Comp. Parasitol.
71(2), 2004, pp. 104–110

Endoparasites of African Forest Elephants (*Loxodonta africana cyclotis*) from the Republic of Congo and Central African Republic

JOHN M. KINSELLA,[1,4] SHARON L. DEEM,[2] STEPHEN BLAKE,[3] AND ANDREA S. FREEMAN[2]

[1] HelmWest Laboratory, 2108 Hilda Avenue, Missoula, Montana 59801, U.S.A. (e-mail: wormdwb@aol.com),
[2] Field Veterinary Program, Wildlife Conservation Society, 2300 Southern Boulevard, Bronx, New York 10460, U.S.A., and
[3] Africa Program, Wildlife Conservation Society, 185th Street and Southern Boulevard, Bronx, New York 10460, U.S.A. (e-mail: sblake@wcs.org)

ABSTRACT: Fecal samples were collected from 6 African forest elephants, *Loxodonta africana cyclotis*, from the Nouabalé-Ndoki National Park, Republic of Congo, and the Dzangha-Sangha National Park, Central African Republic. One of the elephants was found freshly dead from natural causes, and 12 species of intestinal parasites (2 bot fly larvae, 1 trematode, and 9 nematodes) were collected during a complete necropsy. In addition, fecal samples revealed the presence of a schistosome, *Bivitellobilharzia* sp., a tracheal nematode, *Mammomonagamus* sp., and a complex of intestinal strongylids and ciliates. The nematode genera *Decrusia* and *Equinurbia* are reported for the first time from African elephants, and the ciliate genus *Latteuria* is reported for the first time from wild elephants. The parasite fauna of the African elephant is discussed in the light of recent genetic evidence that the forest and savannah elephants may be separate species.

KEY WORDS: African elephant, forest elephant, *Loxodonta africana cyclotis*, *Decrusia*, *Equinurbia*, *Bivitellobilharzia*, *Mammomonagamus*, *Latteuria*, ciliate, Africa.

The African elephant, *Loxodonta africana* (Blumenbach, 1797), has traditionally been divided into the *africana* division (savannah or bush elephant), comprising 4 subspecies, and the *cyclotis* division (forest elephant), comprising 2 subspecies (one extinct) (Laursen and Bekoff, 1978). Recent investigators of elephant genetics have suggested that the forest elephant (*Lo. africana cyclotis* Matschie, 1900) is as divergent from *Lo. a. africana* as *Loxodonta* is divergent from *Elephas*, the Indian elephant, and, in fact, may be a different species (Barriel et al., 1999; Roca et al., 2001).

Despite an extensive literature based on the parasites of the African elephant (see reviews by van der Westhuysen [1938], Round [1968], and Bauer and Stoye [1985]), very few articles have mentioned the subspecies of the host, and like most areas of African elephant biological research, collections have been dominated by those from savannah elephants. An exception is an article by Chabaud and Rousselot (1956), who listed 10 species of nematodes from "*Loxodonta cyclotis*." In other cases the subspecies can sometimes be inferred from the locality (e.g., the studies by Condy [1974] and Basson et al. [1971], both of which were outside the range of the forest elephant). Given their genetic, morphological, ecological, and dietary differences, we speculated that the intestinal parasite fauna may also vary considerably between the 2 forms of elephant, although existing data are inadequate to test this hypothesis. In this article we describe the parasite fauna of 6 forest elephants from the Nouabalé-Ndoki and Dzangha-Sangha National Parks of Congo and Central African Republic, respectively, and discuss our results compared with the published literature with particular respect to the evolutionary history and ecology of elephants.

MATERIALS AND METHODS

Fecal samples were collected opportunistically during immobilizations of forest elephants for an ongoing study of ranging behavior using global positioning system telemetry (Blake et al., 2001; Blake, 2002). Feces were extracted manually from the rectum of 1 elephant from Mbeli Bai, Republic of Congo (2°15′35″N; 16°24′44″E), 1 elephant from Mabele Bai, Republic of Congo (2°39′19″N; 16°34′34″E), and 3 elephants from Gobounga Bai, Central African Republic (2°50′46″N; 16°27′50″E) and placed in 10% buffered formalin for storage. A field necropsy was performed within 3 hr of death on an adult female found dying at Gobounga Bai of natural causes and estimated to be 50 yr old. Feces were removed manually from the colon, and a subset (approximately 25%) of the endoparasites were collected from the stomach, small intestine, cecum, and colon. Endoparasites were stored in 70% isopropyl alcohol. All fecal samples and endoparasites were transported to the United States (CITES permit No. 01-US033594/9) for parasite identification.

Fecal samples were concentrated using ethyl acetate sedimentation and mixed with Lugol iodine, and 1 drop of the stained sediment was placed on a slide. Three slides were examined for each sample. Trematodes were stained with Semichon carmine, dehydrated in ethanol, and mounted in

[4] Corresponding author.

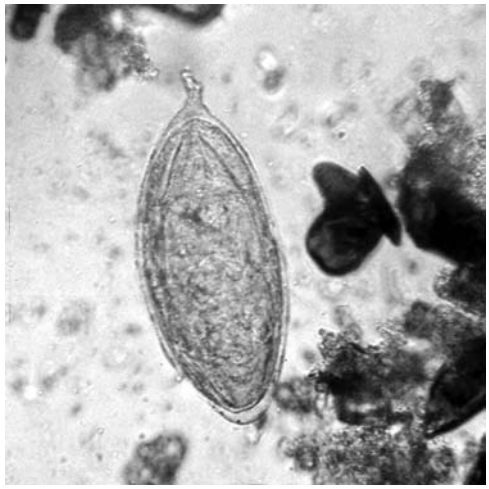

Figure 1. Egg of *Bivitelloharzia* sp. from feces of a forest elephant (×100).

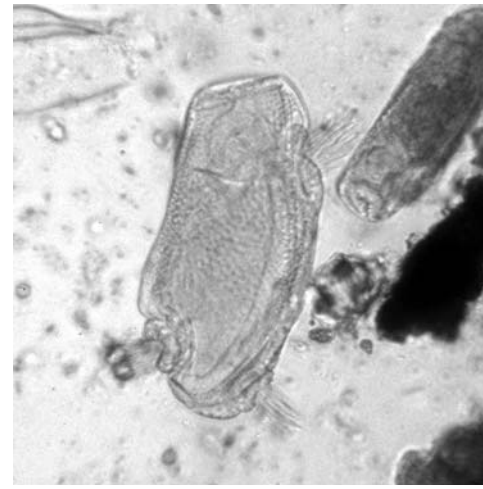

Figure 2. Entodiniomorph ciliate of the genus *Triplumaria* from feces of a forest elephant (×100).

Canada balsam. Nematodes were studied in temporary mounts of lactophenol. Dipteran larvae were studied in ethanol under the dissecting scope and identified using the key of Zumpt (1965). Voucher specimens of parasites were deposited at the U.S. National Parasite Collection, Beltsville, Maryland, U.S.A.

RESULTS

Fecal samples

Feces of 6 forest elephants, including the elephant that was necropsied, were examined for helminth eggs and protozoans. Eggs of *Protofasciola robusta* found in 4 elephants (67%) were identified by direct comparison with eggs dissected from a gravid fluke. Eggs of *Mammomonagamus* sp., which were only found in the feces of 1 elephant (17%), compared closely with eggs dissected from a gravid, *Mammomonagamus loxodontis*, borrowed from the Museum of Natural History, London, U.K. Eggs of a species of *Bivitellobilharzia* (probably *Bivitellobilharzia loxodontae* Vogel and Minning, 1940) were found in 2 elephants (33%) (Fig. 1). No attempt was made to identify the strongylid eggs (other than *Mammomonagamus*) found in 5 of 6 elephants (84%).

Intestinal ciliates were found in all samples (100%), with the most common genera being *Triplumaria* (100%), *Prototapirella* (84%), and *Latteuria* (67%). Species of *Thoracodinium* and *Paraisotricha* were each present in 1 elephant (17%). The 2 most abundant species belonged to the genus *Triplumaria* (Fig. 2), intensities of which ranged from 2 to 3 per microscopic field at ×100. An apparently undescribed species of ciliate was found in 2 samples (33%).

Loxodonta africana cyclotis Matschie, 1900

Digenea

Protofasciola robusta (Lorenz, 1881) Odhner, 1926

(Syn.: *Distomum robustum* Lorenz, 1881)

Temporal distribution: January 2001.

Site of infection: Small intestine.

Type host: Loxodonta africana (Blumenbach, 1797).

Geographic range: Africa: Central African Republic (Lopes et al., 2002; this article), Chad (Poirier, 1909), Congo (van den Berghe, 1943; Dollfus, 1963), Kenya (Round, 1968), Somaliland (Vitovec et al., 1984), South Africa (Basson et al., 1971), Uganda (Dinnik et al., 1963), Zimbabwe (Mettrick, 1962).

Specimens deposited: U.S. National Parasite Collection 92705 (1 vial).

Remarks: This large trematode has been reported from throughout the range of the African elephant. The life cycle of *Pr. robusta* has not been studied but presumably is similar to that of other fasciolid trematodes, in which cercariae emerging from an aquatic snail encyst on vegetation, which is then ingested by the final host.

Nematoda

Quilonia magna Neveu-Lemaire, 1928

Temporal distribution: January 2001.

Site of infection: Cecum.

Type host: Loxodonta africana (Blumenbach, 1797).

Geographic range: Africa: Central African Republic (this article), Congo (Chabaud and Rousselot, 1956), Sudan (Neveu-Lemaire, 1928).

Specimens deposited: U.S. National Parasite Collection 92709 (1 vial).

Remarks: The type locality of this nematode near Loka in southern Sudan is well within the range of the forest elephant (Neveu-Lemaire, 1928). Chabaud and Rousselot (1956) also recorded this species from a forest elephant captured near Brazzaville in the Congo. The life cycle has not been studied.

Quilonia loxodontae Neveu-Lemaire, 1928

Temporal distribution: January 2001.

Site of infection: Cecum, colon.

Type host: Loxodonta africana (Blumenbach, 1797).

Geographic range: Africa: Central African Republic (this article), Congo (Vuylsteke, 1953), Sudan (Neveu-Lemaire, 1928).

Specimens deposited: U.S. National Parasite Collection 92708 (1 vial).

Remarks: The type host of *Qu. loxodontae* is the same host individual as that of *Qu. magna*, and as stated before, the type locality of Loka, Sudan, is well within the range of the forest elephant. The original description was based on 2 females, with the principal differentiating character of 26 petals in the leaf crown, considerably higher than for any other species in the genus. Vuylsteke (1953) reported this species from elephants in the Belgian Congo but again found only females. The males found here are thus the first recorded for the species and will be described elsewhere. The possibility exists that this species is specific to the forest elephant. The life cycle has not been studied.

Quilonia sp.

Temporal distribution: January 2001.

Site of infection: Cecum.

Host: Loxodonta africana cyclotis Matschie, 1900.

Geographic range: Africa: Central African Republic (this article).

Remarks: Several males and females of this species were found in copulo, with the spicule inserted into the vulva and a yellow waxy substance holding them together. There were 38 to 40 petals in the leaf crown compared with 26 petals in *Qu. loxodontae*, previously the highest number of any species in this genus.

Murshidia linstowi Khalil, 1922

(Syn.: *Sclerostomum rectum* Linstow, 1907; *Cylicostomum rectum* [Linstow, 1907] Gedoelst, 1916; *Murshidia recta* [Linstow, 1907] Ihle, 1919; *Murshidia hadia* Khalil, 1922).

Temporal distribution: January 2001.

Site of infection: Colon.

Host: Loxodonta africana (Blumenbach, 1797).

Geographic range: Africa: Cameroon (von Linstow, 1907), Central African Republic (Lopes et al., 2002; this article), Congo (Gedoelst, 1922; Schuurmans-Stekhoven, 1943; van den Berghe, 1943; Vulysteke, 1953; Chabaud and Rousselot, 1956), Liberia (Khalil, 1932), Uganda (Khalil, 1922).

Specimens deposited: U.S. National Parasite Collection 92700 (1 vial).

Remarks: The records of this nematode all fall within the range of the forest elephant. The life cycle has not been studied.

Murshidia vuylstekae Chabaud and Rousellot, 1956

Temporal distribution: January 2001.

Site of infection: Cecum.

Host: Loxodonta africana cyclotis Matschie, 1900.

Geographic range: Africa: Central African Republic (this article), Congo (Chabaud and Rousselot, 1956).

Specimens deposited: U.S. National Parasite Collection 92702 (1 vial).

Remarks: This is the first record of this species since it was described by Chabaud and Rousselot (1956) from a forest elephant captured near Brazzaville in the Congo. The life cycle is unknown.

Decrusia sp.

Temporal distribution: January 2001.

Site of infection: Colon.

Host: Loxodonta africana cyclotis Matschie, 1900.

Geographic range: Africa: Central African Republic (this article).

Specimens deposited: U.S. National Parasite Collection 92706 (1 vial).

Remarks: This is the first record of this genus from Africa. The only known species, *Decrusia additicta* (Railliet, Henry, and Bauche, 1914) (syn.: *Decrusia decrusi* Lane, 1914), was described from the Indian elephant, *Elephas maximus*, in India. Although only females were found in the present study, differences in the number of elements of the leaf crown and the morphology of the teeth in the buccal capsule indicate that this is a previously undescribed species.

Equinurbia sp.

Temporal distribution: January 2001.

Site of infection: Colon.

Host: Loxodonta africana cyclotis Matschie, 1900.

Geographic range: Africa: Central African Republic (this article).

Specimens deposited: U.S. National Parasite Collection 92707 (1 vial).

Remarks: This is the first record of this genus from Africa. The only known species, *Equinurbia sipunculiformis* (Baird, 1859), has been recorded from the Indian elephant in India, Burma, Ceylon, and the Andamans (Yamaguti, 1961). Again, only female nematodes were collected, but differences in the number of elements in the leaf crown indicate that this is also a previously undescribed species.

Parabronema sp.

Temporal distribution: January 2001.

Site of infection: Stomach.

Host: Loxodonta africana cyclotis Matschie, 1900.

Geographic range: Africa: Central African Republic (this article).

Specimens deposited: U.S. National Parasite Collection 92699 (1 vial).

Remarks: A single larva of *Parabronema* was found in the vial with the stomach bots. Three species of this genus have been described from *Lo. africana*: *Parabronema africanum* Baylis, 1921, *Parabronema rhodesiense* Yorke and Maplestone, 1926, and *Parabronema longispiculatum* Graber, 1975.

Leiperenia leiperi Khalil, 1922

Temporal distribution: January 2001.

Site of infection: Cecum.

Type host: Loxodonta africana (Blumenbach, 1797).

Geographic range: Africa: Central African Republic (this article), Congo (Vuylsteke, 1953), Uganda (Khalil, 1922).

Specimens deposited: U.S. National Parasite Collection 92701 (1 vial).

Remarks: Females of *Le. leiperi* are viviparous, so this species of atractid nematode has the capability of multiplying to great numbers within the intestine of its host. The original description by Khalil (1922) lists the host as "African elephant," and the type locality is within the range of *Lo. a. cyclotis*. Chabaud et al. (1989) described a new species, *Leiperenia moreli*, from an African elephant in Zimbabwe, which would have to be *Lo. a. africana*.

Diptera

Cobboldia loxodontis (Brauer, 1897) Roubaud, 1914

(Syn.: *Cobboldia elephantis africani seu loxodontis* Brauer, 1897; *Platycobboldia loxodontis* [Brauer, 1897] Zumpt, 1958; *Cobboldia parumspinosa* Gedoelst, 1915)

Temporal distribution: January 2001.

Site of infection: Stomach.

Type host: Loxodonta africana (Blumenbach, 1797).

Geographic range: Africa: Cameroon (Zumpt, 1965), Central African Republic (Lopes et al., 2002; this article), Congo (Rodhain and Bequaert, 1915), Ghana (Zumpt, 1965), Ivory Coast (Zumpt, 1965), Mozambique (Zumpt, 1965), South Africa (Basson et al., 1971), Tanzania (Zumpt, 1965), Zimbabwe (Condy, 1974).

Specimens deposited: U.S. National Parasite Collection 92703 (1 vial).

Remarks: The adult fly of this species is called the blue elephant stomach bot fly and apparently occurs throughout the range of African elephants and in every subspecies. Larvae of *Co. loxodontis* mature in the stomach and then crawl up to the mouth, where they are ejected when the elephant is feeding. Pupation takes place in the soil, and adult flies hatch

after 2 to 3 wk. The adults are short-lived and lay their eggs at the base of the tusks. All 3 larval stages may be found in the stomach at the same time, and adults appear in all seasons (Zumpt, 1965).

Cobboldia roverei Gedoelst, 1915

(Syn.: *Cobboldia chrysidiformis* Rodhain and Bequaert, 1915, larva only; *Rodhainomyia chrysidiformis* [Rodhain and Bequaert, 1915] Zumpt, 1958, larva only; *Rodhainomyia roverei* [Gedoelst, 1915] Zumpt, 1965)

Temporal distribution: January 2001.

Site of infection: Stomach.

Type host: Loxodonta africana (Blumenbach, 1797).

Geographic range: Africa: Central African Republic (this article), Congo (Gedoelst, 1915; Rodhain and Bequaert, 1915).

Specimens deposited: U.S. National Parasite Collection 92704 (1 vial).

Remarks: The life history of *Co. roverei* has not been studied but is probably similar to that of *Cobboldia loxodontis*. Zumpt and Wetzel (1970) state that the adult flies raised by Rodhain and Bequaert (1915) and named *Co. chrysidiformis*, the green elephant stomach bot fly, do not correspond to the third-stage larvae described by Gedoelst (1915) as *Co. roverei*. Our record is apparently the first since the original decriptions, which were also from the Congo, so the possibility exists that *Co. roverei* is specific to the forest elephant.

DISCUSSION

Although the literature on the parasites of the African elephant is extensive, much of it will have to be reevaluated if, in fact, *Lo. a. cyclotis* is a separate species. Only in a few cases such as Chabaud and Rousselot (1956) is the subspecies *cyclotis* specifically designated. The most extensive survey of internal parasites of *Lo. a. africana* was done by Condy (1974) in Rhodesia (now Zimbabwe). This survey included throat bots, stomach bots, and helminths but not protozoa. Unfortunately, although infections of *Quilonia* spp. and *Murshidia* spp. were ubiquitous, Condy did not attempt to identify them to species because of the confusion in the taxonomic literature, and no voucher specimens were deposited. Basson et al. (1971) examined 32 *Lo. a. africana* from Kruger National Park in South Africa and collected a few parasites but did not do a complete survey.

A large number of helminth genera (e.g., *Bivitellobilharzia*, *Mammomonagamus*, *Quilonia*, *Murshidia*, *Leiperenia*) are shared by African and Indian elephants, but no species are found in both hosts (Bauer and Stoye, 1985). The genera *Decrusia* and *Equinurbia* are monotypic and have been recorded previously only from *Elephas*; it is likely that both species that we found are previously undescribed. Other nematodes found here that could be specific to the forest elephant include *Qu. loxodontae*, *Quilonia* sp., *Murshidia linstowi*, *M. vuylstekae*, and *Le. leiperi*.

African elephants have a complex intestinal ciliate fauna. Eloff and van Hoven (1980) recorded 13 genera and 17 species of ciliates from elephants (presumably *Lo. a. africana*) from South Africa and Zaire. Timoshenko and Imai (1995, 1997) described three new species of *Triplumaria* and 2 species of a new genus, *Latteuria*, from zoo-kept *Lo. africana* in Europe and Russia but did not specify the subspecies of the host. Ours are apparently the first records of *Latteuria* spp. in a wild host. Further studies of our ciliate samples from *Lo. a. cyclotis* may reveal differences from those of Eloff and van Hoven (1980) from savannah elephants. At least 1 species of ciliate found here appears to be undescribed.

Despite the small sample size this study confirms our hypothesis that the endoparasite fauna of the forest elephant is considerably different from the published literature on the savannah elephant. It is especially noteworthy that we have provided the first records of the genera *Decrusia* and *Equinurbia* from African elephants despite the large number of nematode species described from *Lo. africana*. It is possible that these species are specific to *Lo. a. cyclotis*, but more data need to be collected to confirm this. The route by which these genera are common to Asian and African forest elephants, but not to savannah elephants, is unclear; however, it is perhaps not surprising that these species should exist in both genera of extant elephants given that *Elephas* and *Loxodonta* coexisted in Africa for much of their evolutionary history (Shoshani and Tassy, 1996). What is harder to explain is their apparent absence from African savannah elephants, although 2 possibilities seem plausible. First, there is strong evidence for a considerable founder event in savannah elephants (Roca et al., 2001), which may have, simply by chance, eliminated the host populations of these genera from the *Lo. africana* metapopulation. Second, Asian elephants and forest elephants are predominantly

browsers and seasonal frugivores, whereas savannah elephants are more consistently grazers. This could mean that conditions in the gastrointestinal tract are similar in Asian and forest elephants but different in savannah elephants, and these differences may account for the inability of these genera to use savannah elephants as a host.

ACKNOWLEDGMENTS

We thank Veronica Greco for technical help in the laboratory and Eileen Harris for the loan of voucher specimens from the London Museum of Natural History. We thank the governments of the Congo and the C.A.R. for persmission to conduct this study and Save the Elephants and the U.S. Fish and Wildlife Service for funding.

LITERATURE CITED

Barriel, V., E. Thuet, and P. Tassy. 1999. Molecular phylogeny of Elephantidae. Extreme divergence of the extant forest African elephant. Comptes Rendus de l'Academie des Sciences. Serie III, Science de la Vie 322:447–454.

Basson, P. A., R. M. McCully, V. deVos, E. Young, and S. P. Kruger. 1971. Some parasitic and other natural diseases of the African elephant in the Kruger National Park. Onderstepoort Journal of Veterinary Research 38: 239–254.

Bauer, V. C., and M. Stoye. 1985. Endoparasiten beim afrikanischen un asiatischen Elefanten. Praktische Tierarztlichen 1:56–60.

Blake, S. 2002. The ecology of forest elephant distribution and its implications for conservation. Ph.D. Thesis, University of Edinburgh, Scotland, U.K. 329 pp.

Blake, S., I. Douglas-Hamilton, and W. B. Karesh. 2001. GPS telemetry of forest elephants in Central Africa: results of a preliminary study. African Journal of Ecology 39:178–186.

Chabaud, A. G., D. Cuisance, and F. Colas. 1989. *Leiperenia moreli* n. sp. (Nematoda: Atractidae) parasite de l'éléphant d'Afrique. Systematic Parasitology 14:135–140.

Chabaud, A. G., and R. Rousselot. 1956. Nématodes parasites d'un éléphant du moyen Congo. Annales de Parasitologie 31:579–597.

Condy, J. B. 1974. Observations on internal parasites in Rhodesian elephant, *Loxodonta africana* Blumenbach 1797. Proceedings and Transactions of the Rhodesia Scientific Association 55:67–99.

Dinnik, J. A., J. B. Walker, S. F. Barnett, and D. W. Brocklesby. 1963. Some parasites obtained from game animals in western Uganda. Bulletin of Epizootic Diseases of Africa 11:37–44.

Dollfus, R. P. 1963. Hôtes et lieux de récolté de quelques trématodes digénétiques de vertébrés de la collection du Musée royal de l'Afrique centrale. Revue de Zoologie et de Botanique Africaines 68:323–357.

Eloff, A. K., and W. van Hoven. 1980. Intestinal protozoa of the African elephant *Loxodonta africana* (Blumenbach). South African Journal of Zoology 15: 83–90.

Gedoelst, L. 1915. Notes sue les Oestrides. Revue Zoologique Africaine 4:144–161.

Gedoelst, L. 1922. Quelques nematodes parasites de léléphant Africain. Bulletin de la Société de Pathologie Exotique 15:122–127.

Khalil, M. 1922. A preliminary note on some new nematode parasites from the elephant. Annals and Magazine of Natural History, Series 9, 9:212–215.

Khalil, M. B. 1932. Parasites from Liberia and French Guinea. First part: Nematoda. Zeitschrift fur Parasitenkunde 4:431–458.

Laursen, L., and M. Bekoff. 1978. *Loxodonta africana*. Mammalian Species 92:1–8.

Lopes, A., F. Rosa, and M. L. Ferreira. 2002. Contribuicao para o conhecimento dos parasitas de animais silvestres da Republica Centro-Africana. Garcia de Orta Serie de Zoologia 24:75–79.

Mettrick, D. F. 1962. Some trematodes and cestodes from mammals of Central Africa. Revista de Biologia, Lisbon 3:149–170.

Neveu-Lemaire, M. 1928. Strongylidés nouveaux du genre *Quilonia* chez l'éléphant d'Afrique. Annales de Parasitologie 6:186–192.

Poirier, J. 1909. Trématodes parasites de l'éléphant d'Afrique. Association Française pour l'Avancement des Sciences, Comptes-Rendus, Paris 908:580–582.

Roca, A. L., N. Georgiadis, J. Pecon-Slattery, and S. J. O'Brien. 2001. Genetic evidence for two species of elephant in Africa. Science 293:1472–1477.

Rodhain, J., and J. Bequaert. 1915. Sur quelques Oestrides (3° communication préliminaire). Bulletin de la Société de Pathologie Exotique 8:765–778.

Round, M. C. 1968. Checklist of the Helminth Parasites of African Mammals. Commonwealth Agricultural Bureaux, Farnham Royal, Bucks, U.K. 252 pp.

Schuurmans-Stekhoven, J. H. 1943. Parasitic nematodes from the Belgian Congo. Bulletin du Musée Royal d'Histoire naturelle de Belgique 19:1–20.

Shoshani, J., and P. Tassy. 1996. The Proboscidea: Evolution and Paleoecology of Elephants and Their Relatives. Oxford University Press, Oxford, U.K. 502 pp.

Timoshenko, O., and S. Imai. 1995. Eleven new ciliate species of the genus *Triplumaria* (Ciliophora, Entodiniomorphida) from Asian elephant, *Elephas maximus*, and African elephant, *Loxodonta africana*. Journal of Protozoology Research 5:157–175.

Timoshenko, O., and S. Imai. 1997. Three new intestinal protozoan species of the genus *Latteuria* n.g. (Ciliophora: Trichostomatia) from Asian and African elephants. Parasitology International 46:297–303.

van den Berghe, L. 1943. Enquête parasitologique. II. Helminthes parasites. Exploration de Parc National Albert, Mission van den Berghe, Brussels 2:1–30.

van der Westhuysen, O. P. 1938. A monograph of the helminth parasites of the elephant. Onderstepoort Journal of Veterinary Science and Animal Industry 10:49–190.

Vitovec, J., B. Kotrla, H. Haji, and L. B. Hayles. 1984. Fatal infection of an elephant calf caused by the trematode *Protofasciola robusta* (Lorenz, 1881) in

Somaliland. Zentralblatt fur Veterinarmedizin B 31: 597–602.

von Linstow, O. F. B. 1907. Nematoden aus dem Königlichen Zoologischen Museum in Berlin. Mitteilungen aus dem Zoologischen Museum, Berlin 3:251–259.

Vuylsteke, C. 1953. Notes sur les nématodes parasites de l'éléphant d'Afrique. Revue de Zoologie et de Botanique Africaines 48:212–239.

Yamaguti, S. 1961. Systema Helminthum. Vol. III. Nematoda. Interscience Publishers, New York. 1261 pp.

Zumpt, F. 1965. Myiasis in Man and Animals in the Old World. Butterworths Publishing, London, U.K. 267 pp.

Zumpt, F., and H. Wetzel. 1970. Fly parasites (Diptera: Oestridae and Gasterophilidae) of the African elephant *Loxodonta africana* (Blumenbach) and their problems. Koedoe 13:109–121.