sound-producing mechanism of the longhorn sculpin is actuated by contractions of the deep cranioclavicular muscles on both sides. The resulting periodic movements of the pectoral girdle are believed to produce the actual sound vibrations of the surrounding medium. The previously suggested source of the vibrations, pectoral-pelvic girdle stridulation (*2*), was disproved by amputating the pelvic girdle, without injury to the pectoral girdle, in three specimens. For more than 24 hours after the operation, all three fish readily produced apparently normal sounds. In the absence of antagonistic muscles for the production of a reciprocating movement, it is suggested that the deep muscles produce unidirectional movement and that the return movement is produced by the elastic nature of the pectoral-girdle articulations.

Further analysis of the sculpin sound-producing mechanism is in progress. The preliminary results from this species suggest that analogous electrophysiological techniques may assist in providing positive identification of unknown-sound-making structures in other species.

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Some Effects of Specific Organic Compounds on Marine Organisms

In recent years it has become increasingly recognized that sea water contains organic compounds in solution or suspension which may have definite roles in the living processes of marine organisms (*1–3*). Thus it is reasonable to expect that a number of vitamins that may affect the bioeconomy of the sea are produced naturally (*4*).

This report describes two cases of interest which have come from our studies of the organic components of sea water. These results are considered to be significant because the presence of one of the compounds has been demonstrated by chemical methods (*2*) and because the other could easily be presumed to be present. In addition, both components showed definite physiological effects on the animals used.

Table 1. Effect of niacinamide on the pumping rate of an individual oyster.

Niacinamide (ppm)	Reduction in pumping rate (%)
0.42	52
0.83	83
2.08	99
3.33	99
10.00	100
50.00	100

During the experimental work of Collier *et al.*, various organic compounds were introduced into the water supply of experimental oysters [*Crassostrea virginica* (Gmelin)] in an attempt to obtain a response similar to that caused by the natural carbohydratelike substances (*5*). Niacinamide was among these, and although it did not cause an increase in pumping rate, its effect was pronounced and quantitative in nature. The effect was easily repeated from oyster to oyster under a variety of conditions. Briefly, the maximum effect was to cause an immediate increase in the gape (openness of the valves) of the oyster and, simultaneously, a complete cessation of pumping. The niacinamide was introduced into the water-circulating system in various concentrations. Table 1 summarizes the results of a series of experiments on a single oyster. The shell movement is difficult to quantitate, but, as the pumping rate decreased, the gape of the oyster gradually increased and, simultaneously, the adductor muscle lost tonus.

These data are typical, and it can be seen that the pumping rate was inversely related to the concentration of niacinamide. Some points to be noted are (i) that the substance was not acting as an irritant in the normal sense, because an irritant normally causes an oyster to snap shut or show frenetic shell movements, as compared with the quasi-narcosis in this case; (ii) that the valves could be pressed to the closed position but would immediately return to full gape; (iii) that the maximum gape caused by the niacinamide was actually about 10 percent greater than that associated with normal maximum pumping; (iv) that, as the niacinamide was gradually removed by dilution with normal, running sea water, the activity of the oyster resumed the level prevailing before the introduction of the vitamin; and (v) that niacin caused no response in similar concentrations.

Our work on the natural organic compounds in sea water is continuing and further tests with specific organic compounds are under way.

Of a series of compounds used with barnacles, ascorbic acid caused the most clear-cut response. When the barnacles (*Balanus* sp.) were exposed to a maximum concentration of 0.014 mg of ascorbic acid per liter, they immediately initiated copulating activities. The cirri ceased beating, and the penis emerged, unrolled, and sought out nearby barnacles. The ascorbic acid was introduced at one point, and because it was carried through the remainder of the 25-gal tank by convection drifts, all of the barnacles responded in the same manner. This would indicate that they were sensitive to much less than the original concentration. The experiment could be repeated at will with the same results, and changes in *p*H that were caused by adding HCl in place of ascorbic acid did not stimulate the response. The barnacles were fully grown animals that had been reared from larvae in the aquarium where the experiments were performed. These tests were made when the barnacles were 38 days old.

For comparison, glutamate, glycogen, methionine, and inositol were also used and seemed to stimulate a more rapid beat of the cirri. Fish autolysate appeared to depress the rate. None of these caused the responses noted for ascorbic acid.

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11 May 1956

Detection of Tumor-Inducing Factors in Drosophila

Many investigations have been concerned with the occurrence of melanotic tumors in *Drosophila melanogaster*. The effects of environmental modifications—that is, nutrition (*1*), temperature (*2*), and x-radiation (*3*)—on tumor incidence in various strains have been extensively studied. Melanotic tumors have been

Table 1. Response of a tumor-free strain (wild 51–52) to larval-extract injections of various tumor and tumor-free strains.

Donor strain	Larval hosts	Emerged adults	Tumorous adults	Tumor induction (%)
bw tu	647	68	48	71
tu-vg	770	96	61	64
tu-C-S	700	67	39	58
tu-w	697	41	22	54
+/f	400	49	11	22
tu^{36a}	400	54	0	0
C-S	414	53	0	0

produced in a tumor-free strain of *Drosophila* after the injection of hemolymph obtained from a tumorous strain of *Drosophila* (*4, 5*). A tumor-inducing factor, present in acellular *tu-e* larval extracts, when injected into hosts of a tumor-free strain, induced the formation of melanotic tumors which were histologically similar to the tumors present in the *tu-e* strain (*6, 7*). Recent research has been concerned with the activity, properties, and nature of the *tu-e* tumor factor (*8*). This survey was conducted to determine the prevalence of comparable tumor-inducing factors in seven other strains of *Drosophila melanogaster* (*9*).

The technique for the preparation of acellular 96- to 120-hr larval donor extracts, the injection apparatus and procedure, and the preoperative and postoperative care of the 96- to 120-hr host animals was essentially similar to that described by Harnly *et al.* (*6*) and Burton (*10*).

The host strain (wild 51–52) is a tumor-free strain from which no active tumor-inducing factor could be extracted (*6*). However, this strain is highly reactive to the injected tumor factor extracted from *tu-e* larval donors (*6, 10*). Repeated tests have conclusively demonstrated that neither operational injury (incurred in the insertion of the needle into the hosts or in the preoperative and postoperative procedures) nor the injection of diluting medium (Waddington's salt solution) induced tumors in the wild 51–52 hosts (*6, 10*). Barigozzi has also indicated that the trauma of the injection is not causal in the induction of melanotic masses (*4*). A histological study confirmed that injury or the injected diluting medium, or both, did not induce the formation of tumors in the wild 51–52 hosts (*7*).

Four known tumor strains, *bw tu, tu-C-S, tu-w,* and *tu-vg* were tested. Two other strains, *+/f* and *st sr e^s ro ca;* tu^{36a} (hereafter abbreviated tu^{36a}), which were considered to be possible tumor strains (not one tumorous imago was observed in a random sample of more than 500 animals of each of these two strains reared at 25°C on standard food, dissected, and examined) were also tested. The *C-S* strain was a tumor-free strain.

Only adult hosts were dissected and examined for the presence of melanotic tumors because those hosts that failed to reach the imago stage of development might have died before a possible tumor-inducing factor could have operated (Table 1).

Larval extracts of the four tumor strains and one of the purported tumor strains induced melanotic tumor formation in the wild 51–52 hosts, ranging from 22 to 71 percent. Injections of larval extracts of *C-S* and tu^{36a} strains failed to induce the formation of melanotic tumors in host animals.

These results demonstrate that extractable tumor-inducing factors may be obtained from tumor strains other than the *tu-e* tumor strain. However, not all tumorous strains, at least from donors of the age used, provide extracts that contain an active tumor-inducing factor. Extracts of one tumor-free strain (*C-S*) did not possess an active tumor-inducing factor.

Since tumor strains other than *tu-e* contain active tumor-inducing factors, it is very likely that these tumor strains also possess genes involved in the synthesis or activation of tumor-inducing factors or both. Nevertheless, a tumor strain of low incidence that does not possess an active tumor-inducing factor may contain genes that modify tumor gene activity or tumor-inducing factor activity or both (*11*). Indeed, under the proper conditions (ages of donors and hosts) active tumor-inducing factors may possibly be extracted from all tumor strains of *Drosophila melanogaster.*

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5 May 1956

Osmotic Gradients across Cellular Membranes

In a recent article [*Science* **121**, 302 (1955)] W. A. Brodsky and others present arguments to prove that the Franck-Mayer hypothesis for the maintenance of osmotic gradients across cellular membranes is untenable for mammalian tissues. They state that the hypothesis would require a minimal energy expenditure of 21,000 kcal/kg hr to maintain the osmotic gradient obtained when mammalian kidney tissue produces a hypertonic urine. Since this value is about 1000 times the maximal rate observed for mammalian tissues, they conclude that the proposed mechanism is inadequate for the maintenance of the observed osmotic gradients.

It would appear that the authors have overlooked an important point in their analysis—namely, that the energy expenditure required is proportional to the tubular surface area *available* for water transport. The authors calculate the total tubular surface area to be 5×10^5 cm²/kg. This is 2 or 3 times larger than is generally assumed. However, such a discrepancy is of minor importance. Of crucial importance is the fact that the fraction of this total area which is actually available for water permeation may be quite small—for example, water may pass only through "pores" that occupy a small part of the surface area of tubular cells, or possibly only through a small percentage of the total number of cells. Much recent work indicates that flux rates across many living membranes as measured with isotopes can be easily accounted for by extremely small fractions of the total surface area of the membrane and that the area actually available for transport may, in many cases, be only a fraction of 1 percent. If the same is true for kidney tubules, the energy required to maintain the osmotic gradient obtained during production of hypertonic urine would also be only a fraction of 1 percent of that calculated by the authors' methods. Thus, a mechanism of the type proposed by Franck and Mayer does not necessarily demand an impossibly high energy expenditure.

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Since Eugene Grim's comment raises some questions on the problem of intracellular osmotic gradients, it is important to restate the problem and to define some of the terms used.

The analysis considered the solute flux and intensity of respiration required for the steady-state maintenance of an os-