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ATLAS OF KANEOHE BAY

A REEF ECOSYSTEM UNDER STRESS

EXCERPT
Pages 67-91

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VI. D. Benthic Algae of the Bay

Aprilany Soegiarto

In the last four years, over 360 stations have been surveyed in order to determine the role of the benthic algal communities in the Kaneohe Bay reef complex. Eighty-seven species of benthic algae have been recorded from these stations. However, only 29 species were present at five per cent or more of the stations, and only 14 species at ten per cent or more of the stations.

Figure 37 shows the approximate number of species found in the surveyed area. Benthic algae reach maximum numbers of species in the high-energy surf zone around Kapapa Island. The number of species decreases in all directions from there. Toward shore the decrease is due, in part, to the diminishing water motion and associated changes in the substrate. Seaward of the high-energy reef flat, the decrease in diversity is due to the increasing depth and the consequent decrease in light.

At the lagoon edge of the barrier reef only five to ten species of algae are found; fewer still are found in the lagoon depths. In the fore-reef the diversity decreases rapidly below the breaker zone, but is more or less maintained at the five-to-ten species level to a depth of 15 meters. On the fringing and patch reefs the diversity normally is low, except where these reefs are directly exposed to the incoming surf.

Figure 38 shows the geographical distribution of total standing crop of benthic algae in Kaneohe Bay. As with the floral diversity, the standing crop of benthic algae on the barrier reef reaches its maximum value (over 250 g dry weight/m^2) in the surf zone, and generally decreases in all directions. On the fringing and patch reefs the standing crops are generally low. Exceptions to this are the inner reefs which are exposed to wave action, and the reefs of the central lagoon where almost uni-algal stands of *Dictyosphaeria cavernosa* occur on the steep reef slopes (Figure 49).

Sargassum echinocarpum (**limu kala-lau-nunui**), a brown alga (Figure 39), is one of the four species of *Sargassum* found in Hawaiian waters, and it is the most common one. In Kaneohe Bay it is found mainly in high-energy environments, although it has been observed growing relatively well in calm waters. The standing crop of *S. echinocarpum* is large in the high-energy zone (Figure 40). It reaches its maximum in winter months, decreasing markedly in early spring, and reappearing gradually during the summer. It serves as a host for a wide variety of calcareous and non-calcareous epiphytic algae.

Jania spp. (**limu huluilio**), a red alga (Figure 41), is one of the genera of sediment-producing articulate coralline algae. It normally grows epiphytically on other algae, although it may grow on rubble or other hard substrates. Its distribution is limited to high-energy environments, and it is absent from the southern part of the Bay. One of the epiphytic species, *J. capillacea*, demonstrates a marked seasonality in Kaneohe Bay. It appears in the fall months on species of *Sargassum*, increases in abundance, and its standing crop reaches a maximum of about 100 g dry weight/m^2 in late winter, and nearly disappears, along with its host, in early spring.

With few exceptions, the distribution of *Laurencia* spp. (**limu palewawae**), a red alga (Figure 42), in Kaneohe Bay is similar to that of *Jania*. Both are limited to high-energy environments, and are absent from the southern part of the Bay. *Laurencia* is an economically valuable seaweed.

Five species of *Dictyota* (**limu lipoa**), a brown alga (Figure 43), are known from the Hawaiian Islands. Of these, four are found in Kaneohe Bay. They normally grow epiphytically on larger algae, such as *Sargassum*, and are distributed similarly to their hosts.

Acanthophora spicifera is a red alga with no Hawaiian name (Figure 44) and has only recently "invaded" Hawaiian waters (Doty, 1961). This is why there is no Hawaiian name for this limu. At the present time this alga is very common, covering the shallow parts of Hawaiian reefs. In Kaneohe Bay it is widely distributed, growing best on sandy bottoms, and in calm waters (Figure 45).

Dictyopteris australis (**limu lipoa**), a brown alga (Figure 46), is one of three species of this genus found in Hawaii. This alga is generally responsible for the distinctive odor of "rotten" seaweed on Hawaiian beaches after heavy storms. In Kaneohe Bay *D. australis* is abundant in the high-energy reef flat and fore-reef environments, and it may cover much of the bottom at depths greater than 6 m (Figure 47).

Dictyosphaeria cavernosa (**limu lipuupuu**), a green alga, is widely distributed in the tropical Pacific and Indian Oceans and the Caribbean Sea. In recent years this large green alga has become a center of attention because of its response to eutrophication processes, such as those going on in Kaneohe Bay. Except for the southeastern part, *D. cavernosa* is widely distributed in the Bay (Figure 48). Its growth reaches phenomenal proportions on the walls of the patch and fringing reefs in the central part of the lagoon (Figure 49). In this part of the Bay, the standing crop may reach as much as (1000 g dry weight/m^2) as compared with 5 g dry weight/m^2, the average standing crop of this alga on the barrier reef.

With the exception of the southern part, *Hypnea* spp. (**limu huna**), a red alga (Figure 50), enjoys a wide distribution in the shallower portions of Kaneohe Bay. However, each species seems to have a distinct habitat. Some species grow epiphytically on larger algae, while others grow on rocky surfaces in the breaker zone. Due to its high content of agar, *Hypnea* is listed as one of the seaweeds of economic importance.

Because of its small size, *Polysiphonia* spp. (**limu hawane or pu-'alu**), a filamentous red alga (Figure 51), contributes little to the algal biomass in Kaneohe Bay. However, it is very common in the shallow portion of the Bay. Hollenburg (1968a and b) recorded numerous species of *Polysiphonia* from Kaneohe Bay. Most species grow epiphytically on larger algae, but some grow on sandy or silty bottoms.

The following algae, along with *Jania* discussed earlier, have skeletons of $CaCO_3$, and therefore contribute directly to the mass of the reef.

Padina japonica (**limu pepe-iao**), a brown alga (Figure 52), is the commonest species of this genus in Hawaii, and it is the one which is most highly calcified. *P. japonica* is widely distributed across the ocean-reef areas of the Bay. It grows on both sandy and hard substrates, reaching a maximum standing crop in the summer months, after the abundance of *Sargassum* decreases.

Halimeda is one of the most important sediment-producing green algae in tropical reef ecosystems. Its distribution includes all of the shallow warm waters of the world. In the Hawaiian Islands, *H. discoidea* (**limu ekaha**) is the most common species. In Kaneohe Bay it is primarily found on the ocean reef (Figure 53). Its standing crop varies from 1.7 g dry weight/m^2 on the fringing reefs, to over 75 g dry weight/m^2 on the barrier reef (Figure 54).

Hydrolithon reinboldii (no Hawaiian name), a red alga (Figure 55), occurs over the shallow-water portion of Kaneohe Bay, except the southeastern part. This species is the most important crustose coralline alga in the Bay. *H. reinboldii* tolerates a wide range of salinities—17 per mil to 50 per mil (Soegiarto, 1972). Normal salinity in Kaneohe Bay is about 33 per mil. This partly explains why this alga is able to grow on the fringing reefs, close to land, where salinities may drop markedly when it rains. *H. reinboldii* grows as a crust, completely surrounding dead coral and other rubble. It can be recognized by its rough surface texture and its greyish-purple to dark-purple color.

Porolithon gardineri (no Hawaiian name), a red alga (Figure 56), is another important species of crustose coralline algae. It is distributed primarily on the high-energy reef flats. In Kaneohe Bay, *P. gardineri* develops well in the north, where it covers over 10 per cent of the bottom.

Most of the known algal or "lithothamnion" ridges of the Indo-Pacific region are composed primarily of *Porolithon onkoides* (no Hawaiian name), a red alga (Figure 57). It is very abundant in Kaneohe Bay, being widely distributed across the reefs of the Bay, including the southeastern portion of the Bay, but there only in a dying state. This alga is pale to bright pink in color, and is crustose and chalky in texture. It grows on various hard substrates, such as dead coral and basalt rocks. It develops best in intertidal areas exposed to heavy surf.

Perhaps the three encrusting red algae discussed here lack Hawaiian names because the early Hawaiians did not recognize them as limu or algae.

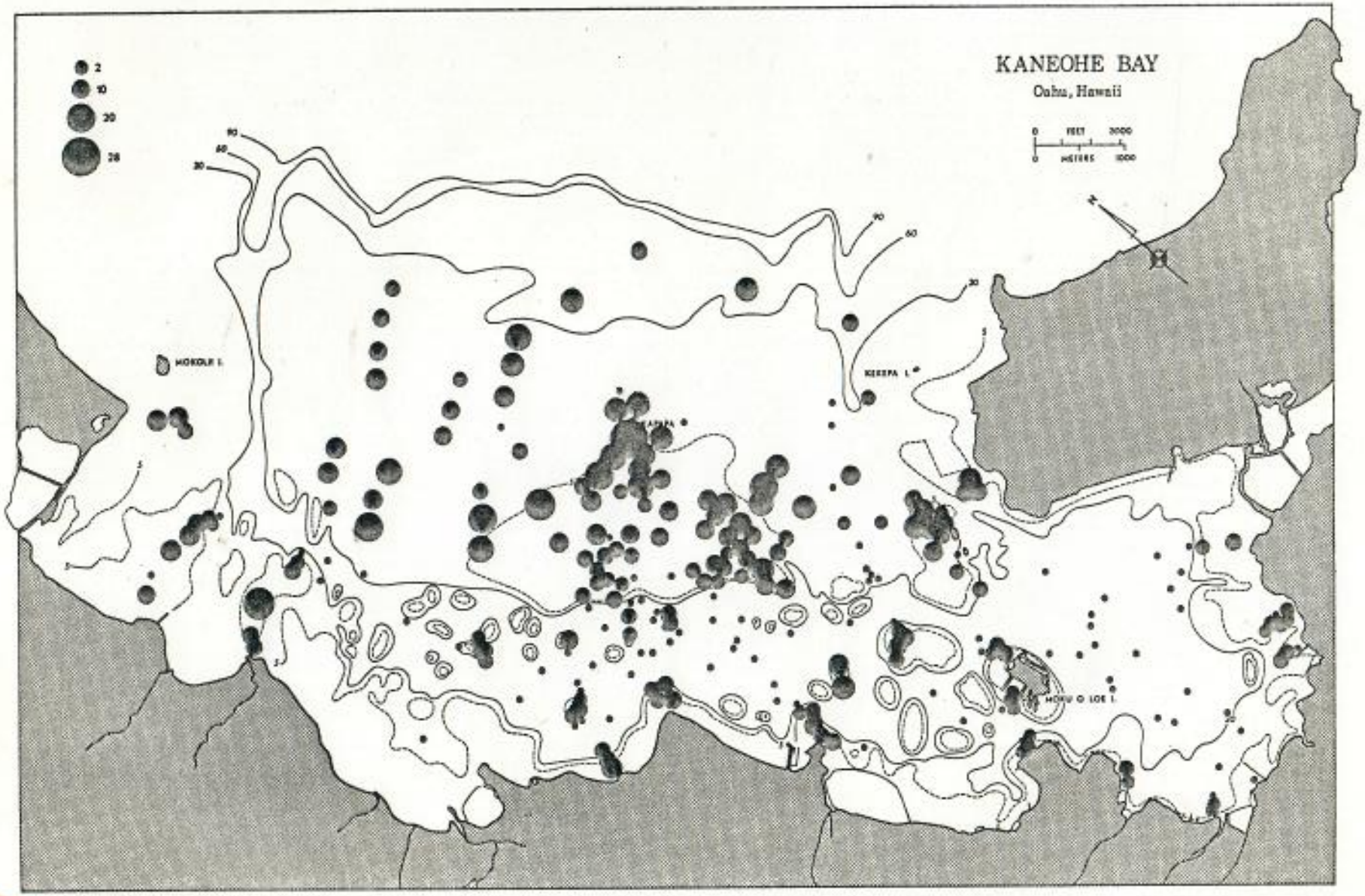

Fig. 37. Number of Species of Algae at a station

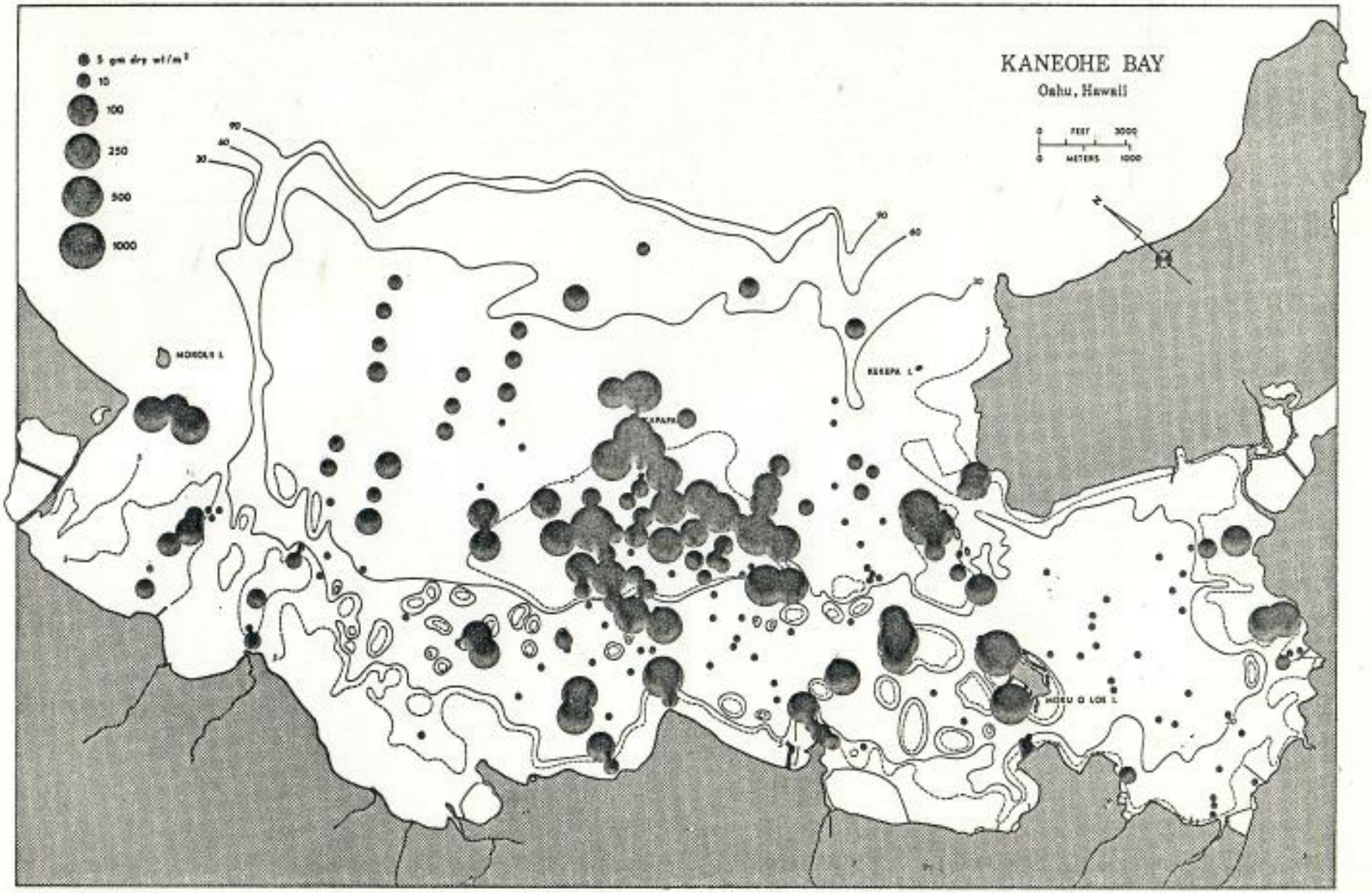

Fig. 38. Algal Biomass at a station

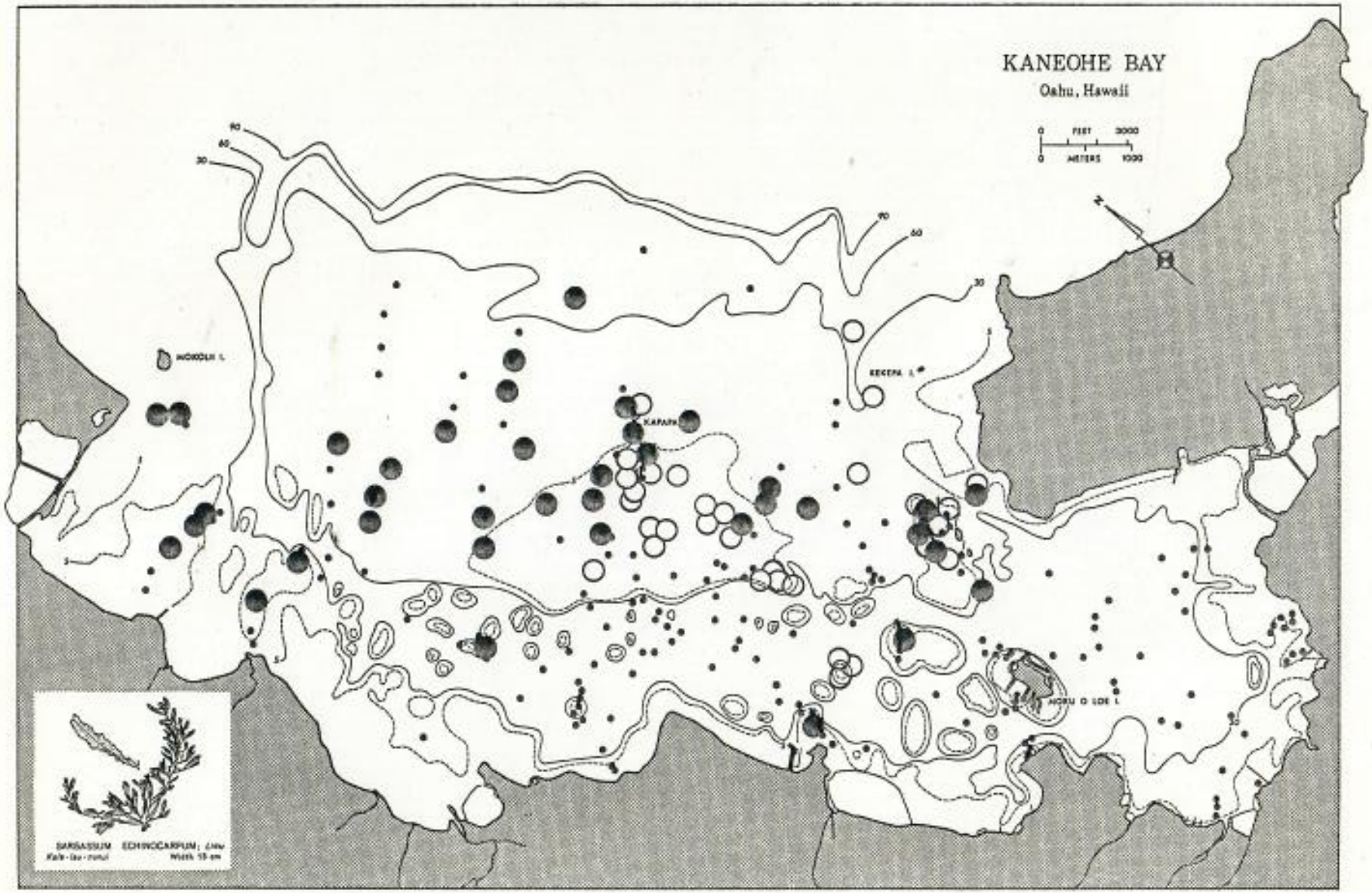

Fig. 39. Sargassum echinocarpum P/A

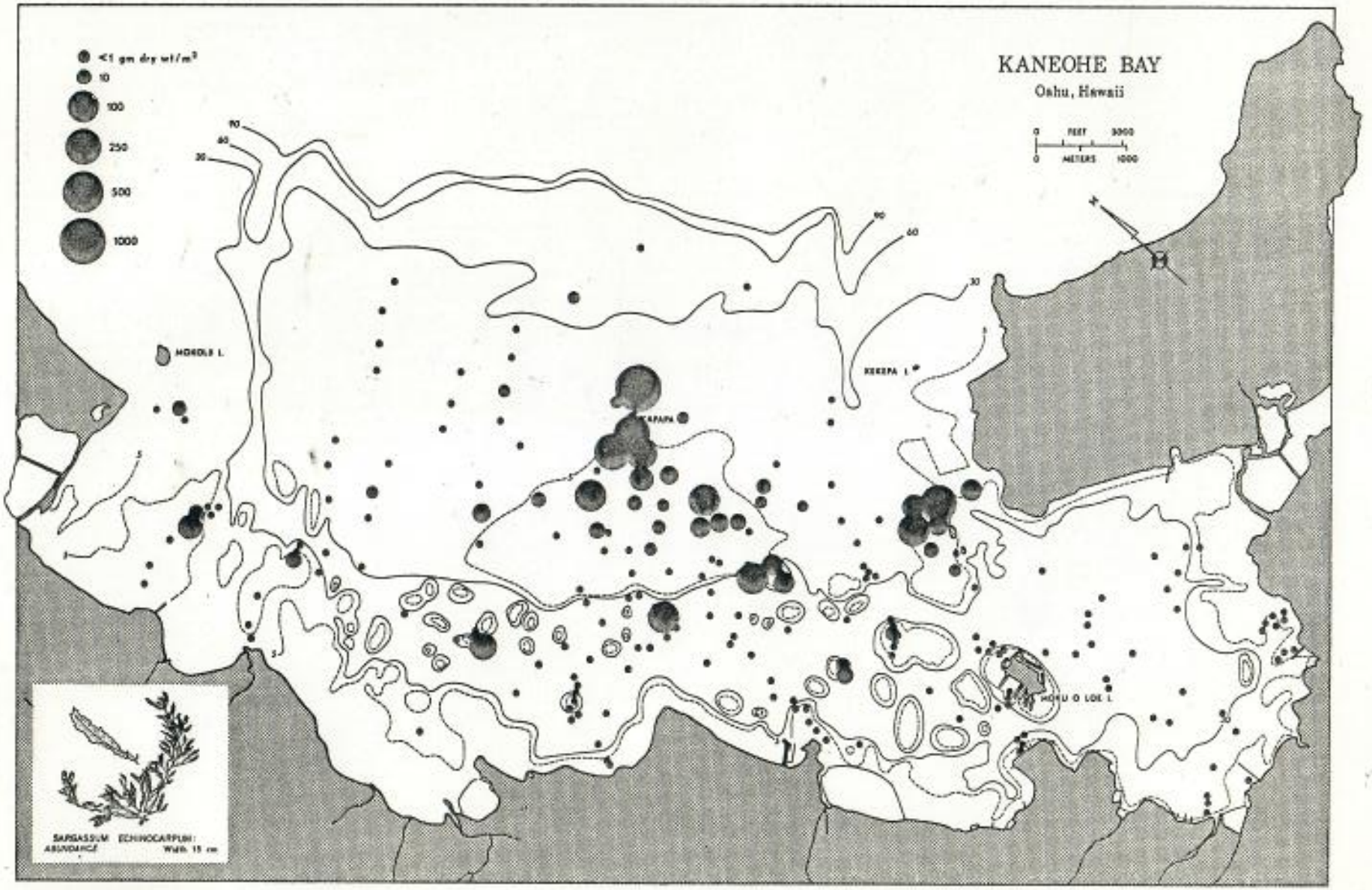

Fig. 40. Sargassum echinocarpum; abundance

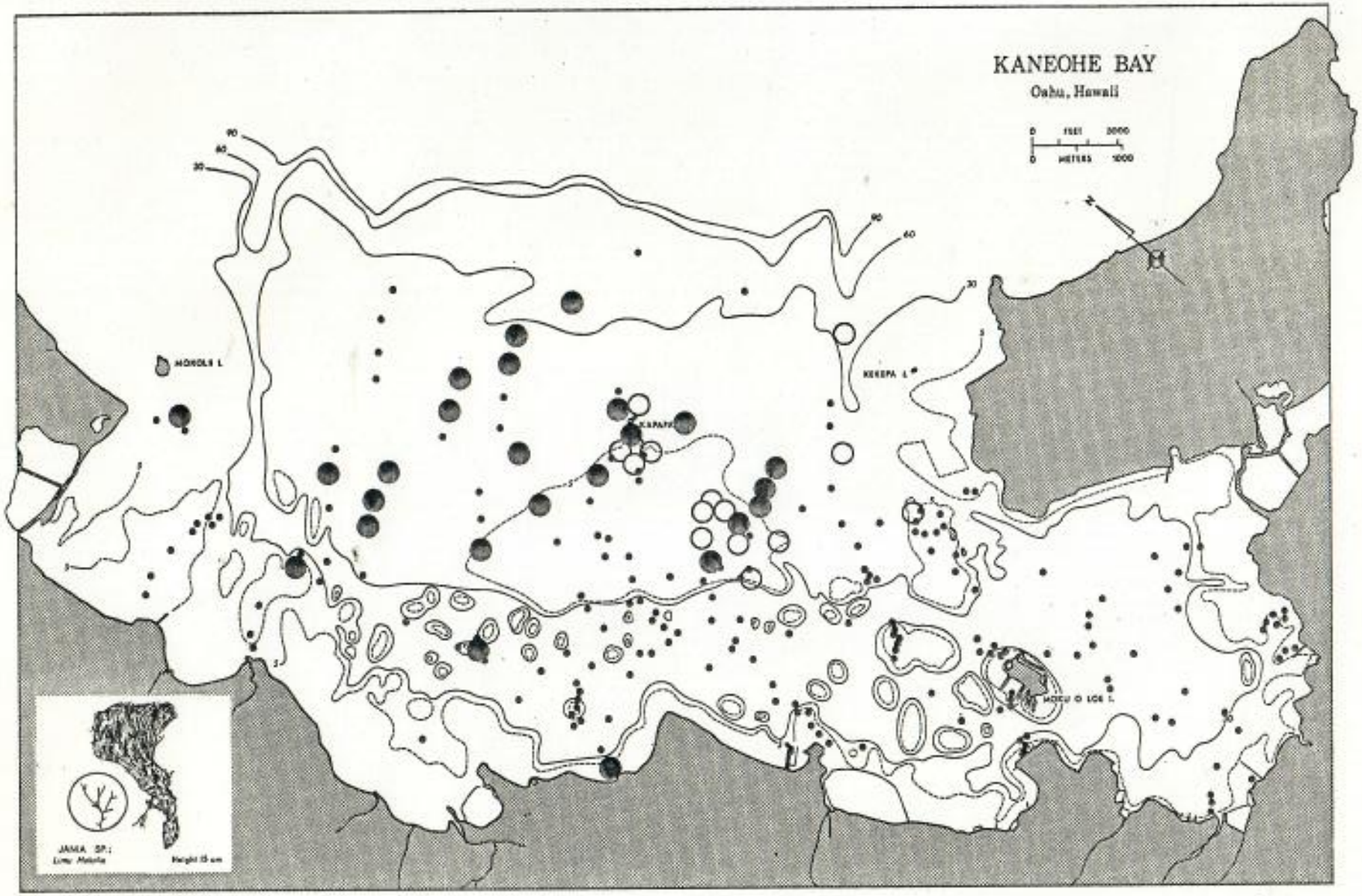

Fig. 41. Jania sp. P/A

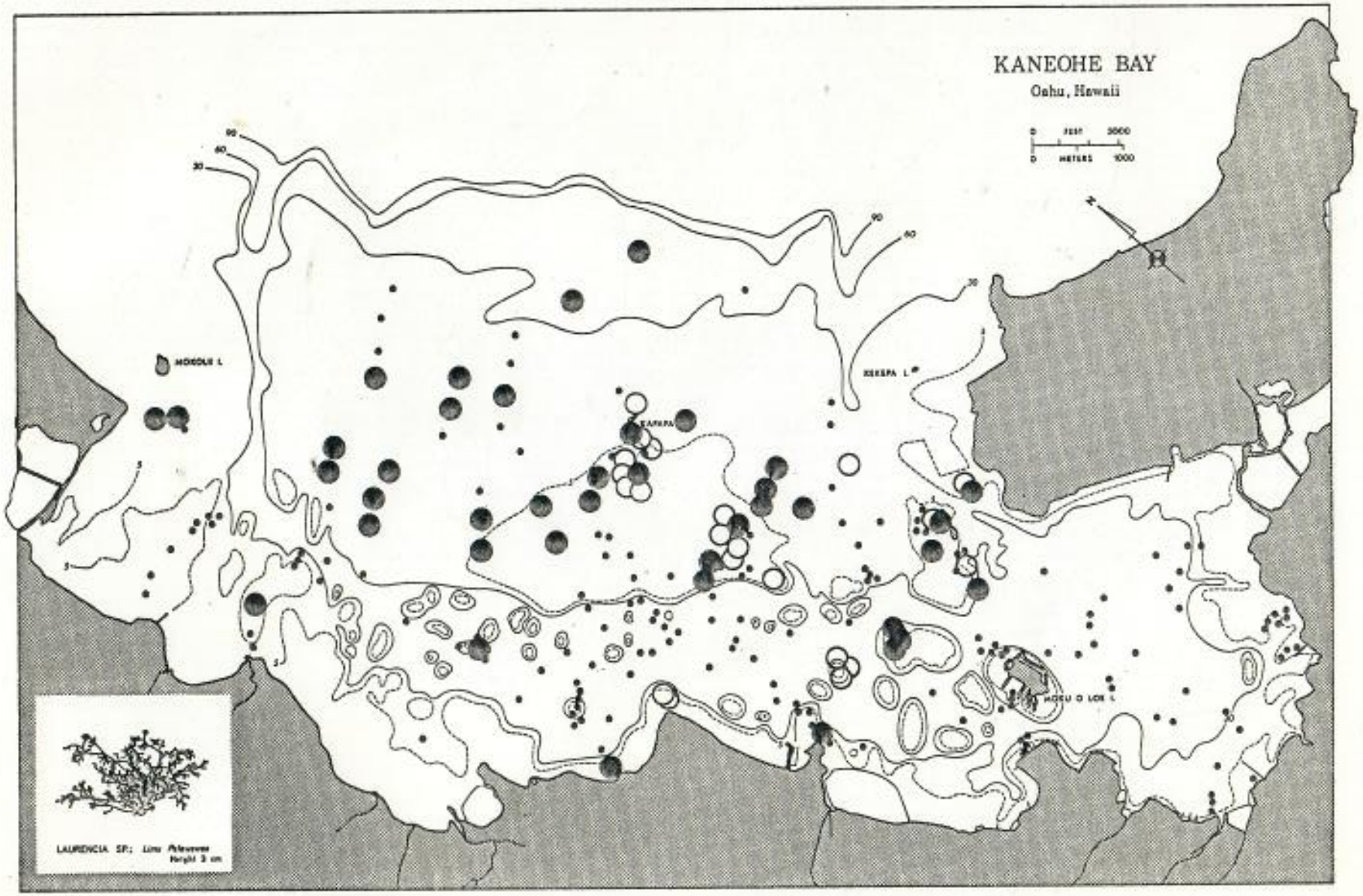

Fig. 42. Laurencia spp. P/A

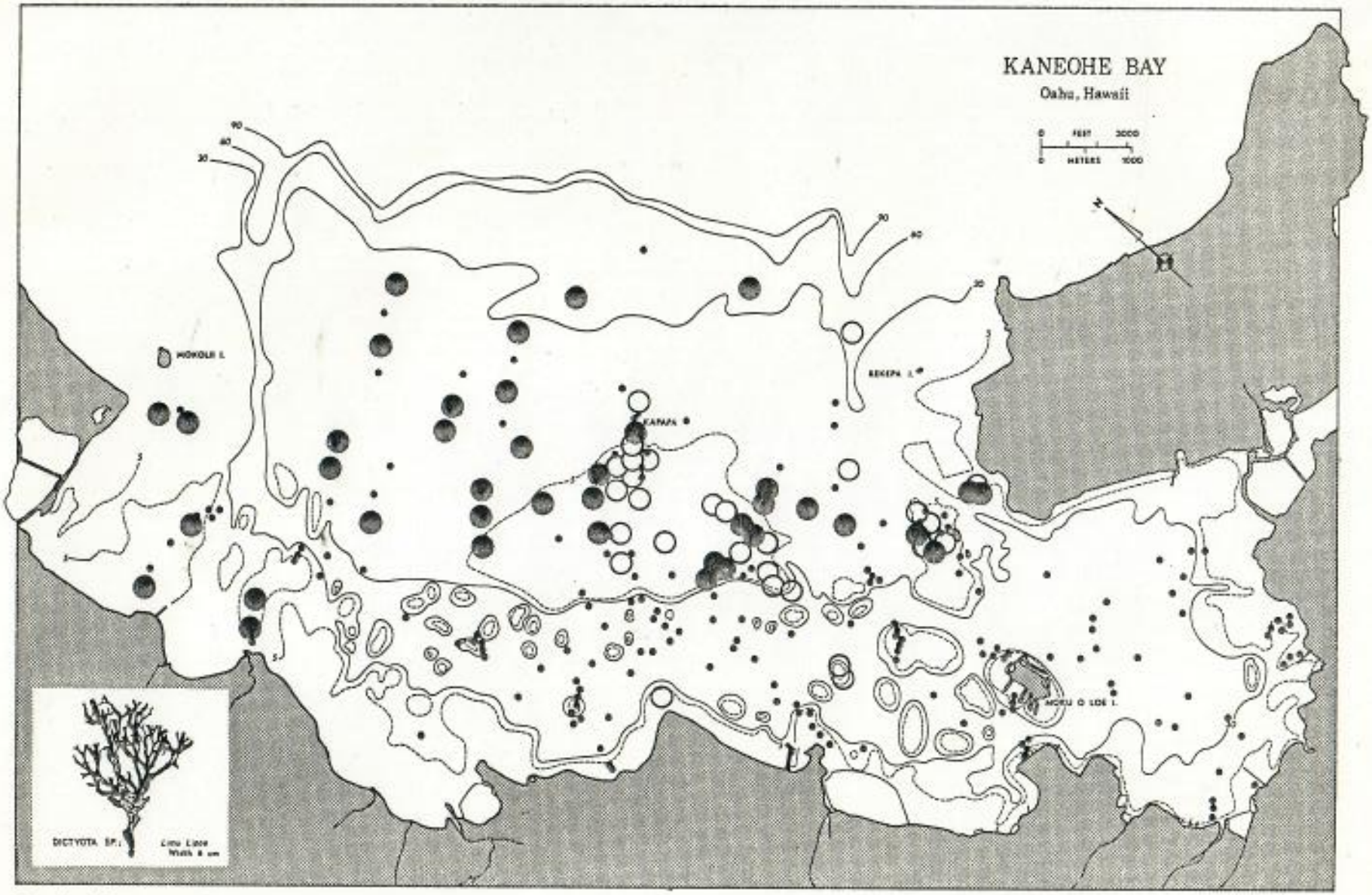

Fig. 43. Dictyota spp. P/A

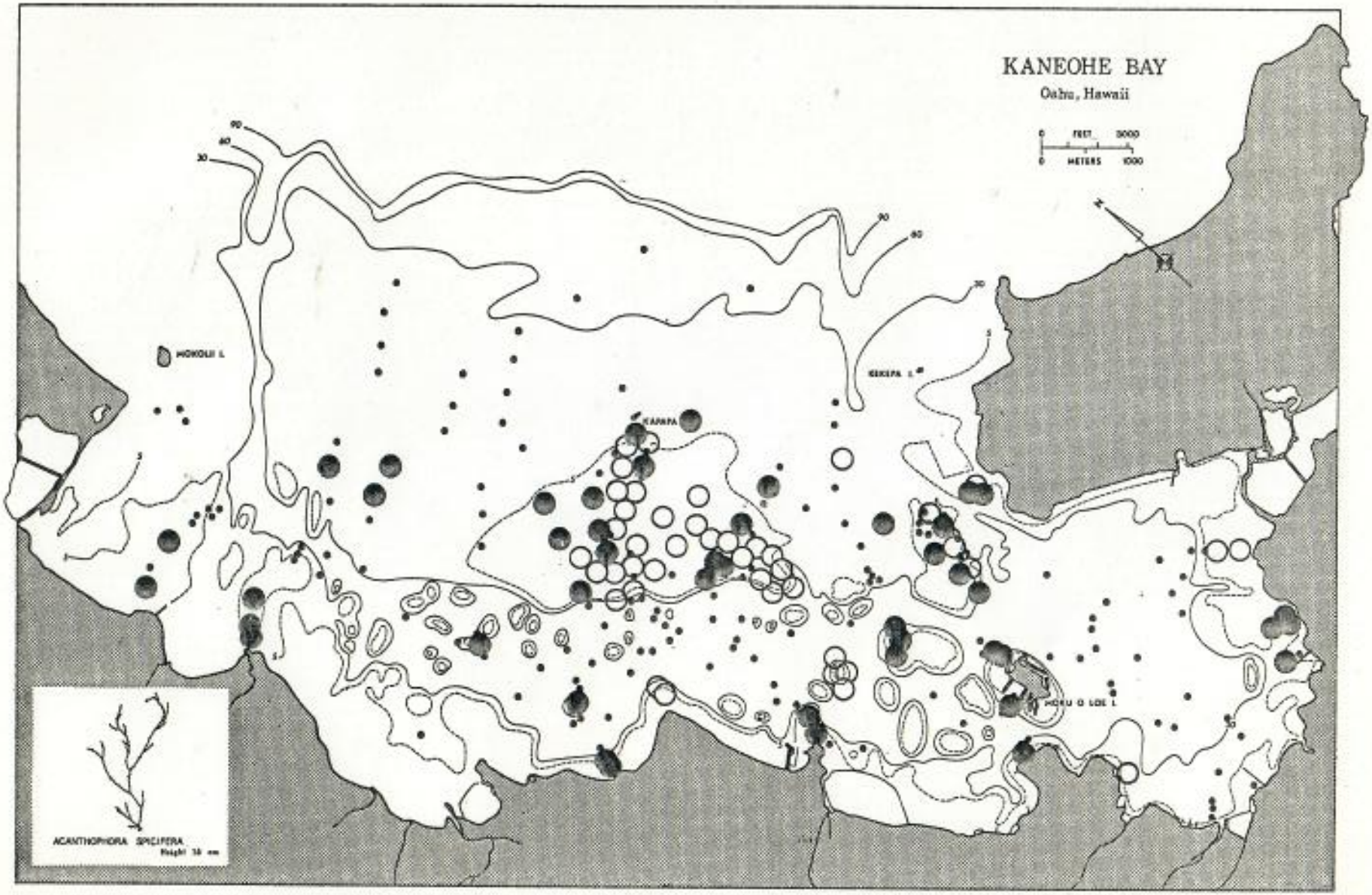

Fig. 44. Acanthophora spicifera P/A

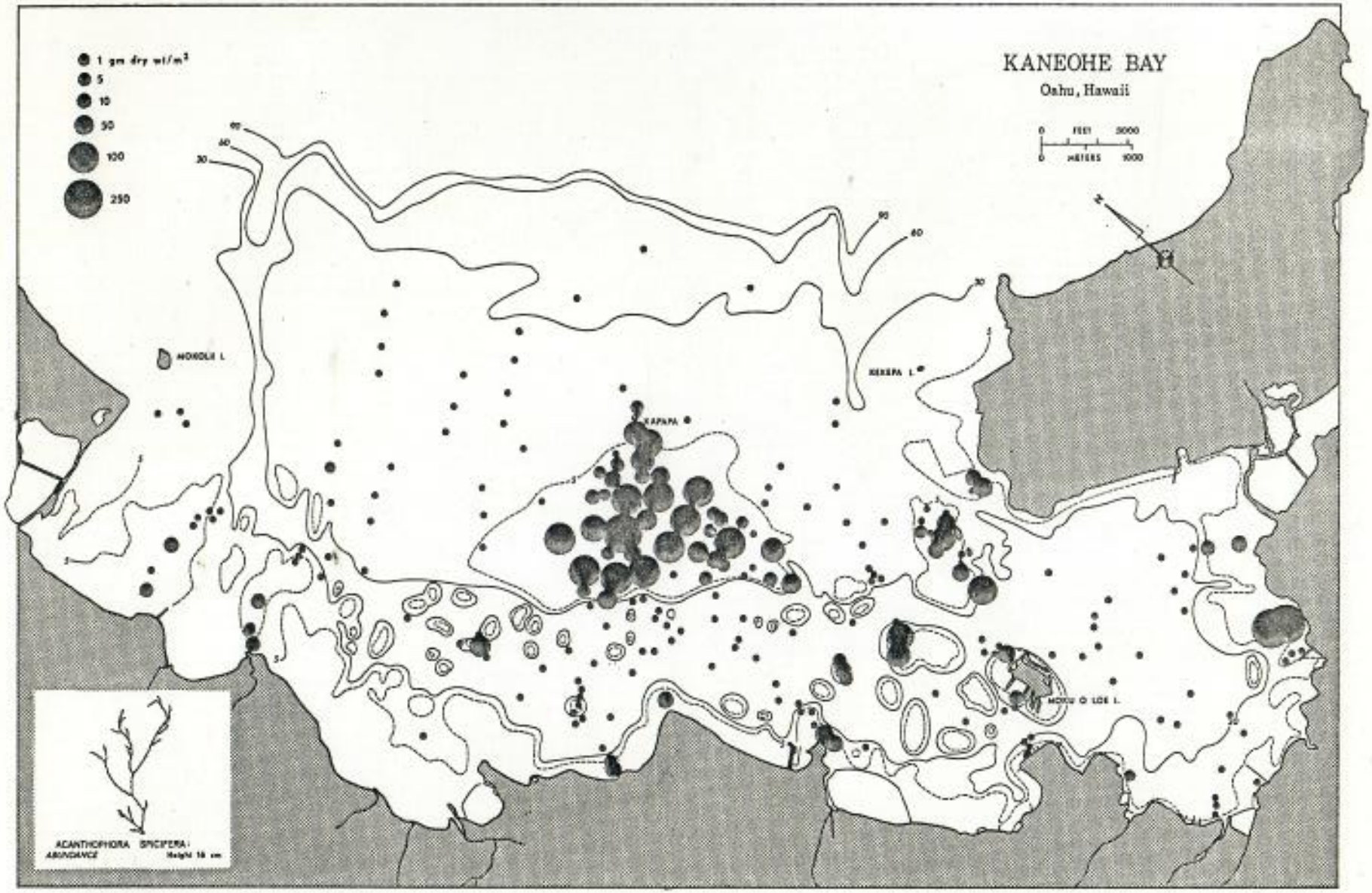

Fig. 45. Acanthophora spicifera; abundance

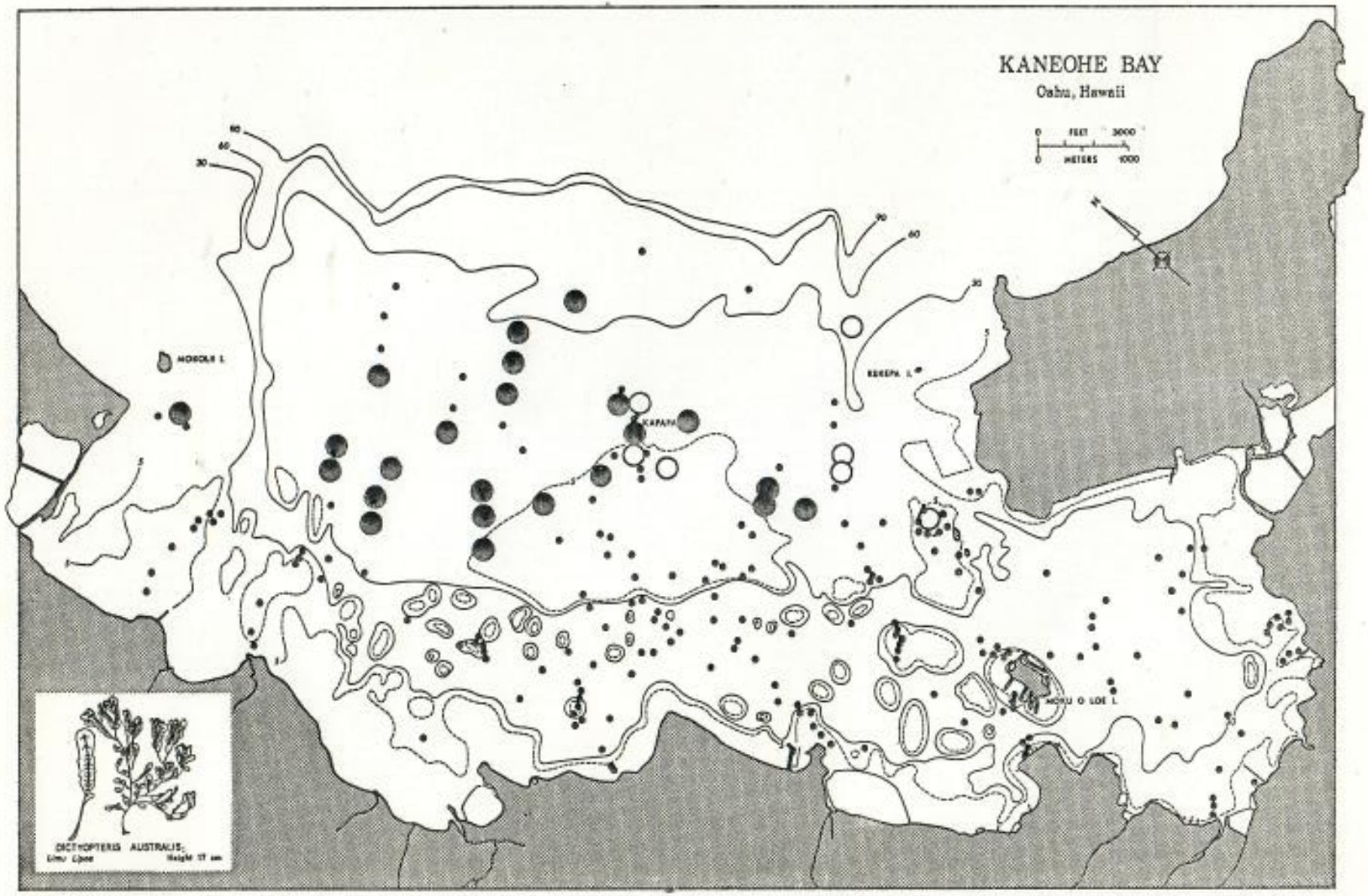

Fig. 46. Dictyopteris australis P/A

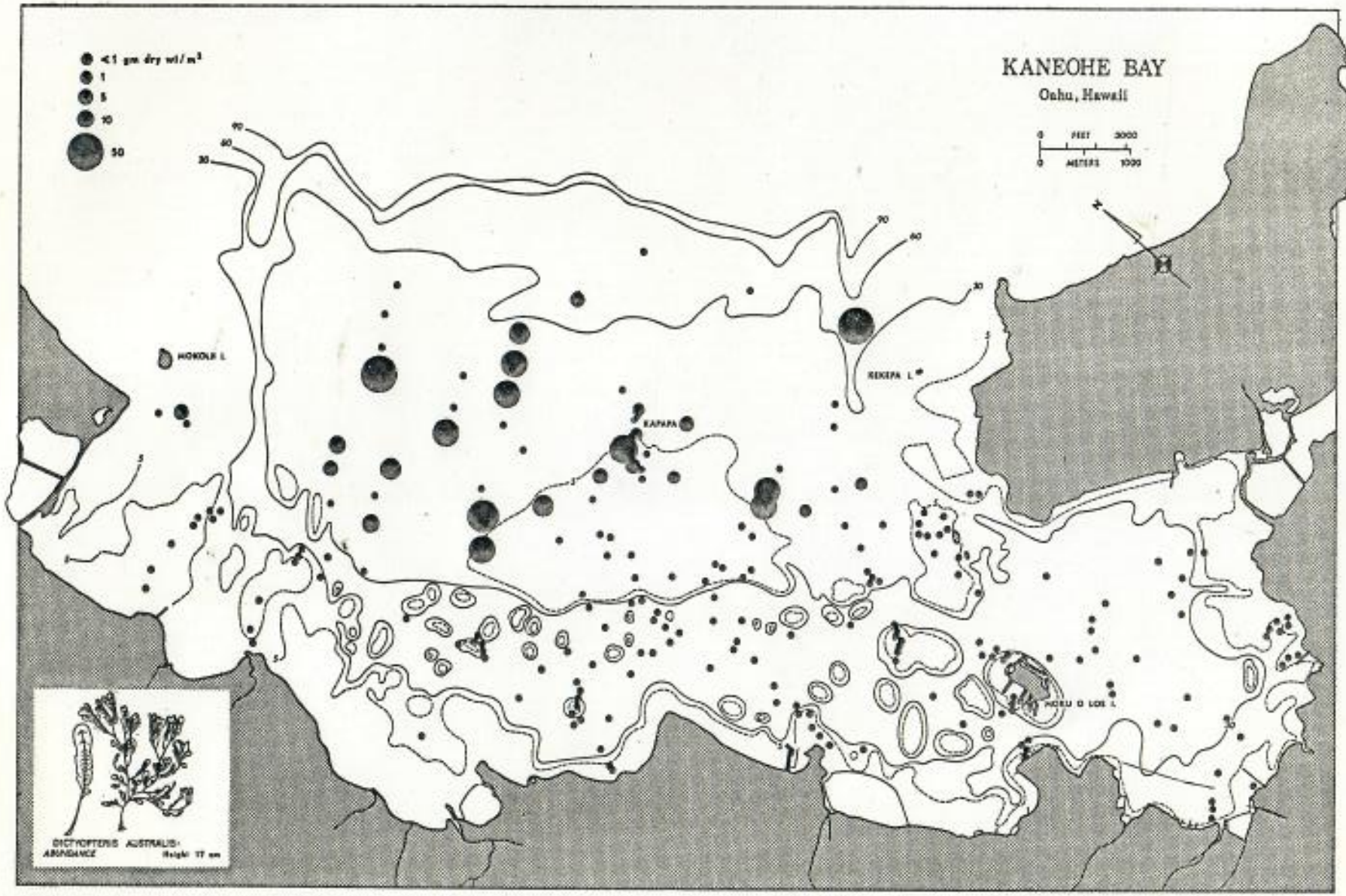

Fig. 47. Dictyopteris australis; abundance

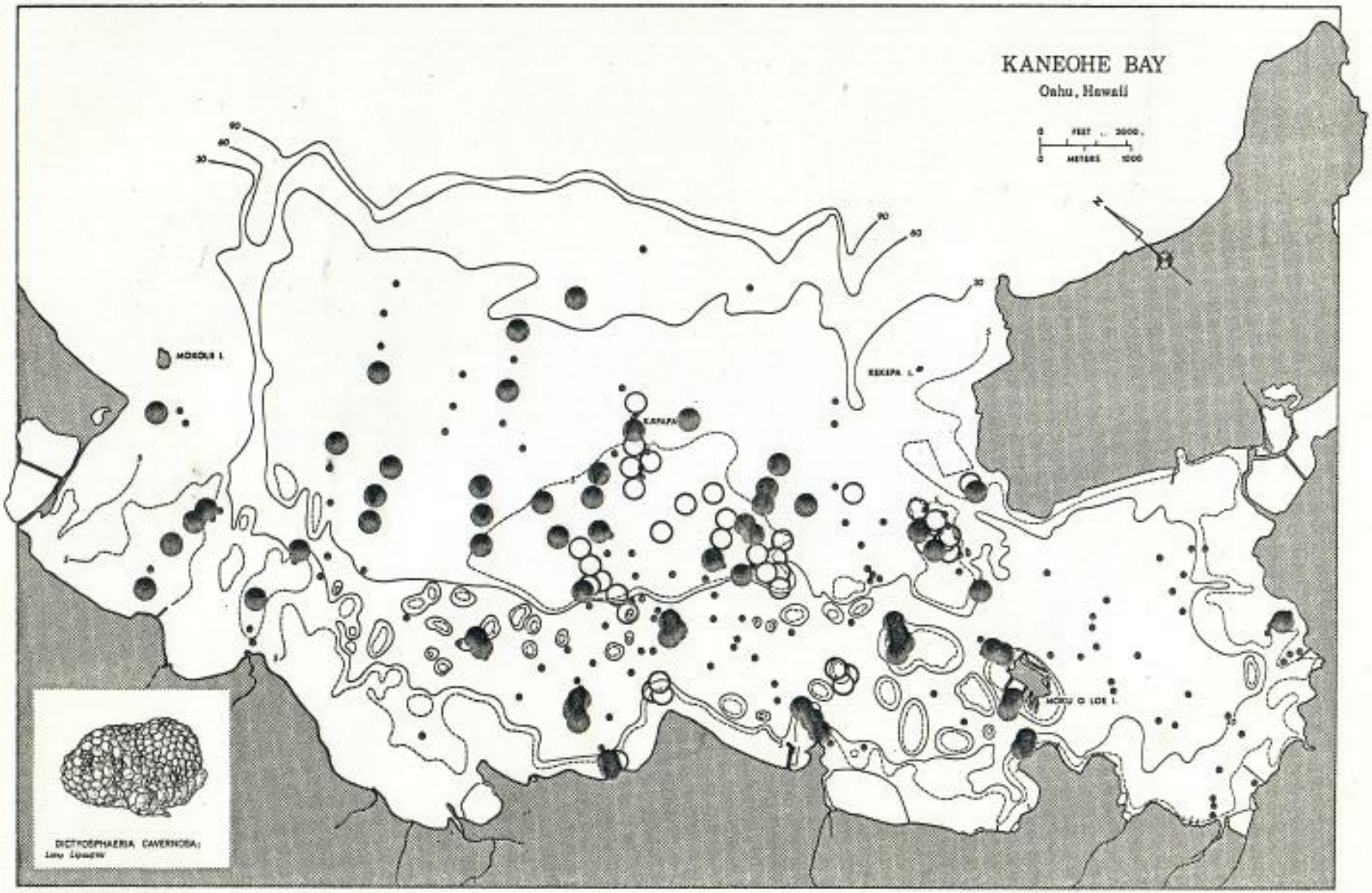

Fig. 48. Dictyosphaeria cavernosa P/A

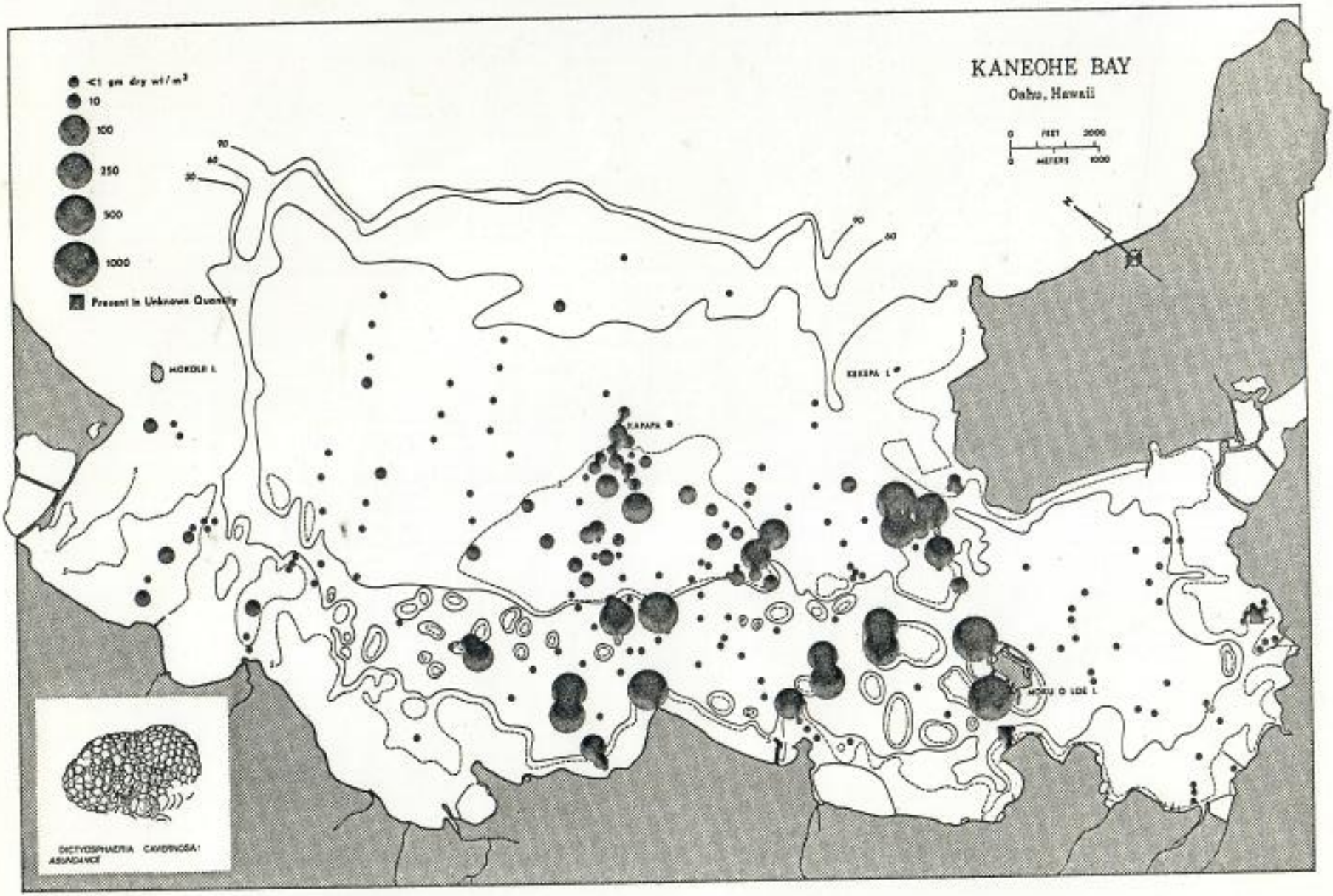

Fig. 49. Dictyosphaeria cavernosa; abundance

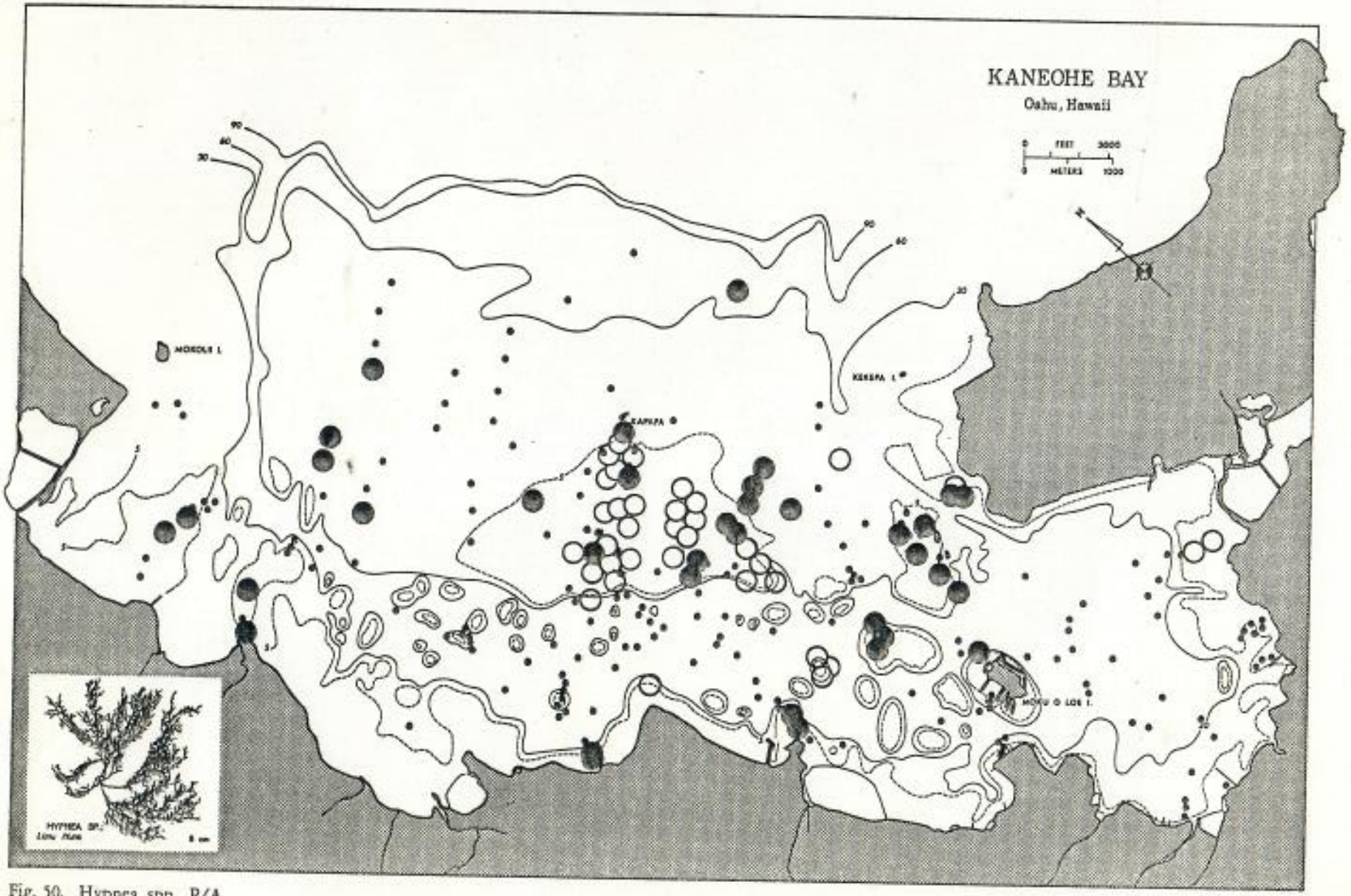

Fig. 50. Hypnea spp. P/A

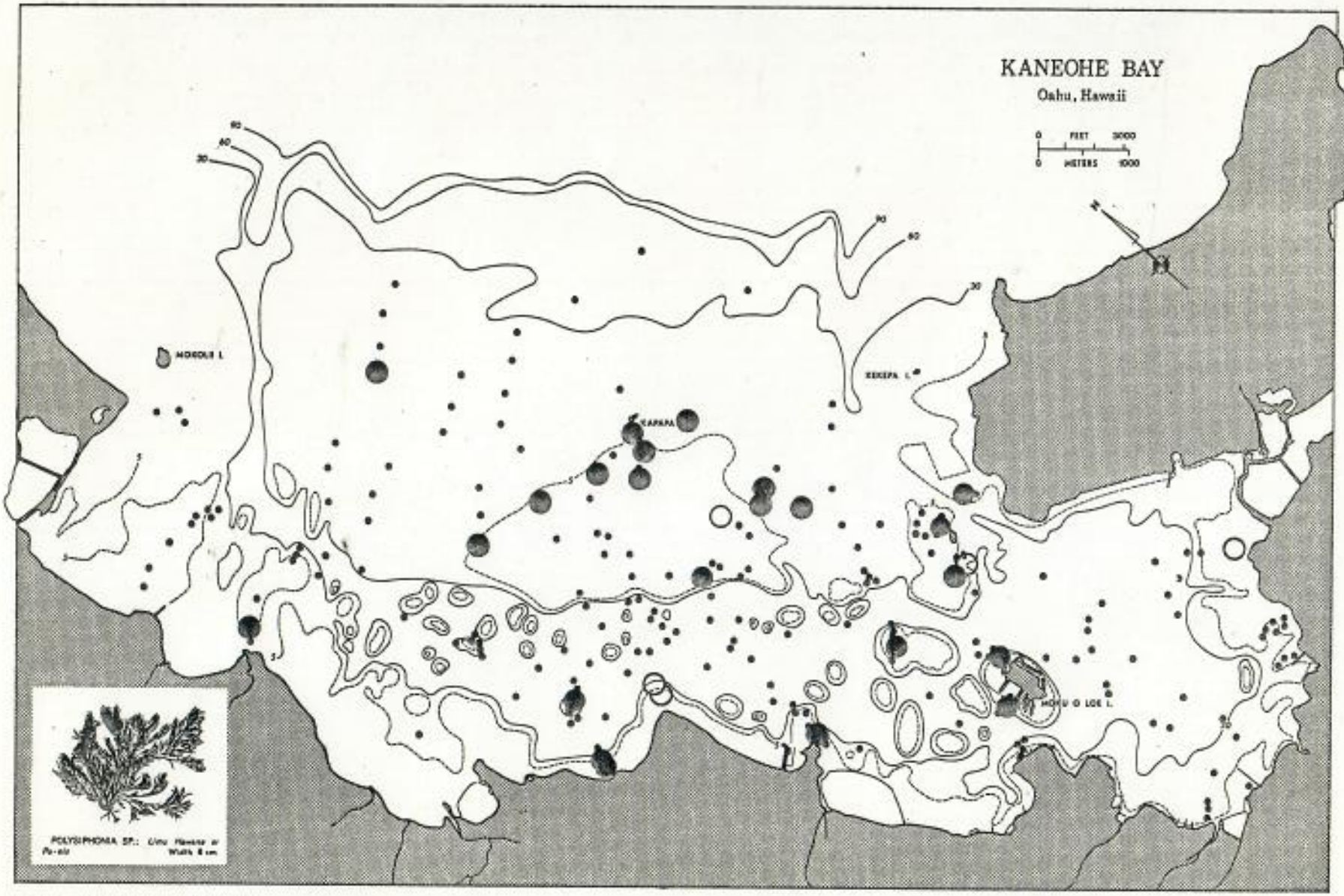

Fig. 51. Polysiphonia spp. P/A

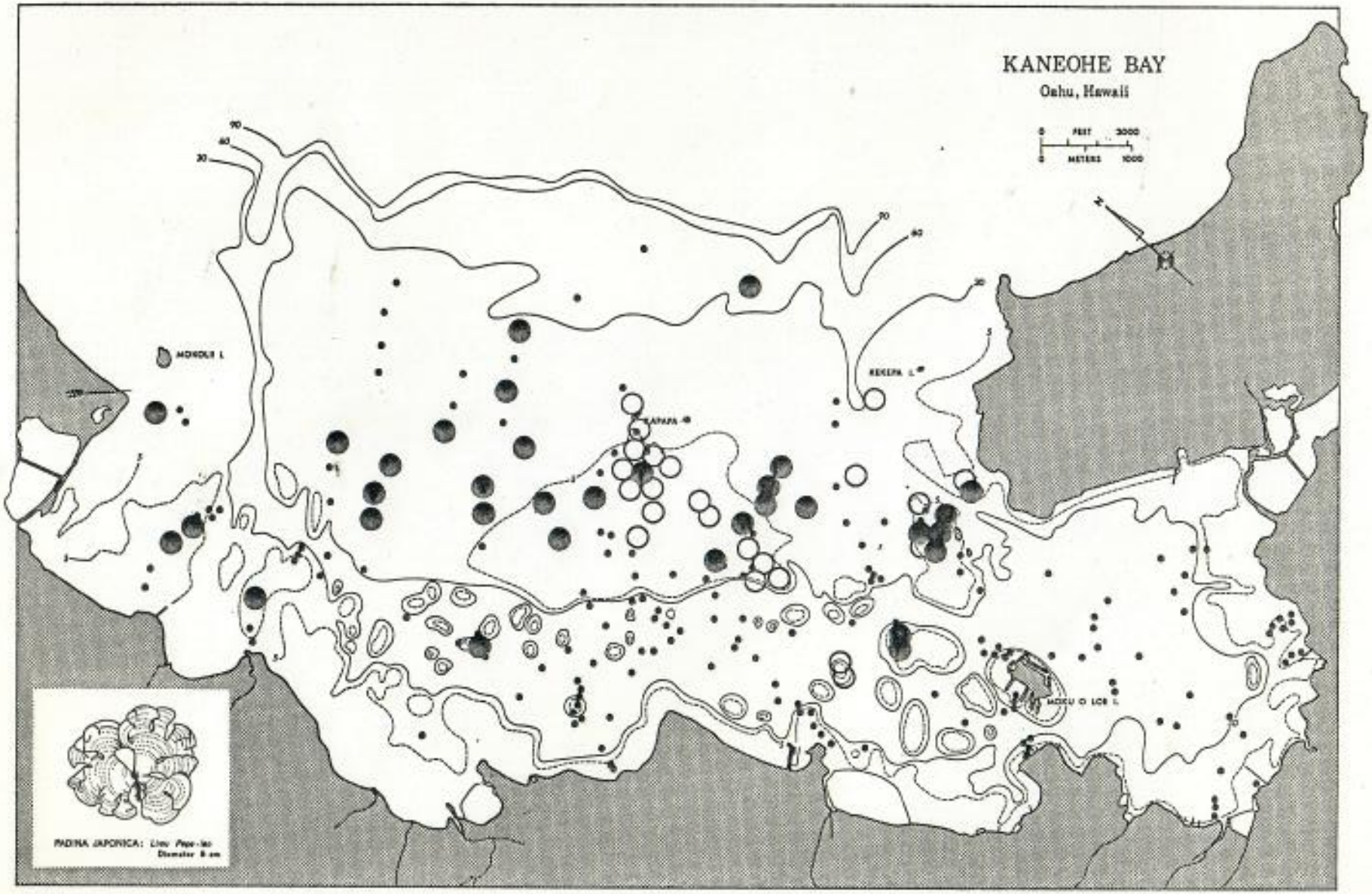

Fig. 52. Padina japonica P/A

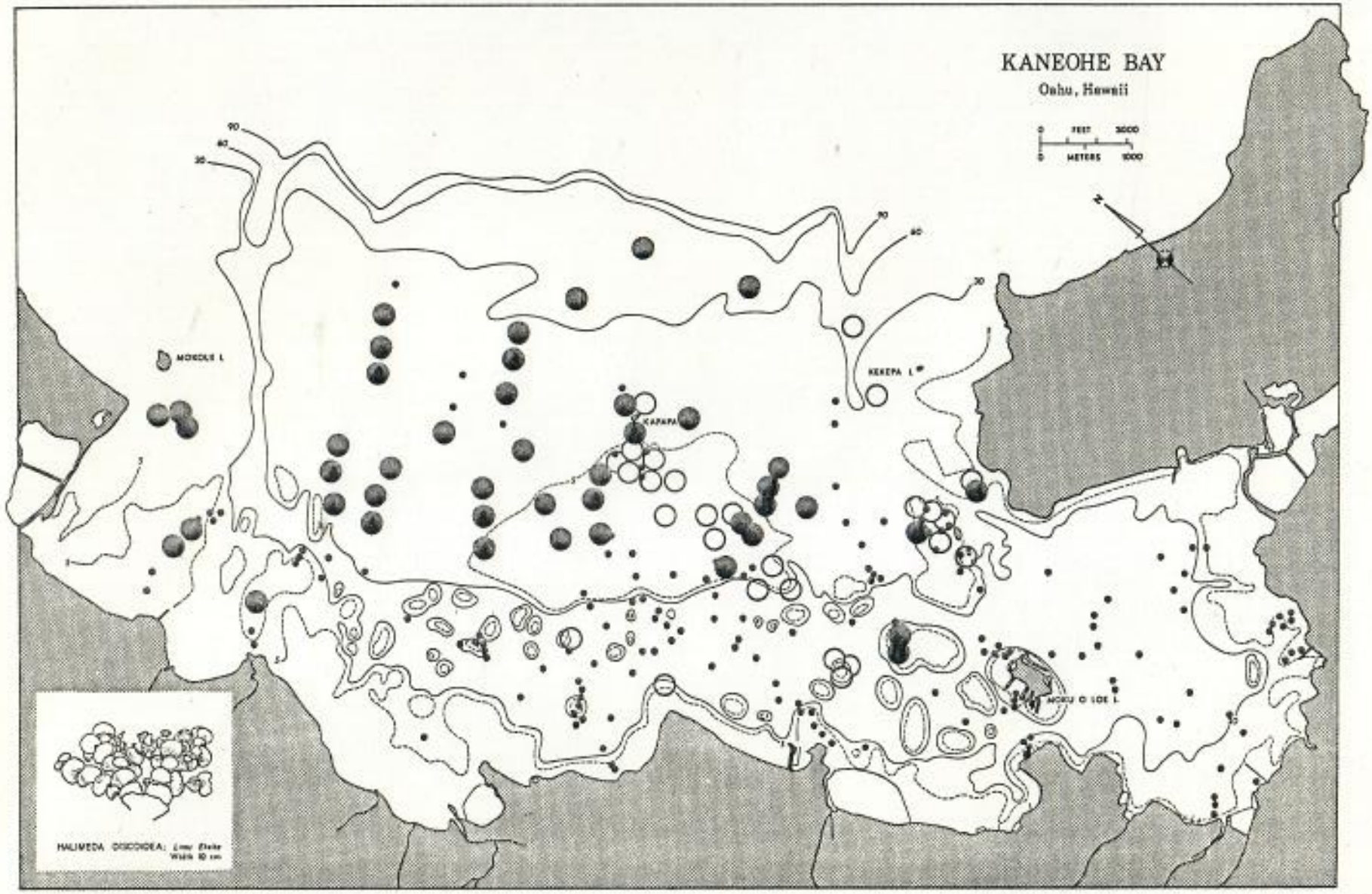

Fig. 53. Halimeda discoidea P/A

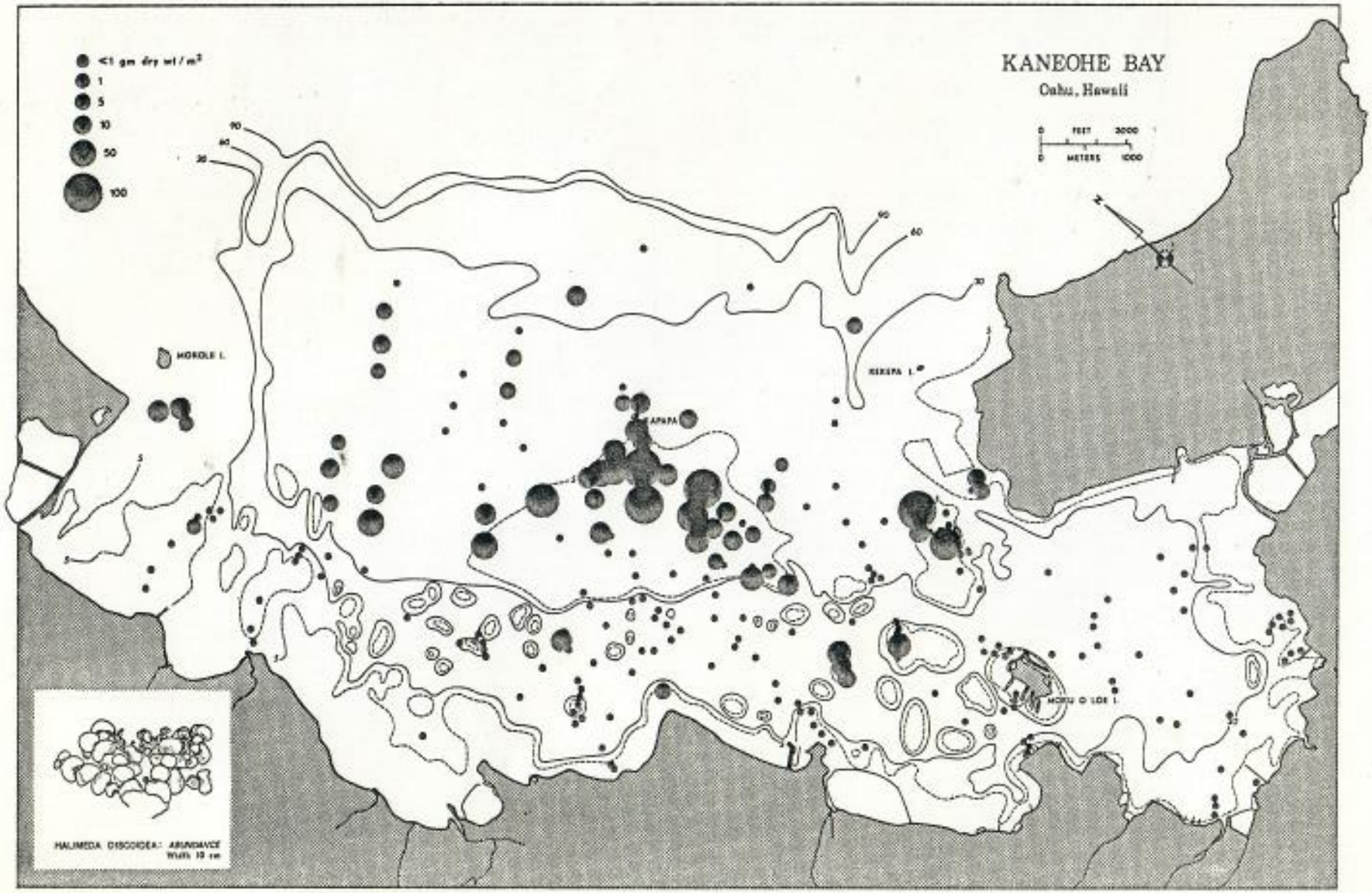

Fig. 54. Halimeda discoidea; abundance

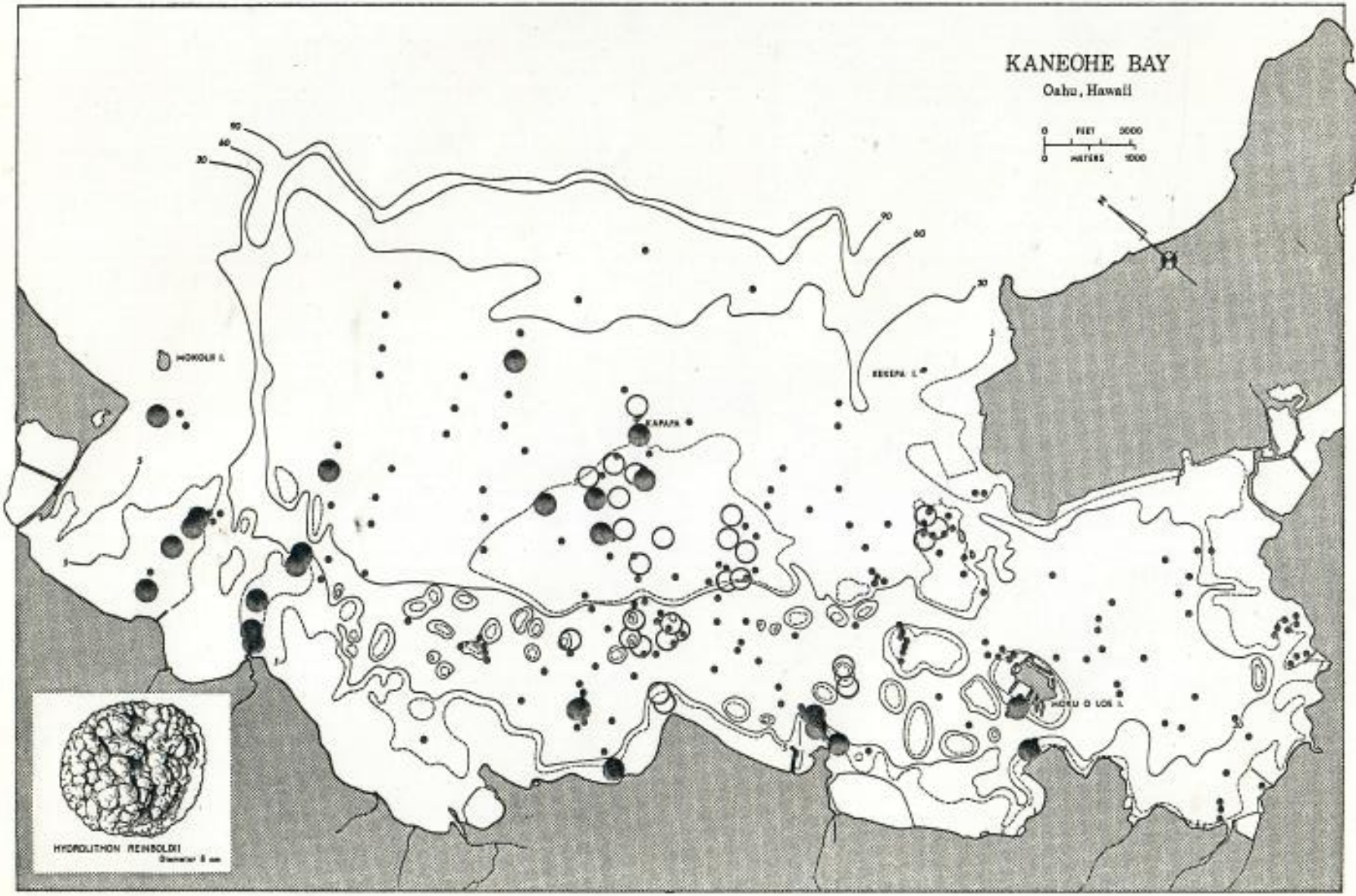

Fig. 55. Hydrolithon reinboldii P/A

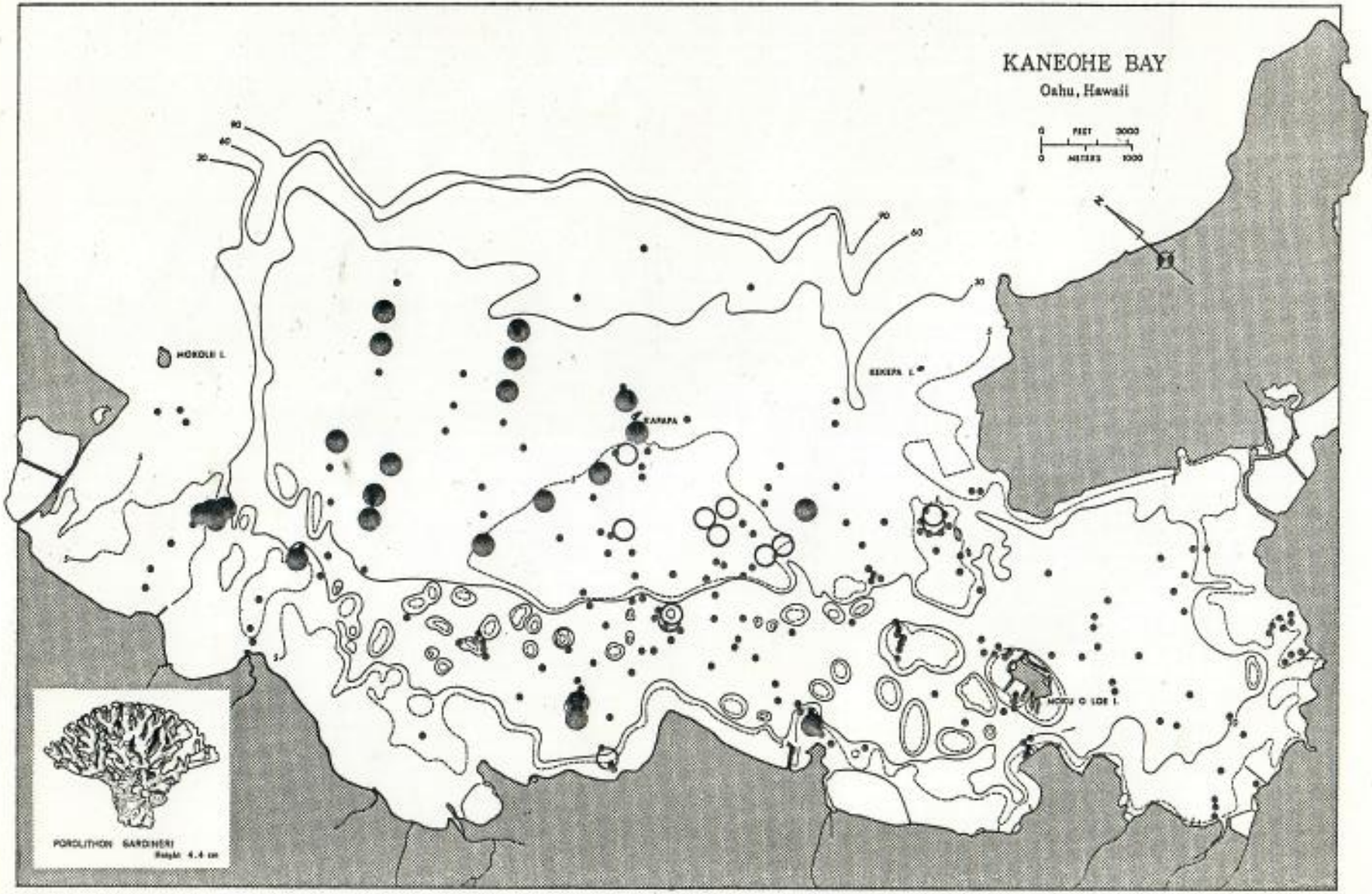

Fig. 56. Porolithon gardineri P/A

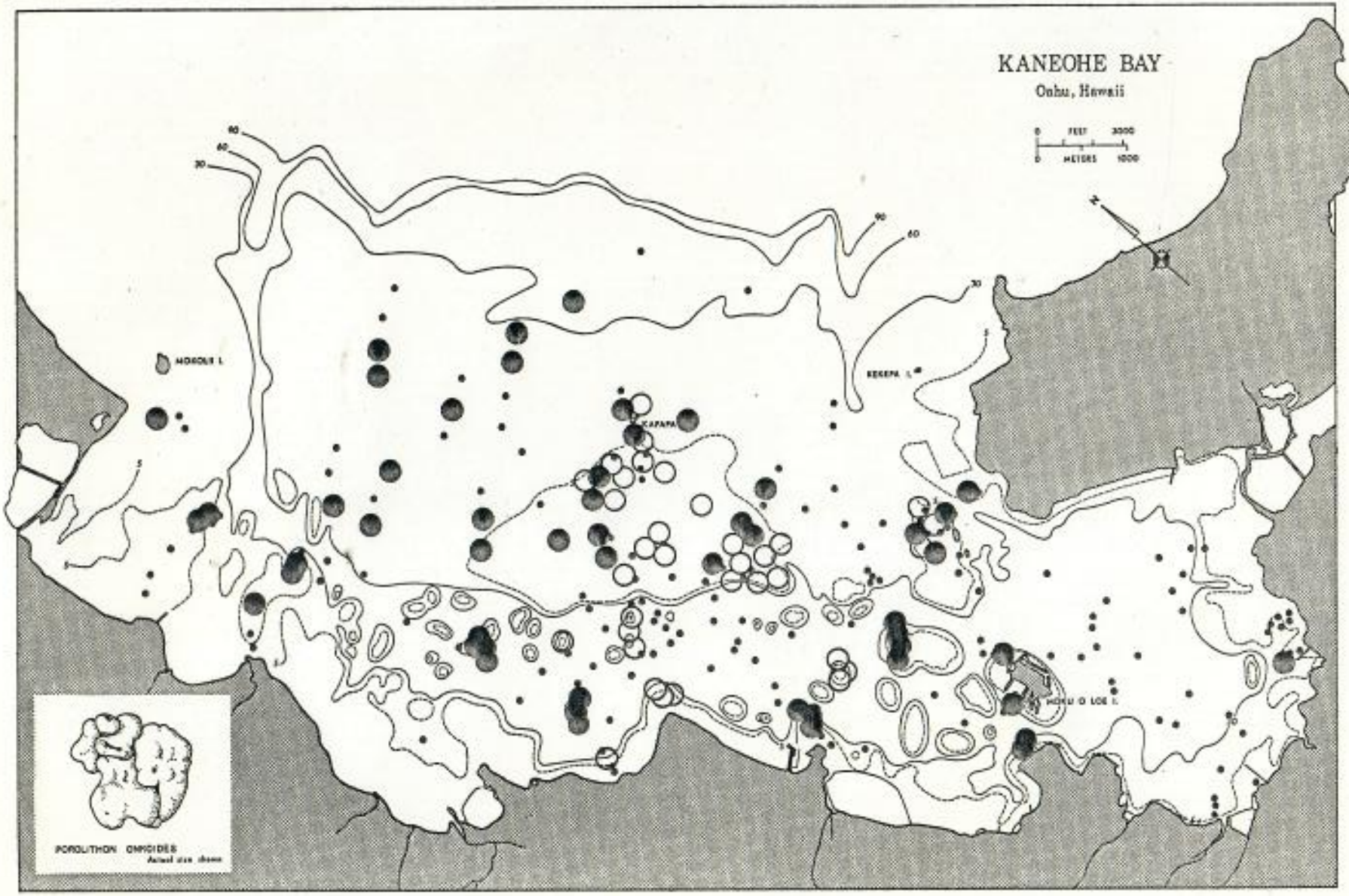

Fig. 57. Porolithon onkoides P/A

VII. Other Surveys

Several biologists not directly associated with the Sea Grant coral reef project have made valuable surveys in Kaneohe Bay. They have generously contributed to this Atlas.