with an aperture 2 in. long and 1 in. in diameter. It is hoped that a focusing collimator as described by Francis *et al.* (*6*) will increase "see-ability" and definition. Work is in progress with this type of equipment (*7*).

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4 October 1956

Nutrition of Plant-Sucking Hemiptera

The technical difficulties of culturing a plant-sucking insect apart from its host have hampered, if not effectively prevented, detailed studies of the biological relationships between sucking insects and their host plants. Many problems of importance to both agricultural and theoretical biology lie in this difficult and complex area of interest. Such problems include the breeding of resistant plants, transmission of plant pathogens, toxicogenesis, host plant specificity, insect nutrition, and many others. Although a few plant-chewing insects have been reared successfully through their life cycles on aseptic purified diets (*1*), no plant-sucking forms (aphids, leafhoppers, plant bugs, and so forth) have been so reared.

Carter (*2*) was apparently the first to devise a technique for maintaining adult leafhoppers apart from a host plant for several days. His method involved offering insects a liquid diet covered with a membrane. The leafhoppers obtained the nutrient by penetrating the membrane with their piercing-sucking mouth parts. This membrane technique has been used by a number of workers to investigate insect transmission of plant viruses, and a number of modifications have been tried. However, as far as is known to us, neither the original technique nor any of its modifications has permitted the successful rearing of the immature stages of any species of plant-sucking insect.

At the beginning of the study reported here (*3*), nymphs of a number of species of aphids, leafhoppers, and plant bugs were used in attempts to rear the insects on liquid diets covered with a large variety of membranes under a number of different environmental conditions. Although some of the insects survived such conditions for 2 or more weeks, no growth or development was observed. At least some feeding occurred, as indicated by intestinal recovery of vital dyes that had been added to some of the liquid diets. The amount of feeding was distinctly suboptimal in all cases, however. The preliminary trials showed that two hemipterous insects were well suited for further investigation, for they were hardy and could be maintained easily in stock cultures on natural food plants. These two species were the large milkweed bug, *Oncopeltus fasciatus* (Dallas) (Lygaeidae), and the one-spot stink bug, *Euschistus variolarius* (P. de B.) (Pentatomidae). Neither of these insects fed successfully under conditions in which the membrane technique or any of its numerous modifications was employed.

In all previous work on the feeding of sucking insects, it was assumed that a liquid diet and a penetrable membrane were necessary conditions for artificial feeding, and the assumption was never subjected to experimental test. Our uniform lack of success with this method led us to test the hypothesis that a liquid diet and a penetrable membrane are not necessary. Using newly hatched nymphs of *Oncopeltus* and *Euschistus*, we tried a number of different diet forms, including gels, powders, and semisolid diets. Nymphs of both species fed and grew slowly on a powdered diet that had been moistened and rolled into small pellets. Under these feeding conditions, a supplementary water source was found to be necessary; it was provided in the form of a moistened cotton wick protruding from the floor of the rearing chamber. The food material was renewed every day to minimize the effect of contamination by microorganisms and because the diets tended to harden as they dried.

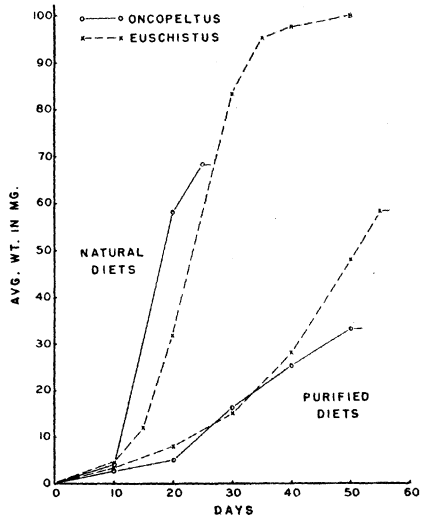

Fig. 1. Growth of *Oncopeltus fasciatus* and *Euschistus variolarus* on natural and purified diets.

Table 1. Components of a purified diet used in studies of the nutritional requirements of *Oncopeltus fasciatus* (Dallas) and *Euschistus variolarius* (P. de B.).

Constituent	Amount used	
	Wt. (g)	Percentage of dry diet
Glucose	6.25	24.3
Soluble starch	6.25	24.3
Sodium caseinate	6.25	24.3
Corn oil	1.25	4.9
Cholesterol	0.25	0.9
Mineral salt mix	0.50	1.9
Brewers yeast powder	5.00	19.4
Distilled water	15.00	0.0
Total	40.75	100.0

Several dozen different dietary formulations were tested, and the diet shown in Table 1 was the most nearly satisfactory. Both species have been reared from egg to adult on this diet. The growth obtained (Fig. 1) was suboptimal, the insects on the purified diets growing at half the rate of the controls on natural diet and attaining but about half the normal body weight. The importance of these results does not lie in the nutritional efficacy of the diets employed, but in the finding that a liquid diet and membrane barrier are not necessary conditions for feeding.

During the course of the investigation, a number of observations were made on factors that influenced the feeding behavior of the two insect species. Feeding appears to be greatly influenced by the physical and chemical conditions imposed by the diet and the rearing chambers employed. Feeding was very poor on the purified diet if the yeast powder was replaced by a mixture of B vitamins. This effect was found to be caused by (i) an unidentified attractant contained in yeast and (ii) a possible repellent effect of choline chloride. Starch stimulated feeding, whereas glucose, fructose, and sucrose did not.

Difficulty was encountered in inducing newly hatched nymphs of *Oncopeltus* to feed on the purified diets. The nymphs would feed readily on eggs of their own species and on milkweed seeds. Nymphal mortality was very high on the purified diet, except in cases where the insects were allowed to feed on eggs or seed for a day or so immediately after hatching. This difficulty was not encountered with *Euschistus*.

The suboptimal growth obtained with the purified diets is not necessarily indicative of nutritional deficiencies.

seems more likely that the difficulties encountered are related to the establishment of conditions optimum to feeding. Avoiding the use of a membrane relatively impermeable to attractants and feeding stimulants is apparently an important step toward the accomplishment of optimum feeding.

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Psychopathologic Symptoms Induced by Bis-Beta-Aminopropionitrile

Several chemical substances have recently attracted much interest because of their hallucinogenic and tranquilizing effects. The purpose of our investigation was to establish whether bis-β-aminopropionitrile (Bis BAPN) (*1*) should be considered as a psychopathogenic compound.

Rats of the Sprague-Dawley (200 g) and Long Evans (280 g) strains were injected intraperitoneally with different amounts of bis-β-aminopropionitrile varying from 0.01 to 10 g per kilogram of body weight. Dosages of 4 g/kg and above were lethal within 2 to 7 days, whereas amounts below 1 g/kg caused no obvious symptoms. Levels between 1 and 2 g/kg produced the most striking psychopathologic phenomena. Immediately following injection of 2 g/kg, motor inactiveness, hypersalivation, and increased respiration were induced. For the following 48 hours the animals showed no abnormal behavior.

After approximately 2 days, the animals that had received 2 g/kg showed a marked hyperactivity. They moved their heads from side to side and twitched their necks in a manner reminiscent of patients with von Economo's encephalitis. When placed in an open space, they ran backward in a coordinated manner. If pushed forward, the rat counteracted by pushing backwards, sometimes with such a force as to produce a complete "backward somersault." The slightest touch incited a screaming that was not observed in the controls.

In all, about 80 animals were treated, with identical results. This peculiar behavioral pattern persisted for about 14 days, at which time a decline in backward running was noted. The rats moved alternately forward and backward and in the intervals frequently circled as if chasing their tails. The motor hyperactivity and head twitching persisted. The rats have remained in this condition during a 5-month period of observation; they have been able to eat and also to gain weight.

Albino mice were also injected intraperitoneally with bis-β-aminopropionitrile in a concentration of 1.5 to 2.0 g/kg. After 3 days a motoric hyperactivity became evident. The mice frequently ran in circles as if they were chasing their tails. Occasionally they moved backward and twitched their heads, but this behavior was much less pronounced than in the rats. This phenomenon resembles the genetical "waltzing" anomaly in certain breeds of white mice (*2*) and the symptoms produced by injection of β-β-iminodiproprionitrile (*3*).

Interesting psychopathologic symptoms were observed in birds (*Melopsittacus undulatus*) following a single intraperitoneal injection of 2 g/kg of bis-β-aminopropionitrile. On the third day a general hyperactivity was noted. It was characterized by persistent locomotion, excessive courtship, and compulsive eating. Other abnormalities of the motoric system were periodical circular movement and backward walking.

The behavioral pattern of fish (*Lepomus gibbosus*) can also be changed by intraabdominal injection of 2 g/kg of bis-β-aminopropionitrile. After a delay of 10 days, the fish showed periods of hyperactivity lasting for about 5 minutes, consisting of gyroscopic movements, barrel rolling, swimming on the back or on the side, and standing on the head. Afterward, the fish regained a normal position. These episodes can be produced at any time by merely touching the fish.

An exciter effect was also observed in invertebrates. Grasshoppers (*Melanoplus*) were injected intraabdominally with 1 and 2 g/kg of the same compound. When the lengths of their leaps were measured, it was found that they were significantly increased after administration of the weakest concentration. A protozoan (*Tetrahymena*) was given bis-β-aminopropionitrile in a concentration of 1/10,000 in the culture medium. When the speed with which this organism transverses the microscopic field was measured, it was found to be about twice as fast as that of the controls.

In all the tested animals, bis-β-aminopropionitrile induced a hyperactivity. The changes of the motoric system were most pronounced, but an excitation in more complex behavioral patterns, such as eating and courtship, was also observed. In addition to an acceleration of the normal behavior, the compound also produces apparently new and abnormal patterns. These abnormalities are strikingly similar to the symptoms produced by lysergic acid diethylamide (LSD-25) (*4*). Contrary to the transitory action of lysergic acid and diethylamide, the symptoms induced by bis-β-aminopropionitrile persist. The reason may be that the latter compound produces permanent alteration of the neurons of the spinal cord and brain (*5, 6*).

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Effects of Desoxyribonucleic Acid Breakdown Products on Bacterial Population Changes and Virulence

During studies on the transformation of various strains of *Brucella* spp. by highly polymerized desoxyribonucleic acid (DNA) from genetically different strains, it has been observed (*1*) that the addition of desoxyribonuclease (DNase) to DNA-containing broth cultures causes rapid population changes from M (mucoid) or R (rough) to S (smooth). As a rule, initially non-S (avirulent) cultures of pathogenic bacteria do not undergo population changes to S (virulent) *in vitro*—that is, the gradual establishment of spontaneously arising S mutant cells in initially non-S populations is not favored (*2*). However, in susceptible hosts, or in the presence of DNA and DNase *in vitro*, such population changes (non-S to S) occur with many non-S strains (Table 1).

Studies with *Brucella* have demonstrated that the latter selective effects involve the inhibition of growth and the killing of non-S cells by a breakdown product of DNA. The breakdown product responsible for these effects does not