

***Dermacentor rhinocerus* (Denny 1843) (Acari: Ixodida: Ixodidae): redescription of the male, female and nymph and first description of the larva**

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ABSTRACT

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Presented is a diagnosis of the male, female and nymph of *Dermacentor rhinocerus*, and the 1st description of the larval stage. Adult *Dermacentor rhinocerus* parasitize both the black rhinoceros, *Diceros bicornis*, and the white rhinoceros, *Ceratotherium simum*. Although various other large mammals have been recorded as hosts for *D. rhinocerus*, only the 2 species of rhinoceros are primary hosts for adults in various areas of east, central and southern Africa.

Adults collected from vegetation in the Kruger National Park, Transvaal, South Africa were reared on rabbits at the Onderstepoort Veterinary Institute, where larvae were obtained for the 1st time.

INTRODUCTION

Although the genus *Dermacentor* is represented throughout the world by approximately 30 species, only 2 occur in the Afrotropical region. These are *D. circumguttatus* Neumann, 1897, whose adults parasitize elephants, and *D. rhinocerus* (Denny, 1843), whose adults parasitize both the black or hook-lipped rhinoceros, *Diceros bicornis* (Linnaeus, 1758), and the white or square-lipped rhinoceros, *Ceratotherium simum* (Burchell, 1817). The latter tick was described by Denny (1843) from a male specimen collected from a black rhinoceros in South Africa. The nymph was first described by Clifford & Anastos (1964).

In the past, many authors attached the specific name *rhinocerotis* De Geer, 1778 to this *Dermacentor* species. However, the name *rhinocerotis* be-

longs to the rhinoceros tick with the binomen *Amblyomma rhinocerotis* (De Geer, 1778).

Schulze (1932) erected the genus *Amblyocentor* for *D. rhinocerus*. Present day workers have ignored this genus since it is morphologically unnecessary, but a few have relegated *Amblyocentor* to a subgenus of *Dermacentor*.

Two subspecific names have been attached to *D. rhinocerus*. Neumann (1910) erected *D. rhinocerus permaculatus* for a few male specimens exhibiting partially or completely fused ornamented spots resembling a female scutum. Estrada-Peña (1992) regards this "as a junior synonym of the nominal subspecies". Lewis (1934) found a male specimen he called *D. rhinocerus arangis*. However, in a footnote attached to the subspecific name he stated, "After examining the specimens of *D. rhinocerotis* (sic) at the Molteno Institute, Cambridge, it has been found that this specimen is merely an atypical example of *D. rhinocerotis*."

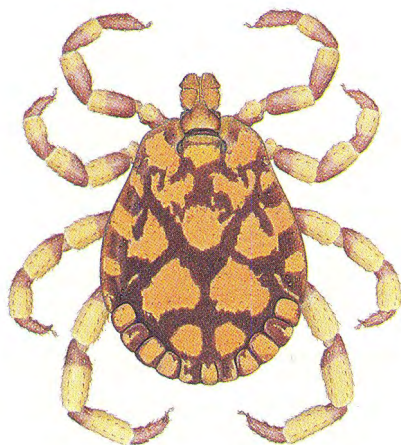
Presented here is a diagnosis of the male, female and nymph, a description of the larva for the 1st time, and host and distribution data for this tick species. Considering the current threatened status of its hosts, *D. rhinocerinus* may soon become another member of the world's extinct fauna.

Measurements given in the description indicate the greatest length × greatest width to the shortest length × narrowest width of the specimens seen.

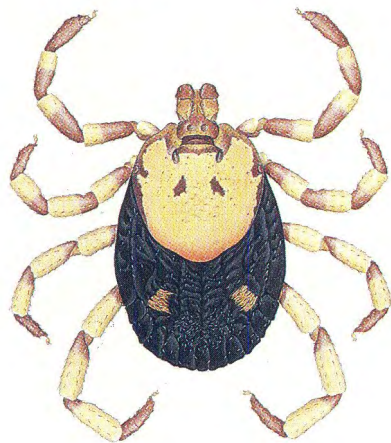
DIAGNOSIS

Male (Fig. 1)

A large tick. Basis capituli rectangular with concave posterior margin, cornua small; palps longer than basis capituli. Eyes flat. Scutum elongate, smooth with few large punctations, background colour chocolate brown; ornamentation typically 4 pairs of ivory patches laterally and 1 patch anteriorly posterior to cervical pits, 2 lateral patches usually present marginally; festoons 1, 3, 4, and 6 usually ornamented. Legs increasing in size from I–IV, segments with distal ornate bands; coxa I with 2 broadly divided, stout triangular spurs.



1



2

FIG. 1–2 *Dermacentor rhinocerinus* (1) male (RML120151), dorsal view; (2) Female (RML120151), dorsal view; A. Olwage del.

Female (Fig. 2)

A large, broad, ovate tick; alloscutum colour dark brown to black with patches of short, dense, reddish-brown setae. Basis capituli rectangular, posterior margin straight, cornua present, short; palps short, broad. Eyes flat. Scutum smooth, broadly cordiform, as long as broad or slightly longer than broad; entirely covered with ivory ornamentation except for brown around cervical pits and eyes, and extending marginally anteriorly to scapulae and posteriorly along scutal edge.

Nymph (Fig. 3–6)

Large, c. 1,15 mm long, 0,75 mm broad; posterior portion of alloscutum covered with long thick setae. Basis capituli (Fig. 3) with cornua absent, anterolateral and posterolateral angles slightly concave; basis capituli ventrally (Fig. 4) with 2 long sharp spurs (note that 1 of the spurs in Fig. 4 is broken); palps constricted basally, widening apically; hypostomal dentition 3/3. Scutum (Fig. 5) with cervical pits deep, internal cervical margins extending almost to scutal margin, external cervical margins parallel to scutal margin. Coxa I (Fig. 6) with 2 subequal triangular spurs.

DESCRIPTION

Larva (Fig. 7–10)

CAPITULUM (Fig. 7, 8) about as broad as long, the length × breadth varying from 0,179 × 0,191 to 0,152 × 0,187 mm.

BASIS CAPITULI (Fig. 7). Length (from base of cheliceral sheaths to posterior margin of basis) × breadth varying from 0,062 × 0,191 to 0,043 × 0,187 mm; dorsally with posterior margin straight then curving anterolaterally over the scapular area of scutum. Ventrally (Fig. 8) without cornua; posthypostomal setae 1 pair; hypostome broadly rounded apically, length varying from 0,070 to 0,066 mm; dentition 2/2 throughout length with c. 5 denticles in each file.

PALPS broad throughout length; length × breadth varying from 0,117 × 0,047 to 0,109 × 0,043 mm; suture between articles II and III indistinct. Palpal article III ventrally with hook-like process apically at junction with article IV.

BODY ovoid, broadest posterior to coxa III. Length (from scapular apices to posterior body margin) × breadth varying from 0,644 × 0,554 to 0,612 × 0,427 mm. Dorsal body setae number 10 pairs; 2 pairs central dorsals and 8 pairs marginal dorsals. Ventral setae number 14 plus 1 pair on anal valves; 3 pairs sternals, 2 pairs preanals, 4 pairs premarginals, 5 pairs marginal ventrals.

SCUTUM (Fig. 9). Length × breadth varying from 0,265 × 0,464 to 0,241 × 0,429 mm; setae minute, 3

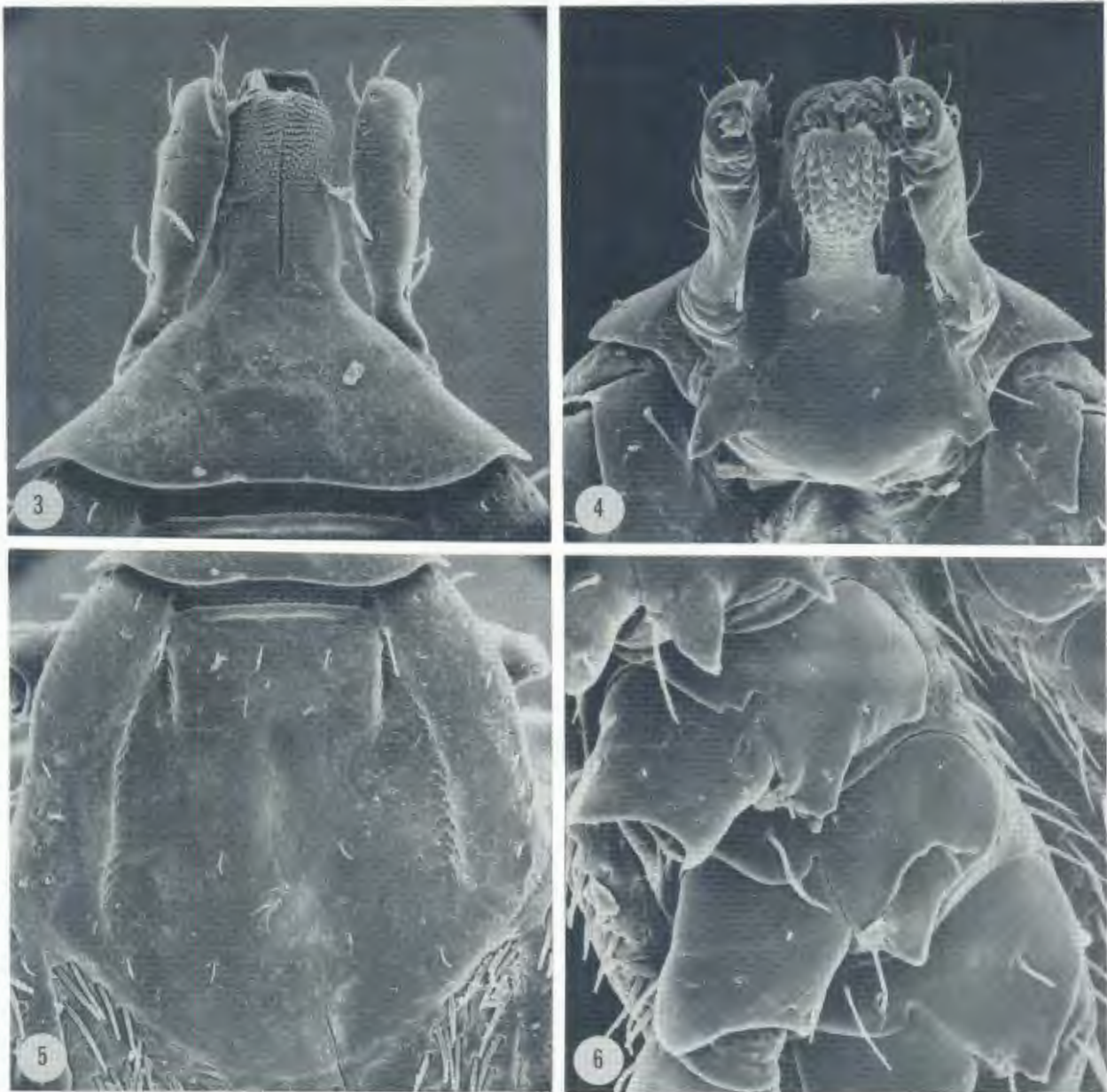


FIG. 3-6 *Dermacentor rhinocerus* nymph (RML37444), (3) capitulum, dorsal view (210 ×); (4) capitulum, ventral view (420 ×); (5) scutum (147 ×); (6) coxae I-IV (420 ×)

pairs; anterior borders smoothly curved, posterior border a smooth shallow curve; cervical pits short, posteriorly directed; eyes at posterolateral angles, relatively large, flat.

Ventral surface

LEGS (Fig. 10). Coxa I with moderately large, triangular internal spur, external spur absent; coxa II and III lacking internal spurs, but each with small triangular external spur. Coxal setae, 3 on I, 2 on II and on III. Tarsus I length × breadth varying from 0,215 × 0,074 to 0,191 × 0,059 mm.

HOSTS

The 2 principal hosts of *D. rhinocerus* are the black rhinoceros, *Diceros bicornis*, and the white or square-lipped rhinoceros, *Ceratotherium simum*. Other recorded hosts include domestic cattle, sheep, donkey, jackal, elephant (*Loxodonta africana*), buffalo (*Syncerus caffer*) and eland (*Taurotragus oryx*) (Arthur 1960). Theiler (1962) cited additional collections from a monitor lizard (*Varanus* sp.), and roan antelope (*Hippotragus equinus*), and 1 collection has been seen from an impala

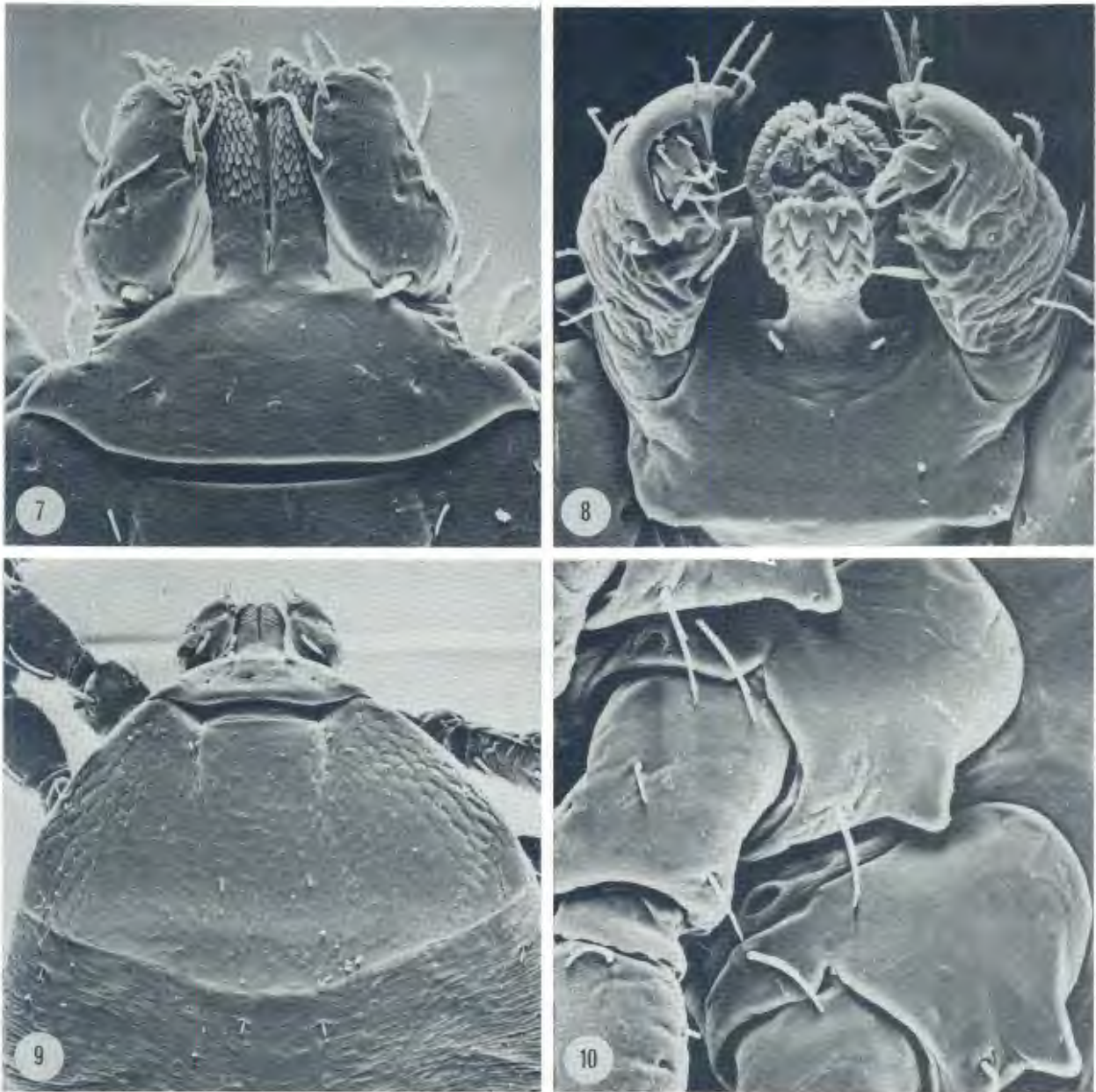


FIG. 7–10 *Dermacentor rhinocerus* larva (RML120151), (7) capitulum, dorsal view (448 ×); (8) capitulum, ventral view (569 ×); (9) scutum (193 ×); (10) coxae I–III (553 ×)

(*Aepyceros melampus*). As Walker (1991) pointed out, though, none of these animals are thought to be significant hosts for maintaining the life cycle of *D. rhinocerus*.

Clifford & Anastos (1964) recorded nymphal *D. rhinocerus* from rodent nests at Garamba National Park in the northeast quadrant of Zaire, indicating that rodents may play an important part in the life cycle of this tick.

DISTRIBUTION

Dermacentor rhinocerus is found within the distribution ranges of the black and white rhinoceros.

Populations of these species have been drastically reduced due to poaching over the past several years. Consequently, the list of countries where it has been recorded (drawn from literature citations) is problematic, and it is by no means certain that these countries represent the present-day distribution of this tick.

For example, between 1980 and 1990, throughout the entire continent of Africa the number of black rhinoceros fell from c. 14 800–c. 3 400 and the animal has become extinct in large parts of its former range. During the same period the southern subspecies of the white rhinoceros (*C. simum simum*),

has actually increased in numbers from $\pm 3\,850$ – $4\,750$, due to an intense conservation effort in South Africa. Nevertheless, the northern subspecies of the white rhinoceros (*C. simum cottoni*) has become extinct in the Central African Republic and the southern subspecies in Mozambique. The northern subspecies exists in the wild only in Garamba National Park, Zaire, where there are 15 ♂♂ and 13 ♀♀ (Zoological Society of San Diego 1991).

Countries from which *D. rhinocerinus* has been collected in the past are Abyssinia (=Ethiopia) (Warburton 1910); Italian Somaliland (=Somalia) (Pavesi 1895); Eritrea (=northern Ethiopia) (Stella 1940); Sudan (King 1911); Belgian Congo (=Zaire) (Nuttall & Warburton 1916); British East Africa (=Kenya) (Neumann 1912); Tanganyika (=Tanzania) (Gerstäcker 1873); Uganda (Neave 1912); Nyasaland (=Malawi) (Old 1909); Northern Rhodesia (=Zambia) (Hoogstraal 1954); Southern Rhodesia (=Zimbabwe) (Jack 1942); Angola (Karsch 1878); Mozambique (Neumann 1897); and South Africa (Denny 1843).

The distribution of *D. rhinocerinus* throughout its range was reviewed by Theiler (1962). Its distribution in the following countries has also been mapped subsequently: Uganda (Matthysse & Colbo 1987); Kenya (Walker 1974); Tanzania (Yeoman & Walker 1967); Zaire (Elbl & Anastos 1966), and Zimbabwe (Norval & Colborne 1985).

Santos Dias (1954) recorded *D. rhinocerinus* from Ruanda-Urundi (=Rwanda and Burundi). Hoogstraal (1956) cited Theiler (in litt.) indicating that this record was in error and both Theiler (1962) and Elbl & Anastos (1966) disregard it.

D. rhinocerinus has been listed as a tick that may be found in Cameroon (Morel & Mouchet 1958), and it has been recorded extraliminally in Madagascar (Brygoo 1963).

MATERIAL EXAMINED

Dermacentor rhinocerinus

(Total examined = 481 ♂♂, 231 ♀♀, 24 nymphs, 7 larvae)

[NHM] = The Natural History Museum, London; [OP] = Onderstepoort Veterinary Institute, Onderstepoort; [UP] = Parasitology Department, Veterinary Faculty, University of Pretoria, Onderstepoort; [JBW] = J. B. Walker's collection; [NTC] = U. S. National Tick Collection, Georgia Southern University, Statesboro.

SUDAN

(Total = 9 ♂♂, 5 ♀♀)

RML89367 [HH32107]. Off vegetation, Bahr el Ghazal (07°46'N, 27°40'E), 23 November 1955, 1 ♂, 1 ♀ [NTC].

RML89368 [HH33018]. Off vegetation, Torit (04°08'N, 32°17'E), Magwe, Equatoria Province, 3 February 1957, 1 ♂, 1 ♀ [NTC].

RML89370 [HH33020]. Off vegetation, Juba (05°12'N, 31°46'E), Mongalla, Equatoria Province, May 1911, H. H. King, 1 ♂, 1 ♀ [NTC].

RML89371 [HH33022]. Off vegetation, near Yirol (06°33'N, 30°30'E), Bahr el Ghazal, 9 June 1954, P. Beasdale, 1 ♀ [NTC].

RML89372 [HH33022]. Off vegetation, 40.3 km west of Yirol, Bahr el Ghazal, 23 November 1955, B. Benson, 3 ♂♂ [NTC].

RML105833 [Nuttall 29b]. Ex *Diceros bicornis* (probably), Nimule (03°36'N, 32°03'E), Equatoria Province, (on Sudan-Uganda border), 22 March 1906, Dr W. A. Densham, 2 ♂♂, 1 ♀ [NHM].

RML109777 [Nuttall 829]. Off vegetation, Azzar, 29 July 1909, H. H. King, 1 ♂ [NHM].

UGANDA

(Total = 104 ♂♂, 28 ♀♀)

1928.4.20.67. 1/2 mile from R. Aswa (Rt. bank), 6.4 km from White Nile, where elephants are accustomed to come for shade, 8 March 1926 (No. 23), Capt. C. R. S. Pitman, 1 ♀ [NHM].

MZI/2. *Diceros bicornis*, Maruzi [= Maruzi County (01°50'N, 32°25'E)], April 1955, Virus Res. Inst., Uganda, 5 ♂♂, 2 ♀♀ [NHM].

MZI/3. Same as immediately above except 7 ♂♂, 6 ♀♀ [NHM].

MZI/5. Same as immediately above except 6 ♂♂ [NHM].

MZI/6. Same as immediately above except 9 ♂♂, 4 ♀♀ [NHM].

MZI/8. Same as immediately above except 19 ♂♂, 2 ♀♀ [NHM].

MZI/10. Same as immediately above except 5 ♂♂, 1 ♀ [NHM].

MZI/11. Same as immediately above except 11 ♂♂, 2 ♀♀ [NHM].

2683i. Rhinoceros, Lango District, 4 May 1910. 1 ♂, 2 ♀♀ [OP].

RML50565. Ex rhinoceros, Lango District, 4 May 1910. 1 ♂ [NTC] [Undoubtedly RML50565 is part of OP2683i].

RML109866 [Nuttall 941a]. Off long grass, 2 days journey from Bussu Meros County, sent 8 October 1909 by Dr H. Bayon, 2 ♂♂, 4 ♀♀ [NHM].

- RML110250 [Nuttall 1440]. Ex either *Diceros bicornis* or *Ceratotherium simum*, Lango District, July 1911, Dr McConnell, 4 ♂♂, 3 ♀♀ [NHM].
- RML110667 [Nuttall 1722]. Host unknown, 9.7 km east of Palango (01°54'N, 32°22'E), Lango District, 10 January 1912, S.A. Neave, 5 ♂♂ [NHM].
- RML111864 [Nuttall 2973]. Host unknown, 1909, Dr H. Bayon, 2 ♂♂ [NHM].
- RML113283 [Nuttall 3911]. Off grass, Maruzi County, Lango District, 30 December 1932, R. W. Mettam, 3 ♂♂, 1 ♀ [NHM].
- No number. Off ground, Moyo (03°39'N, 31°43'E), north-west Uganda, March 1956, R. Bloom, 1 ♂ [JBW].
- No number. Ex white rhinoceros, Moyo, north-west Uganda, April 1956, R. Bloom, 4 ♂♂ [JBW].
- No number. Ex white rhinoceros, north-east Uganda, 6 May 1955, S. F. Barnett, 10 ♂♂ [JBW].
- No number. Ex white rhinoceros, Lomunga, just south of Dingbulungbulu River (03°26'N, 31°38'E), 25 June 1964, I.S.C. Parker, 9 ♂♂ [JBW].
- KENYA
- (Total = 60 ♂♂, 21 ♀♀)
- 1890.3.15.13. Host?, Mombasa (04°03'S, 39°40'E), Grose Smith, 1 ♂ [L. G. Neumann det.] [NHM].
- 1899.7.31.13–15 (part). Host?, C.S. Betton, 1 ♂ [S. Hirst det.] [NHM].
- 1911.12.9.1–320 (part). Host?, Voi (03°23'S, 38°34'E), R. Kemp, 1 ♀ [NHM].
- 1914.4.14.28–31. Rhino, Loita Plains (01°15'S, 35°35'E), 5500 ft., Woosnam, 3 ♂♂, 1 ♀ [NHM].
- 1934.2.15.114. Host?, Suk Plains (01°34'N, 35°37'E), [the words Lake Rudolf and Uganda are also on the label, but this collection almost certainly is from Kenya], E.B. Worthington, Cambridge Expedition to East African Lakes, 1931, 1 ♂ [NHM].
- No number. Host?, Voi, January–July 1897, 1 ♂ [NHM].
- No number. Rhino, Guaso Nyiria (Nyrio on card) (=Ewaso Ngiro. There are 2 rivers with this name, one in the Eastern Province, and another in the Rift Valley Province, Kenya), 22 January 1911, R. Kemp, 10 ♂♂, 1 ♀ [NHM]. Arthur (1960) stated that the host was a hippopotamus, but the vial label clearly reads "rhino".
- No number, [Label is from Veterinary Laboratory, Kabete, No. D.R. 1]. On sofa, Nairobi, 28 May 1931, 1 ♂ [J.B. Walker det.] [NHM].
- No number, [Label is from Veterinary Laboratory, Kabete, No. D.R. 4]. Rhinoceros, Taveta (03°24'S, 37°41'E), 28 October 1931, E.A. Lewis, 1 ♂, 1 ♀ [J.B. Walker det.] [NHM].
- No number, [Label is from Veterinary Laboratory, Kabete, No. D.R. 6]. Rhinoceros (on head), Ziawanie (=Ziwani) (03°23'S, 37°47'E), 21 November 1931, Mr Guy Runton, 9 ♂♂, 1 ♀ [J.B. Walker det.] [NHM].
- No number. Grass, Embu (00°32'S, 37°27'E), from Dr E.A. Lewis, 1 ♂, 2 ♀♀ [NHM]. [There is also a runt ♂ of *Rhipicephalus pulchellus* in this collection—JEK].
- RML33938. Off grass, Mambui (03°07'S, 40°09'E), 1945, from Alex Wiley, 4 ♂♂, 4 ♀♀ [NTC].
- RML57159 [Bishop 35826]. Ex rhinoceros skin, Talek [probably Talek hill (01°23'S, 35°18'E) near the Talek River], 12 June 1948, 2 ♀♀ [NTC].
- RML90790 [HH33014]. Ex *Diceros bicornis*, Embu, Eastern Prov., 5 January 1935, B. Benson, 3 ♂♂ [NTC].
- RML90791 [HH33015]. On ground, Taita, 17.7 km south, Makiow, Coast Province, 11 February 1957, E. S. Ross & R. E. Leach, 1 ♂ [NTC].
- RML90792 [HH33016]. Ex *Diceros bicornis*, Embu, Eastern Province, October 1949, G. Walton, 4 ♂♂ [NTC].
- RML90793 [HH32125]. Ex *Diceros bicornis*, Taita (c. 03°25'S, 38°20'E), Tsavo Park, Coast Province, March 1964, J. B. Foster, 4 ♂♂, 2 ♀♀ [NTC].
- RML120155 [HH77759]. Host unknown, Isiolo (00°21'N, 37°35'E), 22 February 1935, B. Benson, 1 ♂ [NTC].
- RML66590 [Nuttall 3215i]. Ex *Diceros bicornis*, Mombasa or Makindu, British East Africa (Kenya), 27 January 1916, sent by J. O. Shircore, collected by himself or friends, 1 ♂ [NHM].
- RML104827 [Nuttall 251]. Ex *Diceros bicornis* (probably), Kenya (probably), P. H. Ross & Mr Simpson, 3 ♂♂ [NHM].
- RML110163 [Nuttall 1332]. Off grasses, Makindu (02°17'S, 37°49'E), British East Africa (Kenya), 5–7 April 1911, S. A. Neave, 2 ♀♀ [NHM].
- RML110168 [Nuttall 1337]. Off grasses, Mtito Andei (02°41'S, 38°10'E), British East Africa (Kenya), 27 March 1911, S. A. Neave, 1 ♂, 1 ♀ [NHM].
- RML110692 [Nuttall 1751]. Off grass, Magadi Railway between Magadi and Konza, British East Africa (Kenya), January 1912, C. W. Woodhouse, 1 ♂, 2 ♀♀ [NHM].

No number. Ex rhinoceros, east Tana, 27 November 1951, J. Williams, 3 ♂♂ [JBW].

No number. Ex rhinoceros, Makueni (01°48'S, 37°37'E), July 1950, S. G. Wilson, 3 ♂♂ [JBW].

No number. Off grass on bank of Egalok River (01°32'S, 35°02'E), Mara, 16 September 1960, D. W. Brocklesby, 1 ♂ [JBW].

No number. Off grass, Lali (03°00'S, 39°15'E), Galana Game Management Scheme, 1963, I. S. C. Parker, 1 ♀ [JBW].

No number. Ex black rhinoceros, Mazinga Hill (03°22'S, 38°36'E), Voi, 4 June 1964, D. L. W. Sheldrick, 1 ♂ [JBW].

TANZANIA

(Total = 48 ♂♂, 13 ♀♀)

1976.12.13.17. Off grass, Ruaha National Park, January 1970, M. A. Peirce, 1 ♂, 2 ♀♀ [NHM].

RML120154 [HH33023]. Host unknown, 1952, 1 ♀ [NTC].

RML111686 [Nuttall 2784]. Host unknown, Karagwe District (01°30'S, 31°00'E), 3 January 1912, Dr Neubert, 2 ♂♂ [NHM].

W/WA/6. Ex *Diceros bicornis*, near Mto-wa-Mbu (03°22'S, 35°52'E), 14 April 1952, A. C. Brooks, 5 ♂♂ [JBW].

W/WA/65. Ex *Diceros bicornis*, Sanya Juu (03°10'S, 37°00'E), 9 April 1953, A. C. Brooks, 4 ♂♂ [JBW].

W/WA/81. Ex *Diceros bicornis*, Manyoni (05°45'S, 34°51'E), no date, S. M. Moore-Gilbert, 6 ♂♂, 1 ♀ [JBW].

W/WA/143. Free on car, Kwakuchinja (03°41'S, 35°53'E), 13 March 1958, G. H. Swynnerton, 1 ♂ [JBW].

W/WA/173. Ex *Diceros bicornis*, Lake Manyara National Park (03°30'S, 35°50'E), 1961, George Kinoti *et al.*, 5 ♂♂ [JBW].

W/WA/175. Off ground in vicinity of camp, Lake Manyara National Park, 1961, George Kinoti *et al.*, 1 ♀ [JBW].

WA/70. Ex *Diceros bicornis*, Sina Plains (01°17'S, 30°40'E), Kaisho, Karagwe, 31 March 1959, Mrs G. Tullock, originally 20 ♂♂, 2 ♀♀ of which 6 ♂♂, 2 ♀♀ were removed by G. H. Yeoman [NHM].

WA/73. Free on ground, Lake Burigi area (02°00'S, 31°10'E), 26 February 1959, Mrs G. Tullock, 2 ♂♂, 3 ♀♀ [NHM].

No number. Ex rhinoceros, Uhambingeto (07°33'S, 35°54'E), Iringa District, April 1953, S. M. Moore-Gilbert, 1 ♂, 1 ♀ [JBW].

No number. Ex impala, Naberera (04°12'S, 36°56'E), Masailand, December 1959, F. J. W. Hampshire, 1 ♀ [JBW].

No number. From grass under trees, 16 miles east-north-east of Kolo (04°39'S, 36°04'E), near Kondo, Central Province, January 1962, E. Gorton, 1 ♂, 1 ♀ [JBW].

ZAIRE

(Total examined = 41 ♂♂, 37 ♀♀, 19 nymphs)

RML18492 [Bequaert 256]. Ex rhinoceros, Faradje (03°44'N, 29°43'E), 19 March 1911, 5 ♂♂, 1 ♀ [NTC].

RML120152. Ex rhinoceros, Faradje, March 1911, Lang and Chapin Exped., 5 ♂♂, 5 ♀♀ [NTC]. [Bequaert (1930) stated that he saw numerous ♂♂ and ♀♀ of *D. rhinocerinus* in 4 lots off *Ceratotherium simum cottoni* at Faradje (03°44'N, 29°43'E) collected by the Lang and Chapin Expedition during March and April, 1911].

RML36779. Off vegetation, Garamba Park (04°10'N, 29°30'E), 27 May 1952, H. D. Saeger, 10 ♂♂, 10 ♀♀, [2 ♂♂, 2 ♀♀ retained in NTC].

RML37398. Off vegetation, Garamba Park, 23 March 1951, H. D. Saeger, 96 ♂♂, 89 ♀♀ [20 ♂♂, 20 ♀♀ retained in NTC].

RML37399. Off vegetation, Ndelele, 6 May 1952, H. D. Saeger, 34 ♂♂, 48 ♀♀ [9 ♂♂, 9 ♀♀ retained in NTC].

RML37400. From abandoned rodent burrows, Garamba Park, 29 January 1952, J. Verschuren, 1 ♂, 1 ♀, 10 nymphs [6 nymphs retained in NTC].

RML37442. From rodent nests, Garamba Park, 15 January 1951, J. Verschuren, 5 nymphs [NTC].

RML37443. From rodent nests, Garamba Park, 14 February 1951, J. Verschuren, 1 ♂, 3 nymphs [2 nymphs retained in NTC].

RML37444. From rodent nests, Garamba Park, 27 December 1950, J. Verschuren, 12 nymphs [6 nymphs retained in NTC].

MALAWI

(Total = 18 ♂♂, 11 ♀♀)

1908.1.5.63-66. Host?, J. E. S. Old, 2 ♂♂, 1 ♀ [NHM].

RML18495 [Nuttall 563]. Ex rhinoceros, 1907, 1 ♂ [NTC].

RML104866 [Nuttall 320a]. Host unknown, North Nyasa, March 1907, Dr J. E. S. Old, 1 ♂, 1 ♀ [NHM].

RML109933 [Nuttall 1029]. Off grass and leaves, Vua Road, Chilumba (10°27'S, 34°16'E), 13 May 1909, Dr J. B. Davey, 2 ♂♂ [NHM].

RML109973 [Nuttall 1087]. Ex *Diceros* sp., Vua Road, Chilumba, 2 November 1909, Dr J. B. Davey, 2 ♂♂ [NHM].

RML109983 [Nuttall 1097]. Off grass and leaves, Vua Road, Chilumba, 1909, Dr J. B. Davey, 2 ♂♂, 1 ♀ [NHM].

RML110087 [Nuttall 1231]. Ex *Diceros bicornis*, Mpele River, Marimba District, 2 July 1910, Dr E. H. A. Pask, 1 ♂, 1 ♀ [NHM].

RML 110152 [Nuttall 1320]. Host unknown, ? 1910, Dr J. E. S. Old, 1 ♂, 2 ♀♀ [NHM].

RML110170 [Nuttall 1324]. Off grasses, Ngara (10°14'S, 34°07'E), Koronga District, 4 January 1911, Dr J. E. S. Old, 4 ♂♂, 3 ♀♀ [NHM].

RML110171 [Nuttall 1343]. Off grasses (rhinoceros seen nearby), Mpalale, 3 January 1911, Dr J. E. S. Old, 2 ♂♂, 2 ♀♀ [NHM].

ZAMBIA

RML113238 [Nuttall 3856]. Ex *Diceros bicornis*, received 6 July 1932, H. S. Purchase, 1 ♂ [NHM].

ZIMBABWE

(Total=14 ♂♂, 6 ♀♀)

1932.11.14.21. Host?, Matabeleland, B.M. 1926–466, J. S. Jameson, 1 ♀ [NHM].

2462v. Rhinoceros, Mofong busi, November 1924, Dr Mackenzie, from Salisbury Museum, 1 ♂, 1 ♀ [OP].

2580ii. *Diceros bicornis*, Capt. Taylor, 5 ♂♂ [OP].

2683v. Rhinoceros, Sebungwe [probably Sebungwe stream (17°52'S, 27°12'E)], 6 October 1952, Reay Smithers, 1 ♂ [OP].

No Number. *Diceros bicornis*, Benga area [probably Benga stream area (16°42'S, 30°23'E)], 28 July 1970, H. J. Herbert, 2 ♂♂ [OP].

RML50563. Ex rhinoceros, Urunowe, November 1938, 3 ♂♂, 3 ♀♀ [NTC].

RML118420. Ex *Diceros bicornis*, Rukomechie (16°14'S, 29°30'E), 15 June 1986, R. du Toit, 1 ♂, 1 ♀ [NTC].

RML120019. Ex *Diceros bicornis*, Chete Wildlife Area (17°20'S, 27°48'E), 3 October 1990, C. E. Yunker, 1 ♂ [NTC].

MOZAMBIQUE

(Total=8 ♂♂, 3 ♀♀)

1933.8.25.9–13. Ex rhinoceros, near Mocuba (16°51'S, 36°56'E) 1650 ft, 19 January 1932, 3 ♂♂, 1 ♀ [NHM].

RML120153. Ex rhinoceros, Porte Amelia (12°57'S, 40°30'E), October 1912, Liverpool Sch. Trop. Med., 5 ♂♂, 2 ♀♀ [NTC].

NAMIBIA

2683iii. *Ceratotherium simum*, Grootfontein (19°34'S, 18°07'E), 4 August 1933, Government Veterinary Officer, Bedford's dry collection, 1 ♂ [OP].

SOUTH AFRICA

(Total=169 ♂♂, 104 ♀♀, 5 nymphs, 7 larvae)

24621i. *Ceratotherium simum*, Dade Stn., Zululand 19 September 1921, R. H. T. P. Harris, 8 ♂♂, 1 ♀ [OP].

2462ii. *Diceros bicornis*, Hluhluwe Game Reserve (28°05'S, 32°05'E), Zululand, 26 February 1915, D. T. Mitchell, 1 ♂ [OP].

2462iii Rhinoceros, Zululand, 1915?, 2 ♂♂ [OP].

2462iv. *Ceratotherium simum*, Umfolozi Game Reserve (28°20'S, 31°05'E), 4 November 1940, Zoological Survey AM 764, 1 ♂ [OP].

2462vi. Rhinoceros, Zululand, 13 September 1915, D. T. Mitchell, Bedford's collection, 9 ♂♂, 8 ♀♀ [OP].

2580i. *Diceros bicornis*, Nduna River (c. 28°39'S, 31°39'E), Hlabisa, Zululand, 10 March 1910, F. Toppin, 6 ♂♂ [OP].

2580iii. On ground, Umfolozi Game Reserve, November 1950, R. du T.(= R. du Toit), 2 ♀♀ [OP].

2580iv. Blanket drag, Corridor*, Zululand, April 1955, G. Theiler, 2 ♀♀ [OP].

2683iv. *Diceros bicornis*, Somhele (outside Hluhluwe), Zululand, 24 December 1947, G. Theiler, 13 ♂♂ [OP].

2683vi. Male rhinoceros, Nduna River (c. 28°39'S, 31°39'E), Zululand, 10 March 1910, Fred Toppin, Lounsbury collection, 18 ♂♂, 4 ♀♀ [OP].

2997i. Blanket drag, Corridor, Zululand, 16 November 1954, Lois E. Salisbury, 4 ♂♂, 6 ♀♀ [OP].

2997ii. Blanket drag, Corridor, Zululand, 15 November 1954, Lois E. Salisbury, 5 ♂♂, 5 ♀♀ [OP].

2997iii. Blanket drag, Corridor, Zululand, November 1954, Lois E. Salisbury, 2 ♂♂, 5 ♂♂ [OP].

* Corridor is a stretch of country approximately 100 square miles in extent, lying between the Hluhluwe and Umfolozi Game Reserves in Zululand, Natal, South Africa (Neitz 1957)

2997iv. Blanket drag, Ivivi, Corridor, Zululand, 7 February 1955, Lois E. Salisbury, 5 ♂♂, 1 ♀ [OP].

RH 34/77. *Diceros bicornis* (male, from leg), Itala Nature Reserve (c. 27°31'S, 31°17'E), Natal, 3 September 1977, Dr I.R. Lewis, 3 ♂♂ [OP].

No number. *Ceratotherium simum* (male), Kruger Gate (24°59'S, 31°29'E), Kruger Park, Transvaal, 20 October 1987, from anus and perineum, 25 ♂♂, 6 ♀♀; from penis and 1/2 groin 18 ♂♂, 21 ♀♀; from 1/2 skin of back 1 ♂ [UP].

No number. *Diceros bicornis* (old female), Ndumu Nature Reserve (26°53'S, 32°17'E), Natal, 23 September 1989, from 1/2 of body, 1 ♂ [UP].

No number. *Diceros bicornis* calf (female), Ndumu Nature Reserve, Natal, 24 September 1989, from 1/2 of body (not belly), 4 ♂♂ [UP].

No number. *Diceros bicornis* (male), Ndumu Nature Reserve, Natal, 24 September 1989, from 1/2 of posterior of body, 2 ♂♂; from genitalia, 3 ♂♂, 1 ♀ [UP].

No number. *Ceratotherium simum* (female), Kruger Park, Transvaal, from 1/2 of body (scrubbed), 26 ♂♂, 32 ♀♀ [UP].

RML50562. Ex *Ceratotherium simum*, Dade Station, Zululand, 19 September 1921, 2 ♂♂ (Doubtless this collection is part of OP2462i) [NTC].

RML50564. From tops of reeds. Umfolozi River, Zululand, October 1923. 1 ♂, 1 ♀ [NTC].

RML119550. Questing on grass, 7 km east of Numbi Gate (25°09'S, 31°14'E), Kruger Park, 2 March 1989, J. E. Keirans & D. de Klerk, 1 ♂, 1 ♀ [NTC].

RML120151. Questing on grass, 9 km east of Numbi Gate, Kruger Park, 2 March 1989, J. E. Keirans & D. de Klerk, 8 ♂♂, 8 ♀♀, [also 5 nymphs, 7 larvae reared from these adults] [NTC].

AFRICA: UNKNOWN LOCALITY

[Total = 8 ♂♂, 3 ♀♀]

2683ii. No collection data; from Bedford's dry collection, 1 ♀ [OP].

RML46788. Collection data illegible, 2 ♀♀ [Paul Schulze collection in NTC].

RML109255 [Nuttall 555]. No collection data other than [R2592]. 7 ♂♂ in alcohol, 1 ♂ slide mounted [NHM].

REMARKS

Although no detailed life cycle observations were made on this tick during the present study, some were made on the various stages. Adult *D. rhinoceri-*

rinus were placed on cattle and sheep and would not feed. When placed on laboratory white rabbits in feeding capsules adults would feed, although reluctantly. Of the 11 females and 8 males placed on rabbits on 6 March 1989, 7 females fed to engorgement and the last female dropped off the rabbit 12 d after being placed on it. Only 2 of these females laid significant egg masses. Engorged weights of these females were 0,32 and 0,41 g. Larvae were placed on rabbits on 3 July 1989 and the drop-off period was from 8–12 July 1989. Likewise nymphs placed on rabbits on 1 August 1989 began initial drop-off on 8 August 1989.

During the nymphal feeding of *D. rhinocerinus* 3 separate instances of paralysis were observed (A. M. Spickett, unpublished data 1989). In one case 70–80 nymphs, and the other approximately 52 nymphs were fed on rabbits that became paralysed. In the 3rd case 50 nymphs were fed on a rabbit that became paralysed and died on the 7th day. The 50 nymphs were transferred to a 2nd rabbit that became paralysed and died in 19 hours. Post mortem examination of this 2nd rabbit revealed focal areas of myocardial degeneration and necrosis.

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