production of which both Dr. Thomson and the New Zealand Board of Science and Art are to be heartily congratulated.

CHARLES SCHUCHERT

YALE UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE USE OF NAPHTHALENE IN NARCOTIZING EARTHWORMS

THE preparation of earthworms for use in introductory courses in biology usually involves a more or less tiresome procedure of stupefying the animals with low grades of alcohol. In an effort to find some method which would shorten this procedure, experiments were made with a number of substances. Naphthalene in alcoholic solution gave excellent and uniform results.

A stock saturated solution of naphthalene in 95 per cent. alcohol was made up. Earthworms were gathered in the evening by the aid of a flashlight, during the months of May and June. Without preliminary washing the worms were placed in a dish of water, about one hundred specimens per liter. To each liter of water were added 40 cc of the stock naphthalene solution. Immediately the excess naphthalene was thrown out of solution as a curdy precipitate. This precipitate formed a stringy coagulum with the mucus secreted by the worms. In one hour or less the worms had become narcotized, so that pinching brought response only in an occasional worm. The animals were then washed entirely free of foreign matter. This process was not difficult, for the coagulum mentioned above did not adhere to the worms.

The specimens at this stage were found to be very flabby and wrinkled. They were laid, one by one, in fully extended condition, upon a dry paper towel in the bottom of a clean dish. All immature or injured individuals were discarded at this point. After some two or three hundred worms had been arranged on the towel, the latter was folded over and held in place, so that the position of each worm would not be disturbed while the following solution was poured on:

glacial acetic	10 cc
formalin	10 cc
copper sulphate	1 gm
water	1 liter

After a few hours in this solution the worms were found plump, fully expanded and well hardened. They were then transferred, without washing, to 95 per cent. alcohol for storage until needed.

Mixtures of alcohol and formalin may be used as storage solutions. In such solutions it is advisable to include a small quantity of copper sulphate. The bodies of worms as prepared for laboratory use contain a considerable amount of water, and this may dilute the alcohol to such a point that molds are likely to invade the solution and destroy the specimens. Molds which are able to live in fairly strong solutions of alcohol and formalin are unable to get a foothold in solution containing a very small quantity of copper sulphate. If this salt is present to the extent of one per cent., the tissues will be strongly colored. If this is deemed undesirable the amount may be greatly reduced without serious danger of invasion by molds.

It will be noted that acetic acid was a component of the hardening solution, but not of the storage solution. This reagent serves a valuable purpose in causing the worms to become plump and turgid before the formalin has had time to harden them. Long-continued treatment with solutions containing acetic acid has a tendency to make the body wall of the worm tender and therefore easily torn during dissection. Judging by the odor, it appears probable that the acetic acid carried over from the hardening solution to the storage solution combines with the alcohol of the latter to form ethyl acetate within a reasonably short time. This last compound does not appear to injure the tissues.

Comparative tests were made to determine the effects of naphthalene and of alcohol upon earthworms. Ten active worms were placed in a liter of water in each of two dishes. To dish A was added 40 cc of 95 per cent. alcohol; to dish B, 40 cc of saturated solution of naphthalene in 95 per cent. alcohol. At the end of three minutes the worms in dish A were active and writhing; in dish B they were performing peculiar movements as if tying themselves into knots. At the end of thirty minutes the worms in dish A were still active; those in dish B were quiet and moved only slightly after pinching. To test the depth of narcosis 5 cc of glacial acetic acid were added to each dish. The worms in dish A became very active immediately; those in dish B moved feebly. This experiment was repeatedly tried with uniform results. It appears clear that naphthalene has distinct powers as a narcotizing agent in the treatment of earthworms. Experiment demonstrated that worms showing slight movement after thirty minutes in the naphthalene solution, as used, could safely be placed in the hardening solution. The movements of the anterior ends were so feeble that in masses of closely compacted worms the anterior ends failed to get out of position to any serious extent.

This method has several attractive features. The naphthalene brings about narcosis in a relatively short

time. Moreover, narcosis is accompanied by extreme relaxation both of the circular and of the longitudinal muscles of the worm. Full extension of the worm is therefore made possible. So great is the relaxation of the circular muscles that the body wall is thrown into a series of deep longitudinal wrinkles. These, however, entirely disappear during treatment in the hardening solution. The removal of mucus and foreign matter is easy, due to the fact that the strongly coherent coagulum does not adhere to the worms. If the worms are placed in running water the coagulum floats away as the mass is gently agitated. This method gives rapid narcosis, ease in freeing the specimens from foreign matter and mucus, and plump, well-hardened specimens.

ELBERT C. COLE

SPECIAL ARTICLES

THE EFFECTS OF SELECTIVE SOLAR RADIATIONS ON GROWTH AND DEVELOPMENT

TEN chicks (banded) were selected from each of the eight groups used by Higgins and Sheard in their investigations on the parathyroid glands as influenced by selective solar radiations. The filters used were: amber (Pittsburgh No. 48), blue (Pittsburgh No. 56), ordinary window-glass and vitaglass, each about 2 mm. in thickness. To the diet of half of the chicks, 2 per cent. (by weight) of cod-liver oil was added. The standard diet was the Wisconsin all-mash ration, consisting of eighty pounds yellow corn, twenty pounds shorts, five pounds bone-meal, five pounds limestone grits and one pound salt.

The growth of the chicks was estimated from the average weight of the same ten chicks from each of the eight compartments, respectively, the weights being taken biweekly. During the first eighty days it was found that the curves showing the relationship between average weight and age practically coincided when 2 per cent. cod-liver oil was added to the ration, and that similar curves of weight when the standard ration only was fed exhibited the greatest departure from normal (vitaglass or standard ration with cod-liver oil) in the case of the chicks under the amber filter, with blue-glass next. The influence of unfavorable weather conditions (heat and humidity) on the average weight was least marked under vitaglass and most noticeable under the blue and amber filters. The experiments over the eighty-day period indicate that cod-liver oil compensates, in a large part, for the absence of vitamin D, and that the presence of ultra-violet rays of short wave-length (300–330 millimicrons) is an added factor in overcoming various degenerative tendencies.

At the end of six months it was found that the average weight was practically the same (within 3 per cent.) under each of the filters if cod-liver oil was added to the diet. Without cod-liver oil, no departure in average weight was found under vitaglass, 10 per cent. under ordinary glass, 20 per cent. under blue-glass, and 30 per cent. under the amber filter. By reason of the percentages of transmission of solar energy through these filters, together with the fact that the blue-glass used transmits slightly lesser wave-lengths than does ordinary glass and a slightly greater percentage of ultra-violet light, we are forced to the conclusion that the presence of both the longer and shorter (ultra-violet) wave-lengths of sunlight is essential to normal growth.

These results also emphasize the rôle which the parathyroids play in the growth and development of chicks. Hyperplasia of these glands occurs under blue and amber filters in the absence of cod-liver oil. We may postulate that hyperplastic parathyroids develop in an attempted rectification of hypofunctioning through an increase in the size of the glands in order to produce as nearly normal metabolism and development as is possible. Initially, normal growth and development are accomplished through a multiplicity of the functional units. These ultimately break down, causing metabolic disturbances and deficiency diseases.

Our experiments, insofar as they parallel the investigations of others, are not in accord with conclusions commonly accepted. In the experiments of Bovie, young chicks were taken and variously grouped under an environment of sunlight and of light through a greenhouse roof. Their rations consisted of so-called regular feed, regular feed and green stuff, regular feed and cod-liver oil. At the end of the sixty-fifth day it was found that the total weight of the chickens receiving sunlight only through the greenhouse roof is about one-half of the total weight of all the chickens exposed to outdoor sunlight or to the light from the ordinary quartz lamp.

The difference in experimental data and conclusions may be due either to difference in quality of stock or the character of the ration or to both. Obviously, inferior stock will succumb to conditions which will have no effect on superior stock. The matter of ration is evidently important. Our ration was high in its content of minerals (calcium). Biweekly determinations showed that the calcium was about 12 mg for each 100 cc. of serum and the phosphorus about 6 mg. for each 100 cc. of serum during the first three months of observation, irrespective of the character of the light filter.

In conclusion, we have found from experimental data on the quality and quantity of energy in solar