RESEARCH NOTE

Current Knowledge of the Gid Bladder Worm, Coenurus cerebralis (= Taenia multiceps), in North American Domestic Sheep, Ovis aries

A revised checklist on parasites of domestic animals in the United States and Canada (Becklund, 1964, Am. J. Vet. Res. 25: 1380-1416), omitted the gid bladder worm of sheep, Coenurus cerebralis (Batsch, 1786) Rudolphi, 1808, or gid tapeworm of carnivores, Taenia multiceps Leske, 1780 (= Multiceps multiceps). This parasite, which is of medical importance, was deliberately omitted because of the dearth of available information during the last 40 years. Inquiries have since been received for general information on the gid bladder worm in North America as well as on its current incidence and geographic distribution. In an attempt to determine the status of this parasite in sheep, the literature was studied, specimens of sheep and rabbit origin in the National Parasite Collection were examined, and animal disease workers were solicited for information. This report summarizes (1) the pertinent literature, (2) the results of my observations and incidental observations of others, and contains (3) a discussion with some conclusions.

In 1905, Ransom (Bureau Animal Indust., U. S. Dept. Agr. Bull. No. 66, 23 p.) reported on specimens of Coenurus cerebralis collected from the brain of sheep in Montana. Although infections in sheep in North America were reported earlier, Ransom's work was the first well documented report. The certain, probable, and doubtful occurrences of larval and adult Taenia multiceps and T. serialis (Gervais, 1847) Baillot, 1863, of carnivores and the latter's larval stage Coenurus serialis Gervais, 1847, of rabbits, with synonymy and the findings of the earlier workers, were reviewed by Hall (1910, Bureau Animal Indust., U. S. Dept. Agr., Bull. No. 125, Pt. 1, 68 p.). Between 1909 and 1921, Hall wrote numerous articles on C. cerebralis, including Farmer's Bulletin 1150 (1920, issued in 1921, U. S. Dept. Agr., 53 p.) and its replacement 1330 (1923) of which there are several later revisions by other authors. The revisions of this bulletin continued to list C. cerebralis as a parasite of sheep in the United States, but did not include any new information on its occurrence.

Not all workers have concurred with Hall's (1910, loc. cit.) opinion that Multiceps is a separate genus from Taenia, and that Coenurus serialis is distinct from C. multiceps. Cameron (1926, J. Helm. 4: 13-22) did not consider the retention of the genus Multiceps justified simply because it has a coenurus larval stage. Clapham (1942, J. Helm. 20: 31-40) synonymized M. serialis with M. multiceps. She considered that host size and conformation, intermediate hosts, and infection sites, vary in M. multiceps and that this species consists of "two or more races," namely, "ungulate" in which the coenuri are in the central nervous system, and "rodent" in which the coenuri are in the intermuscular connective tissues. More recently, Rausch and Williamson (1959, J. Parasit. 45: 395-403) identified adult cestodes from wolves in Alaska as Taenia multiceps, and Esch and Selk (1965, J. Parasit. 51: 932-937) studied specimens collected from carnivores and rabbits in Oklahoma and concluded that they were T. multiceps and "that the analysis by Clapham (1942) is essentially correct."

To confirm the past existence and determine
the structure of Coenurus cerebralis in sheep, 10 coenuri from the brain of 10 sheep were studied. These coenuri were collected between 1904 and 1911 in Colorado, Montana (8 sheep), and New York. Hooks that appeared fully developed were examined from 13 scolecis from the 10 coenuri. Each rostellum was removed from its scolex intact, cleared in pheno-alcohol solution, the number of hooks counted and then separated and flattened on a slide, and two or three small, as well as large, hooks drawn with the aid of a camera lucida. Similarly studied for comparison purposes were specimens of C. serialis from rabbits. Hooks were examined from 26 scolecis that were removed from 14 coenuri collected from muscular, connective, subcutaneous, pleuoperitoneal, and undetermined tissues of 15 different rabbits in Arizona, California, Colorado, Maine, Montana (2 rabbits), Nebraska, Oklahoma, Ontario, Oregon, New York, Texas (2 rabbits), and Wyoming.

Specimens of C. cerebralis had very thin smooth semitransparent walls with patches of scolecis that mainly protrude internally. The number of hooks on a scolex varied from 26 to 32; most scolices had 28. The lengths of 33 small hooks ranged from 85 to 118 μ (mean 106.7), and the lengths of 30 large hooks ranged from 142 to 168 μ (mean 155.8). Hook conformation was relatively uniform with the main difference between hooks from one scolex, different scolices, and different coenuri involving the angle between the guard and blade and curvature of the blade. Some anomalous hooks were observed and these were not included in measurements. Some scolecides contained oval-shaped accessory hook material, varying in size and in number of pieces, and resembling the primordial hooks in very immature scolecides. This material was situated beside the handles, or within the circle formed by the handles, of both normal and anomalous hooks.

Specimens of C. serialis were similar to those of C. cerebralis, but with opaque thicker walls, frequently with attached host tissues, with some having connecting outgrowths to daughter bladders, and scolecies with generally larger necks making them more prominent. The number of hooks on a scolex varied from 22, besides accessory hook material, to 36; most scolices had 30. The lengths of 62 small hooks ranged from 83 to 115 μ (mean 96.7) and the lengths of 63 large hooks ranged from 125 to 157 μ (mean 143.6). The conformation of the hooks varied more than those of C. cerebralis, and many scolices contained immature and anomalous hooks. The lengths and conformation of the handles varied considerably, and it was often difficult to determine definitively if the handles of some hooks had attained full size. The oval-shaped accessory hook material, here-tofore mentioned, was also present.

Numerous animal disease workers (from Alberta, British Columbia, California, Colorado, Illinois, Kansas, Michigan, Montana, Nebraska, New Mexico, Oregon, Utah, Wyoming, and in Federal regulatory agencies, including meat inspection) were contacted for current information on the occurrence of C. cerebralis. None of the workers contacted had ever encountered this parasite and many replied they had never known anyone who had done so. Dr. Wilber W. Clark (USDA) reported that the brains and spinal cords of sheep from many areas were examined during a survey for scrapie without encountering a coenurus. Moreover, for seven years, (1951–1958) I necropsied numerous sheep and cattle suspected of suffering from clinical parasitism in western and southeastern states without ever finding a coenurus. The only existing specimen from sheep, other than those in the National Parasite Collection, was reported in a letter received from Dr. William D. Lindquist. He found it in 1948 in a museum collection at Michigan State University. The origin and collection date of the specimen is unknown. Thus, coenuri in collections confirm the existence of C. cerebralis over 40 years ago, but no recent report of its occurrence in the United States is obtainable. Consequently, one can now only discuss the facts at hand and speculate on the current presence or absence of this parasite in relation to changes during the last 40 years in sheep management practices and predator control programs.

Scolices of C. cerebralis that I examined could not be distinguished from those of C. serialis by the number, size, and conformation of the hooks. Although not definitive for identification purposes, C. serialis had thicker bladder walls, larger scolex necks, either more undeveloped or anomalous hooks or both, more accessory hook material, and more anomalous scolecides, than C. cerebralis. Also C. serialis had outgrowths to daughter bladders while C. cerebralis did not. Most of the hook anomalies and
accessory hook material observed closely resembled that figured for *Echinococcus* by Lubinsky (1959, Can. J. Zool. 37: 793–801). The most extremely anomalous scolices were found in coenuri removed from a Montana rabbit. Abnormalities included single scolices with up to ten suckers as well as six ill-defined scolices on a common base with each having two to ten suckers and hooks of various sizes and shapes. The hook and sucker arrangements of some of the abnormal scolices closely resembled those photographed by Henry (1934, Ann. Parasit. 12: 384–389).

The differences in the walls of the coenuri of sheep and those of rabbits were observed by the early workers and it is still difficult to judge their taxonomic importance. According to Hall (1910, loc. cit.), the daughter bladders and capsule around the coenuri of rabbits were reported even before the name *Coenurus serialis* was proposed, and some of the early workers did not consider the presence of daughter bladders sufficiently important to recognize *C. serialis* as distinct from *C. cerebralis*. Ransom (1905, loc. cit.) described the American *C. cerebralis* as being spherical, about one inch in diameter, without daughter bladders, with a thin semitransparent wall with the surface having white dots, the scolices, numbering over 100. This description accurately describes my own observations on *C. cerebralis*. Clapham (1942, loc. cit.) surmised her “ungulate race,” which develops in the brain, does not have a capsule produced by the host, whereas, her “rodent race,” which develops in the intermuscular connective tissues, is surrounded by a capsule formed by the host. Esch (1964, J. Elisha Mitchell Sci. Soc. 80: 114–120; 1967, Parasitology 57: 175–179) found that the presence or absence of the host’s capsule depends on the location of the coenuri within the host. Thus, the presence or absence of a host capsule appears to be of little taxonomic value, while the presence or absence of daughter bladders may be important.

Esch’s (1964, 1967, loc. cit.) findings that material of rabbit origin will infect mice and develop successfully in both the central nervous system and intermuscular connective tissues lends credence to the proposal that there is only one species in this country as concluded by Esch and Self (1965, loc. cit.). However, I am reluctant to accept the belief that the form from sheep and that of the rabbit are conspecific because: (1) Esch and Self’s specimens were all collected in Oklahoma and none were from sheep; (2) the origin of Clapham’s specimens of *Multiceps multiceps* (cerebral form) consisting of “three separate and unrelated coenuri and taking at random 225 scolices” is not clear; and (3) most importantly, if the rabbit form will develop in the central nervous system and intermuscular connective tissues of mice, it seems logical to assume that the sheep form should occasionally at least develop in both locations as well, but there is nothing to indicate this has ever happened. In 1910, Hall (Bureau Animal Indut., U. S. Dept. Agr., Circular 159, 7 p.) responded to objections to his belief that the sheep form only develops in the central nervous system as follows: “The idea that well-developed coenurus forms should occur outside of the central nervous system with such frequency as the objections call for, and go undetected in abattoir inspection and post-mortem inspection of other sorts, is not in the least tenable.” Sixty years have passed since 1910, during which time we have had increasingly stricter meat inspection laws, and nothing has been revealed that would alter Hall’s statement. Southwell (1930, The fauna of British India, including Ceylon and Burma, Cestoda, v. 2, 262 p.) summarized the results of feeding experiments by various authors using *T. multiceps* and *T. serialis* in different hosts. He recognized both species based on host and body location sites. Unfortunately, American workers did not try infecting rabbits and sheep with each cestode species. In a revision of the genus *Taenia*, Verster (1969, Onderstepoort J. Vet. Res. 36: 3–58) not only recognizes *T. multiceps* and *T. serialis*, but includes subspecies of the latter.

If *C. cerebralis* still exists as an undetected parasite in the brains of sheep in the United States it must have a very low incidence and limited geographic distribution and has escaped detection only because (1) sheep brains are not routinely examined in abattoirs, (2) signs produced by cerebral coenurus are common to other more prevalent diseases of sheep to which the symptoms would be mistakenly attributed, and (3) necropsies sufficient in depth to detect coenurus are not normally done unless the affected animals are of considerable economic importance. The evidence strongly suggests that
C. cerebralis no longer exists in the United States. This is not surprising, since this parasite was never common nor widely distributed. Its disappearance under modern conditions is very plausible. Considerable changes during the last 40 years have been made in sheep management and predator control practices that would greatly affect the survival of this parasite. Sheep are no longer herded on open range to the extent they were previously and are now mostly maintained under fence where feral dogs and large carnivores are controlled, if not eradicated. Moreover, many farm and ranch dogs are given teniacides, and sheep offal and diseased carcasses are usually buried or destroyed. Hence, this parasite is probably now extinct.

From the foregoing it is concluded that: (1) *Coenurus cerebralis* occurred in the brains of sheep in the United States over 40 years ago; (2) it was never found developed in any other body parts than the brain; (3) the incidence and geographic distribution of this parasite was very limited; and (4) modern sheep management and predator control practices in the United States have probably made this parasite extinct.

WILLARD W. BECKLUND

Beltville Parasitological Laboratory
Animal Disease and Parasite Research Division

Agricultural Research Service
U. S. Department of Agriculture
Beltsville, Maryland 20705

RESEARCH NOTE

Two Cestodes of Amphibians from Ethiopia

*Baerietta janicki* (Hilmy, 1936) Douglas, 1958 (Nematotaeniidae): Three of 10 *Rana angolensis* (Bocage) (Ranidae) collected from the Taffo River (18 km northeast of Addis Ababa), Shoa Province, on 22 November 1968 yielded a total of 15 worms; 3 of 13 collected from the Sebeta River (22 km west of Addis Ababa), Shoa Province, on 20, 27 December 1968 harbored 2, 5, and 7 worms, respectively; and 10 of 24 collected 31 December 1968 and 5 January 1969 from the Kebena River (in Addis Ababa), Shoa Province, were infected with a total of 104 worms. One of 3 *Rana porosissima* Steindachner (identified by Dr. Robert F. Inger, Field Museum of Natural History, Chicago) collected from the Sebeta River on 27 December 1968 harbored three worms. Both *Xenopus ciliatus* Peracca (Pipidae) collected from the Sebeta River on 27 December 1968 were infected with 20 and 30 worms, respectively, whereas two from the Kebena River collected 31 December 1968 were negative. Both *Ptychadena mascarenensis* (Dum. and Bibr.) (Ranidae) collected from the Arussi Mountains (2 km from Assala), Arussi Province, on 29 November 1968 were infected with a total of eight worms. One of three *Bufo regularis* Reuss (Bufonidae) collected on roads in Addis Ababa on 18 March 1969 had a single worm. All collection sites are at an elevation of 2,000 meters or higher. Specimens deposited: USNM Helm. Coll. No. 70803. Our specimens fit very closely the description of specimens from *Bufo regularis* from Rhodesia tentatively identified by Mettrick (1963, Proc. Zool. Soc. London 141: 239–250) as *B. janicki*. Mettrick transferred to this species Joyeux’s (1924, Ann. Parasit. 2: 232–235) *Baerietta jaegerskioeldii* (Janicki, 1928) Hsu, 1935 (syn. *Cylindrotaenia americana* Baer, 1924, nec Jewell, 1916) from *Rana aequiplicata* Werner and *Arthroleptis aequunata* Boulenger (Ranidae) from Mozambique, noting that his material and Joyeux’s “... seem to be much more closely related to *B. janicki* than to *B. jaegerskioeldii...” *B. janicki* was originally described from *Hyperolius (= Rappia) concolor* (Hallowell) and *H. fulvovittatus* Cope (Rhacophoridae) from Liberia.