posterior uterine sac, a longer tail, and a more anteriorly positioned vulva. In addition, the shape of the tail terminus of *A. cibolensis* is quite different from that of *A. spinosus*. It can be separated from *A. clarus* by a longer tail, a more posteriorly located hemizonid in relation to the excretory pore, a shorter posterior uterine sac, and a mucro that is more ventrally located on the tail terminus.

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Differential Morphology of Adult *Ascaridia galli* (Schrank, 1788) and *Ascaridia dissimilis* Perez Vigueras, 1931

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ABSTRACT: The confusing literature on the morphological differentiation of *A. galli* of chickens and *A. dissimilis* of turkeys was reviewed, and the differential characters of the adults were restudied. These species are highly host specific. They are approximately the same size and are similar in appearance. The females cannot be easily separated on the basis of morphological characters, but the males can be identified readily by differences in (1) position of the first and fourth pairs of ventral caudal papillae, and (2) spicular morphology.

The common *Ascaridia* species of chickens (*Gallus gallus*) and of turkeys (*Meleagris gallopavo*) are respectively *A. galli* and *A. dissimilis*. These species show a high degree of host specificity. Recently, we (Kates et al., 1969) had occasion to review the literature on the differential characters of *Ascaridia* species of chickens and turkeys to identify large numbers of specimens recovered from turkeys. We noted some inaccuracies and omissions in the literature which were repeated in recent books and monographs. Consequently, we restudied numerous adult specimens of both species from several lots; only *A. galli* was identified from chickens and only *A. dissimilis* from turkeys. Because of the economic importance and common occurrence of these species, a brief account of the significant literature is given, as well as the results of our study of adult specimens.

Literature Review

Ackert (1931) studied the life history and morphology of *A. galli* and accurately described the adults. He provided descriptions and figures of the caudal papillae and spicules of the male, but did not mention any caudal papillae of the female as did some later authors. The same year, Perez Vigueras (1931) published a description of a new species, *A. dissimilis*, from turkeys, but this paper was not widely available. He described the caudal papillae of the male crudely but accurately, figured two pairs of small caudal papillae in the female but did not figure the spicules, mentioning only that they were subequal, 2.016 and 2.080 mm long, respectively. Wehr (1940), in a paper describing a new species, *Ascaridia bonasae*, from the ruffed grouse, refigured the caudal ends of the males of *A. galli* and *A. dissimilis* and keyed out the three species on the basis of differences in position of the first and fourth pairs of caudal papillae of the males. No mention was made of differences in spicular morphology or of caudal papillae of females. Horton-Smith and Long (1957) refigured the caudal ends and papillae of males of *A. galli* and *A. dissimilis*, and pointed out, as did Wehr (1940), the diagnostic value of the position of the fourth pair of ventral papillae; again no mention was made of spicular differences.

Table 1. Lengths in mm of adult *A. galli* and *A. dissimilis* recorded by various authors.

	A. galli				*A. dissimilis*			
	Male		Female		Male		Female	
Authors	Range	Avg	Range	Avg	Range	Avg	Range	Avg
Ackert, '31	51–76	63	72–116	88	(Not studied)			
Perez Vigueras, '31	(Not studied)				40–65	52	50–85	67
Wehr, '42	(*A. dissimilis* slightly smaller than *A. galli*)							
Mozgovoi, '53	26–70	46	65–100	82	(Not given)			
Horton-Smith & Long, '57	(Not given)				37–45	41	53–70	61
Vasilev, '62	(Not given)				(Not given)			
Baruš, '66	(Not given)				38–52	45	54–72	63
Present authors[1]	60–65	62	80–100	90	50–58	55	70–105	87

[1] Twenty largest specimens measured of each sex of each species.

Kerr (1958) reported that *A. galli* and *A. dissimilis* males were easily separated by differences in the caudal papillae and in length and shape of the spicules, stating that "The spicules of *A. galli* are almost twice as long and the angle of the funnel portion is less acute than those of *A. dissimilis*." We found it impossible to differentiate the males on the basis of these spicular characters. Vasilev (1962) described correctly for the first time the spicules of *A. dissimilis*, and added some minor details to the description of *A. galli* spicules by Ackert (1931). Baruš (1966) redescribed *A. dissimilis*, and also published figures of *A. galli* without accompanying description and measurements. However, Baruš' sketch of the distal spicule tips of *A. galli* is not typical. Both Vasilev and Baruš figured three pairs of small caudal papillae for female *A. dissimilis*, and Vasilev stated that female *A. galli* have one pair of caudal papillae, Baruš did not mention or figure such papillae. Perez Vigueras (1931) originally reported "dos pares de papilas caudales" for female *A. dissimilis*.

Materials and Methods

Several dozen adult specimens of both sexes of *A. galli* and *A. dissimilis* were used in this study; all the former species came from chickens and the latter from turkeys necropsied at this Laboratory. All specimens were fixed and preserved in 70% ethyl alcohol. Although spicules were dissected from many adult males of various sizes, only the largest specimens were selected for measurement of body and spicule length (Tables 1, 2). After the body length of specimens was measured, the caudal ends were severed and cleared in lacto-phenol-glycerine solution. These were studied intact from all aspects, and the male caudal ends were later dissected and the spicules removed intact and mounted in the above-mentioned clearing agent for study and photography.

Results and Discussion

Since the identity of *A. dissimilis* became known in 1931, there is a paucity of data in the literature on the comparative lengths of this species and *A. galli*. Some worm length measurements from the literature and our own are summarized in Table 1. Ackert's (1931) measurements for *A. galli* are similar to ours. Although all specimens measured by the several authors may have been sexually mature, it is possible that the shorter worms had not reached their potential maximum size. Our measurements of large *A. dissimilis* do not differ much from those of *A. galli*. Wehr (1942) stated that *A. galli* adults are slightly larger than *A. dissimilis*, but gave no measurements. Our observations indicate that the two species do not differ much in size when full grown, and that size is not a significant differential character.

Table 2. Lengths in mm of the spicules in male *A. galli* and *A. dissimilis* recorded by various authors.

Authors	*A. galli*		*A. dissimilis*	
	Range	Avg	Range	Avg
Ackert, '31	1.0–2.4	1.94	(Not studied)	
Perez Vigueras, '31	(Not studied)		2.016 & 2.080 (Subequal)	2.048 (?)
Mozgovoi, '53	0.65–1.95	1.30	(Not given)	
Kerr, '58	(*A. galli* spicules almost twice as long as *A. dissimilis*)			
Vasilev, '62	(No measurements given)			
Baruš, '66	(Not given)		1.32–1.79	1.55
Present authors[1]	1.5–2.4	1.9	1.6–2.16	1.92

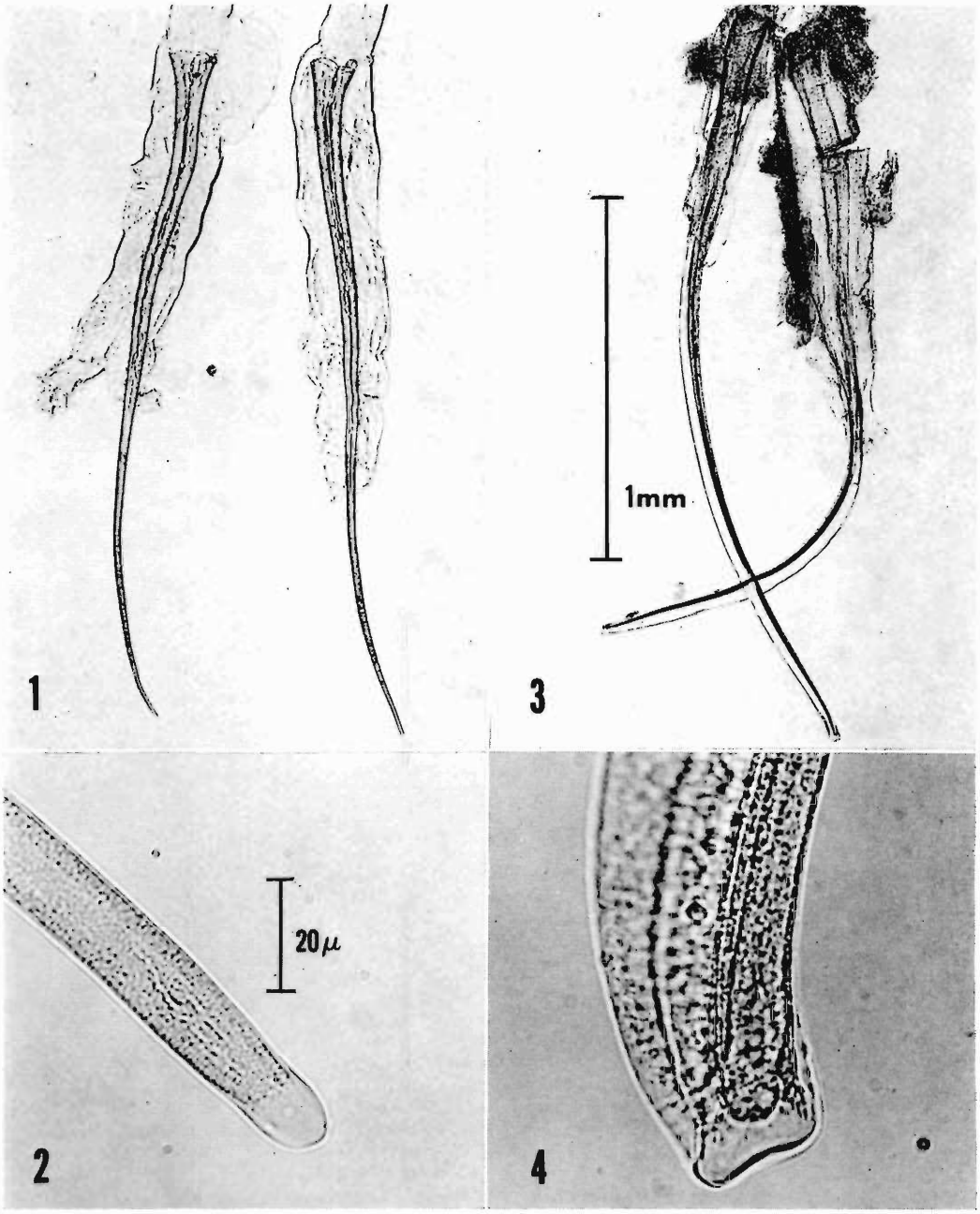
[1] Spicules about equal size. Ten sets of spicules of each species measured after dissection from largest available specimens.

The most useful diagnostic characters of *A. galli* and *A. dissimilis* are found only in the males, i.e., (1) the arrangement of the caudal papillae, and (2) the morphology of the spicules. The differences in the caudal papillae of males have been described by Wehr (1940) and others, and need no further comment. However, the length and morphology of the spicules need some clarification. The number of caudal papillae in females is often difficult to determine and is probably not of much diagnostic value, but will be discussed briefly.

Spicule lengths reported in the literature for both species show considerable variation (Table 2). From our study, spicule length appears to be directly related to size or length of the male specimens. The largest males from each collection had the longest spicules. Our measurements of spicule length of *A. galli* averaged close to those given by Ackert (1931), but Ackert's range of lengths was greater. Our measurements of spicule lengths of *A. dissimilis* averaged close to those given by Perez Vigueras (1931). The latter author, however, may have measured spiclues of only one male specimen, as he reported only a single measurement for each spicule. Whether the spicules of either species are equal or subequal in length appears to be moot, and not of diagnostic significance.

Regardless of the length of the males and the spicules of both species, the males can be separated easily on the basis of spicular morphology (Figs. 1–4). The spicules of *A. dissimilis* look like small drumsticks (Fig. 1), are broad and truncate proximally, 90–100 μ wide, taper gradually distally, and terminate in rounded clear tips 11–12 μ wide (Fig. 2). Baruš (1966) gave the following measurements: proximal ends 79–92, distal ends 11–18, μ wide. The spicules of *A. galli*, when observed at low magnification, superficially resemble those of *A. dissimilis*, and are quite similar for the proximal third of their length. Over the distal two-thirds, however, the heavily sclerotized part of the spicules gradually narrows to a thin strand almost to the distal end, and is accompanied by a membranous structure about twice as wide as the sclerotized strand (Fig. 3). The distal tips of the spicules are more than twice as wide (24–28 μ) as those of *A. dissimilis*, and their typical terminal outline is blunt with a slight indentation at the center (Fig. 4). Variations in the shape of the distal tips of *A. galli* spicules may occur as illustrated by *Ackert* (1931); in some cases these may be real, or due to variations in orientation, or distortion, of the spicules on slide preparations.

Although Perez Vigueras, Vasilev, and Baruš reported that female *A. dissimilis* have two or three pairs of small caudal papillae, and Vasilev reported that *A. galli* females have one pair, we have been unable to confirm these observations fully. On some cleared specimens of female *A. dissimilis* we have seen what appeared to be one or two pairs of such papillae, but have not seen caudal papillae on adult female *A. galli*. If such papillae do occur in a uniform manner on females of these species,



Figures 1–4. Photographs of dissected spicules. 1. Complete spicules of *A. dissimilis*. 2. Distal end of spicule of *A. dissimilis*. 3. Complete spicules of *A. galli*. 4. Distal end of spicule of *A. galli*. Figures 1 and 3 same magnification; 2 and 4 same magnification.

they are not always readily discernible, and thus have little practical value.

Summary of differential character of males

A. galli: First pair of ventral caudal papillae anterior to precloacal sucker; fourth pair of ventral papillae widely separated just posterior to second pair of lateral papillae. Spicules about equal; average length 1.9 mm, with marked membranous structure over about the distal half; distal ends typically blunt with slight indentation, 24–28 μ wide.

A. dissimilis: First pair of ventral caudal papillae opposite precloacal sucker; fourth pair of ventral papillae slightly separated just posterior to cloaca. Spicules about equal; average length 1.92 mm, without marked membranous structure; distal ends clear and rounded about 11–12 μ wide.

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Eimeria tenella: From Sporozoites to Oocysts in Cell Culture

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ABSTRACT: Excysted sporozoites of *Eimeria tenella* were inoculated into monolayer cell cultures of embryonic chick kidney (ECK) and nonembryonic chick kidney (CK). Only two asexual generations were found in cultures prepared from cell suspensions containing few cell aggregates; gametocytes and oocysts were found in cultures prepared from suspensions where cell aggregates were abundant. Gametocytes and oocysts developed faster and in greater quantity in CK cultures. In CK, 175(120–193) oocysts per coverslip were found at 7 days; in ECK, only a few were found at 8 to 9 days. Oocysts that developed in culture sporulated and produced infection when fed to the natural host. During the first 5 days of the patent period, 15,000,000 oocysts were recovered.

Although *Eimeria tenella* has undergone schizogony in all cell types tested, only one complete asexual generation has been obtained in cell cultures established from other than chick tissues. Using sporozoites as the inoculum, mature first generation schizonts were found in cell line Japanese quail fibroblasts and cell line bovine kidney (Patton, 1965), in