illuminated often by our knowledge of the past experiences of the race, but they are largely determined by emotional reactions and channels of thought whose pattern by necessity varies from age to age. It is thus the poetry and philosophy of the present, rather than accumulative knowledge, which play the significant role in outlining the next act in the drama of world history.

ROBERT GOTTSCHALK
Standard Oil Company (Indiana),
910 South Michigan Avenue, Chicago, Illinois

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Q_{10} of the Maximum Tetanic Tension Developed by Isolated Muscle Fibers of the Frog

The experiments (*1*) reported here are essentially confirmatory in nature to those previously analyzed by Bull (*2*). Therefore no review of the extensive literature on the Q_{10} of the maximum developed tetanic tension of muscle will be undertaken.

The technique of isolation, recording, and measurement was the same as that previously described (*3*), except that the stimulator was a Harvard inductorium. The electrodes were two chlorided silver wires each placed one-third of the length of the fiber from each end. The length at which the fiber developed maximum tetanic tension was determined at some particular temperature, and the fiber was stimulated at this length subsequently. The lever was not calibrated for absolute tension. No particular rule was followed in the order of the variation of temperature, but in all instances a complete cycle was carried out; an experiment was rejected if the fiber did not develop approximately the same tension on return to its original starting temperature. The temperatures were changed gradually and the range was limited from 0° to 25°C. Very few experiments were performed at temperatures above 22°C because in many fibers the tetanus was incomplete at higher temperatures.

The results were quite variable. Earlier (*4*) it was noted that when a fiber shortened unevenly it developed more tension than it did when it shortened evenly along its length, but that if stimulation was continued long enough any unevenness became distributed and the tension fell to a value characteristic of the evenly shortened fiber. In order to maintain a tetanus long enough for this to occur the stimulus frequency must be carefully adjusted for each temperature. In particular, the frequency of stimulation for a maintained tetanus at very low temperatures must be very low indeed. The tetanus cuts off quickly at low temperatures if the fiber is stimulated by a Harvard inductorium (*5*). The variable frequency stimulators available to us at the time did not have sufficient power output to compensate for the Ringer solution shunt unless the electrodes were dangerously near the fiber. In theory, multiple cathodes should minimize any unequal shortening, but in practice this has a negligible effect as contrasted with alternating cathodes placed as described in the previous paragraph for single muscle fibers, because the majority are so uneven in cross section along their length. A further contributing factor to the variability in the results must have been the alteration in conduction velocity with temperature (*6*).

Table 1. Data illustrating the variability in two typical experiments.

Expt.	Temp. (°C)	Tension (arbitrary units)	Time (min)
3	16.5	97.8	0
	16.5	100.0	15
	16.5	100.0	20
	7.8	91.1	58
	7.8	91.1	85
	17.0	96.8	110
	21.3	98.0	130
	10.0	88.7	155
	16.8	94.5	175
4	10	90.3	0
	18	97.2	17
	17	97.2	49
	17.7	100	55
	10	91.7	164
	10	94.4	180
	25	97.2	227

Table 1 illustrates the variability in two experiments that were accepted as satisfactory. In both of these the tension tended to be low at the low temperatures, but in others it was high. In each of the eight experiments accepted as satisfactory out of the 25 done, the maximum tension was plotted against the temperature in degrees Celsius, and the best straight line through the points was determined by the method of least squares. The Q_{10} was then determined from the slope of this line. In Table 2 *a* is the intercept of the line, *b* the slope, and *Pa* and *Pb* the probable error of the intercept and slope, respectively. It will be noted that the probable error of the slope *b* is of the same order of magnitude as the slope itself. It is therefore likely that within the limits of experi-

Table 2. Q_{10}'s of the maximum developed tetanic tension of eight single muscle fibers with the constants and the probable errors of the least square lines from which they were calculated.

Expt.	Intercept a	Slope b	Probable error		Q_{10}
			Pa	Pb	
3	89.7	+0.34	3.21	0.21	1.038
4	90.6	+0.31	2.27	0.14	1.033
5	78.5	+0.78	1.98	0.13	1.100
6	74.8	+0.73	3.74	0.20	1.098
12	82.3	+0.53	4.12	0.22	1.063
13	91.0	−0.34	8.77	0.49	0.963
14	80.6	+0.66	14.2	0.86	1.080
15	81.8	+0.84	10.5	0.36	1.103

mental error the maximum tetanic tension developed by a single muscle fiber is the same at all temperatures between 4°C and 22°C.

MARY ANN WASHINGTON
MARY FRANCES ARRIGHI
SIBYL F. STREET
ROBERT W. RAMSEY

Department of Physiology,
Medical College of Virginia, Richmond

References and Note

1. These experiments were reported at a symposium at Edgewood Arsenal, 6–7 Oct. 1952. The report was mimeographed in Chemical Corps Medical Laboratories, Special Report No. 27 (1953), p. 10. The study was aided by contract NR 113-099 between the Office of Naval Research and the Medical College of Virginia.
2. H. B. Bull, *J. Am. Chem. Soc.* **67**, 2047 (1945).
3. R. W. Ramsey and S. F. Street, *J. Cellular Comp. Physiol.* **15**, 11 (1940).
4. R. W. Ramsey, "Muscle," in *Medical Physics,* Otto Glasser, Ed. (Year Book Pub., Chicago, 1944), vol. 1, p. 784.
5. R. W. Ramsey and S. F. Street, in *Biol. Symposia* **3**, 9 (1941).
6. A. Wilska and K. Varjoranta, *Scand. Arch. Physiol.* **83**, 88 (1939).

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Marking of Shrimp

Interest has been shown by the U.S. Fish and Wildlife Service in sponsoring research to find a means to tag shrimp effectively for growth, migration studies, and definition of stocks. According to the proposal the tags should fulfill these conditions:

> . . . (*a*) will not impede the natural movements of the shrimp, (*b*) will not cause abrasion, lesions in, or otherwise damage any tissue of the shrimp, (*c*) will offer minimum opportunity for the entry of parasitic fungi or other pathogens into the tissues of the shrimp, (*d*) will not attract predators, (*e*) will persist throughout the life of the shrimp regardless of age at which mark or tag is imposed or attached, (*f*) can be easily detected and identified by untrained workers in the fishery, both ashore and at sea.

Some preliminary investigations of the usefulness of vital staining for this purpose were made at the Marine Laboratory of the Oceanographic Institute, Florida State University, during October 1954. The shrimp (*Penaeus setiferus*) were captured in Alligator Harbor and the adjacent Gulf of Mexico with a shrimp try net and a minnow seine. They were transported to outside tanks, 10 ft in diameter, supplied with running seawater. The shrimp were fed at infrequent intervals with bits of shrimp, fish, and crabs. A 2-ml insulin-type syringe with a No. 25 needle ½ in. in length was used. Several different colored inks and stains prepared for histological purposes were used in the preliminary experiments. The injections were made by piercing the shell in the posterior abdominal segment. Except when almost immediate death occurred, the stain spread throughout the animal almost instantaneously, presumably via the blood vascular system.

The majority of the stains killed the animals, either immediately or within several hours. Neutral red and methyl blue did not kill the shrimp but, because of the temporary nature of the coloring, were not considered satisfactory. With these two stains, color could be detected only in the branchial chamber after a few hours (concentrated in the gills) and had disappeared altogether within 24 hr. Fast green was very successful. Less than 5 percent mortality was experienced if the animals were handled carefully and not too much stain was injected. It was estimated that about 0.2 ml of the solution was injected into the animal, and the color was still plainly visible after a period of more than 60 days. Mortality was about the same (about 15 percent) in the injected animals as in the controls kept in the same tank. The majority of the animals shed at least once. After shedding, the stain became concentrated in the branchial area but was still very noticeable, especially when contrasted with the control.

These preliminary data satisfy conditions *a, c,* and *f*. Condition *b*, "will not cause abrasions, lesions in or otherwise damage any tissue of the shrimp," is not fulfilled, although it is thought that the damage to the tissue was slight, certainly less than that caused by attachment of a metal or plastic tag. It will not be known whether condition *d*, "will not attract predators," is fulfilled until controlled experiments are performed with marked and unmarked shrimp. It is not yet known whether the color will persist throughout life to fulfill condition *e*.

These findings are reported with the thought that other workers who are interested in marking shrimp may profit by them. It is planned to continue the investigations in the spring when shrimp will again be locally available.

It is felt that if the stains are prepared carefully so that isotonic solutions are made and toxic substances are not used for carriers, this method of marking will prove effective. This method is certainly faster and more economical than tagging with metal or plastic and probably will cause less mortality. It has great possibilities if several contrasting colors can be found, both for marking in several localities in one year to study migration and also for the succeeding year. Because of the short life span of the shrimp the same colors could be used over again, at least within 2 yr.

One difficulty with this method is that individual records cannot be kept and hence, although it is valuable for migration studies, it will not be as suitable for growth studies. However, great numbers of shrimp could be marked in a very short period, and if only shrimp of a restricted size interval were marked with a single color, the growth under natural conditions could be determined when the shrimp were recaptured.

R. WINSTON MENZEL

Contribution No. 27, Oceanographic Institute,
Florida State University, Tallahassee

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