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Heptacarpus littoralis Butler a synonym of *Heptacarpus sitchensis* (Brandt) (Crustacea: Decapoda: Hippolytidae)

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Abstract

Heptacarpus littoralis was differentiated from *H. sitchensis* based on several characters, including absence of a pterygostomian spine (present in *H. sitchensis*); distinctly curved propodi of pereopods III-V, and a smaller and more slender body than *H. sitchensis*. To test whether these differences represent separate species or merely sexual dimorphism within a single species, we collected ovigerous *H. sitchensis* and raised their larvae to determine if both morphologies would occur within the same progeny. By one year of age many of the shrimp had reached sexual maturity; pterygostomian spines were present on all females but only 27% of the males. Males were also smaller on average than females, and developed the curved propodi and other features characteristic of *H. littoralis*. Hence, *H. littoralis* is considered a male form of *H. sitchensis* and a junior synonym.

Key words: *Heptacarpus sitchensis*, *Heptacarpus littoralis*, Hippolytidae, shrimp, Northeastern Pacific, experimental taxonomy

Introduction

The family Hippolytidae encompasses a diverse assemblage of carideans common in the waters of the eastern Pacific Ocean (Wicksten 1990). Within the family, members of the genus *Heptacarpus* Holmes are small to medium-sized shrimp largely restricted to the North Pacific Ocean, where their habitat ranges from the nearshore zone to the continental shelf (Butler 1980).

When sampling in southeastern Alaska, Squires and Figueira (1974) noted an undescribed hippolytid "very close to *Heptacarpus sitchensis*" but lacking a pterygostomian spine. This form was subsequently described as a new species, *H. littoralis*, by Butler (1980), who noted that it also differed from *H. sitchensis* (Brandt) in having a smaller, more slender build, proportionately larger eyes and narrower antennal scale, and having

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long, curved propodi on the third through fifth pereopods. The new species was reportedly sympatric with *H. sitchensis* in intertidal habitats, but not as common (Butler 1980).

Although the presence or absence of a carapace spine is not known to be a sexually dimorphic character in hippolytid shrimps, such features as a slender body and modified pereopods are known to differ between sexes (Bauer 1986; Jensen & Johnson 1999) and it was suspected that *H. littoralis* might actually be male *H. sitchensis*. Collections from Juneau, Alaska to Bodega Bay, California revealed an abundance of both forms (and always sympatric), but ovigerous *H. littoralis* were never found nor have ever been reported. Furthermore, male *H. littoralis* readily mated with female *H. sitchensis* in captivity. Consequently, an attempt was made to raise the larvae of field-collected *H. sitchensis* to determine if their male progeny would have the characteristics of *H. littoralis.*

Methods

Fifteen ovigerous *H. sitchensis* females were collected by dip net from Port Washington Narrows, Puget Sound, Washington, in the summer of 2000. All specimens had well-developed pterygostomian spines and other features consistent with descriptions of *H. sitchensis*, and all well-exceeded the maximum reported size (3.7 mm carapace length) of *H. littoralis* (Butler 1980). Adults were held individually in containers suspended in a circulating, temperature controlled water table (12° C) with a fixed photoperiod (15L:9D). Upon hatching, the larvae were separated from the adults and each hatch was placed in very gently aerated, 240ml plastic cups suspended in the water bath described above. Larvae were fed newly-hatched *Artemia* nauplii; any debris that accumulated at the bottom of the cups was siphoned off daily, and water was changed twice a week. Once they had settled out, the juveniles were fed TetraMin® fish food flakes. Juveniles were periodically examined for changes in morphology; approximately one year after settlement, all surviving individuals were measured, sexed and the presence or absence of a pterygostomian spine was noted. Carapace lengths were measured using an ocular micrometer on a dissecting scope, and shrimp were sexed by examining the second pleopod for the presence of an appendix masculina (Butler 1980). Surviving shrimp were examined and measured again two years after settlement.

Results

The first several postlarval juvenile instars lacked pterygostomian spines, regardless of sex. A total of 63 shrimp, representing larvae from 14 of the original 15 broods, were still alive at one year of age. Of these, 45 (71%) were female and all had pterygostomian spines, although in one specimen they were greatly reduced in size (Fig. 1) and another had a spine on only one side. Of the 18 surviving males, five had well-developed pterygos-

tomian spines, eight had greatly reduced spines, and five lacked the spines entirely. Half of the males with reduced spines were asymmetrical, having a single tiny spine on one side only; all three types of males (with, without, and reduced spines) occurred in broods with female siblings that had spines. Females (carapace length x = 2.45 mm +/- 0.29 *SD*) were significantly larger than males (x = 2.09 mm +/-0.03 *SD*; t-test: t= 3.95, df= 60, p=0.0002).

Only two males had pereopods with curved propodi after one year; when examined again at two years of age, all surviving males had developed curved legs regardless of whether they had pterygostomian spines or not.

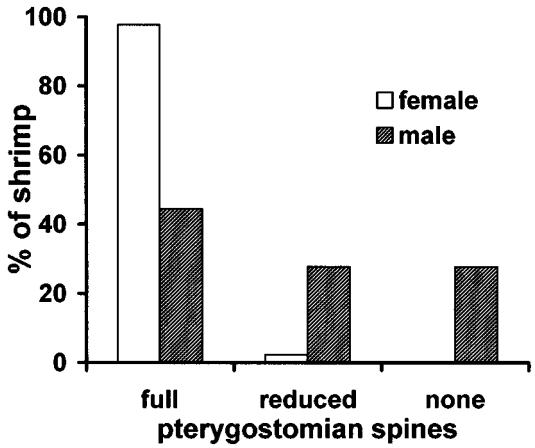

FIGURE 1. Percentage of one year old female (n = 45) and male (n = 18) offspring of *Heptacarpus sitchensis* with fully developed, vestigial, or missing pterygostomian carapace spines.

Discussion

The results of the captive rearing experiment provide unequivocal evidence that *Heptacarpus littoralis* is a male form of *H. sitchensis*, with progeny from a single female *H. sitchensis* developing into both 'species'. There was considerable variation within the males; whether these reflect different mating strategies is not known, but we suspect that it is unlikely. There has been no evidence of protandry in any of the males, even more than two years after they settled out. Furthermore, any potential functional differences between the male forms seem very minor, given the small size (and often asymmetry) of the pterygostomian spines. The curved legs that developed on all of the males probably aid in holding females, as these appendages are used to grasp the female's carapace during copulation (Bauer 1976).

Post-settlement losses were quite high in the culture containers due to cannibalism; males were always smaller than females and suffered disproportionately higher mortality. Before they were isolated to reduce mortality, some of the males mated with siblings that subsequently produced viable eggs.

The original description of *H. littoralis* includes mention of a number of females (Butler 1980), but none were designated as paratypes. Many of these were quite small and, since pterygostomian spines do not appear until late juvenile stages, the spines may have not yet developed. Our examination of two of the larger females deposited by Butler and now in the Canadian Museum of Nature (CMNC 1988-0464, originally NMC 15042) revealed the presence of appendices masculinae, indicating that they are actually males. It is also possible that some female *H. sitchensis* have been labeled as *H. littoralis* as well, since some females apparently never develop pterygostomian spines and curved legs can be a somewhat subjective feature. We have found large female *H. sitchensis* that lacked spines in the field, and among our small population of captive reared females one had miniscule spines and another was missing a spine entirely on one side.

The morphological variability of *H. sitchensis* had previously caused it to be separated into a second species, *H. pictus*, a division that has only recently been corrected (Wicksten et al. 1996). Likewise, the present investigation demonstrates additional variability within this species, and that *H. littoralis* should also be considered a junior synonym of *H. sitchensis.*

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