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PUERTO RICO AGRICULTURAL EXPERIMENT STATION
MAYAGUEZ, PUERTO RICO

Under the supervision of the
UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 38

PARASITES AND PARASITIC DISEASES
OF SWINE IN PUERTO RICO

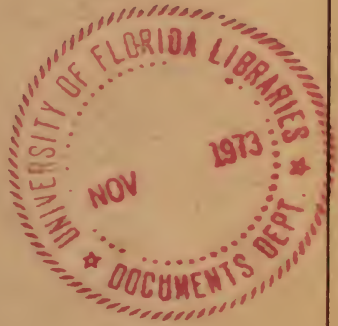
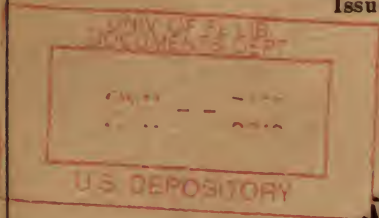
By

H. L. VAN VOLKENBERG

Parasitologist



Issued March 1936



UNITED STATES DEPARTMENT OF AGRICULTURE
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PUERTO RICO AGRICULTURAL EXPERIMENT STATION, MAYAGUEZ

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PARASITES AND PARASITIC DISEASES OF SWINE
IN PUERTO RICO¹

By H. L. VAN VOLKENBERG, *Parasitologist*

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INTRODUCTION

The most serious diseases affecting swine in Puerto Rico seem to be hog cholera, intestinal disorders (enteritis), and parasitic infestations. The fact that as a rule there are no large herds of swine in Puerto Rico, and hence no occasion for crowding, tends to restrict the spread and prevalence of infectious diseases and many parasites. However, this advantage is largely offset by the lack of care and attention given to these animals. Some of the problems of swine raising are to increase the numbers of the animals, improve the quality of the stock, and to raise a higher percentage to profitable maturity.

OCCURRENCE AND DISTRIBUTION OF PARASITES

In many places, especially in the more temperate climates, the ascarid or large roundworm is a menace to the swine industry. In Puerto Rico, the kidney worm is probably as injurious to the pig and potentially as serious to the industry as the ascarid. If many hogs are raised on a farm or on the same plat of ground, the most careful control measures are necessary. The ascarid is most common and injurious among young pigs. Mature hogs do not lose their susceptibility to infection by the kidney worm, and serious infestations

¹ Acknowledgment is made especially of the constructive and very helpful criticism of the manuscript by Maurice C. Hall and F. C. Bishopp of the U. S. Department of Agriculture.

among older animals as well as among the young may occur. The lungworms also thrive, and where pigs are raised and fed in numbers for several years in succession, unless precautions are taken, they may increase sufficiently to cause financial losses instead of profits in this industry. There are other parasites which on many farms are obstacles to profitable swine production.

Infestations with internal parasites, similar to those in other host animals, are more or less seasonal in occurrence. Among the animals slaughtered at Mayaguez, worm parasites are most common during a period of several months beginning with December. One-half or more of these hogs are obtained from the dry southern coastal plain. In the dry sections the bulk of the infestations are picked up during the latter part of the rainy season, whereas in the areas subject to torrential showers they occur at different times during the so-called dry season. However, infestations may occur at any time among pigs closely confined in insanitary, covered pens or heavily shaded yards where the free-living stages of parasites are less influenced by the prevailing weather conditions where they would be out in the open. Other things being equal, the dry areas are superior to other parts of the island for raising pigs, as the environment is less favorable for parasites.

DAMAGE BY PARASITES

Some of the external parasites extract blood from the host and all of them irritate the skin. The internal parasites of the pig cause damage by mechanically injuring tissues and organs and in various other ways. Pigs and young hogs are more susceptible and more seriously injured than older animals. Parasitism prevents the best and most rapid development and reduces vitality and resistance so that infested animals become susceptible to attack by other diseases. Heavy infestations with worms also indicate that the environment is insanitary and unsafe, and that other filth-borne diseases are likely to occur.

SHADE

Hogs must have shade, but the kind and extent of the cover is most important in a climate such as exists in Puerto Rico. A satisfactory structure for providing both shade and shelter consists of a framework about 4 feet high made of posts and poles and having the roof thatched or covered with sheet iron or palm leaves. This structure should be open on all four sides. Preferably the roof should be set on rollers and moved back and forth over its own length every few days, so that the entire area can be exposed periodically to the direct rays of the sun.

Dense, natural shade for yards should be avoided. The common practice of placing yards and feeding places under mango trees or other large trees having thick foliage is conducive to heavy infestations with parasitic worms. Sunshine is not only necessary for growing pigs, but it also acts as an efficient drier and disinfectant and is very destructive to the eggs and larvae of parasites on the ground. Also much of the island is exposed to seasonal and almost daily torrential showers. These rains have a very noticeable effect in washing and cleansing infective material from the soil. In many

yards both these purifying agencies are shut off by trees. In a location open to the trade winds, trees and brush often shield the yard from the prevailing breezes which are cool and pleasant. With a high humidity in this climate, evaporation and drying of the soil is sluggish unless the surrounding air is kept in motion.

The best arrangement as far as sanitation is concerned would be to eliminate all trees and brush in and around the yard and provide a roof shelter for protection from the elements. Otherwise a selection and arrangement of shade trees should be made in order that the direct rays of the sun can reach all parts of the yard at least one-half the day. Trees that branch fairly high from the ground are good for this purpose.

PREVENTIVE MEASURES

If hogs are confined in yards the ground should be kept dry and free of growing vegetation. As previously explained, shade is an important factor in connection with moisture or dryness in hog



FIGURE 1.—A bare yard for hogs located on a sloping hillside. Farrowing pen and yard in background.

yards. Also shade for the microscopic eggs and larvae of parasites on the ground may be provided by any covering that conserves moisture and prevents the penetration of the direct rays of the sun. Therefore all accumulations of left-over feed, especially grass, cane, corn husks, etc., should be cleaned up and removed each day with the manure.

On the heavy soils in the wet sections the yards should be placed on a slope or hillside to insure proper drainage (fig. 1). Otherwise artificial or subsoil drainage must be provided. Any surface water accumulations such as mud wallows must be avoided. If the yards are properly situated the heavy washing rains during one season and the sunlight during both seasons are very effective in carrying away

or destroying the infective material. In the dry sections or where the soils are sandy or porous the drainage requirements are less exact but in like manner the yards must be kept free of all vegetation.

The College of Agriculture at Mayaguez has successfully used bare lots with a herd of purebred hogs over a period of several years and very little attention has been paid to such sanitary measures as cleaning up manure accumulations and rotation of yards. Examinations have shown that these animals are remarkably free of internal parasites. Varying somewhat in detail, other farmers are using dry, bare lots with very little, if any, trouble from parasites. Often this method has developed on individual premises more by accident than design owing to the absence of shade trees and the destruction of the vegetation by the animals themselves.

Yards should not be situated so that one can drain into another. In all cases, the rotation of yards or pastures is very desirable. Each year or oftener a fresh lot should be occupied and, unless plowed, at least 1 year should elapse between successive occupations. Other aids in disinfection are plowing two or more times a year and frequent applications of air-slaked lime to the yards and feeding places. Hogs should not be confined in small, covered pens unless the floors are of tight construction, preferably of concrete, and are kept in a dry, sanitary condition and free of dust. As parasites among unconfined pigs which range over a wide territory are less subject to control by preventive measures, these animals should be confined in sanitary yards or pastures. Cultivated pastures should receive more attention, as several valuable crops for hogs can be grown and pastures can be used during the entire year.

BARE-LOT METHOD OF RAISING PIGS

A special farrowing yard enclosing about 500 square feet should be provided. This yard should be used for only one purpose and by one sow with litter at one time. It must be located on a well-drained, unshaded or properly shaded area. All growing vegetation should be trimmed close to the ground and removed or plowed under, and the surface should be kept in this condition during occupancy. A pen consisting of a concrete floor at least 6 by 6 feet in size, with a roof set on posts, should be constructed in or opening into the yard. Except for woven wire as a barrier the sides of this pen should be open. The sanitary features of the yard can be improved by providing at one end a separate enclosure or feeding floor for the sow and at the other end a creep with a self-feeder for the pigs. The pigs should be prevented from entering the feeding floor.

If previously occupied, the floor of the pen should be scrubbed and disinfected with a 3-percent solution of compound cresol (U. S. P.). A few days before farrowing, the sow, if encrusted with mud and filth, should be scrubbed with a brush, using soap and warm water, on the sides, udder, and entire lower portion of the body, and then placed in the farrowing yard. The bedding must be watched carefully and changed when it becomes foul or wet. The manure and all other accumulations in the yard should be frequently and thoroughly removed and properly disposed of. After weaning, the pigs should be separated from all other hogs and placed in a fresh,

uncontaminated (temporary) pasture or in a yard or yards where no hogs have been during the last year or on ground that has been plowed since hogs were there. If pastures are used for hogs the kidney-worm-control plan (p. 8) should be adopted. These sanitary measures cannot be depended on as a preventive of hog cholera, and immunization should be carried on in accordance with the approved methods of hog-cholera control.

TREATMENT FOR PARASITES

Preventive measures are more important in controlling the internal parasites of pigs than the administration of anthelmintics. There is only one species (ascarid) for which an efficient vermifuge is known, and this worm is of minor importance. Capsules should be used with caution on swine as they often lodge in the pharyngeal pouches and the contents may cause inflammation of the neck, swelling, and suffocation. Also the pig has a comparatively narrow throat, and liquids must be given slowly and carefully. Worm treatments to be given in feed or as mineral mixtures are not satisfactory. Drugs for pigs are best administered by a competent veterinarian.

INTERNAL PARASITES

The internal parasites consist of protozoa, flukes, tapeworm larvae, and roundworms. As a group the roundworms are usually more important than the others. Several of the internal parasites are of special importance because they may be transferred in some stage of their development to man and to other animals. Not all the so-called cosmopolitan species of parasites are known to occur in the native pig. Among those not known from Puerto Rico are the worms that cause the disease trichinosis and the hydatid, *Echinococcus granulosus*, both of which are transmissible to man and which may be fatal.

PROTOZOA

Intestinal disorders cause losses and interfere with the growth and development, especially of pigs and young hogs. Diarrhea is the most common and characteristic symptom. Some of these troubles are brought about by improper feeding, but the majority apparently are caused by one or more groups of bacterial and parasitic infections and are due to the insanitary environment in which the animals live. Among the parasites associated with these disorders are several kinds of worms and protozoa. The intestinal tract of hogs is frequently infested with protozoa of one kind or another. Usually these are harmless forms but at times some of them are pathogenic.

The most common protozoa found in swine are coccidia. These are microscopic round or oval organisms located in the lining membrane of the large intestine. Coccidia are frequently found in fecal examinations, but apparently they are usually pathogenic only to young pigs, causing a lack of appetite and diarrhea. Also the comparatively large, motile organism, *Balantidium coli*, a parasite of man, is frequently encountered. The balantidia, either alone or associated with pathogenic bacteria, at times produce diarrhea with fatalities in young pigs. On autopsy, the large intestine teems with

this organism and extensive ulcers are found, especially in the caecum. Other protozoa, such as amoeba, spirochetes, and trichomonads, are also found in the intestinal tract.

Specific treatments for the protozoan and filth-borne diseases in pigs are unknown. Pigs should be farrowed and raised in dry, bare lots and careful attention should be given to the details of sanitation. Food and water should be given in containers that will not allow contamination of the contents with manure. Scrubbing the sow before farrowing, as previously mentioned (p. 4), may help to prevent infestations by protozoa among sucking pigs.

LUNGWORM

The lungworms, *Metastrongylus elongatus* and *Choerostrongylus pudendotectus* (fig. 2, B), are slender white worms varying from 1 to 5 cm (approximately $\frac{1}{2}$ to 2 inches) in length. They are found in the air passages of the lungs.

Life history.—These worms require earthworms as intermediate hosts. The eggs are coughed up, swallowed, and pass out with the feces and are ingested by earthworms. Pigs become infested by eating infested earthworms.

Importance.—Lungworms are the most common of the more important parasites affecting the pig. They are most abundant in pigs raised in the wet coastal and mountain areas. Pigs on an open range often become heavily infested.

Symptoms and lesions.—The disease is characterized by a cough. Heavy infestations may result in pneumonia. Lungworms may be fatal to young pigs. Infested lungs are conspicuous because of the whitish colored areas on the surface, usually near the tips of the larger lobes.

Treatment.—Medicinal treatment should not be attempted. Sick animals should be placed in clean, dry pens and given an abundance of food.

Prevention.—For unconfined pigs the frequent cleaning and proper disposal of the manure around the feeding and sleeping quarters or from any area where the pig is in the habit of depositing its droppings would eliminate much of the infective material. Pigs wandering farther afield would be less subject to a concentration of infection.

Infestations among confined pigs can be largely prevented by cleaning up all manure accumulations. The concreting of the entire hog lot would materially aid in eliminating these worms as well as others but its cost would limit such construction to exceptional cases only. These worms are unimportant among hogs confined in dry, bare lots. Pigs should be raised under the kidney-worm-control plan or by the bare-lot method.

The practice of inserting a wire ring in the nose of the pig to prevent rooting in the soil is probably an effective control measure for lungworms and also thorn-headed worms.

KIDNEY WORM

The kidney worm, *Stephanurus dentatus* (fig. 2, A), is a thick, mottled worm from 2 to 4.5 cm (approximately $\frac{3}{4}$ to $1\frac{3}{4}$ inches) long. As adults they are located in the abdominal viscera, especially in the fat surrounding the kidneys.

Life history.—Unlike most worm parasites, the eggs of this worm pass out with the urine. The eggs hatch on the ground and infective larvae develop in a few days. These larvae are swallowed with the food or they penetrate the skin. After several months of development in the liver the young worms migrate through this organ into the abdominal cavity. Some go astray and enter the lungs and other

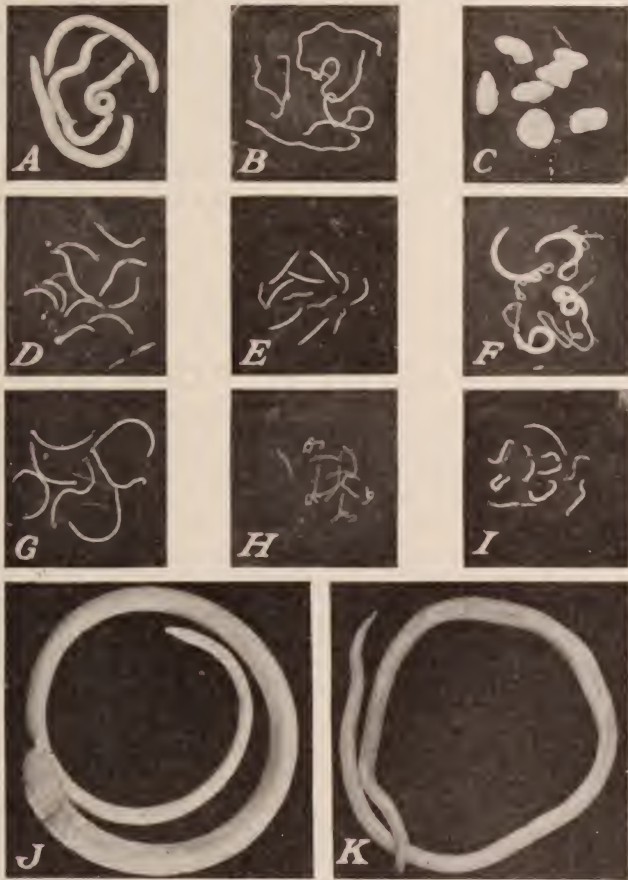


FIGURE 2.—Worm parasites of Puerto Rican hogs: *A*, Kidney worms; *B*, lungworms; *C*, pork measles worms; *D*, American swine hookworms; *E*, common hookworms; *F*, whipworms; *G*, strongyline stomach worms; *H*, red stomach worms; *I*, nodular worms; *J*, thorn-headed worms; *K*, ascarid. *A* to *I* approximately natural size, *J* and *K* slightly reduced.

tissues. This parasite shows a remarkable adaptation or specialization. Numbers of the young worms in the abdominal cavity apparently without following any natural body channel, get to the slender ureters by burrowing through the surrounding fat and puncturing these tubes, thus providing an artificial opening or avenue of elimination for the ova.

Importance.—The kidney worm is one of the most serious parasites of swine in Puerto Rico. Besides the unthriftiness and stunting of growth, there is considerable damage to carcasses from which wormy

livers and other parts must be discarded. Usually pigs confined in dark, damp, and dirty pens harbor heavy infestations with this worm. As massive infestations are often found in hogs of the improved breeds, it is believed by some that they are more susceptible than the native pig. It is probable that as these hogs are more apt to be closely confined, they are more likely to be exposed to a concentration of infection than the native pig, which may have a free range all or part of the time. However, pigs on a free range do not escape infestation.

Symptoms and lesions.—Loss of appetite, swollen abdomen, and emaciation are the usual symptoms. Severe infestations may cause weakness and paralysis of the hindquarters. The liver is injured by the young worms actively migrating through this organ. Most of the livers of slaughtered pigs show varying degrees of fresh injuries or scar tissue formation resulting from infestations with these worms. The mechanical injuries are complicated by bacterial infections and pus production.

Treatment.—Unknown.

Prevention.—The eggs and larvae of this worm are readily destroyed by sunlight, heat, and drying and they cannot survive in the open unless they fall in grass, leaves of trees, corn husks, and other vegetation.

The kidney-worm-control plan² as developed by the Bureau of Animal Industry, United States Department of Agriculture, is effective in controlling this parasite, where pastures are used. Most of the infective material is passed in the area around the sleeping quarters and close to the fences. This plan requires cutting and cleaning away the grass and weeds in a strip 3 to 5 feet wide along the fences on the sides of the pasture lot and a strip about 30 feet wide at the end where the shelters and all other equipment are placed. These strips must be kept free of trash and litter while the pasture is in use. Providing separate feeding pens for the sows and, some distance away, creeps with self-feeders for the pigs also helps to control other parasites as well as kidney worms. The pigs are kept in this pen with the sows until weaning and then are placed on temporary pastures, with only pigs of a similar age raised under the same system.

If the above plan is not followed, pigs should be farrowed in a dry, bare yard and then placed on fresh ground after weaning. In a general way, the more dense the shade, the more growing vegetation, the poorer the drainage, and the more animals on the same area the greater is the need for cleaning up manure accumulations, the rotation of yards, and the adoption of a sanitation system.

HOOKWORM

The common hookworm, *Globocephalus urosublatus* (fig. 2, E), is a slender white worm about 4.5 to 7.5 mm (approximately three-sixteenths to five-sixteenths inch) long. These worms are found in the small intestine.

Life history.—Similar to other hookworms; infection probably takes place by way of the mouth and of the skin.

² SCHWARTZ, B. CONTROLLING KIDNEY WORMS IN SWINE IN SOUTHERN STATES. U. S. Dept. Agr. Leaflet 108, 6 pp., illus. 1934.

Importance.—This is one of the more common and serious parasites. A large percentage of the pigs from the dry southern coastal area are infested.

Symptoms and lesions.—The worms are closely attached to the mucosa of the small intestine, but examinations indicate that they do not have the bloodsucking tendencies and do not produce anemia to the extent of the common hookworms in other animals. However, heavy infestations produce a severe catarrhal inflammation of the intestine, resulting in unthriftiness.

Treatment.—Either oil of chenopodium or tetrachlorethylene is indicated. Oil of chenopodium is given at the dose rate of one-half to 1 fluid dram (approximately 2 to 4 cc) to a 100-pound pig preceded or followed immediately by 2 fluid ounces (approximately 60 cc) of castor oil, or given in the oil. As used to destroy ascarids the smaller dose is less effective but is safer and may be repeated at shorter intervals.

Tetrachlorethylene may be given at the rate of $2\frac{1}{2}$ cc (about $\frac{3}{4}$ fluid dram) for pigs 8 weeks old or weighing 40 pounds. A purgative is not usually necessary, but if pigs are in poor physical condition because of parasites an adequate dose of a saline purge should be given with this drug.

Swine should be fasted for 18 to 24 hours before, and not fed or watered for 3 hours after, treatment for worms.

Prevention.—Sanitation, proper manure disposal, and general cleanliness about yards, buildings, and feeding places used by swine are indicated.

THORN-HEADED WORM

The thorn-headed worm, *Macracanthorhynchus hirudinaceus* (fig. 2, *J*), varies in length from $2\frac{1}{2}$ to 14 or more inches. It occurs in the small intestine. The body is white, cylindrical, and gradually tapers toward the posterior extremity. The body has somewhat the appearance of being segmented, owing to annulations in the cuticle. The head has an invaginating, cylindrical proboscis which bears five rows of backward-projecting hooks.

Life history.—There are several kinds of beetles which are the intermediate hosts of this worm. Among these are the four or five species of white grubs (gusanos blancos) which are the larvae of the *Phyllophaga* (*Lachnosterma*) beetles. Also a common water beetle, *Tropisternus collaris*, is another and apparently an important intermediate host. The ova are passed in the feces and are swallowed by beetles or their larvae. The pig becomes infested with this worm by eating infected beetles or grubs. The water beetle is normally very active but after infection with this intermediate stage, in which a comparatively large cyst develops in the body cavity, it becomes sluggish. Thus it is an easier prey for pigs which may be feeding on the roots of plants in marshy ground.

Importance.—This worm is of considerable importance because of its abundance. Pigs on a free range are most likely to pick up this worm and often harbor heavy infestations.

Symptoms and lesions.—The presence of many thorn-headed worms causes considerable mechanical injury and obstruction to the intestine. The head of the worm is attached to and deeply embedded in the wall of the small intestine. The comparatively large nodules frequently

seen on the outside of the intestinal wall usually indicate the location of the embedded head of the worm. Occasionally deaths are caused by peritonitis resulting from the head perforating the intestine and allowing the contents to escape into the abdominal cavity.

Treatment.—There is no specific treatment known.

Prevention.—Hogs should be prevented from feeding in marshes and along sluggish streams, not only to control infestations of this worm by means of the water beetle but also infestations with the liver fluke and the bloodsucking leeches. Infestations with this worm have not been found among hogs confined in unshaded, bare yards. Apparently the beetles are not attracted to these yards and there is no food for the grubs. Aside from the insertion of a ring in the nose of the pig to prevent rooting the best that can be done for pigs on pastures would be to harbor and protect the large nocturnal toad (*Bufo marinus*). As this toad has brought white grubs under control over thousands of acres of cane land, it should be useful in hog lots and gardens. Before the advent of this toad in 1920, herds of pigs were maintained in cane fields solely for the purpose of following the plow and eating the grubs. At present, the welfare of the pig should receive first consideration.

PORK MEASLES OR PEPITA

The pork bladderworm, *Cysticercus cellulosae* (fig. 2, C), is the intermediate stage of a tapeworm of man. This cysticercus is round or oval in shape and about as large as a small bean. It consists of a capsule or cyst filled with a watery fluid. Inside the capsule as seen from the outside is a conspicuous white spot which indicates the location of the larval head (scolex) of the tapeworm. These cysts are usually located in the muscles. In a heavily infested animal they may be found in other tissues and embedded in the fat.

Life history.—The eggs produced by the adult tapeworm in the human intestine are ingested by swine when human feces are not properly disposed of. As a pig may ingest several gravid segments of the tapeworm, which have passed at one time, and as each segment may contain many ripe eggs, heavy infestations may result and are not uncommon. Many thousands of cysts may occur in one carcass.

Importance.—This parasite is of special importance because of its relation to public health, as the pork tapeworm is considered a dangerous parasite of man. The number of swine carcasses condemned at the abattoirs is not an indication of the prevalence of the pork bladderworm as the buyers of market hogs either avoid the districts where this disease is most common or inspect the animals for the cysts. Pepita seems to be more common in the region of Ponce and Mayaguez and most of the infested pigs are obtained from or can be traced to certain districts in the mountains.

Symptoms and lesions.—The presence of cysticerci is usually not diagnosed in the live animals. However, a heavily infested pig can often be detected by palpating or by discerning the cysts underneath the lining membrane of the under surface of the tongue.

Treatment.—Treatment, which is surgical, is not practical in swine.

Prevention.—To prevent infestation in swine, proper disposal of human excrement must be made. The thorough cooking of pork and

pork products is necessary to prevent infestations with the tapeworm in man.

OTHER INTERNAL PARASITES

Several other worm parasites occur in the pig. As far as is known they are of relatively less importance in Puerto Rico than those already described in this bulletin. Usually the common worms of the pig can be identified from their gross appearance and precise location in the intestinal tract or elsewhere in the body. The morphological differences between two closely allied species, such as the lungworms or nodular worms, are unimportant from a practical viewpoint. Any unusual parasites that are encountered in livestock should be sent to the experiment station at Mayaguez for identification.

The red stomach worm, *Hyostrongylus rubidus* (fig. 2, *H*), is a small, hairlike, reddish worm. Close examination is necessary to discern these worms in mucus scraped from the lining of the stomach. Heavy infestations may produce a catarrhal condition. The maintenance of clean, dry quarters for swine is the indicated control measure.

The strongyline stomach worm, *Ascarops strongylina* (fig. 2, *G*), is a small white worm somewhat larger than the red stomach worm. It varies from 1 to 2.2 cm (approximately $\frac{1}{2}$ to 1 inch) in length. These worms may be embedded in the lining membrane of the stomach or are sometimes unattached and entangled in a mass in the lumen of the stomach. Because of the habit of burrowing, they may cause considerable injury to the stomach. As dung-frequenting beetles are intermediate hosts of this worm, prevention depends on the frequent and thorough cleaning out of manure in order to prevent the beetles from feeding on it. The giant toad might be useful in controlling these beetles. About 50 percent of pigs slaughtered at Mayaguez are infested with one or the other or both species of stomach worms.

The roundworm or ascarid, *Ascaris lumbricoides* (fig. 2, *K*), is a thick yellow or pink worm varying from 6 up to 10 or more inches in length. It is unattached and is usually found in the lumen of the small intestine. If numerous, these worms are very serious, causing digestive disturbances, malnutrition, and stunting in young pigs. In Puerto Rico infestations are uncommon and usually consist of only a few worms.

The American swine hookworm, *Necator suillus* (fig. 2, *D*), located in the small intestine, is somewhat longer and more robust than the common hookworm (p. 8). A few pigs lightly infested with this worm have been found at Mayaguez but further information as to the economic importance of this worm is lacking. This worm is common in Trinidad.

The nodular worms, *Oesophagostomum dentatum* and *O. longicaudum* (fig. 2, *I*), are roundworms found as adults in the large intestine. They vary from 8 to 14 mm (approximately $\frac{5}{8}$ to $\frac{1}{2}$ inch) in length. Some of these worms are white but the majority are of a grayish-brown color. Heavy infestations of this worm are common in the wet coastal areas. These worms are not as serious in pigs as the nodular worms in calves. Control measures depend on sanitation, proper manure disposal, and general cleanliness about yards or buildings occupied by swine.

The whipworm, *Trichuris suis* (fig. 2, *F*), is a white worm found in the caecum and colon. The anterior portion of the body is long and slender and the posterior portion short and thick. The anterior portion is embedded in the lining membrane of the intestine. Whipworms are often found in pigs and calves but usually infestations are light. The control measures are the same as given for the nodular worms.

The liver fluke, *Fasciola hepatica*, is a leaflike flatworm found in the ducts of the liver of cattle, goats, and swine. This worm is common in pigs that have access to swampy ground. Among slaughtered animals a loss occurs in that infested livers are condemned. Pigs should be prevented from feeding in marshes and should not be fed grass obtained from these areas. Directions for fluke control are given in a previous publication of the station.³

The thin-necked bladderworm, *Cysticercus tenuicollis*, consists of a spherical cyst about 2½ cm (1 inch) or more in diameter. The external tough membrane encloses a thinner transparent membrane having a projecting neck and head, the scolex of the tapeworm. This inner cyst is filled with a watery fluid. These bladderworms are usually embedded in the liver or attached to other viscera in the abdominal cavity. The adult tapeworm is found in the intestine of the dog. In natural infestations, which consist usually of one or two cysts, no symptoms are observed in the pig. The cysts should be removed at time of slaughter and destroyed. The deep burying or destruction by burning or otherwise of carcasses of animals dying in the field is another indicated control measure.

EXTERNAL PARASITES

Although several kinds of arthropods or external parasites occur on the hog in Puerto Rico, on the whole they are not considered of much importance. The hardy native pig exposed to plenty of sunlight on the open range seems to be remarkably free from external parasites. However, infestations occur, especially among pigs confined in insanitary quarters, which are detrimental to health and control measures are necessary.

The hog louse, *Haematopinus adventicius*, causes considerable damage to hogs if present in large numbers. In some herds, especially of the improved breeds, this louse is commonly present for years. Under conditions such as exist in Mayaguez this louse is not noticeable except during the hot weather of April and May before the start of the regular, torrential showers, when it increases in numbers. It does not seem to spread and is rarely if ever found on the native hogs brought to the abattoirs.

These lice can be eradicated by hand applications, sprays, medicated hog wallows, or dipping. Hand applications may consist of (1) crude petroleum, (2) crank-case drainings, (3) cottonseed oil and kerosene, equal parts, or (4) lard 1 pound to one-half pint of kerosene. These remedies should be distributed in a thin, even coating over the entire surface of the head and body, including the inner surface of the ears and between the thighs. Freshly oiled or greased

³ VAN VOLKENBURG, H. L. PARASITES AND PARASITIC DISEASES OF CATTLE IN PUERTO RICO. Puerto Rico Agr. Expt. Sta. Bull. 36, p. 18. 1934.

hogs should not be moved rapidly and must be kept under shade. The large fat hogs should be handled or moved only in the evening or early morning.

Demodectic or follicular mange is caused by *Demodex phylloides*, a microscopic, wormlike mite which lives in colonies or groups in the hair follicles and sebaceous glands. This mange is often found in market hogs, but infestations are mild and unimportant. This skin disease is usually not recognized as mange and as being contagious. The lesions usually consist of small, hard nodules the size of a pinhead, or larger, located on the skin of the head, neck, and shoulders. If the disease advances, which occurs only occasionally, these nodules break and discharge pus and suppurating cavities may form. No effective treatment is known, although frequent dippings in crude petroleum check the progress of the disease. In badly infested herds, animals with advanced cases should be destroyed, the remainder fattened for market and disposed of, and the premises cleaned and disinfected before being restocked with healthy hogs.

Sarcoptic mange is caused by *Sarcoptes suis*, a small whitish mite which burrows into the upper layers of the skin. The mites are usually easy to find among the lesions on the inside edge near the base of the ear. They are barely visible to the naked eye if placed on a dark background. Sarcoptic mange is uncommon and it does not spread rapidly in this climate, but it is more noticeable and more serious than demodectic mange. It is usually accompanied by demodectic mange. Stockmen usually recognize sarcoptic mange as a contagious parasitic skin disease.

The same remedies and treatments are used for both lice and mange. Crude petroleum is the most effective known remedy, but in using it precautions must be taken to prevent burning of the skin and overheating of the animal. The arsenical solution as used for cattle ticks is effective if hogs are dipped four times at intervals of 6 or 7 days. Detailed instructions for the treatment and control of hog lice and mange are given in a Farmers' Bulletin of the United States Department of Agriculture.⁴

The primary screw worm or gusano de la herida, *Cochliomyia americana*, is the maggot of a blowfly which may attack any open wound of pigs and other animals. This fly is more abundant some years and during certain seasons but no severe outbreaks have been known to occur. The treatment is to apply a small amount of commercial benzol or chloroform to the infested wound. Benzol is preferable; and if it is used, the blood and serum in the wound should first be swabbed out with cotton. After waiting 3 or 4 minutes a small amount of the material should be introduced into the pockets of the wound and these should then be plugged with cotton. When the worms have been killed, the wound should be lightly covered with commercial pine-tar oil. All wounds should be treated with pine-tar oil to prevent attack by flies.

The sand flea or nigua, *Tunga penetrans*, frequently attacks hogs, especially those that are raised near the seashore. The flea burrows into the skin between and above the claws and its presence pro-

⁴ IMES, M. HOG LICE AND HOG MANGE: METHODS OF CONTROL AND ERADICATION. U. S. Dept. Agr. Farmers' Bull. 1085, 22 pp., illus. 1933. (Revised.)

duces considerable irritation and inflammation. The infested tissues become swollen and pits or ulcers are produced. In a badly infested foot the skin appears honeycombed. Providing a concrete wallow containing 3 to 5 inches of water with a thin layer of crude oil will control lice and would probably be effective in controlling sand fleas. A hog wallow should be provided with a roof for shade. The construction and medication of hog wallows are fully described in a Farmers' Bulletin of the United States Department of Agriculture.⁵

Other external parasites that have been found on the pig are: Mosquitoes; gnats or mimes, *Hippelates* spp.; fleas other than sand fleas; horse ticks, *Dermacentor nitens*, in the ear; and leeches or sanguijuelas.

⁵ See footnote 4.

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