Arch. Hydrobiol.	128	2	209–235	Stuttgart, September 1993

Stream macroinvertebrate communities in the island of Tenerife

By B. Malmqvist[1], A. N. Nilsson[1], M. Baez[2], P. D. Armitage[3] and J. Blackburn[3]

With 6 figures and 5 tables in the text and on 2 appendices

Abstract

Macroinvertebrate communities in seven Tenerife streams were investigated in spring and autumn 1991. All Tenerife streams are small and run for limited distances. Six of the study streams represent a majority of the permanent streams in Tenerife, the seventh being seasonal. A total of 127 taxa were identified. Species richness ranged between 34 and 74, and there was a threee-fold difference in abundance between the richest and poorest sites. The lowest richness value was found at a laurel forest stream site and the highest at an exposed, low elevation (190 m a.s.l.) site. In a partial least square regression analysis, pool size, algae, pH, and temperature were factors that influenced species richness positively. Altitude had a negative influence. The two orders richest in species in all streams were Diptera followed by Coleoptera. Only nine taxa were common to all streams, viz. the gastropod *Ancylus striatum*, the oligochaete *Eiseniella tetraedra*, the dytiscid beetles *Nebrioporus canariensis*, *Agabus biguttatus*, and *Laccobius canariensis*, and the dipterans *Dixa tetrica*, *Simulium tenerificum*, *Zavrelimyia nubila* and *Thienemanniella ?clavicornis*. Another 14 species occurred in six streams. In spring, the overall most numerous taxa were *Hydroptila* sp. (Trichoptera), *Baetis canariensis* (Ephemeroptera), and Orthocladiinae (Diptera), and in autumn, the dipterans *Simulium ruficorne* and Tanytarsini.

Some taxa occurred in a clear seasonal pattern whereas others did not. About half of all taxa could be characterized as habitat specialists defined as those in which >90% of all individuals were found in either pool or riffle habitats. All stream sites contained unique taxa that were not found at other sites. Each stream site also showed major individual differences in the composition of functional feeding groups stressing the individuality of the different streams. The results are discussed in the light of threatening habitat loss for stream-living animals in Tenerife.

Introduction

Tenerife is the largest (2057 km^2) and highest (3718 m) of the Canary Islands situated at a distance of 300 km off the coast of Morocco. Tenerife has a volcanic origin and was never connected to mainland Africa according to the

[1] Addresses of the authors: Department of Animal Ecology, University of Umeå, Sweden.

[2] Dept. of Zoology, University of La Laguna, Tenerife, Spain.

[3] Institute of Freshwater Ecology, Wareham, UK.

0003-9136/93/0128-0209 $ 6.75

prevalent view (Schmincke 1976). Consequently, a relative lack of freshwater animals, especially those with low dispersal capacity, is obvious (though many species are likely to have been introduced accidentally). Today, a mixture of Mediterranean, African and endemic species is found. Most endemics are shared with other Canary Islands, and many also with Madeira. The endemic species known only from Tenerife are very few.

The freshwater fauna of Tenerife has received a varying degree of attention through time depending on which taxonomic groups are referred to. Thus beetles, blackflies, mosquitoes, odonates and water bugs belong to the well-studied groups, mainly due to works by Balke et al. (1990), Crosskey (1988), Baez (1985, 1987), Baena & Báez (1990), while studies on other taxa, for example mayflies and chironomids, are rare. For some macroinvertebrates, including molluscs, non-naidid oligochaetes and leeches, there exists virtually no information. For insects, a bibliography of studies in the Canaries is available (Machado 1987).

Surface waters are gradually vanishing in Tenerife due to deforestation (Melville & Bramwell, in Voggenreiter 1974) and the removal of groundwater (Benl 1967). Furthermore, severe changes of the freshwater habitats are caused by water diversion via pipes and channels for irrigation purposes (Cranston & Armitage 1988) leading more or less to complete loss from the streams high up in the systems. Diminishing natural freshwater is a phenomenon that Tenerife shares with other islands in the archipelago. For example, on Gran Canaria there is an almost complete loss of permanently running waters, habitats that only sixty years ago could be counted in the hundreds (Crosskey 1988). In Tenerife, historical records of water availability are scanty and encompass merely qualitative reports. Therefore it is difficult to quantitatively present figures on the process of water loss of which every islander is aware. The most devastating effects of the continued desiccation of surface waters should be expected to occur primarily in streams, since seasonal winter rains always will fill up pools in many ravines of the island.

In this paper we report on extensive inventory work of the entire macroinvertebrate communities found in seven streams. Six of these streams represent a majority of the remaining permanent streams in Tenerife. Our major aim is to describe, as completely as possible, the composition of the benthic communities at each site and coarsely its relationship with major macrohabitat types, riffles and pools. Through analyses of similarities and differences among all the sites we make predictions of effects on the macroinvertebrate fauna associated with running water on the island should the water continue to disappear from the streams of Tenerife.

To our knowledge this is the first study of stream communities in the Canary Islands. Therefore we have chosen to present the data comprehensively, although without going into depth about the ecology of individual species except for some of the most common ones.

Materials and methods

Sampling was carried out in April and October–November 1991. All seven streams were visited in both seasons and sampling was performed both in riffle and pool habitats. The sampling procedure involved taking one minute kick samples over five areas, each of approximately one square metre, from each habitat. A small handnet was used for this (mesh size, 0.8 mm). Samples were taken so that the number of microhabitats was maximized and always included parts of the margins. Riffles were sampled across the entire stream width, since this always was less than one metre. Data on total species numbers also include specimens collected with unstandardized methods.

Concurrently with each animal sample, several environmental variables were estimated. These included current velocity (estimated as surface velocity), depth, stream width, and substrate (subjectively estimated percentage cover of bedrock, rocks >20 cm, stones 2–20 cm, gravel 0.2–2 cm, and sand or finer <0.2 cm). Discharge was estimated as the product of mean depth, width, and surface velocity corrected with a coefficient of 0.67 to give mean velocity (Jarrett in Gordon et al. 1992). Furthermore the presence and characteristics of instream and riparian vegetation were recorded. A visual inspection of the stream bed yielded simple estimates of quantities (absent, present, or abundant) and qualities of detritus, algae and moss. It was also noted whether a site was shaded from direct sunlight, and, in addition, spot readings of water temperature were made. A water sample was taken for later analyses in the laboratory from each site and season. Variables estimated from the water samples included pH, conductivity, total phosphorus, total nitrogen, and total carbon. Macroinvertebrate samples were preserved individually in 70% ethanol and sorted out from debris later in the same day.

Cloeon is a mayfly genus with particular taxonomic problems (Sowa 1975). Therefore it was not surprising that the Tenerife material contained species which were especially problematic. Available keys were not very helpful. According to Alba-Tercedor et al. (1987) *C. dipterum* (L.) and *C. cognatum* Stephens and one unidentified species occur on Tenerife and are described from Igueste. Our material, which only encompasses larvae, suggests three types, which we refer to as species A, B, and C. Species C was the one most similar to *C. dipterum*. The two others did not conform to known species. Species A larvae have the dorsal side coloured evenly brown, with paler streaks laterally. Gills are very large, pairs almost reaching each other across the back. The lamella of the first pair of dorsal gills about ⅓ of ventral gill lamella. Maxillary and labial palps as in *C. dipterum*. Species B larvae were more evenly coloured than in *C. dipterum*. The dorsal lamella of the first pair of gills was rudimentary, measuring only $\frac{1}{10}$–$\frac{1}{6}$ of the ventral lamella. A distinctive pattern on abdominal terga 9–10 was also obvious.

For chironomids the routines of data compilation were different due to the very laborious mounting and identification work. Larvae were first assigned to subfamilies/tribes and counted. A minimum taxa list was produced by identifying representative specimens of all types in samples where numbers were large, and all specimens where numbers were small. Therefore, chironomids could be included in all analyses on species richness, but not in the calculation of diversity, for example, because of the lack of exact figures on density of species. Instead, chironomids were for each sample assigned to one of four possible categories of abundance, viz. 1, 2–9, 10–99, and 100–999 individuals. Combining these figures does not give useful estimates of true abundances. Therefore those samples which had highest abundance category for each site, habitat and season are listed in Appendix B. The reasons for identifying most chironomids to generic level only is primarily due to the fact that almost all material consisted of larvae, for which the possibilities of correct species determination are limited. However, in a few instances adults were available along with larvae and thereby facilitated identification. In several cases we sent material to specialists for verification or identification (see acknowledgements).

An analysis of functional feeding groups was based on the number of individuals of the most common species combined for the two study seasons and for pools and riffles (those underlined in Appendix A). Here, for practical reasons, we identified the following categories: predators, scrapers, collectors, shredders, piercers and filter feeders. These categories are based on literature information of the food habits of the individual species or those of congenerics. Much of this information derives from MERRITT & CUMMINS (1984). We are aware of the problems related to diet variation among closely related species, ontogenetic shifts in diet, omnivory and the problems with filter feeders belonging also to predator and collector categories. Our intention was primarily to identify major differences among sites concerning the functional roles of the dominant benthic taxa present.

The predictive values of different environmental variables with respect to the number of individuals of selected taxa in net samples and to the total number of individuals and species collected in each stream were analysed using partial least square regression, PLS (MARTENS & NAES 1989).

With PLS a large number of correlated variables are replaced by a few latent variables or components. These new components are used to regress the dependent variable, i.e. the number of individuals or species. The significance of each component is tested by least square fit using X-validation. Values on altitude, pool size, current, and abundance were log-transformed in order to improve the predictive power of the models.

The independent variables used to model the total numbers of individuals and species collected in each stream (N = 7) included altitude, discharge, temperature, pool size, degree of exposure to light, algal cover, occurrence of detritus, conductivity, pH, and nitrogen and phosphorus concentrations.

The analyses of the number of individuals per sample were either run on all 135 samples, or the samples representing the season or habitat with the highest abundance of the actual taxon were selected. In addition to the variables mentioned above, these analyses also included the proportions of five substrate fractions (see below). Current velocity was aborted when only pool samples were analysed.

The streams

Streams are named after their valleys, e.g. Barranco de Afur. Here we refer to the streams only as Afur etc. Four of the streams are situated on the Anaga Peninsula, viz. Taborno, Afur, Ijuana, and Igueste (Fig. 1). Of the other streams, Masca is found on the Teno Peninsula, Infierno in the southwest, and, Rio on the south side of the island, the latter at a decidedly higher elevation than the other sites (Table 1).

All Tenerife streams are small and usually run over short distances only. We did not investigate entire stream sections, although in the seasons we visited the streams, some of them (Infierno, Igueste, Rio) tended to disappear either subterraneously or into irrigation channels and pipes. In Table 1 data on current speed, depth, discharge, temperature and altitude are given. Average current speed did not exceed 0.5 m/s and mean pool depths ranged from 0.1 to 0.2 m. Discharge was greatest in Infierno in April with 0.013 m^3/s but <0.002 m^3/s in Taborno, Ijuana and Igueste. Ijuana and Rio were the coldest streams, whereas Igueste was warmest. Igueste also had the highest conductivity and nitrogen and carbon levels of the permanent streams (Table 2). Phosphorus levels

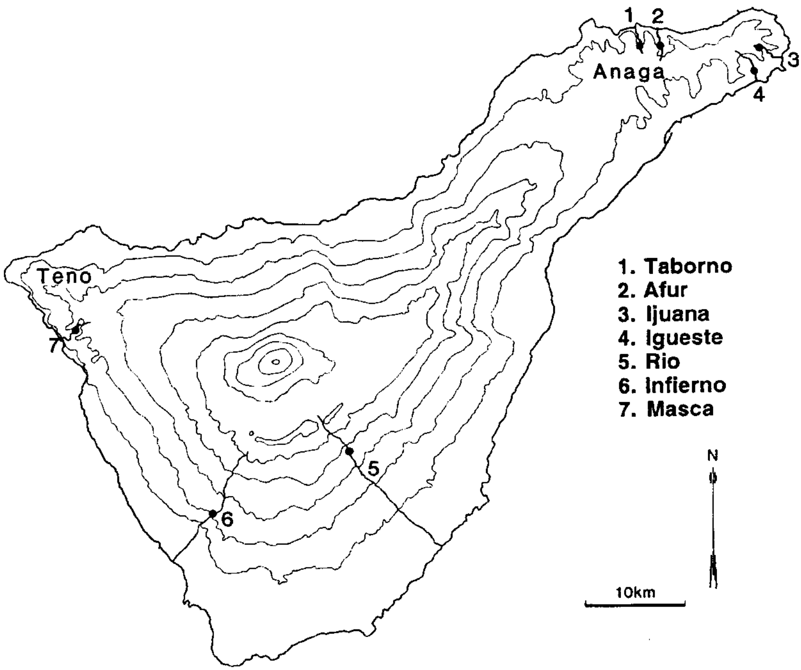

Fig. 1. Map of Tenerife indicating the position of sampling sites. Isopleth intervals of altitudes are 400 m.

Table 1. Altitude, means of current velocity in riffles (mean velocities were below 0.05 cm s^{-1} in pools at all sites), depth, discharge and temperature in seven Tenerife streams sampled in April (A) and October/November (O) 1991.

Site	Current velocity (m/s)		Depth (cm)		Discharge (l/s)		Temperature (°C)		Altitude (m)
	A	O	riffles	pools	A	O	A	O	
Taborno	0.45	–	2	12	1.8	–	14.8	19.1	430
Afur	0.34	0.25	7	15	8.4	6.0	16.7	19.9	190
Ijuana	0.15	0.14	4	12	1.9	1.2	13.1	16.1	770
Igueste	0.20	0.16	2	13	0.8	0.2	19.6	22.8	100
Infierno	0.47	0.37	7	15	13.4	8.2	16.0	17.0	500
Rio	0.25	0.20	6	14	7.3	3.5	12.0	15.6	1450
Masca	0.15	0.28	8	18	4.3	2.0	17.2	17.9	450

were particularly high in Infierno, a fact that probably could be attributed to pollution from the many tourists visiting the valley.

The Taborno stream is surrounded by farmed land. In contrast to the other streams the riffles in Taborno dried out completely in the autumn. Therefore we only have riffle data from the spring survey of this stream. The Afur, Igueste, and Masca streams also flow through areas with farm lots. Further information on vegetation, detritus and algae is given in Table 3.

The small Ijuana stream is the only one situated in laurel forest, which is a mixture of tree species also known as the "Laurisilva" (see e.g. VOGGENREITER 1974 for a description of its composition), representing what was probably once quite a typical lotic hab-

Table 2. Water conductivity, pH, total nitrogen, total phosphorus and total carbon in seven Tenerife streams sampled in April (A) and October/November (O) 1991.

Site	cond (μs/cm)		pH		N (ppm)		P (ppm)		C (mmol/L)	
	A	O	A	O	A	O	A	O	A	O
Taborno	326	504	6.8	6.9	0.36	2.24	0.16	2.29	0.83	0.94
Afur	221	330	7.4	7.5	0.36	0.41	0.16	0.62	0.31	0.41
Ijuana	188	318	6.7	6.4	0.12	0.34	0.11	0.40	0.32	0.37
Igueste	485	775	6.8	7.0	1.83	1.71	0.22	0.93	1.16	1.24
Infierno	392	234	7.8	7.9	0.44	0.50	0.41	2.35	0.33	0.38
Rio	254	323	7.9	7.4	0.16	0.14	0.15	0.50	1.15	1.18
Masca	368	638	6.8	7.1	0.37	0.26	0.13	0.41	1.14	1.24

Table 3. Algae, detritus and vegetation in seven Tenerife streams.

Site	Algae	Detritus	Others
Taborno	moderate amounts of benthic and filamentous	moderate amounts of fine organics	local *Rubus* thickets
Afur	little in Apr, abundant in Nov	small amounts of fine organics	lush riparian herbal vegetation
Ijuana	none	moderate amounts of fine organics	shading laurel forest
Igueste	moderate amounts, more abundant in Nov	small amounts of fine organics	some grass hanging down in the pool margins, exposed
Infierno	sparse, benthic algae	abundant, esp. leaf matter	plenty of roots, shaded
Rio	moderate amounts	small amounts	some aquatic moss, *Salix*, *Apium*
Masca	small amounts	small to moderate amounts	riparian vegetation, incl. *Arundo donax*, some aquatic moss

itat of the island. The stream is the most shaded of the seven due to the closed canopy of the forest although Infierno was also largely shaded, mainly by *Salix canariensis.*

The sampling stations on Igueste and Afur are situated at lower elevations (ca. 190 and 200 m a.s.l., respectively) than in the other streams (430–770 m a.s.l.), whereas the Rio site is situated markedly higher, at ca. 1450 m a.s.l. Eel (*Anguilla anguilla* L.) was present in Igueste and Afur. Other vertebrates are *Hyla meridionalis* Chaplin & Lester and *Rana perezi* Hotz, which are found in many places including the ones reported here.

Tenerife streams typically have cascading fast-flowing sections connecting distinct pool habitats. In some streams a large percentage of the bottom substrate consists of bedrock shutes, especially so in Taborno, Igueste and Masca (Fig. 2). This dichotomy of habitats was less obvious in Ijuana and Rio. The pools contained higher proportions of fine material than the riffle sections and this was especially the case in Afur and Ijuana, where sand and finer materials covered >30 % of the pool beds.

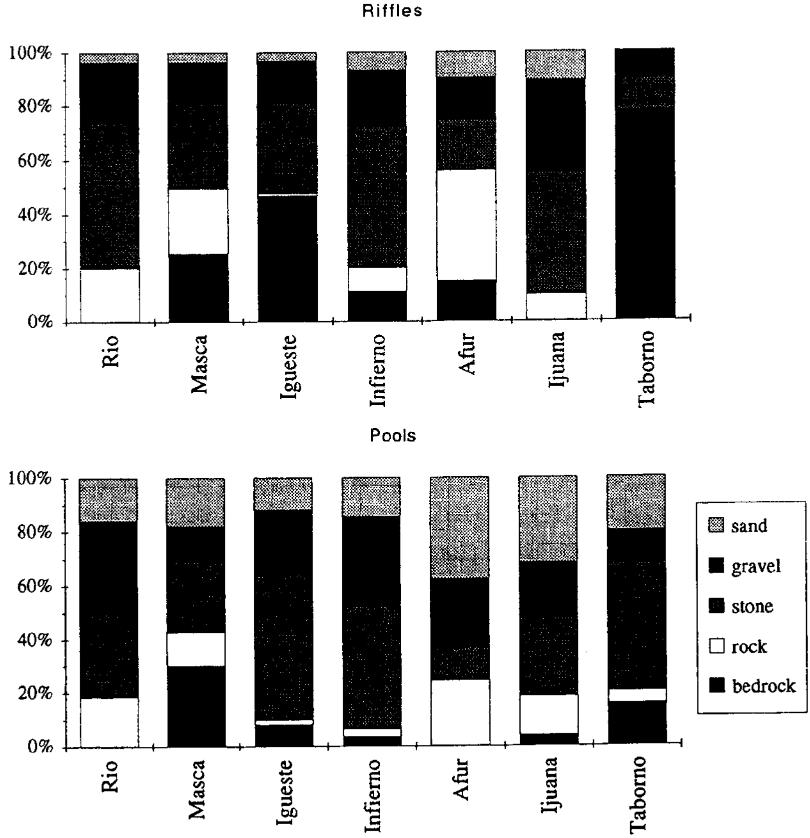

Fig. 2. Percentage composition of streambed substratum from seven Tenerife streams given for pools and riffles.

Results

General patterns

In total, nearly 35,000 individuals belonging to 127 taxa were identified. Mean densities at different sites, habitats, and seasons are given in Appendix A. Diptera was the most diverse order with 55 taxa out of which 34 were chironomids (Appendix B). Another diverse group was Coleoptera with 24 species. Twelve Hemiptera, ten Trichoptera, seven Ephemeroptera, seven Oligochaeta, six Odonata, five Mollusca, and one Turbellaria species were also found.

Only eight species were found at all sites and another fourteen species were recovered from six of the streams (Appendix A). Excluding Taborno, which dries out in the summer, the beetle *Dryops gracilis*, the tanypodine chironomid *Zavrelimyia nubila*, and the turbellarian *Dugesia* sp. (*D. gonocephala* group) were found in all permanent streams. The most abundant larvae in spring were the small hydroptilids of the genus *Hydroptila* followed by the mayfly *Baetis canariensis* (Appendix A). Chironomids of the subfamily Orthocladiinae were also very abundant as were larvae and adults of the dytiscid *Nebrioporus canariensis.* All these taxa occurred in average densities exceeding 20 ind/m^2. In autumn, larvae of the blackfly *Simulium ruficorne,* of the family Chironomidae, and of the biting fly genus *Dasyhylea,* and the flatworm *Dugesia* sp., were most abundant with mean densities $>$10 ind/m^2 (Appendix A).

Clear differences among sites and seasons were obvious with respect to dominant taxa (Appendix A). In some taxa the distribution in riffle vs. pool habitats was distinct whereas other taxa obviously exhibited a more general habitat choice. The most abundant taxa found in riffles were orthocladiines, simuliids, ceratopogonids, *Baetis canariensis,* and *Hydroptila* sp. In pools, larvae of Tanypodinae and Chironomini, *Nebrioporus canariensis, Baetis canariensis,* and *Hydroptila* sp. reached the highest numbers. Less widely distributed taxa were abundant in some streams. To this category belonged, for example *Lepidostoma tenerifensis* and *Pisidium casertanum* in Ijuana, *Oxyethira* sp. in Rio, and *Culiseta longiareolata* in Taborno.

The cluster analysis showed that no site was very similar to another site (Fig. 3). The strongest similarities were found within the cluster Masca-Igueste-Afur, which was in turn markedly different from other groups of paired sites, Infierno-Rio and Taborno-Ijuana.

Site-specific results

Sites differed in species numbers, abundances, and the distribution of different taxa (Table 4). The richest site clearly was Afur, where 77 species and more than 7000 individuals were collected. In the majority of sites, species richness ranged between 59 and 69. Ijuana stood out as relatively species poor,

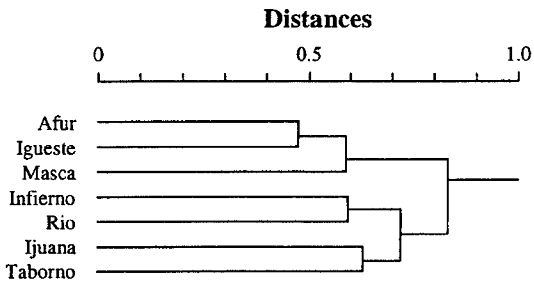

Fig. 3. Cluster analysis based on presence/absence of 120 taxa in seven Tenerife streams. Distance increases with increasing dissimilarity.

Table. 4. Species richness (S), total numbers (N), number of species only found at the site (U), Shannon diversity (H') and evenness (J'), and the number of species in the taxonomic groups Turbellaria (Turb), Oligochaeta (Oligo), Mollusca (Moll), Ephemeroptera (Eph), Odonata (Odo), Heteroptera (Het), Coleoptera (Col), Trichoptera (Trich), and Diptera (Dipt) found in seven streams in Tenerife in April and October–November 1991. Data from qualitative samples are included in S. In total numbers oligochaetes are not included. Diversity and evenness estimates were based on all taxa except chironomids and oligochaetes.

Site	S	N	U	H'	J'	Turb	Oligo	Moll	Eph	Odo	Het	Col	Trich	Dipt
Taborno[1]	59	6251	9	0.93	0.26	0	6	1	4	0	3	15	3	33
Afur	74	7409	3	2.25	0.59	1	3	4	5	5	6	15	6	32
Ijuana	34	3374	4	1.47	0.47	1	2	2	2	2	0	8	5	15
Igueste	68	4932	1	2.23	0.58	1	1	3	4	6	6	14	4	30
Rio	65	3498	5	2.16	0.59	1	1	1	3	2	6	14	6	32
Infierno	57	2875	4	2.04	0.55	1	2	2	5	4	4	15	5	21
Masca	62	6230	3	1.63	0.43	1	1	3	2	3	8	13	4	28

[1] In autumn only pool samples in Taborno.

reaching 36. Here also total abundance was low, a feature shared with Infierno and Rio.

Although species richness was lowest in Ijuana, the percentage of unique species, 11 %, was high. Taborno also had a high degree of unique species; four of the nine unique species (the highest number of unique species found in any stream) were chironomids and three oligochaetes. Here it must be kept in mind that this stream only flows seasonally and therefore acted differently. In contrast, in Afur where species richness was higher than in any other stream, only three, or < 4 % were unique. The values of Shannon diversity indices (excluding chironomids and oligochaetes) were generally low and ranged between 0.93 and 2.25 (Table 4). The diversity index was lowest in Taborno, which also had the lowest evenness value (0.26). Evenness values of the other streams ranged from 0.43 to 0.59.

Taborno was especially rich in various chironomids (Appendix B) and oligochaetes. Afur showed in general high representation of all kinds of taxa, whereas Ijuana was poor, although with four unique taxa, including the only bivalve (Table 4 and Appendix A). Igueste was particularly rich in Odonata, and Infierno (together with Afur) in mayfly taxa. Rio had high numbers of Diptera and Trichoptera taxa, whereas Masca had the highest number of hemipteran species. Interestingly, Taborno and Ijuana were devoid of odonates.

Functional feeding groups

The proportions of different functional groups suggest a substantial heterogeneity among sites (Fig. 4). While some sites were strongly dominated by one or few functional categories (Taborno, Infierno, Masca), others showed a more

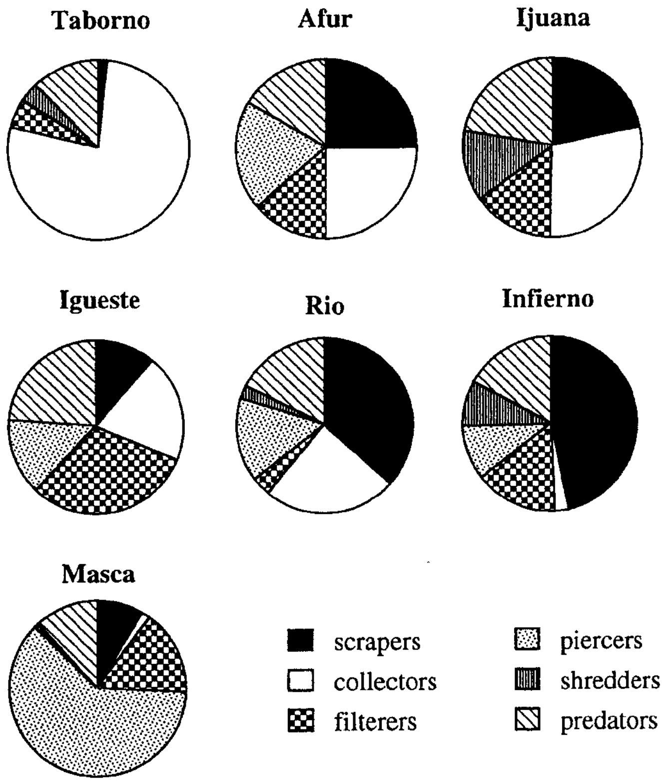

Fig. 4. Proportions of functional feeding groups in seven Tenerife streams. The comparison is based on average densities of the ten most common taxa in spring and autumn samples.

balanced picture. Scrapers were dominant in Rio and Infierno, primarily due to *Baetis canariensis*. Collectors represented >75 % of all individuals in Taborno, because of high abundances of Orthocladiinae and Chironomini, whereas collectors were present in very low numbers in Infierno and Masca. Filterers were found with highest proportions in Igueste and here the blackfly *Simulium ruficorne* was very influential. In Masca, hydroptilid caddis larvae belonging to the category piercers made up well over half of the individuals. These larvae feed primarily by sucking out filamentous algae or by scraping. Piercers were entirely missing in Ijuana and almost so in Taborno. The proportion of shredders was greatest in Ijuana with some 13 % of all individuals. Elsewhere, except for Infierno, shredders were sparse. The most important species of this category were *Lepidostoma tenerifensis* (Ijuana only) and *Dryops gracilis*. Predators were important everywhere.

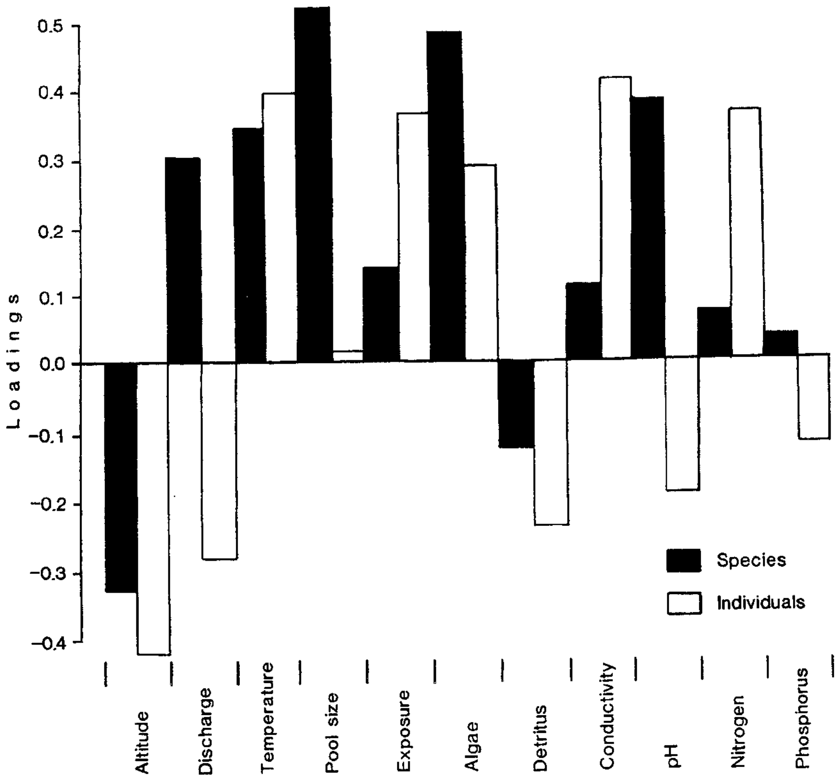

Fig. 5. PLS response loadings for species richness and total abundance to several environmental variables based on data from seven Tenerife streams. The explained variation was 83.8 % for species richness and 66.5 % for total abundance.

Factors related to species richness and the number of individuals

The PLS analyses sorted out factors which might be important in controlling the numbers of species and individuals (Fig. 5). Pool size, amounts of algae, pH and temperature positively influenced species richness, whereas altitude clearly had a negative influence. Several of those factors governing richness also influenced abundance. These were especially altitude and temperature, two partly related variables. Conductivity, nitrogen, temperature, and exposure to light all acted positively on abundances. Whereas species richness did not seem to be influenced by factors reflecting nutritional status, abundance did clearly so in showing high, positive loadings for conductivity and nitrogen. Interestingly, also discharge showed polarity, being positive for species number and negative for abundance.

Further PLS analyses suggested which factors underly the distributions of twelve of the most common taxa (Table 5). Surprisingly, clusters of species

Table 5. Responses of selected taxa to environmental variables analysed by PLS. Variables are abbreviated as: (AG) occurrence of algae, (AT) altitude, (BE) proportion of bedrock, (CO) conductivity, (CU) current, (DI) discharge, (DP) depth, (DT) occurrence of detritus, (EX) degree of exposure, (GR) proportion of gravel, (NI) nitrogen concentration, (pH) pH, (PO) phosphorus concentration, (RO) proportion of rock, (SA) proportion of sand, (ST) proportion of stones, and (TE) temperature. Season is coded as (S) spring and (A) autumn. Habitat is coded as (P) pools and (R) riffles. Only significant components (C#) and variables with loadings >.30 or < −.30 are listed. The % var. gives the cumulated percentage of the variance of the dependent variable explained by the respective component.

Taxa	Season	Habitat	C#	% var.	Loadings			
					>0.40	0.40−0.30	< −0.40	−0.40 − −0.30
Dugesia sp.	S	R	1	57.7	–	NI ST TE	AG	BE
B. canariensis	S	R	1	73.9	–	AT DI pH	–	EX NI TE
Cloeon sp.	S+A	P	1	54.3	CO NI TE	EX	–	AT DI
			2	65.1	–	–	SA	DT
C. luctuosa	S	P	1	52.4	NI TE	CO	AT	–
			2	81.5	–	RO	CO DT ST	–
N. canariensis	S	P	1	61.9	CO NI TE	ST	–	AT
			2	73.8	DI pH	–	–	DT
D. gracilis	S+A	P+R	1	48.3	CU pH PO	DI	–	EX
			2	50.4	CO NI TE	PO	AT	DI
Hydroptila sp.	S	P+R	1	44.0	CO NI TE	–	AT	–
			2	60.2	DI pH	RO	–	NI ST
M. aspersus	S	P	1	64.4	AT	pH	TE	NI
			2	78.2	CO EX ST	AG NI	SA	–
S. guimari	S	R	1	41.2	CU DI PO	pH DT	–	–
S. ruficorne	A	R	1	55.0	DI DP pH	AG RO	–	ST
S. tenerificum	S	R	1	42.1	AT	DI DT	NI TE	EX
Orthocladiinae	S	R	1	61.5	BE CU	–	–	DP GR SA
			2	69.5	DI	AT pH	EX NI	CO TE

with similar responses to a number of different environmental factors were formed. Thus, *Baetis canariensis* resembled Orthocladiinae in responding positively to altitude, discharge, and pH, and negatively to the degree of exposure to light, nitrogen and temperature. Another cluster consisted of *Cloeon* spp., *Caenis luctuosa, Nebrioporus canariensis, Dryops gracilis,* and *Hydroptila* spp. Here, nutrient related variables (conductivity, nitrogen) and temperature led to strong positive responses. Not surprisingly, the blackflies *S. tenerificum, S. guimari* and *S. ruficorne* responded positively to flow, the two latter also to pH. *S. tenerificum* also showed similarities with *Mesophylax aspersus* in positive relationships with altitude, in contrast to the two other simuliids, and negative ones with nitrogen. Here it is of interest to mention that the best models were fitted when using *S. ruficorne* from autumn samples, when this species was most abundant. For the other two blackflies, spring samples were most appropriate, coinciding with the occurrence of these two species.

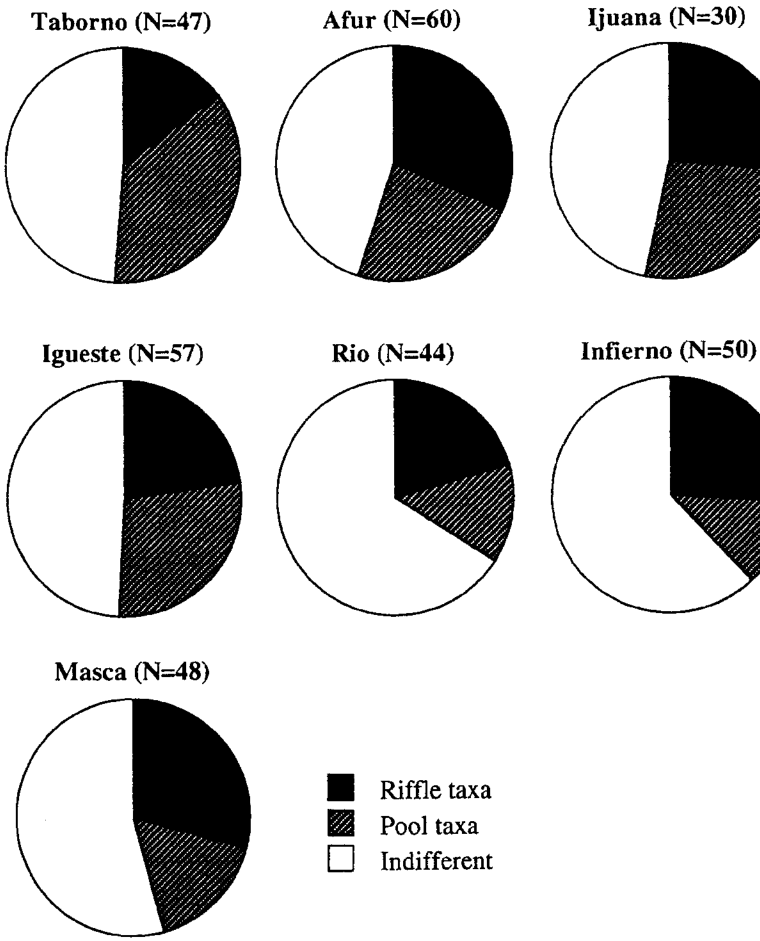

Fig. 6. Percentage composition of habitat specialist taxa, >90% of all individuals recovered from either riffles or pools, and habitat generalist taxa (all others) in seven Tenerife streams. Very rare taxa (<5 inds) were not included.

Of the 71 most common taxa (those with an occurrence of >5 individual specimens) plus 32 chironomids (totally ≥10 specimens), half were habitat specialists in the sense that at least 90% of the individuals were recorded in either pool or riffle habitat. There was some variation among sites in this respect (Fig. 6); Afur and Ijuana had the highest proportion of habitat specialists, Rio and Infierno the least. The highest proportions of pool specialists were found in Taborno and Igueste. Afur, Ijuana, Infierno and Masca had >25% riffle specialists.

Seasonal aspects

No species was common in one season and absent in the other (Appendix A). Some mayfly species were more common in spring than in autumn, and this was also true for small unidentified libellulid odonates, two beetle species, three caddis larvae and five dipterans. In contrast, three odonates, one beetle, *Dryops gracilis*, four dipterans and one mollusc were significantly more abundant in autumn.

Separate account of chironomidae

A total of 34 chironomid taxa was found in the seven streams (Appendix B). Afur and Taborno had most species with >20 taxa. Ijuana, at the other end of the spectrum, had less than 10. Not unexpectedly, Orthocladiinae was the most diverse subfamily with 14 species. The most widespread species were *Zavrelimyia nubila* (Tanypodinae) and *Thienemanniella ?clavicornis* (Orthocladiinae), which both occurred in all the streams. Both highest abundance and greatest species richness were found in Taborno.

About half the number of chironomid taxa could be characterized as habitat specialists. The distribution of these specialists among the different streams showed an interesting pattern. Taborno had most pool specialists, i.e. all eight classified as pool species, whereas the number of riffle species was only three (out of seven possible). In contrast, Infierno had no pool specialist species at all, but four riffle specialists. Most species belonging to the latter category were found in Afur (all seven), where also the total number of habitat specialists was greatest (13).

Whereas many species did not show a distinct preference for either riffles or pools, there were some species that related certain subfamilies to habitat type. Thus, riffle specialist taxa were found among orthocladiines (*Orthocladius rivicola, Eukiefferiella ilkleyensis, Parametriocnemus stylatus, Thienemanniella ?clavicornis*, and *Corynoneura* sp. A) and tanytarsines (*Rheotanytarsus* sp. A and C). On the other hand, larvae of Tanypodinae (*Macropelopia nebulosa* and *Procladius choreus*) and Chironomini (*Polypedilium* sp., *Phaenopsectra* sp., *Chironomus* sp., and *Dicrotendipes* sp.) clearly preferred the pool habitat.

Although some species were markedly seasonal (see below) no pattern on subfamily level was discernible concerning this feature (Appendix B). Ten chironomid species showed both habitat and seasonal specialisation. Interestingly, four out of five autumn species turned out to be pool species, whereas all five spring species were associated with riffles. This pattern was statistically significant (Chi-square$_{[1]}$ = 6.67, $p < 0.01$).

Instances of clear seasonality were *Eukiefferiella ilkleyensis* and *Trissopelopia ?flavida* (the latter species found only in Rio) which were only observed in spring, whereas *Psectrocladius limbellatus, Procladius choreus, Paramerina vaillanti,* and *Dicrotendipes* sp. were only found in autumn.

Discussion

The general features of Tenerife stream communities are reflected in the relative isolation, typical of oceanic islands, balanced somewhat by the relatively great heterogeneity associated with a diversity of habitat types and extensive gradients, e.g. in elevation. The species richness of the streams can best be compared with those of continental water courses. Since northwestern Africa is the closest mainland to the Canary Islands, a comparison with the Moroccan stream fauna would be rational. Bouzidi (1989) found a total of 205 taxa in streams in Grand Atlas spanning over an altitudinal gradient between 890 and 3200 m a.s.l. Species richness per site was within the range of 7–74, and thus comparable to Tenerife sites (34–74). In Upper Sebou (Middle Atlas), Dakki (1979–1986, in Bouzidi 1989) found a total of 230 taxa. In yet another study, El Agbani et al. (1992) described a subset of the fauna (Trichoptera, Plecoptera, Ephemeroptera and Coleoptera: Elmidae) comprising 48 members in the Bou Regreg water system in Middle Atlas. The number of species per site (N = 18) ranged between eight and 29. Likewise, Dakki (1987) found a total of 91 species belonging to these taxonomic groups in Upper Sebou (range for sites 5–41, N = 36). Both studies suggest that the groups investigated are clearly more diverse at Moroccan than at most Tenerife sites (range: 6–11, total number of species within these groups: 18). Obviously the complete lack of elmid beetles and stoneflies in Tenerife is a part of the explanation. Otherwise, the number of species in Tenerife stream sites does not seem strikingly low, especially if one considers the relatively small size of all of the Canarian streams. It is also noteworthy that relatively few species of macroinvertebrates seem to be common to Moroccan and Tenerife streams. Exceptions include *Mesophylax aspersus, Hydropsyche maroccana, Simulium intermedium, S. pseudequinum, S. ruficorne, Cloeon dipterum, Caenis luctuosa, Corixa affinis, Hydrometra stagnorum, Bidessus minutissimus,* and *Meladema coriacea.*

Malicky (1977) gave a detailed description of stream environments in the South Aegean Archipelago, which in several respects showed a clear resemblance to those in Tenerife. In addition, he found that the number of insect species (Diptera excluded) in three permanent streams in Crete varied from 24 to 28, thus within the range found at Tenerife stream sites (16–37).

Since the number of species compared to the mainland still is somewhat on the low side, it could be predicted that a relaxed competition would result in relatively wider niches for each species present. In our data this hypothesis is supported by the presence of relatively few habitat specialists; only about half of all taxa showed an obvious preference for either riffles or pools (Fig. 6).

Even if species richness could be described as relatively high, species diversity clearly was low (Table 4). Indices of richness and evenness were particularly low in Taborno due to the high numbers of orthocladiine larvae present at this site.

Are endemic species more successful than more widely distributed taxa? Several of the endemic Canarian species, e.g. *Baetis canariensis, Simulium guimari, S. tenerificum, Nebrioporus canariensis,* and *Ancylus striatum* were indeed seasonally among the most numerous in several streams. Larvae of *Hydroptila* sp., which probably include two Macaronesian species, one of them also found in Portugal (Malicky 1987), were also very abundant. Among non-endemics which must be considered successful are several chironomids, including *Zavrelimyia nubila,* the blackfly *Simulium ruficorne,* the beetle *Dryops gracilis* and the mayfly *Caenis luctuosa.*

In our analyses of the community structure of Tenerife streams there is an inherent lack of good replicate streams, since natural streams are so scarce. Therefore, in the testing of different features, statistical strength will be weak. In the following, observed patterns will be discussed with this limitation in mind.

The streams studied shared surprisingly few species, and they all contained unique elements. For example, the two streams most alike in this respect, or more correctly, least dissimilar, Afur and Igueste, shared 67 % of their common species pool. Afur and Taborno, situated only 2 km apart had, however, a clearly lower faunal similarity, sharing only 59 % of their species. The Taborno stream dries out in the summer which probably helps explain this lack of resemblance. On the other hand, the two geographically most distant streams, Ijuana and Masca only shared some 23 % of the common taxon pool. This fact suggests that isolation is an important factor. Apart from differences in elevation, and consequently temperature, the streams differed in chemical and physical properties (Tables 1 and 2) as well as in the amounts of detritus, algae, riparian vegetation (Table 3) and substrate composition (Fig. 2), all of which to some extent may contribute to the observed distributional patterns.

The most characteristic features of the fauna include large proportions of dytiscids, dragonflies and chironomids, whereas other typical lotic elements of the continental streams largely are missing, e.g. Plecoptera (not present) and limnephilid Trichoptera (only one species).

Our PLS analyses showed that a limited number of conceptually selected variables explained as much as 83 % of the variation in species richness. The demands of several common taxa could also be expressed with a high accuracy. Small variation in the abiotic variables of the different streams may underly observed distributions along with dispersal-related factors.

The functional organization suggests that the trophic basis strikingly differs among stream sites, although theory predicts similarity among sites within similar stream orders (VANNOTE et al. 1980; all Tenerife streams are of low orders: 1–3). This conclusion is based on the numerical representation of the members of different functional feeding groups. An analysis based on biomass probably would have better reflected different functions, e.g. the piercing hydroptilid caddis larvae which dominated by numbers in Masca would have had less weight. Nevertheless, the diverse pattern in Fig. 4 enhances the conclusion from the cluster analysis that community organization at Tenerife stream sites is exceedingly variable.

Before man changed the vegetation on the island many streams must have been parts of the Laurisilva ecosystem. Today only fragments of the laurel forests remain and among our study streams only Ijuana runs through surroundings of this kind. Possibly, many small streams were like Ijuana with its relatively poor but balanced composition of species. Maybe then also *Lepidostoma tenerificum* was more widespread on the island and not restricted to its only known locality in Ijuana (MALICKY 1992). We suspect that earlier shredders must have been a more prominent functional feeding group, which is now reduced, partly substituted by scrapers.

The depletion of the laurel forest is believed to be one explanation of the expansion of the arid zone up the barrancos in Tenerife (BENL 1967). BENL (1967) also pointed out that the removal of fern vegetation, the extension of cultivation and factory premises, and tourism eventually will lead to a complete drying up of the island. Taking the example with moistloving ferns, a severe reduction has been demonstrated during the period 1920–1970 (BENL & SVENTENIUS 1970). Another indication of this ongoing process is the drying up of many wells (BENL 1967).

As mentioned previously, Tenerife streams show great individuality. Thus they are not interchangeable and none of the studied streams can be pointed out as being in greater need of protection than another. To create an ideal platform for conservation work, all sorts of man-made habitats such as irrigation channels and remaining pools in natural, temporary streams, must be included in an analysis of which species may survive outside the natural permanent streams and which may not. However, until we have further data along these lines, the very limited representation of such remaining streams suggests that special consideration is needed to protect all of them against further exploitation.

Acknowledgements

We owe ROLF LIDBERG special thanks for help with plant names and good company. The following persons kindly helped with identification: CHRISTER ERSÉUS (Oligochaeta), FRANK JOHANSSON (Odonata), HERMAN DE JONG (Limoniidae), PJOTR OOSTERBROEK (Limoniidae), TED VON PROSCHWITZ (Gastropoda), R. SLUYS (Turbellaria), HERBERT REUSCH (Limoniidae), RÜDIGER WAGNER (Empididae, Psychodidae). Water samples were analysed by M. Espino-Mesa. Åsa Eriksson contributed greatly to the project in various ways, including identification of Ephemeroptera. Johan Eklund and Görel Marklund provided technical assistance. We also thank Eric Pattee for detailed and constructive criticism of the manuscript. K-fonden (University of Umeå), the Swedish Institute, and the Swedish Natural Protection Board provided economical support.

References

Alba-Tercedor, J., Báez, M. & Soldán, T. (1987): New records of mayflies of the Canary Islands. – Eos **63:** 7–13.

Baena, M. & Báez, M. (1990): Los Heterópteros acuáticos de las Islas Canarias (Heteróptera; Nepomorpha, Gerromorpha). – Vieraea **19:** 233–244.

Báez, M. (1985): Las libelulas de las Islas Canarias. – Enciclopedia Canarias, Aula de Cultuta de Tenerife, Litografia A. Romero, Santa Cruz de Tenerife, 48 pp.

– (1987): Atlas preliminar de los mosquitos de las Islas Canarias (Diptera, Culicidae). – Vieraea **17:** 193–202.

Balke, M., Hendrich, L. & Cuppen, J. G. M. (1990): Wasserkäfer von den Islas Canarias (Coleoptera: Haliplidae, Dytiscidae, Gyrinidae, Hydrochidae, Hydrophilidae, Hydraenidae, Dryopidae). – Entomofauna **11:** 349–373.

Benl, G. (1967): Die Farne der Insel Tenerife. – Nova Hedwigia **14:** 69–105.

Benl, G. & Sventenius, E. R. S. (1970): Beiträge zur Kenntnis der Pteridophyten-Vegetation und -Flora in der Kanarischen Westprovinz (Tenerife, La Palma, Gomera, Hierro). – Nova Hedwigia **20:** 413–462.

Bouzidi, A. (1989): Recherches hydrobiologiques sur les cours d'eau des massifs du Haut-Atlas (Maroc). Bio-écologie des macroinvertébrés et distribution spatiale des peuplements. – University of Aix-Marseille-III, Thesis, 190 pp.

Cranston, P. S. & Armitage, P. D. (1988): The Canary Island Chironomidae described by T. Becker and by Santos Abreu. – Dt. ent. Z., N.F. **35:** 341–354.

Crosskey, R. W. (1988): Taxonomy and geography of the blackflies of the Canary Islands (Diptera: Simuliidae). – J. Nat. Hist. **22:** 321–355.

Dakki, M. (1987): Ecosystèmes d'eau courante du haut Sebou (Moyen Atlas): études typologiques et analyses écologique et biogéographique des principaux peuplements entomologiques. – Trav. Inst. sci. Rabat, Ser. Zool. No. **42,** 99 pp.

El Agbani, M. A., Dakki, M. & Bournaud, M. (1992): Étude typologique du Bou Regreg (Maroc): les milieux aquatiques et leurs peuplements en macroinvertébrés. – Bull. Ecol. **23:** 103–113.

Gordon, N. D., McMahon, T. A. & Finlayson, B. L. (1992): Stream hydrology. An introduction for ecologists. – John Wiley & Sons, Chichester.

Machado, A. (1987): Bibliografía Entomológica Canaria. – Ínstituto de Estudios Canarios, La Laguna, Tenerife.

Malicky, H. (1977): Übersicht über Ökologie und Zoogeographie der Binnenwassertiere der Ägäischen Inseln. – Biologia Gallo-Hellenica **6:** 171–238.

– (1987): *Hydroptila juba,* bona species. – Trichoptera Newsletter, Lunz **14:** 30.

– (1992): Eine zweite europäische *Lepidostoma* von Teneriffa (Kanarische Inseln). – Ent. Z. (Essen) **102:** 90–92.

Martens, H. & Naes, T. (1989): Multivariate calibration. – John Wiley & Sons, New York.

Merritt, R. W. & Cummins, K. W. (eds.) (1984): An introduction to the aquatic insects of North America, 2nd edition. – Kendall/Hunt, Dubuque, Iowa.

SCHMINCKE, H.-U. (1976): The geology of the Canary Islands. – In: KUNKEL, G. (ed.): Biogeography and ecology in the Canary Islands. – Junk, The Hague, 67–184.
SOWA, R. (1975): What is *Cloeon dipterum* (LINNAEUS, 1761)? – Ent. scand. **6:** 215–223.
VANNOTE, R. L., MINSHALL, G. W., CUMMINS, K. W., SEDELL, J. R. & CUSHING, C. E. (1980): The river continuum concept. – Can. J. Fish. Aquat. Sci. **37:** 130–137.
VOGGENREITER, V. (1974): Geobotanische Untersuchungen an der natürlichen Vegetation der Kanareninsel Tenerife. – Diss. Botanicae **206:** 413–462.

Submitted: 10 August 1992; accepted: 5 April 1993.

Appendix A.

Mean abundance (ind per square metre) of macoinvertebrates at seven Tenerife stream sites. Underlined figures indicate that the taxon was among the ten commonest for actual site and season.

Taxa	Taborno			Afur				Ijuana			
	Riffle	Pool		Riffle		Pool		Riffle		Pool	
	Spring	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
Turbellaria											
Dugesia sp.				25	0.4	3		16	21	18	36
Mollusca											
Physa acuta Drap.				0.2	4.6	0.8	1.6				
Galba truncatula (Müll.)				0.2	1		0.2				
Pseudosuccinea columella (Say)				0.4	3.4	0.8	9				
Ancylus striatum Quoyi & Gaim.	1.4	0.4	1.2	1.8	5.8	1.8	0.2	1	0.4	0.4	0.2
Pisidium casertanum (Poli)								1	1.4	34	15
Oligochaeta											
Eiseniella tetraedra (Savigny)	0.8			3.8		6		5.6	1.6	0.6	0.6
Fridericia sp. A		0.4									
Fridericia sp. B		0.8									
Fridericia sp. C		1									
Tubifex tubifex (Müll.)		*)							0.2	0.2	0.6
Limnodrilus hoffmeisteri (Clapar.)		0.6	3.8		0.8						
Lumbriculus ?variegatus (Müll.).							0.4				
Ephemeroptera											
Baetis canariensis Müll.-Lieb.				299		21		100	26	8.2	4.4
B. nigrescens Navas											
B. pseudorhodani Müll.-Lieb.	0.6			0.4				0.6			
Baetis indet.	1.2			2.2				3.4	1.2		
Cloeon sp. A			21								
Cloeon sp. B		2.4				8.8					
Cloeon sp. C			0.2		0.2		2.8				
Cloeon indet.							0.2				
Caenis luctuosa (Burm.)				13	6.8	153	0.6				
Odonata											
Anax imperator Leach					0.8	0.2	24				
Orthetrum chrysostigma (Burm.)				0.2	12	2.4	9				
Crocothemis erythraea (Brullé)					0.8		67				
Sympetrum nigrifemur (Sélys)											
Trithemis arteriosa (Burm.)						0.2	5				

* Species was present but number uncertain.

Igueste Riffle Spring	Igueste Riffle Autumn	Igueste Pool Spring	Igueste Pool Autumn	Rio Riffle Spring	Rio Riffle Autumn	Rio Pool Spring	Rio Pool Autumn	Infierno Riffle Spring	Infierno Riffle Autumn	Infierno Pool Spring	Infierno Pool Autumn	Masca Riffle Spring	Masca Riffle Autumn	Masca Pool Spring	Masca Pool Autumn	Season**) of greater occurrence (A=April O=Oct-Nov)	Density in the season mentioned (overall mean)
29		13		6.4	61	2.2	11	18	6.4	22	3.2	22	4.4	5.4			
1.6	0.2	2.6	1.4					0.4	3.2		1.8	2.4	4.4	1.2	3.8	O	0.09
			0.6									2	1.4	1.2	5.2	O	1.5
0.2	18	2	2.8	1.8	7	0.4	21	1.8	1.4	0.4	3	37	17	11	6.8		
*)	*)	*)	*)	*)	*)	*)	*)	0.2	0.2	1.2	0.2	*)	0.2	*)	0.2		
								0.8	0.8								
0.2		0.2		106	25	84	1.6	138	1.6	97	0.6					A	61
								1.6				7					
								0.2									
0.8					0.6	1.8		2.6									
0.8		63	7.8							3.4		0.2		12			
	6.5	5	32			0.2	0.8				0.4						
0.6			12						0.2						0.6		
4.6	1.7	30	1.4	0.2		1.4										A	14.4
	0.5		4				5.4									O	2.7
	2.3	1	7		0.2		4		0.2		2	2		1		O	2.7
		0.2	8								0.2					O	5.8
		0.4										0.2		6.6			
		0.2									0.2						

** Only taxa with significantly different occurrences for the two seasons and represented with a minimum of 50 individuals are included.

Appendix A. (Continued).

Taxa	Taborno			Afur				Ijuana			
	Riffle Spring	Pool Spring	Pool Autumn	Riffle Spring	Riffle Autumn	Pool Spring	Pool Autumn	Riffle Spring	Riffle Autumn	Pool Spring	Pool Autumn
Zygonyx torrida (Kby.)				7	1.8		0.2				
Libellulidae sp.											
Heteroptera											
Corixa affinis Leach											
Sigara lateralis (Leach)			0.2								
Notonecta canariensis Kirk.											
Merragata hebroides Buch.-White											
Hydrometra stagnorum (L.)					0.2		1.4				
Microvelia gracillima Reut.											
Velia lindbergi Tam.	0.6			0.4				0.8	0.4	0.6	0.4
Gerris thoracicus Schumm.							0.8				
Coleoptera											
Haliplus lineatocollis (Marsh.)		0.2			1.2	2.2	0.6				
Gyrinus urinator Brullé						0.2					
G. dejeani Ill.											
Gyrinus sp. (larvae)							1				
Bidessus minutissimus (Germ.)											
Hydroporus lucasi Reiche			0.8								
H. discretus Fairm. & Bris.	0.2	2.8	1.2							1.8	
Graptodytes delectus (Woll.)		3.2	5.6			0.2				0.4	
Nebrioporus canariensis (Bed.)	0.6	12	0.2	12	7.4	44	2.6	0.2		1.4	1.6
Agabus biguttatus (Oliv.)	11	7						0.4	0.4	1.6	
A. nebulosus (Forst.)			5.8							0.2	
Meladema coriacea Lap.		4	0.2								
M. imbricata (Woll.)											
Laccophilus hyalinus (De G.)						4.4	6.2				
Ochthebius lapidicola Woll.											
O. quadrifoveolatus Woll.	0.2			0.2							
O. rugulosus Woll.			0.4								
Hydraena serricollis Woll.		0.2						0.2	0.2		
Limnebius gracilipes Woll.		0.2									
Hydrochus grandicollis Kies.											
Laccobius canariensis d'Orch.	0.2	0.2	0.2	0.6	1.2	0.6					0.2
Anacaena haemorrhoa (Woll.)											
Enochrus politus (Küster)							0.2				
Dryops gracilis Karsch				0.6	2.2		0.2		0.2		0.8

Igueste				Rio				Infierno				Masca				Season**) of greater occurrence (A=April O=Oct-Nov)	Density in the season mentioned (overall mean)
Riffle		Pool		Riffle		Pool		Riffle		Pool		Riffle		Pool			
Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn		
0.2								0.8	6.2		0.6	2					
		1.4				2.4		0.2		0.2		0.2		15			
															0.2		
			1.6					0.2									
						0.2	0.2				0.2			1	0.2		
	1.4																
0.2				0.4			0.2	0.2			0.2	0.4	0.2				
							0.4										
												1.2		0.2			
														0.2			
							3				0.2						
												0.2		0.8	0.4		
1.6		1.4	0.2		0.6	0.6	0.2				0.2			0.4	0.2		
			1														
			0.2														
36	6.9	107	10	2.2	0.2	6.8	0.6	1	0.2	27	0.8	30	1.2	43	1	A	23
				1.4		0.2		0.4				0.2				A	1.3
						0.2											
	2.6		3.2								0.4			0.4			
						0.6	0.2										
	1.2	1.8	3.2									0.2					
												0.2					
0.4	1.2	0.4					0.2					0.4	1.6	0.2			
							0.2										
1	3.5	0.4	3.4														
								0.2									
3.2	21	3.2	3.6									2	0.4	0.4			
										0.4	0.2						
0.2		0.2															
0.2				0.2	0.8			4	15	1.2	27	5.2	3.8	0.2		O	3.8

Appendix A. (Continued).

Taxa	Taborno			Afur				Ijuana			
	Riffle	Pool		Riffle		Pool		Riffle		Pool	
	Spring	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
Trichoptera											
Agapetus adejensis End.											
Hydroptila sp.	3.2	0.2		16	24	240	0.2				
Oxyethira sp.					2.2	0.2					
Orthotrichia sp.					0.2		0.4				
Wormaldia tagananana (End.)				12				7	6.6		
Tinodes canariensis McLachlan	3.2	0.2		0.2				0.4			
Polycentropus sp.											
Hydropsyche maroccana Navas				6.8	0.2	0.2					
Lepidostoma tenerifensis Malicky								12	41	9	22
Mesophylax aspersus Ramb.	10	1.4						0.2			0.2
Oecetis sp.								0.4	0.2	0.2	0.2
Diptera											
Limonia (s.l.) sp.	31	1.6		0.6	0.2	0.8					
Satchelliella tenerifensis (Satch.)											
Clogmia albipunctata (Will.)		0.2				0.2					
Dixa tetrica Peus	3.6			14					1.2	0.6	0.8
Anopheles sp.											
Culiseta longiareolata (Macquart)			65								
Culex sp.			24				0.2				
Thaumalea subafricana (Becker)											0.2
Simulium guimari Becker	42			37							
S. intermedium Roub.											
S. pseudequinum Ség.				20		0.2					
S. ruficorne Macquart				32	102		0.2				
S. tenerificum Cross.	21			6.2				26	0.8	3	
Ceratopogoninae											
Forcipomyiinae											
Dasyhylea sp.					1.2		8.4				
Tanypodinae	3.8	66	26	1	0.6	3	5.2	0.8	5.2	12	32
Orthocladiinae	582	53		37	3.4	11	38	0.8	0.2	0.2	0.2
Chironomini		44	154			5	24		0.6	2	0.6
Tanytarsini	0.4	15	8.6	0.4	35	0.2	2.2	0.6	5.4	13	169
Oxycera sp.											
Hemerodromia claripennis Frey	0.8										
Chelifera nubecula (Becker)		0.4									
Limnophora sp.	0.8	0.4		0.8	1		0.2				
Combined mean densities	720	217	320	550	220	510	212	178	115	106	285

Igueste Riffle Spring	Igueste Riffle Autumn	Igueste Pool Spring	Igueste Pool Autumn	Rio Riffle Spring	Rio Riffle Autumn	Rio Pool Spring	Rio Pool Autumn	Infierno Riffle Spring	Infierno Riffle Autumn	Infierno Pool Spring	Infierno Pool Autumn	Masca Riffle Spring	Masca Riffle Autumn	Masca Pool Spring	Masca Pool Autumn	Season**) of greater occurrence (A=April O=Oct-Nov)	Density in the season mentioned (overall mean)
								0.6	1.8								
40	15	117	0.4	2.2	12	29	2.6	2		53	0.8	451	25	255	0.8	A	86.2
0.2				0.2	9.4		49				0.2	0.2	0.2	0.6			
1												0.4					
				1.8	0.8	2.4	1.4										
								4.6	2.6	0.2		17	3.4	0.4		A	2.1
				11	0.4	6.4		1.4	0.4	0.6						A	2.1
				0.4	0.2												
0.4	1		0.2											0.2		A	2.5
										0.2							
								0.2		1.4							
0.8		0.2		1.8	0.2			1.4	0.4	0.6	0.2	4.8				A	2
	13	0.2	21						0.4		0.2					O	2.1
			2.6													O	5.2
			9.4				6.2								1	O	3.2
				0.2													
				1.4	3.6	1		38	6.4	0.8	0.4	14	0.6	0.4		A	9.7
												0.4		0.2			
												0.6					
34	329	1	1.6		2			0.2	1		0.2	12	135		0.6	O	29.3
0.2				13		1.6		32	1.4	0.2		7.8		0.6		A	8
0.4		1		0.2			0.2							8.4			
	1.4		1				0.4	0.2		0.2			2.8		0.8		
	11		1		109		19						1		0.4		
14	3.9	8	7	2.8	1	3.2	5.4			4.2	0.6	2.8	2.8	3.8	0.6		
31	62	0.6	9	3.2	2.4	1.2	0.6	7.2	2.4	2.6	0.2	2	6.2	0.4	0.4	A	52.4
0.2	3.9	16	20				0.4								0.2		
4	7.4	0.4	0.2	0.2	26		0.2	1.6		0.6		1.2	6.6	2	0.4		
								0.2	0.4	0.2	0.4						
				0.6				0.6		0.4							
				0.2		0.6	0.2		0.6	1.4	0.2						
3	8.7	3	0.4									2.6		0.2			
210	523	381	178	157	261	146	135	261	54	219	45	632	219	372	24		

Appendix B.

Relative abundance of chironomid taxa from seven Tenerife stream sites. The sample (of five) with the highest density category is indicated. Categories: 1 = 1, 2 = 2–9, 3 = 10–99, 4 = 100–999 ind per sample.

	Taborno			Afur				Ijuana			
	Riffle	Pool		Riffle		Pool		Riffle		Pool	
	Spring	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
Tanypodinae											
Macropelopia nebulosa (Mg.)		1							2	3	3
Procladius choreus (Mg.)			3				2				
Ablabesmyia longistyla Fitt.			1	2	2	2	2				
Paramerina vaillanti Fitt.											
Paramerina sp. Pe1											
Trissopelopia ?flavida (K.)											
Zavrelimyia nubila (Mg.)	3	4	3			1		2	2	2	3
Orthocladiinae											
Cricotopus sp.A	4	3			2	3	3				
Cricotopus sp.B											
Orthocladius sp.	4	3		2		3					
O. rivicola K.	4	3		3		1					
Paratrichocladius rufiventris (Mg.)	4	3		3	2	2	3				
Psectrocladius limbatellus Holmgr.					3		3				
Rheocricotopus atripes K.	4	3		2				1	1		1
Eukiefferiella ?minor (Edw.)	2	1									
E. ilkleyensis (Edw.)	4	2		2							
Metriocnemus ?fuscipes (Mg.)										1	
Limnophyes sp.	1	1									
Parametriocnemus stylatus (K.)				2	2		1				
Thienemanniella ?clavicornis K.	4	2		3	1	1				1	
Corynoneura sp.A	3			1							
Chironominae: Chironomini											
Polypedilum sp.		2	4			2	3				
Phaenopsectra sp.		3	2			1			1	2	2
Stictochironomus sp.		2									
Chironomus sp.		3	4			3	3		2		
Dicrotendipes sp.			3				3				
Chironominae: Tanytarsini											
Cladotanytarsus sp.		1	2								
Rheotanytarsus sp.A					3		1				2
Rheotanytarsus sp.B											
Rheotanytarsus sp.C	1			2				2	1		
Micropsectra ?notescens (Walk.)									3	3	4
Micropsectra sp.	1	3	3								
Tanytarsus sp.			2				2		2	2	4
Virgatanytarsus sp.					3	1					

*) Taxa subjectively classified into habitat and season specialists.

Igueste				Rio				Inflerno				Masca				Habitat *) P=pool R=riffle	Season *) A=April O=Oct-Nov
Riffle		Pool		Riffle		Pool		Riffle		Pool		Riffle		Pool			
Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn		
																P	
			1												2	P	O
3	2	3	2				2	1		1	1	2	2	3			
			2														
				1	2	1	3	2	1	1				2	1		
				2		2											A
2	1	3	2	1		2	2	2		3				2			
3		2						1		1	1						
					2		2										O
3	3		3										1				
3	3	1		2												R	A
3	1	1										2	1				
	1														2		O
	2		1	2	2	2	2	3		1							
				1	1												
3								1								R	A
	1	1						2	2	2	1	2	3	1		R	
2					2	1		2		1		1	2			R	A
2	1															R	A
1		3	1													P	
																P	
	2		3				2								1	P	O
																P	O
2			1		3		2					1	2			R	O
					3												
				1				2								R	A
																P	
1			1											1	2	P	O
3	1	2	1		2							2	2	2			