CHAPTER 4

ECONOMIC STATUS

Current Opinion  As attested by the following quotations, the majority of earlier investigators in the field have generalized from their observations that *Achatina fulica* presents a problem of very real if not actually serious proportions: "They eat nearly everything in the garden" (Jarrett 1923); "this snail is a very destructive visitor [which will devour] anything that is not too hard or distasteful" (Jarrett 1931); "vast amount of damage to agricultural crops resulting from their attack" (Dias and Thamotheram 1939); "a major pest on a number of larger islands" (Townes 1946). Many other quotations of a similar nature could be given. Most unfortunately, various writers who have had no practical experience in the field aspects of the problem have seized upon these and similar statements, blown them up, embellished them with the products of overactive imaginations in true Sunday supplement style, confused them with information about other agricultural pests, and highlighted them with the sheerest of fantasy until almost terrorizing proportions have been reached. Undoubtedly in many instances these confusions and distortions have been unwitting, but the end results nonetheless have been very damaging to progress in creating a better general understanding of the true proportions of the problem.

Green gave probably the first account of this impending trouble with his note (1910a) about an article which appeared in the August 28, 1910, issue of the *New York Herald* (continental edition). He states that the illustration showing many snails on a coconut stem was superscribed as representing "Snails Destroying Trunk of Coconut Tree." But the situation was to become worse. Statements which
accused _A. fulica_ of “chewing to shreds much of the wild vegetation of the islands” and of having “denuded much of the vegetation in the Hawaiian Islands” were to give way to even greater exaggerations, such as, “countless millions . . . are gobbling down crops on the Hawaiian Islands” and “billions upon billions have already eaten every blade of grass and all the jungle growth on scores of Pacific islands” (Symontowne 1949). An unchallenged climax was finally reached in the magazine section of a newspaper in the western United States (Rhodes 1950). Starting almost immediately in a *reinfortsando* of “astronomical numbers have devastated parts of Hawaii, India and China,” the tempo of exaggeration quickened with an account of a supposed infestation of Ceylon where “the pests appeared in vast numbers one summer morning and by nightfall several thousand acres of farmland were literally crawling with the creatures which ate everything in sight, including the thatched roofs of farmhouses.” Soon all credibility was abandoned and a tremendous crescendo built up to the explanation that the “next day not a live snail could be found on the island” and that “it is guessed the snails, impelled by some strange urge, committed mass suicide in the sea[!]”

In the light of all this excessive exaggeration, it is not only of little wonder but definitely predictable that just the reverse reaction has been engendered in many quarters. Skepticism has grown first into disbelief and finally into complete repudiation of the very idea that _A. fulica_ has provided anything more than a field day for reporters and free-lance writers. Such an attitude on the part of some people has provided the single greatest impediment in setting up protective legislation and otherwise meeting adequately the threat presented by this confused problem. To make matters worse, this skepticism has apparently found its justification in the existence of a fair amount of indisputable evidence that the damage caused by this snail is actually considerably more limited than originally believed. Statements in the literature minimizing the problem have seemed to support further the stand of the skeptics. As early as 1910, Green (1910c:56) pointed out and later reiterated (1911b) that in spite of millions of snails in a heavily infested area “evidence of injury could be found only upon careful search” and that “the casual visitor might pass through the affected area without noticing anything unusual.” Hutson (1920), van Weel (1948), and others have supported this stand. Abbott (1951c) has indicated that the achatinas in their homeland of Kenya and Zanzibar cause apparently slight destruction to agricultural produce despite their large populations. Townes (1945) reported that there was “little damage to vegetation in general” in his
survey of the problem in Micronesia. More recently, J. W. Hes (in litt. Feb. 5, 1952) stated that in Java the economic importance of this snail has been overestimated; Chamberlin's investigation in Tinian (1952a) indicated only "slight damage" to crops on that island and that the rats and insects provided a far worse threat. Olaf Ruhen of New South Wales (vide Morrison 1950a) concluded that there was not even enough evidence against these snails to provide the basis for an article and that "people are just naturally destructive, and want things killed for no other reason than that there are a lot of them." More recently, there has been a tendency even to glamorize the whole subject, thus minimizing still further the problem at hand (e.g., Poling 1954).

This swing of opinion from one extreme to the other is kept in a constant state of vacillation through the appearance in the literature of a great number of conflicting reports, inconsistencies, and apparent discrepancies. These would seem to reflect inaccuracy or incompleteness of observations of those making the reports, and in some instances such is probably the case. In this respect, it is worth while to point out that Hutson in 1920 reported that there was no damage to rubber trees through the action of *A. fulica*. A reversal of opinion started with the report of Weir in 1929 which indicated that the damage had not been sufficient to attract attention. But Beeley, who took over Weir's position, reported six years later positive damage to seedlings and buddings and, shortly thereafter (1938), branded *A. fulica* a pest of "serious economic importance in Malaya." Examples of this sort have quite naturally caused a questioning of other negative reports.

Bias is also undoubtedly an important factor which has insidiously flavored certain other reports. The other factors which have helped create confusion are even more subtle. For instance, in some areas, a certain food plant is not touched at all by the giant snail and is so reported; in other areas, that same species of food plant may be the only one which is at all acceptable and may therefore suffer severe damage. And even in this latter area the damage may be negligible during certain seasons of the year when other food items become temporarily available. During the dry season, damage may be reduced considerably through the fact that a great majority of the snails go into a state of estivation. In some areas advantage is taken of this "snail-free period," especially in the growing of vegetables in small irrigated plots. In contrast, South (1926b) reports greater damage during the dry season because of concentration of snails in the perennially green gardens. The size of the snail population, of
course, will greatly influence the amount of damage. And the size of the population in turn will be determined by many other factors such as the availability of food, moisture, CaCO₃, and temperature extremes. In the early stages of the invasion of a new area, the population quickly reaches its peak and damage is at a maximum; in the later stages the phenomenon of "decline" (discussed below) may reduce the population in a very dramatic fashion with a proportionate reduction in damage.

In much of the recent literature, there is very apparent a growing indifference to the problem of the giant African snail. Undoubtedly a number of reasons are contributing to this trend: the people have lived with the problem long enough to begin to accept it among their other curses; very limited funds in many cases have permitted the problem to continue without recent rechecking and the lack of official reports has been interpreted elsewhere as evidence of cessation of importance in the area in question (India is a case in point in this respect); entomological and mycological problems are so much more acute in many areas that they demand all or nearly all the attention of a seriously limited number of specialists; and lastly, the phenomenon of "decline" has convinced the authorities in some of the older areas of infestation that the "worst is over" and that the problem will continue to diminish.

**Damage to Plants** At this point, it is more than obvious that there is a genuine need for determining as accurately as possible the true economic status of the giant African snail. The first step in making such a determination is to check the literature exhaustively for reports of investigators who have made field observations of damage in areas invaded by this giant snail. But at the outset one is frustrated by the frequency of extreme contrast in the nature of the reports made by observers of varying authoritative stature. In an attempt to resolve these differences, certain writers in the past have rejected some, minimized other, and championed still other data which gave emphasis to their own interpretations. In the present account, however, an attempt is made to embrace all data and then reconcile the differences through an explanation of their apparent underlying causes. In this way, it is hoped that the existing knowledge will be brought into better perspective than has been the case heretofore.

In the following list an honest attempt has been made to prepare an unbiased résumé, giving as concisely as possible the essence of the findings reported in the literature or in correspondence. In every category where this author has made field observations, a note concerning them has been placed first in the series of data and followed
by an asterisk (*) when the observations were made in the infested central and western Pacific islands (Hawaiian, Micronesian, and Bonin Is.) and by a dagger (†) when the observations were made in Ceylon. The data of other investigators are identified by appropriate letters; these in turn are interpreted in the footnote legend. In preparing this list there was no attempt to make it completely exhaustive; instead, there was omitted in every case all information which clearly was quoted from earlier original works already covered or which concerned plants of little or no significance or economic importance. Where there was doubt, the information was included in this list.

Air plant (Bryophyllum pinnatum): The common, dense stands of this plant in the uncultivated areas of the Hawaiian Islands are providing an almost unlimited source of preferred food.*

Albizzia: Where unprotected from snails, only 30 per cent survival of Albizia falcata in E. Java (AV); bark of A. falcata attacked in Sumatra (He); A. lebbek a preferred food plant in Saipan (L).

Amaranthus spp.: A preferred food in Saipan (L); young plants completely destroyed, older ones seriously attacked (W).

Amaryllidaceae: Crinum favored in Malaya (Ja); serious damage to many species (W).

Ampalaya (Momordica charantia): Seriously attacked in Philippines (Pg).

Arrowroot (Canna edulis): Seriously attacked in Philippines (Pg).

Bananas and plantain (Musa paradisiaca): The snails are frequently found on the leaves and trunks; small specimens may work their way deep into the bunches of fruit. Occasionally young bananas are rasped; when they mature the skin appears very badly scarred and is therefore commercially less valuable, though the fruit itself

1 (A)—Anonymous, 1947a; (AV)—van Alphen de Veer, 1954; (Be)—Beeley, 1935; (Be1)—1938b; (Be2)—1938a; (BJ)—Bentham Jutting, 1934, 1952; (Br)—Bertrand, 1928; (Br1)—1941; (C)—Chamberlin, 1952a; (C and G)—Charmoy and Gebert, 1922; (Ca)—A. Campbell in litt. Nov. 19, 1951; (Co)—Corbett, 1933; (Co1)—1937; (Co2)—1941; (Ct)—Cotton, 1940; (D)—G. S. Dun in litt. Aug. 12, 1949 to Dec. 17, 1953; (Da)—Dammeman, 1929; (E and T)—Esaki and Takahashi, 1942; (F)—Fairweather, 1937; (Fe)—Feij, 1940; (G)—Green, 1910c; (G1)—1910b; (G2)—1911b; (H)—Hutson, 1920; (H and K)—Hatai and Kato, 1943; (Ha)—Tom Harrisson in litt. Aug. 25, 1952; (He)—Heubel, 1937, 1938; (Ho)—Holmes, 1954; (Hs)—Hes, 1949, 1950; (Ja)—Jarrett, 1923; (Jk)—Jaski, 1953; (K)—Kondo, 1950c; (K2)—1950a; (K3)—1952; (L)—Lange, 1950; (Le)—Leefmans, 1933a,b; (L and V)—Leefmans and van der Vecht, 1933a, b; (M)—van der Meer Mohr, 1949a; (M1)—1924; (Ma)—Macmillan, 1943; (Mi)—Milsum, 1950; (N)—R. C. L. Notley in litt. Dec. 7, 1950; (O)—Otanes, 1948; (Pb)—Philbrick, 1949; (Pe)—Pemberton, 1938; (Pg)—Pangga, 1949; (Ph)—E. Phillis in litt. Jan. 31, 1950; (Pv)—Paravicini, 1922; (R)—Rappard, 1949; (Ri)—Riel, 1933; (Ry)—H. C. Ray in litt. July 22, 1952; (S)—South, 1926b; (S1)—1923b; (T)—Townes, 1946; (W)—van Weel, 1948-49; (We)—Weber, 1954.
is unaltered. If the bananas split open on the tree, they will almost invariably be consumed by the achatinas frequenting the treetops. Several native reports indicated that young plantings may be killed by the attacks of the snails. Total damage is small.* Inhabitants of Tinian report no damage (C); young leaves eaten in Saipan (E and T); leaves and stems of “pisang” attacked only slightly in Sumatra (He); unverifiable reports in Ceylon that leaves and apparently blossoms of plantain eaten, therefore fruitless (G); preferred by larger snails in Palau Islands (H and K); a chief food plant in Koror, ripening fruit liable to damage (K2); fruit, leaves, and new shoots are damaged in Saipan (L); young leaves eaten (Le); attacked in Philippines, peelings eaten (Pg); attacked in Java (Ri); could not verify damage (W).

Beach morning-glory (Ipomoea pes-caprae): This very common vine serves not only as one of the main shelter plants for achatina but as a good source of food;* a preferred food plant in Saipan (L).

Beans: Fed upon in Saipan (L); eaten voraciously in Filipino Islands (Pg); Phaseolus radiatus seedlings totally destroyed, foliage of older plants skeletonized, but the yam bean (Pachyrhizus tuberosus) suffered no damage (W).

Betel pepper (Piper betle): Untouched (G); no damage (W).

Bird’s-nest-fern (Asplenium nidus): A preferred food plant in Saipan (L).

Blimbing (Averrhoa bilimbi): Fruit completely stripped in Ceylon (G).

Bougainvillea: Both large and small snails attacked in Riouw Archipelago (L and V).

Breadfruit (Artocarpus spp.): The fruit of this tree, whether it be green, overripe, rotting, or dried, is a real favorite of the giant snails. Although the snails have been seen up to about twelve feet in these trees, the fruit which had not fallen was never observed being attacked or showing any signs of attack. Since the native people of many Pacific islands have abandoned the breadfruit for the more easily prepared imported staples, the breadfruit crop in some areas is being allowed to contribute 100 per cent to the maintenance of a larger and still larger snail population which otherwise could not exist. Robert E. Burton of the Agricultural Development Station on Ponape reported that all of a number of sprouted breadfruit clippings brought from the Truk Islands in 1948 were killed by having their bark removed by achatinas.* Inhabitants of Tinian report no damage (C); a chief food plant in Koror (K2); a preferred food plant in Saipan (L).
Cabbage (*Brassica* spp.): This and other Cruciferae are the most preferred food plants in the Philippines (Pg); severe damage in Saipan (L).

*Cacao* (*Theobroma cacao*): In Ceylon the giant snails were frequently seen congregating in great numbers in the areas where the cacao pods were being harvested; they were observed feeding on the flowers, broken pods, seeds, and seedling plants in nurseries; damage varied from slight to severe;† fed on young shoots and flowers in Indonesia (BJ); young seedlings up to two months of age readily attacked and killed in New Britain (D); no damage (H); direct damage by consuming freshly planted seeds, indirect damage by destruction of cuttings of dadap cover crop in Ceylon (N); killed young plants and injured blossoms of bearing trees, impossible to plant new clearings in Ceylon (S); seriously attacked and damaged (W).

*Cactus*: *Opuntia* sp. eaten (BJ); *Opuntia* and *Cereus* suffered damage in Java (L and V); damaged (Pg); attacked in Java (Ri).

*Calophyllum inophyllum*: A definite preference for the leaves of this plant.*

*Canna* sp.: Eaten voraciously in the Philippines (Pg).

*Carambola* (*Averrhoa carambola*): Fruit reported damaged in Ponape.*

*Carrots* (*Daucus carota*): Severe damage to both the tops and the tuberous roots was reported by the inhabitants of Chichi Jima;* fed upon in Saipan (L).

*Cassava* (*Manihot esculenta*): Damage is largely restricted to the young plants, reported to be a serious problem in Romalum, Truk Islands;* Tinian inhabitants report no damage (C); badly damaged, young stems heavily peeled off and killed in Java (Fe); leaves and bark damaged in Sumatra (He); a chief food plant in Koror (K2); attacked in Philippines (Pg); no damage (W).

*Chili peppers* (*Capsicum* spp.): Untouched (G); the fruit, leaves, and bark of *C. annuum* are attacked in Sumatra (He); stem and leaves of *C. grossum* eaten in Rota but damage not serious (K3); fed upon in Saipan (L); no damage (W).

*Citrus* sp.: Near-ripe fallen fruit and foliage of sweet orange (*C. sinensis*) were observed to be eaten on Agiguan;* seedlings seriously attacked in Philippines (Pg).

*Coconut* (*Cocos nucifera*): No damage observed;**† swarming on fronds but no evidence of injury (G); no damage (H, S).

*Coffee* (*Coffea* spp.): Slight damage to berries in Malaya (Co); in Su-
matra, young leaves attacked only when other food is not present (He); observed to attack in Philippines (Pg).

Corn (Zea mays): Only slightest damage to leaves and kernels in Chichi Jima, decaying leaves eaten readily;* inhabitants of Tinian report near destruction of field of very young seedlings, but no appreciable damage to larger plants (C); only slight damage to leaves in Sumatra (He); young seedlings readily eaten in Guam (K₂); fed upon in Saipan (L); seedlings sometimes attacked but no severe damage (W).

Cosmos sp.: Damaged in Philippines (Pg).

Cotton (Gossypium sp.): In Mauritius “it was responsible for a good deal of damage to cotton seedlings, when the attempt was made to plant cotton, on a large scale, in 1911” (C and G).

Cowpea (Vigna sinensis): Cover crop in Ceylon almost completely destroyed (Br); the fruit, leaves, and stems are damaged in Sumatra (He); young plants completely destroyed, older plants skeletonized (W).

Cucumber (Cucumis sativus): Very little damage in Koror;* inhabitants of Tinian report serious damage often to entire plant (C); one of favorite foods in Sarawak (Ha); fed upon in Saipan (L); seriously attacked in Philippines (Pg).

Cucurbitaceae: Especially liable to damage (D).

Eggplant (Solanum melongena): Plants stripped of bark in Ceylon (G); fed upon in Saipan (L); attacked in Philippines (Pg).

Elephant ear (Alocasia sp.): Foliage only sparingly eaten in Ceylon (G); “ape” loaded with snails and eaten (K₁).

Euphorbiaceae: Eaten (BJ); Euphorbia trigona eaten in Java (L and V); inflorescences eaten, but no serious damage (W) (vide Rubber).

Ferns: Fronds of tree ferns (Alsophila lunulata) eaten in Palaus;* young snails especially destructive to garden ferns (G₁).

Flower gardens (general): A wide variety of garden flowers are readily eaten, some of them being quite seriously damaged;*† suffering extensively in New Britain if they are not carefully protected (D); the damage killed young Salvia plants in Sumatra (Fe); “whole gardens devastated” (Jk); do not seem to attack Salvia, Torenia, or Coleus in Ceylon (Ma); serious pest in Seychelles (Mi); decided preference for ornamentals in Philippines (Pg); all agree that greatest damage is to gardens (S); much damage in Malaya (S₁); a real pest in horticulture (W).

Gourd (Lagenaria leucantha): “Upo” seriously attacked in Philippines (Pg).

Grasses: All seem to be nearly completely immune to attack.*†
Gynandropsis speciosa: Complete planting failed in Malaya in spite of controls (S).

Hibiscus spp.: A favorite plant, damage to both flowers and leaves noted;* hedges of this plant were invariably loaded with giant snails; all parts of the plant were subject to attack;† fallen flowers preferred in Palau (E and T, H and K); damaged in Java (Fe); attacked in Philippines (Pg) (vide Okra).

Jak (Artocarpus heterophyllus): The fallen fruit is a great favorite; whole areas of bark, even on mature trees (Fig. 5), may be consumed; young seedlings very susceptible to damage;*† “chew up whole seedlings up to three to four feet in height overnight” (Ho).

Leguminosae (general): A number of unidentified species consumed in the field attest to the wide preference for this group;* damage to the cover crop plant Pueraria thunbergiana was essentially complete on some estates in Ceylon causing indirect damage to Cacao; the more hardy Desmodium triflorum was only slightly attacked; bark of Gliricidia maculata and dadap (Erythrina lithosperma) subject to extensive attack, even in trees in excess of three inches in diameter; flowers of the dadap are a favorite;† large areas in Pueraria cover crop in New Britain barren and not reseeding (D); Centrosema pubescens damaged in Java (Fe); young dadap trees killed by bark removal in Ceylon (H); in Sumatra, the young leaves of C. pubescens and the leaves and bark of Deguelia sp. are damaged, and although under experimental conditions Cassia multitjuga was not touched, the following were readily eaten: Cassia mimosoides, Crotalaria anagyroides, C. striata, Indigofera suffruticosa, Mimosa invisa, Parkia sp., Tephrosia candida and T. vogelii (He); indirect damage to tobacco as young plants of cover and green manure crop (Mimosa invisa) were stripped of their bark in Sumatra (M); particularly destructive to dadap cuttings in cover crop of cacao (N); could not grow leguminous ground cover crops in Ceylon when achatina was at its height (Ph); young dadaps girdled and killed (S).

Lettuce (Lactuca sativa): Native people of Tinian indicate no damage (C); severe damage in Saipan (L); plants of all ages completely defoliated, but only seedlings of L. indica destroyed (W); food of greatest choice in the laboratory (We).

Leucaena glauca: This exceedingly common introduced species in its characteristic dense stands is clearly a preferred food plant from the Hawaiian Islands (where it is known as “Haole koa”) to Chichi Jima; all parts are avidly consumed, including the water-soaked seeds and the exposed roots; the slender stems are frequently seen
bent far over under the weight of snails feeding on the leaflets and
tender bark; occasionally fed upon in Tinian (C); not touched in
Sumatra (He); defoliation of young "lamtoro" trees placed in a
 teakwood stand in Java (R).

_Liliaceae:_ Nearly all lilies seem susceptible to attack; *Crinum* and
other lilies preferred (Da); favored plants (Ja); _Caladium_ not at-
tacked (Ma).

_Malungay (Moringa oleifera)_: Observed being attacked in Philip-
pines (Pg).

_Melons (Cucumis melo; Citrullus vulgaris)_: The fruit and vines of
all types are on the preferred list; on Rota, they cause such de-
struction of watermelon vines that the native people walk several
miles to plant their seeds in an achatina-free area; attacks on the
young fruit will badly disfigure it, interfere with proper develop-
ment, and make it worthless for consumption; *inhabitants of
Tinian report serious damage often to entire plant (C); severe
damage in Saipan (L); rinds consumed (Pg).

_Montanoa hibiscifolia_: The bark and pithy stems deeply and exten-
sively grooved in Hawaii.*

_Morinda (Morinda citrifolia)_: Both the leaves and the mushy, white
fruit were among the most preferred items in Koror; *preferred in
Saipan (L).

_Oil palm (Elaeis guineensis)_: Prefer overripe or underripe fruit in
Malaya (Co1, Co2); attack mainly fallen fruit but also ripening
fruit on branches (F); will attack leaves only if very hungry (He).

_Okra (Hibiscus esculentus)_: Plant practically defoliated and fruit in-
jured to such an extent as to make it valueless in Ceylon (G);
severe damage in Saipan (L).  

_Onion (Allium spp.)_: No damage (W).

_Orchids: Phalaenopsis and Vanda_ damaged in Riouw Archipelago
and Java (L and V); _Phalaenopsis_ spp. damaged in Philippines
(O); attacked in Java (Ri).

_Pandanus_ spp.: No damage observed; *occasionally fed upon (L).

_Papaya (Carica papaya)_: A great many times the snails were seen high
up in the trees; both fruit and bark are damaged; in Ponape mis-
sionaries complained bitterly of attacks on the fruit; *a fallen
tree was completely consumed in a week, a near-prostrate tree
suffered damage to buds and flowers, snails seldom seen in top
of erect trees in Tinian (C); older trees in New Britain are de-
prived of their bark until they wilt and die, seedlings are eaten
away completely (D); ripe fruit damaged in Saipan (E and T);
leaves eaten, young stems ringed and killed (Fe); flowers consumed
in Ceylon (G); fruit, leaves, and bark of young trees damaged in Sumatra (He); preferred by larger snails in Palaus (H and K); chief food plant in Koror, fruit liable to damage (K); preferred food plant in Saipan (L); eaten in Java (L and V); fruit eaten in Philippines (Pg); climb trees and eat ripe fruit (T).

Passion flower (*Passiflora* spp.): One of the commonest plants of choice in the Pacific; fruit, flowers, and leaves eaten; in many areas it is the main if not the sole food item; greatest preference in Tinian (C); the leaves and ripe fruit are preferred items in Saipan (L); most of the snails’ food is the old yellowing leaves and ripe fruit (T).

Peanut (*Arachis hypogaea*): A planter in New Guinea abandoned peanut cultivation largely because the snails made continual appreciable inroads in his fields (D); attacked the leaves, stems, and nuts in Sumatra (He); young plants completely destroyed, older ones seriously defoliated (W).

Pepper vine (*Piper nigrum*): Young pepper vines planted at the base of *Gliricidia* trees in an unthrifty cacao plantation in Ceylon suffered 100 per cent kill because the palm frond shields, set up to protect the vines from the sun, provided shelter for great quantities of hungry achatinas; plant killed by eating outer layers of stem; Tinian inhabitants report vines often killed by snails (C); leaves attacked in Sumatra (He).

Pineapple (*Ananas comosus*): No damage observed or reported in the East Caroline Islands, Hawaiian Islands, or Ceylon; no record of feeding on pineapple (Pe).

*Pipturus albidus*: The fallen leaves of the common “mamaki” of the Bonin Islands were observed to be a definite favorite.*

Pumpkin (*Cucurbita pepo*): In Chichi Jima, the pumpkins had to be raised in protected boxes and then transplanted to prevent them from being chewed off as fast as they came up; inhabitants of Tinian reported serious damage often to entire plant (C); species introduced by Japanese in New Britain entirely eliminated by the snails in some areas (D); leaves skeletonized and stems barked in Ceylon (G); fed upon in Saipan (L).

Radish (*Raphanus sativus*): All parts of the plant attacked in Sumatra (He); fed upon in Saipan (L).

Ramie (*Boehmeria nivea*): Attacked in Philippines (Pg).

Rice (*Oryza sativa*): No damage (G, H, He, W); no harm except breaking down plants with their weight (S).

Roses (*Rosa* spp.): Do not seem to attack in Ceylon; attacked in Philippines (Pg).
FIG. 1.—The largest living *Achatina fulica* Bowdich ever photographed. This specimen, collected in Guam by George D. Peterson, Jr., has an over-all length of nearly one foot and a shell length just short of eight inches. (Photo courtesy of G. D. Peterson, Jr.)
FIG. 2.—The Army Hill population of the giant African snail in Saipan in 1949.

FIG. 3.—Achatina fulica (ca. 85 mm.) with three of several predatory snails that have been considered in its biological control; left to right: Euglandina rosea, Gonaxis quadrilateralis, and Natalina sp. (Photo courtesy of Alan Thistle.)
Rubber (*Hevea brasiliensis*): Occasional specimen seen feeding on latex at tapping site; disfiguring or killing damage to young plants in nurseries considerable in some areas; feed on young seedlings and buddings, continued destruction of buds produces distinctive type of fasciation (Be); drink latex and eat sweet cambium layer of bark exposed by tapping thus causing wounds (Be\(_2\)); serious economic importance in Malaya (Be\(_1\)); feed on young shoots and flowers (BJ); damage to young rubber rather serious in Ceylon (Br\(_1\), Ct); G. A. C. Herklots indicates no very considerable losses in rubber industry (Ca); young trees severely damaged in Sumatra; bark removed, stems ringed, leaves consumed, growing tips and replacement growth damaged to such an extent that death resulted in some cases; older trees not seriously affected although the snails' consumption of latex (proved by crushing snails and observing the latex in the gut) contaminated the latex, sidetracked its flow, and caused the collecting cups to fall to the ground (Fe); no damage (H); young leaves and bark damaged only when more acceptable food is not present (He); bark stripped off, killing young plants; achatinas seen by the hundreds in Ceylon sucking sap in latex cups (N); "learned to drink rubber latex" (Pb); strip succulent bark from young plants, drink latex (Ph); drink a considerable amount of latex (Pv); impossible to plant new clearings in Ceylon in 1916 (S); seriously attacked (W).

*Scaevola frutescens*: Both leaves and flowers are preferred items.*

*Soursop (Annona muricata)*: No apparent damage in Dublon, Truk Islands;* a preferred food plant in Saipan (L).

*Squash (Cucurbita spp.)*: Attacked in Philippines (Pg).

*Staple crops (general)*: Left unharmed in Malaya (Be\(_2\)); no appreciable damage in Malaya (S\(_1\)); damage only a fraction if at all (W).

*Sugar cane (Saccharum officinarum)*: Often found congregating in great numbers on the leaves but damage was practically nil;* damage to leaves on Saipan (E and T); damage in Java, especially to the leaf axils where there is much less concentration of silica cells, but of no real economic importance (Hs); a chief food plant in Koror (K\(_2\)); no record of damage (Pe).

*Sweet potato (Ipomoea batatas)*: The vines provide cover often for phenomenal numbers of snails but damage to leaves and exposed tubers was invariably inappreciable;* not eaten in Tinian according to inhabitants (C); many snails but no damage was noticeable in Ceylon (G); a chief food plant in Koror (K\(_2\)); attacked in Philippines (Pg); foliage sometimes attacked but no serious damage (W); foliage a food of choice in the laboratory (We).
Taro (*Colocasia esculenta*): Foliage is not infrequently attacked, though seldom skeletonized; rarely, damage is caused to exposed roots; total damage is surprisingly almost inconsequential even in areas overrun with snails;* a lot of damage in Kabunga, New Guinea (A); feed only on fallen leaves, but according to the inhabitants of Tinian, the rarely exposed tubers are eaten (C); only slightly affected in New Britain as it is particularly hardy and fast growing (D); foliage eaten very sparingly in Ceylon (G); fallen leaves eaten in Palau (H and K); not affected in Guam (K1); a chief food plant in Koror (K2); only occasionally fed upon in Saipan (L).

*Tea* (*Camellia sinensis*): Every report in Ceylon was negative;† young shoots and flowers are eaten (BJ); no damage in Ceylon (H); young leaves attacked only when there is little else to eat (He).

*Teakwood* (*Tectona grandis*): Year-old plants damaged in S. Sumatra (AV); up to 90 per cent lethal damage to young plants in Java (R).

*Thespesia populnea*: A preferred food plant in Saipan (L).

*Tobacco* (*Nicotiana* sp.): Bark removed from base of plant, stalk weakened so that it blows over easily; leaves of young plants eaten; total damage negligible; will never become a serious pest (M).

*Tomato* (*Lycopersicon esculentum*): Foliage seriously damaged in Guam immediately following the first big rain of the season;* not attacked in Ceylon (Ma); decaying fruit consumed (Pg); indifferent to plants (W).

*Tree nettle* (*Laportea crenulata*): Stems and branches completely denuded, killing the trees; practically exterminated in some localities (G).

*Vegetables (general)*: Most varieties were found to be attacked at least to some extent; in some cases serious damage was caused, especially in small plots adjacent to abandoned or uncultivated areas;*† suffering extensively in New Britain if they are not carefully protected (D); certain plants defoliated and others denuded in small vegetable patches (G2); damage to fresh vegetables caused mainly by the smaller specimens (H and K); a pest (H); farmer in Sinajana-Ordot area of Guam reported that it was not possible to raise vegetables as they were too vulnerable to attack by snails (K1); serious pest in Seychelles (M1); decided preference for succulent vegetables in Philippines (Pg); a serious pest in Ceylon (Pv); “great depredations” in Calcutta (Ry); in some localities in Malaya the growing of certain vegetables has become almost impracticable (S); particularly destructive (T); seriously attacked (W).
Vegetable sponge (*Luffa* spp.): “Patola” seriously attacked in Philippines (Pg).

Weeds and uncultivated plants: Many species are attacked; some are definitely preferred and others are only occasionally eaten;*†* Lange (1950) has prepared an impressive list for Saipan and as far as known, it is the only such list extant.

*Xanthosoma braziliense*: Leaves and stems of “Tahitian spinach” eaten in Hawaii (Ki).

*Yam* (*Dioscorea alata*): The leaves are an obvious favorite; eaten extensively in Ceylon;† no appreciable damage in Tinian (C); young plants eaten down to the ground in Ceylon (G); impossible to plant yams in Rota when snails were abundant (K₃); severe damage in Saipan (L); “ubi” seriously attacked in Philippines (Pg).

*Zinnia linearis*: Attacked in Philippines (Pg).

**Evaluation of Damage** In examining critically the above list, one is left with the very definite conviction that considerably more in the way of careful observation is required before there can be made an accurate evaluation of *A. fulica* as an agricultural and horticultural pest. A review of the reports of damage caused by this snail discloses the fact that the greater share of them are qualitative only. That is, we know what the snail will attack, but we do not know to what extent the snail will attack it. Studies of quantitative damage therefore must be made. Then, when it is known, for example, that the maximum damage to a certain type of plant is negligible, the presence of *A. fulica* in stands of that plant will not cause the needless initiation of elaborate and costly control measures. In spite of these difficulties, certain generalizations and a number of rather specific conclusions can be made at this time. These at least will assist in arriving at a reasonably satisfactory tentative evaluation.

Garden flowers and ornamentals of a great many varieties are among the most susceptible to the attacks of *A. fulica*; often all parts of the plant in all stages of development are eaten. Most vegetables, but especially those belonging to the Cruciferae, Cucurbitaceae, and the Leguminosae, often suffer severe damage. Cuttings and seedlings, even of plants not attacked in the mature state (e.g., breadfruit, cassava, teakwood, etc.), are also preferred food items of this snail; damage to these is caused by their complete consumption or by the removal of bark. According to Jaski (1953), the young snails, up to about four months, feed almost exclusively on young shoots and succulent leaves. Cover crops, and especially those that are leguminous, represent the fourth and last major category of plants which may be severely dam-
aged. In most cases the effects of the damage rest not so much in the physical destruction of the cover crop plants as in the secondary damage to the main crop for which the cover crop is used for green manure, shade, soil retention, moisture retention, and/or nitrogen restoration. A case in point is the almost complete destruction of the leguminous cover crop *Pueraria thunbergiana* in the Dodangoda Post of the Godahene estate in Ceylon. The cacao plants suffered from the reduction of available nitrogen in the soil; and the soil, in turn, suffered marked erosion particularly in the steeper denuded areas. The more woody, hearty legume, *Desmodium triflorum* was substituted because it was more resistant to the attacks of the giant snail; but this cover plant grows more slowly, produces a less dense cover, adds proportionately less nitrogen, and succumbs more readily to one of the plant diseases.

*A. fulica*, however, comes rightfully by this type of destruction as Spence (1938) has reported related achatinids (*Limicolaria zebra* and *L. numidica*) in their native home of British Cameroons destroying leguminous cover crops of *Calopogonium*, *Centrosema*, and *Pueraria*, which were interplanted with oil palms. Not only did the cover crops suffer from the attacks, but the palm fruit itself was eaten. Similarly, there has been reported damage to sesame and coffee by *Achatina craveni* Smith (Salaam 1938); damage to sisal and cotton by *A. zanzibarica* (Tomaszewski 1949); damage to papaya and other plants by *A. albopicta* (Williams 1951); and damage in nurseries by *Limicolaria distincta* and *L. lucalana* (Dartevelle 1954).

Although many plants of little or no economic importance are attacked by *A. fulica*, it is significant that the majority of plants which suffer the greatest damage are conspicuously of the cultivated type. Taylor (1894) quotes from Gain data which similarly show that cultivated plants form nearly two-thirds of those “acceptable” to the snail *Cepaea hortensis*.

Several reports of damage listed above are considerably more significant than they might appear to the casual reader. The observed damage to citrus fruit and seedlings sounds an ominous warning of what might happen should these giant snails become settled in the great citrus growing areas of the world. It has already been established that the climatic conditions particularly suitable for citrus are very nearly equally suitable for *A. fulica*. And, for the skeptics, stranger things than this have happened in the field of malacology. For example, although it was well known that *Theba pisana* had a strong propensity for citrus fruit (both leaves and bark) in its native home (de Stefani 1913) and in California (Basinger 1923a, c, 1927;
Gorton 1919; Smith 1919a, b, 1922), most malacologists would have been somewhat hesitant to announce that its near-relative, *Helix aspersa*, if given the opportunity, could become an almost equally serious pest. But within recent years, just that has happened in Southern California (Anon. 1929; Basinger 1931, 1940; Gammon 1943; Lewis and LaFollette 1941, 1942a, b; Persing 1943–45; Wog-llum 1943).

The over-all damage that results from the feeding of *A. fulica* on rubber trees, fortunately, is not critical in any real sense of the word. Under certain conditions, however, there can be significant and even serious local damage to the young saplings, especially in nurseries. R. C. L. Notley, chairman of the Planters' Association of Ceylon, and E. Phillis, director of the Rubber Research Scheme of Ceylon, have reported in correspondence numerous incidents of serious damage of this sort. In the literature, the works of Beeley and Feij are particularly convincing. The snails' strange but not unique appetite for the fresh rubber latex makes them a nuisance and sometimes a pest on the larger trees when they are being tapped. Green (1909, 1910a), Keuchenius (1914), and Meer Mohr (1924) have shown that the endemic sluglike snails *Mariaella dussumieri* and *Parmarion reticulatus* can be, in the same respects, equally serious pests on rubber. Paravicini (1922) adds the well-known plant pest *Bradybaena similaris* to this list.

All parts of the papaya tree seem inordinately susceptible to the attacks of the giant African snail; and as its fruit is a universal favorite wherever it is available for human consumption, losses would be particularly felt in the areas where the snail is abundant.

Reports of damage to peanut and pepper vines seem to be more than a little significant as these plants figure very prominently in world commerce. In both cases the extent of damage needs to be determined accurately. In the meantime, it will be hoped that the lack of more reports of this sort is indicative of only slight general damage.

Consistent reports of very little or no damage to certain other crops are, in many respects, even more significant than reports of appreciable damage. For example, all members of the grasses, such as sugar cane, corn, rice, and the “grains,” are very conspicuously immune to all but occasional, relatively insignificant damage. And this seems to hold pretty well in all regions of the world, although Herrström (1953) reports slug damage to stored winter wheat. Considering the tremendous importance of these products in the economy of the world, it is a blessing indeed that there is such universal immu-
nity. Other staple starchy crops such as the taros and sweet potatoes are almost as free from serious damage, although the cassava suffers some damage, especially in the young stage; and in some areas the yam is seriously attacked. Newspaper accounts and other reports (e.g., Zuk 1949) to the contrary notwithstanding, the giant African snail cannot be considered in any possible way a threat to the coconut industry. The same can be said for other economically important "woody" plants like the pineapple and the pandanus. The betel pepper, onions, most varieties of chili peppers, and many other highly aromatic or irritating plants are understandably not among the preferred items of \textit{A. fulica}; but one cannot completely generalize from this, as the tree nettle, cactus, and tobacco are appreciably damaged in some instances. The literature is conspicuously almost completely devoid of anything but the most incidental report of damage to coffee and tea plants. From this we can infer that the giant snail can be written off as a possible pest of these plants since otherwise its abundance in the tea- and coffee-growing areas of the East would surely have caused many reports of damage to have been made by this time. Other species of snails, however, have been listed as principal pests of coffee in Brazil (Fonseca and Autuori 1932). The other great beverage plant, the cacao, unfortunately suffers a fair amount of direct and indirect damage.

Of fruits themselves, only the papaya seems to be damaged to a serious extent; the others either have not been reported as damaged or have been reported as damaged only slightly. Perhaps an explanation for this can be found in the fact that there is a definite preference for rotting and therefore fallen fruit. At any rate, it seems safe at this point to assume that another whole category of plant products can be considered very nearly free from significant damage. It should be borne in mind, however, that many of these apparently "immune" plants can and do sometimes suffer complete destruction in the unprotected young stages.

\textbf{Indirect Damage} So far, the only example that has been given of indirect damage to plants concerns the destruction of cover crops. There are others which must be taken into consideration if a fair evaluation of the problem is to be made. Quite probably, many of these have not found their way into the literature because they have not been recognized as damage resulting from \textit{A. fulica}. For example, rice and other plants which are not eaten by the giant snail nevertheless may be badly damaged under conditions where the sheer weight of the snails causes the plants to break. Another example, with an ironic twist, is reported by Dr. E. Phillis who states (in
that in Ceylon some land on tea estates has been rendered unfit for growing tea because the snails were collected and buried in such quantities that the acid soil, demanded by the tea plant, became too strongly alkalized. An equally provocative situation is found in Sarawak where Tom Harrisson states (in litt. Aug. 25, 1952) that the Chinese market gardeners and others are required, in order to minimize damage by \textit{A. fulica}, to keep their plots so clean all the year around that excessive soil erosion has occurred.

Because the giant snail competes with other animals for food, and because it, in turn, provides an increasing source of food for certain carnivorous animals, including paradoxically some with which it is competing, the entering of \textit{A. fulica} into an environment invariably produces a series of ecological chain reactions which in some cases result, via the most devious channels, in damage of a completely unpredictable nature. The snail’s potentiality in this respect should never be underestimated. This whole topic of environmental inter-relationships is discussed under several headings below and summarized in the figure on page 137.

Under the heading of indirect damage must also be considered the possibility that \textit{A. fulica} might carry plant diseases. This possibility finds support in our knowledge of some predisposing aspects of the biology of this snail, viz., the formation of plant wounds through rasping, the proclivity for decaying and rotting vegetation, and the contact with many plants over a relatively short period of time. But although there is no positive evidence in the literature of this snail being implicated in this manner, the lack of experimental evidence one way or the other clearly indicates both the need for such experimentation and the danger of attempting to draw any conclusions at this time. It is apropos, however, to mention at this point references which establish a vector role for gastropod mollusks. Wagner (1896) demonstrated that snails could act as vectors of fungous spores. Later, Gravatt and Marshall (1917) reported that snails were capable of spreading white pine blister rust in greenhouses; on the other hand, slugs apparently were not able to transmit tobacco mosaic to healthy plants (Purdy 1928). Rands (1924) reported that he had repeatedly confirmed the fact that \textit{Zonitoides arboreus} is a vector of “root rot” of sugar cane in Louisiana; and Robbs (1946) listed \textit{Deroceras reticulatum} as one of the disseminators of black rot of cabbages and other Cruciferae. Plate and Frömming (1951) offer additional information on the vector role of slugs in the transmission of fungous diseases of plants. More recently, Frömming (1955) has implicated various species of slugs and snails in the dissemination of potato diseases.
tainly the disease vector aspect of the achatina problem needs badly the attention of a qualified investigator, especially since a danger of this sort could exist without raising the suspicions of the average observer.

**Nuisance Factor** As a nuisance factor, the giant African snail at the height of its invasion can be listed among the worst which plague man. Corbett (1933) was one of the very first to recognize the importance of this factor. The snails multiply in such unbelievable numbers that they crawl all over and into everything, they crush or slip out from under foot almost wherever one steps, they cover things with their excreta and sticky slime trails, and they die in great quantity for various reasons and create rank odors. In this manner they very seriously interfere with normal living and thus assume an importance which may far outweigh any damage they may do to the vegetation. Therefore, in judging the undesirability of *A. fulica*, the nuisance factor must not be lost sight of as it alone more than justifies efforts to keep this snail out of uninfested areas. Unfortunately, those who are prone to minimize completely the threat that this snail presents seem invariably to overlook this very important point.

The highways and other thoroughfares may be lined for miles with living and dead snails. Individuals attempting to cross to the other side may be crushed into a slimy mess, and as such they provide one of the choicest food items for those that survive. But, ironically, those that feed upon the crushed carcasses all too often become crushed themselves and in turn attract other snails which may suffer the same fate. In this manner a genuine road hazard may be formed, especially on the curves and grades. This has been observed in Saipan by Abbott (1949), the present writer, and others. Apropos of this, the following words of Kalshoven (1950) do not need translating, "Toen de Amerikaanse troepen er in 1945 landden, waren de slakken er zo overvloedig, dat de jeeps er slipten." R. C. L. Notley (*in litt*. Dec. 7, 1950) reports them similarly forming "stinking nightmares" on the highways of Ceylon.

Their appetite for whitewash (which contributes lime to their shell) permits them almost to exceed their capacity as a nuisance; for although damage to painted surfaces is rarely extensive, it is disfiguring and adds substantially to maintenance costs. A number of investigators have reported damage of this sort, but Witkamp (1941) has illustrated and made more recent special mention of it.

In Guam, the giant snail so incessantly interfered with the deratization program, by consuming with apparent impunity the warfarin rat bait, that it was necessary either to prebait with a molluscicide or
to use concurrently both a snail bait and a rat bait (Peterson 1957b).

R. K. Enders observed in his survey of the rat problem in Micronesia in 1949 that rat traps set with ordinary baits, such as peanut butter, cheese, bacon, etc., often caught more giant snails than rats. It will be left to the reader's imagination the slimy mess that is created when a rat trap snaps on a snail!

**Health Factor** By their sheer multiplicity the snails will often find their way into open wells, creeks, and other bodies of water. Their rotting carcasses not only render the water unfit for drinking but present a hazard to health. But the hazard does not rest there alone. The thousands upon thousands of dead and dying snails in a heavily infested area form potent breeding sources for filth flies which are carriers of enteric diseases. Annandale (1919) reported the breeding of "blue bottle flies (Pycnosoma or Lucilia dux)" in this way and associated their appearance in Silpur, India, with epidemics of "enteric." Smedley (1928) similarly reported in Malaya the breeding of Megaselia xanthina (i.e., Aphiochaeta) which he indicated can produce a myiasis in the human intestine. Lange (1947), Williams (1951), and others have made comparable observations. In Chichi Jima and Haha Jima of the Bonin Islands, Musca domestica and other filth flies were found breeding in such great quantities that keeping them from one's food even while eating was almost an impossible task. In this particular situation, however, their breeding was made much worse because the inhabitants gathered the snails in large barrels and allowed them to die in the sun and become maggot infested before crushing and using them as fertilizer. Cockroaches presented an equally serious problem in these islands. Since they were often seen at night feeding on dead achatinas, it is assumed that at the very least the snails have aggravated this problem if not actually precipitated it. The health hazard under such conditions is a very great one but its full epidemiological potentiality will not apparently be realized unless and until an enteric disease agent, for which the native people have little or no resistance, is accidentally introduced by outsiders.

The propensity of these snails for feeding on the excrement of humans, household pets, and livestock presents a somewhat different type of problem (Lange 1950; Mead 1950b, c; Garnadi 1951; Williams 1951). Green (1910c) apparently was the first to make this observation; but he believed at the time that by consuming such material, the snails were providing a real source of service. Van Weel (1948), however, interpreted this information in a different way, viz., that the snails would, in addition to their other sins, cause the spread
of "contagious diseases." Actually, this would only be the case if (1) the snails were used for human consumption in the raw or insufficiently cooked state, or (2) flies fed upon the dead, infected snails and in turn contaminated human food, or (3) the disease producing entities were able to pass through the snail and be deposited in an infective state some distance from the original source of infection. It can be seen that none of these alternatives contributes anything of a significant nature to the epidemiological factors involved. In the case of the latter two alternatives, the filth flies themselves are so effective in carrying enteric disease agents that any possible part the snails might have would be inappreciable indeed. Although the first alternative is an extremely unlikely one, Schnell (1919) has indicated that it is not an impossibility as he reports on a case of mass infection of the dwarf tapeworm (*Hymenolepis nana*) in prisoners of war who had eaten raw Weinbergschnecken (*Helix pomatia*).

It is of interest to note in passing that Lebour (1915) demonstrated that the slugs *Deroceras reticulatum* and *Arion circumspectus* would naturally consume proglottids of the tapeworms *Moniezia expansa* of sheep and *Cittotaenia pectinata* of rabbits. Since the ova were found to pass through the digestive tract in a viable state, it is believed that these slugs act as incidental disseminators of disease agents. In the following year, Railliet similarly found fair evidence that carrier pigeons were becoming infected with the tapeworm *Bertiella delafondi* by consuming *D. reticulatum* which had earlier fed on infectious material. This same species of slug as well as three different species of land snails were shown by Taylor (1935) to be capable of acting as the intermediate host of the gapeworm of poultry (*Syngamus trachea*). Both *D. reticulatum* and *Arion ater* were found to be carrying on the surface of their bodies viable ova of two nematode parasites of humans, *Ascaris lumbricoides* and *Trichuris trichiura* (Galli-Valerio 1918). Hanson (1930) and Blaisdell (1950) report, respectively, that the slugs *D. reticulatum* and *Prophysaon andersoni* are the intermediate hosts of the microscopic tapeworm of chickens (*Davainea proglottina*) and the slug *Arion circumspectus* is an intermediate host of the cat lungworm (*Aeluurostrongylus abstrusus*). Similarly the common land snail pests *Bradybaena similaris* and *Subulina octona* are intermediate hosts of the cecum fluke of poultry (*Postharmostomum gallinum*) (Alicata 1938, Thistle 1959a). The rat lungworm, *Angiostrongylus cantonensis* (Chem), was found to be carried normally by unidentified species of garden slugs (Mackerras and Sandars 1954). Recently, Frömming (1952b) empha-
sized that the coprophagous habits of slugs strongly implicates them in spreading the diseases of humans and plants.

But these items are only suggestive in the case of *A. fulica*. Under no circumstances can there be found any grounds for the fears of Morgenstern (1949) who believes that these snails could spread the several dread fluke diseases of humans.

In East Africa, Williams (1951) observed mosquitoes breeding in empty achatinid shells and thus brought attention to a factor which conceivably could be of the utmost importance in areas where disease-carrying mosquitoes prefer this type of breeding site.

**Role as Scavenger** It has been mentioned that *A. fulica* provides at least an incidental benefit by consuming human and livestock excrement. A closer examination, however, shows that this is only one example of many which attest to the fact that this snail contributes much to the plus side of the ledger by acting as a general scavenger par excellence. For example, even a dead black rat near Agaña, Guam, was observed by the author to have been eaten by these snails (cf. Dalgliesh 1907). The fact that they avidly consume the shell and flesh of dead and even putrifying individuals of their own and other species is of but the commonest knowledge. Pangga (1947) has stated, “Growing plants furnish the major portion of its food.” The majority of investigators do not concur in this. Instead, they feel that rotting, soggy, and decaying vegetables, fallen fruits, leaves, and even entire plants are definitely the most frequently selected food items, even in a great many cases where the plants are never touched in the fresh or growing state (Chamberlin 1952a; Esaki and Takahashi 1942; Green 1910c, 1911b; Hatai and Kato 1943; Townes 1946; etc.). Jaski (1953) states that after a snail reaches the age of four months, it shows a definite preference for decaying matter. Garbage and trash of almost any sort, especially if they are wet (e.g., water-soaked cardboard boxes), are also preferred food items (Esaki and Takahashi 1942, Pangga 1949)—so much so, in fact, that Rees (1951) has been moved to conclude that this explains the abundance of snails about native villages. It would seem, however, that their abundance in such places more clearly reflects the fact that the natives themselves have provided the best means for spreading these otherwise very slow snails from one village to another and that their garbage, trash, and waste material are only contributory factors. It is assumed that the frequent consumption of moist soil by these snails is still another expression of scavenging which not only brings in an additional amount of decomposing organic material but assures under normal conditions an adequate intake of certain essential inorganic compounds.
Barnes (1949b) minimizes the importance of the scavenger role of terrestrial gastropods with the suggestion that all the material they eat would normally be broken down by other biological agents. But even in the tropics, agents to which he doubtless refers, viz. bacteria and fungi, reduce the material at a much slower rate. Further, they do not build it back up into an available source of highly nutritious proteins as do the snails, the economic significance of which is emphasized below. Although Green (1910c), Corbett (1933), and a very few others have emphasized the importance of this scavenger role, it is a topic which in general has been ignored by the majority of investigators, probably because the disappearance of dead and decaying material, by its very nature, is neither noticed nor contemplated. On the other hand, even with full cognizance of this scavenger role, it is difficult to evaluate. And, further, because of the unwanted nature of the material consumed, it apparently has seemed pointless to attempt such an evaluation. It will be shown later, however, that a careful evaluation is of worth in that it automatically suggests a very constructive method of control. But, beyond this, it must be concluded that it is the dominance of this scavenger role which unequivocally explains the apparent paradox of great concentrations of these snails existing in uncultivated areas with little or no patent signs of damage to the vegetation. It is quite another story, however, when such concentrations exist in or adjacent to cultivated areas planted with flowers, vegetables, cover crops, or young seedlings or cuttings. In such areas, it is both the normally reduced amount of plant debris and a high preference for succulent plant tissues which decrease scavenging and invite damage. From these statements it can be inferred that in the uncultivated areas A. fulica, through its scavenging, may actually contribute more good than harm and that just the reverse obtains in cultivated areas where the plantings are especially preferred. The nuisance and health factors, of course, will detract in either case to a degree depending upon the nature of the human element. Because this snail spreads largely through the human agency and because it spreads relatively very slowly on its own, there is a strong tendency for snail populations to build up and stay close to inhabited areas. This explains why in the majority of instances the giant African snail must be looked upon as detrimental rather than beneficial. And even in inhabited areas where it causes only a minimum amount of harm, its potentiality for becoming worse argues against maintaining an attitude of indifference.

At any rate, there is at this point clearly neither evidence nor excuse for the tall tales which liken A. fulica to a plague of migratory
locusts. It is only in the most localized areas, under unusually favorable conditions, that damage by these snails will approach anything near the absolute. A not uncommon example of this is found in the small, unprotected, native garden plot surrounded by snail infested bush. The first rains after the dry season may cause the snails to come out of estivation, move into the garden plot en masse and virtually clean it out overnight. But, even under these conditions, the alert native can anticipate this damage and take effective steps to reduce it very considerably. Such measures, however, demand unrelenting effort, and the snail menace therefore still is reduced only to a most undesirable, persistent harassing agent. And in fact it is in this very capacity that the snail assumes its usual role with respect to the susceptible crops of man.

**Unjust Charges** A final aspect in attempting to determine the actual economic status of the giant African snail is found in the subject of "unjust charges." First of all, the nocturnal feeding and secretive habits have given an insidious flavor to the damage caused by this snail. This in turn has caused the snail to fall victim to a great deal of circumstantial evidence. As in many other systems where trouble is afoot, there is need for a scapegoat, and *A. fulica* has been a "natural" for this role wherever it has gone. Its large size, recentness of arrival, and ubiquitousness have all contributed to the "case" against it. In areas where this snail has invaded, it is not difficult to find one or more individuals adjacent to plant damage of any sort. The frequency of such observations has persuaded the native people in many quarters to blame the giant snail for almost everything. A closer inspection may show that some smaller, less conspicuous animal is either largely or entirely to blame for the damage. As an example, the purported damage by *A. fulica* to sweet potato vines in several of the Micronesian islands proved quite clearly to be simple cases of circumstantial evidence. The snails were found in abundance among the obviously chewed vines; however, a more critical examination by the author revealed that it was actually a cutworm and a small flea-beetle which were producing the observed damage. Green (1910c) made comparable observations. The mere presence of many snails seeking the shade of banyan trees, sugar cane, coconut palms, and other essentially immune plants has persuaded native people and certain incautious observers to conclude that even though no discernible damage could be found, damage somehow must be there—and it has been so reported.

In Guam some of the native peoples bitterly accused the snails of "poisoning" their cats and dogs when in reality death was caused
from biting the commonly introduced giant toad, *Bufo marinus*, which is protected by very toxic skin glands. Other, less conspicuous pulmonate gastropods in certain areas join *A. fulica* in creating damage, but actually may escape accusation. Cases of joint damage of this sort have been reported on tobacco (van der Meer Mohr 1949a), oil palm (Corbett 1941), corn (Mead 1950b), gardens (Corbett 1933), and rubber (Beeley 1938a, b; Robson 1914). In certain areas at least, damage to fruits, such as the papaya, may be caused more frequently by birds and rats than by the giant snail (Chamberlin 1952).

The many exaggerated claims and cases of misinformation alluded to earlier are also included under the heading of “unjust charges.” In contrast to the statement that they will “eat anything that will hold still,” there is an impressively long list of economically important plants which are seldom or never attacked. Actually, their only lack of dietary specificity rests in the eating of dead and decaying material.