First record of *Contracaecum* spp. (Nematoda: Anisakidae) in fish-eating birds from Zimbabwe

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ABSTRACT

Endoparasites of fish-eating birds, *Phalacrocorax africanus, P. carbo, Anhinga melanogaster* and *Ardea cinerea* collected from Lake Chivero near Harare, Zimbabwe, were investigated. Adult *Contracaecum* spp. were found in the gastrointestinal tract (prevalence 100 % in *P. africanus, P. carbo* and *A. melanogaster*; 25 % in *A. cinerea*). Parasite intensity was 11–24 (mean 19) in *P. africanus,* 4–10 (mean 7) in *P. carbo,* 4–56 (mean 30) in *A. melanogaster* and 2 (mean 0.5) in *A. cinerea.* The cormorants fed mainly on cichlid fishes and carp; the darters and the grey herons on cichlids. All these fishes are intermediate hosts of *Contracaecum* spp. Scanning electron microscopy revealed that *Contracaecum rudolphii* infected both cormorant species and darters; *C. carlislei* infected only the cormorants while *C. tricuspis* and *C. microcephalum* infected only the darters. Parasites from the grey heron were not identified to species because they were still developing larvae. These parasites are recorded in Zimbabwe for the first time.

Key words: *Contracaecum,* Lake Chivero, mean intensity, nematode, parasite prevalence, piscivorous bird, Zimbabwe.

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INTRODUCTION

Fish-eating birds are abundant in freshwater habitats in Zimbabwe as they are in most parts of Africa and the world over[13]. With the increase in man-made impoundments in the country, many of the bird species have adapted to breeding in these habitats[13,14], which also provide a more abundant source of fish than flowing waters[6,9]. Although the ecology of the birds has been studied to some extent in Zimbabwe's major dams[9,11,12,14], little is documented on their parasitic diseases. These include 1 paper by Beverly-Burton[5] on *Diplostomum mashonense,* a trematode from the grey heron and a Government Veterinary Laboratory record of the nematode *Spiroptera* sp. in 2 cormorants found dead on Lake Chivero in 1995 (T Couto, Department of National Parks and Wildlife Management, Zimbabwe, pers. comm., 2002).

Elsewhere in Africa, the occurrence of parasites in aquatic birds has been determined in Ghana[23] and South Africa[20,21,26], and they range from clinostomid and diplostomid trematodes to cestodes and nematodes. The anisakid nematode, *Contracaecum* sp., is one of the most prevalent parasites in southern African piscivorous birds, infecting 5 avian species[20,21]. Some of the *Contracaecum* species are widely distributed in other parts of Africa, Europe, Asia, Australasia, North and South America[3,27]. It is partly for this reason that the occurrence of *Contracaecum* spp. was investigated in 4 piscivorous bird species at Lake Chivero, Zimbabwe. This study aimed to specifically identify the *Contracaecum* species, the adults of which are only found in the bird definitive host and the larvae of which had been found in some fish from the lake[4] and to compare them with those from South African birds to establish their regional distribution.

Lake Chivero lies 37 km southwest of Harare, the capital of Zimbabwe. It is the city's potable water reservoir and is very eutrophic because of sewage and industrial effluent that is discharged into its feeder streams from Harare and its neighbouring town, Chitungwiza[17]. The lake supports a large fish community and about 12 bird species (T Couto, Department of National Parks and Wildlife Management, Zimbabwe, pers. comm., 2002), of which the reed cormorant *Phalacrocorax africanus* (Gmelin, 1789), the white-breasted cormorant *P. carbo* (L.), the darter *Anhinga melanogaster* Lacapéde & Dauchin, 1802, and the grey heron *Ardea cinerea* (L.), were selected because of their abundance on the lake.

MATERIALS AND METHODS

Four reed cormorants, 4 white-breasted cormorants, four darters and four grey herons were shot with a 0.22 rifle and a 12-bore shotgun firing buckshot at Lake Chivero. Their beaks were sealed with rubber bands to prevent the escape of parasites lodged in the buccal cavity. In the laboratory, the birds were weighed, dissected, and the alimentary canal was opened. Undigested and partly digested fish encountered in the oesophagus and stomach were removed, identified to species level where possible, and weighed. Nematodes either found in the oesophagus or attached to the stomach mucosa were removed, fixed in glacial acetic acid and stored in 70 % ethyl alcohol. Sub-samples of nematodes from each infected bird were set aside for electron microscopy. The remainder was cleared and mounted in lactophenol and the cover slides were sealed with clear nail varnish.

Specimens for scanning electron microscopy (SEM) were cleaned in an ultrasonic cleaner (Branson 3200) to remove debris from the cuticle. They were dehydrated in an ascending series of ethyl alcohol (70 %, 80 %, 90 %, industrial methanol and 100 %) after which they were critical-point dried. They were mounted on stubs and gold-coated for 40 minutes and then examined and photographed under a JEOL 6100 scanning electron microscope between 5–7 kV. Keys by Anderson[3], Hartwich[10] and Yamaguti[27] were used for identification.

RESULTS

All the cormorants and darters were infected with at least 4 nematodes in their alimentary canal (prevalence 100 %) while only 1 grey heron (25 %) was infected (Table 1). The parasite intensity was greatest in the darter compared the

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Table 1: **The infection statistics of *Contracaecum* species found in the alimentary canal of four species of piscivorous birds at Lake Chivero.**

Bird species	Host sex	Host weight (g)	Parasites in oesophagus	Parasites in stomach	Intensity	MI* (per species)	P (%)* (per species)
Phalacrocorax africanus	F	518	8	16	24	18.75	100
	F	551	0	22	22		
	M	552	0	11	11		
	M	619	2	16	18		
Phalacrocorax carbo	F	2065	3	1	4	6.50	100
	M	2525	3	7	10		
	M	2200	4	0	4		
	M	2225	0	8	8		
Anhinga melanogaster	F	1265	0	4	4	30.00	100
	F	1375	11	31	42		
	F	1590	3	53	56		
	M	1205	1	17	18		
Ardea cinerea	F	1775	0	0	0	0.50	25
	F	1635	0	0	0		
	F	1260	1	1	2		
	M	1430	0	0	0		

*MI = mean intensity, P = prevalence.

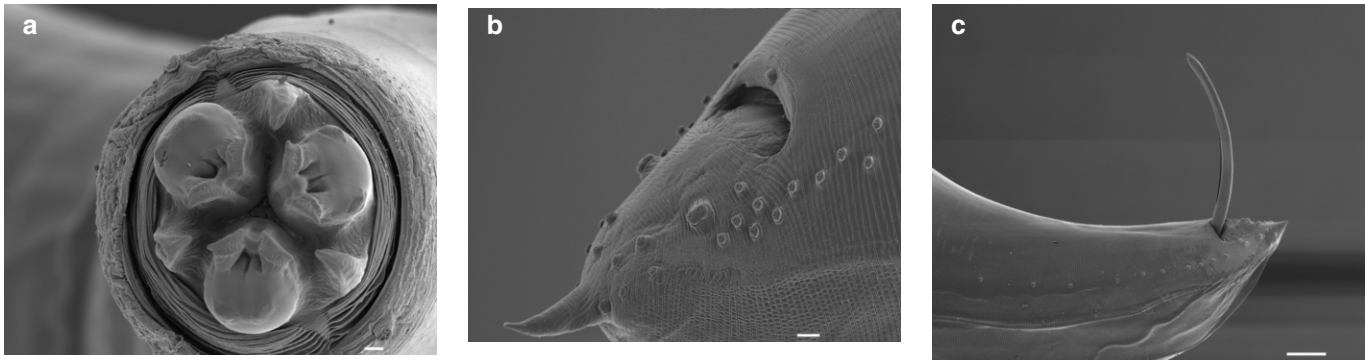

Fig. 1: a, **Head of a female *Contracaecum rudolphii* from a reed cormorant** (scale bar = 10 µm)**;** b, **tail of a male *C. rudolphii* from a white-breasted cormorant showing the arrangement of postcloacal papillae** (scale bar = 10 µm)**;** c, **tail of a male *C. rudolphii* showing the spicules** (fused)**, papillae and caudal alae** (scale bar = 100 µm).

reed cormorant, the white-breasted cormorant and the grey heron. The nematodes were 11–29 mm long (mean 17 mm) and the majority (73 %) were male. The Zambezi bream, *Pharyngochromis acuticeps* (Staindachner), and the Nile bream, *Oreochromis niloticus* (L.), constituted the most abundant species in the diet of the birds (Table 2). The darters and herons preferred *O. niloticus* while the cormorants were not very specific.

Four species of adult *Contracaecum* Raillet and Henry, 1912 were identified: *C. rudolphii* Hartwich, 1964, *C. carlislei* Ortlepp, 1938, *C. microcephalum* (Rudolphi, 1809) and *C. tricuspis* (Gedoelst, 1916). Generic diagnosis using light microscopy was based on the presence of the ventricular appendix and intestinal caecum as well as length measurements, while SEM revealed the detailed structure of the head and tail, the size and number of caudal papillae and spicules in males, which were used for species identification.

Contracaecum rudolphii (Fig. 1)

Lips slightly wider than long; upper lip with marked medial deepening. Lip palp forming 2 lobes in interior margin (Fig. 1a). Males with 25–44 pairs of precloacal papillae arranged irregularly in 2 longitudinal rows and 6–7 pairs of postcloacal papillae (Fig. 1b). Spicules similar and subequal (Fig. 1c). Hosts: *P. africanus, P. carbo* and *A. melanogaster.*

Contracaecum carlislei (Fig. 2)

Three rectangular lips with bilobed anterior surfaces. Large curved interlabia. Dorsal lip with 2 single papillae and subventral lips with a double and a single papilla. Males with 26–34 pairs of precloacal papillae and 5 pairs of postcloacal papillae. Hosts: *P. africanus* and *P. carbo.*

Contracaecum microcephalum (Fig. 3)

Round hexagonal lips forming 2 lobes anteriorly (Fig. 3a). Interlabia not bifurcated but distinctly rounded. Males with 32 pairs of precloacal papillae in 2 longitudinal rows, 5 pairs of simple postcloacal papillae and 1 double pair of postcloacal papillae. Spicules similar and subequal, with longitudinal alae (Fig. 3b). Host: *A. melanogaster.*

Contracaecum tricuspis (Fig. 4)

Three lips with lateral surfaces notched with a point, into which interlabia fit. Dorsal lip with 2 simple papillae; lateroventral lips each with 1 double papilla. Three interlabia each with a slender corpus ending in 3 tips (Fig. 4a). No lateral alae present. Males with 55–78

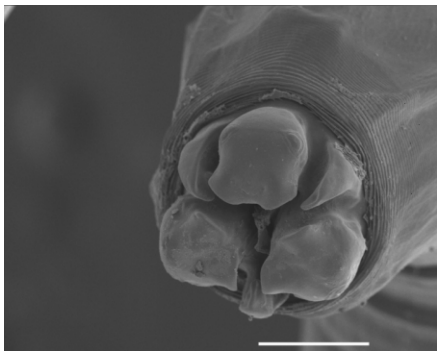

Fig. 2: **Head of *Contracaecum carlislei* from a white-breasted cormorant.** Scale bar = 100 µm.

Table 2: **The diet of 4 bird species collected from Lake Chivero.**

Bird species	Sex	Mass of gut contents (g)	Fish sp. in diet*	No. of fish of each sp.	Mass of fish in diet (g)*	Mean mass of fish in diet (g)
Phalacrocorax africanus	F	ND	*Pa*	2	ND	ND
	F	41	*On*	7	29	4.14
			uc	1	3	3.00
	M	ND	uc	16	ND	ND
	M	ND	*On*	5	ND	ND
Phalacrocorax carbo	F	85	*On*	5	37	7.40
			uc	2	5	2.50
			Pa	1	7	7.00
	M	ND	*Pa*	4	ND	ND
	M	56	*On*	3	15	5.00
			Cc	1	5	5.00
			Pa	2	15	7.50
			uc	1	4	4.00
	M	119	*On*	1	48	48.00
			Pa	2	8	4.00
			uc	2	10	5.00
Anhinga melanogaster	F	147	*On*	5	ND	ND
	F	ND	*On*	2	ND	ND
	F	ND	*On*	7	127	18.14
			uc	1	5	5.00
	M	71	*On*	6	56	9.33
Ardea cinerea	F	ND	uc	16	ND	ND
	F	114	*On*	2	109	54.5
	F	ND	*On*	1	8	8.00
	M	ND	–	0	ND	ND

**Pa = Pharyngochromis acuticeps, On = Oreochromis niloticus, Cc = Cyprinus carpio,* uc = unidentified cichlids, ND = not determined.

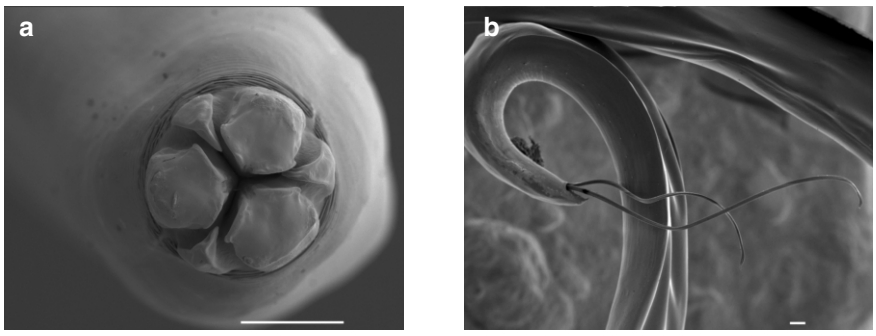

Fig. 3: a, **Head of *Contracaecum microcephalum* from a darter** (scale bar = 100 µm); b, **tail of a male *C. microcephalum* from a darter – note the longitudinal, wrinkle-like alae** (scale bar = 100 µm).

pairs of caudal papillae elaborately arranged laterally, ventrally and distally from the cloacal aperture, 1 double and 5 simple pairs of postcloacal papillae. Spicules subequal (Fig. 4b). Host: *A. melanogaster.*

The worms from the grey heron (*A. cinerea*) were not identified to species level because they were still in their 4th larval stage.

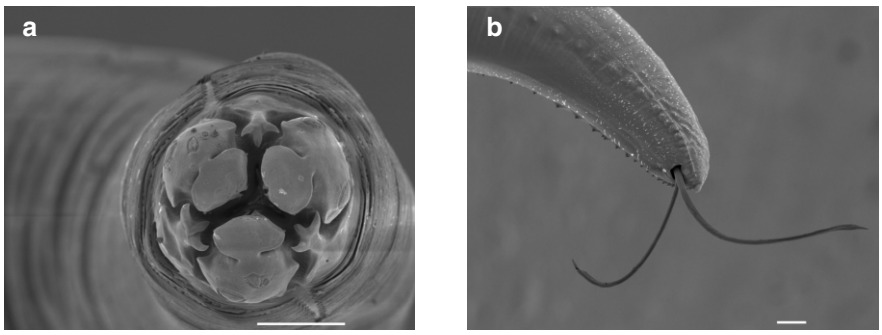

Fig. 4: a, **Head of *Contracaecum tricuspis* from a darter showing the characteristic tri-forked interlabia** (scale bar = 100 µm); b, **tail of a male *C. tricuspis* from a darter** (scale bar = 100 µm).

DISCUSSION

The results obtained from this study indicate that darters and cormorants are the most common hosts of *Contracaecum* species in Lake Chivero. Because of permit restrictions on the size of the sample that could be collected (maximum of 5 per species), samples were too small to make concrete conclusions on the prevalence of this parasite. However, the distribution of the parasites is similar to other related studies where host sample size was low (Table 3).

The *Contracaecum* spp. found in Zimbabwe were all previously described in South Africa[19,21], indicating a possible regional distribution. *Contracaecum carlislei,* for example, was first described by Ortlepp in 1938 from the stomach and oesophagus of *P. africanus* and was thought to be indigenous to South Africa only[19]. More data should be gathered to ascertain the distribution of *C. carlislei* on the continent.

Contracaecum rudolphii is one of the most widely studied species with a cosmopolitan distribution[27]. In Africa, it infects the Pelecaniformes (cormorants, darters and pelicans)[16,19,21,26] and has also been reported from European cormorants[22,25]. It was therefore not surprising to find it in cormorants from Zimbabwe. *Contracaecum microcephalum* also has a worldwide distribution[3,27]. In southern Africa, it infects the herons *Ardea cinerea* and

Table 3: **Comparison between the prevalence** (P) **of *Contracaecum* in piscivorous birds of Lake Chivero and other published studies.**

Parasite species	Host species	Locality	*n*	P (%)	Source
C. rudolphii	*P. carbo*	a, b, c (SA)	2	100	2
		Seshego Dam (SA)	32	97	2
		Middle Letaba Dam (SA)	11	73	1
		Lake Chivero (Zimbabwe)	4	100	4
		Switzerland	3–14	100	3
C. tricuspis	*A. melanogaster*	Seshego Dam	24	100	2
		a, b, d, e, f, g	5	100	2
		Middle Letaba Dam	44	100	1
		Lake Chivero	4	100	4
C. microcephalum	*A. melanogaster*	Seshego Dam	24	100	2
		a, b, d, e, f, g	5	100	2
		Middle Letaba Dam	44	100	1
		Lake Chivero	4	100	4
C. carlislei	*P. africanus*	Middle Letaba Dam	30	100	1
		Lake Chivero	4	100	4

Key: *n* = sample size, SA = South Africa.
Locality: a = Piet Gouws Dam, b = Glen Alpine Dam, c = Ebenhaezer Dam, d = Hudson Ntsanwisi Dam, e = Luphephe Dam, f = Olifants River, g = Tzaneen Dam.
Source: 1 = Saayman *et al.* (1991), 2 = Mokgalong (1996), 3 = Suter (1998), 4 = this study.

A. melanocephala as well as cormorants and darters[21] but it was not found in the grey herons from Lake Chivero. *Contracaecum tricuspis* was originally described from a heron in the Democratic Republic of the Congo[20], but in this study and other related studies in southern Africa, it was found in the darter[20,21].

Stomach content analysis shows that the cichlids, *O. niloticus* and *P. acuticeps* are dominant in the diet of the birds from Lake Chivero, both numerically and by weight (Table 2). This suggests that these fish are most likely the 2nd intermediate hosts of *Contracaecum.* In fact, a number of cichlid fish species and the barbel, *Clarias gariepinus,* have been shown to successfully host the parasite[1,2,7,8,15,16,18,20,24].

It would be interesting to link specific fish species from Lake Chivero to adult nematodes in the birds. So far, larval *Contracaecum* have been found in *Clarias gariepinus* from Lake Chivero[4], but this fish forms a very insignificant part of the birds' diets[9]. Previous studies on the feeding ecology of cormorants and darters in Zimbabwe showed that cichlids constituted over 60 % of their diet, of which *P. acuticeps* and *Pseudocrenilabrus philander* (Weber, 1897) were the most numerically dominant[6,9]. Moreover, Hustler[11] showed that cormorants and darters preferentially fed on prey weighing less than 100 g and this corresponds to the prey obtained in this study (Table 2). This would exclude *C. gariepinus,* which reaches a weight of more than 500 g at maturity, from the birds' diet.

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REFERENCES

1. Aloo P A 2001 Occurrence of larval *Contracaecum* (Nematoda: Heterocheilidae) in three teleostean species from Lake Naivasha, Kenya. *East African Journal of Science* 3: 1–12
2. Amin O M 1978 Intestinal helminths of some Nile fishes near Cairo, Egypt, with redescriptions of *Camallanus kirandensis* Baylis, 1928 (Nematoda) and *Bothriocephalus aegyptiacus* Rysavy and Moravec, 1975 (Cestoda). *Journal of Parasitology* 64: 93–101
3. Anderson R C 1992 *Nematode parasites of vertebrates: their development and transmission.* CAB International, Oxford
4. Barson M 2003 A study of the helminth parasites of fish and fish-eating birds in the Manyame catchment, Zimbabwe. MPhil. thesis, University of Zimbabwe
5. Beverly-Burton M 1963 A new strigeid *Diplostomum* (*Tylodelphys*) *mashonense* n. sp. (Trematoda: Diplostomatidae) from the grey heron in Southern Rhodesia with an experimental demonstration of part of the life cycle. *Revue de Zoologie et de Botanique africaines* 68: 291–308
6. Birkhead M E 1978 Some aspects of the feeding ecology of the reed cormorant and darter on Lake Kariba, Rhodesia. *Ostrich* 49: 1–7
7. Boomker J 1982 Parasites of South African freshwater fish. I. Some nematodes of the catfish [*Clarias gariepinus* (Burchell, 1822)] from the Hartbeespoort Dam. *Onderstepoort Journal of Veterinary Research* 49: 41–51
8. Boomker J 1994 Parasites of South African freshwater fish. VII. Nematodes of some scaled fishes from the Hartbeespoort Dam, Transvaal. *Onderstepoort Journal of Veterinary Research* 61: 197–199
9. Donnelly B G, Hustler K 1986 Notes on the diet of the reed cormorant and darter on Lake Kariba during 1970 and 1971. *Arnoldia Zimbabwe* 9: 319–324
10. Hartwich G 1974 Keys to the genera of the Ascaridoidea. In Anderson R C, Chabaud A G and Willmott S (eds) *CIH keys to the nematode parasites of vertebrates no. 2.* CAB International, Oxford
11. Hustler K 1995 Cormorant and darter prey size selection under experimental conditions. *Ostrich* 66: 109–113
12. Hustler K, Marshall B E 1996 The abundance and food consumption of piscivorous birds on Lake Kariba, Zimbabwe–Zambia. *Ostrich* 67: 23–32
13. Irwin M P S 1981 *The birds of Zimbabwe.* Quest Publishing, Harare
14. Junor F J R, Marshall B E 1987 Factors influencing the abundance of piscivorous birds on Lake Kyle, Zimbabwe. *Ostrich* 58: 168–175
15. Khalil L F, Polling L 1997 Checklist of the helminth parasites of African freshwater fishes. University of the North, Sovenga, South Africa
16 Malvestuto S P, Ogambo-Ongoma A 1978 Observations of the infection of *Tilapia leucosticta* (Pisces: Cichlidae) with *Contracaecum* (Nematoda: Heterocheilidae) in Lake Naivasha, Kenya. *Journal of Parasitology* 64: 383–384
17 Marshall B E 1997 Lake Chivero after forty years: the impact of eutrophication. In Moyo N A G (ed.) *Lake Chivero: a polluted lake.* University of Zimbabwe Publications, Harare: 1–12
18. Mashego S N, Saayman J E 1981 Observations on the prevalence of nematode parasites of the catfish, *Clarias gariepinus* (Burchell, 1822), in Lebowa, South Africa. *South African Journal Wildlife Research* 11: 46–48
19. Mokgalong N M 1996 A study of the gastrointestinal helminths of the Phalacrocoracidae and the Anhingidae in the Northern Province, South Africa. PhD thesis, University of the North
20. Prudhoe S, Hussey C G 1977 Some parasitic worms in freshwater fishes and fish preda-

tors from the Transvaal, South Africa. *Zoologica Africana* 12: 113–147
21. Saayman J E, Mashego S N, Mokgalong N M 1991 Parasites of the fish population with notes on the helminth parasites of the water birds of Middle Letaba Dam. In Saayman J E, Schoonbee H J and Smit G L (Eds) *A postimpoundment ecological study of the Middle Letaba Dam, Gazankulu.* Department of Development Aid, Pretoria: 8.1–8.210
22. Suter W 1998 The apparent increase of nematode infection in the European great cormorant *Phalacrocorax carbo sinensis* population reported by Staub and Ruhle (1996a) is a hoax. *Cormorant Research Group Bulletin* 3: 25–26
23. Ukoli F M A 1968 Three new trematode parasites of the African darter, *Anhinga rufa rufa* (Lacepéde and Daudin, 1802) in Ghana. *Journal of Helminthology* 42: 179–192
24. Van As J G, Basson L 1984 Checklist of freshwater fish parasites from southern Africa. *South African Journal Wildlife Research* 14: 49–61
25. Volponi S 1999 Cormorant research in the Po Delta (NE Italy). *Cormorant Research Group Bulletin* 4: 22–25
26. Whitfield A K, Heeg J 1977 On the life cycles of the cestode *Ptychobothrium belones* and nematodes of the genus *Contracaecum* from Lake St. Lucia, Zululand. *South African Journal Science* 73: 121–122
27. Yamaguti S 1961 *Systema Helminthum. Vol. III. The nematodes of vertebrates. Part I & II.* Interscience Publishers, New York