Studies on the Giant African Snail

By P. W. WEBER

BOARD OF AGRICULTURE AND FORESTRY

(Presidential Address, presented at the meeting of December 14, 1953)

The presence of the giant African snail in Hawaii was discovered in 1938 when a Honolulu resident sought information from the Board of Agriculture and Forestry as to the best methods of breeding it. He had read about a person on Maui who was raising them for food and medicinal purposes and had obtained some for his own use. These had been brought in from Japan in 1936 through the mails and had escaped detection by inspectors. The snails were identified by Dr. C. M. Cooke of the Bishop Museum and the serious nature of the situation recognized. The six snails found in Honolulu were confiscated and the large number in the hatchery on Maui destroyed.

Soon after, other lots were discovered in Honolulu, which were the progeny of some snails brought by a resident returning from Formosa in 1936. These were also destroyed. The Board had high hopes that the infestation had been wiped out, but in the years to come it became more and more apparent that the snails were on the increase and measures had to be taken to suppress them.

The first method of control tried was the use of a 1% spray of Penite, which was applied to the ground and vegetation in the infested areas. This gave very good results, with kills approaching 100%. It is believed that most of the snails were killed by poison absorbed through the foot as the snail passed over the ground, but some may have been killed by ingesting the poison on the leaves as they fed.

Due to the high toxicity of the arsenic in Penite it is not practical for use in residential areas. Here we have had to resort to the use of a standard commercial molluscicide, Bug-Geta pellets, which contain bran as a food or attrahent and the poison metaldehyde. These are scattered among plants and other places where the snails hide.

The next method of control practiced was the distribution of rocks coated with a mixture of calcium arsenate, lime, and cement, the cement acting as a binder. This whitewash is painted on rocks, tree trunks, and other objects upon which the snail might climb. The theory is that the snails are attracted to the calcium which they need for their shells and are killed when they eat the arsenic. The rocks were #2 grade stones, measuring approximately 2x4 inches. These were distributed by hand, spaced about 10 feet apart each way. Later on it was felt that closer spacing, with greater opportunity for contact, would result in a higher mortality. Accordingly we ran tests with equal weights of large and small stones spaced over a plot of ground 50x75 feet. Equal weights were chosen in order to keep the cost of the stones at the same level. With the 10-foot spacing 48 large stones were used. An extra 250 snails were planted in the area to increase the population, which was estimated at 300. The rocks were left for one week, after which all snails were collected for counting and examination. A total of 729 snails of all sizes was found. These were held for one week before examination to allow for delayed poisoning to take effect. Based on an estimated population of 750, the 51 dead snails gave a mortality of 6.8%.

The smaller stones, of #3 coarse grade, measured about ¾-1 inch in each dimension, there being about 1300 stones to be spaced 1 foot 9 inches apart over the lot. The same test was repeated and resulted in a total of 300 snails being killed, or a mortality of 40%.

As a partial check on this figure, every other rock was removed and a third lot of snails introduced. As could be expected the number of dead snails, 138, and the mortality, 18.4%, fell in between the corresponding figures for the wide and close spacings. The use of small stones with a spacing of approximately two feet is the method of control now in practice.

Metaldehyde was tried as a poison to be used in residential and pasture areas where arsenic could not be used. It was found that a spray of wettable metaldehyde applied at the rate of 5 pounds per acre was very effective, the same strength in dust form being nowhere near the spray in effectiveness. This can be used with perfect safety on plants and around the yard.

We next turned to trials of food preferences in an effort to find some substance attractive enough to snails to serve as a lure. A 15-foot circular cage was built out of hardware cloth. A certain amount of the material under test was put out as food and a second lot placed outside the cage to serve as a check on loss of weight due to dessication. All foods were exposed for two nights, with the snails being placed near them each time. Twenty large snails were used, the same snails being used throughout the experiment.

The following materials were tested: *Passiflora foetida, P. laurifolia,* peanuts, papaya, lettuce, koa haole, sweet potato leaves, cabbage, crushed African snails, and bell pepper leaves. These were selected on the basis of various reports and observations, either of snails being found on these objects in the field in large numbers, or of having apparently shown a special taste for them.

The entire vine of the two species of passion fruit was used. In one case the amount eaten was calculated to be ⅛ oz. and in the other ¼ oz. With peanuts, the entire plant was tested, the stems being gathered in loose bunches. The amount eaten was calculated to be ⅛ oz. Several snails were cracked and laid out on small pans. Of these also ⅛ oz. was assumed to be eaten. These figures were arrived at by recalculating the original weight of the amount of food remaining in the same ratio as the amount of the check remaining, and subtracting it from the weight of food put out. All of these differences are so small that they are thought to be due to experimental error, as no evidence of feeding could be found.

Papayas were cut in half and the seeds removed; of 17 oz. put out, 1⅛ oz. were eaten. Seven oz. of koa haole branch tips were put out and 1½ oz. eaten. One pound of cabbage was exposed and 2⅞ oz. eaten. One pound of sweet potato leaves was exposed, 11⅞ oz. being eaten. One pound of lettuce leaves was put out and the entire amount consumed during the first night. From this it will be seen that sweet potato leaves and lettuce were outstanding as foods selected by the snails.

Following this tests were conducted on the ability of the snails and their eggs to withstand cold temperatures. These tests were conducted in standard refrigerators adjusted to run within two degrees of the desired temperature and equipped with hygrothermographs. It was found that an exposure of 24 hours at 45° F. was enough to prevent hatching of the eggs, whether buried in soil or exposed on the surface. All indications point to the fact that eggs are easily affected, the contents drying up within a few days.

The next tests were conducted with dormant and active snails exposed on the surface of damp soil in small pans, and also buried in soil in cardboard boxes, with at least three inches of soil surrounding the snails on all sides. All snails were held for seven days for mortality counts. It was found that with active snails an exposure of 8 hours at 20°, 12 hours at 30°, 24 hours at 40°, and 4 days at 45° were lethal. Upon removal from the cold chambers, the snail bodies were dried and shriveled, while in many liquid filled the aperture to the lip.

In the case of active snails buried in soil, 8 hours at 20°, 24 hours at 30°, 48 hours at 40°, and 4 days at 45° were required to produce 100% mortality.

With dormant snails a longer period was required at each temperature, this period increasing as the temperature rose. Twelve hours were required at 20°, 24 at 30°, 48 at 40°, and 7 days at 45°.

A series of tests on the attractiveness of various odorous chemicals and other materials was run in the cage. We first determined the normal movement of 50 large snails placed in the center of the cage and allowed to roam at will, with nothing in the cage. In a series of tests it was found that ¾ or more of the snails would be found the next morning against the fence in the quarter directly downwind, with all but one or two of the rest below the midline of the cage. There was a constant breeze with a velocity of from two to ten miles per hour. To find out whether or not this movement was due to wind effect, we installed a blower outside the cage directed at the area where the snails were clustered. In each of several tests we found that the snails moved away from the air current to either side, with a few being found on the ceiling of the cage. Further checks were made with the cage covered with a tarpaulin and with the tarpaulin erected as a windbreak around the cage. In this series we received a very random distribution of snails, there being no similarity of pattern between any two tests. This indicates that the snails react negatively to an air current and were not affected by the slight downward slope of the ground within the cage. Therefore any positive reaction should be due to the attractiveness of the lure. With this in mind we tested a number of materials. These were exposed at the upwind center margin of the cage, either in shallow pans or as liquids absorbed on pieces of filter paper. The distance from the point of exposure to the center of the cage was 7½ feet. To check whether or not the odor was being lifted above the snails' horizon we made tests with smoke drift and also by sniffing at the ground in the cage center where the snails were placed for each test. In each case there was no doubt that the wind currents were carrying the scent to the desired place.

The following materials were selected, either for odoriferous qualities or for the reasons given previously:

Aku head soup
Commercial fish oil
Molasses
Fermenting molasses
Fish meal
Fermenting fish meal
Fish viscera preserved with salt and with sulfuric acid
Koa haole leaves
Koa haole leaves ground up in a blendor
Wheat bran
Fermenting wheat bran
Dry metaldehyde
Metaldehyde in solution
Iso-valeric acid
N-valeric acid
Propionic acid
Butyric acid
Acetaldehyde
Formaldehyde
Turpentine
Acetone

All these substances proved to be entirely negative, there being no attraction beyond 1 or 2 snails in any test that were found near the upwind margin and considered to be of no significance.

In the field of biological control we have introduced into Hawaii several predators. One of these is a large carabid beetle, *Tefflus hacquardi,* which is predacious in both the larval and adult stages. The eggs are encased in helmet-shaped mud cells about 10x15 mm. On one end there is only a thin wall of mud, through which the young larva emerges. At this time it is capable of attacking small snails up to 1 inch long. They prefer to feed early in the morning but have been observed feeding at all times of the day. There are three larval instars, the larvae being about 35 mm. long and 12 mm. wide after the last molt. This occurs 2-2½ months after the eggs are laid. They eat an average of three snails a day and stop feeding 3-4 days before going into the final molt. A cell is dug in the ground about 1½ times their length and half as high. The pupal stage lasts from 11-14 days, the adult beetle resting in the cell for 2-3 days before digging its way out to the surface.

The adults mate in the latter part of September and begin laying eggs in October, this continuing for three or four months. Up to 40 eggs are laid during a season. They also prefer to feed in the early morning, and remain in hiding during the day. Usually one medium-sized snail is eaten per day.

They can squirt an acid substance from the posterior end of the abdomen when disturbed or handled. This is strong enough to cause burns on the skin if not washed off soon enough.

Other predators belong to the *Streptaxidae,* a family of carnivorous snails. These are *Streptaxis kibweziensis* and *Edentulina affinis,* which were introduced from Africa. We have had no success in propagating *Edentulina,* but have been able to breed *Streptaxis.* They are oviparous, laying 3-4 eggs at a time. The young snails require about 6 months to reach maturity.

Both *Tefflus* and *Streptaxis* have been liberated in the Kaneohe area. They were marked so that if any were recovered we could tell whether they were progeny of the specimens liberated. One first generation specimen of *Tefflus* was recovered near the point of liberation, but no progeny of *Streptaxis* have been found.

Another predator introduced was the lampyrid *Lamprophorus tenebrosus,* which was brought from Ceylon. These are predaceous in the larval stages, lacerating the flesh of the snail and feeding on the liquid secreted by the snail in defense and on the semi-liquid contents of the intestine. These we have been unable to propagate, all larvae dying before they reached maturity. We hope to secure more and be able to add another enemy in the campaign against the snail.

We realize that the surface has barely been scratched in work on control of these snails and that much remains to be done before any satisfactory results will be obtained. We would be most appreciative of any constructive, or, for that matter, destructive ideas you may have which may help in our efforts to bring this pest under control.