Table 1. Effect of various dietary supplements on rats receiving a diet that produced liver necrosis.

Rats (No.)	Urinary excretion of methylmalonate (μg)	Death (days)	Liver necrosis	Weight gain per week (g)
		No supplement		
16	60 to 180	26 to 51	4+	7 ± 2
		Vitamin B_{12}		
15	0	28 to 48	4+	7 ± 2
		Selenite		
4	60 to 180	28 to 48	0	5 to 8
		Folic acid		
4	60 to 180	31 to 37	4+	4 to 8
		Vitamin E		
16	60 to 180	31 to 37	0	6 ± 2

urine of one rat in 1 day, of another in 2 days, and in the remaining animals by the 7th day. When 10μg were given in one oral dose, methylmalonate disappeared from the urine of all rats within 5 days. A single intraperitoneal dose of 10 μg was followed by disappearance of methylmalonate from the urine of four rats on the second day.

The rats that received a vitamin B_{12} supplement grew at the same rate as those on the basal diet. They developed liver necrosis at the same time as the control rats.

Methylmalonate did not reappear in the urine of any of the treated rats for as long as they survived. Survival in this group of rats averaged 37 days after the diet was begun.

The organic acids which appear in most of the rats on this diet include α ketoglutaric, citric, succinic, and hippuric, as well as methylmalonic acids. Lactic, cis-aconitic, pyrollidone carboxylic, and malic acids appear not infrequently. Approximately 1 to 3 meq of each acid are excreted daily. On the day of the maximum decrease of methylmalonate excretion, a consistent increase in succinate excretion was noted.

Sodium selenite was added to the diet of four rats at 0.2 mg per kilogram of diet. The rats lived and did not develop liver necrosis. No effect of added selenite on methylmalonate excretion was noted during 1 month.

Folic acid deficiency results in a macrocytic anemia which may be confused with vitamin B_{12} deficiency. The diet of four rats was supplemented with folic acid, 1 mg per day. This did not affect the development of liver necrosis or the excretion of methylmalonate.

Methylmalonate excretion was found to decrease in some older rats weighing 50 to 55 g at the start of the diet that produced liver necrosis. This decrease appeared related to a general decrease in organic acid excretion in the older rats.

Sixteen rats were given vitamin E, 1 mg per day. No change in methylmalonate excretion was noted, though these rats did not develop liver necrosis (*6*).

LEWIS A. BARNESS
DIANA G. YOUNG
ROBERT NOCHO
Department of Pediatrics, Hospital of the University of Pennsylvania, Philadelphia 4

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Aeolian Zone

Abstract. *It is postulated that a widespread biotic zone, based on wind-blown organic materials such as pollen and oceanic albuminoids, exists in mountainous and polar regions. The aeolian zone or biome, distinct from alpine and arctic tundra, may be divided into terrestrial, nival, and aquatic divisions.*

The alpine life zone may be defined as a biome existing above timber line in mountainous areas. The upper limits of the zone have not been clearly delineated but, in general, the alpine area has been assumed to extend to the upper limit of green plants. In addition, alpine communities have been considered to be based upon energy derived from resident photosynthetic vegetation. In reports on the ecology of the high altitudes of the Himalayas (*1*), I have referred briefly to a new ecological entity, the aeolian zone, which seems to be discrete and, although at times overlapping the altitudinal range of alpine life, does not appear to be truly alpine in nature. The discovery of animals such as collembolan and thysanuran insects, which feed on wind-blown organic debris or its decay products and live permanently in areas where there are no visible green plants, suggests that there is a distinct ecological category for life supported by wind-transported food.

The presence of salticid spiders on Mt. Everest at an altitude of 6700 m (*2*) extends the known range of animals far above the level of the highest recorded green plants. Salticid spiders, observed between 5200 m and 6100 m on Makalu, near Mt. Everest, feed on mycetophagous anthomyid flies and omnivorous collembolans. In the eastern Himalayas, therefore, it appears that a terrestrial division of the aeolian zone may include these organisms, as well as scavenger and debris-feeding animals such as mites and machilid thysanurans.

The more obvious aeolian food materials consist of pollen, seeds, spores, dead insects, and miscellaneous fragments of plants. This wind-blown debris may have a fairly local origin or it may be carried in the atmosphere from distant sources. Wind-blown albuminoid may also be present. Wilson (*3*) found that albuminoid is an abundant and widespread component of fresh snow in the mountains of New Zealand. The concentration in snow ranges from 0.02 to 0.2 parts per million, a fraction which may amount to several pounds per acre. The source of this albuminoid is sea foam, which contains a high concentration of products of plankton decay. In addition to these aeolian organic materials there are also inorganic nitrogenous substances (ammonia and nitrates) in snow and rain, which may contribute to the nutrition of various organisms.

Nival organisms are primarily dependent upon nutrients obtained by atmospheric transport. Except in special cases (such as the contamination of snow by the excreta of animals), organic and inorganic nitrogenous materials from the atmosphere would account for the nitrogen that is essential to the growth of green algae on snow. Nival plants which are capable of fixing atmospheric nitrogen would generally rely upon the mineral content of wind-transported dust. Thus, some autotrophic organisms may be regarded as representatives of the aeolian zone. Wind-blown organic materials explain the presence of enchytraeid worms, collembola, fungi, and bacteria, and possibly other organisms which live in the snow of high mountainous regions.

Another category of the nival division of the aeolian zone is composed of scavengers, chiefly insects and arachnids, which feed on the many wind-transported, dead insects of mountain snow fields. Mani (*4*) described these animals at length and found that truly phytophagous species decrease as the snow line is approached and that omnivorous and scavenging species increase.

In the Himalayas, populations of insects such as the stone fly *Rhabdopteryx* may be enormous at elevations above 4900 m where they live in torrents emerging from glaciers. The water and the rocks of the stream bed are nearly devoid of algae, and it appears that the insects in these streams subsist on organic debris released from the ice. The aquatic fauna near the glacier furnishes the summer food supply of the white capped redstarts (*Phoenicurus leucocephalus*), which nest and rear young in the vicinity of the stream. Other birds, and perhaps some aquatic mammals, may also be dependent upon insects of the community.

In the eastern Himalayas, at elevations up to 5550 m, stagnant, silted, glacial pools, without noticeable algal growths, support enormous populations of phyllopod crustaceans or chironomid midge larvae. On the surface of pools which have bacterial slime, there is generally a blanketing population of Collembola. Occasionally the pools are visited by birds which migrate across this otherwise inhospitable portion of the Himalayas, but contamination of the pools by excreta is rare. There appears to be no alternative to the assumption that animals of these aquatic habitats survive primarily on organic debris, initially of aeolian origin, which has been released from the glacier.

These considerations of the aeolian zone extend to other mountain ranges and to the polar regions. Wide areas which are devoid of green plants, owing to edaphic and climatic factors, are characteristic of many high mountain ranges. Aeolian life may well exist in these locations if only in the form of bacteria and fungi. The communities of snow, glacial torrents, and glacial pools are commonly represented in many mountain ranges of the world, and temporary aeolian communities may be present in winter snows over wide areas of the earth.

The scavenging insects of snow and cryophytic algal growths are the more obvious polar representatives of the aeolian zone. Kol (*5*) draws attention to wind-blown dust particles which act as sources of minerals for cryovegetation in Alaska. Different species of algae grow in response to the chemical nature of this debris. Savile (*6*) has suggested the possibility that a polar terrestrial aeolian community might exist in areas of shattered limestone surrounded by more fertile terrain. He has, however, clearly emphasized the near sterility of the Beaufort formation in the Canadian arctic (*7*). His observations suggest that organic debris and microorganisms are virtually absent. Coniferous wood, possibly of late Tertiary origin imbedded in the ground, is still intact and undecayed. Similar conditions have been described in many parts of Antarctica. It would appear that terrestrial aeolian animals are not widespread in polar regions.

Where surface water is available, mosses and lichens are frequently present. This flora is generally more abundant in polar environments than it is in the high regions of the Himalayas and, hence, polar terrestrial communities at the highest latitudes are more likely to be based upon these photosynthetic plants. The work of Smith (*8*) indicates that the lichens themselves are dependent upon organic and inorganic materials in precipitation. The nutritional status of plants in extreme environments is unclear, but it is conceivable that lichens, and possibly other photosynthetic terrestrial plants, may be representatives of the aeolian zone. Llano (*9*) supports this view by pointing out the possible role of wind-blown guano as a source of nutrients for lichens living far within the Antarctic interior.

Nutritional materials of aeolian origin are ubiquitous and the organisms that utilize these various substances are nearly so. Debris feeders are rather inconspicuous in most situations, but at high altitudes and latitudes, where climatic or edaphic conditions are very unfavorable for photosynthetic plants, some saprophytic and scavenging organisms are able to survive. On snow or other surfaces where small quantities of water permit the growth of photosynthetic plants, the aeolian materials directly or indirectly supply essential nutrients. The release of aeolian materials by the melting of snow and glacial ice supplies nutrients to aquatic organisms. The terrestrial, nival, and aquatic divisions of the aeolian zone can thus be distinguished from alpine or tundra communities and conceived as the constituent parts of a discrete ecosystem, the limits and detailed structure of which are not adequately known (*10*).

LAWRENCE W. SWAN

Department of Biology,
San Francisco State College,
San Francisco, California

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Microradiography of Fossilized Teeth

Abstract. *Microradiographic studies of fossil reptilian and amphibian teeth reveal an excellently preserved microstructure with little if any apparent mineralization except in the region of obvious fractures. X-ray diffraction has shown that the invading mineral near fractures is hematite, and x-ray spectroscopy has shown that relatively large amounts of yttrium are present.*

Microradiography in which characteristic x-rays from a target appropriate to the sample are used as the radiation source makes it possible to recognize much microscopic detail in thin sections