Food Composition of the Endemic Plain Swift Apus unicolor in the Canary Islands (Macaronesia)

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Food composition of the endemic Plain Swift *Apus unicolor* in the Canary Islands (Macaronesia)

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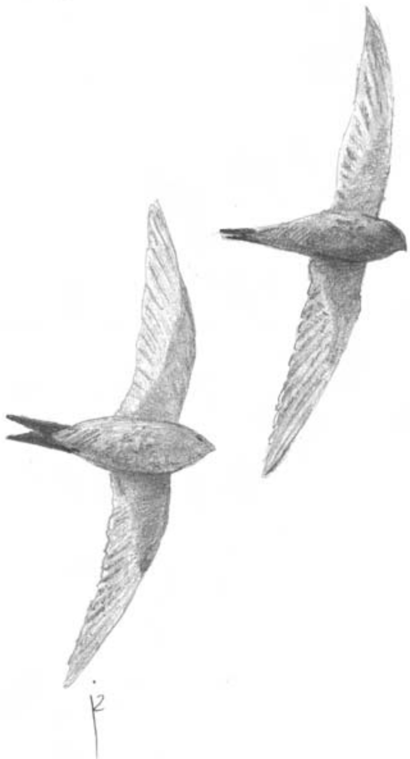

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As a first step to investigate the foraging ecology of the Plain Swift *Apus unicolor* in the Canary Islands, we studied the food brought to the nestlings. A total of 12,800 aerial prey items were identified from 32 food boluses. 97.3% of the prey items were insects, most of which (96%) were from the orders Coleoptera, Diptera, Hemiptera and Hymenoptera. Other orders represented were Dermaptera, Ephemeroptera, Lepidoptera, Mecoptera, Psocoptera and Thysanoptera. Spiders made up 2.6% of the prey items. Prey sizes ranged from 0.5 mm (body length) to 9.7 mm (average 2.46 mm, SD 0.90). There was substantial variation in the prey types among the 32 food boluses, both at the level of orders and of families. Prey size was more similar among the boluses suggesting that prey size was more important than prey type to the swifts. The results are in agreement with previous studies of swift diets.

Key words: Plain Swift, *Apus unicolor*, nestling diet, feeding ecology, Tenerife, Canary Islands, oceanic islands

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The study of diet composition provides baseline information on a bird's biology (Sutherland *et al.* 2004). Although numerous avifaunal studies have been made on oceanic archipelagos (e.g. Galapagos and Hawaii), the Canary Islands (a subtropical archipelago in the eastern Atlantic Ocean, Macaronesia) have received less intensive study. The avifauna of the Canary Islands has been summarized in the past (Bannerman 1963) and recently some species have been the subject of more detailed study (Garcia-del-Rey *et al.* 2007a,b).

Among the species inhabiting the Canary Islands that received considerably less attention is the Plain Swift *Apus unicolor*, a common summer resident and breeder in Madeira and the Canary Islands (Bannerman & Bannerman 1965, Cramp 1985, Chantler 2000). In winter it is present in coastal northwest Africa from Mauritania to Morocco (Smith 1968, Cramp 1985, Chantler 2000). Although previously considered by Lack (1955, 1973) and Brooke (1970, 1971) to be a smaller, local subspecies of the widely distributed Common Swift *Apus apus*, the Plain Swift has more recently been accorded full species status (Cramp 1985, Dowsett & Forbes Watson 1993, Chantler 2000). The Plain Swift's natural history has been described in the literature (Bannerman & Bannerman 1965, Cramp 1985, Chantler 2000) but only recently more detailed accounts of its breeding biology, morphology and moult were published (Garcia-del-Rey 2006, Garcia-del-Rey *et al.* 2008). In this paper we present an analysis of the aerial arthropod prey gathered by Plain Swift during the breeding season in the Canary Islands as a first step to investigate the foraging and trophic ecology of this endemic bird species.

METHODS

We collected food boluses from the bucal cavity of 32 different adult Plain Swifts captured while attending nestlings at Los Silos (28°22'N, 16°49'W, 91 m above sea level), San Miguel (28°6'N, 16°37'W, 581 m a.s.l.), Tenbel (28°1'N, 16°38'W, 15 m a.s.l.) and El Sauzal (28°28'N, 16°26'W, 436 m a.s.l.) on the island of

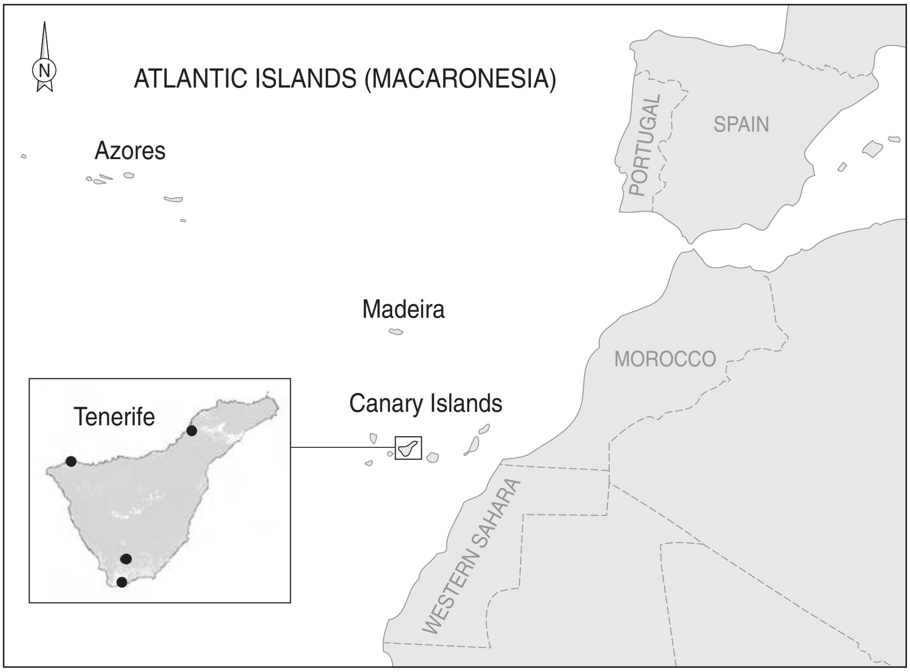

Figure 1. Canary Islands study area with dots showing Plain Swift *Apus unicolor* food bolus collection sites on Tenerife.

Tenerife, Canary Islands (Fig. 1). Collections were made at varying times throughout the day between 13 July and 17 August 2005. Each bolus was stored individually in 70% ethanol for later study. Individual prey items were tabulated and identified under a stereo dissecting microscope to family or superfamily level when possible. The Hymenoptera were identified using Goulet & Huber (1993) and the other orders of insects using Borror *et al.* (1982). The taxonomy used follows Borror *et al.* (1982). The head to tail length of each prey item, excluding antennae and caudal appendages, was measured with an ocular micrometer; all values were rounded to the nearest 0.1 mm.

RESULTS

A total of 12,800 identifiable prey items were recovered from the 32 food boluses (Online appendix 1). Individual boluses contained 114–870 prey items (Table 1) with a mean of 400 (SD = 185.7). Insects made up 97.3% of the prey items. Spiders (Araneae) were found in 26 of the 32 boluses but made up only 2.6% of the prey items. Three mites (Acari) were found in two of the boluses, and although they may have been parasitic on one of the larger insect prey items are included here for completeness.

Prey items belonging to the insect orders Coleoptera, Diptera, Hemiptera and Hymenoptera were found in all 32 boluses and accounted for 96% of the prey items; Dermaptera, Ephemeroptera, Lepidoptera, Mecoptera, Psocoptera, and Thysanoptera were present in only 3–15 boluses and accounted for only 2% of the prey items (Online appendix 1). The most numerous order represented was Hemiptera (7101 prey items) followed by Diptera (2036 prey items), Hymenoptera (1970 items) and Coleoptera (1192 prey items, Online appendix 1). Dipterans were the most diverse prey types with prey items identified belonging to 25 families (Online appendix 1). Aphids (Aphididae) were the most abundant single prey type with 3388 individuals recovered from all 32 boluses. Also numerous were seed bugs (Lygaeidae) with 2792 prey individuals recovered from 31 boluses and 1390 flying ants (Formicidae) recovered from 29 boluses.

At the ordinal level, there was substantial variation among boluses in even the commonly occurring prey types (Fig. 2). Hemiptera had a mean of 221.9 individuals per bolus, ranging from 6 to 570; 7 boluses had fewer than 100 Hemiptera and 7 contained more than 300. Similarly, Diptera had a mean of 63.6 individuals per bolus, ranging from 3 to 293 individuals; 12 boluses had fewer than 25 Diptera and 6 contained more than 100.

Table 1. Size of prey items taken by Plain Swifts in the Canary Islands. Size categories are: 1 = 0.5–1.4 mm, 2 = 1.5–2.4 mm, 3 = 2.5–3.4 mm, 4 = 3.5–4.4 mm, 5 = 4.5–5.4 mm, 6 = 5.5–6.4 mm, 7 = 6.5–7.4 mm, 8 = 7.5–8.4 mm, 9 = 8.5–9.4 mm, 10 = 9.5–10.4 mm.

Bolus	Size categories										Average size (mm)	*n*	SD
	1	2	3	4	5	6	7	8	9	10			
1	42	293	51	15	2	4	2				2.17	409	0.794
2	38	454	165	20	3	1	1				2.27	682	0.625
3	15	136	42	12	1	1					2.37	207	0.715
4	2	33	24	42	13						3.28	114	1.067
5	28	67	222	12							2.71	329	0.662
6	4	36	30	49	4	2	1				3.21	126	1.045
7	33	314	196	31		4	1				2.46	579	0.743
8	23	361	32	11	3	2	2	1			2.22	435	0.726
9	3	40	119	55	2	3	2	2		1	3.20	227	1.065
10	15	135	46	10	7	4					2.49	217	0.902
11	15	110	84	18	2	9	1				2.65	239	1.037
12	109	423	18	4	1						1.84	555	0.451
13	58	341	241	13	2	5					2.38	660	0.763
14	24	114	139	6	1		2				2.52	286	0.748
15	63	293	111	11	3						2.16	481	0.616
16	5	129	32	4	2	9	2			1	2.63	184	1.200
17	25	173	69	67	9	2					2.66	345	0.961
18	9	387	37	10	8	6					2.31	457	0.669
19	175	181	109	36	14	8	3				2.20	526	1.100
20	42	159	34	7	7	11	10				2.46	270	1.402
21	38	144	91	13	5	10	2		1		2.49	304	1.134
22	127	253	75	2	1	4				1	2.03	463	0.780
23	55	217	81	11		5					2.18	369	0.767
24	52	427	63	4	2	2	1		1		2.17	552	0.655
25	51	256	85	5	2	1		1	1		2.18	402	0.786
26	17	174	46	6	4			1			2.29	248	0.723
27	27	479	137	201	26						2.73	870	0.932
28	50	523	153	39	3	1	2				2.29	771	0.700
29	10	121	89	140	32	9					3.27	401	1.096
30	37	275	73	12	3	7	9	1			2.35	417	1.064
31	17	144	238	78	8	1					2.86	486	0.753
32	15	113	46	9	3	1		2			2.36	189	0.999
Total	1224	7305	2978	953	173	112	41	8	3	3	2.42	12800	0.903

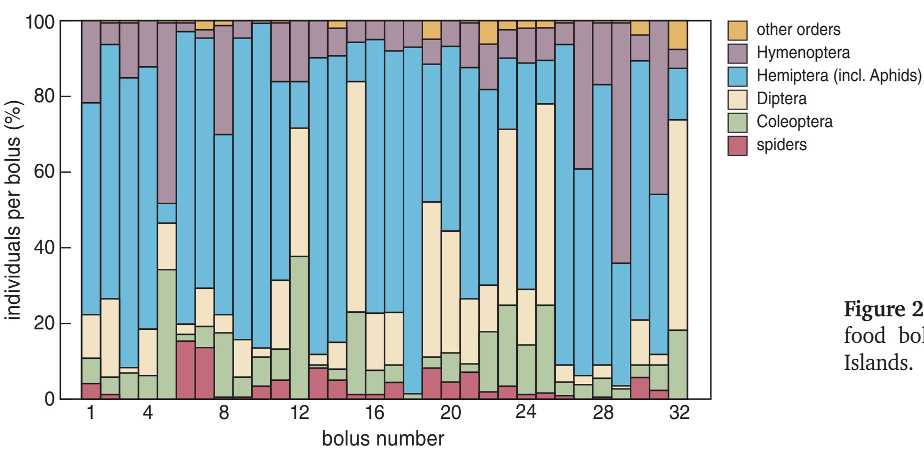

Figure 2. Prey type composition (%) of food boluses of Plain Swifts, Canary Islands.

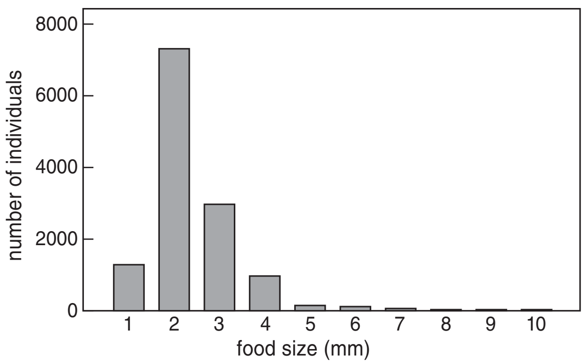

Figure 3. Frequency distribution of size of prey items taken by Plain Swifts, Canary Islands.

At the family level, there was substantial variation among boluses as well. Aphids were found in all 32 boluses (average 106.5, SD = 132.1), ranging from 1 to 452 per bolus; 15 boluses contained fewer than 50 aphids and 6 had more than 200. Similarly, seed bugs (Lygaeidae) ranged from 1 to 294 individuals per bolus in 31 boluses (average 87.6, SD = 78.5); 11 boluses contained fewer than 50 individuals and 6 had more than 200.

Prey items taken by Plain Swifts ranged in size from 0.5 mm to 9.7 mm (Table 1) with a mean of 2.46 mm (SD = 0.90). The largest single prey item was an unidentified lepidopteran and the smallest an aphid. The size of the prey items was similar among boluses. A total of 10,285 (80.4%) of the prey items fell between 1.5 and 3.4 mm body length (Fig. 3). The modal size for 31 of the 32 boluses also fell within this range. Only 1213 (9.5%) of the prey items fell below this range and 1302 (10.1%) were larger, of which 55 (<1%) had a body length greater than 6.4 mm (Fig. 3).

DISCUSSION

Aerial foraging birds as swifts and swallows are selective in the prey they catch (Bryant 1973, Waugh 1979, Cucco *et al.* 1993), and selection is dependent on the vertical distribution of suitable prey in the air. As a consequence, there may be large variation in time and space (Cucco *et al.* 1993). Accordingly, the great diversity of prey types described in this paper for the Plain Swift is not unexpected. Several other *Apus* species showed a similar diversity of aerial prey (spiders and insects) captured during the chick rearing period (Collins 1980, Collins *et al.* 2009, 2010). Termites (Isoptera) and reproductive ants (Formicidae) are prominent in the diets of tropical species (Collins 1968, 1980, Waugh & Hails 1983, Tarburton 1986) but were absent from the diet of the Plain Swift, an endemic species of the subtropics (i.e. Madeira, Salvages, Canary Islands). Other examples of geographic differences in the diet of *Apus* swifts have been summarized Cramp (1985) and Collins *et al.* (2009).

In addition to the kind of prey, swifts are selective in the size of the prey items captured. Although this is in part dictated by the availability of prey sizes, each species of swift has a preference for a particular range of prey sizes. The modal size of prey captured reflects the swifts' consumption of the abundance of smaller insects and spiders in the air column (Glick 1939). Larger prey items are usually avoided. This is shown in the Plain Swift (Table 1, Fig. 3) and several other species of *Apus* and *Tachymarptis* (Collins *et al.* 2009, 2010). The body size of the swift influences the size of the prey consumed with larger species taking, on average, larger prey (Collins *et al.* 2009).

This study shows that the Plain Swift has a similar food choice as a number of other swifts. Swifts take a wide variety of arthropod prey types but seem to choose prey primarily by size. Although the more abundant smaller-sized prey items in the air column (Glick 1939) make up the bulk of the diet, Plain Swifts do take larger prey when available. Future studies in Macaronesia should try to assess food availability and weather conditions during the collection period as a means to investigate food selection by this endemic species.

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SAMENVATTING

Een manier om te achterhalen wat gierzwaluwen eten is het verzamelen en analyseren van de voedselbal die ouders naar hun nestjongen brengen. Deze methode werd toegepast bij de Madeiragierzwaluw *Apus unicolor*, een soort die uitsluitend op Madeira en de Canarische Eilanden broedt. In totaal werden in enkele kolonies op Tenerife 32 ballen verzameld. In deze ballen werden 12.800 prooien aangetroffen, hoofdzakelijk bestaande uit insecten van de orders Coleoptera (kevers), Diptera (vliegen en muggen), Hemiptera (wantsen, cicaden e.d.) en Hymenoptera (vliesvleugeligen). Spinnen kwamen slechts in kleine aantallen voor met 2,6% van het aantal prooien. De grootte van de prooien was gemiddeld 2,46 mm, met als uitersten 0,5 en 9,7 mm. De ballen verschilden sterk in samenstelling van de prooidieren, terwijl de grootte van de prooien veel meer overeenkomst vertoonde. Dit duidt erop dat de grootte van de prooi voor de gierzwaluwen een belangrijk selectiecriterium is. (JS)

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Appendix is available online at
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Appendix 1. Types and sizes of prey items taken by Plain Swift, Canary Islands.

Order	Family /superfamily	*n*	Number of boluses	Percent occurrence	Size (mm) Average	SD	Range
Acari	Unidentified	3	2	6.3	0.71	0.00	0.7– 0.7
Araneae	Unidentified	337	26	81.3	1.72	0.85	0.6– 5.0
Coleoptera	Anthicidae	151	24	75.0	2.65	0.56	1.6– 3.7
	Bostrichidae	12	5	15.6	3.65	0.45	3.0– 4.4
	Byrrhidae	3	3	9.4	2.48	0.82	2.0– 3.4
	Cerambycidae	9	7	21.9	2.35	0.26	2.0– 2.9
	Chrysomelidae	34	12	37.5	2.32	0.30	1.6– 2.9
	Coccinellidae	64	18	56.3	2.85	1.24	1.1– 5.1
	Cucujidae	6	4	12.5	1.91	0.17	1.7– 2.1
	Curculionoidea	44	22	68.8	2.75	0.71	1.7– 5.1
	Dermestidae	2	1	3.1	2.50	0.10	2.4– 2.6
	Elateridae	3	3	9.4	1.19	0.36	0.9– 1.6
	Histeridae	1	1	3.1	2.43	0.00	
	Nitidulidae	146	23	71.9	2.35	0.48	1.0– 4.0
	Phalacridae	3	1	3.1	1.81	0.16	1.7– 2.0
	Pselaphidae	34	10	31.3	2.29	0.21	1.4– 2.7
	Scarabaeidae	2	2	6.3	3.21	0.30	3.0– 3.4
	Scolytidae	347	23	71.9	1.80	0.42	1.0– 4.7
	Staphylinidae	249	27	84.4	2.37	0.60	1.1– 7.0
	Unidentified	1192	32	100.0	2.25	0.69	0.9– 7.0
Dermaptera	Unidentified	14	4	12.5	6.23	1.28	5.3– 9.4
Diptera	Agromyzidae	90	20	62.5	2.39	0.44	1.3– 3.9
	Asilidae	1	1	3.1	5.86		
	Asteiidae	11	4	12.5	1.81	0.20	1.4– 2.0
	Bombyliidae	1	1	3.1	9.57		
	Calliphoridae	10	7	21.9	5.96	2.11	3.1– 9.7
	Chloropidae	355	17	53.1	1.57	0.28	0.9– 2.7
	Conopidae	1	1	3.1	3.43		3.4– 3.4
	Diopsidae	1	1	3.1	2.14		
	Dolichopodidae	13	7	21.9	2.19	0.53	1.6– 3.3
	Ephydridae	2	2	6.3	2.57	0.81	2.0– 3.1
	Heleomyzidae	185	17	53.1	2.53	0.33	1.6– 3.6
	Muscidae	108	20	62.5	5.65	1.27	2.6– 7.9
	Unidentified	61	17	53.1	2.55	1.00	1.3– 7.0
	Nematocera	451	26	81.3	1.82	0.37	1.0– 3.4
	Oestridae	30	7	21.9	3.70	0.77	2.0– 5.3
	Phoridae	155	23	71.9	2.07	0.55	1.0– 4.3
	Pipunculidae	3	2	6.3	2.00	0.38	1.7– 2.4
	Scatopsidae	3	2	6.3	3.67	2.43	1.9– 6.4
	Sciaridae	6	1	3.1	2.29	0.30	1.9– 2.6
	Sciomyzidae	1	1	3.1	3.00		
	Simuliidae	82	8	25.0	2.66	0.42	1.7– 5.1
	Sphaeroceridae	426	25	78.1	1.80	0.26	1.0– 2.7
	Stratiomyidae	3	2	6.3	3.43	0.14	3.3– 3.6
	Syrphidae	4	4	12.5	7.36	0.88	6.6– 8.6
	Tachinidae	2	2	6.3	5.43	2.22	3.9– 7.0
	Tephritidae	31	4	12.5	2.60	0.47	2.0– 4.0
Diptera total		2036	32	100.0	2.23	1.12	0.9– 9.7
Ephemeroptera	Unidentified	28	4	12.5	4.10	1.29	2.0– 6.4

Appendix 1. Continued

Order	Family /superfamily	*n*	Number of boluses	Percent occurrence	Size (mm) Average	SD	Range
Hemiptera	Anthocoridae	164	25	78.1	1.90	0.38	1.4– 3.7
	Aphididae	3388	32	100.0	1.98	0.33	0.5– 3.0
	Cercopidae	1	1	3.1	5.14	-	
	Cicadellidae	267	31	96.9	2.68	0.91	1.1– 6.1
	Cixiidae	92	19	59.4	3.06	0.44	2.1– 4.4
	Cydnidae	3	2	6.3	4.43	0.87	3.4– 5.0
	Delphacidae	32	14	43.8	2.53	0.36	1.9– 3.3
	Lygaeidae	2792	31	96.9	2.72	0.66	1.1– 6.6
	Miridae	86	21	65.6	3.04	0.62	1.9– 4.6
	Pentatomidae	4	4	12.5	3.29	1.91	1.6– 5.1
	Psyllidae	265	19	59.4	2.33	0.50	1.1– 3.4
	Ropalomeridae	4	4	12.5	6.21	0.18	6.0– 6.4
	Tingidae	3	2	6.3	2.43	0.62	1.7– 2.9
Hemiptera total		7101	32	100.0	2.34	0.65	0.4– 6.6
Hymenoptera	Agonidae	6	4	12.5	1.43	0.22	1.2– 1.8
	Bethylidae	7	5	15.6	2.66	0.99	1.8– 4.7
	Braconidae	66	21	65.6	2.49	0.70	1.4– 4.7
	Chalcidoidea	440	30	93.8	1.73	0.55	0.7– 3.9
	Cynipidae	2	2	6.3	1.17	0.39	0.9– 1.4
	Diapriidae	24	9	28.1	2.10	0.66	1.4– 4.1
	Eucoilidae	9	5	15.6	1.44	0.26	1.1– 1.9
	Formicidae	1390	29	90.6	3.50	0.75	0.9– 6.3
	Ichneumonidae	22	11	34.4	3.70	1.29	1.6– 6.1
	Unidentified	1	1	3.1	2.08		
	Proctotrupoidea	3	2	6.3	2.94	1.70	1.7– 4.9
Hymenoptera total		1970	32	100.0	3.03	1.05	0.7– 6.3
Lepidoptera	Unidentified	19	15	46.9	6.53	1.69	2.9– 9.7
Mecoptera	Unidentified	4	3	9.4	4.79	1.70	2.3– 6.0
Psocoptera	Unidentified	49	14	43.8	1.85	0.50	1.1– 2.9
Thysanoptera	Unidentified	47	10	31.3	1.71	0.28	1.0– 2.3
Grand total		12800	32	100.0	2.42	0.90	0.4– 9.7