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LITTORAL PENAEIDEA CHIEFLY FROM THE BINGHAM OCEANOGRAPHIC COLLECTION

WITH A REVISION OF *PENAEOPSIS* AND DESCRIPTIONS OF TWO NEW GENERA AND ELEVEN NEW AMERICAN SPECIES

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INTRODUCTION

The present observations on littoral and sublittoral penaeids of the world are a continuation of the preceding discussion of this fauna (Burkenroad, 1934). As in the previous paper, the present studies are chiefly centered about American Penaeinae and Eusicyoninae.

Approximately forty-one species of Penaeinae and Eusicyoninae (including those described in this paper), divisible among eleven genera, are known to occur on the Atlantic and Pacific coasts of America, of which twenty are Pacific, sixteen are Atlantic, and five may be regarded as common to the two coasts, although in not all of these is there absolute bioceanic identity. A majority of the species occurring on one American coast are represented on the other continental slope by one or more forms, relationship to which is closer than to species of other parts of the world. These congeneric pairs extend in differentiation from complete identity to a high order of distinction. Cases in which a species of one coast is not represented on the other are of great interest as perhaps fixing dates and directions of migration or even of differentiation of new types, but many of these cases may be apparent, not real, or may be based in other circumstances, ecological or fortuitous. Thus, the absence from Pacific America of a form representing *Parapenaeus longirostris* might indicate that this species reached Atlantic America, from the Eastern Atlantic, after the elevation of the interoceanic barrier; but it is also possible that a Pacific American representative may yet be found.

Many of the American species or superspecific groups have no close affinities in other regions; others show considerable resemblance to portions of the Indo-Pacific and the Eastern Atlantic faunas, although only one of the American Penaeinae and Eusicyoninae, an apparently cosmopolitan bathypelagic form, has been reported identical with an Indo-Pacific species, and only three (one of which is the bathypelagic species mentioned above) range to the Eastern Atlantic. More detailed generalization of the relations of the American Atlantic and Pacific faunas to one another and to those of other parts of the world is for the present dangerous. The extraordinary richness in peneids of the tropical west coast of America has not been realized in the past: eleven new American species are described below, of which ten are from the Pacific; three heretofore undiscovered Pacific species indistinguishable from Atlantic forms are also recorded. One of the new Pacific species requires a new genus for its reception; two genera, *Trachypeneus* and *Parapeneopsis*, the former not known to exist on the western coast, the latter not known to occur in America, are shown to be represented by three and by one species respectively; the number of species of the genus *Eusicyonia* known from Pacific America is increased from three to nine. The littoral sergestid *Acetes*, not heretofore known from western America, is found to be represented by an undescribed species. In such circumstances, successful consideration of the complex problems of distribution and affinity of the faunas of the two American coasts and their relations to the peneids of the remainder of the world is contingent upon further study. Since it has become evident in the course of the work that purely systematic knowledge of the peneids of other regions which might have been supposed better known was to some extent inadequate, and that even the larger groupings, genera and subfamilies, required fresh consideration, a monographic approach to the peneids is probably desirable. Toward this the present and the preceding paper, and further studies now in preparation, may be regarded as contributions of material.

LIST OF NEW GENERA, SUBGENERA, SPECIES AND SUBSPECIES

Protrachypene, n. gen.
Trachypeneopsis, n. gen.
Trachysalambria, n. subgen.

Penaeopsis (*Metapenaeopsis*) *mineri* n. sp.

Protrachypene precipua, n. gen. and sp.

Trachypeneus (*Trachysalambria*) *similis pacificus*, n. subsp.

Trachypeneus (Trachysalambria) byrdi, n. sp.
Trachypeneus (Trachysalambria) brevisuturae, n. sp.

Parapeneopsis balli, n. sp.

Eusicyonia parri, n. sp.
Eusicyonia disparri, n. sp.
Eusicyonia disedwardsi, n. sp.
Eusicyonia aliaffinis, n. sp.
Eusicyonia disdorsalis, n. sp.

Acetes americanus limonensis, n. subsp.
Acetes binghami, n. sp.

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The material upon which this paper is based is chiefly contained in the Bingham Oceanographic Collection. It is derived from invertebrate collections made under the direction of Mr. Harry Payne Bingham during the first and third, Atlantic American, and second, Pacific American, Oceanographic Expeditions of the "Pawnee" in 1925, 1926, and 1927; from an Indopacific collection gathered by Mr. Richard Colestock in the markets of various Oriental seaports during the first months of 1933; from collections obtained in the market of Panama City during December, 1933, by Mr. Junius Byrd; from collections made in the Bay of Panama and at Colon during February, 1934, by Professor A. E. Parr and M. D. Burkenroad; and from material collected by Mr. Marshall Bishop.

Some undescribed material in the collection of the Zoology Department of the Peabody Museum at Yale, especially that obtained on the west coast of Central America by Mr. F. H. Bradley in 1866, has been available, as have the peneid collections of the American Museum of Natural History. The examination of a number of specimens has been permitted by the Museum of Comparative Zoology at Harvard; and of an example of the new genus *Trachypeneopsis* by the Rijks Museum van Natuurlijke Historie of Leiden. To the authorities of these institutions I wish to acknowledge my deep indebtedness. Especially am I grateful to Dr. R. W. Miner and Dr. W. G. Van Name of the American Museum of Natural History, who generously provided facilities for a portion of the work. To Mr. Colestock, to Mr. Byrd, to Mr. Bishop, and to Mr. James Zetek I wish to express my

appreciation of their friendly and effective aid in obtaining valuable material. Finally, the completion of this portion of the study has been facilitated and its further prosecution made possible by the encouragement and assistance of Professor A. E. Parr, director of the Bingham Oceanographic Foundation.

SYSTEMATIC ACCOUNT

PENAEIDAE Bate

PENAEINAE Burkenroad, 1934

PENAEOPSIS Bate, restricted

Penaeopsis, BATE (A. Milne Edwards MS), 1881; A. MILNE EDWARDS and BOUVIER, 1909, part; DE MAN, 1911, part; SCHMITT 1926a, part.
Parapenaeus, SMITH, 1886, part; DE MAN, 1911, part; BALSS, 1925, part.
Metapenaeus, WOOD MASON and ALCOCK, 1891, part; ALCOCK, 1905 and 1906, part.
Metapenaeopsis, BOUVIER, 1905a.
Archipenaeopsis, BOUVIER, 1905b.
Leptopenaeus, KISHINOUYE, 1929.
Ceratopenaeus, KISHINOUYE, 1929.
Erythropenaeus, KISHINOUYE, 1929.
NOT *Penaeopsis*, FAXON, 1895.

The generic titles *Penaeopsis* and *Metapenaeus* have been regarded as synonymous by most authors since Milne Edwards and Bouvier, 1909, and have been at all times so defined as to include identical groups of species. The limits of the genus in this usual unrestricted sense, have been considered as set by the presence of a pleurobranch on XIII but not on XIV, the absence of longitudinal and transverse sutures from the carapace, and the presence of exopodites on most of the walking legs. These characters have been attributed to over sixty species, but as will be shown below, not only do certain species included in the "genus" fail to conform to the above definition, but the other, conformable, species do not constitute a homogeneous group and cannot be maintained as a single genus.

The genus *Penaeopsis* in the unrestricted sense in which it has been employed by preceding workers usually has been subdivided into two groups: those species lacking, and those possessing marginal spines on the telson. Unfortunately this division obscures natural relationships, and has given rise to much confusion. Most, and probably all, of the species, "Group I," described as lacking the marginal armature, actually possess it. Thus De Man, 1924, has noted the presence of minute mobile lateral spines, previously overlooked, in *P. brevicornis* (H. M. Edwards) and *P. lysianassa* (De Man) of "Group I," and a similar armature is present in *P. affinis* (H. M. Edwards), *P. monoceros* (Fabricius) and *P. joyneri* (Miers), in which it has been stated to be absent. Conversely, *P. cognatus* Nobili; *P. stebbingi* Nobili; the superspecies comprising *P. ensis* (deHaan), *P. intermedius* (Kishinouye), *P. intermedius anchista* De Man and *P. endeavouri* Schmitt, all of which have been placed in "Group II" among the the species, chiefly with asymmetrical petasma, possessing marginal spines, are very closely related to the species of "Group I," rather than to the other species of "Group II." Two of the species which have been included in "Group II," *Penaeus richtersii* Miers (*Penaeopsis*, De Man, 1911) and *Metapeneus mobilispinis* Rathbun, lack the pleurobranch of somite XIII and bear only a remote relationship to any of the other species of the "genus."

Of other efforts at subdivision of *Penaeopsis*, Schmitt, 1926a, although adhering to the usual separation by presence or absence of telson armature, suggests that a group of species consisting of *P. serratus* A. Milne Edwards, *P. rectacutus* (Bate), *P. coniger* (Wood Mason and Alcock), and *P. coniger* var. *andamensis* (Wood Mason and Alcock), might be separated from the remainder of the genus by the following characters:

INNER ANTENNULAR FLAGELLUM OF THE MALE WITH THE BASAL PORTION SET OFF BY A MORE DISTAL KNOB OR DENTICLE, FLAGELLA OF BOTH SEXES AS LONG AS OR LONGER THAN THE PEDUNCLE; SHORT SCALE-LIKE EXOPODS, EXCEPT IN P. CONIGER ANDAMENSIS; TELSON ARMED WITH TWO OR THREE PAIRS OF MOVABLE SPINES IN ADDITION TO A DISTAL, IMMOVABLE PAIR; BRANCHIAL FORMULA OF THE EIGHTH SOMITE POSSIBLY DIFFERENT FROM THAT OF THE "METAPENEI" IN THAT THE ANTERIOR GILL IS PERHAPS A PLEUROBRANCH RATHER THAN AN ARTHROBRANCH.

We may note that *P. coniger* and *P. coniger andamensis* possess, in common with many of the species which Schmitt lumps as "Metapenei," an asymmetrical petasma; while the petasma of *P. serratus* and *P. rectacutus* is symmetrical. There is no real difference in homology of the anterior dorsal gill of the eighth somite between any Penaeidae, although the gill has been variously termed both arthrobranch and pleurobranch. The difference in length of antennular flagellum and its nature in the male between *P. coniger* and *P. coniger andamensis*, and the other species with asymmetrical petasma seems rather to point a near relationship of *P. serratus* and *P. rectacutus* to all of "asymmetrica" than to distinguish the four species selected by Schmitt as more closely related to one another than to the second group, evidently regarded by Schmitt as homogeneous, composed of the remainder of the species with asymmetrical petasma; *P. affinis* (H. M. Edwards) and its allies; and the two species which lack the pleurobranch of XIII. For these and other reasons it may be said that Schmitt, on the basis of insufficiently diagnostic characters, has suggested a grouping of the species of "*Penaeopsis*" which fails to coincide with natural boundaries.

Kishinouye, 1929, has proposed the separation of species with asymmetrical petasma from the remainder of the "genus," a division with disadvantages similar to but less obvious than those inherent in Schmitt's grouping. The differentiating characters employed by Kishinouye are: PETASMA ASYMMETRICAL, ENDOPOD OF FIRST MAXILLA UNISEGMENTED, AN EXOPOD ON THE FIFTH LEGS, AND THE RECEPTACULUM SEMINIS SEPARATED INTO TWO DISTINCT SACS. Kishinouye divides his group into the three genera *Leptopenaeus*, *Ceratopenaeus*, and *Erithropenaeus*. However, although these three series of species form, as pointed out by Kishinouye, "a quite natural assemblage," and one well distinguished from *Penaeopsis monoceros* and its allies, their distinction from *Penaeopsis serratus* and related species with symmetrical petasma, which Kishinouye's method of division lumps with *P. monoceros* and with *P. richtersii*, is not discussed. As to the differentiating characters employed, the sperm receptacles of American species with asymmetrical petasma do not include the pair of sac-like enlargements to which Kishinouye refers, while those of *P. serratus* and its allies do include such structures. The nature of the endopod of the first maxilla, whether or how "segmented," is a character of considerable value, but one not substantiating Kishinouye's concepts. The maxillulary palp in all Penaeinae which I have examined is composed of a single segment; its distal portion may, however, be produced as a more or less constricted lobe of variable length, which when long is separated from the basal portion by an area of folding, and may be further divided by more or less marked constrictions at which folding occurs. These subdivisions are almost certainly not distinct articles separated by true joints. In Kishinouye's three genera of "asymmetrica," the palp is short and its distal end is unproduced, while in the *P. monoceros* and *P. richtersii* groups there is a distal lobe; but since the maxillula of *P. serratus*, with symmetrical petasma, is of the same form as in the asymmetrica, the character does not possess the diagnostic value ascribed to it by Kishinouye. Finally, the three genera into which Kishinouye divides the species with asymmetrical petasma, although they appear to be natural superspecific groups, seem to form no more than one section of "asymmetrica," the American species forming a section equivalent in importance, by Kishinouye's characters, to one composed of all three Indo-pacific groups.

The names *Metapenaeopsis* and *Archipenaeopsis* created and later retracted by Bouvier were based upon misinterpretations of the branchiae. It is unfortunately necessary to define and utilize in a subgeneric sense the former of these names, as indicated in a succeeding paragraph.

The species which have been included under *Penaeopsis* form three major groups which are clearly of generic importance. The smallest of these three groups, to which reference has been made (Burkenroad, 1934) as "the first of three genera confused under the name '*Penaeopsis*'," is composed of *P. richtersii* and *P. mobilispinis*. It resembles the other two genera only superficially, the pleurobranch of somite XIII being absent as in *Trachypeneus* and related genera. This group therefore needs no further consideration in connection with the revision of *Penaeopsis;* its distinctive features will be discussed on a later page as those of *Trachypeneopsis*, new genus. *P. serratus* and *P. rectacutus* of Schmitt's subgroup *Penaeopsis* of the unrestricted genus; together with the species of the three genera proposed by Kishinouye (which number among them members of both of Schmitt's subgroups), make up the genus *Penaeopsis* in a restricted sense by virtue of including Milne Edward's generic type, *P. serratus*. To this numerous group of species, reference has been made in the preceding paper as "the third of three genera confused under the name '*Penaeopsis*'." Since the type of Wood Mason's genus *Metapenaeus* is a species belonging to a different generic group than does the type of *Penaeopsis* Bate, *Metapenaeus* may be revived in a restricted sense for the species related to *P. monoceros* and *P. affinis*, which have been mentioned in the preceding paper as forming "the second of three genera confused under the name 'Penaeopsis'."

METAPENAEUS Wood Mason and Alcock, restricted

Basal segment of antennular peduncle without a spine on its median border. Maxillulary palp with a produced, constricted distal portion. Petasma with a pair of channeled, spout-like distolateral projections; without distoventral projections. Anteroventral angle of the carapace without a pterygostomian or branchiostegal spine. Telson armed with a series of mobile lateral spines of variable size; no fixed lateral spines. Anterior pereiopods with, fifth pair without an exopodite. Basis of third chelipeds usually (probably always) armed. Somite XIII with a pleurobranch. Carapace without longitudinal and transverse sutures.

Known species confined to the Indopacific (save for certain migrants into the Mediterranean through the Suez Canal). Type, *Metapenaeus affinis* (H. Milne Edwards). Named species: *M. affinis* H. M. Edwards, *mutatus* Lanchester, *monoceros* Fabricius, *elegans* De Man, *incisipes* Bate, *deschampsi* Nobili, *cognatus* Nobili, *spinulicauda* Stebbing. *M. stebbingi* Nobili. *M. dobsoni* Miers, *joyneri* Miers, *brevicornis* H. M. Edwards, *lyssianassa* De Man. *M. macleayi* Haswell, *demani* Roux. *M. ensis* De Haan, *intermedius* Kishinouye, *intermedius anchista* De Man, *endeavouri* Schmitt.

PENAEOPSIS Bate, restricted

Basal segment of antennular peduncle with a spine on its median border. Maxillulary palp without a produced distal portion. Petasma without deeply channeled spout-like distolateral projections. Anteroventral angle of the carapace with a pterygostomian spine. Telson armed with a pair of fixed lateral spines behind a series of mobile ones. All pereiopods with exopodites of more than vestigial nature. Basis of third chelipeds never armed. Somite XIII with a pleurobranch. Carapace without longitudinal or transverse sutures.

Distribution cosmopolitan. Type, *Penaeopsis megalops* (Smith) (*P. serratus* Milne Edwards and Bouvier, 1909; not *Penaeus serratus* Bate, 1881). Species falling into two subgenera as follows:

I. *Penaeopsis* Bate, sensu stricto. Petasma symmetrical. Vestigial anterior arthrobranch of somite XIII absent. Named species: *P. megalops* Smith, *serratus* Bate, *rectacutus* Bate.

II. *Metapenaeopsis* Bouvier, 1905a, redefined. Petasma asymmetrical. Vestigial anterior arthrobranch of somite XIII present [save in *P. lamellatus* (De Haan) according to Schmitt, 1926a]. Type, *Penaeopsis* (*Metapenaeopsis*) *pubescens* (Bouvier). Species divisible into two sections, as follows:

SECTION 1. External piece (distoventral projection) of the left petasmal endopod reduced to a rudiment. Known distribution limited to the Atlantic and the American Pacific. Species: *P. goodei* Smith, *smithi* Schmitt, *kishinouyei* Rathbun, *mineri*, n. sp., and *pubescens* Bouvier.

SECTION 2. Distolateral projection of the left petasmal endopod as large as or larger than the right one. Known distribution limited to the Indopacific. Species grouped by Kishinouye, 1929, as follows: (Leptopenaeus) *P. philippii* Bate [with which *P. coniger andamensis* (Wood Mason and Alcock) and *P. philippinensis* (Bate) are synonymous, Calman, 1923], *coniger* Wood Mason and Alcock, *sibogae* De Man, *distinctus* De Man. (Ceratopenaeus) *P. dalei* Rathbun, *mogiensis* Rathbun (with which *P. hilarulus* De Man is synonymous, Schmitt, 1926a), *lamellatus* De Haan, *borradalei* De Man. (Erythropenaeus) *P. acclivis* Rathbun, *barbatus* De Haan (with which *P. akayebi* Rathbun is synonymous, De Man, 1911). Other named Indopacific species probably of the section are: *P. assimilis* De Man, *batei* Miers, *commensalis* Borradaile, *consobrinus* Nobili, *evermanni* Rathbun, *gallensis* Pearson, *gracilis* Dana, *longipes* Paulson, *novae-guineae* Haswell [with which *P. stridulans* (Alcock) is synonymous, Schmitt, 1926a], *perlarum* Nobili, *quinquedentatus* De Man, *vaillanti* Nobili, *velutinus* Dana.

In the preceding paper (1934), the genera of Penaeinae have been arranged in four supergeneric series or maniples centering about *Penaeus* Fabricius, *Parapenaeus* Smith, *Trachypeneus* Alcock, and *Macropetasma* Stebbing. *Penaeopsis* Bate as here restricted was referred to the **Parapenaeus** series; *Metapenaeus* Wood Mason and Alcock as here reestablished, to the **Trachypeneus** series. Since these two genera are members of different maniples, a number of characters common to all other members of either supergeneric group are diagnostic for *Metapenaeus* and *Penaeopsis* with reference to each other, and have therefore been included in the generic definitions employed in the foregoing revision. The distribution of these characters of more than generic significance among the Penaeidae is as follows:

The PARAPENAEID SPINE of the distomedian region of the basal article of the antennular peduncle appears to be present in premysis or mysis stages of all Penaeidae. The spine occurs in postmysis stages of Penaeinae and some Aristaeinae, but it persists to maturity in *Penaeopsis, Parapenaeus* and *Artemesia* alone of the Penaeidae which I have examined.

The ultimate pair of lateral teeth of the telson are fixed in the adults of Solenocerinae (possibly in a few Aristaeinae) and Eusicyoninae, in which they are usually not preceded by mobile lateral spines; and in *Penaeopsis, Parapenaeus,* and *Artemesia* alone of Penaeinae, in which they are preceded by mobile spines. There is never more than one pair of fixed lateral teeth, which appear to be derived from a mobile larval pair usually longer than the rest and fourth from the base of the telson, and which may survive as a pair of mobile spines, unchanged, in the adult of other forms.

A constricted, produced distal portion is present on the maxillulary palp of *Solenocera,* where it is short and not well separated; in *Funchalia* and *Penaeus,* where it is elongate and constricted at several points; in *Trachypeneus, Xiphopeneus, Parapeneopsis,* where it is often extremely short and scarcely separated by a fold or constriction from the basal portion; and in *Metapenaeus* where it is of medium length and well separated. On the contrary, a lobe is completely absent in *Penaeopsis, Parapenaeus,* and *Artemesia,* and in the Eusicyoninae.

In the petasma of *Metapenaeus,* as in the **Trachypeneus** series, there is a pair of deeply channeled distolateral projections and no pair of distoventral projections. On the contrary, in the petasma of *Parapenaeus* and *Artemesia* and in modified but recognizable form in the subgenus *Metapenaeopsis* of *Penaeopsis,* there is a pair of distoventral projections in addition to a laterodistal pair which is only slightly or not at all channeled. This type of petasma also characterizes *Macropetasma* and the Eusicyoninae. The petasma of the subgenus *Penaeopsis* is anomalous, being of the open, simple form found in Aristaeinae, Solenocerinae, and the **Penaeus** series of Penaeinae, in which, contrary to *Penaeopsis,* it is usually correlated with an unenclosed sperm receptacle.

By the points mentioned above, *Metapenaeus* seems clearly distinct from *Penaeopsis* in characters which, by their correlated presence or absence over a wide range of Penaeinae may be taken to be of considerable importance. However, in one character otherwise of considerable significance—the presence of a pleurobranch on somite XIII—*Metapenaeus* resembles the **Parapenaeus** series including *Penaeopsis,* and differs from the entire **Trachypeneus** series.

In two characters of less general significance, *Metapenaeus* is clearly set off from *Penaeopsis:* The exopodite of its fifth leg only is absent; and the basis of its third chelipeds is armed with a spine. In the first of these characters *Metapenaeus* differs from almost all other Penaeinae (the loss being parallelled in one species of *Penaeus*) so that the distinction, while convenient, because of its uniqueness cannot be evaluated as an indicator of affinity. The second character may perhaps strengthen the evidence for relationship between *Metapenaeus* and the *Trachypenaeus* series, since an armature of the third leg basis seems otherwise to occur among Penaeidae only in certain forms related to *Trachypeneus*, as *Atypopenaeus*.

In a number of characters which seem of little significance for the elucidation of phylogenetic relationship, *Metapenaeus* and *Penaeopsis* resemble one another. Thus the vestigial anterior arthrobranch of somite XIII is present in *Metapenaeus*, most of the species of the subgenus *Metapenaeopsis* of *Penaeopsis*, and in species of *Trachypeneus* and related genera; while it is absent in other species of *Trachypeneus* and in the subgenus *Penaeopsis* and in *Parapenaeus*. The branchial lamella of somite VII is filamentose in *Metapenaeus*, *Penaeopsis*, *Artemesia* and those species of the **Trachypeneus** series available to me; while it is bare of filaments in *Parapenaeus*. The thelycum of both *Metapenaeus* and *Penaeopsis* is of the enclosed type found in Eusicyoninae and in all Penaeinae except certain members of the **Penaeus** series and *Macropetasma*, the sperm receptacles being formed by cavities of a deep, essentially transverse depression of the anterior part of sternite XIV. In *Metapenaeus* and in the American species of *Metapenaeopsis*, no portion of this depression is especially expanded; the spermatophores enter each lateral half of the groove by median openings, the sperm being extruded at the lateral, anterior ends of the groove. In the subgenus *Penaeopsis*, as in *Parapenaeus*, a portion of the groove on either side is deeply invaginated to form a pair of large membranous sacs in which the spermatophores are deposited, and entrance and exit of the receptacles are not distinctly separated. Receptacles somewhat similar to both types are found among *Trachypeneus* and other genera of that series, and a receptacle almost identical with that of the subgenus *Penaeopsis* occurs in Eusicyoninae. Longitudinal and transverse sutures of the carapace are limited, within the Penaeidae, to members of the *Trachypeneus* and *Parapenaeus* series. Within the former group the structures appear in all possible degrees of development and combination, either, neither, or both being present; within the latter group, the sutures are present in *Parapenaeus*, absent in *Artemesia*. Thus, it does not seem necessary to assume that the absence of the sutures both in *Metapenaeus* and *Penaeopsis* implies a near degree of relationship. Finally, it may be mentioned that in the American species of the subgenus *Metapenaeopsis* of *Penaeopsis* and in the American section of Division I of *Trachypeneus* the basis of the third maxillipedes is armed with a spine, a condition which has not been described for other Penaeidae. It is very doubtful that this interserial resemblance is fraught with any phylogenetic significance.

The evidence detailed above seems to justify the conclusion that of the species formerly included under the name *Penaeopsis*, those here referred to *Metapenaeus* are more closely related to *Trachypeneus*, those here referred to *Penaeopsis* more closely related to *Parapenaeus*, than is either group of species to the other.

Metapenaeus stands apart from the otherwise very compact *Trachypeneus* series, particularly in the presence of a pleurobranch on somite XIII and the absence of an exopodite from the fifth leg. *Penaeopsis*, on the other hand, is only slightly distinguished from *Parapenaeus*, aside from the absence of longitudinal and transverse sutures, by the filamentose branchial lamella of its seventh somite; the presence of more than one pair of mobile lateral spines preceding the fixed pair of the telson; the less reduced exopodites of the walking legs; and the presence of a petasma either asymmetrical, or open and lacking produced distolateral and distoventral projections.

Since several distinctions between the two subgenera of *Penaeopsis* have been pointed out, it may be of value to call attention to some of the numerous minor resemblances, in addition to those mentioned by Schmitt, 1926a, as common to *P. serratus* and *P. coniger*, between *Penaeopsis* and those members of *Metapenaeopsis* which formed Kishinouye's "genus" *Leptopenaeus.* The orbital angle is undentiform in the subgenus *Penaeopsis* and in the *P. coniger* group, dentiform in the remainder of "asymmetrica." The basis of the second chelipeds is unarmed in the *P. coniger* group, as is usual in *Penaeopsis* but unusual among the remaining species of *Metapenaeopsis.* The mobile lateral spines of the telson are not compactly grouped in *P. coniger* and related species, more as in *Penaeopsis* than as in the other species of *Metapenaeopsis.* The paired spines of the posterior margin of sternite XI, very weakly indicated in the *P. serratus* group, are in the *P. philippii* group weaker than is usually the case in "asymmetrica" (it may be noted that some indication of paired posterior projections of sternite XI, and sometimes of IX, X, and of the three posterior sternites as well, are present in all Penaeidae; they are particularly well developed on X and XI in Eusicyoninae). It can hardly be doubted that the *P. coniger* group is congeneric with the other species with the distinctive asymmetrical petasma. Therefore, although it might be possible to regard *Penaeopsis* as sufficiently distinct from *Metapenaeopsis* to stand as a separate genus, in view of the very close relationship presaged by the numerous minor resemblances between the two groups, it seems advisable to regard them as forming a single genus.

Since previous descriptions and figures of *Artemesia*, the third genus of the *Parapenaeus* series, are in many respects inaccurate, and since the form has been previously regarded (Bouvier, 1908; Balss, 1925) as a peculiar one occupying an isolated position, brief mention in this place of the characters in which it resembles and by which it is distinguished from *Penaeopsis* and *Parapenaeus* may be desirable. Through the kindness of the Museum of Comparative Zoology at Harvard I have been enabled to examine a male and three females of *A. longinaris* Bate, reported by Milne Edwards and Bouvier, 1909.

Artemesia displays a very strongly developed parapeneid spine; a distal pair of lateral telson spines completely fused to the body of the telson (although the line of juncture remains clearly visible); a pleurobranch on somite XIII but not on XIV; a thelycum which externally very closely resembles that of *Parapenaeus*, the subgenus *Penaeopsis*, and the Eusicyoninae, and which almost certainly includes a pair of invaginated sac-like sperm receptacles as in those forms; a maxillulary palp which lacks a produced distal portion; and a petasma (quite incorrectly figured by Bouvier) which repeats part for part including the posterodistal spine and lamella the structures found in *Parapenaeus longirostris*, although the lamella mediad the base of the distolateral spine on either side is produced to form a shallowly channeled rigid spout-like projection. These characters definitely place it with the **Parapenaeus** series.

Artemesia differs from *Parapenaeus* and *Penaeopsis*, and indeed, from all other Penaeinae and Eusicyoninae, by the presence of a small but filamentose anterior arthrobranch on XIII, a character otherwise found only in Aristaeinae and Solenocerinae. *Artemesia* is further excepted from the parapenaeine mode by lacking a branchiostegal or pterygostomian spine, a condition which however occurs even in one species of *Parapenaeus*. In the complete loss of exopodites except that of IX and perhaps in the loss of leg-base armature, it seems to represent one extreme of the reduction series formed by *Metapenaeopsis*—*Penaeopsis*—*Parapenaeus*. In the presence of filaments on the branchial lamella of VIII and the complete absence of longitudinal and transverse sutures, it agrees with the genus *Penaeopsis*. Its maxillulary palp lacks the conspicuous spine or spines of the median projection present in other peneids.

Subgenus **PENAEOPSIS** Bate, sensu stricto

Penaeopsis megalops (Smith)

Figure 1, page 20.

Parapenaeus megalops SMITH, 1886; ALCOCK, 1906.
Penaeopsis serratus BATE (A. Milne Edwards MS), 1881.
Artemesia talismani BOUVIER, 1905a.
Penaeopsis serratus MILNE EDWARDS and BOUVIER, 1909; DE MAN, 1911; BALSS, 1925; SCHMITT, 1926a; BOONE, 1927, part.
Parapenaeus paradoxus (Bouvier) BOONE, 1927, part.
Not *Penaeus serratus* BATE, 1881.

19 adult, 7 juvenile males, carapace length 10 to 20 mm; 13 adult, 1 juvenile female, carapace length 10 to 24.5 mm. *B.O.C. 35.* North of Glover Reef, Gulf of Honduras, 366 fathoms, May 20, 1925.

8 adult, 3 juvenile males, carapace 10 to 17 mm; 29 adult, 5 juvenile females, carapace 12 to 22 mm. *B.O.C. 36.* North of Glover Reef, Gulf of Hunduras, 484 fathoms, April 20, 1925.

In naming his Indopacific species as *Penaeus serratus*, Bate, assuming the two forms to belong to distinct genera, sought by this means to emphasize its near relationship to the Atlantic MS species *Penaeopsis serratus* A. Milne

Edwards. *Penaeus serratus* from the Pacific is described by Bate on an earlier page than the mention of the Atlantic form, and since both species are now known to refer to the same genus, the name *serratus* has priority for the Pacific species. Bate, De Man, 1911, and Balss, 1925, believe that the Atlantic and Pacific forms, though closely related, are distinct. De Man therefore erects a new name, *Penaeopsis challengeri*, for one of the pair, but unfortunately applies it to the Pacific species; his name must therefore be placed in the synonymy of *P. serratus* (Bate). There seems no doubt that Smith's *Parapenaeus megalops* is identical with Milne Edwards' *Penaeopsis serratus;* the former name therefore replaces the latter, preoccupied one for the Atlantic species. If, however, *Penaeus rectacutus* (Bate) should be found identical with *P. serratus* (Bate), the former takes precedence over the latter by page priority, and the latter name again becomes available for the Atlantic species.

No clear diagnostic distinctions between *Penaeopsis rectacutus* (*Parapenaeus rectacutus* of most authors) and *P. serratus* have ever been established. Bate himself (1888) seems to have felt some uncertainty as to the distinctness of the two forms, and indeed, transferred some cotypes of *P. serratus* as first described, to *P. rectacutus*. If I interpret his ambiguous sentence correctly, Bate also suggests that one form may be only a variety of the other. Since the time of Bate both species have been reported, but the results of examination of both by the same worker have only been made public by De Man and by Balss, who placed the two in different genera, for no very evident reasons. The single specimen referred by the former author to *P. serratus* was a very early juvenile for contrast with which no juvenile specimens referred to *P. rectacutus* were available; while the latter author has not discussed the distinctions between specimens which he refers to the two species, and indeed, has figured for his *P. serratus* a thelycum resembling Bate's figure of *P. rectacutus* much more strongly than Bate's figure of *P. serratus*. Between accounts of one or the other species by Alcock, 1901 and 1906; De Man; Kemp and Sewell, 1912; and Balss, there are some differences which may or may not signify that two Indo-pacific species of the genus actually exist. A comparison of the literature with the extensive material of *P. megalops* available to me indicates the distinctness of the Atlantic from the Indopacific species, and may throw some light upon the differences between various accounts of Indopacific specimens.

In descriptions and figures of Indopacific material, the maximum number of rostral teeth is less than thirteen, of which none are behind the orbital margin. In only a few specimens of *P. megalops* were there less than fourteen rostral teeth, the mode being above fourteen, and the maximum eighteen; while one rostral tooth was always behind the orbital margin. The rostrum of *P. rectacutus* has been described as straight, that of *P. serratus* as arched. The rostrum of *P. megalops* was variably straight, to considerably arched especially in the smaller specimens, and was either horizontal or ascending.

The anterior cervical sulcus of *P. rectacutus* and *P. serratus* has for both been described or figured as descending either obliquely or in a sigmoid curve. The sulcus in *P. megalops* descends in a sigmoid curve, the upper limb of which is, however, more oblique than in Bate's figure of *P. serratus*.

The telson of both Indopacific species is described as bearing two pairs of mobile spines save by Alcock, who found three pairs in specimens attributed to *P. rectacutus*. I have found a third pair of mobile spines in one specimen of *P. megalops*.

The second pair of chelipeds is described as unarmed in Indopacific material, save by Alcock who found a basisal spine in females of his *P. rectacutus;* by Kemp and Sewell, who imply that it may be variably present or absent in *P. rectacutus;* and by Balss, who found it present in the two specimens referred by him to the same species. I have observed that the armature of the second leg is subject to occasional variation in species of the genus, one specimen of *Penaeopsis* (*Metapenaeopsis*) *mineri* lacking the basisal spine present in other examples of that species. A second leg armature does not, however, occur in any of the available specimens of *P. megalops*, and it seems surprising that Alcock should describe, both for this character and that of telson armature, conditions rare in material of the subgenus available to others.

The distoventral angles of the petasma of Indopacific material have been described both as rounded and as produced. In *P. megalops* (figure 1) the angle appears either rounded or bluntly produced, dependent on the plane in which the margins are observed.

The thelyca figured by Alcock for his *P. rectacutus* and by Balss for his *? P. challengeri* seem without significant differences; both figures are probably within the limits of tolerance of Bate's figure of *P. rectacutus*. The thelycum of *P. megalops* seems different from the above by the fact that the posterior margin of the median plate overlaps the anterior median margins of the lateral hoods, instead of being overlapped by them, and is deeply emarginate rather than straight. The differences between Bate's figure of the thelycum of *P. serratus* and that of his *P. rectacutus* are superficially quite striking, but are perhaps not of great importance. In the immature thelycum of *P. megalops* the lateral hoods are reduced in size, which not only permits the transverse depression to gape widely, but exposes the lateral parts of the median plate to view. With some allowances for inaccuracy, Bate's figure of *P. serratus* is remarkably like what might be inferred as to the immature thelycum of *P. rectacutus*.

It therefore appears that without further studies of Indopacific materials, distinctions between *P. rectacutus* and *P. serratus* cannot be satisfactorily drawn. The fact that the two females referred by Balss to *P. rectacutus* possessed, like those referred to the same name by Alcock, a spine on the basis of the second legs, while like the material examined by De Man, they lacked the third pair of telson mobile spines observed by Alcock, seems to support the possibility that differences in these structures, the most obvious reported between various Indopacific specimens, may be attributable to intraspecific, not interspecific, variation.

The presence of an anteriorly directed median spine on sternites XIII and XIV of "*P. serratus antillensis*" Milne Edwards and Bouvier and of "*P. challengeri*" De Man, is a larval character present in the postmysis stages of many Penaeinae. The stage seems to be unusually prolonged in *Penaeopsis*, but is as much so in the postlarva of *Penaeus* species (*P. japonicus* Bate?) described by Stebbing, 1914, as "*Penaeus pulchricaudatus*," and in the possibly adult *Penaeopsis evermanni* (Rathbun), 1906, and De Man, 1911 (the latter reference being perhaps to the larva of another species rather than to the form described by Rathbun). The fact that exopods were absent from the walking legs of De Man's very young individual of "*P. challengeri*" is evidently another of the attributes, as in other Penaeinae, of this SICYONINE stage in ontogeny. In juvenile males of *P. megalops*, in addition to the spines of sternites XIII and XIV which disappear in the adult, there is a persistent blunt protuberance on XII which represents a spine similar to the more posterior ones. In juvenile females, this protuberance of XII in males is represented by a sharp tooth, which becomes converted to a blunt knob in the adult. The spine of XIII in juvenile females is represented in adults by the anterior part of the median plate of the thelycum.

In addition to sexual differences in antennular flagella which have been noted by several workers for species of the subgenus, it may be mentioned that the third segment of the antennular peduncle of *P. megalops* is in the adult male much stouter than in the female. The thelycum very closely resembles that of *Parapenaeus longirostris* (Lucas), Burkenroad, 1934, especially in internal structure.

It seems probable that a Pacific American congener of *P. megalops*, at present not known, will be found. The species is not strictly speaking a littoral one but has been included in the present paper for convenience in treating the genus.

SUBGENUS **METAPENAEOPSIS** Bouvier

Penaeopsis goodei (Smith)

Figures 2 and 3, page 23.

? *Penaeus pubescens* STIMPSON, 1871.
Parapenaeus goodei SMITH, 1886.
Parapenaeopsis rathbuni BOUVIER, 1905b.
Archipenaeopsis vestitus BOUVIER, 1905b.
Metapeneus goodei ALCOCK, 1906.
Penaeopsis goodei MILNE EDWARDS and BOUVIER, 1909; DE MAN, 1911; SCHMITT, 1924a; BOONE, 1927, part.
Penaeopsis vestitus SCHMITT, 1924a.

1 male, carapace 7 mm; 2 females, carapace 8 and 9.3 mm. *B.O.C. 24.* Dry Tortugas, Florida, February 10, 1931.

1 female, carapace 11 mm. *B.O.C. 22.* Saddle Rock, Bahamas, March 23, 1925.

2 females, carapace 7.5 and 10.5 mm. *B.O.C. 23.* Royal Island Harbour, Eleuthera Island, Bahamas, April 14, 1925.

1 male, carapace 8.8 mm. *B.O.C. 21.* Swan Island, Caribbean, April 12, 1925.

1 male, carapace 5.3 mm, 5 females, carapace 10 to 6.5 mm. *B.O.C. 20.* Glover Reef, Gulf of Honduras, April 16, 1925.

The Bingham material has been directly compared with Smith's type, a male of carapace length 11 mm from the Bermudas, in the collection of the Zoology Department of the Peabody Museum of Natural History.

Penaeopsis goodei (Smith) of Milne Edwards and Bouvier includes a male, of which the telson was figured, originally mentioned as *Parapenaeopsis rathbuni* Bouvier; and a female, of which several figures including one of the thelycum were given, originally mentioned as *Archipenaeopsis vestitus* Bouvier. The characters which lead Schmitt, 1924a, to suggest the separation of these specimens from *Penaeopsis goodei* seem of little importance. The nature as described by Bouvier of the setae of the branchial region—simple rather than compound—is, as will be shown in a succeeding paragraph, probably not a valid distinction. The figure of the thelycum, although inaccurate, is that of an immature female of *P. goodei*. The statement that the right lamella of the petasma of the male is spoon-shaped makes it probable that this specimen is also *P. goodei*. There is nothing to suggest, as Schmitt thinks possible, that the male belongs to still another species than the female.

In *P. goodei* as well, as in the other American species of *Leptopenaeus* which have been examined, the third maxillipedes and the first and second legs have a basisal armature, and the first legs an ischial spine.

A third Atlantic species of *Metapenaeopsis*, known since Bouvier, 1905a, as *P. pubescens*, occurs on the west coast of Africa. This species seems closely related to, but distinct from, *P. goodei* by the structure of its thelycum according to a figure by Balss, 1916, as well as by certain other characters, such as the elongated second pair of mobile lateral spines of the telson noted by Milne Edwards and Bouvier, 1909. The attribution to Stimpson, 1871, of the name *P. pubescens* as applied to this Eastern Atlantic species is improper.

Penaeus pubescens was described by Stimpson from the West Indies. His account has been generally assumed to refer to a species of the genus *Penaeopsis*, but although in part applicable, the description in some points fails to coincide with characters universally displayed by that genus. In such points as Stimpson's notations agree with those of the African *Penaeopsis*, they agree to the very same extent with the West Indian *P. goodei*. Since there is no available evidence that the African form ranges to the Antillean type locality of *Penaeus* *pubescens* Stimpson it seems necessary either to apply the name *pubescens* Stimpson to *Penaeopsis goodei* or to apply it neither to this nor to the African form. It is possible that the name *Penaeus pubescens* does not refer to any species of *Penaeopsis* at all. Stimpson's statements (which usually may be relied upon) that the leg bases of this species are unarmed and that the telson bears only one pair of lateral spines, fail to agree with what is very conspicuously the state of all known species of *Penaeopsis*. The only other genus to which the remainder of the description might apply seems to be *Parapenaeopsis*, in various species of which a carinated second pleonic somite, lack of postrostral carina and produced anteroinferior angle of the carapace, as well as unarmed leg bases and reduced telson armature, are known. The discovery of the new species *Parapenaeopsis balli* on the Pacific American coast, coupled with the occurrence of the related *Parapenaeopsis atlantica* Balss in the Eastern Atlantic, renders it possible that a since-undiscovered species of *Parapeneopsis* from which Stimpson's description of *Penaeus pubescens* was drawn exists in the Western Atlantic. Therefore, since Stimpson's name may be provisionally accepted as referring to another genus, and since the appellation *P. velutinus* Dana of Miers, 1881, is obviously not applicable, the West African species of *Penaeopsis* may be known as *P. pubescens* (Bouvier).

Penaeopsis smithi Schmitt

Figures 4, 5, and 6, page 21; figure 7, page 24.

Penaeopsis smithi SCHMITT, 1924a, 1924b.
Penaeopsis goodei BOONE, 1927, part.

2 females, carapace 10 mm. *B.O.C. 25.* Saddle Rock, Bahamas, surface, March 23, 1925.

1 female, carapace 9.5 mm. *B.O.C. 27.* Green Cay, Bahamas, seine, March 13, 1927.

1 female, carapace 10 mm. *B.O.C. 26.* Green Cay, Bahamas, surface, night, March 17, 1925.

4 females, carapace 7.5 to 11 mm. *B.O.C. 28.* Green Cay, Bahamas, surface, February 27, 1927.

1 male, carapace 7 mm; 11 females, carapace 9 to 10.5 mm. *B.O.C. 29.* Swan Island, Caribbean Sea, April 12, 1925.

In addition to the above, three immature and one subadult male ranging from 4 to 6 mm in carapace length; and one immature female 5 mm in carapace length, from the Bahamas, Cuba, and Puerto Rico were made available by the American Museum of Natural History. The present records extend the known range of *P. smithi* considerably to the northward.

The pubescence of the branchial region of the carapace of *Penaeopsis smithi* is plumose at least in major part, and is not, as stated by Schmitt, simple; there are no qualitative differences in the nature of the tomentum between *P.*

smithi and *P. goodei*, although there appear to be quantitative ones. The pinnulae of the setae, which are arranged upon the shaft like the barbs of a feather, are, especially in *P. smithi*, readily rubbed off, when little trace of the points of attachment remains. The setae of both species show some differentiation into two types, the one short, stout and curved with stout and rigid pinnulae; the other long and slender with long, flexible, less easily detached pinnulae. The setae of the second type are most abundant on the branchial region just above the membraneous branchiostegite, and in advance of the hepatic spine. Setae of the first type are perhaps shorter and sparser, and with more delicate pinnulae in *P. smithi* than in *P. goodei*. It is possible that intermixed with the compound setae in the former species a few truly simple ones may occur, but owing to the ease with which the pinnulae are lost, this is difficult to determine.

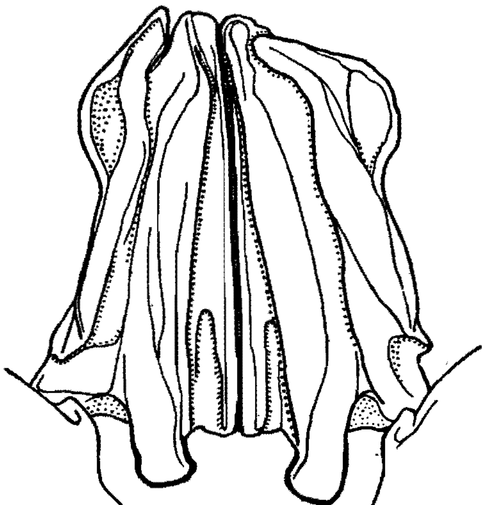
The length and proportions of the telson tip, and its lateral armature are subject to some variation, as is also the degree of accentuation of the median dorsal ridge of the third pleonic somite. These characters are of considerable value in distinguishing *P. smithi* from *P. goodei*, but are perhaps not completely diagnostic. Schmitt, 1924b, in describing *P. smithi* as differentiated from *P. goodei* by its slender telson tip, has probably reversed the statement that he wished to make. Measurement of the length of the external scale of the antennular peduncle by comparison with the cornea of the eyes is not satisfactory, since the apparent length of the latter varies with its rotation and by shrinkage. A measurement of the scale against the length of the basal segment of the peduncle exclusive of the spine at its anteroexternal corner indicates that the scale is, although variable, usually somewhat longer in *P. goodei* than in *P. smithi*, as correctly stated by Schmitt. We may perhaps doubt the accuracy of the comparison of *P. goodei* with *P. pubescens* in this character by Milne Edwards and Bouvier.

Schmitt's figures of the thelycum of *P. smithi* and *P. goodei* are not accurate, but are sufficient for recognition of the adults; his text is erroneous, the thelyca being compared in nonhomologous parts.

The simpler thelycum of *P. goodei* may be considered first. Its structure is as follows: Near the posterior margin of sternite XIV is a raised transverse belt the anterior margin of which is cut into three projecting ridges, a median flanked by a pair of laterals. Anterior to this belt is a tilted subrectangular transverse area the posterior part of which is depressed and is overhung by the posterior elevated belt, while its straight anterior margin is elevated. From the middle of the anterior margin of the subrectangular area a longitudinal elevated bridge, posteriorly broad and anteriorly narrow, runs forward to join the anteromedian part of the median plate of sternite XIII. From the lateral part of the subrectangular area on either side there extends forward a raised plate, the LATERAL HOOD of sternite XIV. The transverse groove between sternites XIV and XIII, the hollow of which serves as sperm-receptacle, runs along the anterior and median margins of the lateral hood on either side, and is continued mediad along the anterior margin of the subrectangular area to the longitudinal bridge, the lateral margins of which it follows forward to the juncture of the bridge with the median plate. The transverse groove thus has the shape of a cursive *w* the two halves of which are separated by the median bridge. The median plate of sternite XIII gives rise from its posterolateral margins to elevated laterally directed ridges, the LATERAL PARTS, between which and the anterior margins of the lateral hoods of sternite XIV the lateral portions of the transverse groove are bounded. The median plate of XIII is continued posteriorly on either side of the midline by an oval, elevated boss which occupies the space between the lateral hoods and the median bridge of XIV. The anteromedian extremity of the transverse groove on either side is expanded and forms a pit between the posterior part of the median plate and the median bridge. From this pit in impregnated females a plug of male secretion protrudes; it is probable that the spermatophores are inserted into the receptacles at these two points. The receptacles are formed simply from the rather shallow fissure of the transverse groove, which is most deeply invaginated beneath the lateral hoods, but does not give rise to a large membraneous sac as in *Penaeopsis megalops*.

The thelycum of *Penaeopsis smithi*, in spite of superficial dissimilarity, is built upon essentially the same plan as the above. The subrectangular area of sternite XIV is very much shorter along its longitudinal axis than in *P. goodei*, and is much less clearly set off from the posterior, three-ridged transverse belt. The lateral hoods extend much farther anterolaterad and posteromediad. The longitudinal bridge is extremely narrow and very long; its anterior part being hidden by the overlapping of the posterior parts of the median plate of XIII. The anterior part of the median plate is reduced to a very narrow curved strip. The posterior part on either side, equivalent to the short oval bosses of *P. goodei*, is much elongated commensurate with the reduction in length of the antero-median region of the median plate of XIII and of the subrectangular area of sternite XIV. The median limbs of the transverse groove are thus greatly elongated; further, instead of terminating at the point where it reaches the median plate, as in *P. goodei*, either median limb of the groove turns laterad, then to posterior, then, turning sharply anteriorad, descends beneath the surface of the posterior part of the median plate as a deep closely wound spiral pit. From this pit the groove agains runs posterolaterad across the posterior part, to terminate in a broad depression. The significance of these highly complex convolutions of the anteromedian limbs of the transverse groove is unknown, since only that portion equivalent to the groove of *P. goodei* seems to be utilized in sperm storage. In the smallest female of *P. smithi* which I have examined the thelycum is almost indistinguishable from that of adult *P. goodei*, except that the continuations of the anteromedian ends of the transverse groove are present in simple form, almost effecting the isolation of the posterior from the anterior parts of the median plate.

Schmitt's description of the thelyca of *P. smithi* and *P. goodei* errs in his homologization of the elevated anterior part of the subrectangular area of *P. goodei* with the lateral hoods of *P. smithi*, which he regards as the lateral portions of a similar transverse plate which has been "virtually obliterated" in the midline. The lateral hoods of *P. goodei* are completely omitted from the comparison, and would, in the figure offered by Schmitt, be hidden by the fourth leg bases. The "longitudinal curved elements" described by Schmitt for *P. smithi* represent those portions of the posterior parts of the median plate which lie mediad



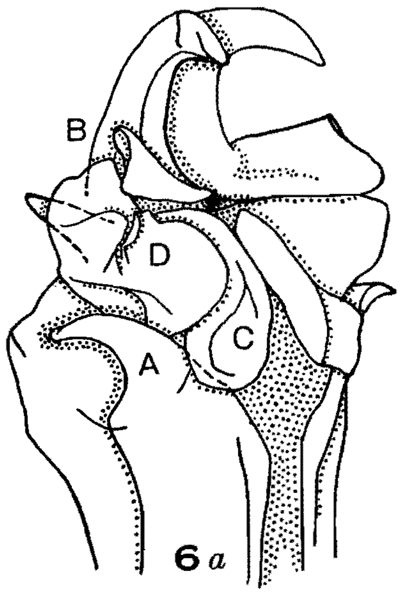
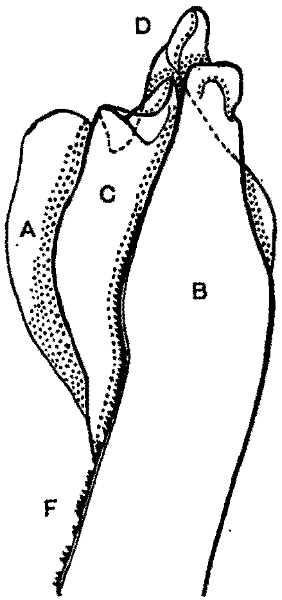


Figure 1. *Penaeopsis megalops* (Smith).
Petasma, ventral view × 9.
Figure 6a. *Parapenaeus longirostris* (Lucas).
Petasma, distal portion, ventrolateral view (Louisiana adult) × 28.5. Lettering as in figure 5.

the continuation of the transverse groove, and are not by themselves equivalent to the "rounded platelets" of *P. goodei*. Schmitt's description and figure of two "platelets" on each side in *P. goodei* is probably based on an impregnated female, in which he has mistaken the plug of male secretion protruding from the terminus of the transverse groove for a second "platelet" anteromedian to the posterior part of the median plate, the first "platelet."

The two species under discussion are very distinct in petasmal structure. As a preliminary to the statement of these differences, it is necessary that the structure and derivation of the asymmetrical petasma be elucidated. Kishinouye, 1929, is the first to describe the complicated male copulatory organ of the "asymmetrica" completely, but his account is of little value in interpreting



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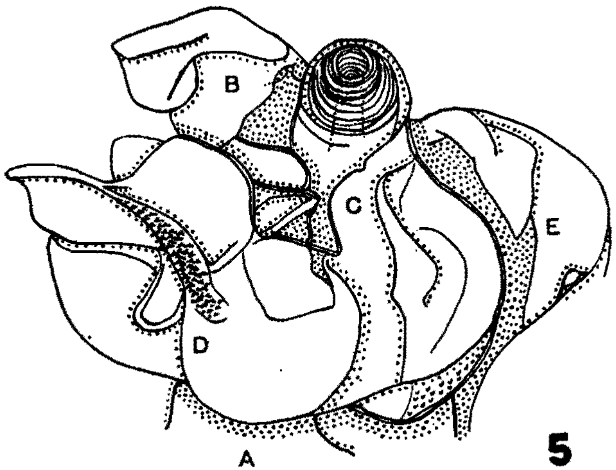

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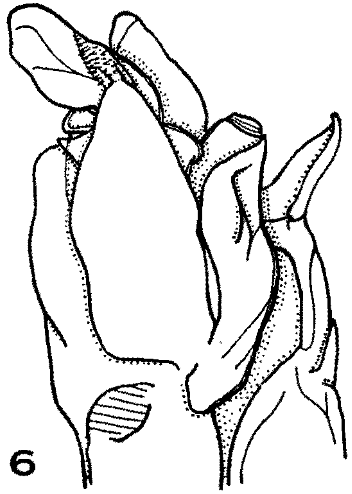

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Figure 4. *Penaeopsis smithi* Schmitt.
Petasma, juvenile, right ramus, dorsal view × 48. Lettering as in figure 5.

Figure 5. *Penaeopsis smithi* Schmitt.
Petasma, adult, distal portion, right external piece removed, ventrodistal view × 45.
A. Right distoventral projection (external piece).
B. Right distomedian lobe (proximal part).
C. Right distoventral flap (convoluted distal part).
D. Right distolateral lobe (second distal part).
E. Distal portion of left endopod.
F. Cincinnuli on median edge of distomedian lobe.

Figure 6. *Penaeopsis smithi* Schmitt.
Same as figure 5, ventral view × 30.

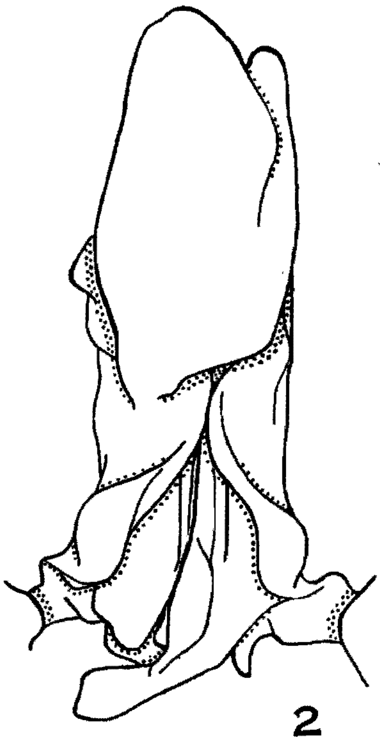
the homologies of the appendage. For his nomenclature, one capable of more general application will here be substituted.[1]

The copulatory appendages of the first male pleopods of peneids may be termed endopods, an interpretation supported by their ontogeny, and by the nature of the homologous rudimentary structures of the female. The terms ventral and dorsal will be applied as though the petasma lay parallel to the long axis of the shrimp. From the ventral face of each petasmal endopod in the subgenus *Metapenaeopsis*, nearer to its distal than its proximal end, springs a lamella (the "external piece" of Kishinouye) which may completely cover the more distal portion ("internal piece"). The proximal portions of the two petasmal endopods of *Metapenaeopsis* are not symmetrical, but are otherwise enough like those of the normal petasma to need no description. The appearance of the proximal portions, and that of the right "external piece" may be observed in the appended ventral views of the whole petasma. The left "external piece" is in the Indopacific species longer than the right one, but in the American species it is reduced to a vestige. The "internal piece" of the left endopod of the petasma may be simple or may be divided into more than one lobe; in the American species it is a simple flexible flap. The right "internal piece" is divided into three main lobes which may be subdivided. One of these (the "proximal part") is on the dorsal side of the endopod. A second (the "convoluted distal part") occupies the median margin of the distal portion of the endopod. A third (the "second distal part") is placed ventrolaterally and bears spinules upon at least one of the lobes into which it may be subdivided.

In the simple open petasma of *Penaeus* or of *Penaeopsis megalops* the distal margin of each endopod is more or less divided into three main lobes or regions. The most median of these, which may be termed the DISTOMEDIAN LOBE surmounts the hook-bearing median margin of the endopod. The second lobe, the DISTOLATERAL, is placed lateral to the first, and distolateral to the end of a deep longitudinal pleat of the endopod. In certain forms, such as *Penaeus*, the dorsal surface of this second lobe may be spinulose. Ventrolateral to the second lobe is placed the third, which surmounts the usually chitinized and rib-like ventrolateral margin. This third lobe may be termed the DISTOVENTRAL.

[1] A somewhat similar descriptive system has been proposed by Balss, 1927 (Wiss. Ergeb. Deutschen Tiefsee-Exped., XXIII, 6), for the open petasma of the Aristaeine *Amalopenaeus*. Of the terms given in a further paragraph, DISTOLATERAL LOBE is equivalent to "Lobus medianus" of Balss. The DISTOVENTRAL FLAP is equivalent to "Lobus externus" of Balss. The DISTOVENTRAL PROJECTION, which with the flap makes up the DISTOVENTRAL LOBE, is not named in Balss' system, although in *Amalopenaeus*, as in *Metapenaeopsis*, the two structures are separated. The DISTOMEDIAN LOBE is not distinguished by a name in Balss' system. Since the terms proposed by Balss are not sufficiently complete for general application, the nomenclature proposed in a succeeding paragraph is not withdrawn, although to the extent to which the two systems are equivalent it presents no advantages.

In the more complex petasma of *Trachypeneus, Eusicyonia, Metapenaeopsis* or *Parapenaeus*, the endopod is longitudinally folded over in such a manner that the margin which in the open petasma was lateral, is here ventromedian, and the endopod in cross-section would have the shape of a U with the closed end placed laterally. The median edge of the dorsal limb of this U bears the hooks or cincinnuli by which the endopod is hooked to its fellow of the opposite side, while the ventral limb of the U may not extend so far mediad as does the



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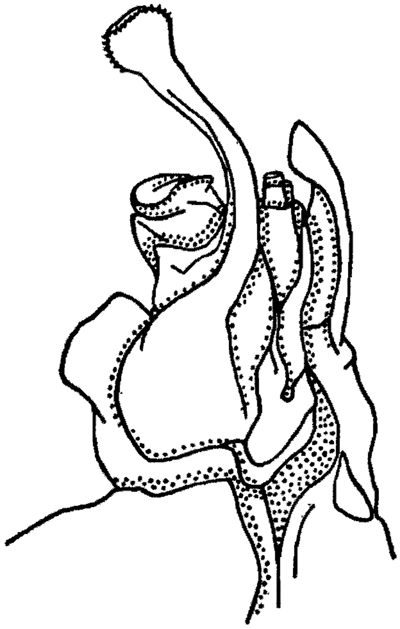

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Figure 2. *Penaeopsis goodei* (Smith).
Petasma, ventral view × 12.5.
Figure 3. *Penaeopsis goodei* (Smith).
Petasma, distal portion, right external piece removed, ventral view × 18.6.

dorsal, and does not become attached to the ventral limb of the opposite endopod to form a perfect tube.

A careful examination of the juvenile state of the asymmetrical petasma of *Metapenaeopsis*, and comparison with the adult state, reveals that this petasma is of the same basic pattern as that of other peneids. Kishinouye's "proximal part" surmounting the cincinnulated median margin of the endopod, is a fleshy, subdivided distomedian lobe. Kishinouye's "second distal part" is a much thickened and divided distolateral lobe; as in many forms with open petasma, a portion of this lobe in *Metapenaeopsis* is spinose. Finally, Kishinouye's "convoluted distal part" is, with the "external piece," a portion of the disto-ventral lobe of the petasma. In the adult male, the "convoluted part" forms a tight roll of thin chitinized tissue, which may become unwound, when, as in the figure of *P. mineri*, it projects as a spirally twisted flap. This rolled-up flap is continuous ventrolaterally with the distolateral lobe; while dorsomedially it is free from although touching against the cincinnulate median margin and the distomedian lobe. The "convoluted distal part" thus seems to represent the produced free margin of the distoventral lobe, which has been rolled up like a flat spring. In the juvenile petasma figured, the distoventral lobe has as yet been no more produced than to form a single whorl. The "external piece" of

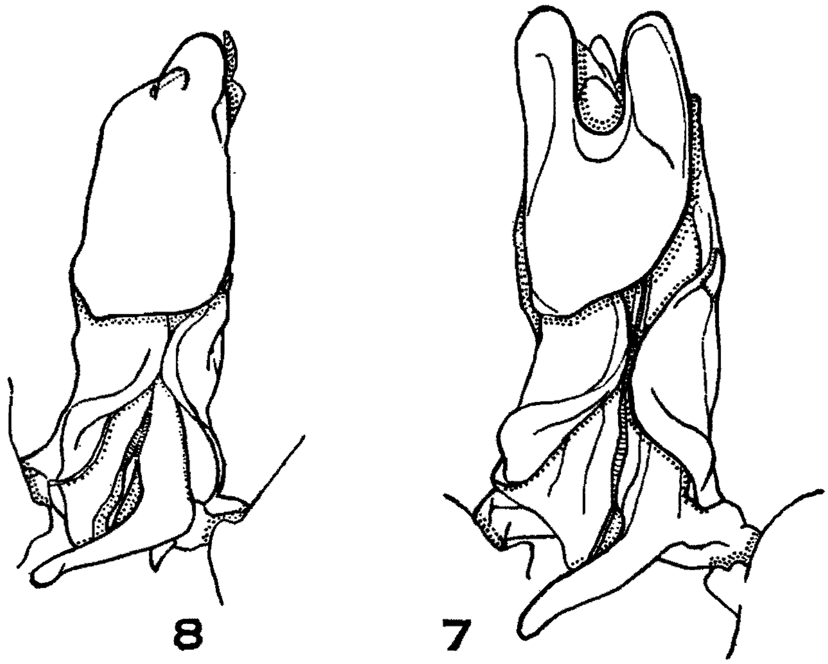

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Figure 7. ***Penaeopsis smithi*** **Schmitt.**
Petasma, ventral view × 20.4.
Figure 8. ***Penaeopsis mineri*****, n. sp.**
Petasma, ventral view × 20.4.

the asymmetrical petasma appears to represent the main portion of the distoventral lobe of the open petasma, in which latter it often forms a stout projection. As the coiled flap is to be regarded as produced from the margin of this same lobe, the "external piece" may be termed the DISTOVENTRAL PROJECTION, and the "convoluted distal part" the DISTOVENTRAL FLAP.

The symmetrical petasma of *Parapenaeus longirostris* (Lucas) (figure 6a) carries a distal armature of lobes and spines which seem to be homologous in detail with the very complex distal armature of the asymmetrical petasma of *Metapenaeopsis;* the petasma of *Parapenaeus* shows a much greater resemblance to the highly specialized one of *Metapenaeopsis* than does the petasma of any other peneid. Thus, corresponding to the distomedian lobe of the right endopod of *Penaeopsis smithi*, which is subdivided into a dorsal and a ventral element, there is in *Parapenaeus* a large dorsomedian spine-like projection which carries a fleshy flap at the inner side of its base. Corresponding to the distolateral lobe in the *Metapenaeopsis*, which is composed of a projecting, divided, spinulose inner part proximolateral to which is a projecting lobulate bracket, there is in the *Parapenaeus* a broad lateral spine, with a fleshy flap at its base which is continuous with the first flap. Corresponding to the disto-ventral coiled flap in the *Metapenaeopsis* there is an unproduced fleshy flap in the *Parapenaeus*, continuous with the flap lateral to it, but with a free median margin. Corresponding to the distoventral projection in the *Metapenaeopsis* there is a stout spine in an equivalent position in the *Parapenaeus*, from the inner side of which the flap homologous with the coiled flap of *Metapenaeopsis* takes rise.

Between the adult petasma of *P. smithi* Schmitt and that of *P. goodei* (Smith) the following are the chief differences:

P. smithi—Right distoventral projection deeply cleft into two subequal lobes. Left endopod not extending nearly as far distad as does the right distomedian lobe. Inner part of the distolateral lobe a blunt vertical cone (not extending much above the level of the distomedian lobe) joined to the dorsolateral edge of which is a projection which does not rise above the level of the cone. Spinules are placed on the distal surface of the projection in the region where it joins the cone. At the base of the left endopod, laterad the projecting median spur, is a low rounded prominence.

P. goodei—Right distoventral projection less deeply cleft, the left lobe usually smaller than the right. Left endopod extending nearly as far distad as does the right distomedian lobe. Inner part of the distolateral lobe a greatly produced slender clavate projection rising far above the level of the distomedian lobe, and bearing spinules upon its distal surface. Laterad the median spur at the base of the left endopod is a long slender tooth, visible even in dorsal view.

Penaeopsis (Metapenaeopsis) mineri,[1] new species

Figures 8, page 24; 9 and 10, page 27.

1 female, holotype, *B.O.C. 39.* Conception Bay, Lower California, May 26, 1926.

In addition to this specimen, there are contained in the collection of the American Museum of Natural History a male and a female from the Gulf of California, which may be regarded as paratypes; and a male from Saboga Island, Pearl Islands, Gulf of Panama.

Dimensions—Holotype, total length about 48 mm, carapace 11.3 mm, rostrum 7 mm, telson broken. Paratype female, total 32 mm, carapace

[1] Named for Dr. Roy Waldo Miner.

6.5 mm, rostrum 3.9 mm, telson 4.5 mm. Paratype male, total 30 mm, carapace 6 mm, rostrum 3.2 mm, telson 3.8 mm.

Description—Rostrum straight, slightly above or below the horizontal, ranging in extent from the basal fourth of the second segment of the antennular peduncle to the last third of this segment. Rostrum armed above with 9 or 10, usually 10 teeth in addition to the epigastric. Teeth large, crowded; first tooth well in advance of the orbital margin. A line through the tips of the teeth describes a curve whose highest point is at about the third or fourth tooth. Anteriormost tooth from one to one and one-half times as far from the tip as from the penultimate tooth. Epigastric tooth placed nearly at the anterior one-fourth of the carapace.

Orbital angle dentiform. Pterygostomian spine slender, acute; behind it the ventral margin slopes first downward, then backward. Dorsal cervical sulcus short; ventral continuation of the cervical sulcus somewhat sigmoid, turning obliquely downward anterior to the hepatic spine in the direction of the ventral margin, which it does not reach. Cardiaco-branchial sulcus and carina absent. Postrostral carina disappears just in front of the epigastric tooth, the buttress of which extends posteriorly for only a very little way.

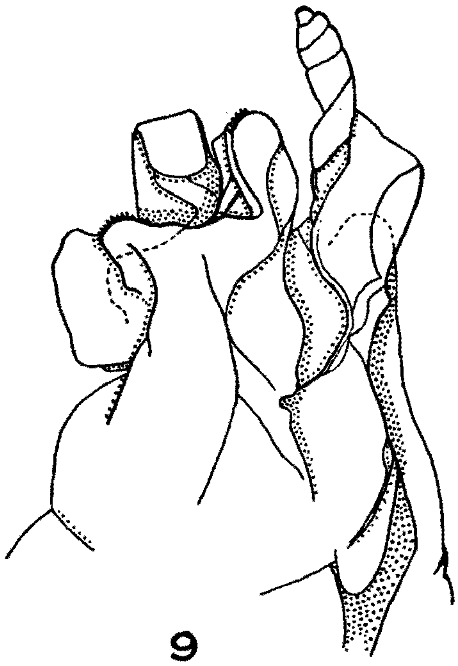
Third pleonic somite dorsally compressed to a faint median longitudinal peak; fourth, fifth and sixth somites carinated. The carina of the sixth somite only ends posteriorly in a tooth. There is a shallow transverse sulcus on either side of the median line of the second somite. The lateral fixed spines of the telson are short, not reaching to the middle of the long slender tip. The posterior of the three pairs of mobile spines reaches to or falls short of the tips of the fixed spines; the penultimate pair of mobile spines reaches a little beyond or falls short of the bases of the ultimate pair.

The carapace is thickly set with plumose setae, sparsest in the branchial region, strongest on the branchiostegal region and in the sulci. The pleon bears patches of tomentum, most extensive dorsally.

The sternal spines between the bases of the second legs are long and slender in both sexes.

Conspicuous sexual modification of the antennular flagella, which are somewhat shorter than the last two segments of their peduncle, is lacking. The external scale of the basal segment of the antennular peduncle is considerably less than one-half the length of the external margin of the segment. The minute spine of the ventromedian margin of this segment is placed less than one-third the length of the segment from its anterior end. The third pereiopods variably extend from four-fifths the length of the antennal scales as much as to their tips. The first legs are bispinose; the third maxillipedes bear a basisal spine. The second legs have a basisal armature in the three specimens from the Gulf of California but lack the spine in the Panamanian male. The exopods of the walking legs are long and slender, reaching to or beyond the distal end of the ischium.

The thelycum, although superficially strikingly dissimilar, actually represents a modification of the same basic pattern characteristic of *P. goodei* and *P. smithi*. The transverse belt of the posterior portion of sternite XIV bears distinct lateral projecting ridges, but the median ridge of this belt is only differentiated from the subrectangular area lying anterior to it by the presence of a line of setae, such as in *P. goodei* crown a veritable ridge. The subrectangular area is very conspicuous. Its anterior margin is much elevated, and far over-



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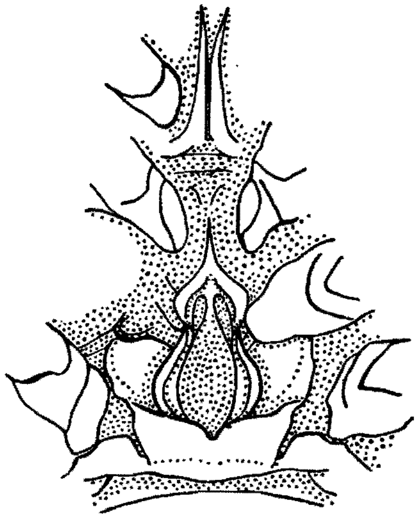

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Figure 9. *Penaeopsis mineri*, n. sp.
Petasma, distal portion, right external piece removed, ventral view × 33.3.
Figure 10. *Penaeopsis mineri*, n. sp.
Thelycum × 16.

hangs the posterior end of the median longitudinal bridge, as well as the posterior portions of the oval bosses of somite XIII. Medially the anterior margin of the subrectangular area is deeply notched. Anterolaterally the subrectangular area is continued into the large lateral hoods, from which it is incompletely separated by a ridge. The longitudinal bridge is posteriorly very broad; anteriorly it narrows considerably before joining the anterior part of the median plate of XIII. This part of the median plate forms a narrow U-shaped elevation, from the closed anterior end of which springs a long, slender, anteriorly directed spine. From the posterolateral margins of the median plate extend the laterally directed ridges (the LATERAL PARTS) which overlap the anterior margins of the lateral hoods and with them enclose the lateral portions of the transverse groove. The ends of the U-shaped anterior part of the median plate are separated from the structures representing the posterior parts by a deep narrow transverse cleft. Each posterior part has the form of a very elongate, high lamella, the posterior end of which is hidden under the subrectangular area, while between the two lamellae the much less elevated longitudinal bridge is enclosed as a deep oval depression overgrown with setae. The transverse groove turns to posterior on either side between the median margins of the lateral hoods and the bases of the lamelliform posterior parts, and is continued to the posterior ends of the lamellae, beneath the overhanging subrectangular area. The groove appears to turn anterior here, and to continue up the median sides of the posterior parts, between them and the longitudinal bridge, to the anterior part of the median plate. It is anteromedially so shallow, however, that it is probably no more than a vestige bereft of the sperm-storing function which this portion of the groove possesses in *P. goodei* and *P. smithi*.

The distoventral projection of the right endopod of the petasma is shallowly cleft into a small right and a large left lobe. The left distoventral projection is rudimentary. The tip of the left endopod does not extend nearly as far distad as does the right distomedian lobe. The median part of the right distolateral lobe differs from that of both *P. goodei* and *P. smithi* in that it bears spinules in two separated patches, upon the tip of a lateral lobe as well as upon the distal end of a medial projection extending considerably further distad than does the lateral projection. At the base of the left endopod, laterad the median spur, is a proximomedially directed tooth sometimes visible in ventral view.

The reference of Smith, 1886, to *P. goodei* from the Bay of Panama is probably to be regarded as founded on specimens of *P. mineri*, as is probably also the record by Boone, 1930, of *P. kishinouyei* Rathbun from Costa Rica. *P. kishinouyei* of Boone, 1931, from Panama, is the male of *P. mineri* referred to above. *Penaeopsis* species, Schmitt 1924c, from Lower California, is perhaps the present form.

Penaeopsis mineri is, although much more closely related to them than to any described Indopacific species, so distinct from the Atlantic American species as to make it impossible to decide with which of them its affinities lie. It is perhaps somewhat more nearly related to *P. goodei*.

If the description of *Penaeopsis kishinouyei* Rathbun, 1902, is accurate, as the fact that Schmitt, 1927, does not offer to modify the definition originally set forth seems to indicate, then the present species is quite distinct from the Galapagos form. The right distoventral projection of the petasma of *P. kishinouyei* is figured as deeply cleft and with the right lobe much larger than in *P. mineri*. Rathbun's statement that the left half of the petasma is longer than the right, if actually based on the left endopod and not on a median lobe of the right one, is a clear distinction. The anterior part of the median plate of the thelycum, as figured and described, lacks a median spine; the striking lamelliform posterior parts characteristic of *P. mineri* are not indicated, and indeed the "lateral plates" are described as broad and fused. The rostrum as described bears a smaller number of teeth, and the epigastric tooth seems to be placed farther posterior than its position in *P. mineri.*

METAPENAEUS Wood Mason and Alcock, restricted

Metapenaeus, WOOD MASON and ALCOCK, 1891, part; ALCOCK, 1905 and 1906, part; NOBILI, 1903 and 1906, part.
Penaeopsis, MILNE EDWARDS and BOUVIER, 1909, part; DE MAN, 1911, part; SCHMITT, 1926a, part.
NOT *Metapenaeus*, RATHBUN, 1919; STEINITZ, 1932.

Metapenaeus affinis (H. Milne Edwards)

Penaeopsis affinis, DE MAN, 1924.

1 male, semimature, total length 81 mm. *B.O.C. 42.* Georgetown, Penang February, 1932.

Of the twenty named species[1] which may be attributed to *Metapenaeus* as here restricted, eight seem to be forms closely related to *M. affinis.* This group of nine named species is somewhat difficult of precise evaluation. Of it, *Penaeus villosus* Guerin-Mèneville, 1830, appears from the description to be a member of the *M. affinis* group, but the subsequently published figure appears to represent a species of *Penaeopsis.* The name, in the absence of a type from which its characters might be more definitely determined, may be discarded.

The figured male of *Penaeus incisipes* Bate, 1888, is, as pointed out by De Man, apparently a specimen of *M. monoceros* (Fabricius). Although in his description Bate states that the species lacks basisal spines on the third legs (a negative character not found among known species of *Metapenaeus*) these spines are shown as present in the figure of the male. In the figure of the female referred to the same species, Bate has shown no spines on either the third or the second legs; further, the thelycum is not of the type characteristic of *Metapenaeus.* It thus seems probable that to the male of *M. monoceros* or *M. affinis*, Bate has joined a female of another genus, perhaps *Parapenaeopsis.*

In *Metapenaeus deschampsi* Nobili, 1903, the largest male described, clearly immature since the petasmal endopods were not yet joined, was of a size at which the meral notch of the fifth legs is in *M. monoceros* sometimes extremely inconspicuous. The figure of the thelycum, with due allowance for Nobili's diagrammatic mode of representation, seems indistinguishable from that of *M. monoceros.* It must, however, be admitted that even at the small size of

[1] It may be mentioned that *Metapenaeus palaestinensis* Steinitz, 1932, is a *Trachypeneus*, evidently a migrant through the Suez Canal, which by a misinterpretation of the posterior arthrobranch of XIII as a pleurobranch and other errors, and by a mistaken application of Alcock's definition of *Metapenaeus*, was placed in that genus without its having been observed by the author that *Metapenaeus* as defined by Alcock had sometime before been relegated to the synonymy of *Penaeopsis.*

60 mm. the coxae of the fourth legs of females of *M. monoceros* bear an easily perceptible projection stated by Nobili to be absent in his form.

M. elegans De Man, which is described (1911) as closely related to *M. affinis* but differing from it by shorter fifth legs and a different petasma, seems in these and other characters to fall within the range of somewhat immature *M. monoceros*. Thus, a poorly marked median dorsal carina on carapace and pleon may occur in immature specimens of *M. monoceros*, while the absence of the projection at the distal end of the ischium of the fifth legs of *M. elegans* is not diagnostic since this feature is not constantly present in young specimens of *M. monoceros*. To satisfactorily differentiate the two species on the basis of present information seems difficult.

M. cognatus Nobili (1906) is as described not differentiable from *M. monoceros*. The numerous small mobile spines present along the margins of the telson are not diagnostic of Nobili's form, for although the telson of *M. monoceros* and of many other species of the genus has been stated to lack a lateral armature, mobile spines appear to be present in all.

M. spinulicauda Stebbing, 1914, is quite possibly an immature specimen of *M. monoceros*. A lateral armature of the telson, as mentioned above, cannot be utilized to distinguish this from the latter species. The armature of the endopod of the second maxilla, given by Stebbing as a significant character, seems to be equivalent to that of the maxilla of *M. monoceros* except that in the latter there are three very small spines proximad the two large ones which were perhaps overlooked by Stebbing. The petasma of *M. spinulicauda*, which is that of a quite immature individual, is not distinguishable from this organ in *M. monoceros* of the same size. If Stebbing is actually dealing with *M. monoceros*, he has overlooked the spine at the distal end of the ischium of the first leg; it seems possible that this has occurred, since the presence of a basisal spine on the third legs, characteristic of the genus, has also been overlooked.

M. mutatus Lanchester, 1901, is not by the description and figures differentiable from *M. affinis* as figured by Alcock, 1906, and De Man, 1924, with which species the author failed to compare it. The possible identity of *M. mutatus* with *M. affinis* has been suggested by Alcock.

M. demani Roux, 1917, may be mentioned in this place. The form, as described, seems to be very like *M. macleayi* Haswell as described by Schmitt, 1926a, although not mentioned by the latter author in his discussion of Haswell's species. The telson of *M. demani* is described as unarmed, while that of *M. macleayi* is stated to bear four pairs of marginal spinules, but to judge by the condition in the remainder of the genus, *M. demani* probably bears lateral armature of some sort. The arrangement of the rostral spines, regarded by Roux as diagnostic of his form, seems not very different from that found in *M. affinis*, and even more like that of *M. macleayi*. The median lobe of the petasma is thrown into folds along its lateral margin which seem somewhat to resemble those of the male of *M. affinis* contained in the present collection. The precise affinities of *M. demani* are not at present clear, but it is probably not very closely related to *M. affinis*.

As to the two well-established species of the group, *M. affinis* and *M. monoceros*, no clear statement of diagnostic distinctions between them has been made. It would appear that although the dorsal median carination of the carapace and pleon of *M. affinis* may be weaker than that of *M. monoceros*, the range of variation in both species is sufficient to create considerable overlap; likewise the length of the appendages and the number of rostral teeth (the first usually greater, the last usually less in *M. affinis* than in *M. monoceros*) seem too variable to be of diagnostic value. Differences in the shape of the rostrum (somewhat sigmoid and cristate in *M. affinis*, straight in *M. monoceros*) perhaps provide a fairly constant criterion. The occurrence of a spine at the distal end of the ischium of the first legs, absent in my specimen of *M. affinis* but present though of variable size in all material of *M. monoceros*, may be of significance, but this structure is in related forms, as *M. lysianassa*, not constant in its occurrence.

The meral notch, tooth, and margin distad the tooth of the fifth leg appear to become distinctive only in very fully adult males, such as have been rarely reported. In the single male of *M. affinis* at my disposal, the tooth is short and triangular, as it is in the single nearly adult male of *M. monoceros* in the collection; the margin of the merus of the latter, behind the tooth, is entire just as in *M. affinis*. A projection is present near the distal end of the ischium of the male of *M. monoceros* which is not present in the other less nearly mature males nor in the specimen of *M. affinis*. The proximal part of the external margin of the exopod of the uropods is in the male of *M. affinis* conspicuously concave, while it is in all the specimens of *M. monoceros* not emarginate; however, both Alcock, 1906, and Kishinouye, 1900, figure the emargination as present in their specimens of the latter species. The protuberance reported to occur on the peduncle of the uropods of *M. affinis* is not visible in the present specimen. Some doubt of the diagnostic value of the various characters mentioned in the present paragraph is permissible; at any rate they seem of use only for the differentiation of large, mature individuals, and it is quite possible that the undistinctive juvenile condition of the structures might on occasion be maintained in individuals of either species otherwise adult, in which case some confusion of the two species might result, and may have resulted.

A very considerable degree of variation may be observed in the figures of the petasma of the two species offered by various authors, which is perhaps due in part to an insufficient understanding of the structure of the organ. The endopods of the petasma of *Metapenaeus* are equivalent to endopods of a simple open petasma such as that of *Penaeus* in which the lateral parts have become folded mediad across the ventral faces of the endopods nearly to the median line. The laterodistal corner of the external margin of each half of the petasma is produced as a short trough-like horn (the distolateral lobe) open along its distal surface. The distomedian lobe has the form of a projecting flap of the dorsal side of the endopod between the median cincinnulated margin and the distolateral lobe. This flap bends over ventrolaterally, partly overlapping the distolateral and distoventral portions of the petasma. The distomedian lobes are short and simple in the immature male, but may with growth so increase in size as to quite conceal the lateral horns in ventral view. Such an hypertrophy of these lobes is peculiar to the genus although a somewhat similar condition occurs in a few species of *Parapenaeopsis*.[1] In various figures and descriptions of the petasma of *Metapenaeus*, the distomedian lobes have not been indicated to be free from those parts which they merely hood. It is probable that the differences between various figures of *M. monoceros* or *M. affinis* represent not only true variation in the size and shape of the flaps with age, locality, or individual, but in considerable part merely reflect differences of little real significance in folding or placement of the fleshy, unsupported lobes. So far as can be determined from available material, the principal difference in petasma between the two species under consideration lies in the fact that in *P. affinis* the distomedian flap is deeply crenellated along its distolateral margin, while in *M. monoceros* it is here entire. In none of my material of the latter form do the flaps rise so high above the lateral horns before folding over ventrally as in the figures by De Man, 1911, and Kishinouye, 1900.

The thelycum of *M. monoceros*, and probably also of *M. affinis*, seems subject to considerable change with age (see Schmitt, 1926a), but is probably fairly distinct in adults of the two species. Kishinouye's figure of this structure in *M. affinis* differs so considerably from the figures by De Man, 1924, and Alcock, 1906, as to make doubtful a reference merely to age differences.

In both *M. affinis* and *M. monoceros*, as in other species of *Metapenaeus* in which their presence has been denied, the lateral margins of the telson are armed with a series of mobile spines. These are very small and numerous in the above two species, lying inconspicuously along the dorsolateral margin above the sharp edge beneath which the cilia are rooted. An intergrading series of conditions may be found, through *M. joyneri* and *M. brevicornis*, to the *M. ensis* group in which certain spines at the distal end of the series are so much enlarged as to be very conspicuous.

Metapenaeus monoceros (Fabricius)

Penaeopsis monoceros, DE MAN, 1924; SCHMITT, 1926a; MONOD, 1930.

1 male, carapace length 20 mm; 3 females, carapace 12.5 to 25 mm. *B.O.C. 46.* Singapore, Straits Settlements, February, 1933.

2 males, carapace 16.5 mm. *B.O.C. 49.* Georgetown, Penang, February, 1933.

[1] In the new genus *Protrachypene*, discovered after the foregoing was written, and described below, very similar flaps occur.

1 male, carapace 19 mm; 1 female, carapace 26 mm. *B.O.C. 48.* Port Swettenham, Selangor, February, 1933.

1 male, carapace 19 mm; 2 females, carapace 12 and 15 mm. *B.O.C. 47.* Port Said, Egypt, March, 1933.

In addition to this material, a male 9 mm in carapace length from Hong Kong, and a male 15 mm and female 18.5 mm in carapace length from Amoy, China, in the collection of the American Museum of Natural History, were available.

The minimum total length of the females examined was 57 mm, the maximum 123 mm. None were impregnated. The smallest male was 43 mm, the largest, 100 mm. The largest male with the copulatory endopods not hooked together was 95 mm in total length.

This species, and the following one, appear to be recent migrants to the Mediterranean by way of the Suez Canal (Balss, 1927).

Metapenaeus stebbingi Nobili

Penaeopsis stebbingi, TATTERSALL, 1921; MONOD, 1930.
NOT *Penaeopsis stebbingi*, SCHMITT, 1926a.

1 male, 2 females. *B.O.C. 40.* Port Said, Egypt, March, 1933.

Schmitt, 1926a, is right to compare the thelycum figured by Balss, 1914, as *Penaeopsis mogiensis* (Rathbun) juvenile with that figured by Tattersall under the name of *Penaeopsis stebbingi*. It is obvious, however, that the numerals of Tattersall's figures have been misplaced, and that the thelycum numbered as *M. stebbingi* actually represents that of *Penaeopsis vaillanti* Nobili, and vice versa. Balss' specimen is evidently to be referred to *P. vaillanti*. Schmitt's statement that Balss' figure is nicely fitted by the original description of the sternal armature and leg base spines of *M. stebbingi* does not accord with my interpretation of Nobili's statements, since Balss depicts a conspicuous pair of sternal spines between the second legs and the third legs as unarmed, characters impossible to *M. stebbingi* or indeed to any other known species of *Metapenaeus*.

Tattersall's figure 10 of the petasma of *M. stebbingi* is sufficient for recognition. His figure 12, although incomplete, may serve for identification of the thelycum. The median plate of sternite XIII in the present species is short and inconspicuous, and is placed close beneath the overhanging lateral hoods of sternite XIV; the structure is, although described by Nobili, 1906, omitted both from his figure and from that of Tattersall.

The mobile spinules of the lateral margins of the telson of *M. stebbingi* are minute, but larger and less numerous than are those of *M. monoceros* and *M. affinis*.

Metapenaeus brevicornis (H. Milne Edwards)

Penaeopsis brevicornis, DE MAN, 1924.

52 males, immature, total length, 45 to 75 mm.; 43 females, immature, total

length 45 to 75 mm.; 1 female, adult, total length 100 mm. *B.O.C. 51.* Singapore, Straits Settlements, February, 1933.

3 males, adult, total length 80 mm.; 1 female, adult, total length 90 mm. *B.O.C. 50.* Georgetown, Penang, February, 1933.

The differences between the adults of this species and of *M. lysianassa* (De Man) have been well described by De Man, 1887 and 1924, and Alcock, 1906. In young individuals of the two species, however, the differences are much slighter. The rostrum of *M. brevicornis* becomes with decreasing size of the individual nearly as short as that of *M. lyssianassa,* in which last the rostrum seems to change its proportionate length very little with change in size. The expansion of the ischium of the fifth legs characteristic of the adult female of *M. lysianassa* is not discernible in juveniles; and the thelycum is sometimes quite similar in young individuals of both.

A difference between the species in armature of the telson, described for adults by De Man, 1924, is unchanged by age, and diagnostic. It may be noted that in addition to the pair of spines near the distal end of the telson in *M. brevicornis,* there is a proximal series of very much more minute spinules overlooked by De Man. The difference between this armature and that of *M. lysianassa* therefore lies in the fact that in the latter the lateral spines regularly enlarge from proximal distad; while in *M. brevicornis* there is a sudden increase in size affecting the last one or two spines.

M. brevicornis possesses an ischial spine on the first legs, which is sometimes quite small, but never absent. In *M. lysianassa* the ischial spine is usually lacking, but is occasionally present.

The thelyca of very young females of the two species are usually distinguishable in that the entire median plate is distinctly embossed upon the sternum of *M. lysianassa* even at a carapace length of 8 mm., whereas its anterior portion is usually not developed in females of *M. brevicornis* of carapace length less than 15 mm. The entire median plate is, however, occasionally developed in the latter, when the immature thelyca appear somewhat alike.

There are slight differences between young as well as adult females of the two forms in the shape of the coxal projection of the fifth legs, that of *M. brevicornis* being incised, that of *M. lysianassa* entire. The basal portion of the outer margin of the exopod of the uropod of adult males of *M. brevicornis* is somewhat emarginate.

The difference noted by De Man between the petasma of his males of *M. brevicornis* and that figured by Alcock and by Lanchester, appears to be dependent on age. Among the numerous Singapore males examined the petasma of the largest (carapace length 15 mm.) had more divergent lateral horns (DISTOLATERAL LOBES), and filaments (appendages of the short DISTOMEDIAN LOBES) attached nearer the middle of the distal margin than in the smaller specimens, which resembled De Man's figures. Three large Georgetown males (carapace length more than 16 mm.) had divergent cornua and filaments attached in the middle as in Alcock's figure. It seems probable that the change in petasma occurs quite suddenly, at a total length of about 75 mm. The length and shape of the filaments is variable. These structures are equivalent to much narrowed flaps of the sort found in the *M. affinis* group.

In *M. brevicornis*, and probably in *M. lysianassa*, as to a greater degree in the nearly related pair, *M. dobsoni* (Miers) and *M. joyneri* (Miers), the basisal spine of the third leg of the male is larger than that of the female. There seems to be a remarkable parallelism between thelycum and petasma in these two pairs of species. In *M. brevicornis* and *M. joyneri*, where the petasma has conspicuous free distal filaments, the lateral hoods of the thelycum are widely separated by the posterior part of the median plate; while in *M. lysianassa* and *M. dobsoni*, the petasma of which is not reported to bear free filaments, the lateral hoods of the thelycum meet in the median line for part of their length.

In a male and a female of *M. joyneri* in the collection of the Department of Zoology of the Peabody Museum of Natural History, the telson possesses a lateral armature very similar to that of *M. lysianassa*. The peduncle of the uropods of the male of this Japanese species, an individual about 83 mm. in length but probably only semimature, does not differ from that of the female; there is no tooth like expansion of the merus of the fourth leg; the meral tooth of the fifth leg is very small; and the enlarged basisal spine of the third leg does not reach to the end of the ischium and does not have an expanded tip.

The thelycum of *Metapenaeus brevicornis* is typical of the genus. The transverse groove serves as sperm receptacle, without an especial cavity being formed from it by the deep invagination of a limited part of the groove such as occurs in *Parapenaeus*, *Trachypeneus* or *Eusicyonia*. The thelycum of *Metapenaeus* differs conspicuously from that of the American species of *Metapenaeopsis* only in that the transverse groove is continuous across the midline; this difference is not a clearly significant one, since the character varies from genus to genus within the same series, and even within genera, as in *Trachypeneus*.

In the two large impregnated females of *M. brevicornis* the ventral surface of the thelycum is hidden beneath a pair of large white conjoined pads of non-sperm-bearing material deposited by the male. To the middle of the dorsal surface of the pair of pads is attached a plug of yellow horny material continuous with the posterior end of the investiture of the spermatophores contained in each half of the transverse groove. Upon removal of the white pads, the subrectangular anterior part of the expanded median plate of sternite XIII, lifted above the sternal surface by a narrow longitudinal support, may be seen to be continued posteriorly as a broad elevation, emarginate posteriorly and overlapped on the sides by the lateral hoods of sternite XIV. From the posterior portion of sternite XIV the lateral hoods extend forward on either side to disappear beneath the expanded anterior portion of the median plate of XIII. Between the median anterior margin of the portion of XIV which rises laterally into the lateral hoods, and the concave median posterior margin of the posterior part of the median plate of XIII, there is a gap from which the plug of yellow male secretion mentioned above protrudes. This gap evidently serves as entrance to the sperm cavities.

Dissection reveals that the transverse groove runs anterolaterally on each side from its exposed posteromedian section, between the narrow basal support of the median plate and the median margins of the lateral hoods. The lateral hoods lap over the posterior part of the median plate, and are overlapped by its anterior part, beneath which the much expanded transverse groove is concealed. Each of the sperm receptacles thus enclosed opens anterolaterally just behind the level of the fourth leg bases, at which point the lateral hoods are terminated. Both lateral cavities are filled with sperm embedded in a clear yellow matrix. The broad anterior exits of the cavities are blocked by the expanded coxal projections of the fourth legs. Across the anterior surfaces of the sperm masses scratches are perceptible which appear to have been made by movements of the spines set on the coxal projections. It is probable that the two spermatophores are inserted by the male through the posterior opening, which is then stoppered with a plug of the yellow material; and that the mass breaks up at the time of oviposition, when the sperm ooze out of each anterior opening to be swept forward by movements of the fourth leg bases. Such a process has been observed in *Penaeus trisulcatus* by Heldt, as mentioned with reference to *Penaeus brasiliensis* in the preceding paper.

The function of the pair of white externally applied pads is uncertain, and it may be noted that in the impregnated female of *M. lysianassa* available to me these structures were set on very much askew. The spermatophores, including the pads, are completely preformed in the male, one of the pair lying in the enlarged distal end of each vas deferens. The distal end of the vas in *Metapenaeus* seems very similar to the same structure in *Penaeus*. The white pads are perhaps rudimentary homologues, as suggested by Kishinouye, of the appendages of the spermatophore of *Penaeus*, which have been shown in the preceding paper to function for attachment of the exposed spermatophores in peneids with open thelycum.

Metapenaeus lysianassa (De Man)

Penaeopsis lysianassa, DE MAN, 1924.

1 male, about 40 mm total length; 9 females, 40 mm juvenile to 85 mm adult with spermatophore. *B.O.C. 45*. Singapore, Straits Settlements, February, 1933.

1 female. *B.O.C. 43*. Georgetown, Penang, February, 1933.

1 cephalothorax. *B.O.C. 44*. Port Swettenham, Selangor, February, 1933.

Metapenaeus intermedius *variety* **anchista** (De Man)

? *Penaeus monoceros ensis*, DE HAAN, 1850.
? *Penaeus intermedius*, KISHINOUYE, 1900.

? *Metapenaeus ensis* ?, ALCOCK, 1906.
Penaeopsis ensis, BALSS, 1914.
Penaeopsis intermedia anchista, DE MAN, 1922.
? *Penaeopsis endeavouri*, SCHMITT, 1926a.

1 male, semimature, total length 104 mm. *B.O.C. 41.* Port Swettenham, Selangor, February, 1933.

In addition to this specimen, an immature male from Singapore of total length 83 mm, in the collection of the Department of Zoology of the Peabody Museum of Natural History; and an adult female of 145 mm total length from Hong Kong, in the collection of the Museum of Comparative Zoology at Harvard, were available for examination.

Four named species, certainly very closely related, may be termed the *M. ensis* group. These, *Penaeus monoceros ensis* De Haan from Japan; *P. intermedius* Kishinouye from Japan, *Penaeopsis intermedia anchista* De Man from the East Indies, and *P. endeavouri* Schmitt from Queensland, Australia, are all rather uncommon, and extensive comparisons have not been made. The diagnostic distinctions between the forms seem somewhat uncertain.

Kishinouye, 1900, fails to consider the relationship of his *M. intermedius* to *M. ensis* (De Haan), which latter, like De Haan, he compares with *M. monoceros.* No material resembling the figure by Kishinouye in the characters of horizontal rostrum and large anterior pair of lateral telson spines has since been reported.

De Man, 1920, has proposed a varietal name, *M. i. anchista*, for East Indian specimens with elevated rostrum, short anterior pair of telson spines, and short posterior pair of telson spines. At the same time, De Man has prepared, from the notes of another observer upon the type of De Haan's species apparently made without direct comparison with East Indian material, a list of the diagnostic differences between *M. ensis* and *M. i. anchista.* It may be observed that *M. ensis* is reported to resemble *M. i. anchista* and to differ from Kishinouye's figure of *M. intermedius* in the two chief characters supposedly distinguishing the latter two forms, its elevated rostrum and small anterior pair of telson spines. The differences between *M. ensis* and *M. i. anchista* are stated to be as follows: the third pleonic somite of *M. ensis* bears a median dorsal carina; a carina extends from the hepatic spine to the posterior border of the carapace; the ischial spine of the first cheliped is much shorter than the basisal; and the posterior of the three pairs of lateral telson spines is longer than in *M. anchista.* In the last of these characters, De Man notes that *M. ensis* resembles Kishinouye's figure of *M. intermedius.* In the other characters, De Man seems to assume that *M. intermedius* differs from *M. ensis* in the same way as does *M. intermedius anchista:* but it may be observed that there is no available information about Kishinouye's form which might serve as basis for this assumption.

Schmitt, 1926a, has added some confusion to the case by attributing, without explanation, three specimens the geographical derivation of which is not mentioned to *M. intermedius;* while at the same time, he both states that he has not seen De Man's *M. i. anchista* and refers the Singapore specimen described (as *M. ensis*) by Balss, 1914, which is certainly identical with De Man's specimens, to *M. intermedius*. In attempting to find the reasons which led Schmitt to consider his specimens as relating to Kishinouye's rather than to De Man's form, it was observed that in comparing this material with *M. endeavouri*, Schmitt fails to mention any differences between the former specimens and the Australian material in rostrum, figured for the latter as ascending; and in telson, figured for the latter as with a small anterior pair of lateral spines. Therefore, in the characters considered by De Man as diagnostic of *M. i. anchista*, Schmitt's material seems to agree with that form, and not with *M. intermedius* with which it is identified. Schmitt's reference of Balss' East Indian specimen to the Japanese name seems to preclude the possibility that geographical considerations have influenced his determination, the basis for which is therefore not apparent.

Summarizing the above complex situation, if *M. i. anchista* De Man is not certainly distinct from *M. intermedius* Kishinouye, it is simultaneously true that *M. intermedius* has not been shown to be distinct from *M. ensis* De Haan in the characters reported to distinguish the latter form from *M. i. anchista.* I am inclined to believe that the differences between Kishinouye's figure and other known specimens of the group in rostrum and telson are of doubtful significance; and that the differences reported between the type of *M. ensis* and other known specimens in pleonic carina and cardiaco-branchial carina need confirmation.

M. endeavouri (Schmitt) 1926a, is described as differing from Schmitt's *M. "intermedius"* by its larger size; its more pubescent carapace and pleon; its thelycum without a posterior median tubercle, with an emarginate rather than convexly projecting anteromedian margin of the median plate and with the lateral plates not bent at right angles in the middle; the smaller size of the coxal projections of the fourth legs of the female; and the presence of a small spine-like projection mediad the distolateral projection of its petasma, which lacks the "small point on the outer proximal margin," and has a different "protuberance of the inner distal angle" and of the "proximolateral angle" of the distal end. The telson armature of *M. endeavouri*, not described by Schmitt, is figured by him as consisting of only two pairs of lateral spines instead of three. This is probably an error.

The figure of the thelycum of a small East Indian female by De Man, 1922, a description expanding that by De Man, 1920, and evidently overlooked by Schmitt, seems not to be accurate in detail. This figure differs from that of a larger East Indian female by Balss, and resembles Schmitt's Australian form, in lacking the posteromedian tubercle; while it resembles Balss' figure and differs from Schmitt's in the convex anterior margin of the median plate, and is intermediate in the length of the coxal projections of the fourth legs. De

Man fails to refer to Balss' note. The figure of the petasma by De Man, 1922, is that of a quite immature male.

The three specimens of the *M. ensis* group at my disposal, from Singapore and Hong Kong, seem to pertain to a single species. In all, the third pleonic somite completely lacks a carina. The female has a blunt but conspicuous sulcus-bordered carina extending as far as the anterior two-fifths of the fourth pleonic somite; in the two males this carina extends only to the middle of the segment. The carapace lacks a crest between the hepatic buttress and the posterior border, but it may be noted that a prominent cardiaco-branchial ridge borders the setose sulcus ventrally, and although it does not reach anteriorly to the hepatic buttress, is connected with it by a convex area channeled only by a short transverse sulcus. The rostrum of all three specimens ascends at an angle of about ten degrees, the tip being straight or a little upturned; and reaches beyond the base of the third segment of the antennular peduncle. In the two males the armature is $\frac{10 + 1}{0}$; in the female, $\frac{9 + 1}{0}$. Only one tooth besides the epigastric, in contradiction of De Man's figure and description, stands behind the orbital margin.

In the two males, the anterior lateral spine of the telson is less than two thirds the length of the posteriormost one; and the posteriormost reaches less than halfway to the tip. In the large female, the anterior spine is relatively longer, about three fourths the posterior, and the telson tip is somewhat shorter and slenderer than in the Singapore specimens. It may be noted that a band of minute spinules accompanies the enlarged spines. It is evident that these specimens correspond to those regarded by De Man as *M. i. anchista*.

The pubescent areas of the integument of the three available specimens seem subject to increase in extent as well as in density of ciliation with increase in size of the individual. In the two smaller specimens the patches on the second, third and fourth pleonic pleura range up to one-fourth the length of the pleura, while in the larger Chinese female, these patches occupy over two fifths the length of the pleura. The branchial region of the carapace, naked in the smaller specimens, displays three conspicuous pubescent areas in the large one: a long ventral longitudinal stripe and two shorter dorsal patches beneath the cardiaco-branchial ridge.

The thelycum is essentially similar in structure to that of *M. monoceros* (Fabricius). In the present specimen it bears a conspicuous posteromedian ridge or tubercle, as described by Schmitt for his "*P. intermedius*," which he appears to consider identical in female genital apparatus with the Singapore female examined by Balss. However, as in *M. endeavouri*, the Chinese specimen has a median notch at the anterior margin of the median plate, rather than a convexity. It is possible that the convexity shown in figures by Balss and De Man actually refers to the anterior part of the ridge upon which the expanded median plate is supported, rather than to the anterior margin of the plate itself.

The coxal projections of the fourth legs of the Chinese female are long, and the lateral plates are bent at right angles in the middle.

The petasma does not completely coincide with Schmitt's description of his "*P. intermedius.*" The smaller spine mediad the distolateral projection, stated to be present in *M. endeavouri*, absent in *M.* "*intermedius*," is present in the fairly mature male of the present report. Differences postulated between the Australian form and *M.* "*intermedius*" in length of "protuberance of the inner distal angle" and shape of the "proximolateral angle of the terminal portion" are certainly of doubtful significance. These characters refer to the flap-like projection of the mediodistal lobe, which bends over ventrolaterally as in *M. monoceros*, hooding the ventral margin of the petasma. This structure in other species of *Metapenaeus* is quite variable, especially with age; the difference in size between Schmitt's Australian material and available northern males would probably be sufficient to account for some structural diversity. In the mature male available to me the distolateral projection overtops the distomedian lobe, as in *M. endeavouri*, but not in the northern material reported by Schmitt.

It seems from the above that the diagnostic value of some differences between *M. endeavouri* and northern forms postulated by Schmitt cannot be completely confirmed, although there appear to be several real differences. I do not believe that the disparities between my material and Schmitt's description of specimens which he refers to *M. intermedius* signify that a real difference in petasma and thelycum between Schmitt's material and De Man's *M. i. anchista* actually exists. It is of interest that the Chinese female, nearer the Australian specimens in size than any previously recorded northern specimens of the *ensis* group, shows a recognizable increase over smaller specimens in the density and area of pubescence.

Although it is probable that several species may actually exist within the *ensis* group, until range of variation and degree of geographical intergradation in the supposedly diagnostic characters are better known, and until the actual existence of some of these characters has been confirmed, the possibility that all named species of the group are synonymous with *M. ensis* De Haan must be considered.

TRACHYPENEOPSIS, New Genus

Genotype, *T. mobilispinis* (Rathbun), Atlantic America. Other species of the genus, *T. richtersii* (Miers), Indopacific.

Definition—Penaeinae of the **Trachypeneus** series in which the thirteenth somite lacks a pleurobranch; there are no longitudinal and transverse sutures on the carapace; the antennular peduncle does not bear a parapenaeid spine; the maxillulary palp has a small distal lobe; all the pereiopods bear moderately long and slender exopodites; both maxillipedes bear exopods; all of the epipodites are unfurcated; the basis of the first chelipeds only is armed with a spine;

and the telson bears three mobile lateral spines the distal of which is supported on a much produced basal shoulder.

The superficial resemblance of the species of this genus to *Penaeopsis* and to *Metapenaeus* has caused their confusion with the latter two groups. From both, *Trachypeneopsis* is readily separable by its different branchial formula and unfurcate epipods. From the former it is additionally distinguished by the lack of a parapenaeid spine and of a pair of fixed teeth distal to the mobile lateral spines of its telson. From the latter it further differs by the presence of an exopodite on the fifth legs, and the absence of a spine from the basis of the second and third chelipeds.

The absence of both longitudinal and transverse sutures distinguishes *Trachypeneopsis*, like *Metapenaeus*, from other members of the **Trachypeneus** series. The new genus appears to be most closely related to *Atypopeneus*, in which, however, De Man has found the transverse suture to be present. It is further distinguished from *Atypopeneus* by its buttressed antennal spine, its short antennular flagella, the reduced armature of the proximal segments of its chelipeds, the armature of its telson, its peculiar petasma, and probably by the lack of furcation of its epipods. This latter feature seems to be unique among adult Penaeinae, in which the epipods of VIII and XII at most, as far as is known, are unfurcate; and recalls the condition found in Aristaeinae and certain Solenocerinae.

Trachypeneopsis has been referred to in the preceding paper (Burkenroad, 1934) as the "first of three genera confused under the name '*Penaeopsis*'."

Trachypeneopsis mobilispinis (Rathbun)

Metapenaeus mobilispinis, RATHBUN, 1919.

Material examined includes a female, 39 mm in total length, probably a cotype, very kindly loaned by the Rijks Museum van Natuurlijke Historie of Leiden; and a female of carapace 7.7 mm, total length about 34 mm, from Turks Island, Bahamas, discovered among recent accessions to the collection of the American Museum of Natural History. This second specimen represents the first record of the species since its description, and extends its range very considerably to the northward.

The close relationship between the Indopacific *T. richtersii* (Miers) and the Antillean species seems heretofore to have escaped attention. Differences between the Pacific species as described and figured by Miers, 1884, Rathbun, 1906, and De Man, 1911; and the latter seem extremely slight, and hardly worthy of notation without corroboration by direct comparison.

The following additions to the description of *T. mobilispinis* may be made:

Somite XIII bears, in addition to the posterior arthrobranch, a conspicuous unfilamentose vestige of an anterior one. The lobule on the posterior margin of the gill-bearing section of this somite is not ciliated. The "rudimentary arthrobranch" (branchial lamella) of somite VII is filamentose. Epipods are present on the second maxillipedes and the first, second and third legs. The exopodites of the walking legs have a strong constriction in the middle, in addition to their basal joint. There is a basisal spine and a very minute ischial on the first legs: the others are unarmed. The paired teeth of the posterior margin of sternite XI are no more conspicuous than in other members of the Trachypeneus series. The endopod of the first pleopod of the female is completely absent, as in the American species of *Metapenaeopsis* but not in *Metapenaeus;* those of following pleopods are unusually small. The eye reaches well beyond the internal antennular scale, instead of failing to reach its tip as stated by Rathbun. The proximal segment of the antennal peduncle bears a very elongate spine on its lateral margin. The anterior part of the lateral margin of the antennal scale does not bear minute spinules such as are present in the American species of *Metapenaeopsis.* The fourth pleonic tergum, like the fifth, is incised posteriorly; it is dorsally compressed but not carinate. Only the sixth somite bears a minute median spine at the posterior end of the dorsal carina. The lateral spines of the telson are much like those of the *M. ensis* group of *Metapenaeus,* but the basal shoulders on which the ultimate pair of spines is borne are much more elongated and the minute mobile spines scattered among the enlarged ones in the *M. ensis* group are absent in *T. mobilispinis.*

The petasma of *T. mobilispinis* as figured by Rathbun differs from that figured by her for *T. richtersii* (both figures being dorsal views) by the absence in the latter of a projection between the distolateral lobe and that figured as projecting proximal to it. Rathbun states, however, that two lobes instead of one are visible behind the median, terminal lobe in a ventral view of the petasma of *T. richtersii.* Ventral views of the petasma not being available, the homologies of the various projections cannot be determined. If, as is possible, petasma is constructed upon the same lines as that of *Metapenaeus,* a ventral view should indicate the distomedian lobes to be produced as free flaps bent down over the ventral surface; the distolateral lobes to be channeled like the lateral cornua of *Metapenaeus;* the intermediate lateral projections to be protuberances of the cornua, or possibly the exposed tips of the distomedian flaps; and the proximolateral projections perhaps to be merely exaggerated shoulder-like protuberances of the sides of the petasma.

The thelycum of *T. mobilispinis* agrees closely with that figured by Rathbun for *T. richtersii.* The "median acute spine" anteriorly "between the bases of the fourth legs and visible in that [Rathbun's] figure" which De Man states to be present in his specimen of *T. richtersii,* is absent in the female of *T. mobilispinis* examined. Moreover, I cannot find an indication of such a spine in Rathbun's figure referred to. There is, between the fourth legs, a high median longitudinal ridge projecting from the sloping anterior face of the median plate of the thelycum, but this ridge does not bear any trace of a spine in the adult Atlantic form although one is probably present in postlarvae. The anteromedian angles of the lateral plates of *T. mobilispinis* terminate in dentiform projections, as do those of *T. richtersii* according to De Man. The posterior continuum of the median plate of the thelycum bears in its middle a spiniform projection, somewhat as indicated in Rathbun's figure of *T. richtersii.*

Rathbun's description of the thelycum of *T. mobilispinis* is misleading; the "shallow concavity with uneven surface" is the median plate, lifted high above the general level of the sternite; the "low, curved smooth ridge" bounding the "concavity" on either side consists of the raised inner edges of the broad lateral hoods, elevated high above the sternal level. The lateral hoods embrace the median plate on its lateral margins, while posteriorly they merge with the posterior portion of sternite XIV. The large coxal nibs of the fourth legs overlap the lateral parts of the sloping anterior face of the median plate, and abut behind against the anterior margins of the lateral hoods. This thelycum seems quite similar to the type found in *Metapenaeus,* although without dissection it is impossible to ascertain that the posterior pair of openings between the median plate and the lateral hoods on either side of the median line, near the point where the lateral hoods merge with the remainder of sternite XIV; and the anterior pair of openings, between the foremost portions of the lateral hoods and the sides of the median plate, lead into a simple enclosed cavity like that of *Metapenaeus.*

No Pacific American congener of *T. mobilispinis* is at present known, but it is probable that one will be discovered.

PROTRACHYPENE, New Genus

Only known species, *Protrachypene precipua,* new species, Pacific America.

Penaeinae of the **Trachypeneus** series. The thirteenth somite lacks a pleurobranch; there are both longitudinal and transverse sutures on the carapace; and the second maxillipede lacks any trace of an exopod.

The antennal carina and sulcus are well developed. The telson is armed with a series of eight or more minute mobile lateral spines. The antennular flagella are elongated. The third maxillipede and all the pereiopods bear exopods. The epipods of the first and second legs are furcated, those of the third leg and second maxillipede entire. The fourth and fifth legs are immoderately long and slender, flagelliform; but with the joints entire, not subdivided. The chelae of the three anterior legs are extremely weak, with much lengthened palm and short fingers. The petasma has a flap on the proximal part of the dorsal walls of the spout-like distolateral lobes which is overlapped by the ventral wall of the spout instead of overlapping it. The transverse groove of the fourteenth sternite of the female is continuous across the segment but is not deeply invaginated in the midline; the sperm receptacles are formed by shallow lateral invaginations. The spermatozoa are not organized into numerous small spermatophores.

Protrachypene is of interest as resembling in certain respects the genus *Metapenaeus*, i. e., in the redundant lateral armature of the telson, and the flap of the dorsal walls of the petasmal cornua. Other characters—lack of a pleurobranch on the thirteenth somite, presence of longitudinal and transverse sutures on the carapace—indicate it to be very closely allied to *Trachypeneus*. In one important feature, the complete loss of the exopodite of the second maxillipede, *Protrachypene* is unique in its series, and is paralleled only by *Artemesia* and *Macropetasma* among Penaeinae; in both of the latter genera the exopods of five appendages posterior to the second maxillipedes are also absent, whereas in *Protrachypene* these rami are very well developed. Unique also are the peculiar chelae. The combination of other characteristics is not completely duplicated in any of the other genera of the series.

Protrachypene precipua, new species

Figures 11 and 12, page 47.

1 male, 1 female, adult, types. *B.O.C. 106*. 64 males, 119 females, juvenile to adult, cotypes. *B.O.C. 107*. Bella Vista Beach, Panama City; seine; 9:00–12:00 A.M., February 9, 1934.

3 males, 4 females. *B.O.C. 108*. Bella Vista Beach, Panama City; cast-net; 9:00–11:00 P.M., February 9, 1934.

2 females (one impregnated). *B.O.C. 109*. Panama City Market (reported locality, Chame Point); February 10, 1934.

6 males, 11 females. *B.O.C. 110*. Panama City Market; February 12, 1934.

Dimensions—Type male, carapace 13.8 mm; rostrum, 16 mm; total, 75 mm. Type female, carapace 15.3 mm; rostrum 20 mm; total 88 mm. Size range in carapace length, male, 7–13.8 mm, female 6–15.3 mm.

Description—The branchial lamella of the seventh somite is filamentose. The thirteenth somite lacks any vestige of an anterior arthrobranch.

The rostrum is extremely long in adults, projecting far beyond the antennular peduncle; it is up to 2 mm longer than the carapace in males, and to 5 mm longer in females. At a carapace length of about 10 mm in males, 11 mm in females, the rostrum becomes shorter than the carapace, down to less than half as long as the carapace in the smallest specimens. The subcylindrical, styliform, unarmed distal portion of the rostrum of adults usually amounts to more than two-thirds of the whole. The rostrum has a pronounced sigmoid curve, although the terminal part is not strongly ascending. The rostral crest is armed above with 7 to 9, usually 8, teeth in advance of the epigastric, two of which are behind the orbital margin. The posteriormost two teeth are part of a crowded group of four, of subequal size, in advance of which are placed the remaining teeth, decreasing in size and at increasing intervals anteriorly. The anteriormost rostral tooth usually lies somewhat behind the level of the second segment of the antennular peduncle. The crest of the rostrum is high and lamelliform over the orbit, the depth of the dorsal serrations being relatively very slight. This supracarinal crest completely disappears somewhat behind the anteriormost tooth, at which point the lateral carinae reach the dorsal margin and are terminated.

The epigastric tooth is placed in advance of the level of the hepatic; the lateral ridge of the rostrum disappears before reaching it. The postrostral carina is distinct almost to the posterior margin of the carapace.

The orbital angle forms an obtuse tooth. The antennal and hepatic spines are well developed. The anteroinferior angle of the carapace is slightly produced. The cervical sulcus is shallow, setose, and indistinct, without an accompanying carina; it extends to only slightly above the level of the longitudinal suture. The cardiaco-branchial sulcus and carina are extremely strong. Anteriorly the cardiaco-branchial merges with the anterior cervical, which runs straight toward the antero-inferior angle but falls far short of reaching it. The antennal sulcus and carina are well developed.

The longitudinal suture reaches very little, not a fifteenth of the carapace length, behind the anterior margin; and thus falls far short of the hepatic spine. The transverse sulcus is faintly marked but present, at the level of the third legs.

The posterior pereionic tergum is hardly set off from the anterior pleonic tergum, save by absence of pubescence. There is a low middorsal longitudinal ridge on the first three pleonic somites, a sharp carina on the last three, in each of which it terminates in a small tooth. The sixth pleonic somite has a strong, slightly arched, longitudinal lateral carina, which is continued on the sides of the fifth somite as a Λ-shaped ridge.

The telson is long, slender and acuminate, without any sudden narrowing behind the distalmost lateral spines. Its lateral armature consists of 8 to 15 pairs of rather irregularly placed mobile spinules set just dorsal to its ventrolateral margin. The distalmost three to six pairs are occasionally perceptible even to the naked eye, but the increasingly minute proximal spines are difficult to make out. The distalmost pairs are set upon fairly well developed acetabula. The spines are all well spaced; they run from one-ninth or more posterior to the proximal shoulder, to within one-seventh of the tip.

The dorsal and lateral surfaces of the entire animal, with the exception of the rostrum and postrostral carina, the antennal, anterior cervical, and cardiaco-branchial sulci, the pleonic dorsal and lateral carinae, the posterior pereionic tergum, and a few other small patches on carapace and pleon, are covered with a fairly dense, short pubescence.

The general form, with rather slender cephalothorax and relatively deep pleon, is somewhat similar to that of *Metapenaeus brevicornis*.

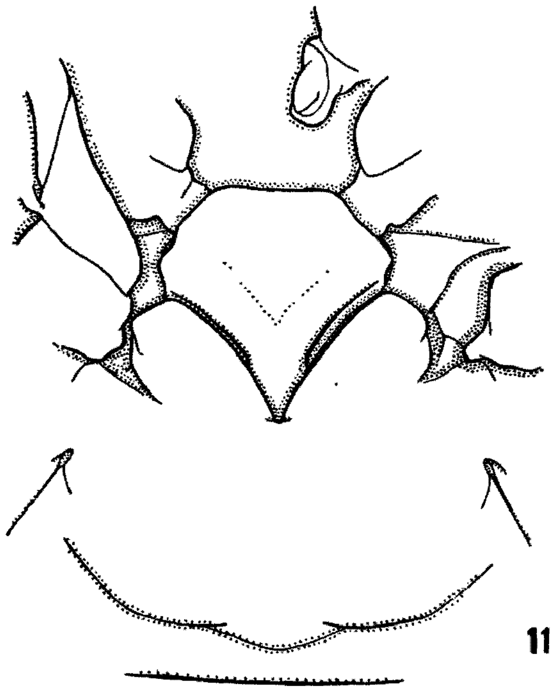
There is no parapeneid spine on the inner margin of the basal segment of the antennular peduncle, similar to other members of the series. The internal scale of the first segment of the antennular peduncle has a truncated tip. The superior antennular flagellum is long and slender, the basal part being little enlarged; it is a third or less longer than the carapace, and somewhat less than twice as long as the inferior flagellum. The antennal scale reaches well beyond the antennular peduncle. The antennal peduncle is very long, reaching to beyond the first segment of the antennular peduncle.

The terminal lobe of the maxillulary palp is present but very short; its mediodistal lobe is armed with a single strong spine; and the posterior surface of the main portion with a longitudinal row of four stout spines. The maxillary palp has three strong spines on its anterior distal face, in addition to the posterior tooth, and the row of spinules on the median margin. The propodus of the second maxillipede is peculiarly produced at its proximolateral corner, into a high subtriangular projection. The exopod of the third maxillipede reaches to near the end of the carpus; while that of the second maxillipede is completely absent.

The basis of the first cheliped is armed with a long and slender spine; that of the second with a minute protuberance, or, often, spine; the ischium of the first leg is produced at its inner distal angle into a large triangular tooth; the other legs are unarmed. All three chelipeds have in the adult an extraordinarily long and slender palmar part of the propodus, with very weak, short, straight fingers. The fingers of the third leg may measure little more than a fourth of the palm in length, while the chela is nearly three-fourths as long as the carpus, and more than ten times as long as broad. In juveniles the chelae are of normal form, with strong fingers more than half the length of the palm. All the chelipeds are slender; the third extend beyond the middle of the second joint of the antennular peduncle, but fall short of the end of the third; the second beyond the first joint; the first legs not to the middle of the first antennular joint. The entire median margin of the first chelipeds, ischium through dactyl, bears long, thickly set setae, while the second and third legs are similarly setose on carpus and chela. The fourth and fifth legs are very long, extremely slender and fragile, and are complete in very few of the available individuals. The fifth legs overreach the antennular flagella, the fourth legs to two-thirds the propodus of the fifth. The merus, carpus, and propodus of the fifth legs are subequal in length and about twice the ischium. The tip of the unjointed dactyl of the fourth legs is styliform; that of the fifth legs was not present in material examined. The fourth and fifth legs are sparsely set with scattered setae. The pereiopodal exopods are long, slender and thin, not broad and fleshy as in *Trachypenaeus*.

The first pleopods of the female lack any vestige of an endopod, although the notch from which these rami spring in some Penaeinae is present. The second pleopods of the male bear an appendix masculina consisting of a short stalk topped by a rather large subrectangular structure strongly troughed on its posterior face, and with the margins closely set with short spinules.

The petasma resembles that of *Trachypeneus* in general appearance. The cornua terminate in a slender beak curved proximad and turned out of the lateral plane in a ventral direction. Below the bases of this beak the cornua expand to form a rounded projection. The ventral walls of the cornua overlap the dorsal ones. The anterior portions of both walls, externally, are scabrous. Mediad a small projection surmounting the anteromedian margin of the endopod, equivalent to the vestige of a distomedian lobe in *Trachypeneus*, the dorsal wall of either distolateral spout gives rise to a subrectangular flap which bends over anteriorly to lie in the channel of the spout. This flap seems to be equivalent to the lateral parts of the hypertrophied distomedian lobe in *Metapenaeus*, in which the flap is continuous to the cincinnulated median margin



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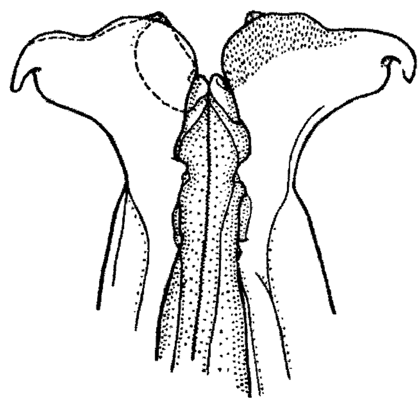

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Figure 11. *Protrachypene precipua*, n. gen. and sp.
Thelycum × 10.5.
Figure 12. *Protrachypene precipua*, n. gen. and sp.
Petasma, distal portion, somewhat distoventral view × 10.5.

of the endopod, and not separated by a notch from a lobe surmounting the median margin as in *Protrachypene*.

The median plate of the thelycum bears some resemblance in outline to a clover-leaf, although the anteromedian and the lateral convexities, always shallow, are sometimes not perceptibly isolated. Some distance medioposterior to either lateral convexity of the median plate, a sulcus appears which runs posteromediad parallel to the margin of the narrowing neck of the plate. These sulci, which appear to form the entrance-grooves of the thelycum, and which are separated by the lamelliform margins of the median plate from the exit-channels of the sperm receptacles, are unique. The arrangement may be compared with the somewhat similar device for separating entrance and exit of the sperm receptacle in the first Division of *Trachypeneus*, where the middle portion of the transverse groove is deeply invaginated to form a commodious chamber into which the sacciform sperm receptacles open, the exit-channels being cut off from the median chamber by their position laterodorsad the elevated median plate. The mode of separation of entrance and exit in *Protrachypene* may also be compared with that in *Metapenaeus*, where it is effected by the elimination, as in *Penaeus*, of functional exit-channels. The entrances are in *Metapenaeus* placed at the posterior ends of elongated sperm receptacles lying between median plate and lateral hoods, which are really equivalent to the exit-channels of *Trachypeneus* or *Protrachypene*, and at the anterior ends of which the exits lie.

The lateral hoods of *Protrachypene* run rather far forward, as inconspicuous slightly raised areas, to the anterior margin of the median plate, where the exits are situated. At the level of the widest part of the median plate, the lateral hoods are conspicuously elevated. From this point their median margins slope backward and inward to meet in the midline, leaving a V-shaped gap between, which is filled by the posterior part of the median plate. The transverse groove between median plate and lateral hoods is continuous across the apex of the V, but is not deeply invaginated there. On either side of the midline the transverse groove is invaginated to form the sperm receptacle proper, a vertically flattened trough-shaped chamber with concave dorsal and convex ventral floor. The posterior part of the receptacle is not expanded into a large sac as in the first Division of *Trachypeneus*. By the baffle and gutter arrangement of the edge of the median plate, the entrance of the receptacle is forced to its postero-median end, while the exit-channel commences anterolaterally at the point where the less elevated anterior portion of the lateral hood takes rise.

The lateral margins of the lateral hoods are notched at the level of the posterior edges of the fifth legs. Behind these notches the surface of the fourteenth sternite is unsculptured except for a shallow U-shaped sulcus near its posterior margin.

In the single impregnated female, a plate of sperm-free male secretion projects from the apex of the V-shaped gape between the lateral hoods, its posterior end being implanted in the shallow median portion of the transverse groove.

Dissection of the male reveals an interesting intermediacy of genital structure between that of *Trachypeneus* and *Metapeneus*. The elongated upper portion of the vas deferens is balled together in a much convoluted mass, as in *Trachypeneus*, but there is no spermatophore-sheath-secreting gland, and the sperm are not aggregated into encased bundles. The middle portion of the vas is tubular, without typhosole, as in *Trachypeneus*. In the enlarged lower end of the vas occurs a mass of sperm apparently not enclosed or embedded in any sort of sheathing. In the glandular evagination of this lower part of the vas is found a plate of sperm-free material, evidently that affixed to the median plate of the female. The spermatozoa are elongated cylinders swollen at either end and with a slender spike-like projection at one end. The orifices of the vasa deferentia are subcoxal.

The juvenile individuals show no striking nonsexual changes save the shortening of the rostrum and the normal form of the chelae. In juvenile females, the rudiments of the complex transverse groove and lateral hoods of the adult appear, as is usual, in the form of a slightly arched transverse sulcus with a raised posterior lip, somewhat in advance of the middle of the fourteenth sternite.

The striking superficial resemblance of *Protrachypene* to young *Xiphopeneus*, in company with which it was taken, is noteworthy.

The color in life was translucent, with chromatophores not producing pronounced pattern save for a double transverse rusty band across the posterior dorsal surface of the pleonic somites.

Protrachypene seems to be one of the most abundant of Panamanian peneids at the season and locality of enquiry. It was not included in market samples obtained three months earlier in the year, but the size of the animal is so slight that it is culled from the catch by the fishermen and brought to sale only by accident.

TRACHYPENEUS Alcock

No member of the genus has heretofore been recorded from the American Pacific. The three species from this area described below are all members of Division I of Burkenroad, 1934.

The second Division of the genus, completely limited to the Indopacific, is quite sharply distinct from the first one, and displays a close resemblance to *Parapeneopsis* Alcock. It seems desirable to give formal recognition as subgenera to these two Divisions of *Trachypeneus.*

Trachypeneus anchoralis (Bate), designated the genotype by Alcock, 1901, has been shown by Schmitt, 1926a, to be composed of two species. One, represented by Bate's figured male, is evidently a member of Division I closely related to *T. curvirostris* (Stimpson). The other, represented by Bate's figured female, is a member of Division II, since it is shown by Schmitt to lack epipodites on the first and second legs, and since, according to Bate's and Schmitt's figures, the thelycum seems to lack an unpaired median invagination. Schmitt restricts the name *T. anchoralis* to the component species which belongs to Division II. Accepting this usage, Division II, Burkenroad, 1934, may be regarded as the subgenus *Trachypeneus* s. s.

TRACHYSALAMBRIA,[1] New Subgenus

Genotype, *Trachypeneus* (*Trachysalambria*) *curvirostris* (Stimpson). Species chiefly American. Epipodites present on the first three pairs of legs; transverse

[1] Salambria, modern name of the Thessalian river Peneus, to which the river-god of the same name was autochthonous.

suture of the fourteenth sternite of the female invaginated in the midline to form an unpaired pocket.

SECTION 1, Burkenroad, 1934

Trachypeneus (Trachysalambria) similis pacificus, new subspecies

1 male, 1 female, adult, types. *B.O.C. 52.* 27 males, carapace 6 to 11 mm, total length 27 to 50 mm; 57 females, carapace 8 to 25 mm, total length 36 to 99 mm, cotypes. *B.O.C. 53.* Pearl Islands, Gulf of Panama (Latitude 8/29/40 N, Longitude 78/52/30 W), 19 to 24 fathoms, March 31, 1926.

1 male, 22 females. Paratypes. *B.O.C. 54.* Concepcion Bay, Lower California, May 23, 1926.

In the characters by which the Atlantic *Trachypeneus similis* is distinguished from the Atlantic *T. constrictus,* which have been discussed in the preceding paper, *T. pacificus* agrees with the former; it possesses a postrostral carina distinct almost to the posterior margin of the carapace; a very pubescent sixth pleonic somite; a long slender terminal portion of the telson beyond the distalmost lateral spines, which tapers gently to the tip without an enlarged proximal portion; an antennal peduncle reaching well beyond the external scale of the base of the antennular peduncle; an exopod on the fifth leg not reaching to the distal end of the basis; a sculptured shield on the fourteenth sternite of the male, the posteriorly directed apex of which is not constricted off from its base; and a thelycum of which the anterior margins of the lateral and median plates are truncated rather than convexly produced, and the surface of which is naked instead of pubescent. In a further diagnostic character not mentioned in the preceding paper, *T. pacificus* resembles *T. similis* and is distinct from *T. constrictus:* On the ventrolateral surface of the sixth pleonic somite an arched longitudinal ridge occurs which is bordered above by a sulcus, and is carinated at one, or usually two points to produce cicatrices much like those of *Penaeus.* This ridge is absent in *T. constrictus,* although a faint trace of the sulcus is perceptible.

T. pacificus is distinguishable from *T. similis* only by its somewhat more pubescent sixth pleon; the larger penultimate spines of its telson, which are placed farther anteriorad the distalmost pair than in *T. similis;* the lack of a concavity at the middle of the anterior margin of the median plate of its thelycum, such as is usual in *T. similis* where this part of the margin, except rarely, slopes without sharp definition into the ridge extending forward from beneath the plate; the slightly oblique truncation of the anterior margins of the produced posterior lips of the transverse groove, which slope posterolaterally from their anteromedian angles; and the different shape of the posteromedian projection of the coxa of the fifth pereiopods, which is usually somewhat rectangular in outline rather than triangular. The third chelipeds are modally somewhat longer than those of *T. similis,* the range beyond the antennal peduncle being from five-sixths of the propodus to one-half the carpus; whereas the usual reach in *T. similis* is little more than the propodus beyond the end of the antennal peduncle.

In 17 specimens, 3 had seven rostral teeth not counting the epigastric; 2 had seven teeth plus an anterior vestige; 7 had eight teeth; 4 nine teeth; 1 ten teeth. The posterior tooth of the rostrum varies in position from behind to before the orbital margin. A vestigial unfilamentose anterior arthrobranch is present on somite XIII, as in all the American species of Division I but not in the Indopacific *Trachypeneus curvirostris* of the same subgenus. The branchial lamella of somite VII is filamentose. The third pleonic somite is dorsally compressed but hardly carinate; the second has two very faint short parallel longitudinal grooves in the middle of its tergum, but the space between them is not carinate. The anteroventral angle of the carapace is not rectangular, the ventral margin sloping downward from the angle, then turning backward.

The differences between the present form and its Atlantic relative, although extremely slight, are sufficient for ready recognition. Since it is improbable that any geographical area containing intermediates between the two forms exists, it seems proper to recognize these slight differences with a name. Whether or not the Atlantic and Pacific components of a congeneric pair should be considered specifically distinct seems a purely academic question, since all grades of differentiation, from no recognizable differences to very extreme ones, occur in the various pairs known to me. In the present case the differences seem to correspond in degree with those generally classed as subspecific.

As has been mentioned in the preceding paper, there is no known Pacific congener of the Atlantic species closely related to *T. similis*, *T. constrictus*. This difference seems correlated with the fact that *T. constrictus* has a more northern and eastern center of distribution than *T. similis*, and appears to be replaced by the latter in the regions of former communication between the American Atlantic and the Pacific. Further records of occurrence of the two Atlantic species are provided by the following catalogue numbers in the Bingham Oceanographic collection: *T. similis* (Smith): *55* and *56*, Siguanea Bay, Isle of Pines, 12 fathoms, April 6, 1925, four females, ["*T. constrictus* (Stimpson)" and "*Penaeopsis goodei* (Smith)," part, of Boone, 1927]; *57*, New Providence, Bahamas, stomach of *Mycteroperca*, March 16, 1925, 1 subadult male ["*Penaeopsis goodei* (Smith)," part, of Boone, 1927]; *58* and *59*, Pensacola Bay, Florida, February and March, 1932, 2 males and eight females, all adult. *T. constrictus* (Stimpson): *87*, off Matanzas Inlet, Florida, 8 to 10 fathoms, April 2, 1934, 1 male and 34 females.

Trachypeneus (Trachysalambria) byrdi,[1] new species

Figure 13, page 54.

3 females, type and cotypes. *B.O.C. 60.* Panama City Market, December 8, 1933.

[1] Named for Mr. Junius Byrd.

Dimensions—Type female, total length about 185 mm; carapace 49 mm. Cotype females, total lengths 115 and 140 mm, carapace 27 and 33 mm.

Description—An unfurcate epipodite is present on the third leg and the second maxillipedes; a furcated one on the first and second legs. Branchial lamella of the seventh somite filamentose; an unfilamentose vestige of an anterior arthrobranch on the thirteenth somite. The basis only of the first and second legs is armed; the third maxillipede also bears a basisal spine. The longitudinal suture of the carapace extends nearly to the posterior margin, far behind the conspicuous transverse suture. The posterior lip of the transverse groove of the thelycum is produced as a pair of free flaps; the median portion of the transverse groove is enlarged to form an unpaired pocket.

The rostrum of the type is broken and regenerating at the level of the fourth tooth. In the smaller cotype, the distal part of the rostrum is lost; the remainder, 19 mm long, extends beyond the tip of the antennular peduncle and bears eight teeth in addition to the epigastric, of which one lies behind the level of the orbital margin. The penultimate tooth lies above the distal third of the second segment of the antennular peduncle; the ultimate tooth, about one-half the size of the penultimate, lies over the middle of the third segment, and is one and one-half times as far from the penultimate as the latter from the antepenultimate. In the larger cotype the rostrum is 26 mm in length; the distal 10.5 mm is unarmed, and projects 7 mm beyond the antennular peduncle. There are seven teeth in addition to the epigastric; the position of the ultimate indicates it to correspond to the penultimate tooth of the preceding specimen.

The rostrum has a sigmoid curve, its base rising to a low crest of which the highest point is at the level of the first tooth in advance of the orbit; its middle portion slopes downward to a point at the level of the base of the second segment of the antennular peduncle, beyond which the distal portion turns strongly upward. The ventral lateral carina of the rostrum, which in other species of section 1 of the subgenus extends distally to beyond the sixth tooth, here fails to reach the fourth tooth, while the sulcus between this carina and the dorsal one is very shallow.

The postrostral carina is blunt but strongly marked to the posterior margin of the carapace; it is slightly flattened behind the epigastric tooth, and shallowly sulcate for a very short space at the point where the cervical sulcus would cross if continued.

The cervical sulcus disappears dorsally before attaining the level of the longitudinal suture. The portion of this sulcus which lies ventral to the hepatic spine is continued backward as a well marked cardiaco-branchial suture margined beneath by an obtuse but conspicuous ridge.

The longitudinal suture is generally bifurcated somewhat in advance of its posterior end; it reaches within two or three millimeters of the posterior margin of the carapace. The transverse suture is rather short but strongly marked; its upper portion is sloped somewhat to posterior of the vertical.

The carapace is finely punctate-pubescent over its entire dully-polished surface, most sparsely so on the posterior part of the branchial region.

The third, fourth, fifth and sixth pleonic somites are sharply carinated in the dorsal midline; each carina, including that of the third somite, ends posteriorly in a conspicuous small tooth. The second somite bears a weak carina on the posterior two-thirds of the tergum. The first somite is very faintly but perceptibly carinate in the dorsal midline; it is separated from the posterior pereionic tergum only by a very shallow sulcus indicating the line of fusion.

The lateral surface of the sixth pleonic somite bears an arched longitudinal ridge bordered above by an ill-defined sulcus. This ridge is raised at an anterior and at one or two posterior points into cicatrices such as are conspicuous in *Penaeus*. The sixth pleonic somite is very sparsely pubescent over its general surface, although two rather densely punctate longitudinal bands exist on each side of the tergum, one just lateral to the middorsal carina, the other further ventrad.

The rather short, regularly acuminated telson bears a dorsal sulcus flanked by a pair of carinae. The ridge lateral to the carina on either side, strongly marked in the other species of the section, is here obsolete. The lateral margins of the telson are completely unarmed.

The antennular flagella are subequal in length, and as long as or somewhat longer than their peduncle. The antennal peduncle extends from a third to two-fifths its length beyond the external scale of the basal segment of the antennular peduncle. The third maxillipedes reach about to the end of the antennal peduncle; their exopod reaches about as far as to the end of the meral joint of the endopod. The exopod of the fifth legs is very small, not over one-fourth the length of the large bladder-like exopods of the anterior legs. The first pleopods of these female specimens have a hardly perceptible vestigial endopod.

The median plate of the thelycum has a convex anterior margin extending free well anterior to its vertical support. The middle and posterior portions of the median plate are depressed. The posterior lip of the transverse groove of the fourteenth sternite is produced as a pair of semicircular flaps which overlap the posterior part of the median plate. The median longitudinal gape between these two flaps is quite short, not reaching more than halfway back to the level of the constrictions marking the bases of the lateral hoods. These constrictions are deeper than in related species. The surface of the thelycum is naked. In the impregnated, large, type female a clear yellow secretion was observed to protrude from the slit, evidently part of a sperm-free mass stored in a median pocket of the thelycum, as in other species of the subgenus.

In one of the characters described above, the presence of a tooth at the posterior end of the middorsal carina of the third pleonic somite, *T. byrdi* differs, so far as I am aware, from all other adult Penaeinae, Eusicyoninae, and Solenocerinae, and parallels certain Aristaeinae. In a second character, the absence of armature on the lateral margins of the telson, *Trachypeneus byrdi* differs from other species of the genus; in this lack it resembles certain species of the related genus *Parapeneopsis*, which are without a telson armature among forms in which it is predominantly present. In at least two characters, viz: the presence of a carina on all pleonic somites including the first, and the occurrence of teeth at the posterior ends of the middorsal carinae of pleonic somites in advance of the sixth, *T. byrdi* differs from the remainder of the subgenus. In spite of these

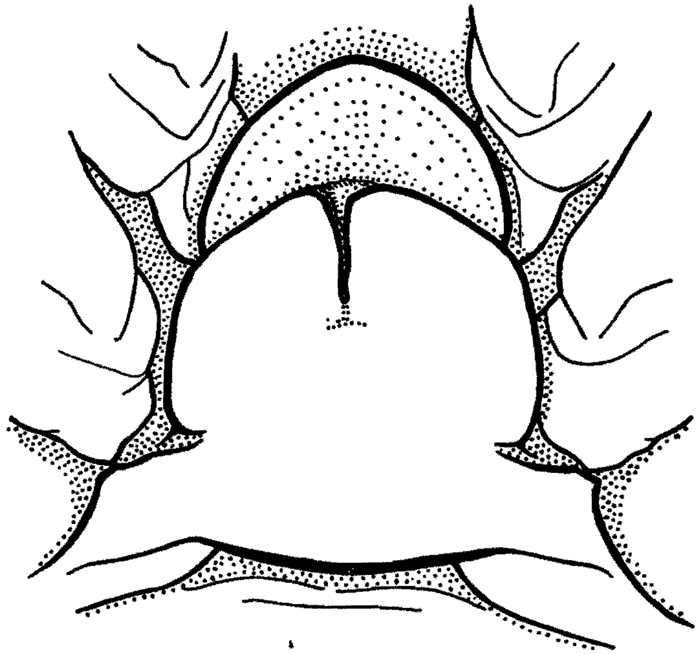


Figure 13. ***Trachypeneus byrdi*, n. sp.** **Thelycum × 5.5.**

divergences, the species seems to be properly a member of section 1 of the subgenus.

From the other two species of section 1, *T. byrdi* differs most conspicuously in addition to the above characters by its elongate sigmoid rostrum with styliform distal half and obsolescent ventral lateral carina; its well-marked cardiaco-branchial ridge; its more extensive longitudinal fissure; the absence of a dense, stout, anteriorly pointing pubescence from the anterodorsal part of its carapace; the obsolete lateral ridge of its telson; its longer antennular flagella; its shorter third maxillipedes; the extreme minuteness of the endopod of the first pleopoda in its females; and its relatively enormous size. Its habitus is that of such a species of *Parapenaeopsis* as *P. sculptilis*.

T. byrdi resembles *T. constrictus* more than it does *T. similis* in the convex anterior margins of median plate and paired flaps of the thelycum, and in the failure of the slit between the flaps to reach as far posterior as the level of the notches of the lateral hoods, as well as in the sparse pubescence of the branchial region of its carapace and sixth pleonic somite. It resembles *T. similis* more than it does *T. constrictus* in the absence of pubescence from the surface of its thelycum; its strong postrostral carina; the conspicuous arched lateral ridge on its sixth pleonic somite; the extension of its antennal peduncle to considerably beyond the external antennular scale; and the degree of reduction of the exopod of its fifth leg.

In the preceding paper I have mentioned that the modern distribution of the two Western Atlantic species of *Trachypeneus* seemed to explain, on the assumption of its continuance from the past, the occurrence of a close congener of *T. similis* in the American Pacific, and the absence therefrom of a congener of *T. constrictus*. The discovery, since that discussion was written, of *T. byrdi*, a species clearly pertaining to the section of the subgenus erected to contain *T. similis* and *T. constrictus*, and somewhat resembling the latter species in the structure of its thelycum, necessitates a reëxamination of this hypothesis.

Upon careful consideration, it appears, first, that *T. byrdi* resembles *T. similis* more than *T. constrictus* in most of the characters distinguishing the latter two, and second, that *T. byrdi*, although more closely related to *T. constrictus* and the two subspecies of *T. similis* than to any others of the genus, is yet so remote from both that it cannot be regarded as forming one element of a bioceanic pair with either. It seems probable that the slight resemblance which the thelycum of *T. byrdi* bears to that of *T. constrictus* is not significant of a nearer relationship to that form than to *T. similis*, and therefore that the hypothesis of a significant correlation between the northeastern present center of distribution of *T. constrictus* and its lack of Pacific congener is not affected by the discovery of the new Pacific member of the section.

SECTION 2, Burkenroad, 1934

Trachypeneus (Trachysalambria) brevisuturae, new species

Figure 14, page 56.

The holotype, a male taken at Acajutla, El Salvador in April, 1866, by Mr. F. H. Bradley, is in the collection of the Zoology Department of the Peabody Museum of Natural History.

Dimensions—Total length 31 mm, carapace 6.5 mm, rostrum 2.9 mm, telson 3.8 mm.

Description—An epipodite is present on the first, second and third legs, and on the second maxillipedes, the anterior and posteriormost being unfurcated. Somite XIII, in addition to the posterior arthrobranch, bears an unfilamentose vestige of an anterior one; the posterior margin of the gill-bearing section of the somite carries a ciliated "hairy lobule," as in various other species of this and related genera. The basis of the first and second legs is armed with a very long and slender spine, while the ischium of the first legs bears a very small one. The longitudinal suture of the carapace is short, not reaching as far posterior as the level of the hepatic spine. The transverse suture is present.

The rostrum does not extend beyond the eye. It is not cristate over the orbit. The base is ascending; the distal portion curves downward to the horizontal. The rostrum is armed above with eight teeth in addition to the epigastric, with a rudimentary ninth tooth near the tip. The posterior rostral tooth is behind the orbital margin.

The orbital angle is produced as a large acute tooth. The postrostral carina is not strong, being only faintly indicated behind the point where the cervical sulcus would cross if continued, about at the posterior two-fifths of the carapace. The cervical sulcus is very faint dorsally, but reaches well above the level of the longitudinal suture. The cardiaco-branchial sulcus is obsolete.

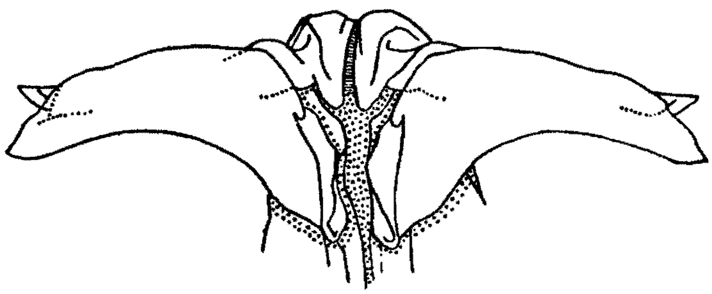


Figure 14. *Trachypeneus brevisuturae*, n. sp.
Petasma, distal portion, distoventral view × 41.5.

The fifth and sixth somites of the pleon and the posterior four-fifths of the fourth are carinated in the dorsal median line. The carina of the sixth somite only ends in a small tooth. The telson has a lateral armature of four pairs of mobile lateral spines, the penultimate pair of which is not set close to the base of the ultimate pair, but well anterior to them. The telson slopes regularly to its tip without narrowing suddenly at or behind the last pair of spines.

The carapace is naked in the branchial region; it is sparsely pubescent dorsally behind the cervical groove, heavily so before it. Patches of the carapace are naked anteroventrally, but from the ventral portion of the cervical sulcus a heavy growth of setae takes rise. The pleon is very sparsely ciliated save for a narrow dorsal band on the fifth and sixth somites.

The third walking legs extend the length of the dactyl beyond the antennal peduncle; the fourth legs to the tip of the peduncle; and the fifth legs beyond the middle of the antennal scale.

The petasma ends distolaterally in short, slender cornua the tips of which are slightly curved to ventral, and somewhat more so to proximal. The elongate gap between the dorsal and ventral walls of the spout-like distolateral projection is in this species shifted to the dorsal margin by the increased length of the overlapping ventral wall. Near the tip of each horn on its dorsal surface is a tooth-like point directed dorsolaterally, so that in apical view of the petasma, the cornua appear bifurcate. This point locks the enlarged ventral flap down over the dorsal wall of the spout.

From the condition of the petasma and of the genital orifices I should consider this specimen to be mature, though perhaps not of maximum size for its sex. Females are no doubt much larger.

Trachypeneus brevisuturae displays a very striking resemblance to the Indopacific species of the subgenus and section, *T. curvirostris* (Stimpson), Kishinouye 1900, De Man, 1907, Schmitt, 1926a, and to *T. asper* as described by Alcock, 1906, and *T. anchoralis* (Bate) of De Man, 1911 (not the *T. anchoralis* female of Bate, which Schmitt's description shows to be a member of the subgenus *Trachypeneus* s. s.), which are regarded by Schmitt as synonymous with *T. curvirostris*. From the Indopacific species *T. brevisuturae* seems to be distinguished by its shorter postrostral carina; uncarinated second and third pleonic somites; more extensive dorsal cervical groove; weaker pubescence of the branchial region of the carapace and of the pleon; larger penultimate lateral spines of the telson which are placed farther anteriorad the bases of the fourth pair; more shortly triangular telson tip; shorter walking legs; quite different petasma, especially by the dorsal point of the distolateral projections; and thirteenth somite with the vestige of an anterior arthrobranch.

From an examination of two males of *T. curvirostris* (Stimpson) from Japan, kindly placed at my disposal by the Zoology Department of the Peabody Museum, it would appear that descriptions of this species require some modification. An ischial spine on the first legs, present in *T. brevisuturae* but not in the species of the American section 1, is, although not described by Kishinouye, Alcock, or De Man, present in the specimens examined by me. A faint dorsal cervical sulcus is perceptible to some distance above the hepatic spine. The vestigial anterior arthrobranch of somite XIII, which is present in the other members of the subgenus *Trachysalambria* (no information as to the occurrence of this structure in the subgenus *Trachypeneus* s. s. being extant), appears to be absent in these two specimens, although their condition precludes absolute certainty. The anteroventral corner of the carapace is, as in other species of the genus, not strictly rectangular, the ventral margin sloping downward from the slightly produced angle before turning backward.

The crude and certainly in large part erroneous description of "*Metapenaeus*" *palaestinensis* Steinitz, 1932, evidently refers to a *Trachypeneus* (*Trachysalambria*) of section 2, and it seems probable that the organism is an Indopacific migrant through the Suez Canal. *Trachypeneus* has not been heretofore been known to have made its way into the Mediterranean. If Steinitz is correct in stating that a rudimentary anterior arthrobranch occurs on the thirteenth somite of his material, and if this structure should prove to be constantly lacking in the Japanese *T. curvirostris*, its presence or absence might serve as a diagnostic difference between Indopacific forms of section 2, believed by Schmitt to pertain to a single species.

PARAPENEOPSIS Alcock

This genus seems to be clearly distinguishable from the second division of *Trachypeneus* (the subgenus *Trachypeneus* s. s.) only by the absence of epipodites from its third pereiopods. It is a peculiar fact that, as in *Trachypeneus*, some of the species of *Parapeneopsis* possess, while some lack, the epipodites of the first and second walking legs. *Parapeneopsis balli*, new species, which constitutes the first American record of the genus, with *P. atlantica* Balss and eight Indopacific forms, two of which are represented in our material, have pereiopodal epipods. Four Indopacific species, one of which is represented in our material, are without epipods behind the second maxillipede. There do not appear to be other differences correlated with the variation in branchial formula, such as in *Trachypeneus* divide the genus into two clearly distinguished groups.

If we should consider the four epipodial formulae displayed within *Parapeneopsis-Trachypeneus*, viz: (120,000)-(123,003), as characterizing homogeneous groups, it is readily evident that no scheme of descent will permit the pairing of the groups without the attribution of some of the resemblances between different groups to independent, converging development. For instance, if 123 (*Trachysalambria*) should be regarded as giving rise to 003 (*Trachypeneus* s. s.) by loss of the first and second epipods, and the latter to 000 (*Parapeneopsis*) by loss of the third; then if 120 (*Parapeneopsis*) is regarded as deriving from the other group which lacks third epipods, 000 (as is implied by the accepted generic grouping), its resemblance to 123 in possessing first and second epipods must represent a convergent reproduction of these structures. There seems to be no strong reason for believing that the presence of the third epipod indicates 003 to be more closely related to 123 than does the presence of the first and second epipods in 120.

The 123 (*Trachysalambria*) group is contrasted in structure of thelycum to the other three groups 003, 000, and 120. Since to regard the latter groups as comprising forms more closely related to one another than to 123, and as representing the three possible changes from a common ancestral formula, would remove the difficulty of choosing between the resemblances in third and in first and second epipodial formulae as a basis for postulating relationships, it is possible that a generic grouping of the species of *Parapeneopsis-Trachypeneus* primarily based upon thelycal structure might be more advantageous than the accepted one primarily based on presence or absence of the third epipod. It may be noted that in the pair of groups 120 and 000 the affinities of various species appear to cross, independently, the boundaries set up by epipodial formula. In the lack of material of the 003 group I am unable to say whether these species display many features in common with 123 not characterizing 000 and 120, or whether they may merge with the 000-120 complex. It may be of significance that 003 and 000 are limited to the Indopacific, where 120 has its greatest development; while 123 has its greatest concentration in America. That the American *Xiphopeneus* seems rather clearly to have been derived from that section of 123 which has Indopacific representatives may perhaps afford evidence that the 123 type of thelycum with median pocket is relatively stable, so that its absence in 003 may indicate a considerable remoteness of that group from 123. The differentiation of *Xiphopeneus* also seems evidence that the center of distribution of 123, although the group includes Indopacific representatives, has for a considerable period been American as opposed to the Indopacific center common to the 003, 000, and 120 groups.

Parapeneopsis sculptilis (Heller)

Parapeneopsis sculptilis, ALCOCK, 1906.
Parapeneopsis sculptilis variety *cultrirostris*, ALCOCK, 1906.
Parapenaeopsis sculptilis, DE MAN, 1924.

5 males, total length 89 to 92 mm; 8 females, total length 88 to 143 mm. *B.O.C. 64*. Georgetown, Penang, February, 1933.

Of the five males, the three larger specimens are of the "variety" *cultrirostris*, with short, depressed rostrum armed to its distal end. The two smaller males possess a long sigmoid rostrum similar to that of females. The actual difference in size between these males is therefore more accurately expressed in terms of carapace excluding the rostrum than in total length, as follows: cultrirostris form, 25.5, 25, and 23.5 mm; female form, 20.5 and 21 mm.

I am unable to find any other differences between the two forms of male than those of rostrum. The depressed rostrum of the cultrirostris form appears to be precisely equivalent to the basal portion of the female type rostrum, and merely to lack its elongate upturned tip. It seems probable, although the material is not sufficient basis for a positive statement, that the cultrirostris form represents neither a variety nor, as also suggested by Alcock, a dimorphic male form, but is simply an adult instar ultimately attained by all males.

The petasma of *P. sculptilis* is of the type characteristic of the **Trachypeneus** series, although it is modified from the simpler petasma found in *Metapenaeus*, *Trachypeneus*, and the American and West African species of *Parapeneopsis*. The distolateral cornua, instead of being open and gutter-like, or loosely roofed over, are sealed into perfect tubes by the fusion of their dorsal and ventral walls. They open, like the fangs of a crotaline snake, only by a minute aperture at their tips. The distomedian lobe of each petasmal endopod is greatly expanded over the condition found in *Trachypeneus* and the other species of *Parapeneopsis* except *P. hardwickii*, and approaches the condition of the hypertrophied, hood-like distomedian flaps of *Metapenaeus*.

The protopodites of the male pleopods, especially the first pair, bear upon the anterolateral margins of their basal thirds a large triangular lobe in addition to the bracket at the base of the petasma.

The antennular flagella are, as described by De Man for his East Indian material, shorter than the peduncle, not longer as stated by Alcock. It may be noted here that the antennular flagella of *Parapeneopsis nana* Alcock, described (1906) as one-third of the peduncle in length, are in the figure shown as two-thirds of it.

In two of the females of the present collection three extremely minute pairs of mobile lateral spines are present on the telson, which is in the other specimens completely unarmed.

The rather remarkable coloration of formalin-preserved material three months after fixation is as follows: On an orange-red ground, (which is intense above and paler ventrolaterally and on the appendages except the posterior part of the uropods), there are arranged saddles of white in such a manner that the shrimp appears to have six broad vertical bands of color. The underlying epidermis contains red chromatophores, but the color seems to reside chiefly in the densely calcareous, almost opaque shell. Mr. Richard Colestock offers the information that the coloration was similar, but more brilliant, in fresh though not living material.

? **Parapeneopsis hardwickii** (Miers)

Figures 15 and 16, page 62.

? *Penaeus hardwickii*, MIERS, 1878.
? *Penaeus sculptilis*, HENDERSON, 1893, part.
? *Parapeneopsis sculptilis* variety *hardwickii*, ALCOCK, 1906.

1 male, 20 females. *B.O.C. 70.* Singapore, Straits Settlements, February, 1933.

4 males, total length 60 to 96 mm; 30 females, total length 85 to 115 mm. *B.O.C. 71.* Port Swettenham, Selangor, February, 1933.

1 female. *B.O.C. 68.* Georgetown, Penang, February, 1933.

In addition to this material, a female from Amoy, China in the collection of the American Museum of Natural History has been available for examination.

The rostrum is sigmoid in shape, extending at least a fourth and usually a third or more of its length beyond the antennular peduncle. The ultimate rostral tooth is placed over the second segment of the antennular peduncle, the ascending distal half or more of the rostrum being unarmed. There are seven or eight teeth in addition to the epigastric, the modal number being eight, of which the first is placed behind the orbital margin. A line connecting the tips of the teeth is hardly cristate over the orbit; the tips of the teeth are very little uptilted, and their posterior dorsal margins almost horizontal. The lateral ridge of the rostrum is usually distinct to well in advance of the ultimate tooth, and is continued posteriorly nearly to the epigastric tooth as a distinct carina paralleling a more dorsal sulcus. In *P. sculptilis*, the rostrum is shorter; more cristate over the orbit; with distinctly uptilted teeth the modal number of which appears to be seven in addition to the epigastric; and with a shorter lateral carina.

The postrostral carina continues nearly to the posterior margin of the carapace. It is sulcate, the sulcus being more broadly open and less constricted between its postepigastric and its cervical expansions than is the case in *P. sculptilis*. The sulci which in *P. sculptilis* run along above and below the cardiaco-branchial ridge are in *P. hardwickii* nearly obsolete, and the ridge is therefore inconspicuous in the latter species. The longitudinal suture usually extends behind, but sometimes ends anterior to the transverse suture. The anteroventral angle of the carapace is somewhat produced but hardly dentiform; the anterior portion of the cervical sulcus ends well behind the margin. The carapace is somewhat tomentose in its anterodorsal region, while the remainder of the carapace and the pleon are finely granulate.

The sulcate crest present on the first to third pleonic terga of *P. sculptilis* is absent from these somites in *P. hardwickii*, although the third is somewhat compressed in its posterior part. The fourth, fifth and sixth somites are sharply carinate, but the small spine in which these segments end in *P. sculptilis* occurs in the present species only on the sixth. The telson bears from three to five, usually four, pairs of mobile lateral spines. These spines, although not conspicuous, are much larger than those occasionally present in *P. sculptilis*. The apical pair is the largest; the penultimate and antepenultimate pairs smaller and subequal; the anteriormost pair, set considerably proximad the others, smallest.

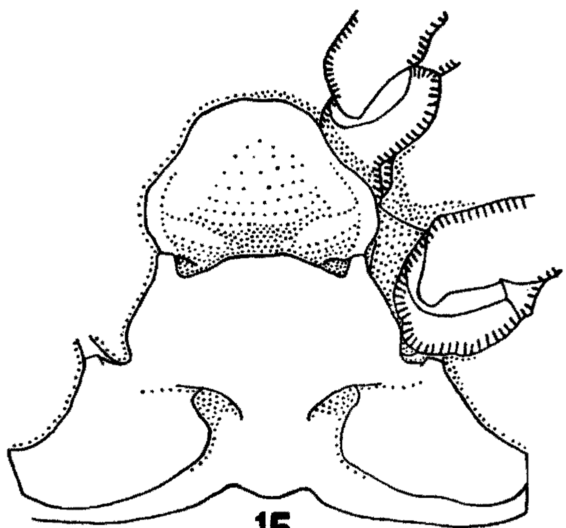
The antennular flagella are somewhat longer than their peduncle. The antennal peduncle is slender, and never extends as far as to the end of the eye; whereas in *P. sculptilis* the structure is stouter and extends well beyond the eye.

The basis of the first and second legs is armed with spines considerably longer and slenderer than are those of *P. sculptilis*. The ischium of the first legs and the basis of the third are, as in the related form, unarmed. The uropods extend about one-sixth of the telson length beyond the telson and are thus comparatively longer than are those of *P. sculptilis*.

The petasma is much like that of *P. sculptilis*, but the distomedian lobes, instead of extending wing-like in a distolateral direction beyond the lateral cornua, are considerable smaller and shorter. The lateral margins of the petasma rise straight to the cornua instead of being considerably constricted just below them as in *P. sculptilis;* the cornua are elongate and their tips are directed laterally, not twisted to point lateroventrally. There is a clump of setae on the sternum of the male of *P. hardwickii* just behind the coxal projection of the fifth leg which is absent in *P. sculptilis*.

The lateral hoods of the thelycum of this, as of most other species of *Para-*

peneopsis, are very considerably reduced. The transverse groove is represented only by two very short lateral sections enclosed between the lateral hoods and the median plate. The minute pair of sperm receptacles here formed have ventral entrances by notches bounded anteriorly and medially by the median plate; and posteriorly and laterally by the lateral hoods. The exit from each cavity is a narrow gap between the dorsolateral margin of the median plate and the anteromedian margin of the lateral hood, which embraces the median plate. The chief difference between the thelycum of *P. hardwickii* and that of



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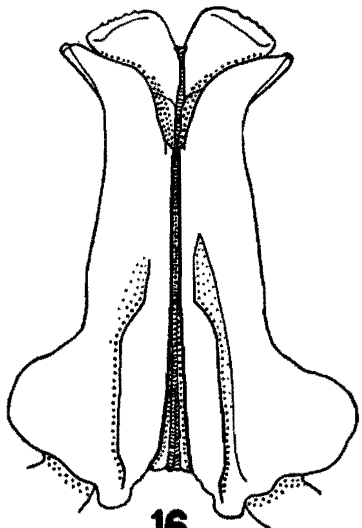

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Figure 15. *Parapeneopsis hardwickii* (Miers). Thelycum, × 8.

Figure 16. *Parapeneopsis hardwickii* (Miers). Petasma, ventral view × 8.

P. sculptilis lies in the much less extensive entrance notches of the former species, the bridge between the median plate of XIII and the sternite posterior to it being along a surface over half as broad as the median plate itself, while in *P. sculptilis* the notches (the median ends of either half of the transverse groove) extend far in toward the median line and the union between the median plate and posterior sternal surface occurs across a much narrower neck. There is a further conspicuous difference between the two species in the shape of the lateral margin of the lateral hoods of XIV, which are in *P. sculptilis* much more deeply indented behind their point of contact with the median plate.

The sperm cavities are astoundingly minute, having capacities of much less than a cubic millimeter in mature females. The small quantity of sperm, relative to other peneids, which can be stored in these receptacles, must therefore be utilized in *Parapeneopsis* with a very great relative efficiency; or the quantity of eggs to be fertilized by a single impregnation must be small. The extremely specialized injection apparatus of the male is evidently correlated with the minuteness of the female receptacles. Dissection of the male reveals that, as in *Trachypeneus* and *Xiphopeneus*, but not in *Metapenaeus*, *Penaeus*, *Parapenaus*, *Penaeopsis* and *Eusicyonia*, the sperm are packed in numerous minute ellipsoidal membraneous sacs. In the present species there are not more than thirty or forty spermatozoa in each of the minute spermatophores, loosely packed without orderly arrangement. The spermatophores in the lower end of the vas deferens are mixed with a rather abundant matrix of minute refracting granules; in the cavities of the thelycum following transfer, the walls of the spermatophore seem to disintegrate, and the sperm to lie embedded in the compacted matrix. The sperm are elongate, with a tapering, cylindrical refracting appendage at one end and a refracting disc at the other. They thus resemble the spermatozoa of *Xiphopeneus*.

In impregnated females the entrance notches are filled with a gummy yellowish material which is copiously spread over the adjacent hollows of the median plate. In some species of *Parapeneopsis* (notably in *P. atlantica* Balss, where the margins of sternites XIV and XIII are raised chalice-like to hold the mass) the sperm-free male secretion smeared over the surface of the thelycum becomes enormous in quantity. The thelycum of *Parapeneopsis* seems to derive from a less simplified form such as is found in the first subgenus of *Trachypeneus*, in which this secretion is stored in a special median cavity of the transverse groove and may be necessary to seal the relatively very wide entrances to the sperm receptacle. The mass in *Parapeneopsis*, aside from the small quantity which actually seals the narrow entrances to the cavities, appears functionless.

The coloration of *P. hardwickii* is quite different from that of specimens of *P. sculptilis* preserved under the same conditions. The entire animal is suffused with pale pinkish-orange, stronger at certain points than at others, but in no way gathered into bands. There is a sprinkling of blue chromatophores on the pleon, posterior and anterior margins of the carapace, and especially on the rostrum; such blue pigment is almost lacking in *P. sculptilis*. The postrostral carina is a vivid orange-brown, a tint not found in the corresponding region of *P. sculptilis*.

The specimens described above under the name *? P. hardwickii* are certainly distinct from *P. sculptilis*, and are quite different from any other known species of *Parapeneopsis* except the form described by Miers. There are some differences between Miers' description and the above, and it was at first intended to accept Alcock's statement that *Penaeus hardwickii* Miers is merely a variety of *P. sculptilis*, describing the present material as a distinct species under the name *Parapeneopsis colestocki*. However, the discrepancies, to be mentioned below, do not seem sufficient to warrant such procedure.

Both Miers and Alcock mention the telson of *P. hardwickii* as unarmed, a statement not applying to the present species, and especially curious in view of the fact that Alcock had apparently discovered the rare and much more minute lateral spines of *P. sculptilis*. Miers' description of *P. hardwickii* is perfectly applicable to the present species in other characters, except that the antennular flagella are figured as shorter than the peduncle, a distinguishing characteristic of *P. sculptilis*. Alcock, in controversion of his text, figures the antennular flagella of his *P. sculptilis* as shorter than the peduncle; and in consideration of his statement as to telson armature it seems possible that the text may in part have been derived from specimens of the present species. I am unable to discover any similarity in the female genital sternites of the present specimens, as contrasted with *P. sculptilis*, to Alcock's description of the thelycum of *P. hardwickii* as like a "vertical section of a mushroom." Henderson, 1893, seems to have confused the present species with the true *P. sculptilis*, and other records of the latter may be doubtful in part or whole.

From the related *Parapeneopsis uncta* Alcock the present species appears clearly distinguished by the lack in the former of a spine on the basis of its second chelipeds and of a lateral telson armature; the absence in ventral view of distomedian lobes from its petasma; its shorter antennular flagella and longer uropods; its shorter rostrum; its more strongly defined cardiaco-branchial sulcus, and its less tomentose carapace.

Parapeneopsis balli,[1] new species

Figure 17, page 65.

Two males, the type and cotype, were taken at Acajutla, El Salvádor, in April, 1866, by Mr. F. H. Bradley. The type is contained in the collection of the Zoology Department of the Peabody Museum of Natural History; while the cotype has been deposited in the American Museum of Natural History.

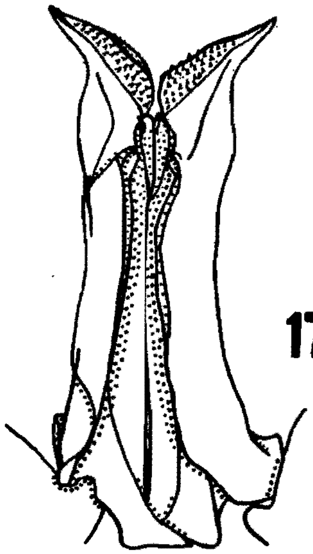
Dimensions—Type, total length about 37 mm, carapace 7.8 mm, rostrum 3.8 mm, telson 4.4 mm (tip broken). Cotype, total length about 21.7 mm, carapace 4.8 mm, rostrum 1.9 mm, telson 3 mm.

Description—An epipodite is present on the first and second legs and on the second maxillipedes. Somite XIII lacks any vestige of an anterior arthrobranch; a ciliated "hairy lobule" is present on the posterior margin of the somite. Longitudinal and transverse sutures are present, the former extending somewhat behind the middle of the carapace, but not to the level of the transverse suture.

The rostrum of the type reaches to the basal one-fifth of the second segment of the antennular peduncle. It is directed upward at the base, the upper margin rising into a crest highest just beyond the orbital margin. The tip is horizontal. The blade narrows considerably distal to the third tooth. The armature consists of six teeth in addition to the epigastric, of which the most proximal is behind the orbital margin. The ultimate tooth is as far from the tip as from the penultimate tooth, and one and one-half times as far from the latter as the latter from the antepenultimate.

[1] Named for Dr. Stanley Crittenden Ball.

The orbital angle is small but dentiform; the anteroinferior angle of the carapace rounded. The postrostral carina extends as an obtuse but not sulcate ridge to the posterior one-fourth of the carapace. The dorsal cervical sulcus reaches about as far dorsad as the longitudinal suture; it ascends very obliquely, roughly paralleling the anterior part of the cardiaco-branchial ridge. The anterior cervical sulcus (which is continued behind the hepatic spine as the cardiaco-branchial sulcus) does not reach nearly to the anterior margin of the carapace. It is not sigmoid, and is directed forward rather than ventrad.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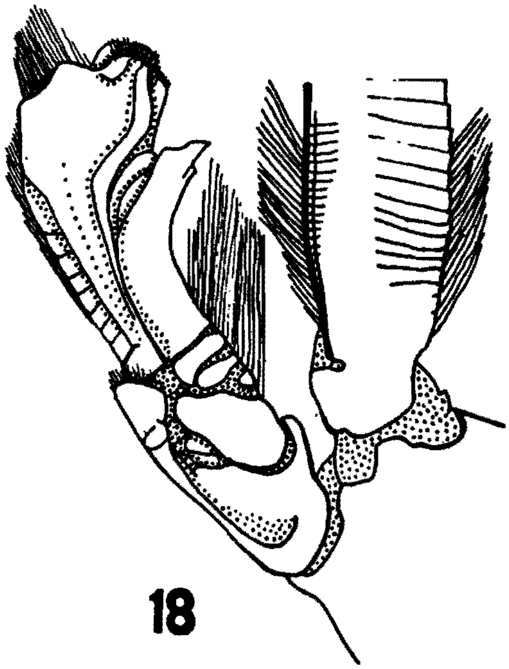
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Figure 17. *Parapeneopsis balli*, n. sp.
Petasma, ventral view × 18.2.
Figure 18. *Parapeneopsis hungerfordi* Alcock.
Second pleopod of male, showing appendix masculina and modified endopod, posterolateral view × 12.

The third pleonic somite bears a blunt trace of a middorsal crest on its posterior part; the fourth, fifth and sixth somites are carinate, the carina of the fifth and sixth being sulcate, and ending posteriorly in a blunt tooth. The extreme tip of the telson is broken; to this point no trace of a lateral armature is perceptible.

The entire carapace is punctate-pubescent, although very weakly so in the branchial region; the pubescence is especially strong in the anteroventral area.

The third walking legs reach to the basal half of the antennal peduncle; the fourth fall short of this point; the fifth fall somewhat short of the end of the antennal scale. All the legs are completely unarmed. The outer antennular flagella are about one-fourth shorter than the inner; the inner are about one-fifth their length longer than the antennular peduncle and the same amount shorter than the carapace.

The petasma possesses very small basolateral wing-like lobules. The lateral cornua are short and are directed laterodistally, somewhat as in the figure of *P. uncta* Alcock, 1906. The distomedian lobes, however, are directed ventrally somewhat like those of *P. atlantica* Balss, 1925, being neither greatly expanded and lapping the lateral cornua as in the Indopacific *P. sculptilis* (Heller) and *P. hardwickii* (Miers) nor absent as in the figures of *P. stylifera* (H. Milne Edwards) Alcock, 1906, *P. cornuta* (Kishinouye), 1900, *P. maxillipedo* Alcock, *P. gracillima* Nobili (De Man, 1924), and *P. nana* Alcock, nor directed dorsally as they appear in the figure of *P. uncta* Alcock. The distal margins of the cornua are scabrous and spinose. The ventral margins of these spout-like projections overlap the dorsal ones, the channels being thus loosely roofed over. The type appears to be mature.

The immature cotype male has a shorter rostrum which does not extend beyond the basal segment of the antennular peduncle, and is less cristate in advance of the orbital margin than in the type. There are five teeth in addition to the epigastric, and a further rudimentary one near the tip. The telson bears three pairs of very minute and closely crowded mobile lateral spines near the tip. Behind the ultimate spines the telson narrows very sharply to a short and slender point.

The outer antennular flagella of the cotype are little more than one-half the inner; the inner are as long as the peduncle, about two-thirds as long as the carapace. The third legs extend beyond the middle of the antennal peduncle, the fourth pair beyond the peduncle, while the fifth fall well short of the end of the antennal scale.

Parapeneopsis balli shows no striking relationship to any Indopacific species. It is quite distinct from the Eastern Atlantic *P. atlantica* Balss, especially in its more sparingly toothed and not styliform rostrum; definite postrostral carina; anterior cervical sulcus not sigmoid and directed anteriorad rather than ventrad; more minute and distally concentrated telson spinules; walking legs unarmed at base; and very different petasma which, however, in the structure of its distomedian lobes and in the fact that the anterior and posterior walls of the lateral cornua are not soldered together to form a perfect tube, seems nearer to that of *P. atlantica* than to the Indopacific species as far as these are known to me.

It may be noted that the longitudinal suture of *P. atlantica* does not extend nearly to the posterior margin of the carapace as figured and described by Balss, 1925, and stated for the male by Schmitt, 1926b, in any of the material in the collection of the American Museum of Natural History; in which the fissure reaches no farther than to somewhat behind the middle of the carapace. It may also be noted that Balss, although declared by Schmitt to describe basisal spines as present on the first legs only, correctly mentions them as "auf den ersten beiden pereiopodenpaaren."

Parapeneopsis balli is distinguishable from all the species in which epipodites are present on the first two walking legs except *P. gracillima* Nobili by its complete lack of basisal armature on the chelipeds, as well as by other characters. It is readily separated from *P. gracillima* by the fact that the latter lacks an epigastric tooth, has longer antennular flagella, and has longer, slenderer lateral cornua of the petasma, which appears to lack distomedian lobes.

It seems possible that *Penaeus pubescens* Stimpson is the Atlantic American congener of *Parapeneopsis balli.* If Stimpson's description is correct the two forms appear to be distinct in many features. *Parapeneopsis balli* is the first recognized member of the genus to be taken in American waters.

Parapeneopsis hungerfordi Alcock

Figures 18, page 65; 19 and 20, page 69.

Parapeneopsis hungerfordi, ALCOCK, 1905.

4 males, maximum total length, 120 mm. *B.O.C. 65.* Singapore, Straits Settlements, February, 1933.

3 males, maximum total length 88 mm; 10 females, maximum total length 120 mm. *B.O.C. 67.* Port Swettenham, Selangor, February, 1933.

3 males, total lengths 65 to 77 mm; 14 females, total lengths 74 to 94 mm. *B.O.C. 66.* Georgetown, Penang, February, 1933.

The present material, taken far from the type locality, agrees fairly well with Alcock's brief and rather general diagnosis of three specimens, the only heretofore known, from Hong Kong. It is a remarkable circumstance that abundant material of this and of *P. hardwickii,* neither reported since Alcock, 1906, should have been obtained remote from previous records in the commercial catch of a relatively well known area.

Parapeneopsis hungerfordi, unlike the three species of the genus described above, lacks epipodites behind the second maxillipedes, and with *P. tenellus* (Ortmann), *P. acclivirostris* Alcock, and *P. venusta* De Man, has been mentioned in a preceding paragraph as the 000 group.

The female rostrum is shorter than in *P. sculptilis,* extending very little, not over one-eighth of its length, beyond the antennular peduncle. Its basal, armed portion is less depressed than in *P. sculptilis;* the distal portion, which is unarmed for no more than one-third, usually one-fourth, of the rostral length, is slightly ascending beyond the penultimate tooth. There is a small but conspicuous epigastric tooth. The rostral teeth are well spaced; the distalmost not much separated from the penultimate. The tips of the teeth, particularly the posterior ones, are not much uptilted. The rostrum is hardly cristate over the orbital margin. The number of teeth varies from six to eight in addition to the epigastric, the modal number being seven. The rostrum of the male is slightly shorter than that of the female, but not as short as in Alcock's specimen in any of my material; the distal portion is somewhat less upcurved than in the female.

The postrostral carina, which reaches almost to the posterior margin, is sulcate, but the sulcus is not strongly constricted in its midsection. The antero-inferior angle of the carapace is almost as acute as that of *P. sculptilis*. The anterior portion of the cervical sulcus does not reach the margin. The cardiaco-branchial sulcus is fairly well marked; the sulcus ventral to the cardiaco-branchial carina almost obsolete. The longitudinal fissure extends to somewhat behind the level of the transverse.

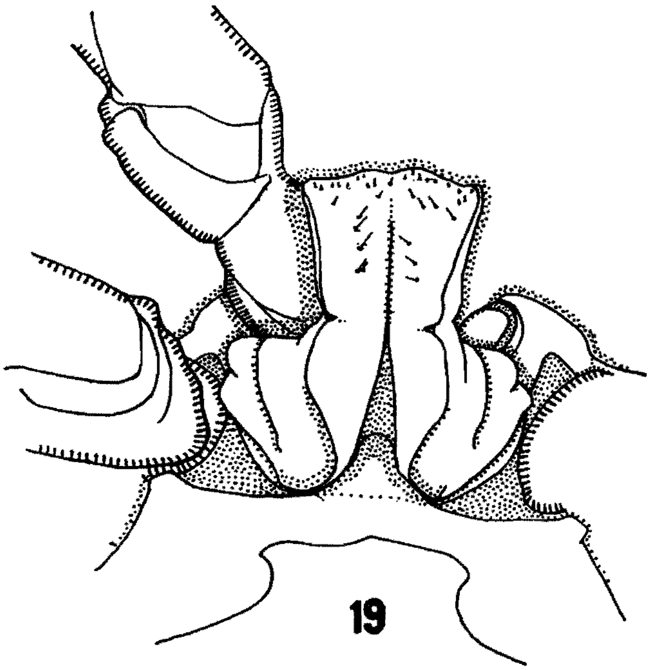
There is a faint longitudinal depression in the dorsal midline of the anterior part of the first pleonic somite, a very faint compression of the posterior part of the second, and a slight compression of the third; the fourth, fifth and sixth are sharply carinate, but only the sixth ends posteriorly in a spine. The telson is completely unarmed. The surface of carapace and pleon is punctate.

The antennular flagella are hardly more than one-half the length of the peduncle in the female, slightly longer in the male. The antennal peduncle is much shorter than in *P. sculptilis*, not reaching the middle of the eye. There are strong elongate basisal spines on the first and second legs. The first pleopod of the female has a minute endopod, which is larger than the barely discernible rudiment found in *P. sculptilis* or in *P. atlantica* Balss.

The petasma is of a striking and peculiar form. The distomedian lobes, as in all species of *Parapeneopsis* except *P. sculptilis* and *P. hardwickii*, are greatly reduced, and form a pair of hardly perceptible lobules on either side of the point where the cincinnulate median margins of the endopods terminate. The distolateral lobes, instead of being the usual laterally directed hornlike appendages, are semirectangular and are directed straight distad, their median margins nearly in contact. They are greatly enlarged, being nearly three quarters as long as the body of the petasma. At the laterodistal corners of these highly modified cornua there is a fleshy tooth directed mediodistad. Dorsad and mediad this tooth is a fleshy lobule. The lateral bracket-like projections at the proximal ends of the petasmal endopods have, as in Alcock's words, "the free edge deeply notched."

The first pleopods of the male lack the basal anterolateral projections found in *P. sculptilis* and *P. hardwickii*. The appendix masculina of the male second pleopods is quite similar to this structure in *P. sculptilis*, but the endopod has been converted into a stiff, ridged, spatulate blade, its flagelliform character being completely lost.

The thelycum is modified from the form typical of *Parapeneopsis* by the almost complete obliteration of the usually extensive sternal area behind the juncture of the median plate and the lateral hoods. This obliteration has been accomplished by the displacement of the median ends of the transverse groove to a posterior position. The median plate, which is longitudinally depressed in the midline, thus extends far back, almost to the level of the posterior margins of the fifth legs. Between the fifth legs it is greatly expanded, having the form of a low plate extending so far laterad as to almost cover the narrow sternal ridges which form the posterior parts of the lateral hoods. The anterior expanded parts of the lateral hoods extend forward from beneath the outer anterior margins of the expanded parts of the median plate. The exits of the minute sperm-receptacle cavities are on the inner margins of the anterior parts of the lateral hoods, in the gap between these and the narrower anterior part



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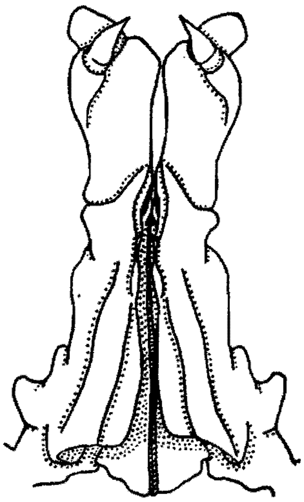

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Figure 19. *Parapeneopsis hungerfordi* Alcock. Thelycum × 8.

Figure 20. *Parapeneopsis hungerfordi* Alcock. Petasma, ventral view ×8.

of the median plate. The entrances appear to lie just behind the median plate on either side of its triangular depressed part. The receptacles are thus very much elongated, but their lumens are extraordinarily narrow posteriorly, expanding beneath the broadened anterior parts of the lateral hoods. The appearance of the thelycum is somewhat variable with individual, and considerably so with size. In the younger females, by contrast with the large figured specimen, the thelycum has a median plate with more sloping and unsinuous anterior margin; shorter, broader median depression, and less distinctly delimited lateral expansions.

The elongate spermatozoa, somewhat like those of *P. hardwickii*, are in the vas deferens of the male found enclosed, from one to two hundred per packet, in minute, resistant, bean-shaped sacs. The posterior pointed ends of the sperm cells are all directed toward a point which would correspond to the hilum of a bean. Mixed with the spermatophores are long, curved, doubly clavate rods of a clear refracting substance, which evidently correspond to the minute refracting granules in *P. hardwickii*.

In formalin preserved material there is a conspicuous transverse band of orange coloration on the posterior part of the tergum of each pleonic somite.

P. hungerfordi is readily distinguished from other species which lack epipodites on the first and second legs, as follows: From *P. tenellus* and *P. acclivirostris* by the absence in these of an epigastric tooth and a postrostral carina, and the occurrence in them of a more typical thelycum. The petasma of *P. tenellus* seems to be of a quite usual form characteristic of a number of species with epipods on the first and second legs, *P. stylifera* (H. Milne Edwards), *P. cornuta* (Kishinouye) *P. maxillipedo* Alcock, *P. gracillima* Nobili, and *P. nana* Alcock. From *P. venusta* De Man, *P. hungerfordi* is distinguished by the absence in the former species of a postrostral carina and a basisal spine on the second leg, the presence of a lateral telson armature, and of a thelycum of normal type.

A considerable number of the characters described above, especially the lack of any clear carination on the anterior three pleonic terga and the conspicuous modification of the endopod of the second pleopods of the male are difficult to reconcile with Alcock's statement that in other respects than its different branchial formula, the more rectangular anteroinferior angles of its carapace, its shorter antennular flagella and its different thelycum and petasma, *P. hungerfordi* resembles *P. sculptilis*. Alcock's brief description of thelycum and petasma are with some manipulation of the terms applicable to the present form, but it is within possibility that they apply to a related but distinct species. Therefore, although the probability that the specimens described above are identical with the Chinese material examined by Alcock is sufficiently strong so that they have been attributed to *P. hungerfordi*, attention may be called to their possible distinctness.

EUSICYONINAE Burkenroad, 1934

EUSICYONIA Stebbing

Prior to the present studies about twenty-two or -three species and varieties of *Eusicyonia* were known, thirteen from the Indopacific, one from the Eastern Atlantic and Mediterranean, five from the American Atlantic, and three from the American Pacific. In the preceding paper (Burkenroad, 1934), the distinctness of the stillborn American Atlantic *E. stimpsoni* (Bouvier) from *E. dorsalis* (Kingsley) has been demonstrated. The present paper adds another undescribed species, *E. parri*, to the fauna of the American Atlantic, and removes one previously accepted form, *E. carinata americana* (De Man), to the synonymy of *E. laevigata* (Stimpson). Six species are added to the American

Pacific fauna, of which two are identical with Atlantic species, while four are new.

The Eusicyoninae are an extremely uniform monogeneric assemblage. No means of subdividing the genus has heretofore been suggested, and it is perhaps for this reason as well as because full advantage has not been taken of the excellent specific characters available, that some confusion of the species has existed.

The genus *Eusicyonia* is divisible into two superspecific groups, which center about *E. carinata* (Olivi) and *E. edwardsi* (Miers) respectively, as follows:

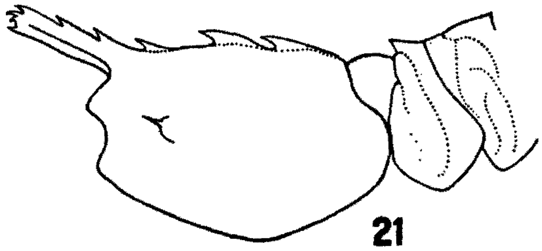
DIVISION I. Antennal angle unarmed. Dorsal carina of the second pleonic somite notched dorsad the junction of the transverse sulci. Dorsal carina of the fifth pleonic somite not ending posteriorly in a tooth or sharp angle. Basis and ischium of the first chelipeds armed with a spine. Species examined: *E. laevigata* (Stimpson), Atlantic and Pacific America; *E. parri*, n. sp., Atlantic America; *E. disparri*, n. sp., Pacific America; *E. carinata* (Olivi), Mediterranean and Eastern Atlantic; *E. ocellata* (Stimpson), Indopacific.

In the above species of Division I, which may be termed the **carinata** group, there are only two or, barely, three carapacic teeth behind the level of the hepatic spine; the posteromedian sulcus of the second and third pleonic somites turns anteriorly at its dorsal end and is margined above by a longitudinal ridge; and the petasma displays a deep notch in its lateral margins.

It appears that all or almost all of the known Indopacific species of the genus are also to be considered as members of Division I, although available descriptions and figures are to a considerable extent insufficient for final determination of this point. *E. rectirostris* (De Man), *E. parvula* (De Haan), *E. ocellata* (Stimpson), *E. laevis* (Bate), *E. curvirostris* (Balss), and *E. bispinosa* (De Haan) appear to be more or less typical members of the **carinata** group. Records of *E. carinata* (Olivi) from the Indopacific in all probability refer to related but not identical species.

On the other hand, *E. cristata* (De Haan), *E. furcata* (Miers), *E. japonicus* (Balss), and *E. lancifer* (Olivier), although they appear to pertain to the Division in diagnostic characters, diverge from its more typical members by the occurrence of three or more postrostral teeth behind the level of the hepatic spine. *E. furcata* seems somewhat to resemble *E. ocellata*, and like it has longitudinal ridges parallelling the anteriorly turned dorsal ends of the posteromedian pleural sulci. It may be noted that in specimens of *E. ocellata* available to me, the petasma lacks clearly cut lateral notches. *E. cristata*, *E. japonicus*, and *E. lancifer* seem to be nearly related forms and to lack, as far as information is available, the longitudinal pleonic ridges and petasmal notch.

The longitudinal pleonic pleural ridge does not occur in all members of the first Division, and very slight indications of a similar ridge are borne by *E. affinis* (Faxon) and *E. aliaffinis*, n. sp., of the second Division. The petasmal notches seem to occur only in Division I, although they are not there of universal occurrence. The various numbers of postrostral teeth occurring behind the hepatic spine in the first Division are in part overlapped by tooth ratios occurring in the second, but it may be of some significance that no members of Division II with three or more teeth constantly behind the level of the hepatic spine are known, whereas conversely, no known members of Division I [with the possible exception of *E. benthophila* (De Man), the affinities of which are doubtful] have fewer than two teeth behind the level of the hepatic spine. Of the char-



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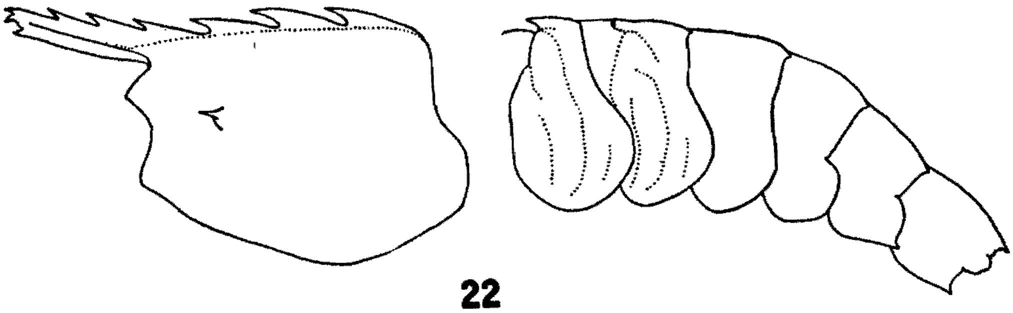

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Figure 21. ***Eusicyonia laevigata*** **(Stimpson).**
Carapace and anterior portion of pleon of Puerto Rican female, lateral view × 4.4.

Figure 22. ***Eusicyonia parri*, n. sp.**
Carapace and pleon, lateral view × 4.4.

acters given rank as diagnostic of the first Division as a whole, a very broad, shallow and inconspicuous emargination of the second pleonic carina occurs in *E. affinis*, *E. aliaffinis* and *E. edwardsi* (Miers) of the second Division. In *E. trispinosa* (De Man), a species certainly very closely related to *E. carinata* in other characters (although with three postrostral teeth behind the hepatic spine), and even displaying the petasmal notch, there seems to be no incision in the dorsal carina of the second pleonic somite; the same may be remarked of *E. fallax* (De Man). *E. benthophila* (De Man) bears a considerable resemblance to *E. affinis* (Faxon) [rather than, as De Man has it, to *E. picta* (Faxon)], and indeed might be a typical member of that group were its first chelipeds not reported to be armed on basis and ischium. The lack of a true, buttressed, tooth at the acute antennal angle of *E. benthophila*, another carinata-like character, may be merely an attribute of immaturity, since the buttress is ill-marked in juveniles of the second Division.

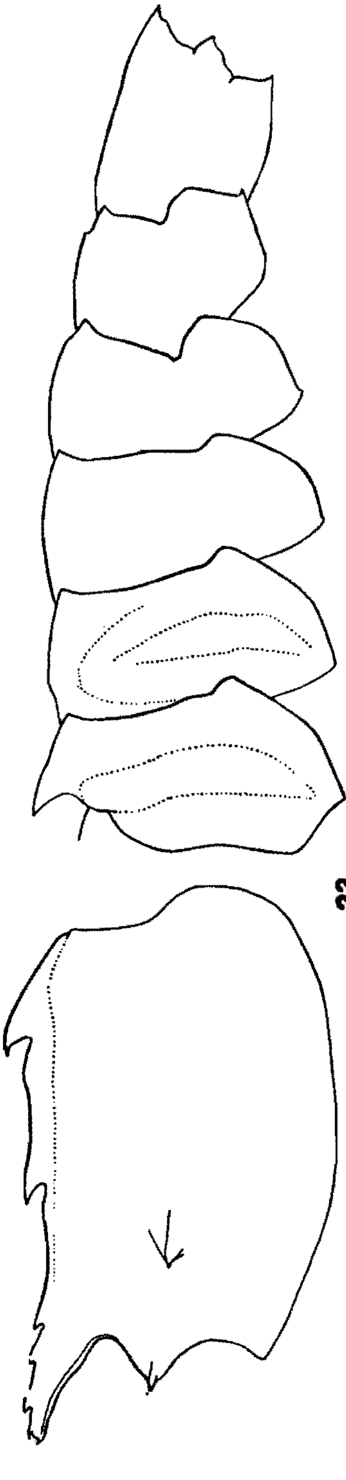
DIVISION II. Antennal angle armed with a buttressed spine. Dorsal carina of the second pleonic somite not incised. Dorsal carina of the fifth pleonic somite ending posteriorly in a tooth or sharp angle. Basis and ischium of the first chelipeds unarmed. Lateral margins of the petasma not sharply notched. Posteromedian pleural sulci not contributing dorsally to the formation of a conspicuous longitudinal marking. Species chiefly or completely limited to America.

1. **brevirostris** group. Postrostral carina with three or four teeth behind the orbital margin, of which three are large and placed far behind the orbit. *P. brevirostris*, (Stimpson), Atlantic and Pacific America.

2. **edwardsi** group. Postrostral carina with two or three teeth behind the orbital margin, of which two are large and placed far behind the orbit. *E. edwardsi* (Miers), Atlantic America; *E. disedwardsi*, n. sp., Pacific America; *E. penicillata* (Lockington), Pacific America.

3. **affinis** group. Postrostral carina with two teeth behind the orbital margin, of which one is large and placed behind the level of the hepatic spine. *E. affinis* (Faxon), Pacific America; *E. aliaffinis*, n. sp., Pacific America; *E. stimpsoni* (Bouvier), Atlantic America; *E. picta* (Faxon), Pacific America; *E. dorsalis* (Kingsley), Atlantic America; *E. disdorsalis*, n. sp., Pacific America. As has been previously mentioned, the Indopacific *E. benthophila* closely resembles *E. affinis*, so far as information is available, and may in its divergencies actually represent a point of intergradation of the first and second Divisions.

An account of the morphology and development of Eusicyoninae bearing on their relationship to other Penaeidae, with a considerable revision of the views previously current, has been given in the preceding paper (Burkenroad, 1934). The characteristics of the subfamily which are important in the evaluation of its species may be discussed as follows: The range of adult size within a species of the genus is much greater than in other Penaeidae. Sexual maturity may be attained at a size so much less than the maximum, and immature individuals are relatively so rare that a rapid maturation and a very extended adult life seem implied. I have observed impregnated females of *E. disdorsalis* over the enormous range in carapace length of 6.1 to 17.6 mm, and males with united copulatory endopods from 5.5 to 13 mm. Differences between small and large individuals of any species are slight and chiefly affect the rostral length, elevation, and distal armature, these features in general becoming respectively shorter, more horizontal, and with more numerous distal teeth as size increases; and the armature of the pleonic pleura, which generally increases in strength and extent with growth. The male and female genital sternites often change slightly with increasing size; and the relative positions of the postrostral teeth of the carapace may change to a very small extent. The petasma, after union of its halves, and the pleonic sculpture, seem to be astonishingly constant.



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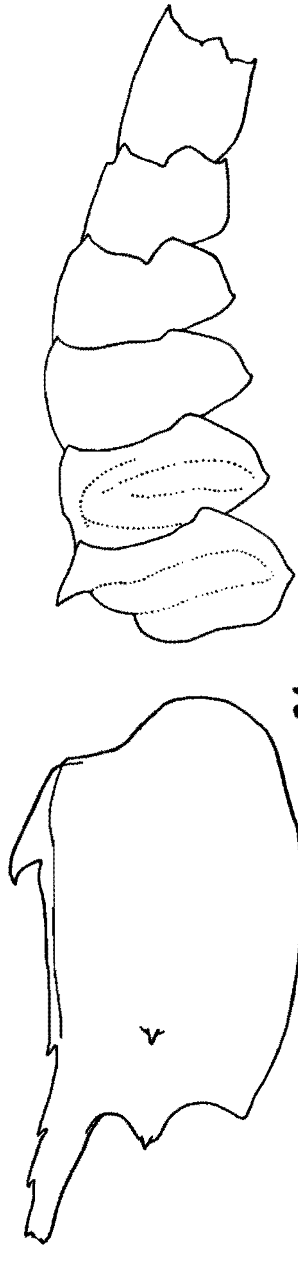

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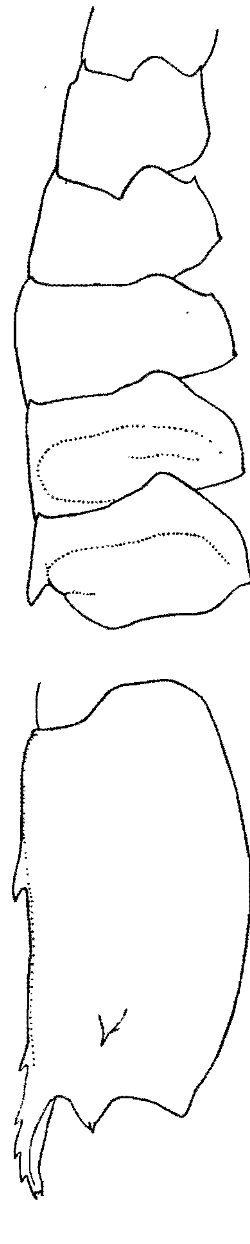

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The range of interspecific variation within the genus in any set of structures—as for example, in the number of postrostral teeth—is not very great, but the various possible recombinations of the different sets of characters are sufficient to provide quite clearcut diagnostic distinctions between a considerable number of species. It is very probable that future studies will provide species to fill certain unoccupied niches left by possible recombinations within the known range of variation of the genus.

The postrostral armature, as well as the rostrum, is subject to some individual, intraspecific, variation, and although providing characters of great value in separating superspecific groups, is not as serviceable for specific differentiation unless the range of variation can be fixed.

The thelycum and the corresponding male genital sternites, less varied than among other penaeid groups, sometimes supply diagnostic features; the thelycum chiefly by the outline of the posterior margin of the thirteenth sternite, which forms the anterior lip of the transverse groove; the male genital area chiefly by the shape of the transverse elevation lying just anterior to the suture between the thirteenth and fourteenth sternites. The length and outline of the large spine of the thirteenth sternite are too insusceptible of exact description and with too limited a range of variation over the genus and too high a rate of individual variability, to be of very considerable service.

The pleonic pleural armature of *Eusicyonia* is subject to considerable intraspecific variation, chiefly with age, but when the range of this variation or its size-correlation can be determined, is taxonomically useful. The armature always consists of a posteriorly directed tooth or acute angle at the posterior ventral margin of the pleura of the sixth pleonic somite; this may be increased by the addition of POSTERIOR VENTRAL spines or angles on somites anterior to the sixth. The increase always occurs from behind forward both ontogenetically and between species, so that the segments posterior to any which bear a posterior ventral spine will be armed. The armature of the pleon may be further increased by the appearance of spines or angles on the anterior surfaces of the pleural ventral margins, these ANTERIOR VENTRAL spines chiefly occurring on the somites anterior to those bearing posterior ventral spines, although the two series often overlap in the middle of the pleon. An additional armature may appear posterodorsal to the posterior ventral spines. The pleural armature is increased in direct correlation with increase in size of the individual. A rounded angle usually precedes an unarmed but acute angle, and this a veritable tooth, in the course of individual development.

Figure 23. *Eusicyonia disedwardsi*, n. sp.
Carapace and pleon, lateral view × 3.7.

Figure 24. *Eusicyonia aliaffinis*, n. sp.
Carapace and pleon, lateral view × 3.7.

Figure 25. *Eusicyonia disdorsalis*, n. sp.
Carapace and pleon, lateral view × 3.7.

The transverse sulci of the pleon, which have not heretofore been employed with any precision, provide extremely constant and valuable specific characters. The most complete series of these grooves would be composed of six sulci on either side of each somite, as follows: From a dorsal midpoint on each dorso-lateral surface, two grooves, the ANTERIOR and the POSTERIOR TERGAL SULCI, extend ventrad for a variable distance, sometimes to the ventral margin. From a ventral midpoint two grooves, the ANTEROMEDIAN and POSTEROMEDIAN PLEURAL SULCI, run dorsad within the area enclosed by the tergal sulci. From a still more ventral midpoint two grooves, the ANTERIOR and the POSTERIOR PLEURAL SULCI, run dorsad outside the area enclosed by the tergal sulci. The sulci vary in occurrence, depth, length, and direction from somite to somite in a single individual, as well as between equivalent somites in different species. They appear to be practically invariable with growth or otherwise, within the species. Anastomoses between tergal and pleural sulci may occur, and it is often difficult to be certain of the precise homologies of the various grooves according to the foregoing scheme. The sulci are present in a form most nearly like ideal series given above on the second and third somites. On the lateral surfaces of the sixth pleonic somite there is a longitudinal sulcus flanked above and below by ridges.

DIVISION I

Eusicyonia laevigata (Stimpson)

Figures 21, page 72; 26, page 82; and 32, page 91.

Sicyonia laevigata, STIMPSON, 1871; RATHBUN, 1901, part; HAY and SHORE, 1918.
Sicyonia carinata americana DE MAN, 1907.

Material examined includes a female of carapace length 4.9 mm, total length 20 mm, a female of carapace 4.7 and total length 18 mm, and two males, one damaged, the other of carapace 3.3, total length 14 mm, collected on the Pacific coast of Panama in 1866 by Mr. F. H. Bradley, and contained in the collection of the Zoology Department of the Peabody Museum of Natural History. Of Atlantic material for comparison, 2 males and 9 females from the collections of the Zoology Department of the Peabody Museum and of the American Museum of Natural History were available. This material was collected in Puerto Rico, the Bahamas, and North Carolina; it ranges in carapace length from 2.6 to 12.1 mm, the two males being respectively 2.9 and 4 mm.

There are no perceptible diagnostic differences between the Atlantic and the Pacific specimens, although the rostrum of Pacific specimens is somewhat shorter than that of Atlantic specimens of similar size. There are no previous Pacific American records of any species of the Division.

The Pacific specimens may be described as follows: Dorsal carina of the carapace with three teeth behind the orbital margin, of which two are behind the level of the hepatic spine. The posterior tooth in the three undamaged specimens is respectively 28, 30 and 31% of the carapace length anterior to the posterior margin of the carapace. The penultimate tooth is 58% anterior to the posterior margin. The anterior tooth is 11 to 12% behind the orbital margin and 8 to 12% anterior to the hepatic spine. The distance between the anterior and the middle tooth is in all three specimens greater than that between the middle and the posterior tooth, although almost imperceptibly so in the two larger individuals. All measurements in this and succeeding paragraphs have been made with micrometer ocular at a magnification of not less than 9 diameters.

The postrostral teeth are directed anteriorly at an angle of less than 45° to the dorsal margin of the carapace. In advance of each tooth, the low carina which forms the crest of the preceding tooth is practically obliterated. The middle tooth is the largest; the anterior tooth is much smaller than the two posterior to it, about equal in size to the rostrals, and appearing as a part of that series.

The rostrum is fairly elongate, from 46 to 51% of the carapace in length, its average being 48.6%. It is quite narrow, the depth just anterior to the basal tooth being 11 to 13, mean 12%. The superior and inferior margins are subparallel; that is, there is little taper from base to tip. The length of the rostrum makes conspicuous its elevation of about 20°. It bears two teeth behind the terminal portion, of which the posteriormost is in the smaller specimen 10, in the two larger, 13% anterior to the orbital margin. The second tooth is placed somewhat distad the middle of the rostrum. The third tooth, which might be regarded as occurring on the dorsal margin of the rostrum, is placed about as far from the second tooth as is this from the posterior tooth. Its anterior margin is 6 to 8% of the carapace length behind the tip of the fourth tooth, and slightly behind the posterodorsal margin of the sixth, ventralmost tooth. The terminal portion of the rostrum in these specimens appears divided into four teeth, the two middle elements projecting farthest and being separated from each other by a shallower notch than they are from the tooth ventral, and particularly, that dorsal to them. Just above the ventral margin of the rostrum near its distal end on either side are one or two, usually two, short stout mobile spines. The spines of the two sides are not symmetrically placed, those of one side occurring in advance of those of the other.

The antennal angle is unarmed, although it is not rounded. The ocular stylets are very short.

The pleonic somites are sculptured as follows: The first segment is grooved by a complete posteromedian pleural sulcus and a short anteromedian one which is obliterated a short distance ventrad its juncture with the anterior margin of the pleuron. Some distance below the point of obliteration a barely perceptible short continuation of the anteromedian pleural can be made out. The second and third somites bear an anterior tergal and a short posterior one;

a short shallow anteromedian pleural, and a posteromedian pleural which, somewhat above the middle of the lateral surface, turns sharply anteriorad. The longitudinal terminal portion of this sulcus is margined above by a low but perceptible ridge. The fourth and fifth segments bear a posterior tergal and an anterior one which is obliterated for a considerable interval below its short dorsal section, reappearing farther ventrad. The sixth somite bears the usual two sulci here regarded as anterior tergal and posteromedian pleural, as well as the longitudinal sulcus.

There is a deep cleft in the dorsal carina of the second somite, above the juncture of the tergal sulci and directly in line with the anterior of them. The posterior end of the dorsal carina of the fifth somite slopes gently to the apex of the cleft in the posterodorsal margin, without a sharp dentiform descent. The ventral pleural margins are rounded except for a posterior tooth on the fifth and sixth somites. The surface of the pleon is punctate but not rugose or tuberculate. The telson bears a pair of large, conspicuous fixed teeth; there is also in these small Pacific specimens, an anterior pair of mobile spines.

The petasmal endopods of the two minute males are completely united. The distolateral projections do not converge toward one another, but are strongly curved anteriorad. The distoventral projections taper strongly beyond an expanded basal portion, and are directed distad; while their distalmost portions are folded back proximad. The lateral edges of the petasma are deeply and conspicuously notched at a point somewhat nearer to its proximal than to its distal end.

The tip of the external scale of the basal segment of the antennular peduncle does not reach forward farther than to the fringe of setae posteriorly bounding the anteromedian naked area of the article.

In the Atlantic material examined for comparison with the Pacific, the posterior of the postorbital teeth of the carapace ranges from 23 to 36%, mean, 29.5%; and the middle tooth from 51 to 64%, mean 57%, anterior to the posterior margin of the carapace. The anterior tooth is from 4 to 15%, mean 10%, posterior to the orbital margin; and from 8 to 20%, mean 12%, anterior to the level of the hepatic spine. In all save one small male the distance between the anterior and the middle tooth is greater than that between the middle and the posterior tooth. The distance between the anterior postorbital tooth and the posteriormost rostral tooth ranges from 4 to 16%, mean 9%, less than the distance between the anterior and the middle tooth of the carapace.

The rostrum is elevated at an angle ranging from horizontal in the smallest specimen to about 35° elevation above the horizontal, the usual angle being over 20°. Its length ranges from 41% in the very minute specimen, to 59% of the carapace, some increase in relative length with increase in size seeming to occur. Excluding the largest and the smallest specimen; that is, within a size range of 3 to 6.5 mm carapace length, the rostral length ranges from 50 to 60%, the mean being 55%.

The posterior rostral tooth ranges from 9 to 17%, mean 13.3% anterior to the orbit; the third tooth from less than 4 to 8% behind the anteriorly directed tip of the fourth tooth. The second tooth is usually placed slightly posterior to the midpoint between the first and third. In the largest specimen the distal end of the rostrum bears five teeth (including the third tooth from the base); in three smaller specimens it bears three teeth; in the remainder, four.

In all specimens except the largest one, which appears to exceed any previously recorded maximum, the telson bears a pair of mobile lateral spines just distad the basal shoulders. Since all except the smallest female appear to be sexually mature, or at least, impregnated, the presence of these mobile lateral spines cannot be considered as a juvenile character, although they are evidently lost in the later course of adult existence.

It has apparently never been observed that *Eusicyonia laevigata* is almost indistinguishable from *E. carinata* (Olivi) of the Eastern Atlantic and Mediterranean, although De Man, 1907 and 1911, in designating as *Sicyonia carinata americana* an *Eusicyonia* from Brazil which evidently represents *E. laevigata*, indirectly acknowledges this similarity. By no described character can De Man's material be distinguished from *E. laevigata*, with which he fails to compare it, while at the same time his description of the anterior tooth of the carapace as much smaller than the two following and than the corresponding tooth in Mediterranean material; and of the third rostral tooth as placed immediately behind the tip, clearly does not apply to *E. parri*, n. sp., to be described in a further paragraph.

The foregoing material of *E. laevigata* has been compared with three males and three females of *E. carinata* from Messina, the examination of which was very kindly permitted by the Museum of Comparative Zoology. These specimens range from 8.7 to 17.9 mm in carapace length, the largest, about 72 mm in total length, being more than 10 mm longer than the known maximum as given by De Man, 1911. The anteriormost tooth of the carapace of *E. carinata* seems relatively larger than that of *E. laevigata*, although it is conspicuously smaller than the two posterior teeth. It is constantly placed far anterior to the level of the hepatic spine, at an average of 14.6% (range 12.4 to 15.8%) behind the orbital margin, and 32.6% (range 30 to 36%) anterior to the middle tooth. The anterior tooth is 6.3% (range 2.8 to 10.8%) farther from the middle tooth than is the latter from the posterior tooth. The rostrum of *E. carinata*, ranging from the horizontal to 10°, is less elevated than is that of *E. laevigata*. It generally bears three dorsal teeth, the anterior of which is generally much further behind the bi- or trifurcate tip than in *E. laevigata*, and the posterior of which seems relatively closer to the orbital margin than in the American form. The ventral tooth of the rostrum is generally placed much farther proximad the elongate terminal portion than is that of *E. laevigata*.

The median concavity of the posterior margin of sternite XIII of the female of *E. carinata* seems much shallower than that of *E. laevigata*. The petasma is very similar to that of the American form, but with shallower midlateral notches (which are, incorrectly, not represented in the figure by Pesta, 1918), and with distolateral projections somewhat convergent as well as curved dorsally. The sharpest distinctions between the two species are provided by the pleonic sculpture. In *E. carinata* the pleonic integument is heavily wrinkled and the sulci are very deep. The anteromedian pleural sulcus of the first pleonic somite is continued without interruption to the ventral margin, being joined somewhat above the margin to the posteromedian pleural. There are rather poorly marked posterior pleurals on the first, second and third somites. The posterior tergals of the second and third somites extend more strongly below the level of the dorsal end of the posteromedian pleurals. The anterior tergal of the fourth somite extends ventrally without any obliteration of its midportions.

It may be noted that those among the specimens described as *E. laevigata* by Rathbun, 1901, with "six dorsal teeth instead of five" probably pertain to *E. parri*, n. sp.

Eusicyonia parri,[1] new species

Figure 22, page 72.

1 female, holotype. *B.O.C. 75.* Crooked Island, Bahamas, seine, March 26, 1927.

Dimensions—carapace length 6.3 mm, total length 24.5 mm.

In addition to the holotype, a small damaged female from Tallaboa, Puerto Rico, in the collection of the American Museum of Natural History, has been available. The pleon of this specimen measures 7.8 mm in length, so that the missing carapace was probably about 2.5 mm in length, excluding the rostrum.

Description—Postrostral carina bearing three large subequal teeth of which the anteriormost, placed only slightly in front of the level of the hepatic, is considerably larger than the teeth of the rostral series, and is 2% closer to the middle tooth of the carapace than to the posterior tooth of the rostrum. The posterior tooth is 29%, the middle tooth 55% anterior to the posterior margin. The anterior tooth is 22% from the orbital margin and 4% in advance of the hepatic spine; the distance from the anterior to the middle is less than that from the middle to the posterior tooth.

The rostrum, 52% of the carapace in length and 12% in depth just in front of the posterior tooth, is elevated at an angle of about 15°. It bears three teeth behind the terminal portion, of which the posteriormost is 1% anterior to the orbital margin. The second rostral tooth is placed somewhat closer to the posterior than to the third rostral tooth. The third tooth is placed 20% behind the distalmost extension of the rostrum. The terminal portion of the rostrum bears three teeth, between the middle and the ventralmost of which the rudiment

[1] Named for Professor Albert Eide Parr.

of a fourth tooth is visible. There are no mobile spinules on the ventrodistal margin of the rostrum.

The tip of the telson is broken; a pair of mobile lateral spines is present.

The emargination of the posterior margin of the thirteenth pereionic sternite is shallower than in any females of *E. laevigata*, and considerably shallower than in the larger specimens comparable in size with the representative of *E. parri*.

The first pleonic somite bears a short anteromedian pleural, like that of *E. laevigata*. A little below the point where the groove disappears, however, it reappears and is conspicuously continued nearly to the ventral margin. It does not join the posteromedian pleural ventrally. The first and second pleonic somites bear a shallow but readily perceptible posterior pleural sulcus. The dorsal and ventral portions of the anterior tergal of the fourth somite are separated by a very narrow area of obliteration.

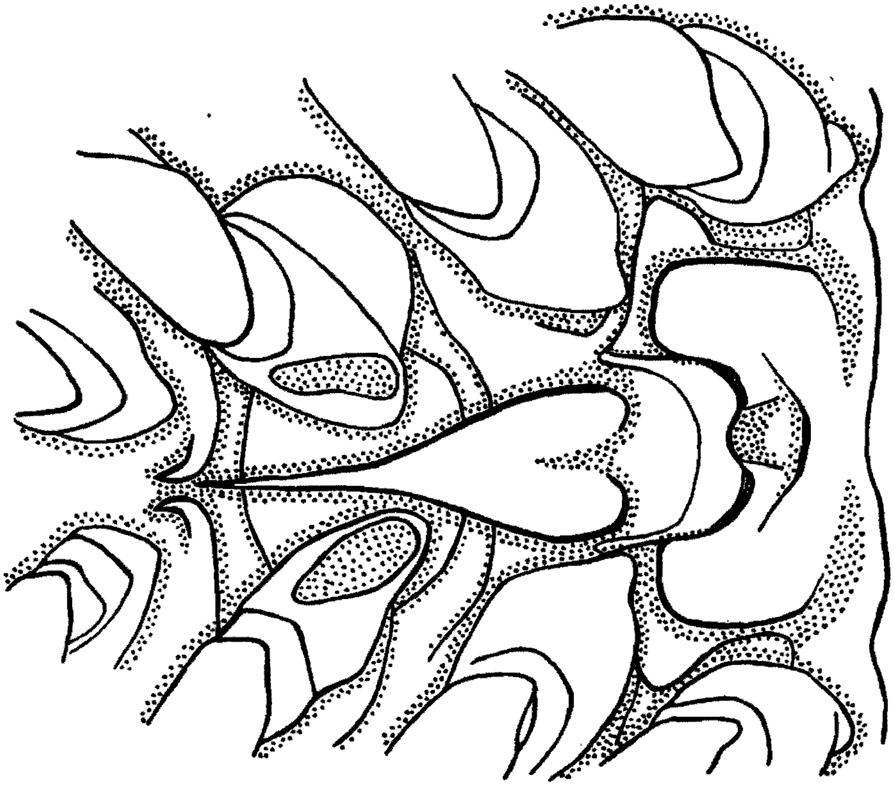
The minute and imperfect Puerto Rican female has a posterior pleural sulcus faintly indicated on the first two pleonic somites. The anteromedian pleural of the first somite is conspicuously continued ventrally. The emargination of the posterior margin of the thirteenth pereionic sternite seems shallower than in comparable small females of *E. laevigata*. It is probable that this individual pertains to *E. parri*.

Eusicyonia parri, although very similar to both *E. laevigata* and *E. carinata*, differs from both in a number of characters. The anterior tooth of the carapace is relatively much larger than in either of the other two species, and is placed much closer to the middle tooth and much farther from the orbital margin, as well as less in advance of the level of the hepatic spine. The posterior tooth of the rostrum is placed much nearer the base than in *E. laevigata*, and somewhat nearer than in *E. carinata;* the third tooth conspicuously farther behind the tip than in *E. laevigata*, while the ventral rostral tooth is placed nearer the tip than in *E. carinata*. The posterior pleural sulci of the anterior pleonic somites, and the strong ventral continuation of the anteromedian pleural of the first somite, clearly distinguish *E. parri* from *E. laevigata*, while the smooth integument, shallower sulci, shorter second and third posterior tergals, and conspicuously interrupted first anteromedian pleural and fourth anterior tergal clearly differentiate it from the more nearly similar *E. carinata*.

I have no hesitation in describing *E. parri* from a single perfect specimen and the pleon of another, since two Pacific examples in very complete agreement with the Atlantic form except by their lack of the posterior pleural sulci are available, and will be described below as *E. disparri*, n. sp.

It is probable that some of the material reported by Rathbun, 1901, as *E. laevigata*, pertains to *E. parri*.

E. parri resembles is some respects the Indo-Pacific *E. trispinosa* De Man. In the figure of that species, however, the third rostral tooth is shown as considerably behind the level of the hepatic spine; the dorsal carina of the second pleonic somite is not notched; the antennal angle is more obtuse; and there are



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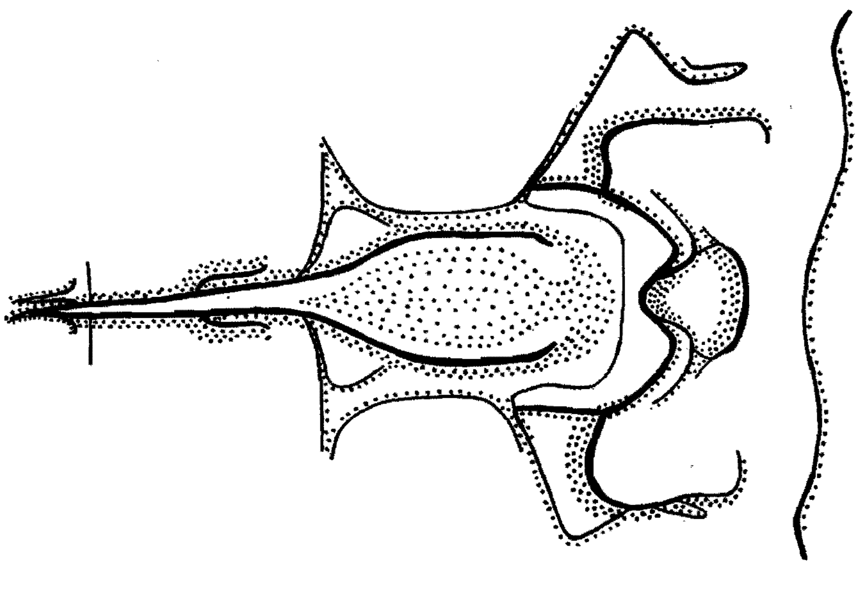

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probably other differences. It may be noted that although De Man speaks of only two transverse sulci on the first pleonic somite of *E. trispinosa*, as in *E. carinata*, his figure shows, as in *E. parri*, a third, posterior pleural, sulcus.

E. disparri, new species

Figure 27, page 82.

2 females, type and cotype. *B.O.C. 73.* Gonzaga Bay, Lower California, seine, May 17, 1926.

Dimensions—Type, carapace length 9.3 mm; cotype, 9.2 mm. Type, total length 44 mm; cotype, 42 mm.

Description—Posterior postrostral tooth of the type 25, of the cotype 27% anterior to the posterior margin of the carapace; middle tooth of the type 52, cotype 54% anterior to the postmargin; anterior tooth 25 and 22% behind the orbital margin, closer to the middle tooth of the carapace than is this to the posterior tooth, not placed anterior to the level of the hepatic spine, and 0 and 4% closer to the middle tooth of the carapace than to the posterior rostral tooth.

The rostrum is elevated at an angle of about 35°. In the type it is somewhat under 50, in the cotype 47% of the carapace in length. Its depth just in front of the posterior tooth is in both specimens 16% of the carapace length. The basal "rostral" tooth is in the type actually behind the orbital margin by 2%; in the cotype it is 2% anterior to the orbital margin. The second rostral tooth is closer to the third than to the basal tooth. The third rostral tooth is in the type 15, in the cotype 13% behind the ultimate extension of the rostrum. In both specimens, there is a single mobile spinule on either side of the ventrodistal margin of the rostrum. There are in the type four terminal teeth and the rudiment of a fifth; in the cotype five terminal teeth.

The anterior two pleonic somites lack a posterior pleural sulcus. The fourth somite of the type is armed with a short posterior ventral tooth. The telson of the type lacks, while that of the cotype bears, a pair of mobile in addition to the pair of fixed lateral spines.

Eusicyonia disparri seems to be identical with *E. parri* save in the absence of a posterior pleural sulcus on the anterior pleonic somites and in the shorter, deeper and more elevated rostrum. The loss of the pleural sulcus is, curiously enough, paralleled in other Pacific species as compared with their Atlantic congeners. It is probably a character of sufficient constancy to be regarded as specifically distinctive.

There is some superficial resemblance between *E. parri* and *E. disparri*, and *E. brevirostris*, in that the posterior tooth of the rostrum of the former two

Figure 26. *Eusicyonia laevigata* (Stimpson).
Thelycum of the largest female (Puerto Rico) × 10.4.
Figure 27. *Eusicyonia disparri*, n. sp.
Thelycum × 10.4.

species is placed so close to the orbital margin, and the large anterior tooth of the carapace so close to the level of the hepatic spine that individual variation sometimes carries these teeth posterior to the levels which, for convenience, I have arbitrarily selected as critical, thus reproducing the carapacic dental formula of *E. brevirostris*. Since, however, the distinctions between the species include those given as distinguishing Division I from Division II, confusion is impossible. The posterior shift of the carapacic teeth of *E. parri* and *E. disparri*, relative to *E. carinata*, seems to parallel the shift which has occurred on a more extensive scale in such Indopacific members of the Division as *E. lancifer*.

DIVISION II

Eusicyonia brevirostris (Stimpson)

Sicyonia cristata, DE SAUSSURE, 1858 (not *S. cristata* DE HAAN, 1850).
Sicyonia brevirostris, STIMPSON, 1871; MILNE EDWARDS and BOUVIER, 1909.
Sicyonia edwardsi, HAY and SHORE, 1918; BOONE, 1927, part.

1 male, carapace 18.1 mm, total length 70 mm. *B.O.C. 79.* Off the Pacific coast of southern Mexico (lat. 14/40/20 N., long. 92/40/30 W.), trawl, April 9, 1926.

1 male, carapace 24.2, total length 82 mm. *B.O.C. 78.* Green Cay, Bahamas, stomach of *Mycteroperca venenosa*, March 17, 1925.

In addition to the above, the examination of a small male 8.9 mm in carapace and 45 mm in total length from off the coast of North Carolina in 27 fathoms has very kindly been permitted by the American Museum of Natural History; and of a male 15.2 mm in carapace length, four females ranging from 12.1 to 14.4 mm in carapace length, and a very small individual 5.3 mm in carapace length, of which the pleon is unfortunately missing, from the Straits of Florida, by the Museum of Comparative Zoology. These latter specimens have been previously reported by Milne Edwards and Bouvier, 1909. A small female, 6.0 mm in carapace length, from the Yucatan Bank, was also loaned by the Museum of Comparative Zoology.

Eusicyonia brevirostris has not been previously known to occur on the Pacific coast of America. No significant differences between the Pacific specimen and the nine Atlantic ones was ascertainable.

The Pacific specimen affords the following description: dorsal carina of the carapace high, cut into four teeth behind the orbital margin, of which the posteriormost is 25.4% of the carapace length anterior to the posterior margin; the penultimate 20.4% from the ultimate; the antepenultimate 26.4% anterior to the penultimate and 5% posterior to the level of the hepatic spine; and the anteriormost 22% in advance of the antepenultimate and 5% behind the orbital margin. A line through the tips of these teeth is convexly curved, its highest point occurring at the penultimate tooth. The anteriormost tooth, in size, shape, and position, except that it lies behind the orbital margin, falls into the rostral series.

The short and slender rostrum, narrowing considerably to its tip, is 20% of the carapace in length. It bears two teeth behind the bifurcated terminal section, of which the posterior is about 5% from the orbital margin. The ventral terminal tooth extends farther distad than does the dorsal.

The antennal angle is armed with a small spine. The ocular stylets are long.

The pleon is heavily tuberculate. Its sculpture is as follows: The first somite is cut by complete anteromedian and posteromedian pleurals, a posterior pleural, and a posterior tergal. The second and third somites bear two tergals, two median pleurals which extend very far dorsad, and a posterior pleural. The fourth somite bears three sulci which are probably to be interpreted as a short posterior tergal, an anterior tergal joining ventrally with a shallow anteromedian pleural, and a long posteromedian pleural reaching very far dorsad. The fifth somite bears an anterior and a long posterior tergal; the sixth a posteromedian pleural, an anterior tergal, and a longitudinal sulcus.

The pleura of the first four somites are armed with an anterior ventral angle which is produced on the third and fourth into a blunt spine. The last three somites are armed with a posterior ventral tooth. The posterior end of the dorsal carina of the fifth somite is damaged, but appears to have descended to the cleft as a conspicuous though not produced tooth.

The tip of the telson is damaged but the traces of a pair of fixed lateral spines are visible.

The petasma very closely resembles that of *E. edwardsi.*

In the Atlantic material examined, no variation in pleonic sculpture was detected, except that the tuberculation becomes weaker, the angle at the posterior end of the dorsal carina of the fifth somite less sharp and high, and the produced teeth of the ventral pleural angles weaker (to the point of disappearance) with decreasing size.

A fairly considerable amount of variation in the position of the teeth of the carapace occurs, which displays no clear correlation with size, although it is possible that the teeth tend to shift somewhat posteriorly with growth. The posterior tooth of the carapace ranges from 23 to 28.4%, mean 25.5%, in front of the posterior margin; the penultimate tooth from 19.1 to 24.4%, mean 22%, in front of the posteriormost. The antepenultimate tooth ranges from 26.8 to 35.2% in front of the ultimate, the average being about 30%. The fourth or anteriormost tooth which occurs on the carapace is not constantly behind the orbital margin and indeed ranges from 5.7% behind the margin to 7.4% in advance of it without any clear correlation with size of individual being apparent. This tooth ranges from 20 to 29.8% in advance of the antepenultimate. The posterior rostral tooth ranges from 3 to 25% in advance of the orbital margin, or 9 to 18% in advance of the fourth tooth.

The rostrum of the six specimens in which it is unbroken (which do not include either the largest or the smallest individuals) ranges in length from 30 to 55% of the carapace, and is elevated at an angle to the carapace of from about 5° to 45°. It constantly bears two teeth in advance of the tooth which ranges behind the orbital margin; and the tip may be armed with either two or three teeth.

It seems probable that Bouvier is incorrect in regarding the interpolated third tooth of the rostral tip as characteristic of young specimens; it seems more likely that, as in *E. edwardsi*, the tooth may be present or absent without relation to size. Bouvier's suggestion that the rostrum decreases in length and elevation with increase in size of the individual appears to be correct; it may be noted, however, that this change is highly irregular, and that there seems to be a greater range of individual variability in this character in *E. brevirostris* than in any other species of *Eusicyonia* which I have examined. It is noteworthy that the antepenultimate tooth of the carapace is constantly anterior to the hepatic spine over a considerable size-range in material from the Straits of Florida; constantly behind it in the material from other localities. I see no reason to disagree with Bouvier's conclusion, that the type of *E. cristata* (De Saussure) and that of *E. brevirostris* (Stimpson) are specifically identical.

Eusicyonia disedwardsi, new species

Figures 23, page 74; 29, page 87; and 34, page 91.

1 male, holotype. *B.O.C. 72.* Concepcion Bay, Lower California, May 3, 1926.

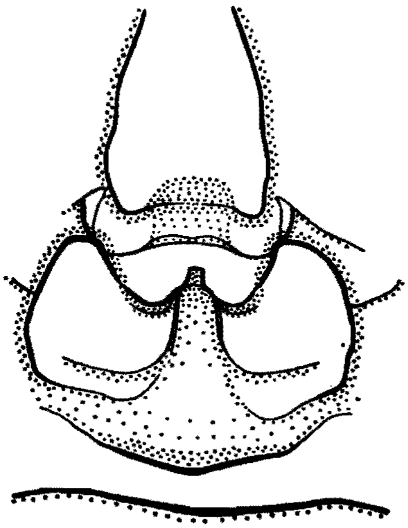
Dimensions—Carapace length 10.4 mm, total length 42 mm.

Description—Postrostral carina bearing three teeth behind the orbital margin, of which the posteriormost is 26% of the carapace length from the posterior margin; the middle tooth 36% from the orbital margin and well posterior to the hepatic spine; the anteriormost 2% from the orbital margin. Behind the posterior tooth the middorsal carina of the carapace is high; anterior to it the carina is lower, descending again at the smaller middle tooth to the still lower carina which culminates in the anteriormost tooth of the carapace. This latter, which is about equivalent in size to the rostral tooth anterior to it, is much smaller than the two teeth behind the level of the hepatic spine.

The rostrum narrows considerably from the base to the bifurcate tip. The dorsal margin of the rostrum bears three teeth behind the two terminal ones. It is elevated at a very considerable angle to the dorsal margin of the carapace, about 35°. Its length is about 26% of that of the carapace.

The pair of median stylets borne by the ocular somite are divergent, being bent conspicuously laterad near their tips.

The pleonic sculpture most nearly resembles that of *E. penicillata.* The an-



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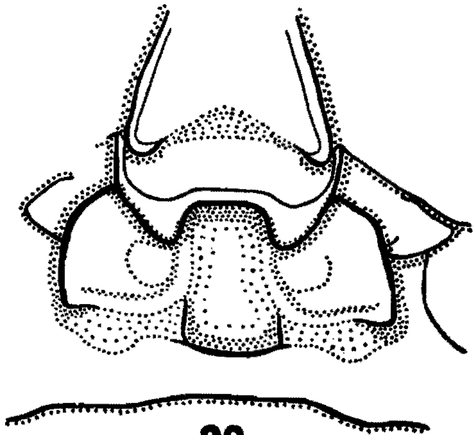

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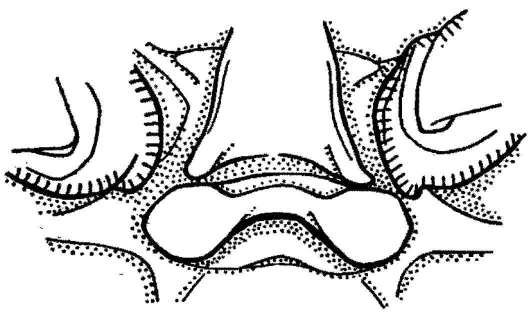

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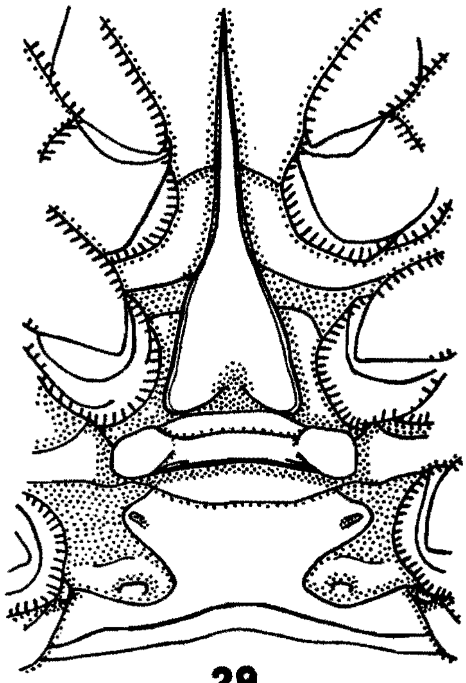

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Figure 28. *Eusicyonia edwardsi* (Miers).
Thelycum × 13.

Figure 29. *Eusicyonia disedwardsi*, n. sp.
Male genital sternites × 13.

Figure 30. *Eusicyonia penicillata* (Lockington).
Thelycum × 13.

Figure 31. *Eusicyonia penicillata* (Lockington).
Male genital sternites × 13.

terior four pleonic somites lack more than the faintest trace of a posterior pleural sulcus. The first somite lacks even a trace of a posterior tergal, and the dorsal portion of the posteromedian pleural is obliterated. The pleura of each of the anterior four somites are armed with acute anterior ventral angles flared somewhat outward. The pleura of the fifth and sixth somites are armed with a posterior ventral tooth.

The telson bears a pair of small but conspicuous fixed lateral spines.

The posterior margin of pereionic sternite XIII is slightly concave, but without any deep and conspicuous median emargination.

The pair of laterodistal projections of the petasma are short, with antrorse tips, and do not bear any trace of accessory filaments. The distoventral projections are short and stout, with proximally turned tips. In this single available specimen, the petasmal endopods are not yet completely hooked together proximally, and the individual is to be considered as subadult.

In all its characters *E. disedwardsi* seems practically identical with the Atlantic American *E. edwardsi* (Miers) except in the obsolescence of the posterior pleural and other sulci. In this latter character it resembles the related Pacific coast species, *E. penicillata* (Lockington). It is described as a new species with some hesitation, since, being smaller than any available individual of *E. penicillata*, the possibility is present that it represents the juvenile form of that species. However, since all evidence indicates that modification of structure is more or less negligible from the smallest to the largest individuals with joined petasmal rami or impregnated thelycum, and since in particular *E. penicillata* shows no tendency to change in the direction of *E. disedwardsi* down to sizes not greatly larger than the holotype of that form, it seems a defensible conclusion that *E. disedwardsi* is a distinct species. The fact that *E. penicillata* is very much more different from *E. edwardsi* than are other Pacific species of *Eusicyonia* from their Atlantic congeners may indicate that *E. disedwardsi* is the Pacific representative of the Atlantic form, while *E. penicillata* is a more divergent offshoot of the same stock.

Eusicyonia penicillata (Lockington)

Figures 30 and 31, page 87; figure 33, page 91.

Sicyonia penicillata LOCKINGTON, 1879; SCHMITT, 1924c; BOONE, 1930.

4 males, 2 females. *B.O.C. 83.* Bay San Felipe, Lower California, seine, May 19, 1926.

6 males, 15 females. *B.O.C. 84.* Angeles Bay, Lower California, otter-trawl, 17 to 23 fathoms, May 13, 1926.

35 males, 25 females. *B.O.C. 85.* Concepcion Bay, Lower California, otter trawl, May 3, 1926.

Size range in carapace length of the above material is, males, 12.1 to 20.1 mm; females, 10.7 to 23.0 mm.

E. penicillata may be characterized as follows: There are three teeth on the dorsal carina of the carapace behind the orbital margin. Of these the anteriormost is placed close to the posteriormost rostral tooth and is about equivalent to it in size, being much smaller than the two teeth behind the level of the hepatic spine. The anterior tooth is usually placed about 5% of the carapace length behind the orbit, the range being from 1 to 8%. There is no perceptible change in the relative position of this tooth with differences in sex or size. The middle postorbital tooth, which is always well behind the level of the hepatic spine, averages 38% of the carapace length behind the orbital margin, but is quite variable in position within a range of from 33 to 43%. Its position displays no clear correlation with sex or size of the individual. The posterior tooth is usually placed about 26% of the carapace length from the posterior margin. It is perhaps placed slightly farther anterior in males than in females and in small than in large individuals, but this correlation, if real, is rather effectively masked by the considerable degree of individual variation. The range of position of the posterior tooth is from 23 to 30% anterior to the posterior margin. There is some evidence of a correlation between the positions of the posterior and middle teeth; when the former fall anterior or posterior to their modal distances from the posterior margin, the latter tend to be placed respectively nearer to or farther from the orbit; or, in other terms, the distance between the two teeth seems to remain more constant than the distance from the margin of either tooth.

The rostrum ranges in length from 11 to 25% of the carapace length. It is longer in small than in large individuals and in females than in males. The modal rostral length of males below 16.5 mm in carapace length is 15%; above this length, 17%; of females below, 16%; of females above, 19%. The rostrum varies in elevation from horizontal to about 30°, the angle usually being slight. The breadth decreases from base to tip, occasionally very conspicuously. The dorsal margin generally bears one tooth behind the bifurcate distal part, but in about one individual out of ten there is an additional tooth behind the two terminal ones, often close enough to them to create the appearance of a trifurcate tip.

The ocular stylets are sometimes bent very slightly outward at their tips, but never to a noticeable extent. The stylets are relatively longer in large than in small individuals, and may extend to the median base of the corneal surface.

The tuberculate pleonic terga and pleura are sculptured as follows: The first somite bears an anteromedian pleural which is continued without break nearly to the ventral margin; as well as a posteromedian pleural the dorsal end of which reaches the anterior margin; and a faint trace of a posterior tergal. The second and third somites bear two tergals, two median pleurals which extend far dorsad, and a very faint trace of a posterior pleural. The fourth somite bears a shallow, short posterior tergal, a long anterior tergal, and a very long posteromedian pleural meeting the joined tergals dorsally. The fifth somite bears an anterior tergal and a posterior pleural which joins it dorsally. The sixth somite bears two similar sulci, which respectively extend along the dorsal and anterior margins of the somite, and the ventral and posterior ones; in addition to a deep longitudinal sulcus on the tergum of either side.

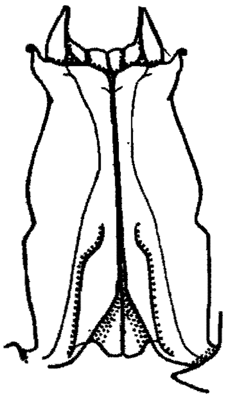
The first to fourth pleonic somites are armed with an acute anterior ventral angle, the angles of the third and fourth somites being somewhat produced as laterally directed spines. The fifth and sixth, and occasionally the fourth, somites are armed with posterior ventral spines. This armature becomes relatively stronger with increasing age.

The telson bears a usually conspicuous pair of fixed lateral teeth.

The posterior margin of the thirteenth pereionic sternite of the male is deeply but rather broadly emarginate in the middle. In the female the emargination in a similar position is extremely narrow, although relatively as well as absolutely somewhat broader in small than in large individuals. The maximum breadth of the female emargination is less than 0.3 mm, the minimum about 0.1 mm.

The petasma seems to be unique in a genus marked by considerable uniformity in this structure. Both pairs of distal projections are produced to extremely long, slender and pliant tips, the total length of the distolateral projection being over half that of the remainder of the endopod. From the thickened base of this lateral projection a slender filament springs which is as long as from one-half to two-thirds the distance from its point of origin to the tip of the projection proper. The petasma shows no change in form from the smallest to the largest available males, in all of which, however, the endopods are completely united.

As compared with four males of *E. edwardsi* (Miers) ranging from 11.3 to 19 mm in carapace length and five females ranging from 13.4 to 15.0 mm, *B.O.C. 82*, Isle of Pines (*E. edwardsi*, part, Boone, 1927), the following differences are perceptible: The middle tooth of the postrostral carina seems usually to be placed slightly closer to the orbital margin in *E. edwardsi*. The anterior tooth is usually placed closer to the orbital margin than in *E. penicillata*, never more than 3% of the carapace behind, and in a few cases above or anterior to the margin. The rostrum is longer, the range in length being 21 to 33%, and the mean 26%. The elevation of the rostrum is generally somewhat greater. The ocular stylets diverge strongly at their tips. The pleonic sulci are much stronger, and a conspicuous posterior pleural occurrs on the first four somites. The fixed lateral spines of the telson are smaller, and are occasionally no more than vestigial. The distal projections of the petasma lack elongated tips, and the lateral pair do not bear accessory filaments. The posterior margin of the thirteenth pereionic sternite of the male lacks a deep median emargination; the emargination in the female (figure 28, page 87) is much wider, ranging between .55 and .7 mm. The setae of the various pubescent structures are less long and dense than are those of large specimens of *E. penicillata*, in which species the density of pubescence increases with increasing size.



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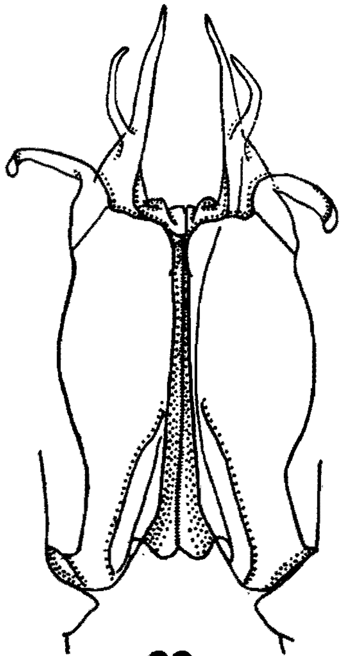

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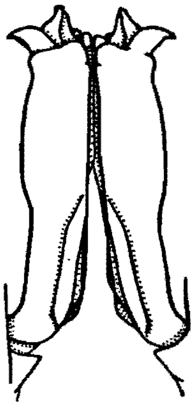

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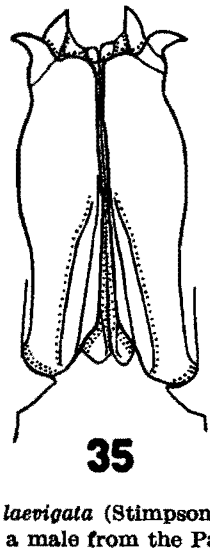

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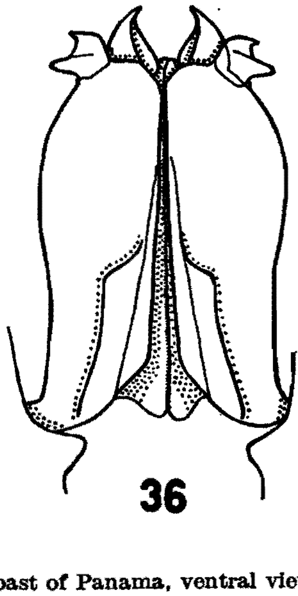

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Figure 32. *Eusicyonia laevigata* (Stimpson).
Petasma of a male from the Pacific coast of Panama, ventral view × 28.5.

Figure 33. *Eusicyonia penicillata* (Lockington).
Petasma, ventral view × 13.

Figure 34. *Eusicyonia disedwardsi*, n. sp.
Petasma, ventral view × 13.

Figure 35. *Eusicyonia picta* (Faxon).
Petasma, ventral view × 13.

Figure 36. *Eusicyonia disdorsalis*, n. sp.
Petasma, ventral view × 13.

The examination of a very small male of *E. edwardsi*, 6.1 mm in carapace length, in the collection of the Museum of Comparative Zoology, one of the Blake specimens from Flannegan Passage reported by Milne Edwards and Bouvier in 1909, gives the following evidence as to variation with size in species of the **edwardsi** group: The petasmal endopods are in this specimen completely hooked together, the petasma being identical with that of larger specimens. The pleon is identical with that of larger individuals except that its surface is less conspicuously tuberculate, and that the anterior ventral pleural angles of the third and fourth somites are not produced. The transverse ridge behind the spine of the thirteenth pereionic sternite is relatively wider and shorter than that of the larger adults, and with a perhaps somewhat more concave posterior margin. The ocular stylets are shorter but are as in the large specimens conspicuously divergent at their tips. The antennal spine, as usual in small specimens of *Eusicyonia*, is weaker. The posterior tooth of the carapace, at 30.3% from the posterior margin, is 2% farther anterior than is the extreme in the larger specimens; the middle tooth, at 34.1%, is 1% closer to the posterior tooth than is the extreme in the larger specimens. Other measurements fall within the range of the larger specimens.

As has been previously mentioned, *E. disedwardsi* Burkenroad differs from *E. penicillata* precisely as does *E. edwardsi* save that its pleonic sulci seem to be even shallower and less complete than are those of *E. penicillata.*

It may be noted in passing that *Sicyonia edwardsii* of Hay and Shore, 1918, from Beaufort, North Carolina, purportedly the farthest northern record, actually refers according to the figure given, to *E. brevirostris* (Stimpson).

Contrary to the statements of Milne Edwards and Bouvier, 1909, the cardiacobranchial ridge of *E. edwardsi* as well as of the two related Pacific species is continuous with the buttress of the hepatic; the ocular stylets may reach to the base of the cornea in large individuals; and there is occasionally a small posterior ventral tooth on the fourth pleonic somite.

Eusicyonia aliaffinis, new species

Figure 24, page 74.

1 male, holotype. *B.O.C. 74.* Pacific coast of southern Mexico (lat. 14/48/40 N., long. 92/54/40 W.), trawl, 19 to 30 fathoms, April 9, 1926.

Dimensions—Carapace length 8.7, total length 34.5 mm.

Description—The anterior postrostral tooth is 18% of the carapace length, the posterior 71%, behind the orbital margin. The carina between these teeth is relatively higher than in *E. picta* or *E. disdorsalis;* it is conspicuously elevated in advance of the posterior tooth, which is very high. The posterior margin of the posterior tooth slopes to the hinder edge of the carapace as a high carina. The anterior tooth, like the rostrals to which it is subequal in size, is larger than the anterior tooth found in *E. picta* or in *E. disdorsalis*, and is placed barely in front of the level of the hepatic spine rather than well before it.

The rostrum is about 37% of the carapace in length, and is elevated at a considerable angle, about 30°. It bears two teeth behind the terminal part, the posterior of which is 4% of the carapace length in advance of the orbital margin. The anterior tooth is 17% from the end of the rostrum. The anterior end is obliquely truncate, the more projecting ventral and shorter dorsal margins ending in a short tooth, while between them a third tooth, now broken, appears to have existed.

The ocular stylets are like those of *E. picta*.

The pleonic sculpture is as follows: The first somite bears deep anteromedian and posteromedian pleural sulci, both of which are complete, joining near the ventral margin of the pleuron. The second and third somites bear two tergals, and two median pleurals the anterior of which is much deeper and longer than that of *E. picta;* all four sulci being deeply incised. The fourth somite bears an anterior and posterior tergal which extend to the ventral margin where they meet; the fifth somite a long posterior and a short anterior tergal; the sixth an anterior tergal, a posteromedian pleural, and a deep longitudinal sulcus. The pleon is rugose and tuberculate.

There is an anterior ventral angle on the first to fourth pleonic somites, a trace of a posterior ventral angle on the fourth, and a posterior ventral spine on the fifth and sixth somites.

The posterior end of the dorsal carina of the fifth somite of the pleon descends sharply to the apex of the cleft, but is not produced into a tooth. A similar but smaller angle occurs on the fourth somite. The carina of the second somite is, although not notched above the juncture of the tergal sulci, shallowly emarginate at this point. The tooth of the anterior end of the carina of the first somite is more elevated than in *E. picta*, and the anterior margin of the tooth descends vertically rather than in an overhanging oblique.

The telson is armed with a pair of small but conspicuous fixed lateral teeth.

The petasma endopods of the holotype are not united. The distolateral and distoventral projections are short and slender, and are not furcate.

E. aliaffinis is very closely related to *E. affinis* (Faxon), a species known from Malpelo and Cocos Islands in depths of from fifty-two to one hundred and twelve fathoms. Three specimens of *E. affinis*, evidently male and female cotypes and a female paratype, in the collection of the Museum of Comparative Zoology, have been available for examination.

Faxon, 1895 is in error in regarding *E. affinis* as the Pacific American representative of *E. edwardsi*. Although *E. affinis* and *E. aliaffinis* display a general resemblance to the **edwardsi** group, they differ in bearing only two postrostral teeth, only one of which lies behind the level of the hepatic spine. This dentition is quite similar to that of the *E. dorsalis* and *E. stimpsoni* groups of species. An Indopacific form, *E. benthophila* (De Man) appears closely to resemble *E. affinis*, but bears a basisal and ischial armature on the first legs. There is no known Atlantic congener of *E. affinis* and *E. aliaffinis*.

E. aliaffinis differs from *E. affinis* most conspicuously in the characters of its pleon, which is practically indistinguishable from that of *E. disedwardsi.* In *E. affinis* the first pleonic somite bears a shallow anteromedian pleural sulcus extending less than one-fourth of the distance from its point of origin to the ventral margin. This sulcus is in *E. aliaffinis* deep and complete, extending almost to the ventral margin to meet the posteromedian pleural. In *E. affinis* the posteromedian pleural sulci of the second and third somites extend dorsally only to within a third of the distance between the dorsal midline and ventral margin from the dorsal midline; the sulci turn anteriorad at their dorsal ends and are margined above by a low longitudinal ridge. In *E. aliaffinis* the posteromedian pleural sulci extend to within a fourth from the dorsal midline, and do not turn anteriorly. The anteromedian pleural sulci of the second and third somites of *E. affinis* are broad and shallow and do not reach nearly as far dorsad as the short posteromedian pleurals. In *E. aliaffinis* the anteromedian pleurals are deep and well-marked and nearly meet the posteromedian pleurals dorsally.

The posterior end of the dorsal carina of the fifth somite of *E. affinis* descends no more sharply than that of the fourth somite in *E. aliaffinis*, while the carina of the fourth somite in *E. affinis* slopes gently downward behind without any angular descent at all.

The ventral margins of the pleura of *E. affinis*, stated by Faxon to be broadly rounded, display a faint trace of an anterior angle on the first to fourth somites, much weaker, especially on the first somite, than the corresponding angles in *E. aliaffinis.* There is no trace in *E. affinis* of the posterior ventral angle of the fourth somite which is present in the holotype of *E. aliaffinis.*

The pleonic surface of *E. affinis* is punctate and setose, but smooth; not wrinkled and tuberculate as in *E. aliaffinis.*

The carapace of the two species is very similar. The dorsal carina of the female paratype of *E. affinis*, behind the margin of the posterior tooth, is lower than that of *E. aliaffinis;* the anterior tooth of the carapace is relatively nearer to the orbital margin; the rostrum is shorter and less elevated, and the posterior rostral tooth placed farther in advance of the orbital margin; the antennal spine is much less stout and without so marked a buttress as in *E. aliaffinis*, but it is possible that there is sufficient variation in these characters to make them of little critical value.

The transverse ridge near the posterior margin of the fourteenth sternite of the male of *E. affinis* is much wider and shorter and is more arched than that of *E. aliaffinis*, and the lateral, longer portions of it do not extend as far mediad.

The petasma of the adult male type of *E. affinis* resembles that of *E. edwardsi.*

Since the only known specimens of *E. affinis* are large adults, while the holotype of *E. aliaffinis* is much smaller and is juvenile, there exists a possibility that the latter may represent a developmental stage of *E. affinis*, and not a distinct species. However, in all species of *Eusicyonia* of which a considerable size range has been available to me, the sulci of the pleon are very constant, and, if they change at all, merely grow relatively deeper with increase in size; the pleural armature increases both in strength and extent with growth; and the rugosity of the integument becomes more pronounced. I therefore feel that the considerable differences displayed by the specimen here described as *E. aliaffinis* represent specific distinctions, and that, as in a number of other Pacific American forms, closely related but distinct northern and southern species exist.

Eusicyonia picta (Faxon)

Figure 35, page 91.

Sicyonia picta FAXON, 1893 and 1895.

1 female, carapace length 10.3 mm. *B.O.C. 80.* Angeles Bay, Lower California, 17 to 23 fathoms, May 13, 1926.

1 male, carapace length 11.5 mm. *B.O.C. 81.* Gonzaga Bay, Lower California, seine, May 17, 1926.

E. picta presents the following characteristics as compared with *E. disdorsalis*, n. sp., to be described in a further paragraph: The anterior postrostral tooth is placed somewhat, the posterior conspicuously farther behind the orbital margin than in *E. disdorsalis*, the distance from the orbit of the latter tooth averaging 65% in the two available specimens, well outside the extreme range in *E. disdorsalis*. The posterior tooth is continued backward from its sharply cut anterior edge as a high crest. Anterior to the tooth the carina is low; just in front of the tooth it forms a slightly higher elevation terminating in a very short but abrupt descent about a millimeter in front of the tooth.

The rostrum is somewhat shorter and is elevated to a greater angle than is usual in *E. disdorsalis*. The rostrum bears seven teeth in both specimens, of which three form a trifurcate tip; the intermediate of these three terminal teeth is in one specimen represented by no more than a rounded lobe. In one specimen the rostral teeth have the distally concentrated appearance shown in Faxon's figure; in the other the rostrum presents an appearance much like that of *E. disdorsalis*. The lateral ridge of the rostrum runs parallel and very close to the ventral margin, rather than angling up toward the dorsal margin as in *E. disdorsalis*.

The ocular stylets are longer.

Although the anteromedian pleural sulcus proper of the first pleonic somite is as short as in *E. disdorsalis*, this groove in *E. picta* is obscurely continued ventrad by a depression too broad and shallow to be called a sulcus, but not represented in *E. disdorsalis*. On the second and third pleonic somites the posteromedian pleural is distinct from the posterior tergal, which does not extend below the middle of the lateral surface of the somite. An anterior tergal and a short shallow anteromedian pleural are also present.

The first through fourth somites have an anterior ventral angle or spine; only the fifth and sixth bear a posterior ventral spine. The pleural margin dorsad the anterior angle of the first somite is convex, rather than concave. The posterior margins of the posterodorsal clefts of the fourth and fifth somites are not as strongly produced as in *E. disdorsalis*. The tooth in which the carina of the fifth somite terminates posteriorly is considerably produced as a curved spine.

The telson bears a pair of small but conspicuous fixed lateral spines.

The distoventral projection of the petasma is not bifurcate.

E. picta therefore differs from *E. disdorsalis* in precisely the same manner that its Atlantic congener *E. stimpsoni* (Bouvier) differs from *E. dorsalis* (Kingsley), as described by Burkenroad, 1934. Faxon's coupling of *E. picta* with *E. dorsalis* is incorrect, but in his time the latter had not been differentiated from *E. stimpsoni*. It may be noted that Faxon's figure of the telson of *E. picta*, showing lateral spines absent, contradicts the text and is perhaps derived not from the same individual shown in the other figure, but from a specimen of *E. disdorsalis*. However, these figures are not particularly accurate in detail, and the omission of the lateral teeth may be an oversight.

I have not undertaken a direct comparison of *E. picta* with *E. stimpsoni*. The former seems to differ from the Atlantic species by its less deep and inflated carapace, its shorter rostrum in which the two dorsal elements of the trifurcate tip do not extend as far distad as the ventral ones; the shallower sculpture of its pleon, and perhaps in other ways. *E. picta* appears to be less distinct from *E. stimpsoni* than is *E. disdorsalis* from *E. dorsalis*.

The only previous published records of *E. picta*, those of Faxon, refer to greater depths, between 100 and 200 fathoms, and localities considerably to the southward, off the coast of Panama.

Eusicyonia disdorsalis, new species

Figures 25, page 74; and 36, page 91.

1 male, 1 female, types. *B.O.C. 76*. 4 males, 7 females, cotypes. *B.O.C. 77*. Pearl Islands, Gulf of Panama (lat. 8/29/40 N., long. 78/52/30 W.), 19 to 24 fathoms, March 31, 1926.

Dimensions—Range in carapace length, males 8.2 to 13 mm; females 5.8 to 17.6 mm.

In addition to the above specimens, the collection of the Zoology Department of the Peabody Museum of Natural History contains the following material of this species: a male of 8.5 mm carapace length and three females of 7.1 to 11.1 mm carapace length collected on the Pacific coast of Central America by Captain Dow in 1872; a male with the same data of collection 5 mm in carapace length; 6 males ranging from 4 to 5.9 mm in carapace length and 4 females ranging from 4.3 to 6.2 mm in carapace length taken on the Pacific coast of Panama by

Mr. F. H. Bradley in 1868; and a female 6 mm in carapace length with the same data of collection. Whether or not these extra specimens, which were found in different containers than the others with the same data, represent distinct localities, is doubtful; and I am inclined to believe that all of the above material was obtained in the Gulf of Panama.

Description—The dorsal carina of the carapace behind the orbital margin bears two small teeth, the anterior and smaller of which is little more than a third as far from the posteriormost rostral tooth as from the posterior tooth of the carapace, and is about equal to the rostral tooth in size. This anterior tooth of the carapace, which is placed well in front of the level of the hepatic spine, ranges from 6 to 11% of the carapace length behind the orbital margin, modally 8% behind, and averages slightly closer to the margin in small than in large specimens. The posterior tooth, which ranges from 44 to 52% behind the anterior tooth (52 to 61% behind the orbital margin), the modal distance behind the anterior tooth being 50%, averages closer to the anterior tooth in small than in large specimens. The carina behind each of these two teeth, although sharply marked, is very low.

The rostrum ranges in length from 26 to 37% of the carapace length, the average length being about 31%, and is slightly longer in small than in large individuals. The rostrum is usually about horizontal, although it is occasionally somewhat elevated, and has the distal portion conspicuously decurved. The rostrum bears three teeth, rarely four, behind the bifurcate tip. The fifth tooth, the ventralmost of the two terminals, is smaller than the fourth and does not extend as far distad. The distal part of the rostrum beyond the third tooth ranges between 3 and 8% of the carapace in length, the modal extent being 5%. There is a very slight indication that the relative length of this section of the rostrum, in contrast to the relative length of the whole, may increase somewhat with increasing size.

The antennal angle is armed with a short spine.

The ocular stylets are short, not reaching much beyond the narrow base of the ocular peduncle.

The pleonic somites are sculptured as follows: The posteromedian pleural sulcus of the first somite is complete; the anteromedian pleural extends only a short distance ventrad from the anterior margin. The second and third somites bear a posterior tergal reaching nearly to the ventral margin, an anterior tergal reaching the anterior margin some distance above the ventral margin, and a short posteromedian pleural. It is possible that the ventral half of the posterior tergal represents the posteromedian pleural, although there is no trace of a gap between; and that the sulcus here termed posteromedian pleural is actually the anteromedian. The fourth somite bears a posterior tergal only; the fifth both anterior and posterior tergals; and the sixth an anterior tergal and a posteromedian pleural, together with a longitudinal sulcus. All these sulci are very shallow. The surface of the pleon is not tuberculate.

The first to fourth pleonic somites inclusive are armed with an anterior ventral angle, acute in the larger individuals, in which last the third to sixth somites are armed with a spinose posterior ventral angle. The posterior angle loses its boldness with decrease in size of the individual, and in the smallest ones is faintly indicated on the fourth somite only.

The pleural margin just dorsad the anterior angle of the first somite is concave. The relatively well-defined short ventral margin between the angles of each pleuron from first to fourth is convex. The posterior margins of the postero-dorsal clefts of the fourth and fifth somites are produced as long curved spines. The posterior end of the carina of the fifth somite is not produced as a pronounced tooth, although it descends sharply to the apex of the cleft.

The telson bears only the vestiges of a pair of fixed lateral spines.

The distoventral projection of the petasma is bifurcate. Even in the smallest male, in which the endopods are not hooked together, the petasma is of approximately the same form, except that the swelling at the middle of the lateral margins is much less marked. The lower lobe of the bifurcate disto-ventral projection is always longer and stouter than the distal lobe, and with a much more obtuse tip.

It may be noted that the petasmal rami were joined in males of more than 6 mm carapace length and even in some of those of smaller size, while the sperm receptacles were impregnated in a female of 6.1 mm carapace length. In individuals of less than 6 mm a pair of mobile lateral spines occurr on the telson considerably anterior to the vestiges of the fixed pair. These mobile spines are absent in larger individuals.

E. disdorsalis is the Pacific American congener of the Atlantic *E. dorsalis* (Kingsley), as distinguished from *E. stimpsoni* (Bouvier) in the preceding paper. It is separable from *E. picta* (Faxon), the Pacific American congener of *E. stimpsoni*, by the same characters as distinguish the two Atlantic species. *E. disdorsalis* is distinguishable from *E. dorsalis*, on the basis of comparison with three specimens from Louisiana, the only certainly known in addition to the type, as follows: The anterior tooth of the postrostral carina seems to be set somewhat farther behind the orbital margin in *E. dorsalis*, while the interval between the anterior and posterior teeth is somewhat shorter. The posterior-most rostral tooth is set somewhat closer to the orbital margin, the relative distances in the three specimens falling outside the range in *E. disdorsalis* of comparable size (carapace shorter or longer than 8 mm, respectively). The entire rostrum is somewhat longer; the distal portion is longer; the ventral of the two terminal teeth is smaller relative to the dorsal; and the distal part of the rostrum is not so markedly depressed. The spine of the antennal angle is longer. The pleonic pleural armature is more vigorous; the second somite bearing an acute or spinose posterior ventral angle in large specimens, in which, also, the pleon is somewhat tuberculate. The ventral margins of the first to fourth pleura are concave rather than convex. The ventral furca of the distoventral projection of the petasma is relatively shorter, slenderer, and with a sharper tip than in *E. disdorsalis*.

SERGESTIDAE Dana

SERGESTINAE Bate

ACETES H. Milne Edwards

Division I, Burkenroad, 1934

Epipodite of the second maxillipede not provided with a podobranch. Rostrum with fewer than two denticles behind the terminal point. Third joint of the inferior antennular flagellum of the male without a large distally directed spine or spines. Coxa of the third legs of the female without a distomedian tooth.

Acetes americanus limonensis, new subspecies

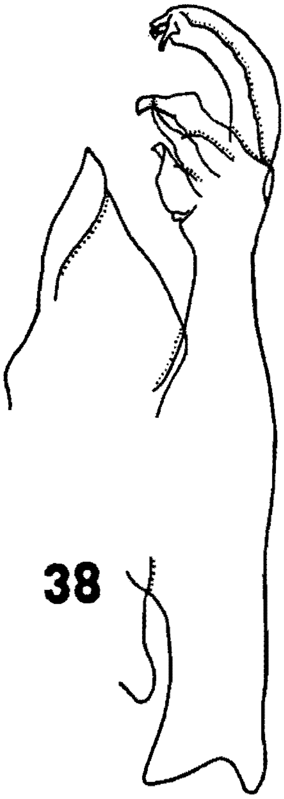
Figures 37 and 38, page 100.

1 male, carapace length 3 mm, total 12 mm; 1 female, carapace 4.1, total 14.3 mm, types; 1 male, cotype. *B.O.C. 104.* Mouth of the Sweetwater River, Limon Bay, Canal Zone, Panama; seine; February 12, 1934.

Description—Except for its different petasma and female genital sternite, *A. a. limonensis* is indistinguishable from the other described Atlantic forms of the Division which have been reported from Brazil (*A. americanus* Ortmann, 1893, with which *A. brasiliensis* Hansen, 1919, is probably identical), North Carolina (*A. carolinae* Hansen, 1933), and Louisiana (*A. carolinae louisianensis* Burkenroad, 1934, with which the present form has been directly compared).

The petasma in both males of *A. a. limonensis* has a pars externa reaching above the base of the capitulum, but not as high as in the Brazilian specimen figured by Hansen, 1919. The midsection of pars media is somewhat expanded, with a convex, not concave median margin; but is somewhat slenderer than in Louisiana males, and much slenderer than in Hansen's figure of a Brazilian male. It may be noted that the apparent degree of expansion of the midsection of pars media may be affected by the pressure of the cover glass. The capitulum of pars media is less swollen and globose than in the other described forms. The inner lobe of the capitulum is much longer than in the Carolina male figured by Hansen, 1933, and is considerably longer than in Louisiana males, possibly even longer than in the Brazilian form. The tip of the inner lobe is armed with three truncated spines, in contradistinction to specimens from more northerly localities, which usually display only two spines, and to the Brazilian form, reported to bear four spines. The lateral lobes of the capitulum seem to resemble those of the Carolina and Louisana material in that the chitinous tips of the distal and proximal lobes are flattened and truncate, but to resemble the Brazilian form in the considerable length of the third, distal, lobe.

The breadth of the median emargination of the posterior margin of the genital



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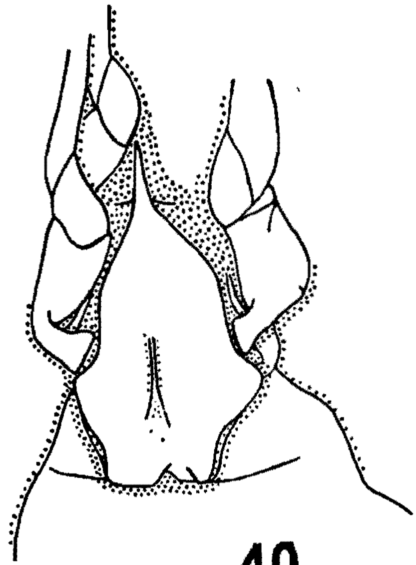

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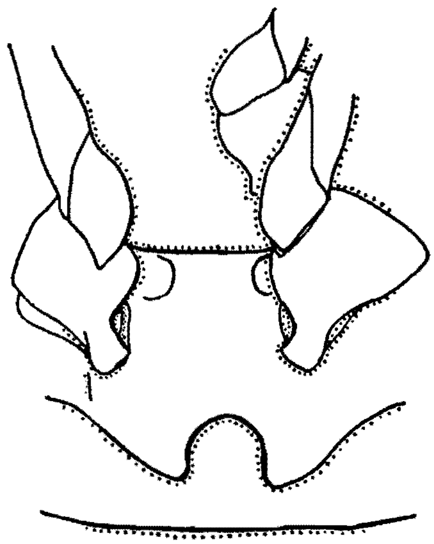

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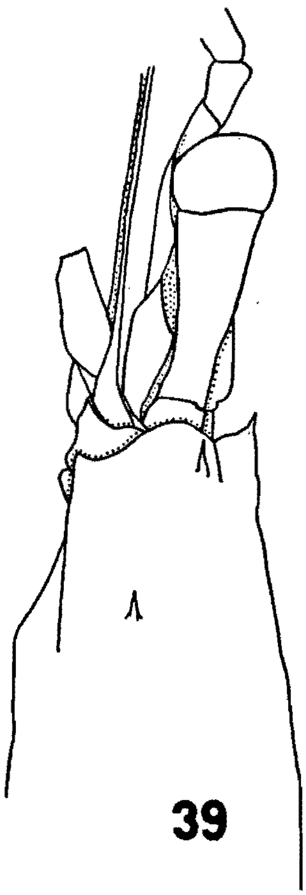

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sternite of the female is somewhat greater than its length. The anterior margin of the concavity forms a rather shallow arch. The sublateral free projections between which the emargination is enclosed taper to a definite tip, and are slightly incurved; their breadth, measured across the middle of their length, is only slightly less than their length. In these characters the Panamanian specimen seems to fall about midway between Carolina and Brazilian material as figured by Hansen. *A. a. limonensis* differs sharply from Louisiana females by the arched, not straight, anterior outline of the median emargination, and the much shorter, stouter, and less incurved sublateral projections of its genital sternite.

Although the Panamanian material seems rather clearly differentiable from all previously described members of the Division, the allocation to it of a systematic position is fraught with difficulty. There seem, in view of the intermediacy of its characters between those of the southern *A. americanus* Ortmann and of the northern form described by Hansen as *A. carolinae*, only two possible procedures: to describe the present specimens as a distinct species, or to regard all the Atlantic American members of the Division as comprising a single species subject to considerable geographical variation. Since material from each of the four known localities is different from the rest in the characters of its petasma and female genital sternites, and since the material from intermediate localities is also intermediate in structure as compared with the geographical extremes of the series, it seems better to accept the second possibility. The Atlantic American members of Division I are therefore to be regarded as the species *Acetes americanus* Ortmann, ranging from Beaufort, N. C. through the Gulf of Mexico and the Caribbean to the Amazon, and divisible for the present into four local races which further material may indicate to intergrade completely: *A. a. americanus* Ortmann, Brazil; *A. a. limonensis* Burkenroad, Panama; *A. a. louisianensis* Burkenroad, Louisiana; and *A. a. carolinae* Hansen, North Carolina.

Acetes binghami,[1] new species

Figures 39 and 40, page 100.

1 female, subadult, holotype. Carapace 3.2, total length 12.2 mm. *B.O.C. 105.* Bella Vista Beach, Panama City; seine; February 9, 1934.

Description—Epipodite of the second maxillipede without a podobranch.

[1] Named for Mr. Harry Payne Bingham.

Figure 37. *Acetes americanus limonensis*, n. subsp.
Genital sternite × 38.

Figure 38. *Acetes americanus limonensis*, n. subsp.
Left petasmal endopod, dorsal view × 87.

Figure 39. *Acetes binghami*, n. sp.
Carapace, anterior portion, lateral view × 17.3.

Figure 40. *Acetes binghami*, n. sp.
Genital sternite × 38.

Base of the third legs without other armature than the expanded nib at the proximomedian corner of the coxa. Rostrum completely without denticles behind the terminal point; short, with produced slender tip. Transverse diameter of the corneal surface of the eye 38% of the length of the distal segment of the ocular peduncle including the cornea. Second segment of the antennular peduncle 58% as long (measured along the median margin) as the third segment. Inferior antennular flagellum with seven segments, about one-sixth longer than the third segment of the peduncle. Thickened basal portion of the superior antennular flagellum as long as the third segment of the peduncle. Antennal scale extending as far as the basal one-third of the third segment of the antennular peduncle.

Third maxillipedes not extending as far as the basal two-thirds of the antennal scale; third legs not reaching the tip of the scale. Coxal expansions of the third legs rather long, broader at tip than at base, and with a truncated free edge. Ciliated portion of the external margin of the exopod of the uropod 39% of the entire margin, set off from the proximal unciliated portion by a small tooth. Exopod 4.3 times as long as broad; the ciliated portion of its external margin only very shallowly concave. The distal margins of the telson curve inward to two short teeth between which is enclosed the slightly convex posterior margin. There is one stout seta laterad either terminal tooth, and four setae between them.

Genital sternite bearing an escutcheon-shaped elevation, the narrow anterior portion of which extends forward between the bases of the second legs, apparently beyond the suture delimiting the genital sternite. Behind the third legs, the elevated surface is considerably expanded, narrowing again to a subrectangular posterior portion terminated by a straight posterior margin which appears to reach to the boundary between pereion and pleon. This posterior portion is not a free projection. There is a slight longitudinal ridge in the midline of the broadest portion of the elevation. The sperm receptacles appear to be empty. They evidently open upon the perpendicular margins of the elevation, just anterior to the bases of the third legs.

The holotype is slightly distorted by pressure, and it is probable that the asymmetry displayed by the elevation of the genital sternite, as well as the emargination of the left side of its posterior margin, are artifacts.

Acetes binghami represents the first record of the genus from Pacific America. By the absence of a podobranch from its second maxillipede, the lack of rostral teeth, and the absence of a tooth at the distomedian angle of the coxa of the third legs, it is set apart from the known Indopacific species and the Atlantic American *Acetes paraguayensis* Hansen, and is marked as a member of the peculiarly American Division I, represented in the Atlantic by *A. americanus* Ortmann. It is probable that the male, when discovered, will lack a large anteriorly-directed spine on the third segment of the inferior antennular flagellum, and that its petasma will not be provided with pars astringens.

Acetes binghami differs from *A. americanus* in several characters, but especially in its unique genital sternite. The absence of all rostral denticulation is unique if characteristic, but is possibly not constant; a similar condition has been observed as an exception in a single female of *A. americanus louisianensis* Burkenroad; and the aberrant loss of one of the two denticles of a female of *A. serrulatus* (Krøyer) by Hansen. The basal portion of the superior antennular flagellum seems slightly longer than in *A. a. louisianensis;* the antennal scale does not reach as far, relative to the antennular peduncle; the third maxillipedes and third legs are slightly shorter. These differences are probably of little significance. The exopod of the uropod is slightly broader than in the extreme of the *A. americanus* series, where the length appears to vary from 4.5 to 5 times the width; the ciliated part of the external margin seems clearly less concave than in *A. a. louisianensis.* The coxal projections of the third legs are of somewhat different shape. Finally, the sculpture of the genital sternite, especially the elevation extending anteriorly as a narrowing ridge between the bases of the second legs, is without parallel in the genus.

SUMMARY

A. PENAEIDAE. PENAEINAE.

1. *Penaeopsis* auct. is composed of the three generic groups *Penaeopsis* Bate, restricted; *Metapenaeus* Wood Mason and Alcock, restricted; and *Trachypeneopsis*, new genus. These genera are defined, and the species referable to each are listed; the first mentioned belongs to the **Parapenaeus**, the last two to the **Trachypeneus** series. *Artemesia* Bate, the third genus of the **Parapenaeus** series, is redescribed.
2. *Penaeopsis* Bate, restricted, of which *Leptopenaeus* Kishinouye, *Ceratopenaeus* Kishinouye, and *Erithropenaeus* Kishinouye are synonyms, consists of the two subgenera *Penaeopsis* sensu stricto, and *Metapenaeopsis* Bouvier. The latter, composed of the species with asymmetrical petasma, is divisible into an Eastern Atlantic and American section 1 with atrophied distoventral projection of the left petasmal endopod, and an Indo-Pacific section 2.
3. *Penaeopsis serratus* (Bate), of which *P. challengeri* DeMan is a synonym, refers to an Indo-Pacific species. It is possible, as indicated by variation in structure within the Atlantic *P. megalops* (Smith), that *P. serratus* is synonymous with *P. rectacutus* (Bate).
4. The American species of *Metapenaeopsis*, including a new Pacific species, are described and discussed. The closely related West African species of the section is evidently not *Penaeus pubescens* Stimpson, but since this latter appears to be a *Parapeneopsis*, may be known as *Penaeopsis pubescens* (Bouvier).
5. *Metapenaeus* Wood Mason and Alcock is limited (save for historica

migrations) to the Indo-Pacific. Additions are made to the descriptions of several species. The status of a number of named forms related to *M. affinis* (H. M. Edwards), and to *M. ensis* (DeHaan) is doubtful; in addition to these, *Penaeus villosus* Guerin-Mèneville is indeterminable; *M. stebbingi* (*Nobili*) Schmitt [*Penaeopsis mogiensis* (Rathbun) Balss, part] refers to *Penaeopsis vaillanti* (Nobili); and *Metapenaeus palaestinensis* Steinitz is a *Trachypeneus*, probably a migrant from the Red Sea. The female of *Metapenaeus incisipes* figured by Bate is probably a species of *Parapeneopsis*.

6. The new genus *Trachypeneopsis* is erected for *T. mobilispinis* (Rathbun), and the very closely related Indo-Pacific *T. richtersii* (Miers). The known range of *T. mobilispinis* is extended nine degrees north of the previous record.
7. *Protrachypene precipua*, n. gen. and sp., is an unique Pacific American form in some respects intermediate between *Metapenaeus* and *Trachypeneus*.
8. *Trachypeneus* Alcock is composed of two subgenera, the Indopacific *Trachypeneus* sensu stricto, and the predominantly American *Trachysalambria*, n. subgen. It is possible that the former is more nearly related to the predominantly Indo-Pacific *Parapeneopsis* Alcock than to *Trachysalambria*.
9. Three new forms of *Trachypeneus* (*Trachysalambria*) are described from Pacific America, an area from which the genus has not been previously recorded. One of these is referable to the otherwise Indo-Pacific section 2 of the subgenus while the remaining species are related to Atlantic American forms, one being no more than subspecifically differentiated from *T. similis* (Smith). Additions are made to the description of the Japanese *T. curvirostris* (Stimpson); it is suggested that more than one Indo-Pacific species of the section may exist.
10. The Indo-Pacific *Parapeneopsis hardwickii* (Miers) and *P. hungerfordi* Alcock are redescribed and their known range considerably extended. *Parapeneopsis sculptilis* var. *cultrirostris* Alcock is probably no more than the normal adult male form. A new species of *Parapeneopsis*, more closely related to *P. atlantica* Balss than to known Indo-Pacific representatives, is described from Pacific America. It is possible that *Penaeus pubescens* Stimpson is referable to the genus, which has otherwise not been previously recorded from America.

B. PENAEIDAE. EUSICYONINAE.

11. *Eusicyonia* Stebbing consists of two fairly distinct divisions, the first cosmopolitan, the second American. Four new Pacific American species and one from the Atlantic are described and compared with

related species. Material indistinguishable from the Atlantic American *E. laevigata* (Stimpson) and *E. brevirostris* (Stimpson) is recorded from Pacific America. *E. carinata americana* (DeMan) is synonymous with *E. laevigata* (Stimpson).

C. SERGESTIDAE. SERGESTINAE.

12. A new subspecies of *Acetes americanus* Ortmann, intermediate between that form and *A. carolinae* Hansen, is described from the Atlantic coast of Panama. It is suggested that *A. carolinae* is a subspecies of *A. americanus*.
13. A new species of *Acetes* from the Bay of Panama, a member of the American Division I, constitutes the first record of the genus from Pacific America.

D. MORPHOLOGY.

14. A generally applicable terminology for the peneid petasma is prepared. The homologies of the asymmetrical petasma with that of other members of the **Parapenaeus** series are discussed. The structure of the petasma of certain members of the **Trachypeneus** series is made known and the various types are compared. Of especial interest is the perfection of the petasma as an injection apparatus in certain species of *Parapeneopsis*, correlated with an extreme specialization of the female receptacles.
15. The internal structure, homologies, and probable mode of operation of the thelycum of a number of Penaeinae are described, including a discussion of certain methods of separation of the entrance and exit to the sperm receptacles.

Figures from camera lucida drawings by the author.

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