

REPORT OF AN ENZOOTIC OF PARASITIC PROVENTRICULAR WORMS (SPIROPTERA INCERTA SMITH) OF PARROTS, WITH CONTROL OF SAME.

(From the Laboratory of Comparative Pathology, Philadelphia Zoological Garden.)

By FRED D. WEIDMAN, M.D.

THE first part of this subject has already been reported in fullest detail before the Academy of Natural Sciences,¹ where in 1913 its clinical, scientific, and therapeutic phases were brought out by microscopic slides, gross museum specimens, and lantern lecture. Since that time the hygienic measures instituted against the disease have been attended by a full measure of success, for which reason a further exposition of the subject, this time to medical eyes, would appear warranted.

Deaths among Psittaci.

Statistical Table for Parrot House.

<i>Year Ending.</i>	<i>Verminous.</i>	<i>Not Verminous.</i>	<i>Total from all Causes.</i>	<i>Percentage Dying with Worms.³</i>	<i>Number of Psittaci in Collection (Census).</i>	<i>Percentage of Mortality from all Causes.⁴</i>
March 1, 1906	3	45	48	6	Not obtainable	—
March 1, 1907	16	29	45	36		—
March 1, 1908	17	36	53	32		—
March 1, 1909	20	16	36	56		—
March 1, 1910	10	30	40	25		—
March 1, 1911	12	29	41	29	132	23.7
March 1, 1912	24	57	81	30	142	36.3
March 1, 1913	0 ¹	31	31	0	149	17.2
March 1, 1914	0 ²	34	34	0	163	17.9
March 1, 1915	0	26	26	0	173	13.0
Total . .	102	333	435	—	—	—

¹ Fifteen died in isolation.

² One died in isolation.

³ Percentage calculated on total number of deaths, because census figures were not available prior to 1911. This would permit calculations of only two percentages.

⁴ Calculated on total number of parrots exhibited during the year. Obtained by adding number of deaths for the year to the census at end of year.

¹ "Proceedings of the Academy of Natural Sciences of Philadelphia," March 1913, p. 126. See also the Fortieth, Forty-first, Forty-second, and Forty-third Annual Report—Zoological Society of Philadelphia—1912, 1913, 1914, 1915.

In the 1913 communication 102 parrots and seventeen other birds were listed as having died during seven years (up to March 1912) showing these worms. Since that time sixteen other parrots, out of twenty which were isolated, have also died with these worms, making a grand total of 135.

The cause of this disease, which I name "psittacic spiropteriasis," is a small round worm, described in 1908 and named *spiroptera incerta* by Dr Allen J. Smith. It is, in brief, dull or yellowish white, of about the size and shape of the human hookworm; it

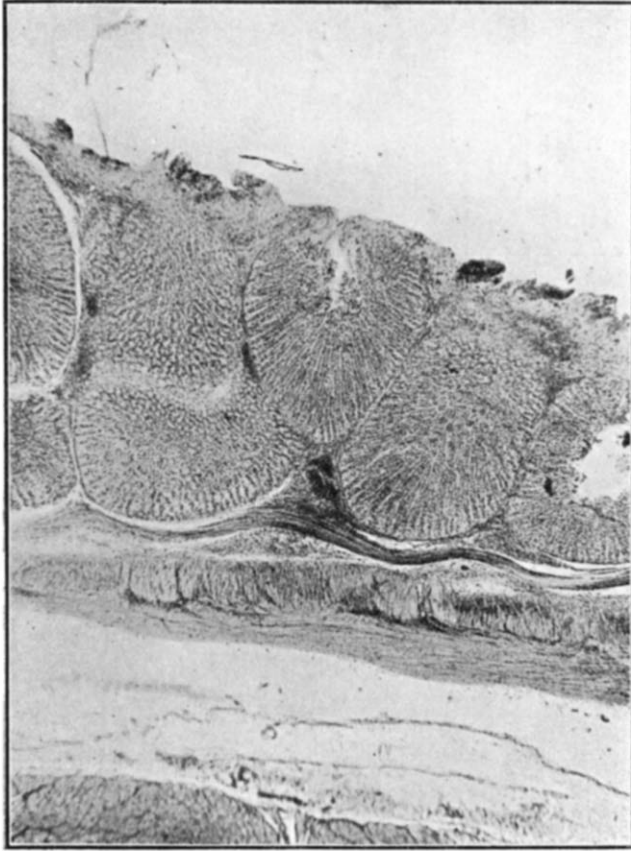


FIG. 1.

burrows into the proventricular mucosa, or lies in the thick mucoid deposit upon the surface of same. The worms number one to fifty. While they may be found in other birds, it is especially the parrots which are infested (in the proportion of 118 to 17).

In light infestations the host seems healthy. In severe ones it is emaciated, may emit a wheezing sound, or pass mucus from nostrils and mouth. The lesion is essentially an ulcerative catarrh, with at times adenomatous proliferation. The mucus in connection therewith is very tough and so abundant as to often occlude the

lumen and distend same to proportions of gizzard. In such cases the heart is displaced, cloaca pressed upon by the depressed gizzard; in one instance the walls were sufficiently attenuated to permit escape of worms into nearby air sacs. Pathogenicity is still further shown by marked decrease in parrot mortality since elimination of the disease early in 1913. (See Table.)

Death takes place by (1) destruction of the (for birds) important proventricular glands, (2) obstruction of the passage of food, (3) rupture of proventricle and consequent serositis, and (4) toxemia, as shown by occasional perineural round-cell infiltration.

The enzootic was controlled, first, by renovating the parrot house, and, secondly, by detecting and isolating infested birds. This took place in January and February 1912. Recurrence is prevented by

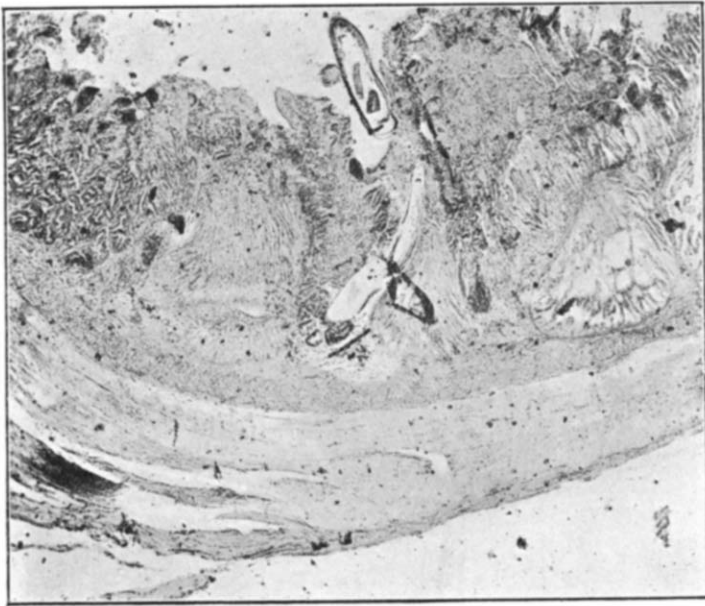


FIG. 2.

examining every new arrival before being passed to the parrot house for exhibition. In this latter connection we have to report that we have never been able to find ova in the droppings of a new arrival (there have been seventy-eight in two years), a discovery which would throw some light on the source of the parasite.

Renovation was thorough, consisting in removal of all old cages, prolonged formalin disinfection, painting of the exhibition room, and installation of new cages.

Detection of infested birds was found to be possible only by examination of droppings for ova, although several other means were tried, and we feel that the successful control of this disease will be directly proportionate to the accuracy with which infested birds are diagnosed.

Ordinarily this is not a simple matter. The examination of bird

droppings for parasitic ova is difficult, and results are uncertain when performed in a simple watery medium. This is due to the quantity of opaque vegetable cells, the urates, and sometimes mucin, which either obstruct the view of underlying ova or prevent the production of a thin layer of material. The simple expedient of boiling with an alkali at once largely corrects all these difficulties and does not destroy the ovum, which has very thick walls. Vegetable cells are clarified, and mucus and urates thereby dissolved. Our routine method is as follows: Boil droppings for five minutes in 10 per cent. potassium hydroxide, shake one minute, boil three minutes, centrifuge for one minute. Two portions of the sediment are examined for ova under

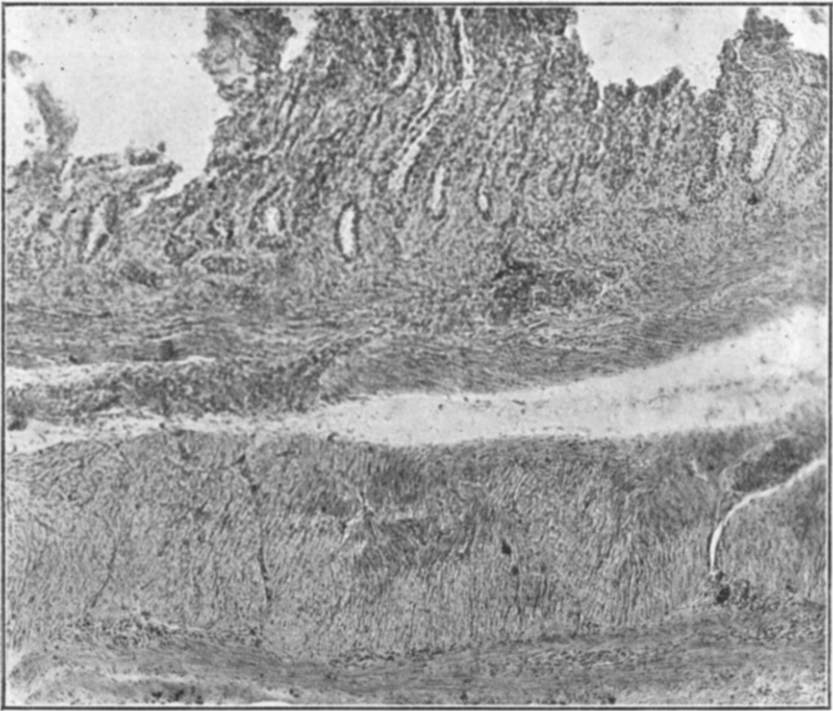


FIG. 3.

the two-thirds lens, one from the surface and one from the bottom. The preparation of each specimen, examined in lots of ten, requires five minutes. The examination under the lens requires ten minutes where no ova are present. When present they are detected usually in less than one minute, although one case was diagnosed only after eight minutes. The total time for examining one bird is thus fifteen minutes. A mechanical stage is used, and the entire wet specimen is gone over.

With a view to decreasing the amount of debris, the birds have been starved for twelve hours in the case of smaller birds, or twenty-four hours in the case of large ones. The droppings are collected during the subsequent twelve hours. That this is a necessary pro-

cedure is shown by subsequent examinations of these same birds where they have not been starved. In every case the eggs are more concentrated where the bird has been starved. This was shown practically in the case of a Green-cheeked Amazon which was passed as not verminous during our preliminary experiments without starving, but detected after starving.

Employing this method, twenty parrots out of 140 examined were detected and segregated at the laboratory, the others being returned to exhibition in the renovated parrot house. Conjointly with this, experiments were carried out in reference to therapeusis and to life-history of the worm, but they led to nothing which might be of value

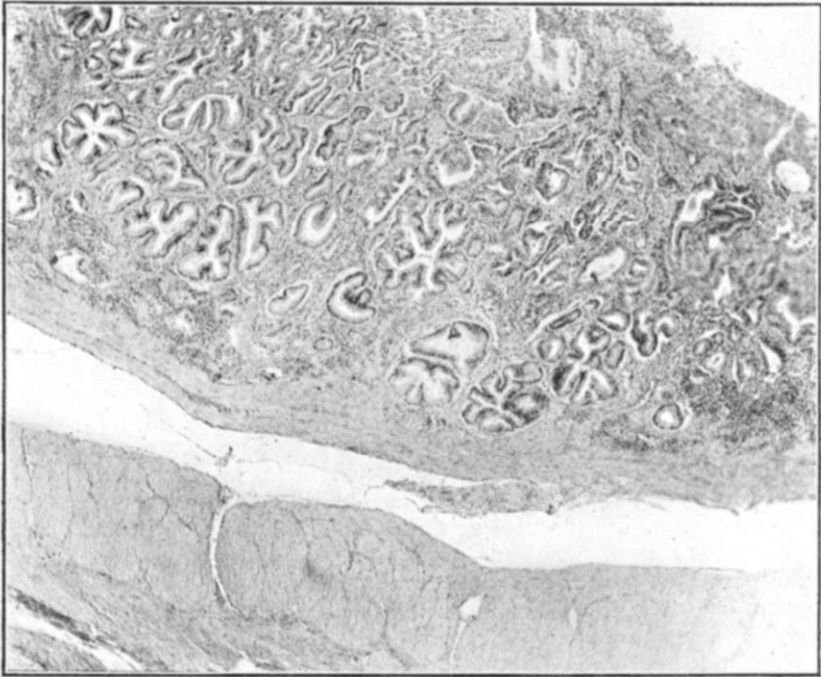


FIG. 4.

in combating the disease. Full notes of these experiments are given in the 1913 communication.

The findings since 1912 are based partly on the twenty parrots segregated at the laboratory. Within a year fifteen had died, and shortly thereafter the sixteenth died, all showing proventricular worms at autopsy. The remaining four now, to our surprise, showed no ova when examined by the improved method. All of these had been very lightly infested in 1912, showing but few ova in droppings. One died later, after an experimental injection during xanthoma research, its proventricle containing no worms at autopsy. The other three survive, and droppings still show no ova. It is our belief that the worms have died out,—passed through their span of life just as human hookworms are known to do in seven years,—and that

the host will recover unless reinfested. These three birds appear to be in perfect health.

During the last three years (since the overhauling in 1912) no parrots have come to autopsy from the parrot house with proventricular worms, and we now consider the enzootic over. This has meant a decrease in the death-rate among the parrots of 33 to 50 per cent.

Our experience in this garden leads us to conclude:—

1. That there is an enzootic disease of parrots caused by a proventricular spiroptera (*spiroptera incerta* Smith) which may cause serious mortality.

2. The geographical source and life-history of the parasite is unknown.

3. The parasites may die out spontaneously where the bird is but lightly infested.

4. Therapeusis is inefficient.

5. The disease may be controlled by employing appropriate diagnostic and hygienic measures.

On account of the comparative inaccessibility of this publication (it is now out of print) the original description by Smith is here added. This is only a portion of his article; the balance discusses the incidence, pathogenicity, and probable life-cycle of the parasite.

"The structural characteristics of the worm are constant, but there is considerable variation in size of the mature specimens as obtained from different hosts, and often among the examples obtained from a single bird. The average maximum length of fully developed females was a little over 14 mm.; thickness, 0.45 mm.; average maximum length of males, 8 mm.; thickness, 0.31 mm. The smallest adults were occasionally but little more than half the size of the average; the largest female observed in the entire material was 20.5 mm. long and 0.6 mm. in diameter; the largest male observed, 12 mm. long and 0.35 mm. in diameter. The largest examples were found in the conures and in the Senegal parrot. The worms are of filarial shape, long and slender, cylindrical in section, rigid and colourless. Thickest level of females is at about two-thirds of length from head; of males, near middle of body length. From these levels the specimens taper anteriorly in delicate manner to the head end, which at base of lips in a female of 12 mm. length measured 0.08 mm. diameter (0.06 mm. in male somewhat over 8 mm. in length). Posteriorly the females taper uniformly and finely to an acutely conical straight tail, with the tip slightly inclined dorsally; the tail of the male a little less acutely conical and curled ventrally. Cuticle finely striated transversely, transparent; and on each side of the head end the cuticle is raised into an uncertain and asymmetrical expansion with crenulated margin (in the female used for measurements reaching 1 mm. backward from head to one side and less than half this distance on the other). The head is small and is provided with six lips. Of these, two are large, thick, lateral lips with broad and nearly straight anterior border, the sides incurved, and the base about half the length of the anterior free border. These lips are armed with three prominent conical teeth on the anterior border; on their external surface, from base to anterior

border, extends a depressed median line, on each side of which the lip substance rises in a rounded elevation. Midway between the free border and base on the external surface is a horizontal row of three small and easily overlooked papillæ. On each side of these lateral teeth is a smaller submedian lip with rounded margin and broad base, unarmed. Dorsally and ventrally between the two adjacent submedian lips is a sharp-edged prominence projecting into the oral cavity, looking from the outside like an interlabial tooth. About the bases of the lips the body cuticle rises into a collar of small and irregular eminences. There is a well-marked oral cavity, the base lying about the same distance back of the base of the lips as the lateral lips rise in height above their base; base of cavity horizontal, its lateral walls rising from it at nearly right angles. The œsophagus is long and slender (in male of over 8 mm. length it measures 2.5 mm. in length; in female of 12 mm. length, 3.5 mm.); for a short distance from the base of the oral cavity it is thin-walled and narrow, thereafter widening and becoming thicker-walled and definitely muscular. It opens into the intestine by a rather prominent valve-like arrangement. The intestine is straight and opens in the female subterminally (0.2 mm. from tip of tail); and in the male a little more anteriorly (0.35 mm. from tip of tail) in a cloaca. Caudal end of male provided with lateral alar cuticular expansions (not quite symmetrical) supported at base by irregular and small rays from the body wall, enclosing a bursa. The cuticle within this bursa is arranged in long rectangular plates, running in the long axis of the worm and contrasting sharply with the transverse striæ of the rest of the cuticle. Within this bursa are ten pairs of papillæ and one unpaired precloacal papilla. These are arranged as follows from tip of tail forward: Nos. 1, 2, 3, and 4 are quite small and situated just in front of tip of tail, No. 2 (smaller than No. 3) and No. 3 nearly on same level. (No. 2 median to No. 3); equal distances between Nos. 1, 3, and 4. No. 5 is about halfway between tip of tail and cloaca, larger than the above; No. 6 about halfway between No. 5 and cloaca, this pair not entirely symmetrical; No. 7 at or just in front of cloaca; Nos. 8, 9, and 10 in row anterior to No. 7, and separated from No. 7 and each other successively by uniformly increasing distances. Nos. 5, 6, 7, 8, 9, and 10, and the unpaired precloacal papilla, considerably larger than Nos. 1, 2, 3, and 4. Male spicules unequal. Testicular tubes plicated along the intestine.

"In the female there are two ovarian tubes, anterior and posterior, which with their oviducts lie densely folded along the intestine, nearly hiding the latter in the greater part of the length of the worm. These unite into a short and inconspicuous uterine and vaginal tube, which opens ventrally at an easily overlooked vulvar orifice within the first third of the length of the worm. Ova are colourless, elliptical in shape, with thick walls, each containing a more or less well-developed larval worm. They measure as an average $38\ \mu$ in length and $18\ \mu$ in transverse diameter (small examples as low as 34 by $16\ \mu$; largest examples as high as 42 by $20\ \mu$).

"The larval forms met were, as a rule, but 2 or 3 mm. in length, and often showed some appearance as of undergoing moult, the old cuticle separating about the tail end of the worm. The mouth parts

were less complex than in the adults. In the young sexual forms about the only feature of importance noted was the fact of the lack of development of the bursa by the formation of the lateral caudal expansions, the papillæ being, however, seen in the older examples."

COCCIDIUM BIGEMINUM STILES IN SWIFT FOXES (HABITAT WESTERN U.S.)

By the Same.

THIS infection was detected during a routine examination of the fæces of all the canidæ for hookworm ova, a swift fox having recently died with such parasites present. As a result of this examination, among other things coccidial oöcysts were found in two swift foxes, which were at once isolated, since the one had had a diarrhœa for several days. Both foxes, when in isolation, showed diarrhœa, the one more marked than the other. In the former the oöcysts were in great numbers, and in about a week the animal died. The second fox, on the other hand, passed very small numbers of cysts, spontaneously recovered, and after isolation for several weeks was returned to exhibition, the fæces no longer containing oöcysts.

The structures examined from fresh fæces *ante-mortem* follow the original description of the oöcysts of *coccidium bigeminum* very closely. They have a double contour. The same specimen of fæces may display oöcysts some of which contain one and some two spores. The measurements of oöcysts were as follows:—

One spore forms

$30 \times 30 \mu$
 $30 \times 25 \mu$
 $40 \times 30 \mu$

Two spores form

$31 \times 28 \mu$
 $32 \times 26 \mu$
 $32 \times 25 \mu$
 $25 \times 27 \mu$
 $35 \times 30 \mu$
 $38 \times 30 \mu$

Both single and double spored oöcysts are subspherical to elliptical in form. The spores at this time have a single contour, are coarsely granular, and faintly bile-stained. They measure 14 to 16 μ in diameter in the case of double forms and 18 to 22 μ in single ones.

Freshly passed fæces were diluted with tap water and several (twelve) oöcysts were kept at room temperature under constant observation in life chambers under several microscopes. Single spored forms divided by simple hour glass constriction in from four to six hours, the two spores now coming to almost fill the oöcyst. Within twenty-four hours the spore had acquired a double contour, showed four hyaline, banana-shaped sporozoites and a granular "rest body." The latter was of considerable size, occupying now about half of the spore. As time passed its centre became hyaline and the granules fewer, the hyaline centre increasing slightly in size as the whole "rest body" diminished. In about a week (five to seven days) the granules had practically entirely disappeared, the "rest body" now appearing as a sharply outlined hyaline body surrounded