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New records of Chironomidae (Diptera: Insecta) from the Azores, Macaronesia

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Collections of Chironomidae from aquatic habitats on the Azores islands of São Miguel and Flores during August 1997 and on São Miguel, Terceira and Graciosa in September-October 1998, yielded 33 species-level taxa. Representatives of 16 taxa in three subfamilies are new generic / species records for the Azores archipelago: **Tanypodinae** - *Procladius (Holotanypus) choreus* (Meigen), *Paramerina* sp. griechenland, *Zavrelimyia* sp.; **Orthocladiinae** - *Metriocnemus (Inermipupa) carmencitabertarum* Langton et Cobo, *Orthocladius (Eudactylocladius)* sp., *Psectrocladius limbatellus* (Holmgren), *Psectrocladius* sp., *Pseudorthocladius* sp., *Smittia contingens* (Walker); **Chironominae** - *Chironomus cingulatus* Meigen, *Chironomus cf annularius* (De Geer), *Glyptotendipes barbipes* (Staeger), *Glyptotendipes pallens* (Meigen), *Polypedilum nubifer* (Skuse), *Micropsectra* sp. (cf *lindrothi* Goetghebuer), *Paratanytarsus grimmii* (Schneider). A revised checklist is provided, incorporating and updating previous records.

Keywords : Insecta, Chironomidae, Azores, Macaronesia, distribution.

Introduction

The islands of the Azores archipelago lie in the Atlantic Ocean approximately 1,600 km west of Portugal between latitudes 39° 43′N and 36° 95′N. The islands are of volcanic origin, have a total landmass area of 2,333 km^2 and span a distance of approximately 500 km in a general north-west sequence between longitudes 25° 00′W and 31°05′W. Three groups of islands are recognised, the eastern group of São Miguel, Santa Maria and the Formigas islet, a central group of Faial, Pico, São Jorge, Terceira and Graciosa and the western group of Flores and Corvo (Fig.1). The islands experience a temperate / sub-tropical climate and high humidity resulting from the direct influence of the Gulf Stream. Annual land temperatures range between 14°C and 25°C while the surrounding seawaters vary between 16° C and 22°C. The flora is predominantly of European and Mediterranean origin.

The Azorean insect fauna has been the subject of many investigations during the last century. Viera & Borges (1993) and Borges & Viera (1994) provide a comprehensive bibliography of these entomological studies covering a diverse range of taxonomic groups. More recently Kehlmaier (1998) compiled a database and checklist of the dipteran species previously recorded from the Azores based on all relevant late 19th and 20th century studies. Most information on the Azorean chironomid fauna stems from collections made in 1938 by Frey, Storå and Cedercreutz and reported by Storå (1945). Subsequently, Freeman (1959) examined and reported on collections made by Brinck and Dahl from the Lund University Expedition to Madeira and the Azores in 1957. Kehlmaier (1998), «not claiming completeness or actuality» provided a list of the species-level chironomid taxa compiled from these studies but citations were based on earlier taxonomic concepts and did not take account of recent taxonomic advances or generic revisions. Cobo et al. (2002) applied current taxonomy to the existing Azorean records in their recent inventory of Portuguese Chironomidae. A total of 33 Azorean species-level taxa is recognised in the literature, four of which were deemed *nomina dubia* by Ashe and Cranston (1990) while Cobo et al. (2002) cite five *nomina dubia*. In 1997 and 1998 Chironomidae were collected from aquatic habitats on four islands of

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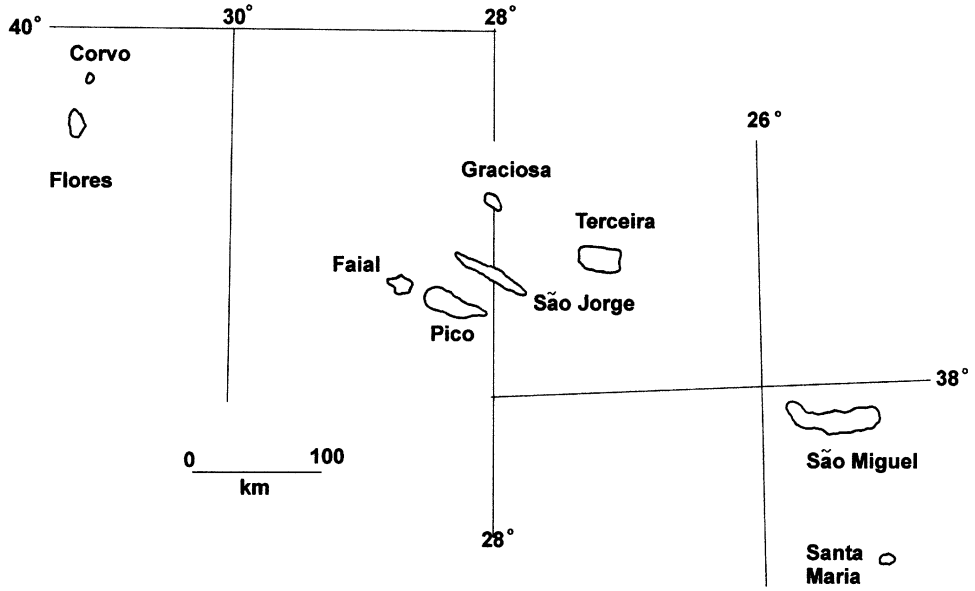

Fig. 1. Islands of the Azores Archipelago.

the Azorean archipelago: São Miguel and Flores (August 1997 - M.T. Furse), São Miguel, Terceira and Graciosa (September/October 1998 - M.T. Furse, S.J. Hughes, D. Murray, W. Murray). The results of these studies, providing new records and clarification of the status of some existing records, are presented in this paper.

Methods

Adult Chironomidae were collected by aerial sweep netting. Skimming of surface waters of ponds, reservoirs, animal drinking troughs and ornamental ponds and fountains, by fine-mesh net using techniques described by Langton (1991) or by use of drift nets placed in flowing waters, yielded pupal exuviae and some pharate adults. Some collections were made in open deep wells by lowering a drift net to obtain surface floating exuviae. Larvae were obtained at some sites. All specimens were preserved in 70 % alcohol and later processed and treated according to methods outlined in Wiederholm (1983, 1986, 1989 for larvae, pupal exuviae and adults respectively).

Because of the restricted number of exposed natural freshwater habitats on the islands, collection effort in some cases was restricted to artificial habitats such as stone or concrete watering troughs, abandoned baths, and artificial and ornamental pools, which none the less proved to be rich sources of chironomid material. Specimens were obtained in a total of 55 collections, from inland habitats associated with freshwaters and also in some marine coastal areas, on the four islands visited. Seventeen collections (2 marine) were undertaken on São Miguel, 20 (4 marine) on Terceira, 15 (3 marine) on Graciosa and 3 on Flores (no marine samples). Details of site locations and dates on which collections were made are given in Table 1.

Results

The chironomid taxa recorded

A list of the taxa present in the samples examined from the 55 collections is given in Table 2. Thirty-three species-level taxa from the subfamilies Telmatogetoninae, Tanypodinae, Orthocladiinae and Chironominae were identified, sixteen of which constitute records not cited for the archipelago in previous literature. Determinations by previous workers were based on features of the adult male imago alone whereas modern chironomid systematics relies on characters from all life history stages, pupal exuviae particularly yiel-

Table 1. Sites on São Miguel, Terceira, Graciosa and Flores from where collections of Chironomidae were obtained in 1997 and 1998. Latitude / longitude data in **bold type** are approximate. Site codes are used for species records in Table 2.

Date	Code	Location	Latitude N	Longitude W
		São Miguel		
18-8-97	SM1	Lagoa de Eguas, inlet stream	**37°49.6'**	**25°44.9'**
18-8-97	SM2	Trough on road, north east of Cerrado das Freiras	37°51.5'	25°46.6'
23-9-98	SM3	Small pond at tea factory	37°49.1'	25°23.8'
23-9-98	SM4a	Ornamental ponds at Community Centre, Terra Nostra	**37°46.3'**	**25°18.7'**
23-9-98	SM4b	Thermal pool in Terra Nostra Park	**37°46.3'**	**25°18.7'**
23-9-98	SM4c	Ornamental pond inside east gate of Terra Nostra Park	**37°46.3'**	**25°18.7'**
23-9-98	SM5	Lagoa das Furnas, near fumeroles	37°46.1'	25°19.9'
24-9-98	SM6	Ribeiro do Lameiro, south of road EN1-1a	37°48.7'	25°28.1'
24-9-98	SM7	Ribeira dos Caldeiroes, waterfall south of road EN1-1a	**37°50.6'**	**25°15.9'**
24-9-98	SM8	Trough at cross road, EN1-2a, south of Nordeste	**37°49.1'**	**25°08.9'**
24-9-98	SM9	Un-named stream, south of road En1-2a	37°47.8'	25°10.6'
24-9-98	SM10	Lay-by on tributary of Rba Quente, on EN2a	37°44.9'	25°18.6'
24-9-98	SM11	Lagoa das Furnas, shoreline	37°45.8'	25°19.7'
24-9-98	SM12	Lagoa das Furnas, pumice-strewn south east shore	37°45.1'	25°19.7'
25-9-98	SM13	Pond at Universidade dos Açores, Ponta Delgada	37°44.7'	25°39.9'
23-9-98	SMm1	Marine sample on rocky shore at Ponta Delgada	37°44.4'	25°39.7'
25-9-98	SMm2	Marine sample at Praia do Populo, Ponta Delgada	37°44.9'	25°37.4'
		Terceira		
29-9-98	T1	Trough at Serrata	38°45.1'	27°21.9'
30-9-98	T2	Lagoa do Negro	38°44.8'	27°16.1'
30-9-98	T3	Trough near Pico de Cancela	**38°43.8'**	**27°16.7'**
30-9-98	T4	Lagoa da Falca - lake, stream, trough	38°43.1'	27°17.4'
30-9-98	T5	Rba Urzal, bridge at Quatros Ribeiras	38°47.1'	27°13.7'
1-10-98	T6	Lagoa do Junco	38°42.6'	27°07.4'
1-10-98	T7	Lagoa do Ginjal	38°41.8'	27°09.5'
1-10-98	T7a	Trough near L. do Ginjal	38°41.5'	27°09.6'
1-10-98	T8	Trough, Sra do Rosario, Caminha das Guerilhas	38°41.0'	27°16.4'
1-10-98	T9	Trough, Ribera Brava x-road, Picos dos Padres	38°41.7'	27°17.4'
2-10-98	T10	Trough, Tereiro da Macela	38°46.0'	27°15.0'
2-10-98	T11	Tributary of Rba Urzal	38°46.4'	27°13.7'
2-10-98	T12	Trough 2Km south east of Ponta das Quatros Ribeiras	38°47.1'	27°12.8'
2-10-98	T13	Trough at Farroco, south of Ponta do Misterío	38°47.5'	27°12.3'
3-10-98	T14	Trough near entrance to Foreleza de S. Joao Baptista	**38°39.2'**	**27°13.6'**
3-10-98	T15	Trough, Rua Jose Agostinho, Angra do Heroísmo	**38°39.4'**	**27°13.6'**
30-9-98	Tm1	Marine sample from rock pools, Biscoitos	38°48.1'	27°15.5'
1-10-98	Tm2	Marine-sample on shoreline at Baía de Vila Maria	38°39.3'	27°15.5'
2-10-98	Tm3	Marine sample on shoreline at Praia da Vitória	38°43.5'	27°03.6'
2-10-98	Tm4	Marine sample on shoreline at Quatro Riberas	38°47.5'	27°13.8'
		Graciosa		
26-9-98	G1	Trough before Caldeira tunnel	39°01.8'	27°59.0'
26-9-98	G2	Trough at Canada Longa	39°02.4'	27°59.2'
26-9-98	G3	Troughs, inshore from Baia de Engrade	39°01.5'	27°57.4'
27-9-98	G4	Trough near Pedreias	39°02.7'	28°02.6'
27-9-98	G5	Bath in field, Caminho do Meio	39°04.3'	28°01.9'
27-9-98	G6	Municipal trough, Canada do Brijes	39°04.5'	28°03.9'
27-9-98	G7	Small reservoirs near Ribeirinha	39°03.2'	28°02.6'
27-9-98	G8	Eutrophic pond near Caldeirinha	39°02.6'	28°01.7'
27-9-98	G9	Trough near windfarm- west side of Serra Dormida	**39°02.2'**	**28°01.6'**
28-9-98	G10	Concrete pool at Santa Cruz Cultural Centre	39°05.2'	28°00.7'
28-9-98	G11	Deep well, Caminha de Igreja	39°03.7'	28°01.2'
28-9-98	G12	Path to Furna do Enxofre	39°01.4'	27°58.3'
28-9-98	Gm1	Marine rocky shore at Santa Cruz	39°05.2'	28°00.4'
28-9-98	Gm2	Marine sample -harbour at Santa Cruz	39°05.1'	28°00.2'
28-9-98	Gm3	Marine sample on rocky shore at Praia	39°03.1'	27°58.3'
		Flores		
13-8-97	F1	Shoreline of Lagoa Basa	39°24.4'	31°13.2'
13-8-97	F2	Cascata pool, Rba das Casas, Porto de Faja Grande	39°27.5'	31°15.2'
14-8-97	F3	Tank in Parque Florestal, Fazendas de Santa Cruz	**39°27.7'**	**31°09.2'**

Table 2. Distribution of the 33 chironomid taxa identified from samples collected in 1997 and 1998 at sites (codes in Table 1) on São Miguel, Terceira, Graciosa and Flores. Site codes in **bold type** indicate new species records for the island. «Status» indicates new records for the Azores archipelago.

Taxon	S. Miguel	Terceira	Graciosa	Flores	Status
Subfamily Telmatogetoninae					
Thalassomya frauenfeldi Schiner		Tm2			
Subfamily Tanypodinae					
Macropelopia nebulosa (Meigen)		T14			
*Procladius (Holotanypus) choreus (*Meigen)		**T2, 3, 7b, 10, 13**	**G4, 5, 7, 9, 10**		New
Paramerina sp (sp Griechenland Fittkau 1962)		**T5, T12**			New
Zavrelimyia sp	**SM6, 7**	**T4**			New
Subfamily Orthocladiinae					
Camptocladius stercorarius (De Geer)		T2			
Cardiocladius freyi Storå ?	SM2	T5		F2	
Cricotopus (Halocladius) varians (Stæger)			**Gm1**		
Cricotopus (Isocladius) ornatus (Meigen)		**T9**			
Cricotopus (Isocladius) sylvestris (Fabricius)		**T1, 7, 13**	**G2, 3, 7, 9, 10**		
Cricotopus sp			**G6**		
Limnophyes minimus (Meigen)				F2	
Metriocnemus fuscipes (Meigen)		T11			
Metriocnemus (Inermipupa) carmencitabertarum Langton & Cobo		**T15**			New
Orthocladius (Eudactylocladius) sp	**SM7**	**T5, 12**		**F2**	New
Parametriocnemus stylatus (Kieffer)		T5		F2	
Psectrocladius limbatellus (Holmgren)		**T9, 12, 13**			New
Psectrocladius sp				**F1**	New
Pseudorthocladius sp	**SMm2**				New
Pseudosmittia brevifurcata (Edwards)			**Gm2**		
Rheocricotopus (Psilocricotopus) atripes (Kieffer)	SM6			F2	
Smittia contingens (Walker)	**SM6**				New
"Thalassosmittia" atlantica (Storå)		Tm 1,2 3,4	**Gm1, Gm3**		
Thienemanniella clavicornis (Kieffer)		**T5**			
Subfamily Chironominae					
Chironomus cingulatus Meigen	**SM11, 12**	**T2, 3, 7b, 10, 12**	**G3, 4, 9, 11**		New
Chironomus riparius Meigen	SM2, 8	**T9, 12, 15**	**G9, 10**	**F3**	
Chironomus cf annularius (De Geer)			**G10**		New
Glyptotendipes (Phytotendipes.) barbipes (Staeger)	**SM13**	**T3, 15**	**G2, 4, 6, 7**		New
Glyptotendipes (P) pallens (Meigen)		**T2**	**G3, 10**		New
Polypedilum (Polypedilum) nubeculosum (Meigen)		T8, 10, 12			
Polypedilum (Polypedilum) nubifer (Skuse)		**T3, 9, 13, 14**	**G2,G7**		New
*Micropsectra sp. (*cf *lindrothi* Goetghebuer)		**T12**		**F1**	New
Paratanytarsus grimmii (Schneider)		**T2, 9**			New
Number of taxa recorded on each island	9	24	12	8	
Number of taxa new to each island	6	16	12	4	

ding a wealth of taxonomic characters not available or used extensively in taxonomic resolutions by earlier workers. The collection and examination of pupal exuviae in this study has confirmed the presence of some previously recorded taxa, provided evidence of previously unrecorded taxa and also suggests that some former determinations may be inaccurate. A species list, incorporating the known distribution of Chironomidae on the eight islands studied during previous investigations and in the present study, is given in Table 3. This table includes species regarded as nomina dubia by Cobo et al. (2002) and by Ashe & Cranston (1990), pending further taxonomic investigation and final resolution. The sixteen taxa that constitute new

Table 3. Updated list of chironomid species-level taxa from São Miguel (SMi), Terceira (Ter), Graciosa (Gra), São Jorge (SJo), Pico (Pic), Faial (Fai), Flores (Flo) and Corvo (Cor). Previous / existing records are denoted «P», existing records confirmed in the present study are denoted «C», new records are denoted «N».

	SMi	Ter	Gra	SJo	Pic	Fai	Flo	Cor
Telmatogeninae								
Thalassomya frauenfeldi Schiner	P	C		P	P	P	P	P
Tanypodinae								
Macropelopia nebulosa (Meigen)	P	C		P			P	
Procladius (Holotanypus) choreus (Meigen)		N	N					
Paramerina pygmaea (van der Wulp)	P	P						
Paramerina sp. Griechenland (sensu Fittkau 1962)		N						
Telmatopelopia nemorum (Goetghebuer)	P	P		P			P	
Zavrelimyia nubila (Meigen)	P			P	P	P	P	
Zavrelimyia sp (sensu Hughes & Murray 2000)	N	N						
Diamesinae								
Diamesa (Nesodiamesa) alata Storå	P	P				P		
Orthocladiinae								
Camptocladius stercorarius (De Geer)	P	C		P	P	P	P	
Cardiocladius freyi Storå	C	C		P			C	
Chaetocladius melaleucus (Meigen)	P	P					P	P
Cricotopus (Halocladius) sp	P			P	P	P	P	
Cricotopus (Halocladius) varians (Staeger)			N	P		P	P	
Cricotopus (Isocladius) ornatus (Meigen)	P	N						
Cricotopus (Isocladius) sylvestris (Fabricius)	P	N	N					
Cricotopus sp (larva)			N					
Limnophyes minimus (Meigen)	P	P			P	P	C	
Metriocnemus fuscipes (Meigen)	P	C		P	P	P	P	
Metriocnemus (Inermipupa) carmencitabertarum Langton & Cobo		N						
Orthocladius rivularis (nomen dubium)	P						P	
Orthocladius (Eudactylocladius) sp	N	N					N	
Parametriocnemus stylatus (Kieffer)	P	C				P	C	
Psectrocladius insularis (nomen dubium)	P	P		P		P	P	P
Psectrocladius limbatellus (Holmgren)		N						
Psectrocladius sordidellus (Zetterstedt)	P	P						
Psectrocladius sp							N	
Pseudosmittia azorica (Storå) (nomen dubium)	P	P	P	P	P	P	P	P
Pseudorthocladius sp	N							
Pseudosmittia brevifurcata (Edwards)			N	P	P			
Rheocricotopus (Psilocricotopus) atripes (Kieffer)	C	P		P		P	C	
Smittia aterrima (Meigen)	P							
Smittia contingens (Walker)	N							
"Thalassosmittia" atlantica (Storå)	P	C	N		P	P	P	P
Thienemannia gracei (Edwards)				P				
Thienemanniella clavicornis (Kieffer)	P	N						
Chironominae								
Chironomus venustus Staeger	P	P	P	P				
Chironomus cingulatus Meigen	N	N	N					
Chironomus dorsalis Meigen	P	P		P		P	P	
Chironomus riparius Meigen	C	N	N		P	P	N	
Chironomus cf annularius			N					
Glyptotendipes barbipes (Staeger)	N	N	N					
Glyptotendipes pallens (Meigen)		N	N					
Polypedilum (Polypedilum) nubeculosum (Meigen)	P	C			P			
Polypedilum (Polypedilum) nubifer (Skuse)		N	N					
Micropsectra junci (Meigen) - syn *subviridis*	P	P		P	P	P	P	P
Micropsectra freyi Storå (nomen dubium)				P				
Micropsectra cf lindrothi Goetghebuer		N					N	
Paratanytarsus grimmii (Schneider)		N						
Tanytarsus sp	P				P		P	P
Total number of taxa from each island	**35**	**36**	**14**	**18**	**13**	**16**	**24**	**7**

records for the Azores, and the further records of species already known to occur in the Azores, extend considerably the knowledge base of chironomid distribution in the archipelago.

Some of the recently discovered taxa appear to have a restricted distribution on the islands from which samples were obtained. For example, *Procladius choreus, Glyptotendipes pallens* and *Polypedilum nubifer* were only obtained on the central group islands of Terceira and Graciosa while *Glyptotendipes barbipes* was found in these central islands and on the eastern island of São Miguel. In contrast, *Cardiocladius freyi* and the hygropetric *Eudactylocladius* sp. occur across the archipelago from São Miguel to Flores while species such as *Smittia contingens* and *Paratanytarsus grimmii* are thus far only known from São Miguel and Terceira respectively.

Azorean chironomid species - area relationship

Combining results from the present study with those of earlier investigations reveals differences in chironomid species richness (α diversity) between the Azorean islands. MacArthur and Wilson (1967) demonstrated a linear relationship between the logarithm of species number and the logarithm of island area for discrete island groups within a geographic region. Data from the present and past studies in the Azores provides the species-area relationship plot in Fig 2. Datapoints for Corvo, Faial, São Jorge and Pico, based only on records from earlier studies, fall below the regression line, in contrast to the recently investigated islands of Flores, Graciosa, Terceira and São Miguel. The low species number on the smaller, more remote, island of Corvo is not unexpected. The data points for Faial and São Jorge lie closer to predicted values but the point derived from the low species number on Pico would suggest that further collection effort would be likely to yield additional species records there.

Comments on some records

Subfamily Tanypodinae

***Procladius choreus* (Meigen)** : The records of *Procladius* from Terceira and Graciosa are the first findings of the genus for the Archipelago. *P. choreus* has a widespread Palaearctic distribution and is also known from Madeira and the Canary Islands.

***Paramerina pygmaea* (van der Wulp), *Paramerina* sp. Griechenland** : Freeman (1959) first recorded *Pentaneura cingulata*, now a synonym of *P. pygmaea*, from specimens collected on São Miguel. A possibility exists, however, that adults identified by Freeman

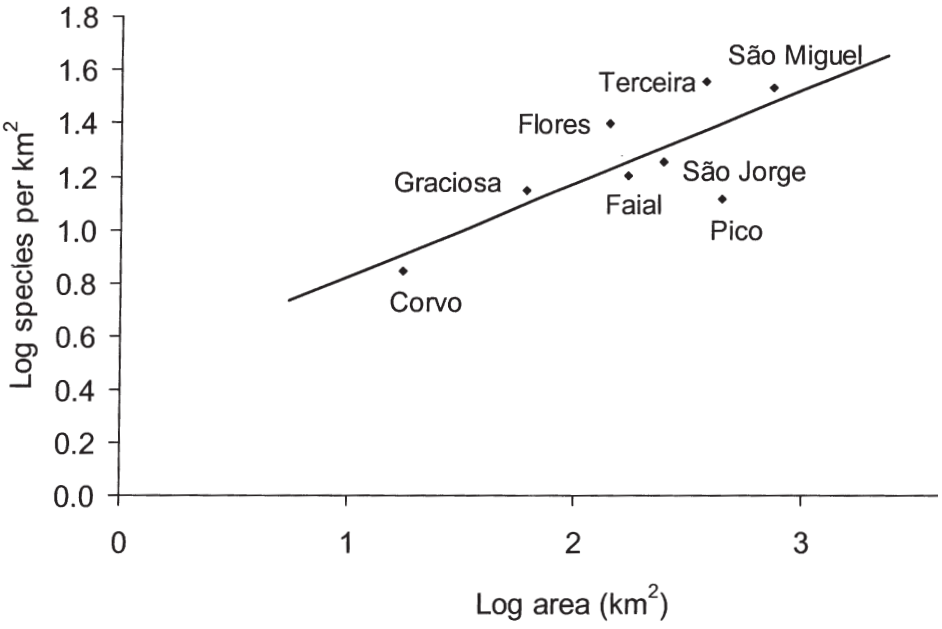

Fig. 2. Chironomid species area relationship for islands of the Azores Archipelago.

belong to an undescribed species within *Paramerina* whose characteristic pupal exuviae, designated as *Paramerina* sp. Griechenland (Fittkau 1962), were collected on Terceira in this study. Pupal exuviae of this species have been found in a number of circum-Mediterranean countries (Langton 1991). It is known from the Iberian Peninsula and has also been recorded from Madeira (Hughes & Murray 2000).

***Telmatopelopia nemorum* (Goetghebuer)** : Storå (1945) provided the only known records of this species, as *Ablabesmyia nemorum*, from four of the Azorean islands. The species is now placed in *Telmatopelopia* Fittkau.

Zavrelimyia nubila* (Meigen) and *Zavrelimyia sp. : Storå (1945) recorded *Ablabesmyia nubila*, now in *Zavrelimyia* Fittkau, on São Miguel. As with *P. pygmaea* cited above, some doubt exists about the record of *Z. nubila* since pupal exuviae obtained on São Miguel and Terciera in this study differ from descriptions of *Z. nubila* in Fittkau (1962) and from key characters in Langton (1991). The Azorean exuviae are similar to those recorded from Madeira (Hughes & Murray 2000) and described in Hughes & Murray (2001). Associated adults of this species have yet to be discovered and described. It is likely that the records of the taxon «*Ablabesmyia nubila*» by Storå (1945) from the Azores, and of «*Pentaneura nubila*» by Freeman (1959) from Madeira, may both be assigned to this new taxon which may also occur on the Canary Islands. Armitage et al. (1995) provide a record of an undetermined species «*Zavrelimyia nubila*?» from Tenerife. More recently, material collected during 1999 in a survey of insects of the Caldera de Taburiente National Park, La Palma Island, coordinated through the Museo Nacional de Ciencias Naturales, Madrid, has also yielded adult males of an undescribed *Zavrelimyia* species (D. Murray, pers. com.).

Subfamily Orthocladiinae

***Camptocladius stercorarius* (De Geer)** : This species, recorded on Terceira in the present study, was previously recorded as *Smittia stercoraria* by both Storå (1945) and Freeman (1959). Larvae of *C. stercorarius* characteristically live in animal dung. The species has a widespread Azorean distribution and also occurs in Madeira and the Canary Islands.

***Cardiocladius freyi* Storå** : Adult males of *Cardiocladius freyi* were described by Storå (1936) from collections made on the Canary Islands of Gran Canaria and Tenerife in 1931. Later Storå (1945) gave additional records from the Azores (São Miguel, Terceira and Flores) and Madeira. *C. freyi* has not so far been recorded elsewhere, perhaps indicating an endemic Macaronesian distribution. The pupa of *C. freyi*, although known from studies on Madeira (Hughes & Murray 2000), is thus far undescribed. However, exuviae collected during this study, also on São Miguel, Terceira and Flores, are similar in form to those collected in Madeira and are readily recognised by their smooth dorsal thoracic surface, in contrast to the highly tuberculate thorax in the other common European species, *C. fuscus* and *C. capucinus*.

***Halocladius (Halocladius) varians* (Staeger)** : This marine coastal species, recorded on Graciosa in this study, was previously recorded from São Jorge and Flores as *Cricotopus halophilus* (Meigen) now considered as a synonym of *Halocladius varians* (Staeger) (Hirvenoja 1973).

***Halocladius (H.)* sp.** : Storå (1945) recognised the marine species *Cricotopus vitripennis* Meigen from São Miguel, São Jorge, and Flores. According to Hirvenoja (1973) a large proportion of records cited in the early literature as *C. vitripennis* actually belong to *H. (Halocladius) variabilis* (Staeger). However, Hirvenoja noted that the Azores specimens identified by Storå differed from his concept of *H. (H.) variabilis* and suggested that the Azorean specimens might possibly represent a new species within *Halocladius*. Murray & Hughes (2000) provided a brief diagnosis of another undescribed *Halocladius* species from Madeira. This, however, differs from the Azorean species.

***Metriocnemus (Inermipupa) carmencitabertarum* Langton & Cobo** : This species, recorded from a municipal trough in Angra do Heroismo, Terceira, is hitherto only known from the Iberian Peninsula (Soriano et al. 1997). Although its characteristic pupal stage was recognised from the River Zezere, Portugal and included in Langton (p. 82: 1991) as «Orthocladiinae gen.? sp.? Pe3», its description as a new species within the new subgenus *Inermipupa* was based on material collected in 1994 in Galicia, north-western Spain (Langton & Cobo, 1997).

***Orthocladius (Eudactylocladius)* sp.** : Exuviae of this characteristic taxon, obtained on São Miguel, Terceira and Flores, differ from known species. The presence of a posterior point band on tergite VIII separates the species from *E. fuscimanus* (Kieffer) but the presence of three equally strong anal macrosetae distinguishes it from *Eudactylocladius olivaceus* (Kieffer) and *Eudactylocladius* Pe2 in Langton (1991). A single adult male *Eudactylocladius*, collected from Rba. das Casas, Flores along with pupal exuviae, also differs from known species. The structure of the hypopygium bears a striking resemblance to Storå's (1945 - Fig 28) depiction of *Or-*

thocladius rivularis. A strong possibility exists that the material identified as *Eudactylocladius* sp in this study may belong to *O. rivularis*. Resolution of this question must await critical examination of any available material of *O. rivularis* from previous collections.

***Psectrocladius limbatellus* (Holmgren), *P. sordidellus* (Zetterstedt), *Psectrocladius* sp**. : The characteristic exuviae of *P. limbatellus,* collected on Terceira, represent the first record of this species from the Azores. A second species, *P. sordidellus*, was recorded by Storå (1945) under its synonym *P. stratiotis*. Previous records exist for a third species, *P. sordidellus* var *insularis* Storå, considered *nomen dubium* in Ashe & Cranston (1990). During the present study a single pupal exuviae, differing from *P. limbatellus* and *P. sordidellus*, was obtained at Lagoa Basa on Flores presenting evidence of a third *Psectrocladius* taxon on the archipelago. It is not possible, however, to correlate this specimen with the doubtful taxon, *P. sordidellus* var *insularis* Storå.

***Pseudorthocladius sp* ?** : The record of a single *Pseudorthocladius* adult male over rocks on the marine shoreline at Ponta Delgada on São Miguel represents the first record of this genus from the Azores. Collection and further examination of additional material is necessary to bring the determination to species.

***«Thalassosmittia» atlantica* (Storå)** : This species was originally described from the Canary Islands as *Eukiefferiella atlantica* by Storå (1936). It is also known from Madeira and may be regarded a characteristic marine (endemic?) species on rocky coastal regions of Macaronesian islands. It was first recorded from the Azores by Storå (1945) and later by Freeman (1959). In this study numerous adult (male and female) imagines were obtained from marine coastal sites on Terceira and Graciosa. While it is a valid species, its generic placement is currently unstable. Storå (1936) was uncertain about its generic placement in his original description and while some characters suggested placement in *Smittia*, based on defining features in wing venation, he assigned it to *Eukiefferiella*. Freeman (1959) also considered this species within *Eukiefferiella*, but as a subgenus of *Nanocladius.* Armitage (1986) provided modern descriptions of the adult male, based on his examination of original type specimens and new material collected on Tenerife, but also suggested some uncertainty about its generic placement in *Eukiefferiella.* Subsequently, having found and described larvae, pupae and adult females, Armitage and Tuiskunen (1988) transferred the species to the genus *Thalassosmittia.* However, Wang and Sæther (1993) excluded *T. atlantica* in their work on the Palaearctic species of *Thalassosmittia* and more recently Sæther et al. (2000) treated «*T. atlantica*» as a separate taxon in the key to genera of the known Palaearctic Chironomidae. Further detailed examination of all life history stages is desirable and while it is apparent that the species is related to *Thalassosmittia*, it may prove necessary to erect a new genus to accommodate the species and resolve this predicament.

Subfamily Chironominae

***Chironomus cingulatus* Meigen; *C. cingulatus* var. *venustus* Staeger; *C. dorsalis* Meigen; *C. riparius* Meigen; *C.* cf *annularius* (De Geer)** : Three species of Chironomus are cited in previous studies. The species variety *C. cingulatus* var. *venustus*, recognised by Storå (1945) is now considered a valid species, *C. venustus* (Staeger). In the present study *C. venustus* was not found but exuviae determined as *C. cingulatus* were recorded from São Miguel, Terceira and Graciosa. *C. dorsalis* was reported by Storå (1945) but not found either by Freeman (1959) or in this study. Under the name *C. thummi*, Freeman (1959) reported *C. riparius* from São Miguel, Faial and Pico and in this study numerous exuviae were collected from the Terra Nostra thermal pools on São Miguel. Among the collections from an artificial pool at the Santa Cruz Community Centre, exuviae of *C. riparius* were obtained together with a second species tentatively identified as *C*. cf *annularius* (De Geer).

***Glyptotendipes (Phytotendipes) barbipes* (Staeger), *G. (P.) pallens* (Meigen)** : These are the first records of the genus *Glyptotendipes* from the Azores. The characteristic pupal exuviae of both species were obtained in mutually exclusive sites on Terceira and Graciosa. *G. barbipes* only was recorded on São Miguel. *G. pallens* is also known from Madeira (Hughes & Murray 2000).

***Polypedilum (Polypedilum) nubifer* (Skuse)** : *P. nubifer*, obtained on Terceira and Graciosa, has not been found previously in the Azores. Becker (1908) described *P. lene*, which was synonymised with *P. nubifer* by Cranston & Armitage (1988), from the Canary Islands. The species was reported from Madeira by Hughes & Murray (2000) and has an almost worldwide distribution.

***Micropsectra freyi* Storå, *M. junci* (Meigen), *Micropsectra sp.* (cf *lindrothi* Goetghebuer)** : *Micropsectra freyi* was previously recorded from São Jorge by Storå (1936). It was not found in Azores material examined by Freeman (1959) but was present in contemporaneous collections examined from Madeira. The species was considered *nomen dubium* in Ashe & Cranston (1990). *M. junci* (Meigen) was found in both previous

investigations on the Azores as *M. subviridis* (Goetghebuer) but it was not found in the present study. Collections from a roadside trough near Pico de Padres on Terceira (site T9) and from Lagoa Basa on Flores (site F1) contained exuviae which do not fully key out to species in Langton (1991) and are cited here as *Micropsectra* sp. (cf *lindrothi* Goetghebuer). Similar exuviae are present in collections from ongoing studies on Madeira (personal observation) and a possibility remains that these may represent the immatures of *M. freyi* or another, undescribed, species.

***Paratanytarsus grimmii* (Schneider) and *Tanytarsus* sp** : This record of *P. grimmii* constitutes the first record of the genus from the Azores. *P. grimmii* is a parthenogenetic species with a seemingly world-wide distribution (Langton et al. 1988). Apart from its natural occurrence in shallow stagnant waters, it is also a common nuisance species in water distribution systems and frequently occurs in tap water. A possibility exists that the citation by Storå (1945) of records of females only of a green *Tanytarsus* species from São Miguel, Pico, Flores and Corvo may also relate to *P. grimmii* since Storå drew particular attention to the fact that only females of the small «*Tanytarsus*» species were obtained from larval rearings - («die Züchtung ergab nur Weibchen» - Storå, 1945, p 32). None of the collections in the present study contained representatives of the genus *Tanytarsus*.

Discussion

Forty nine species-level taxa are now recorded for the Azores archipelago but the number of species known from individual islands varies between 7 on Corvo and 36 on Terceira. These values are low in comparison with other Macaronesian islands, e.g. Madeira has 61 known species-level taxa (Hughes et al. 1998, Murray & Hughes 2000, Hughes & Murray 2000) while Tenerife, Canary Islands has 59 known species-level taxa (Armitage et al. 1995). The Macaronesian chironomid fauna is noticeably depauperate in comparison with the 147 species known from the Mediterranean island of Corsica, a mere 80 km from Italy (Laville & Langton 2002) and the greater distance of Macaronesian islands from continental landmasses, from where colonisation most likely occurred, may be a factor in this paucity. However, comparison of the number of species on different island landmasses may be misleading for islands of different size. According to Hengeveld et al. (1995) simple rescaling of area (A) using 1/4 power of area ($A^{1/4}$) is a useful «rule of thumb» that facilitates comparison of species richness in islands of different size. Rescaling of the species area relationship (number of species divided by $A^{1/4}$) provides area-adjusted values (AAV) that allow more favourable comparison. Thus, AAVs for individual Azorean islands vary from 8.1 on Terceira (36 species) to 3.4 on Corvo (7 species) with intermediate values of 6.5 on São Miguel (35 species), 5.0 on Graciosa (14 species), 4.6 on São Jorge (18 species) and 4.4 on Faial (16 species). The 24 species known from Flores give an AAV of 6.9, more than twice that of Pico which is almost three times larger in area but which has a low AAV of 2.8 from its 13 known species.

In relation to other Macaronesian islands the AAV of 8.7 for Tenerife (59 species) is more or less comparable with Terceira whereas the AAV of 11.4 for Madeira (61 species) is noticeably higher. The relative poverty of the chironomid fauna of the Macaronesian islands is again evident when compared with Corsica (AAV 15.2 for 147 species-level taxa) but the comparison is more marked compared to the larger, more northern-latitude, temperate Atlantic islands of Great Britain (578 species, Chandler 1998) and Ireland (445 species, Murray & Murray 2003) with AAVs of 26.4 and 26.1 respectively. These relatively high values reflect the closer proximity of these islands to the Palaearctic European landmass, their broader range of favourable habitats and the intensity of collection and publication of records. In contrast, Iceland, even more northerly in latitude and which is also well investigated, has 77 species (Hrafnsdottir et al. 2000, Murray 1999) yielding a low AAV of 4.3. Although abundant in surface waters and potentially habitat-rich, Iceland's harsh climate and isolation could account for its low species richness.

Faunal composition on oceanic islands is determined not only by past dispersal patterns but also by previous opportunities for colonisation and current potential for survival. Environmental variables offered by landscape heterogeneity, landmass area and altitudinal gradient play a major role, but for a taxon such as the Chironomidae the availability of aquatic habitats is a fundamental necessity. The scarcity of natural exposed surface waters on some Azorean islands has most likely influenced chironomid colonisation and survival opportunities and may account for the low species richness observed. However, information on island faunal composition is also dependent on intensity of collection. It is reasonable to expect that further collecting effort for Chironomidae in the Azores will yield additional species records for the Archipelago and may ultimately yield information that could alter the apparent distribution patterns observed in this brief study.

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