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Observations on Cestodes in North American Owls with the Description of *Choanotaenia speoty-* *tonis* n. sp.* (Cestoda: Dipylidiinae)

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Little is known concerning the helminths parasitic in several major groups of the North American avifauna. This appears to be particularly true of the parasites of owls. Over the past few years the writer has had the opportunity of examining a fairly large series of these birds, and they have been found to be infected with several helminths of unusual interest (Chandler and Rausch, 1947).

It should be pointed out that most of the owls examined were not killed for this purpose alone, but were obtained from game farms and refuges, under conditions where their destruction was considered necessary. Strict protection of raptors, under ordinary conditions, is most desirable at all times.

This paper is concerned with two species of cestodes encountered in 85 owls, representing 10 species and sub-species, examined over the past 5 years. The birds examined were: great horned owl, *Bubo v. virginianus* (Gmelin); arctic horned owl, *Bubo virginianus subarcticus* Hoy; barn owl, *Tyto alba pratincola* (Bonaparte); screech owl, *Otus asio naevius* (Gmelin); barred owl, *Strix v. varia* Barton; short-eared owl, *Asio f. flammeus* (Pontoppidan); long-eared owl, *Asio wilsonianus* (Lesson); snowy owl, *Nyctea nyctea* (Linnaeus); saw-whet owl, *Cryptoglaux a. acadicae* (Gmelin); and burrowing owl, *Speotyto cunicularia hypugaea* (Bonaparte).

Except for the arctic horned owl, collected in Manitoba, and the burrowing owls, collected in Colorado, all the birds examined were from the North Central States area. Through the cooperation of the staff of the Wisconsin State Game Farm, at Poynette, Wisconsin, a large number of owls was secured from that area. Most of these were immature great horned owls, collected during the winter months.

Cestodes are generally uncommon in owls, as pointed out by Wolffhügel (1900), who reviewed host records previous to that time. The most common cestode occurring in owls is *Paruterina candelabraria* (Goeze, 1782). Ransom (1909) reported this species from the short eared owl; he also listed *Taenia strigis-acadicae*, superficially described by Leidy (1855), which may or may not be identical with *P. candelabraria*. According to the files of the Zoological Division of the Bureau of Animal Industry, no cestode has been recorded

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Figs. 1-5. *Paruterina candelbraria*.—1. Proglottid slightly past maturity—showing early development of uterus; 2. Scolex without rostellar hooks; 3. Rostellar hooks; 4. Gravid proglottid; 5. Shed proglottid as found in feces of the host. Figs. 6-8. *Choanotaenia speotytonis*.—6. Mature proglottid; 7. Rostellar hook; 8. Scolex.

from either the great horned owl or the burrowing owl. This information was not obtained for the other North American owl species.

I. *PARUTERINA CANDELABRARIA* (Goeze, 1782)

Figs. 1-5

The writer found *P. candelabraria* on 9 different occasions; 8 times in the great horned owl, and once in the barred owl. Cestodes from two screech owls, collected by Dr. F. N. Hamerstrom, in Iowa, probably belong to this species also, although poor preservation made definite specific determination impossible. In addition, the writer secured 2 immature cestodes from a snowy owl, but identification could not be made.

Paruterina candelabraria was completely described by Wolffhügel (1900), but since his description is not readily accessible, it might be of some value to include here a description of this species, based on North American material.

Diagnosis.—Maximum length of strobila 300 mm; greatest width, attained in post-mature proglottids, about 1 mm in well-relaxed specimens. Mature proglottids wider than long, gradually increasing in length after maturity. Gravid proglottids decrease in width; terminal proglottids measure about 600 μ wide by 2 mm long. Longitudinal muscle fibers strongly developed and numerous. Scolex, from 213 to 284 μ in diameter, not sharply set off from neck; suckers average 102 μ in diameter. Rostellum armed with about 50 hooks, arranged in a double row. Large hooks measure from 39 to 46 μ long (average 42 μ); small hooks measure from 29 to 34 μ long (average 33 μ).

Ventral excretory canals variable in diameter, from 28 to 130 μ , with greatest diameter occurring in mid-section of segment. Transverse canals similar in diameter to narrow part of ventral canals. Dorsal canals are lateral to ventral canals; about 16 μ in diameter.

Irregularly alternating genital pores are situated near the middle of mature proglottids. Genital ducts pass between longitudinal excretory canals. Cirrus sac, averaging 132 by 46 μ in mature proglottids, may or may not overlap ventral excretory canal. Cirrus unarmed; about 60 μ long by 10 μ in diameter. Ductus ejaculatorius somewhat coiled within cirrus sac. Vas deferens strongly coiled medial to ventral excretory canal; coils persist in gravid proglottids, where they are situated between the margin of the parauterine organ and the ventral excretory canal.

Testes ovoid; from 28 to 35 (average 31) in number, and measuring from 33 to 46 μ in diameter in mature proglottids; not all in same plane. Testes lateral and posterior to female genital organs, extending forward to level of genital pore.

Vagina opens posterior to and in same plane as cirrus sac; distal end provided with well-developed sphincter. Vagina usually dilated to about 30 μ in diameter from genital pore to level of proximal end of coils of vas deferens (about 350 μ). Function of enlargement not clear; it appears to be filled with spermatozoa in some segments. After narrowing in diameter, the vagina runs

downward to join the elongate seminal receptacle; latter is about $30\ \mu$ in diameter, and situated between ovarian lobes.

Ovary, in mature proglottids, consists of two spherical lobes up to $100\ \mu$ in diameter; situated near mid-line in posterior half of proglottid. Vitelline gland hemispherical, situated immediately behind and parallel to ovary. Uterus first seen as two lateral lobes immediately dorsal to ovary. It is often impossible to separate the two, giving the impression that the ovarian lobes become confluent and enlarged. Ovary disappears soon after appearance of uterus; vitelline gland and seminal receptacle persist longer, and gradually disappear as uterus increases in size. As proglottids become older, uterus migrates toward posterior margin; the parauterine organ, at first tortuous in outline, gradually appears from the anterior margin of the uterus and extends to the anterior margin of the proglottid. Uterus gradually assumes an ovoid shape at posterior margin of proglottid, occupying the entire space between excretory canals. Parauterine organ gradually becomes straighter toward posterior end of strobila, remaining somewhat sinuous to time proglottid is shed. In last few proglottids the gravid uterus is seen at the immediate margin, giving rise to a large, lateral projection; this enlargement is usually aporal, but may occur on either side.

Gravid proglottids break near the level of the genital pore, although they appear very weak at the level of the uterus. Very few eggs, if any, can be seen inside the parauterine organs, either in gravid or shed proglottids. Eggs very numerous, from $30\ \mu$ to $33\ \mu$ long by $20\ \mu$ to $23\ \mu$ wide (average 31 by $21\ \mu$).

DISCUSSION

Through the kindness of Dr. Jean G. Baer, Director of the Institut de Zoologie, Université de Neuchâtel, the writer had the opportunity to examine several slides of *P. candelabraria* from European owls. These slides, from *Strix* and *Asio*, were from the collection of the late Professor Fuhrmann, from material from the Museums of Berlin and Vienna.

Since the slides were quite old, it was not possible to make out all the morphological details; however, the specimens agreed very closely with those from North American owls. As far as could be determined, the gravid uterus was relatively larger in the European specimens, and the parauterine organ was straighter. The average egg measurements were identical. On the single scolex examined, the hooks were appreciably larger than those of the American specimens. The large hooks averaged $56\ \mu$, while the small hooks averaged $43\ \mu$. While these are larger than usual, there is considerable variation in hook size, according to Wolffhügel (1900). The hooks were identical in shape.

Since Wolffhügel did not have available terminal or shed proglottids, he was uncertain as to the complete development of the uterus and parauterine organ. Shed segments, as removed from the feces of the host, had a very typical appearance (Fig. 5). Eggs are not ordinarily found in large numbers in the parauterine organ, and in most cases none at all could be seen. The writer had available for comparison only one other species of the genus *Par-*

uterina; this was *P. similis* (Ransom, 1909), from the yellow-billed cuckoo. In *P. similis* likewise, the eggs could not be seen in the parauterine organ.

Two other species of *Paruterina* have been recorded from owls: *P. otidis* Baczynska, 1914, and *P. angustata* Fuhrmann, 1906. Both species are readily differentiated from *P. candelabraria*. *Paruterina angustata* has unilateral genital pores, fewer testes (20), and is much smaller in size (50 mm); *P. otidis* has fewer testes (15), alternating genital pores, many more hooks (92), and is also of small size (20 mm).

Slides containing whole-mounts of *P. candelabraria* have been deposited in the collections of the U. S. National Museum and the Institut de Zoologie, Université de Neuchâtel.

II. *Choanotaenia speotytonis* n. sp.

Figs. 6-8

One of two burrowing owls collected for the writer by Mr. N. C. Negus, near Denver, Colorado, contained a large number of cestodes apparently belonging to the genus *Choanotaenia* Railliet, 1896. These represent an undescribed species. Since the cestodes were taken from viscera preserved in formalin, certain details unfortunately could not be obtained.

Diagnosis.—Strobila about 30 mm long, containing from 70 to 100 proglottids. Greatest width about 1100 μ , attained in late mature proglottids. Proglottids of relaxed strobilae longer than wide; contracted proglottids bell-shaped and strongly annulated, about 820 μ wide by 355 μ long (mature). Scolex from 270 to 290 μ in length; suckers average 156 μ in diameter. Rostellum strongly developed and armed with a single row of 18 hooks. Hooks measure from 46 to 56 μ in length (average 52 μ).

Ventral excretory canal about 23 μ in diameter; dorsal canal about 10 μ . Genital pores, situated near anterior end of proglottid, irregularly alternate. Genital ducts pass between longitudinal excretory canals. Cirrus sac usually somewhat inclined toward anterior end of proglottid; about 100 by 33 μ . Vas deferens strongly coiled, with coils extending from near end of cirrus sac to medial margin of aporal lobe of ovary. Vasa efferentia run from anterior margin of testes. Testes from 19 to 22 in number (average 20), and measure from 29 to 33 μ (average 31 μ). Testes extend on both sides forward from posterior margin of proglottid to level of posterior margin of respective ovarian lobe.

Vagina opens posterior to and in same plane as cirrus sac, and runs medially and posterior to enter large seminal receptacle (about 55 μ in diameter in mature proglottids). Ovary arranged in two separate, lobed masses; aporal mass considerably larger, and more anterior. Vitelline gland semilunar in shape; situated just posterior to seminal receptacle, and extending around it on either side forward to the posterior margin of the respective ovarian mass. Uterus sac-like; exact course of development not clear. Entire gravid proglottid filled with eggs, which appear, on frontal section to be enclosed within cells in the parenchyma. Eggs ovoid; from 46 to 53 μ long by 39 to 43 μ wide. Hooks of embryo about 16 μ long.

Host.—*Speotyto cunicularia hypugaea* (Bonaparte) (Western burrowing owl).

Locality.—Near Denver, Colorado.

Habitat.—Small intestine.

Type.—Slides containing cotype specimens have been deposited in the helminthological collection of the U. S. National Museum. Additional specimens have been deposited in the collection of the Institut de Zoologie, Université de Neuchâtel.

DISCUSSION

This cestode has been assigned to the genus *Choanotaenia* by virtue of the arrangement of the eggs in the gravid uterus, as determined by means of frontal serial sections, and by comparison with cestodes of this genus from other avian hosts. Some confusion exists concerning the genera *Choanotaenia* Railliet, 1896, *Anomotaenia* Cohn, 1900, and *Paricterotaenia* Fuhrmann, 1932. The synonymy and relationships of these genera have been discussed by several writers (Johnston, 1911; Fuhrmann, 1932; Patwardhan, 1935; López-Neyra, 1935; Owen, 1946). A given cestode can often be assigned only with considerable difficulty to one of the above genera, since the character of the uterus cannot always be readily recognized. The writer has followed the arrangement of Joyeux and Baer (1936) for the European species of these genera. It is probable that some of the poorly described species will need to be reassigned to other genera, when additional material becomes available for study.

In addition to the few mammalian forms, there are at present about 50 apparently valid species of the genus *Choanotaenia* found in avian hosts. These cestodes are mainly parasites of charadriiform and passeriform birds. The mammalian species are not discussed in this paper, since they are not closely related to *C. speotytonis*.

A single species belonging to the genus under consideration has previously been recorded from strigiform hosts. *Choanotaenia strigium* Joyeux and Timon-David, 1934, was described from *Otus scops* (L.) in France. Prior to this record, all described owl cestodes belonged to the genus *Paruterina*. *Choanotaenia strigium* differs from the present species in having a larger number of testes (about 40), fewer hooks (12), an undivided ovary, and a different arrangement of the vitelline gland and seminal receptacle.

Owen (1946) described *C. numenii* from the long-billed curlew, and depended upon the position of the genital pore for differentiation from a number of other species. To the list of species with the genital pore in the anterior corner of the proglottid *C. speotytonis*, and no doubt others, can be added. It is often not possible to determine the position of the genital pore from the available description, and since the state of contraction of the strobila must also be taken into consideration when determining the relative position of the genital pore, it is the opinion of the writer that this character is of little diagnostic value.

Choanotaenia speotytonis can be distinguished apparently without difficulty from all other species of the genus which have been comparatively well

described. The main characters used for differentiation are considered here separately. It can be noted that most of the species differ from *C. speotytonis* in more than one main character.

Several species (*C. cayennensis* (Fuhrmann, 1907), *C. cayennensis africana* (Joyeux and Baer, 1928), *C. cingulifera* (Krabbe, 1869), *C. crateriformis* (Goeze, 1782), *C. dispar* Burt, 1940, *C. guiarti* (Tseng Chen, 1932), *C. iola* Lincicome, 1939, *C. macracantha* (Fuhrmann, 1907), *C. manipurensis* Patwardhan, 1935, *C. musculosa* (Fuhrmann, 1896), *C. passerina* (Fuhrmann, 1907), *C. secunda* (Fuhrmann, 1907), *C. sinensis* Joyeux and Baer, 1935, and *C. southwelli* (Fuhrmann, 1932) possess two rows of hooks, while *C. speotytonis* has only a single row. However, this character apparently cannot always be determined with certainty. *Choanotaenia chandleri* (Moghe, 1925) may have either 1 or 2 rows, and *C. meliphagidarum* Johnston, 1911, has been described as having an unarmed rostellum.

Several species differ from *C. speotytonis* in the number of hooks present on the rostellum; they are *C. abassenae* Joyeux, Baer, and Martin, 1936, *C. arctica* (Baylis, 1919), *C. burhini* Burt, 1940, *C. cayennensis* (Fuhrmann, 1907), *C. cayennensis africana* (Joyeux and Baer, 1928), *C. cayennensis scolopacis* Joyeux and Baer, 1939, *C. cingulifera* (Krabbe, 1869), *C. corvi* Joyeux, Baer, and Martin, 1936, *C. crateriformis* (Goeze, 1782), *C. delachauxi* (Baer, 1925), *C. delachauxi megacantha* López-Neyra, 1935, *C. dispar* Burt, 1940, *C. fieldingi* Maplestone and Southwell, 1923, *C. guiarti* (Tseng Chen, 1932), *C. glareolae* Burt, 1940, *C. gondwana* Inamdar, 1934, *C. infundibulum* (Bloch, 1779), *C. joyeuxi* Tseng Chen, 1932, *C. macracantha* (Fuhrmann, 1907), *C. magnihamata* Burt, 1940, *C. manipurensis* Patwardhan, 1935, *C. marchali* (Mola, 1907), *C. musculosa* (Fuhrmann, 1896), *C. numenii* Owen, 1946, *C. passerina* (Fuhrmann, 1907), *C. rostrata* (Fuhrmann, 1918), *C. secunda* (Fuhrmann, 1907), *C. sinensis* Joyeux and Baer, 1935, *C. southwelli* Fuhrmann, 1932, *C. stagnatildis* Burt, 1940, *C. stercoraria* (Baylis, 1919), *C. triganciensis* Joyeux and Baer, 1939, *C. tringae* Joyeux, Baer, and Martin, 1936, *C. uncinata* Fuhrmann, 1918, and *C. uniconornata* (Fuhrmann, 1908).

Although some species (*C. polyorchis* (Klaptocz, 1908), *C. microsoma* Southwell, 1922, *C. lobipluviae* Burt, 1940, and *C. iola* Lincicome, 1939) overlap in number of hooks present, they can be differentiated from *C. speotytonis* by other characters. The number of hooks is not known for *C. rost-lata* (Fuhrmann, 1908), and *C. meliphagidarum* Johnston, 1911, has been described as having an unarmed rostellum. Both of these can be differentiated by other characters.

Hook measurements differ from those of *C. speotytonis* in a number of species: *C. abassenae* Joyeux, Baer, and Martin, 1936, *C. arctica* (Baylis, 1919), *C. burhini* Burt, 1940, *C. cayennensis africana* (Joyeux and Baer, 1928), *C. cayennensis scolopacis* Joyeux and Baer, 1939, *C. chandleri* (Moghe, 1925), *C. cingulifera* (Krabbe, 1869), *C. corvi* Joyeux, Baer, and Martin, 1936, *C. crateriformis* (Goeze, 1782), *C. delachauxi* (Baer, 1925), *C. delachauxi megacantha* López-Neyra, 1935, *C. dispar* Burt, 1940, *C. fieldingi* Maplestone and Southwell, 1923, *C. guiarti* (Tseng Chen, 1932), *C. glareol-*

lae Burt, 1940, *C. gondwana* Inamdar, 1934, *C. infundibulum* (Bloch, 1779), *C. iola* Lincicome, 1939, *C. joyeuxi* Tseng Chen, 1932, *C. lobipluviae* Burt, 1940, *C. macracantha* (Fuhrmann, 1907), *C. magnihamata* Burt, 1940, *C. manipurensis* Patwardhan, 1935, *C. microsoma* Southwell, 1922, *C. musculosa* (Fuhrmann, 1896), *C. numenii* Owen, 1946, *C. passerina* (Fuhrmann, 1907), *C. polyorchis* (Klaptocz, 1908), *C. rostrata* (Fuhrmann, 1918), *C. secunda* (Fuhrmann, 1907), *C. sinensis* Joyeux and Baer, 1935, *C. southwelli* Fuhrmann, 1932, *C. stagnatildis* Burt, 1940, *C. stercoraria* (Baylis, 1919), *C. triganciensis* Joyeux and Baer, 1939, *C. tringae* Joyeux, Baer, and Martin, 1936, and *C. uncinata* Fuhrmann, 1918.

Hook measurements overlap in only two cases, in *C. cayennensis* (Fuhrmann, 1907) and *C. uniconornata* (Fuhrmann, 1908); these are readily differentiated from *C. speotytonis* by means of other characters.

The number of testes differs from that of *C. speotytonia* in *C. abassenae* Joyeux, Baer, and Martin, 1936, *C. burhini* Burt, 1940, *C. cayennensis* (Fuhrmann, 1907), *C. cayennensis africana* (Joyeux and Baer, 1928), *C. chandleri* (Moghe, 1925), *C. cingulifera* (Krabbe, 1869), *C. corvi* Joyeux, Baer, and Martin, 1936, *C. delachauxi megacantha* López-Neyra, 1935, *C. glareolae* Burt, 1940, *C. infundibulum* (Bloch, 1779), *C. iola* Lincicome, 1939, *C. joyeuxi* Tseng Chen, 1932, *C. lobipluviae* Burt, 1940, *C. macracantha* (Fuhrmann, 1907), *C. magnihamata* Burt, 1940, *C. manipurensis* Patwardhan, 1935, *C. marchali* (Mola, 1907), *C. musculosa* (Fuhrmann, 1896), *C. numenii* Owen, 1946, *C. polyorchis* (Klaptocz, 1908), *C. rostellata* (Fuhrmann, 1908), *C. southwelli* Fuhrmann, 1932, *C. stagnatildis* Burt, 1940, *C. stercoraria* (Baylis, 1919), *C. tringae* Joyeux, Baer, and Martin, 1936, and *C. uncinata* Fuhrmann, 1918.

The number of testes overlaps that of *C. speotytonis* in *C. arctica* (Baylis, 1919), *C. chandleri* (Moghe, 1925), *C. crateriformis* (Goeze, 1782), *C. guarti* (Tseng Chen, 1932), *C. delachauxi megacantha* López-Neyra, 1935, *C. dispar* Burt, 1940, *C. gondwana* Inamdar, 1934, *C. joyeuxi* Tseng Chen, 1932, *C. meliphagidarum* Johnston, 1911, *C. passerina* (Fuhrmann, 1907), *C. sinensis* Joyeux and Baer, 1935, and *C. uniconornata* (Fuhrmann, 1908). The number of testes is not known for *C. cayennensis* (Fuhrmann, 1907), *C. delachauxi* (Baer, 1925), *C. fieldingi* Maplestone and Southwell, 1923, *C. microsoma* Southwell, 1922, and *C. secunda* (Fuhrmann, 1907). These all differ in other characters from *C. speotytonis*.

Other differences occur, such as in length of cirrus sac, size of testes, and arrangement of the female reproductive organs; it is not necessary to discuss these in order to differentiate *C. speotytonis*.

Certain of the previously described species are not considered in this paper; the descriptions of *C. platycephala* (Rudolphi, 1809), *C. taylori* Johnston, 1912, and *C. zoniferae* Johnston, 1912, are not adequate. The descriptions of *C. missoeri* Skrjabin and Popoff, 1924, and *C. littorae* De Muro, 1934, could not be obtained.

ADDENDUM

After this paper was submitted for publication the writer had the opportunity to make certain observations on the life cycle of *Paruterina candelabraria* (Goeze, 1782).

A barred owl, *Strix v. varia* Barton, was collected on March 10, 1948, in central Wisconsin, and was found to be infected with two cestodes of this species. After the gravid proglottids were removed, the strobilae were fixed, stained, and mounted. Examination of the gravid proglottids revealed many eggs in the uteri and parauterine organs, and active embryos were observed within the eggs.

The gravid proglottids were fed to three young laboratory mice, *Mus musculus* L., and to a wild-trapped gray squirrel, *Sciurus carolinensis leucotis* Gapper. These animals were autopsied on the 29th and 30th days after the feeding of the proglottids. Cysticeroids were found in extremely large numbers in the livers of the mice, and the size and shape of the hooks showed these to be larvae of *Paruterina candelabraria*. No cysticeroids were observed in the squirrel.

Parts of the infected livers were fed to a great horned owl, *Bubo v. virginianus* (Gmelin), and it is hoped that there will be an opportunity to attempt to infect native North American mice. A complete report will be published elsewhere.

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