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INTRODUCTION

Since the first species of the crustacean subclass Mystacocarida was discovered in 1943, a small but dedicated number of psammonologist have taken every opportunity to discover new localities for this group as they traveled along the world's coastlines. To date, this search has revealed only three species : *Derocheilocaris typicus* Pennak & Zinn, 1943, *D. remanei* Delamare Deboutteville & Chappuis, 1951, and *D. galvarini* Dahl, 1952. Thus, it is with real pleasure that I can report that mystacocarids from a new locality on the northeast coast of the United States prove to belong to a new, fourth species.

ACKNOWLEDGEMENTS

The locality for this new species was first discovered by Dr. Joseph L. Simon, then of the Marine Biological Laboratory in Woods Hole. He gave word of his discovery to Dr. Donald J. Zinn of the University of Rhode Island, who subsequently turned that collection and some additional material over to me. I would like to express my appreciation to Drs. Simon and Zinn for allowing me to work on this material. I would also like to thank Mr. Bruce W. Found, then of Bowdoin College, for making yet further collections of mystacocarid material for me.

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Finally, I wish to thank my colleague Mr. George R. Hampson for his help in a recent search for new mystacocarid localities along the portion of the coastline separating the locality of the new species and the northern limit of *Derocheilocaris typicus*.

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SYSTEMATIC DESCRIPTION

Derocheilocaris ingens n. sp.

Holotype. — U.S. National Museum no. 125654, adult male.

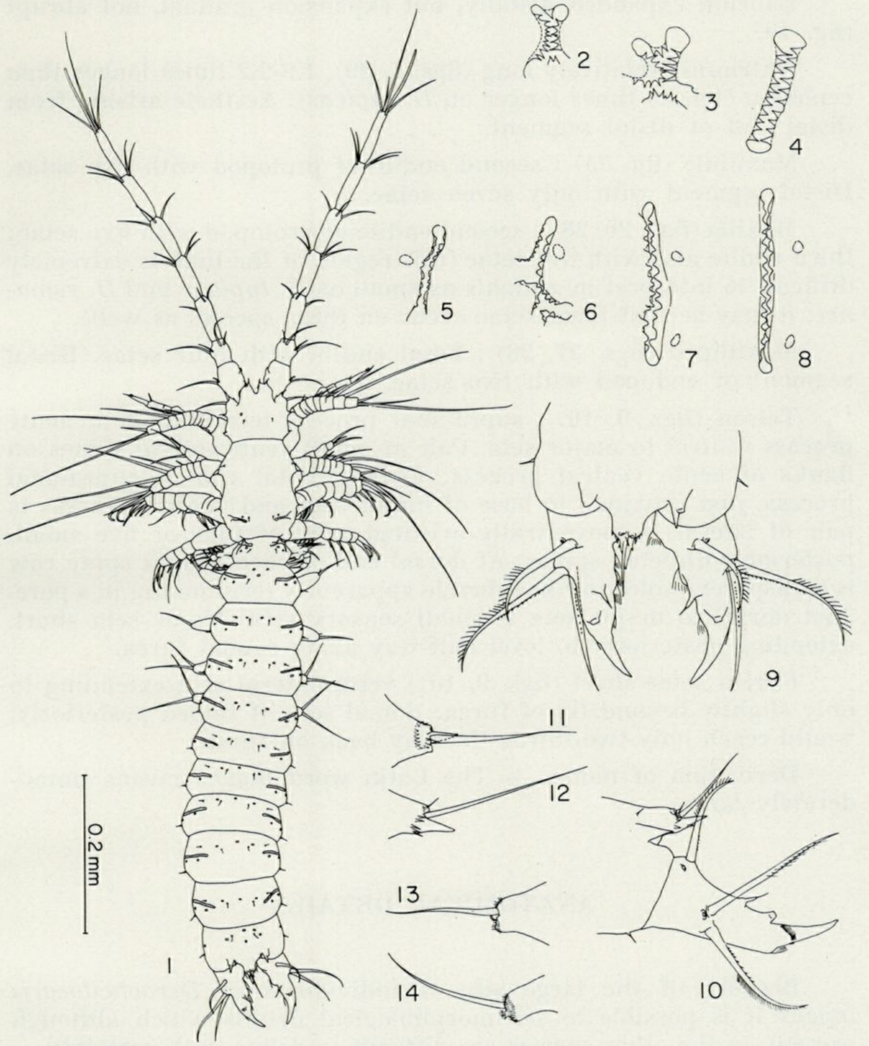
Paratypes. — U.S. National Museum no. 125655, 20 individuals, both sexes.

Distribution. — Reid State Park, Sagadahoc County, Maine, U.S.A., southeast of the city of Bath. From the intertidal zone of a steeply sloping, coarse sand beach.

Diagnosis. — Very large, about 1.5 times longer than *D. typicus*; body of adult .76-1.01 millimeters long, averaging .96 millimeters. Stage 1 larva also large, 2.4 millimeters long.

Constriction separating antennulary portion from rest of cephalon (figs. 1, 16) less pronounced than in other species (figs. 18, 20). Posterolateral corners of antennulary portion of cephalon obtuse, but with pair of short, anteriorly directed, laterally projecting hooks. Anteromedial lobes of antennulary portion of cephalon widest at base, their medial margins converging evenly posteriorly, with well rounded anterolateral margins; ventral surface of each anteromedial lobe with two conspicuous, spiny tubercles (figs. 15-17). Posterior portion of cephalon bulging laterally at level separating antennary and mandibular segments (fig. 16) but not forming the conspicuous ventrolaterally directed pair of protuberances (*organe latéral prémandibulaire* of Cals *et al.*, 1968) characteristic of *D. typicus* (fig. 18) and *D. remanei* (fig. 20). No eye lenses apparent.

Lateral toothed furrows : furrow in maxillary region of cephalon (fig. 5) undivided dorsally, although in many specimens an irregular discontinuity in the anterior wall of the furrow about one-third the way down from its dorsal end indicates incipient development of the anterior branch. Furrow on maxillipedal segment (fig. 6) bifid dorsally, but anterior branch reduced and posterior branch relatively much longer.



Figures 1, 5-10. — *Derocheilocaris ingens* n. sp. : 1, adult male, dorsal; 5, maxillary toothed furrow; 6, maxillipedal toothed furrow; 7, first thoracic toothed furrow; 8, second thoracic toothed furrow; 9, telson and caudal furca, dorsal; 10, telson and caudal furca, lateral.

Figures 2-4, 13, 14. — *Derocheilocaris typicus* Pennak & Zinn, 1943 : 2, maxillary toothed furrow; 3, maxillipedal toothed furrow; 4, first thoracic toothed furrow; 13, supra-anal process, dorsal; 14, supra-anal process, lateral.

Figures 11, 12. — *Derocheilocaris remanei* Delamare Deboutteville & Chappuis, 1951 : 11, supra-anal process, dorsal; 12, supra-anal process, lateral.

Labrum expanded distally, but expansion gradual, not abrupt (fig. 19).

Antennule relatively long (figs. 1, 29), 1.9-2.2 times longer than cephalon (1.4-1.6 times longer on *D. typicus*). Aesthete arising from distal end of distal segment.

Maxillule (fig. 25) : second endite of protopod with two setae. Distal segment with only seven setae.

Maxilla (figs. 26, 28) : second endite of protopod with five setae; third endite also with five setae (this region of the limb is extremely difficult to interpret in animals as small as *D. typicus* and *D. remanei*; it may be that these setae occur on these species as well).

Maxilliped (figs. 27, 28) : basal endite with four setae. Distal segment of endopod with two setae.

Telson (figs. 9, 10) : supra-anal process terminating in acute process ventral to major seta. Pair of small ventrolateral spines on flanks of acute ventral process; toward distal end of supra-anal process, just proximal to base of major seta and ventral process is pair of lateral, dorsoventrally oriented rows of four or five small, posteriorly directed spines. At dorsal end of each lateral spine row is transparent volcano-like tubercle apparently terminating in a pore. Just dorsal to major seta is small sensory seta. Major seta short, extending posteriorly to level half-way along caudal furca.

Furcal setae short (figs. 9, 10); ventrolateral seta extending to only slightly beyond tip of furca; dorsal seta, if folded posteriorly, would reach only two-thirds the way back on furca.

Derivation of name. — The Latin word *ingens* means immoderately large.

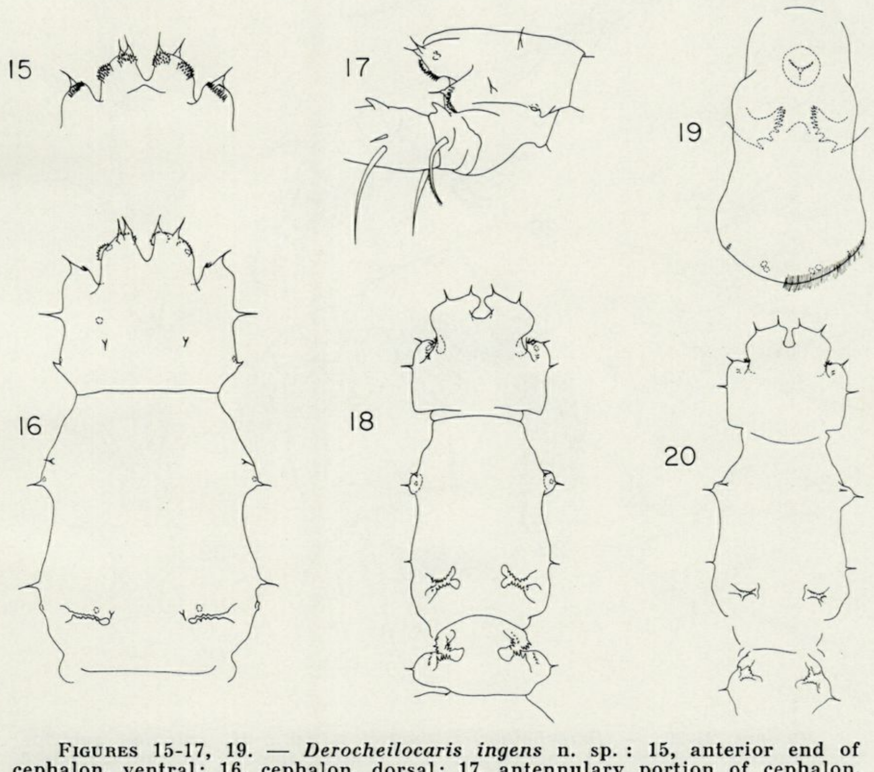
ANATOMICAL DETAILS

Because of the large size of individuals of *Derocheilocaris ingens* it is possible to see morphological details which although present on the other species are difficult to define with certainty.

The small spine-like setae which occur in pairs on the anteromedial and lateral lobes of the antennulary portion of the cephalon are well known (figs. 1, 15, 16). They are characterized by small size, a broad base, and an abruptly thinner distal portion. Such setae may be found all over the body (fig. 1). They have a bilaterally symmetrical distribution on various portions of the cephalon, the dorsal, lateral and ventral surfaces of the maxillipedal, thoracoabdominal and telsonic segments, and the dorsal surface of the caudal furca. It is likely that these setae are tactile receptors of the nervous system.

In animals stained with methyl blue in lactic acid, numerous pores flush with the cuticular surface become apparent on the trunk (figs. 1, 16). These pores are present on all body segments, but are absent from the limbs. Just under the cuticle are clumps of cells associated with the pores, suggesting that the latter function as exit ducts for glands.

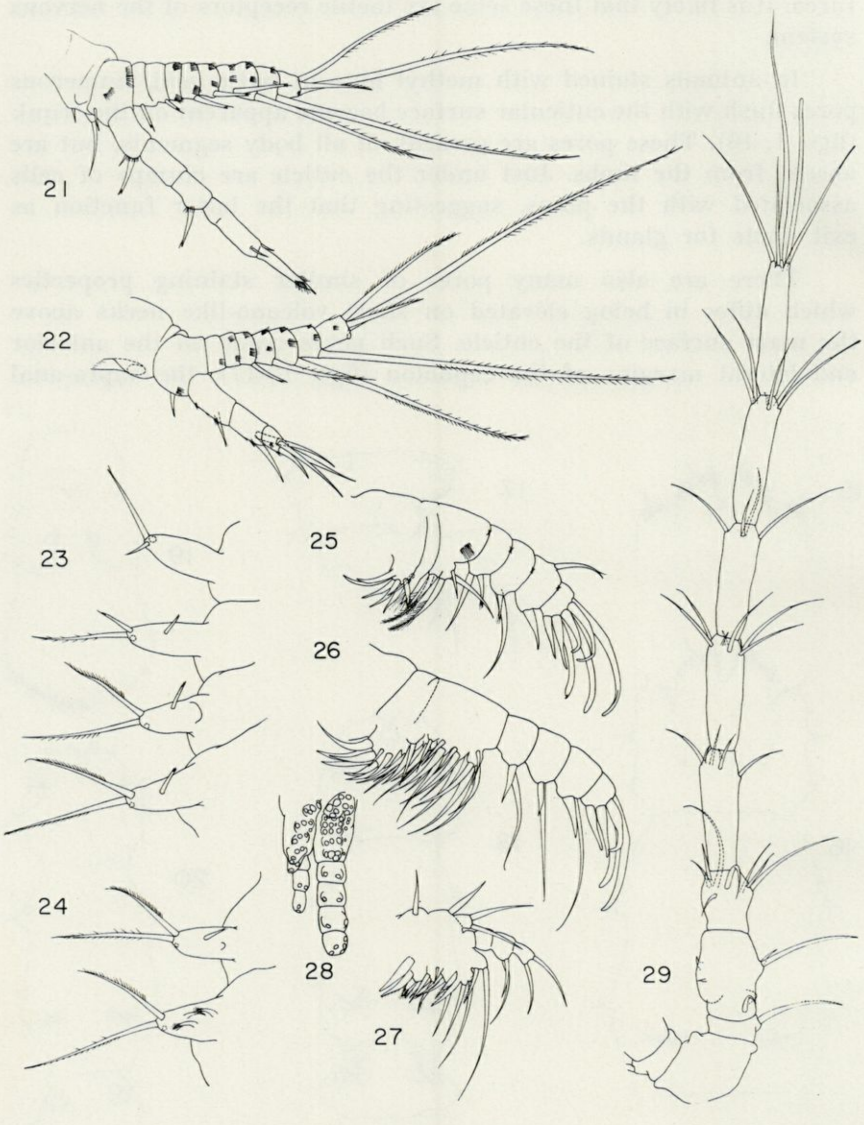
There are also many pores of similar staining properties which differ in being elevated on short volcano-like necks above the main surface of the cuticle. Such pores occur on the anterior and lateral margins of the cephalon (figs. 15-17), the supra-anal



Figures 15-17, 19. — *Derocheilocaris ingens* n. sp. : 15, anterior end of cephalon, ventral; 16, cephalon, dorsal; 17, antennulary portion of cephalon, lateral; 19, labrum, ventral, showing mandibular gnathobases.

Figure 18. — *D. typicus*, cephalon and maxillipedal somite, dorsal.

Figure 20. — *D. remanei*, cephalon and maxillipedal somite, dorsal.



FIGURES 21-29. — *Derocheilocaris ingens* n. sp. : 21, antenna, anterior; 22, mandible, anterior; 23, thoracopods 1-4, ventral, female; 24, thoracopods 3, 4, ventral, male; 25, maxillule, anterior; 26, maxilla, anterior; 27, maxilliped, anterior; 28, maxilla and maxilliped, medial, showing attachment positions of medial setae; 29, antennule, ventral. Note that the limbs shown in figures 21, 22, 25-27 are illustrated from a full anterior view; this was achieved because the large size of the animals made dissection possible.

process (figs. 9, 10), the caudal rami (figs. 9, 10), and the tips of the exopods of the antennae (fig. 21) and mandibles (fig. 22). These pores may well serve glands of the sort just mentioned.

VARIABILITY

In order to assess the degree of variation in *Derocheilocaris ingens* twenty adults were randomly selected and inspected to detect deviations from the illustrated individuals. Primary attention was devoted to setation and general shape. The protopodal setation of the maxillules, maxillae and maxillipeds was not studied because of the difficulty of accurate inspection of those regions. Nor were minor setae on the antennules or small tactile setae on the trunk inspected.

A large number of differences were seen, but in all cases but one, these variations occurred on only one side of the animal. The following sorts of differences were noted : conspicuous reduction in size of setae on furca or mandible; loss of setae or presence of extra setae on all appendages except furca; one type of seta replaced by another on antenna; large seta growing from one of the limbless abdominal segments; absence or fusion of spiny tubercles on anteromedial lobes of cephalon; malformation of supra-anal process and anteromedial cephalic lobes; absence of maxillule and maxillary toothed furrow. Among the twenty individuals, 42 such incidents were noted. All but four individuals had at least one malformation; two individuals displayed as many as seven. Only four specific kinds of difference were noted to occur more than once.

Because these differences display no preferential pattern, occur on only one side of the animals and in many cases are clearly malformations, it is not appropriate to consider them true individual variations as usually conceived. The first two reasons in particular suggest that the primary cause is not genetic and that the differences should be considered congenital defects.

The incidence of such defects is surprisingly large in this population. In a similar analysis of twenty individuals of *Derocheilocaris typicus* from Nobska Beach, only ten differences were noted, and these were distributed among only eight individuals. As with *D. ingens,* in all cases only one side of the animal was affected. In all but one case, the defect was no more than the absence of one or two setae; in the one severe instance, the endopod of the mandible was missing.

These abnormalities may well be the result of the imperfect healing of mechanical damage. If this is the case, the higher degree of abnormalities in *D. ingens* from Reid State Park can be explained as being a result of the much more disturbed, high energy environment present there.

DISCUSSION

In some of the most important respects, *Derocheilocaris ingens* is more different from *D. typicus* and *D. remanei* than the latter species are from each other. The shape of the cephalon, the spiny tubercles on the anteromedial lobes of the cephalon, the continuous row of teeth on the anterolateral lobes of the cephalon, the form of the maxillary and maxillipedal lateral toothed furrows, the short setae on the caudal furca, and the huge size of the animal are all features unique to this species.

The presence of two setae on the distal segment of the maxillipedal endopod and the form of the supra-anal process show this species to be more closely related to *D. remanei* (figs. 11, 12) than to *D. typicus* (figs. 13, 14). The morphology of the latter structure is particularly significant. The common presence in *D. ingens* and *D. remanei* of a pair of raised pores, a small tactile seta dorsal to the major seta, and the presence of coarse spines around the base of a pointed terminal process is surely more than coincidence.

It is a common feature in arthropods that an increase in size is accompanied by allometric changes in a variety of morphological features. This is not the case with *D. ingens*. The features listed in the diagnosis do not appear to be allometric differences, and in all other respects this species is identical to other members of the genus. Even the setal count, a character which is especially sensitive to differences in body size, is the same. The close similarity in early all respects of this species to other members of the Mystacocarida re-enforces the fact of great conservativeness in this subclass.

As part of the present study, grain size analyses were made of the sand in which *D. ingens* was found and of sand from Nobska Beach containing *D. typicus* (fig. 30). The sediments are similar in their sorting coefficients, but differ markedly in mean diameter. The sand from Reid State Park, with a mean diameter of 1.00-1.42 millimeters, is twice as coarse as that from Nobska Beach.

Grain size is an index of pore space size, an environmental feature of great importance to interstitial organisms (JANSSON, 1967). If the space is too small, not only will circulation of water

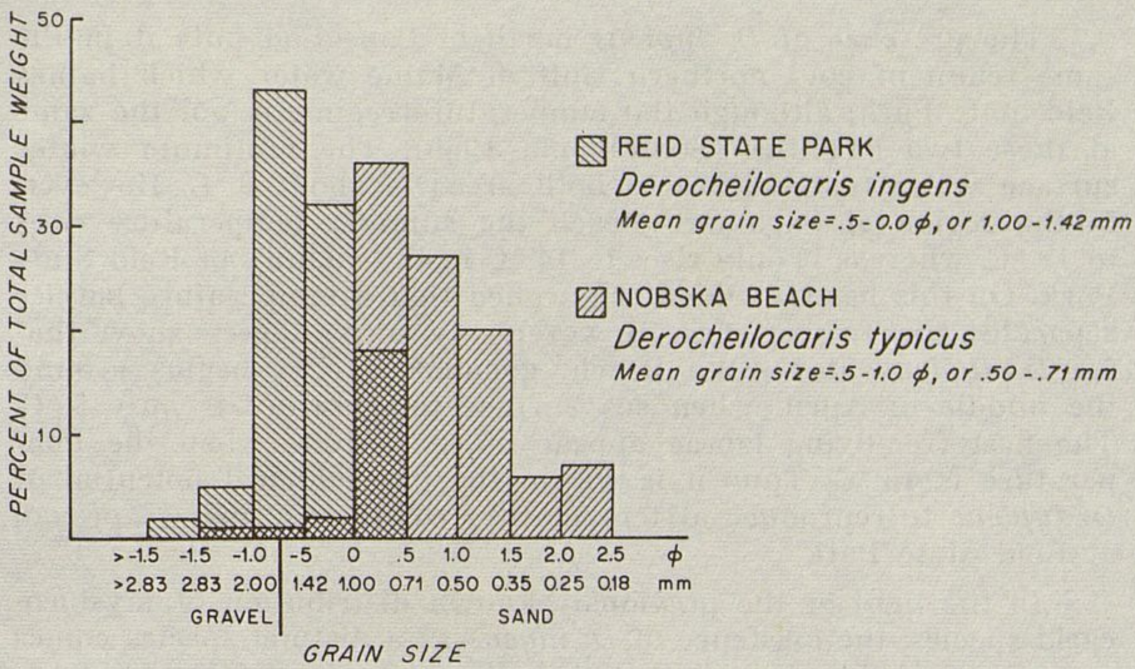


FIGURE 30. — Grain-size analysis of characteristic, mystacocarid-bearing sands from Reid State Park (type locality of *D. ingens*) and Nobskâ Beach (type locality of *D. typicus*).

be inhibited, but organisms with limited abilities of constriction and distortion will not be able to move about. If the space is too large, some kinds of animals will not be able to gain sufficient purchase to move effectively. Observation of *D. typicus* in the laboratory reveals its helplessness when lying on an open, unrestricting surface such as microscope slide. It cannot travel because it cannot brace itself. If under these circumstances a coverslip is dropped upon the slide, the animal will immediately begin to cruise about because in these relatively confined conditions it can now gain purchase with its body and limbs in order to thrust itself forward. This observation demonstrates that mystacocarids are ambulatory, not natatory organisms, and would be helpless in too coarse a sand. Thus it is particularly satisfying to note that the coarse sands of Reid State Park are inhabited by a truly enormous mystacocarid.

If the beaches in which *D. ingens* and *D. typicus* live are characterized by basically different grain sizes, then there is no reason why the range of the two species should not overlap. So far, this is not known to be the case. *Derocheilocaris ingens* is known only from Reid State Park. Until recently, *D. typicus* was not thought to occur north of Cape Cod. However, a recent search for this species north of Cape Cod revealed its presence at Sagamore Beach, south of Plymouth, on Cape Cod Bay. Thus, the known range of the two species is separated by only 140 miles.

The presence of *D. typicus* north of Cape Cod puts it in the same realm of cold northern Gulf of Maine water which bathes Reid State Park, although the temperature regime is not the same at these two localities (SCHROEDER, 1966). The minimum winter surface water temperature in both areas is about 2 °C. However, in the region of Sagamore Beach the summer temperature rises to 18 °C, whereas it only rises to 14 °C in the vicinity of Reid State Park. On this basis, it might be argued that a temperature barrier separates the two species. However, my own studies show that for *D. typicus* at Nobska Beach, gonadal activity begins around the middle of April, when sea surface temperature is only 5 °C. The first free-living larvae appear in early June when the temperature is 15 °C. Thus it is within the physiological potential of *D. typicus* to reproduce at temperature conditions such as prevail at Reid State Park.

In the light of the previously known distribution of mystacocarid species, the existence of *D. ingens* as a distinct species comes as a considerable surprise. *Derocheilocaris remanei* ranges from the Bay of Biscay, into the Mediterranean, down the coast of Africa, around the Cape of Good Hope, to Durban, South Africa, on the Indian Ocean (DELAMARE DEBOUTTEVILLE, 1960; FIZE, 1963; GRIMALDI, 1963). *Derocheilocaris typicus* occurs along nearly the entire coast of the United States, from north of Cape Cod, to Miami, Florida (HESSLER & SANDERS, 1966). Even the poorly known *D. galvarini* gives evidence of having a considerable range along the Pacific coast of South America (DAHL, 1952; NOODT, 1961). In the case of *D. typicus* and *D. remanei* the broad geographic range also encompasses a considerable range in climates.

The pattern of mystacocarid distribution which emerges is one in which single species dominate long stretches of continental coastline, the barriers which separate species being nothing less than major ocean or continental bodies. The close proximity of the geographic ranges of *D. ingens* and *D. typicus*, with no major intervening geographic or ecologic barrier is a strong exception to this pattern.

That *Derocheilocaris ingens* has greater affinity with the Euro-African species, *D. remanei*, than with the neighboring North American species, *D. typicus*, raises additional intriguing questions about the origin of the geographic pattern we see today. Until more is known about the northern range of *D. typicus* and the entire range of *D. ingens*, any inquiry must remain the loosest sort of speculation.

ABSTRACT

Derocheilocaris ingens n. sp., from the coast of Maine, U.S.A., is more similar to *D. remanei* than it is to *D. typicus*. The geographic ranges of *D. ingens* and *D. typicus* are not known to overlap, but there is no obvious environmental feature which precludes this possibility. The huge size of *D. ingens* correlates well with the coarseness of the sand grains between which it lives. Individuals from the type locality show a high incidence of malformations which are interpreted as improper healing of wounds caused by movement of the sand grains in this high energy environment.

RÉSUMÉ

Derocheilocaris ingens n. sp., des côtes du Maine, U.S.A., est plus proche de *D. remanei* que de *D. typicus*. Les aires de répartition de *D. ingens* et de *D. typicus* sont actuellement distinctes, mais aucune particularité écologique claire ne s'oppose à l'existence d'une zone de recouvrement. La très grande taille de *D. ingens* correspond bien à la grosseur des grains de sable entre lesquels il vit. Les spécimens de la localité typique présentent un grand nombre de malformations interprétées comme une mauvaise cicatrisation de blessures produites par les mouvements des grains de sable dans ce biotope à forte agitation.

ZUSAMMENFASSUNG

Derocheilocaris ingens n. sp. der Küste von Maine (U.S.A.) steht *D. remanei* näher als *D. typicus*. Die Verbreitungsgebiete von *D. ingens* und *D. typicus* sind deutlich getrennt, aber keine klare oekologische Besonderheit steht dem Vorhandensein einer Bedeckungszone entgegen. Die Grösse von *D. ingens* entspricht der Grösse der Sandkörner, zwischen denen diese Art lebt. Die Exemplare der Typlokalität zeigen eine grosse Zahl von Missbildungen, die als mangelhafte Vernarbung von Verletzungen zu deuten sind, die durch die Verschiebungen der Sandkörner in diesem durch starke Wasserbewegung gekennzeichneten Biotop entstanden sind.

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