COMMENT AND REPLY ON 'SOME DIFFERENCES BETWEEN DISTRIBUTARY AND BRAIDING CHANNELS' BY S. J. RILEY

COMMENT: GRAHAM TAYLOR† AND K. D. WOODYER*

We wish to comment on Riley's point that data for a number of his sites on the Namoi-Gwydir streams plot in the 'straight' field of an Ackers and Charlton (1970) plot of stream slope versus discharge (Riley (1975 Fig. 2)). Riley points out that these streams are meandering and not straight. However, before doing this, it is necessary to clarify a few points bearing on this section of his paper. Firstly in Figure 2 Riley plots the 'Ackers and Charlton natural' line with a negative slope of 0.271 and labels it with a negative slope of 0.12, neither of which is correct. The original Ackers and Charlton relation was quoted correctly by Riley as $S' = 0.0009\ Q^{-0.21}$. The correct line plots considerably higher than that plotted by Riley on page six of his paper.

Riley also used straight line thalweg slopes for comparison with the Ackers-Charlton model for which they use straight line water slopes. Recent work by us in the region of Dangar Bridge (one of Riley's sites) have shown straight line water gradients to be approximately 1.9×10^{-4}, slightly higher than the straight line thalweg gradients used by Riley. This has the effect of moving his point closer to the 'meandering' field of Ackers and Charlton. We also consider the bankfull discharge at Dangar Bridge to be 240 m^3s^{-1}, 37 m^3s^{-1} higher than that given by Riley.

We are only familiar with the Dangar Bridge site used by Riley, however the following comments may well apply to some of the other sites mentioned by Riley.

Riley states that five of his nine sites plot in the 'straight' field but have meandering channels. This he explains by saying "Either the Ackers and Charlton line is not generally applicable or the Namoi-Gwydir streams are not in a live-bedded condition". We take issue with Riley on both these points.

Firstly the Barwon River at Dangar Bridge is live-bedded, but the banks are very cohesive and relatively immobile (see below). Since Ackers and Charlton refer to their streams as meandering presumably the banks are relatively mobile, as well as the bed being "live".

Secondly, although the Barwon River is sinuous, there are straight reaches of considerable length. Adjacent to these reaches are numerous cutoff meander-loops, similar in size and morphology to the modern channel, indicating that the

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river has straightened its course in places in the recent past. This, together with data collected from ancient analogues of the Barwon suggests that many of the present and past sinuous streams of this region develop straight reaches during the latter stages of their development. The straight reaches of both the Barwon and its ancient analogues have bed-gradients approximating those of long reaches of the present channel. In the case of both the present river, with a bankfull discharge of about 240 m3s–1, and the ancient river, with an estimated bankfull discharge of 600 m3s–1 (Taylor 1976), these discharge-gradient points fall below the Ackers-Charlton regression line in the 'straight' category. Therefore the Ackers-Charlton relationship applies to these the straight reaches.

Much of the Barwon River is highly sinuous. Over a 50 km reach downstream of the Namoi River the average sinuosity is 2.3. However, it is not currently developing deposits characteristic of a meandering stream (e.g. meander scroll complexes). Moreover the channel has not shifted significantly in the last 100 years (Woodyer *et al.*, in press). The authors (op cit) show that much of the sinuous morphology is inherited and only slight modifications have been made to the channel since it developed from a mixed-load meandering channel. Due to partial damming, fine suspended load previously passed through the system, is deposited over the point sands protecting them from erosion. Thus much of the channel becomes fixed in this sinuous form which reflects its past history. However, Taylor (1976) has shown that this latter stage of development progresses to a straight channel due to progressive damming and blocking of the suspended-load sinuous channel. It is this effect which causes anabranches to form during the final phases of development (*cf* Riley 1973). Thus the channel of the modern river is a composite of channel reaches in different stages of development. On the basis of these observations it cannot be claimed that the Ackers-Charlton regression is not generally applicable. All that can be claimed is that the Namoi-Gwydir system channel reaches which are sinuous (but which are not actively meandering) fit into the Ackers-Charlton 'straight' category. This categorization appears reasonable since these reaches are capable of straightening themselves. It can be claimed also that just as streams have to have 'live bed' beds they also have to have 'live banks' to fit the Ackers-Charlton classification.

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REPLY: S. J. RILEY*

Taylor and Woodyer raise several points which I shall discuss in the order that they present them.

They are indeed correct concerning the position of the Ackers and Charlton (natural channel) line. Figure 1 is a redrafted, correct version of Figure 2 in my original paper.

My estimate of bedslope for the Barwon River at Dangar Bridge is 1.5 x 10–4, whereas Taylor and Woodyer estimate 'straight line' water gradient as 1.9 x 10–4. Woodyer and Taylor have confused the issue somewhat by using the term 'straight line thalweg gradient'. Thalweg gradient is the gradient along the stream and hence analogous to bed slope, but 'straight line' slope is, as defined by Ackers and Charlton (1970, p.354), the slope between two points on the channel and is analogous to what is often called 'valley slope'.

If Taylor and Woodyer mean 'bed slope' by 'straight line thalweg slope' then their estimate is 4 x 10–5 greater than mine. If they mean 'straight line slope' then, after correcting their straight line slope back to bed slope (using their estimate of sinuosity), their slope is 7 x 10–5 less than mine.

My only comment about these differences is that they respectively represent differences in elevation of 4 and 7 cm per kilometre. Even if Taylor and Woodyer's slope values are adopted the position of the Dangar Bridge point remains within the Ackers and Charlton straight class.

Taylor and Woodyer estimate the bankfull discharge at Dangar as 240 m^3/sec. They do not state how they derived this value, whereas the reader is referred to my original paper for details.

The question of whether the Barwon River at Dangar Bridge is in a live bed condition can only be answered from detailed studies of the bed of the stream, something which I have not been able to do. However, my general observations would suggest that, while there is sand on the bed, most of it would be thrown into suspension during high flows and reveal a resistant bed underneath. Many of the other channels that I surveyed and the beds which I was able to sample and examine in detail did have resistant beds, often capped with a thin veneer of fine sand and silt. Taylor and Woodyer actually claim that the fine sands protect 'point sands' (?) from erosion. I would suggest that there is much work to be done concerning the nature of bed sediment transport along the Barwon and the exact nature of the 'live bed' condition.

The question of whether the meanders of the Barwon are inherited is open to debate and I await their publications. However, it is worth noting that

a) rivers with cohesive banks are known to have very slow rates of lateral migration
b) the relations between bankfull width and discharge and between bankfull discharge and wavelength closely fit the Barwon River data for Dangar Bridge (Fig. 2)

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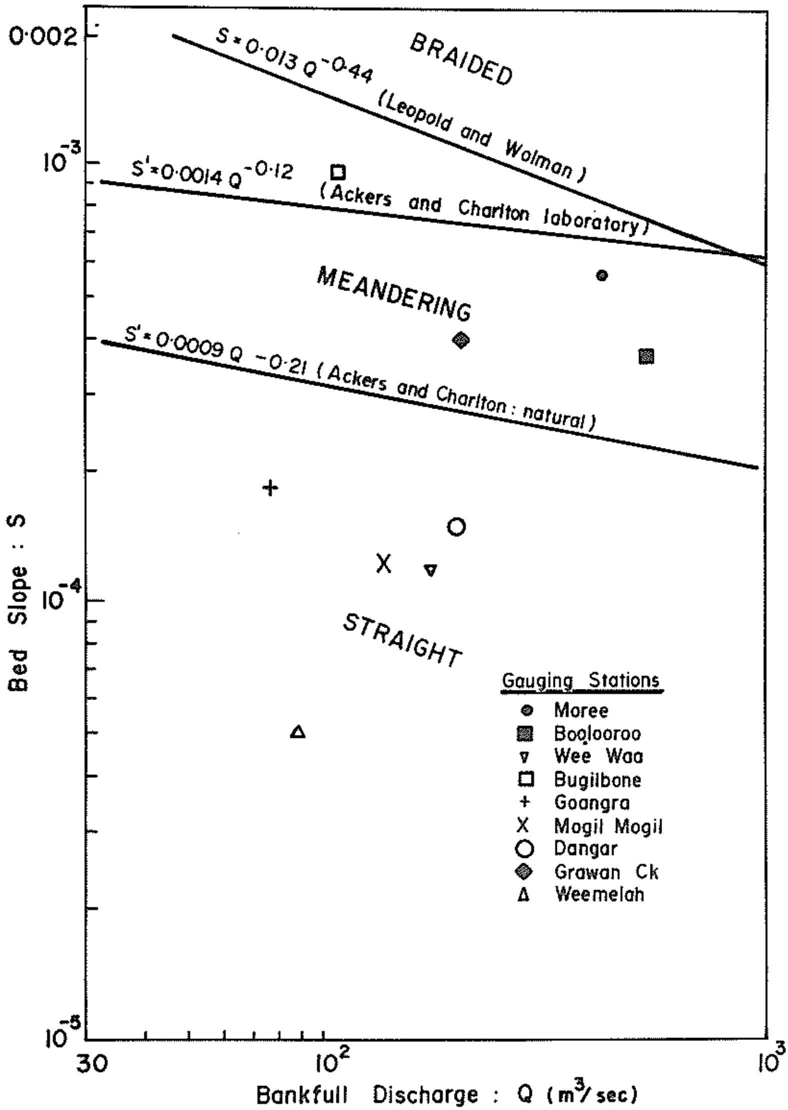

Figure 1 Corrected slope-discharge channel pattern classification for the Namoi-Gwydir system. S is bed slope, S′ is straight line slope. Plotted positions are for bed slope.

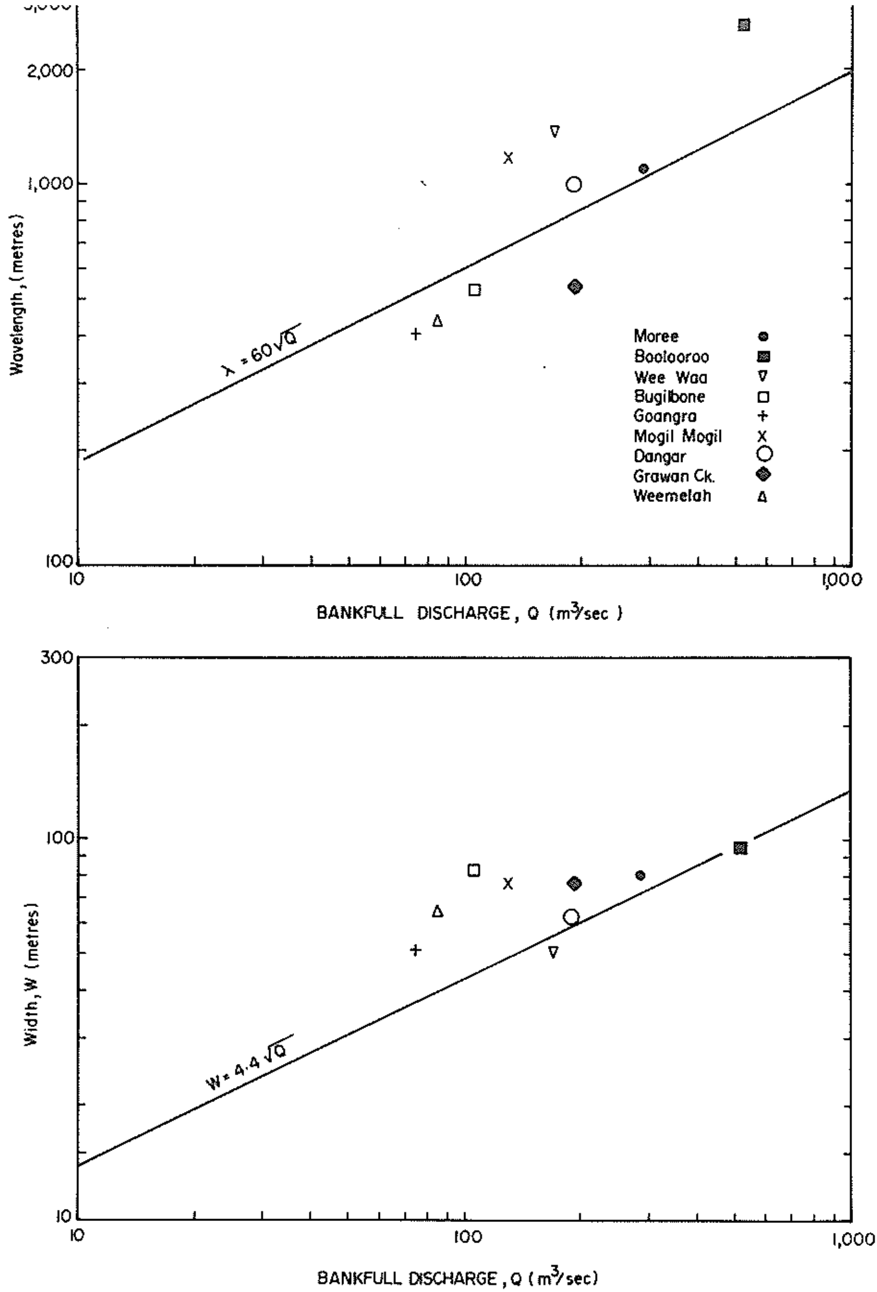

Figure 2 Bankfull discharge – wavelength and bankfull discharge-width relations for meandering streams and for the Namoi-Gwydir system. Wavelength is defined herein as twice the average distance between successive points of inflection in the channel pattern. versus Q is Leopold and Wolman relation and W versus Q is Simons and Albertson relation.

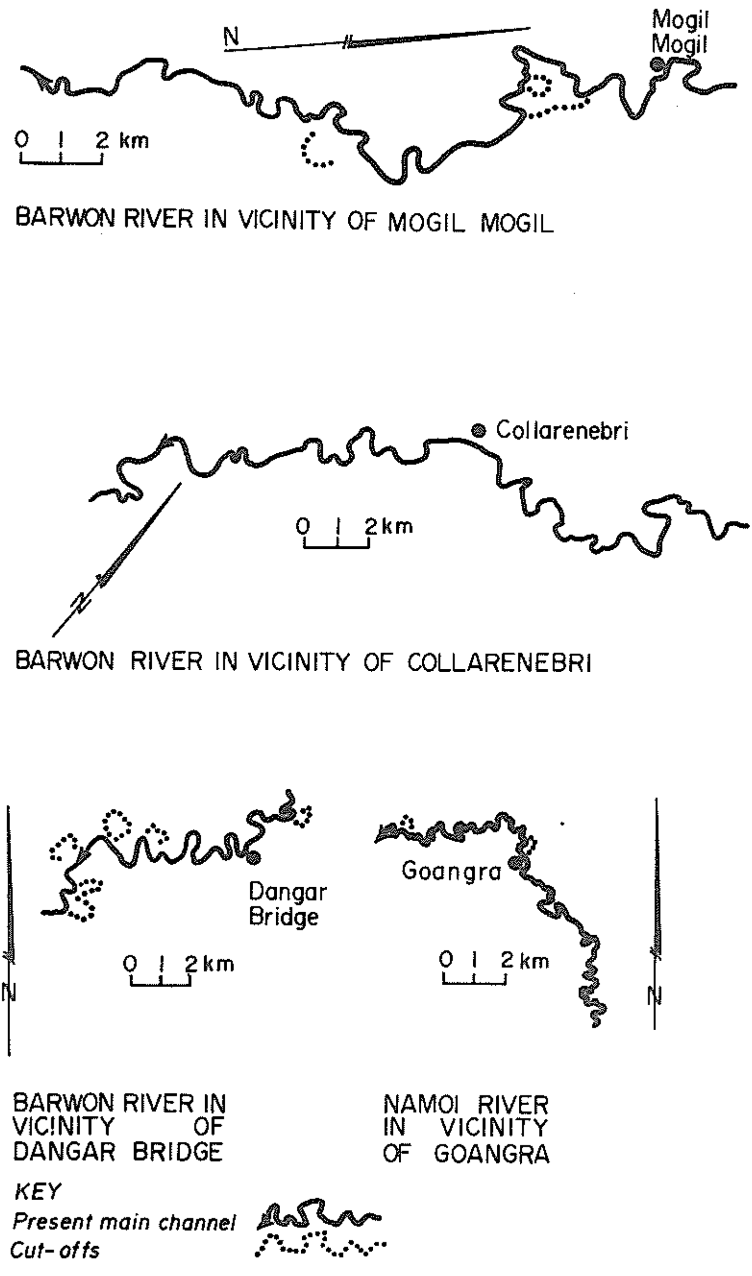

Figure 3 Channel patterns of the Barwon and Namoi Rivers at several gauging station sites. Not all cut-offs have been mapped in.

c) the existence of straight reaches near cutoffs in no way proves that the river is straightening as any meander abandonment must lead to temporary straightening. There are straight reaches along the Barwon River, but as Taylor and Woodyer admit, most of the river has a meandering channel pattern (Fig. 3).

The causes of meandering are as yet unclear and I await Taylor and Woodyer's contribution to this problem.

I must thank Taylor and Woodyer for their comments. There is opportunity for much more work in the area and I consider that the ideas that Taylor, Woodyer and I present are by no means conclusive.

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