OCCURRENCE IN SAGAMI BAY, JAPAN, OF *SCOLECODES*, A REMARKABLE COPEPOD PARASITE OF ASCIDIANS

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With 13 Text-figures

An opportunity to extend most strikingly a geographic distribution and a very puzzling breadth of host diversity has been presented by a specimen made available for study from the Laboratory of His Imperial Majesty the Emperor of Japan. Grateful acknowledgement is offered His Imperial Majesty and the Laboratory of the Imperial Household for discovery of the specimen and for permission to study it in detail.

Previous knowledge of notodelphyid copepods, symbiotic (in various degrees of trophic relationship) with ascidians has disclosed certain interesting trends of specificity of host preference and some general indications as to zoogeographic patterns (ILLG, 1958, ILLG and DUDLEY, 1961, 1965). Equally interesting and challenging features have emerged in certain cases which are contradictory in regard to the generalizations.

The single specimen studied here was extracted, evidently after some years of preservation, from *Cnemidocarpa fertilis* (HARTMEYER), collected on March 14, 1954, in Sagami Bay, Japan, depth 120 meters. In dissection of the host some cutting of the posterior part of the parasite's body occurred. Doubtless the expulsion of nauplii from the incision led to the detection that the vermiform parasite was a crustacean. For study of the single example the appendages of one side only were removed and those which could be transferred to a permanent mounting medium are on a slide as a permanent record. The body proper, with the remaining intact appendages, is preserved as a wholemount in polyvinyl lactophenol (GURR, London) from which it will be possible to extract it for further study. The urosome, which was sketched in preliminary study, was unfortunately destroyed in the attempt to transfer it to a permanent mounting.

The result of careful anatomical study has been to identify the copepod as a specimen of *Scolecodes huntsmani* (HENDERSON), large mature female, 5.5 mm in length. The general outline of the body (fig. 1) and details of the appendages support this identification very emphatically. The antennule (fig. 2) conforms excellently.

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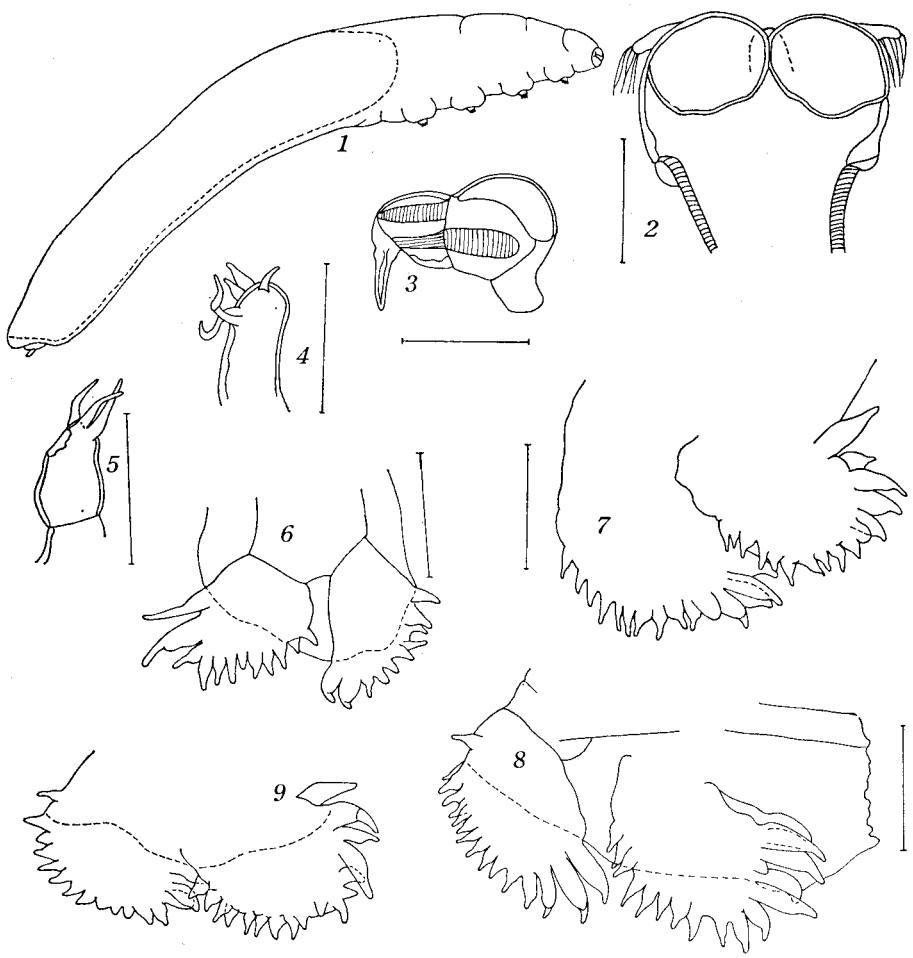
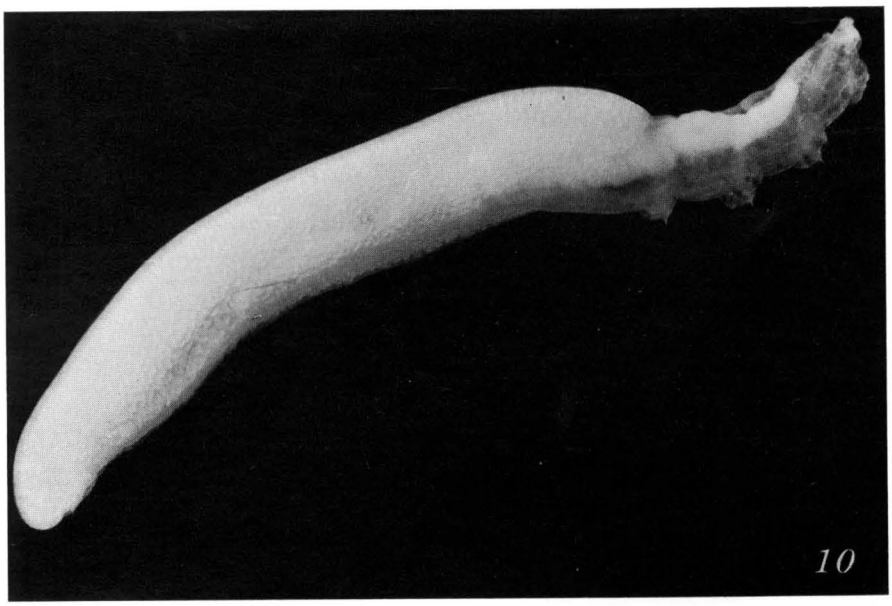
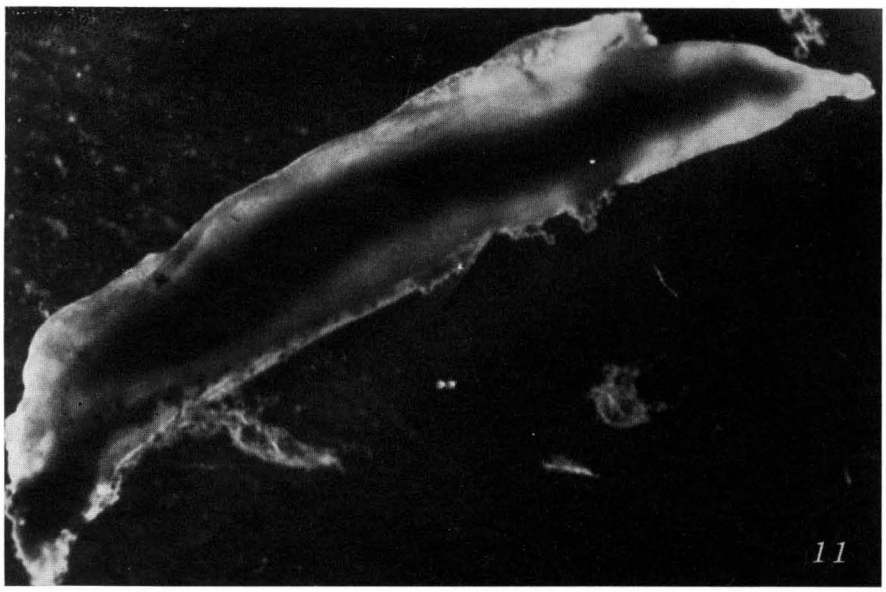


Figs. 1–9. 1—female, general habit; overall length 5.5 mm; 2—antennules; 3—antenna; 4—mandible; 5—maxilla; 6—first leg; 7—second leg; 8—third leg; 9—fourth leg; scales accompanying figures 2–8 represent 0.01 mm.

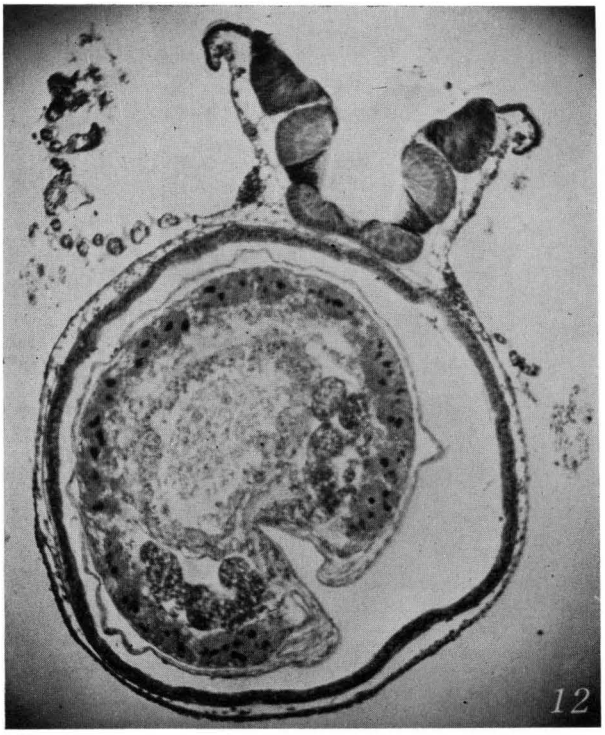
The antenna (fig. 3) is exactly appropriate to earlier general descriptions (ILLG, 1958). Some fine details, presented by DUDLEY (1966) were not made out on the specimen. The mandible (fig. 4) and maxilla (fig. 5) and the swimming legs (figs. 6–9) conform in detail to the species as we have studied it. The urosome also supports the identification.

In connection with the introductory statement above, this discovery is a most remarkable one. The zoogeographic range is extended markedly-from the West coast of the United States and Canada to Sagami Bay, Japan. Much more striking is the expansion of the roster of hosts to five species. The form was originally described from *Pyura haustor* (STIMPSON) and infestation in *Styela gibbsii* (STIMPSON) was





Figs. 10–11. 10—Adult female of *Scolecodes huntsmani* (HENDERSON). The swollen part of the body is the incubatory pouch containing many developing nauplii. Band-like oviducts are evident in the anterior portion of the body. (Photograph, Dr. P. L. DUDLEY)
11—Isolated cyst, of ascidian tissue, showing funnel at anterior end, and vaguely seen to contain adult female of *Scolecodes huntsmani* (HENDERSON). (Photograph, Dr. P.L. DUDLEY)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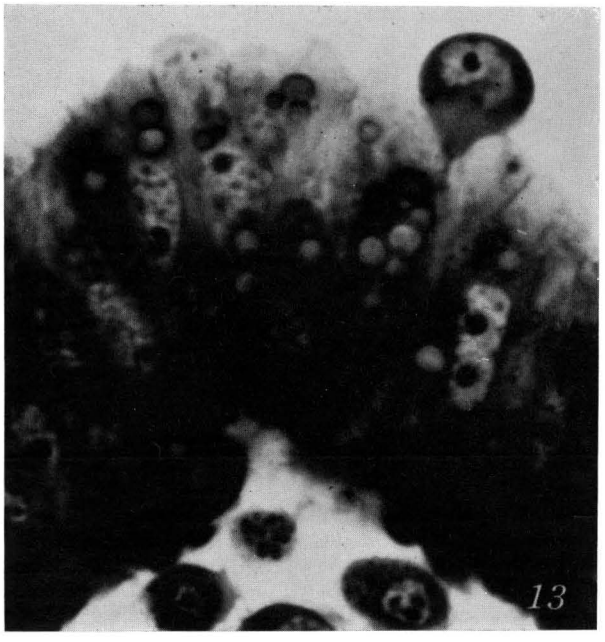
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mentioned. Our study added *Boltenia villosa* (STIMPSON), and now a fourth genus, *Cnemidocarpa*, is added. When we learned of the present specimen we started a search which yielded an additional host, *Cnemidocarpa finmarkiense* (KIAER), in our region. This diversity of hosts is significant because the species has been demonstrated to be a full parasite, with a complex host-symbiont relationship. The location in the host of adult females is in a cyst located in the subendostylar blood sinus (figs. 10–11). DUDLEY (1968) demonstrated host cells in the digestive tract of the copepod, determined that these were specially formed, and further, that the cyst is host tissue (figs. 12–13). The organization of the cyst is in a very high degree. It has consistent anatomical features, including a funnel which furnishes communication to the exterior by way of the atrial cavity. These details and various others, including ultrastructure studies of the cyst and special cell by electron microscopy have been presented by DUDLEY (1968) in her thorough study of the relationship of host and parasite.

It is amazing that the relationship of ascidian and copepod apparently involves opposite aspects of specificity. The degree of organization of the host response is most unusually high for an invertebrate. The elaborate gross structural elements of the cyst, involving particularly the intricate external funnel, and the cellular phenomenon of the elaboration of a specialized cell, would seem to bespeak a remarkably detailed level of interspecies communication — in effect, a high degree of specificity. It is very tempting to speculate on the adaptive significance to the host of the elaborated cell and on the possible steps by which the eliciting of this response by the host led to exploitation as a food source by the parasite. Taxonomically, the extent of the relationship is far from specific. Five host species have now been tallied, and they are assignable to four genera in two families. The situation is clearly not a case in which the taxonomic system of the ascidians is thereby challenged. The anomaly is in the high degree of opportunistic adaptability of this parasite.

It is to be hoped that further specimens of this copepod will become available from the new locality. Perhaps a taxonomic separation from the American species will be necessary when more details emerge. However, the complexity of the situation seems to have been sufficiently developed in the originally known range and the present specimen points up most dramatically the biological issues involved.

Figs. 12–13. 12—Transverse section of endostyle and subendostylar blood vessel of *Styela gibbsii* (STIMPSON). Tightly appressed against the blood vessel wall in a cyst wall of ascidian tissue, and contained within the cyst is a cross-section of the body of *Scolecodes huntsmani* (HENDERSON), female. (Photograph, Dr. P. L. DUDLEY)

13—Columnar cells forming a cyst within the subendostylar blood vessel of *Styela gibbsii* (STIMPSON), with a cyst cell taking a spherical shape and migrating to the lumen of the cyst. The cyst contains a female of *Scolecodes huntsmani* (HENDERSON), which will utilize the spherical cell as food. (Photograph, Dr. P.L. DUDLEY)

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