Leech parasitism of waterfowl in North America

DAVID L. TRAUGER and JAMES C. BARTONEK

Introduction

Leech parasitism of waterfowl is apparently widespread in North America, but the incidence and significance of these infestations is poorly documented. McDonald (1969) catalogued the helminth parasites of waterfowl and listed 16 species of Anatidae and 14 species of other waterbirds, mostly from the Northern Hemisphere, reported to have been infested by leeches. Meyer and Moore (1954) and Moore (1964, 1966) have made important contributions towards understanding of leech parasitism of waterfowl in North America. Earlier records were published by Sooter (1937) and Low (1945). Considerable information on the relationship of leeches and aquatic birds was obtained by three Canadian workers studying the helminth fauna of grebes (Podicipitidae) (Gallimore 1964), the American Coot *Fulica americana* (Colbo 1965), and ducks (Anatinae) (Graham 1966). Recently, Bartonek and Trauger (1975) reported on the nature and incidence of leech infestations among a waterfowl population of the northern forest zone. Europeans have long been aware of leech parasitism of waterfowl (Weltner 1887; Büchli 1924) and have contributed much towards our knowledge of leech biology and ecology (Mann 1962). This paper presents a review of the distribution and significance of leech parasitism of waterfowl in North America.

Identification of leeches

Leeches of the genus *Theromyzon* (= *Protoclepsis*) are often called 'duck leeches' in the literature (Herter 1929; Christiansen 1939; Mann 1962). The principal species of leech infesting North American waterfowl is *Theromyzon rude* (Meyer & Moore 1954; Moore 1964, 1966; Bartonek & Trauger 1975), but Sooter (1937), Butler (1940) and Low (1945) referred to *T. occidentalis*. Moore and Meyer (1951) studied some specimens previously regarded as *T. occidentalis* and found them to be *T. rude*. They noted that leeches obtained from dying ducks were so engorged with blood that specific identification was often impossible, but they believed that there were three or four species of *Theromyzon* leeches in North America whose distributions were related to waterfowl flyways. Moore (1964) considered *T. meyeri* as synonymous with *T. occidentalis*, but he cautioned that 'inasmuch as there has been considerable confusion with respect to the species of the genus *Theromyzon*, which are represented in the North American fauna, it seems not unlikely that at least some of the records . . . for *T. meyeri* actually refer to leeches now designated as *T. rude*'.

McDonald (1969) listed *T. maculosum*, *T. occidentale*, *T. rude*, *T. sexoculatum*, and *T. tessulatum* as leech parasites of waterfowl. Recently Klemm (1972) critically examined major leech collections and most type specimens in an attempt to clarify the nomenclature and identification of North American leeches. He recognized only three species of *Theromyzon*: *T. maculosum* (= *T. meyeri*), *T. rude* (= *T. occidentalis*) and *T. tessulatum*. *T. tessulatum* and *T. maculosum* have been found parasitizing waterfowl in Europe, including USSR (Herter 1929; Christiansen 1939; Rollinson *et al.* 1950; Mann 1951; Roberts 1955; Kuznetsova 1955; Lang 1969; Keymer 1969; Fjeldsa 1972; Gräfner & Baumann 1974).

Although more host records exist for *T. rude* among various species of North American waterfowl (Meyer & Moore 1954), Moore (1964, 1966) concluded that *Placobdella ornata* also feeds on blood extracted from various aquatic birds. Bartonek & Trauger (1975) found both *T. rude* and *P. ornata* infesting ducks and other waterbirds. Mathers (1948) suggested that *Macrobdella decora*, *Haemopsis marmorata*, and *H. lateralis* parasitized wading birds. McDonald (1969), Sawyer (1972) and Davies (1973) presented additional information on the identification, taxonomy, distribution and hosts of leeches in North America.

Nature of parasitism

Herter (1929) and Mann (1962) described responses of leeches to a variety of stimuli. Responses of *Theromyzon* spp. which favour encounters with ducks included: (1) a positive phototactic movement by hungry

leeches and the opposite for satiated leeches; (2) an attraction towards and attachment to an object warmed to 33–35°C; (3) an attraction towards a disturbance or vibration in the water; (4) a tendency for hungry leeches to congregate near the surface of the water; and (5) a chemotactic movement towards objects that have been in contact with the preen gland of ducks. We categorized leech infestations of waterfowl according to the site of attachment: (1) eyes; (2) nasal chamber; (3) body; and (4) elsewhere (Bartonek & Trauger 1975).

Eyes

Although several European workers have reported leeches infesting the eyes of ducks and geese (Herter 1929; Christiansen 1939; Roberts 1955; Lang 1969; Keymer 1969; Gräfner & Baumann 1974), this type of infestation was first reported in North American waterfowl by Bartonek & Trauger (1975). Leeches were found attached to the conjunctiva canthus of the eye beneath the nictitating membrane (Figure 1). This position protected the leeches from scratching by the bird. Apparently leeches seldom, if ever, attached themselves to the cornea. Although no more than one adult leech was usually found per eye, its large size would restrict the vision of the bird or even blind it. Engorged leeches were readily apparent from a distance through binoculars or telescopes. Young leeches, often several per eye, were found beneath the nictitating membrane and eyelid, often detectable only by post-mortem examination.

Adult leeches apparently gained access to the eyes from the plumage of the head. Young leeches also used at least two other methods: (1) being transported by the parent leech entering the eye; and (2) entering the nasal chamber, either independently or on the parent leech, and then moving to the eye via the lacrimal duct.

Pressure from a fingertip against the medial edge of the nictitating membrane causes it to slip back exposing the leech, which can then be pulled loose from the conjunctiva with forceps. After the leech is removed, the conjunctiva remains inflamed and swollen for several hours, but blood exudes from the wound for only a few minutes. The eyelid frequently remains closed for a time due to irritation from the anticoagulant hirudin secreted by the leech. Gräfner & Baumann (1974) also found that leech infections resulted in defective vision. Kuznetsova (1955) and Roberts (1955) reported that the cornea of waterfowl became opaque after leeches fed at the conjunctiva. The former also observed that sometimes the eye increased in size, even obtruding from the orbit. We did not observe any such signs of eye injury to ducks handled in our study.

Nasal chamber

The nasal chamber is the most prevalent site of infestation (Figure 2) according to a number of North American workers (Kalmbach & Gunderson 1934; Sooter 1937; Butler 1940; Low 1945; Erickson 1948; Meyer & Moore 1954; Mendall 1958; Banko 1960; Moore 1964, 1966; Bartonek & Trauger 1975). In Europe, Büchli (1924), Herter (1929), Rollinson *et al.* (1950), Mann (1951), Kuznetsova (1955), Lang (1969), Keymer (1969), and Fjeldså (1972) documented occurrences in nasal chambers of ducks and geese.

Figure 1. Leeches attached to the conjunctiva beneath the nictitating membrane. These were fairly common parasites of Ring-necked Ducks and other boreal breeding waterfowl. (*David Trauger.*)

Figure 2. A leech *Theromyzon rude* engorged with blood. It partially protrudes through the nare of this adult female Lesser Scaup. (*David Trauger.*)

Leeches were attached to the mucosa anywhere within the bird's nasal chamber, but generally posterior from the nares up to, and occasionally inside, the lacrimal ducts (Bartonek and Trauger 1975). Those deep within the nasal chamber were usually detected only after post-mortem examination, but some adults were visible through the nares. Engorged leeches protruding from the nares were swollen on both ends and constricted in the middle where the body passed through the nare. Such leeches were readily observed from a distance with the aid of binoculars or telescopes (Figure 3).

Entrance to the nasal chambers by adult and young leeches was probably gained through the nares following attachment to the bill, and less frequently through the buccal cavity and pharynx following ingestion. In addition, young leeches were likely transported on adults.

Ducks reacted to the apparent discomfort by scratching at protruding leeches, shaking their heads, and sneezing, forcibly expelling air through the nares while the bill was immersed in water (Bartonek & Trauger 1975; Kuznetsova 1955). Although ducks may scratch and injure some protruding engorged leeches, we never observed a duck free itself of a leech through purposeful effort. Low (1945), however, reported that Redheads *Aythya americana* expelled the smaller leeches from their nasal chambers by sneezing.

We used forceps to remove conspicuous leeches from the nasal chambers of ducks captured for banding. Kuznetsova (1955) suggested as a prophylaxis rinsing with aqueous solutions of gastric juice, sodium chloride (10%), vinegar or ammonia. Lang (1969) treated infested ducks with Ophthaine.

Figure 3. Leeches protruding from the nares of juvenile Lesser Scaup (second from left). They were visible at considerable distance, particularly with the aid of binoculars or telescopes. (*James Bartonek.*)

Body

Leeches were also attached to the bird's body, on legs, feet, breast or cloaca (Bartonek & Trauger 1975). Leeches that had not yet fed were frequently seen moving on the plumage of recently killed birds. These movements were generally towards the head, suggesting that feather direction may stimulate a taxis movement towards sites which are more protected from the preening activities of the bird. Erickson (1948), Meyer and Moore (1954), Banko (1960), and Moore (1964, 1966) also reported leeches on the body surfaces of waterfowl in North America, but there are few references to this type of infestation in Europe (Rollinson *et al.* 1950).

Elsewhere

Leeches have been reported to occupy the trachea (Herter 1929; Mann 1951; Moore 1966), bronchi (Quortrup & Shillinger 1941), buccal cavity (Erickson 1948; Meyer & Moore 1954), larynx (Herter 1929), oesophagus (Weltner 1887), and brain (Büchli 1924; Herter 1929). Kuznetsova (1955) found leeches more often in the upper respiratory tracts, especially the nasal chambers, than attached within the oesophagus or to the conjunctiva.

We found leeches in the buccal cavity, pharynx, and larynx of autopsied birds but believed that they probably move there from the nasal chamber after the birds died. In addition, leeches were found in some oesophagi, proventriculi, and ventriculi of ducks examined for food habits (Bartonek and Murdy 1970; Bartonek 1972). Although leeches were apparently eaten as food, they also may have been ingested during preening.

Significance of parasitism

Leech infestations among ducks, geese, and swans have apparently occurred widely in North America, especially in northern and western areas (Figure 4). A review of the literature in conjunction with our own observations and communications with other workers revealed leech parasitism of twenty species of waterfowl in the United States and Canada (Table 1). A variety of other waterbirds have also been infested by leeches.

Sooter (1937) found four of six Blue-winged Teal *Anas discors* ducklings infested with leeches in north-west Iowa, but Bennett (1938) was unable to assess the severity of the parasitism. Sooter (1937) believed that

Figure 4. Distribution of leech parasitism of waterfowl in North America. Relative size of circles indicates the number of waterfowl species parasitized by leeches.

the death of a 1-week-old American Coot was caused by a leech obstructing the respiratory tract, but Blue-winged Teal and Pied-billed Grebes *Podilymbus podiceps* were not adversely affected. F. J. Vande Vusse (pers. com.) states that *T. rude* is still commonly observed in nasal passages and on the plumages of Blue-winged Teal and Coots in north-western Iowa. Low (1945) also found that 80% of 4- to 11-week-old Redhead ducklings were infested with leeches in Iowa, but older juveniles appeared to be free of them. Although two adults that died from lead poisoning were heavily infested with leeches, he could not attribute any mortality directly to such parasitism.

Mendal (1958) frequently encountered both adult and young Ring-necked Ducks

Table 1. Species of North American waterfowl reported to have been parasitized by leeches.

Host species	Source reporting leech infestation: This review*	Bartonek & Trauger (1975)	McDonald (1969)	Moore (1966)	Other references
Whistling Swan *Cygnus columbianus*	+			+	
Trumpeter Swan *Cygnus cygnus buccinator*	+			+	+ Banko (1960)
White-fronted Goose *Anser albifrons frontalis*	+				
Lesser Snow Goose *Anser c. caerulescens*	+				
Canada Goose *Branta canadensis* ssp.	+				
Northern Pintail *Anas acuta*		+	+	+	+ Meyer & Moore (1954)
American Green-winged Teal *Anas crecca carolinensis*		+			
Mallard *Anas platyrhynchos*	+	+	+	+	+ Quortrup & Shillinger (1941)
Gadwall *Anas strepera*	+			+	
American Wigeon *Anas americana*		+		+	
Blue-winged Teal *Anas discors*			+	+	+ Sooter (1937)
Shoveler *Anas clypeata*	+	+		+	
Canvasback *Aythya valisineria*	+	+			+ Erickson (1948)
Redhead *Aythya americana*	+		+		+ Low (1945)
Ring-necked Duck *Aythya collaris*	+	+			+ Mendall (1958)
Lesser Scaup *Aythya affinis*	+	+	+	+	+ Meyer & Moore (1954); Graham (1966)
Surf Scoter *Melanitta perspicillata*		+			
American White-winged Scoter *Melanitta fusca deglandi*		+			
Bufflehead *Bucephala albeola*		+			
North American Ruddy Duck *Oxyura j. jamaicensis*	+		+		+ Meyer & Moore (1954); Graham (1966)

* Previously unpublished observations contributed by McDonald, Johnson, Pospichal, Bromley, Weller, and Pearson as noted in text.

Aythya collaris with leeches attached around the bill and nares in Maine. Although he found no indication that they harmed the ducks, he suspected that suffocation could result if leeches blocked the nares. Erickson (1948) found only a few small leeches on the feathers of healthy Canvasbacks *Aythya valisineria* in Oregon but noted many in the buccal and nasal cavities of dead and sick waterfowl. Cornwell and Cowan (1963) made no mention of leeches parasitizing Canvasbacks in Manitoba, but M. W. Weller (pers. com.) observed leeches feeding on the brood patches of incubating Redheads on the Delta Marsh, Manitoba.

Banko (1960) reported observations of leeches in the nasal chambers of two cygnet Trumpeter Swans *Cygnus cygnus buccinator* of the Red Rock National Wildlife Refuge in Montana. Banko thought that leeches were little more than a nuisance to the larger swans but could contribute to the mortality of small cygnets, and Moore (1966) reported the death of a cygnet attributed to a leech in the trachea.

Leech infestations of the Pintail *Anas acuta*, Lesser Scaup *Aythya affinis*, and Ruddy Duck *Oxyura jamaicensis* were first reported by Meyer and Moore (1954) from specimens collected at Whitewater Lake in south-western Manitoba. Moore (1965) noted leech parasitism of a Mallard *Anas platyrhynchos* and four species of grebe (Horned Grebe *Podiceps auritus*, Pied-billed Grebe, Red-necked Grebe *Podiceps grisegena*, Eared Grebe *Podiceps caspicus* in Alberta. Subsequently, Moore (1966) listed the Gadwall *Anas strepera*, Pintail, Shoveler *Anas clypeata*, American Wigeon *Anas americana*, Blue-winged Teal, Lesser Scaup, Mallard, Trumpeter Swan, and Whistling Swan *Cygnus columbianus* as well as the American Coot and Western Grebe *Aechmophorus occidentalis* parasitized by leeches. Both *T. rude* and *P. ornata* were identified as the parasites in the above infestations.

Graham (1966) reported a higher incidence of leech infestation among 96 Ruddy Ducks in Alberta than among 216 Lesser Scaup. Adults were more heavily infested than young. Among 348 grebes examined by Gallimore (1964), a higher percentage (20–30%) of adult Red-necked and Western Grebes were parasitized by leeches than Horned and Eared Grebes (10–20%). Of six Pied-billed Grebes, two were infested. Again, more adults were parasitized than young. Colbo (1965), who studied 371 American Coots, determined that about 10% of the adults and 20% of the immatures were infested with leeches.

Bartonek and Trauger (1975) observed leech infestations in Mallard, Pintail, Green-winged Teal *Anas crecca carolinensis*, American Wigeon, Shoveler, Ring-necked Duck, Canvasbacks, Lesser Scaup, Bufflehead *Bucephala albeola*, White-winged Scoter *Melanitta fusca deglandi*, and Surf Scoter *Melanitta perspicillata* near Yellowknife, Northwest Territories. In addition to these 11 species of ducks, the Red-necked Grebe, Horned Grebe, and Black-throated Diver *Gavia arctica* were also parasitized. *T. rude* was the principal leech involved in the waterfowl infestations, but *P. ornata* was also encountered. High incidences of leeches were found in Lesser Scaup and American Wigeon.

Leon L. Johnson (pers. com.) found leeches infesting Ring-necked Duck captured by nightlighting for banding at Rice Lake National Wildlife Refuge in Aitken County, Minnesota. During late September leeches were found in one or both eyes of 22% of 293 ducks in 1970; 36% of 499 were infested in 1971. The leeches were non-selective for age or sex. Although these data suggest a fairly high incidence of leech infestation of Ring-necked Ducks, Johnson stated that 1,250 diving ducks annually captured by nightlighting in Roseau, Mahnomen and Beltrami Counties of Minnesota were unafflicted by leech parasitism. In addition, Lewis M. Cowardin (pers. com.) has annually captured about 1,000 ducks by nightlighting on the Chippewa National Forest about 120 km (75 miles) north-west of Rice Lake, but none of these birds was parasitized. Carl E. Pospichal (pers. com.) had previously observed Canvasbacks blinded by leeches at Rice Lake National Wildlife Refuge.

In south-central Alaska, Robert G. Bromley (pers. com.) removed leeches from under the nictitating membranes of three Dusky Canada Geese *Branta canadensis occidentalis*. These birds were captured with about 500 other geese on Alaganik Slough of the Copper River Delta between 23 July and 2 August 1974. An additional 40 nest-trapped females, captured in early June, were not infested.

Waterfowl weakened by disease are apparently more susceptible to leech infestations than healthy birds. Kalmbach and Gunderson (1934) and Quortrup and Shillinger (1941) reported that leeches aggravated cases of botulism, but they doubted that they were ever the primary

cause of death. Sciple (1953) implied that leeches were commonly encountered among ducks suffering from botulism poisoning. Bartonek also has observed ducks afflicted with botulism poisoning and infested with leeches on marshes adjacent to the Great Salt Lake in Utah. Gary L. Pearson (pers. com.) told us that leeches have been observed in the eyes, nares, and cloaca of Mallard, Pintail, Shoveler, Gadwall and Blue-winged Teal affected with botulism in North Dakota. Meyer and Moore (1954) speculated that leeches were responsible for the deaths of ducks on Whitewater Lake, Manitoba. We suspect that the birds were also poisoned, as this lake has a history of outbreaks of botulism.

Between 1957 and 1968, Malcolm E. McDonald (pers. com.) routinely noted the occurrence of leeches infesting waterfowl necropsied for parasites (Table 2). *T. rude* was considered an active parasite of living birds, whereas *P. ornata* found in the nasal cavities of some birds was assumed to be a post-mortem invader. The large number of leeches observed in some specimens suggested that they might be a mortality factor, especially regarding the high loss of juvenile Trumpeter Swans at the Red Rock Lakes National Wildlife Refuge in Montana. Three young swans (4–7 weeks) were infested by 35, 71, and 72 leeches, respectively. McDonald noted that the frequency of leech parasitism varied in relation to season, habitat, and location. Summer birds collected in Montana (Red Rock Lakes NWR) and Idaho (Camas NWR) were infested at higher rates, 77% and 62% respectively, compared to 1–3% in Utah (Bear River MBR). Red Rock Lakes and Camas National Wildlife Refuges have lush, spring-fed wetlands where leech populations were very high. Bear River Migratory Bird Refuge is an alkaline marsh with restricted variety of life.

Meyer and Moore (1954) considered *T. rude* as a major cause of death among waterfowl, especially young birds, on prairie wetlands of Canada. Moore (1966) believed that *T. rude* was responsible for considerable mortality in young waterbirds in Alberta. Smith *et al.* (1964) noted that some ducklings on the North American prairies would die from suffocation caused by leeches. Bartonek and Trauger (1975) attributed the deaths of several young waterfowl to leech parasitism. Quortrup and Shillinger (1941) mentioned that occasional cases of verminous pneumonia developed in ducks infested with leeches in the bronchi.

Mortality to domestic and captive waterfowl from leech *T. tessulatum* infestations has been reported frequently in Europe. Kuznetsova (1955) characterized severe leech infestations of the upper respiratory system as usually causing short, laboured breathing and terminating in death from asphyxiation. He estimated mortality rates of 15–20% and 80–90% for two groups of ducks and geese on state-operated farms in the USSR. Hilprecht (1956) reported that leeches also contributed to mortality of swans on a large scale in Europe. Rollinson *et al.* (1950) and Mann (1951) attributed the

Table 2. Leech parasitism of waterfowl examined post-mortem by Dr Malcolm E. McDonald, 1957–1968.*

Species	Number of individuals infested (Number examined)	Location	Number of leeches found
Whistling Swan	3 (35)	Utah	3–25
Trumpter Swan	10 (14)	Montana	1–72
Lesser Snow Goose	2 (14)	California	5–7
White-fronted Goose	1 (8)	California	3
Canada Goose	1 (20)	Utah	2
Mallard	5 (68)	Utah, Idaho, Montana	1–74
Gadwall	3 (55)	Idaho	9–15
Shoveler	1 (13)	Montana	15
Canvasback	3 (14)	Montana	1–18
Redhead	2 (15)	Utah, Montana	9–23
Lesser Scaup	2 (9)	Nebraska	19–24
Ruddy Duck	2 (10)	Utah, Montana	2–16

* Detailed records filed at Bear River Research Station, U.S. Fish and Wildlife Service, Bear River, Utah.

deaths of 24 ducklings on a large millpond in England to leeches infesting the nasal cavity. Mann (1951) found no previous records of *Theromyzon* being associated with the deaths of birds in Great Britain, but Rollinson *et al.* (1950) cited several references to infestations causing extensive mortality among waterfowl elsewhere in Europe (Weltner 1887; Büchli 1924). A Falkland Flightless Steamer Duck *Tachyeres brachypterus* at the Wildfowl Trust (1950) died from leech parasitism. Keymer (1969) reported mortality of waterfowl infested by leeches.

Need for research

Although Mann (1962) reviewed existing knowledge of leech biology and ecology, further work is needed on the leeches infesting waterfowl, particularly *T. rude*. Moore and Meyer (1951) summarized available information on the description, anatomy, and distribution of this species and later presented additional findings pertaining to its life history (Meyer and Moore 1954). Although they considered the information relatively incomplete, they concluded that the behaviour of *T. rude* was similar to that of *T. tessulatum*, the biology of which has been studied in considerable detail by Herter (1929) and Christiansen (1939). Hagadorn (1962) reported on some aspects of the biology of *T. rude*, especially the physiology of the reproductive cycle.

Until Herrmann's (1970) work, no broad ecological studies of leeches had been published in North America. He found that *T. rude* and *P. ornata* were widely distributed in relation to several chemical and physical factors. Scudder and Mann (1968), investigating the distribution of leeches in relation to salinity, found that *T. rude* exhibited tolerance to the widest range of environmental conditions compared to nine other species of freshwater leech. Gallimore (1964), Colbo (1965) and Graham (1966) also examined some ecological factors influencing leech parasitism of aquatic birds. Herrmann (1970) noted an interesting relationship between *T. rude* and *P. ornata*; they were frequently found in close physical association in shallow waters inhabited by a variety of waterfowl.

Leech-waterfowl relationships are still poorly understood. Sawyer (1972) stated, 'there is little doubt that *T. rude*, like its European congenitor, *T. tessulatum*, can be a cause of morbidity and mortality of young waterfowl, but the economic significance of this problem requires critical examination.' Future studies should be directed toward investigating the effects of leech parasitism upon individual birds, with emphasis on evaluating the debilitating impact of leeches on the growth and development of ducklings and on determining the combined effects of leeches, other parasites, and diseases on the health and survival of young waterfowl. Although Graham (1966) has made an important start in studying the helminth ecology of breeding waterfowl, the nature and incidence of leech infestations in relation to host species, age, habitat, and season need to be investigated in other areas for comparison with our observations. In addition, such questions as the dynamics and duration of infestations, feeding rates and frequency, blood volumes extracted, gross pathology, and host selectivity are of particular interest.

Meyer and Moore (1954) noted that *T. rude* commonly occurred in the northern United States and southern Canada, especially along the Rocky Mountain duck flyway. Subsequent records have indicated that leech infestations of North American waterfowl are probably widespread throughout northern and western breeding grounds (Figure 4). Although the incidence of infestation is high in some northern forest waterfowl populations, the evidence suggests that the mortality directly attributable to leeches is probably low (Bartonek and Trauger 1975). Nevertheless, the contributing causes to mortality of juvenile waterfowl are often difficult to detect; it is even more difficult to ascribe relative values to them.

Leeches may indirectly contribute to mortality rates of waterfowl. Ducks may die from predation because leeches impair their vision or hinder their escape. Blinded ducks may not feed effectively. The debilitating effects may also retard growth and development of ducklings, and might prevent migration before freeze-up or adversely affect reproduction the following year. A partial obstruction of the respiratory tract must surely hinder breathing and the diving abilities. Blood parasites or toxic substances may also be transmitted in the anticoagulant of vector leeches. Sick and disturbed birds are prone to leech infestations; sick birds may succumb from the additional stress caused by parasitism.

Acknowledgements

We thank Dr Frederick J. Vande Vusse, Dr Malcolm E. McDonald, and Ms Ell-Piret Multer

for assistance in identifying and obtaining several references. To those contributing personal observations of leech infestations, we express sincere gratitude. Dr Gary L. Pearson, George A. Swanson, and Dr Gary L. Krapu provided editorial assistance on earlier drafts. Dr McDonald offered helpful suggestions for final improvements.

Summary

Leech parasitism of waterfowl is widespread in North America. Twenty species of ducks, geese and swans have been infested by leeches, particularly *Theromyzon rude* and *Placobdella ornata*. Sites of attachment include the eyes, nasal passages, and body. Information is lacking on the biology and ecology of duck leeches. Their significance as morbidity and mortality factors and their continental distribution should be determined in relation to waterfowl habitats and populations.

References

Banko, W. E. 1960. *The Trumpeter Swan*. North American Fauna No. 63.

Bartonek, J. C. 1972. Summer foods of American Widgeon, Mallards, and a Green-winged Teal near Great Slave Lake, Northwest Territories. *Canad. Fd.-Nat.* 86: 373–6.

Bartonek, J. C. and Murdy, H. W. 1970. Summer foods of Lesser Scaup in Subarctic taiga. *Arctic* 23: 35–44.

Bartonek, J. C. & Trauger, D. L. 1975. Leech (Hirudinea) infestations among waterfowl near Yellowknife, Northwest Territories. *Canad. Fd.-Nat.* 89: 234–43.

Bennett, L. J. 1938. *The Blue-winged Teal: its ecology and management*. Collegiate Press, Ames, Iowa.

Büchli, K. 1924. Bloedzuigers in de neusholte van eenden. *Tijdschrift voor Diergeneeskunde* 51: 153–5.

Butler, W. J. 1940. Leeches in ducks. *Montana Livestock Sanitary Board Report*, 1939–1940: 12.

Christiansen, M. 1939. *Protoclepsis tesselata* (O. F. Müller), der Entengel, als Ursache von Krankheit, u.s. Konjunktivtis, bei Gänsen und Enten. *Zeitschrift für Infektionskrankheiten, Parasitäre Krankheiten und Hygiene der Haustiere* 55: 75–89.

Colbo, M. H. 1965. Taxonomy and ecology of the helminths of the American Coot in Alberta. Unpub. M.S. thesis. University of Alberta, Edmonton, Alberta.

Cornwell, G. W. & Cowan, A. B. 1963. Helminth populations of the Canvasback (*Aythya valisineria*) and host-parasite—environmental interrelationships. *Trans. N. Amer. Wildl. and Nat. Res.* Conf. 28: 173–99.

Davies, R. W. 1973. The geographic distribution of freshwater Hirudinoidea in Canada. *Canad. J. Zool.* 51: 531–45.

Erickson, R. C. 1948. Life history and ecology of the Canvasback, *Nyroca valisineria* (Wilson) in southwestern Oregon. Unpublished Ph.D. thesis, Iowa State College, Ames, Iowa.

Fjeldså, J. 1972. Records of *Theromyzon maculosum* (Rathke 1862): Hirudinea, in N. Norway. *Norw. J. Sc.* 20: 19–26.

Gallimore, J. R. 1964. Taxonomy and ecology of helminths of grebes in Alberta. Unpublished M.S. thesis, University of Alberta, Edmonton, Alberta.

Gräfner, V. G. & Baumann, H. 1974. Blutegelbefall bein Wassergeflügel. *Angew Parasitol.* 15: 121–4.

Graham, L. C. 1966. The ecology of helminths in breeding populations of Lesser Scaup (*Aythya affinis* Eyton) and Ruddy Ducks (*Oxyura jamaicensis* Gmelin). Unpublished M.S. thesis University of Alberta, Edmonton, Alberta.

Hagadorn, I. R. 1962. Functional correlates of neurosecretion in the rhynchodellid leech, *Theromyzon rude*. *Gen. and Comp. Endrocrinology* 2: 516–40.

Herrmann, S. J. 1970. Systematics, distribution and ecology of Colorado Hirudinea. *Amer. Midl. Nat.* 83: 1–37.

Herter, K. 1929. Reizphysiologisches Verhalten and Parasitismus des Entenegels *Protoclepsis tesselata* O. F. Müller. *Zeitschrift für vergleichende Physiologie* 10: 272–308.

Hilprecht, A. 1956. *Hockerschwan, Singschwan, Zwerschwan*. Wittenburg Lutherstadt: A. Ziemsen Verlag.

Kalmbach, E. R. & Gunderson, M. F. 1934. Western duck sickness, a form of botulism. *U.S. Dep. Agric. Technical Bull.* No. 411.

Keymer, I. F. 1969. Infestation of waterfowl with leeches. *Vet. Rec.* 85: 632–3.

Klemm, D. J. 1972. *Freshwater leeches (Annelida: Hirudinea) of North America*. Biota of Freshwater Ecosystems Identification Manual No. 8. U.S. Environmental Protection Agency. Washington, D.C.

Kuznetsova, O. N. 1955. Piyaviki-parazitei vodoplavayuschei ptitsei. *Ptitsevodstvo* 5: 32–4.

Lang, D. C. 1969. Infestation of ducklings with leeches. *Vet. Rec.* 85: 566.

Low, J. B. 1945. Ecology and management of the Redhead, *Nyroca americana*, in Iowa. *Ecol. Mono.* 15: 35–69.

Mann, K. H. 1951. On the bionomics and distribution of *Theromyzon tessulatum* (O. F. Müller), 1774 (= *Protoclepsis tesselata*). *Annals and Magazine Nat. Hist.* 4: 956–61.

Mann, K. H. 1962. Leeches (Hirudinea). Their structure, physiology, ecology, and embryology. New York: Pergamon Press.
Mathers, C. K. 1948. The leeches of the Okoboji region. *Iowa Academy of Science Proc.* 55: 397–425.
McDonald, M. E. 1969. *Catalogue of helminths of waterfowl (Anatidae).* U.S. Bur. Sport Fish. Wildl. Spec. Sc. Rep. Wildl. No. 126.
Mendall, H. L. 1958. The Ring-necked Duck in the Northeast. *Univ. Maine Bull.* 69: 1–317.
Meyer, M. C. & Moore, J. P. 1954. Notes on Canadian leeches (Hirudinea) with the description of a new species. *Wasmann J. Biol.* 12: 63–96.
Moore, J. E. 1964. Notes on the leeches (Hirudinea) of Alberta. *Nat. Mus. Canada, Nat. Hist. Papers* 27: 1–15.
Moore, J. E. 1966. Further notes on Alberta leeches (Hirudinea). *Nat. Mus. Canada, Nat. Hist. Papers* 32: 1–11.
Moore, J. P. & Meyer, M. C. 1951. Leeches (Hirudinea) from Alaskan and adjacent waters. *Wasmann J. Biol.* 9: 11–77.
Quortrup, E. R. & Shillinger, J. E. 1941. 3,000 wild bird autopsies on western lake areas. *J. Amer. Vet. Medical Assoc.* 99: 382–7.
Roberts, H. E. 1955. Leech infestation of the eye in geese. *Vet. Rec.* 67: 203–4.
Rollinson, D. H. L., Soliman, K. N. & Mann, K. H. 1950. Deaths in young ducklings associated with infestations of the nasal cavity with leeches. *Vet. Rec.* 62: 225–7.
Sawyer, R. T. 1972. North American freshwater leeches exclusive of the Piscicolidae, with a key to all species. *Illinois Biol. Mono.* 46: 1–154.
Sciple, G. W. 1953. *Avian botulism: information on earlier research.* U.S. Bur. Sport Fish. Wildl. Spec. Sc. Rep. Wildl. No. 23.
Scudder, G. G. E. & Mann, K. H. 1968. The leeches of some lakes in the Southern Interior Plateau region of British Columbia. *Syesis* 1: 203–9.
Smith, A. G., Stoudt, J. H. & Gollop, J. B. 1964. Prairie potholes and marshes, pp. 39–50, in *Waterfowl Tomorrow.* Ed. J. P. Linduska. Washington, D.C.: U.S. Bur. Sport Fish. Wildl.
Scooter, C. A. 1937. Leeches infesting young waterfowl in northwest Iowa. *J. Parasitol.* 23: 108–9.
Weltner, W. 1887. *Clepsine tesselata* O. Fr. Müll. aus dem Tegelsee bei Berlin lebend vorzeigen. *Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin.* 17: 85.
Wildfowl Trust. 1950. Pathology: parasites. *Wildfowl Trust Ann. Rep.* 3: 52.

Dr David L. Trauger, Northern Prairie Wildlife Research Center, U.S. Fish and Wildlife Service, Jamestown, North Dakota 58401.
Dr James C. Bartonek, Office of Biological Services, U.S. Fish and Wildlife Service, Anchorage, Alaska 99501.

The delicately patterned Marbled Teal *Marmaronetta angustirostris*. (*Joe B. Blossom*).