length, evenly rounded, with lateral rugosites.

Hosts: *Amphistichus rhodoterus* (2); *Citharichthys sordidus* (2); *C. stigmaeus* (2); *Cymatogaster aggregata* (2); *Rhacochilus vacca* (4); *Hyperprosopon argenteum* (1); *Ophiodon elongatus* (1,2); *Phanerodon furcatus* (2,4); *Sebastes mystinus* (3); *Trachurus symmetricus* (4); rock cod (1); flounder (1); (Pac). Records: (1) Richardson (1905); (2) Brusca (1978, 1981); (3) Hobson (1971); (4) Turner et al. (1969).

Body devoid of rugosities; peraeopods without carina (Fig. 12) ..... *Lironeca californica* Schioedte and Meinert, 1883

Frontal margin of cephalon narrowly rounded; eyes large (Fig. 12A). Terminal segment of maxilliped palp with 3 large, 1 small apical spine, and 1 lateral spine (Fig. 12D). Maxilla 1 with 3 apical spines (fig. 12E). Maxilla 2 with 2 apical spines on outer lobe; inner lobe unarmed (Fig. 12F). Pleotelson evenly rounded, with median carina (fig. 12L).

Records: (1) Fee (1926); (2) Hatch (1947); (3) Arai (1967, 1969); (4) Brusca (1981). Brusca's (1981) record of *A. affinis* came from outside Canadian waters, but the host is a potential host of this isopod within Canadian territory.

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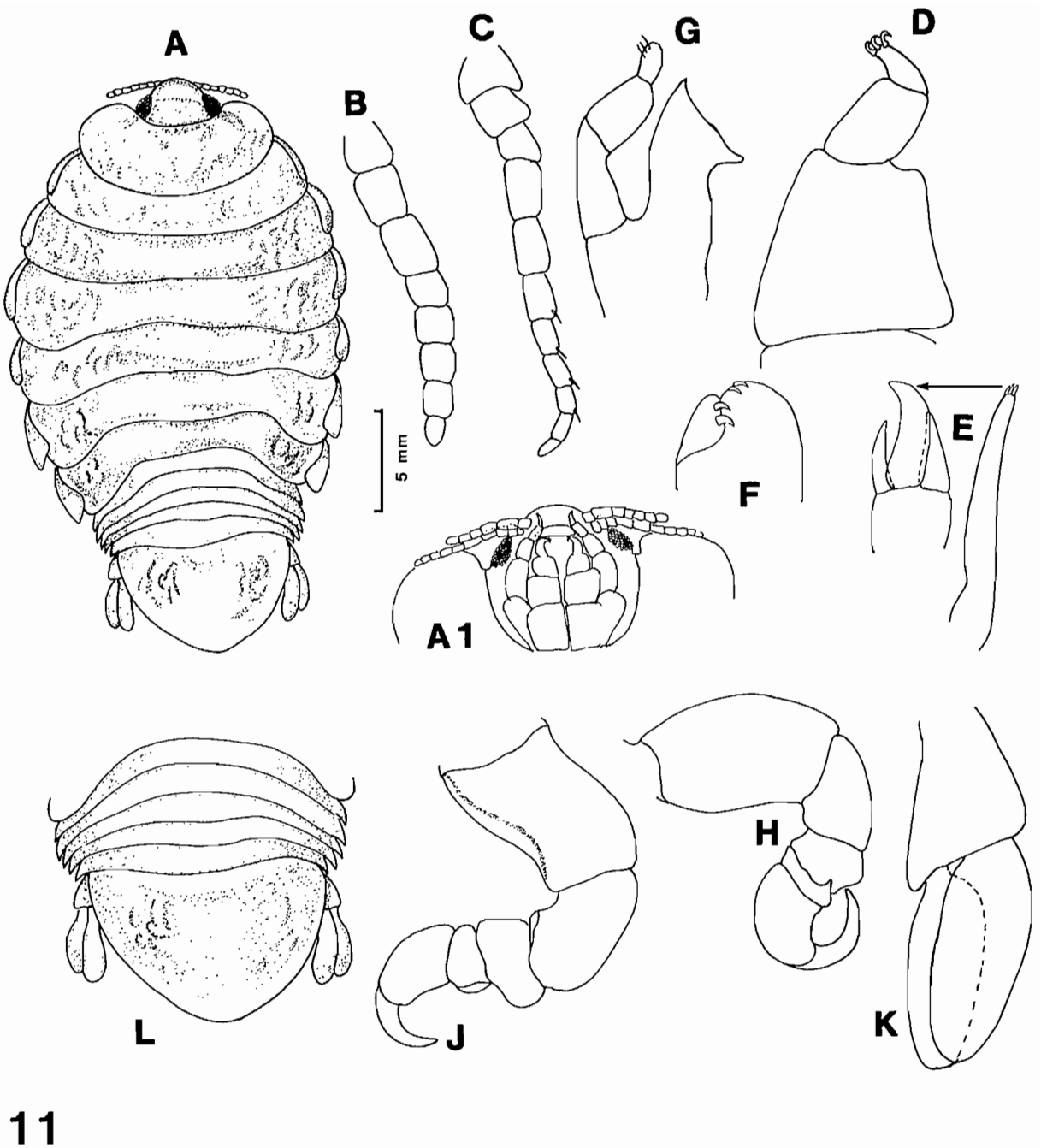

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FIG. 11 *Lironeca vulgaris*. A. Dorsal view; Al. Ventral view of cephalon; B. Antenna 1; C. Antenna 2; D. Maxilliped; E. Maxilla 1; F. Maxilla 2; G. Mandible; H. Pereopod 1; J. Pereopod 7; K. Uropod; L. Pleon.

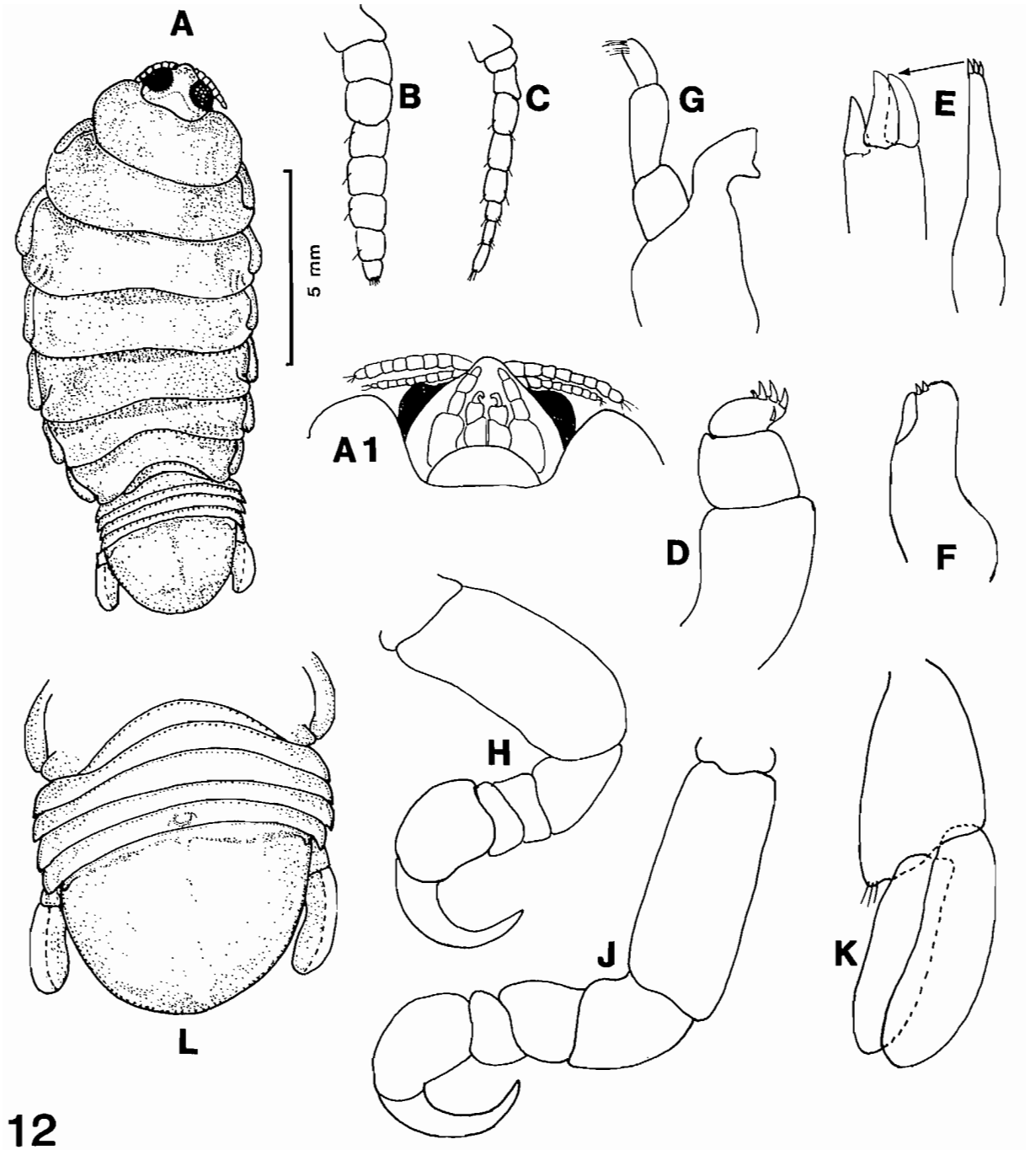

FIG. 12 *Lironeca californica*. A. Dorsal view; Al. Ventral view of cephalon; B. Antenna 1; C. Antenna 2; D. Maxilliped; E. Maxilla 1; F. Maxilla 2; G. Mandible; H. Pereopod 1; J. Pereopod 7; K. Uropod; L. Pleon.

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AMPHIPODA

E. L. BOUSFIELD
AND Z. KABATA

ABSTRACT

BOUSFIELD, E.L., AND Z. KABATA. 1988. Amphipoda, p. 149-163. *In* L. Margolis and Z. Kabata [ed.] Guide to the parasites of fishes of Canada. Part II. Crustacea. Can. Spec. Publ. Fish. Aquat. Sci. 101: 184 p.

This report is a brief presentation of Amphipoda parasitic on Canadian fishes, or known to be their potential parasites. It includes also amphipod species occurring close to Canadian territory and expected to be discovered within its limits in the future. In addition to illustrations and keys to identification of these Amphipoda, this report contains an introduction to amphipod morphology.

The Canadian fauna of parasitic Amphipoda comprises at present 11 identifiable species, belonging to four families: Lafystiidae (3 genera, 6 species), Pardaliscidae (1 genus, 1 species), Trischizostomatidae (1 genus, 1 species), and Lysianassidae (1 genus, 3 species).

RÉSUMÉ

BOUSFIELD, E.L., AND Z. KABATA. 1988. Amphipoda, p. 149-163. *In* L. Margolis and Z. Kabata [ed.] Guide to the parasites of fishes of Canada. Part II. Crustacea. Can. Spec. Publ. Fish. Aquat. Sci. 101: 184 p.

Le présent travail est un bref exposé des espèces d'Amphipoda parasites des poissons des eaux canadiennes ou qui sont des parasites potentiels. Il porte aussi sur les espèces d'Amphipoda signalées dans les eaux limitrophes et qui seront probablement observées à l'avenir dans les eaux canadiennes. En plus des illustrations et des clés d'identification des espèces d'Amphipoda parasites, le présent document contient une introduction à la morphologie des Amphipoda.

La faune canadienne d'espèces parasites appartenant à l'ordre Amphipoda regroupe 11 espèces identifiables appartenant aux 4 familles suivantes: Lafystiidae (3 genres, 6 espèces), Pardaliscidae (1 genre, 1 espèce), Trischizostomatidae (1 genre, 1 espèce) et Lysianassidae (1 genre, 3 espèces).

INTRODUCTION

Amphipoda are a group of malacostracan Crustacea characterized by a small to medium size, laterally compressed body (though the bodies of some are wider than deep), uniramous ambulatory thoracic legs, sessile eyes, and absence of a carapace. Approximately 6,000 species are known at present. Most of them are free-living bottom dwellers and free-swimming in marine, brackish, and freshwater habitats, but many species have adopted a semiterrestrial or terrestrial mode of life. The dominant type of food is organic debris of both plant and animal origin. However, some amphipods have become associated with other organisms. Their interrelationships with these organisms range from loose and sporadic to close and intimate. Amphipods include in their numbers micropredators and parasites, both obligate and facultative.

Parasitic and semiparasitic Amphipoda can be found on a wide variety of hosts, both invertebrate and vertebrate. Some are associated with plants. Several groups have become specialized as associates or ectoparasites of fishes. Bousfield (1987) described their relationship with fishes as follows:

"Some may be facultative rather than obligate parasites, and may live freely on the bottom or in the water column during some or most of their lives. Some amphipod parasites on fishes may be termed "hitchhikers," clinging to various skin surfaces or gills of the host by means of clamp-like gnathopods (e.g., in Trischizostomatidae, *Opisa* group lysianassids, the pardaliscid *Rhynohalicella*) or prehensile peraeopods (in Lafystiidae) (Bousfield 1982). Species of lysiananssoidean and pardaliscoidean parasitic groups may swim sporadically in the water column, presumably both for the purpose of mating, or at least mate-finding, and for seeking out new fish hosts." "Parasitic amphipods apparently do not occur on freshwater or anadromous fishes, and are usually found on slow-moving, slow-growing benthic sharks and bony fishes of cold or deep waters (Vader and Romppainen 1987). Many of these fishes (e.g., rockfish (*Sebastes*), sculpins (*Myoxocephalus* and *Cottus* spp.), goosefishes (*Lophius* spp.), and flatfishes (Pleuronectidae)) may be described as "ambush predators." The morphological modifications of the mouthparts of the parasitic amphipods and the occurrence of these animals around the mouth

fringes, opercular plates, gills, pectoral fins, anal opening, and surface wounds of the fishes suggest that the amphipods are actively feeding on surface mucus, skin tissues, body wastes and discarded food items of the host."

Amphipoda parasitic on Canadian fishes are very poorly known. Margolis and Arthur (1979) did not include even one species in their comprehensive synopsis. Stebbing (1888) published an incompletely illustrated account of "*Lafystius sturionis*" from an unspecified *Cottus* caught off Halifax, Nova Scotia. Relatively few species, mainly of the genus *Opisa*, have been recorded in the Canadian Atlantic and Arctic waters. There are no records of this group of parasites on fishes of the Canadian Pacific, although species of *Lafystius* and *Opisa* have been found in Washington and Alaska. Their presence in the intervening British Columbian stretch of the ocean must be strongly suspected. The most recent and comprehensive account of Amphipoda parasitic on Canadian fishes has been published by Bousfield (1987). This part of the Guide is based on his publication.

It appears that the prevailing view on the loose specificity of amphipods is less than universally valid. For example, members of the family Trischizostomatidae tend to be specific, as adults, to a narrow range of fish hosts (Sexton 1908; Vader and Romppainen 1987). In some instances at least, the ranges of host species appear to be wide only because several amphipods were misidentified as a single species.

The morphology of Amphipoda is illustrated in a general way in Fig. 1. The body of an amphipod (Fig. 1A) consists of three tagmata. The anteriormost head (H) is followed by seven peraeon segments (R1–R7), the equivalent of the thorax, and by the abdomen, consisting of two parts: a three-segmented pleon (L1–L3) and an equally three segmented urosome (U1–U3). The head carries anterolaterally two pairs of appendages, the first (a1) and the second (a2) antennae, situated on both sides of a more or less prominent protrusion, the rostrum. Both pairs consist of basal peduncles (pd) and terminal flagella (f). In some species, the first antenna has also a small accessory flagellum (af). The head also accommodates a pair of multifaceted eyes (e), the number and size of facets differing from species to species. The ventral surface of the head is the site of the buccal apparatus (ba), which consists of four pairs of mouth parts. The mandible consists of a basal part, on distal inner margin with cutting incisors, lacinia, and blades (Fig. 1B) and a 3-segmented palp (Fig. 5H). In flesh-eating species the palp is sometimes, and a grinding molar is usually, lacking (Fig. 6E). The first maxilla (Fig. 1C) consists of inner (ip) and outer (op) plates and a palp (p). Two plates, inner (ip) and and outer (op), are also present in the second maxilla (Fig. 1D), which has no palp. The latter is, however, present in the maxilliped (Fig. 1E). Each of the seven segments of the peraeon carries a pair of uniramous limbs, peraeopods (PR). These limbs are seven-segmented, their basal segments, or coxae, being expanded into ventrolateral plates (c, Fig. 1A) and serving as a protective covering for the gills and brood plates (spoon-shaped structures with setiferous margins, attached to the margin of the coxae). The seven peraeopod segments (Fig. 1G), from base to apex, are known as coxa (c), basis (b), ischium (i), merus (m), carpus (ca), propod (pr), and dactyl (d). The first two pairs of peraeopods are modified into so-called gnathopods, which might be subchelate (as in Fig. 6C), chelate (as in Fig. 1F) or simple. The first three segments of the abdomen (pleon) have ventral projecting epimeral plates and each carries a pair of biramous limbs, the pleopods (PL, Fig. 1A,H), with multisegmented, setiferous rami. The appendages of the urosome, the uropods (UP, Fig. 1A,J) are also biramous, but their rami are either one- or two-segmented. The third urosome segment (U3, Fig. 1A) carries also a terminal plate, the telson (T, Fig. 1A), either entire or bilobed, dorsal to the anus. (For more details on amphipod morphology consult Bousfield (1973).)

Sexual dimorphism among parasitic amphipods hitherto found in Canadian waters is limited to the details of armature and the degree of development of appendages and is not likely to lead to misidentification of the species (cf. Figs. 4E and 5A).

This account includes those species of Amphipoda which either have been found attached to fishes in Canadian waters, or are strongtly suspected of being present in these waters. The list, obviously far from definitive, comprises 11 species belonging to six genera and four families.

KEYS TO AMPHIPODA

Key to families

1 Body broader than deep; rostrum large, flat, apically truncated; first antenna slightly longer than second, without accessory flagellum; coxa 4 deepest, with acute apex; outer ramus of third uropod shorter than inner, one-segmented and with rounded tip ..... Lafystiidae

Body slender, deeper than broad; rostrum very short (broadly acute if large); first antenna shorter than second (often markedly so, especially in males), accessory flagellum present; coxa 4 not much deeper than coxa 3, with rounded apex; outer ramus of third uropod longer than inner, usually two-segmented and with acute tip 2

2 Eyes usually absent or weakly pigmented; gnathopods similar in form and size, second gnathopod with strongly developed dactyl; coxae small, loosely overlapping, coxa 3 broader than deep; urosome segments usually with mid-dorsal processes ..... Pardaliscidae

Eyes usually large, multifaceted, pigmented; gnathopods dissimilar in form and size, second gnathopod usually mitten-like, with minute dactyl; coxae large, deep, coxa 3 usually deeper than broad; urosome segments usually without dorsal processes 3

3 Rostrum prominent, reaching beyond first segment of second antennae; coxal plate 2 distinctly largest and deepest; telson plate-like, undivided; brood plates (female) moderately broad, margins profusely setiferous ..... Trischizostomatidae

Rostrum small or absent; coxal plate 4 usually largest and deepest; telson usually bilobate; brood plates (female) slender, with few marginal setae ..... Lysianassidae

Family TRISCHIZOSTOMATIDAE

A small family of gammaridean Amphipoda, Trischizostomatidae is now known to consist of at least eight species (Bousfield 1987), grouped in two genera: *Trischizostoma* Della Valle, 1893 and *Guerina* Della Valle, 1893. Member species are parasitic on fishes inhabiting deeper waters of the Northeast Atlantic and the Mediterranean, extending south as far as South Africa.

No trischizostomatid amphipods have yet been recorded from Canadian waters. It is, however, highly probable that species of *Trischizostoma* will be eventually encountered, because known hosts of this genus are present in this region. In particular, *Etmopterus niger,* commonly found in deep Canadian Atlantic waters, is known to carry *Trischizostoma raschi* Boeck, 1861. Stephensen (1923) recorded this amphipod in the North Atlantic, west of Iceland. Further search will undoubtedly add it to the Canadian fauna.

Trischizostoma raschi Boeck, 1861 (Fig. 1A)

Head with rostrum covering bases of first antennae; eyes very large, multifaceted, pigmented, meeting dorsally. First antenna well developed, with short flagellum; second moderately long in females, more elongate in males. Mandibular palp large, with brush-like distal setae. Both pairs of maxillae styliform, with much reduced palps. Maxilliped palp well developed. Coxal plates shallow, coxa 2 largest. First gnathopod large and strong, second slender, elongate, with apical microchela. Peraeopod 4, merus radially expanded, larger than in peraeopod 3. Pleosome segments short, with deep side plates; pleopods strong. Urosome segments short, uropods with broadly lanceolate rami.

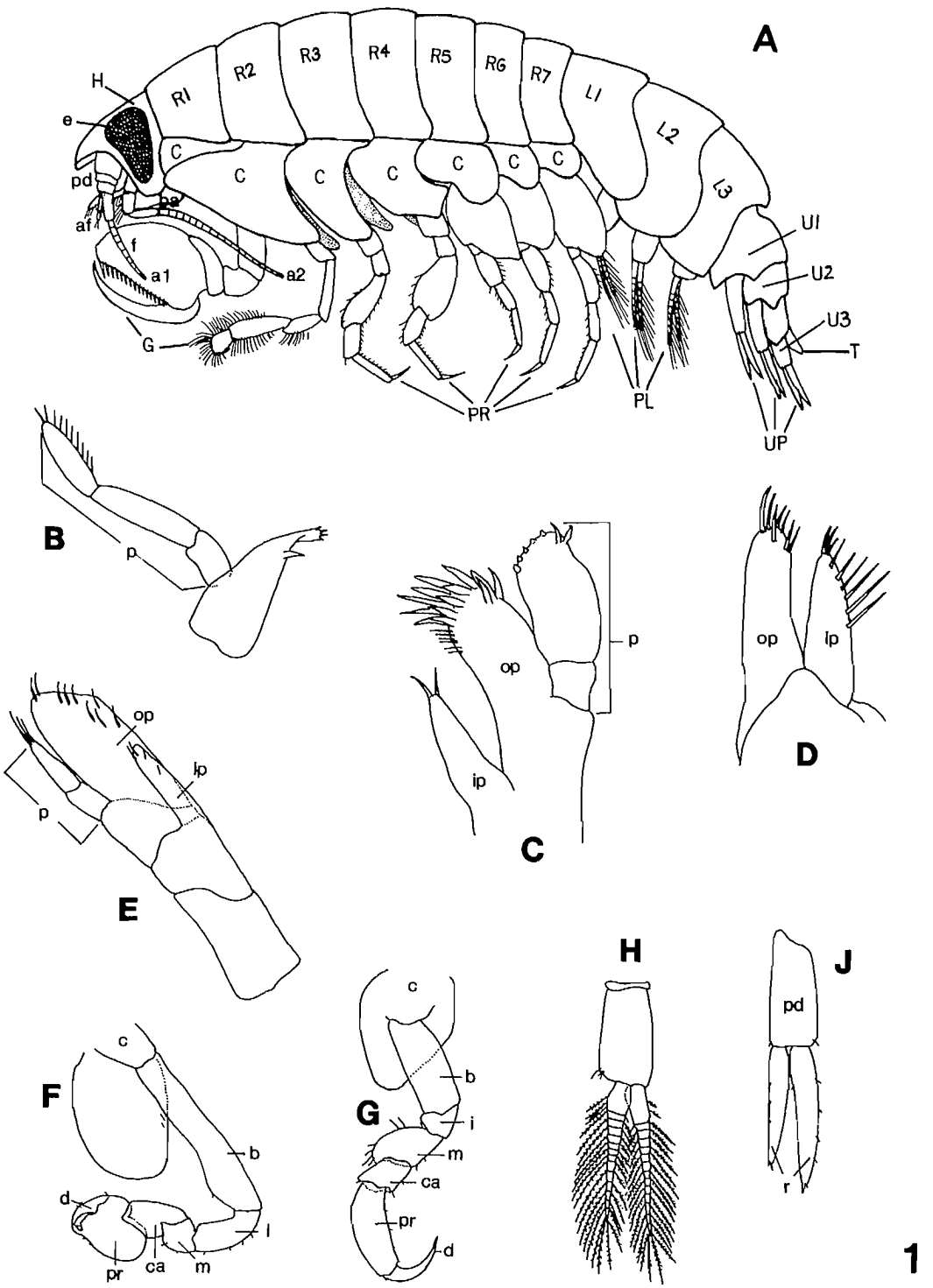

FIG. 1. *Trischizostoma raschi* and generalized structure of Amphipoda. A. *T. raschi*, lateral; B. Generalized mandible; C. First maxilla; D. Second maxilla; E. Maxilliped; F. First gnathopod; G. Peraeopod; H. Pleopod; J. Uropod.
G, F — gnathopods; H — head; L1-L3 — pleopod segments 1-3; PL — pleopods; PR — peraeopods; R1-R7 — peraeon segments 1-7; U1-U3 — urosome segments 1-3; T - telson; af — auxiliary flagellum; al — first antenna; 2a — second antenna; b — basis; ba — buccal apparatus; c — coxa; ca — carpus; d — dactyl; e — eye; f — flagellum; i — ischium; ip — inner plate; m — merus; op — outer plate; p — palp; pd — peduncle; pr — propod; r — ramus.

Family LYSIANASSIDAE

The diagnostic characteristics of this family are adequately outlined in the key to the families. Of interest in the context of this account is the subfamily Lysianassinae Hurley, 1963, grouping cold-water (boreal and subarctic) genera. Several genera of this subfamily form a distinct subgroup referred to as the *Opisa* group (Bousfield 1987), from the name of one of its genera. The members of this group are mainly parasitic or semiparasitic on fishes. They are readily recognizable by a generally small body size, enlarged and strongly prehensile first gnathopod (subchelate or chelate), and reduced palp of the maxilliped.

The only members of this subgroup hitherto recorded from Canadian seas belong to the genus *Opisa*.

Opisa Boeck, 1876

Sexually dimorphic, with pelagic adult male. Body and coxal plates deep, coxa 1 shortest, largely overlapped by coxa 2. Flagellum of second antenna short in female, elongate in male (Fig. 2B). First gnathopod powerfully chelate (Fig. 2A), second slender, microsubchelate. Abdominal side plates 1–3 deep, hind corners not produced. Uropod 3, rami with plumose margins (especially in males). Telson deeply bilobed, apices of lobes with notch and spinule (lobes usually longer in male).

Type species: *Opisa eschrichti* Krøyer, 1842.

Key to species of *Opisa*

1 Coxal plate 5 wider than deep, depth less than length of basis (Fig. 2A); telson lobes usually lacking dorsolateral spines (Fig. 2D); posterior margin of abdominal plate 3 evenly crenulated or denticulated (Fig. 2A); maxilliped palp exceeding outer plate by length of dactyl only (Fig. 2C); eyes very large, rectangular, 10–12 facets wide (more in male) (Fig. 2B); second antenna barely longer than first, flagellum 6- or 7-segmented in female, more than 10-segmented in male ..... *O. tridentata* Hurley, 1963

Skin (near pectoral fins) of *Hexagrammos decagrammus*, *Sebastes maliger*, *S. mystinus*, *S. ruberrimus*, and *Squalus acanthias*. (Pac) (Hurley 1963; Bousfield 1987).

Coxal plate 5 deep, depth greater than length of basis; telson lobes always marginally spinose (Fig. 2F); posterior margin of abdominal plate 3 smooth; maxilliped palp exceeding outer plate by more than dactyl (Fig. 3C) 2

2 Gnathopod 1, propod and dactyl large (Fig. 2E), long axis of propod parallel to that of carpus; second antenna distinctly longer than first in female, flagellum at least 10-segmented (Fig. 3A, B); uropods 1 and 2, rami evenly tapering and normally spinose (Fig. 3D, E); uropod 3, inner margins of rami lined with plumose setae (Fig. 3F); eyes subrectangular, 5–6 facets wide ..... *O. eschrichti* Krøyer, 1842

Skin of *Gadus morhua* and *Melanogrammus aeglefinus*. (At1) (Dunbar 1954; Shoemaker 1930a, b; Brunel 1961; Ledoyer 1975; Bousfield 1987).

Gnathopod 1, propod and dactyl small, long axis of propod set at upward angle to long axis of carpus (Fig. 3J); uropods 1 and 2, rami with mediodistal notch and stout spine (Fig. 3K, L); uropod 3, margins of rami bare (or nearly so) (Fig. 3M); eyes very large, 6–7 vertical rows of pigmented factes (Fig. 3G); second antenna very small, partly masked by coxae, flagellum 4-segmented ..... *O. odontochela* Bousfield, 1987

Skin and gills of *Sebastes maliger*. (Pac) (Bousfield 1987).

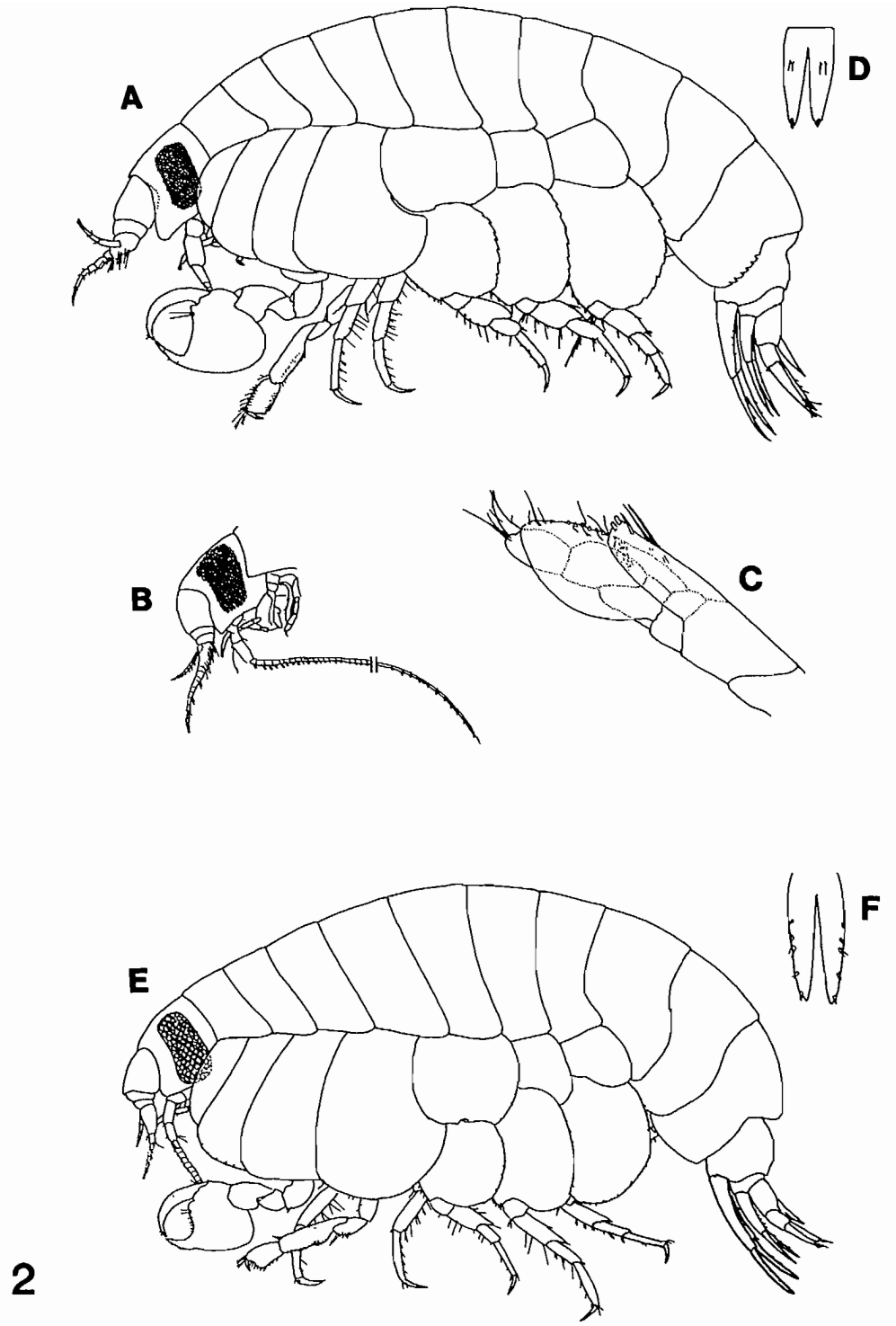

FIG. 2. *Opisa tridentata* and *O. eschrichti*. A. *O. tridentata*, female, lateral; B. Same, male, head, lateral; C. Maxilliped; D. Telson; E. *O. eschrichti*, female, lateral; F. Same, telson.

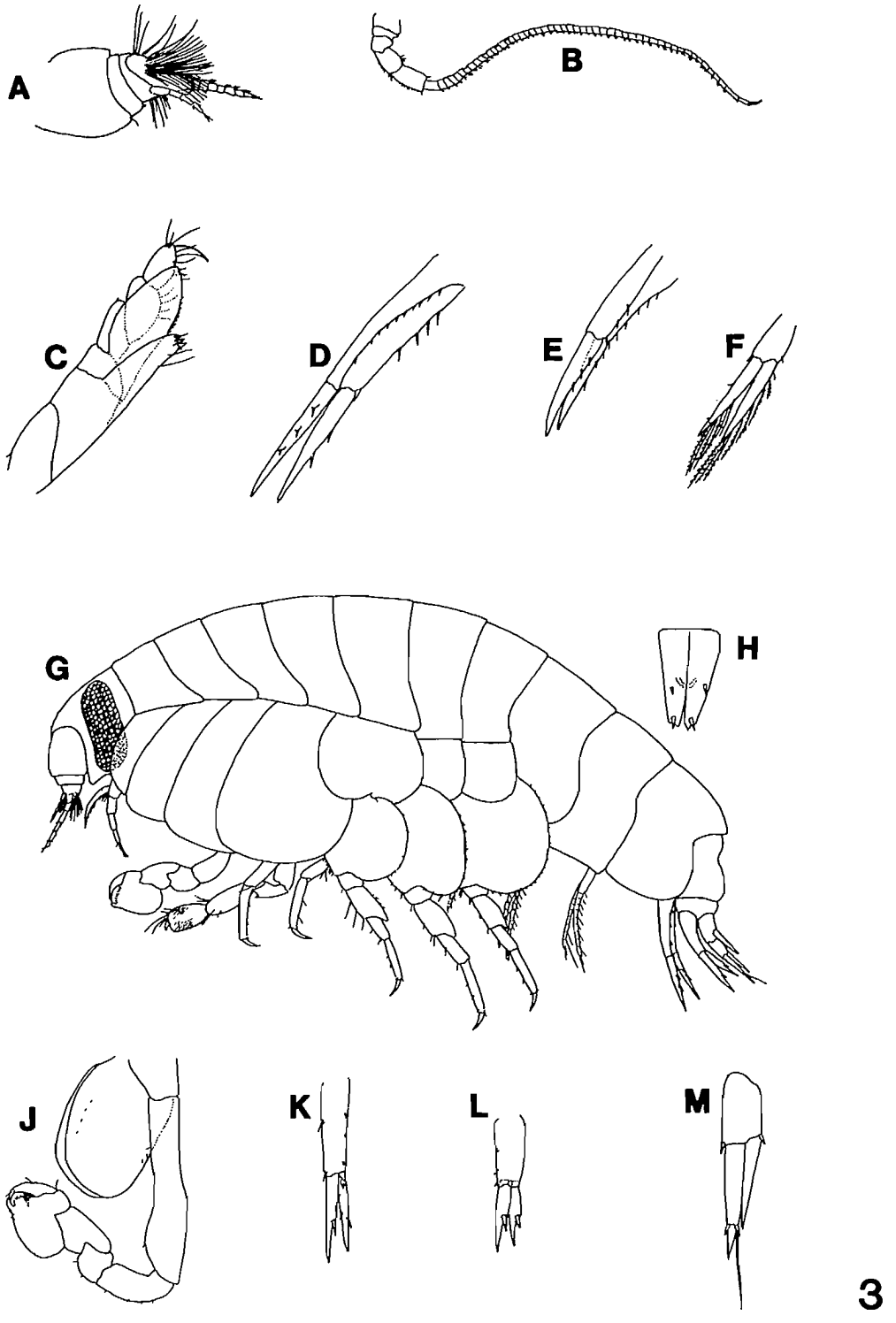

FIG. 3. *Opisa eschrichti* and *O. odontochela*. A. *O. eschrichti*, male first antenna; B. Same, second antenna; C. Maxilliped; D. First uropod; E. Second uropod; F. Third uropod; G. *O. odontochela*, female, lateral; H. Same, telson; J. First gnathopod; K. First uropod; L. Second uropod; M. Third uropod.

Family PARDALISCIDAE

This family, diagnostic features of which are included in the key to the families, comprises currently about 50 species, distributed among 18 genera. Most of them are littoral or bathypelagic, free-living, epibenthic predators. Members of two genera: *Halicella* Schellenberg, 1926, and *Rhynohalicella* Karaman, 1974, are believed to be ectoparasitic on fishes. Only the latter genus is considered here as possibly associated with Canadian fishes.

Rhynohalicella Karaman, 1974

This genus is based on the species originally described by Barnard (1971) as *Halicella halona*. The genus *Halicella*, considered to be an aberrant member of its family, comprised at that time only two known species: *H. parasitica* Schellenberg, 1926 and *H. halona*. The former was discovered in association with a host fish. The latter, originally discovered off the coast of Oregon, was found in Canadian waters in a sample dredged from the bottom. Karaman (1974), on the basis of differences in the mouth parts, made it the type of his new genus. The generic diagnosis is as follows:

Mouth parts forming a cone below head. Labrum incised, straight. Eyes absent. First and second (Fig. 6F) maxilla without inner plates. Maxilliped without inner plate, outer plate broad, fairly long. Gnathopods and peraeopods simple. Uropods well developed, slender. Telson longer than broad, bifid.

Rhynohalicella halona (Barnard, 1971) (Fig. 6D–H)

Body slender, deeper than wide (Fig. 6D); urosome with dorsal processes, weak on segment 1, strong on 2. Coxae (especially coxa 5) very shallow, elongate (Fig. 6D). First antenna (flagellum 22-segmented) shorter than second. Mandibular palp reduced to small, recessed papilla near base. Maxilliped with 4-segmented palp. First gnathopod with concave palmar margin of propod (Fig. 6G), both first and second (Fig. 6H) richly spiniferous and setiferous. Abdominal side plates 2 and 3 with weakly acuminate hind corners.

Host unknown. (Pac) (Bousfield 1987).

Family LAFYSTIIDAE

This family contains currently seven species, belonging to three genera, that can be considered here. These species are parasitic or semi-parasitic on the gills, mouth fringes, and external surfaces of demersal fishes.

In addition to characters listed above in the key, species of Laphystiidae are distinguished by the following diagnostic features: Dorsal surface of body smooth. Eyes usually large, multifaceted and somewhat protruding from head surface. Peraeopods 3–7 prehensile, with dactyls large, curved or hooked. Coxae 1–4 moderately deep, increasing in size posteriorly; posterior lobes of coxae 5–6 attenuated below. Abdominal side plates deep, pleopods well developed, telson entire.

Mouth parts reduced, buccal mass subconical. Mandibular palp strong, with posterior margin of third segment setiferous. First maxilla with vestigial palp. Maxilliped with narrow inner plate and reduced palp. First gnathopod slender, simple; second weakly subchelate.

Males have relatively large eyes, stronger rostrum, and more numerous aesthetascs on first antenna. Females usually larger and with more strongly produced posteroventral lobe on coxa 5.

Key to genera of Lafystiidae

1 Head not wider than long, rostrum rounded (Fig. 4B); bases (2nd segments) of peraeopods 5–7 similar to one another, with broad posterior expansions, carpus usually shorter than ischium (Fig. 4A); first urosome segment only slightly longer than deep (Fig. 4A); coxal gill on peraeopod 7 ..... *Protolafystius* Bousfield, 1987

Head distinctly wider than long; rostrum truncated; bases of peraeopods 5–7 dissimilar, generally oval and broad, carpus subequal in length to ischium; first urosome segment with length twice depth (lateral view); peraeopod 7 lacking coxal gill 2

2 Peraeopods other than gnathopods about equally strongly developed (third slightly stronger than others) and prehensile; coxa 6 with attenuated hind lobe in both sexes; tip of dactyl of second gnathopod forming minute chela (Fig. 5D); maxilliped palp two-segmented (Fig. 5C)..... *Lafystius* Krøyer, 1842

Peraeopods 3–4 clearly more powerfully prehensile than 5–7; coxa 6 with shallow, rounded posterior lobe (Fig. 6A); dactyl of second gnathopod apically attenuated (Fig. 6C); maxilliped palp apparently one-segmented (Fig. 6B) ..... *Paralafystius* Bousfield, 1987

Protolafystius Bousfield, 1987

In addition to its type species, this newly-described genus (Bousfield 1987) contains at least two other species from Californian waters (Bousfield unpublished data). Its generic diagnosis, in addition to the features listed in the key to the genera, contains the following:

Body relatively long and slender (Fig. 4A). Head with notched anterior margin. Antennae short, subequal. First maxilla with tall outer plate, its apex subacute (Fig. 4C); second maxilla with inner plate shorter than outer. Maxilliped with tall inner plate and 2-segmented palp. Propod of first gnathopod without posterodistal setae; tip of dactyl of second gnathopod microchelate. Coxa 4 largest and deepest; hind lobes of coxae 5 and 6 deep, rounded. Pleon with side plates normal, of about equal depth. Pleopods strong, with long, setose rami; clothespins spines cleft-tipped, numerous, Uropod rami with conspicuously spinose margins. Telson with shallow apical incision. Coxal gills relatively large and long, smallest on P7. Brood plates on 2–4 large, with marginal setae numerous, moderately long; brood plate 5 sublinear, with long marginal setae.

Type species: *Protolafystius madillae* Bousfield, 1987.

Protolafystius madillae Bousfield, 1987 (Fig. 4A-D)

First and second antennae subequal in length (Fig. 4A); first maxilla (Fig. 4C) with narrowing inner plate carrying two apical setae; maxilliped (Fig. 4D) with elongate inner plate and two-segmented palp. Coxae 1–2 small (Fig. 4A), subequally deep, coxa 3 longer, subrectangular, 4 very large, acuminate, 5–6 with broad and deep posterior lobes.

Gills of *Parophrys vetulus*. (Pac) (Bousfield 1987).

Lafystius Krøyer, 1842

This well-known genus of Amphipoda is represented in Canadian waters by three recently described species (Bousfield 1987). Literature sources leave no doubt that *Lafystius* lives parasitically on teleost and some clasmobranch fishes, though, like most amphipods, its members can survive without a host for some time. Hence, although two of the species recently added to the Canadian fauna were not collected directly from a host, they are included here in confident expectation that subsequent finds will establish the identity of the host(s). The key below includes also an unspecified *Lafystius* and *L. sturionis*, neither recorded from Canada, but both considered possible candidates for inclusion in the Canadian fauna.

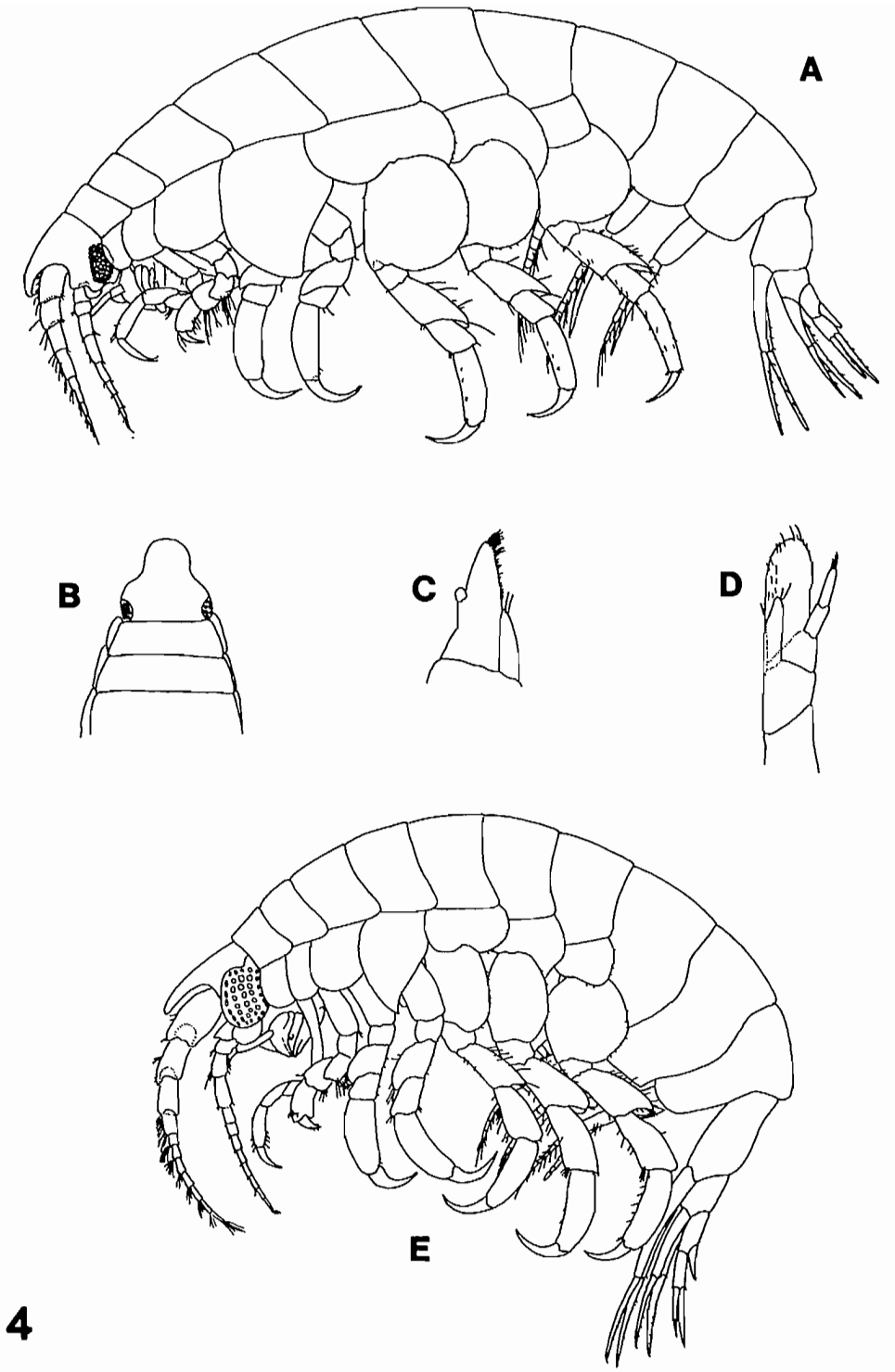

FIG. 4. *Protolafystius madillae* and *Lafystius morhuanus*. A. *P. madillae*, female, entire, lateral; B. Same, head, dorsal; C. First maxilla; D. Maxilliped; E. *L. morhuanus*, male, lateral.

The diagnostic characteristics of the genus, other than those shown in the key to the genera, are: Body relatively short, with head usually bent upwards at an angle. First antenna stouter than second, with 7- to 10-segmented flagellum, second slender, with 5- to 9-segmented flagellum. Pleon side plates (especially 2–3) deeper than wide. Rami of pleopods more than 10-segmented. Telson apically rounded.

Type species: *L. sturionis* Krøyer, 1842.

Key to species of *Lafystius*

1 Eyes large (usually more than 25 facets), covering large areas on sides of head. Propod of first gnathopod with large posterodistal marginal spines 2

Eyes small (fewer than 25 facets), covering less than half of sides of head. Propod of first gnathopod apparently without posterolateral spines or setae ..... *Lafystius* sp.
Mouth fringes of *Lophius americanus*. (Atl) (Holmes 1905).

2 Eyes of medium size (usually 25–35 facets). Propod of first gnathopod with 7–11 anterodistal spines. First antennae with 9- to 11-segmented flagellum (Fig. 5A). Third segment of mandibular palp with 10 or more posterior marginal setae (Fig. 5B) 3

Eyes (even in females) very large (usually 35–60 facets). Propod of first gnathopod with 4–6 anterodistal marginal spines. First antenna with 5- to 8-segmented flagellum. Posterior margin of third segment of mandibular palp with 6–8 setae 4

3 Abdominal side plate 2 with produced, acute hind corner. Tip of dactyl of second gnathopod with unequal spine and posterolateral process. Inner plate of first maxilla with three apical setae ..... *L. sturionis* Krøyer, 1842
Skin of many fish species, including *Gadus morhua* and *Lophius piscatorius*. (Atl). (Auct.).

Abdominal side plate 2 without produced hind corner (Fig. 5A). Tip of dactyl of second gnathopod (Fig. 5D) with subequal spine and posterodistal process. Inner plate of first maxilla with 2(1) apical setae ..... *L. morhuanus* Bousfield, 1987
Maxilliped palp (Fig. 5C) with 3 apical setae, distinctly shorter than outer plate. Coxal plates (Fig. 5A) somewhat longer than half length of basis.
Skin of *Gadus morhua, Melanogrammus aeglefinus, Myoxocephalus scorpius, Macrozoarces americanus, Raja radiata, R. senta,* and *R. erinacea*. (Atl) (Bousfield 1987).

4 Eye with about 40 facets (Fig. 5G). Propod of second gnathopod with nearly square posterodistal angle. Coxa 6 very deep behind, 4/5 length of basis. Basis of peraeopod 7 with proximomedial setae only ..... *L. frameae* Bousfield, 1987
First antenna (Fig. 5G) with 8-segmented flagellum, second (Fig. 5G) with 7-segmented flagellum. Third segment of mandibular palp (Fig. 5H) with 8 marginal and 1 apical seta.
Host unknown. (Atl) (Bousfield 1987).

Eye with about 60 facets (Fig. 5E). Propod of second gnathopod with acuminate, strongly produced posterodistal angle. Coxa 6 shallow behind, about half depth of basis. Basis of peraeopod 7 with distinct clusters of proximal and distal medial facial setae ..... *L. acuminatus* Bousfield, 1987
First and second antennae (Fig. 5E) with 6-segmented flagella. Third segment of mandibular palp (Fig. 5F) with 7 marginal and 2 apical setae.
Host unknown. (Atl) (Bousfield 1987).

Holmes' (1905) scrupulously detailed description leaves no doubt that the *Lafystius* sp. he discovered in the buccal region of *Lophius americanus* is not conspecific with other species recorded above. In spite of the absence of Canadian records of this species and of *L. sturionis*, the widespread occurrence of their hosts in our waters suggests the likelihood of their presence.

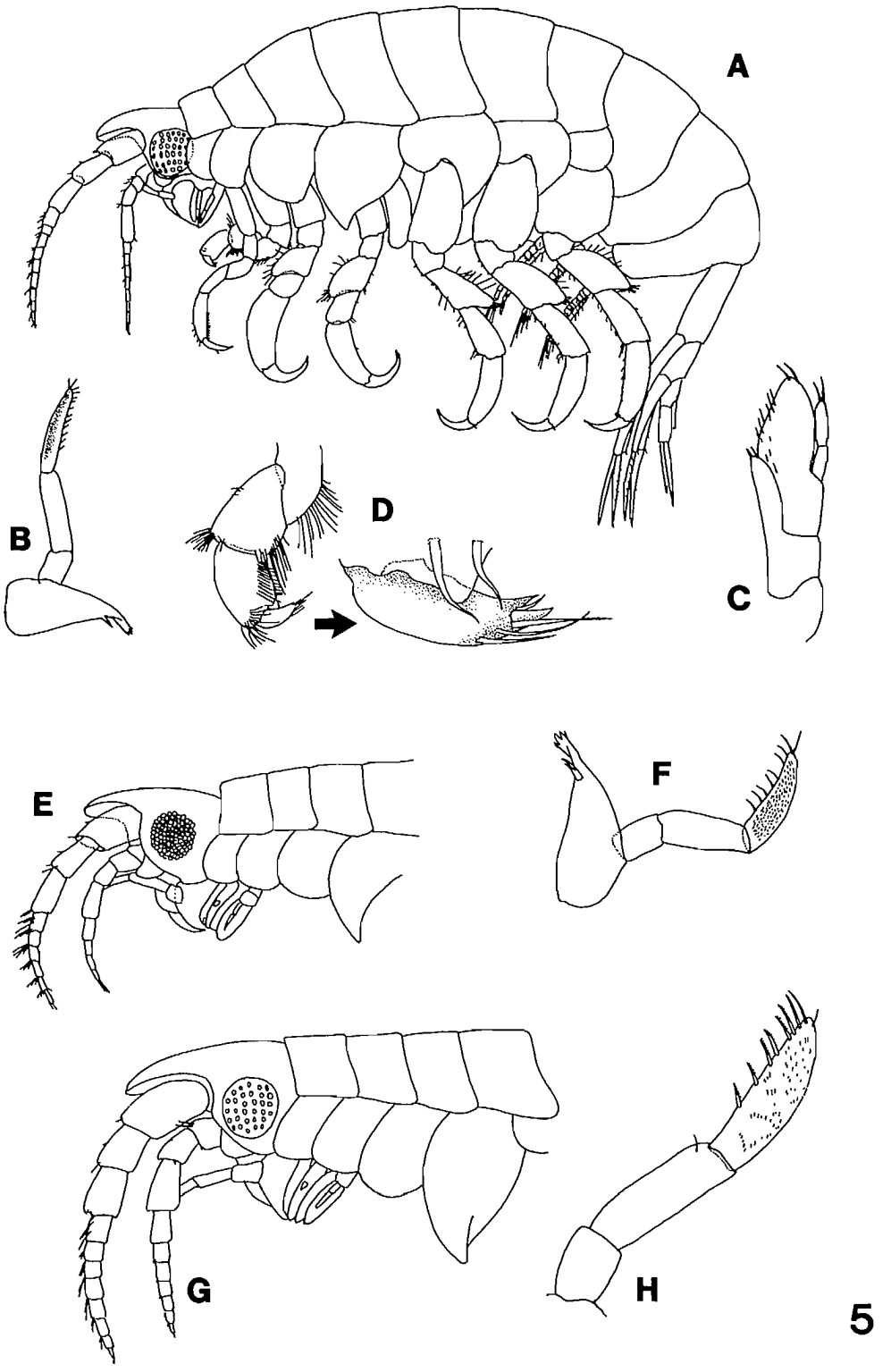

FIG. 5. *Lafystius morhuanus*, *L. acuminatus*, and *L. frameae*. A. *L. morhuanus*, female, entire, lateral; B. Mandible; C. Maxilliped; D. Second gnathopod; E. *L. acuminatus*, female, head, lateral; F. Same, mandible; G. *L. frameae*, male, head, lateral; H. Same, mandibular palp.

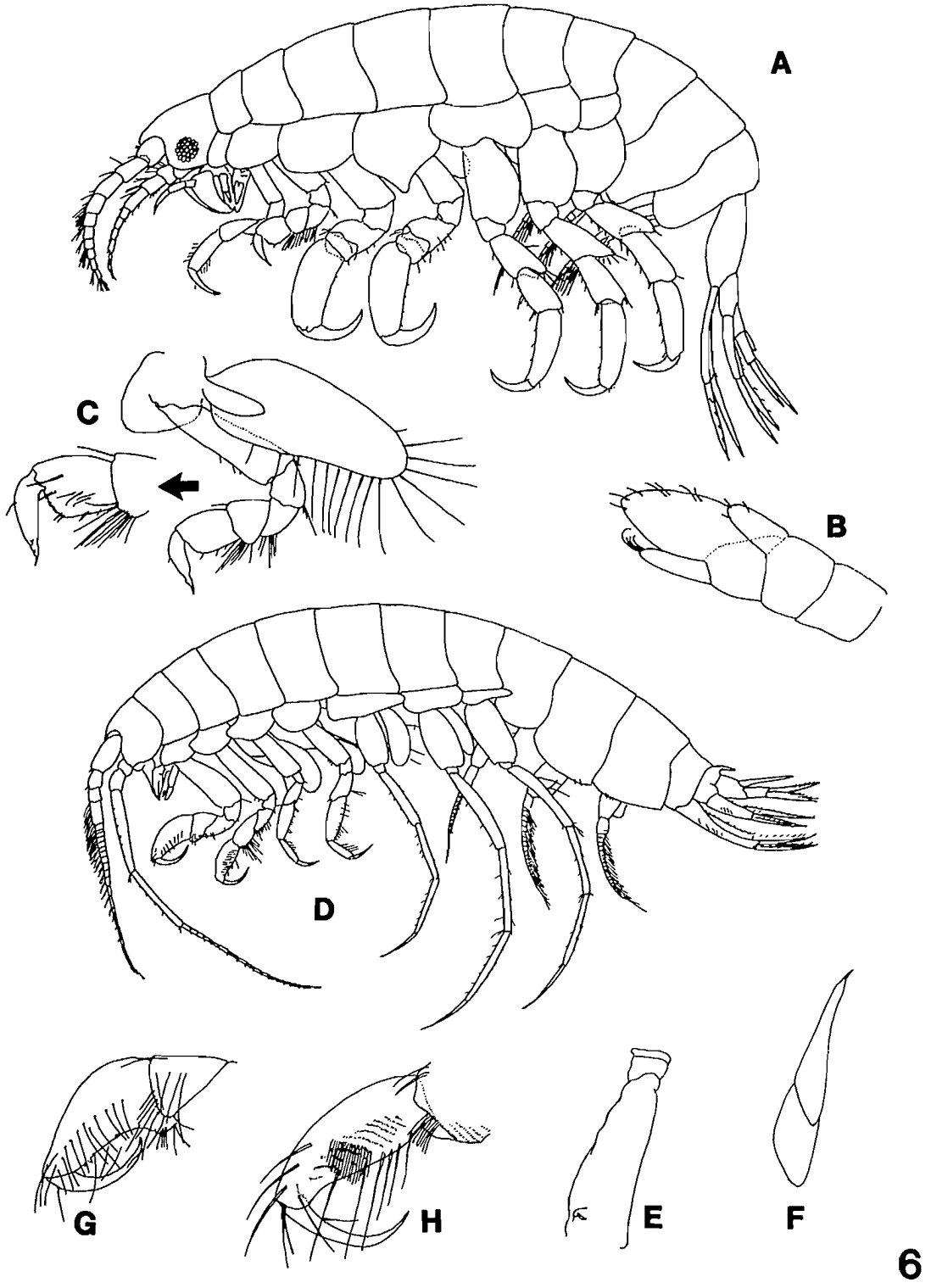

FIG. 6. *Paralafystius mcallisteri* and *Rhynohalicella halona*. A. *P. mcallisteri*, female, lateral; B. Same, maxilliped; C. Second gnathopod; D. *R. halona*, female, lateral; E. Same, mandible; F. Second maxilla; G. First gnathopod; H. Second gnathopod.

Paralafystius Bousfield, 1987

Rostrum short (Fig. 6A). Peduncular segment 1 of first antenna shorter than segment 2. First maxilla with short, distally truncated outer plate; second with subequal plates. Maxilliped (Fig. 6B) with short inner plate and one-segmented palp. Coxa 1 much smaller than coxa 2. Posterior margin of propod of second gnathopod (Fig. 6C) with few spines only. Posterior lobes of coxae 5–6 not produced below. Peraeopods 5–7, corpus not shorter than merus. Abdominal side plate 2 narrow, much deeper than 1 or 3. First uropod slender, elongate. Tips of rami of uropods 1 and 2 with slender, unequal spines. Telson with subtruncate, entire tip. All brood plates large, with long marginal setae. Coxal gills sac-like, absent from P7.

Type species: *Paralafystius mcallisteri* Bousfield, 1987.

Paralafystius mcallisteri Bousfield, 1987 (Fig. 6A–C)

With characters of the genus. No specific features yet determined, other than those given in Bousfield (1987). Host uncertain, but the following fish species have been taken together with *P. mcallisteri*: *Bathymaster signatus*, *Hemilepidotus hemilepidotus*, *H. jordani*, *Hexagrammos decagrammus*, and *Sebastes melanops*. No other amphipods were present. (Pac) (Bousfield 1987).

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HOST–CRUSTACEAN PARASITE LIST

HOST–CRUSTACEAN PARASITE LIST

(A) — Amphipoda; (B) — Branchiura; (C) — Copepoda; (I) — Isopoda.

Class: AGNATHA
Order: PETROMYZONTIFORMES
Family: Petromyzontidae
Petromyzon marinus
Ergasilus caeruleus (C)

Class: CHONDRICHTHYES
Order: SQUALIFORMES
Family: Lamnidae
Carcharodon carcharias
Anthosoma crassum (C)
Dinemoura latifolia (C)
Pandarus sinuatus (C)
Isurus glaucus
Dinemoura producta (C)
Lamna nasus
Echthrogaleus coleoptratus (C)
Family: Carchariidae
Carcharius taurus
Nemesis robusta (C)
Pandarus sinuatus (C)
Family: Squalidae
Centroscyllium fabricii
Albionella centroscyllii (C)
Etmopterus princeps
Ommatokoita sp. (C)
Somniosus microcephalus
Aega psora (I)
Ommatokoita elongata (C)
Squalus acanthias
Eudactylina acanthii (C)
Opisa tridentata (A)
Pseudocharopinus bicaudatus (C)
Order: RAJIFORMES
Family: Torpedinidae
Torpedo nobiliana
Pandarus floridanus (C)
Family: Rajidae
Bathyraja richardsoni
Lernaeopodina longimana (C)
Raja binoculata
Lepeophtheirus parviventris (C)
Lepeophtheirus pravipes (C)
Lepeophtheirus sp. (C)
Pseudocharopinus dentatus (C)
Rocinela angustata (I)
Rocinela propodialis (I)
Schistobrachia tertia (C)
Raja erinacea
Eudactylina corrugata (C)
Lafystius morhuanus (A)
Lernaeopodina longimana (C)
Raja inornata
Dendrapta cameroni longiclavata (C)
Raja jenseni
Lernaeopoda sp. (C)
Raja laevis
Acanthochondrites annulatus (C)
Caligus elongatus (C)
Charopinus dubius (C)
Lernaeopodina longimana (C)
Raja radiata
Aega psora (I)
Dendrapta cameroni cameroni (C)
Eudactylina corrugata (C)
Lafystius morhuanus (A)
Lernaeopodina longimana (C)
Schistobrachia ramosa (C)
Raja rhina
Eudactylina similis (C)
Lepeophtheirus parviventris (C)
Lernaeopodina pacifica (C)
Pseudocharopinus dentatus (C)
Schistobrachia tertia (C)
Raja senta
Lafystius morhuanus (A)
Raja stellulata
Eudactylina similis (C)
Raja sp.
Caligus elongatus (C)
Rocinela belliceps (I)
Order: CHIMAERIFORMES
Family: Chimaeridae
Hydrolagus affinis
Lernaeopodina longibrachia (C)
Hydrolagus colliei
Acanthochondria epachthes (C)
Acanthochondria rectangularis (C)
Caligus clemensi (C)
Rocinela belliceps (I)
Hydrolagus sp.
Rocinela belliceps (I)

Class: OSTEICHTHYES
Order: ACIPENSERIFORMES
Family: Acipenseridae
Acipenser brevirostrum
Argulus alosae (B)
Dichelesthium oblongum (C)
Acipenser fulvescens
Argulus stizostethii (B)
Acipenser oxyrhynchus
Dichelesthium oblongum (C)
Acipenser transmontanus
Lepeophtheirus salmonis (C)
Order: ANGUILLIFORMES
Family: Anguillidae
Anguilla rostrata
Ergasilus caeruleus (C)
Ergasilus celestis (C)
Ergasilus sp. (C)
Family: Congridae
Conger oceanius
Caligus elongatus (C)

Family: Synaphobranchidae
Synaphobranchus kaupi
Lophoura gracilis (C)
Order: CLUPEIFORMES
Family: Clupeidae
Alosa aestivalis
Clavellisa cordata (C)
Alosa pseudoharengus
Clavellisa cordata (C)
Alosa sapidissima
Clavellisa cordata (C)
Clupea harengus harengus
Caligus elongatus (C)
Clupea harengus pallasi
Bomolochus cuneatus (C)
Caligus clemensi (C)
Order: OSTEOGLOSSIFORMES
Family: Hiodontidae
Hiodon alosoides
Ergasilus sp. (C)
Order: SALMONIFORMES
Family: Salmonidae
Coregonus artedii
Argulus stizostethii (B)
Argulus sp. (B)
Ergasilus auritus (C)
Ergasilus caeruleus (C)
Ergasilus nerkae (C)
Ergasilus sp. (C)
Salmincola extensus (C)
Coregonus clupeaformis
Achtheres pimelodi (C)
Argulus stizostethiii (B)
Ergasilus auritus (C)
Ergasilus caeruleus (C)
Ergasilus nerkae (C)
Ergasilus sp. (C)
Salmincola corpulentus (C)
Salmincola extensus (C)
Salmincola thymalli (C)
Coregonus hoyi
Salmincola corpulentus (C)
Coregonus kiyi
Salmincola extensus (C)
Salmincola corpulentus (C)
Coregonus reinhardti
Salmincola corpulentus (C)
Coregonus sp.
Argulus stizostethii (B)
Salmincola corpulentus (C)
Oncorhynchus gorbuscha
Caligus clemensi (C)
Lepeophtheirus salmonis (C)
Salmincola californiensis (C)
Salmincola sp. (C)
Oncorhynchus keta
Caligus clemensi (C)
Lepeophtheirus salmonis (C)
Salmincola californiensis (C)
Oncorhynchus kisutch
Caligus clemensi (C)
Ergasilus auritus (C)
Ergasilus nerkae (C)
Lepeophtheirus salmonis (C)
Salmincola californiensis (C)
Oncorhynchus nerka
Caligus clemensi (C)
Ergasilus auritus (C)
Ergasilus caeruleus (C)
Ergasilus nerkae (C)
Lepeophtheirus salmonis (C)
Salmincola californiensis (C)
Salmincola carpionis (C)
Salmincola sp. (C)
Oncorhynchus tschawytscha
Lepeophtheirus salmonis (C)
Salmincola californiensis (C)
Oncorhynchus sp.
Caligus clemensi (C)
Prosopium cylindraceum
Ergasilus caeruleus (C)
Ergasilus luciopercarum (C)
Salmincola extensus (C)
Salmincola thymalli (C)
Salmincola sp. (C)
Prosopium williamsoni
Achtheres sp. (C)
Ergasilus nerkae (C)
Salmincola californiensis (C)
Salmincola edwardsi (C)
Salmincola extensus (C)
Salmincola thymalli (C)
Prosopium sp.
Salmincola thymalli (C)
Salmo clarki
Lepeophtheirus salmonis (C)
Salmincola californiensis (C)
Salmincola edwardsi (C)
Salmo gairdneri
Argulus pugettensis (B)
Caligus clemensi (C)
Caligus elongatus (C)
Ergasilus nerkae (C)
Lepeophtheirus salmonis (C)
Salmincola californiensis (C)
Salmo salar
Argulus stizostethii (B)
Ergasilus sp. (C)
Lepeophtheirus salmonis (C)
Salmincola corpulentus (C)
Salmincola salmoneus (C)
Salmo trutta
Ergasilus sp. (C)
Salmonidae (unidentified)
Ergasilus auritus (C)
Ergasilus nerkae (C)
Salvelinus alpinus
Salmincola carpionis (C)
Salmincola edwardsi (C)
Salvelinus fontinalis
Argulus stizostethii (B)
Caligus elongatus (C)

Ergasilus auritus (C)
Ergasilus luciopercarum (C)
Ergasilus sp. (C)
Lepeophtheirus salmonis (C)
Salmincola carpionis (C)
Salmincola edwardsi (C)
Salmincola sp. (C)
Salvelinus fontinalis x *S. namaycush*
Ergasilus caeruleus (C)
Salvelinus malma
Salmincola californiensis (C)
Salmincola carpionis (C)
Salmincola edwardsi (C)
Salmincola siscowet (C)
Salvelinus namaycush
Ergasilus auritus (C)
Ergasilus nerkae (C)
Salmincola californiensis (C)
Salmincola edwardsi (C)
Salmincola siscowet (C)
Salmincola sp. (C)
Stenodus leucichthys
Salmincola sp.
Thymallus arcticus
Ergasilus nerkae (C)
Salmincola thymalli (C)
Family: Osmeridae
Hypomesus pretiosus
Lironeca californica (I)
Osmerus mordax
Ergasilus auritus (C)
Ergasilus labracis (C)
Ergasilus manicatus (C)
Thaleichthys pacificus
Haemobaphes diceraus (C)
Haemobaphes disphaerocephalus (C)
Family: Bathylagidae
Bathylagus euryops
Paeonocanthus antarcticensis (C)
Family: Esocidae
Esox lucius
Argulus stizostethii (B)
Ergasilus luciopercarum (C)
Esox masquinongy
Ergasilus caeruleus (C)
Order: MYCTOPHIFORMES
Family: Myctophidae
Benthosoma glaciale
Sarcotretes scopeli (C)
Order: CYPRINIFORMES
Family: Cyprinidae
Acrocheilus alutaceus
Ergasilus caeruleus (C)
Carassius auratus
Lernaea cyprinacea (C)
Couesius plumbeus
Ergasilus nerkae (C)
Cyprinus carpio
Argulus appendiculosus (B)
Ergasilus caeruleus (C)
Lernaea cyprinacea (C)
Mylocheilus caurinus
Ergasilus nerkae (C)
Notropis cornutus
Ergasilus caeruleus (C)
Notropis hudsonius
Ergasilus luciopercarum (C)
Argulus stizostethii (B)
Notropis sp.
Ergasilus sp. (C)
Pimephales notatus
Ergasilus cyprinaceus (C)
Pimephales promelas
Ergasilus cyprinaceus (C)
Ptychocheilus oregonensis
Ergasilus nerkae (C)
Richardsonius balteatus
Ergasilus nerkae (C)
Semotilus atromaculatus
Argulus catostomi (B)
Ergasilus caeruleus (C)
Lernaea cyprinacea (C)
Semotilus corporalis
Ergasilus caeruleus (C)
Family: Catostomidae
Carpiodes cyprinus
Ergasilus caeruleus (C)
Catostomus catostomus
Ergasilus caeruleus (C)
Ergasilus centrarchidarum (C)
Ergasilus nerkae (C)
Ergasilus sp. (C)
Catostomus commersoni
Argulus appendiculosus (B)
Argulus catostomi (B)
Argulus stizostethii (B)
Ergasilus caeruleus (C)
Ergasilus nerkae (C)
Ergasilus sp. (C)
Catostomus macrocheilus
Ergasilus nerkae (C)
Ictiobus cyprinellus
Argulus appendiculosus (B)
Moxostoma anisurum
Ergasilus caeruleus (C)
Moxostoma erythrurum
Ergasilus caeruleus (C)
Ergasilus sp. (C)
Order: SILURIFORMES
Family: Ictaluridae
Ictalurus melas
Argulus catostomi (B)
Ictalurus nebulosus
Achtheres pimelodi (C)
Ergasilus versicolor (C)
Ergasilus sp. (C)
Ictalurus punctatus
Achtheres pimelodi (C)
Ergasilus versicolor (C)
Noturus flavus
Ergasilus versicolor (C)
Noturus gyrinus

Ergasilus versicolor (C)
Order: PERCOPSIFORMES
Family: Percopsidae
Percopsis omiscomaycus
Argulus versicolor (B)
Argulus sp. (B)
Ergasilus caeruleus (C)
Ergasilus luciopercarum (C)
Order: LOPHIIFORMES
Family: Antennariidae
Histrio histrio
Pennella sagitta (C)
Family: Lophiidae
Lophius americanus
Lafystius sp. (A)
Order: GADIFORMES
Family: Gadidae
Gadus macrocephalus
Chondracanthus palpifer (C)
Clavella adunca (C)
Clavella irina (C)
Haemobaphes diceraus (C)
Lepeophtheirus hospitalis (C)
Lepeophtheirus parviventris (C)
Lepeophtheirus sp. (C)
Rocinela belliceps (I)
Gadus morhua
Aega psora (I)
Caligus curtus (C)
Caligus elongatus (C)
Caligus sp. (C)
Clavella adunca (C)
Clavella sp. (C)
Lafystius morhuanus (A)
Lernaeocera branchialis (C)
Opisa eschrichti (A)
Rocinela belliceps (I)
Gadus ogac
Aega psora (I)
Lernaeocera branchialis (C)
Gairdropsaurus ensis
Sphyrion lumpi (C)
Lota lota
Ergasilus caeruleus (C)
Melanogrammus aeglefinus
Caligus curtus (C)
Caligus elongatus (C)
Clavella adunca (C)
Clavella sp. (C)
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Opisa eschrichti (A)
Merluccius bilinearis
Caligus curtus (C)
Caligus elongatus (C)
Chondracanthus merluccii (C)
Merluccius productus
Caligus sp. (C)
Chondracanthus palpifer (C)
Clavella perfida (C)
Haemobaphes diceraus (C)
Lepeophtheirus sp. (C)
Neobrachiella insidiosa f. pacifica (C)
Microgadus proximus
Clavella adunca (C)
Lepeophtheirus sp. (C)
Microgadus tomcod
Argulus alosae (B)
Caligus curtus (C)
Caligus elongatus (C)
Molva molva
Aega psora (I)
Pollachius virens
Caligus curtus (C)
Caligus elongatus (C)
Clavella adunca (C)
Clavella sp. (C)
Theragra chalcogramma
Caligus clemensi (C)
Clavella perfida (C)
Haemobaphes theragrae (C)
Haemobaphes sp. (C)
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Lepeophtheirus paulus (C)
Lepeophtheirus sp. (C)
Urophycis tenuis
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Coryphenoides rupestris
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Clavella adunca (C)
Sphyrion lumpi (C)
Macrourus berglax
Chondracanthodes radiatus (C)
Clavella adunca (C)
Clavellomimus macruri (C)
Lateracanthus quadripedis (C)
Lophoura bouvieri (C)
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Nezumia bairdi
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Clavella adunca (C)
Lycenchelys verillii
Haemobaphes cyclopterina (C)
Lycodes atlanticus
Clavella pinguis (C)
Lycodes lavalei
Diocus frigidus (C)
Tanypleurus alcicornis (C)
Lycodes polaris
Clavella stichaei (C)
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Clavella stichaei (C)
Diocus frigidus (C)
Haemobaphes cyclopterina (C)
Macrozoarces americanus
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Antimora rostrata
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Fundulus heteroclitus
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Menidia menidia
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Ergasilus labracis (C)
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Ergasilus centrarchidarum (C)
Ergasilus sp. (C)
Lernaea cruciata (C)
Lepomis auritus
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Lepomis gibbosus
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Ergasilus caeruleus (C)
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Argulus appendiculosus (B)
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Ergasilus centrarchidarum (C)
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Argulus appendiculosus (B)
Ergasilus sp. (C)
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Ergasilus caeruleus (C)
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Hatschekia conifera (C)
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Argulus pugettensis (B)
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Lironeca californica (I)
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