Nearly all the major crop pests in California—including plant parasitic nematodes—have been introduced on or in host plants or as contaminants on articles of commerce. There are, however, a number of nematode species of serious economic importance in other parts of the world which are not known to occur in California, including potato parasitic nematodes in the Mississippi Valley and other southeastern states; the soybean cyst nematode, found on Long Island in 1941, is believed to have been established there as early as 1934. Soon after the nematode was detected, an intensive control and containment program was started. Surveys for the golden nematode, made several times throughout the major potato-producing areas of the United States, including California, produced no evidence of wider occurrence. European workers familiar with the species estimate that a population level of about one million per acre in the top foot of soil would probably not be detected by usual survey methods. On Long Island, the nematode has been found, by its injury to potato plants, in fields previously surveyed and believed not to be infested.

In California, the state and county departments of agriculture have recently intensified efforts to further explore the seriousness of plant parasitic nematodes as agricultural pests and to resolve the possibilities of control or containment by practical and economic regulatory measures.

The California Agricultural Code defines an agricultural pest, in terms that clearly include plant parasitic nematodes. However, evaluation of the pest potential of nematodes and action to restrict or prohibit their further dissemination is more difficult than with many other organisms. Information concerning pathogenicity of many nematodes is incomplete. Adequate knowledge of nematode distribution within the state is not available. Investigation into all phases of disease problem, or are non-injurious.

Examination for nematodes is usually valueless unless laboratory extraction procedures are used and careful identifications are made under high magnification by experienced nematologists.

Restrictive actions against nematodes have been attempted many times in the United States. Quarantines against the root-knot nematode in potato were once attempted and later abandoned. Federal quarantines now in existence include those for the golden nematode of potato and the soybean cyst nematode of soybean.

California has a quarantine against the soybean cyst nematode of soybean. Nematodes present in planting stock or in established crops, to determine whether the species found are potentially injurious, are the cause of an existing disease problem, or are non-injurious.

Examination for nematodes is usually valueless unless laboratory extraction procedures are used and careful identifications are made under high magnification by experienced nematologists.

Restrictive actions against nematodes have been attempted many times in the United States. Quarantines against the root-knot nematode in potato were once attempted and later abandoned. Federal quarantines now in existence include those for the golden nematode of potato and the soybean cyst nematode of soybean.

California has a quarantine against the burrowing nematode of citrus which was found entering the state on certain subtropical and tropical ornamental plants.

There is no general agreement on the effectiveness of quarantine restrictions and containment programs for nematodes. The golden nematode of potato, found on Long Island in 1941, is believed to have been established there as early as 1934. Soon after the nematode was detected, an intensive control and containment program was started. Surveys for the golden nematode, made several times throughout the major potato-producing areas of the United States, including California, produced no evidence of wider occurrence. European workers familiar with this species estimate that a population level of about one million per acre in the top foot of soil would probably not be detected by usual survey methods. On Long Island, the nematode has been found, by its injury to potato plants, in fields previously surveyed and believed not to be infested.
Nematode Structure and Life

A wide range of life habits requires combination of characters for identification of parasites classified among nematodes.

The many thousands of species of nematodes in the phylum Nemata are a group of animals commonly placed into four categories: parasites of man and animals; parasites of plants; species living in marine and brackish water; and free-living soil and fresh-water species. No single character or criterion can be used to distinguish nematodes from other similar animals, although one feature—not structural—sets nematodes apart, and that is the tremendous variation in size. Nematodes vary in length from the 1,425" ectoparasites of plants to the 25' long parasite of whales.

Nematodes are generally elongate cylindrical and taper at both ends. Deviations in shape occur mainly in the animal and plant parasitic forms. In some forms the adult females may be obese, saccate, spherical or kidney-shaped. In addition to differences in size and shape, all nematodes have certain features in common regardless of whether marine, soil or fresh-water, animal or plant parasites.

The alimentary canal begins with the oral opening which is anterior, terminal and usually surrounded by lips which bear the cephalic sensory structures: papillae, setae, amphids, and so forth. Following the oral opening is the buccal cavity or stoma which may or may not be armed by teeth, jaws or a stylet—spear. The esophagus, sometimes called the pharynx, is formed of one, two or three distinct parts in which a variety of valves and glands may be located. Anteriorly the tubular intestine is separated from the esophagus by the esophageo-intestinal valve; posteriorly the intestine joins the rectum which ends in a terminal or subterminal anus in the female and a cloaca in the male. Externally nematodes are covered by a resistant cuticle which may or may not exhibit surface modifications. Internally nematodes are not segmented and the somatic musculature is limited to longitudinal fibers. As a result of this almost unique musculature nematodes move mainly in a dorso-ventral plane.

The excretory system in its simplest form can be described as consisting of collecting tubules located in or near the lateral hypodermal chords. The collecting tubules connect anteriorly with a renette cell which excretes its contents to the environment by way of an excretory duct. The system undergoes many variations. In some groups of nematodes there is a single collecting tubule and in still others only the renette cell and excretory duct remain.

There are also features of the reproductive system of nematodes that can be utilized to separate them from other pests at least once in every 12-month period. Growers and sellers of nursery stock are required to maintain effective control over all plant pests. When a pest is found that is of limited distribution or is not known to be established in California the pest must be eradicated in a way satisfactory to the authorities.

To comply with the regulations, an infestation of a nematode—of known economic importance—must be determined to be under effective control, but there are no known practical and reliable methods of measuring nematode populations which may be present in nursery stock but not showing evidences of infection. Furthermore, there are no methods available to significantly reduce or to eliminate a nematode infestation in most nursery stock other than by destroying the stock itself.

In California, efforts are being directed toward resolving some of the problems presented by the growth and sale of nursery stock. If an effective pre-planting treatment of nursery growing grounds followed by protection of the plantings against further infection during growth can be accomplished, certification of California-grown nursery stock at origin should be possible.

To obtain a more accurate and complete picture of nematode distribution in California, records of the University and the California Department of Agriculture are being compiled and coordinated. When complete the distribution patterns demonstrated should provide a firm basis for practical quarantine regulations affecting both California growers and importers of agricultural products.

A program of collection and collation of additional knowledge of nematodes established, and of those entering and moving within the state, is being attempted. In the program, a portion of the necessary laboratory work has been delegated to personnel of the County Agricultural Commissioners' offices. The California Department of Agriculture has prepared instructions for use by the counties in certain standardized methods to extract nematodes from plant tissue and from soil. Specimens of the nematodes are preserved and sent to Sacramento for identification.

The county laboratory program has shown promise of adding materially to the knowledge necessary for practical quarantine actions.

W. H. Hart is Extension Specialist in Plant Nematology, University of California, Davis.