

Descriptions of Two New *Lotobia* Species with Reanalysis of Intrageneric Relationships and Discussion of the Systematic Status of *Lotobia* Lioy within the Subfamily Sphaerocerinae (Diptera: Sphaeroceridae).

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ABSTRACT

Two new species from Africa, *Lotobia nigeriana* and *L. southafricana*, are described and illustrated. These two new species are similar each other, but can be differentiated based on the coloration and male genitalic structure. Relationships among all 24 *Lotobia* species are analyzed using cladistic method. Revised synapomorphies for the genus *Lotobia* are provided and taxonomic status of the genera of the subfamily Sphaerocerinae is also discussed.

Key words: Diptera, Sphaeroceridae, Sphaerocerinae, *Lotobia*, Phylogeny

INTRODUCTION

In the latest revision of the primarily Afrotropical genus *Lotobia* Lioy, Kim and Han (1990) treated 22 species including nine new species. Here we report two additional new species from Nigeria and South Africa, and a reanalysis of the phylogenetic relationships among *Lotobia* species. Current phylogenetic status of *Lotobia* and related genera within the subfamily Sphaerocerinae are also discussed.

MATERIALS AND METHODS

The terminology and morphological interpretations used in this paper follow McAlpine (1981) and

Han and Kim (1990). For *Lotobia* descriptions, the following ratios are used: wing-thorax ratio (wing length/thorax length); vein R4 + 5 ratio (length of section between basal node and r-m/length of section between r-m and wing tip); vein M ratio (length of section between bm-cu and r-m/length of section between r-m and dm-cu).

Data for the analysis of specific relationships, except for the two new species, were obtained from Kim and Han (1990), but, as necessary, the reference collection of the Frost Entomological Museum (Pennsylvania State Univ.) was examined to confirm previous morphological information. PAUP software (Swofford, 1993) was used to generate maximum parsimony trees. Assumptions and settings used for PAUP analyses are discussed in the appropriate sections.

Collection abbreviations are as follows: NMSA, Natal Museum, Pietermaritzburg, South Africa; USNM, U.S. National Museum of Natural History, Washington, D.C., USA; PSU, Frost Entomological Museum, the Pennsylvania State University, University Park, USA.

RESULTS AND DISCUSSION

Lotobia nigeriana, sp. nov. (Figs. 1-7)

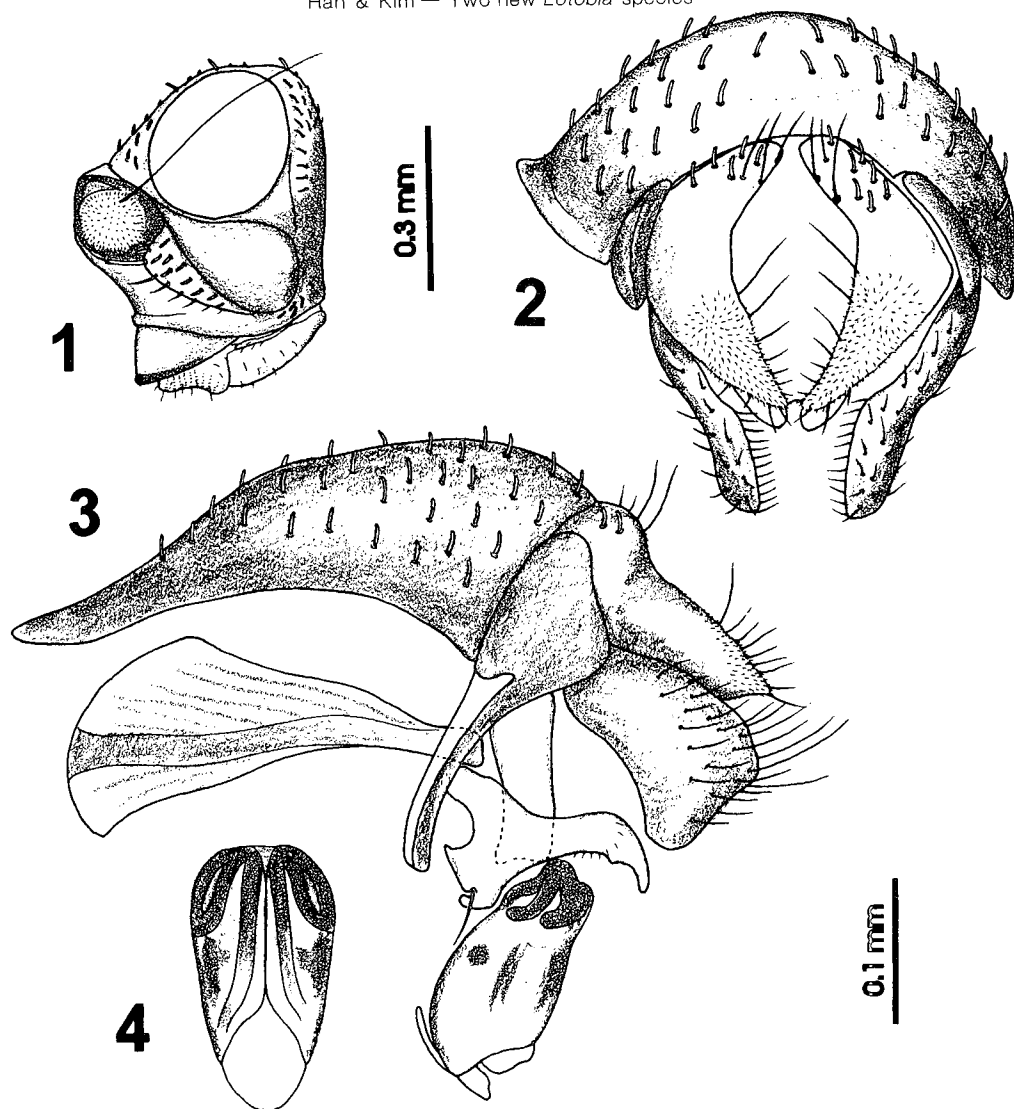
Description. Almost entirely yellow brown, subshiny, 2.5-2.7 mm long.

Head (Fig. 1) entirely yellow brown except for dark brown compound eye; head length 0.9-0.95x head height; frons width 0.54x head width in dorsal view; eye round in profile; inner vertical seta 0.3x as long as distance between base of seta and ocellar triangle; outer vertical seta and 2 fronto-orbital setae as long as inner vertical seta, approximately twice as long as other setulae nearby; postocular setae in irregular rows; epistoma 0.67-0.73x as long as wide; clypeus 0.5-0.55x as long as wide; infragena bare, shiny; facial ridge with 2-3 subvibrissal setae and 2 short but distinct supravibrissal setae, vibrissa as long as flagellomere 2; scape short, flattened with 2 distinct hairlike setae; pedicel with 2 long marginal setae; flagellomere 1 densely pubescent with long arista.

Thorax entirely yellow brown, covered with numerous blunt setulae, 1.3-1.4x as long as wide; postpronotal lobe with about 30 blunt setulae; acrostichal setulae arranged in 3-4 irregular rows on presutural scutum; dorsocentral setulae separated from acrostichal setulae by bare area between them; only hind notopleural seta distinguishable; scutellum with 15-17 marginal tubercles, usually with 2 basal tubercles fused at base; legs yellow brown with fore and hind femora about 1.3x as thick as midfemur; wing 1.82-1.94 mm long, hyaline with pale yellow vein; wing-thorax ratio 2.03-2.21; vein R4 + 5 ratio 3.6-3.7; vein M ratio 1.18; A1 + CuA2 almost straight; halter pale yellow.

Male abdomen (Fig. 5) 1.3x as long as wide; tergite 1 + 2 about 1.5x as long as tergite 3; tergite 4 as long as tergite 3; tergite 5 semicircular, 0.7x as long as tergite 4. Sternites 2-4 with fine setulae and a pair of short marginal setae; sternite 5 reduced; genitalia (Figs. 2-4) with cercus crescentic in caudal view, not clearly notched dorsally in lateral view; surstylus widened and truncated apically; paramere with short anterior process and long, pointed posterior process; distiphallus largely covered with membranous sheath, leaving small apical process in lateral view; membranous distiphallic sheath with distinct pattern.

Female abdomen (Figs. 6, 7) with segments 1-4 about 1.3x as long as wide; tergite 1+2 about 1.5x as long as tergite 3 and 1.2x as long as tergite 4; tergite 5 much smaller than preceding tergites;



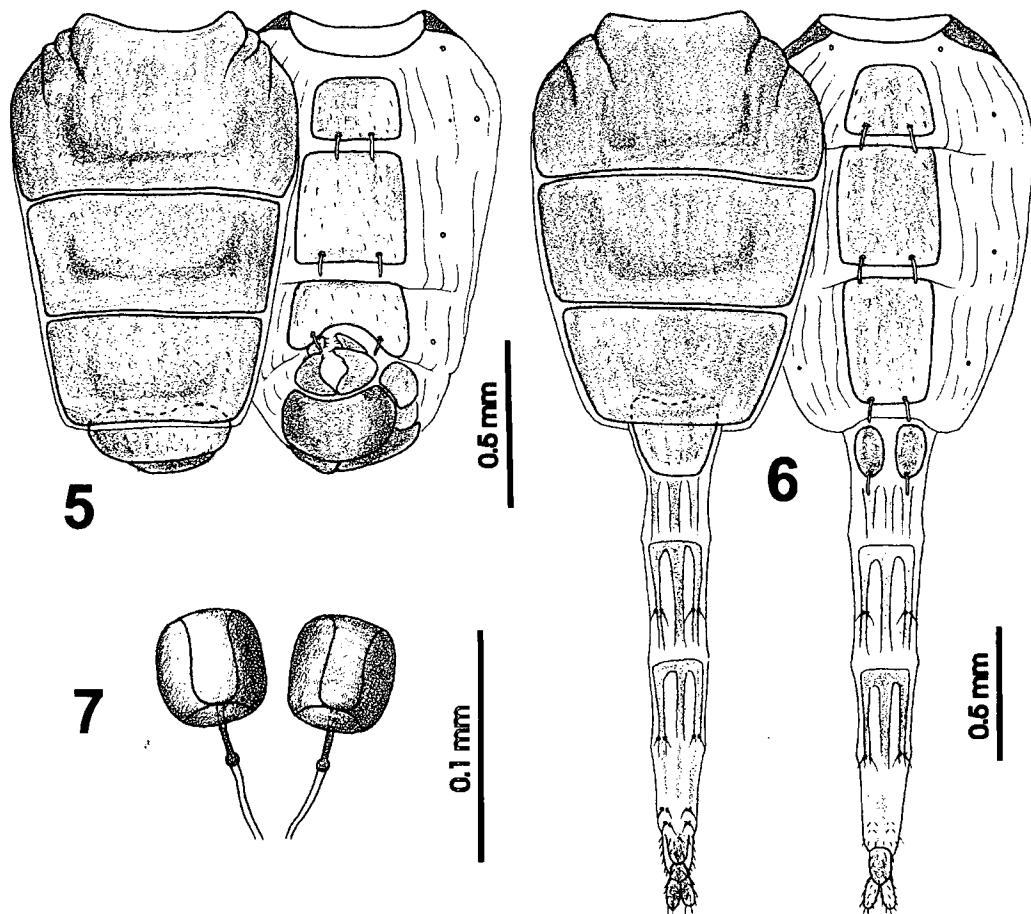
Figs. 1-4. *Lotobia nigeriana*, sp. nov.: 1, head, lateral view; 2, male genitalia, caudal view; 3, male genitalia, lateral view; 4, distiphallus, caudal view.

sternite 3 posteriorly widened, about 1.5x as long as sternite 2; sternite 4 narrowed posteriorly, similar size as sternite 3; sternite 5 divided into two small round sclerites; postabdomen long, largely membranous; 2 spermathecae dark brown, oblong in outline with narrow and apically knobbed basal stems.

Type Material. Holotype ♂, NIGERIA, Zaria, Samaru, 3.III.1967, J.C. Deeming (USNM) - right wing missing; abdomen dissected; left wing, scutellum and hindlegs broken off from the body and glued on card point. Paratypes: Same locality and collector as the holotype, 1.VII. 1967, 1♂ 1♀ (PSU), 1♀ (USNM); 25.IX.1966, 1♀ (USNM).

Etymology. This species is named after the type locality, Nigeria.

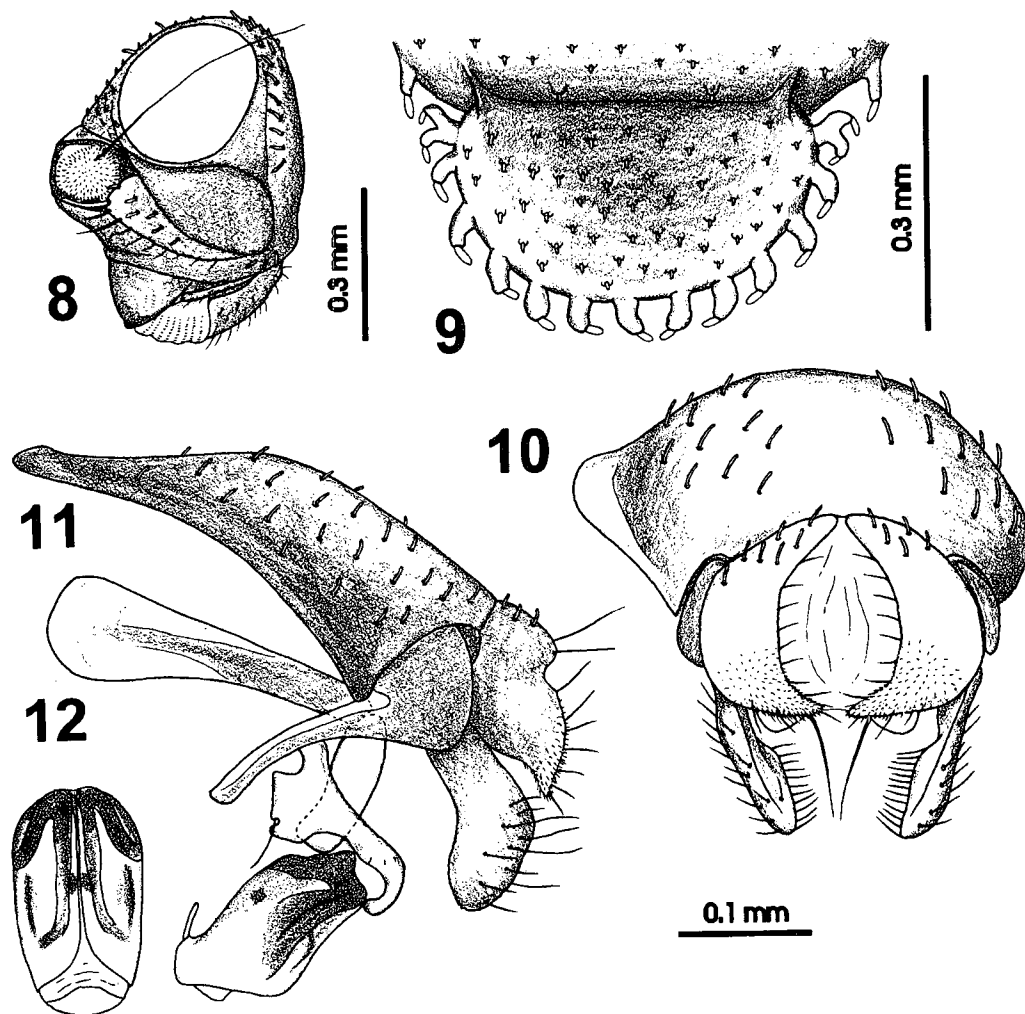
Remarks. *Lotobia nigeriana*, *L. southafricana*, and *L. elegans* look similar and can be distinguished from other known *Lotobia* species by the largely yellow brown to brown body. Among



Figs. 5-7. *Lotobia nigeriana*, sp. nov.: 5, male abdomen, dorsal and ventral view; 6, female abdomen, dorsal and ventral view; 7, spermathecae.

these three species, *L. elegans* is the easiest species to separate based on a pair of black elongated processes on the male abdominal sternite 4 (Kim and Han, 1990). It also has the acrostichal and dorsocentral setulae almost completely diffused; in the other two species, the acrostichal setulae can be clearly distinguished from the dorsocentral setulae by a bare area. *Lotobia nigeriana* is usually entirely yellow brown, while *L. southafricana* has a brown scutum contrasting with yellow brown postpronotal lobes. The basal portion of the scutellum is also brown in *L. southafricana* (Fig. 9). We do not, however, know if these characters are consistent based on the limited materials available to us, because this level of color variation sometimes occurs within a single species when a large series of specimens are examined. *Lotobia nigeriana* and *L. southafricana* are so similar that examination of male abdominal structures is required to safely distinguish them. Male genitalia provide distinct differences between these two species. Especially, the cercus in lateral view have a distinct dorsal notch in *L. southafricana* (Fig. 11), but are only slightly concave dorsally in *L. nigeriana* (Fig. 3). Females should be identified by association with male specimens from the same collecting lot.

***Lotobia southafricana*, sp. nov.** (Figs. 8-15)

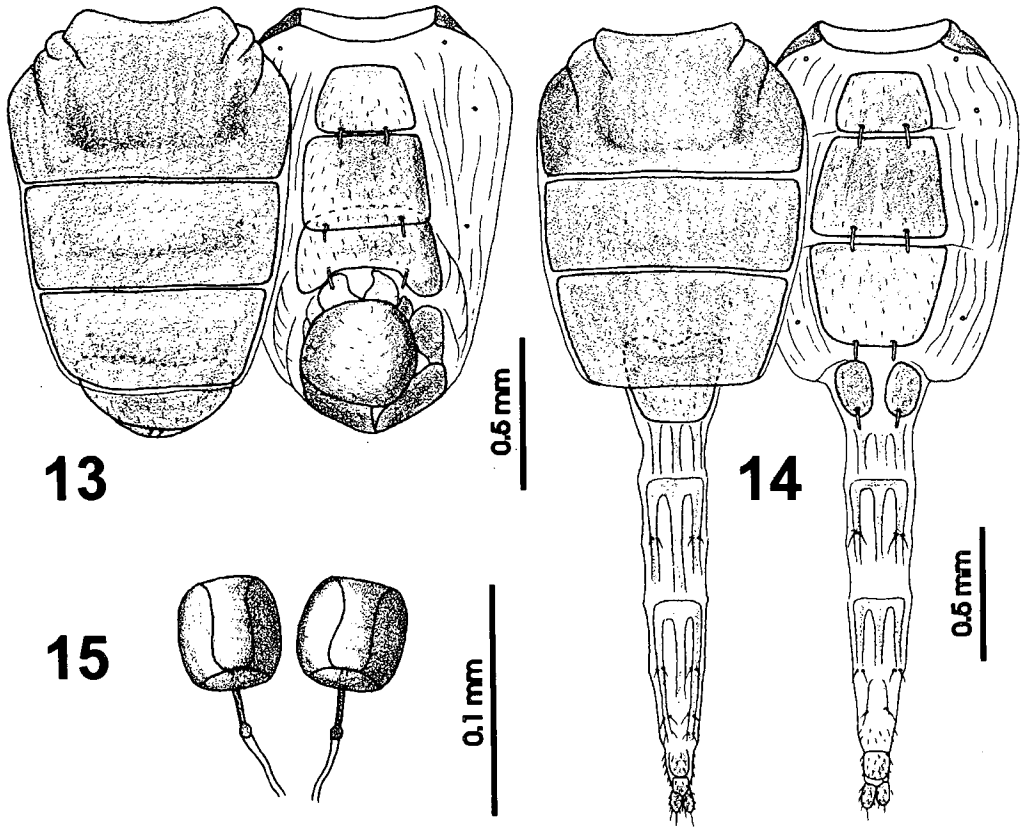


Figs. 8-12. *Lotobia southafricana*, sp. nov.: 8, head, lateral view; 9, scutellum with posterior part of scutum, dorsal view; 10, male genitalia, caudal view; 11, male genitalia, lateral view; 12, distiphallus, caudal view.

Description. Almost entirely yellow brown, subshiny, 2.5-2.6 mm long.

Head (Fig. 8) entirely yellow brown except for dark brown compound eye; head length 0.91-0.95x head height; frons width 0.54-0.67x head width in dorsal view; eye round in profile; inner vertical seta 0.3-0.5x as long as distance between base of seta and ocellar triangle; outer vertical seta and 2 fronto-orbital setae as long as inner vertical seta, approximately twice as long as other setulae nearby; postocular setae in irregular rows; epistoma 0.73-0.85x as long as wide; clypeus 0.6x as long as wide; infragena bare, shiny; facial ridge with 2-3 subvibrissal setae and 2 short but distinct supravibrissal setae, vibrissa as long as flagellomere 2; scape short, flattened with 2 distinct hairlike setae; pedicel with 2 long marginal setae; flagellomere 1 densely pubescent with long arista.

Thorax yellow brown to brown, covered with numerous blunt setulae, 1.3-1.4x as long as wide; postpronotal lobe with about 30 blunt setulae, yellow brown, contrasting with brown scutum; acrostichal setulae arranged in 3-4 irregular rows on presutural scutum; dorsocentral setulae



Figs. 13-15. *Lotobia southafricana*, sp. nov.: 13, male abdomen, dorsal and ventral view; 14, female abdomen, dorsal and ventral view; 15, spermathecae.

separated from acrostichal setulae by bare area between them; only hind notopleural seta distinguishable; scutellum (Fig. 9), basally brown, marginally yellow brown with 15-16 marginal tubercles; 2 basal scutellar tubercles fused at base; legs yellow brown with fore and hind femora about 1.4x as thick as midfemur; wing, 1.71-2.17 mm long, hyaline with pale yellow vein; wing-thorax ratio 1.91-2.13; vein R4+5 ratio 3.6-4.2; vein M ratio 1.1-1.4; A1+CuA2 almost straight; halter pale yellow.

Male abdomen (Fig. 13) 1.3x as long as wide; tergite 1 + 2 about 1.5x as long as tergite 3; tergite 4 as long as tergite 3; tergite 5 semicircular, 0.5x as long as tergite 4. sternites 2-4 with fine setulae and a pair of short marginal setae; sternite 5 reduced; genitalia (Figs. 10-12) with cercus crescentic in caudal view, clearly notched dorsally in lateral view; surstylus widened and truncated apically; paramere with short anterior process and long, strongly bent posterior process; distiphallus largely covered with membranous sheath, leaving small apical process in lateral view; membranous distiphallic sheath with distinct pattern.

Female abdomen (Figs. 14, 15) with segments 1-4 about 1.4x as long as wide; tergite 1 + 2 about 1.2x as long as tergite 3; tergite 3 as long as tergite 4; tergite 5 much smaller than preceding tergites; sternite 3 rectangular, about 1.5x as long as sternite 2; sternite 3 and 4 similar shape and size; sternite 5 divided into two small round sclerites; postabdomen long, largely membranous; 2

spermathecae dark brown, oblong in outline with narrow and apically knobbed basal stems.

Type Material. Holotype ♂, SOUTH AFRICA: Johannesburg, Bedford Ridge, 4. III. 1953. A.L. Capener (USNM) - abdomen dissected. Paratypes: Same data as holotype, 1♂ 1♀ (PSU), 1♀ (USNM); Natal, Hinton Road, 13. XII. 1953, 1♀ (NMSA).

Etymology. This species is named after the type locality, South Africa.

Remarks. See "Remarks" of *L. nigeriana*.

Intragenetic Relationships of *Lotobia* Lioy

Kim and Han (1990) provided a cladogram for *Lotobia* species in the latest world revision. We reexamine these relationships in light of the two new species. We have used the same characters and character states as in our previous study, but have changed some character polarities because they were not well justified before (see next paragraph). The revised character state distribution is in Table

Table 1. Character state distribution of characters used in cladistic analysis of *Lotobia* spp. ? = uncertain state.

OTU\CHARACTER	1	2	3	4	5	6	7	8	9	1	1	1	1	1	1	1	1
Hypothetical Ancestor	a	?	a	a	a	?	?	a	?	?	?	?	a	a	a	a	?
<i>halidayi</i>	a	c	a	a	a	a	a	?	b	a	a	b	a	a	a	a	?
<i>pallidiventris</i>	b	c	a	b	b	a	b	a	b	a	a	a	a	a	a	a	b
<i>endrodyi</i>	b	?	a	b	b	?	c	a	?	a	a	?	a	a	a	a	?
<i>africana</i>	b	a	b	b	b	a	a	a	a	a	a	a	a	a	a	a	b
<i>arcuata</i>	b	a	b	b	b	a	a	a	a	a	a	a	a	a	a	a	b
<i>saegeri</i>	a	a	a	b	b	a	a	b	a	a	a	b	a	c	a	a	b
<i>turbatrix</i>	a	a	a	b	b	a	a	b	a	a	a	b	a	c	a	a	b
<i>nigra</i>	a	a	a	b	b	a	a	b	a	b	a	b	a	a	a	a	b
<i>alpina</i>	a	a	a	b	b	a	b	b	a	b	a	b	a	a	a	a	?
<i>kivuensis</i>	a	b	a	b	b	a	b	b	a	b	a	b	a	a	a	a	a
<i>kovacsi</i>	a	c	a	b	b	a	a	b	a	a	a	b	a	a	a	a	a
<i>similiter</i>	a	b	a	b	b	a	d	b	a	a	a	b	a	a	a	a	a
<i>dura</i>	a	b	a	b	b	a	a	b	a	a	a	b	a	a	a	a	?
<i>upembaensis</i>	a	a	a	b	b	a	a	b	a	a	a	a	a	a	a	a	a
<i>wittei</i>	a	a	a	b	b	a	a	b	a	a	a	a	a	a	a	a	a
<i>nigerinana</i>	a	b	a	b	b	b	a	b	?	a	a	a	a	a	a	a	b
<i>southafricana</i>	a	b	a	b	b	b	a	b	?	a	a	a	a	a	a	a	b
<i>elegans</i>	a	c	a	b	b	a	?	b	a	c	a	a	a	a	b	a	a
<i>simia</i>	a	b	a	b	b	b	a	b	a	a	a	b	b	a	b	b	a
<i>temboensis</i>	a	b	a	b	b	b	a	b	a	a	a	b	b	a	b	b	a
<i>eritima</i>	a	b	a	b	b	b	a	b	b	a	b	b	c	b	b	b	?
<i>moyoensis</i>	a	b	a	b	b	b	a	b	b	a	b	b	c	b	b	b	a
<i>dolabrata</i>	a	b	a	b	b	a	a	b	b	c	c	b	c	a	b	b	b
<i>flavofemorata</i>	a	a	a	b	b	?	a	b	b	a	b	b	c	a	b	b	a

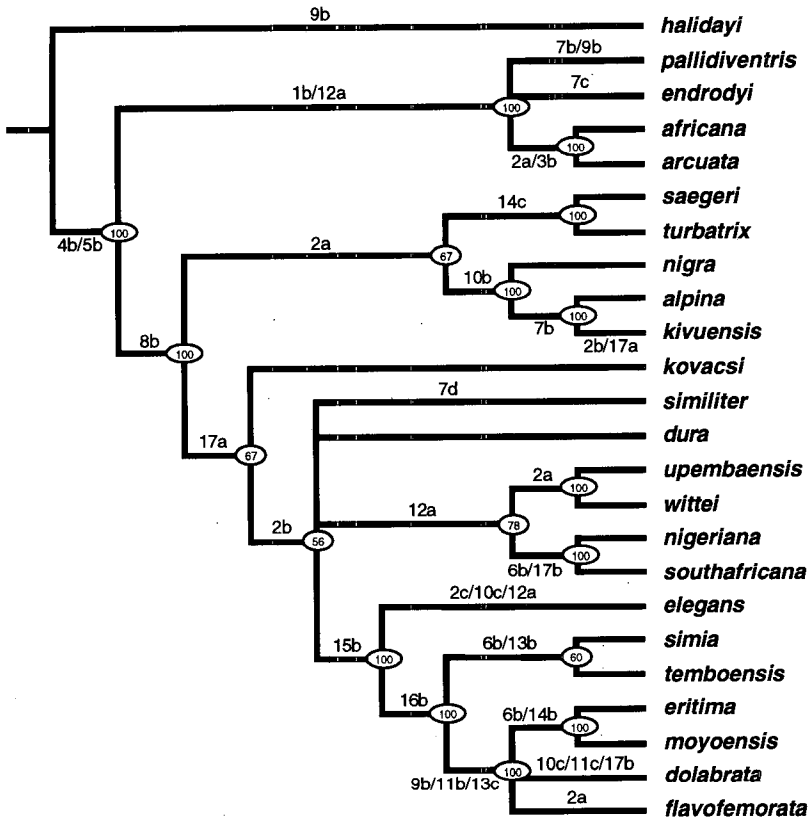


Fig. 16. Cladogram of *Lotobia* spp. 50% majority rule consensus tree of 135 most parsimonious trees. Numbers and letters on branches refer to characters and states representing hypothesized apomorphic changes. Numbers in circles indicate % consensus values.

1. Refer to Table 1 of Kim and Han (1990) for the description of each character.

Since the monophyly of the closest genus *Ischiolepta* Lioy is not clear (Han and Kim, 1990), we also examined character state distributions in *Safaria* Richards and *Trichosphaerocera* Papp for outgroup comparison. Character states highly consistent in all outgroups were considered as plesiomorphic for *Lotobia*. They are states "a" of character 1, 3-5, 8, and 13-16. These nine characters plus structural characters 10 and 11 were each weighted (three, five, and ten times) in three separate analyses. We down-weighted characters 2, 6, 9, and 12 because they were coloration, which tended to be more homoplastic. Characters 7 and 17 were also down-weighted because they were variable in the outgroups (Han and Kim, 1990; Han and Marshall, 1992). All the multistate characters were assigned as unordered except for character 11, whose character direction is relatively clear. A search for the most parsimonious trees was conducted using the heuristic setting of PAUP (Swofford, 1993). We used ten replications of random addition of taxa to minimize possible bias from input order. To root the tree, we included the hypothetical ancestor in the analysis. For the reconstruction of character state changes at the branches of this cladogram, the DELTRAN character state optimization criterion was used (Swofford, 1993).

A total of 135 most parsimonious trees was found. The three different weighting schemes

produced identical trees, but the consistency index increased from 0.75 to 0.81 when the weights were changed from three to ten times for the selected characters. A 50% majority rule consensus tree is presented in Fig. 16. The resulting cladogram is somewhat different from that of Kim and Han (1990), but the differences are mainly associated with the nodes displaying lower consensus values. The most significant difference is the position of *L. elegans*. It is supported as a sister group of seven species (*simia* to *flavofemorata*, Fig. 16) on the basis of a single male genitalic structure (character 15). This appears to be caused by the higher phylogenetic weight given to character 15 in this analysis. The *L. saegeri* and *L. turbatrix* clade is grouped with the clade including *L. nigra*, *L. alpina* and *L. kivuensis*. This relationship, however, is supported in only 67% of trees and is based on the color of clypeus, which appears to be highly subject to homoplasy. The new species, *L. nigeriana* and *L. southafricana*, are grouped together and are recognized as the sister clade of *L. upembaensis* and *L. wittei* in 78% of the most parsimonious trees.

Current Systematic Status of *Lotobia* and Related Genera

The primarily Afrotropical genus *Lotobia* Lioy belongs to the subfamily Sphaerocerinae, which includes nine nominal genera (Kim, 1968, 1972; Papp, 1978). Monophyly of the Sphaerocerinae appears to be clearly supported by five synapomorphies: 1) presence of two or more marginal scutellar tubercles (Fig. 9); 2) arista bare; 3) reduction of long macrosetae, especially on the thoracic dorsum; 4) katatergite with large projection; and 5) two spermathecae (plesiomorphy: three spermathecae). These character states are rare or lacking in other sphaerocerid subfamilies or sphaeroceroid families. Relationships of Sphaerocerinae to the other subfamilies, Limosiniinae and Copromyzinae, are unknown. Within the Sphaerocerinae, relationships among the nine recognized genera are not clearly resolved. The so-called *Lotobia* group, including *Safaria* Richards, *Ischiolepta* Lioy, and *Lotobia*, has been recognized as a monophyletic group and their relationships discussed (Kim, 1972; Kim and Han, 1990; Han and Kim, 1990). The *Sphaerocera* group (sensu Kim, 1972), appears to be a paraphyletic group, which were defined based on plesiomorphic characters. This group currently includes the following genera: *Sphaerocera* Latreille, *Parasphaerocera* Spuler, *Mesosphaerocera* Kim, *Neosphaerocera* Kim, and *Afromyia* Kim.

Papp (1978) erected an interesting new genus, *Trichosphaerocera*, which has characteristics of both the *Lotobia* and the *Sphaerocera* groups. This genus is based on a single species from Africa. The following characters discussed by Papp (1978) seem to be possible autapomorphies for *T. africana* Papp: 1) body setulae long and slender (not to be confused with the typical macrosetae, which are reduced); and 2) preabdominal sternites widened laterally, touching tergites. These two character states are unique within the Sphaerocerinae but sometimes found in the Limosiniinae and Copromyzinae. Therefore, it is also possible to consider them plesiomorphic, as indicated by Papp (1978). According to Papp's illustration, this species has six marginal scutellar tubercles, which may be a synapomorphy with the so-called *Lotobia* group genera. More than six marginal scutellar tubercles in *Ischiolepta* and *Lotobia* can be interpreted as character states further progressed from six tubercles.

While monophyly of the most sphaerocerine genera has not been rigorously tested, Kim and Han (1990) suggested monophyly of *Lotobia* based on three synapomorphies, and recognized *L. halidayi* as a sister group of all the remaining species. We here propose a revised list of synapomorphies for

Lotobia: 1) presence of basal marginal scutellar tubercle (Fig. 9); 2) epandrium flattened (Figs 3, 11) - plesiomorphy: strongly convex, bonnet-shaped; and 3) distiphallus with thick membranous sheath covering at least basal half (Figs. 4, 12). All these character states are unique within Sphaerocerinae. The shape of the male surstylus, which was included as a synapomorphy in Kim and Han (1990), appears to be somewhat variable intragenerically and is removed from the revised list.

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아프리카산 *Lotobia*속(파리목, 애기똥파리과)의 2신종과 속내의 계통분석 및
*Lotobia*속이 애기똥파리아과 내에서 차지하는 계통학적인 위치 고찰

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적 요

아프리카산 2신종, *Lotobia nigeriana*와 *L. southafricana*를 그림과 함께 기재한다. 이 두 종은 형태적으로 상당히 유사하나 색깔과 응성생식기의 구조에 입각, 구분이 가능하다. 이로서 *Lotobia*속은 전세계적으로 24종이 기록되며 이들의 종간 유연관계를 분지계통학적으로 분석하였다. *Lotobia*속의 synapomorphy들을 다시 제시하였고 근연속들의 계통분류학적인 현황도 아울러 언급하였다.