Current Research

Chironomus samoensis is a complex of species

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Abstract

Chironomus samoensis, as currently recognised, is not a single species but a complex of more or less closely related species. *C. samoensis* Edwards 1928 is redescribed from additional material, and considered to occur only in the Pacific region. Reasons for excluding material from other areas are given. *C. flaviplumus* Tokunaga 1940 is confirmed as the correct name for the Japanese material, the Indian material described by Chattopadhyay *et al*. (1991) is given the new name *C. indiaensis*, and new names are required for material from Australia and additional species from India.

Introduction

Chironomus samoensis Edwards 1928 was originally described from Samoa, American Samoa (Pago Pago) and Tonga. Since then, the species has been reported from other parts of Oceania (Tokunaga 1964, Cranston and Martin 1989), Australia (Martin 2011), Japan (Hashimoto 1977; Sasa and Hasegawa 1983), Taiwan (Yamamoto 1996), China (Wang 2000) and India (Chattopadhyay *et al*. 1991). However, as I will endeavour to show, most of these reports are misidentifications, and *C. samoensis* is probably limited to Oceania.

I have not had the opportunity to examine the Edwards types, and his description does not include many characters important for species identification and is without illustrations. However, he did provide sufficient details to exclude many specimens described as *C. samoensis* from belonging to that species. One important feature is the superior volsella (SV) of the male, which Edwards compares specifically to the SV figured for *C. imberbis* (Kieffer 1917), as well as to other species such as *C. dorsalis,* and *C. hawaiiensis,* which all have a superior volsella (SV) of the D type (Strenzke 1959). While Kieffer's illustration of the nomen dubium *C. imberbis* is not all that clear, all the known *Chironomus* species around the Sydney area, the type location of *C. imberbis*, have a SV of the D type. In contrast to the Edwards (1928) description, some other descriptions of *C. samoensis* refer to the male as having a boot- or foot-shaped superior volsella (e.g. Fig. 12a in Tokunaga 1964 (but see below), Chattopadhyay *et al*. 1991), corresponding to Strenzke's (1959) S type.

I believe that specimens I collected as larvae from Mapusaga, Tutuila Island, American Samoa (-14.29, 170.70), (29 February 1971), as well as a specimen from Faratogo, Tutuila (coll: N.R. Spencer, 29 June1964) from the Bishop Museum collection, are most probably the species described by Edwards, and they will therefore be more fully described here. The Bishop Museum specimen is labelled as *C, samoensis*, perhaps by Tokunaga, but this point is not certain. This will include a description of the immature stages for the first time. In general, the morphological terminology follows Sæther (1980), Webb & Scholl (1985) and Vallenduuk & Moller Pillot (1997). Colour could not be determined from these slide-mounted specimens.

Results and Discussion

Male

Head: AR - 2.94 (2.51 - 3.23, 4); frontal tubercles 33 µm (29-38, 4) long and 15µm (14-17, 3) wide; palpal proportions (micron) - 46 : 46 : 193 : 234 : 354; clypeal setae 17-23.

Thoracic setae: Acrostichal - at least 14 or 15; dorsolateral - 17-21; prealar - 4-5; scutellar in two rough rows, ant. 5-12, post. 12-15.

Wing length 2.58 mm (2.40-2.68, 4), width 0.63 mm (0.60-0.66, 4), VR 1.03 (1.02-1.04, 4).

Legs: pale, tarsi slightly darker. Relative length of leg segments in Table 1.

Table 1. Lengths and ratios of leg segments of *Chironomus samoensis*

Leg	Fe	Ti	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5	LR	F/T	BR
PI	1107	1000	1507	810	750	670	330	1.50-1.52	1.08-1.12	1.54-1.75
PII	1170	1040	675	365	245	160	115	0.62-0.67	1.07-1.17	
PIII	1290	1245	1185	513	385	233	153	0.78-0.82	1.03-1.05	

Abdomen: pale, with darkening as described by Edward. Hypopygium: (Fig. 1) similar to that of *C. dorsalis*, with the SV of the D type, similar to fig. e of Strenzke (1959). The inferior volsella (IV) has mainly simple, curved setae, but a small number appear to have a small simple fork near the tip. About 4-6 setae on the 9th tergite near the base of the anal point.

Ta1 1020 ; Ta2 620 : Ta3 470 : Ta4 610 : Ta5 340; Ta4 about same length as Ta2, and about one third longer than Ta3.

Pupa: (Fig. 2)

Exuviae length 6.8 (6.5-7.0, 3) mm (male), inner margin of wing case about 1.34 (1.27-1.42, 3) mm (male). Pale, with darkened caudolateral spurs. Cephalic tubules 87 (76-115, 3) µm long and 66

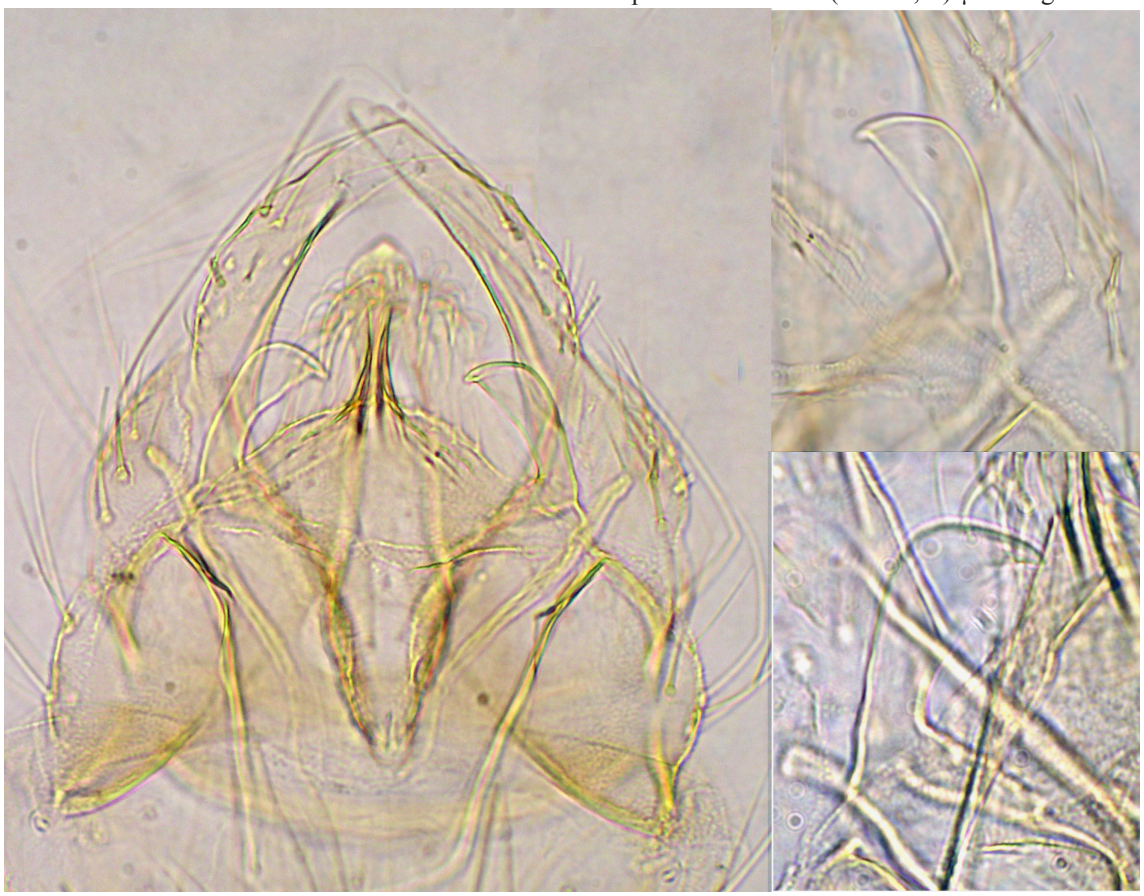

Figure 1. Male hypopygium of *Chironomus samoensis* (left), superior volsella (right). Note the partly beaked apex of SV in the lower figure.

Female:

No adult females are available amongst the present material, but one pupa with a pharate female was present. An important character is the relative proportions of the fore leg, particularly the tarsi, as Tokunaga (1964) notes that the Ta4 of specimens he assigned to *C. samoensis* was unusually long. The approximate lengths of these segments were measured (in micron) as: Fe 900 ; Ti 750 ; (56-80, 3) µm across the base, subterminal bristle about 68-80 µm in length. Basal ring about 151 (129-164, 3) long and 70 (54-85, 3) µm. About 67-77 hooks in row on segment II. Slight development of Pedes spurii B on segment II, progressive development of Pedes spurii A from segments IV to VI. Caudolateral spur of segment VIII about 180 (155-200, 3) µm long, with 1 to 3 spines. 78-88 taeniae on each side of the anal lobe of male.

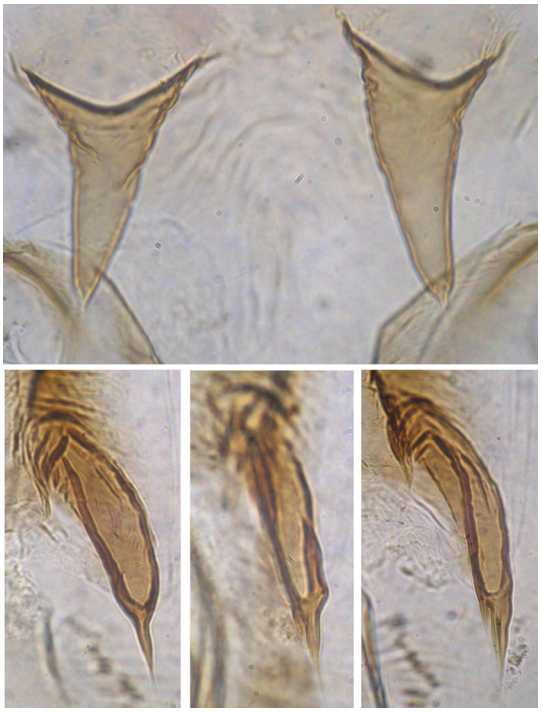

Figure 2. Pupal exuviae of *Chironomus samoensis*. Cephalic tubercles (above) and variations of spines on caudolateral spurs of segment VIII (below).

Larva: (Fig. 3)

A medium sized plumosus-type; length about 12.5-12.7 mm (female) and 10.8-11.8 mm (male); lateral tubules about 280-360 µm; ventral tubules relatively long (anterior 1.76-2.16 mm; posterior 1.80-2.68 mm), posterior pair longer and coiled; anal tubules moderately long (about 1.6-2.6 times longer than wide), dorsal pair (240-410 µm) slightly longer than ventral pair (215-370 µm). Head capsule pale with darkening of the posterior half of the gula, frontal apotome sometimes pale but mostly with slight darkening, ventral head length 261-318 µm. Distance between antennal bases greater than the distance between the S4 setae. Mentum wider than usual, about 0.6 of ventral head length; centre trifid teeth with c2 teeth well developed (essentially type IV); 4th laterals reduced to about the level of 5th laterals (type II), 6th lateral variable, sometimes arising at same level as other laterals but generally appearing to be at a slightly lower level, apparently due to breakage resulting from wear. Ventromental plates separated by about 35-41% of the width of the mentum; each with about 32-35 striae. Pecten epipharyngis with about 13 (10-16, 8) sharp pointed teeth. Premandible with sharp teeth, outer tooth shorter than inner tooth, which is about twice as wide as the outer tooth. Mandible about 208-228 mm long, with 3rd inner tooth relatively pale and only partly separated (type II), about 13 (12-14, 8) striae on inner margin

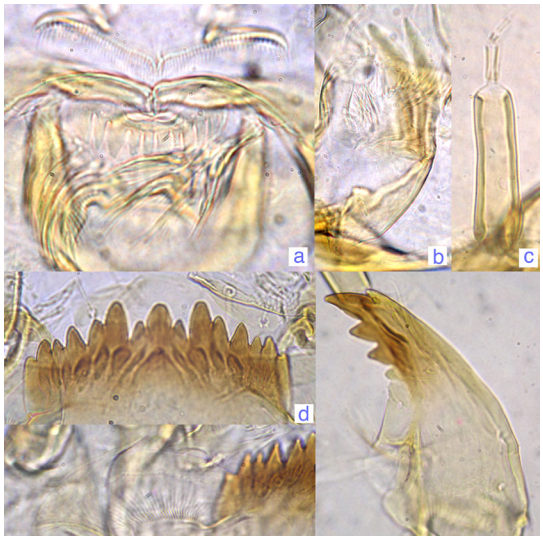

Figure 3. Features of the larval head capsule of *Chironomus samoensis*. a. Labrum and pecten epipharyngis, b. Premandible, c. Antenna, d. Mentum, e. Ventromentum, f. Mandible.

at base, pecten mandibularis sparse, with about 8 (7-10, 5) setae. Antenna five segmented, with A1 almost 4 times longer than wide, RO between 0.4 and 0.5 up from the base of the segment; relative length of antennal segments (micron) 110 : 24 : 6 : 11: 7 ; AR 2.03-2.30.

Cytology

The polytene chromosomes (Fig. 4) available from six salivary gland squashes, prepared by the technique of Martin *et al.* (2006), are not of high quality, but are sufficiently good to show significant differences to those of other species that have been called *C. samoensis*. The arm combination is similar, being pseudothummi-cytocomplex (AE, BF, CD, G). There are at least two nucleoli, one central in arm G, and one about region 20 of arm F, with a large puff that may be a nucleolus near the middle of arm C. There are two Balbiani rings near one end of arm G. The only banding pattern that could be completely identified was that of arm A, which is the basic pattern of *C. holomelas* (Wuelker 1980).

Based on these descriptions, diagnostic features of the species are: Frontal tubercles relatively long; LR about 1.50 -1.52, fore Ta5 about one third of the length of the fore tibia, SV of the D-type, or “beaked”; in female fore Ta4 longer than Ta3 and about the same length as Ta2. In larva, antennal segment 3 relatively short, usually shorter than A5. In the polytene chromosomes, the nucleolus in arm G is median, and there is a further nucleolus about region 20 of arm F and usually a large puff in arm C.

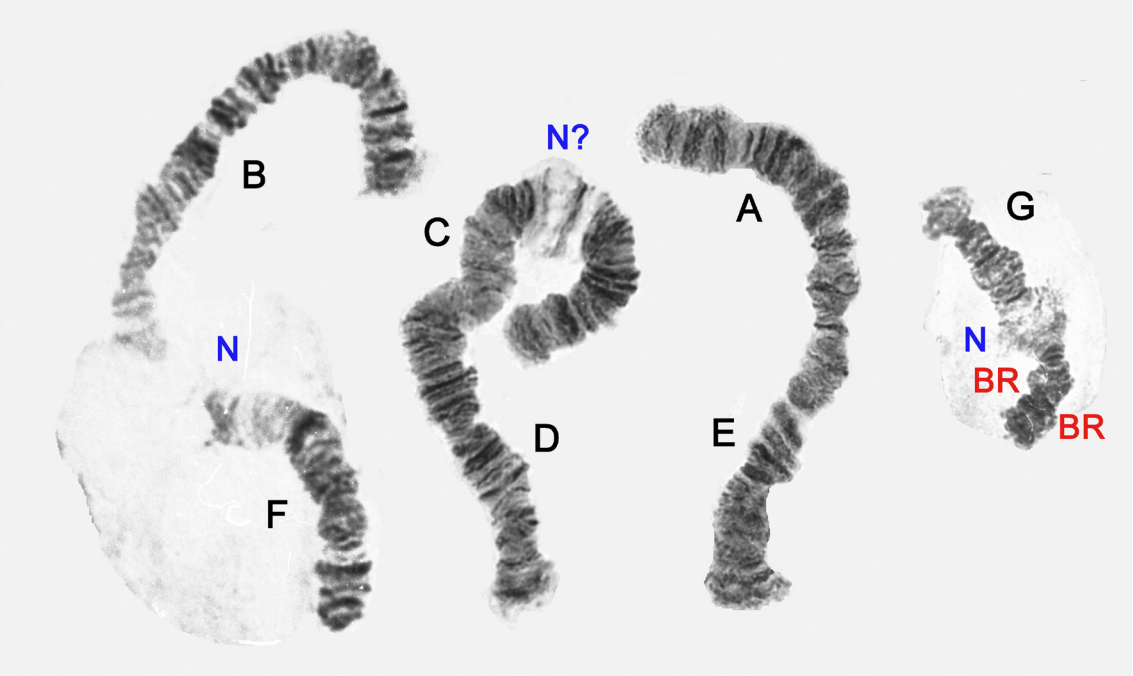

Figure 4. Salivary gland chromosome complement of *Chironomus samoensis*. A-G - chromosome arm identifications, N - Nucleolus, BR - Balbiani ring.

The first re-description of *C. samoensis* was by Tokunaga (1964). While the male colouration, AR and LR are quite similar to those described by Edwards, and Tokunaga describes the SV as similar to *C. dorsalis*, his figure has a triangular apex which can be misinterpreted as an S-type. However, Tokunaga's illustration of the SV is presumably intended to depict the somewhat "beaked" SV seen in some specimens (for which there is no equivalent in Strenzke's SV types). Tokunaga makes particular comment on the relative length of the tarsal segments of the fore leg of the female - "in female the fore tarsus with segment 4 far longer than 3 and slightly longer than 2". He then gives the relative lengths of the segments as Fe 110 ; Ti 86.5 Ta1 163.5, Ta2 84.5 ; Ta3 81.5 ; Ta4 88.5 ; Ta5 38.5. The relative lengths are about the same as those found for the Samoan specimen. The specimens described by Tokunaga from Micronesia are probably *C. samoensis*, although their LR is higher (1.75-1.84) and Tokunaga mentions the female abdomen as having faint oval spots on the terga, while Edwards states only that it is without distinct markings. In the event that re-examination of Tokunaga's specimens (the specific location of which is not given) indicates that this is a different species, the name *Chironomus eximius* Johannson (1946) might be an available name. Otherwise, the Tokunaga description provides details of adult morphology not included in the present re-description.

On the other hand it can be shown that the species identified as *C. samoensis* from other geographic areas do not fit these descriptions of the species. Material from Japan has been described both as *C. samoensis* (Hashimoto 1977) and as *C. flaviplumus* Tokunaga 1940, and, while there is agreement that there is only one species, there is uncertainty as to which name should be used. Sasa (1978) used the name *C. flaviplumus* on the basis that the AR of Japanese specimens was higher (about 4.0) than that of *C. samoensis*, and the fore Ta5 was longer compared to the fore Ti (about 0.42). Although he gave the lengths of the leg segments of the female, he did not note that those of the fore tarsi did not agree with those of *C. samoensis* as specified by Tokunaga (1964). Ta4 is only the same length as Ta3 and shorter than Ta2. Despite this, Sasa and Hasegawa (1983) accepted the synonymy of the two species and it has been used in this way by many authors (Sasa and Kawai 1987; Elbetieha and Kalthoff 1988; Kuhn *et al*. 1987; Wuelker *et al*. 1989). Wuelker *et al*. recognized the synonymy as doubtful, but incorrectly stated the probable correct name was *C. fulvipilus*. These authors also gave the banding sequences of chromosome arms A, E. and F., and photographs of the other arms were kindly made available to the author. These show that at least arms A and G differ from those of *C. samoensis.* Arm A does not have the basic sequence of *C. holomelas*, but differs by complex inversions: flaA1, 1a-i, 2k-d, 9 - 4, 13 - 14, 3h-i, 12 - 10, 2c - 1k, 3a-g, 15 – 19 (Wuelker et al. (1989).

The nucleolus in arm G is virtually terminal, not central.

Given the differences noted above, it is clear that Sasa's 1978 assessment was correct and the Japanese material should be called *C. flaviplumus*.

Chironomus samoensis has also been reported from Taiwan (Yamamoto 1996) and China (Wang 2000), but no details of the specimens were given. It is therefore unclear whether they are *C. flaviplumus* or another species.

A species occurring in northern Australia was initially identified as *C. samoensis* (Martin 2011), but the morphology and cytology now indicate that this is incorrect. The Australian species is a close relative of *C. flaviplumus*, but is not identical. The AR of the adult males is lower (2.4-2.9), the LR is higher (1.82-1.96 cf. 1.63) and the fore Ta5 is slightly shorter (about 0.37 of Ti in males, 0.34 in females). The tarsal proportions of the female are similar to those of *C. flaviplumus*. Cytologically, the nucleolus in arm G is virtually terminal, but arm A carries the basal sequence as in *C. samoensis*, and arm F differs from that of *C. flaviplumus* by a simple inversion In14d-9. A new name will be required for this species.

Finally, *C. samoensis* has also been reported from India, with a detailed description of West Bengal specimens by Chattopadhyay *et al*. (1991). I have been sent material identified as *C. samoensis* from Jammu and Kashmir, but these specimens do not agree with the description of Chattopadhyay *et al*., or that of *C. flaviplumus*. The Jammu and Kashmir material may be comprised of two different species, although one may be *C. incertipenis* Chaudhuri and Das, 1996. The essential difference from *C. samoensis* evident in the description of Chattopadhyay *et al*. (1991) is that the superior volsella is a definite boot-shape (S-type), rather than similar to that of *C. dorsalis*, and so differs from any of the species discussed above. The fore Ta5 is slightly shorter, at 0.28 of Ti, but the description makes no mention an unusually long Ta4 in the female. While colour can be variable, it may be noted that the Indian specimens are described as generally brown rather than the green or yellowish colour of *C. samoensis* or *C. flaviplumus*. There are also differences in the larva. The larval head capsule is described as pale, the premandible has the outer tooth longer, the AR is lower (only 1.86) and the A3 segment is relatively longer (longer than A4, not shorter). There is no cytological data definitely associated with this species. This species therefore requires a new name, and is renamed *C. indiaensis*.

The material from Jammu and Kashmir requires further study as it comprises mostly larvae, with only a few adults. The situation is compounded by the fact that there are a number of described Indian species which are close cytologically, and have adults similar to those of the *C. samoensis* group. These include *C. incertipenis* Chaudhuri and Das 1996, which differs mainly in the dark, pointed anal point of the adult male and the shorter blunt inner tooth of the larval premandible, and *C. ramosus* Chaudhuri, Das and Sublette 1992, where the most obvious differences are the higher number of teeth in the larval pecten epipharyngis and the essentially equal teeth of the premandible. DNA sequence of the mitochondrial COI gene is available for a number of the Jammu and Kashmir specimens, including three adult males, and these indicate relationship to *C. flaviplumus*, with only 5-7% base differences. The adult males (Fig. 5), while close to the *C. samoensis* group, are not *C. samoensis* and probably not *C. flaviplumus*. These adults are missing many leg segments or the antennae, which makes comparison difficult. They all have a "beaked" superior volsella. The AR is lower (about 3); LR is about 1.6 on the only specimen with the fore tarsi, and fore Ta5 is about 0.4 of Ti.

Figure 5. Male hypopygium of a *Chironomus* species from Farooq Nagar, Jamu and Kashmir, India (Coll: P. Khanna) related to *C. samoensis*. Inset: "beaked" superior volsella.

The larvae from Jammu and Kashmir do not seem to belong to either *C. samoensis* or *C. flaviplumus*, or to *C. indiaensis*. The head capsules generally have a darkened gula and the FA is very dark, sometimes mainly at posterior. The antennae

seem variable, with only some having a very short segment A3, others being longer than A5; AR about 1.9-2.0; the premandible teeth are nearer to equal length, and the outer tooth is about three quarters as wide as the inner tooth.

Cytologically, most of these specimens have the arm F sequence flaF1 of Wuelker *et al*. (1989), but some specimens have the basal arm A sequence homA1, as in *C. samoensis,* while others a sequence that differs from flaA1 by a simple inversion. The nucleolus in arm G is generally subterminal, but the presence of a nucleolus cannot be definitely established in some specimens. While related to *C. incertipenis* and *C. ramosus*, they do not appear to be either of those species. *C. ramosus* characteristically has a nucleolus in arm B, and not in arm G (Nath and Godbole 1997), while *C. incertipenis* is present in Jammu and Kashmir, but differs in the mtCOI sequence (unpublished data).

The presence of *C. flaviplumus* in India cannot be definitely ruled out, but it is more likely that at least two new names will be required for the material from Jammu and Kashmir.

Summary

These observations indicate that *C. samoensis* has not been found in any area other than the on Islands of the Pacific Ocean. *C. flaviplumus* could be more broadly distributed than its current range in Japan and Korea, the species described as *C. samoensis* by Chattopadhyay *et al*. (1992) can be renamed as *C. indiaensis,* while two or three new names will be required for other specimens from India, and Australian material.

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