

Chick

PYCNOGONIDS

Sea Spiders of California

Sea spiders are neither spiders nor crustaceans. They are a separate class of the phylum Arthropoda (or a separate subphylum according to some). They do, however, have considerable gross anatomical similarity to spiders. The following comments on the general anatomy and natural history of sea spiders are drawn in large part from a semi-popular synopsis by King (1974) augmented with observations by others (particularly Bouvier 1923). King's account is recommended to all interested in the ecology or taxonomy of California sea spiders.

STRUCTURE

Most pycnogonids have four pairs of legs, although species with five or six pairs are found elsewhere in the world (Fry and Hedgpeth 1969), and may be located in waters offshore California. An anterior proboscis, a dorsal ocular tubercle, and a posterior abdomen are found along the midline of the body (Fig. 1). The ocular tubercle may either be absent (as in the aberrant interstitial Rhynchothorax) or may range from a low nub to a long thin "turret" raised far above the dorsum. It may be followed by one or more anoculate tubercles along the dorsal midline. The abdomen may in some species protrude above the dorsum rather than posteriorly.

Three other types of appendages occur: chelifores, palps, and ovigers. Chelifores are short, 1-4 segmented limbs above the proboscis, usually ending in chelae. Posteroventral from these a pair of palps are located in some species. Chelifores and palps are not present in all species, and their structure varies with age in some families. The chelifores may be chelate in the young and achelate in the adult (eg. Achelia), or chelate throughout their development (eg. Nymphon). In the Endeidae and Colossendeidae the chelifores are completely lost with the transition from juvenile to adult.

Ovigers are, as their name suggests, primarily organs for transport and storage of eggs. In the Pycnogonidae, Endeidae, and Phoxichilidiidae they are found only on males (eg. Anoplodactylus), while they occur on both sexes in the remaining five families. They usually bear a brush-like elaboration of the last few segments termed a strigillus, which is of diagnostic value, as are both the number of oviger articles and their proportions. In groups where the female also bears ovigers, they are not used by the female for egg carrying.

While the full range of oviger function is not yet clear, observations of living pycnogonid females suggest the secondary purpose of ovigers is cleaning (Hedgpeth and Haderlie 1980). The strigillus and curved terminal segments of ovigers are scraped up and down the walking legs in grooming behavior similar to that found in most arthropod groups. During periods when males are not carrying eggs they are able to use their ovigers for grooming instead. In some deep-water species males have not been observed carrying eggs on their ovigers, and the primary oviger use in both sexes seems to be grooming.

The main type of appendage in pycnogonids is the walking leg. Legs consist of three coxae, a femur, two tibiae, a tarsus, a propodus and a terminal claw (Fig. 1). Either the propodus or terminal claw may bear one or more auxiliary claws as well. Characters of interest on legs are: length; proportions of segments; presence and position of spines or tubercles; presence, number, shape, and location of femoral cement glands in the male; and details of the terminal claw and the "sole" and "heel" of the propodus. Femoral cement glands extrude a substance used by the male to hold the eggs together as a cohesive mass, and to stick them to the oviger.

Characters of the proboscis of taxonomic importance are; length, shape, jaw structure, and angle of attachment to the body. Frey and Hedgpeth (1969) in a study of antarctic pycnogonids, developed a comprehensive system for description of proboscis shape as a simple formula (Attachment A).

The body is variable in general shape (discoid to elliptic), degree of separation of the lateral processes, spination, and presence of tubercles on midline or lateral processes. The optical tubercle bears 2-4 eyes (generally 4) in pairs. The relative sizes of the anterior and posterior pairs may differ. The abdomen seldom has characters of taxonomic utility, but in a few species presence or position of abdominal spines, or the length and curvature of the abdomen itself can be diagnostic.

SEXUAL DIFFERENCES AND SEXING

Sexes are separate in pycnogonids (although hermaphroditism was reported by Marcus [1952]). Sexual dimorphism is usual, but not extreme. For many species this creates a problem in sexing individuals. Often there is no gross dimorphism, and accurate sex determination is dependant on finding and recognizing the male or female gonopores, the femoral cement gland structures of the male, or eggs in the legs of the female. The following cheery comment is from King 1974. "In both males and females the reproductive openings are situated at the base of some or all of the legs. The specific legs and the number of legs possessing gonopores vary in different species and are not necessarily the same in both sexes." Daunting as this statement is, all is not lost. As all species bear gonopores on the posterior legs, start looking for gonopores on leg 4 and move forward. Gonopores are located at or near the distal end of coxa 2 in both sexes. In the male the gonopore is often elevated above the general level of the segment (the genital spur of Child 1979).

Pycnogonids engage in pseudocopulation with the male either above or below the female. Species with the male above (eg. Pycnogonum spp. have the male gonopore on the ventral side of the segment, and the female gonopore on the dorsal side of the segment. This allows direct apposition of the two apertures during pseudocopulation and facilitates fertilization. Species in which the male adopts a position under the female have the gonopores on the ventral side of coxa 2 in both sexes for the same reason.

FEEDING

Pycnogonids lack the complex mouthparts possessed by crustaceans. The tips of their proboscides bear tripartite jaws. When these are poorly developed the proboscis lumen appears to be a simple pore, or a pore flanked with fine denticles (in some Endelidae). Observations on feeding of various species suggests that most feeding is suctorial. Food consists of detritus; living diatom films, "aufwuchs", or fine filamentous algae; coelenterates; annelids; mollusks; ectoprocts; or ascidians. Species with chelate chelifores may use these organs to transport morsels to the mouth. Species feeding on coelenterates, annelids, mollusks, or ascidians force the tip of their proboscis into the host and suck up body fluids. Ectoproct feeders suck individual zooids from their zooaria.

Information of feeding habits in pycnogonids is still accumulating. Early reports of associations between pycnogonids and particular "prey" species need careful review. Although developing juveniles may have a parasitic relationship with a particular species, the adult may use the juvenile host as habitat rather than food, actually feeding on other organisms.

GROWTH AND DEVELOPMENT

Pycnogonid eggs are developed within the legs of the female, extruded through the female gonopores, fertilized externally during extrusion, and then carried by the ovigers or on the legs of the male. Initial developmental stages are passed in the egg. Once the protonymphon larval stage is reached two developmental paths are used, direct and anamorphic. In direct development the young remain in the egg until they reach full adult configuration.

In anamorphic development they are hatched as protonymphon larvae with only the first three sets of appendages and no walking legs. They sequentially add body segments posteriorly, each with a pair of legs. As they mature they pass through 2,4,6, and 8 legged juvenile molts before reaching full adult morphology. Along the way they may lose functional chelae, or the entire chelifore, yielding achelate adults.

The protonymphon larvae of some species locate the adult food substrate, penetrate the tissues and encyst (Dogiel 1913). Development proceeds at the expense of the host until the juveniles exit the host tissue and take up a predatory adult existence. In testate hosts the juveniles may adopt a position within the shell as an ectoparasite (Benson & Chivers 1960). Hedgpeth (1975) maintains parasitism during part of the life cycle is the norm; Child and Nakamura (1982) that it is rare.

CALIFORNIA PYCNOGONID FAUNA

Undescribed species of pycnogonids are either less common, or less frequently recognized in California waters than are seemingly new species of other arthropods. There are 39 currently recognized described species reported to occur in California, several provisionally connected to known species, and at least two undescribed species: a total of between 41 and 44 different pycnogonids. Very few of these are taken in benthic sampling of soft substrates with remote samplers. Most of the species occur intertidally or in shallow subtidal areas on rock substrate or as microepifauna associated with large attached animals or plants. Nearly all the world families are represented in our waters, but many genera found elsewhere are unreported here. For instance only 3 (or 4 if one questionable record is verified) of the 22 genera of Callipallenidae have been recorded from our waters. As in other arthropod groups the local pycnogonid fauna is a mixture of northern and southern elements.

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Please send any comments, corrections, and distributional information from your records to one of the above for inclusion in the next update version.

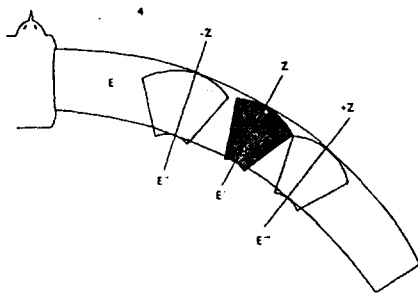
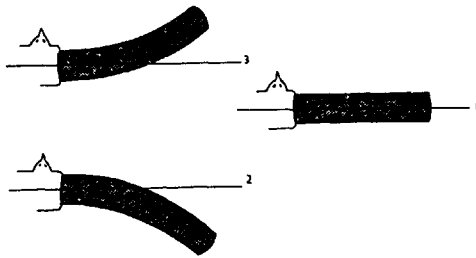


FIG. 6—Types of proboscis curvature in Pycnogonida: 1, straight; 2, downcurved; 3, upcurved; 4, types of variation in the distribution of curvature, E=uniform throughout, E' = greatest curvature about midpoint of length of axis, E'' = greatest curvature proximal to the midpoint of the axis length, E''' = greatest curvature distal to the midpoint of the axis length. Z indicates the midpoint of the axis length. (See text for further discussion.)

THE SHAPE OF THE PROBOSCIS IN PYCNOGONIDA (Figs 5, 6)

The shapes of proboscides in pycnogonids have frequently been described by a single adjective, e.g., "clavate", "oval", "spindle-shaped", etc. Such descriptions can include wide variations, and conceal a number of character states of proboscis shape which are of use in diagnosing affinities or differences between individuals or taxa.

In order to make such character states available for use in keys, descriptions, and comparisons, a scheme of classification of proboscis shape is proposed here and used throughout the work. The number of co-ordinates used in this scheme has been kept to a minimum. It is extremely difficult to represent any biological form geometrically, but the present scheme appears to have worked well for the collections studied, and has proved to be an adequate method for describing intraspecific variation in proboscis shape.

The co-ordinates used in the scheme are the distal and proximal diameters of the proboscis; the presence or absence of a dilation at some point along the proboscis; the position of such a dilation with relation to the mid-length of the proboscis; the presence or absence, and the size relative to the proximal diameter, of a second and more distal dilation; and the type of curvature of

the proboscis. Assessment of curvature is made from the lateral aspect, and the other criteria are assessed from the dorsal aspect.

Descriptions of proboscis shape using this scheme of classification may be written out in simple formulae, e.g., *Colossendeis robusta*, B''' : 1; *Ammothea australis*, D or D' or A : 1 or 2; E. The second example indicates the range of variation of proboscis shape encountered in this species. The types of expression of the various criteria which have been observed in pycnogonids are shown in Figs. 5 and 6.

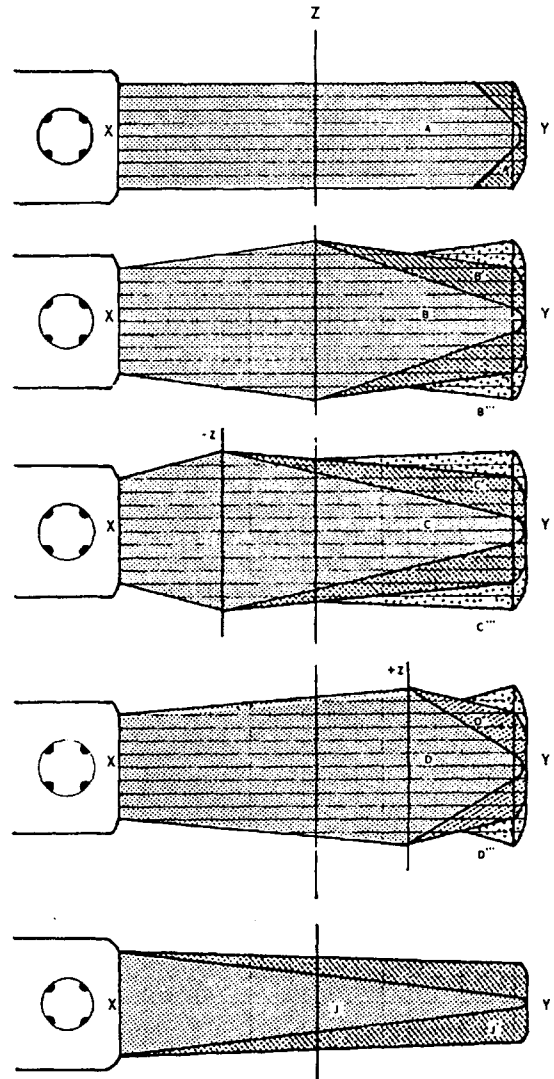


FIG. 5—The five main types of proboscis shape in the Pycnogonida. The criteria involved are: The presence or absence, and position, of one or two dilations; the relative diameters of the proboscis at its insertion into the cephalic somite and at its distal extremity. X and Y indicate proximal and distal diameters; Z indicates the midpoint of the longitudinal axis. (See text for further details.)

ATTACHMENT A. Proboscis shape description in pycnogonids (From Fry and Hedgpeth 1969)

TAXONOMIC LIST OF CALIFORNIA PYCNOGONIDS

Family Ammotheidae

Achelia

alaskensis (Cole 1904)

Ammothea alaskensis Cole 1904

Ammothea nudiuscula Hall 1913

Achelia gurjanovii Losina-Losinsky 1961

chelata (Hilton 1939)

Ammothea euchelata (Hedgpeth 1941)

echinata Hodge 1864

A. fibulifera Dohrn 1881

gracilipes (Cole 1904)

latifrons (Cole 1904)

simplissima (Hilton 1939)

spinoseta (Hilton 1939)

Ammothea

hilgendorfi (Böhm 1879)

Lecythorhynchus hilgendorfi

L. marginatus Cole 1904

Ammothella

biunquiculata (Dohrn 1881)

menziesi Hedgpeth 1951

setosa Hilton 1942

spinifera Cole 1904

tuberculata Cole 1904

Eurycyde

spinosa Hilton 1916

Nymphopsis

spinosissima (Hall 1912)

Ammothella spinosissima Hall 1912

Tanystylum

californicum Hilton 1939

T. intermedium of Hedgpeth 1940

duospinum Hilton 1939

intermedium Cole 1904

non *T. intermedium* of Hedgpeth 1940

T. panamum Hilton 1942

T. intermedioides Hedgpeth 1961

nudum Hilton 1939

occidentalis (Cole 1904)

Clotenia occidentalis Cole 1904

oculospinum Hilton 1939

Genus A of MBC (between Nymphopsis and Cilunculus)

sp. A of MBC

Family Callipallenidae

Anoropallene

palpida (Hilton 1939)

Oropallene heterodonta Hilton 1942

Anoropallene crenispina Stock 1956

Callipallene

californiensis (Hall 1913)

Pallene californiensis Hall 1913

Callipallene sollicitatus Child 1979

pacifica (Hedgpeth 1939)

TAXONOMIC LIST OF CALIFORNIA PYCNOGONIDS

Family Callipallenidae (cont.)

Decachela

discata Hilton 1939

sp. A of MBC

Family Colossendeidae

Hedgpethia

californica (Hedgpeth 1939)

Colossendeis californicus

C. chitinsa Hilton 1943

C. bicornis Turpaeva 1958

Rhynchothorax

philopsammum Hedgpeth 1951

Family Endeidae

Endeis

nr. procera

Family Nymphonidae

Nymphon

heterodenticulatum Hedgpeth 1941

pixellae Scott 1913

N. solitarium Exline 1936

? *N. variatum* Hilton 1942

Family Phoxichilidiidae

Anoplodactylus

californicus Hall 1912

A. californiensis Hall of Hedgpeth 1941

A. portus Calman 1927

A. robustus of Hilton 1939 (non Dohrn 1881)

A. carvalhoi Marcus 1940

A. projectus Hilton 1942

erectus Cole 1904

nodosus Hilton 1939

oculospinus Hilton 1942

pacificus Hilton 1942

viridintestinalis (Cole 1904)

Phoxichilus compactus Hilton 1939

Endeis compacta Hilton 1943

A. compactus (Hilton 1939) of Austin 1985

cf. pacificus of MBC

Phoxichilidium

femoratum (Rathke 1799)

parvum Hilton 1942

P. hokkaidoense Utinomi 1954

quadridentatum Hilton 1942

Family Pycnogonidae

Pycnogonum

rickettsi Schmitt 1934

stearnsi Ives 1892

PYCNOGONIDA COLLECTED
PT. CONCEPTION - SAN DIEGO

						P	S	
						T	C	M
B	L					O	L	C
A	H	A	M	M	R	O	W	
T	Y	C	B	E	C	M	R	M
T	P	O	C	C	O	A	P	L

Achelia chelata				X	X				
Achelia echinata					X				
Achelia latifrons				X					
Achelia simplissima				X	X				
Amothea hilgendorfi		X		X	X				
Amotheidae Genus A sp A				X					
Ammothella menziesi				X					
Ammothella setosa		X			X	X			
Ammothella tuberculata				X					
Anoplodactylus californicus			X	X					
Anoplodactylus erectus	X	X		X	X	X		X	X
Anoplodactylus nodosus					X	X			
Anoplodactylus oculospinus				X			X		
Anoplodactylus pacificus			X						
Anoplodactylus viridintestinalis				X					
Anoropallene palpida		X		X					
Callipallene pacifica	X			X					
Decachela sp A				X					
Endeis nr procera				X					
Eurycyde spinosa				X					
Hedgpethia californica				X					
Nymphon heterodenticulatum				X	X	X			
Nymphon pixellae			X	X	X			X	
Nymphopsis spinosissima				X					
Phoxichilidium femoratum				X					
Pycnogonum rickettsi				X		X	X		
Pycnogonum stearnsi			X	X				X	
Rhynchothorax philopsammum				X					
Tanystylum californicum				X	X	X			
Tanystylum duospinum				X					
Tanystylum nudum				X					
Tanystylum intermedium		X		X					
Tanystylum occidentalis				X					

Photopygus jordanae

- BATT - BATTELLE-VENTURA
- HYP - HYPERION
- LACO - LOS ANGELES COUNTY
- MBC - MARINE BIOLOGICAL CONSULTANTS
- MEC - MARINE ECOLOGICAL CONSULTANTS
- ORCO - ORANGE COUNTY
- PTLOMA - SAN DIEGO
- SCCWRP - SCCWRP

PYCNOGONIDA

KEY TO THE SOUTHERN CALIFORNIA FAMILIES*
(Child, 1979; adapted from Hedgpeth, 1948)

1. Chelifores and palps present; ovigers on both sexes.....2
 Chelifores or palps, or both, absent or greatly reduced;
 ovigers in both sexes or male only.....4
2. Chelifores or chela, or both, vestigial (some achelate) [palps
 4- to 10-segmented; ovigers 9- or 10-segmented, with or
 without feeble strigilis and terminal claw, with simple or
 denticulate spines].....**Ammotheidae**
 Chelifores and chela well developed, functional.....3
3. Palps 5-segmented [oviger 10-segmented with strong
 strigilis, terminal claw and denticulate spines; propodus with
 auxiliary claws].....**Nymphonidae**
 Palps absent, reduced to small knobs, or with 4 segments
 [oviger 10-segmented, with strigilis, simple or denticulate
 spines, with or without terminal claw; propodus with or
 without auxiliary claws].....**Callipallenidae**
4. Palps 4-segmented; chelifores absent; ovigers 10-segmented in
 both sexes [with weak strigilis, terminal claw and spines with
 feeble denticulations; propodus with auxiliary claws].....
 **Colossendeidae**
 Palps absent; chelifores present or absent; ovigers in male
 only.....5
5. Chelifores present, functional; ovigers 5- or 6-segmented in
 male only [lacking strigilis and terminal claw, spines simple;
 auxiliary claws absent or tiny and weak].....**Phoxichilidiidae**
 Chelifores and palps absent; ovigers in male only.....6
6. Body and legs slender (Anoplodactylus-like); ovigers
 7-segmented, lacking strigilis and terminal claw, spines
 simple; strong auxiliary claws.....**Endeidae** *
 Body and legs stout, short, with or without reticulations;
 ovigers 7- to 9-segmented, lacks strigilis; terminal claw and
 simple or bifid spines present; auxiliary claws small or
 lacking.....**Pycnogonidae**

* Only one species of the Endeidae, Endeis nr procera,
(Fig. 2) has been reported to occur in southern California by SCAMIT
agencies.

Family AMMOTHEIDAE

KEY TO THE GENERA OF SOUTHERN CALIFORNIA
(Child, 1979)

1. Body circular or discoidal, lateral processes touching or only narrowly separated distally; scape of chelifore 1-segmented; palps 4- to 8-segmented.....2

Body more slender, lateral processes separated by half their length or widely separated; scape of chelifore with 1 or 2 segments; palps 9- or 10-segmented.....3
2. Palp 8-segmented; chela present but vestigial; proboscis pyriform; 1st and 2nd coxae with tall dorsolateral tubercles..
.....Achelia

Palp 4- to 7-segmented; chela usually absent, scape reduced to short knob; proboscis usually a tapering cylinder or tubular; 1st coxae only with low rounded tubercles.....Tanystylum
3. Proboscis 2-segmented, a proximal cylinder articulated with pyriform proboscis; most appendages with large pointed spines; abdomen large, spinose; chela vestigial; palps and ovigers 10-segmented; without auxiliary claws.....Eurycyde *

Proboscis of usual single segment, pyriform, ovoid, or cylindrical, with constrictions.....4
4. Palps 9- or 10-segmented, chelifores inserted at distal margin of cephalic segment.....5

Palps 8-segmented, chelifores inserted within anterior cavity of cephalic segment.....Genus A of MBC ****
5. Proboscis ovoid or modified cylindrical; palps 9-segmented....
.....5

Proboscis pyriform; palps 9- or 10-segmented.....Ammothella
6. Proboscis ovoid, egg-shaped; trunk with 2 tall median tubercles; legs with tall setose tubercles; chelifores with 3 segments; abdomen long, bent posteriorly.....Nymphopsis **

Proboscis cylindrical, ends constricted; tall tubercles absent; chelifores blunt, with 2 segments; ocular tubercle a low cone; abdomen short, blunt.....Ammothea ***

Only the four species of their respective genera listed below have been reported from southern California:

- * Eurycyde spinosa (Fig. 2); ** Nymphopsis spinosissima (Fig. 3); *** Ammothea hilgendorfi (Fig. 4); **** Genus A sp. A of MBC (Fig. 5).

Genus ACHELIA
(modified from Light's Manual, 1975)

1. Never chelate in adult.....2
 Chelate in adult.....Achelia chelata (Fig. 6)
2. Trunk and legs conspicuously spinose, with small spinose
 tubercles on 1st coxae.....3
 Without spiny processes or knobs on 1st coxae, but some
 species with fingerlike spurs.....4
3. Terminal segments of palps with ventral lobes.....
 Achelia spinoseta (Fig. 6)
 Palps without ventral lobes, but subcylindrical.....
 Achelia echinata (Fig. 6, 7)
4. First coxae with fingerlike dorsal processes; propodus with
 basal spines; palps 8-jointed.....5
 First coxae without such processes; no large basal spines on
 propodus; palps 7-jointed.....6
5. Processes on coxae 3/4 as long as the joint; proboscis
 narrowly elliptical.....Achelia gracilipes (Fig. 6, 8)
 Processes on coxae less than 1/2 as long as the joint;
 proboscis broadly elliptical.....
 Achelia alaskensis (Fig. 6, 9, 10)
6. Chelifore with conspicuous dorsal tubercles.....
 Achelia latifrons (Fig. 11, 12)
 Chelifore smooth, without dorsal tubercles.....
 Achelia simplissima (Fig. 6)

Genus **TANYSTYLUM**
(from Hedgpeth, 1941)

1. Proboscis tapered to a point.....2
Proboscis rounded, body very compact.....
.....Tanystylum occidentalis (Fig. 13)
2. Delicate, pale form.....3
Light brown, knobby form, with articulations of joints lighter
than body, or white.....4
3. Sharp, spinelike protuberance on lateral processes; proboscis
narrow; living on Obelia.....Tanystylum intermedium (Fig. 14)
Without spines on body or lateral processes; proboscis broader
.....Tanystylum nudum
4. Three spines at base of second tarsal segment; ovigers
10-jointed.....Tanystylum californicum (Fig. 15)
Two spines at base of second tarsal segment; ovigers unjointed
.....Tanystylum duospinum (Fig. 15)

Genus **AMMOTHELLA**

(modified from Light's Manual,
1975 and Hedgpeth, 1941)

1. Body compact; disciform; lateral processes close together;
legs short, stout.....2

Body more or less elongate; lateral processes separated; legs
long and slender.....3
2. Tubercles present on dorsal posterior margins of first two or
three trunk segments; tubercle present on distal margin of
dorsal surface of lateral process; eye tubercle about as long
as basal diameter.....Ammothella tuberculata (Fig. 16)

Tubercles absent on dorsal surface of trunk segments and on
lateral process; length of eye tubercle about three times the
basal diameter.....Ammothella spinifera (Fig. 17, 18)
3. Dorsal tubercles present on midline of trunk and on lateral
processes.....4

Dorsal tubercles absent.....Ammothella biunguiculata (Fig. 19)
4. Propodus about 4 times as long as its dorsoventral width,
without large basal spines at "heel", but with regular series
of large spines along "sole"; auxiliary claw 3/4 as long as
terminal claw.....Ammothella setosa (Fig. 18)

Propodus about 3 times as long as wide, heel well developed,
with 3 large, basal spines; auxiliary claw 1/2 as long as
terminal claw.....Ammothella menziesi (Fig. 18, 20)

Family NYMPHONIDAE

KEY TO THE SPECIES OF NYMPHON FROM SOUTHERN CALIFORNIA
(adapted from Hedgpeth, 1941)

1. Large, conspicuous form over 50 mm in extent.....2
Small, delicate form, 25-30 mm; moderate depths; living on tunicates (off Catalina Island).....Nymphon heterodenticulatum
2. Fingers of chelae short, thick; legs stout, with scattered spines; neck short (Puget Sound - Bering Sea, circumpolar)....
.....Nymphon grossipes (Fig. 21)
Fingers of chelae slender; legs slender; neck long (southern California).....Nymphon pixellae (Fig. 21)

Family CALLIPALLENIDAE

KEY TO THE GENERA OF SOUTHERN CALIFORNIA
(Child, 1982)

1. With segmented palps or palp tubercles.....2
Without trace of palps.....3
2. Ovigera with terminal claw; auxiliary claws present.....Oropallene
Ovigera without terminal claw; auxiliary claws absent.....Anoropallene *
3. Chela with serrate or denticulate fingers, auxiliary claws present.....Callipallene
Chela fingers smooth, without teeth, auxiliary claws absent....Decachela

* Only one species of Anoropallene, A. palpida (Fig. 22), has so far been reported to occur in southern California waters by SCAMIT agencies.

Genus CALLIPALLENE
(adapted from Hedgpeth, 1941)

- Body distinctly segmented; offshore.....Callipallene pacifica (Fig. 23)
Segmentation of last two trunk segments indistinct; body rather compact; littoral.....Callipallene californiensis (Fig. 23-25)

Genus DECACHELA

- Trunk and legs not conspicuously spinose.....Decachela discata (Fig. 26)
Entire body heavily spinose....Decachela sp. A of MBC (Fig. 26)

Family COLOSSENDEIDAE

KEY TO THE SPECIES OF SOUTHERN CALIFORNIA

- Ocular tubercle extremely low; eyes absent.....
.....Rhynchothorax philopsammum (Fig. 27)
- Ocular tubercle high.....Hedgpethia californica (Fig. 28)

Family PHOXICHILIDIIDAE

First trunk segment projecting over proboscis forming long neck (except in A. viridintestinalis); oviger 6-jointed with very small terminal segment.....Anoplodactylus

First trunk segment not elongated anteriorly to form neck; oviger with sixth segment partially or completely fused to fifth.....Phoxichilidium

Genus PHOXICHILIDIUM

KEY TO THE SPECIES OF SOUTHERN CALIFORNIA (adapted from Hedgpeth, 1941)

With minute knobs or "palpi" just posterior to chelifores.....Phoxichilidium parvum (Fig. 29)

Without such knobs.....Phoxichilidium femoratum (Fig. 30, 31)

Genus ANOPLODACTYLUS

(modified from Hedgpeth, 1941)

1. First trunk segment not conspicuously overhanging proboscis; vivid green guts apparent throughout body and legs.....Anoplodactylus viridintestinalis (Fig. 32)

First trunk segment overhanging forward, so that proboscis appears ventral in origin; guts not green.....2

2. Lateral processes separated at base.....3

Lateral processes contiguous at base, body compact; littoral...Anoplodactylus californicus (Fig. 33)

3. Lateral processes and first coxae each with a pair of tubercles.....Anoplodactylus oculospinus (Fig. 34)

Lateral processes and first coxae each with one tubercle or none.....4

4. Without knobs on legs.....5

Knobs on long joints of legs...Anoplodactylus nodosus (Fig. 35)

5. Lateral processes with dorsal tubercles.....Anoplodactylus erectus (Fig. 36)

Lateral processes without dorsal tubercles.....Anoplodactylus pacificus (Fig. 37)

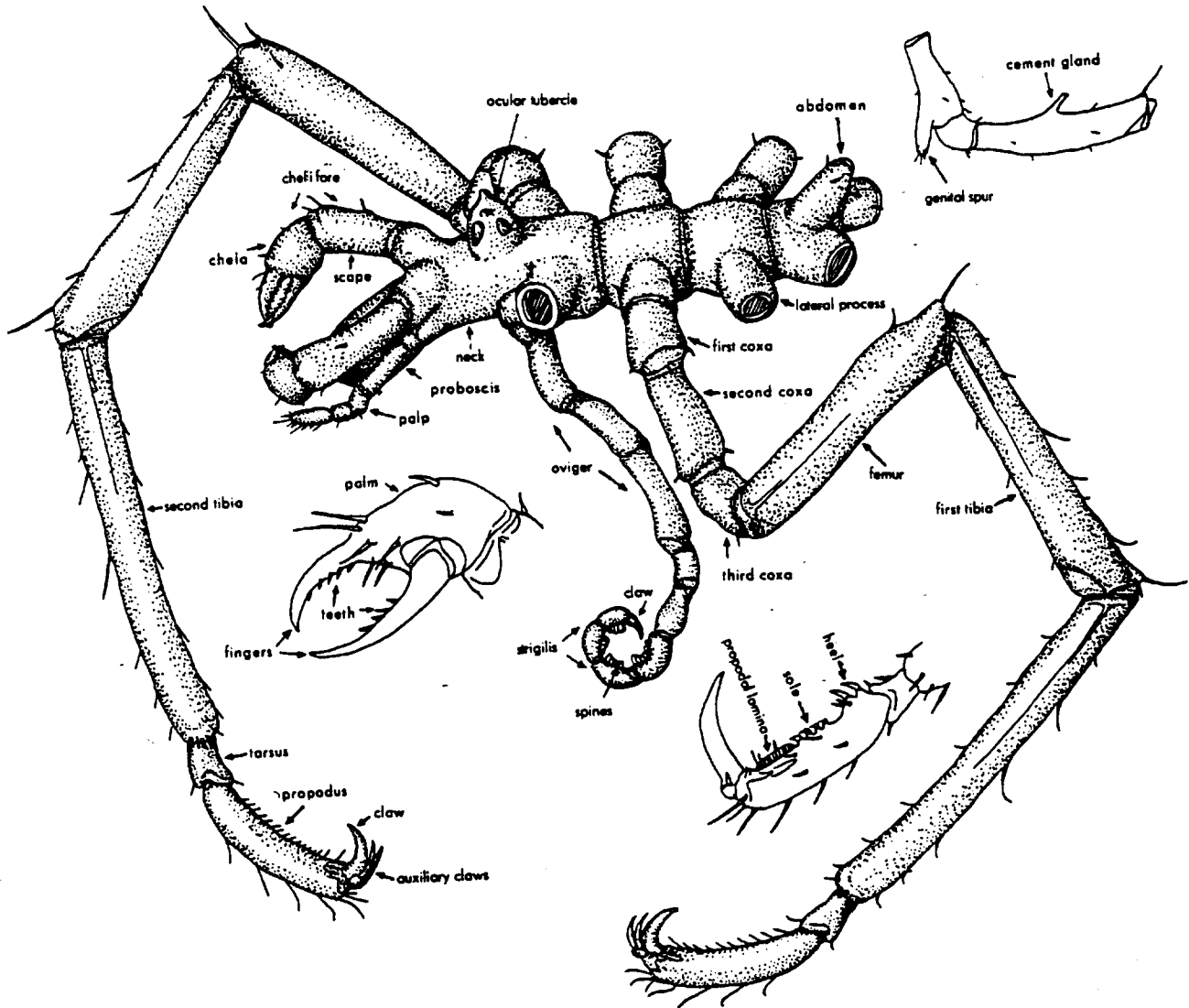
Family PYCNOGONIDAE

KEY TO THE SPECIES OF PYCNOGONUM FROM SOUTHERN CALIFORNIA
(adapted from Light's Manual, 1975)

Body apparently smooth, but minutely granular; even-toned in color (ivory to light pink); dorsal tubercles when present not much higher than their dorsal diameter. Littoral; often on Cribrina or Metridium, and Abietinaria.....Pycnogonum stearnsi (Fig. 38)

Body of uneven tone, usually light brown with dark lines or clear areas between darker patches ("reticulated"); dorsal trunk tubercles, higher than basal diameter. Subtidal; on wharf pilings and on anemones.....Pycnogonum rickettsi (Fig. 39)

Fig. 1

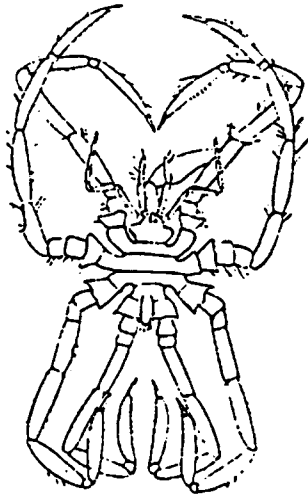


A DIAGRAMMATIC PYCNOGONID, WITH INSETS OF OTHER PYCNOGONID APPENDAGES, SHOWING TERMS USED IN KEYS. (FROM CHILD, 1979)

Fig. 2

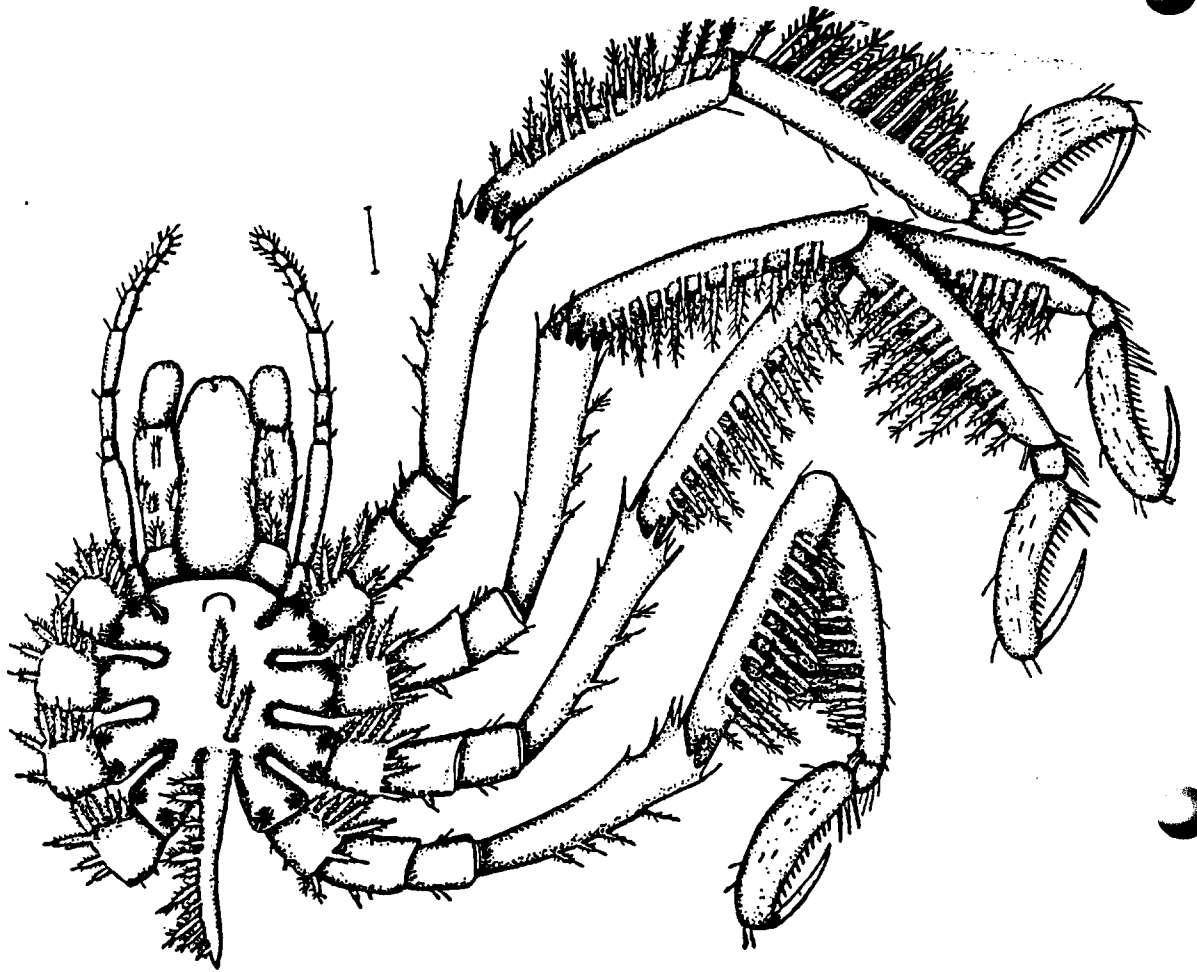


Endeis procera: A, body, dorsal; B, terminal segments of leg.
(from Fry & Hedgpeth, 1969)



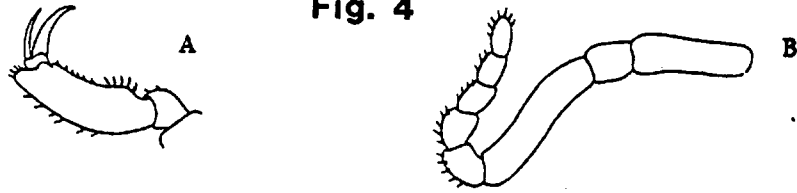
Eurycyde spinosa (from Hilton, 1939)

Fig. 3

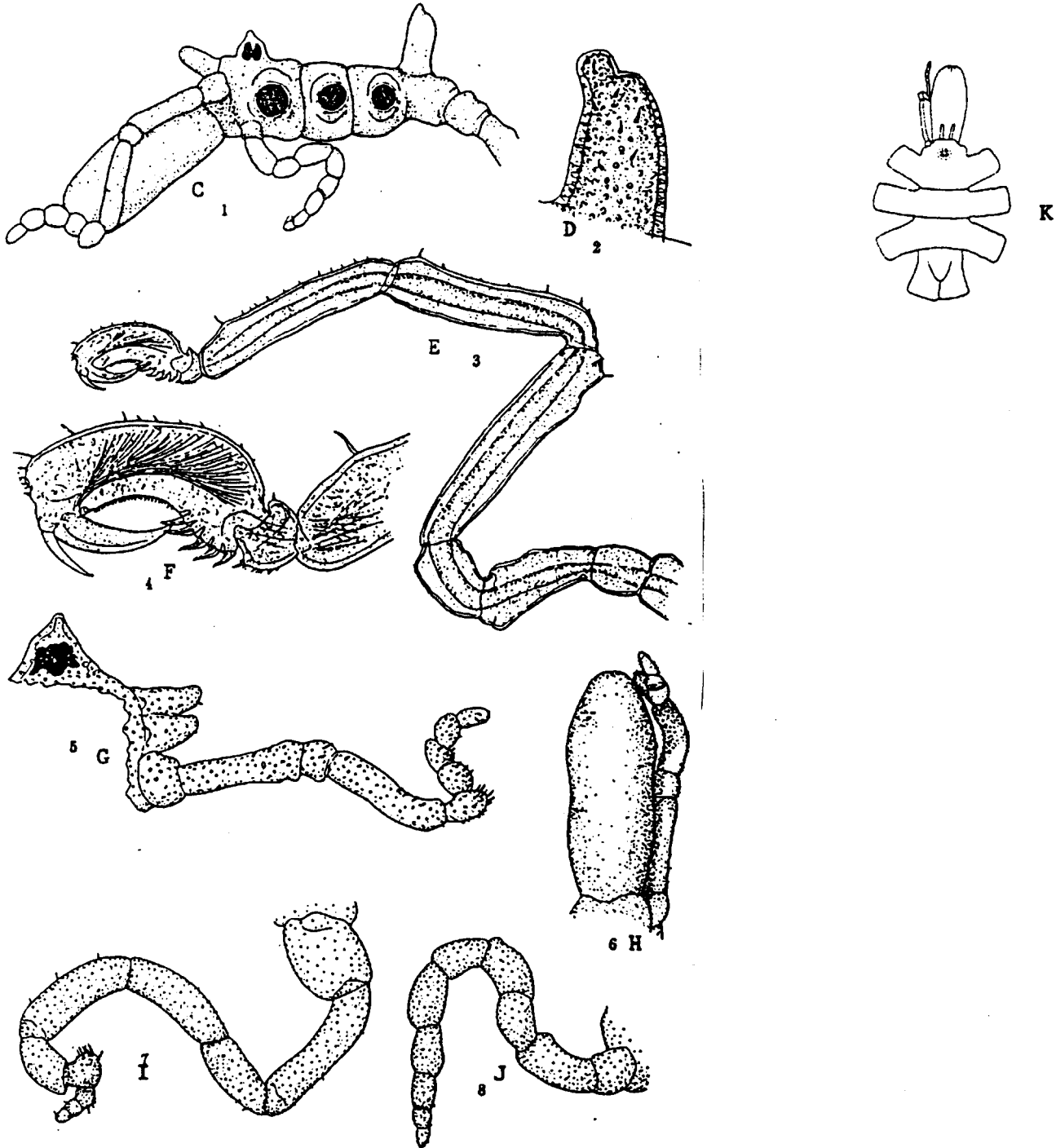


Nymphopsis spinossima (from Hilton, 1942)

Fig. 4

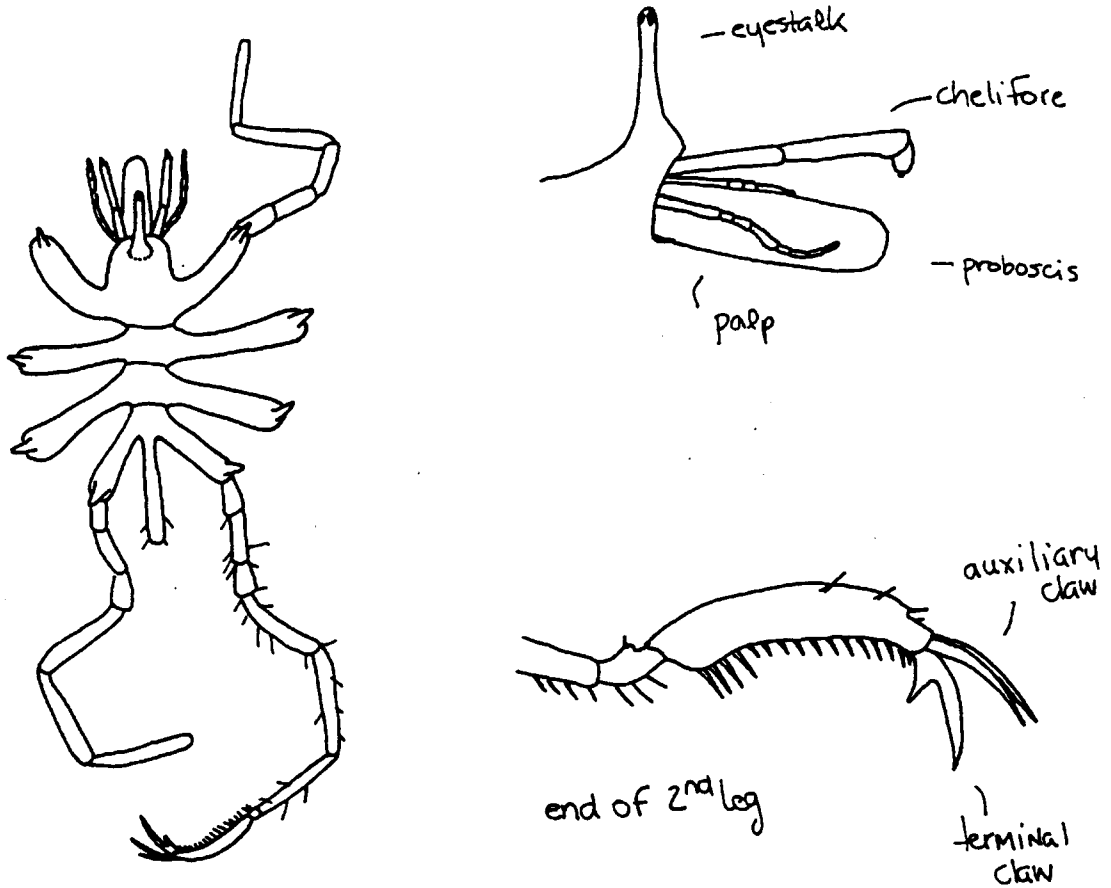


Ammothea hilgendorfi: A, tarsus and propodus; B, palpus.

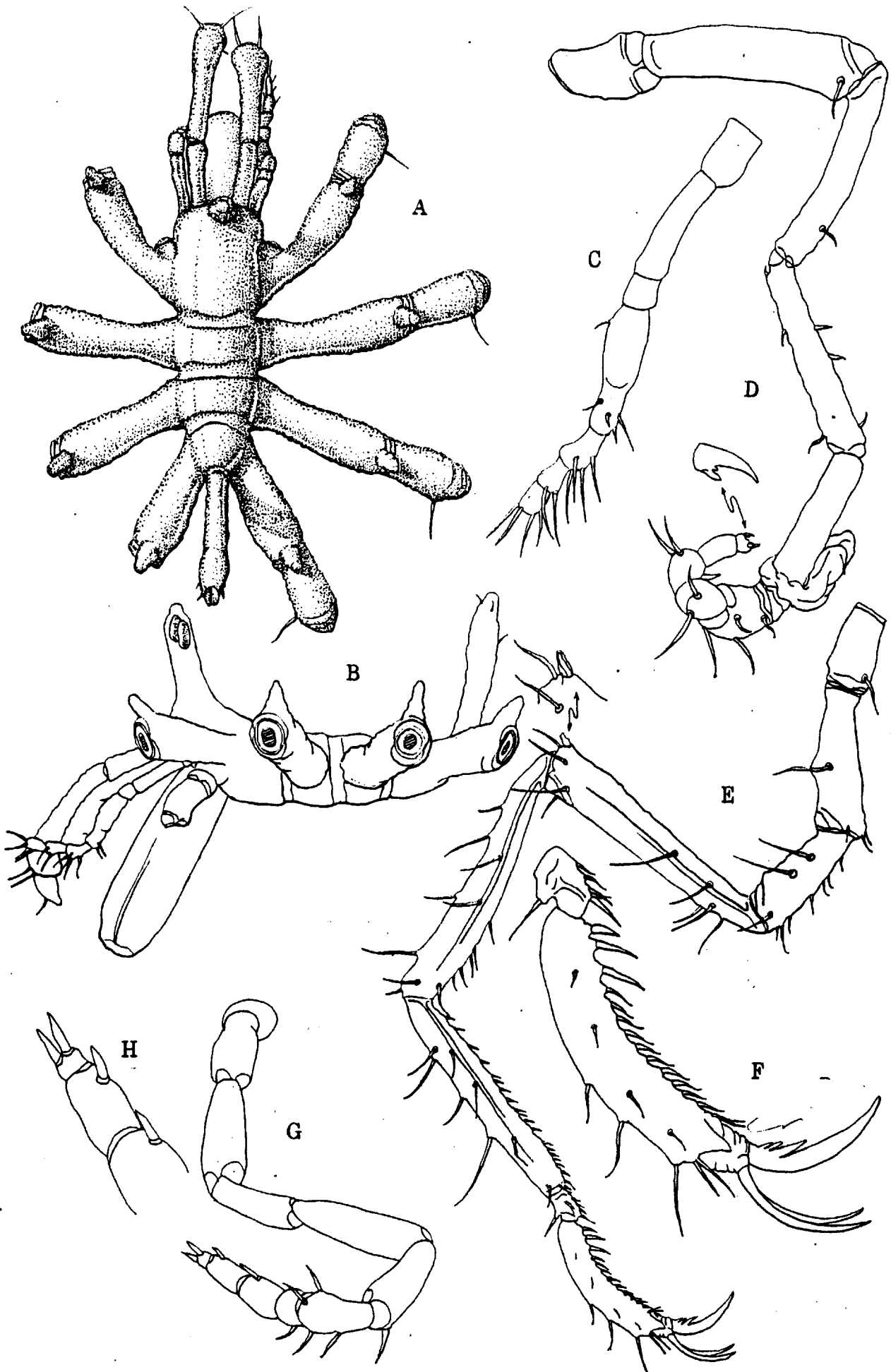


Ammothea hilgendorfi: C, female, lateral; D, caudal segment; E, third right leg of male; F, foot; G, eye tubercle, chelifere, and right palp of male; H, proboscis and palp, dorsal; I, left oviger of male; J, right oviger of female; K, body, dorsal. (from Cole, 1904)

Fig. 5



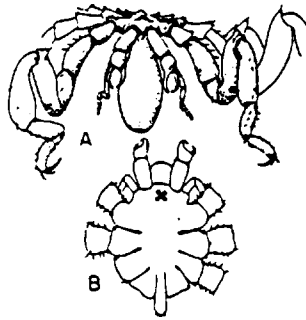
Ammonotheidae: Genus A sp. A of MBC



Prototrygaeus jordanae Child 1990 (in press)

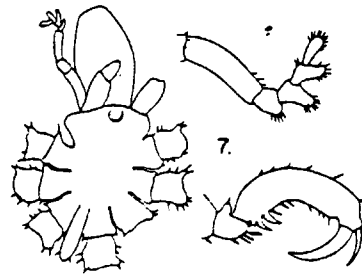


Fig. 6



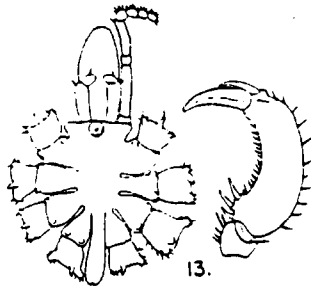
Achelia chelata

(from Hedgpeth, 1975)



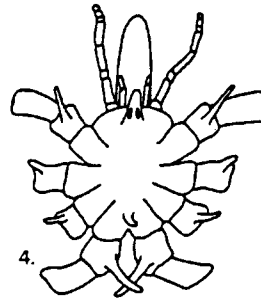
Achelia spinoseta

(from Hedgpeth, 1975)



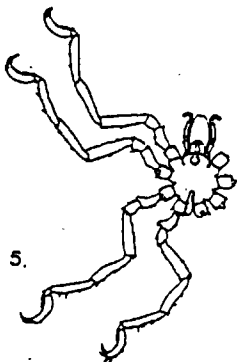
Achelia echinata

(from Hedgpeth, 1975)



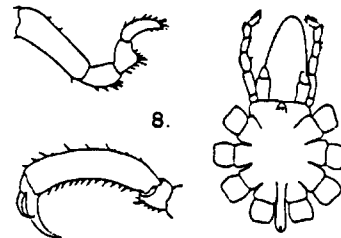
Achelia gracilipes

(from Hedgpeth, 1975)



Achelia alaskensis

(from Hall, 1913)

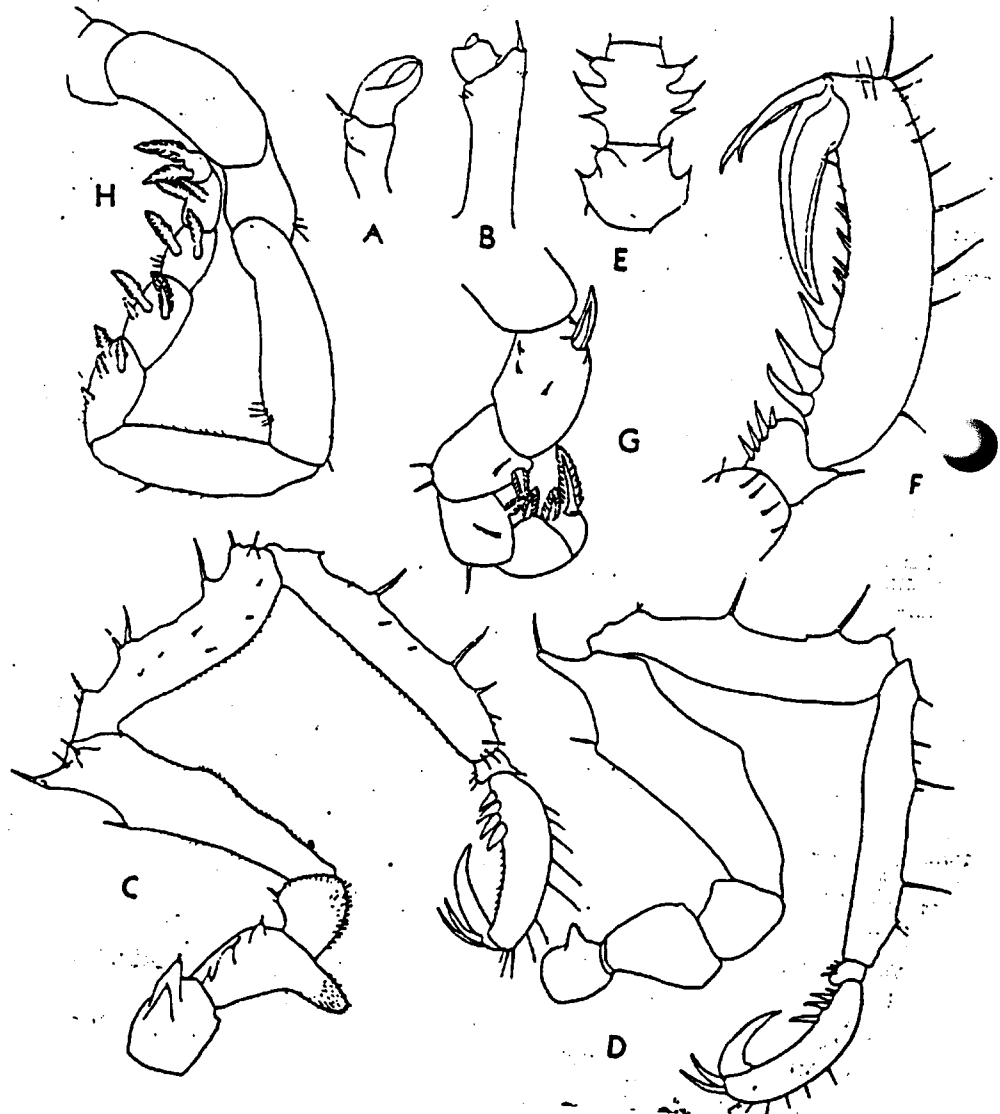
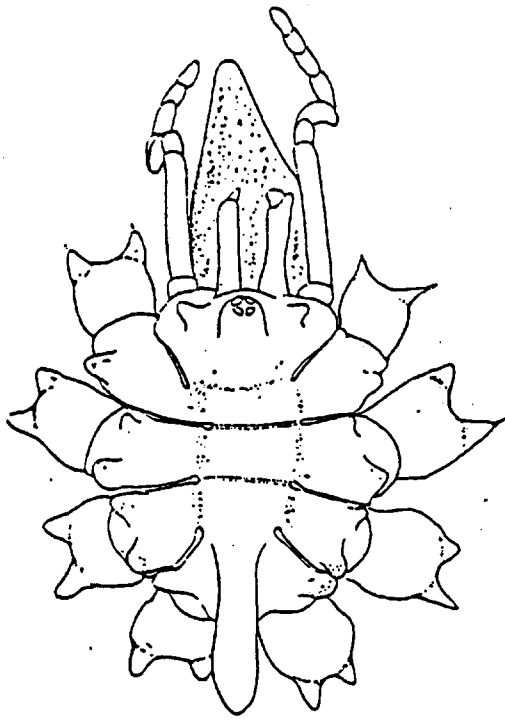


Achelia simplissima

(from Hedgpeth, 1975)

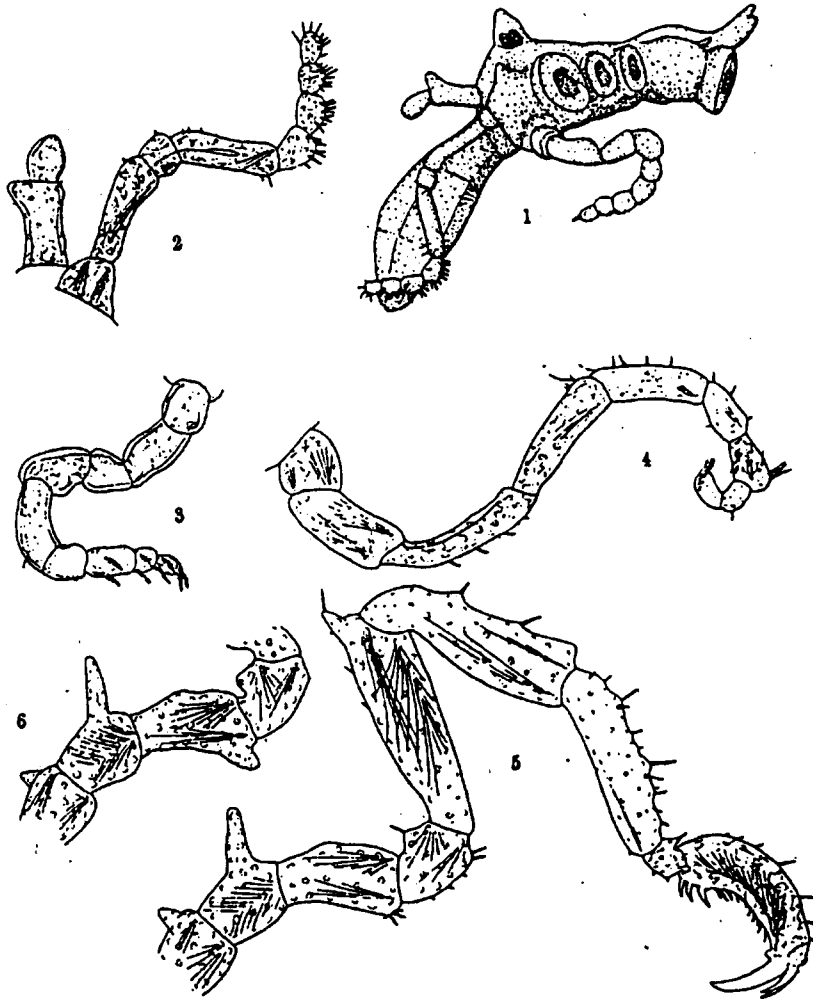
Fig. 7

Achelia echinata

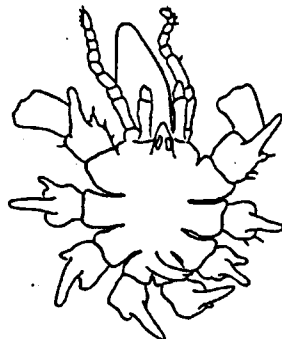


Achelia echinata: A, chelifere in young specimen; B, chelifere in adult; C, fourth leg of male; D, fourth leg of female; E, dorsal view of first and second coxae in male; F, tarsus and propodus in female; G, terminal joints of oviger in male; H, oviger of female. (from Utinomi, 1954)

Fig. 8



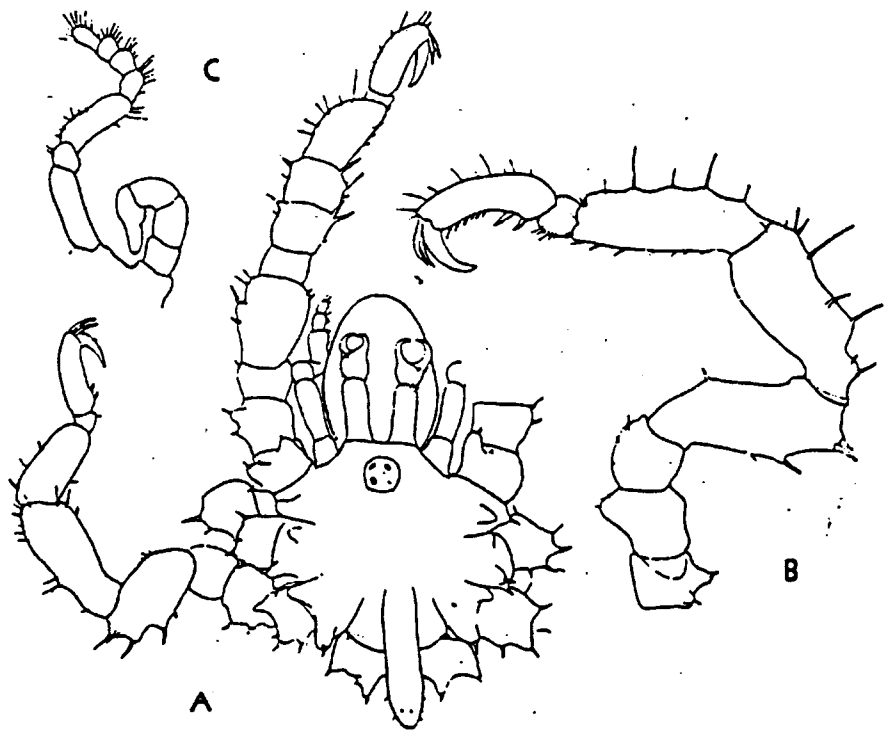
Achelia gracilipes: 1, female from left side; 2, right chelifere and palp of female; 3, right oviger of female; 4, left oviger of male; 5, second right leg of male; 6, lateral process and coxal joints of third right leg of male. (from Cole, 1904)



A. gracilipes

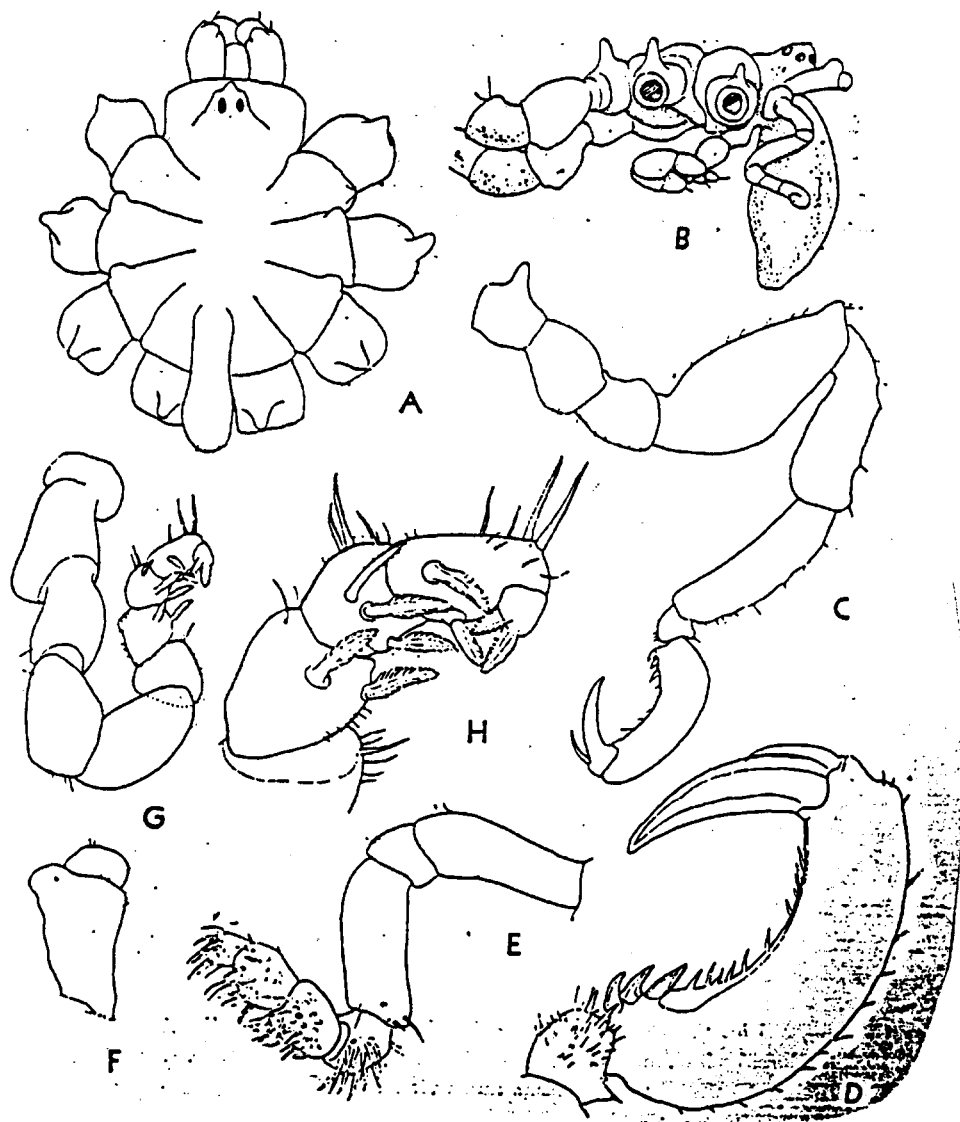
(from Hedgpeth, 1975)

Fig. 9



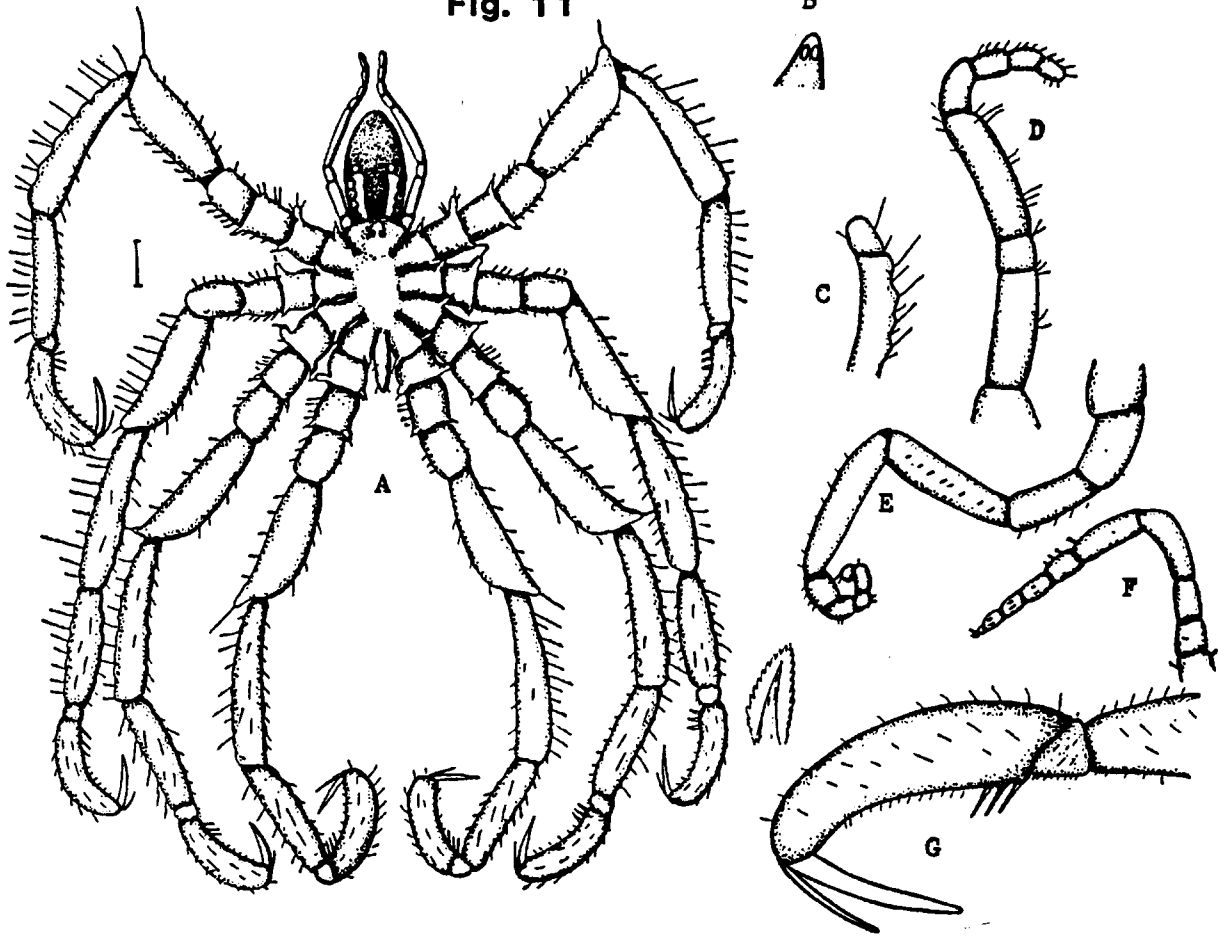
Achelia alaskensis: A, dorsal view, most of legs omitted; B, fourth leg; C, palpus and oviger. (from Utinomi, 1954)

Fig. 10



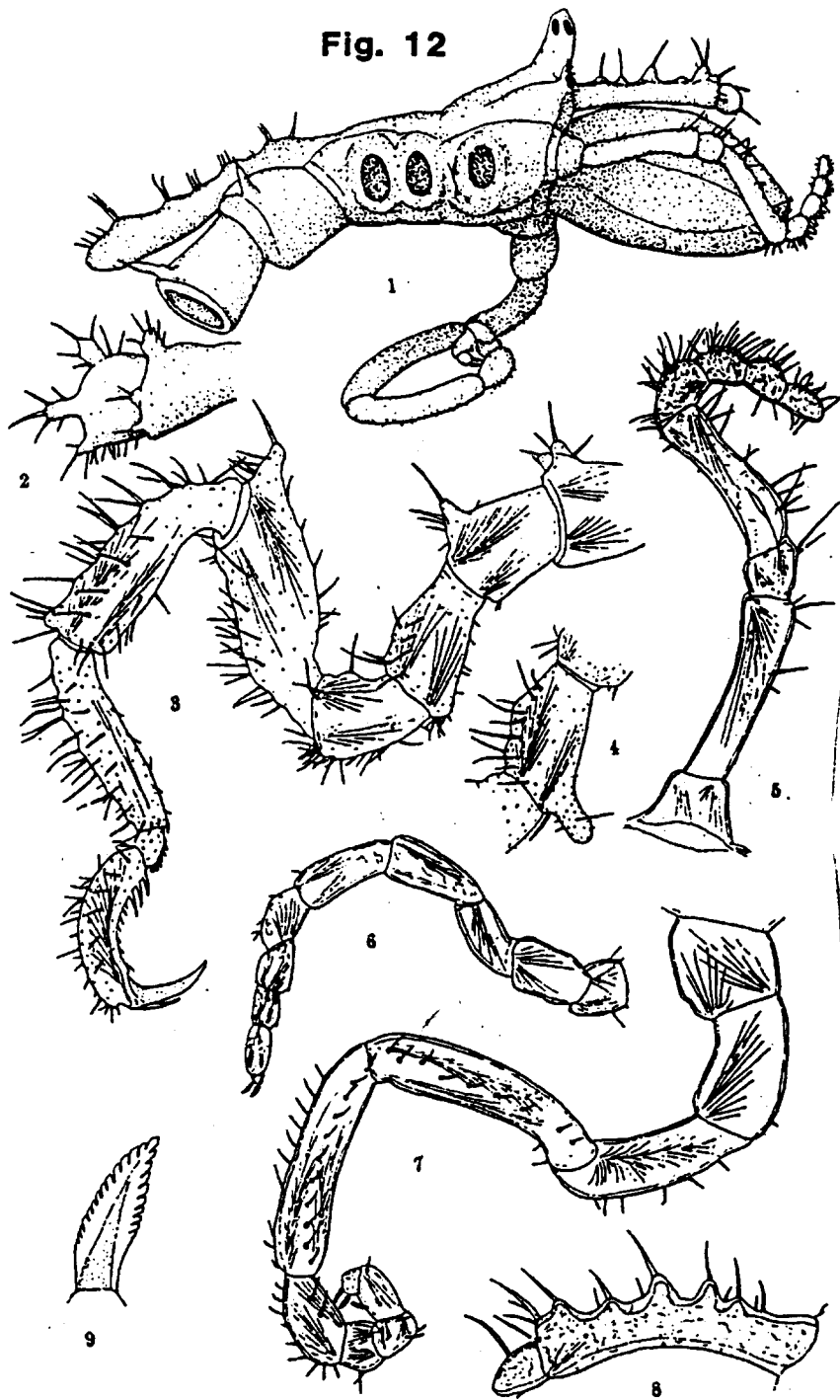
Achelia alaskensis: A, dorsal view of trunk; B, lateral view of trunk; C, third leg; D, tarsus and propodus; E, palpus; F, chelifore; G, oviger; H, terminal joints of oviger. (from Hilton, 1942)

Fig. 11



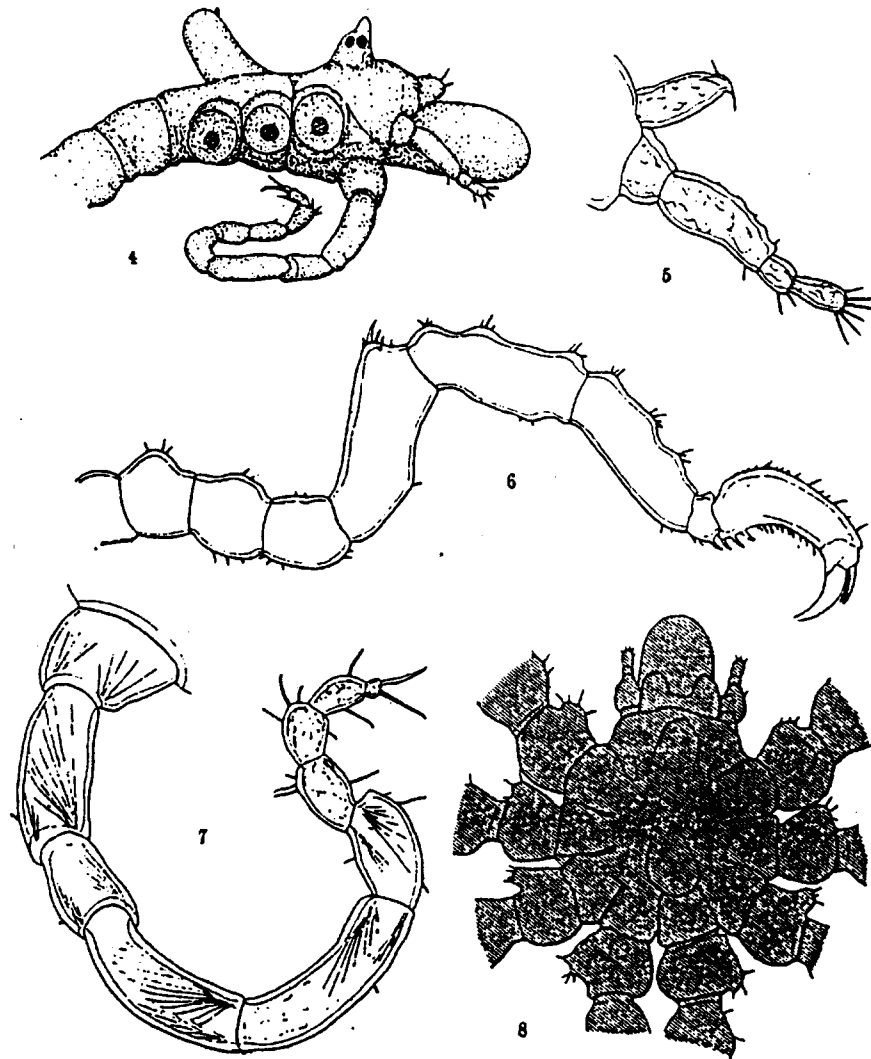
Achelia latifrons: A, whole mount, dorsal; B, eye tubercle; C, chelifore; D, palp; E, oviger of male; F, oviger of female; G, tarsus. (from Hilton, 1942)

Fig. 12



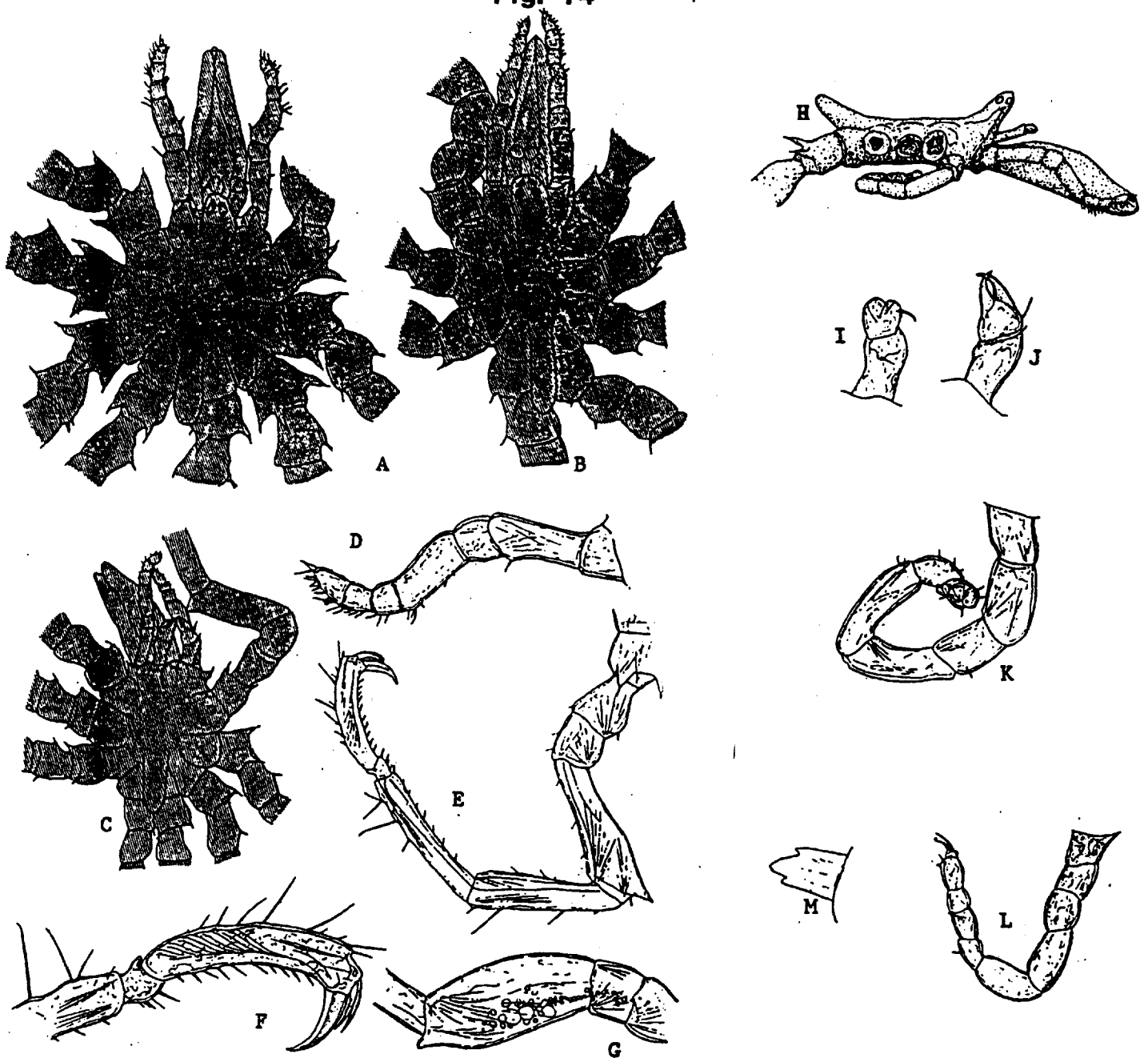
Achelia latifrons: 1, male, right side; 2, lateral process and first coxal joint of third left leg of male, dorsal; 3, second right leg of male; 4, second coxal joint of third right leg of male; 5, palp of female; 6, oviger of female; 7, oviger of male; 8, chelifere of female; 9, denticulate spine from oviger of male. (from Cole, 1904)

Fig. 13



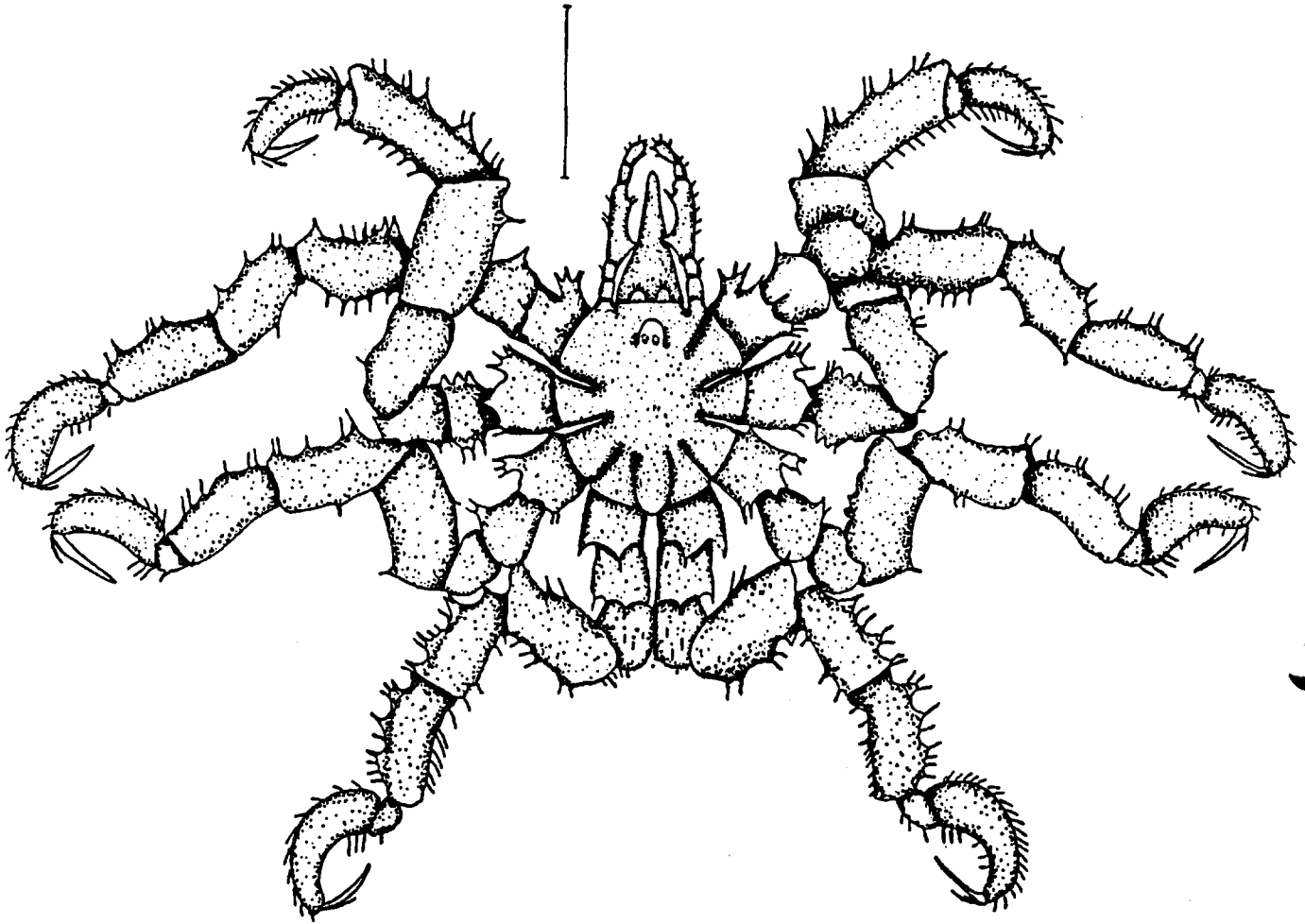
Tanystylum occidentale: A, male, lateral; B, chelifore and palp of male; C, third right leg of male; D, left oviger of male; E, body, male, dorsal. (from Cole, 1904)

Fig. 14

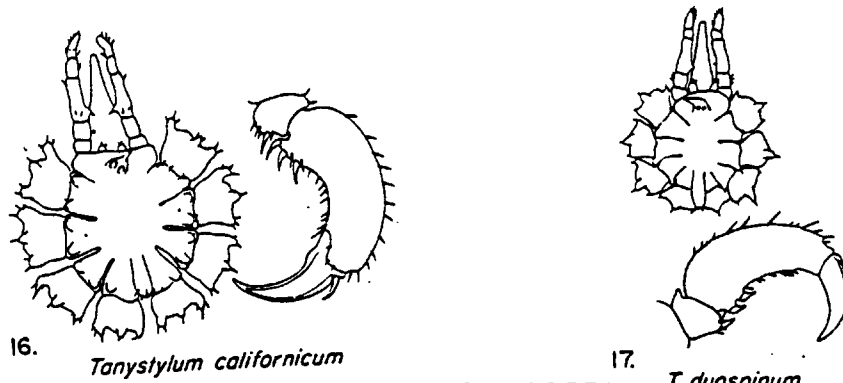


Tanystylum intermedium: A, male, dorsal; B, female, dorsal; C, immature specimen; D, left palp of female; E, second right leg of male; F, foot; G, femoral joint of second left leg of female; H, male, lateral; I, right chelifere of male; J, right chelifere of immature specimen; K, left oviger of male; L, left oviger; M, spine from joint 9 of oviger. (from Cole, 1904)

Fig. 15



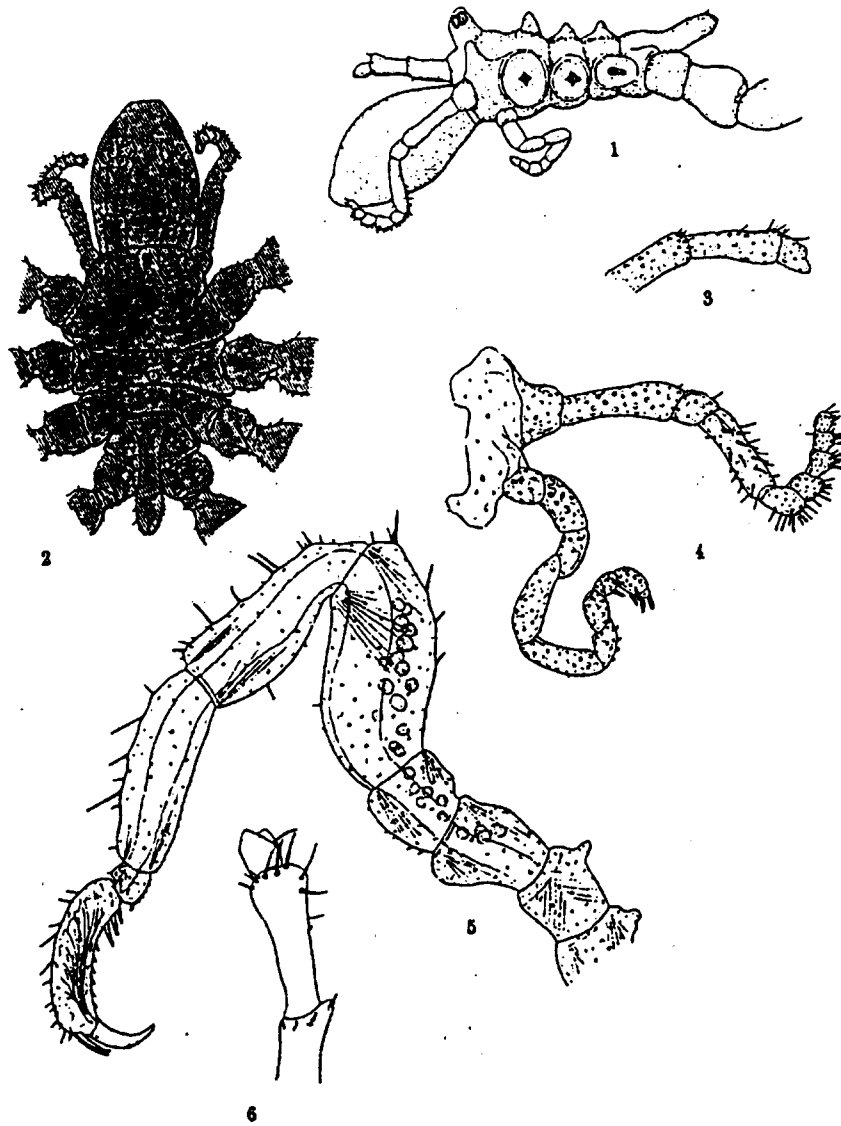
Tanystylum californicum
(from Hilton, 1942)



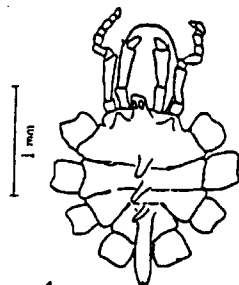
16. *Tanystylum californicum*
(from Hedgpeth, 1975)

17. *T. duospinum*

Fig. 16

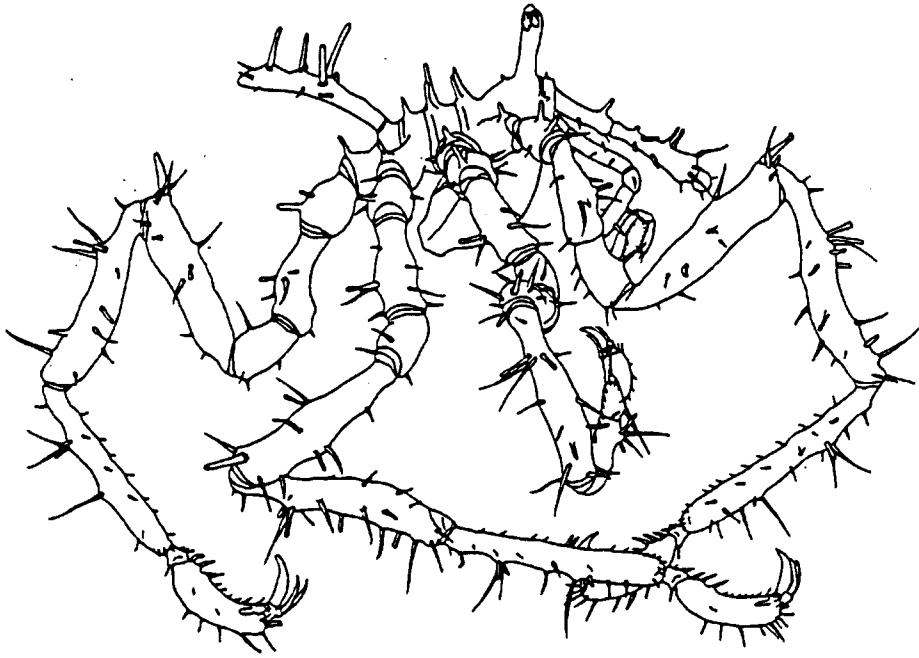


Ammothella tuberculata: 1, female from left side; 2, female, dorsal; 3, right chelifore of female; 4, right palp and right oviger of female; 5, second left leg of female; 6, right chelifore of female. (from Cole, 1904)

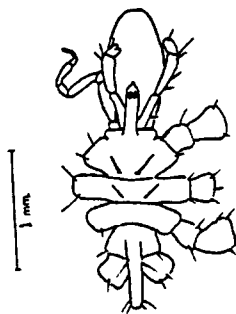


A. tuberculata (from Hedgpeth, 1975)

Fig. 17

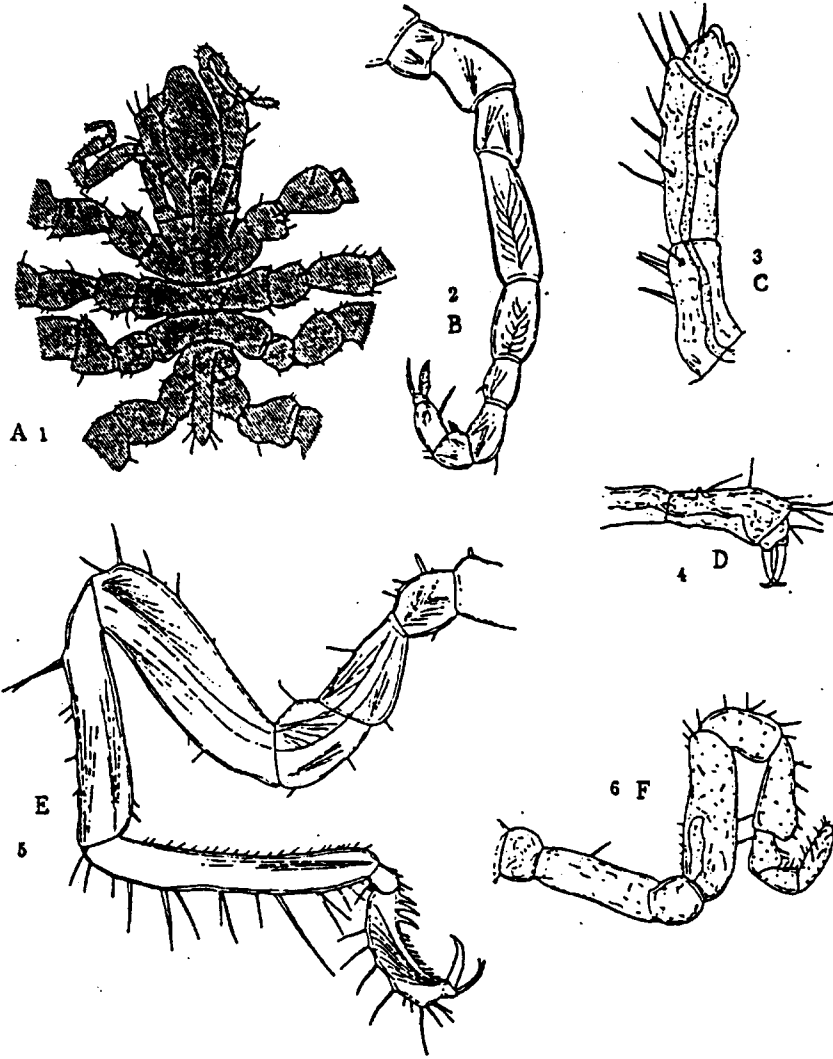


Ammothella spinifera
(from Child, 1980)

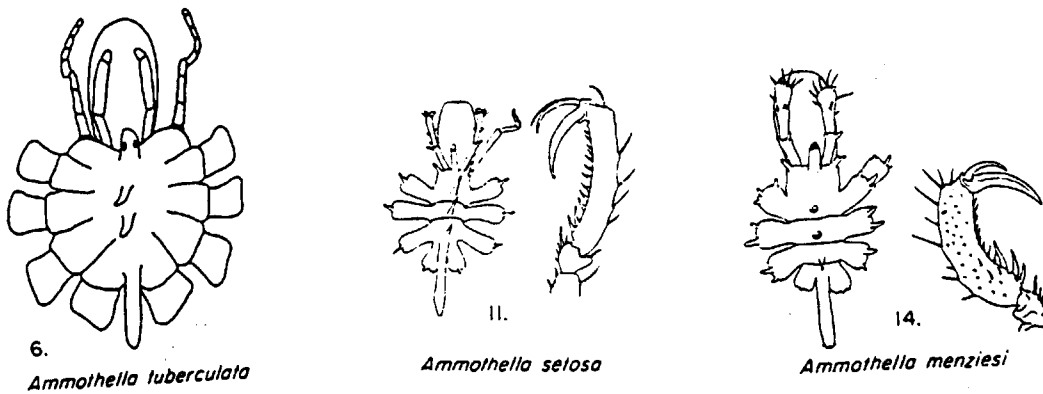


A. spinifera
(from Hedgpeth, 1975)

Fig. 18

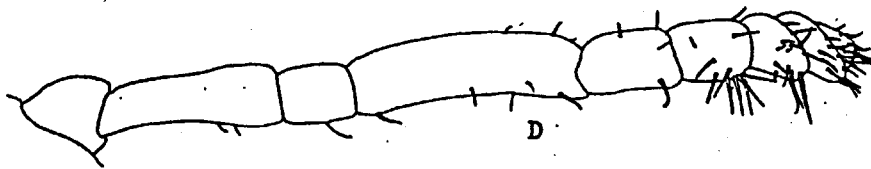
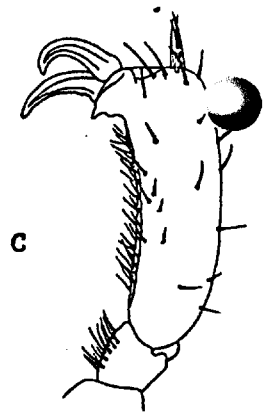
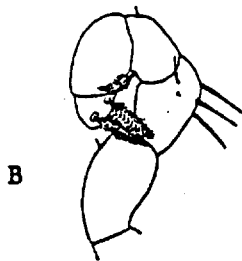
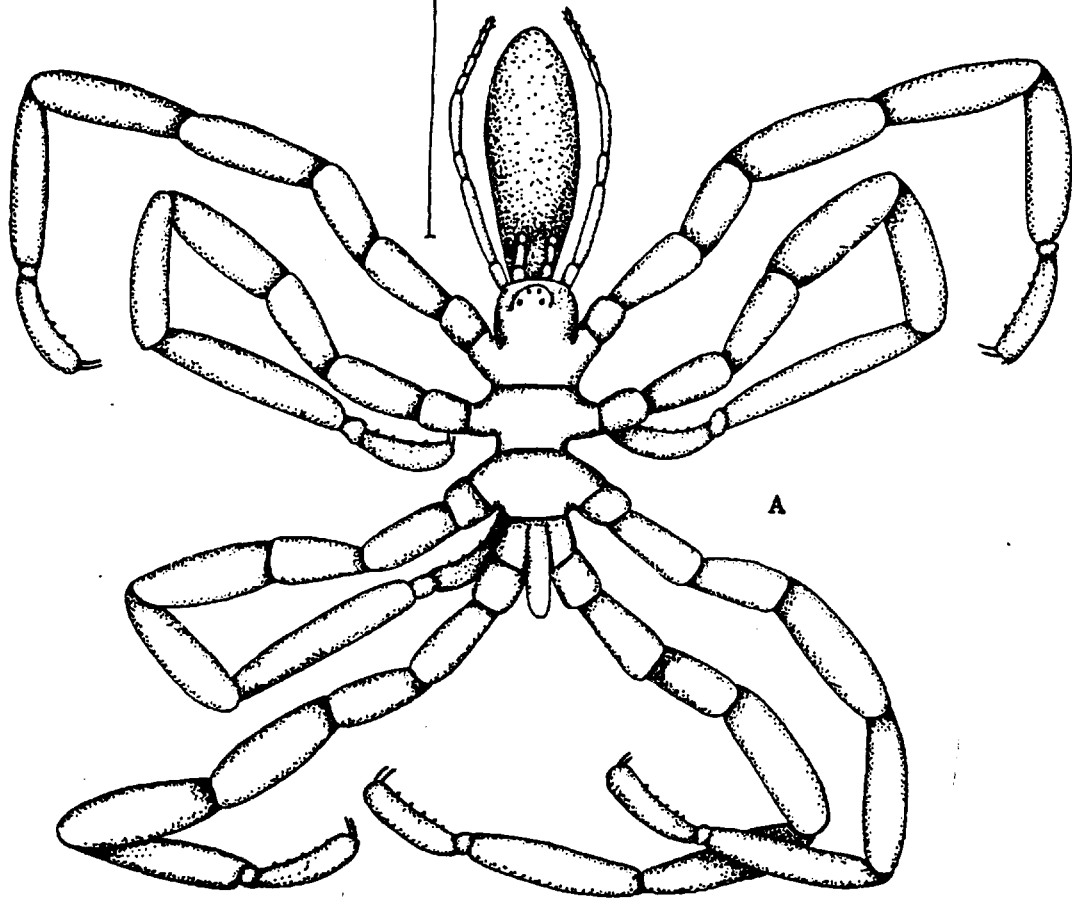


Ammothella spinifera: A, female, dorsal; B, left oviger of female; C, left chelifere of female; D, left chelifere of immature specimen; E, first left leg of female; F, left palp. (from Cole, 1904)



(from Hedgpeth, 1975)

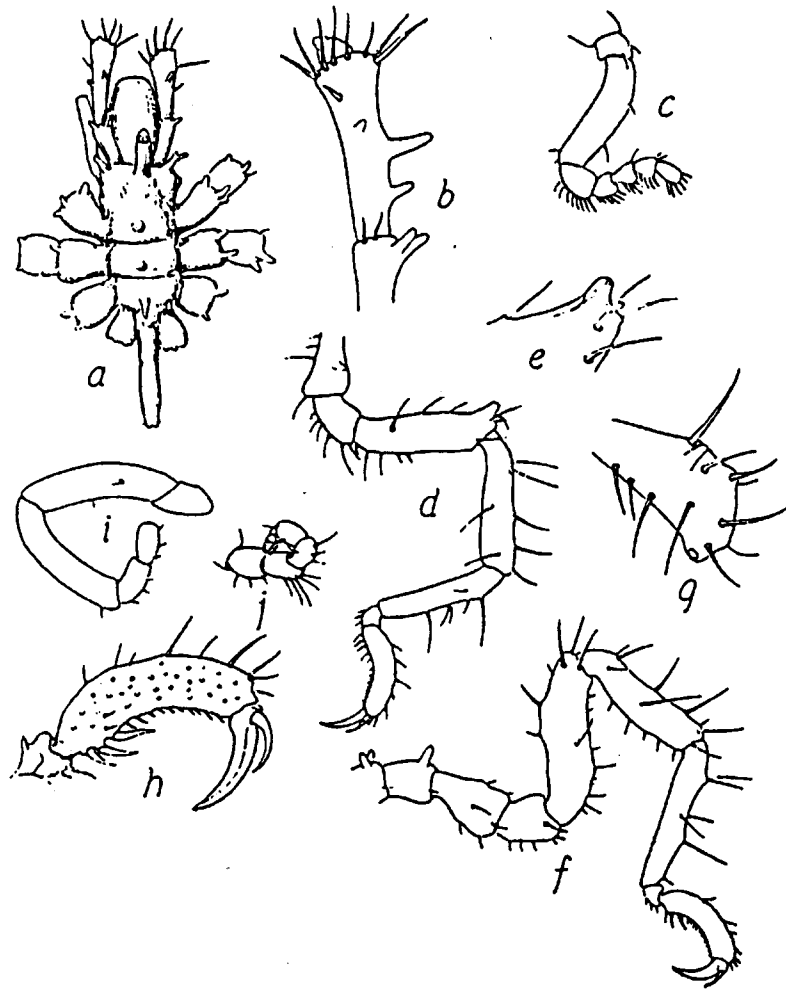
Fig. 19



Ammothella biunguiculata: A, whole mount, dorsal; B, terminal joints of oviger; C, tarsus; D, palpus; E, chelifore. (from Hilton, 1942)

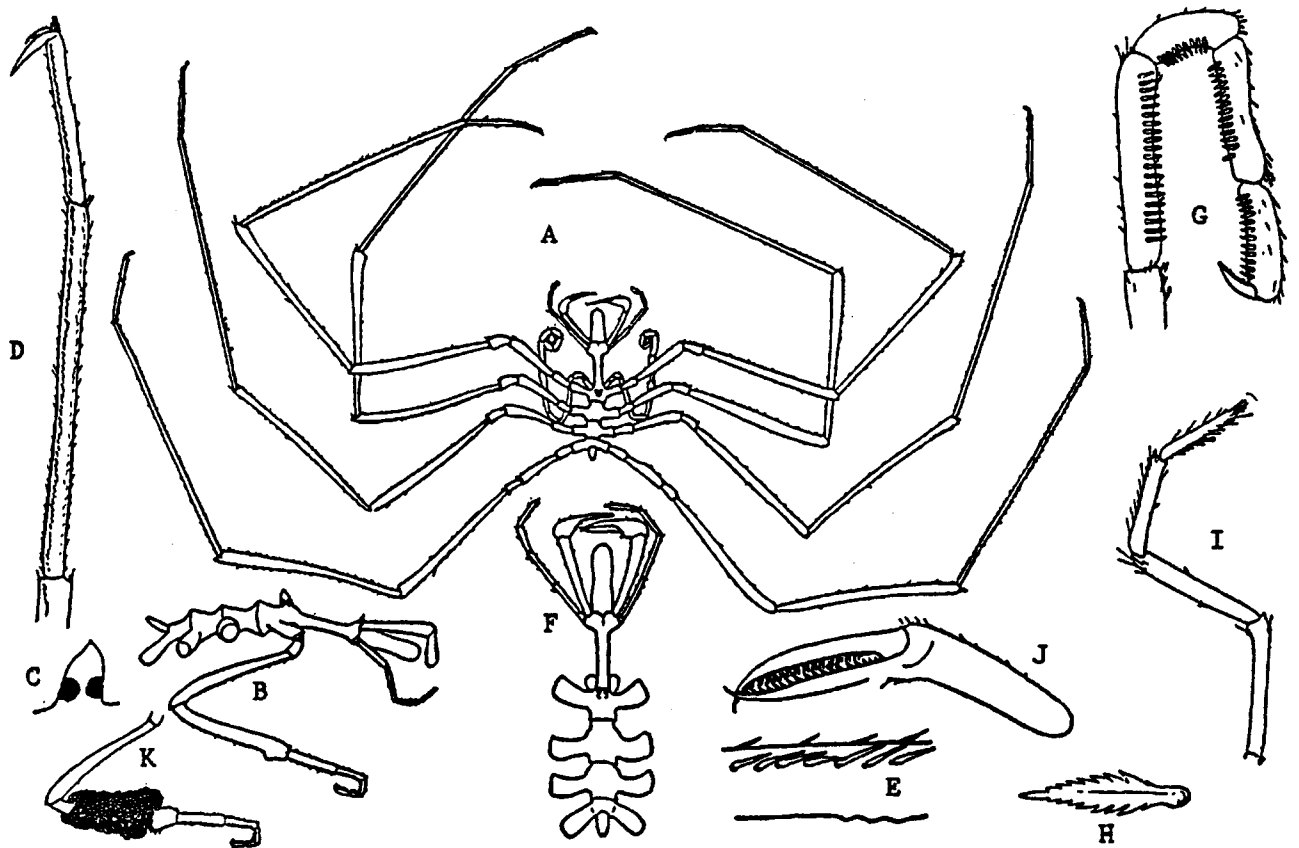
3 specimens, 2♀ + 1♂ intertidal @ -1.0' on -1.3'tide, Bird Rock, San Jolla, aka 15 Nov 47

Fig. 20

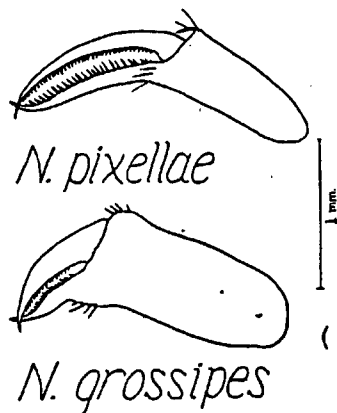


Ammothella menziesi: A, trunk, dorsal; B, chelifore, lateral; C, distal segments of palpus, lateral; D, third leg; E, detail of cement gland opening; F, third leg of female; G, detail of sexual opening on second coxal segment; H, tarsus and propodus; I, segments 4-8 of oviger; J, terminal segments of oviger. (from Hedgpeth, 1951)

Fig. 21



Nymphon pixellae: A, body, dorsal; B, same, lateral; C, eye tubercle; D, terminal joints of legs; E, spines on terminal joints of leg; F, dorsal view; G, terminal joints of ovigers; H, spine of oviger; I, palp; J, chela; K, oviger with egg mass. (from Hilton, 1942)



(from Hedgpeth, 1941)

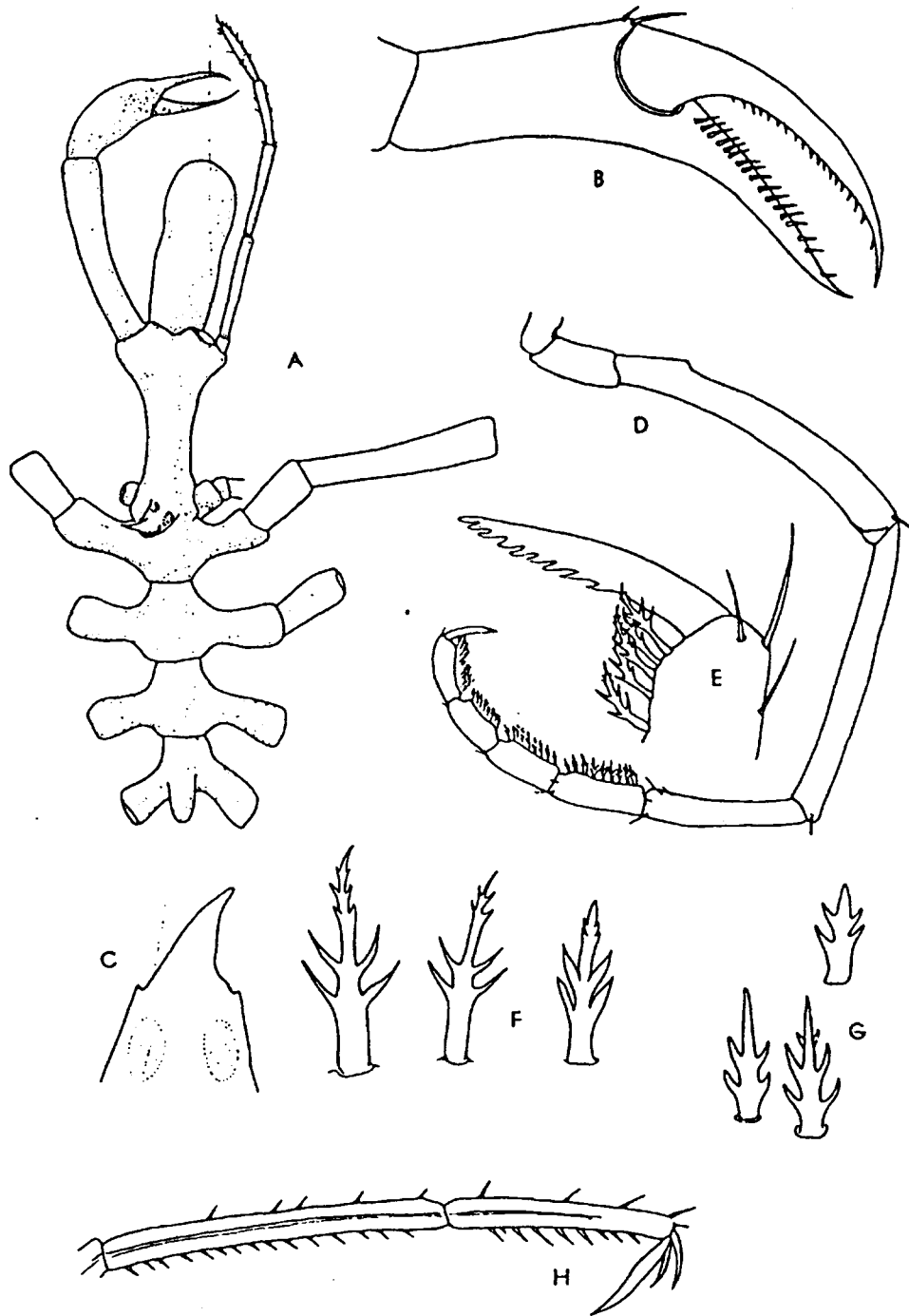
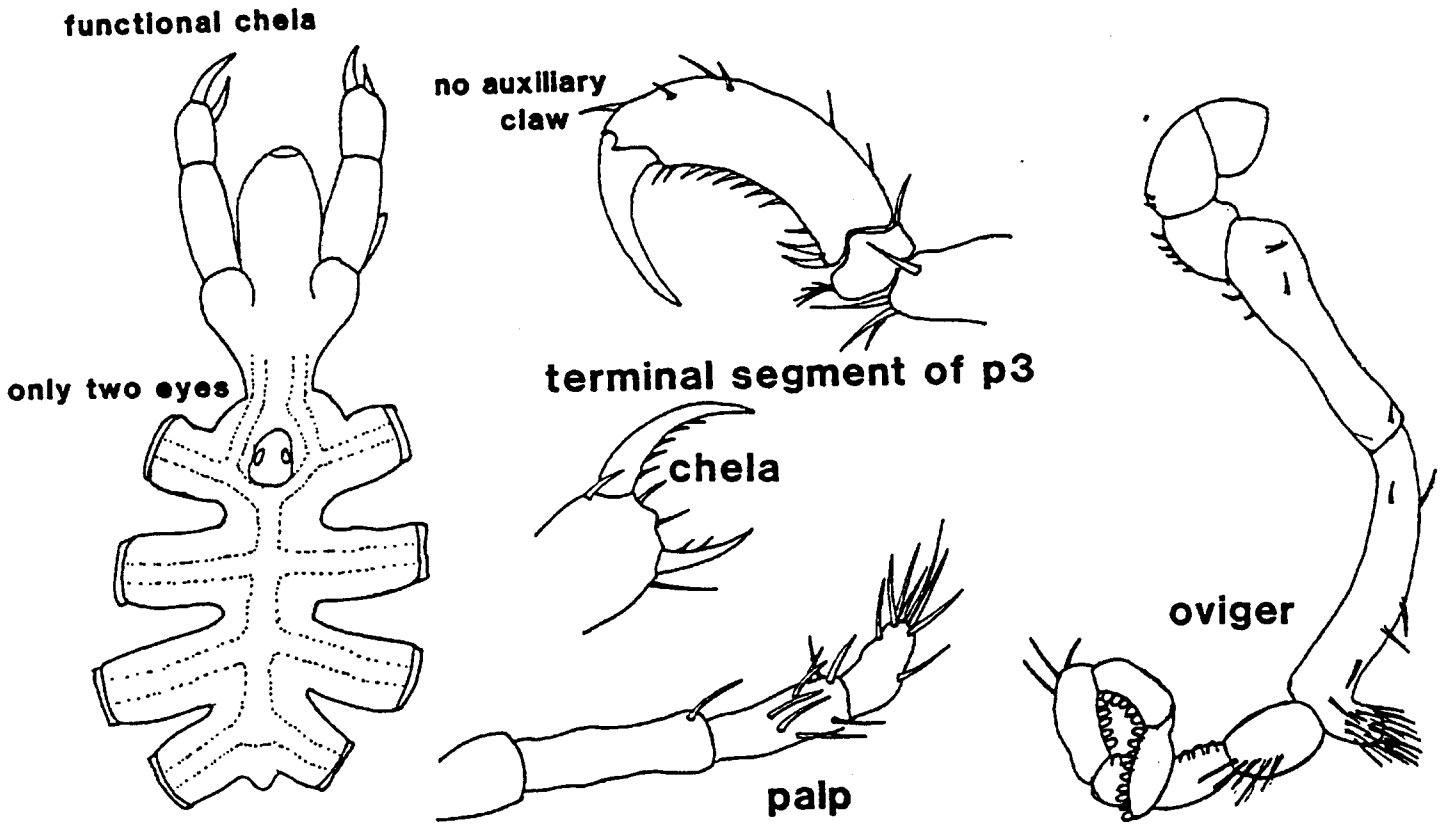


PLATE 1. *Nymphon heterodenticulatum* sp. nov.: Figs. a. Dorsal view of holotype. $\times 20.5$. b. Chela, paratype, $\times 41$. c. Front view of eye tubercle, $\times 62$. d. Oviger, paratype, $\times 41$. e. Terminal spine and portion of tenth joint of oviger, $\times 285$. f. Denticulate spines from oviger, $\times 1500$. g. Denticulate spines from oviger of *N. gracillimum*, Calman (After sketches by Dr. Gordon). h. Tarsus, paratype, $\times 41$. All figures except c done with the aid of a camera lucida. Magnifications approximate.

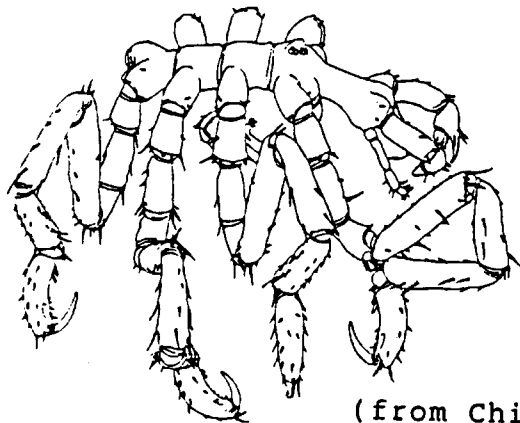


Fig. 22



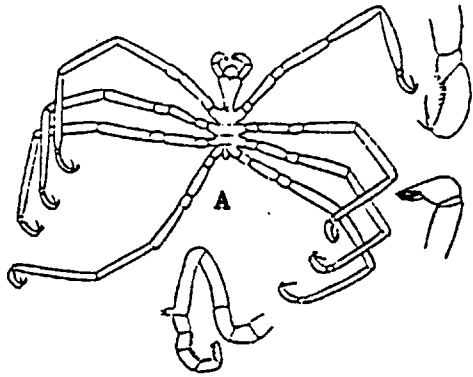
(Phillips, unpublished material)

Anoropallene palpida

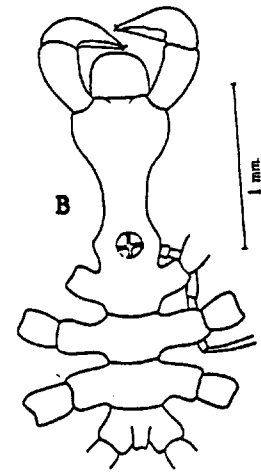


(from Child, 1980)

Fig. 23

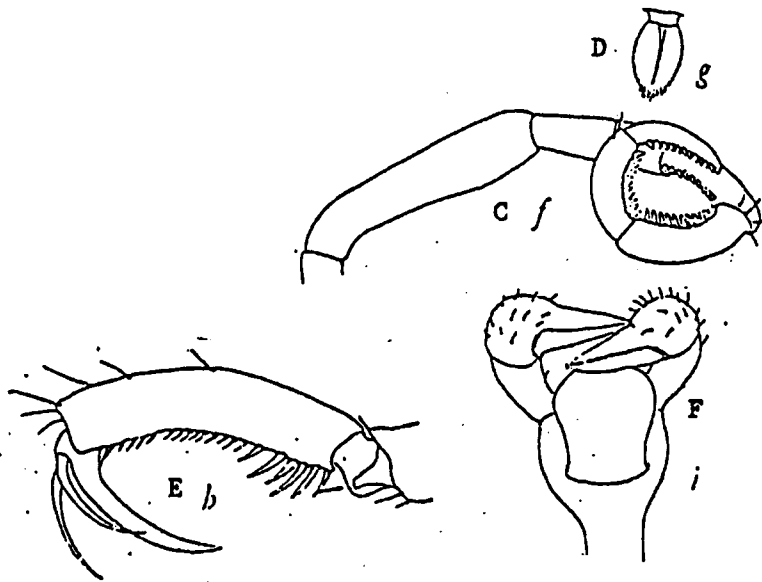


(from Hilton, 1939)

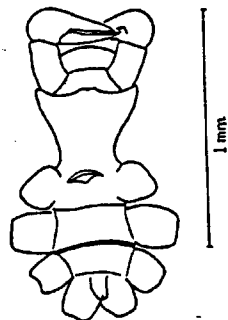


C. pacifica

(from Hedgpeth, 1941)



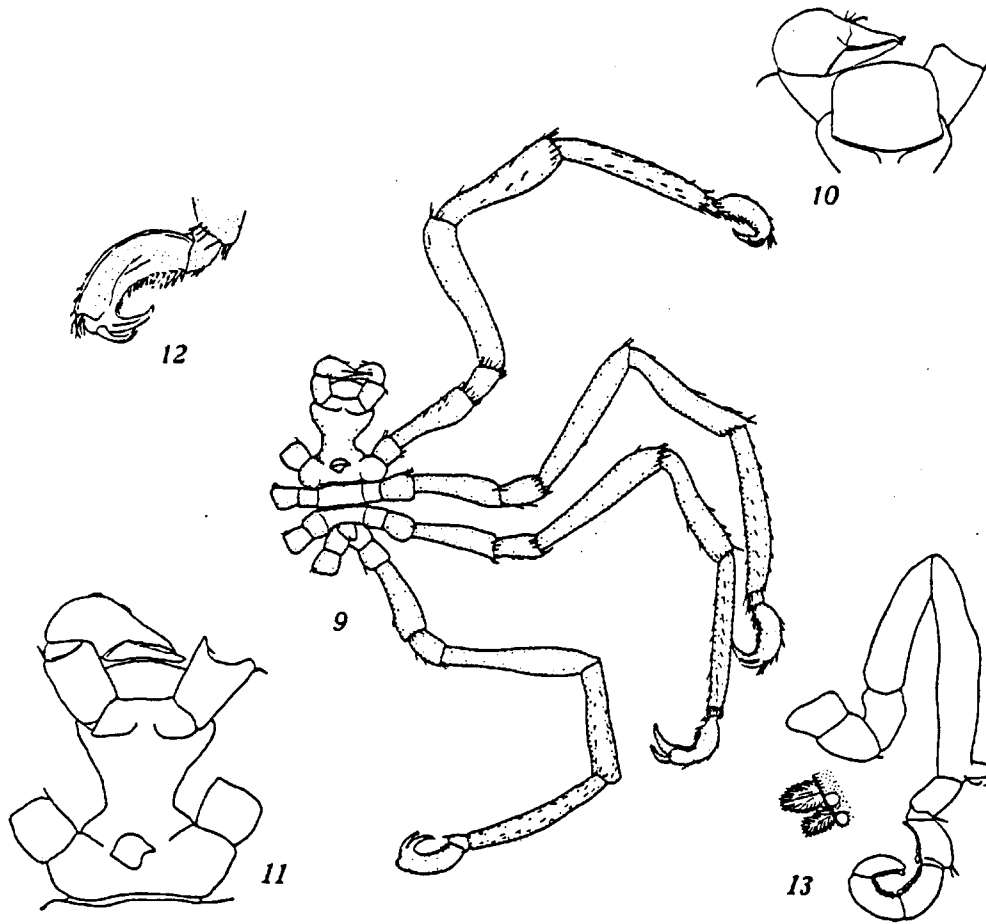
Callipallene pacifica: A, body, dorsal; B, trunk, Dorsal; C, Ovigers; D, spine from oviger; E, tarsus; F, proboscis and chelae.



C. californiensis

(from Hall, 1913)

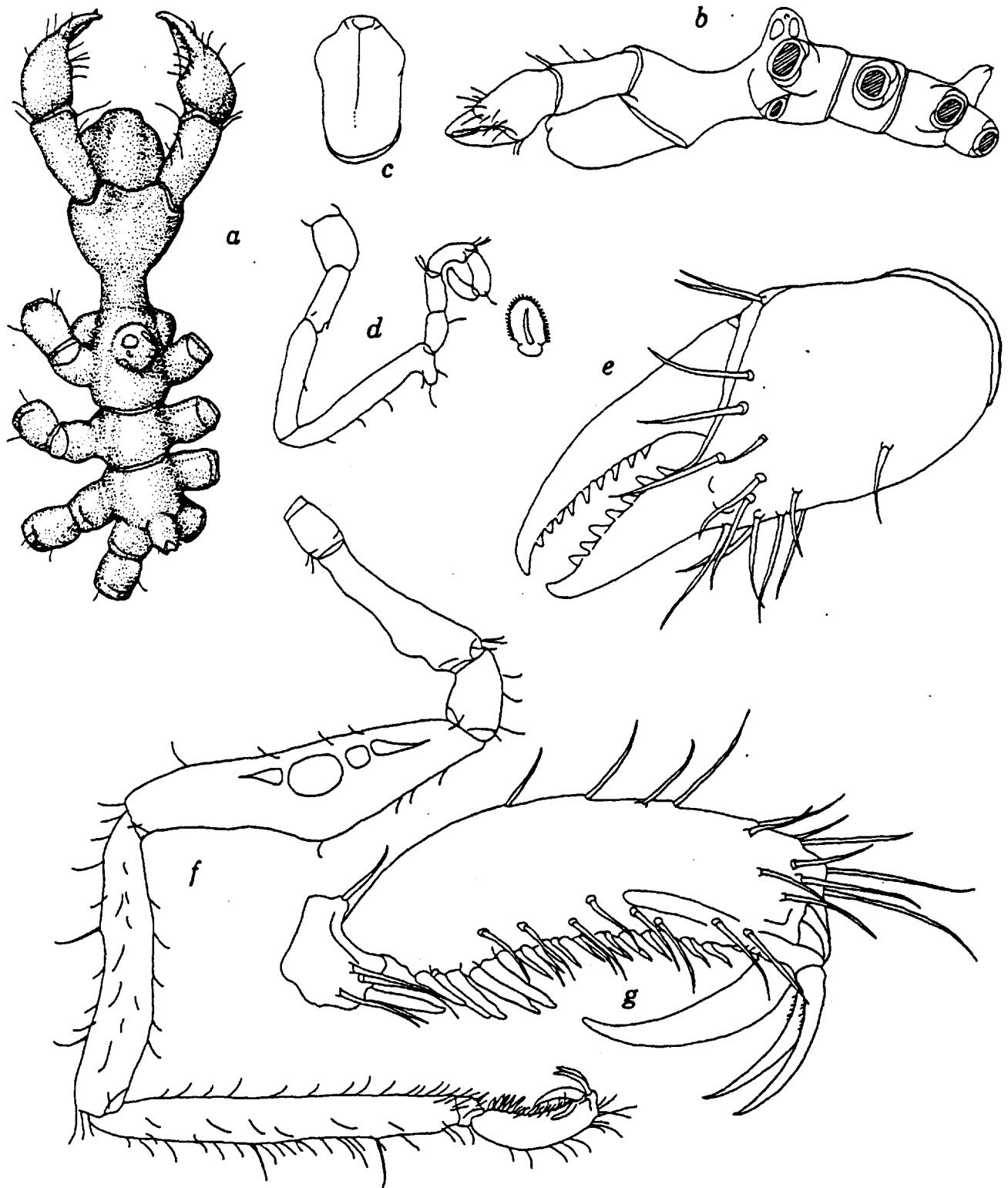
Fig. 24



Callipallene californiensis: A, trunk, dorsal, female; B, proboscis and chelifore; C, proboscis, chelifore and first body segment; D, tarsus of leg 1; E, left oviger and two of the denticulate spines greatly enlarged. (from Hall, 1913)

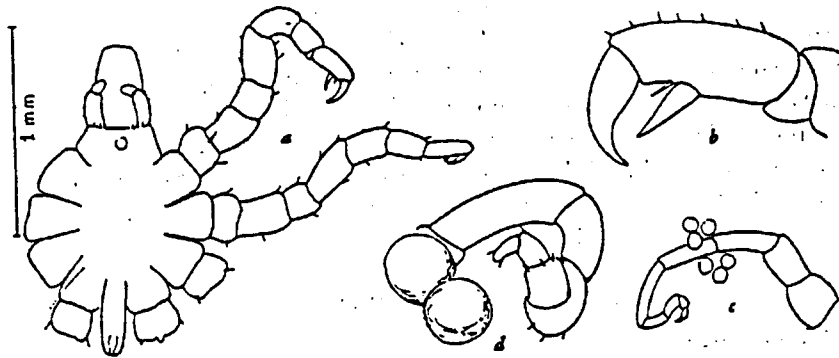
2 ovigerous taken by hand 10-14 of Nov 1897 taken by Hall, Nov 15, 1897

Fig. 25

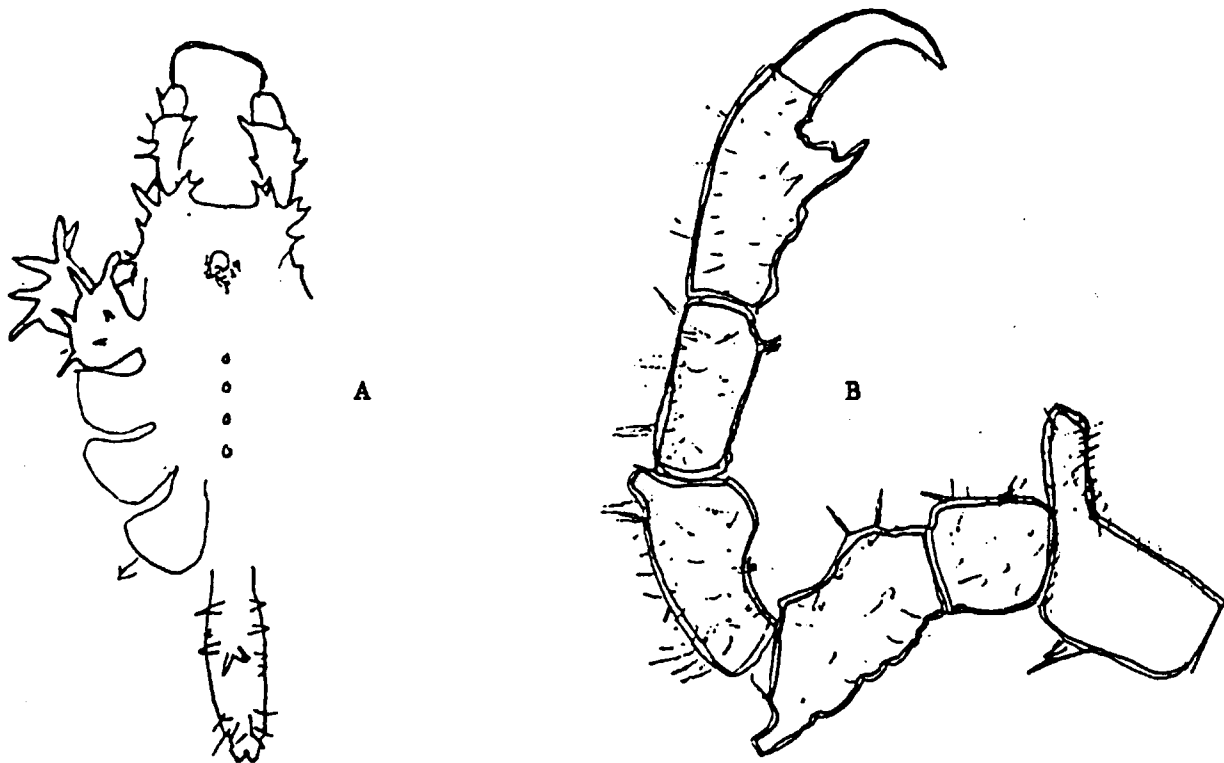


Callipallene californiensis: a, trunk, dorsal; b, trunk, lateral; c, proboscis, ventral; d, oviger, with enlargement of terminal spine; e, chela; f, third leg; g, terminal segments of third leg. (from Child, 1979)

Fig. 26

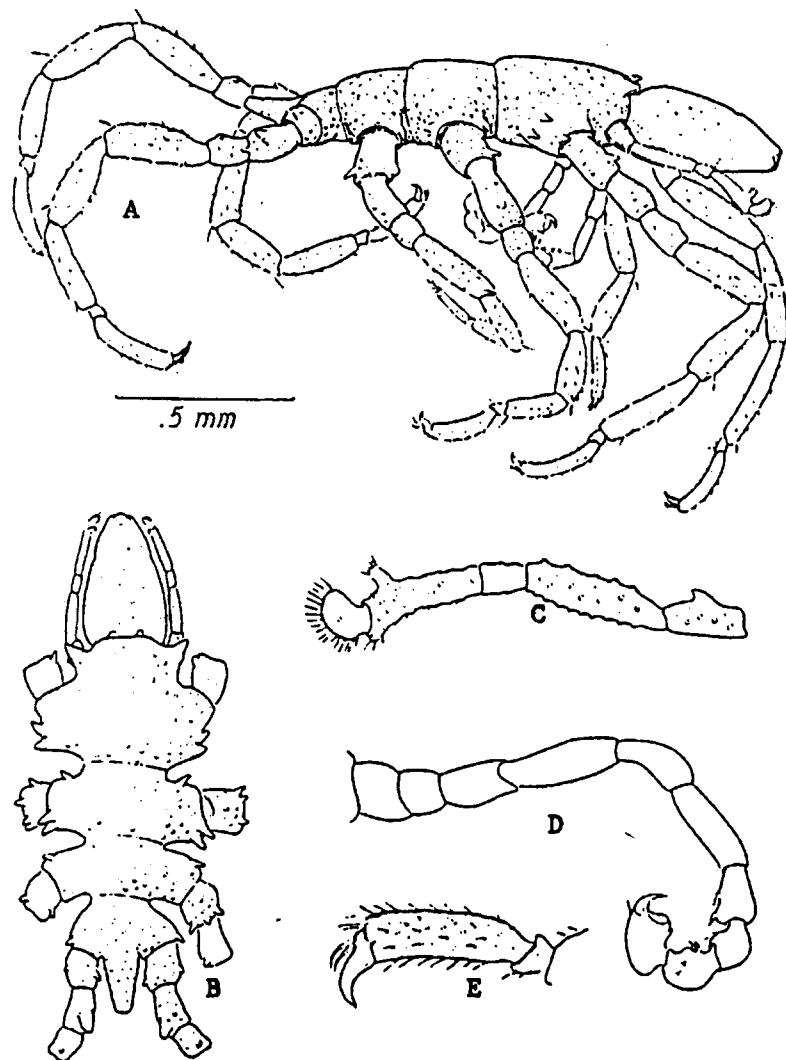


Decachela discata: A, body, dorsal; B, tarsus and propodus; C, oviger; D, detail of oviger. (from Hedgpeth, 1949)



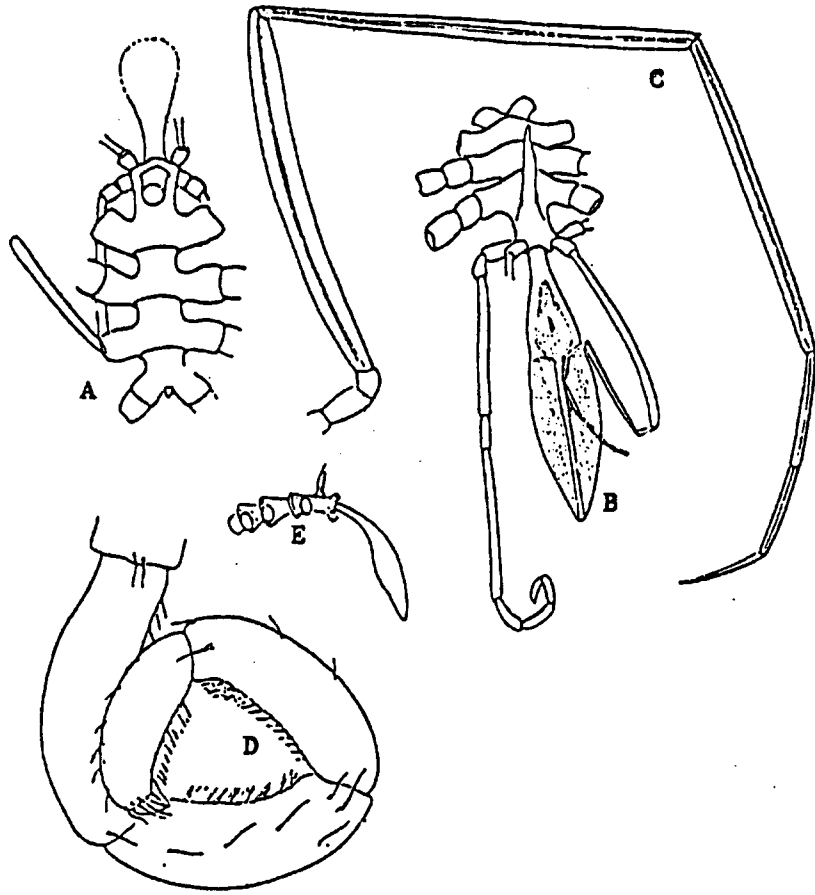
Decachela sp.A. of MBC: A, body, dorsal; B, left fourth leg.
(from Cadien, unpublished material)

Fig. 27



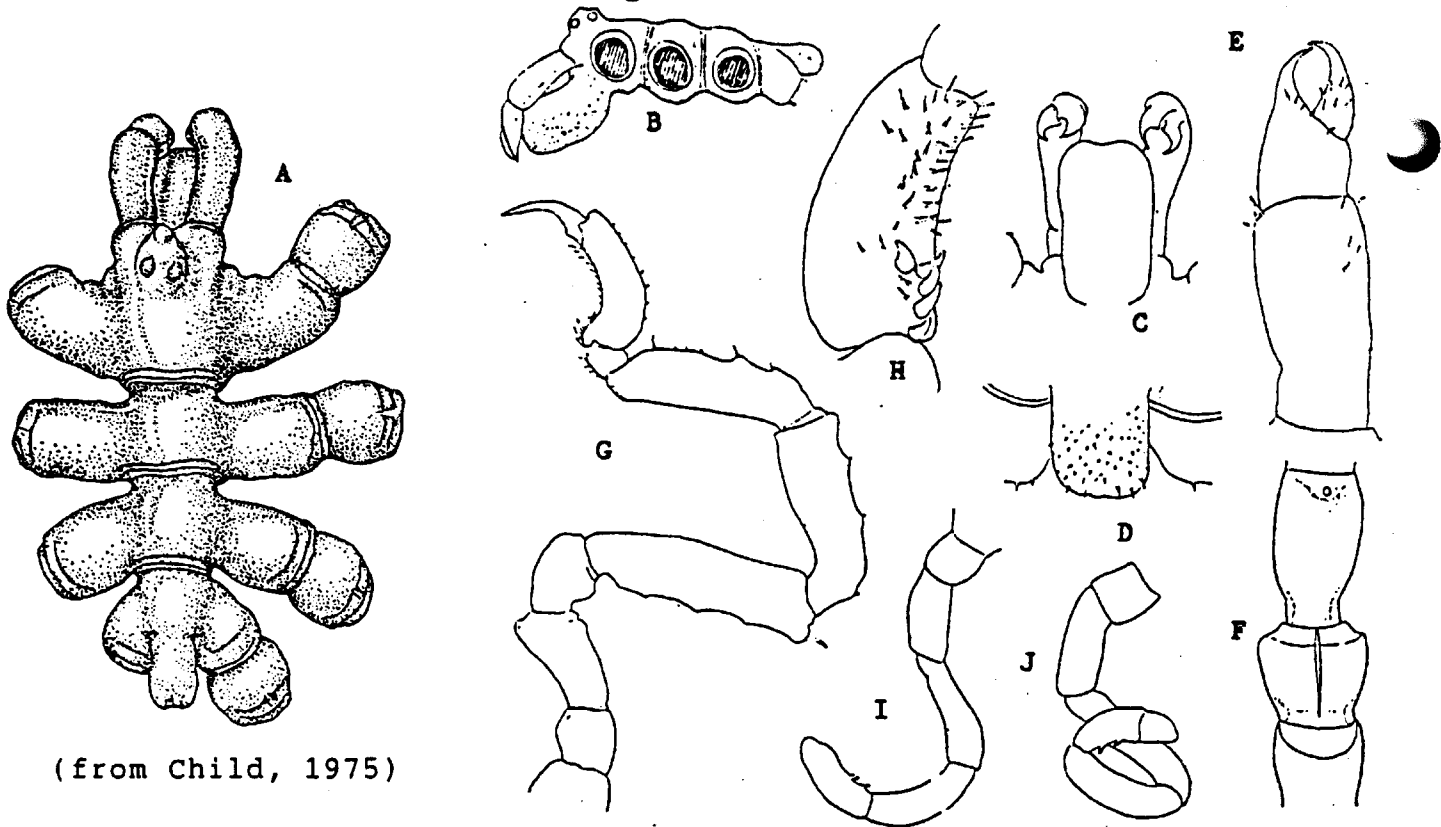
Rhynchothorax philopsammum: A, holotype, lateral; B, trunk, lateral; C, palpus, lateral; D, oviger; E, tarsus and propodus. (from Hedgpeth, 1951)

Fig. 28



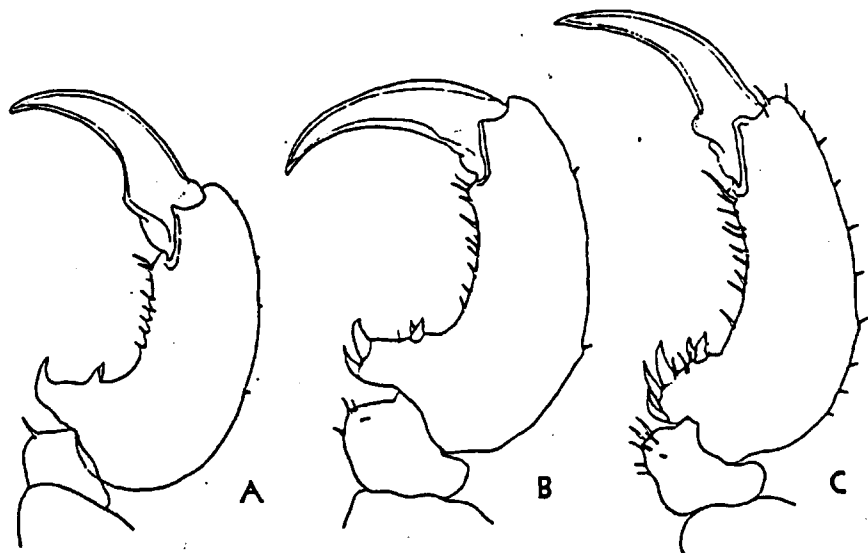
Hedgpethia californica: A, trunk, dorsal; B, trunk and proboscis; C, third leg; D, terminal segments of ovigers; E, trunk, lateral (from Hedgpeth, 1939)

Fig. 29

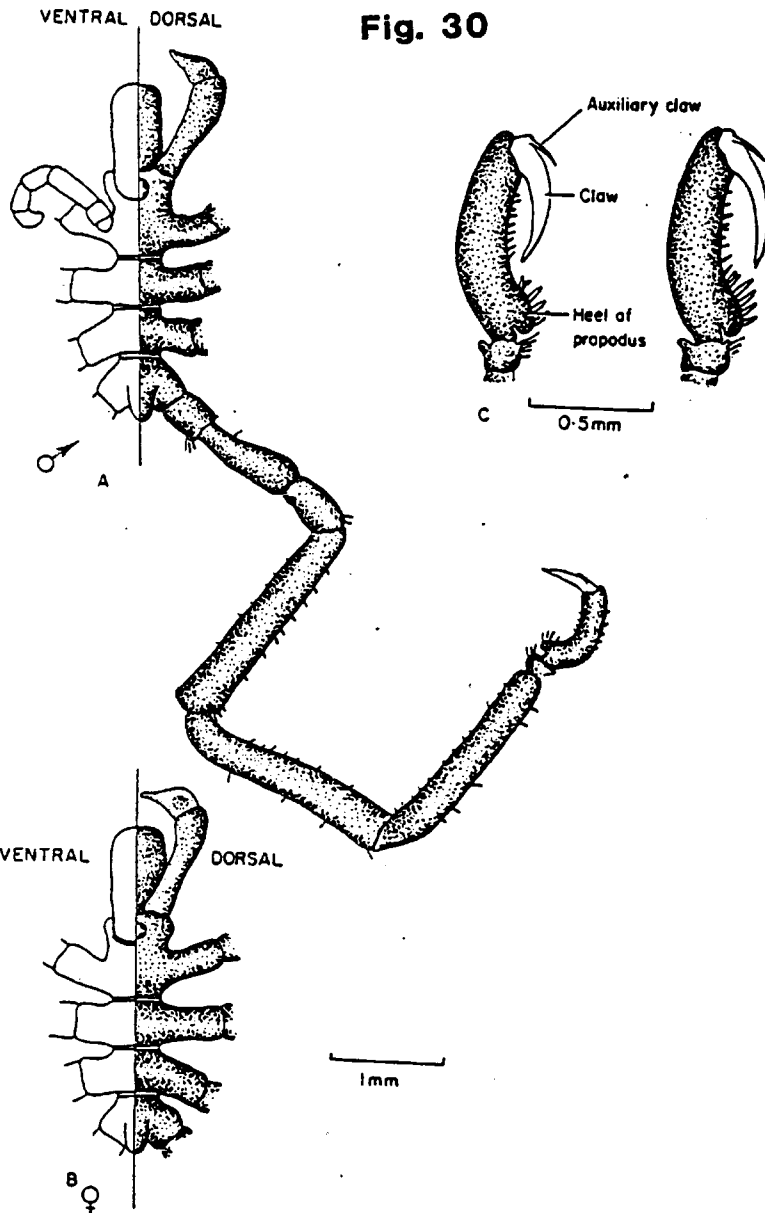


(from Child, 1975)

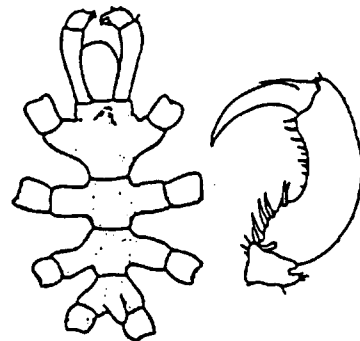
Phoxichilidium parvum: A, trunk, dorsal; B, trunk, lateral; C, ventral view of proboscis and chelifores, D, abdomen; E, chelifore; F, two coxal joints of second leg with lateral process; G, first leg; H, propodus; I, oviger; J, oviger. (from Utinomi, 1954)



Phoxichilidium parvum: A, B, C, variations of tarsus and propodus. (from Utinomi, 1954)



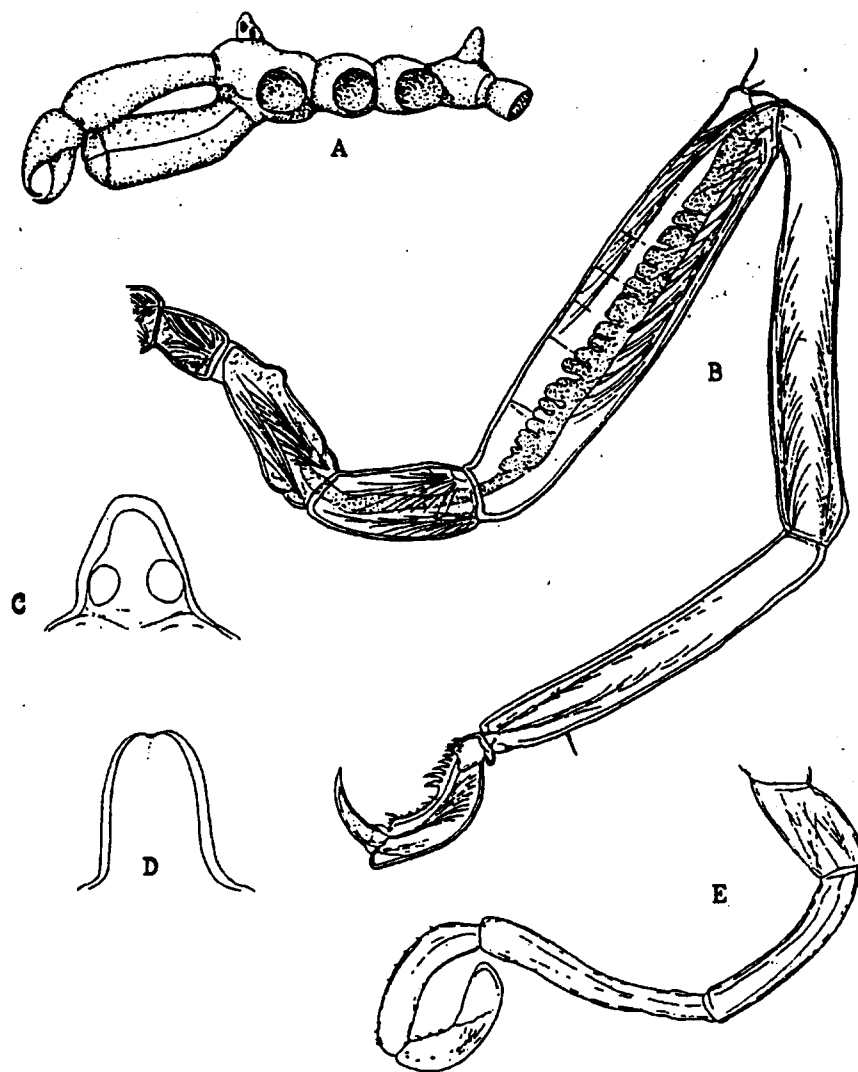
Phoxichilidium femoratum: A, ventral and dorsal aspects (male); B, ventral and dorsal aspects (female); C, types of propodus. (from King, 1974)



Phoxichilidium femoratum

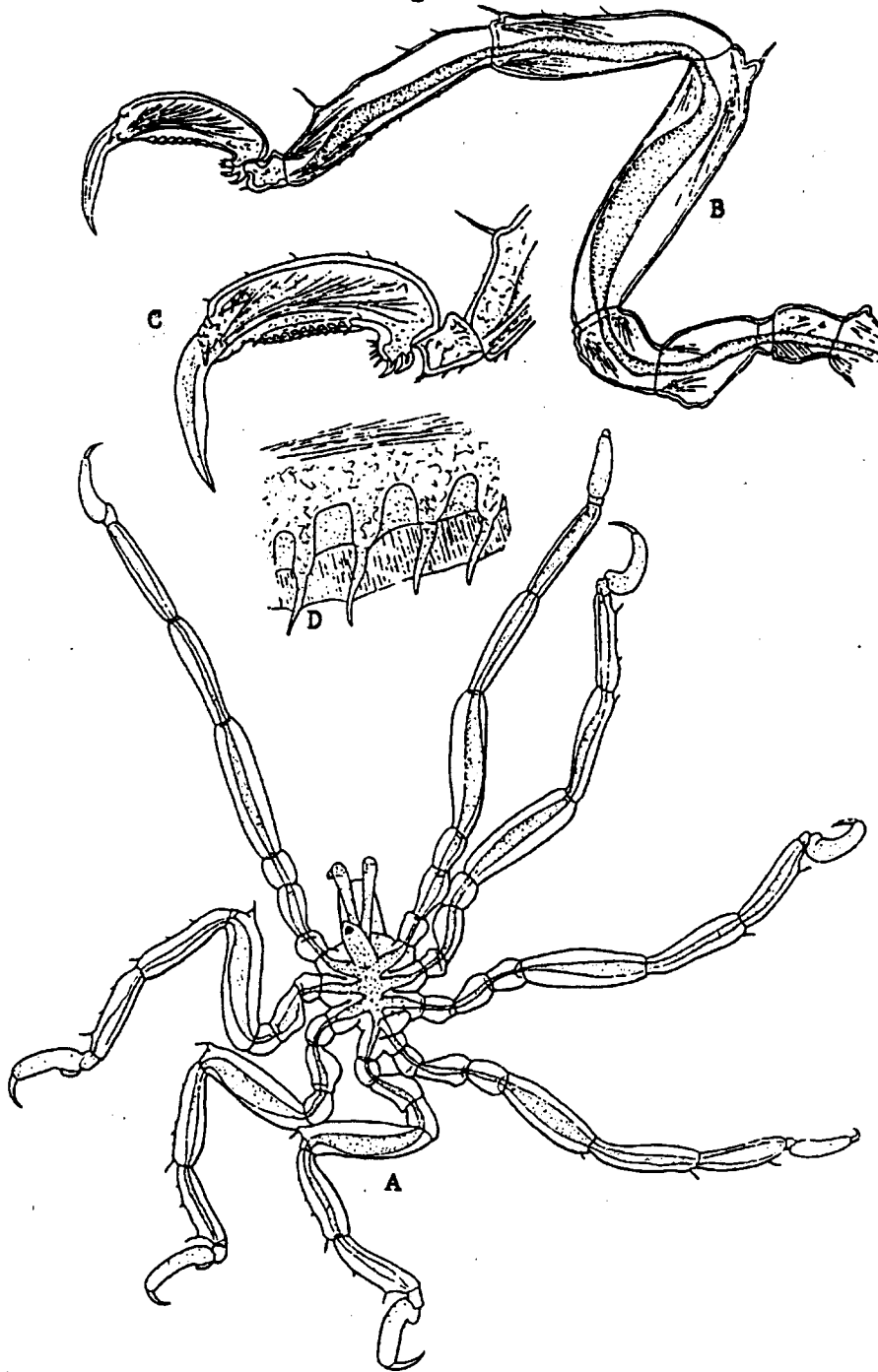
(from Hedgpeth, 1948)

Fig. 31



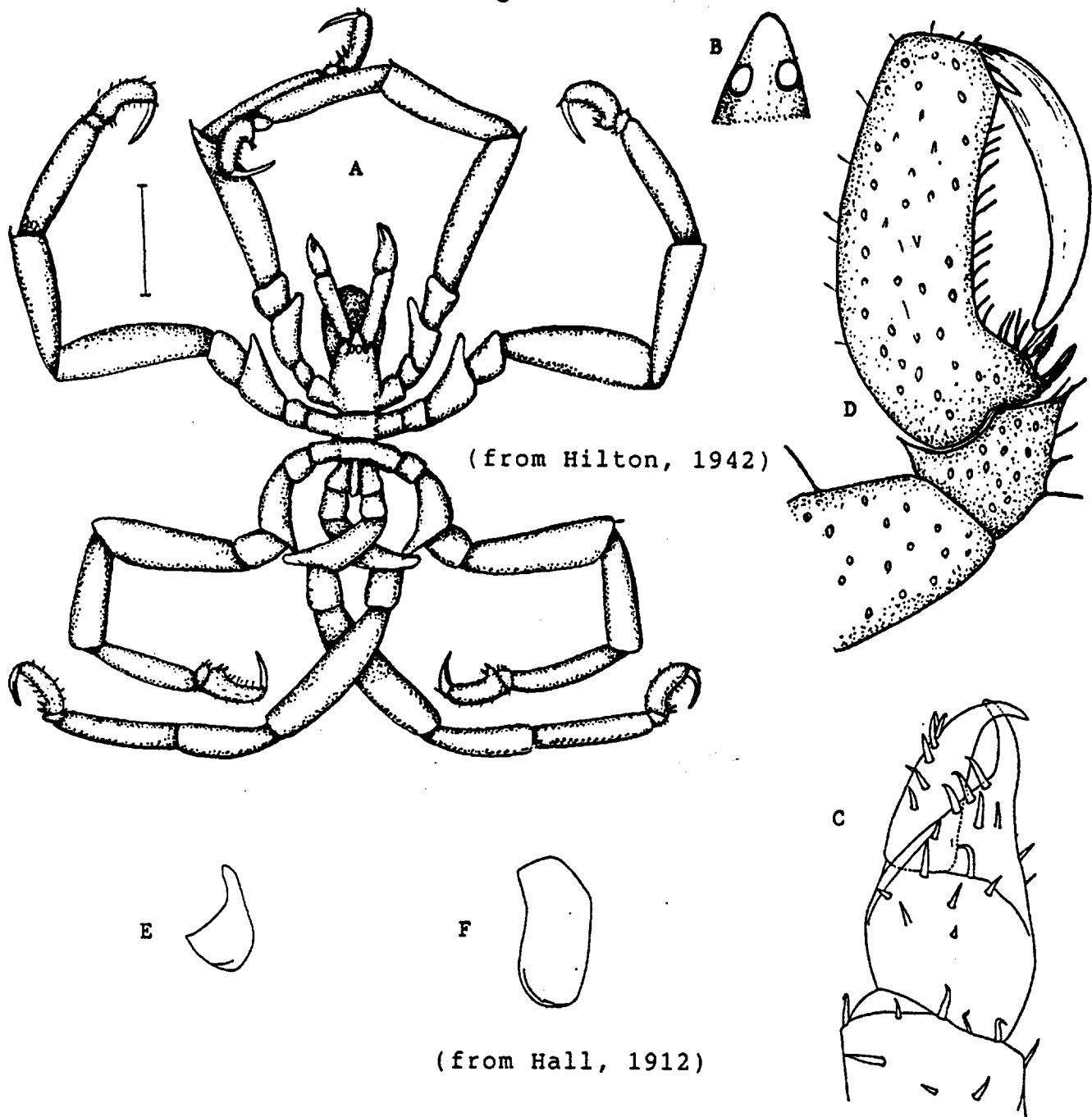
Phoxichilidium femoratum: A, female, lateral; B, second left leg of female; C, eye tubercle; D, caudal segment; E, right oviger of male.
(from Cole, 1904)

Fig. 32



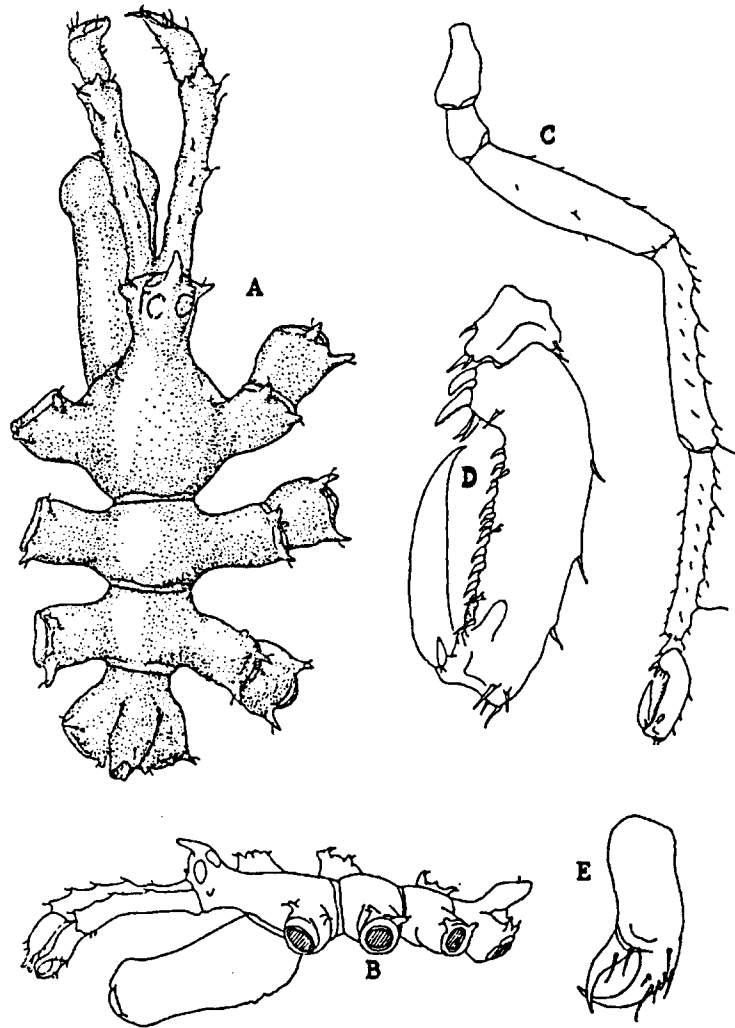
Anoplodactylus viridintestinalis: A, whole mount, dorsal; B, second left leg; C, foot; D, portion of sole. (from Cole, 1904)

Fig. 33



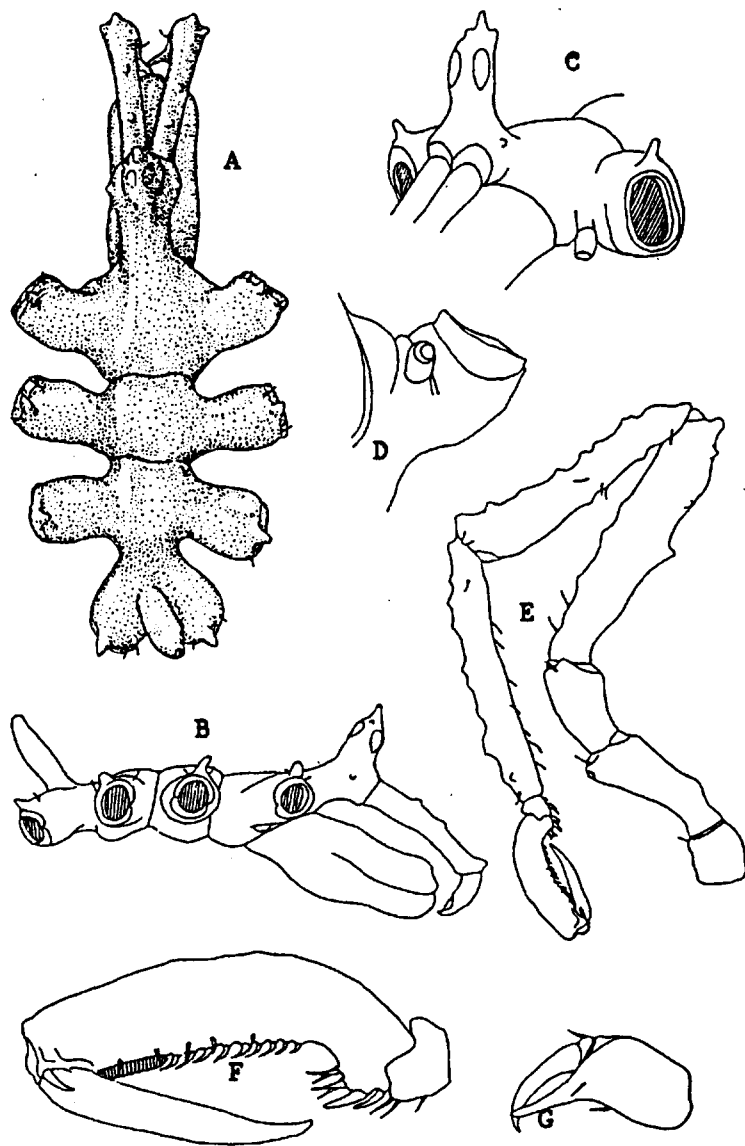
Anoplodactylus californicus: A, whole mount, dorsal; B, eye tubercle; C, terminal joint of chelifore; D, tarsus; E, palpus; F, oviger.

Fig. 34



Anoplodactylus oculospinus: A, trunk, dorsal; B, trunk, lateral; C, third leg; D, terminal segments of third leg; E, chela. (from Child, 1975)

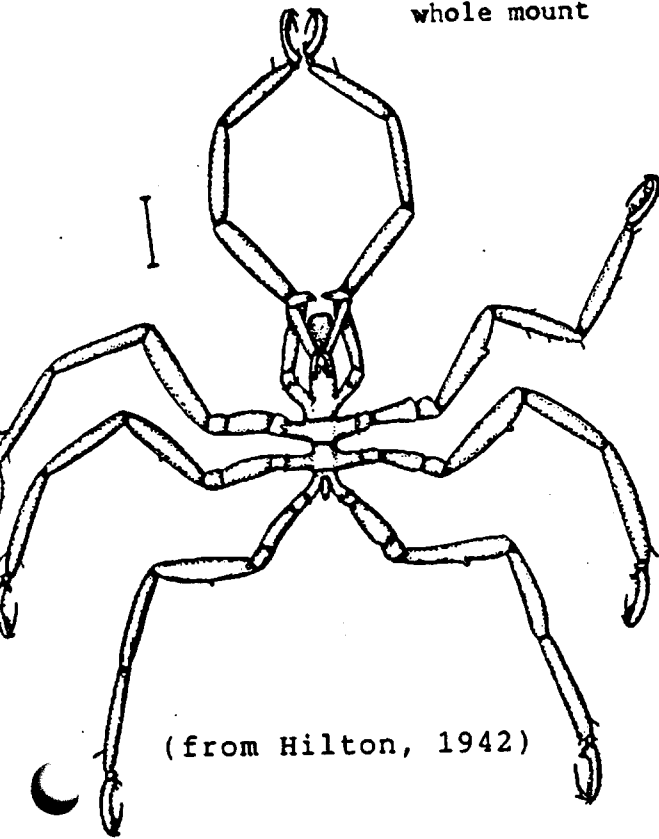
Fig. 35



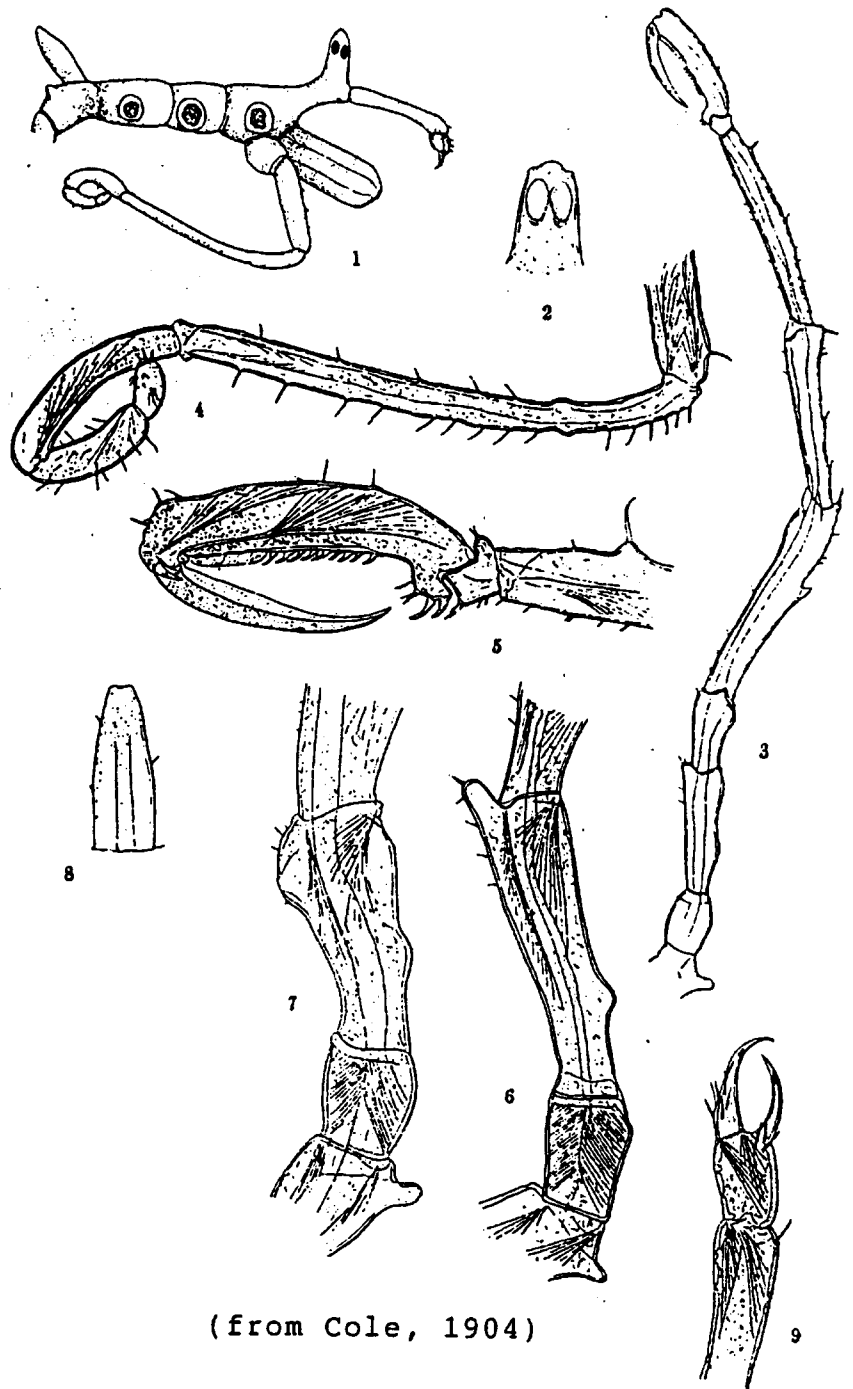
Anoplodactylus nodosus: A, dorsal view of trunk; B, trunk, lateral; C, oblique view of trunk; D, ventral first lateral process with oviger implantation; E, third leg; F, terminal segments of third leg; G, chela.
(from Child, 1975)

Fig. 36

Anoplodactylus erectus
whole mount



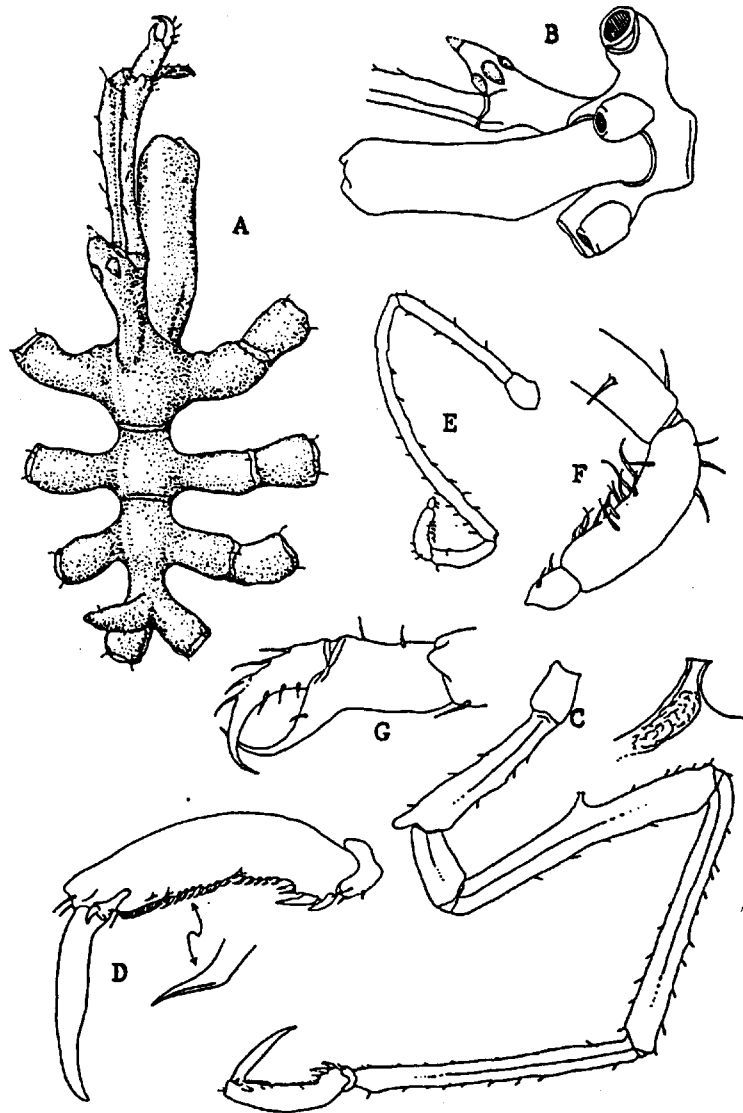
(from Hilton, 1942)



(from Cole, 1904)

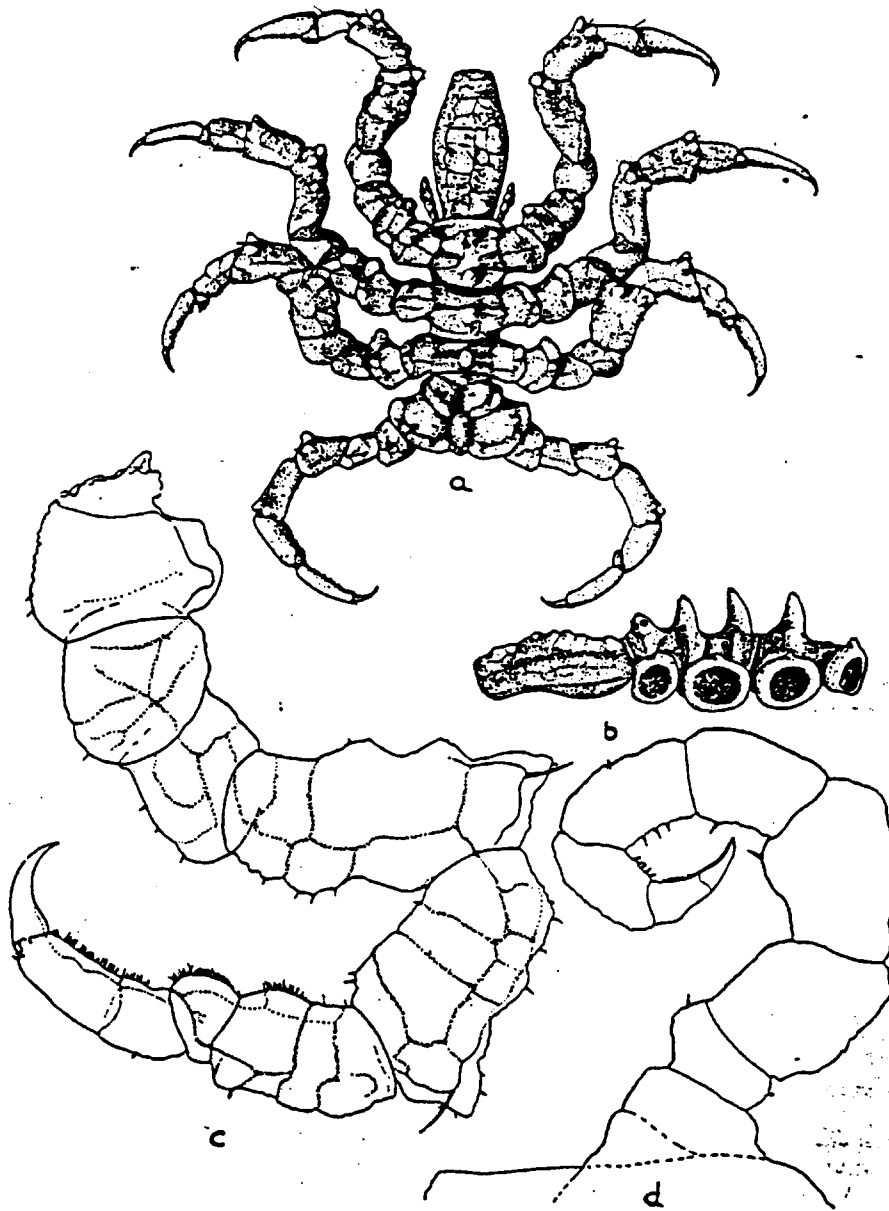
Anoplodactylus erectus: 1, male, lateral; 2, eye tubercle of female; 3, third right leg of male; 4, terminal part of left oviger; 5, foot; 6, second coxal joint of fourth right leg of male; 7, second coxal joint of second right leg of female; 8, caudal segment of female; 9, left chela.

Fig. 37

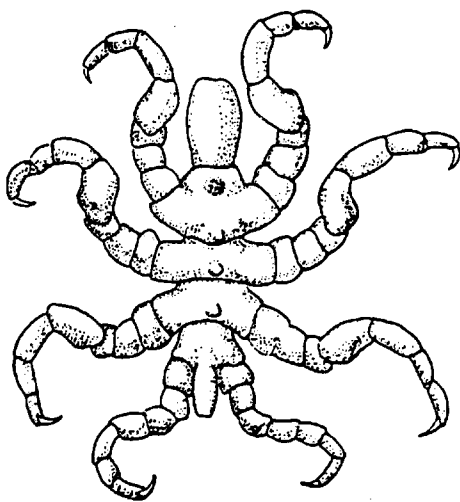


Anoplodactylus pacificus: A, trunk, dorsal; B, truck, ventral, oblique; C, third leg with enlargement of femoral cement gland; D, terminal segments of third leg, with enlargement of sole spine; E, oviger; F, oviger terminal segments; G, chela. (from Child, 1975)

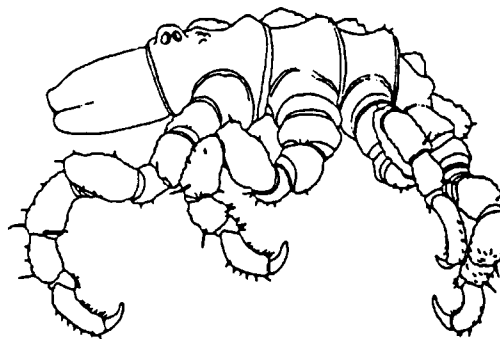
Fig. 38



Pycnogonum rickettsi: a, dorsal view of holotype; b, lateral view; c, third right leg; d, oviger. (from Schmitt, 1934)



(from Hedgpeth, 1975)



(from Child, 1980)

Pycnogonum stearnsi: dorsal view of whole mount.



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