

PROGOMPHUS NIGELLUS AND *PHYLLOCYCLA*
HAMATA, TWO NEW DRAGONFLIES FROM BRAZIL
(ODONATA: GOMPHIDAE)

Belle, J., 1990. *Progomphus nigellus* and *Phyllocycla hamata*, two new dragonflies from Brazil (Odonata: Gomphidae). – Tijdschrift voor Entomologie 133: 27-30, figs. 1-10. [ISSN 0040-7496]. Published 31 July 1990.

Descriptions and illustrations are given of two new species of Gomphidae (Odonata) from Brazil, viz. *Progomphus nigellus* and *Phyllocycla hamata*. Both male holotypes were collected in Brazil, State of Rondonia, Fazenda Rancho Grande.

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Key words. — Brazil; *Progomphus*, *Phyllocycla*; new species.

INTRODUCTION

To the courtesy of Dr. Rosser W. Garrison at Azusa, California, I had the pleasure of receiving for description two new gomphid species which he had collected himself during his investigations in the area southwest of Ariquemes in the State of Rondonia, Brazil. The material in question consists of three males; the corresponding females still remain to be discovered. The new taxa are here published under the names *Progomphus nigellus* and *Phyllocycla hamata*. The holotypes are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.; the paratype is in the collection of Dr. Garrison.

Progomphus nigellus spec. nov.
(figs. 1-6)

Material. — Brazil: State of Rondonia, Fazenda Rancho Grande, 62 km SW of Ariquemes (10° 50' S, 63° 7' W, 187 m), 2-11 November 1989, 1 ♂ (holotype), R. W. Garrison.

This species is the fourth member of the *guyanensis* group to which also belong *Progomphus guyanensis* Belle, 1966, *Progomphus approximatus* Belle, 1966 and *Progomphus boliviensis* Belle, 1973. The males of this infrageneric group differ from those of the closely allied *complicatus*-group in having the superior anal appendages armed with a sharply-pointed basal externo-lateral dilatation.

Progomphus nigellus is perhaps as nearly related to *Progomphus boliviensis* as to the other two members of the group. The male superior anal appendages are similar to those of *boliviensis*, the inferior anal appendage approaches more that of *approximatus* while the anal tubercles resemble

those of *guyanensis*. The morphological differences and similarities in the terminalia of the abdomen will be seen by comparing the figures of the present species with the corresponding ones of the other three members earlier published by me (Belle 1966, 1973).

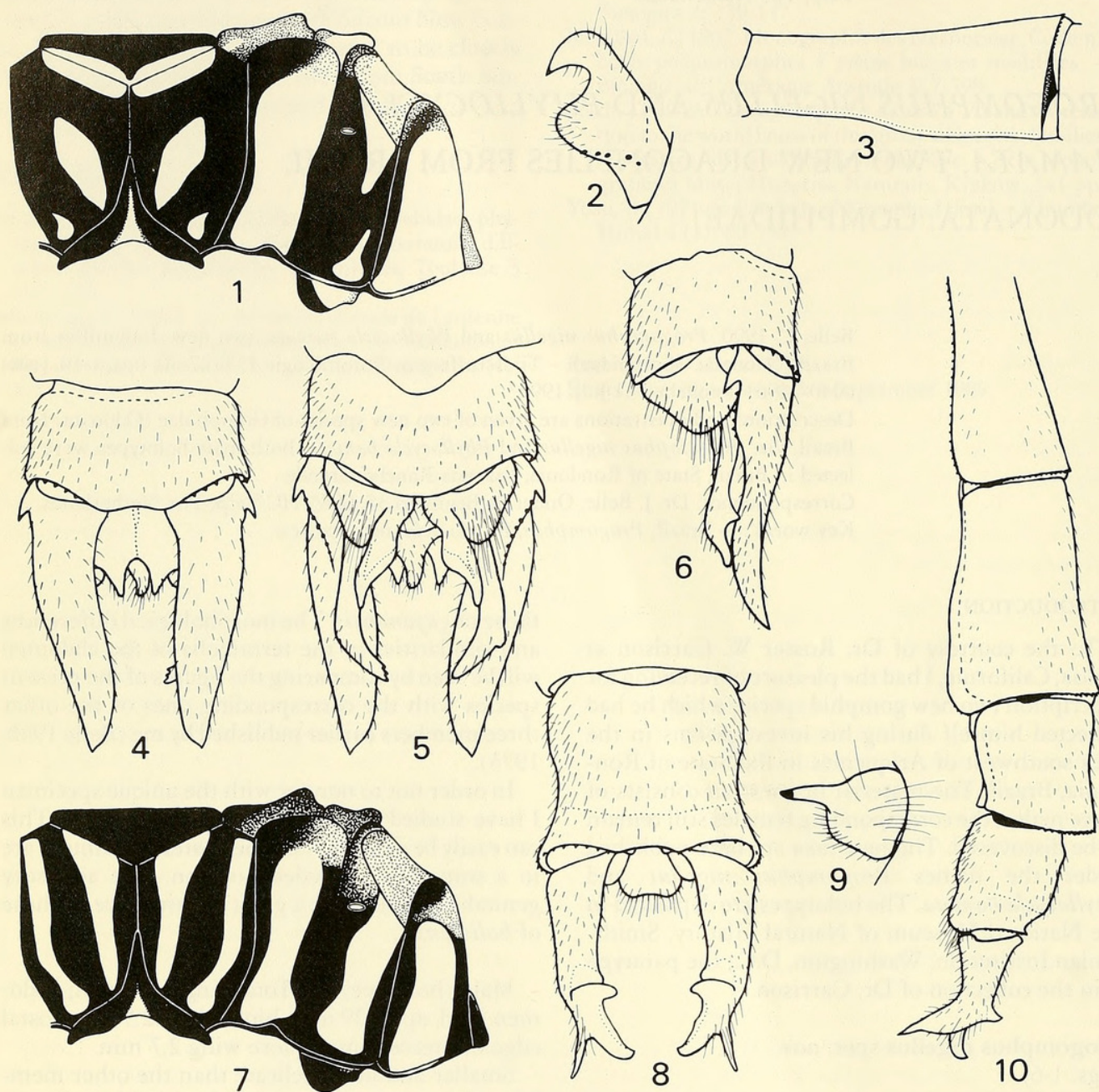
In order not to tamper with the unique specimen I have studied the accessory genitalia *in situ*. This can easily be done because the posterior hamules are in a somewhat extruded position. The accessory genitalia then exhibit a great resemblance to those of *boliviensis*.

Male (holotype). — Total length 38 mm; abdomen (incl. app.) 29 mm; hind wing 22.5 mm; costal edge of pterostigma of fore wing 2.7 mm.

Smaller and more delicate than the other members of the group. Coloration done in black, brown and greenish white (= pale) but the pale markings on the abdomen are yellow. Face predominantly pale, slightly tinged brown at posterior parts of labrum and postclypeus. Superior surface of frons and occipital plate pale. Vertex brown. Rear of head brown with a pair of small submedian pale spots on top and a pair of larger pale markings on temporae. Crest of occiput slightly and evenly concave, thinly fringed with pale hairs which are about as long as half the middorsal length of the occipital plate.

Prothorax with pale middle lobe and black hind lobe. Thoracic colour pattern black with pale markings, resembling that of *boliviensis* but with metepimeral pale stripe partly developed and interrupted in middle (fig. 1).

Legs dark brown but inner side of first femora pale and second and third femora becoming lighter brown toward the bases.



Figs. 1-10. — 1-6, *Progomphus nigellus* spec. nov., male holotype: 1, diagram of thoracic colour pattern; 2, right posterior genital hamule, ventral; 3, seventh abdominal segment, left profile; 4, tenth abdominal segment and anal appendages, dorsal; 5, the same, ventral; 6, the same, left profile. — 7-10, *Phyllocycla hamata* spec. nov., male holotype: 7, diagram of thoracic colour pattern; 8, tenth abdominal segment and anal appendages, dorsal; 9, right posterior genital hamule, ventral; 10, apical segments of abdomen and anal appendages, left profile.

Wings with a brown tinge, blackish brown venation and brown pterostigma. Brace vein present. Ante-en postnodal cross-veins of first series 10:14-16:12/11-11-11:10 in fore and hind wings, respectively. Second primary antenodal cross-vein the fifth. Basal subcostal cross-vein present. All supra-triangles one-celled. All subtriangles and triangles two-celled with two rows of cells following but with an extra initial cell at hind angle of triangle in hind wings. Intermedian cross-veins 7-7/5-4 in fore and hind wings, respectively. Anal field of fore wing

two cells wide for a distance of two cells. Hind wings with five paranal cells, three (left) and four (right) postanal cells, three rows of cells behind Cu₂, and a three-celled anal triangle.

Abdomen predominantly dark brown or blackish brown. Terminalia of abdomen black, including upper surface of superior anal appendages (contrary to the other members of the group which have the apical part of the upper surface pale or partly pale). Sides of segments 1 and 2 largely yellow. Sides of segments 3 to 7 with a small, yellow basal

spot. Middorsum of segment 2 with a round yellow spot that tapers to hind border of segment. Segments 3 to 7 with a middorsal yellow line over whole length of segment, the line being very fine on segments 4 to 7. There is no tubercle of any sort on venter of segment 1. Segment 7 slightly widening on apical half of segment (fig. 3). Posterior genital hamule and anal appendages shaped as shown in the accompanying figures. Tip of branches of inferior anal appendage ending with three teeth.

In his letter of 7 April 1990, Dr. Garrison informed me, that he had collected this male on a trail at about 4:00 p.m., just before it rained, in company with a male of *Aphylla dentata* Selys. In addition to these species and *Phyllocycla hamata* spec. nov. described below, he had also taken *Zonophora calippus klugi* Schmidt and *Phyllogomphoides cepheus* Belle in the same environment.

***Phyllocycla hamata* spec. nov.**
(figs. 7-10)

Material. — Brazil: State of Rondonia, Fazenda Rancho Grande, 62 km SW of Ariquemes (10° 50' S, 63° 7' W, 187 m), 2-11 November 1989, 2 ♂ (holotype and paratype), R. W. Garrison.

This species is the seventh member of the *volSELLa* group (cf. Belle 1988). Dr. Garrison recognized it as an undescribed species and wrote from Azusa on 19 February 1990 to me that the males are nearest to my *armata* but whose morphology of the appendages is different. The species is peculiar by the huge hook which arises erect on the upper surface of each male superior anal appendage.

Male (holotype; abdomen broken between segments 4 and 5). — Total length 43 mm; abdomen (incl. app.) 33 mm; hind wing 25.5 mm; costal edge of pterostigma of fore wing 2.9 mm.

Head brown with pale (= leaden grey) markings. Labrum lighter brown along free border and with a symmetric pair of weakly developed pale spots. External surface of genae largely pale. Anteclypeus pale. Postclypeus with a pale spot on each lateral side. Superior surface of frons pale, darker on the middle line. Rear of head lighter on tempora. Crest of occiput slightly concave, fringed with brown hairs which are about as long as the middorsal length of occipital plate.

Prothorax black above. Pterothorax black to dark brown with pale (grey to grey-green) stripes; its colour pattern shaped as shown in diagram (fig. 7).

Femora brown, but brownish yellow on inner sides of first and second femora and on posterior side of third femora basally. Distal spines of anterior outer row of third femora more or less spaced and one-fifth to one-fourth as long as local diameter of femur. Tibiae, tarsi and claws black.

Wings with a brown tinge, black venation and light brown pterostigma. Brace vein present. Ante- and postnodal cross-veins of first series 12:17-15:13/11:12-12:11 in fore and hind wings, respectively. Second primary antenodal cross-vein the fifth. Basal subcostal cross-vein present in all wings. Supratriangle in right hind wing three-celled, in other wings two-celled. Subtriangles in fore wings two-celled, in hind wings one-celled. Triangles two-celled with two rows of cells following but with an extra initial cell at hind angle of triangle in hind wings. Intermedian cross-veins 9-8/6-6 in fore and hind wings, respectively. Anal field of fore wings two cells wide for a distance of two cells in anterior row. Hind wings with four paranal cells and three postanal cells (the fourth paranal cell is the first postanal cell), a one-celled anal loop, three rows of cells behind Cu₂, and a four-celled anal triangle.

Abdomen dark brown with paler markings as follows: Sides of segments 1 and 2 largely yellow. Sides of segments 3 to 7 with yellow baso-lateral spots, the basal spots of both sides of segment 7 connected on the middorsum at extreme base. There is a yellow middorsal line on segments 2 to 7. Sides of segments 8, 9 and 10 largely brown-yellow. Lateral dilatations of segments 8 and 9 narrow and black. Lateral margins of segment 8 with four (left) and three (right) denticles at apex, those of segment 9 denticulated at extreme base. Posterior margin of segment 10 denticulated at level of bases of superior anal appendages. Dorso-apical rim of segment 10 about one-fourth the middorsal length of segment. Superior anal appendages black and shaped as shown in figs. 8 and 10. Rear margin of vesicle deeply cleft, bottom of cleft rounded and without a median elevation of any sort. Tip of posterior genital hamule rather long (fig. 9).

The male paratype lacks the tip of the left superior anal appendage but for the rest the specimen is in a perfect condition. The pale markings of the pterothorax are yellowish green and the dark lateral stripes brown. The wings are slightly brown-tinged. The cubito-anal interspace of the right hind wing has two cross-veins instead of the usual single cross-vein and the pterostigma is a trifle larger than that of the male holotype. The measurements of the male paratype are: Total length 42.5 mm; abdomen (incl. app.) 32.5 mm; hind wing 24.5 mm; costal edge of pterostigma of fore wing 3 mm.

Remark. — I take this opportunity of correcting a misprint in the description of *Phyllocycla armata* Belle, 1977. On page 7, in rule 7 from above, part of a line has been left out. We have to read: "Trigonal interspace in fore wings starting with two rows of cells from triangle outwards, that in hind wings starting with a row of three cells against triangle followed by two rows of cells."

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A BIOGEOGRAPHIC ACCOUNT OF THE GRASSHOPPERS (ORTHOPTERA: ACRIDOIDEA) OF SULAWESI, INDONESIA

Monk, K. A. & R. K. Butlin, 1990. A biogeographic account of the grasshoppers (Orthoptera: Acridoidea) of Sulawesi, Indonesia. – *Tijdschrift voor Entomologie* 133: 31–38, tabs. 1–4. [ISSN 0040-7496]. Published 31 July 1990.

Nineteen acridid species were collected from the Dumoga Bone National Park and its environs in North Sulawesi, Indonesia, during 1985: two were new to science and one was known previously only from the Philippines.

The total acridoid fauna of Sulawesi, including these three species, comprises 61 species of Acrididae (53 Catantopinae, four Oedipodinae, three Acridinae, one Gomphocerinae) and one species of Pyrgomorphidae. This fauna has four main characteristics: (a) a high level of specific and generic-level endemism, (b) low generic-level diversity but a high number of species per genus, (c) diverse distributions outside Sulawesi, and (d) localised distributions within the island.

In the Catantopinae, 83% of species are endemic to Sulawesi, reflecting the importance of the island as an area of endemism. Species distributions within Sulawesi suggest that each region of the island (North, Central, South and South-east) may also be an area of endemism in its own right.

These observations are discussed in relation to the geological history of Sulawesi. They suggest that for much of its history the island has been more isolated from other land masses than it is at present, and that it has been fragmented either into separate islands or by ecological barriers.

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Key words. – Biogeography, Sulawesi, Wallacea, grasshoppers, endemism.

INTRODUCTION

Although the Acridoidea in temperate zones and in dry equatorial areas are well-known, only wide ranging, economically-important pests, e.g. *Oxya japonica japonica* Thunberg and *Locusta migratoria* Linnaeus, have been studied in wet equatorial areas. The taxonomic work in South-east Asia by Ramme (1941) and Willemse (1951, 1956, 1957) is an exception but it has not been extended. In particular, the acridoid fauna of Sulawesi has been largely ignored despite the great interest in other animal groups inhabiting the island.

Sulawesi lies in a deep sea region, also including the Lesser Sunda Islands (Lombok to Timor) and the Moluccas, with lies between two continental margins: the Sunda (Malaysia and the Greater Sunda Islands), and the Sahul shelves (New Guinea and offshore islands). Classically, this area was seen as the meeting point of two major biotas: the Oriental and the Australasian. Wallace (1869) originally

separated them by dividing Bali (and Borneo) from Lombok (and Sulawesi). Although Wallace's Line may apply to some groups such as freshwater fish and mammals, the diversity of biogeographical patterns across this region for different taxonomic groups is high (see George 1987). Even with this overlap of broad transitional zones, Wallacea (a collective term for the islands of the deep sea region) is generally considered to be insular and biotically impoverished, but with unique characteristics indicating long periods of isolation (Dickerson et al. 1928).

Sulawesi covers 159,000 km² divided into four regions, Utara, Tengah, Selatan, and Tenggara, or North, Central, South, and South-east Sulawesi, respectively (see Whitten, Mustafa & Henderson 1987, for geographical details). North Sulawesi is a narrow peninsula, 772 by 103 km. Volcanoes, 1800–2400 m above sea level (asl), range along the peninsula. Seismic activity was recorded during 1985 and

1986. Limestone outcrops (possibly Cretaceous) occur in the western half of North Sulawesi. The northern peninsula is linked with Central Sulawesi by a narrow neck of land at the western extremity. The Sangihe and Talaud Islands lie between the northern tip of North Sulawesi and the Philippines. Central Sulawesi is also mountainous, with peaks reaching 2000-3000 m asl. A limestone mountain range running north to south through South Sulawesi is 500-1000 m asl and bisected by a narrow plain. The lakes on the plain are only 1-2 m deep and were once part of the sea, suggesting that at least this peninsula may have been partially submerged at times. The single volcano in this region, Lompobatang (2871 m asl), is extinct. The peninsula of South-east Sulawesi has a western mountain range reaching 2800 m asl and a lower-lying eastern area.

The vegetation is affected by regional climatic differences. Central Sulawesi has the greatest ratio of wet to dry months, whereas more seasonal rainfall occurs in the peninsulas (Whitmore 1984). The central region is covered in evergreen rain forest, whereas semideciduous forest is more common in the peninsulas (Walker 1982). Open habitats are mainly secondary, due to forest clearance for agriculture (Whitten et al. 1987).

Geologically Wallacea is a highly complex region originating in an interaction between the South-east Asian, Australian, and Pacific plates (Charlton 1986). The present island of Sulawesi is believed to be derived from two fragments that originated separately during the breakup of east Gondwanaland about 320 My ago, and remained separate during a northerly move starting 220 My ago (Audley-Charles 1987). From the late Cretaceous onwards, these fragments probably formed part of an archipelago between the Asian mainland and Australia-New Guinea but their positions relative to other land masses are uncertain. Holloway (1987) emphasized two alternative theories about the relationship of Sulawesi with Borneo: 1. The fragment now forming the western part of the island (North, South and part of Central Sulawesi) has always been in about its present position relative to Borneo, whereas the eastern fragment was Australasian in origin, 2. The two fragments were both isolated island arcs, now fused and thrust towards Borneo. The present island was probably formed about 15 My ago. The area of land above sea level, its division into separate islands and its climate are additional factors which must have contributed to the present day fauna of Sulawesi but about which little is known (Morley & Flenley 1987).

It is now believed that Sulawesi was never linked by land bridges to any other land mass following its formation 15 My ago (Audley-Charles 1987; Holloway 1987). During the Pleistocene, the sea level fell several times when affected by the Glacial expan-

sion of the ice caps. The largest drop, 170,000 years ago, linked Sundaland (Sumatra, Java, Bali, and Borneo) with the Asian mainland, with land extensions northward to the Philippines. Exposed land also extended around South Sulawesi toward the Lesser Sunda Islands, and from Central Sulawesi eastward toward New Guinea. During these periods of low sea level a drier, more seasonal climate prevailed and dry savannah may have extended through the Philippines to the Lesser Sunda Islands and into Australia, separating two large, wet rainforest areas in Sundaland and New Guinea; some seasonal plants still survive in South Sulawesi (van Steenis 1979). The climatic fluctuations and corresponding vegetational changes of the Quaternary are now known to have occurred in the late Tertiary as well (Morley & Flenley 1987).

MATERIALS AND METHODS

The analysis reported here is based on a combination of data from the literature and collections made by the authors and others in the Dumoga-Bone National Park, North Sulawesi during 1985. This work formed part of the Royal Entomological Society's 'Project Wallace' expedition. Insects were collected by sweeping, beating, and hand-searching. Agricultural crops, grassland, and primary semideciduous forest (undergrowth, bushes, saplings, and trees up to 2 m) were examined at all times of day and night and in three separate periods covering most of the year. Specimens collected from the tree canopy during the British Museum (Natural History) fogging programme (N. Stork, unpublished) were also examined.

The principal published records of the acridid fauna of Sulawesi are: Ramme (1941), Dirsh (1954), Willemse (1951, 1956, 1957, 1968), Hollis (1968, 1971, 1975), Kevan & Chen (1969), and Ritchie (1982). Family and subfamily classification follows that adopted in the collection of the British Museum (Natural History).

RESULTS

Expedition collection of North Sulawesi Acridoidea

Nineteen species from eighteen genera of Acridoidea were found in the Dumoga Bone National Park and its environs during 1985 (table 1). This includes two undescribed catantopine species, from the genera *Tarbaeus* and *Bibracte*, both of which were collected from the canopy by fogging. One species, *Eoscyllina luzonica*, was previously known only from the Philippines and was collected only from limestone grassland in the western part of the National Park. This suggests that the data available in the literature on the species present in Sulawesi

Table 1. Species of Acridoidea occurring in Sulawesi and their distributions.

		Wings ¹		Distribution ²		
				Outside	Within	
Pyrgomorphidae						
<i>Atractomorpha</i>	<i>psittacina psittacina</i> de Haan	+	W	Across S, P	All	
Acrididae						
Acridinae						
<i>Acrida</i>	<i>willemsei</i> Dirsh	+	W	Across S, P	All	
<i>Calliphlaeoba</i>	<i>celebensis</i> Ramme	+	B	Sulawesi	N, C	
<i>Phlaeobacris</i>	<i>reticulata</i> Willemse		W	—	C	
Gomphocerinae						
<i>Eoscyllina</i>	<i>luzonica</i> Bolivar I	+	W	P	N	*
Oedipodinae						
<i>Heteropternis</i>	<i>obscura</i> Blanchard	+	W	Across	All	
<i>Aiolopus</i>	<i>thalassinus tamulus</i> Fabricius	+	W	Across	All	
<i>Locusta</i>	<i>migratoria</i> Linnaeus	+	W	Across	All	
<i>Gastrimargus</i>	<i>marmoratus</i> (Thunberg)		W	Across	All	
Catantopinae – Endemic genera						
<i>Alectorolophus</i>	<i>deceptor</i> Ramme	+	B	—	SE, N	*
	<i>obscoenus</i> Brunner von Wattenwyl	+	B	—	N	*
	<i>unilobatus</i> Brunner von Wattenwyl		B	—	S	*
	<i>applicatus</i> Brunner von Wattenwyl		B	—	S, C	*
	<i>speciosus</i> Brunner von Wattenwyl		B	—	S	
	<i>mutator</i> Ramme		B	—	N	*
	<i>sororum</i> Ramme		B	—	C	*
	<i>lineatus</i> Ramme		B	—	C	*
	<i>guttulosus</i> Ramme		B	—	N	*
<i>Acrolophus</i>	<i>cornutus</i> Ramme		B	—	C	*
<i>Alectorolophellus</i>	<i>heinrichi</i> Ramme		B	—	S	*
<i>Mengkocacris</i>	<i>olivacea</i> Ramme		W?	—	SE	*
<i>Heinrichius</i>	<i>nobilis</i> Ramme		W	—	N	*
<i>Celebesia</i>	<i>acuticerca</i> Bolivar C	+	W?	—	N	*
	<i>ferruginata</i> Brunner von Wattenwyl		W?	—	N	*
	<i>heinrichi</i> Ramme		W?	—	S	*
<i>Paramesambria</i>	<i>flavomaculata</i> Willemse		B	—	S	*
<i>Paracranae</i>	<i>celebesia</i> Willemse	+	B	—	N	*
Catantopinae – Non-endemic genera						
<i>Tarbaleus</i> Brunner von Wattenwyl	sp. n.	+	B	M, NG	N	*
<i>Oxya</i>	<i>japonica japonica</i> Thunberg	+	W	Across S, P	All	
	<i>bolaangensis</i> Hollis		W	—	N	*
	<i>stresemanni</i> Ramme		W	—	C	*
<i>Gesonula</i>	<i>mundata pulchra</i> Rehn	+	W	Across S	N	
<i>Chitaura</i>	<i>brachyptera</i> Bolivar I	+	B	M, Java, India?	N	
	<i>flavolineata</i> (Willemse)		B	—	N	*
	<i>atrata</i> Ramme		B	—	C	*
	<i>mirabilis</i> Carl		B	—	C	*
	<i>ochracea</i> Ramme		B	—	S	*
	<i>vidua</i> Carl		B	M	S	
	<i>mengkoka</i> Ramme		B	—	SE	
	<i>samanga</i> Carl		B	—	S, SE, C	
	<i>poecila</i> Ramme		B	—	N	*
	<i>elegans</i> Ramme		B	—	S	*

Table 1. Species of Acridoidea occurring in Sulawesi and their distributions. (continued).

		Wings ¹		Distribution ²	
				Outside	Within
<i>Oxytauchira</i>	<i>gracilis</i> Willemse		W	Burma	C *
<i>Stenocatantops</i>	<i>splendens</i> Thunberg	+	W	Across	all
	<i>angustifrons</i> Walker		W	Across	S
<i>Bibracte</i> Stål	sp. n.	+	B	S, M, P	N *
<i>Valanga</i>	<i>transiens</i> Walker	+	W	Across	N, C
<i>Oxyrrhypes</i>	<i>meyeri</i> Willemse		W	S	? *
	<i>obtusa</i> de Haan		W	S	N, C
<i>Cranaella</i>	<i>carnipes</i> Ramme		B	P	N *
<i>Tristria</i>	<i>pisciforme</i> Serville		W	S	N
<i>Austracris</i>	<i>guttulosa guttulosa</i> Walker		W	P, A	N
<i>Mesambria</i>	<i>maculipes</i> Stål	+	B	A	India? all
	<i>elegans</i> Ramme		B	—	S
	<i>trapezina</i> Ramme		B	—	C *
	<i>rectangularis</i> Ramme		B	—	N *
<i>Traulia</i>	<i>kukenthali</i> Ramme		W?	S, P, M	? *
	<i>sanguinipes</i> Stål		W?	—	? *
<i>Apalacris</i>	<i>gracilis</i> Willemse		W	S, P	S
	<i>incompleta</i> Willemse		W	—	S
	<i>celebensis</i> Willemse		W	—	? *
<i>Moessonia</i>	<i>tenebrifera</i> Walker		W?	NG	N

Notes

+ indicates a species collected by Project Wallace

- 1 - W - fully winged
W? - winged but probably a poor flier
B - brachypterous or wingless
- 2 - Distributions outside Sulawesi:
M - Moluccas
S - Sundaland
P - Philippines
A - Australasia
NG - New Guinea
Across - at least Sundaland to New Guinea

2 - Distributions within Sulawesi:

- all - all four regions
N - North
S - South
SE - South-East
C - Central

* indicates that the species is known only from one or a few sites.

are reasonably reliable since intensive collecting produced so few undescribed species, and those only from inaccessible habitats. Data on distribution within Sulawesi is less reliable with a significant proportion of species described from only one or a few localities. However collecting localities in the past have been widespread and so this may reflect very localised species distributions (see below). A probable exception is Central Sulawesi, parts of which remain very inaccessible. The expedition collection represents only a small proportion of the total acridoid fauna of Sulawesi (16 out of 59 described species) and this is also likely to be a result

of localised species distributions rather than under-collecting.

The acridoid fauna of Sulawesi

Expedition and literature data give a total of 62 Sulawesi acridoid species in 33 genera and five sub-families (table 1). The Catantopinae form by far the largest group with 53 species. This very diverse subfamily, which some authors consider to be an amalgam of several distinct subfamilies (eg Dirsh 1961), is one of the few acridoid groups to have adapted to forest environments. All of the non-

catantopine species in Sulawesi are forest edge or open habitat species whereas about 80% of catantopine species occupy habitats within the forest. Related to this is the occurrence of flightless species, with wings either absent or reduced, which are much more common in the Catantopinae (37/53 species) than in the other subfamilies (1/9 species). Flightlessness in grasshoppers is probably an adaptation to poor habitat quality, diversion of resources away from wing and flight muscle production allowing earlier reproduction and/or greater fecundity (Ritchie et al. 1987), and is common in forest species in other areas (Jago 1973).

Flightlessness clearly limits dispersal and so may have an impact on levels of endemism. In Sulawesi endemism is high for the Acridoidea, as it is for many other groups (Whitten et al. 1987) including Eumastacidae and Tetrigidae in the Orthoptera (Butlin et al 1989, Blackith & Blackith 1988). Overall 74% of acridoid species are endemic to Sulawesi but the proportion is higher in the Catantopinae (83%) than in the other subfamilies (22%). There is a clear link with the ability to fly: only two out of nine non-endemic catantopines are flightless, and the one flightless non-catantopine is endemic (table 1).

Table 2. Comparison of the Catantopinae of Sulawesi and Java.

	Java	Sulawesi
Number of species recorded	47	53
Number of genera recorded	34	24
Number of species per genus	1.38	2.21
Proportion of endemics – species	40%	83%
– genera	15%	33%

Table 3. Distributions outside Sulawesi.

	Non-endemic Species ¹	Non-endemic Genera ²	Relationships of Endemic Genera ³
Across	5	1 (10)	0
Sunda Shelf	7	4 (8)	2
Borneo	0	0 (0)	1
(exclusively)			
Philippines	1	1 (1)	0
(exclusively)			
Moluccas	1	0 (0)	0
(exclusively)			
Australasia	1	2 (3)	1

Notes

1. Includes distributions of *Oxya japonaci japonaci*, *Gesonula mundata pulchra*, and *Austracris guttulosa guttulosa*. All species have distributions 'Across' but the subspecies have informative distributions.
2. Excluding (including) genera with non-endemic species.
3. See text for details.

The special nature of the Sulawesi fauna can be appreciated better if it is compared with the fauna of Java. Java is the most comparable island in the region in terms of land area (126,500 km²) but is part of the Sunda Shelf and has a clearly Oriental fauna. This comparison can be made most easily for the Catantopinae using data from C. Willemse (1956, 1957), F. Willemse (1965) and Hollis (1971, 1975). The total number of species recorded is similar (table 2) but the number of genera present in Sulawesi is lower with a significantly greater number of species per genus ($\chi^2 = 6.5$ P < 0.01) Endemism at the species level in Sulawesi is twice that in Java, as is generic level endemism.

Biogeographical links

Sharing of taxa between Sulawesi and its surrounding areas is summarised in table 3 for non-endemic species (and subspecies) and genera. It is clear that Sulawesi shares the greatest number of species and genera with the Sunda Shelf as a whole (Peninsula Malaysia, Borneo, Sumatra, Java and Bali). This bias is strongest at the specific level but is also present among non-endemic genera. We have found no exclusive links with Borneo at either level, despite the close proximity of the two islands.

Links with the Philippines are mostly due to species or genera which also occur on the Sunda Shelf but there are two exclusive links, the gomphocerine *Eoscyllina luzonica* and the catantopine genus *Cranaella*. No species shared between Sulawesi and the Lesser Sunda Islands have been identified. To the east there is one species, *Chitaura vidua*, which occurs in Sulawesi and the Moluccas and one, *Austracris guttulosa*, which is distributed widely in Australasia and for which Sulawesi is the western limit. At the generic level there are two further links to the east, the genera *Moessionia* and *Tarbaleus*.

For endemic genera biogeographical information can only be derived from the distribution of sister genera but since the phylogeny of these groups has been studied very little these relationships are not known with any certainty. The following relationships, suggested by Ramme (1941) and Willemse (1951, 1956, 1957), are included in table 3. A group of four endemic genera, the Acrolophi (*Acrolophus*, *Alectorolophus*, *Alectorolophellus* and *Mengkocacris*), has apparently evolved within Sulawesi, indicating a long period of isolation. The nearest relatives of this generic group are apparently *Paralectorolophus* and *Lyrolophus* which occur on Lombok and Java respectively. The acridine genera *Calliphlaeoba* and *Phlaeobacris* are both probably related to *Phlaeoba* which has a Sunda Shelf plus Philippines distribution.

Heinrichius is believed to be most closely related to *Noliba* and therefore provides the only exclusive

link with Borneo. *Paracranæ* is part of the *Cranæ* group of genera which occurs in the Moluccas and New Guinea (Willemse 1977a, b).

Two genera are problematic because their nearest relatives are non-endemic Sulawesi genera. This implies that the latter are polyphyletic since the Sulawesi representatives of the two genera of each pair are likely to be more closely related to one another than the Sulawesi species of the non-endemic genus are to species in the same genus occurring elsewhere. *Celebesia* is believed to be most closely related to *Traulia* (Sulawesi and the Sunda Shelf), an *Paramesambria* to *Mesambria* (Sulawesi and India, Henry 1942). The distribution of *Mesambria* is particularly surprising but it is paralleled by *Chitaura* which also has an Indian representative (Hollis 1975). Neither of the two endemic genera (*Celebesia* and *Paramesambria*) has been included in table 3.

Endemism within Sulawesi

Mosaic distributions of species or subspecies within Sulawesi have been noted for several animal groups, eg macaques, carpenter bees, pond skaters (Whitten et al 1987 and see Knight & Holloway 1990). Ramme (1941) commented on a similar phenomenon in the Catantopinae and this appears quite striking when the island is divided into regions (table 4). A high proportion of the species present in any one region are known only from that region. This is particularly clear in the two most species rich genera in Sulawesi: *Alectorolophus* has nine species, seven of which are known from only one region, and *Chitaura* has ten species, nine of which are known from only one region. However the distributional information available is limited. Many species (table 1) are known from only one locality, but collecting localities overall have been widely distributed around the island and so this may represent genuinely very restricted distributions. Where more localities are known, five out of seven endemic and six out of eight non-endemic species are restricted to one region. Intensive searching of a restricted area during the Project Wallace expedition yielded only a small proportion of the total number of catantopine species known to occur in

Sulawesi (10/53) but a much higher proportion of the species known to occur in North Sulawesi (9/21). Only one species previously reported from another region was collected. Nine of the species not collected on the expedition were previously reported only from the western part of the peninsula of North Sulawesi, (particularly Toli-Toli) distant from the Dumoga-Bone National Park, suggesting that distributions are also restricted within regions. The within island endemism in the genus *Chitaura* is particularly striking in this context. Species in this genus are brightly coloured and conspicuous and occur on the forest edges as well as in light gaps within the forest. It is unlikely that the expedition would have failed to collect any species occurring in the Dumoga Bone area and yet only one of the ten Sulawesi species was found. This argument applies to collecting of *Chitaura* in general and so this genus gives strong support to the existence of intra-island endemism, and would be a good candidate for further work.

DISCUSSION

The Acrididae of Sulawesi show four main characteristics: (a) a high level of endemism, (b) low generic diversity but a high number of species per genus, (c) diverse distributions outside Sulawesi, and (d) localised species distributions within the island. These features have parallels in several other animal groups (Whitten et al 1987, Knight & Holloway 1989) and can be related to the geological history of the island.

The Acridoidea did not begin their radiation until the mid-Tertiary (Sharov 1968), that is after the break up of Gondwanaland and the beginning of the proposed northward movements of the fragments of present day Sulawesi. Thus the current Acridoid fauna of Sulawesi must have originated by dispersal and its low generic diversity can be explained in one of two ways: either Sulawesi was more isolated for much of its history than it is at present, or it has only recently become dry land due to tectonic uplift. The former explanation is more consistent with the observation of high levels of specific and generic endemism and high numbers of species per genus on the island, all of which suggest a long period of independent evolution for the Sulawesi acridoids. The sources of colonists for Sulawesi appear to have been numerous although the largest number of shared species and genera is clearly with the Sunda Shelf region. This may be partly due to the higher diversity of Acridoidea in Asia than in Australasia but there are several species or subspecies distributions which extend eastwards only as far as Sulawesi and very few equivalent Australasian distributions which extend westwards to Sulawesi. Thus at least a part of Sulawesi appears to have been closer to the Sunda Shelf than to Australasia for a significant

Table 4. Regional distribution of Catantopine species within Sulawesi.

Region	Number of species occurring in:	
	that region only	that region and elsewhere
North	19	5
Central	8	6
South	12	5
South-East	3	5

part of its history. However its current proximity to Borneo is probably recent since there are no exclusive biogeographical links at the level of shared species or genera. This is also true in other animal groups, notably the butterflies (Vane-Wright 1990). Exclusive links with the Philippines and Moluccas are also weak and may be recent. This is consistent with a general geological view of the area as a collision zone in which the area of dry land is increasing and land masses are moving closer together.

The high proportion of endemic species and genera in Sulawesi, the number of species per genus, and the evidence for evolution of new genera within the island all suggest not only a long period of isolation but also the opportunity for considerable evolutionary change and speciation. The mosaic distributions of species, particularly in the forest dwelling, flightless catantopines, may provide a clue to the conditions which have favoured these developments. Mosaic distributions are a feature of several other animal groups (Whitten et al 1987, Knight & Holloway 1990) and the patterns in different groups appear to be broadly coincident, defining areas of endemism within Sulawesi. The simplest explanation for these areas of endemism is past fragmentation of Sulawesi. This could have been in the form of an archipelago at times of higher sea level or before tectonic uplift and volcanic activity had created the present land mass (Musser 1987), or due to reduction in the extent of forest habitats in periods of drier climate (Morley & Flenley 1987). The wingless, forest adapted catantopines would be particularly susceptible to population fragmentation by such processes. Evolutionary divergence on islands or in refugia would have been followed by expansion to form the present mosaic distribution. Contact zones between the forms have not been studied, or indeed accurately located, and so the consequences of renewed contact are unknown. In general several possible types of interaction exist: sufficiently divergent forms may be able to spread into sympatry progressively obscuring the mosaic pattern, less divergent forms may interact at sharp parapatric boundaries due to ecological exclusion, or where reproductive isolation is incomplete a hybrid zone may form (Barton & Hewitt 1985). Identification and analysis of such contact zones is likely to be a very productive area for future research.

Strict isolation on islands or in refugia may not be necessary for evolutionary divergence (Barton 1989), especially in an island with the curious shape of Sulawesi in which gene flow between populations inhabiting different peninsulas would be extremely restricted even if they were connected by continuous suitable habitat. However, divergence without isolation is likely to produce different patterns of variation for individual characters within

species as well as for different species. Coincidences of patterns of variation are most likely to be produced by contraction and expansion of populations, and this process may be necessary for the completion of speciation (Hewitt 1989).

The mosaic distributions of species within Sulawesi constitute evidence either for the archipelagic nature of the land mass in the past or for habitat fragmentation during climatic fluctuations, or both. The time scale for these changes, and thus for the evolution of the Sulawesi endemics, is uncertain. They could have occurred mainly in the Pleistocene or over a much longer time scale of the order of the 15 Myrs suggested as the time since the formation of Sulawesi as a single unit (Audley-Charles 1987). Most probably the present fauna of Sulawesi is the result of several superimposed periods of divergence. Studies of genetic divergence and detailed investigations of the contact zones appear to be the way forward in understanding the evolution of the Sulawesi grasshoppers.

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TWO NEW SPECIES OF *SARCOPHAGA* MEIGEN FROM MADEIRA AND MAINLAND PORTUGAL (DIPTERA: SARCOPHAGIDAE)

Pape, T., 1990. Two new species of *Sarcophaga* Meigen from Madeira and mainland Portugal (Diptera: Sarcophagidae). — Tijdschrift voor Entomologie 133: 39-42, figs. 1-9. [ISSN 0040-7496]. Published 31 July 1990.

Sarcophaga (*Discachaeta*) *amputata* sp.n. (Madeira) and *Sarcophaga* (*Pierretia*) *ilicida* sp.n. (Portugal) are described and their phylogenetic affinities are discussed. *S. ilicida* was bred from the millipede *Ommatoiulus moreleti* (Lucas, 1860).

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Key words. — Diptera; Sarcophagidae; New species; Madeira; Portugal.

INTRODUCTION

A number of specimens representing two undescribed species of *Sarcophaga* Meigen were recovered from various sources. As the accompanying biogeographical and biological information is rather interesting, it is felt that the following descriptions are justified, although they do not form part of a more thorough revision.

Depositories for specimens examined are indicated by the following acronyms:

BMNH — British Museum (Natural History), London, England; NMWC — National Museum of Wales, Cardiff, England; ZMUC — Zoologisk Museum, University of Copenhagen, Denmark.

SYSTEMATIC PART

Sarcophaga (*Discachaeta*) *amputata* sp.n. (figs. 1-4)

Type material. — Holotype ♂, Madeira (Portugal): Between Canical & Prainha, 5.viii.1981, M. Jones (NMWC). The holotype is in good condition, glued to the pin along the right side of thorax and with the terminalia dissected and glued to a piece of cardboard pinned with the specimen.

Paratypes. Madeira: 1♂ 1♀, [no further locality, but with the number 1948-301], T.W. Wollaston (BMNH, NMWC); 2♀, data as holotype (NMWC, ZMUC); North end of Deserta Grande, 1♂ 1♀, 18.viii.1981, M. Jones (ZMUC, NMWC).

Description

Male. — Head. Narrowest part of frons 0.25-0.30 × head width. Parafrons with a uniserial row of setae along the eyemargin, the lower setae of this row being long and bristly. Postgena with white setae in about posterior 0.50-0.75

(strict lateral view).

Thorax. Proanepisternum setose in about upper half. Chaetotaxy: 3 indistinct pairs of presutural acrostichals, postsutural acrostichals absent or represented by the prescutellar pair only, dorsocentrals = 3 + 3, intra-alars = 1 + 2, supra-alars = 1 + 3, post alars = 2. Scutellum with a pair of apicals, 3-4 pairs of marginals and without discals. Mid femur with 2-3 anteroventral bristles, no posteroventral bristles. Hind tibia with a sparse row of elongated posteroventral setae.

Abdomen. Tergites 3-4 with silvery grey microtomentum mainly restricted to anterior half and almost non-changing; interrupted by a median black stripe. Tergite 5 with microtomentum reduced to narrow strips in antero-lateral position. Terminalia black or blackish brown. Protandrial segment with a row of marginal bristles. Cercus in profile with a distinct subapical dorsal hump. Aedeagus with very long harpes that terminates in a distinct hook, and a long, terminally bifid juxta. Gonopod with the usual row of long setae along dorsal margin but with some additional setae on the median surface.

Length: 8-9 mm (estimated from dissected specimens).

Female. — Very like the male apart from the usual sexual dimorphism. Abdominal pattern slightly more changing and with the median black stripe almost absent. Mid femoral organ not differentiated. Terminalia red. Tergite 6 broadly arched, the dorsal part reduced to a narrow strip, and marginal bristles only present laterally.

Length: 7.0-7.5 mm.

Distribution. — Palaearctic: Madeira islands (Madeira, Deserta Grande).

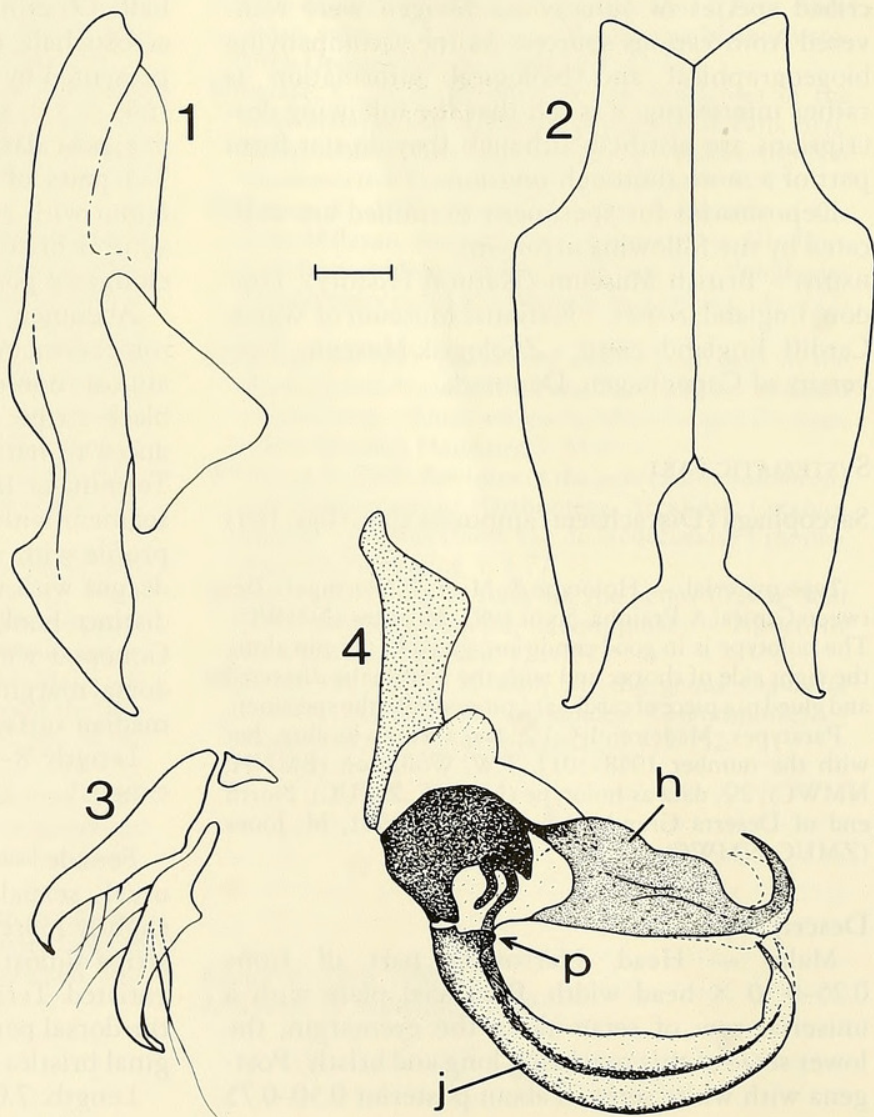
Etymology. — A Latin adjective, *amputatus* = cut off, amputated. The name refers to the structure of the aedeagus where the pair of very short arms at juxtal base will separate the species from all other species of the subgenus *Discachaeta*.

Remarks. — The sarcophagid fauna of Madeira was reviewed by Pape (1986), who listed a total of five species, three of which were judged to be recent introductions by man. The present species is interesting as it is the third apparently endemic species, and much evidence is in favour of considering this the sister species of the Madeiran *Sarcophaga* (*Discachaeta*) *kunonis* (Pape, 1986). The latter species was described in the genus *Discachaeta* Enderlein, which here is given subgeneric rank following the wide concept of *Sarcophaga* employed by Ségué (1941), Downes (1965) and Pape (1988). *Discachaeta* is probably a monophyletic group, this hypothesis being corroborated by at least the following character states that all seem to be derived with

regard to the groundplan of the Sarcophaginae and probably with regard to that of *Sarcophaga* sensu lato as well: 1) Male hind coxa with a ventro-medial pad of short spiny bristles; 2) Aedeagal juxta more or less dome-shaped and arching over the lateral styli; 3) Base of juxta with a pair of arms or processes; 4) Male cercus dorsally with a flattened or concave area and with a more or less distinct hump subapically; 5) Female mid femoral organ, if present, in apical position.

Defined in this way, *Discachaeta* contains six species, all distributed in the western Palaearctic. (Note that the species *Discachaeta* *gigas* Povolný, 1986 was transferred to *Heteronychia* Brauer & Bergenstamm (*Eupierretia* Rohdendorf) in an addendum of the original paper.)

The hypothesis that *Sarcophaga* *amputata* and *S. kunonis* are sister species is corroborated by the presence in these two species of at least five character states that are judged to be derived with regard to the ground plan of *Discachaeta* and not found in any other species of this taxon: 1) Postgena with at least some black setae in anterior part, 2) Proanepisternum setose, 3) Abdominal tergite 5 almost de-



Figs. 1–4. *Sarcophaga* *amputata*, male terminalia. 1, right cercus and surstylus, lateral view, setae omitted; 2, cerci, posterior view, setae omitted; 3, right paramere + gonopod, lateral view; 4, aedeagus, lateral view. Abbreviations: h = harpes, j = juxta, p = process at juxtal base. Scale = 0.1 mm.

void of microtomentum, 4) Male gonopod with long setae on the median surface (fig. 3), and 5) Female mid femoral organ reduced, i.e. indistinct or absent. *Sarcophaga amputata* is easily separated from *S. kunonis* in both sexes by the greater extension of white postgenal setae. These cover at least one half (strict lateral view) of the postgena in *S. amputata* while they are almost absent in *S. kunonis*. However, as the Madeiran fauna of Sarcophagidae may still be incompletely known, the shape of the aedeagus still provides the best clue to reliable identifications.

Sarcophaga amputata may be widespread on the main island and is the first species of Sarcophagidae recorded from the Desertas islands.

Sarcophaga (Pierretia) *iulicida* sp.n. (figs. 5–9)

Type material. — Holotype ♂, Portugal: Mourão, ex *Ommatoiulus moreleti*, larva 8.v.1987, pupa 14.v.1987, adult 30.v.1987, P.T. Bailey (BMNH). The holotype is in good condition, with the puparium glued to a piece of cardboard and the dissected terminalia stored in glycerine in a microvial, both items pinned with the specimen.

Description

Male. — Head. Narrowest part of frons $0.25 \times$ head width. Parafracial plate with a row of setae along the eyemargin. The upper part of the row consists of uniserial setae, the lower part is irregularly biserial with 3–5 long bristles anterior to the

setae. Arista with longest hairs about 4 x as long as second aristomere. Gena with black setae only, postgena with white setae only.

Thorax. Proanepisternum bare. Chaetotaxy: 2–3 distinct pairs of presutural acrostichals, postsutural acrostichals (including prescutellars) not differentiated, dorsocentrals = 3 + 3, intra-alars = 1 + 2, supra-alars = 1 + 3, postalars = 2. Scutellum with 2 pairs of lateral scutellar bristles, 1 pair of short apicals, and 1 pair of discals. Mid femur with 3 anteroventral bristles and a row of posteroventrals. Apical posteroventrals slightly stronger than apical anteroventrals. Hind tibia without elongated setae.

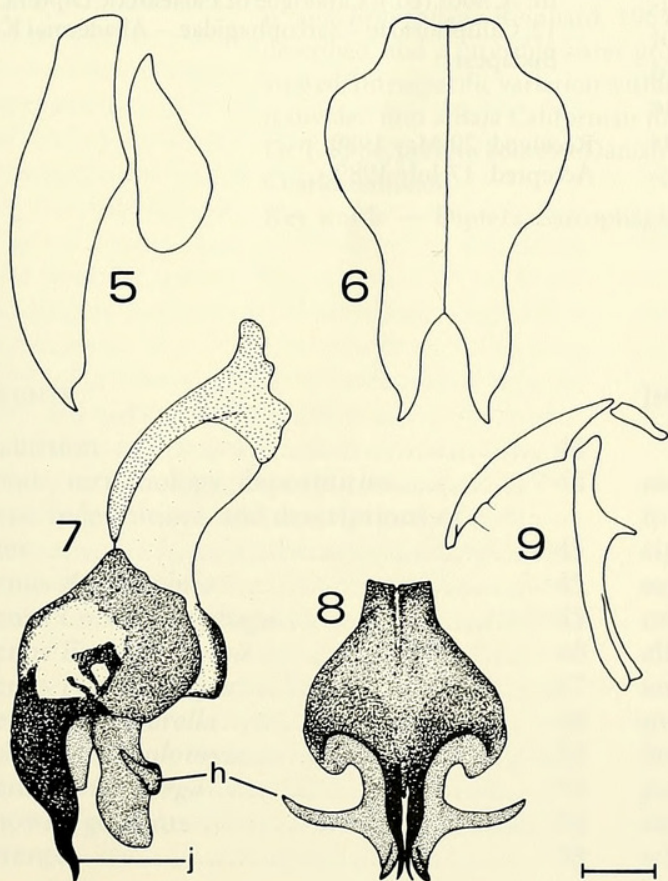
Abdomen. Tergites 3–4 with strong median marginals on T5 with a complete row of marginals. Terminalia black, protandrial segment without marginal bristles. Aedeagus with well developed harpes, each of which has a narrow winglike process that is directed laterally and opposite to its counterpart. Vesica reduced to a simple swelling or hump. Juxta moderately long and deeply cleft.

Length: 7 mm (estimated from dissected holotype).

Female. — Unknown.

Puparium of the usual barrel-shape and with the posterior spiracles in a deep pit as in most species of Sarcophaginae.

Distribution. — Palaearctic: Portugal.



Figs. 5–9. *Sarcophaga iulicida*, male terminalia. 5, right cercus and surstylus, lateral view, setae omitted; 6, cerci, posterior view, setae omitted; 7, aedeagus, lateral view; 8, distiphallus, dorsal (= posterior) view; 9, right paramere + gonopod, lateral view. Abbreviations: h = harpes, j = juxta. Scale = 0.1 mm.

Etymology. — A noun in apposition. From the Latin *iulus* = multiped, millipede, and *-cida* = suffix denoting cutter, killer, killing. The name refers to the millipede-parasitizing habit of the species.

Remarks. — The present species belongs to a probably monophyletic group whose members all possess an aedeagus very similar to that of *Sarcophaga nigriventris* Meigen. The group is defined by the characteristic and probably apomorphic shape of the aedeagal juxta, which can be dissolved into the two character states: 1) Juxta deeply cleft, and 2) Juxtal prongs tapering. Both states are readily seen on figs. 7–8. No formal genus-group name has been applied explicitly to this taxon, but the concept of *Pierretia* Robineau-Desvoidy (sensu stricto) of Verves (1986) is very close, the only difference being that this author includes *Sarcophaga granulata* Kramer, which does not possess either of the derived character states. I prefer to restrict the name *Pierretia*, as a subgenus of *Sarcophaga*, to the group of species possessing the two above mentioned character states, i.e. *Sarcophaga discifera*/Pandellé, *S. iulicida*, *S. lunigera* Böttcher, *S. nigriventris*, *S. socrus* Rondani, *S. soror* Rondani, *S. sororcula* (Rohdendorf) and *S. villeneuvei* Böttcher. *Sarcophaga iulicida* may easily be separated from other members of the subgenus by the wing-like projection of each of the harpes which is directed laterally and set at right angles to the longitudinal axis of the aedeagus. This is most easily seen in dorsal (= posterior) view (fig. 8).

The biology of *Sarcophaga iulicida* is interesting as very few Diptera are known to parasitise millipedes, and among the Sarcophagidae only species of the New World genus *Spirobolomyia* Townsend have been repeatedly bred from live millipedes. The habits of other species of the subgenus *Pierretia* (as defined above) indicate a broad to very broad spec-

trum of hosts or prey. Thus, the species *Sarcophaga nigriventris* has been bred from snails, beetles, grasshoppers and bees (see references in Pape 1987).

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REVISIONARY NOTES ON AMERICAN SARCOPHAGINAE (DIPTERA: SARCOPHAGIDAE)

Pape, T., 1990. Revisionary notes on American Sarcophaginae (Diptera: Sarcophagidae). Tijdschrift voor Entomologie 133: 43-74, 66 figs. ISSN 0040-7496. Published 31 July 1990. Selected New World genera of Sarcophaginae are redefined: *Argoravinia* Townsend, 1917 is treated as a senior synonym of *Raviniopsis* Townsend, 1918, syn. n., *Comasarcophaga* Hall, 1931 as a senior synonym of *Archimimus* Reinhard, 1952, syn. n., and *Emblemasoma* Aldrich, 1916 as a senior synonym of *Pessoamyia* Lopes, 1938, syn. n. and *Colcondamyia* Reinhard, 1963, syn. n. *Microcerella* Macquart, 1851 is considered as synonymous to the tribe Microcerellini, except that *Cryptosarcophila* Townsend, 1931 is excluded, and 6 new names are proposed to replace junior secondary homonyms: *Microcerella aulacophyto* nom. nov. for *Aulacophyto auromaculata* Townsend, 1919; *Microcerella austrohartigia* nom. nov. for *Austrohartigia bicoloricauda* Lopes, 1981; *Microcerella boettcherimima* nom. nov. for *Boettcherimima hypopygialis* Lopes, 1950; *Microcerella boetia* nom. nov. for *Boettia ecuatoriana* Lopes, 1982; *Microcerella carchia* nom. nov. for *Carchia andina* Lopes, 1982; and *Microcerella jujuyia* nom. nov. for *Jujuyia alvarengai* Lopes, 1980. *Microcerella bermuda* sp. n. (Bermuda Is) and *M. adelphe* sp. n. (eastern Canada & USA) are described and the phylogenetic relationships to other members of the genus are discussed. *Microcerella acridiorum* (Weyenbergh, 1875) is considered a senior synonym of *Xenoppiella dysciniti* Blanchard, 1966, syn. n. *Fletcherimyia* Townsend, 1917 and *Spirobolomyia* Townsend, 1917 are discussed in a phylogenetic context and it is argued that both taxa should be excluded from *Blaesoxipha* (s.l.) [Protodexiini + Impariini]. Species limits within the genera are revised and *Fletcherimyia abdita* sp. n. (southeastern USA) and *Spirobolomyia latissima* sp. n. (southeastern USA & Mexico) are described. *Tripanurga* Brauer & Bergenstamm, 1891 is redefined and treated as a senior synonym of *Metoposarcophaga* Townsend, 1917, syn. n. and *Erucophaga* Reinhard, 1963, syn. n. *Tripanurga guatemala* sp. n. (Guatemala) is described, and a probable sister group relationship to *T. villipes* (Wulp, 1895) is demonstrated. Intraspecific variation within *T. aurea* (Townsend, 1917) is discussed and the species is divided into a Baja Californian form and a mainland form.

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Key words. — Diptera; Sarcophagidae; generic redefinitions; new species; New World.

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INTRODUCTION

The New World fauna of Sarcophagidae deviates markedly from that of the Old World with regard to diversity. The subfamily Miltogrammatinae has significantly fewer species, which in part is to be expected as the fauna of the Palaearctic Region is much more fully known and the extension of generally species-rich areas as dry savannas, shrublands and semi-deserts is much larger, e.g. on the African mainland and in Central Asia. Within the subfamily Sarcophaginae, on the other hand, species richness *per se* is greater in the New World, and as the sarcophagine fauna of especially the neotropics, where the large majority of species occur, is still

very insufficiently known, this difference may become even more pronounced with time. The New World fauna of Sarcophaginae has diversified morphologically and biologically to a degree unrivalled by the Old World members of this subfamily. Some New World species have green eyes, several have a metallic abdomen, and variations in setosity and configuration of the male terminalia are legio and often much more radical than those of the Old World species. The New World species *Peckia gulo* and *Tricharaea occidua* represent the largest and the smallest species of Sarcophaginae, respectively, and sarcophagine life habits include parasites of millipedes and insects, as well as predators of reptile eggs, hymenopteran kleptoparasites and generalized scavengers. The much greater morphological and biological diversity of New World species of Sarcophaginae compared to those of the Old World has caused pronounced differences of opinion regarding generic limits within this subfamily (especially so, because many of the previous authors have been more interested in differences than in similarities). Numerous monotypic genera have been proposed, with no other warranty than their 'uniqueness' and/or weirdness.

My research on New World Sarcophaginae, especially in connection with a major conspectus of the genus *Blaesoxipha* covering species limits and inter- and infrageneric phylogenetic relationships (Pape in prep.), during a one-year fellowship at the National Museum of Natural History (USNM), Washington, D.C., has led me to propose some phylogenetically more consistent generic definitions. It is felt that these definitions, in addition to being theoretically sound, support identification and information retrieval purposes better, and it is considered appropriate to make the information available as a single paper, with descriptions of several hitherto unrecognized species which turned up during my study, rather than split it into several generic revisions and isolated descriptions of species. Thus, it should be stressed that the present paper is far from a comprehensive treatment of all New World genera, and the fact that most genus-group taxa have been excluded does not mean that these are accepted by me. Older genus-group taxa such as *Pachygraphia* Brauer & Bergenstamm, 1891, *Lepidodexia* Brauer & Bergenstamm, 1891, and *Johnsonia* Coquillett, 1895 are especially in need of a critical revision and will probably have to be redefined as much broader entities in order to absorb the numerous 'less aberrant' and probably paraphyletic genera that often are considered 'closely related' to these genera. Much remains to be done before generic limits stabilize, and more thorough character analyses are needed before the taxa above species level can emerge as well corroborated monophyletic groups.

METHODS, TERMINOLOGY, DEPOSITORIES

Specimens were dissected by conventional cutting of terminalia and heating in potassium or sodium hydroxide for about five minutes with subsequent rinsing in distilled water and transfer through alcohol to glycerine. Drawings of terminalia were made from glycerine preparations, either directly by using an ocular grid or from semipermanent slide mounts in glycerine gel using a projecting compound microscope.

Names of genus-group and species-group taxa mentioned in the text are given without the conventional citing of the original author except where this has any direct bearing on nomenclature, e.g. in the lists of synonyms. According to the International Code on Zoological Nomenclature, authors do not form part of the name proper (ICZN: 51,a), and they often serve no other purpose than as a reference to the original source of the name. Recent revisions are usually a better authority on the identity of a species or genus than the original description. For the present paper, identities of taxa not explicitly defined are easily retrieved from the references cited in the associated discussion or from the most recent regional catalogues, i.e. Downes (1965) and Lopes (1969), but see also Shewell (1987).

Morphological terms follow McAlpine (1981) except that I have adopted Sabrosky's (1983) use of 'microtomentum' for the dense cuticular micro-pubesence that may give surfaces a pollinose or pruinose appearance.

As no generic cladogram of the Sarcophaginae has been produced in the present or any other paper I have made no attempt of evaluating transformation series polarities for the character states used in the generic diagnoses, i.e. whether apomorphic or plesiomorphic at the level in question (which would be nothing but 'qualified guesses' based on my own more or less explicitly developed ideas of generic phylogeny). The character states listed in the diagnoses are, of course, only a fraction of those known, and I have restricted the lists to contain only those states that seem to be unique (and therefore possibly autapomorphic) as well as states judged by me to possess 'diagnostic power' (i.e., they will in combination serve to define the taxon in question).

The institutions from which material examined or otherwise referred to is deposited have been abbreviated with the following acronyms:

- AMNH: American Museum of Natural History, New York, USA;
- CAS: California Academy of Sciences, San Francisco, USA;
- CNC: Canadian National Collection of Arthropods, Ottawa, Canada;
- FSCA: Florida State Collection of Arthropods, Gainesville, USA;

- MACN: Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina;
 MCZ: Museum of Comparative Zoology, Cambridge, USA;
 MNHN: Museum National d'Histoire Naturelle, Paris, France;
 NMW: Naturhistorisches Museum Wien, Austria.
 UNAM: Instituto de Biología, Universidad Nacional Autónoma de México;
 USNM: National Museum of Natural History, Washington, D.C., USA;
 ZML: Zoologiska Museet, Zoologiska Institutionen, Lund, Sweden;
 ZMUC: Zoological Museum, University of Copenhagen, Denmark.

GENERIC REDEFINITIONS AND DESCRIPTIONS OF SPECIES

Genus *Argoravinia*

Argoravinia Townsend, 1917b: 190, 193, 195. Type species: *Sarcophaga argentea* Townsend, 1912 (= *Sarcophaga rufiventris* Wiedemann, 1830), by original designation.

Raviniopsis Townsend, 1918: 160. Type species: *Raviniopsis aurea* Townsend, 1918, by original designation. Syn. n.

Sarcophagina Curran, 1928: 102. Type species: *Sarcophagina candida* Curran, 1928, by original designation.

Pachygraphomyia Hall, 1933: 259. Type species: *Pachygraphomyia spinosa* Hall, 1933, by original designation.

Diagnosis. — The genus *Argoravinia* may be defined by the following character states:

- 1) Aedeagus with a very long and S-shaped median stylus, see, e.g., Roback (1954: fig. 39);
- 2) One or more setae on the underside of the stem of r_{2+3} elongate;
- 3) Male cercal prong bent backwards;
- 3) Ejaculatory apodeme large.

As tentatively suggested by Pape (in press), the genera *Argoravinia* and *Raviniopsis* should be treated as synonyms. They have been included in a subtribe of their own (within Sarcodexiini) by Lopes (1975a, 1982e), the monophyly of which although never corroborated by explicit reference to probable apomorphies has never been questioned. Lopes (1982e) lists a number of character states, but only some of these can be considered derived with regard to the groundplan of the Sarcophaginae, and this author does not propose any most probable sister group. The two very distinctive character states 1-2 mentioned above seem to be autapomorphic and will fully define the genus. The remaining two character states may diagnose the taxon further, but these may be plesiomorphic at the level of *Argoravinia* (i.e. define a more inclusive group) as discussed under *Tripanurga*.

Having corroborated the monophyly of *Argoravinia*, it remains to be discussed why a splitting is opposed. One argument is the small size of this taxon, with a total of 7 species recognized at present. Even if monophyletic subgroups can be recognized (and in theory a complete resolution into dichotomies should be possible), nothing is gained by erecting formal genus-group names if one then has to create new family-group names (e.g. tribes and subtribes) to keep the related taxa together. Another, more formal, argument is the subgroups proper. *Argoravinia* in the narrow sense of Lopes (1976), including *A. rufiventris* and *A. alvarengai*, is most probably monophyletic, defined by the autapomorphic process from the posteroventral margin of the epandrium that partially covers the surstylus, and by the much more distinctly S-shaped median stylus compared to the remaining *Argoravinia* (see figs. in Lopes 1976 and 1988b). I have not found any character state shared only by these remaining species, which were treated as *Raviniopsis* by Lopes (1988b), that may be considered apomorphic at this level, and none have been suggested. If the monophyly of the taxon cannot be corroborated, it has to be either split or widened until fitting a pattern for which character state distributions corroborate a hypothesis of strict monophyly. In the present case, the obvious choice is a merging with the older *Argoravinia*.

Genus *Comasarcophaga*

Comasarcophaga Hall, 1931: 280. Type species: *Comasarcophaga texana* Hall, 1931, by original designation.

Tejasomyia Reinhard, 1945: 68. Type species: *Tejasomyia nexilis* Reinhard, 1945, by original designation.

Archimimus Reinhard, 1952: 140. Type species: *Archimimus camatus* Reinhard, 1952, by original designation. Syn. n.

Diagnosis. — The genus *Comasarcophaga* may be defined by the following character states:

- 1) Male mid femur apically with a short comb-like row of posteroventral spines;
- 2) Male cercal prong bent backwards;
- 3) Aedeagal juxta slightly displaced ventrally relative to longitudinal axis of aedeagal tube, the latter thereby appearing 'hump-backed' (figs. 1-4, additional figs. in Lopes 1979 and Lopes & Tibana 1988);
- 4) Aedeagal vesica appearing more or less square in lateral view (cf. figs. mentioned above).

The genus *Comasarcophaga* was described by Hall (1931) as a monotypic genus for his new species *C. texana*. Downes (1965) synonymized *Comasarcophaga* with *Tejasomyia*, thereby adding the species *C. nexilis*, and apparently only these two species were included in the genus by Shewell (1987: 1168), who gave "2 spp.; Texas, California". Another species, *Sarcophaga prolepsis*, described

by Reinhard (1947) from Arizona, was transferred by Downes (1965) to *Blaesoxipha* subgenus *Servaisia*, and later by Lopes (1988d) to *Archimimus*. Lopes & Tibana (1988: 324) defined *Archimimus* in part by the features: "styli of glans and median process spinous" (lateral and median styli in my terminology) and "arista plumose to tip". However, by including *prolepsis* and *longispinus* (Lopes 1988d), which both possess simple lateral and median styli with small denticles as well as a pubescent or short-plumose arista with a distinctly bare tip, conditions perfectly like those found in most other Sarcophaginae, the definition breaks down at least for these characters. Other character states listed by Lopes & Tibana (1988) as diagnostic for *Archimimus* are: 3-4 post-dorsocentral bristles, proanepisternum bare, male mid femur with apical comb-like posteroventral spines, aedeagal vesica strongly sclerotized, and female tergite 8 (7 in my terminology) setose. These states, however, do not secure an unambiguous definition of the taxon as this combination is found in other genera, e.g. *Blaesoxipha* in part and *Comasarcophaga*.

Of the four states listed in the definition above, 1 and 2 are found in several other genera. Only 3 and 4 seem to be unique (i.e., autapomorphic), but, unfortunately, they are less clear cut and more difficult to describe as are many other characters of the male terminalia. *Comasarcophaga* in the present definition may be divided into two groups based on similarity (as perceived by me) of the male terminalia: one containing *longispinus*, *nexilis*, *prolepsis* and *texana*; another containing the remaining members. This agrees with Lopes (1988d: 918), who mentioned that *longispinus* and *prolepsis* was "provisionally included in *Archimimus* in spite of some important differences from the type-species: last female sternite large and clypeal arch of the first instar larva complete". Differences as such, however, cannot reject phylogenetic relationships, and as I have found no better way to describe the species explicitly in terms of shared character states, lumping all *Archimimus* with *nexilis* and *texana* in a broader *Comasarcophaga* is necessary to maintain the monophyly of the taxon.

Terminalia of species of *Comasarcophaga* not figured by Lopes (1979) and Lopes & Tibana (1988) have been illustrated in figs. 1-12.

The only biological information available for *Comasarcophaga* is a single breeding record of a male *C. texana* from the bulimulid snail *Rabdotus dealbatus*, and the fact that another male of this species has been collected from a dysentery fly trap (Neck & Lopes 1973).

Genus *Emblemasoma*

Emblemasoma Aldrich, 1916: 56. Type species: *Emblemasoma erro* Aldrich, 1916, by original designation.

Pessoamyia Lopes, 1938: 333. Type species: *Pessoamyia prosternalis* Lopes, 1938, by original designation. Syn. n.

Colcondamyia Reinhard, 1963a: 82. Type species: *Colcondamyia falcifera* Reinhard, 1963a, by original designation. Syn. n.

Golcondamyia Reinhard, 1963b: 152. Unjustified emendation of *Colcondamyia*.

Diagnosis. — The genus *Emblemasoma* may be defined by the following character states:

- 1) Prosternum broadened (Shewell 1987: fig. 28);
- 2) Male mid femur apically with a row of comb-like posteroventral spines.

When Lopes (1938) described *Pessoamyia* he did not present any hypothesis as to possible relationships to other genera, and the main reason for describing the genus apparently was the "prosternum extraordinariamente desenvolvido" (p. 333). Later, Lopes (1971b: 89) presented a "study of species showing large and inflated prosternum", although without commenting on the similarly equipped *Colcondamyia*, and he uncritically accepted the validity of the two genera discussed (i.e. *Emblemasoma* and *Pessoamyia*). Actually, he did not even mention whether or not he considered the enlarged prosternum as indicating phylogenetic relationship, but he later erected the subtribe *Emblemasomatina* (Lopes 1975b, as tribe in 1982e and 1988c), including all the above-mentioned genera (Lopes 1982e), and he explicitly recognized the modified prosternum to be autapomorphic within the Sarcophagidae (Lopes 1988c).

As shown in the list of synonyms given above, I prefer to reduce the (sub)tribe to the generic level, and at least three reasons should be considered. Firstly, the comparatively small size of the entire taxon (i.e. *Emblemasoma* in the present sense), does not, in my opinion, necessitate a generic subdivision to enhance the clarity of the phylogenetic relationships between the included species. Admittedly, a group consisting of *Pessoamyia* and *Emblemasoma* sensu Lopes (1988c) may probably be monophyletic based on the shared possession of a highly modified male cercus, which in profile has a subapical dorsal knob and ends in a blunt hook (Lopes 1988c: figs. 17, 42, 45), but I prefer to name this assemblage of species the *erro* species-group rather than use a formal genus-group name. Secondly, while the monophyly of *Emblemasoma* in the present sense seems reasonably well corroborated (the species are also biologically similar in being parasites or predators of insects, as far as known), the monophyly of the groups recognized by Lopes (1988c) seems much less corroborated. Thus, the only derived character states defining the taxon *Pessoamyia* seem to pertain to the aedeagus (vesica reduced, vesica spinous, 'lateral plates' hyaline, see key in Lopes 1975b), and Lopes (1988c: 17)

admitted that males are needed to decide whether species for which only females are known "belong to *Pessoamyia*, *Emblemasoma* or to a distinct genus". Thirdly, the enlarged prosternum provides an easy-to-see feature for the recognition of the taxon and thus of value from the point of view of the non-specialist (e.g. when using a generic key).

Note that Pape (1987) included *Emblemasoma auditrix* in a wide concept of *Blaesoxipha*, and the bent male cercus and the fused abdominal sternites 6-8 of *auditrix* are indeed reminiscent of the condition found in some species of *Blaesoxipha* (Soper et al. 1976). However, my revised concept of the latter genus (Pape in prep.) includes all sarcophagine species with the lateral styli non-conducting and fused ventrally through a median sclerotization (?vesica). Therefore, the three free and apparently sperm-conducting (i.e. hollow and communicating with the spermduct) styli of *Emblemasoma* combined with the lack of a row of trochanteral spines provides evidence that neither *E. auditrix* nor all of *Emblemasoma* should be included in *Blaesoxipha* (see also discussion under *Fletcherimyia* and *Spirobolomyia*). Evidence for either placement of *auditrix*, however, is rather sparse, and I prefer the present inclusion of this species in *Emblemasoma* mainly because an inclusion within *Blaesoxipha* would require that the free styli should be considered a reversal, which so far has not been shown to occur in any other species of Sarcophaginae. A detailed numeric cladistic analysis of all sarcophagine genera is needed to test this hypothesis.

Genus *Fletcherimyia*

Fletcherimyia Townsend, 1917b: 191. Type species: *Sarcophaga fletcheri* Aldrich, 1916, by original designation.

Peltopyga Townsend, 1917b: 191, 194. Type species: *Sarcophaga celarata* Aldrich, 1916, by original designation.

Diagnosis. — The genus *Fletcherimyia* may be defined by the following character states:

- 1) Male mid femur apically with a short comb-like row of posteroventral spines;
- 2) Male cercal prong bent backwards;
- 3) Aedeagus with lateral styli shortened;
- 4) Aedeagal vesica a single tongue-shaped structure (figs. 13-18);
- 5) Aedeagal juxta with cuticular pubescence along the distal margin (figs. 13-18);
- 6) Female abdominal tergite 6 strongly convex;
- 7) Female abdominal sternites 6-7 fused;
- 8) Larvae unable to develop to maturity outside pitchers of *Sarracenia*.

Character states 5 and 6 seem to be autapomorphic.

Fletcherimyia and *Peltopyga*, both monotypic, were described in the same paper by Townsend

(1917b). When Townsend (1938) later redescribed these genera, he still included only the type species in *Peltopyga* while he did not state how many species were included in *Fletcherimyia*. Downes (1965) catalogued the Nearctic species and treated *Fletcherimyia* and *Peltopyga* as synonyms, including four similar species, all of which were known to deposit their larvae in pitchers of *Sarracenia*, in *Fletcherimyia* as subgenus of *Blaesoxipha*.

This apparently obligate association with pitcher plants is reflected in the distribution in that all species of *Fletcherimyia* have their center of distribution in the eastern part of the continent. Buckell & Spencer (1957) listed *Sarcophaga fletcheri* from Canada (Robson, B.C.), but I have been unable to confirm this and the record was apparently not accepted by Downes (1965). Species of *Sarracenia* are mainly eastern in distribution although the most wide-ranging species, *S. purpurea*, reaches far west to the District of Mackenzie and the extreme northeastern part of British Columbia (Cody & Talbot 1973). *Sarracenia purpurea* is known from one locality only in B.C., a peat bog approximately 30 km south of Fort Nelson (Krajina 1968), and the record of *fletcheri* from Robson seems unlikely. It should be expected that species of *Fletcherimyia* require a certain density of *Sarracenia* localities to be able to maintain stable populations.

Males of *Fletcherimyia* can often be seen resting on the rim of the *Sarracenia* pitchers, and these may serve as the aggregation site. Females larviposit large first stage larvae singly into newly opened pitchers, and the larvae feed on invertebrates caught in the fluid. The larva lives submerged, but with the posterior end kept at the water surface to facilitate respiration. The mature larva leaves the pitcher and pupates at the base of the plant (Forsyth & Robertson 1975, Fish 1976, Fish & Hall 1978).

A few other species of Sarcophagidae breed in the pitchers of insectivorous plants: The Nearctic *Sarcophaga* (*Liosarcophaga*) *sarraceniae* in *Sarracenia* pitchers (Aldrich 1916) and the Oriental *Sarcophaga* (*Pierretia*) *urceola* in *Nepenthes* pitchers (Beaver 1979, Shinonaga & Beaver 1979), but these are easily shown by morphological evidence to have evolved the life habit independently from species of *Fletcherimyia*, and even from each other, as indicated by the subgeneric assignment given in parentheses.

Roback (1954) gave figures of the aedeagus of the four species known to him, but instead of straightening out the homologies of the acrophallic sclerotizations, he simply introduced the morphological term 'stematis' for the type of acrophallus found in *Fletcherimyia*. Lopes (1971a: 4) stated that "the opening [of the acrophallus] is very much complicated" and proposed that it had "a different origin" from that of *Blaesoxipha*. This, however, seems

little warranted as there is no evidence that the sperm exit proper is not homologous throughout the Sarcophagidae (and probably all of Diptera), and therefore may serve as an important morphological landmark. If this is accepted, *Fletcherimyia* falls nicely within the groundplan pattern of the Sarcophaginae in that all species possess three styli which all seem to be more or less tubular and connected to the common sperm duct (fig. 18).

With the additional species described below, the genus contains five species, but some other species should be mentioned as they have been assigned to the genus *Fletcherimyia*. Lopes (1946) described *F. speciosa* from Mexico and included *Sarcophaga cesator* as well, and Rohdendorf (1971) described *Fletcherimyia zayasi* from Cuba. These three species, however, all belong to *Blaesoxipha*, the monophyly of which is corroborated mainly by the transformation of the lateral styli into non-conducting structures and a sclerotized ventromedian bridge connecting these (Pape unpubl.). It should be stressed that although Lopes (1971a: 5) stated that *Fletcherimyia* (and some other taxa) did "not belong to *Tephromyiini* [= the present *Blaesoxipha* in part]" simply because they were "good genera", it is perfectly possible to argue for the inclusion of *Fletcherimyia* within *Blaesoxipha*, e.g. as a subgenus (Downes 1965), simply by widening the concept of *Blaesoxipha* sufficiently (e.g. by defining this genus on the comb-like pv bristles of the male mid femur). This does not, of course, alter the well corroborated hypothesis that species of *Fletcherimyia* as presently recognized, form a monophyletic group. My reason for not including *Fletcherimyia* within *Blaesoxipha* is primarily that the resulting taxon, although possibly monophyletic if also containing *Comasarcophaga* and *Spirobolomyia* discussed elsewhere in the present paper, would be much more vaguely defined in the sense that the monophyly would be much more tentative. Considering the well corroborated monophyly of *Blaesoxipha*, *Comasarcophaga*, *Fletcherimyia* and *Spirobolomyia* respectively, as well as their rather different external morphology, I see no convincing arguments for combining them into one taxon. It could be argued that the combined taxon would be more easy to identify in conventional sorting of specimens, as dissections of the male terminalia, which often are necessary for the non-specialist and therefore prevent handling a large number of specimens, would be reduced to a minimum. I still prefer, however, to give the criterion of monophyly higher priority than that of usefulness.

Fletcherimyia abdita sp. n. (figs. 13, 19, 24)

Type material. — Holotype ♂, USA: Alabama, Theodore, reared from *Sarracenia drummondii*, 10.vi.1916,

F.M. Jones [paratype of *Sarcophaga rileyi*, cf. Aldrich (1916: 243)] (USNM). Paratypes. — USA: 1♂, data as holotype but with the date 22.vi.1916 [paratype of *Sarcophaga rileyi*] (USNM); 2♂, locality as holotype but without date (FSCA, ZMUC); Florida, Freeport, 2♂, 25.vi.1921, [no collector, label in Jones' handwriting], reared from *Sarracenia drummondii* (FSCA); Mississippi, Biloxi, 1♂, 6.vi.1921, 2♂, 23.vi.1921, 2♂, 25.vi.1921, F.M. Jones, reared from *Sarracenia sledgei* (4 in FSCA, 1 in ZMUC).

Description

Male. — General morphology similar to other species of *Fletcherimyia* (see descriptions in Aldrich 1916), but separated from these by the structure of male abdominal sternite 5 and male terminalia (compare figs. 13-28). The following description is restricted to these diagnostic features.

Abdomen: Posterior margin of sternite 5 with accessory lobes like those of *F. celarata* but slightly raised from the plane of the remaining sternite so that a small flange penetrates behind (morphologically above) it (fig. 19). Sternite 5 of *F. celarata* has accessory lobes broadly rounded, level with remaining sternite (fig. 20), and dark brown along posterior margin in contrast to the yellowish remaining sternite. Sternite 5 of *F. rileyi* has tapering accessory lobes and posterior margin concolorous with remaining sternite (fig. 23).

Terminalia: Cercus, as seen in posterior view, with an outline intermediate between that of *F. fletcheri* and *F. rileyi*. The aedeagus is similar to that of *F. fletcheri*, but the juxta is broader and more square and the vesica is larger with a spinelike process at about middle (fig. 13).

Female. — Unknown.

Etymology. — A Latin adjective, from *abditus* = hidden, concealed, put away. The name refers to the fact that the holotype was found amongst paratypes of *F. rileyi*.

Distribution. — Nearctic: USA (Alabama, Florida, Mississippi).

Biology. — Larvae scavengers in pitchers of *Sarracenia drummondii* and *S. sledgei*.

Genus *Microcerella*

Microcerella Macquart, 1851: 209 (236). Type species: *Microcerella rufomaculata* Macquart, 1851, by original designation.

Doringia Weyenbergh, 1875: 85. Type species: *Nemorea acridiorum* Weyenbergh, 1875, by original designation. Syn. n.

Euparaphyto Townsend, 1912: 359. Type species: *Euparaphyto alpina* Townsend, 1912, by original designation. Syn. n.

Xenoppia Townsend, 1915: 20. Type species: *Xenoppia*

- hypopygialis* Townsend, 1915, by original designation.
- Camptopyga* Aldrich, 1916: 41. Type species: *Camptopyga aristata* Aldrich, 1916 [= *Xenoppia hypopygialis* Townsend, 1915], by original designation.
- Hypopelta* Aldrich, 1916: 49. Type species: *Hypopelta scrofa* Aldrich, 1916, by original designation.
- Aulacophyto* Townsend, 1919: 158. Type species: *Aulacophyto auromaculata* Townsend, 1919 [secondary junior homonym of *Euparaphyto auromaculata* Townsend, 1919: 157] [= *Microcerella aulacophyto* **nom. nov.**], by original designation. **Syn. n.**
- Gymnopsoa* Townsend, 1919: 161. Type species: *Gymnopsoa texana* Townsend, 1919, by original designation.
- Catheteronychia* Townsend, 1927: 230. Type species: *Catheteronychia chaetosa* Townsend, 1927, by original designation. **Syn. n.**
- Xanthobrachycoma* Townsend, 1927: 232. Type species: *Xanthobrachycoma analis* Townsend, 1927, by original designation. **Syn. n.**
- Townsendmyia* Prado & Fonseca, 1932: 167. Type species: *Stephanostoma argenteum* Prado & Fonseca, 1932 [= *Sarcophaga* (Bellieria) *halli* Engel, 1931], by original designation. **Syn. n.**
- Alaccoprosopa* Townsend, 1934: 202. Type species: *Alaccoprosopa apicalis* Townsend, 1934, by original designation. **Syn. n.**
- Austrohartigia* Townsend, 1937a: 115. Type species: *Austrohartigia magellanica* Townsend, 1937a [= *Sarcophaga spinigena* Rondani, 1846], by original designation. **Syn. n.**
- Microcerellamyia* Hall, 1937: 354. Type species: *Microcerellamyia retusa* Hall, 1937, by original designation. **Syn. n.**
- Itiophyto* Hall, 1937: 355. Type species: *Itiophyto engeli* Hall, 1937, by original designation. **Syn. n.**
- Mimophytomyia* Hall, 1937: 357. Type species: *Mimophytomyia chilensis* Hall, 1937 [= *Alaccoprosopa apicalis* Townsend, 1934], by original designation.
- Phaesarcodexia* Hall, 1937: 362. Type species: *Phaesarcodexia aldrichi* Hall, 1937 (also as *Brachicoma aldrichi*) [= *Sarcophaga spinigena* Rondani, 1864], by original designation.
- Eumicrocerella* Hall, 1938: 253. Type species: *Eumicrocerella duca* Hall, 1938, by original designation. **Syn. n.**
- Scopaediscus* Blanchard, 1939: 802. Type species: *Scopaediscus muehni* Blanchard, 1939, by original designation. **Syn. n.**
- Boettcherimima* Lopes, 1950: 706. Type species: *Boettcherimima hypopygialis* Lopes, 1950 [secondary junior homonym of *Xenoppia hypopygialis* Townsend, 1915] [= *Microcerella boettcherimima* **nom. nov.**], by original designation. **Syn. n.**
- Parahypopelta* Blanchard, 1955: 30. Type species: *Parahypopelta salavini* Blanchard, 1955, by original designation. **Syn. n.**
- Chapiniola* Dodge, 1965: 253. Type species: *Chapiniola impressa* Dodge, 1965, by original designation. **Syn. n.**
- Steatopyga* Dodge, 1965: 254. Type species: *Steatopyga mirabilis* Dodge, 1965, by original designation. **Syn. n.**
- Boetia* Dodge, 1965: 255. Type species: *Boetia curiosa* Dodge, 1965, by original designation. **Syn. n.**
- Xenoppiella* Blanchard, 1966: 182. Type species: *Xenoppiella dyscineti* Blanchard, 1966 [= *Nemorea acridiorum* Weyenbergh, 1875, **syn. n.**], by monotypy. **Syn. n.**
- Azuayia* Dodge, 1967: 681. Type species: *Azuayia tripartita* Dodge, 1967, by original designation. **Syn. n.**
- Borgmeierisca* Lopes, 1972: 349. Type species: *Borgmeierisca pilicoxa* Lopes, 1972, by original designation. **Syn. n.**
- Townsendisca* Lopes, 1974: 193. Type species: *Townsendisca matucanensis* Lopes, 1974, by original designation. **Syn. n.**
- Xenoppina* Lopes, 1975d: 573. Type species: *Xenoppina andina* Lopes 1975d, by original designation. **Syn. n.**
- Aulacophytoides* Lopes, 1978a: 765. Type species: *Aulacophytoides alvarengai* Lopes, 1978a, by original designation. **Syn. n.**
- Jujuyia* Lopes, 1980: 238. Type species: *Jujuyia alvarengai* Lopes, 1980 [secondary junior homonym of *Aulacophytoides alvarengai* Lopes, 1978a] [= *Microcerella jujuyia* **nom. nov.**], by original designation. **Syn. n.**
- Mallochisca* Lopes, 1982b: 364. Type species: *Mimophytomyia mallochi* Hall, 1937, by original designation. **Syn. n.**
- Penaissa* Lopes, 1982b: 365. Type species: *Penaissa quimaliensis* Lopes, 1982b, by original designation. **Syn. n.**
- Cuzcomyia* Lopes, 1982b: 367. Type species: *Cuzcomyia rufipes* Lopes, 1982b, by original designation. **Syn. n.**
- Carchia* Lopes, 1982b: 368. Type species: *Carchia andina* Lopes, 1982b [secondary junior homonym of *Xenoppina andina* Lopes, 1975d; [*Microcerella carchia* **nom. nov.**], by original designation. **Syn. n.**
- Azuaya*: Lopes (1982b: 363); erroneous subsequent spelling of *Azuayia*.
- Boettia*: Lopes (1982b: 363, 1982d: 607); erroneous subsequent spelling of *Boetia*.
- Parahypopelta*: Lopes (1969a: 8, 81); erroneous subsequent spelling of *Parahypopelta*.
- Phaesarcodexia*: Lopes (1969a: 8, 82; 1981: 327); erroneous subsequent spelling of *Phaesarcodexia*.
- Townsendimyia*: Lopes (1969a: 9, 1974: 195, 1975a: 271, 1982b: 363); erroneous subsequent spelling of *Townsendmyia*.

Diagnosis. — The genus *Microcerella* may be defined by the following character states:

- 1) Eyes green (live or fresh material);
- 2) Male protandrial segment black;
- 3) Hypandrial arm swollen at level of gonopod;
- 4) Postgena with at least some black setae close to genal suture.

The generic synonymizations presented above are straightforward in the sense that the identities of the type species of most genus-group names are well known and the monophyly of what is here considered as *Microcerella* has never been questioned. One exception is the taxon *Xenopiella dyscineti*, which was mentioned as being a potential member of the group by Lopes (1982b) but left with no further comment, as the holotype (which is the only specimen known) was not examined. This uncertainty resulted from the insufficient original description by Blanchard (1966), who gave a not very informative description of the male terminalia and did not provide any figures, only giving some chaetotaxic characters and stating that the terminalia were "muy abultado" (p. 183). I have examined the male holotype (MACN), which was mounted on cardboard and completely hidden in dense

mould. After partly cleaning of the specimen and remounting of the terminalia, it turned out to be a typical member of *Microcerella* (s.l.) and a junior synonym of *M. acridiorum*, **syn. n.** [Note that I have not revised the type material pertaining to the latter name, and I have followed Lopes (1969b), who reviewed its taxonomic history.] To corroborate this, and to facilitate recognition and identification, figures of the terminalia of the holotype of *X. dyscineti* are provided (figs. 29-32, compare Lopes 1969b: figs. 55-58). The holotype, which is perfectly intact except for dissected (but well preserved) terminalia, is heavily moulded and glued to a piece of cardboard on its right side. Terminalia and an empty puparium are mounted on separate pieces of cardboard pinned with the specimen. It is labeled "S/ *Dyscinetus gagates*, adulto.", "Tandil 6-XI-1958 Bazan, R.", "*Xenopiella dyscineti* gen. et sp. nov. det. E. E. Blanchard", and "*Xenopiella dyscineti* E. E. Blanchard 1966 Holotypus [red label]".

Lopes (1982b) noted that the monotypic genus *Sarcophagulopsis* (type species: *S. trigonophymi*) possibly belonged to the Microcerellini. It is, however, a *Blaesoxipha* sensu lato and will be revised by Pape (in prep.).

Somewhat ironically, the identity of the type species of the genus *Microcerella* proper, *M. rufomaculata*, has never been thoroughly revised. Séguy (1925: 184) and Townsend (1931: 72, 1937b: 202) examined and redescribed the female holotype in MNHN, leaving no doubt of the assignment to *Microcerella* in the present sense, but no attempt has ever been made to associate the female with male specimens, for which reason the identity is highly uncertain. As other species are known from the male sex only, it is very probable that *M. rufomaculata* is a senior synonym of one of these [an obvious candidate being *M. sarcophagina*, the male holotype of which, however, may be lost, as mentioned below].

To accommodate all species of the taxa synonymized within *Microcerella* above, a number of new names have been proposed. These names, which all should be treated as nouns in apposition, are formed by using the name of their former genus as species epithet. Two other secondary homonyms are not covered in the list of generic synonyms. They are given below, following the procedure given above:

Microcerella boetia **nom. nov.** for *Boettia* [sic!] *ecuatoriana* Lopes, 1982d: 613 [secondary junior homonym of *Euparaphyto ecuatoriana* Lopes, 1982c: 495].

Microcerella austrohartigia **nom. nov.** for *Austrohartigia bicoloricauda* Lopes, 1981: 334 [secondary junior homonym of *Mesothyrsia bicoloricauda* Enderlein, 1928: 151].

The genus *Microcerella* is defined in the most narrow sense by Lopes (1969a) in the Neotropical catalogue, as he includes only one species, *M. sarcophagina*, besides the type species *M. rufomaculata*. The taxon *M. sarcophagina*, like *M. rufomaculata*, has remained enigmatic since its description by Thomson (1869), and the male holotype, which is the only specimen known, seems to be lost. [P. I. Persson (NMRS) has informed me that he has been unable to recover the holotype, which was sent as a loan to the late H. R. Dodge in the 1970's, and I did not succeed in finding it among the remnants of the Dodge-collection in FSCA.] Without any clue as to the structure of the terminalia, especially the aedeagus, the identity can only be a qualified guess whenever a detailed generic revision with extensive information of species present in the type locality concerned becomes available.

Lopes (1982b) provides a key to the genera of Microcerellini, and his *Microcerella* keys out mainly on the length of the first flagellomere relative to that of the pedicel, i.e. whether the former is "twice the length" (*Microcerella*) or only "a little longer" (*Microcerellamyia*) than the latter, and his measurements are apparently based partly on the original figures of Macquart (1851, pl. 22: fig. 1). It seems to me, therefore, that although *Microcerella rufomaculata* fits well within the tribe Microcerellini, and thus within *Microcerella* in the present sense, the narrow concept of *Microcerella* sensu Lopes needs revision and is tentative at best.

Lopes (1982b) discussed the limits of Microcerellini and mentioned *Austrohartigia*, *Doringia*, and *Aulacophyto* with ten, four, and five species respectively (the latter now with an additional three described by Tibana & Lopes (1988)), and he noted that "the majority of the remaining [27] genera are monotypic" (p. 359). Note that Lopes (1982b) divided the Microcerellini into the subtribes Microcerellina and Hypopeltina. A single two-state character separates these two groups, namely the possession of a pubescent versus a plumose arista (key entry only), but obviously both states cannot be assumed *a priori* to be apomorphic at this level as no third state from which they could be derived independently exists within the Sarcophaginae. No further explanation is given and the classification appears to be artificial. I have not been able to split the tribe into a few well defined and probably monophyletic groups, and instead of accepting the wealth of monotypic or very small genera that do not convey much information (and actually often are a burden for identification and information retrieval), I have lumped all species into one genus. Downes (1965) and Shewell (1987), who are dealing exclusively with the much sparser Nearctic fauna, also apply a broader concept when they include four species within *Microcerella*, one of which has been recorded from the neotropical region (*M.*

hypopygialis, see Lopes 1980, 1982a). *Microcerella* in this broadened sense is very well defined and equals the tribe Microcerellini as presented in Lopes (1982b, 1982e), except that I exclude the monotypic genus *Cryptosarcophila* as discussed below. Lopes (1969a: 7, 1982b: 361) mentioned that all species seen by him in fresh condition have green eyes, truly a unique condition within the Sarcophagidae. The green colour disappears after death although the eyes may retain a feeble greenish tinge (at least for some years). I have not seen live or fresh specimens of any of the Nearctic species, and although at least *M. texana* seems to be green-eyed (as judged from recently captured specimens in the USNM), information is needed from living or freshly killed material. Therefore, although I know of no exceptions within *Microcerella*, or of any (homoplastic) occurrences of green eyes in other sarcophagine genera, I cannot fully assess the strength of this character state for defining the genus. The majority of species of *Microcerella* have a bare, pubescent or short plumose arista and males of almost all species have a dark brown or black protandrial segment (first genital segment of authors, syntergosternite 7-8 of McAlpine 1981), distinctly contrasting to a bright red or orangish epandrium. No species have their male terminalia entirely red, and the black/black condition found in *M. muehni* and in the probably monophyletic clade [*M. hypopygialis* + *M. texana* + *M. valgata*] is most probably derived from the black/red condition. The aedeagus is highly characteristic by the very rigid connection between basi- and distiphallus that probably allows little or no articulation. Apart from a few species that have a highly modified aedeagus, the ventral surface of the distiphallus is equipped with a flat, sclerotized scale or plate. All species seen by me have the hypandrial arms more or less swollen at the level of the gonopods. The female terminalia show fused sternites 6-8 much like the condition seen in *Spirobolomyia*, *Comasarcophaga*, and many *Blaesoxipha*, and tergite 6 is entire and more or less extended beyond the posterior rim of tergite 5.

Cryptosarcophila, with *C. chaetosa* as type species and only species included, was transferred to the Microcerellini by Lopes (1982b), but I prefer not to include this taxon in *Microcerella*. The reason for this is simply that I have not been able to recognize any convincing shared and assumed synapomorphic character state defining a clade containing only *Cryptosarcophila* and *Microcerella*. Although I have not examined any specimens of *C. chaetosa* myself, Lopes (1975e: 46) redescribed the species from the male holotype and noted that it has the "genital segments red", which most probably is plesiomorphic relative to the red/black or black/black condition in all *Microcerella*. Moreover, the arista is plumose and the aedeagus has no scalelike

ventromedian plate or process. *Cryptosarcophila chaetosa* resembles many *Microcerella* in having the white postgenal setae restricted to the hypostomal bridge below the neck, which probably is a derived condition relative to the groundplan of the Sarcophaginae. Many other genera, however, seem to share this character state, e.g. *Johnsonia*, *Neophyto* and perhaps *Notochaeta*, and it does not provide evidence for inclusion particularly in *Microcerella*.

Little information is available on the biology of *Microcerella*, but species have been bred from land snails, beetles and grasshoppers, and in the laboratory on horse blood serum (Blanchard 1966; Lopes 1969a, 1973).

Microcerella is most diverse in the neotropical region and especially at high altitudes and in the southern temperate zones. It was therefore surprising to find two specimens of an undescribed species of *Microcerella* from Bermuda, and even more so as the fauna of Sarcophagidae of these islands otherwise seems to consist entirely of a few widespread and possibly introduced species. Actually, the Diptera fauna of the Bermuda Islands is rather meager and with only few endemics. Many older Bermudan records of Sarcophagidae are misidentifications and only *Helicobia morionella*, *H. rapax*, *Oxysarcodexia ventricosa* and *Ravinia lherminieri*, all listed from Bermuda by Williams (1958, 1959), and all very common, widespread North American species, seem reliable (I have seen recently collected material of all but the latter species in USNM).

Research on the Nearctic *Microcerella*, evoked by the discovery of the Bermudan species, revealed that what has been considered a single taxon, *M. scrofa*, actually covers two sibling species. Previous illustrations of terminalia in Aldrich (1916: fig. 13), Roback (1954: fig. 39) and Lopes (1982c: figs. 43-47) seem to be of *M. scrofa* proper, while the species figured as *Hypopelta scrofa* in Hallock (1940: figs. 1-2) probably is its sibling *M. adelphe* (the surstylus figured by Hallock is perfectly *scrofa*-like, but this may be due to the rather simple outline provided by this author and the fact that the thornlike surstylar process is difficult to see in strict lateral view). Both new species of *Microcerella* are described below.

Microcerella bermuda sp. n. (figs. 33-36)

Type material. — Holotype ♂, "Bermudas [printed] vii 8 [handwritten, black ink] J:8 [handwritten, pencil] Davis [printed]" (MCZ). Paratype, 1 ♂, "Bermuda Islands July 4 1905, T. K" [only "4" handwritten] (ZMUC). Both types bear a label reading "Sarcophaga n. sp. det. ALDRICH".

Description.

Male. — Head: Narrowest part of frons 0.24× head width. Outer and inner vertical bristle well

developed. Two weak ocellars present, the bristles much weaker than the pair of postocellars. Frontal bristles (7)-8; row continuing to just above level of apex of scape and distinctly curving laterally when seen from above. Fronto-orbital plate otherwise bare. Para-facial plate with a row of 4 setae in ventral part close to eye margin. Postcranium with posteriormost postgenal setae and setae below occipital foramen white; other setae black. Scape distinctly raised above lunule, pedicel somewhat elongate, first flagellomere $1.5\times$ as long as pedicel. Arista well developed, $2\times$ as long as first flagellomere and short plumose. Palpus black.

Thorax: Proanepisternum and postalar wall bare. Metasternum setose. Chaetotaxy: $acr = 0 + 1$, $dc = 4$ (anteriormost 2 weak) + 3, $ia = 2$ (inner posthumeral + a weak presutural) + 2, $sa = 2 + 3$, $pa = 2$. Scutellum with 2-3 marginals (if 3 then the two posterior ones close together), one pair of weak discals, and one pair of apicals (slightly irregular in the holotype).

Wing: Tegula black or brownish, basicosta yellow, veins yellowish brown. Costal spine about $1.5\times$ as long as crossvein r-m. Setal row of r_{4+5} just surpassing half the distance to r-m.

Legs: Midfemoral apical pv bristles not spinelike (no midfemoral comb), hind tibia without any elongated pv or p setae.

Abdomen: Ground colour black, microtomentum forming the usual silvery grey, tessellate and changing pattern. Tergite 1+2-3 without median marginal bristles, T4 with a weak pair, T5 with a complete row of marginals. ST3-4 with long setae with wavy or undulating tips.

Terminalia: Protandrial segment dark reddish brown, with a few bristles on disc and a complete row of marginals. Epandrium bright red. Cercus and surstylus densely setose, cercus broad and plate-like when seen in posterior (dorsal) view, S-shaped in lateral view. ST9 (hypandrium) with a reduced disc but with arms greatly swollen at level of gonopodal articulation. Gonopod shortened but rather broad at base, partly hidden by the swollen hypandrial arm (lateral view), and with setae scattered along most of the distal margin. Aedeagus with a short basiphallus that is rigidly hinged to the distiphallus. Distiphallus with a large transversely flattened plate carried on a narrow petiole from the ventral surface. Juxta present, well sclerotized and forming two arms slanting ventrally and basally. Lateral styli tubular, median stylus weakly sclerotized and somewhat inflated, all styli projecting between juxtal arms.

Length. — 10.0 mm.

Female. — Unknown.

Etymology. — A noun in apposition. Named for the type locality.

Distribution. — Nearctic: Bermuda Is.

Note. — Johnson (1904) mentions a "*Sarcophaga* sp. ? A smaller form of which a number of specimens were collected by Mr. Davis, July 8". These specimens may or may not include the holotype of the present species but obviously the note refers to the very collecting trip where it was taken (identical collector, locality and day + month) and settles with reasonable certainty the year when the holotype was collected as 1903, when Mr. C. Abbott Davis visited the islands.

Microcerella adelphe sp. n. (figs. 38, 40-43)

Type material. — Holotype ♂, USA: Maryland, Montgomery County, Rockville, 14.vi.1969, G. Steyskal (USNM). Paratypes, Canada: Ontario, Ottawa, 1♂, 4-7.viii.1982, L. Huggert (ZML); Quebec, Mount Tremblant, Lac aux Atocas, 1♂, 28.viii.1956, E.B. Thurman, "Biting & Sweeping" (USNM). — USA: Georgia, 1♂, [no date], C. V. Riley [terminalia lost] (USNM); Minnesota, Eaglesnest, 1♂, 29.vii.1958, W. V. Balduf (USNM); New York, Tompkins Co., [...] (illegible ?Ellio), 1♂, 25.viii.1956, B. Foote, lab reared ex *Polygura thyroides* (ZMUC); New York, Tompkins Co, Varna, 1♂, 17.vii.1946, A. Stone (USNM); North Carolina, Great Smokie Nat. Park, Newfnd Ridge, 1♂, 11.vii.1941, A. L. Melander (USNM); Virginia, Great Falls, 1♂, 21.vi.1931, A. C. Melander, 1♀, "x.23,20", J. M. Aldrich (both in USNM); West Virginia, Cranberry Gla., 1♂, 2.vi.1955, H. V. Weems (USNM).

Description

Male. — Very similar to *M. scrofa*. I have found only few diagnostic characters, all pertaining to the terminalia, and the description is accordingly restricted to these structures. Moreover, to facilitate a separation from *M. scrofa*, the description is given as one entry of a recognition couplet. For details of general morphology, the description of *M. scrofa* in Aldrich (1916) should be consulted.

- Surstylus distally evenly rounded. Distiphallus broadest proximal to middle (lateral view) and with the appendages at the ventral surface rather slender (figs. 37, 39, 44) *Microcerella scrofa*
- Surstylus distally with a concave incision and a thornlike process. Distiphallus broadest at or distal to middle (lateral view) and with the appendages at the ventral surface more compact (figs. 38, 40, 43) *Microcerella adelphe*

One female has been included in the type series of *M. adelphe* although I cannot separate it morphologically from that of *M. scrofa*. Geographical evidence, however, suggests that *M. adelphe* may have a more easterly extended distribution relative

to *M. scrofa* (see below). A female from Ohio (Amherst) is accordingly judged to belong to *M. scrofa*.

Etymology. — A noun in apposition. From the Greek *adelphē* = sister, the name refers to the probable sister group relationship with *M. scrofa*.

Distribution of *M. adelphē*. — Nearctic: Canada (Ontario, Quebec), USA (Georgia, Maryland, Minnesota, New York, Virginia, West Virginia).

Biology. — The only information available is the breeding record from the snail *Polygura thyroides* (from label of one of the paratypes from New York State), and *M. adelphē* is probably predatory on snails, as many of its congeners. *Microcerella adelphē* may actually be the "undescribed species [which] parasitizes snails" mentioned by Downes (1965: 951). Nothing is known of the biology of *M. scrofa*.

Distribution of *M. scrofa*. — Nearctic: Canada (Ontario [nr. Stratford]), USA (Alabama [Birmingham], Illinois [Algonquin], Indiana [Lafayette], Kansas [Topeka], Louisiana [Opelousas], Ohio [Amherst], Texas [College Station], and Wisconsin [state record only]). The specimens on which this distribution is based are deposited in USNM (US records) and ZML (Canadian record).

The apparent sympatry of *M. adelphē* and *M. scrofa* in at least part of their range (one male of each species from Canada: Ontario) is strong evidence that the rather slight differences reflect a reproductive barrier.

The closest relative of *M. adelphē* is most probably *M. scrofa*, as already mentioned. Both species possess a highly modified distiphallus with lateral sclerotized plates that extend posteriorly, thereby forming a deep, narrow groove along the posterior surface. Moreover, the gonopods are very characteristic by being greatly extended anteriorly, strongly curved upwards (or dorsally), and almost joining in the median plane (fig. 42). The group consisting of the sibling species *adelphē* + *scrofa* is probably the sister group to *Microcerella bermuda*. The character corroborating this hypothesis is the shape of the gonopod. In all three species, the gonopod has transformed from the elongate and more or less narrow structure found in all other *Microcerella* into a short or low, but very broad plate. The scattered setae that cover most of the distal margin may be used as a morphological landmark indicating the homologue of the posterior (or dorsal) margin of the plesiomorphic gonopod. The sister group of *adelphē* + *scrofa* + *bermuda* will probably be found among the Neotropical members of the group, as the three remaining Nearctic species of *Microcerella* may have the Argentinean species *M. muehni*

as their closest relative, these four species sharing the derived black/black condition of terminalia.

Genus *Spirobolomyia*

Spirobolomyia Townsend, 1917a: 43. Type species: *Sarcophaga singularis* Aldrich, 1916, by original designation.

Diagnosis. — The genus *Spirobolomyia* may be defined by the following character states.

- 1) Male mid femur apically with a row of comb-like posteroventral spines;
- 2) Male abdominal sternite 5 with bristles along the posterior margin;
- 3) Male abdominal sternite 5 with a pair of bristly pads on the disc;
- 4) Male cercal prong bent backwards;
- 5) Male cercus with a sinuous lateral margin (posterior view);
- 6) Male cercus with short spinelike setae on the dorsal surface;
- 7) Basal parameral sclerite elongated ("additional forcipes" of Lopes 1975f);
- 8) Aedeagus with a beaklike projection arching over the heavily sclerotized juxta (fig. 48);
- 9) Aedeagal vesica beaklike and sclerotized;
- 10) Female abdominal sternites 6-8 fused;
- 11) Female abdominal tergite 6 with the median (= dorsal) part of the posterior margin devoid of setae and produced in a tongue-like projection (Lopes 1975f: figs. 8, 17, 26).

Townsend seldom explained the etymological derivation of his numerous generic names, but when he erected the genus *Spirobolomyia* with a type species that had been bred from a millipede, it seems probable that he, although he gave no mention of species other than the type species, included *Sarcophaga flavipalpis* as well, as this very similar species had been "reared ... from a myriapod" (Aldrich 1916: 258). Accordingly, he later stated that *Spirobolomyia* "Ranges in two species" (Townsend 1938: 68). Downes (1965) widened the concept by including *Sarcophaga basalis* and *S. ohioensis* in *Spirobolomyia* (as subgenus of *Blaesoxipha*), the biology of which is still unknown. It might be guessed that they are all parasitoids of the millipede genus *Narceus*. Note that I am here following Keeton (1960), who revised the Spirobolidae and argued that *Spirobolus* (consistently misspelled *Spasobolus* by Aldrich 1916: 186, 258) should be used for the group of Old World (China) species only, while *Narceus* should be applied to its New World sister group. As the name *Narceus* is the oldest genus-group name within the tribe Spirobolini, *Narceus* is the valid name in the present context whether or not Keeton's infratribal classification is accepted.

Species of *Spirobolomyia* are mainly distributed

in the eastern and southeastern parts of the Nearctic Region but extend along the east coast into the northern part of the neotropical region. The range extends from Canada: southern Quebec, (1♂ of *S. flavipalpis* in ZMUC) south to Mexico: Tamaulipas (1♂ of *S. latissima* in FSCA, see under type material below) and Chiapas (8♂ 2♀ of *S. obioensis* in CNC). The western limit of distribution seems to run through Wisconsin, Iowa, West Virginia, and Alabama (Downes 1965), and the Nearctic distribution is closely matched by the distribution of *Narceus* given in Keeton (1960).

The life habit, although only known for two species and without any evidence that no other food source can be utilized, is interesting insofar as very few Diptera parasitize or prey upon millipedes. Within the Sarcophagidae, I know of only two other records: Specimens of *Blaesoxipha beameri* in USNM (4♂, USA: California, Riverside) bear a label reading "Ex *Tylobolus* sp. near *hebes*" probably referring to a species of the spirobolid genus *Hiltonius*. Although this may refer to parasitism, predation or even scavenging, the food source nevertheless is a millipede. No other information is available on the biology of *B. beameri*. A single male specimen of *Sarcophaga iulicida* from Portugal (BMNH), with an affiliation in the subgenus *Pierretia* sensu stricto of Verves (1986), was bred from a specimen of *Ommatoiulus moreleti* (Pape 1990). Note that the parasitism of millipedes has not been used as a character state corroborating the monophyly of *Spirobolomyia*. Parasitism of a particular taxon is difficult to handle in a character analysis as parasites do not parasitize taxa as such, and although it seems reasonable that the peculiar habit of *Spirobolomyia* is evidence of phylogenetic relationship I prefer to avoid an explicit scoring.

Spirobolomyia was, like *Fletcherimyia*, included in *Blaesoxipha* as a subgenus by Downes (1965). However, all *Spirobolomyia* possess tubular styli that are free of each other and apparently functional, i.e. sperm conducting, and they do therefore not form part of the probably monophyletic group of species with only the median stylus tubular and with platelike lateral styli that are fused in the median plane. The latter group is the genus *Blaesoxipha* in the sense of the present author. The male midfemoral comb, the presence of short spines on the dorsal surface of the male cercal prong, the recurved male cercal prong, and the fused female abdominal sternites 6-8, however, are character states *Spirobolomyia* shares with *Blaesoxipha*. At least the latter four states seem derived with regard to the groundplan of the Sarcophaginae, and including *Spirobolomyia* within *Blaesoxipha* (i.e. widening the concept of the latter) may be theoretically sound on the present state of knowledge, and my reason for not doing this is, as given for *Comasarcophaga* and *Fletcherimyia*, that the

monophyly of the resulting taxon seems, at least to me, to be much more tentative than the monophyly of the groups included. A comprehensive phylogenetic analysis of all sarcophagine genera is needed to settle this issue. Lopes (1975f: 156) simply discarded a relationship between *Spirobolomyia* and *Blaesoxipha* by stating that "there is no close relationship between the two genera", but he later (1988a: 130) elaborated on this postulate by referring explicitly to the "long styli of glans" (= lateral styli of the present paper) being present in species of *Spirobolomyia* but absent in his *Impariini* (= *Blaesoxipha* (in part) of the present paper). The possession of functional lateral styli will corroborate that *Spirobolomyia* does not form part of the clade here considered under the name *Blaesoxipha* (unless other evidence favour a reversal), but as the character state obviously is plesiomorphic at the level of the Sarcophaginae, it is totally uninformative regarding the phylogenetic position of *Spirobolomyia* relative to *Blaesoxipha*.

Species limits were discussed in detail by Lopes (1975f), but the number of specimens at his disposal was rather limited and a more extensive material has revealed another, previously undescribed species. As only characters found in the male terminalia distinguish this species from *S. obioensis*, and as species of *Spirobolomyia* in general are separable only by reference to their terminalia and sternite 5, I have restricted the description to include these structures only. Information on general appearance of *Spirobolomyia* can be found in Aldrich (1916), Hall (1927), Townsend (1938) and Lopes (1975f).

Spirobolomyia latissima sp. n. (figs. 45-48, 50)

Type material. — Holotype ♂, USA: Texas, Menard, 1929, E. O. Cushing (USNM). Paratypes, USA: Texas: 16♂, data as holotype (14 in USNM, 2 in ZMUC); 1♂ v.1930, otherwise as holotype (USNM); NW Blanco Co., Davis Ranch, 1♂, 22.iv.1959, J. F. McAlpine (CNC); Reagan Wells, 1♂, 27.vi.1927, R. W. Laake (USNM); Sonora, 1♂, 10. [month not interpreted].1920, O. G. Babcock (USNM); Hidalgo Co., 7♂, 29.iii.-9.x.1946, USPHS dysentery fly trap (USNM); Hidalgo Co., 3♂: 4.ii.1932, 1♂: 3.viii.1934, H. J. Reinhard (3 in CNC, 1 in ZMUC); Brewster Co., Big Bend National Park, Basin, 1♂, 14.vi.1950, R. F. Smith (AMNH). — Mexico: Tamaulipas, 9 km W Antiguo-Morelos, 1♂, 21.vii.1954, Univ. Kansas Exp. (FSCA).

Description

Male. — Abdomen: Sternite 5 deeply incised and with strong, spinelike bristles along the basal (or median) half of the posterior margin of each lobe. A pair of raised pads with strong bristles on the posterior, flattened surface are present on the disc.

Terminalia: Cercus very broad in posterior view, with a sinuous outer (or lateral) margin and a greatly swollen flaplike extension basally on the

cercal prong. A few short spines are present on the dorsal surface and along the margin of the hump-like lateral convexity. Cercal setae are arranged in two groups: a smaller one close to the median line of articulation between the cerci, and a more extensive one distal to this. Aedeagus with the dorsal (or posterior) surface raised into a narrow crest. Vesica well sclerotized and of about the same size as the beaklike structure arching over the juxta.

Female. — Probably very like the female of *S. ohioensis*. Among nine females from Texas, Hidalgo Co., 14.iii.-23.x.1946 (USNM), all caught in dysentery fly traps, may be specimens of *S. latissima*. I have not been able, however, to find any differences between these and a female specimen of *ohioensis* pinned with a presumed conspecific male (USNM), and as the distribution of these two species seems to be largely sympatric, I have not included any females in the type series.

Etymology. — A Latin adjective, from *latissimus* = the broadest. The name refers to the male cercus, which is very broad in posterior view.

Distribution. — Nearctic: USA (Texas). Neotropical: Mexico (Tamaulipas).

Females of *Spirobolomyia* are very similar and I cannot at present identify female specimens to species with any certainty. This implies a problem, as the holotype of *Sarcophaga pallipes* is a female. Aldrich (1930) examined this type and established its relationship, but he was not able to make a species level identification: "I can not separate [it] from females of *singularis* and several others" (p. 19). Townsend (1938) and Roback (1954) considered *S. pallipes* a senior synonym of *S. singularis*, while Downes (1965) listed *pallipes* as "Probably *Blaesoxipha* (*Spirobolomyia*) sp.". Lopes (1975c) likewise examined the type of *pallipes* and synonymized it with *Sarcophaga basalis*, but his decision obviously was tentative as he "was unable to [find] good characters to separate the female[s] of the *Spirobolomyia* with red legs" (p. 548). Apparently, his decision was based largely on the equal size of the primary types, which really does not provide especially convincing evidence as to their conspecificity. When Lopes (1975f) later produced a key to species of *Spirobolomyia*, he did not include the females and he did not examine any female specimens of *S. ohioensis*. For the present paper, I have accepted the synonymy of *S. basalis* with *S. pallipes*, awaiting more information on diagnostic female character states.

Roback (1954) illustrated the aedeagus and abdominal sternite 5 of *S. singularis* (as *pallipes*), *S. flavipalpis* (as *flavipes*, error) and *S. basalis*. Lopes (1975f) gave a detailed description of these species

as well as of *S. ohioensis* and provided illustrations of various parts of both male and female terminalia. Both authors should be consulted for additional information. The key of Lopes (1975f), however, is not easy to use and the posterior view of the male cerci is provided for two species only (that of *S. basalis* even at a slightly skewed angle). The posterior outline of the male cerci provides a very easy means of identification and has the advantage that this attribute often is visible even in specimens with only partly spread terminalia. For the present paper, I have provided illustrations of the posterior cercal outline for all species (figs. 49-53), and for completeness a couplet is provided to separate *S. latissima* from the very similar *S. ohioensis*:

- Aedeagus with long vesica and a crest running along the dorsal surface (fig. 48). Cercus very broad in posterior view (figs. 46, 50). Setae of cercal base separated into two groups by an area with no or very few setae: A small group close to the suture between the cerci and a larger group along the outer (or lateral) margin (fig. 46) *latissima*
- Aedeagus with shorter vesica (Lopes 1975f: fig. 35), dorsal surface distinctly keeled but not raised into a crest. Cercus narrower in posterior view (fig. 49). Setose part of cercal base without any interruption, setae forming a continuous cover from suture between the cerci and out along the outer (or lateral) margin *ohioensis*

Genus *Tripanurga*

Tripanurga Brauer & Bergenstamm, 1891: 367. Type species: *Sarcophaga albicans* Wiedemann, 1830, by designation of Townsend (1916: 9).

Thelylepticocnema Townsend, 1917a: 43. Type species: *Sarcophaga incurva* Aldrich, 1916, by original designation.

Glaucosarcophaga Townsend, 1917a: 45. Type species: *Glaucosarcophaga knabi* Townsend, 1917a [= *Sarcophaga albicans* Wiedemann, 1830], by original designation.

Metoposarcophaga Townsend, 1917a: 46. Type species: *Sarcophaga pachyprocta* Parker, 1916 [junior primary homonym of *pachyprocta* Hagen, 1881; = a species of the *Sarcophaga importuna* Walker complex], by original designation. Syn. n.

Zygastropyga Townsend, 1917b: 191. Type species: *Zygastropyga aurea* Townsend, 1917b, by original designation.

Cacotrophus Reinhard, 1947: 99. Type species: *Cacotrophus beameri* Reinhard, 1947, by original designation.

Erucofaga Reinhard, 1963a: 75. Type species: *Erucofaga triloris* Reinhard, 1963a, by original designation. Syn. n.

Diagnosis. — The genus *Tripanurga* may be defined by the following character states:

- 1) Aedeagal basiphallus with an epiphallus-like process;
- 2) Aedeagal basiphallus shaped as an elongated

and narrow tube, strongly contrasting to the compact distiphallus (*T. aurea* showing a secondary thickening);

- 3) Aedeagal distiphallus compact and more or less globular;
- 4) Aedeagal distiphallus with a fringe of filiform processes at the anterior margin (Lopes 1978b: figs. 6-8; the present figs. 57, 61);
- 5) Parameral bristle slightly flattened;
- 6) Ejaculatory apodeme large;
- 7) Male cercal prong bent backwards.

The groundplan of the probably monophyletic group Paramacronychiinae + Sarcophaginae is characterized by an almost completely reduced epiphallus, but in all species of *Tripanurga* the proximal part of the basiphallus is extended into a distinct process that is broad at the base, tapers gradually and slants backwards or posteriorly (Roback 1954: figs. 316-335; Lopes 1978b: fig. 6; Shewell 1987: fig. 58c; the present figs. 57, 61). Shewell (1987) applied the term epiphallus to this structure, but I prefer to avoid it as the basiphallic process in *Tripanurga* cannot be considered homologous to the epiphallus of the Miltogrammatinae and Calliphoridae but rather to its base.

Character states 3-5 are here considered autapomorphic, and probably state 2 as well as the condition in *T. aurea*, which possesses a rather strong basiphallic tube (fig. 61), is judged to be secondary. The shape of the distiphallus may indicate a transformation with a gradual increase in the size of the dorsal humps: *importuna*-type → *villipes*-type → *sulculata*-type → *aurea*-type (compare Roback 1954: plates 23-24, and the present figs. 57, 61). The unique (i.e. autapomorphic) shape of the *aurea*-type distiphallus makes a reversed polarity highly improbable. If this is accepted, *T. aurea* cannot be considered the sister group of all other *Tripanurga* and the broad basiphallus found in this species has to be considered a secondary specialization (i.e. apomorphic).

The genus *Tripanurga* was described by Brauer & Bergenstamm (1891) to contain "1. *albicans* Wd. (*Sarcophaga*). 2. *dimidiata* Wd. 3. *bicolor* S.M.C. Bras" (p. 367). The latter name is apparently a nomen nudum while the second probably is Wiedemann's (1830) *Sarcophaga dimidiata*, which currently is regarded as a species of *Notochaeta*, e.g. by Lopes (1969a). Two years later Brauer & Bergenstamm (1893) included (or mentioned) *albicans* only, and Townsend (1916) designated this as the type species, probably without having seen the type or any conspecific specimens. Townsend spent six months of 1928 visiting European and American museums and examining a large number of types, and he later published the results in various papers. For *Sarcophaga albicans*, he gave the type depositories as: "Male Ht in Wien and male Pt in Lima"

(Townsend 1931: 75), which would have been an effective lectotype designation if only a single syntypic specimen had been present in Vienna (NMW). Townsend probably incorporated one of the original type specimens in his own collection, and when he later moved from Lima to Washington, D.C., bringing his collection along, the paratype (which with the present lectotype designation automatically becomes a paralectotype) was deposited in the USNM (Townsend 1937b: 221). Aldrich went to Europe in 1929, i.e. after Townsend, but he published his results a year earlier, although without designating any of the specimens examined as lectotypes. He did, however, give an extensive description of two males of *Sarcophaga albicans* in NMW, "Undoubted types" (Aldrich 1930: 8). As both these males are still present in NMW, and as Townsend's visit in Vienna antedated that of Aldrich, Townsend must have incorporated one of three original syntypic males in his own collection and not one of the two seen by Aldrich as stated by Lopes (1978b). One of these two remaining specimens was then chosen by Townsend to be the holotype. This is to be considered as a valid lectotype designation only if the specimen in case can be properly recognized, but as Townsend neither labelled one of the males in question (he never labelled his 'designated' lectotypes) nor cited any information that could refer to one particular specimen, I have simply regarded Townsend's designation as invalid and chosen one of the two available specimens, which I have labelled as lectotype. This male is in good condition except that it lacks right first flagellomere + arista, left foretarsus, right midleg, left hind leg, right hind tarsus, and has the terminalia dissected and glued to the lowermost label. It is labelled "Brasilien" (printed) and "*albicans* Wd J 48 Coll. Winthem" (last two words printed), and its identity as *Tripanurga albicans* is herewith verified. The two paralectotypes in USNM and NMW respectively have been labelled as such.

Silvestri (1903) described the species *Tripanurga termitophila*, probably on a single female which he recovered and apparently bred from a termite nest. The holotype has never been revised [I have not tried to locate this specimen, which is from Santa Ana, Misiones, in Tucumán Province, Argentina, and not just "America Meridionalis" as stated by Lopes (1969a: 47)] and *Tripanurga* has in practice remained monotypic since Brauer & Bergenstamm (1893) excluded (or omitted) *Sarcophaga dimidiata*. Some authors, however, have stressed the strong similarity to *Metoposarcophaga* and related taxa. Aldrich (1930) mentioned that *Sarcophaga albicans* resembled the type species of both *Metoposarcophaga* and *Zygastropyga*, and Roback (1954: 81) mentioned that *Tripanurga* "will probably fall within the genus *Metoposarcophaga*" as *T. albicans*



Belle, Jean. 1988. "A synopsis of the species of *Phyllocycla* Calvert, with descriptions of four new taxa and a key to the genera of Neotropical Gomphidae (Odonata, Gomphidae)." *Tijdschrift voor entomologie* 131, 73–102.

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