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Notes on the frugivorous fruit fly (Diptera: Tephritidae) fauna of western Africa, with description of a new *Dacus* species

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Abstract. The species richness of the frugivorous fruit fly fauna of western African (in particular of Ivory Coast, Ghana, Togo, Benin and Nigeria) is discussed. The diversity is compared at a national level and between the ecoregions within the national boundaries of the study area. A new species, *Dacus goergeni* sp. nov. is described and additional taxonomic notes are presented.

Keywords. Dacini, Afrotropical, fruit flies, Tephritidae, West Africa.

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Introduction

Tephritidae are picture-winged flies of variable size and worldwide distribution. Although commonly named 'fruit flies', the larvae of some species develop in other parts of the host plant, including flowers, seeds and stems (White & Elson-Harris 1994). True frugivorous tephritids mainly belong to the Dacini (sometimes referred to as subfamily Dacinae) and include the genera *Bactrocera* Macquart, *Dacus* Fabricius (Dacina), *Ceratitis* McLeay, *Capparimyia* Bezzi, *Carpophthoromyia* Austen, *Neoceratitis* Hendel, *Perilampsis* Bezzi and *Trirhithrum* Bezzi (Ceratitidina) (Thompson 1999), several of which are of agricultural importance as pests of commercial fruits and vegetables (White & Elson-Harris 1994). However, the majority of fruit fly species of these genera are reported from a limited number of indigenous non-commercial fruits.

The West African fauna has been extensively studied over more than a century. In particular, the fauna of Ivory Coast, Ghana, Togo, Benin and Nigeria has been more or less continuously researched, with

expeditions dating back to 1912 when F. Silvestrii was sent out by the Board of Agriculture and Forestry of the Territory of Hawaii in search of natural parasitoids of the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann, 1824) (Silvestri 1913). In recent decades, research carried out in these countries by staff from the Cotonou station of the International Institute of Tropical Agriculture (IITA), has contributed considerably to our knowledge of the regional tephritid fauna. This work has been complemented by national fruit fly research activities in several countries such as Benin (Vayssières *et al.* 2005), Ivory Coast (N'depo *et al.* 2009), Togo (Amevoin *et al.* 2009) and Nigeria (Umeh *et al.* 2008). The scope of our analysis is therefore restricted to the area confined by the political boundaries of the above mentioned countries because of the relatively high number of sampling events and the sampling continuity in time. Although incomplete, it covers a large proportion of the main terrestrial ecoregions found in this area, as defined by Burgess *et al.* (2004), in particular the Western and Eastern Guinean Forests, the Guinean Forest Savannah Mosaic and a representative proportion of the West Sudanian Savannah. It, therefore, allows us to provide some preliminary data on the species richness and faunal similarity between these ecoregions. During the identification of material for this study, a hitherto undescribed species belonging to the genus *Dacus* was discovered, which is also described in this paper.

Material and methods

The study was based upon all available tephritid specimens in collections worldwide, plus those literature records that could be checked for accuracy. Study of the extensive collection at IITA (Cotonou) proved especially valuable. That collection is predominantly the result of sampling activities by Dr G. Goergen (IITA). Additional specimens were available through sampling by Dr J.-F. Vayssières of CIRAD and attached to IITA. In total, 9814 specimens, collected during 1965 sampling events, were included in the study. Sampling events were not standardized or of equal intensity, but the result of occasional collecting events within the framework of ongoing research activities. All these records are entered in the fruit fly specimen database at the Royal Museum for Central Africa and are also publicly available through http://projects.bebif.be/fruitfly/index.html, including information on sampling methods (lure attraction, sweeping, rearing) when known. All specimens were (re-)identified within the scope of recent taxonomic revisions (De Meyer 1996, 1998, 2000, 2006, 2009; De Meyer & Copeland 2001; De Meyer

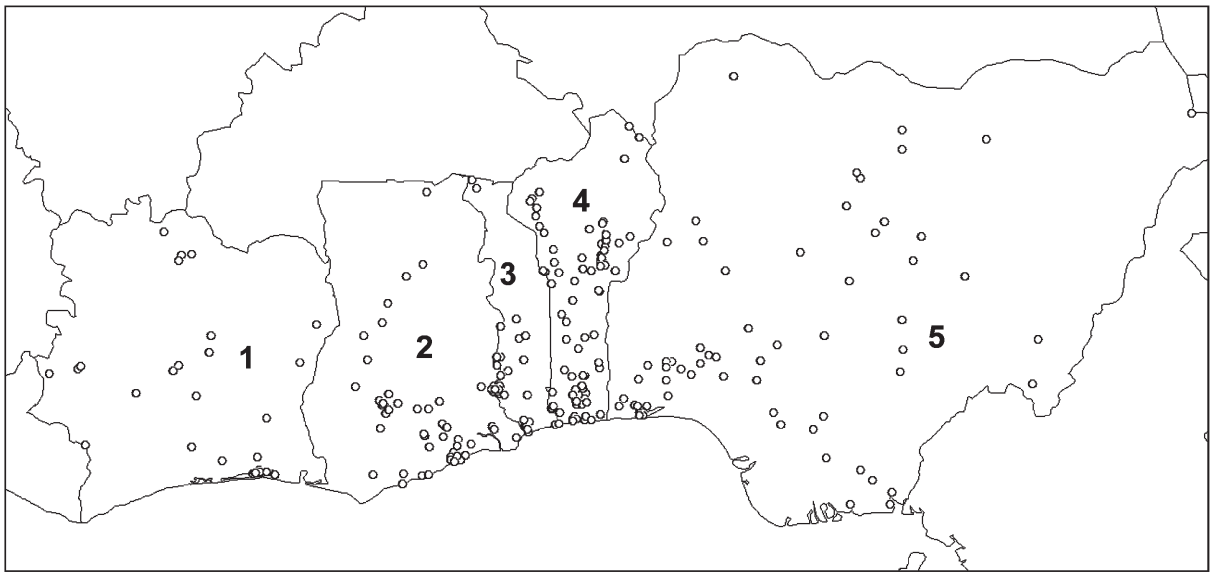

Fig. 1. Country boundaries of Ivory Coast (1), Ghana (2), Togo (3), Benin (4) and Nigeria (5) with sites of collecting events for Tephritidae (open circles).

& Freidberg 2005, 2006; White 2006; White *et al.* 2003; White & Goodger 2009) or during subsequent visits to collections using these recent revisions.

All collecting events were then plotted on a map representing the country boundaries (Fig. 1) and the ecoregions (Fig. 2) using ArcView GIS (version 3.2). Geographical co-ordinates were based on GPS readings indicated on the samples, or geo-references of particular localities checked on various GIS databases, and are available through the above mentioned website (http://projects.bebif.be/fruitfly/index.html). The respective collecting events per country and per ecoregion were calculated using selection functions within the ArcView GIS software.

The data were analyzed, comparing the data sorted as country records and as ecoregion records both in absolute figures and as percentages. Both methods were included because country richness estimates allow governments to evaluate national diversity, while ecoregional estimates puts the observed richness in a larger regional perspective with regard to biodiversity conservation. Because of differences in sampling methodology, which does not allow to compare individuals obtained through the different methods, only incidence based analyses were conducted. Compositional similarity was calculated by means of the incidence based Jaccard and Sørensen indices using MSExcel according to the formulas in Magurran & McGill (2011). Estimated species richness incidence parameters ICE and CHAO2 were calculated using EstimateS (version 8.2) (Colwell 2012). For this, the different samples were divided in 10 year periods (1891-1910, 1911-1920, etc.) resulting in 12 samples. This approach was suggested by Meier & Dikow (2004) to use collection specimens for richness estimations, except that we used 10 year periods rather than 5 years because of the limited number of records for certain periods. As species richness is known to have a positive relationship with area size (Burgess *et al.* 2004), this can be corrected for by using a mathematical approach using the formula developed by Rosenzweig (1995): $BVd=BV/A^z$ with BV being the biological value in question (in our analysis the species richness), A being the area (in square kilometers) and BVd the biological value corrected for area, and with ^{z} set at 0.2 as suggested by Burgess *et al.* (2004). This was done both for country and ecoregion richness data.

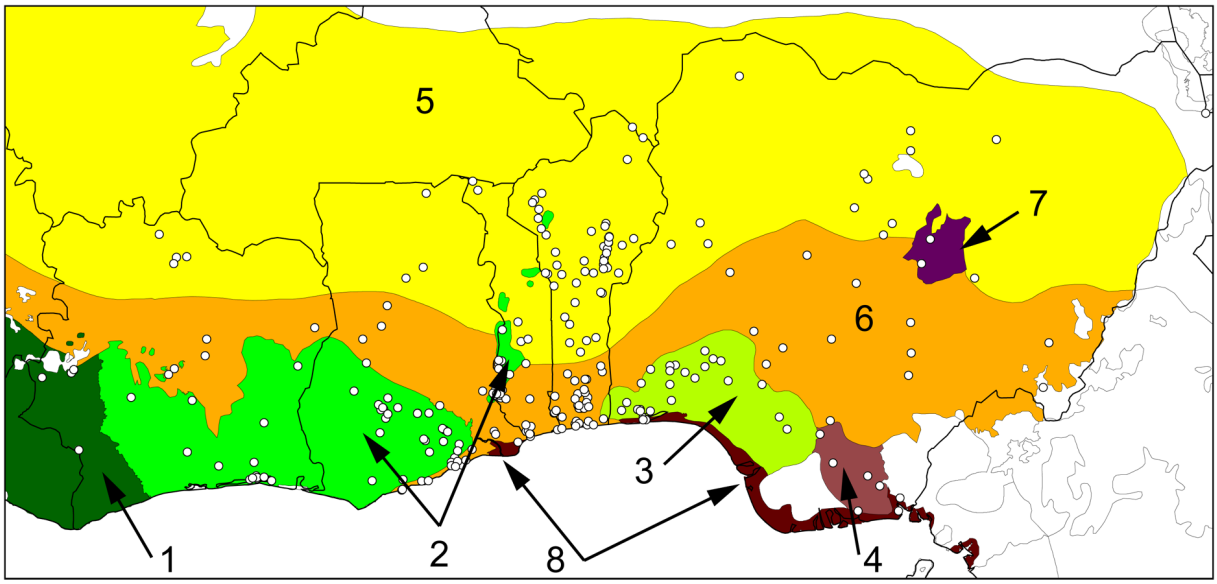

Fig. 2. Ecoregion boundaries of West Guinean Lowland Forest (1), East Guinean Forest (2), Nigerian Lowland Forest (3), Cross-Nigerian Transition Forest (4), West Sudanian Savannah (5), Guinean Forest Savannah Mosaic (6), Jos Plateau Forest Grassland Mosaic (7), Central African Mangroves (8), with sites of collecting events for Tephritidae (open circles).

Abbreviations

IITA = International Institute for Tropical Agriculture, Dar es Salaam
NHM = Natural History Museum, London
RMCA = Royal Museum for Central Africa, Tervuren

Results

Biodiversity

The total number of collecting events (1965) were divided over 285 point localities (Fig. 1).

The total number of species found in the study area was 117 (Table 1), which is about 30 % of all known Dacina and Ceratitidina species in the Afrotropical region. For the genera *Carpophthoromyia*, *Ceratitis* and *Perilampsis*, the percentage was 40% or higher. The genus *Neoceratitis* Hendel was absent from western Africa, and the genera *Capparimyia* and *Bactrocera* were poorly represented. The species

Table 1. List of Tephritidae recorded from the different countries and ecoregions in the study area. (abbreviations: WGLL = West Guinean Lowland Forest; EGF = East Guinean Forest; NLF = Nigerian Lowland Forest; CNTF = Cross-Nigerian Transition Forest); WSS = West Sudanian Savannah; GFSM = Guinean Forest Savannah Mosaic; JOS = Jos Plateau Forest Grassland Mosaic; CAM = Central African Mangroves).

Genus	Species	Ghana	Togo	Benin	Nigeria	Ivory Coast	WGLL	EGF	NLF	CNTF	WSS	GFSM	JOS	CAM
Bactrocera	*cucurbitae*	x	x	x	x	x		x	x	x	x	x	x	
Bactrocera	*invadens*	x	x	x	x	x		x	x	x	x	x	x	x
Bactrocera	*mesomelas*	x	x	x	x	x	x	x	x			x		x
Capparimyia	*melanaspis*			x								x		
Carpophthoromyia	*dividua*	x				x		x				x		
Carpophthoromyia	*interrupta*	x						x				x		
Carpophthoromyia	*nigribasis*	x						x						
Carpophthoromyia	*pseudotritea*	x	x	x	x	x	x	x	x		x	x		
Carpophthoromyia	*scutellata*				x	x		x			x			
Carpophthoromyia	*tritea*					x		x						
Carpophthoromyia	*vittata*	x			x			x	x			x		
Ceratitis	*acicularis*					x		x						
Ceratitis	*anonae*	x	x	x	x	x		x	x		x	x	x	
Ceratitis	*antistictica*		x	x	x			x	x			x		x
Ceratitis	*barbata*	x			x	x			x			x		
Ceratitis	*bicincta*	x			x			x	x			x		
Ceratitis	*bremii*	x	x	x	x	x		x	x		x	x	x	
Ceratitis	*capitata*	x	x	x	x	x		x	x		x	x		
Ceratitis	*colae*	x	x	x	x	x	x	x	x		x	x		
Ceratitis	*connexa*				x									x
Ceratitis	*cosyra*	x	x	x	x	x		x	x		x	x	x	
Ceratitis	*discussa*			x								x		
Ceratitis	*ditissima*	x	x	x	x	x	x	x	x		x	x		x
Ceratitis	*dumeti*					x					x			

Genus	Species	Ghana	Togo	Benin	Nigeria	Ivory Coast	WGLL	EGF	NLF	CNTF	WSS	GFSM	JOS	CAM
Ceratitis	*fasciventris*	x	x	x	x	x	x	x			x	x		
Ceratitis	*flava*		x	x		x		x			x	x		
Ceratitis	*flexuosa*	x	x	x	x	x		x	x		x	x		
Ceratitis	*grahami*	x						x						
Ceratitis	*guttiformis*	x						x				x		
Ceratitis	*hamata*					x		x						
Ceratitis	*lentigera*	x	x	x	x			x	x		x	x		
Ceratitis	*lepida*	x						x						
Ceratitis	*lineata*	x						x						
Ceratitis	*lunata*			x							x			
Ceratitis	*melanopus*	x						x						
Ceratitis	*morstatti*	x			x			x	x		x	x		
Ceratitis	*neostictica*	x						x						
Ceratitis	*paracolae*				x				x					
Ceratitis	*pedestris*			x		x		x			x			
Ceratitis	*penicillata*	x	x	x	x	x	x	x	x		x	x		
Ceratitis	*punctata*	x	x	x	x	x		x	x		x	x		
Ceratitis	*quinaria*			x		x					x			
Ceratitis	*semipunctata*				x				x					
Ceratitis	*silvestrii*			x	x	x					x		x	
Ceratitis	*stictica*	x	x					x				x		
Ceratitis	*striatella*	x	x	x	x			x			x	x	x	
Ceratitis	*tripteris*				x	x	x		x					
Ceratitis	*whitei*			x								x		
Dacus	*acutus*				x						x		x	
Dacus	*albiseta*			x							x			
Dacus	*annulatus*		x	x	x			x	x		x	x		
Dacus	*armatus*	x	x	x	x	x	x	x	x		x	x		x
Dacus	*aspilus*			x							x			
Dacus	*bakingiliensis*			x							x			
Dacus	*binotatus*				x								x	
Dacus	*bivittatus*	x	x	x	x	x	x	x	x	x	x	x		x
Dacus	*botianus*			x	x				x		x		x	
Dacus	*carnesi*	x	x	x	x	x	x	x	x			x		
Dacus	*ceropegiae*				x				x					
Dacus	*chapini*				x				x		x		x	
Dacus	*ciliatus*	x	x	x	x	x	x	x	x		x	x		
Dacus	*collarti*		x		x			x						
Dacus	*congoensis*			x	x						x		x	
Dacus	*croceus*				x				x					
Dacus	*diastatus*	x	x	x	x	x	x	x	x		x	x		
Dacus	*disjunctus*	x	x	x	x			x	x		x	x		
Dacus	*elutissimus*		x									x		
Dacus	*fasciolatus*					x	x							
Dacus	*flavicrus*		x		x	x	x	x	x					x
Dacus	*frontalis*			x								x		
Dacus	*fuscovitttatus*		x		x	x		x	x			x		x

Genus	Species	Ghana	Togo	Benin	Nigeria	Ivory Coast	WGLL	EGF	NLF	CNTF	WSS	GFSM	JOS	CAM
Dacus	*gabonensis*		x			x	x	x						
Dacus	*goergeni* sp. nov.		x	x				x				x		
Dacus	*guineensis*			x							x			
Dacus	*gypsoides*				x				x					
Dacus	*hamatus*		x	x	x			x	x		x			
Dacus	*humeralis*	x	x	x	x	x	x	x	x		x	x		
Dacus	*inflatus*				x				x					
Dacus	*inornatus*			x	x							x		x
Dacus	*kurrensis*				x								x	
Dacus	*langi*		x	x		x	x	x			x	x		
Dacus	*limbipennis*	x	x	x	x	x	x	x	x		x			
Dacus	*longistylus*			x	x						x	x		
Dacus	*lounsburyii*				x								x	
Dacus	*maynei*	x						x						
Dacus	*mediovittatus*		x	x		x		x				x		
Dacus	*parvimaculatus*		x			x	x	x						
Dacus	*plagiatus*				x				x					
Dacus	*pleuralis*		x	x	x			x	x		x	x		
Dacus	*punctatifrons*	x	x	x	x	x	x	x	x		x	x		
Dacus	*schoutedeni*					x	x							
Dacus	*serratus*				x						x			
Dacus	*setilatens*		x					x						
Dacus	*goergeni sp.nov.*		x	x				x				x		
Dacus	*theophrastus*	x	x	x	x	x	x	x	x		x	x		
Dacus	*transitorius*		x		x			x	x				x	
Dacus	*trigonus*				x	x	x		x					
Dacus	*umehi*			x	x				x		x			
Dacus	*vertebratus*	x	x	x	x			x	x	x	x	x	x	x
Dacus	*xanthinus*				x								x	
Perilampsis	*atra*	x	x	x	x	x		x	x			x		x
Perilampsis	*decellei*				x	x		x	x					
Perilampsis	*deemingi*				x						x			
Perilampsis	*formosula*				x				x					
Perilampsis	*furcata*			x	x	x		x	x		x	x		
Perilampsis	*pulchella*		x		x			x	x		x			
Perilampsis	*woodi*				x	x		x	x		x		x	x
Trirhithrum	*basale*				x				x					
Trirhithrum	*brachypterum*				x				x					
Trirhithrum	*coffeae*	x	x		x	x	x	x			x	x		x
Trirhithrum	*dimorphum*	x			x			x	x			x		
Trirhithrum	*homogeneum*	x						x						
Trirhithrum	*inscriptum*	x				x		x				x		
Trirhithrum	*leonense*	x	x					x				x		
Trirhithrum	*nigerrimum*	x	x	x	x			x	x		x	x		x
Trirhithrum	*nigrum*	x	x		x			x	x			x		
Trirhithrum	*obscurum*	x	x		x	x	x	x	x			x		

Table 2. Species richness by genus for Tephritidae in the ecoregions within the study area (abbreviations: WGLL = West Guinean Lowland Forest; EGF = East Guinean Forest; NLF = Nigerian Lowland Forest; CNTF = Cross-Nigerian Transition Forest); WSS = West Sudanian Savannah; GFSM = Guinean Forest Savannah Mosaic; JOS = Jos Plateau Forest Grassland Mosaic; CAM = Central African Mangroves).

	WGLL	WGLL%	EGF	EGF%	NLF	NLF%	CNTF	CNTF%	WSS	WSS%	GFSM	GFSM%	JOS	JOS%	CAM	CAM%	ALL	ALL%
Bactrocera	1	4.0	3	4.0	3	5.0	1	33.3	2	3.6	3	5.2	2	11.1	2	13.3	3	2.6
Capparimyia	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.7	0	0.0	0	0.0	1	0.9
Carpophthoromyia	1	4.0	7	9.3	2	3.3	0	0.0	2	3.6	4	6.9	0	0.0	0	0.0	7	6.0
Ceratitis	5	20.0	27	36.0	17	28.3	0	0.0	19	34.5	21	36.2	5	27.8	3	20.0	38	32.5
Dacus	16	64.0	25	33.3	26	43.3	2	66.7	26	47.3	20	34.5	10	55.6	6	40.0	51	43.6
Perilampsis	0	0.0	5	6.7	6	10.0	0	0.0	4	7.3	2	3.4	1	5.6	2	13.3	7	6.0
Trirhithrum	2	8.0	8	10.7	6	10.0	0	0.0	2	3.6	7	12.1	0	0.0	2	13.3	10	8.5
Total	25	100.0	75	100.0	60	100.0	3	100.0	55	100.0	58	100.0	18	100.0	15	100.0	117	100.0
Total/area	2.2		6.6		6.5		0.5		3.1		3.9		2.7		3.8			

accumulation curve, however, did not show any leveling off (Fig. 3), and both ICE and CHAO2 indicated a higher estimated species richness (mean ICE 168.44; mean CHAO2 153.3).

When the fauna of the different ecoregions was compared (Table 2), the highest species richness was found in the East Guinean Forest (75 species) and the Nigerian Lowland Forest (60 species), followed by the Guinean Forest Savannah Mosaic (58) and the West Sudanian Savannah (55). The lowest species richness was found in the Cross-Nigerian Transition Forest (4). The same tendencies were observed after correction for area size. The West Sudanian Savannah was especially rich in *Dacus* species but

Table 3. Incidence based similarity indices (a: Jaccard; b: Sørensen) for Tephritidae between the ecoregions in the study area (abbreviations: see Table 2) (range 0-1, with 0 being no similarity and 1 being complete similarity).

a) Jaccard

	JOS	WSS	GFSM	WGLL	NLF	EGF	CNTF
CAM	0.10	0.13	0.20	0.18	0.19	0.17	0.19
JOS		0.22	0.10	0	0.15	0.11	0.16
WSS			0.42	0.23	0.43	0.42	0.07
GFSM				0.26	0.48	0.60	0.07
WGLL					0.27	0.27	0.04
NLF						0.48	0.07
EGF							0.05

b) Sørensen

	JOS	WSS	GFSM	WGLL	NLF	EGF	CNTF
CAM	0.18	0.23	0.33	0.3	0.32	0.29	0.32
JOS		0.36	0.18	0	0.26	0.19	0.27
WSS			0.59	0.38	0.60	0.59	0.14
GFSM				0.41	0.64	0.75	0.13
WGLL					0.42	0.42	0.07
NLF						0.65	0.13
EGF							0.10

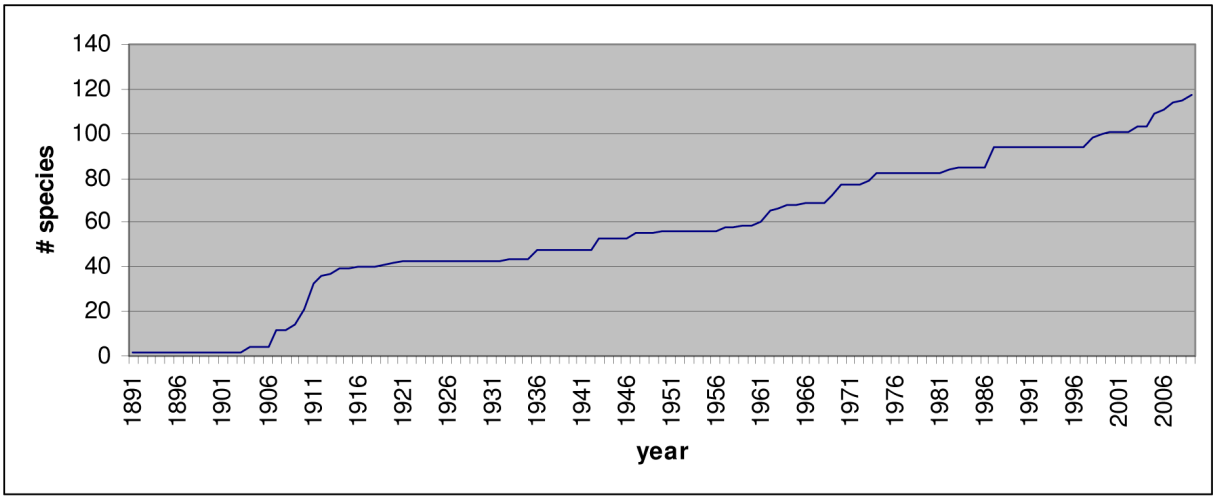

Fig. 3. Species accumulation curve for tephritid species recorded from study area.

very poor in *Trirhithrum* species (in particular when expressed as a percentage of the total fruit fly fauna). On the other hand, the Guinean Forest Savannah Mosaic and East Guinean Forest were very rich in *Trirhithrum*. The Beta-diversity was very heterogenous (Table 3) with especially Central African Mangroves, Jos Plateau Forest Grassland Mosaic, and Cross-Nigerian Transition Forest showing low similarity with the other systems. Highest similarity was found between the East Guinean Forest and the Guinean Forest Savannah Mosaic. For some of the ecoregions that are present within the political boundaries of the area studied, no collecting records were available. This was the case for the Niger Delta Swamp Forests, the Cross-Niger Transition Forests, the Cross-Sanaga-Bioko Coastal Forests, the Cameroon Highlands Forests (all in Nigeria) and the Guinean Montane Forests (in Ivory Coast).

When the fauna within the different political boundaries was compared (Table 4), the highest species richness was found in Nigeria (77 species) while all other countries had a similar richness (52-55

Table 4. Species richness by genus for Tephritidae in the different countries within the study area.

	Ivory Coast	Ivory Coast%	Ghana	Ghana%	Togo	Togo%	Benin	Benin%	Nigeria	Nigeria%	ALL	ALL%
Bactrocera	3	5.8	3	5.8	3	5.8	3	5.5	3	3.9	3	2.6
Capparimyia	0	0.0	0	0.0	0	0.0	1	1.8	0	0.0	1	0.9
Carpophthoromyia	4	7.7	5	9.6	1	1.9	1	1.8	3	3.9	7	6.0
Ceratitis	20	38.5	23	44.2	16	30.8	20	36.4	21	27.3	38	32.5
Dacus	18	34.6	12	23.1	25	48.1	27	49.1	36	46.8	51	43.6
Perilampsis	4	7.7	1	1.9	2	3.8	2	3.6	7	9.1	7	6.0
Trirhithrum	3	5.8	8	15.4	5	9.6	1	1.8	7	9.1	10	8.5
Total	52	100.0	52	100.0	52	100.0	55	100.0	77	100.0	117	100.0
Total/area	4.1		4.4		5.8		5.3		4.9			

Table 5. Incidence based similarity indices (a: Jaccard; b: Sørensen) for Tephritidae between the countries in the study area. Range 0-1, with 0 being no similarity and 1 being complete similarity).

a) Jaccard

	Benin	Togo	Ghana	Ivory Coast
Nigeria	0.43	0.47	0.40	0.39
Benin		0.53	0.37	0.41
Togo			0.51	0.49
Ghana				0.41

b) Sørensen

	Benin	Togo	Ghana	Ivory Coast
Nigeria	0.61	0.64	0.57	0.56
Benin		0.69	0.54	0.58
Togo			0.67	0.65
Ghana				0.58

species). After correction for country area, the highest richness was observed in Togo and Benin. The Beta-diversity was rather similar between all countries (Table 5) with Jaccard indices varying between 0.37 and 0.51 and Sørensen indices between 0.54 and 0.69. The highest similarity was between the fauna of Benin and Togo while the lowest similarity was found between Benin and Ghana. Second lowest similarity was between Nigeria and Ivory Coast.

Taxonomy

Phylum Arthropoda Siebold, 1848
Classis Insecta Linnaeus, 1758
Ordo Diptera Linnaeus, 1758
Familia Tephritidae Macquart, 1835
Genus *Dacus* Fabricius, 1805

Among the material, one *Dacus* species, new to science, was discovered. It is hereby described.

Dacus (Psilodacus) goergeni sp. nov.
urn:lsid:zoobank.org:act:47F1AD2E-9183-4C0F-A65B-D9FDBB15DB1D
Fig. 4

Etymology

Named in honour of the collector, Dr Georg Goergen, who is also the founder and conservator of the entomological collections at the International Institute of Agriculture.

Material

Holotype

♂, TOGO, Kloto, Jan. 2006, 'on *Solanum* sp.', leg. G. Goergen (deposited in collection of IITA).

Paratypes

TOGO: same locality as holotype, 1 ♂, Dec. 2005, 'on *Acacia auriculiformis*'; 2 ♂♂, 5 ♀♀, Jan. 2006; 1 ♂, 3 ♀♀, Jan. 2006, 'on *Solanum* sp.'; 4 ♂♂, 1 ♀, Jan. 2008; 1 ♂, 1 ♀, Feb. 2008. BENIN: Lokossa, 1 ♂, 1 ♀, Jan. 2006. All leg. G. Goergen. Paratypes deposited in collections of IITA, NHM and RMCA.

Description

Size. 6.2-7.5 mm, wing length 4.8-6.6 mm.

Head. Pedicel and 1st flagellomere not longer than ptilinal suture. Face (Fig. 4A): antennal furrow without a dark spot; upper area with a dark marking, tending to an inverted V-shaped dark marking (in some specimens this extends down each side of carina and may be mistaken for facial spots). Frons: frontal setae 0, orbital seta 0.

Thorax. Scutum (Fig. 4B) predominantly fuscous, tending to red-brown antero-laterally; postpronotal lobe entirely pale, yellowish; notopleural callus pale posteriorly, anteriorly concolorous with scutum; notopleural xanthine probably isolated from notopleural callus but can appear almost joined (as in wedge form); lateral and medial postsutural vitta absent. Scutellum without any dark patterning (except for basal dark margin, which is very narrow). Anepisternum (Fig. 4C) with a stripe from notopleural callus to (or almost to) katepisternum; stripe very broad (anteriorly extending almost to postpronotal lobe); extended onto katepisternum. Laterotergal xanthine confined to katatergite.

Thoracic setae. Anterior notopleural seta present; anterior supra-alar seta present.

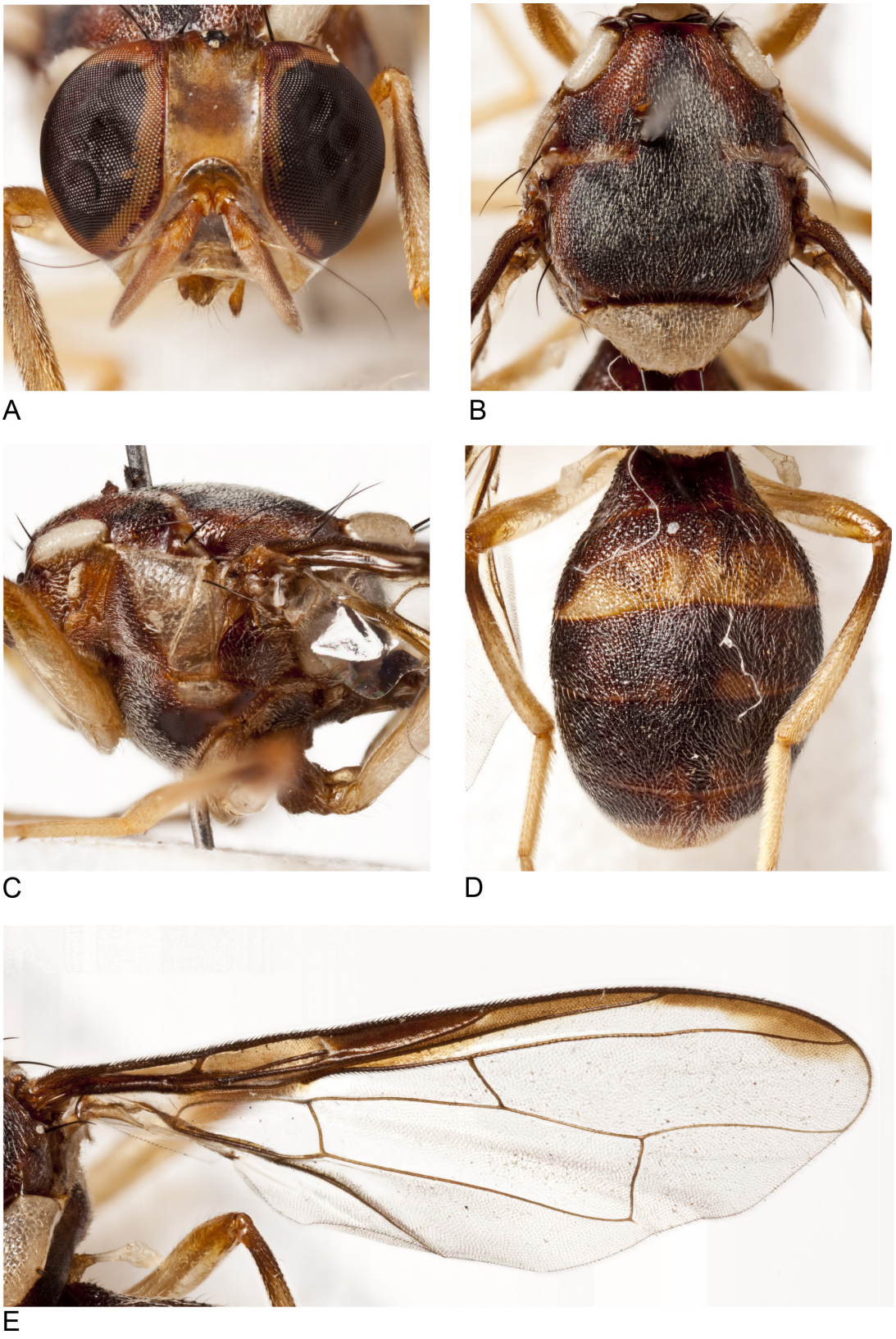

Fig. 4. *Dacus goergeni* sp. nov. **A**. Head, frontal view. **B**. Thorax, dorsal view. **C**. Thorax, lateral view. **D**. Abdomen, dorsal view. **E**. Wing.

Wing (Fig. 4E). Basal cell bc without microtrichia; cell c with an almost complete (> 90%) covering of microtrichia; cell bm without microtrichia. Narrow subbasal raised section of cell br with extensive covering of microtrichia; partly bare in apical half. Crossvein R-M beyond middle of cell dm. Costal band complete; shallow, not or barely extending below vein R_{2+3}, except in basal section (before crossvein R-M) and at wing apex; expanded into a small spot at apex. Anal streak absent (but with a trace of colour confined to cell bcu). Cells bc and c coloured (not as deep as costal band). Without any crossbanding.

Legs. Forefemur pale, yellowish, sometimes indistinctly darkened apically; midfemur bicoloured (pale basal half to two-thirds, red-brown apically); hindfemur pale, yellow, rarely distinctly darkened apically.

Abdomen. Predominantly fuscous; shape and patterning, see Fig. 4D. Tergites I-V all fused.

Male

Tergite III with some very fine hairs (possible vestigial pecten); lacking hindtibia preapical "pad". Basal costal sections without specialised setae.

Female

Aculeus pointed, similar to *B. stylifer*.

Host

No host records known (some material is indicated as being found on *Solanum* sp. or *Acacia auriculiformis* but there is no indication that either of these plants is a host).

Distribution

Reported from Benin and Togo.

Remarks

The new species is very similar to *Dacus stylifer* which is an East African species. It differs in the wing cell c having almost complete coverage of microtrichia in the males (50% in male *stylifer*); the mid-femur bicoloured (pale in typical *stylifer*); the notopleuron bicoloured and sutural xanthine distinct, unlike typical *stylifer*. *Dacus goergeni* sp. nov. is placed in the ill-defined subgenus *Psilodacus*, based upon a combination of characters, which typify the grouping, including the lack of facial spots: the dark, almost inverted V-shaped, dark marking at the top of the face; lack of anal streak and male pectin; it differs from most *Psilodacus* spp. in having anterior supra-alar setae. The type specimens were captured in the Guinean Forest Savannah Mosaic and the Eastern Guinean Forest ecoregions. Label information indicates that the specimens were collected in forested areas.

Other taxonomic notes

Dacus pleuralis Collart, 1935

Among the material examined was a male specimen collected at Ibadan, Nigeria (4-8 Dec. 2003, cue lure traps, leg. G. Goergen), in addition to the male specimen studied earlier (White & Goodger 2009). It shows some morphological deviation from the earlier collected specimen and from the type material as redescribed in White (2006): the xanthines (katatergite and anatergite) are fused, while in the typical *D. pleuralis* the xanthines are clearly separated. The anterior supra-alar seta is absent or vestigial while well developed in the typical *D. pleuralis*. These differences, however, appear to be intraspecific variation and do not warrant separate description.

Dacus mochii Bezzi, 1917

Dacus mochii was described from Eritrea, but the type specimens were lost. White (2006) placed it in synonymy with *D. annulatus* Becker, based on the similarity of the original description. Subsequently, White & Goodger (2009) reported a specimen from Ethiopia, which was clearly not *D. annulatus*, but was a good match to the description of *D. mochii*, which they then removed from synonymy. Amongst the material examined here, there was a male specimen from Kloto, Togo (Mar. 2006, leg. G. Goergen), which is very similar to the *D. mochii* from Ethiopia, except that it has pallid face spots. Togo is a considerable westward expansion of the known distribution of a species otherwise known only from a restricted area of East Africa. Since it concerns a single specimen whose identity is uncertain, we excluded it from the richness analysis.

Dacus blepharogaster Bezzi, 1917

A male specimen from Sérou, Benin (Dec. 2005, leg. G. Goergen) differs from *D. blepharogaster*, as described by White (2006) in having some red pattern on the third abdominal tergite. However, since this species belongs to a group that needs proper revision (*Dacus (Lophodacus*) *brevis* group as defined by White 2006) and since only one specimen was found in the collections studied, it is not described as a separate species. As the previous species, this is also predominantly an East African species (Kenya, Eritrea and Ethiopia) but was not included in the richness analysis.

Discussion

In general, the frugivorous tephritid fauna of western Africa is very rich, with about 30% of all known species found in Sub-Saharan Africa. However, the estimated species richness indices indicate that the actual number of species can be considerably higher and, thus, the present knowledge should be considered preliminary. A number of species appear to be endemic as they have until now only been recorded from the study area: *Ceratitis grahami* Munro, 1935, *C. guttiformis* Munro, 1935, *C. lepida* (Munro, 1969), *C. neostictica* De Meyer, 1998 (all Ghana), *Dacus albiseta* White & Goodger, 2009 (Benin), *D. acutus* White & Goodger, 2009 and *D. kurrensis* White & Goodger, 2009 (both Nigeria). In addition, a number of species that appear to be endemic for the larger area of West Africa, are present in the study area: *Carpophthoromyia tritea* (Walker, 1849) (recorded from Ivory Coast and Sierra Leone); *Ceratitis lunata* Munro, 1935 (Sierra Leone and Benin); *C. paracolae* De Meyer & Freidberg, 2006 (Nigeria and Cameroon); *C. tripteris* (Munro, 1957) (Sierra Leone, Ivory Coast and Nigeria); *Dacus carnesi* (Munro, 1984) (Benin, Ivory Coast, Ghana, Liberia, Nigeria and Togo); *D. elutissimus* Bezzi, 1924 (Senegal and Togo); *D. flavicrus* Graham, 1910 (Ivory Coast, Liberia, Nigeria, Sierra Leone and Togo); *D. guineensis* Hering, 1944 (Benin, Guinea and Senegal); *D. umehi* White, 2006 (Benin, Guinea and Nigeria); *D. xanthinus* White & Goodger, 2009 (Nigeria and Senegal); *Perilampsis atra* Munro, 1969 (Benin, Cameroon, Ghana, Ivory Coast, and Nigeria); *P. decellei* Munro, 1969 (Cameroon, Ivory Coast and Nigeria); *P. furcata* Munro, 1969 (Benin, Chad, Ivory Coast, and Nigeria); and *Trirhithrum dimorphum* Munro, 1934 (Ghana, Nigeria, and Sierra Leone).

Remarkable is the presence of a number of species that was hitherto only known from eastern and/or southern Africa but that are now reported for the first time from Western Africa, which results in a large westward expansion of their known distribution range. Such cases are *Capparimyia melanaspis* (Bezzi, 1920) (the only representative of this genus which was only known from sub-Saharan eastern and southern Africa, see De Meyer & Freidberg (2005)), *Ceratitis discussa* Munro, 1935, and *Dacus lounsburyii* Coquillett, 1901. This pattern had already been observed for *Dacus botianus* (Munro, 1984), *D. ceropegiae* (Munro, 1984), *D. plagiatus* Collart, 1935, *D. serratus* (Munro, 1984) and *Perilampsis woodi* (Bezzi, 1917) (White 2006; De Meyer 2009) and the aberrant specimens of *D. blepharogaster* and *D. mochii* (*cf. supra*) might also confirm this pattern once their identity is confirmed.

When looking at Beta-diversity indices, the low overall similarity of the Central African Mangroves, the Jos Plateau Forest Grassland Mosaic and the Cross-Nigerian Transition Forest ecoregions is probably a reflection of the relatively low richness of these regions in comparison with the others. A plausible possibility for differences between the other ecoregions could be caused by the different fruit fly / host plant associations. *Ceratitis*, *Carpophthoromyia* and *Trirhithrum* species, for example, are mainly infesters of fleshy tree or shrub fruits (e.g., from Anacardiaceae, Annonaceae, Euphorbiaceae, Rubiaceae, Rutaceae or Sapotaceae, see De Meyer *et al.* 2002 and White *et al.* 2003), representatives of which are predominantly found in forested areas. *Dacus* species, on the other hand, are infesters of creepers and climbers of either Cucurbitaceae, asclepiad Apocynaceae, or Passifloraceae (White 2006). The West Sudanian Savannah is relatively rich in *Dacus* species while low in *Trirhithrum* species. The West Guinean Lowland Forest, Nigerian Lowland Forest, East Guinean Forest and Guinean Forest Savannah Mosaic are relatively rich in *Trirhithrum*, and the latter two are also low in *Dacus* and *Carpophthoromyia* richness. However, the species composition of the West Guinean Lowland Forest (relatively rich in *Dacus* species) does not correspond with this general tendency. Hancock (1989) already indicated that certain species groups within *Dacus* show a marked preference for forest and moist woodland habitats in Southern Africa, appearing only occasionally in drier woodlands, while other groups do not occur in forests. It could well be that a similar division is observed here, leading to the discrepancy in some regions. However, this requires further investigation, in particular with regard to host plant data.

As for national differences, it is not surprising that the highest similarity is found between neighbouring countries, (Benin and Togo) while the second lowest similarity is found between Nigeria and Ivory Coast, which are the two countries at the extremes of the study area. The lowest similarity, which is found between Benin and Ghana, appears to be the result of Benin having a considerably higher number of *Dacus* species not present in Ghana, while Ghana is relatively rich in *Ceratitis*, *Carpophthoromyia* and *Trirhithrum* species. Again, this could be the result of the different host plant preferences and the relative proportional representation of the different ecoregions in these two countries, with the forested areas in Benin being very restricted and much more widespread in Ghana while Benin is predominantly occupied by the West Sudanian Savannah. It must be emphasized though, that this study is not based upon a standardized sampling program with identical sampling intensity and methodology. This can have an impact on and presents a weakness of the Beta-diversity analysis both at ecoregional and country level. Although a regular sampling protocol at frequent intervals in all areas could provide more reliable information, given the magnitude of the study area, the field conditions, and the life history of the flies, this is currently not considered a realistic approach.

The Conservation Status Index for all ecoregions in the study area for which fruit fly data are available is considered either Critical (East Guinean Forest, Nigerian Lowland Forest, Cross-Nigerian Transition Forest, Jos Plateau), Endangered (Guinean Forest Savannah Mosaic, Central African Mangroves) or Vulnerable (West Guinean Lowland Forest, West Sudanian Savannah) (Burgess *et al.* 2004). The two regions with highest species richness are among the Critical ones: East Guinean Forest and Nigerian Lowland Forest. In the last decade two invasive species of Asian origin have been recorded from western Africa: *Bactrocera invadens* Drew, Tsuruta & White, 2005 (Drew *et al.* 2005; Goergen *et al.* 2011) and *B. cucurbitae* Coquillett 1899 (Vayssières *et al.* 2007). Both, particularly the former, are known to show competitive displacement of indigenous species (Ekesi *et al.* 2009, Mwatawala *et al.* 2009), and are now found in all countries and ecoregions of the study area. *B. cucurbitae* is also known to be a strong invader (Mwatawala *et al.* 2010) and is now found mainly in the Guinean Forest Savannah Mosaic and West Sudanian Savannah. Although the majority of the existing data refer to economically significant crops and species, it is likely that such invasive species will also have an impact on the global indigenous fruit fly diversity.

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