tion also has a clear but less marked effect ($P < .0005$). Neither arcuatus nor principalis stimulation affected auditory discrimination, a point clearly relevant to results from experiments with surgical lesions (*6*).

A few points bear emphasizing. Arcuatus stimulation is without effect on delayed alternation; this finding reinforces a view derived from experiments with surgical lesions that the focus for the deficit is to be found near sulcus principalis. However, the division is not made as sharply with surgical lesions. Second, the poststimulation control period for delayed alternation yields scores as good as those of the prestimulation period. Hence, it appears that the deficit literally can be turned on and off at the discretion of the experimenter. Finally, it should be stressed again that no overt motor responses to stimulation were evident, nor could one detect any change in the animals' motivation or willingness to be tested. Indeed, with the parameters of stimulation employed, the only reliable behavioral indication that the stimulation was having any effect whatsoever was the inability of the animals to perform delayed alternation tasks.

It appears, therefore, that electrical stimulation can reproduce some of the effects of surgical lesions in the frontal region. It also has certain clear advantages over lesions that commend its wider use for the analysis of cortical function. The deficit appears to be fully reversible, and hence each animal can be used as its own control. Indeed, there would seem to be no obstacle to obtaining "double dissociation" within a single organism. Furthermore, electrical stimulation appears to permit a somewhat finer fractionation than is possible with surgical lesions. Finally, certain types of questions, such as those involved in separating the effects on short-term storage from the effects on long-term storage, cannot be unequivocally answered with surgical lesions because these questions are of the form: Is behavior acquired during a "lesion" state altered in a subsequent "nonlesion" state? (*7*).

LAWRENCE WEISKRANTZ
LJUBODRAG MIHAILOVIĆ*
CHARLES G. GROSS†
Psychological Laboratory, University of Cambridge, England

References and Notes

1. K. L. Chow and P. J. Hutt, *Brain* **76**, 625 (1953).
2. J. Olds and P. Milner, *J. Comp. Physiol. Psychol.* **47**, 419 (1954).
3. H. E. Rosvold and J. M. R. Delgado, *ibid.* **49**, 365 (1956).
4. J. M. R. Delgado, *Electroencephalog. and Clin. Neurophysiol.* **7**, 637 (1955).
5. A paper describing the visual discrimination tasks is in preparation.
6. L. Weiskrantz and M. Mishkin, *Brain* **81**, 406 (1958).
7. We are pleased to acknowledge the assistance of S. Hopkins and R. Hutchison. This research was supported in part by the Air Research and Development Command, U.S. Air Force.
* On leave from the Medical School, University of Belgrade, Belgrade, Yugoslavia.
† U.S. Public Health research fellow.

8 February 1960

Glacial Retreat in the North Bay Area, Ontario

Abstract. Geological and palynological studies in Ontario and Quebec, supported by radiocarbon dates, suggest that the opening of the North Bay outlet and the initiation of the Stanley-Chippewa stages in the Huron and Michigan basins took place 10,000 to 11,000 years ago.

Deglaciation of the vicinity of North Bay, Ontario, opened a discharge channel to the east by the way of Mattawa and Ottawa river valleys, initiating the low-water Stanley and Chippewa stages in the Huron and Michigan basins. This event provides an ideal starting point for a chronology of deglaciation of the region north of the Great Lakes.

Opening of the North Bay outlet is generally judged to have taken place about 6000 years before the present (B.P.) (*1*, Table 22), but new radiocarbon dates suggest that this event may have occurred 4000 to 5000 years earlier. The dates may be divided into two categories: (i) minimum dates for deglaciation of localities in the vicinity of North Bay, which may be used directly as minimum dates for the opening of the North Bay outlet; (ii) minimum dates for events recorded in deposits of the glacial Lake Barlow-Ojibway (Fig. 1) of northern Ontario and Quebec, and James Bay Lowland. To these dates must be added estimates, based on varve counts and extrapolations, of the number of years required for the ice margin to retreat from North Bay to the localities concerned.

The Champlain Sea reached its highest limits at Ottawa some 10,000 to 11,000 years ago (*2*), and the post-Champlain Sea peat in the St. Lawrence Lowlands has been dated at about 9500 years (*3*). Terasmae (*2, 3*) has suggested that the Champlain Sea episode is in part contemporaneous with the Valders substage. Recent studies indicate that the ice had retreated north of Pembroke and Deep River, latitude about 46° north, during the Champlain Sea episode. This reasoning suggests an age of about 10,000 years for the opening of the North Bay outlet.

Lee (*4*) established a minimum age of 9130 ± 350 years (sample W-345) for the archeological site at Sheguiandah on Manitoulin Island. This date on a bog bottom sample (elevation about 720 feet) is a minimum date for post-Lake Algonquin time in the Huron basin. A pollen diagram for the Sheguiandah bog (*4*) correlates well with two other radiocarbon dated pollen sequences from High Hill bog and Little Current bog, Manitoulin Island. An age of 9560 ± 110 years (sample GRO-1926) for the bog bottom sample from the High Hill bog (elevation about 860 feet) is a minimum age for early post-Lake Algonquin time. The Little Current bog (elevation about 1010 feet) is above the highest postulated level of Lake Algonquin (*1*) and provides a pollen sequence beginning shortly after deglaciation of that locality. A sample of the basal organic deposit in this bog was dated at 9450 ± 350 years (sample I GSC-3), but the pollen sequence begins in the underlying silty clay, indicating that deglaciation of the site took place some time earlier.

A sample of basal peat and a pollen profile were collected from a bog in the Fossmill channel, the earliest proposed outlet at North Bay. This sample was dated at 6090 ± 85 years B.P. (sample GRO-1924). However, the palynological evidence shows that mixed hardwood forest (including hickory and walnut) grew near this site at the time, and hence the ice retreat from Fossmill must have occurred much earlier.

Palynological studies about 10 miles north of North Bay, made by Ignatius (*5*) and by Terasmae have shown that lacustrine deposits and peat began to accumulate there about 9500 years ago.

Clay varves number 1163 to 2027 of Antevs' Timiskaming series (*6*), deposited in glacial Lake Barlow-Ojibway, have been remeasured at 12 localities (*7*) scattered through a north-south distance of 50 miles and an east-west distance of 56 miles. Varve diagrams prepared from these measurements show good agreement with one another and with diagrams prepared by Antevs (*6, 7*), especially for "normal" varves. Agreement is less satisfactory for those parts of the diagrams which represent thick proximal varves, or thin ultra-distal varves. The restudy confirms Antevs' counting of the varves and his calculations of the rate of retreat of the ice sheet northward across the basin of glacial Lake Barlow-Ojibway.

The rate of ice retreat, from 454 feet (*8*, p. 143) to 926 feet per varve cycle (*7*, p. 160) is compatible with interpretation of the varves as annual deposits, but not with interpretation of them as diurnal deposits. Terasmae has found that pollen is markedly more abundant in the silt layers than in the clay layers of the same varves. Distribution of the pollen is best explained by assuming that the silt is a summer layer, the clay a winter layer, and the

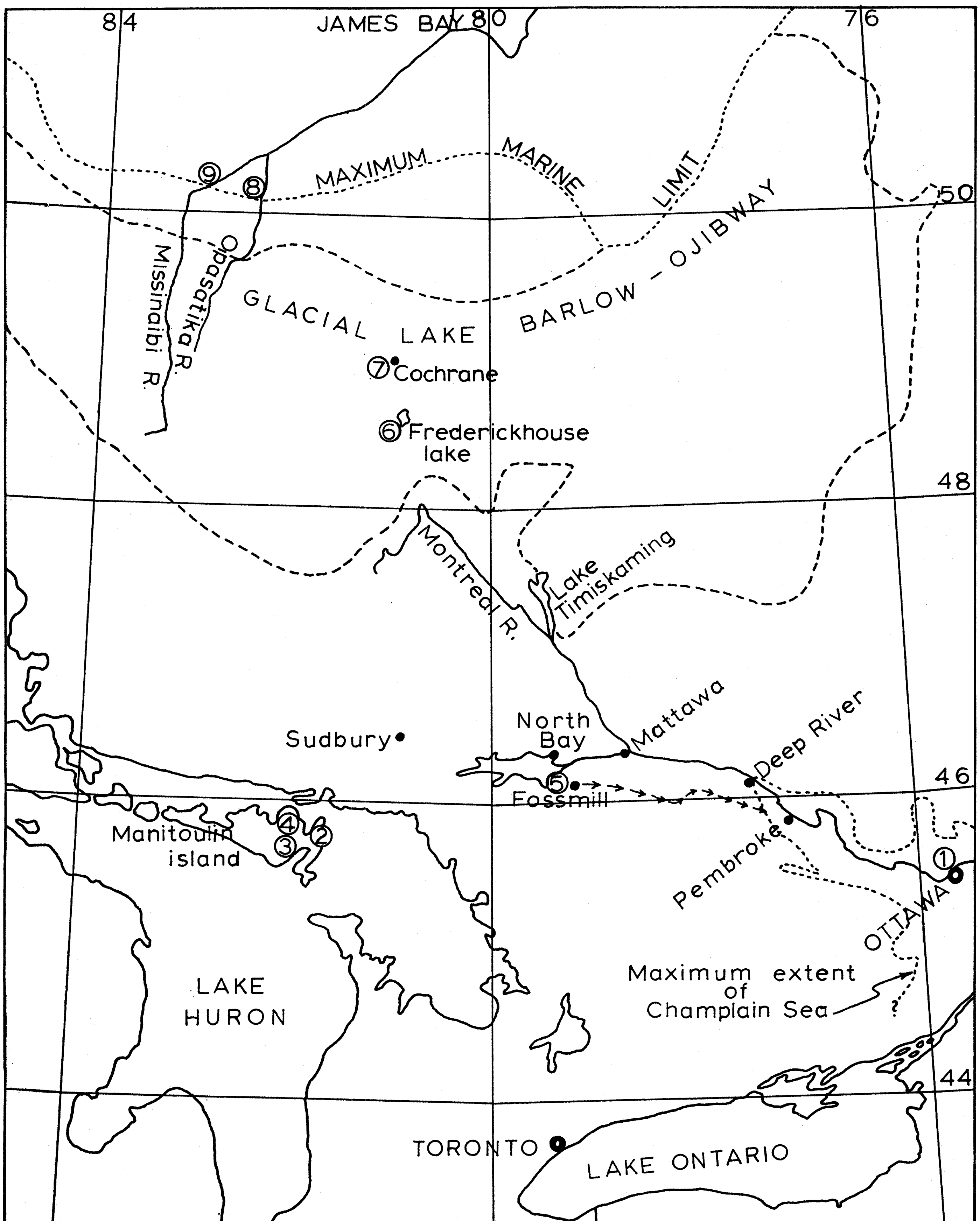

Fig. 1. Index map showing localities where samples dated by radiocarbon methods were taken. The dates and sample numbers follow: 1, Ottawa, 10,850 ± 330 years (Y-216); 2, Manitoulin Island, 9130 ± 350 years (W-345); 3, Manitoulin Island, 9560 ± 110 years (GRO-1926); 4, Manitoulin Island, 9450 ± 350 years (I GSC-3); 5, Fossmill, 6090 ± 85 years (GRO-1924); 6, Frederickhouse Lake, 6730 ± 200 and 6970 ± 310 years (Y-222); 7, Cochrane, 6380 ± 350 years (W-136); 8, Opasatika River, 7280 ± 80 years (GRO-1698); 9, Missinaibi River, 7875 ± 200 years (I GSC-14).

silt-clay couplet an annual deposit. We therefore believe that the classic interpretation of varves as annual deposits applies to the varves deposited in glacial Lake Barlow-Ojibway.

Antevs measured some 2027 varves, beginning with varve 1 at the base of a section at the mouth of Montreal River, where it enters Lake Timiskaming. Some 58 varves have since been measured above varve 2027, bringing the total to 2075 (*7*). The Cochrane ice readvance, recorded by widespread clay till overlying disturbed varved clay (there is no terminal moraine) is judged to have culminated in year 2025 of the varve chronology (*7, 8*)—that is, 2025 years elapsed from the beginning of deposition of varve 1, when the ice margin stood just north of the mouth of Montreal River, to attainment of the Cochrane maximum. Antevs calculated that the ice margin retreated 454 ft/yr in the southern part of the Barlow-Ojibway basin (*8*, p. 143). Extrapolation of this rate southward to cover retreat across the interval of 57 miles between North Bay and the mouth of Montreal River gives a result of 670 years. Thus, the time interval between the opening of the North Bay outlet and the attainment of the Cochrane maximum was about 2025 plus 670 years, or 2695 years, and between the opening of the North Bay outlet and the end of the varve record, 2075 plus 670 years, or 2745 years.

A bog bottom sample collected by Ignatius (*5*) and Elson from south of the limit of the Cochrane readvance (*9*) yielded radiocarbon ages of 6730 ± 200 and 6970 ± 310 years B.P. (sample Y-222). The sample was of a shell-rich layer 10 to 15 cm thick, overlain by 3.5 m of peat and underlain by gray homogeneous clay; the same succession overlies the uppermost varves of the standard sequence along the shores of the nearby Frederickhouse Lake. This date gives a minimum age of 6970 years B.P. for deposition of varve 2075, and 6970 plus 2745 years or 9715 years B.P. for the opening of the North Bay outlet.

Sample W-136, collected by T. N. V. Karlstrom (*10*), provides a minimum age of 6380 ± 350 years B.P. for deglaciation of the vicinity of Cochrane, Ontario, after the Cochrane readvance. There is no record of the retreat of the Cochrane ice lobe after its advance to a position 21 miles south of Cochrane. If 200 years are allowed for the uncovering of the Cochrane site, then we may calculate a minimum date of 6380 plus 200 plus 2695 years, or 9275 years for the opening of the North Bay outlet.

Even earlier opening of the North Bay outlet is implied by dates on shells from near the upper limits of the marine submergence along Opasatika and Missinaibi rivers. The respective radiocarbon ages of 7280 ± 80 (sample GRO-1698) and 7875 ± 200 years (sample I GSC-14), agree fairly well with each other. The older date is taken as a minimum age for the beginning of the marine episode. If 400 years are allowed for ice retreat from the Cochrane maximum to the opening of James Bay Lowland to marine invasion, we arrive at a date of 7875 plus 2695 plus 400 years, or 10,970 years B.P. for the opening of the North Bay outlet (*11*).

J. TERASMAE
OWEN L. HUGHES
Geological Survey of Canada, Ottawa, Ontario

References and Notes

1. J. L. Hough, *Geology of the Great Lakes* (Univ. of Illinois Press, Urbana, 1958).
2. J. Terasmae, *Science* **130**, 334 (1959).
3. ——, *Geol. Survey Can. Bull. No. 56* (1959).
4. T. E. Lee, *Can. Field-Naturalist* **71**, 117 (1957).
5. H. Ignatius, unpublished thesis, Yale Univ., 1956.
6. E. Antevs, *Geol. Survey Can. Mem. No. 146* (1925).
7. O. L. Hughes, unpublished thesis, Univ. of Kansas, 1959.
8. E. Antevs, *Am. Geogr. Soc., Research Ser. No. 17* (1928).
9. O. L. Hughes, *Geol. Survey Can. Paper No. 55–41* (1956.).
10. T. N. V. Karlstrom, *U.S. Geol. Survey Bull. No. 1021-J* (1956).
11. We are indebted to Professor Hl. de Vries of Groningen, Netherlands, for several radiocarbon measurements, and to Dr. J. G. Fyles, Geological Survey of Canada, for a critical reading of the manuscript. This paper is published by permission of the director, Geological Survey of Canada.

11 January 1960

Experimental Production of Mongoloid Hamsters

Abstract. Hamsters injected at birth with fractions or cell-free filtrates of transplantable human tumor cells as well as certain tissues derived from human beings and rats carrying spontaneous cancers have developed a mongoloid deformity.

This report describes an experimentally induced deformity in hamsters that resembles mongolism (*1*). It is characterized by small size, flat face or microcephalic domed head, protruding eyes and tongue, abnormal teeth or absence of teeth, and bone fragility (Figs. 1–4). The animals are less pugnacious than normal hamsters, live amicably with one another, and can be handled readily.

The phenomenon was observed incidentally during a series of experiments wherein fractions of transplantable human tumor cells (*2*), prepared by ultracentrifugation or sucrose gradient techniques, were utilized for antigen studies (*3*) and injected into rats, mice, and hamsters of various ages. None of the rats or mice, whether newborn or older, ever exhibited abnormalities, although more than 50 litters were treated in each species. However, among the 100 litters (Table 1) of newborn hamsters, (comprising 932 babies) that received the fractions, 81 mongoloid animals appeared. They were evenly divided as to sex (41 males, 40 females), a ratio that has continued in further experiments. The single injection given to the babies, immediately after birth, was 0.03 ml, or less, of material suspended in 0.25*M* or 0.88*M* sucrose (*3*). All the fractions produced some mongoloid animals. Though the injections were usually given subcutaneously, the results were the same if an intraperitoneal route was employed. Hamsters that received control injections of 0.25*M* sucrose, 0.88*M* sucrose, Locke-Ringer's solution, or distilled water remained normal. The mongoloid effect could be produced up to 2 and, occasionally, 3 days after birth but not later. Twenty pregnant mothers given 0.5-ml doses intraperitoneally 1 to 4 days before delivery produced large litters that were normal. At the present writing, mothers are being treated earlier in their pregnancy and a large number of babies are being injected *in utero* at various periods before birth.

Tests were undertaken to determine if tissues other than the six tumors first studied (H Ep 3, HS 1, H Ad 1, H Emb Rh 1, A-42, and H Ep 5) contained the factor. As seen in Table 1, 185 newborn hamsters were injected with tumor, liver, and spleen fractions obtained from a patient with carcinoma of the liver. One baby, injected with a fraction of "normal" liver area from this patient, became a mongoloid animal, entirely similar to the others described. In a subsequent series of experiments, it was found possible to induce the deformity in a few hamsters injected with fractions of the livers or spleens of cancer patients, and of rats carrying spontaneous tumors. Spontaneous tumors of human beings, rats, or mice and tissue fractions derived from normal human beings, rats, mice, or hamsters were found to be without activity, as were tissue fractions prepared from adult mongoloid hamsters themselves.

It was not possible to tell whether or not the babies were going to be odd for at least 10 to 14 days after birth. At this time it became evident that the mongoloid babies were smaller than normal babies and that their faces were flatter. Many also had long, needle-like, curved teeth that made the mother refuse to nurse them. When the babies began to supplement their nursing at