acid. The mixture of these two nucleotides was adsorbed on a column of 'Dowex-1' (chloride form), eluted with hydrochloric acid gradient, lyophilized, dissolved in water, and subjected to paper chromatography (Whatman No. 1; solvent, *n*-butanol : acetic acid : water, 5 : 2 : 3). The R_F of the radioactive area coincided with a known preparation of 5-iodo-2′-deoxyuridylic acid (R_F 0·16) and was separated from deoxyguanylic acid (R_F 0·05). Thus, it was established that the radioactivity derived from IUdR-^{125}I was present in the DNA-polymer and in nucleotide form.

It has been shown that IUdR is incorporated into the DNA of mammalian, bacterial and plant cells and that it specifically replaces the thymidine component. It was concluded from the present experiments that IUdR was incorporated into vaccinia virus DNA, and that 18 per cent of the viral DNA-thymidine was replaced by the analogue. Base ratios and extinction values for vaccinia virus DNA used in the calculations have been reported previously[12]. The significance of the observed incorporation of IUdR into the DNA of vaccinia virus in relation to the anti-viral activity of this analogue remains to be elucidated.

This investigation was supported by research grants *CY*-5262 and *E*2213-*C*3 of the U.S. Public Health Service and *GP*-0397 of the U.S. National Science Foundation.

WILLIAM H. PRUSOFF
Y. S. BAKHLE*
Department of Pharmacology,
J. F. McCREA
Department of Molecular Biology and Biophysics,
Yale University,
New Haven, Conn.

* Fellow of the James Hudson Brown Fund.

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SOIL SCIENCE

Age of the Youngest Hydrated Halloysite in Kyushu

IT has been well established that allophane formed from volcanic ash is followed by crystallization to hydrated halloysite in some circumstances. How many years are needed for the formation of hydrated halloysite in Nature?

A buried surface soil containing hydrated halloysite would offer a suitable sample for dating the mineral by means of radiocarbon measurements, if the soil contains enough organic carbon and has been isolated from biotic activity since the soil was covered with ash. Simultaneously with weathering of volcanic ash, organic matter will start to accumulate in the surface layer of the ash soon after deposition. This accumulation of organic matter would be stopped by any thick cover of ash that later fell, but the weathering of ash would still go on. So the age of volcanic ash in a previous surface layer can be estimated by the content of carbon-14 in the organic matter, provided that the period of time of carbon accumulation is negligibly short as compared with the ash-age.

In this respect, the mantle of volcanic ash on Aso Volcano in Kyushu Island, laid down as a series of showers since the later period of Pleistocene, would offer suitable samples for investigation. The ash-mantle is usually several metres thick, often including former surface soil layers that are easily distinguishable from over- and underlain layers by their high humus content. Clays of upper layers of a profile, less weathered ones, are mostly composed of allophane without kaolin, while those of lower layers, more weathered ones, tend to contain predominant hydrated halloysite with more or less allophane. If the latter layers contain organic matter, such as remains of plants from those days when the layers were on a surface, they would qualify as samples.

Examined samples were collected from a profile which is located on a gentle slope at the western foot of the central cone of Mt. Aso (Choyo, 32° 53′ N., 131° 0′ E.). The profile is about 8 m thick, and 17 layers at least were discernible[1]. X-ray and differential thermal analyses revealed that four upper layers contain predominantly allophane in the clay fraction but with no kaolin, and that the fifth layer (depth: 140–190 cm) is the uppermost one containing hydrated halloysite, the content of which was estimated to be about 33 per cent of the clay fraction (-2μ) by allocation of chemical and dehydration data and cation-exchange capacity delta-values to its constituent minerals (Table 1). This hydrated halloysite is evidently youngest in the Aso district, and probably in Kyushu. The mineral shows similar X-ray diffractive, differential thermal, and electron microscopic properties to the hydrated halloysite derived from volcanic ash and pumice already reported by several workers. That is, the mineral exhibits spherules or curled laths in shape and a low crystallinity. The organic carbon of this layer was calculated to be 8,650 $\pm$200 years old by measurements of radiocarbon by Prof. Kigoshi at Gakushuin University in Tokyo. This value undoubtedly represents an average of organic carbon accumulated in the layer while it was on the surface.

Table 1

Location	Horizon	Depth (cm)	Organic carbon (%)	In clay fraction: Allophane (%)	Hydrated halloysite (%)
Choyo	1	0–30	8·2	67	0
	2	30–80	2·4	75	0
	3	80–90	1·2	73	0
	4	90–140	1·7	68	0
	5	140–190	11·0	37	33
Kanoya	1	0–30	5·6	70	0
	2	30–70	12·1	72	0
	3	70–130	1·8	80	0
	4	130–175	7·1	74	0
	5	175–225	2·5	75	0
	6	225–275	4·0	30	35

The period of the carbon accumulation could be roughly estimated from the carbon content of the layer. Since the bulk density of this layer is 0·6, its organic carbon amounts to 330 tons/hectare. Assuming that the carbon was accumulated at 1 ton/hectare/year and that no loss of carbon occurred following annihilation of vegetation due to the ash-cover, the flourishing period of vegetation comes to 330 years. Although the second assumption is not the case in a strict meaning, the decomposition of humus in buried Ando soils is undoubtedly extremely slow. It would be difficult to settle the rate of carbon accumulation in ancient days. However, there is some evidence that 2 tons carbon/hectare/year or even more could be accumulated in volcanic ash soils[2], and consequently it might be probable that 330 tons carbon was accumulated in a hectare even in a shorter time than 330 years. According to the foregoing, it would be concluded that the hydrated halloysite of the fifth layer was derived from the ash that fell between 8,000 and 9,000 years ago, and is the youngest in the Aso district.

In comparison with this, another volcanic ash profile was examined in the same way. The profile is located on the Kasanohara tableland (Kanoya, 31° 24′ N., 130° 52′ E.). Although it has little connexion with the ash of Aso Volcano, origins of ashes and pumices consisting of the profile are still obscure. Three former surface layers are observed in the profile, that is, 2nd, 4th, and 6th in Table 1.

Hydrated halloysite was not found as far as the fifth layer (depth: 225–275 cm), and the sixth layer, the third former surface layer, was the uppermost one containing the mineral. Namely, the hydrated halloysite of this layer is youngest in the profile at Kanoya. However, this layer is beyond the limits of carbon-14 dating, that is, older than 30,000 years. The particles of the mineral are not so different in shape from those of Choyo, and show spherules, curled laths, and short tubes. The particles of Choyo are mostly composed of spherules, while tubes are dominant in the Kanoya mineral. This might explain the metamorphosis of spherules into tubes. Kuwano *et al.*[3] considered that the layer belongs to the lower loam of the Pleistocene Epoch. This would mean that it is about 30,000 years old or more and is consistent with the radiocarbon measurements.

We wish to thank Prof. Kunihiko Kogoshi for dating humus.

SHIGENORI AOMINE
NOBUFUMI MIYAUCHI

Faculty of Agriculture,
Kyushu University,
Fukuoka, Japan.

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PSYCHOLOGY

Ipsilateral Confusion in 2-Choice and 4-Choice Responses with the Hands and Feet

THE experiments to be described here suggest that confusion occurs between ipsilateral responses in certain choice-reaction tasks. This finding has apparently not been reported before.

In the first of the present 4-choice experiments, the subject responded to a positional display consisting of four neon indicator bulbs set in a black screen so as to form a square 4 in. × 4 in. The subject sat facing the screen, and responded by pressing morse keys with the hands and feet. Details of the apparatus will be given in a later communication. The required response to the top right signal was the right hand, to the bottom right signal the right foot, and similarly on the left side. 45 subjects each responded to 80 signals, 20 for each foot and each hand, presented in a random order. 513 errors were made, giving a total error rate of 14·25 per cent. The distribution of these errors is given in the matrix in Table 1. 98·1 per cent of the errors were ipsilateral (for example, right-hand responding to right foot signal, left foot responding to left-hand signal, etc.). There were no diagonally opposite errors (for example, left foot responding to right-hand signal, etc.).

Two further 4-choice experiments were afterwards carried out with slightly altered displays, one with the signals in the form of a square 1¼ in. × 1¼ in., and the other

Table 1. ERRORS MADE IN FOUR-CHOICE REACTION TASK WITH HANDS AND FEET

Correct Response	Errors: RH	LH	RF	LF
RH		2 (2) 0·2%	105 (42) 11·7%	0
LH	4 (4) 0·4%		0	139 (42) 15·4%
RF	116 (38) 12·9%	0		2 (2) 0·2%
LF	0	143 (42) 15·9%	2 (2) 0·2%	

Down the side of the matrix is indicated the correct response. The columns across show the number of errors made to each signal by each of the other limbs. The figures in parentheses give the number of subjects contributing to the total ($N = 45$). Errors are also expressed as percentages of the total number of responses to each signal.

with them in the form of a rectangle, 4 in. (vertical dimension) × 1¼ in. In each experiment 13 subjects each responded to 800 signals, 200 for each foot and each hand, presented in a random order. Results were obtained similar to those of the first experiment. With the small square display, in the first half of the experiment (that is, the first 400 responses for each subject), 97·9 per cent of the errors were ipsilateral (total error rate 11·0 per cent), and in the second half 97·1 per cent were ipsilateral (total error rate 11·3 per cent). With the rectangular display, in the first half 97·6 per cent of the errors were ipsilateral (total error rate 9·6 per cent), and in the second half 85·3 per cent were ipsilateral (total error rate 11·9 per cent).

The same predominance of ipsilateral errors occurred again in a further 4-choice experiment, this time with tactile stimuli. The response movements were the same as in the three previous experiments, and tactile stimulation was provided by screws attached by an adjustable extension to the plunger of a solenoid. 12 subjects each responded to 800 signals, as in the second and third experiments. In the first half of the experiment 98·7 per cent of the errors were ipsilateral (total error rate 8·3 per cent); in the second half 85·5 per cent were ipsilateral (total error rate 6·2 per cent).

Two 2-choice experiments were carried out with the original square display (4 in. × 4 in.). Each was in three parts, with the two responses being either ipsilateral, contralateral or diagonally opposite. In the first, one of the two responses was always the right hand, the alternative being the right foot, left hand, or left foot, respectively. In the second, one of the two responses was the left foot and the alternative was the left hand, right foot, or right hand, respectively.

In each part of each experiment six subjects each responded to 300 signals over three sessions. In each session the three parts were presented in a different order. The mean reaction times for both the right hand and the left foot were least when the alternative response was the contralateral limb, and greatest when it was the ipsilateral (Table 2). In both cases analysis of variance showed that the differences were significant ($D < 0·01$). The number of errors was also greatest when the alternative response was ipsilateral.

Table 2. VARIATION IN TWO-CHOICE REACTION TIMES ACCORDING TO ALTERNATIVE RESPONSE

	Alternative response: Contralateral	Diagonally opposite	Ipsilateral
Exp. 1	(LH)	(LF)	(RF)
Group mean right hand RT (ms)	281	290	316
Mean σ	38	42	51
Total errors	14	10	34
Exp. 2	(RF)	(RH)	(LH)
Group mean left foot RT (ms)	301	320	346
Mean σ	40	45	60
Total errors	18	22	56

These findings indicate confusion between ipsilateral hand and foot responses, leading either to errors between them, or to a lengthened reaction time when distinction between them is required. In the only previous experiment on reaction times that appears to be relevant, Davis[1] found no difference in the mean 2-choice reaction time between a situation in which the responses were made by the two hands, and one in which they were made by two fingers on one hand. This gives a warning against generalizing from the present findings to the conclusion that all ipsilateral responses are liable to be confused.

This work was carried out with the help of a research studentship from the Department of Scientific and Industrial Research. I thank Dr. J. A. Leonard, of the Medical Research Council's Applied Psychology Research Unit at Cambridge, for his advice.

K. W. BLYTH*

Psychological Laboratory,
University of Cambridge.

* Present address: The Nuffield Foundation, London.

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