The Sucking Lice (Anoplura: Echinophthiriidae) of the Northern Fur Seal; Descriptions and Morphological Adaptation

KE CHUNG KIM

The Frost Entomological Museum, Department of Entomology, The Pennsylvania State University, University Park, Pennsylvania 16802

ABSTRACT

The sucking lice *Antarctophthirus callorhini* (Osborn) and *Prochinophthirius fluctus* (Ferris) of the northern fur seal, *Callorhinus ursinus* (L.), are described and illustrated. The immature stages of *A. callorhini* and *P. fluctus* are fully described and illustrated for the first time. Morphological adaptation of these species is discussed in relation to their microhabitats.

The northern fur seal, *Callorhinus ursinus* (L.), harbors 2 distinct species of the sucking lice, *Antarctophthirus callorhini* (Osborn) and *Prochinophthirius fluctus* (Ferris). Both of these species of sucking lice have been known to occur simultaneously on individual seal pups (Ferris 1934, 1951, Jellison 1952). Sucking lice have not been recorded from adult seals. Virtually nothing is known about the ecology and life history of *A. callorhini* and *P. fluctus*. Eggs and nympha! stages of *A. callorhini* have not been known, and only 1st and 3rd nympha! stages of *P. fluctus* have been briefly described and illustrated (Ferris 1916, 1934).

In the summer of 1969 I had the opportunity to initiate a study of the ecology and life history of the sucking lice of the northern fur seal on St. Paul Island, Pribilol Islands, Alaska. In this investigation specimens of eggs, nympha, and adults of both species became available for study. The immature stages of *A. callorhini* and *P. fluctus* found on *C. ursinus* are herewith described and illustrated. Morphological terminologies of the Anoplura are those previously published (Kim 1965, 1966a, b).

DIFFERENCES BETWEEN *A. Callorhini* AND *P. Fluctus*

*A. callorhini* and *P. fluctus* have considerable morphological similarity. In both species the forelegs are small and weak, while the middle and hind legs are enlarged and specialized for holdfast. Both species have well-developed thoracic phragmata, a notal pit, and specialized spiracles. In a microscopic examination, *P. fluctus* is easily distinguishable from *A. callorhini* by having simple setae, although varying in length, no scales on the abdomen (Fig. 27 and 35), and 4-segmented antennae (Fig. 33).

In *A. callorhini* the antennae of the adults are 5-segmented, but those of the nympha! are 4-segmented. The terminal segment of the antennae is compound. The antennae of *P. fluctus* are 4-segmented in the nympha! and adult stages. Adults and nympha! of *A.

---

1 Authorized for publication as Paper no. 3821 in Journal Series of the Pennsylvania Agricultural Experiment Station, University Park, Pa. This research was partly supported by a grant from the Smithsonian Institution Office of Ecology, and Contract no. 14.17-001-2038, Bureau of Commercial Fisheries, U.S. Fish and Wildlife Service. This is the lst report of the investigation entitled "Ecology and life history of the sucking lice (Anoplura, Echinophthiriidae) of the northern fur seal, *Callorhinus ursinus* (Pennsylavia, Otariidae)." Received for publication Aug. 18, 1970.

---


The species was originally described by Osborn (1899) on the basis of several specimens. Nympha! stages have not been described previously. Male and female were described and illustrated by Ferris (1934). Eggs, nymphs, and adults are herewith described and illustrated.

Type Data.—Osborn (1899) listed the Type no. 3501, USNM, in the description of this species which was based on "a number of examples from the
lateral ridges. Fleshy sensory papillae sclerotized, distributed as in 3rd instar.

ACKNOWLEDGMENTS

We are indebted to Miss Janet Fendya for executing all figures. W. W. Wirth and L. V. Knutson of the Systematic Entomology Laboratory, USDA, read the manuscript critically and offered numerous suggestions for its improvement.

ABBREVIATIONS USED IN FIGURES

A, antenna; ASP, anterior spiracle; ASI, anal slit; AT, accessory teeth; BT, breathing tube; DB, dorsal bridge; DC, dorsal cornu; ES, epiclinal sclerite; HD, hypostomal bridge; HS, hypostomal sclerite; IP, interspiracular process; LS, ligulate sclerite; M, microtubular end; MI, mouthhook; PaB, papillary bud; PB, parastomal bar; PP, perinal pad; PR, prysmiostral ridge; PST, posterior spiracular tube; R, ray; S, sensillum; SP, spinele pole; SpA, spiracular area; SpP, spiracular scar; StC, stigmatic chamber; VC, ventral cornu; W, window.

All measurements indicated by scale lines are in millimeters.

REFERENCES CITED


Fig. 1–6.—*A. collorhini*. 1, Male; 2, female; 3, dorsal view of head and thorax, male; 4, antennae, male; 5, denticles, nymph 3; 6, tibiotarsus of hind leg, male.

*PM*—Photomicrographs.

*SEM*—Scanning electron micrographs.
Fig. 7-12. *A. collorhini*. 7, Setae and scales on male abdomen; 8, scales on female abdomen (phase contrast photomicrograph); 9, dorsal view of lateral part of male abdomen showing spiracles, setae, and scales; 10, ventral view of female genitalia; 11, tarsus and claw of fore leg, nymph 3; 12, middle and hind legs of nymph 3.
northern fur seal, Callorhinus ursinus, from Pribilof Island. However, no type specimen of this species has been found in the collections of the National Museum of Natural History, Smithsonian Institution (Johnson 1958; personal communication, Dr. K. C. Emerson, Apr. 17, 1970). An attempt has been made to locate the type specimens. Osborn’s Anoplura collection in the Ohio State University Insect Collections should have included the type of A. callorhinii. However, a careful examination of the Osborn collection failed to locate the type (personal communication, Dr. Charles A. Triplehorn, Apr. 27, 1970). Further search failed to locate the type in the collections of the Iowa State University, Ames (personal communication, Dr. J. L. Laffoon, Apr. 26, 1970). The present evidence indicates that the type specimens of A. callorhinii have been lost or destroyed. A neotype may eventually be needed for this species, but no such designation is necessary at present. This species is distinct and easily differentiated from other related species. The type specimens of A. monachus Kellogg & Ferris are deposited in the Ferris collections of the University of California, Berkeley.

Description.—MALE (Fig. 1): Total body length 2.98 mm (X). Head (Fig. 3) longer than wide; anterior margin heavily sclerotized, with barlike labrum; maxillary vestige distinct and heavily sclerotized; ventral labrum connected to long apodemes; posttarsal ventral angle developed, with 2 long and numerous short lateral setae; posteralabral angle not developed; each paramere slender and pointed with its basal arm curved mesad; pseudopenis V-shaped, with its apical arm short, thick and rounded at apex; gonopods and spermatheca, but with an elongated area of crowded setae on each side of 9th sternite; no specialized genital setae and vulvar fimbriae present.

EGG (Fig. 22): Length 0.78 mm, width 0.42 mm; grayish white and shiny; operculum with 12–15 small knoblike tubercles.

NYMPH 1 (Fig. 15): Total body length 0.60 mm (X), range 0.47–0.80 mm. Head (Fig. 20) about as wide as long; anterior margin rounded; labroocular area heavily sclerotized; with well-developed denticles; posteralabral angle strongly developed; with 2 long lateral setae and 1 anterior peg (MH); posteralabral angle distinctly developed; CS minute or absent; OS represented by 2 pegs on each side; dorsally with 3 lateral pegs anterior to antenna; 1 PAS peglike; AS normal; 2 pegs at the base of antennae; 2 SHS long; IPCS long; 1 PDHS and 2 ADHS arranged horizontally; ventrally with 1 preterminal peg and 1 VPHS; maxillary vestige distinct; ocipital apophyses not developed. Antennae 4-segmented; basal segment large; terminal segment about twice as big as segment 3, with 2 small sensory and about 7 peg organs at apex. Thorax (Fig. 21): Dorsally with weakly developed thoracic phragmata; metathoracic phragmata not evident; median apophysis not developed; notal pit indistinct; mesothoracic spiracle minute; pronotum with 1 exterior peg and 3 inner setae on each side; mesonotum with 2 exterior pegs, 2 inner setae on each side and a pair of central setae; metanotum with 1 exterior peg and 2 inner setae on each side; each, all plate with a peg. Legs as in adult; femur with 1 ventral peg. Abdomen short, oval, with no indication of tergites, sternites or paratergites; 6 spiracles present; dorsally with 8 rows of DCAS, each row with 4 setae, and 6 rows of DLAS, each of the 1st 3 rows with 2 setae and the remaining rows ending each setae with 8
Fig. 13-18.—*A. callorkini*. 13, Nymph 3; 14, nymph 2; 15, nymph 1; 16, ventral view of apex of nymph 3 abdomen showing "sex setae"; 17, antenna, nymph 3; 18, last segment of nymph 3 antennae showing peg organs and sensoria.
Fig. 19-26. *D. callorchini* 19, Thoracic phragmata, nymph 3; 20, head, nymph 2; 21, thoracic dorsum, nymph 1; 22, egg; 23, nymph 2; 24, spiracular apparatus of male abdomen; 25, male genitalia; 26, types of setae.
pegs present exterior to DLAS on each side; ventrally with 8 rows of VCAS, each row consisting of 2–3 setae; 25 pegs scattered lateral to VCAS; 2 AnS present; no scales present.

**NYMPH 2** (Fig. 14, 23): Total body length 1.61 mm (X), range 1.23–1.96 mm. **Head** about as wide as long; anterior margin rounded; haustellum with well developed denticles (Fig. 5); postantennal angle developed, with 2 long lateral setae; anterior region with about 7 clypeal setae in a row; dorsally with 3–5 pegs and scattered small setae; venter with 1–3 pegs and 2–3 setae; rim of antennal socket heavily sclerotized; labrum well developed and ventrally surrounding mouthparts; maxillary vestige distinct; occipital apophyses short to elongated. **Antenna 4-segmented**: terminal segment more than twice as long as segment 3, with 2 small sensoria and about 7 peg organs at apex (Fig. 17, 18). **Thorax**: Dorsally with pro-, meso-, and metathoracic phragmata well developed, similar in length and not connected (Fig. 20); mesothoracic phragmata not reaching the notal sclerites; median apophysis developed, narrow, longitudinal; notal pit distinct, surrounded by sclerites; mesothoracic spiracles minute, with specialized closing apparatus; dorsally each segment with 1–4 pegs and scattered setae of varying lengths; ventrally with numerous pegs and 14–18 setae; coxal plates each with peg; no sternal plate present. **Legs** as in the adults. **Abdomen oval**, with no indication of tergal, sternite, and paratergal plates; 6 small spiracles present, each with specialized closing apparatus; dorsally with 9 rows of regular setae, pegs scattered on the anterolateral area, and scales densely arranged on the apical 2/5 of the abdomen; ventrally with about 32 CAS, pegs scattered on anterior 1/5, and scales sparsely scattered on the posterior 3/5 of abdomen; anal segment rounded; sexual dimorphism beginning to show in mature specimens of this stage; female nymphs with 2 diverging rows of variously sized "sex setae" (Fig. 16).

**NYMPH 3** (Fig. 5, 11–13, 16–19): Total body length 2.24 mm (X), range 2.00–2.60 mm; similar to other nymphs, unless mentioned otherwise. **Head** ventrally with 3–6 pegs and 4–6 setae; occipital apophyses further prolonged and usually connected at apex. **Thorax** with phragmini similar to those in nymph 2; mesothoracic phragmata not reaching notal sclerites; metathoracic phragmata as long as mesothoracic phragmata; notal sclerites distinct, surrounding notal pit; ventrally with 12–17 pegs and scattered setae. **Legs** as in Fig. 11 and 12. **Abdomen** with setae, scales and pegs denser than in nymph 2.

**Remarks**—Nymph 1 is distinguishable from nymphs 2 and 3 by having short occipital apophyses, short thoracic phragmata (Fig. 19, 21), ventral side of head without pegs, ventral side of thorax bare and abdomen with only setae, and pegs sparse. Nymph 2 may be distinguished from nymph 3 by having mesothoracic phragmata reaching notal sclerites, and occipital apophyses parallel and not converged at apex.


**Proechinophthirius fluctus** Ferris

(Fig. 27–40)

**Echinophthirius fluctus Ferris** 1916: 366, f. 1–4; McAtee 1923: 142.

**Proechinophthirius fluctus** (Ferris). Ewing 1923: 149.


**Proechinophthirius fluctus ochotensis** Blagoveshchensky 1966: 458. (Type host—**Callorhinus urinus**, Sea of Okhotsk, Tyumen Islands.)

This species was originally described on the basis of 2 ตำ, 1 แ, and several nymphs (Ferris 1916). The female and what appeared to be nymph 1 were described and illustrated (Ferris 1916), and the nymph 3 was illustrated with a short description (Ferris 1934). Eggs, nymphs, and adults are herewith described and illustrated. Blagoveshchensky (1966) described a new subspecies, *P. fluctus ochotensis*, on the basis of 1 ตำ and 1 แ. At present the subspecific designation of *P. fluctus* is not justified, and is not recognized in this paper.

**Type Data**—Holotype male and several paratypes (2 ตำ, 1 แ, several nymphs) collected from a museum skin of *Enmeiotaxis jubata*, no other data (presumably from Alaska); deposited in the Ferris Collection of the Department of Entomology, University of California, Berkeley.

**Description**—**MALE** (Fig. 27, 29, 31, 32, 35, 36, 40): Total body length 3.34 mm (X); slender and delicate species. **Head** (Fig. 31) longer than wide, with its anterior margin more or less rounded; anterior margin membranous, with labrum not heavily sclerotized; anterior part with long lateral hairlike apodemes; maxillary vestige distinct; postantennal angles strongly developed, with 2 long lateral setae (SMHS); dorsally with setae of varying lengths scattered, and posteriorly with 6–7 long setae; posterolateral angle not developed, but with spiniform projection; occiput slightly constricted; occipital apophyses elongated; ventral side with 10 long setae posteriorly and 7 long lateral setae, and centrally with 2 irregular rows of setae. **Antenna 4-segmented** (Fig. 33): basal segment enlarged, with a posteroangular seta spiniform; segment 2 about twice as long as segment 3; terminal segment as long as segment 3, with 2 small sensoria and about 10–11 peg organs at apex (Fig. 34). **Thorax** about as long and slightly wider than the head; prothoracic phragmata elongated and converging; mesothoracic phragmata continuous across the notum, not inclining the notal pit (Fig. 27); metathoracic phragmata not continuous; coxal condyles connected by a continuous sclerotic band; sternum membranous, with a median apophysis; no sternal plate developed. **Legs** (Fig. 32): Forelegs small, weak with unmodified
tibia and tarsus, and with acuminate claw; middle and hind legs similar in shape and size, very large and strongly specialized for holdfast (Fig. 32), each with tibiotarsus and large, blunt claw. **Abdomen** elongated, without tergal, sternal, and paratergial plates; 6 small spiracles present, each with a specialized closing apparatus (Fig. 29, 39); dorsally and ventrally with 8 approximate rows of pegs and setae; no scales present (Fig. 35, 36); anal segment slightly enlarged with 6–8 small setae on each side. **Genitalia** (Fig. 40): basal apodeme long, rather broad with a median longitudinal keel; parameres slender, knife-shaped, with both ends rounded; pseudopenis U-shaped, without distinct apical arm, articulating with apical condyles of basal apodeme; endomere sclerotized, anteriorly expanded and posteriorly con-

![Images of lice](image)

**Fig. 27-30.** *P. fluctus*. 27, Male; 28, female; 29, spiracular apparatus of male abdomen; 30, female genitalia.
Fig. 31–36.—*P. fluvius.* 31, Dorsal view of male head; 32, middle and hind legs of male; 33, female antenna; 34, last segment of female antenna showing peg organs and sensoria; 35, setae on male abdomen; 36, abdominal seta of male.
pected and wishbone-shaped; aedeagus sclerotized, connected to posterior arms of endomes.

**FEMALE** (Fig. 28, 30, 33, 34): Total body length 3.58 mm (X). Head, thorax, legs, and abdomen as in male unless mentioned otherwise. **Thorax** with metathoracic phragma barely reaching the notal sclerites. **Genitalia** (Fig. 30) with a pair of genital bars; vulva fringed with setae and with a crowded cluster of long setae on each side of 9th sternite.

**EGG** (Fig. 38): Length 0.73 mm, diam 0.45 mm; grayish white, smooth; operculum with 6 tubercles.

**NYMPH 1** (Fig. 37): Total body length 0.85 mm (X). Head much longer than wide; anterior margin rounded; preantennal part unusually long; about as long as the postantennal bead; labrocapeal area heavily sclerotized; occiput prolonged, but apophyses not developed; postantennal angle strongly produced; posteralateral angle not developed; OS represented by 1 large and 2 small pegs; 1 PAS normal; preantennal head with 2 lateral pegs; AS normal; SHS spiniform; 1 SHS normal; 3 MHS present; no distinct ADHS and 1 PDPHS present; postantennal head with 3 setae arranged in a longitudinal row; ventrally with 1 preantennal lateral peg and VPFS small. Antennae 4-segmented, with terminal segment about as long as segment 3; basal segment dorsally with a very large peg and ventrally with a smaller peg; segment 2 ventrally with an anterior peg and 1 large thumblike tubercle; segment 3 with 1 tubercle; terminal segment with 2 inconspicuous sensoria and 7 peg organs at apex. **Thorax** shorter and slightly wider than head; phragmaidate developed, but none continuous across the notum; notal pit indistinct; no notal scierote developed; mesothoracic spiracle small; each segment dorsally with 1 large lateral peg and 2 normal setae (DPTS, DMHS, DTS (= dorsal metathoracic seta)); ventrally with no trace of plate on each coxal plate; each coxal plate with a few setae. **Legs**; Forelegs small, weak with slightly modified tibia and acuminate claw; fore tibia with an apical lobe; middle and hind legs similar in shape and size, each with modified tibiotarsus and blunt claw. **Abdomen** with 6 small spiracles and specialized closing apparatus, and no scales; no tergal, sternal, or paranotal sclerites developed; dorsally with 2 longitudinal rows of long CAS and ventrally with 7 rows of setae, 0-2, 0-1, 0-4, 1-4, 1-4, 1-4, 1-4; 2 minute setae present on the apical margin; anal segment rounded.

**NYMPH 2**: Total body length 1.13 mm (X). Head, thorax, legs, and abdomen as in nymph 1 unless mentioned otherwise. Head dorsally with 4 OS on each side, the exterior one being a large peg and the inner OS being small pegs; 1 PAS small peg; AS large peg; SHS large peg and MMHS and PMHS minute setae; SHS peg; 1 SHS minute setae; ACHS peg; PDPHS peg; 1 small peg placed medio-posterior to PDPHS; a few minute setae scattered on the head; ventrally with 1 minute setae before the base of antennae and 3 pegs arranged in a longitudinal row on each side. Antennae 4-segmented; segment 2 with 2 dorsal pegs and 1 ventral tubercle. **Thorax**: Pronotum with 3 exterior pegs and 1 inner setae; mesonotum with 3 exterior pegs and 2 inner setae; metasternum with 1 exterior peg and 2 inner setae; coxal plates each with 2-3 short, spatulate setae; about 6 setae scattered between coxal plate 3. **Abdomen** dorsally with 16 rows of DCAS, the first 9 rows each with 2 setae and the posterior rows each with 3-10 setae; anterior 7 DLAS distinct, but posterior LAS increasing in number and continuous to CAS; segments 4-7 each with 1 long, spiniform setae on lateral margin; ventrally with about 20 irregular rows of long VCAS and 1-3 VLSAs on each segment; segments 3-6 each with 2-3 long, spiniform, spatulate setae on lateral margin; posterior setae generally slender, spatulate and occasionally serrated on the side.

**NYMPH 3**: Total body length 1.66 mm (X). Similar to nymphs 1 and 2, unless mentioned otherwise. Head with anterior margin strongly sclerotized; pegs larger and setae longer; dorsally with 28-30 regular setae, a pair of large pegs at the center, 2 long, strong setae on each side of the lateral margin, and 3 long setae on each side of the occiput; ventrally with 4 long pegs, 8 pairs of central setae in a longitudinal row, and 3 long setae on each side of its posteralateral margin. Antennae 4-segmented; basal segment with 1 dorsal and 1 ventral peg and with a small spiniform seta on the posteralateral angle; segment 2 about 1/2 as large as the basal segment, with no tubercle. **Thorax**: Prothorax with 1 large exterior peg and 11 long setae on each side; mesothorax with 2 large exterior pegs and 2 long setae on each side; metathorax with 1 large exterior peg and 2 long setae on each side; ventrally with numerous regular setae. **Abdomen** with regular setae of varying size; DCAS placed in more irregular rows, ca. 80 or more in number; numerous DLAS on the posterior area; slightly spatulate and occasionally serrate on the side; VCAS and VLSAs regular and numerous. Sexual characters quite evident.


**MORPHOLOGICAL ADAPTATION**

Survival of obligate ectoparasites depends solely on the host animals and the microenvironment that the host provides. The sucking lice of the northern fur seal being ectoparasitic and essentially terrestrial, must have adapted for survival and propagation of the species to the combination of marine and terrestrial environments. The unique biological traits found among the sucking lice of the Echinothripsidae, which are exclusively parasitic on marine
Fig. 37-40.—*P. fluctus*. 37, Nymph 1; 38, egg; 39, spiracular apparatus of male abdomen; 40, male genitalia.
carnivores of the order Pinnipedia, are evolutionary manifestation of the continuous selection and adaptation by these ectoparasites to 2 contrasting environments.

The sucking lice of pinnipeds have several unique morphological adaptations in spiracles, setae, and abdomen which are not found in other groups of Anoplura. The thoracic and abdominal spiracles are similar in shape and size. The spiracular atrium is a simple chamber consisting of 3 major parts; a short membranous papilla, a heavily sclerotized tube, and bulblike 2nd chamber. The closing apparatus comprises a stout, heavily sclerotized, triangular plate with a large chitinous apodeme at the center. The triangular plate articulates with the proximal end of the sclerotized tube within the 2nd chamber. The membranous atrial wall continues to join the trachea from the proximal end of the sclerotized atrium (Fig. 24, 39). The occlusor muscle which originates from the body wall is attached to a large chitinous apodeme. This muscle rotates the apodeme and moves the triangular plate in a forward direction, depressing the knoblike projection into the hollow (Webb 1946). The spiracles of these lice have presumably become modified in structure to close for protecting the tracheal system against flooding with water (Webb 1946) or for conserving air during the long periods of immersion (Scherf 1963).

The echinophthirids have various types of setae: namely, normal setae, spiniform setae, pegs, and scales (Fig. 26, 35). Pegs and scales are rather distinctive in this group. Although no information is available as to what homoeostatic significance these pegs and scales have, the setal modification is easily related to aquatic existence of the lice. The sucking lice of pinnipeds lack abdominal sclerotization; no toagal, sternal, or paratergal plates are developed. This morphological feature is not unique to this group, but provides larger surface area for cutaneous respiration.

Antarctophthirus oigmorhini Enderlein found on Leptonychotes weddelli Lesson are known to survive in water at 6°C for 14 days and are thought to obtain oxygen from water by diffusion through the cuticle (Murray et al. 1965). A similar phenomenon was also reported for Leptophthirus macrorhini Enderlein on Mirounga leonina (L.) at low temperature (Murray 1964, Murray and Nicholls 1965). Scherf (1963) concluded that Antarctophthirus triechchi Boheman and Echinophthirus kordius Offers used abdominal spiracles for inhalation and thoracic spiracles for exhalation. He further stated that a volume of air was trapped in the spiracular atrium by the well-developed closing apparatus.

A. callorhini, as other echinophthirids, has distinctive scales on the abdomen (Fig. 7-9) in all stages but nymph 1, and a spiracular atrium with a large triangular plate, a large chitinous apodeme, and a peculiar sclerotized collar which marks the beginning of a tubular part (Fig. 24). On the other hand, P. fluctus has simple setae and pegs but no scales, although in nymphal stages 2 and 3 posterior abdominal setae may be long, spicate, and occasionally serrate. This species also has the spiracular atrium which consists of a smaller triangular plate, a smaller chitinous apodeme, and simple tube. The apical part of the atrium is bulbous and rather similar to that of terrestrial sucking lice. A. oigmorhini and L. macrorhini are usually found on the areas of the skin less densely covered with hairs; A. oigmorhini is found on the tail, ankle, hip, and hind flippers as well as anal and penial orifices of male seals, and L. macrorhini is found on hind flippers. The data collected in the preliminary investigation show that P. fluctus is usually confined to the pelage proper, and A. callorhini is found on and around naked skins, namely eyelids, nostrils, auditory canals, penial orifice and umbilical area of the black pups. The preliminary data of the pelagic collection show that nympha 1 of A. callorhini inhabits the underfur layer along with P. fluctus and lacks the abdominal scales.

Although the sucking lice have not previously been collected from adult seals, ecological components of the microhabitat in the underfur layer of the adult seem to be optimal for successful maintenance and development of the lice while at sea. The underfur layer contains sufficient oxygen, and the outer surface of the host body covering is about 13 degrees colder than the center of the body and about 15 degrees warmer than the water. The sucking louse infestation of adult seals was confirmed by Cook's technique (Cook 1954a, b). P. fluctus is actually living in a terrestrial environment while the host animal is at sea, because of their water-free habitat, the underfur layer. On the other hand, A. callorhini is constantly subjected to water because of its habitat preference. The morphological features of these species seem to coincide with their microhabitats. In other words, lack of scalelike setae in Proechinophthirus and the nympha 1 of A. callorhini may indicate the retention of primitive terrestrial morphological features. Proechinophthirus has actually been in terrestrial existence, and has not perhaps needed to modify its setae. However, the latter stages of Antarctophthirus as other echinophthirids were perhaps forced to develop scales because of their aquatic existence. Morphological adaptation of these insects will be further explained by additional information on biology, ecology, and physiology of each species.

Acknowledgments

I am grateful to the Smithsonian Institution Office of Environmental Sciences (formerly Ecology) and the U.S. Bureau of Commercial Fisheries for their financial aid to make this field research possible. Deepest appreciation is extended to Dr. Helmut K. Bueschner, Senior Ecolologist, Smithsonian Institution for his encouragement and support in initiating this study. I am also indebted to Mr. Ford Wilke, Mr. William Peck, Mr. Alton Roppel, Dr. Mark Keyes and other personnel of the Marine Mammal Biological Laboratory of the U.S. Bureau of Commercial Fisheries for their help, advice, and cooperation during this study. A personal appreciation is also ex-
tended to Mrs. Verda Haas for her excellent assistance in preparing specimens for study.

REFERENCES CITED


THE SERIAL LITERATURE OF ENTOMOLOGY
A Descriptive Study
1970
Prepared by Gloria M. Hamman, George Washington University Medical Center, Biological Sciences Communication Project, Washington, D. C. for The Entomological Society of America. This publication provides information concerning 762 serial publications, worldwide, which in general contain 25% or more articles related directly to some aspect of entomology. $2.25 postpaid. Order from:

ENTOMOLOGICAL SOCIETY OF AMERICA
4603 Calvert Road
College Park, Maryland 20740