Table 1. Results of analyses of staurolite.

Component; ion	1 [001]	2 [010]	3 [110]
SiO_2	25.96	27.66	27.50
TiO_2	0.32	0.64	0.46
Al_2O_3	55.93	53.57	53.82
FeO	14.07	13.98	13.84
ZnO	0.2	0.2	0.2
MnO	.19	.17	.16
MgO	1.99	2.11	2.13
Anhydrous totals			
	98.66	98.33	98.11
Numbers of ions on the basis of 30 cations			
Si	7.27	7.80	7.76
Al	0.73 } 8.00	0.20 } 8.00	0.24 } 8.00
Al	17.72	17.60	17.66
Ti	0.07 } 18.00	0.14 } 18.01	0.10 } 18.00
Fe^{3+}	.21	.27	.24
Fe^{2+}	3.09	3.03	3.02
Mg	0.83 } 4.01	0.89 } 4.00	0.89 } 3.99
Mn	.05	.04	.04
Zn	.04	.04	.04

be expected to differ from an "equilibrium composition." As the Kwoiek area is one of contact metamorphism related to the Coast Range Batholith, it is reasonable to presume that the metamorphic event took place during a brief period relative to regional metamorphic events. The concept of kinetic control of composition is not unknown in synthesis experiments (*8*); it may be an important process in the governing of compositions of metamorphic minerals.

The zoning in Mg within individual sectors probably reflects changes in the physical conditions of the environment, because the behavior of Mg is nearly the same in all three sectors, rather than being a growth-rate phenomenon. If the crystal grew under conditions of increasing temperature, which possibility is reasonable, an implication of the Mg zoning pattern is that the Mg : Fe ratio of the staurolite decreases, in the assemblage chlorite-biotite-garnet-staurolite, with increase in temperature.

The region marked [010]′ in Fig. 3 typically has a high concentration of graphite inclusions, is added to the [010] region without a concurrent growth in the [110] or [001] sectors, and has 0.05 percent Cr_2O_3. The [010]′ sector is present in its entirety on only one side of the profile of Fig. 3, being partially resorbed from the other side, and it has an anomalously low content of Mg; it is not apparent in Fig. 2 because it blends optically with the background. Petrologic explanation of this phenomenon remains speculative. It may be that depletion of other elements in the pore fluid increased the chemical activity of Cr in the pore fluid to such an extent that it could go into staurolite in the last stage of staurolite growth.

Other minerals that have formed during the process of metamorphic recrystallization and that exhibit sector zoning are andalusite and kyanite. White and White (*6*), without apparently recognizing the sector distribution pattern of Ti in kyanite, nevertheless presented oral evidence that Ti can be sectorally zoned in kyanite. Andalusite of the Kwoiek area shows differences of birefringence between crystallographic sectors. The lower birefringent sector, [001], contains 1.05 percent Fe_2O_3, 0.12 percent TiO_2, and 0.70 percent MgO. The higher birefringent sectors, [100] and [010], contain 0.28 percent Fe_2O_3, 0.04 percent TiO_2, and 0.08 percent MgO. These data are consistent with those of Chinner *et al.* (*9*), who recognized similar compositional variations correlating with the birefringent differences, but apparently did not recognize the sectoral significance.

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Hemoglobin Variants in Koreans: Hemoglobin G Taegu

Abstract. *Hemoglobin G Taegu, an electrophoretically slow hemoglobin with a structural anomaly believed to be in the β-T-3 section of the beta chain, was the only variant found among 6700 normal Koreans. Four subjects, 0.06 percent, had the G-hemoglobin variant in addition to normal hemoglobin A. Hemoglobin E, known in numerous groups from Southeast Asia and the variant most frequently seen in Chinese subjects, was not found among the Koreans we tested.*

During the past decade numerous Asian ethnic groups have been surveyed for hemoglobin variants. Although most studies have involved insufficient numbers of subjects, it has been clearly demonstrated that the Asian groups differ markedly from each other with respect to the variety and incidence of the variants. From our preliminary studies reported here it appears that Korean people have a low incidence of hemoglobin variants.

So far we have studied 6700 Koreans, 4841 males and 1859 females, all presumably normal and healthy. Our first samples of blood were obtained from 2110 male members of the army of the Republic of Korea stationed near Taegu, Korea (*1*); recently, 4590 additional blood samples were obtained from school children and university students of both sexes in the vicinity of Seoul. Blood samples were collected by finger prick into merthiolate-treated capillary tubes and were allowed to clot. The samples were maintained under refrigeration until returned by air to Taipei for analysis. Hemolysates were made from the clots (*2*) and were analyzed by the Smithies vertical starch-gel method (*3*) with the tris-ethylenediaminetetraacetate-borate buffer system at *p*H 8.9 (*4*).

One male in the initial group of 2110 subjects and two males and one female in the second group of 4590 subjects were found to have a slow hemoglobin in addition to normal hemoglobin A. In all four subjects the slow component migrated at a rate characteristic of the G hemoglobins. The overall incidence of the variant in the present group of Koreans was low—4 in 6700 or 0.06 percent.

Studies of structure are in progress on the G hemoglobin from the blood of our initial subject found in Taegu (*1*). Special studies [by urea-dissocia-

tion starch-gel electrophoresis (*5*) of the globin, prepared according to Beale (*6*)], indicated that the anomaly is in the beta chain (*7*). Preliminary studies of peptide mapping on tryptic digests of the globin have revealed that the β-T-3 peptide is abnormal in the present G hemoglobin; the β-T-3 section includes the 13 amino acid residues from position beta-18 to beta-30. The name G Taegu has been adopted pending further work.

It appears significant that no instances of hemoglobin E were found among these Korean subjects. Hemoglobin E has been found among numerous ethnic groups of Southeast Asia (*8, 9*); in fact, it appears to have been found in almost every group examined in that part of the world. In most of those groups the incidence of hemoglobin E is at least 1 percent and in some groups, such as the Thai, Burmese, and Cambodians, it is quite high. In the Chinese groups studied the incidence is appreciable but lower; for example, Vella reported 0.27 percent among 10,031 Chinese subjects in Singapore and surrounding areas (*10*), and 0.09 percent were found among normal Chinese residents in Taiwan (*11*). This trend of lower incidence in the Chinese becomes more marked in the Japanese, in which one subject with hemoglobins A and E was found among approximately 120,000 Japanese subjects tested (*12*). Similarly, among the aborigines in Taiwan, who are of Proto-Malayan stock, but relatively long-time inhabitants of Taiwan, no hemoglobin E was found among 4501 subjects (*9*). The present results of no hemoglobin E among 6700 Koreans fit the same pattern of reduced incidence of hemoglobin E in northern and eastern Asia.

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Angiostrongylus cantonensis: Proof of Direct Transmission with Its Epidemiological Implications

Abstract. *Infective larvae of the rat lungworm* Angiostrongylus cantonensis, *presumed cause of human eosinophilic meningoencephalitis, are shed in mucus exuded by naturally infected Malayan slugs* (Microparmarion malayanus). *Larvae passed by slug hosts were recovered from lettuce and produced normal infection in white rats. Lettuce sold in the local public market also yielded small numbers of infective larvae. Experimental evidence from rats suggests that the local human population, exposed to repeated low-level infections, may become immunized against the rare massive exposure and against clinical disease that might otherwise result after ingestion of heavily infected raw mollusks.*

Infection of rats with third-stage larvae of *Angiostrongylus cantonensis* can occur without ingestion of the mollusk intermediate host. In Malaya the commonest intermediate host is *Microparmarion malayanus,* an abundant nocturnal shelled slug of field and garden. Normally 40 to 50 percent of the slugs from our collection locality are infected, harboring on average 250 larvae; levels of infection range from 80 to 4000 worms per infected slug. Infective larvae pass spontaneously from this mollusk while it is feeding; embedded in the mucus trail left by the slugs, they remain viable for at least 72 hours. In our initial experiments we placed 50 field-caught, naturally infected slugs on five lettuce leaves (about 50 g) for 24 hours. After removing the slugs, we washed the leaves and searched them for *Angiostrongylus* larvae. Worms recovered from the washings were examined for removal of the abundant free-living worms as well as parasitic nematodes other than *Angiostrongylus.* From 30 such 50-g batches of lettuce, 368 living third-stage larvae of *Angiostrongylus* were recovered, averaging about 0.25 larva shed per slug (0.62 per infected slug on the average) and 2.5 larvae per individual leaf per night (or 12.5 larvae per batch of 5 leaves). These data include only larvae removed and identified; undoubtedly others adhered to the leaves or were missed.

Larvae recovered from the lettuce were fed by pipette to unanesthetized white rats. Fourth-stage larvae and subadult *Angiostrongylus* were found in the brains of these rats 13 to 15 days later. Adult worms were recovered from the lungs and hearts of other rats after 34 to 36 days (Table 1).

Because of difficulty in location of all worms passed from the slugs, exposed lettuce was also fed to rats. Fewer adults but more larvae were recovered after such feedings than after direct ingestion of larvae, but the numbers were small and no conclusions can yet be drawn. The time of autopsy

Table 1. Worms recovered from ten white rats infected with *A. cantonensis* larvae collected from lettuce.

Larvae fed (No.)	Days before killing	Worms recovered (No.)
28	15	1
47	15	3
28	13	0
44	34	13
45	34	10
31	33	4
28	36	1
30	36	5
42	35	20
45	34	12