SEXUAL mosaics have been reported in three genera of Crustacea. A bilateral mosaic of Carcinus was found to have a testis on one side and a mixed gonad on the other (Veillet 1945). Gynandromorphs with a testis and ovary have been reported in Homarus (see review by Chace and Moore 1959) and in the cladoceran, Simocephalus (Banta, Wood, Brown and Ingle 1939). No intersex or mosaic of Artemia has been reported previously.

The method of sex determination in Artemia is of interest because one bisexual race and many parthenogenetic races have been reported to be polyploid (Barigozzi 1957; Barigozzi and Tosi 1959). The cytological studies of Artemia (reviewed by Barigozzi 1957) have not demonstrated the presence of heterochromosomes nor a difference in chromosome number in the two sexes.

Although no studies have been made of sexual differentiation in Artemia, extensive studies have been made of another crustacean, Orchestia gammarellus. Charniaux-Cotton (1960) has demonstrated that differentiation in this amphipod is mediated by a male hormone produced by an androgenic gland. Homologous male and female tissues respond in the same manner to the hormone. Therefore, the hormone suppresses the normal differentiation of genetically female tissue.

In the following morphological descriptions, we have used the terminology of Lochhead (1941, 1950) with few exceptions. We have adopted the term uterus used by Goldschmidt (1952) to designate the organ in which the eggs undergo segmentation. We use the terminology of CasseU (1937) for the male reproductive system.

External sexual dimorphism in Artemia is seen in the larger size and modified shape of the male antennae. The male has a penis on each side of the body, whereas the female has one median ovisac.

The male has two separate reproductive systems, one on each side of the body. Each consists of testis, seminal vesicle, and vas deferens. When the penis is retracted, the seminal vesicle is folded in a U-shaped loop. During copulation, the penis is everted, the seminal vesicle is straightened, and the inner surface of the vas becomes the outer surface of the penis. The female reproductive system consists of two ovaries, two pouch-like oviducts, and a median uterus which lies within the ovisac. Attached to the uterus are four clusters of shell glands.

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The gynandromorph was descended by four generations of brother-sister matings from California amphigonic diploid shrimp which had received 300 roentgens of X-ray irradiation. The young adult had attained a length of 6.7 mm at the time it was examined under the microscope and photographed. It was then imbedded in paraffin and sectioned.

Examination of the transparent living animal revealed that the entire right side of the body was composed of normal male tissue; sperm were seen within the testis and seminal vesicle. On the left side there was a small antenna characteristic of the normal female. The ovisac was equivalent to the half ovisac of a female but the distal portion was deflected to the side (Figure 1). Within the ovisac was one oviduct and two clusters of shell glands connected to the uterus. The ovary contained five yolky eggs.

Histological study indicated that the testis and ovary lay in their normal positions. The half uterus did not join with any portion of the male reproductive system. Although male and female tissues did not merge, they were in close proximity in the genital segments. In Figure 2, the seminal vesicle is seen to be a distance of a few microns from the shell glands.

This bilateral gynandromorph suggests that sex determination in Artemia is chromosomal rather than environmental. The right and left sides of the shrimp may have been determined at the first cleavage division. The presence of an ovary and a testis indicates that the gonads arose from two different germ cells.
A gynandromorph has been accepted by many authors as evidence that the chromosomes determine the sex characteristics of each cell of the body by autodifferentiation rather than through the action of sex hormones. Such evidence is not conclusive because the cells on the two sides of the body, being of different genetic constitution, may respond differently to the same hormone. Furthermore, it is possible that hormones are present which govern cyclical physiological processes such as egg maturation. The discovery of this gynandromorph does indicate, however, that if a sex hormone is present in Artemia, it has no action in suppressing the differentiation of either the gonad or the accessory reproductive organs of the opposite sex. This is in contrast to the situation in Orchestia which was outlined above.

**SUMMARY**

A bilateral sex mosaic of Artemia was found to have a testis containing sperm on the right side and an ovary containing eggs on the left. If a sex hormone is present in the brine shrimp, it does not suppress the differentiation of the gonad or of the accessory reproductive organs of the opposite sex.
LITERATURE CITED


LOCHHEAD, J. H., 1941  Artemia, the "brine shrimp." Turtox News 19: 41–45.
