14 mg/kg to determine the extent of dechlorination and rate of elimination of chlorinated compounds from the body over a 14-day period. For analysis, the ^{36}Cl ion was converted to phenylmercuric [^{36}Cl]chloride (*8*), which was recrystallized to a constant specific activity. Comparable studies with [^{14}C]-toxaphene yielded no metabolites labeled with ^{14}C in the recrystallized phenylmercuric chloride fraction, so metabolites of toxaphene other than chloride ion do not interfere in this method of isotope dilution analysis. Most of the [^{36}Cl]toxaphene is metabolized before excretion, less than 0.7 percent of the ^{36}Cl appearing in urine and less than 3 percent in feces as unmetabolized toxaphene. About 5 percent of the administered ^{36}Cl appears in urine and 21 to 24 percent in feces as partially dechlorinated metabolites of toxaphene. The remainder of the excreted ^{36}Cl, accounting for 44 to 57 percent of the administered [^{36}Cl]toxaphene dose, is chloride ion in the urine. For comparison, 90 percent of the ^{36}Cl from labeled NaCl administered to rats is excreted as chloride ion in the urine.

To get an idea of the variation in rate and the degree of metabolism of toxaphene components, we chromatographed [^{36}Cl]toxaphene on the silica gel–hexane column and combined the fractions in the order of elution so that seven subfractions were obtained, each containing one-seventh of the total ^{36}Cl content of [^{36}Cl]toxaphene. These subfractions do not differ greatly in their selectivity for poisoning mice and houseflies, but the toxicity of the subfractions to these organisms varies from one-sixth to three times that of technical toxaphene. The seven subfractions and toxaphene itself are dechlorinated to similar extents and eliminated at similar rates by rats despite a 16-fold toxicity difference for mice and a 10-fold difference for houseflies between the least toxic and the most toxic subfractions.

The results reported here suggest that many of the toxaphene components contain the same or similar biodegradable groupings that undergo in vivo dechlorination in mammals, with about half of the C-Cl bonds on an average being metabolically labile. This does not mean that half of the C-Cl bonds in each component are cleaved since the studies to date involve mixtures of many components, some of which may undergo a small degree of dechlorination while others are more extensively or even completely dechlorinated and fragmented. Two sets of structural features are therefore of interest relative to the individual toxaphene components. An appropriate steric relationship between certain chlorines present in only a few constituents may determine the neurotoxic potency. Biodegradable sites such as chloromethyl and other groupings are probably present in most if not all of the toxaphene components. The composition of technical toxaphene and the structure, metabolic fate, and environmental persistence of the toxaphene components should be defined more completely by the procedures described above.

JOHN E. CASIDA*
ROY L. HOLMSTEAD
SAFY KHALIFA
JOHN R. KNOX†, TOMIHIKO OHSAWA
Division of Entomology and Parasitology, University of California, Berkeley 94720
KENNETH J. PALMER
ROSALIND Y. WONG
Western Regional Research Center, U.S. Department of Agriculture, Albany, California 94710

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* Send reprint requests to J.E.C.
† Present address: Department of Organic Chemistry, University of Western Australia, Nedlands 6009.

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Phosphate Absorption Capacity and Acclimation Potential in Plants along a Latitudinal Gradient

Abstract. *The capacity for phosphate absorption by marsh plants is negatively correlated with the soil temperature of the habitat of origin. Species and races from thermally fluctuating environments achieve greater compensatory changes in the phosphate absorption rate through temperature acclimation than their counterparts from more stable environments.*

Related organisms living at very different temperatures may exhibit similar metabolic rates, as a result of both evolutionary modifications and acclimation (a compensatory change in the rate in response to a change in growth temperature). These forms of temperature compensation have been well-documented in animals (*1*) but have only recently received attention by botanists. Evolutionary temperature compensation of plant processes usually (*2, 3*) but not always (*4, 5*) occurs. Acclimation of photosynthesis and respiration generally compensates for seasonal temperature changes, but the extent of this compensation is not consistently correlated with the extent of temperature fluctuation in the habitats from which the species derive (*5, 6*), although this correlation was found in one comprehensive study (*3*). The results of the study presented here indicate that the rate of phosphate absorption is finely attuned to the local thermal regime and that both evolutionary and acclimatory forms of temperature compensation consistently occur in this process.

Species and races of marsh plants were selected for study from habitats along latitudinal gradients of temperature and thermal stability, ranging from the cold, thermally stable soils of the arctic tundra (Barrow, Alaska; latitude, 71°18′N) to the warm, thermally fluctuating soils of a desert oasis (Thousand Palms, California; latitude, 33° 49′N). The soil thermal regimes in this report are characterized by July mean soil temperatures; details of the thermal regimes and temperature measurements

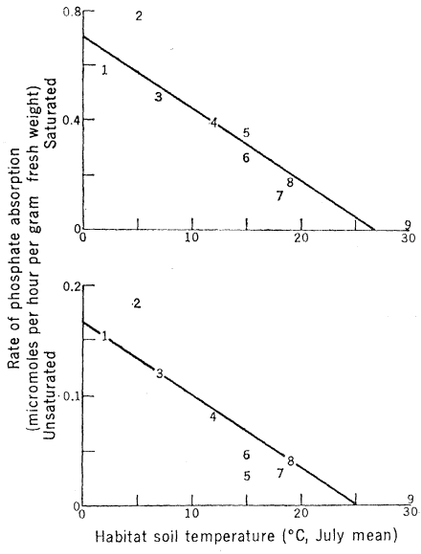

Fig. 1. Correlations of saturated and unsaturated rates of phosphate absorption by species and races from different thermal regimes with the July mean soil temperatures of the habitats of origin. The saturated rate is V_{max}; the unsaturated rate is calculated at an ecologically occurring external phosphate concentration (1.0 μM). Both correlations are significant ($P < .01$); correlation coefficients are 0.92 and 0.90, respectively. All roots were acclimated to 5°C, and the phosphate absorption rates were measured at 5°C. Species and collection sites of populations studied are as follows: species 1, *Eriophorum angustifolium*, Barrow, Alaska (71°18′N); species 2, *Dupontia fischeri*, Barrow, Alaska; species 3, *Carex aquatilis*, Barrow, Alaska; species 4, *Eriophorum scheuchzeri*, Fairbanks, Alaska (64°50′N); species 5, *Scirpus microcarpus*, Los Gatos, California (37°13′N); species 6, *Eleocharis palustris*, Fairbanks, Alaska; species 7, *Carex aquatilis*, Circle Hot Springs, Alaska (65°29′N); species 8, *Eleocharis palustris*, Corvallis, Oregon (44°34′N); species 9, *Scirpus olneyi*, Thousand Palms, California (33°49′N).

have been described elsewhere (*7*). All species except one (*Dupontia fischeri*, Gramineae) are sedges, and all have similar thick, unsuberized, unbranched, aerenchymatous first-year roots typical of water-saturated soil environments.

Experimental plants were grown from rhizomes collected in the field in an aerated solution culture in a controlled environment chamber. All nutrients except phosphate were maintained at optimum concentration (*7*); the phosphate concentration (1.0 μM) approximated that of the soil solution of many habitats (*8*). Light and air temperature simulated a subarctic summer regime (*7*), and root temperatures were maintained at either 5° or 20°C. After 4 weeks of acclimation, the terminal 10 cm of roots were excised, the rate of phosphate absorption was measured at 5° and 20°C from a solution of $CaCl_2$ and NaH_2PO_4 labeled with ^{32}P (*7, 9*), and the radioactivity of the roots was determined by liquid scintillation (*10*). Measurements were made at five phosphate concentrations (1 to 20 μM), covering the range of the low concentration phase or mechanism of phosphate absorption in these species (*7, 11*) and probably covering the upper limits of phosphate concentrations found in the soil solutions in the selected habitats (*8*). Four replicate measurements at each concentration were used to calculate the maximum velocity (V_{max}) of phosphate absorption and the rate of absorption at a concentration of 1.0 μM phosphate (*12*). Neither excision nor the presence of microorganisms on the root surface significantly affected the results (*7*).

There is a significant negative correlation ($P < .01$) between the rate of phosphate absorption by roots acclimated to and measured at 5°C and the July mean soil temperature of the habitat from which the population derives (Fig. 1). This is evident at both saturating and ecological phosphate concentrations. Cold-adapted species and races also have higher rates of phosphate absorption than their warm-adapted counterparts when grown at 20°C and measured at 5° or 20°C (*7*), an indication that the correlations shown in Fig. 1 reflect more than the superior performance of cold-adapted species at low temperatures. Rather, cold-soil species have a higher capacity for phosphate absorption than warm-adapted species, thus compensating for the depressing effect of low temperature upon metabolic reaction rates. Evolutionary temperature compensation is also evident in racial comparisons of the same species. Cold-adapted races of both *Eleocharis palustris* and *Carex aquatilis* have a higher V_{max} of phosphate absorption than warm-adapted races (Fig. 1). The habitat temperature or some closely correlated factor has clearly been of great importance in the adaptive differentiation of the phosphate absorption system along the latitudinal temperature gradient investigated.

The evolution of species and ecotypes results in adaptation to the total environment, yet environmental variables such as temperature fluctuate through the season; the results discussed above suggest that high phosphate absorption capacities are adaptive at low temperatures. Temperature compensation of phosphate absorption also occurs on a seasonal basis as a result of acclimation (*7, 13*), permitting a seasonal tuning of genetically determined absorption capacities. Acclimation is genetically controlled (*3, 5*), so that different species may have different acclimation potentials, here defined as the ratio of the V_{max} of 5°C-acclimated roots to the V_{max} of 20°C-acclimated roots, measured at a standard temperature, 5°C in this study (*14*). A high acclimation potential leads to a large compensatory change in the rate of absorption in response to a change in the temperature at which the plant is growing; this would be impor-

Table 1. Acclimation potential of phosphate absorption in species and races of marsh plants originating from soil environments of differing thermal stability. The acclimation potential (the ratio of the V_{max} of 5°C-acclimated roots to the V_{max} of 20°C-acclimated roots, measured at 20°C) is significantly greater ($P < .05$) in species from thermally fluctuating environments than in those from stable environments. The significance was determined by the Kruskal-Wallis test for nonparametric samples.

Species	Site	Acclimation potential $\left(\frac{V_{max}\ 5°C}{V_{max}\ 20°C}\right)$
	Stable environment	
Dupontia fischeri	Barrow, Alaska	1.00
Carex aquatilis	Barrow, Alaska	1.93
Eriophorum angustifolium	Barrow, Alaska	3.38
	Fluctuating environment	
Eleocharis palustris	Fairbanks, Alaska	7.15
Carex aquatilis	Circle Hot Springs, Alaska	8.57
Eleocharis palustris	Corvallis, Oregon	11.47
Scirpus microcarpus	Los Gatos, California	18.29

tant in more fluctuating environments (*3*). Arctic soils experience considerably less seasonal temperature fluctuation than those of the temperate zone (*7*). Populations and species from arctic tundra have significantly lower ($P < .05$) acclimation potentials, when rates are measured at 20°C, than species from more fluctuating environments (Table 1). A similar latitudinal trend in acclimation potential was observed when rates were measured at 5°C (*7*).

Latitudinal trends in the phosphate absorption capacity and the acclimation potential of phosphate absorption indicate that this physiological process has adapted to local temperature regimes ranging from warm, thermally fluctuating soils to cold, stable soils. Further studies, particularly in the tropics, will be necessary to separate the selective influence of temperature fluctuation from that of temperature per se.

F. STUART CHAPIN, III
Institute of Arctic Biology, University of Alaska, Fairbanks 99701

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Plasma Dopamine β-Hydroxylase: A Possible Aid in the Study and Evaluation of Hypertension

Abstract. *The activity of dopamine β-hydroxylase (DBH) in plasma ranged from 2 to 100 units per liter of plasma in 82 apparently healthy subjects (ages 22 to 35 years). A nonnormal pattern of distribution was evident: 62 subjects had values below 35 units (18 ± 1), while 13 of the remaining 20 subjects had values above 60 units (80 ± 5). Those with low DBH activity had lower values for urinary catecholamine excretion (31 ± 3 micrograms), with normal and stable blood pressure; those with high DBH activity had higher values for urinary catecholamine excretion (72 ± 6 micrograms), with greater lability of arterial blood pressure. The DBH activity was significantly elevated in patients with labile (74 ± 2 mm-Hg) or fixed (57 ± 2 mm-Hg) essential hypertension. The results indicate that plasma DBH activity is low and that it falls within a narrow range in young adults with normal and stable blood pressure.*

Dopamine β-hydroxylase (DBH) (E.C. 1.14.2.1), the enzyme that converts dopamine to norepinephrine, is present in the synaptic vesicles of postganglionic sympathetic neurons (*1*). The release of norepinephrine from the nerve terminal appears to occur via the process of exocytosis, an event that is also accompanied by the simultaneous release of the soluble portion of DBH (*2*). For this reason, it has been proposed that plasma DBH activity may serve as an index of the activity of the sympathetic nervous system (*3*). Thus far, however, the successful application of measurements of DBH activity has been restricted by the wide range of values that has thus far been described in supposedly normal subjects, and by the large degree of overlap between these values and those observed in certain disease states (*4, 5*). Parallel measurements of the plasma and urinary concentrations of catecholamines have exhibited a similar degree of overlap and scatter (*6*).

Our study was undertaken to define the range of plasma DBH activity more exactly in apparently healthy subjects, and to establish its relation to the quantitative excretion of total urinary catecholamines and the day-to-day lability of blood pressure. Blood was collected in heparinized tubes via venipuncture of the antecubital vein; the tubes were cooled in ice, and the blood sample was then centrifuged for 10 minutes. Activity of DBH in plasma was measured in 82 apparently healthy subjects (ages 22 to 35 years) (*4*). The results are shown in Table 1. The values ranged from 2 to 100 international units and did not have a normal pattern of distribution as judged by a chi-square test for goodness of fit ($P < .001$). Sixty-two subjects (76 percent) had values below 35 unit/liter [mean: 18 ± 1 (S.E.M.) unit/liter], while 13 of the remaining 20 subjects (16 percent) had values above 60 unit/liter (mean: 80 ± 5 unit/liter). It should be noted that 53 of the 62 values in the first group actually fell below 25 units per liter of plasma. The observed pattern of distribution suggested that more than one population might be included within this group of apparently healthy subjects.

Table 1. Distribution of plasma dopamine β-hydroxylase activities, expressed as international units (micromoles per minute) per liter of plasma at 37°C in a group of control subjects.

Activities (I.U.)		*N*	% Total *N*
Range	Mean ± S.E.M.		
2–100 (total)	31 ± 3	82	100
2–35*	18 ± 1	62	76
36–59	48 ± 2	7	9
60–100†	80 ± 5	13	16

* In this group 53 of the 62 values were below 25 (low DBH group). † High DBH group.

Accordingly, further studies were carried out in five subjects from the low DBH group (plasma DBH activity less than 25 unit/liter) and six subjects from the high group (plasma DBH activity greater than 60 unit/liter). Blood pressure was evaluated by the auscultatory method in the supine and upright positions between 9 and 10 a.m. for seven consecutive days. Blood samples were obtained on days 2 and 5, and 24-hour collections of urine were obtained on day 2.

Urinary concentrations of norepinephrine and epinephrine were determined fluorometrically (*7*) and expressed as micrograms per gram of creatinine (*8*). Comparison with creatinine minimizes the influence of individual variation in lean body mass and the completeness of urine collections (*9*), but it does not