nique in which a cortical electrode was used to record responses evoked by the light tap of a roving tactile stimulator.

On an outline of the brain shown in the top of Fig. 1, there is a topographic composite made from superimposition of locations of selected areas of sensory representation in 16 opossums.

Comparison may be made in the same figure with a composite, similarly made, of the areas of motor representation in five opossums. The medial surface of the hemisphere which contains the areas for hindlimb and tail is not shown. There is correspondence in location of sensory and motor representations of each somatic subdivision and it is seen that the area from which tactile responses from a body part were recorded is the same area in which stimulation elicited movement of that body part.

A study undertaken to see if this unique mode of cortical representation is a general characteristic of marsupials has now been completed on eight wallabies (*Thylogale eugenii*) imported from Australia. The brain in these smaller members of the kangaroo family is larger and more fissured than that of the opossum. Composites of the results in the wallaby, illustrated in the middle of Fig. 1, show a sensorimotor organization similar to that found in the more primitive opossum. The portion of the area for tail and hindlimb shown to extend above the outline of the lateral surface is located on the adjacent medial surface. Although a somewhat broader field is activated with cortical stimulation techniques, the correspondence of locations of sensory and motor representations is striking. In front of the lower lip representation in both sensory and motor studies were found small areas of upper lip representation (labeled U), probably related to elaboration of heightened function of the lips in this animal.

A homunculus-like figure on a brain outline is used in the bottom of Fig. 1 to picture the sensorimotor representation of the body form in each marsupial. In addition, each outline shows the boundary of the visual area as activated by a flash of light and the auditory area as activated by a click.

A small area (labeled S II) with complete body representation was found in the opossum within cortex that was also responsive to click. This is undoubtedly the second somatic sensory area that has been established, in a homologous position, in placental mammals. Although this area was not found in the wallaby, it is presumed to lie within the fissure bordering the sensorimotor area inferiorly. In each marsupial, stimulation in front of the sensorimotor area gave responses from the eyes which included eye movement, changes in pupillary caliber, retraction of the nictitating membrane, and closure of the eye. This area is probably homologous with the frontal eye fields found in placental mammals. In each figure the back is represented caudally with the limbs and mouth parts projecting rostrally, and it is noteworthy that this is the orientation shown by Woolsey (*3*) to be the basic pattern of somatic sensory area I in placental mammals (*5*).

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31 May 1963

Insect Fecundity and Fertility: Chemically Induced Decrease

Abstract. *Ingestion of arsenite by braconid wasps, which have mature ovaries at eclosion, results in a nonselective lowering of egg production; of the eggs produced, the percentage of eggs hatched was not lowered. The effectiveness of the somatic tissues concerned with food assimilation and utilization was altered. The folic acid antagonist, methotrexate, inhibits developing gametes directly, so that differential destruction of gametes and death of zygotes occurs.*

Sublethal doses of arsenic have been shown to reduce the fecundity of various species of adult Diptera (*1*). Interesting speculations arise concerning the influence of this pesticide on natural populations of insects during the years that arsenicals were used in quantity on fields and orchards. The report (*1*) emphasized the necessity for determining more exactly the effects of pesticides and chemisterilants.

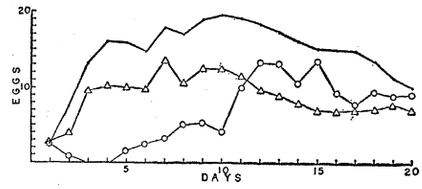

Fig. 1. Patterns of egg production in Habrobracon. The daily average number of eggs per female has been plotted for three samples of 20 females each. At the first feeding following emergence, experimental wasps ingested single, sublethal meals of either $NaAsO_2$ (0.005 percent) or methotrexate (0.006 percent) in sugar water. Controls received sugar water only. Dots, control; open triangles, sodium arsenite; and open circles, methotrexate.

By failing to develop, the immature ovaries of young adult flies react similarly to agents of diverse chemical nature and physiological influence (*2*). The parasitoid wasp known in genetic literature as Habrobracon (*Bracon hebetor* Say) provides a diagnostic basis for the cytological analysis of ovarian damage. In contrast to the Diptera typically used in sterilant experiments, wasps at eclosion have fully differentiated ovaries. Each of the synchronized polytrophic ovarioles, of which there are invariably four, contains a series of developing units ranging from oocytes in first meiotic metaphase to interphase oogonia. Thus differential effects upon specialized, transitional, and primitive cells can be easily assessed.

Figure 1 presents a comparison between the egg production of normal control wasps and those fed a sublethal dose of sodium arsenite ($NaAsO_2$), a most poisonous form of arsenic. The $NaAsO_2$ curve, one of a group obtained from a series of graded doses, shows that over a period of 20 days egg production is lower but parallel to control values. A similar decrease in egg production can be obtained with a variety of enzyme inhibitors. Dissected ovarioles from similarly treated wasps lacked degenerating cells, which suggests the occurrence of a general somatic debility instead of a specific cytological effect upon the germ line.

Also shown on Fig. 1 is the different result obtained after a single feeding of the folic acid antagonist (*3*), methotrexate. Dissection revealed that atrophy of nurse cells and degeneration of oocytes were responsible for the insect's failure to deposit eggs on days

3 and 4. Poor egg production on days 6 to 11 was traced to difficulties in mitosis and differentiation. Improvement on later days was a reflection of the unsusceptibility of interphase oogonia. Multiple sublethal doses that interfere with successive waves of differentiation are necessary to eliminate egg deposits after the 15th day.

Similar patterns of damage were obtained from other metabolite analogs. These include 6-diazo-5-oxo-L-norleucine, aureomycin, and halogenated deoxyuridines, suggesting that in the adult holometabolous insect the gonad is the target for interference with either protein or nucleic acid synthesis.

Difficulties in embryonic development, reflected as a low hatchability, are an excellent indication of nucleoprotein abnormality. For example, in the methotrexate experiment, hatchability was reduced to about 40 percent, while in the arsenite experiment, hatchability was consistently above 90 percent, not differing significantly from control values. As a destructive measure for insects, death of offspring can be even more important than a temporary numerical decrease in gametes or adults. Von Borstel (*4*) has repeatedly emphasized the importance of induced genetic lethals, particularly those of the dominant type, for promoting population collapse of insect pests.

Although not generally appreciated, genetic lethals have been used successfully in the eradication of the screwworm. This is implied by Knipling when he writes about "sterile" sperm competing with normal sperm (*5*). Accordingly, current attention in the search for potent chemisterilants, which need not be broadcast for pest control, seems properly concentrated upon the antimetabolites, and also upon alkylating agents which may have a related mode of action (*6*).

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24 June 1963

Salt Incorporation in Natural Ices

During a mid-January (1963) cold spell at Socorro, New Mexico, the freshly frozen ice on several small, shallow lakes had a surface appearance similar to that observed by Knight (*1*) on a number of Arctic lakes. Some areas of the ice surface appeared quite white or milky, possibly because of entrained air bubbles, presumably with the *c*-axes of the ice crystals vertically oriented, while the remaining portion appeared to be relatively clear ice of a darker color with the *c*-axes horizontally oriented.

Ice grown in the laboratory against a cold metal freezing block will invariably have the *c*-axis of the crystal oriented perpendicular to the block and parallel to the direction of the thermal gradient. The growing surface of such ice selectively incorporates ions from the melt into its developing structure (*2*).

Under carefully managed conditions, this incorporation of ions maintains, in the nascent layers, a space charge sufficient to develop a potential barrier of over 200 volts across the water-ice interface. Although such electrical manifestations are not likely to be observed in relatively impure terrestrial waters, the advancing *a-b* plane of an ice crystal, under a great variety of conditions, is effective in the transport of ions into the ice (*3*). These considerations led us to suspect that the lake ice with *c*-axes vertical would have a larger salt concentration than the lake ice with *c*-axes horizontal.

Pairs of ice samples were taken from two lakes which appeared to have very pronounced patterns of both types of ice. The samples of ice were rinsed four times with cold distilled water immediately after collection and were allowed to melt gradually at room temperature. The results of a chemical analysis for the major ions in the melted ice (Table 1) show that the ice grown under conditions of a vertically oriented *c*-axis contained more salt (2.5 to 10 times) than the other sample. The ice from Lake I appeared to be uniformly 6 cm thick in the areas sampled. The lake water had originated from a 18.3-m (60-ft) well about 3.3 km (2 miles) from the Rio Grande River. Lake II was formed by waters of the Rio Grande, and the ice was approximately 4 cm thick. Since the pairs of ice samples gathered were from ice of the same thickness, the rate of ice growth may be assumed to be the same.

Table 1. Analyses of ice samples from two lakes (in milliequivalents per liter). In clear ice, the *c*-axis is horizontal; in milky ice, the *c*-axis is vertical.

Ion	Lake I		Lake II	
	Clear	Milky	Clear	Milky
$Ca^{++} + Mg^{++}$	0.04	0.14	0.20	0.38
Na^{+}	.02	.33	.14	.34
K^{+}	.002	.012	.008	.016
HCO_3^{-}	.02	.30	.14	.36
Cl^{-}	.015	.12	.053	.11
SO_4^{--}	.02	.44	.13	.45
Total solids*	.05	.84	.34	.83

* Estimated by conductivity.

The increased salt content in the ice grown with a vertically oriented *c*-axis can only be explained on the basis of high surface energy and unsatisfied bonding, as indicated in the effect of Workman and Reynolds.

The results give further evidence that the freezing of terrestrial waters is an important geochemical process (*4*).

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27 May 1963

Electronarcosis and Evoked Cortical Responses

Abstract. *Evoked response data and electrocorticograms were recorded in macaque monkeys under the influence of electronarcosis currents sufficient to render the animals unresponsive to peripheral nerve stimulation. The data were obtained from chronically implanted electrodes in the sensory cortex as well as depth electrodes directed to thalamic and reticular loci. At the levels of current used, the amplitude characteristics of the evoked response data were not appreciably modified.*

Electronarcosis can produce sufficient unresponsiveness to stimuli to permit surgical procedures and has been used with success in both animals and man (*1*). However, the influence of electronarcosis on the electroencephalogram and upon evoked cortical responses has not been assessed previously because the currents used to produce anesthesia have a magnitude several hundred times greater than those