practice were asked to cooperate in a study of food and fluid intake of normal children; they were advised not to influence their youngsters to drink more or less than usual, but merely *record* everything taken by mouth for a 48-hour period. When children were of school age, mothers were asked to make the measurements on a weekend. Otherwise, any convenient 2-day period was used. Cards were furnished to simplify recording all food, milk, water, fruit juices, and so forth, together with entries for methods of preparing formula, mixing juices, soup concentrates, or dried milk. Volumes were recorded in ounces.

Mothers chosen to participate in the test were those we felt would be cooperative and reliable. And it was perhaps significant that a number of them discarded original records they felt were incomplete or otherwise unsatisfactory, requesting additional forms to use at a later time.

Data cards were collected, tabulated, and analyzed. The daily findings in the four cities, by age, and in terms both of total fluid and tap-water intake, have been shown in Fig. 1 and set out in detail in Table 1.

Several features of these data are noteworthy. First, mean tap-water intakes resembled those reported by others (*2–4*), and were consistently less than half the total daily fluid volume consumed for all age groups. As the standard error of the means show, intake tended to be uniform in the children studied. It was apparent also that total fluid intake increased with age and that, proportionately, consumption of tap water decreased.

The study excluded the summer months in the hope that differences in fluid consumption would be observed between children spending the fall, winter, and spring in the North or the Far West and those living in Georgia and Florida, where more clement weather usually prevails. No differences whatever were observed in total fluid intake, a finding at variance with that reported by others (*3–5*). In the age range from 2 to 9 months tap-water consumption (Table 1) may have been less in Michigan than in the other areas, otherwise, again, no differences were noted. In the light of negative observations by Galagan *et al.* (their Table 2, in *4*), breakdown by sex was not undertaken.

Finally, daily intake of tap water of 500 ml or more (roughly, 1 pint) was rarely reported, even among older children. Dehydration is no problem among normal children resident in the United States, but this relatively limited average intake ought to be kept in mind when programs of fluoridation of drinking water are under consideration (*6*).

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Translocation in the Giant Kelp Macrocystis

Abstract. *Experiments with C^{14}-labeled bicarbonate demonstrate that organic products of photosynthesis are transported through the stipe tissue of* Macrocystis. *Depending upon conditions, not all of which have been fully ascertained, the direction of transport may be either predominantly apical or toward the base of the plant.*

Sieve-filament members, structurally similar to the sieve elements in the phloem of many vascular plants, occur in the giant kelp *Macrocystis* (*1*). However, as yet, there is no absolute proof that the sieve filaments of *Macrocystis* function in transport as do the sieve tubes of vascular plants; indeed, transport of any substance through intact stipes of this or related algae is still open to question (*2*).

Crafts (*3*) calculated rapid rates of transport from measurements of the amount of exudation from freshly cut stipes of this alga. This exudate was assumed to have originated from the sieve filament members of the "phloem" because, "the sieve tubes of the phloem are the only specialized elements capable of such rapid conduction."

Convincing evidence for translocation of organic products through stipes of *Macrocystis* has been presented by Sargent and Lantrip (*4*). They found that the daily increase in dry weight in the apical region of a frond exceeded the daily product of photosynthesis in that region, while the mature blades produced an excess of photosynthate. They concluded that some of the excess organic products formed in the blades near the surface and some distance behind the apex must be transported to the less organically rich, actively growing apical region. Also the rate of photosynthesis of whole fronds during the summer was greatly in excess of the rate of growth; therefore, these workers predicted that some translocation basally, and storage in the haptera might occur. The stored product was presumed to supply the holdfast and young developing fronds and sporophylls with an energy source for spring growth.

The use of radioisotopes should facilitate the confirmation of some of this earlier work, and in addition disclose the tissue or tissues participating in translocation, the substance or substances translocated, and the mechanisms of translocation. In this preliminary study, two short-term experiments have been conducted.

An intact plant of *Macrocystis* was collected by a diver from the sublittoral zone at Corral Beach, Malibu, California, on 27 November 1962. The plant was carried to the laboratory and deposited in an aquarium containing 60 gallons of natural sea water at a temperature of 17°C. A mature intact blade (No. 44 back from the apex) was placed in a rectangular transparent plastic reaction chamber which was open at the top. The reaction chamber was immersed to within half an inch of the open top so that only a few inches of stipe and the bladder of blade No. 44 were exposed to the air above the chamber; the rest of the plant remained in the natural sea water. The reaction chamber (16 by 4¼ by ½ inch) was filled with about 500 ml of freshly prepared and sterilized artificial sea water medium ASP-2 (*5*), to which was added a few milliliters of a $NaHCO_3$ solution labeled with C^{14} (about 1 mc). Three 20-watt fluorescent lamps, giving a light intensity of 8 klux, were placed against the glass wall of the aquarium so that they faced the flat surface of the blade in the reaction chamber. The remaining portion of this side of the aquarium was masked with thick black paper to prevent light from reaching other parts of the plant.

Table 1. Radioactivity in different parts of a *Macrocystis* plant. Experiment 1, 1 hour; S, stipe; B, blade; x, cross-section; p, piece.

Tissue and section	Blade No.	Distance from apex (ft)	Activity* (count/min)
S, x (unlabeled c)	40	4.5	2
B, p (unlabeled c)	40	4.5	3
S, x (labeled)	apex	0	1
B, p	apex	0	3
S, x	8	1.0	0
B, p	8	1.0	0
S, x	20	2.2	3
B, p	20	2.2	0
S, x	30	3.8	483
S, x	43	5.0	161
B, p	43	5.0	5
S, x, apical side	44	5.3	564
B, p (washed)	44	5.35	55,635
S, x, basal side	44	5.4	378
S, x	45–46	6.0	88
S, x	60	8.5	3
S, x	80	13.0	0
S, x (above holdfast)	110	22.0	1
Hapteron (basal holdfast), x		23.0	7

* The number above normal background; averages of two runs in different planchet holders.

After 1 hour of illumination 12- to 18-inch lengths of stipe were cut proceeding from apex to base. This operation was performed in less than 1 minute to avoid artifacts which might have been induced by exudation from the cut end of the stipe. Sections of stipe and pieces of blades were cut from each 12- to 18-inch length of plant. Stipe sections were made approximately 1 mm thick and three to seven sections were included on each planchet, depending on the diameter of the sections, in order to provide approximately an equivalent surface area. Tissues were treated with a few drops of $0.1N$ NaOH prior to drying for the first series of determinations of radioactivity (Nuclear Chicago model D-47 gas-flow counter). Counting was considered to be at infinite thickness, and replicate counts were made in different planchet holders with a standard error of less than 5 percent.

The results are reported in Table 1. It is clear that a significant quantity of labeled product reached the stipe in the region of blade 30, a distance of 1.6 feet from blade 44, which was immersed in the labeled solution of artificial sea water. Posterior transport also occurred at least to blade 46, 0.65 foot from blade 44. Samples of stipe were not taken between blades 30 and 20.

After this first series of determinations, planchets containing labeled material were treated with an excess of $0.1N$ HCl to remove inorganic carbon. Material so treated showed no reduction in radioactivity.

The second experiment was performed with a plant collected on 15 February 1963. This plant differed from the one collected in November by its somewhat shorter length; a greater number of blades had been removed by wave action and a greater number of young fronds were growing from the basal haptera. The experimental procedures were identical with those used in the first experiment, with the following modifications: (i) blade No. 50 was immersed in the solution of artificial sea water and isotope; (ii) the temperature of the sea water was 27°C; (iii) the duration of exposure to both isotope and illumination was 45 minutes, and (iv) before sectioning, the entire portion of the frond anterior to blade 50 was severed, and the portion of the frond posterior to blade 50 was cut immediately.

Table 2. Radioactivity in different parts of a *Macrocystis* plant, 45 minutes.

Tissue and section	Blade No.	Distance from apex (ft)	C^{14} recovered (count/min)*
B, p	apex	0	3
S, x	10	0.5	4
S, x	18	1.0	2
S, x	25	1.6	1
B, p	24	1.5	4
S, x	32	2.5	0
S, x	38	3.2	5
S, x	44	3.9	11
S, x	49	4.7	4
B labeled	50	4.8	
S, x	51	4.9	2,192
S, x	55	5.6	35
S, x	60	6.4	9
S, x	68	7.8	5
S, x	75	9.0	2
S, x	109	16.5	3

* Number is the above normal background; averages of two runs in different planchet holders.

Table 2 presents the data from this experiment. There is no indication from the distribution of radioactivity that transport occurred apically, but rather there appears to have been radioactive material in the stipe tissue located in the region of blade 55, a distance of 0.75 foot toward the base from the immersed blade.

The results of these preliminary studies confirm the inferences made by Sargent and Lantrip (*5*) that organic products of photosynthesis are exported from mature blades under conditions of bright illumination. The results further support the prediction of these investigators that the direction of export may be both apical and basal. The possibility of an artifact induced by exudation of cut stipes is ruled out because, in the first experiment the labeled material reached a length of stipe (blades 20 to 30) which was harvested within a few seconds of the first cut; in the second experiment, the labeled material was found near blade 55 which was cut only about 10 seconds after the anterior 49 blades and stipe had been severed from the frond. In fact, the manner of cutting in the second experiment would, if anything, tend to extract the labeled product from the stipe since the direction of exudation was opposite to that of the translocation. In no instance did radioactive material enter the blades along the stipe.

These experiments were probably too short to be useful in calculating rates of transport. However, in the first experiment, at 17°C a distance of nearly 2 feet was traversed toward the apex in 1 hour; this figure is about one half of the average rate calculated by Crafts (*3*) for transport in "phloem," based on studies of exudation. Under different experimental conditions, perhaps higher values of translocation can be achieved with the isotope technique.

The direction and quantity of the translocated substance or substances may be influenced by several factors, such as the season of the year, which in turn influences the growth and maturation of new fronds.

The evidence in this report does not demonstrate that the sieve filaments constitute the true conduits of transport in *Macrocystis*. However, it does show that organic material is translocated from mature blades through at least one tissue in the stipe of this marine alga and that the direction of translocation may be both apical and basal (see *6*).

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