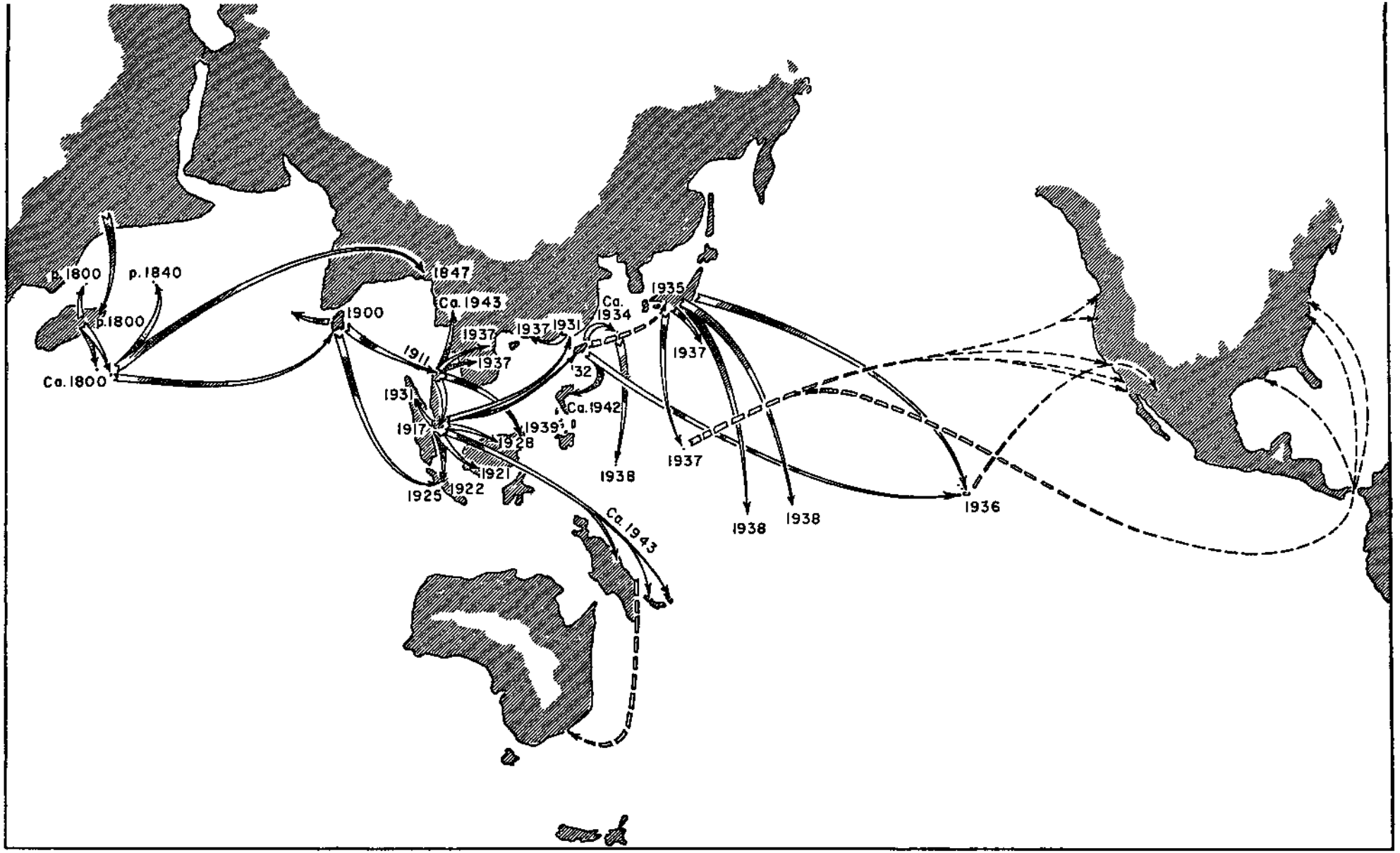
CHAPTER 2

DISPERSAL OF THE GIANT AFRICAN SNAIL

Much has been written about the travels that *Achatina fulica* has made since it left its original home in East Africa. The most outstanding treatises on the subject are: Bequaert (1950*b*), Lange (1950), Pemberton (1954), Rees (1951), and van Weel (1948) in the English language; Kalshoven (1950) in Dutch; Merle (1949) in French; Boettger (1951) in German; Sonan (1936) and Esaki and Takahashi (1942) in Japanese; and Aguayo (1950) in Spanish. An examination of the rather considerable literature on the subject has revealed many disturbing discrepancies and conflicts. In so far as it is possible to do so, these have been resolved, clarified, or explained in order to arrive at a better understanding of what has taken place and what will probably take place in the next relatively few years. Chief among the items of misinformation being perpetuated in the literature are those which concern the presumed establishment of this snail pest in the "South Pacific," New Caledonia, Yap, the Marshall Islands, the continental United States, and the West Indies. There is also the frequent misstatement that *A. fulica* has been eradicated in Hawaii. It should be emphasized that the only place in the United States where this snail is established is Hawaii, although it has been intercepted and destroyed in Arizona (Mead 1959*a*, *b*) and



During the nineteenth century the giant African snail moved slowly eastward across the Indian Ocean from its East African home. Upon reaching Southeast Asia, however, it moved at an increasing rapid pace, appearing almost simultaneously in many primary sites of infestation in East Asia and the Pacific Islands. With the advent of the Second World War, it spread to many other Pacific islands and was intercepted alive at American and Australian ports. This snail pest is still on the move and predictably will become established in agriculturally important sites farther east in the next relatively few years. Broken lines indicate interceptions; solid lines indicate establishment; *ca.* = circa; *p.* = prior to. (Drawn by D. B. Sayner.)

in a number of ports in the continental United States. It also should be emphasized that, so far as we know, the giant snail has not become established anywhere in the Marshall Islands.

Because people have been alerted to the dangers and the rapid spread of this snail, any large snail has been immediately suspected by the uninitiated as being *A. fulica*. For example, it was possibly an *Amphidromus* which caused van Brero (1933) to miscalculate the time *A. fulica* had been in Java (Leefmans 1933*b*). A large *Vivipara* in New York caused an "Achatina invasion" scare which was dramatically played up in the local papers. The campaign in Los Angeles in 1951 to rid itself of a Mediterranean edible snail, *Otala lactea*, ran headlong into trouble because the announced common name of the snail, "the African snail," created the impression in many parts of the country, through newspaper channels, that the giant African snail had already become established in California (cf. Wibberley 1951).

In the following paragraphs there has been set up under each appropriate geographical title, as far as the available information permits, a concise statement of the history of the establishment of the giant African snail, its development, and its present status. Special efforts have been made to avoid any secondary source of reference.

Bismarck Archipelago The first record of the giant African snail appearing in New Britain and New Ireland brought the news that this pest was present in great quantities (Anon. 1947*a*, *c*). It seems apparent that the original introductions were made by the Japanese forces prior to 1945 (Anon. 1948*e*). G. S. Dun of the Lowland Experiment Station at Keravat in New Britain has conducted considerable valuable research on the giant snail in this region. Unfortunately, much of it has not yet found its way into the literature. He reports (*in litt.* April 21, 1950) that the snail has also become established in the Duke of York Islands.

Bonin Islands (Ogasawara Gunto) Mead and Kondo (1949) with the late D. B. Langford made the first survey of these islands to discover the snails well established on Chichi Jima, Haha Jima, and Ani Jima. The snails were introduced in Chichi Jima from Japan in 1937–38 as an item of primitive medicine (see p. 151). Five to six years later the snails were seen quite commonly in the lowlands about the harbor (Futami Ko). Jerry Savory reported that they were plentiful in June, 1943, when he was evacuated from Chichi Jima to Japan. On April 2, 1946, a high tidal wave washed over a good portion of these lowlands and for the rest of that year and the succeeding year there were relatively few snails seen. In 1948, however, the

snails appeared in unprecedented numbers and in 1949 they were still more abundant (Mead 1950*b*). Ten years later the snails were reported to be continuing as a serious pest.

Wilson Savory stated that the snails were introduced on Haha Jima soon after they were introduced on Chichi Jima. The farmers on that island, however, soon recognized that the snails were a pest and they did everything they could to prevent their spread. The island was completely evacuated in 1944. The absence of man as a disseminating agent and the presence of the hermit crab, *Cenobita perlatus,* as a predator probably account for the fact that the eleven- to twelve-year-old population was found in 1949 to be limited to a surprisingly small area in the abandoned port village of Okimura. The Ani Jima population in 1949 appeared to be limited to the southwest portion of the island. The giant snails introduced on the tiny island of Higashi Shima were reportedly wiped out by the large endemic population of hermit crabs. The fishermen of Chichi Jima reported that in their numerous trips to Muko Jima and Ototo Jima, no giant snail had ever been seen; and they seriously questioned that the snails had ever been introduced in these islands.

Burma Essentially nothing is known of the status of the giant African snail in Burma except that it has been established there for a number of years. The infestation started either from the nearby populations in Bengal or, more likely, from Malaya through the agency of the Japanese occupation forces.

Caroline Islands According to Esaki and Takahashi (1942), the giant snails were first introduced into Ponape, near the village of Kolonia, in the fall of 1938; the specimens were reportedly brought from Okinawa by a Mr. Junki Miyahira. By 1949, the snail was found well established in a number of localities in the vicinity of Kolonia (Mead 1950*b*). At that time, searching parties found no sign of the giant snail on the nearby islands of Pingelap, Mokil, or Kusaie.

Dublon was apparently the first of the Truk Islands to become infested (Townes 1946). The snails were probably brought in prior to 1940; and because of the concentration of health resorts on this island, it is possible that the snails were intended to be used for their presumed medicinal properties (Mead 1950*b*). As nearly as could be determined from questioning the Trukees, the giant snails were introduced into Moen and Romalum from Dublon by the Japanese some time prior to 1945; but they did not show up in Uman, near Sapota, and Fefan, near Sannuk, until 1948.

Esaki and Takahashi (1942) were responsible for the often quoted, erroneous report that the giant snails are on Yap Island.

Ceylon In 1900 Oliver Collett, an enthusiastic conchologist, introduced into his estate at Rozelle (near Watawala) specimens of the giant snail which he obtained either from Mauritius or India (Green 1910*b*). On the advice of E. E. Green, as many specimens as possible were collected and destroyed, but not before some had accidentally been carried on vegetables to the coastal town of Kalutara. In ten years' time, the "Kalutara snail" (Singhalese: *gombela* or *golubela*) was found so well established in both the original sites and adjacent areas that eradication was considered impossible. Today it is found in every province in Ceylon (Mead 1955*b*).

China Herklots (1948) found full-grown specimens of the giant snail in the Amoy University compound in June, 1931. Upon inquiry, he learned that they had been brought on plants imported from Singapore. Jarrett (1931, 1949) identified the specimens and made the official announcement. No recent word has been received about this infestation; but it is more than likely that the snails have spread from Amoy Island to the mainland. From the initial mainland infestation, other sites of infestation inevitably will become established.

Formosa A dozen specimens of the giant African snail were introduced into this island from Singapore by a Formosan government official, Mr. Kumaichi Shimojo, in January, 1932. Because of the cold weather and improper rearing techniques, all the specimens died. In April, 1933, twelve additional specimens were brought in and these survived and propagated to form breeding stock for subsequent introductions to Japan and Micronesia (Esaki and Takahashi 1942). By 1940, the giant snail had spread almost throughout the island (Kaburaki 1940). Vosburgh (1950) made interesting observations on this snail in the interior of Formosa.

Hawaiian Islands Pemberton (1938) has given us a complete and detailed report of the introduction of the giant snail on Oahu and Maui. In 1936, a young lady returning from Formosa brought two specimens of the giant snail in her baggage and released them in her Oahu garden for aesthetic reasons. The specimens were neither declared nor discovered by the port inspectors. In November of that same year, a man imported specimens through the mails from Japan to breed them in his home town of Makawao in Maui and to sell them as materia medica. Esaki and Takahashi (1942) were not correct in indicating that the imported specimens came from Okinawa. The infestations were not discovered until June, 1938 (Fullaway 1939), and in spite of intensive and continuous control measures, eradication proved impossible, notwithstanding the frequent state-

ments in the literature to the contrary. On Oahu, the snail quickly spread from Pauoa Valley to Kaneohe on the windward side; and on Maui it spread from Pauwela Gulch to other parts of the island. By 1944, there were eight foci on Oahu and six on Maui (Fullaway 1941, *et seq.*). These populations were successfully corralled for several years; but by 1951, new foci many miles away were making their appearance (Wong 1951, Thistle 1953*b*, Weber 1954). Today, the populations on Oahu are numerous and scattered. The infestation on Roundtop near Honolulu is clearly among the most dense on record (Mead 1959*b*). Although snails were found in the possession of two men on Lanai, there has been no report of an infestation on that island (Pemberton *et al.* 1939). In March, 1958, however, these snails were found well established near Mana in the northwest tip of Kauai; and two months later an infestation was first noticed near Hilo on Hawaii (Mead 1958*a*, *b*, 1959*b*; Thistle 1959*a*).

Hong Kong On April 3, 1941, Jarrett positively identified as *A. fulica* several snail specimens from the Happy Valley–Sookunpoo area in Hong Kong Island (Herklots 1948). It was his belief that the pest had been brought from Amoy, China, by Chinese duck farmers four years previously. This would establish the date of the original infestation as 1937 (Jarrett 1949). Within a decade, the infestation had spread to a number of places on the mainland (Dean 1950).

India In February, 1847, W. H. Benson (1858) collected specimens of *A. fulica* in Mauritius and released them the following April in the Chouringhie Gardens near Calcutta. Later he learned that they had spread a great deal. He also learned that all the specimens released by Captain Hutton in Mussoorie (Masuri) at 6,600 feet altitude at the foot of the Himalayas in the Dehra Dun district of the United Provinces died because of the severe winter. By 1907 they were common in the gardens of Calcutta (Annandale), and by 1910 the infestation reportedly had spread all over northern Bengal and new foci had developed in Bombay (Green 1910*c*, *d*) and further north in Rajkot (Comber). Ghose (1960) indicates that this snail is found in some districts of Eastern Pakistan and in the northern and eastern parts of West Bengal, but it is rare in the western parts of West Bengal. The snail is also to be found in parts of Orissa and Bihar (Behura 1955). H. C. Ray of the Zoological Survey of India adds to this list the Central Provinces and Berar, although neither he nor Ghose was able to obtain information regarding the present status of the Bombay infestation.

Indonesia Probably more has been written about the introduction and spread of the giant snail in Java than about the situation

in any other place except possibly Hawaii; unfortunately, however, the records are not always in agreement. Kalshoven (1950), for example, reported that the giant snail was first brought into Buitenzorg (Bogor) from Singapore in 1922; but it has also been stated (Anon. 1925) that they arrived in 1925 in a shipment of grass plants from Peradeniya, Ceylon. Leefmans (1933*a*, *b*) said that specimens were introduced clandestinely into Sukabumi, a suburb of Batavia (Djakarta), in 1930–31 and were taken into Batavia by plant breeders in 1933. Riel (1933) discovered the snails near Batavia in 1933 and learned from the local inhabitants that they came from Singapore. Van Weel (1948) and Jaski (1953) add confirmatory evidence. Benthem Jutting (1952*b*), Djaenoedin (1942), Franssen (1936), van der Goot (1939), and Waterschoot (1933) contribute further information on the continued spread of the snail. The most complete early paper on the subject is that of Leefmans and van der Vecht (1933*a*, *b*, *c*). L. J. M. Butot, formerly of the Museum Zoologicum Bogoriense, makes the following statement regarding the giant snail population in Java (*in litt.* Aug. 1, 1952), "I venture to say that the whole of Java is infested except the mountain region upwards of 1000M and some uncultivated parts below that level."

Van der Meer Mohr (1935, 1940, 1941, 1948) and van Weel (1948) give the best accounts of the spread of the snail in Sumatra. This pest apparently first made its appearance in northeastern Sumatra near Tandjong Poera, northwest of Medan, in 1930 or 1931, although it has been speculated that the snail may have been on the island since 1921. It showed up in southeastern Sumatra near Palembang in 1931 or 1932. Shortly after that, it appeared almost simultaneously in a number of localities (Anon. 1941, Heubel 1937, Kalshoven 1950).

Latif (1933*a*) reported achatina from Poelau Bintan, Riouw Archipelago, and explained that the inhabitants had seen the snail in that region since about 1903. Van Weel (1948) justifiably questions the initial date of establishment and sets it conservatively at 1932. The original specimens apparently came from Singapore (Leefmans and van der Vecht 1933*a*, *b*, *c*).

Latif (1933*c*) reported the giant snail for the first time from East Borneo, indicating that it was found in Balikpapan in 1921 and ten years later it was found in Samarinda. It was discovered in Koetai in 1938 (Witkamp 1941) and in Tenggarong about two years after that (van Weel 1948).

G. S. Dun has stated (*in litt.* Aug. 12, 1949) that the giant snail is found in Celebes and in Halmahera of the Moluccas Islands; but this information has not been confirmed.

Japan The giant snail (Japanese: *katatsumori*) was imported a number of times into Japan proper from Formosa. Esaki and Takahashi (1942) believed that the first shipments started in 1935; but Tokubei Kuroda stated (*in litt.* Dec. 20, 1949) that they started "previous to 1933." This would set the date close to the time when the snails made their first appearance in Formosa; for this reason, Boettger's (1951) date of 1925 would seem to be out of line. A number of magazine and newspaper articles popularizing the raising of snails for food and medicinal purposes were instrumental in precipitating a rather large-scale importation of snails into Kobe, Osaka, Nagoya, and Nara. In May, 1936, it was recognized by the Ministry of Agriculture and Forestry that the giant snail was a menace. Regulations were set up immediately to confiscate and destroy all live specimens in the country and prohibit the entry of further shipments. The timely, thorough measures, along with the severe winter climate, were completely effective in preventing the establishment of this snail pest; and to this day, it is believed not to be present anywhere in Japan.

Malaya Both South (1923*b*, 1926*b*) and Jarrett (1923, 1949) agree that the giant snail first entered Malaya in its northernmost section, in Kedah, in 1911. From Kedah the snail was apparently taken in 1922 to Province Wellesley by Chinese duck farmers who used the snails as duck feed. From these northern infestations, the snail quickly spread south into many areas of the peninsula (Birkinshaw 1928, Corbett 1929, Doscas 1929, South 1922, *et seq.*). There has been much speculation as to the origin of the initial infestation. It may have been imported directly from India or Ceylon, or it may have come from India via Burma. In a relatively recent colonial publication (Anon. 1954), it is stated that the snail was probably introduced from Ceylon in 1911.

Maldive Islands During the Yale Seychelles Expedition in 1957, Alan J. Kohn collected specimens of *A. fulica* on Hitadu Island and Gan Island in the Addu Atoll; but he encountered no snails on Ile du Coin, Peros Banhos Atoll, in the Chagos Archipelago. The comparatively large amount of commerce between these islands and Ceylon makes it most probable that the giant snail has been introduced from Ceylon not once but several times.

Mariana Islands All available evidence points to the conclusion that the giant snail first made its appearance in the Marianas almost simultaneously in Rota, Saipan, and Tinian some time between 1936 and 1938 (Mead and Kondo 1949).

Esaki and Takahashi (1942) state that Hiroshi Kuwahata of Saipan

made an investigation of the snail problem on that island in April, 1941, and concluded that the snails had been introduced the previous month. But the very widespread nature of the infestation at that time makes his conclusion untenable. Other estimates place the date nearer 1940 (Abbott 1949, Bequaert 1950, Lange 1950). Mr. Joaquin Guerrero, who was acting director of the Naval Government Agricultural Experiment Station in Guam in 1949, gave the author permission to quote the following from his report of December 26, 1945 which was addressed to the head of the Commerce and Industry Department: "Mr. Jose Roberto volunteered the statement that during the Japanese administration, he was shown a sample of these snails preserved in alcohol by the Japanese authorities and was told they were deliberately introduced into Saipan and Rota by the Okinawans for use as food from one of the islands of the East Indies."

Guerrero's report announced that the presence of the giant snail on Guam first came to the attention of the American authorities just eight days previous to his report and that an investigation brought to light a single area of infestation at Santa Rita. Guerrero states, "In order to determine the possible time when this plant pest made its invasion into Guam, I made an inquiry from Mr. Jose I. Shimizu, a Japanese half-caste and old resident of the island, and was told that the subject snails first made their appearance in Guam in 1943 when the Japanese shipped into Guam sweet potatoes from Rota island." Inquiries made by the author and Kondo did not bear out the often quoted alternative suggestion that the giant snails were brought into Guam in 1946 on pandanus leaves shipped from Saipan for native handicraft (Abbott 1948, 1949).

By July, 1946, three separate infestations were found on Guam. At least seven in north and central Guam existed in the fall of 1949 (Kondo 1950*a, c*). Four years later, infestations appeared in the southern part of the island and it was predicted that it was only a matter of time until the rich farming valleys in that section of Guam would be overrun with snails (Peterson 1957).

The giant snail undoubtedly was taken from Tinian or Saipan to the small island of Agiguan (Aguijan), just off the southwest coast of Tinian, shortly before World War II; for it was found to be well established when it was first discovered on this uninhabited island in July, 1949 (Mead and Kondo 1949). The experimental introduction of the predatory snail *Gonaxis kibweziensis* on this island has caused more to be writen about its giant snail population than that of almost any other island in the West Pacific. Davis, Kondo, Mead, Owen, and Peterson have been the main contributors.

During the period September 21–October 1, 1949, Kondo (1950*a*, *c*) made an intensive survey of Pagan Island and found it to be the most northern of the infested islands in the Mariana chain. He states, "The snail was first introduced in 1939 by Sato Gumi whose wife had an infected lung. He raised the snails for medicinal purpose but a man named Sonohara raised many of them for food."

Mead and Kondo visited the inhabited islands of Agrihan and Alamagan in 1949 and found no verbal or environmental evidence of the giant snail.

Mauritius Bequaert (1950*b*) offers convincing evidence in support of his belief that *A. fulica* did not become established on the island of Mauritius much before 1800. He translates the following from the earliest published record of the infestation here (Bosc 1803): "I have heard from an inhabitant of Mauritius that the wife of a governor of the island, ailing of the chest, had on doctor's orders fetched from Madagascar many of these snails, since there were none in this part of the colony. She died shortly after and the snails spread over the island, increasing to the extent of becoming a calamity. They have been hunted several times, but they are even now very common." This at last sets straight an often quoted story which Benson (1858) erroneously associated with the introduction of this pest on Réunion. Since the original home of this species is in East Africa (Bequaert 1950*b*), it has been assumed that the snails were taken from East Africa to Madagascar in recent times by natives who intended establishing them as an accustomed source of food (Dollfus 1899). Probably from there they were taken to the Comoro Islands (Morelet 1860). A short time before 1847, a second species, *Achatina panthera,* was introduced into Mauritius by Sir David Barclay (Benson 1858). Recent reports from Mauritius indicate that this newcomer has taken over the lowlands from sea level to 1,200 feet, forcing *A. fulica* to maintain its populations at the 1,200–2,000-foot level.

New Guinea There is little doubt that the Japanese forces were responsible for the introduction of the giant snail into this island prior to 1945, about the same time that it was introduced in nearby New Britain and New Ireland (Anon. 1948*e*). Allan (1949), Morrison (1950*b*) and De Wilde de Ligny (1953) have reported on the New Guinea infestation.

North Borneo G. S. Dun of the Lowlands Agricultural Experiment Station in New Britain, reports (*in litt.* Nov. 25, 1949) that he had learned that the giant snail first appeared in British North Borneo about 1939 and that it was "introduced to rubber plantations outside Beaufort on infested budwood brought from Malaya."

Palau Islands In their search for information about the history of the giant snail populations in the Palau Islands, Esaki and Takahashi (1942) learned from the Palau Office of the Micronesian government that the first introduction was made about May, 1938, by Shoichi Nishimura, a farmer on Babelthaup (Asahi-mura), who planned to breed them for use as food. Because for two years the giant snail had been prohibited in Japan and Formosa, it is presumed that he obtained his specimens from Okinawa. In November of that year a flood washed the snails into the lowlands of the Garumisukan River. They survived the flood and began multiplying. But before this some of the breeding stock sent by Nishimura to several people on Koror made the inevitable escape from inadequate cages, and natural populations were soon developing in the field. Although in 1939 Hatai and Kato (1943) could hardly find any specimens on Koror, by 1940 drastic control measures had to be instituted in a vain attempt to halt the manifestly rapidly expanding population.

In addition to Babelthaup and Koror, Kondo (1950*a*, *c*) found Auluptagel (Aurapushekaru) and Peleliu infested with the snails. Mead (1950*b*, *c*) added Anguar and Urukthapel to this list; and Lange (1950) added Malakal and Arakabesan. Other infested islands unquestionably exist.

Philippine Islands There still remains considerable uncertainty regarding when and how the giant snails made their way to the Philippines. G. H. Haldén writes (*in litt.* Nov. 1, 1949) that he observed them in Pampanga and Santo Tomas, Luzon, during the Japanese occupation, and he sent to the author a shell specimen which he had collected at that time. It has been suggested that they were brought from Formosa by Japanese soldiers (Anon. 1946*a*). Pangga (1949), who gives the best account of the problem in this area, follows this suggestion and sets the date of entry as 1942, although he states that people claim specimens were collected in Pasay, Rizal Province, before the war. By 1949 most of the provinces of Luzon were infested, including the following: Batangas, Bulacan, Camarines Sur, Cavite, Laguna, Nueva Ecija, Nueva Vizcaya, Pampanga, and Rizal.

Réunion Bequaert (1950*b*) concluded that the giant snail reached Réunion early in the nineteenth century, shortly after it became established on Mauritius. Férussac found it present in 1821. It was Lesson's (1830) feeling that this species had been brought to

Réunion from Madagascar; but Bequaert stated that it came from Mauritius.

Ryukyu Islands Nothing in the printed record has come to light to indicate when the giant snail was first introduced into the Ryukyus. It is most likely, however, that specimens from Formosa were brought to Okinawa some time in 1934 or 1935, that is, shortly after this pest became established in Formosa. It should be recalled that it reportedly was from Okinawa that specimens were introduced into some of the Mariana and Palau islands several years before the war. The latest information is that the snail has become established in Amami Oshima, which is close to half way between Okinawa and Kyushu, the south island of Japan (Mead 1958*a*, *b*).

Sarawak According to Jarrett (1931, 1932), the giant snail was introduced into Kuching in 1928 by Chinese farmers who intended using the snails as feed for poultry. Tom Harrisson of the Sarawak Museum writes (*in litt.* Aug. 25, 1952), "The snails have steadily spread in the last 20 years but still have not reached far up most of the rivers nor into the uplands. Centers of introduction seem to have been in the southeast and southwest, and the distribution gets lower and lower as one goes north."

Seychelles It is not known when the giant snails were taken to this group of islands. Dufo recorded them as being present in 1840. Rees (1951) concluded that the snails were introduced from Mauritius. Dupont (1935) listed *A. fulica* as being on Mahé, Praslin, and Silhouette.

Singapore In February, 1922, Jarrett (1923) received several snail specimens from the Balestier District of Singapore for identification. These he identified as *A. fulica.* From an examination of the infestation, he concluded that they could not have been introduced into the island before 1917 (Jarrett 1949). This places the Singapore infestation six years later than the first infestation in northern Malaya and sets straight some of the confusion in the earlier literature (cf. South 1926*b*). It is of the highest likelihood that Singapore received its infestation from Malaya, and not once, but many times.

Thailand Living specimens from Thailand were obtained in 1938 by Boettger (1951); from this he concludes that at least by 1937, the first snails entered from infested areas in Malaya. This agrees with the estimates of Abbott (1949) and Rees (1951). Ariyant Manjikul of the Central Research Station in Bangkhen writes (*in litt.* Feb. 14, 1952): "In Thailand this snail is confined to the southern prov-

inces of the peninsular strip of this country. It is supposed to have been introduced by the Chinese from Malaya. It makes a very good feed and the duck raisers collect them for the purpose." In December, 1957, Mead (1958*a*, *b*) found thoroughly intrenched infestations of this snail in central Bangkok.

Vietnam Both Boettger (1951) and Rees (1951) agree that the giant snail must have reached Vietnam by 1937. Efforts to obtain more recent information on the status of the infestation have failed.