NOTES

CONJOINED TWIN ADULT SHRIMP
(DECAPODA: PENAEIDAE)

A two-headed roughback shrimp, *Trachypenaeus similis* (Smith), caught at the entrance to Galveston Bay, TX 10 May 1987 by Harold Fraley, together with a color photograph of the specimen taken subsequent to capture, was sent to me for identification, morphological examination, and deposit in the crustacean collection of the National Museum of Natural History (USNM 234419), Smithsonian Institution.

The specimen (Fig. 1) is composed of two cephalothoraxes (heads) perfectly aligned with the median sagittal plane and conjoined posteriorly to an unpaired, normally segmented abdomen. The cephalothoraxes and abdomen were disarticulated when the preserved specimen reached me in October 1987, but were restored to normal position easily with aid of the photograph as a guide. The lower cephalothorax is that of an adult female, carapace length including rostrum 32 mm, short carapace length (orbital margin to posteromedian edge of carapace) 21 mm; respective measurements for the upper carapace are 34.4 mm and 21.7 mm. The abdomen is flexed and twisted to the left, and the fourth and fifth segments are damaged, hence its length cannot be measured accurately. Comparison of the specimen with spermatophore bearing females of the species in the USNM crustacean collection indicates that it is adult in size, about 85 mm total length.

Shrimps are sometimes caught and preserved while in the act of molting. In that event the carapace being molted tends to be loosened at the thoraco-abdominal juncture so that its posterior end can be flipped dorsally and away, freeing the husklike old carapace from the underlying soft new carapace. A first impression that this specimen was caught and preserved while in the act of molting was not borne out by the structures observed.

The integument of each carapace is firm, as is that of the other exoskeletal parts. Both carapaces are similar in shape and structure, including the part of the lower carapace that is hidden by the upper one. It is noteworthy that the upper carapace is larger than the lower, just the opposite of what would be expected if the upper one represented an ecdysial discard. Eyes in both heads have normal dark corneal pigment, though the corneal surfaces are shriveled by preservation. Antennules, anten-
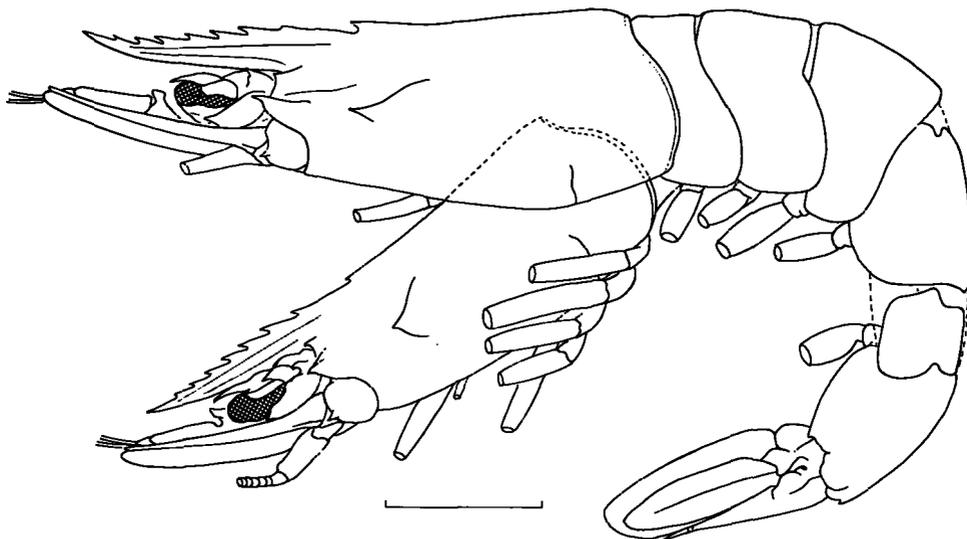

FIGURE 1.—Conjoined twin *Trachypenaeus similis* in diagrammatic lateral view, distal parts of appendages intentionally deleted, except for those of uropods. Scale = 1 cm.

nae, mandibles and associated palps, first and second maxillae, and first, second, and third maxillipeds are present and apparently normal on both heads, though the antennal flagella are broken and the right third maxilliped has apparently been lost from the upper head. Similarity in the cephalothoraxes is limited to features pointed out above.

The lower cephalothorax has normal appendages and internal organs, or traces of them, except for some broken and missing articles on the pereopods. The heart, hepatopancreas, and gonads apparently disintegrated during the interval of time between capture and fixation, hence lost all traces of their conformation in life. Fluids from the disrupted circulatory system were fixed as irregular clots. The mouth, esophagus, stomach, and a fragment of the gut are present, though the latter is connected neither to the pyloric stomach nor to the sector of intestine that courses through the abdomen to the anus. However, one can visualize that the path of the intestine in the lower cephalothorax was functionally normal before it was disrupted by breakdown of the other internal organs that surrounded it in life.

The upper cephalothorax lacks a mouth, the sternal plate between the mouthparts is not perforated, and there is no esophagus, stomach, or fragment of intestine. It seems therefore that the upper cephalothorax, though equipped with normal head appendages, could not function in feeding. Moreover, the rear part of the upper cephalothorax fitted over the rear part of the lower one like a firmly pulled down cap, with its branchiostegites deeply overlapping those of the lower one. In this arrangement the posterior part of the lower cephalothorax filled the space that would normally have been occupied by pereopods, external reproductive structures, thoracic endophragmal system and body wall, gills, and internal organs of the upper cephalothorax. As a result there was little or no room for development of these structures in the upper cephalothorax, although there may have been a heart. The membrane that lined the branchiostegites and body wall of the upper cephalothorax seems to have extended backward from the region of the cervical groove to merge with its counterpart in the posterior region of the lower cephalothorax, and with the normal integumental lining of the abdomen in order to have maintained confluence in the blood sinuses.

The abdomen, though crushed at the level of the fourth and fifth segments, bears normal pleopods, uropods, and telson. The anterior end of the abdominal muscle mass is preserved in a shape that fits the posterior end of both cephalothoraxes, but the main connection extended into the functional lower one in which complete organ systems were located.

There is a large literature treating malformations of decapod crustaceans, primarily lobsters, freshwater crayfishes, and crabs, but there is little published information of this sort on shrimps (Bateson 1894; Johnson 1968; Johnson and Chapman 1969; Pauley 1974), aside from the subject of disease which is not at issue here (Couch 1978). The most exhaustive account is that of Bateson who, along with many others before and after, discussed duplication of parts, intersexes, and malformations that occur during molting, Pérez Farfante (1980), for example, noted anomalous intersexes in the Indo-West Pacific needle shrimp, *Penaeopsis rectacuta* (Bate). The majority of these accounts treat malformed limbs or their parts (for a well-illustrated example see Shuster et al. 1963). Fewer studies are concerned with teratology.

Monsters with fused double cephalothoraxes, though rare, have long been known among larvae of the lobsters *Homarus americanus* H. Milne Edwards and *H. gammarus* (Linnaeus) (Herrick 1896, 1911). Ryder (1886) noted four forms of conjoined twins in larval American lobsters: lateral fusion of cephalothoraxes that demonstrated absence of eyes, possession of a single median eye or paired eyes representing the right eye of the right larva and left eye of the left larva, while the abdomens of each type were separate and divergent at a wide angle, and cephalothoraxes of two embryos fused together along their dorsal surfaces, with full complement of eyes, appendages, and separate abdomens, but with internal organ systems fused. Ryder attributed all of these twinnings to fusion coincident with the process of gastrulation and gradual formation of the embryos. Herrick (1896, 1911) discussed and figured some of these cases also but thought that fusion came later in development than gastrulation.

I have found no account of conjoined twinning in shrimps, and no report of twinning that parallels the case presented here. What is amazing is that an animal so bizarre could molt at all, let alone progress through a series of molts to attain mature size. Whether the deformity resulted from embryonic malformation or from subsequent injury cannot now be determined, although angle of divergence and median sagittal alignment of the cephalothoraxes suggests that the malformation resulted from aberrant molting.

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NOTE ON MUSCLE GLYCOGEN AS AN INDICATOR OF SPAWNING POTENTIAL IN THE SEA SCALLOP, *PLACOPECTEN MAGELLANICUS*

During the reproductive cycle of the Atlantic sea scallop, *Placopecten magellanicus*, glycogen levels rise and fall in the hemolymph (Thompson 1977) and in the adductor muscle (Robinson et al. 1981; Gould 1983), reflecting the buildup of glycogen reserves in the muscle and their later transfer to the gonad. Muscle glycogen normally rises to a yearly peak in spring after the phytoplankton blooms, then is transferred to the gonad for gamete differentiation and maturation (Robinson et al. 1981). The glycogen transfer is followed by an increase in size of the maturing gonad and a loss of muscle weight (Gould 1983). During the autumnal algal blooms, glycogen levels in the muscle rise again slightly and drop thereafter to an annual low during the winter months, when the small energy reserves are used for basal maintenance and to initiate gametogenesis.

Glycogen reserves from the muscle and lipid reserves from the digestive gland are the major sources of stored energy supplied to the scallop gonad. High spring glycogen levels most dramatically indicate the degree of buildup of energy stores used to fuel gamete differentiation and maturation, whereas low winter muscle glycogen levels correspond to the postspawning exhaustion of reserves. Winter values higher than the normal range for any given population, therefore, could indicate an unusually large and extended period of nutrient availability, but more probably would suggest resorption of gametes.

We suggest, therefore, that the spring peak and the winter ebb of muscle glycogen be used as measures of the relative spawning potential and spawning success, respectively, for *Placopecten*. Sampling during these two seasons may readily provide information on the recruitment contribution of different scallop populations.

Timing of the seasonal high and low values for this metabolic parameter can vary by several weeks from year to year, reflecting the timing and intensity of phytoplankton blooms (themselves dependent on other environmental variables), and the time and degree of success in spawning. To obtain a practical data base for this major measure of seasonal energy reserves, therefore, we sampled a single bed of sea scallops öff Asbury Park, NJ, on a year-round monthly basis for 3½ years. In examining mean annual high and low muscle glycogen values for these scallops, data were averaged for animal collections