Division of Agricultural Sciences, University of California

California AGRICULTURE

Reports of Progress in Research by the California Agricultural Experiment Station

Volume 13 Number 11

NOVEMBER
1959

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Poultry at High Altitudes

chicken colony at White Mountain Research Station is used for study of the adaptation of animals to climatic stress

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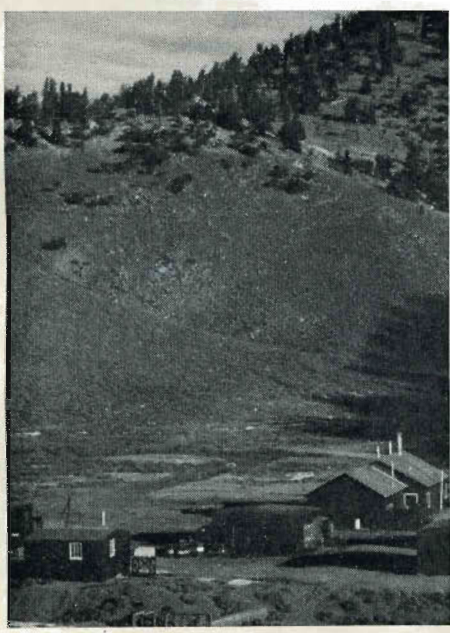
Physiological adaptation—the ability to change so as to live more or less normally in a previously unfavorable or stressing environment—is one of the most universal properties of living things. However, the native ability of animals to adjust to variations in their environment has to a large extent been sacrificed in breeding animals for modern high standards of production.

As extensive suburban developments force livestock enterprises toward marginal lands such as mountain and desert areas, characterized by severe climates, the influence of the environment on animal agriculture has become a matter of economic importance.

In the past two decades, the environmental physiology of domestic animals has been studied in order to establish optimum environmental standards and to devise means of obtaining them. Although practical systems for control of environment have been developed, to meet periods of climatic extremes, the possibilities of using the natural adaptiveness of the individual animals have largely been neglected. However much additional research is needed, to develop basic information on physiological adaptations and to work out management practices which may utilize animal adaptation to adverse climatic conditions.

Crooked Creek Laboratory, elevation 10,150′, seen from the south. Chicken brooder in foreground, at the left.



Mount Barcroft Laboratory, elevation 12,470′, seen from the north. Laboratories and offices are in the Quonset hut, poultry house in foreground, at the left.

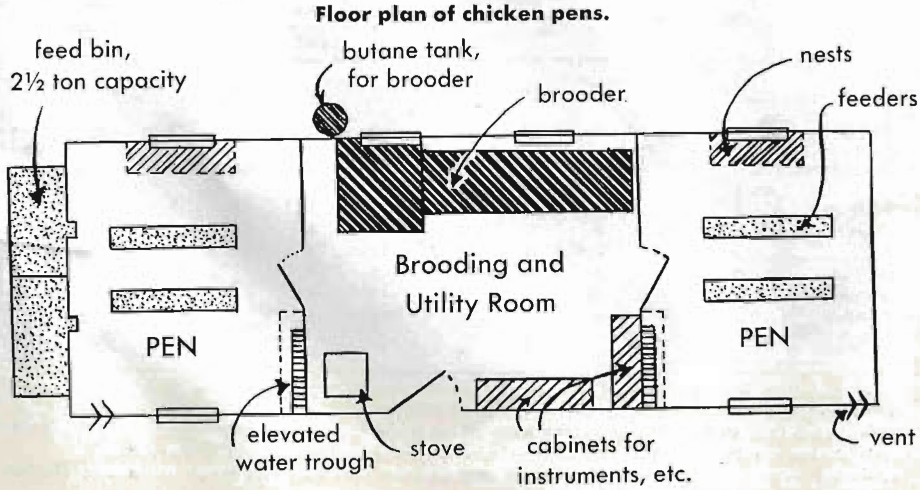
Experiments are in progress at the White Mountain Research Station, near Bishop, to obtain information on the way chickens adapt to the climatic stress of high altitude. Although high altitude is not a usual factor in California agriculture, it can be used as a tool to obtain more information concerning the physiological adaptation of domestic animals to climatic stress. High altitudes are detrimental because the decreased atmospheric pressure results in an oxygen deficiency, which affects all parts of the animal body. High-temperature and high-altitude stresses appear to be quite similar in that the same endocrines are involved in adaptation to both. There is some evidence that adaptation to one gives protection against exposure to the other.

Most environmental studies are complicated by the need for special chambers with more or less elaborate controls, which are expensive and difficult to operate satisfactorily over long periods. At a high-altitude station, however, this environmental stress can be applied uniformly and indefinitely, with no special effort or apparatus.

In 1953, preliminary studies were made with turkeys and chickens at the Crooked Creek Laboratory, at elevation 10,000′ on White Mountain. Results disclosed that poults would grow normally and reach sexual maturity, and also that mature chickens could adapt to this environment and resume normal egg production. These results indicated that colonies of domestic birds could be maintained at fairly high elevations with the rations and husbandry practices developed for sea-level use.

In the summer of 1955, a colony of SCWL—Single Comb White Leghorn—chickens was established at the Mount Barcroft Laboratory, at elevation 12,500′ on White Mountain. The chicken house contained two pens, each with a capacity of 50 hens, with a connecting room for brooding. The whole structure was insulated and provided with an oil heater against winter temperatures as low as –19°F. A floor-management plan was adopted, as it was simpler for station maintenance. Deep litter provided some

Floor plan of chicken pens.



protection for the birds in case heat should fail; usually the pen temperatures were kept at about 50°F. Commercial nests were provided and a daily egg-production record was maintained, without trapnesting. Ordinary commercial feeds available in the Owens Valley were used. A feed storage bin of approximately three-ton capacity was located outside the building. Arrangements provided for the incubation of eggs at the Crooked Creek Laboratory and for brooding chicks at the Mount Barcroft Laboratory.

The experimental design was kept as simple as possible, for easy maintenance under severe conditions. The first objective of the experiment was to develop a high-altitude strain of chickens by breeding the survivors for several successive generations. Because adaptation to high altitude probably depends on many physiological processes, not all of which may be present in any individual, such an adapted strain would collect these factors and thus facilitate their recognition and study.

The high-altitude colony was stocked with day-old chicks from the randombred SCWL line at Davis. These birds were preferred to other available lines because the large colony maintained at Davis serves as a genetically stable population for comparison with the high-altitude strain.

The effect of exposure to high altitude on survival was quite marked. Of the original group—184 chicks, excluding those sacrificed for organ weights and other tests—84% died in the first year. Mortality was particularly severe during brooding—39%; excluding these early deaths, there was a 69% mortality. Males—with 88% mortality—were much more susceptible to high-altitude stress than females—with 53%. Because of the very high mortality, the flock was examined for infectious disease, but none was found. The principal cause of death appeared to be a chronic heart insufficiency. Progeny of the original stock—whether hatched at the Crooked Creek Laboratory or at Davis—suffered about 50% mortality in the first year, almost equally divided between the sexes.

The effect of high altitude on growth was not what would be expected from the excessive mortality. Up to maturity the high-altitude birds were about 15%–25% heavier than similar groups raised at sea level. Isolation, with the consequent improved hygienic condition of the flock, may have aided the enhanced growth. Possibly some of the growth effect may result from selection, if the weaker and perhaps more slowly growing individuals are eliminated.

In mortality after six months of age, selection did not appear to be a factor. Birds dying at that time had apparently adapted and grown normally. Several weeks before death they would become listless and lose weight progressively. Exhaustion of the adaptive capacity is also known in man—as Monge's disease. Natives of high-altitude stock may suddenly become acutely mountain-sick; they must go to lower elevations or perish. In man, as in these birds, a chronic circulatory failure is prominent.

Birds of sea-level origin raised at high altitude were altered physiologically: heart rates were decreased, respiratory frequency and circulating red cell concentrations were greatly increased, as compared with sea-level birds. However, differences disappeared after several weeks when birds were brought to sea level.

The birds raised at high altitude attained sexual maturity at the usual age. The egg production of the flock ranged between 50 and 60 eggs per hundred hens per day during the first year of laying. Male fertility was adequate; 88% of the incubated eggs were fertile. However, hatchability at Crooked Creek—elevation 10,000′—was quite low: 3% for eggs of the parent stock and 9% for their second generation. At Davis—sea level—the hatchability for all groups was about 60%.

Detailed metabolic studies have been deferred until the high-altitude strain is developed. Attempts to induce or simulate the adapted condition in previously unexposed birds must await completion of the high-altitude studies.

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The above progress report is based on Research Project No. 1817. This work is also supported by a research grant, No. H-1920, from the National Heart Institute, U. S. Public Health Service.

The White Mountain High-Altitude Research Station in Mono County has laboratories at elevations of 10,000′, 12,500′, and 14,250′. Nello Pace, Professor of Physiology, University of California, Berkeley, is Operations Director.

LYGUS

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bug control as either a spray or a drench.

Chlorinated hydrocarbon-phosphate combination treatments—such as DDT-Dylox—apparently resulted in a complementary chemical action which caused greater mortality of lygus nymphs than did DDT or toxaphene alone. In most cases, it caused also a higher percentage mortality of the adult bugs—a most significant and unusual result.

Lygus control depends on many factors, which in turn depend on a host of additional factors.

Lygus Control Dependency Factors

Population Density	**Crop**	**Types, Acreage**
	Bioclimate	**Geography, Crop**
	Predator	**Species, Number**
	Biotic potential	**Climate, Food**
Chemical	**Type of crop**	**Seed, Market**
	Time of application	**Plant devel., Season**
	Type of application	**Foliage, Tolerance, and Thoroughness**
	Number of bugs	**Climate, Food**
Tolerance	**Chemical used**	**Metabolism, Genetic**
	Type of crop	**Nutrition, Season**
	Biotic potential	**Bioclimate, Food No. of generations**
	Application	**Thoroughness, Amount**

The density of the lygus population depends on crop types and acreage; on bioclimate in relation to the crop and local geographic features; on the number and species of predators; and on the bug's biotic potential, in relation to climate and food supply.

The selection of the chemical to use should be based on a consideration of the type of crop—whether for seed or for market—and on the lygus population density with its various factors. The season of chemical application will depend on the amount or stage of plant development. Effectiveness of the method will depend on the type and thoroughness of application, on the amount of foliage, and on the tolerances of the beneficial and destructive insects.

In turn, insect tolerance to a chemical compound depends on the chemical used, probably in relation to the insect metabolism and the processes of genetic selection. Tolerance may vary with the type of crop and the nutrition it provides according to the season; with the amount of chemical and thoroughness of application; and with the biotic potential and the number of generations. Tolerance depends also on the length of time during which insects that can tolerate the particular chemical have been reproducing themselves under similar conditions of crop and climate.

Experiments with other chemicals and combinations are being planned with special emphasis on as many as possible of the dependency factors.

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John Campbell, Nurseryman, Department of Entomology, University of California, Davis, assisted with the field work. Land for the experimental treatments at Davis was contributed by the Department of Vegetable Crops.

The above progress report is based on Research Project No. 1565.