movements. The one important thing is to have a skilled pianist as subject capable of making the free ballistic movements. If the rate per sec. of the movements, as well as the path, is fixed, it is easy to see the shift of this middle point of oscillation of the indicator pointer with each change in length of excursion of the movement series, and approximate readings may be made to show the proportionality.

If the subject increases the rate per sec. of such a series of ballistic movements, the readings of the level indicator show some interesting relations. As the subject approaches his maximum rate, the amount of action-current indicated reaches a maximum; apparently the muscles are exerting their maximum force; from that stage on the increase in rate per sec. reduces the excursion proportionally. The maximum rate per sec. is achieved with the minimum excursion; in the final stage the excursion is very slight and the coordination is irregular and a "forced tremor" supervenes.

It is evident that there is a maximum number of available fibers for a given movement and when that number is in action the increase of rate of the repeated movement depends on reducing the excursion so that the flexor and extensor groups of fibers can each take up the momentum in reversing the movement of the limb; at last the coordination breaks down, the movements are irregular and a forced tremor is the result.

These results were obtained repeatedly with some four subjects. The maximum rate differs somewhat from subject to subject, but there are no essential differences in the quantitative relations of action-current and contraction. It is obvious that the findings fit the all-or-none hypothesis for the contraction of human muscle fibers.

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CHEMICAL VERSUS MORPHOLOGICAL SPECIES DIFFERENCES

THE writer has had the opportunity to make analyses of the sap of plants of the genus *Valonia* from many localities. Under current classification based upon morphology, these plants are referable to three or four different species. But, as has already been pointed out in the case of plants classed as *Halicystis ovalis* (Lyng.) Areschoug, chemical differences contravene morphological characteristics.[1] These chemical distinctions have since been utilized in segregating part of the genus *Halicystis* as a new species.[2]

Table I shows the relevant data in the case of genus *Valonia*. The new analyses in this table were made by the following methods: Halide was determined by titration with silver nitrate; it consists predominantly of chloride. K + Na was determined as total sulfate, K as chlorplatinate and Na by dif-

TABLE I

CHEMICAL CHARACTERISTICS AND ENVIRONMENTAL DATA FOR VARIOUS REPUTED SPECIES OF VALONIA

Reputed species	Locality	Habitat	Depth	Water temperatures*	Composition of sap				Condition of materials	Authority (See footnotes)
					K	Na	Cl	K/Na		
			m	°C.						
Valonia utricularis	Naples	On rocks	0	?	368	20.4	369	(18.0)	= –	4
	"	" "	0	?	291	152	418	1.91	= –	5
	"	" "	0	18°	372	266	639	1.43	Fair (March)	–
V. macrophysa	Naples	On tunicates	30	12°	465	164	657	2.77	Good (February)	–
	Dry Tortugas, Fla.	On masonry	0	28°	494	97	617	5.10	Good (June)	6
	Bermuda	On coral rocks	0	25°	517	90	597	5.73	–	7
V. ventricosa	Makahaa, Tonga	Under rocks	0.3	25°	497	125	619	3.97	Excellent (Sept.)	–
	Main shore, Tonga	On sea weeds	1.0	25°	545	55	620	9.92	" "	–
	Dry Tortugas, Fla.	Under rocks	0.3	28°	562	46	618	12.21	" (June)	–

* Water temperatures are only rough approximations.
+ Mean of four controls.

1 S. C. Brooks, *Proc. Soc. Exp. Biol. Med.*, 27: 409–12, 1930.

2 L. R. Blinks and A. H. Blinks, *Bull. Torrey Bot. Club*, 57: 389–95, 1930.

3 A. Meyer, *Ber. Deutsche Bot. Ges.*, 9: 77–9, 1891.

4 S. Camlong and L. Genevois, *Bull. Sta. Biol. Arcachon.*, 27: 309–21, 1930.

5 E. Pantanelli, *Bull. Orto Bot. R. Univ. Napoli*, 6: 1–37, 1918.

6 S. C. Brooks, *Protoplasma*, 8: 389–412, 1929.

7 W. J. V. Osterhout, *Jour. Gen. Physiol.*, 5: 225–30, 1922.

ference. Data as to habitat, depth, and water temperature are germane, because of their possible physiological effects on different representatives of a single species. All plants were freshly gathered, and in good condition, except as noted.

The data relating to *Valonia utricularis* show that in this species there is relatively little selective accumulation of potassium: this species stands at the bottom of the list in so far as selective permeability is concerned. Meyer[3] regards his data as probably inaccurate, and this is almost surely the case with regard to the value for Na. All three analyses refer to plants from the same vicinity, and some seasonal differences are to be expected, as Camlong and Genevois have shown in the case of other marine algae.[4]

Plants usually referred to *V. macrophysa* Kütz have been collected for analysis from three stations: Naples, Bermuda and the Dry Tortugas Keys of Florida. The plants from the Golfo di Pozzuoli near Naples, where they grow at a depth of about 30 m, attached to tunicates, show less power of selective accumulation than do plants supposedly of the same species, which grow attached to rocks in shallow water in Bermuda and Florida. The former grew at a temperature which at the time of collection (January) was not far from 12°, while the latter were flourishing at a water temperature of about 28°. Some suggestion of a morphological difference is apparent, although Professor W. R. Taylor has been unable after careful study to find any certain difference. Yet in Florida the ratio of K to Na is about 5, while near Naples it is about 2.75. Other collections at Naples showed some variation from this figure, but the ratio of K to Na did not in any case exceed 3.17. The Bermuda plants resemble the Florida plants in all respects.

Are we here dealing with physiological variants, or with distinct valid species? If the habitats of the two types could be interchanged would their physicochemical characteristics change too!

The plants classed in the table as *V. ventricosa* present a still more puzzling situation. The two samples from Tonga tentatively assigned to this species may very well in one of the two cases be *V. forbesii* J. G. Aghard. Morphological characters said to distinguish the two species are most unsatisfactory, and field identification was impossible. Professor W. A. Setchell has kindly examined specimens of the Makahaa collection, and tentatively assigns them to *V. ventricosa*. The habitat of the plants collected at Makahaa was like that of *V. ventricosa* in the Dry Tortugas of Florida: under coral rocks on sand in about one foot of water or less at low tide. The plants along the main shore reef of Tonga grew on and among other algae in considerably deeper water. Yet the sap of these latter plants was like that of Florida specimens of *V. ventricosa,* while that of the former was much more like that of *V. macrophysa* Kütz from Florida and Bermuda.

These facts lead us to inquire whether physicochemical characteristics which are quantitatively well defined may not be valuable aids to the systematist. In some cases it is possible that environmental factors alone have produced the chemical differences noted. Yet it hardly seems likely that this is ordinarily the true explanation, any more than that it is the true explanation of morphological differences. Further study may well make chemical analysis an indispensable tool for the systematist.

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