THE DEVELOPMENTAL STAGES OF THE CALANOID COPEPOD *LABIDOCERA WOLLASTONI* (LUBBOCK) WITH OBSERVATIONS ON ITS EGGS (1)

by

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Résumé

Les étapes du développement de *Labidocera wollastoni* sont décrites et comparées à celles d'autres espèces du même genre. Les femelles pondent des œufs lisses ou épineux. L'observation de l'éclosion, montre qu'elle est immédiate chez les premiers et présente une diapause chez les seconds.

Introduction

While examining aspects of the reproductive biology of *Pontella mediterranea* Claus at the Station Zoologique, Villefranche-sur-Mer (Grice and Gibson, in press) observations were made on the eggs and development of *Labidocera wollastoni*, a species which often was found co-occurring with *P. mediterranea. L. wollastoni* is one of three species of *Labidocera* present in the Mediterranean Sea, the other two being *L. acutifrons* (Dana) and *L. brunescens* (Czern.). Except for the nauplii of *L. acutifrons* and *L. brunescens*, the developmental stages of these Mediterranean species have not been described. We thank the Director, Dr. Paul Bougis, for permitting us to visit the Station Zoologique and Dr. Robert Fenaux for assisting us in obtaining laboratory space and plankton collections.

Methods

Neuston collections were made near Cape Ferrat from September to November 1979. Individual adult *L. wollastoni* were removed from the samples and placed in 125-ml dishes and fed *Artemia* nauplii. Eggs were usually laid within 12 hours and were transferred by pipette to 75-cc dishes containing filtered seawater for observation. Nauplii were fed *Prorocentrum* and *Peridinium* and copepodids received *Arte-*

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mia nauplii in addition to these dinoflagellates. Developmental stages were removed and preserved in 5 percent formalin for subsequent illustration.

DEVELOPMENTAL STAGES

Eggs

Two types of eggs were laid, a spiny and a smooth (spineless) type. Both were about 120μm in diameter. The spiny eggs had a central greenish mass surrounded by a clear area as described for the diapause eggs of *L. aestiva* by Grice and Lawson (1976), and they did not hatch within one day at 20°-21°C. The smooth eggs did not contain a central mass and hatched within one day at 20°-21°C.

Nauplii

(Figs. 1, 2)

The naupliar development is similar to that of other species of *Labidocera.*

Nauplius I (Figs. 1A, G; 2A, G) — Total length: .18-.20mm. Two short spines arising from caudal area. Terminal segment of antennule with 4 setae.

Nauplius II (Figs. 1B, H; 2B, H) — Total length: .27-.28mm. One long and One very short seta arising from caudal area. Masticatory seta on basipodal segment of left and right antennae elongate and subequal.

Nauplius III (Figs. 1C, I; 2C, I) — Total length: .30-.32mm. Caudal area has 2 spines subterminally, 2 long, subequal setae on left side and 2 smaller setae on right side. Terminal segment of antennule with 6 setae.

Nauplius IV (Figs. 1D, J; 2D, J) — Total length: .34-.38mm. Caudal area as in preceding stage. Terminal segment of antennule with 11 setae. Rudiment of maxillule present. Mandible with gnathal lobe.

Nauplius V (Figs. 1E, K; 2E, K) — Total length: .42-.44mm. Caudal area with small lateral spines. Terminal segment of antennule with 13 setae.

Nauplius VI (Figs. 1F, L; 2F, L) — Total length: .48-.52mm. Terminal segment of antennule with 15 setae. Maxillule multilobed, rudiments of maxilliped and first and second feet present.

FIG. 1

Labidocera wollastoni

A, nauplius I; B, nauplius II; C, nauplius III; D, nauplius IV; E, nauplius V; F, nauplius VI; G, antennule, nauplius I; H, antennule, nauplius II; I, antennule, nauplius III; J, antennule, nauplius IV; K, antennule, nauplius V; L, antennule, nauplius VI.

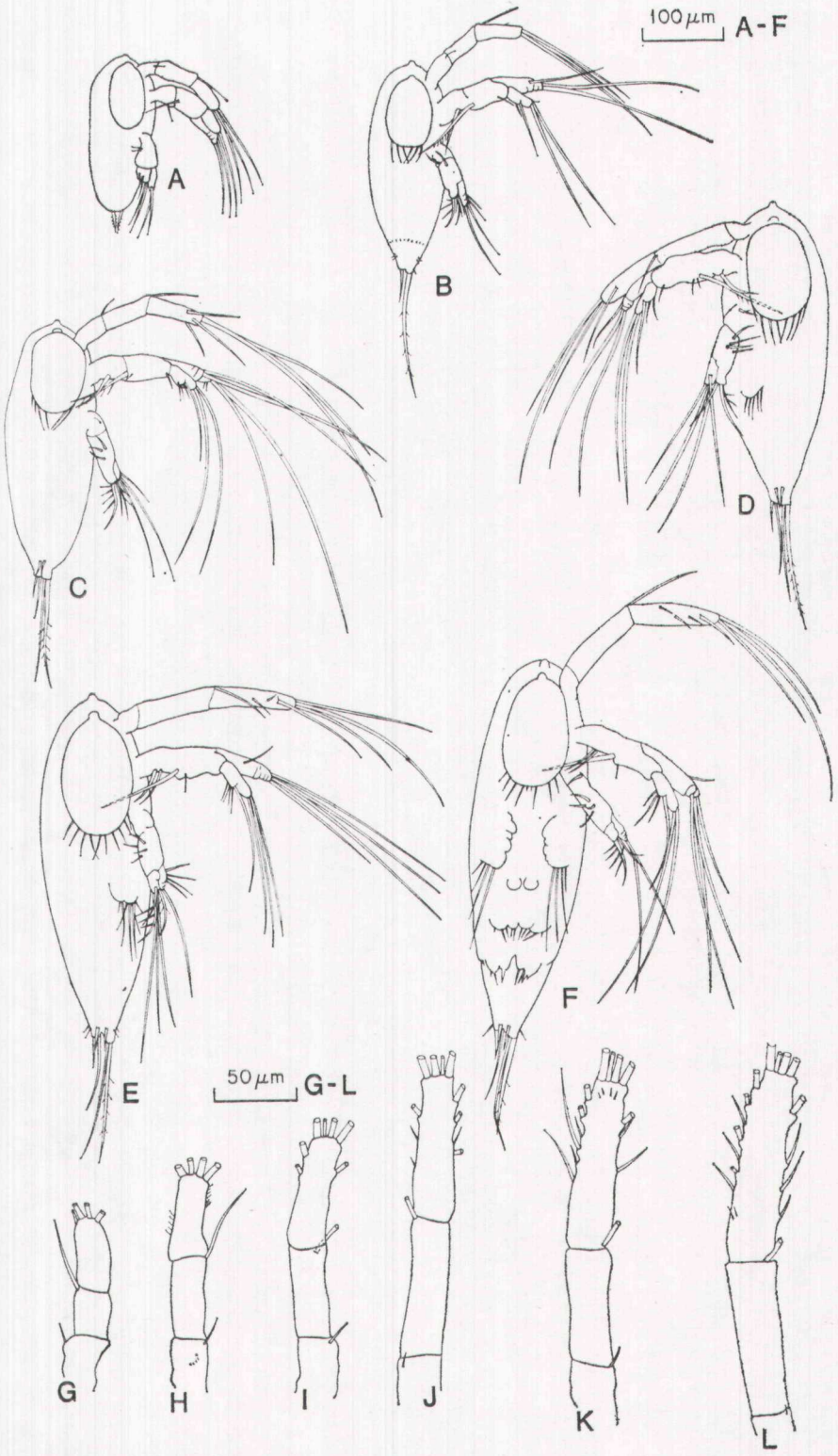

FIG. 1

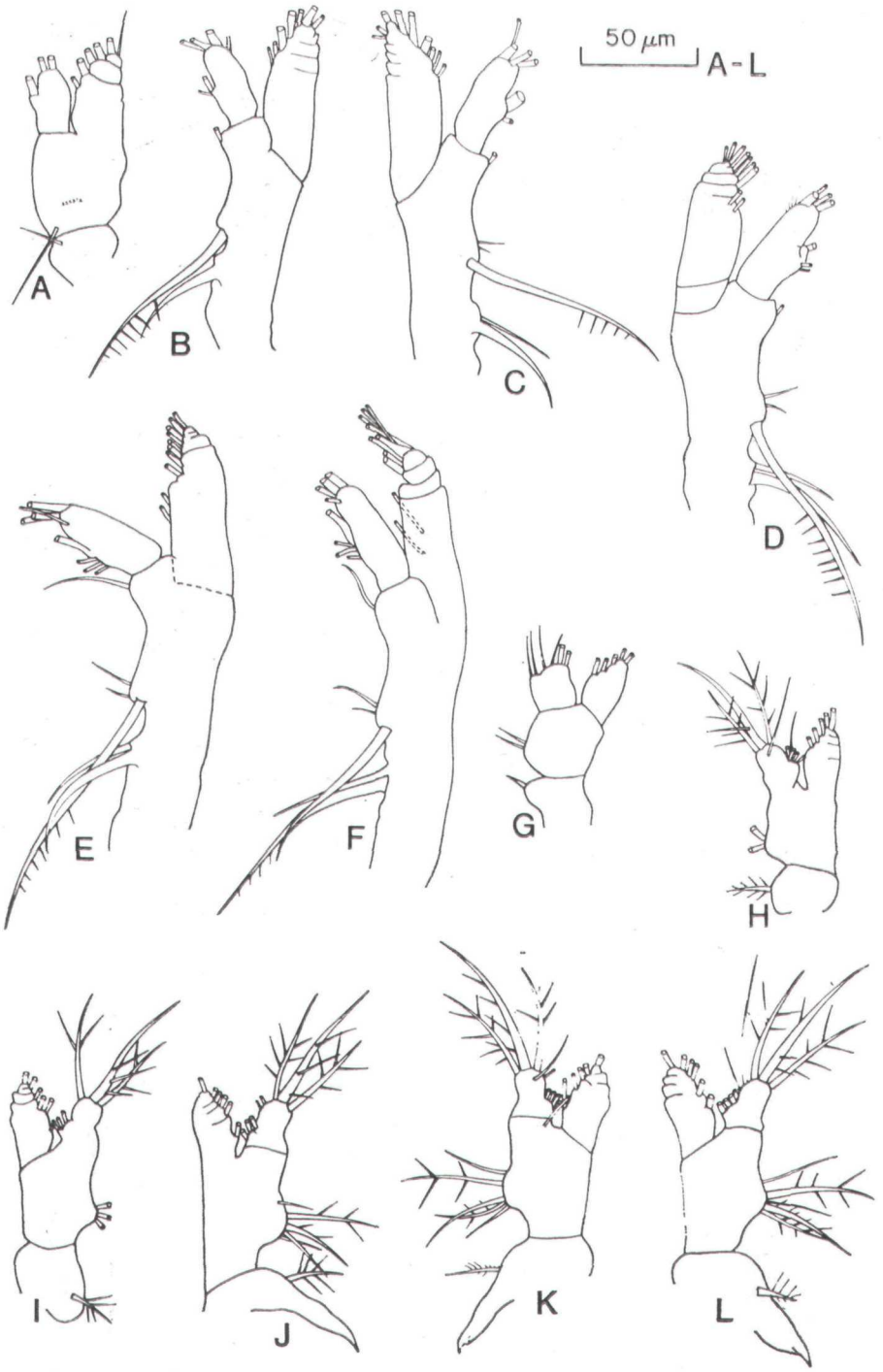

FIG. 2
Labidocera wollastoni

A, antenna, nauplius I; B, antenna, nauplius II; C, antenna, nauplius III; D, antenna, nauplius IV; E, antenna, nauplius V; F, antenna, nauplius VI; G, mandible, nauplius I; H, mandible, nauplius II; I, mandible, nauplius III; J, mandible, nauplius IV; K, mandible, nauplius V; L. mandible, nauplius VI.

Copepodids and adults
(Figs. 3-7)

Copepodid I (Figs. **3A;** 4A, H; 5A, B, M; 6A, G, M; **7A)** — Total length: .64-.70mm. Metasome composed of 3 segments, urosome of 2 segments. Two pairs of feet.

Copepodid II (Figs. 3B; 4B, I; 5C, D, N; 6B, H, N; 7B, G) — Total length: .89-.91mm. Cephalosome with rostrum, lateral spines and a pair of dorsal lenses in this and subsequent stages. Three pairs of feet.

Copepodid III (Figs. 3C; 4C, J; 5E, F, O; 6C, I, O; 7C, H, L) — Total length: 1.0-1.1mm. Four pairs of feet.

Copepodid IV (Figs. 3D; 4D, K; 5G, H, P; 6D, J, P; 7D, I, M, P, Q) — Total length: 1.3-1.4mm. Urosome consists of 3 segments. Sexes recognizable by structure of fifth feet, female fifth feet symmetrical, male asymmetrical.

Copepodid V (Figs. 3E, F; 4E, L; 51, J, Q; 6E, K, Q; 7E, J, N, R, S) — Total length, female: 1.6-1.7mm, male: 1.6-1.8mm. Female urosome consists of 3 segments, male of 4 segments. Female fifth feet symmetrical, male with right terminal segment enlarged.

Adult (Figs. 3G, H; 4F, G, M; 5K, L, R; 6F, L, R; 7F, K, O, T, U) — Total length, female: 2.2-2.3mm; male: 2.0-2.2mm. Female urosome of 3 segments, genital segment with dorsal protuberance. Male urosome of 4 segments, right antenna modified, right fifth foot chelate.

Hatching **and** development time

At incubation temperatures of 20°-21°C, the spineless eggs generally hatched within 24 hours of deposition whereas only one out of 142 spiny eggs hatched under similar conditions. Clutches of eggs from **15** individual females consisted of one type of egg. Spiny eggs did not hatch after incubation at temperatures of 20°, 16°, 10°, or 4°C for 20 days followed by warming to 25°C Spiny eggs laid on October 21 at room temperature (19°-20°C) in Villefranche by three females were returned to Woods Hole by one of us (V.G.) on November 5 (5 days in transit) where they were incubated at 18°-19°C. These eggs began hatching in early December and continued to hatch intermittently until January 3 at which time 77 of the 79 eggs had hatched. The development time from egg to adult varied from 28 to 32 days at temperatures of 18°-21°C.

DISCUSSION

The general structure of the naupliar stages is similar to *L. brunescens* and *L. acutifrons* as described by Sazina (1967) and Bjornberg (1972) respectively. The naupliar stages of *L. wollastoni* are

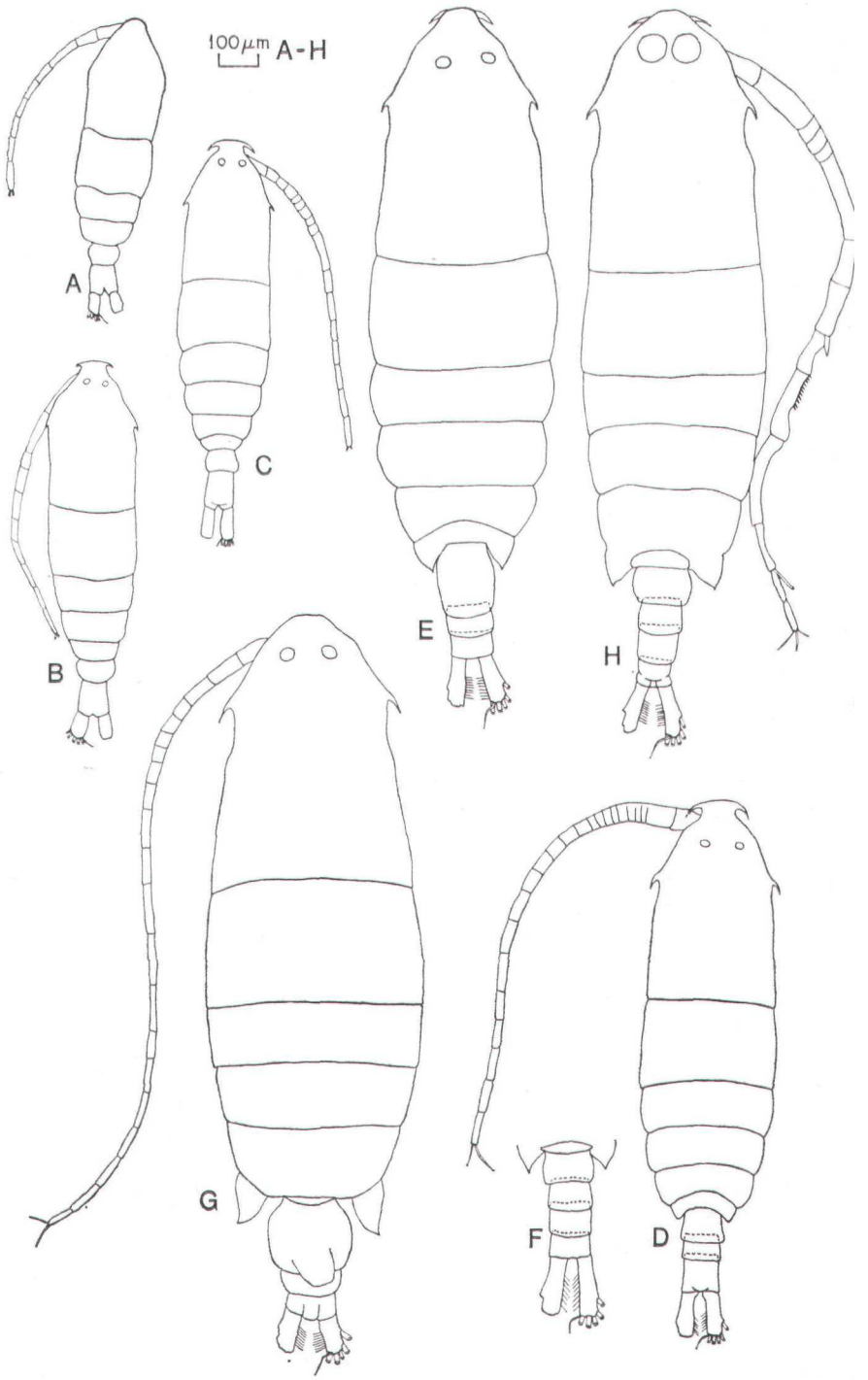

FIG. 3
Labidocera wollastoni
A, copepodid I; B, copepodid II, C, copepodid III; D, copepodid IV, E, copepodid V, female; F, copepodid V, male urosorae; G, adult female; H, adult male.

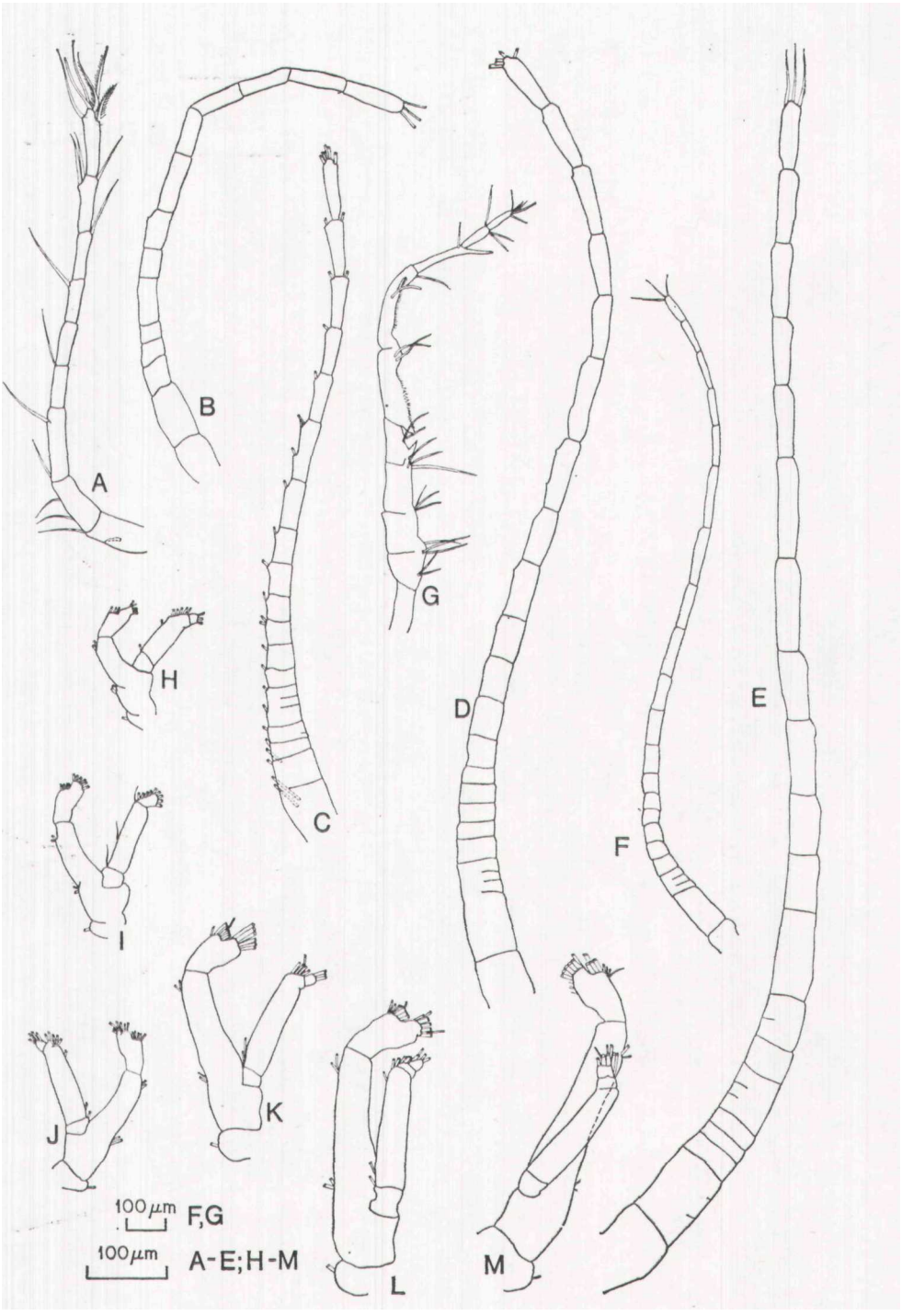

FIG. 4

Labidocera wollastoni

A, antennule, copepodid I; B, antennule, copepodid II; C, antennule, copepodid III, D, antennule, copepodid IV; E, antennule, copepodid V; F, antennule, adult female; G, antennule, terminal part, adult male; H, antenna, copepodid I; I, antenna, copepodid II; J, antenna, copepodid III, K, antenna, copepodid IV; L, antenna, copepodid V; M, antenna, adult.
Setae omitted from most antennules.

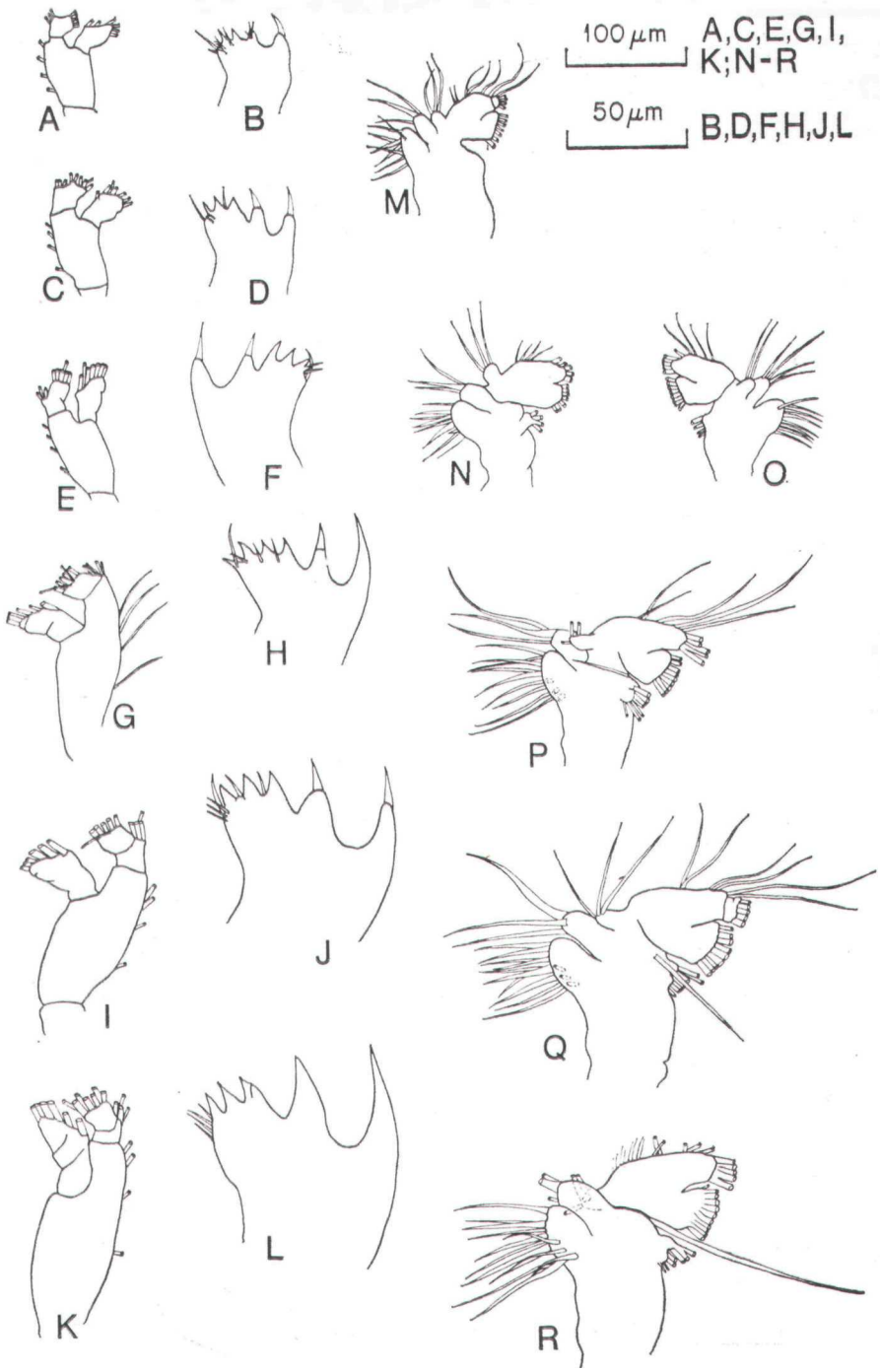

FIG. 5

Labidocera wollastoni

A, mandible, copepodid I; B, mandible blade, copepodid I; C, mandible, copepodid II; D, mandible blade, copepodid II; E. mandible, copepodid III; F, mandible blade, copepodid III; G, mandible, copepodid IV; H, mandible blade, copepodid IV; I, mandible, copepodid V; J, mandible blade, copepodid V; K, mandible, adult; L, mandible blade, adult; M, maxillule, copepodid I; N, inaxillule, copepodid II; 0, maxillule, copepodid III; P, maxillule, copepodid IV; Q, maxillule, copepodid V; R, maxillule, adult.

more elongate and larger than the corresponding stages of *L. brunescens.* They are also larger than the two naupliar stages (III, IV) of *L. acutifrons* that were described by Bjornberg. Unlike the nauplii of *L. aestiva* and certain other species discussed by Gibson

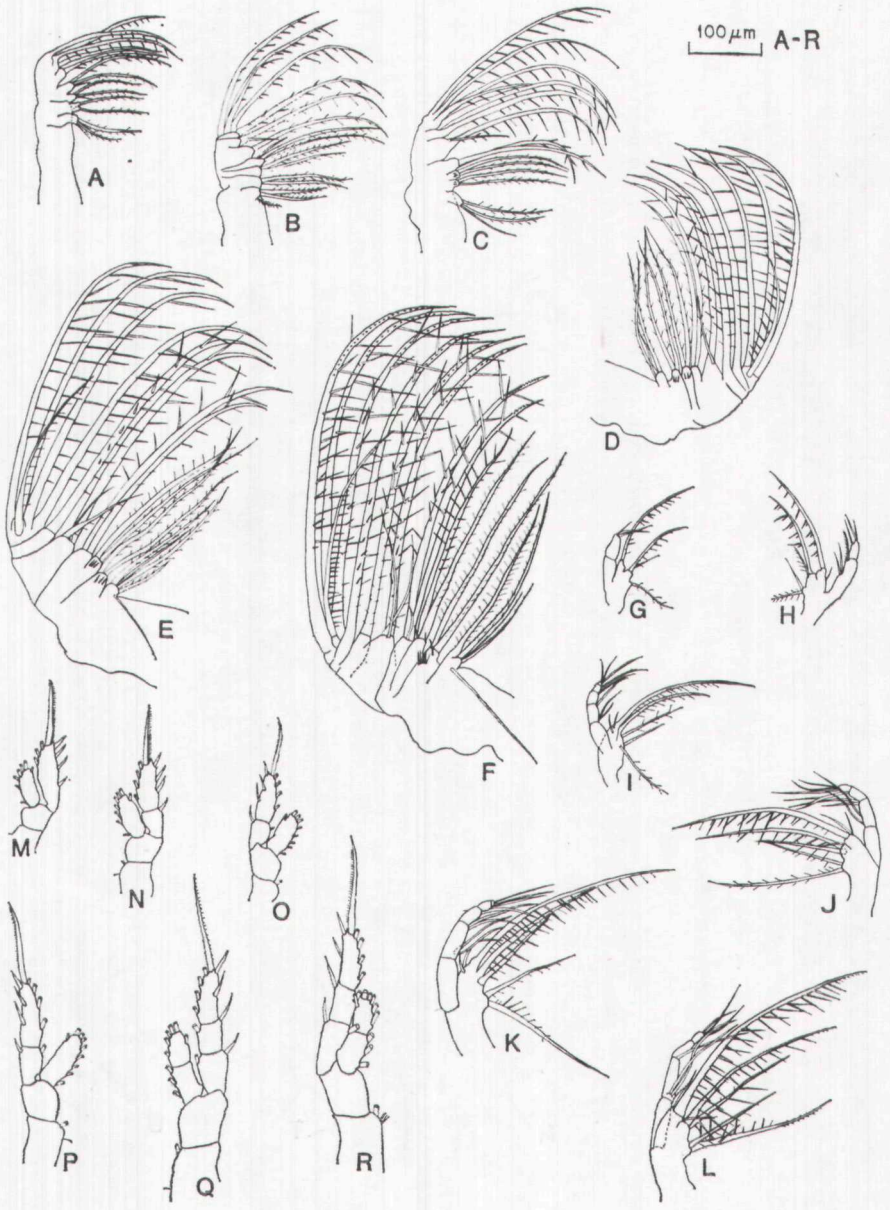

FIG. 6
Labidocera wollastoni

A, maxilla, copepodid I; B, maxilla, copepodid II; C, maxilla, copepodid III; D, maxilla, copepodid IV; E, maxilla, copepodid V; F, maxilla, adult; G. maxilliped, copepodid I; H, maxilliped, copepodid II, I, maxilliped, copepodid III; J, maxilliped, copepodid IV; K, maxilliped, copepodid V; L, maxilliped, adult; M, first foot, copepodid I; N, first foot, copepodid II; O, first foot, copepodid III; P, first foot, copepodid IV; Q, first foot, copepodid V; R, first foot, adult.

and Grice (1977), the elongate spines on the basipodal segments of the left and right antenna of *L. wollastoni* are subequal in length. The copepodid stages are generally similar to those of other described

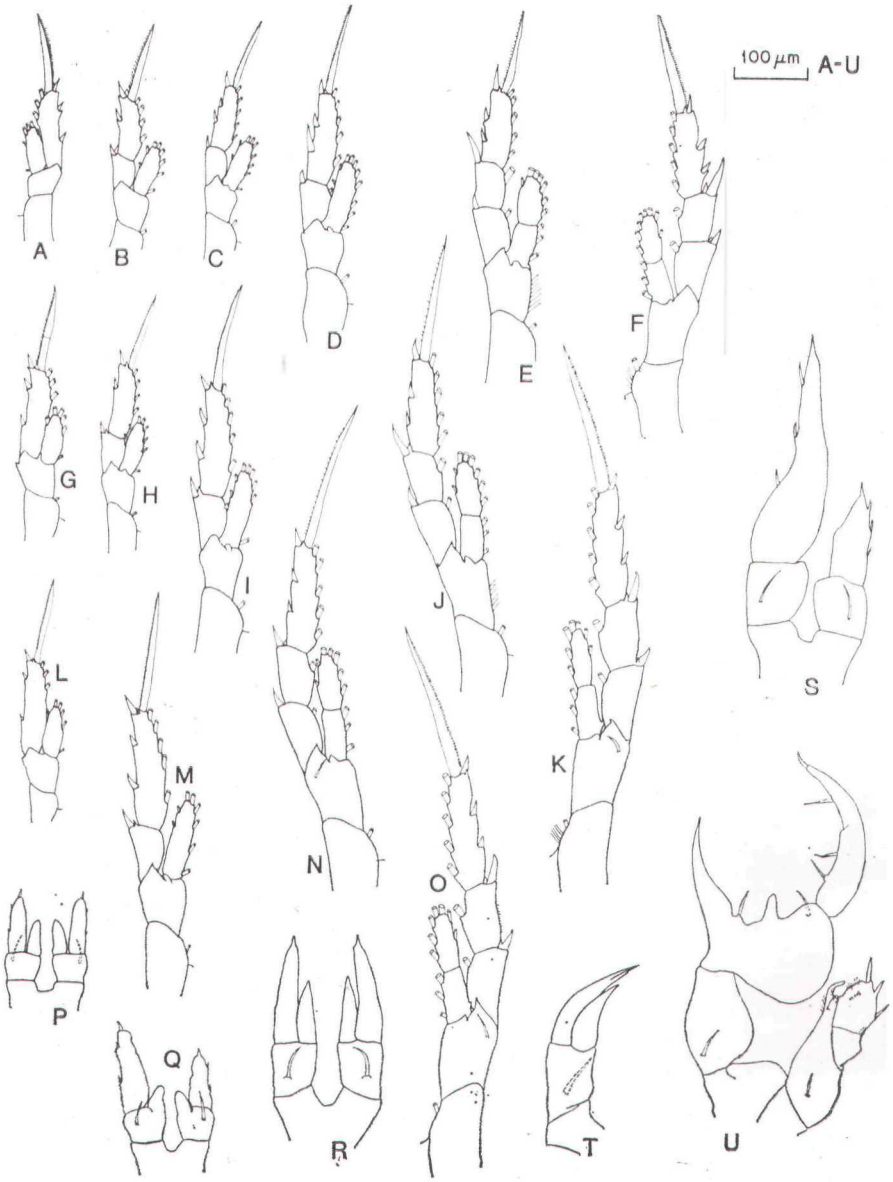

FIG. 7

Labidocera wollastoni

A, second foot, copepodid I; B, second foot, copepodid II; C, second foot, copepodid III; D, second foot, copepodid IV; E, second foot, copepodid V; F, second foot, adult; G, third foot, copepodid II; H, third foot, copepodid III; I, third foot, copepodid IV; J, third foot, copepodid V; K, third foot, adult; L, fourth foot, copepodid III; M, fourth foot, copepodid IV; N, fourth foot, copepodid V; O, fourth foot, adult; P, fifth foot, female copepodid IV; Q, fifth foot, male copepodid IV; K, fifth foot, female copepodid V; S, fifth foot, male copepodid V; T, fifth foot, adult female, U, fifth foot, adult male.

copepodids of *Labidocera.* As in other species, the sexes can be distinguished in Stage IV by the structure of the fifth pair of feet.

The hatching of diapause and subitaneous eggs of *Labidocera aestiva* is described by Grice and Gibson (1975) and Marcus (1979). A review of diapause eggs occurrence in copepods and the factors effecting egg survival and hatching is provided by Grice and Marcus (1981). The hatching of eggs of *L. wollastoni* is similar to that described by these authors for other species and suggests that the smooth eggs and spiny eggs of *L. wollastoni* are subitaneous and diapause respectively. Evidence for this classification is provided by the fact that smooth eggs hatched within one day at temperatures of 20-21 °C while only one egg out of 142 spiny eggs hatched within this period. Unlike *L. aestiva in* which chilling shortens the refractory period and permits the eggs to accumulate in a state ready to hatch (Marcus, 1979) the eggs of *L. wollastoni* failed to hatch after incubation at 2-3°C for three weeks. They apparently were viable as the central greenish mass, characteristic of spiny eggs, remained intact. The sporadic hatching of spiny eggs, after about 40 days at 18°-20°C was similar to that described by Marcus (1979) for *L. aestiva* diapause eggs that were maintained at 19°C and hatched asynchronously over a period as long as 126 days. These limited observations on the eggs of *L. wollastoni* indicate that diapause eggs are part of the life history cycle of this species and suggest the need for further experimental work to elucidate the factors influencing their production, survival and hatching.

Summary

The stages of development of *Labidocera wollastoni* are described and compared with those of other species of the same genus. Two types of eggs are laid, spiny or smooth. The observation of hatching shows that smooth eggs and spiny eggs are respectively subitaneous and diapause.

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