Use of unfertilised margins on intensively managed grassland by Black-tailed Godwit *Limosa limosa* and Redshank *Tringa totanus* chicks

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In order to formulate management measures for breeding meadow birds that are suitable for integration into modern dairy farming, we studied the use of unfertilised grassland margins by chicks of Black-tailed Godwits *Limosa limosa* and Redshanks *Tringa totanus*. The study site consisted of 100 ha of intensively and commercially managed grassland and 20 ha of grassland that was managed for breeding meadow birds. In total ten management types were present, one of which was the unfertilised margins. The margins were 3 m wide and situated on both sides of ditches. There were 193 m of margins per ha. The average density of Black-tailed Godwit families with chicks in the margins was four times higher than expected from the overall average across all fields. The average density of Redshank families with chicks was seven times higher in the margins than expected. For both species, the margins had a higher density of families than the management types "mown-beginning-of-May" and "mown-beginning-of-June". The densities of families in the margins did not differ from those in the traditional management types "reserve" and "mown-end-of-June" for both species. Redshank families also preferred "shallow-pool" as a chick habitat. Black-tailed Godwit families especially used the margins during mowing activities. However, survival of the chicks in the margins was not studied. Because large-scale mowing is a main cause of poor survival of Black-tailed Godwit chicks, the function of unfertilised margins as a refuge during mowing activities promises to make an important contribution to chick survival in intensively exploited grasslands. But this should be confirmed by further study.

INTRODUCTION

In the Netherlands, grassland-breeding meadow birds are rapidly declining (Hagemeijer & Blair 1997, Teunissen & Soldaat 2005). Two of these species are Black-tailed Godwit *Limosa limosa limosa* and Redshank *Tringa totanus britannica*. The decline in the Black-tailed Godwit population is of particular international conservation concern (Thorup 2006). For this species, the bottleneck is inadequate breeding success because too few chicks survive due to early and large-scale mowing and probably predation (Schekkerman *et al.* 2008, 2009, Schekkerman & Müskens 2000). The key solution is to ensure that there is a sufficient amount of tall grass with an open vegetation structure during the pre-fledging period (May to mid-June) in which chicks can feed and find cover (Schekkerman & Beintema 2007, Schekkerman & Müskens 2000, Oosterveld unpubl. data). Redshanks will also benefit from this, because their chicks also make frequent use of tall grass. However, in modern dairy farming it is a problem to ensure that there is enough of this "chick land" (compare Kleijn *et al.* 2007). The late-mowing of fields (8, 15, 22 June) does not fit well with efficient, highly-productive, cattle-farming and farmers are reluctant to apply such conservation measures (Oosterveld *et al.* 2007). To preserve Black-tailed Godwits on farmland we need to develop new management techniques, which fit better with modern dairy farming; one of these may be unfertilised grassland margins. The edges of grasslands are usually of marginal value for productive farming, because they cannot be managed efficiently and are under the influence of weeds from outside the field. If the margins of a field are managed less intensively, the productivity of the field is only slightly reduced and if financial compensation is offered (which is possible under current agri-environment schemes in the Netherlands) it can even be attractive for farmers.

The question is whether these unfertilised grassland margins offer suitable habitat for Black-tailed Godwit and Redshank chicks to fledge. We studied this question in a pilot study on a modern dairy farm in the north of the Netherlands by recording the use of the margins by chicks in comparison with other grassland types.

METHODS

Study site and management types

We carried out this study in spring 2007 on a dairy farm near Kollumerpomp, in the north of the Netherlands (53°17'N, 6°12'E) situated in an open, wet grassland area on a young sea-clay soil. On the 100-ha farm there were 3-m wide grassland margins on both sides of nearly all ditches (Fig. 1). The margins had not been fertilised since 2002; they are not mown during the first cut in May, but at the second cut in June. After five years without fertilisation, the productivity of the vegetation had declined; so, by 2007, a fairly open and locally herb-rich vegetation had developed. As well as the margins, the 3-m wide ditches also have short and diverse

shore vegetation in which the chicks can hide. Therefore, because wader chicks swim well, the margins and ditches offer 9-m wide "refuge strips" that they can use when the grassland is mown in May. In total there were 19.3 km of unfertilised margins on the 100-ha farm, with a total area of 5.8 ha (excluding the ditches) and a density of 193 m per ha. Apart from the unfertilised margins there were eight other types of management on the farm (Table 1). A small 20-ha reserve was also included in the study site, but field margins there were not managed in the same way as on the experimental farmland. Thus the study area comprised 120 ha and included a total of ten different types of management (Fig. 2). Both Black-tailed Godwit and Redshank chicks are highly mobile; for example, godwit chicks can cover 3–4 km per day shortly after hatching and 5–12 km when they are older (Schekkerman & Boele submitted). Therefore, on a 100-ha farm such mobility means that all chicks of both species would have a reasonably equal chance of reaching land under all of the different types of management (see Fig. 2).

The landscape of the study area is flat, wide and open; the only vertical structures being the farm buildings in the south-west corner (Fig. 2). Black-tailed Godwits are known to avoid the vicinity of vertical structures by 100–250 m (Melman *et al.* 2008, Wymenga *et al.* 2006). By far the majority of the land in the study area is >100–250 m from the farm buildings and similar structures on adjoining land; therefore it is assumed that they did not influence the distribution of the wader families. The reserve is specially managed for meadow birds and is mown late (after 22 June). Most of the farmland is intensively managed in the interests of efficient farming, but there are also fields that are the subject of management agreements, which are mown after 8 or 15 June. These fields are of the types "mown-beginning-of-June" and "mown-end-of-June". The type "mown-beginning-of-June" is the most common (Table 1) because a considerable number of fields could only be mown at the beginning of June due to bad weather in May. At the south end of the reserve there was a 1.1 ha field with a 0.5 ha shallow pool.

Data collection

All Black-tailed Godwit and Redshank families were traced at 1–4 days intervals during 17 May to 22 June in order to evaluate their use of the various types of grassland. We noted on which field the chicks were located and whether they were in the margin or in the main part of the field. The location of the chicks was determined mainly by observing the parents. When an observer approached, the parents would come close to the observer and give loud alarm calls. When the observer retreated, they would return to their young. From the parents' behaviour and often from a glimpse of the chicks (especially when older they will often venture away from the cover of tall grass), the position of the chicks could be determined almost precisely. On every field visit, the status of each field, whether it had been mown, etc., was also determined. On the basis of these records, the management of every field was assigned to a particular type (Table 1); for example three fields were described as "grazed", i.e. used exclusively for cattle grazing throughout the chick period. Nineteen fields were designated "mown-beginning-of-June" because they were mown on 4, 8 or 12 June (after which there was re-growth because they were not grazed or used for any other purpose until 22 June).

Fig. 1. Unfertilised 3–4 m wide grassland margins along ditches all over the study farm near Kollumerpomp, the Netherlands.

Analyses

To assess the use of the different parts of the fields as chick habitat, we compared the densities of Black-tailed Godwit and Redshank families in the margins with the expected (overall average) densities and with the densities in the main parts of the fields. For these analyses we used the 32 fields with an unfertilised margin, irrespective of management type. For each field, we calculated the density of families (number per hectare) in the margins and in the central part as the number of observations of families over 14 visits divided by 14 times the relevant area. To test the difference in density between the

Table 1. Types of field management during May–June 2007 on the study farm near Kollumerpomp, the Netherlands.

	Management type	No. of fields	Area (ha)	% of total area	Mowing date(s)
1	Shallow pool	1	1.1	0.9	
2	Arable	4	11.5	9.6	
3	Grazed	3	7.4	6.1	
4	Mown & grazed	4	10.2	8.5	17 May
5	Mown beginning May	8	17.7	14.7	2 May
6	Mown mid-May	2	4.9	4.1	17 May
7	Mown beginning June	19	35.8	29.7	4, 8, 12 June
8	Mown end June	5	6.3	5.3	after 22 June
9	Unfertilised margin	32	5.8	4.8	
10	Reserve	14	19.7	16.4	after 22 June
Total		**92**	**120.2**	**100**	

Description of management types:
Shallow pool: a pool with shallow shores and a maximum depth of *c.*20 cm.
Arable: maize and barley with a height of some decimetres during the pre-fledging period.
Grazed: grazing by adult and yearling dairy cattle. Fields were assigned to this type when there were cattle present at any moment during the pre-fledging period and there was no other management.
Mown and grazed: fields of this management type were mown and grazed successively during the pre-fledging period. The date is the date of first cut.
Mown: the date is the date of first cut.
Unfertilised margin: 3 m wide, unfertilised field margin on each side of the ditch, along fields of one of the other management types, except reserve.
Reserve: fields with herb rich and open structured vegetation, mown at the end of June.

Fig. 2. Distribution of unfertilised field margins, field management types, Black-tailed Godwit and Redshank nests on the study farm near Kollumerpomp, the Netherlands in May–June 2007.

margins and central parts of the fields we used a paired *t*-test to determine whether the difference across all 32 fields was significantly different from zero. In this way we corrected for local effects. The expected (overall average) density (number per hectare) was calculated as the total number of families located over 14 visits, divided by 14 times the total area of the 32 fields. The differences between expected and observed densities were statistically tested with a parametric one-sample *t*-test. The data were first checked for normality.

The use of the margins was also analysed in comparison to other management types. For this we compared densities of Black-tailed Godwit and Redshank families in the field margins and the nine other management types (i.e. including the management type "reserve"). For each field (minus the area of the margins), the average density of families over the total observation period was calculated. For each type, the density of families was calculated as the average density on all fields of that type. The differences were tested parametrically with a One-way ANOVA with post hoc Tukey-test after checking the data for normality. All statistical procedures were carried out using the SPSS 14.0 program.

RESULTS

The average density of Black-tailed Godwit families in the margins was four times higher than expected (One sample *t*-test, $t_{31} = 4.727$, $P < 0.001$) and more than five times higher than in the centre of fields (One sample *t*-test, $t_{31} = 5.015$,

$P < 0.001$) (Fig. 3).

The average density of Redshank families in the margins was more than seven times higher than expected (One sample *t*-test, $t_{31} = 3.914$, $P < 0.001$) and more than ten times higher than in the centre of fields (One sample *t*-test, $t_{31} = 4.193$, $P < 0.001$) (Fig. 3).

Black-tailed Godwit families reached highest densities in the management type "margin", followed by "reserve" and "mown-middle-of-May" (Fig. 4). The density in "margin" was significantly higher than in "mown-beginning-of-May" and "mown-beginning-of-June" (One-way ANOVA, $F_8 = 4.75$, $P < 0.001$, Tukey post hoc test $P = 0.005$ respectively $P < 0.001$). We could not demonstrate significant differences in respect of the other types, mostly because of the small sample sizes.

Redshank families reached the highest density in "shallow-pool", followed by "margin" and "reserve" (Fig. 4). Only the differences between "margin" and "mown-beginning-of-May" and "margin" and "mown-beginning-of-June" are significant (One-way ANOVA, $F_8 = 3.53$, $P = 0.001$, Tukey post hoc test, $P = 0.04$ respectively $P = 0.004$). As with the Black-tailed Godwit, we could not demonstrate other significant differences between field-type for Redshank because of small sample sizes.

Use of the grassland margins by the Black-tailed Godwit chicks was not equal over time (Fig. 5). It shows two peaks that follow periods in which many fields were mown (17 May, 4 and 8 June). After 10 June, selection decreases and fields that were mown at the end of May become important. Presumably by that time the grass was sufficiently high to afford concealment.

Use of the margins by Redshank chicks also shows some peaks, but the peaks are spread over the whole period and on different dates compared with those for Black-tailed Godwit (Fig. 5). The shallow pool becomes very attractive to Redshanks in June.

DISCUSSION

Influence of weather

The preceding winter was mild and April was extraordinarily dry. Several pairs of Black-tailed Godwits (and Redshanks to a lesser extent) did not breed or only started to nest from the beginning of May, probably because they could not access earthworms due to the hard clay soil. In May and June, the weather was unfavourable with periods of rain. Early in the season there was a lot of grass because of the mild winter. This was mown early (on 2 May), but because of the ensuing wet weather a substantial proportion of the fields could only be mown for a first cut at the beginning of June (especially 4 June). Normally, the margins are mown together with the second cut around mid-June, but in 2007 this did not take place until after 22 June. Therefore the margins were available longer than usual; however a proportion of the godwits and Redshanks also bred later than usual. We do not think the unusual weather led to unrepresentative results.

Unfertilised margins as chick habitat

Black-tailed Godwit and Redshank chicks showed a far stronger preference for the unfertilised margins than expected according to area. Moreover the densities were significantly higher than in fields that were mown at the beginning of May (2 May) and at the beginning of June (4, 8, 12 June). They showed no such preference for fields that were mown after 15 June including the reserve.

For Black-tailed Godwit chicks the unfertilised margins served as a refuge during periods of large scale mowing in May and June. These periods are the bottlenecks when chick survival is strongly reduced (Schekkerman *et al.* 2008).

The use of the margins by Redshank chicks was more evenly spread over the chick period. The preference of Redshank families to forage on the sides of ditches is well known (Milsom *et al.* 2002, Schekkerman 1997). This is probably why the selection of margins by Redshank chick is stronger than in Black-tailed Godwits.

Postponement of mowing into June on farmland and reserves is a common management prescription to enhance survival of meadow-bird chicks. Under the current Netherlands Agri-environment Scheme, there is an array of agreements for mowing after 1, 8, 15 or 22 June. Our findings show that, in relation to Black-tailed Godwit and Redshank chicks, unfertilised margins are equally or more beneficial than simply deferred mowing. This result is consistent with that of Schekkerman & Müskens (2001) who found that fields with refuge strips (comparable to margins) were selected nearly as often as unmown fields (until 1, 8, 15 or 22 June) and those with re-grown grass (>15–20 cm). We saw the chicks of both species foraging regularly at the edge of mown and unmown grass and seeking cover in the unmown margin when danger appeared.

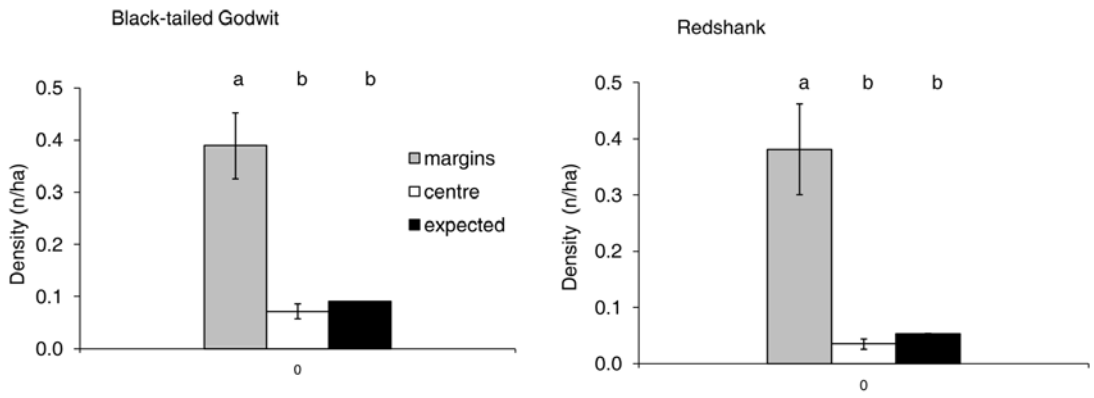

Fig. 3. Density of Black-tailed Godwit and Redshank families (number/ha±SE) in the unfertilised margins, in the centre of the fields and as expected (= average density over the whole area of farmland) on the study farm near Kollumerpomp, the Netherlands in May–June 2007. The letters above the columns (a & b) indicate significance of differences: non-significant ($P > 0.05$) if they are the same letter, significant ($P < 0.001$) if they are different letters (N = 159 Black-tailed Godwit families and 103 Redshank families).

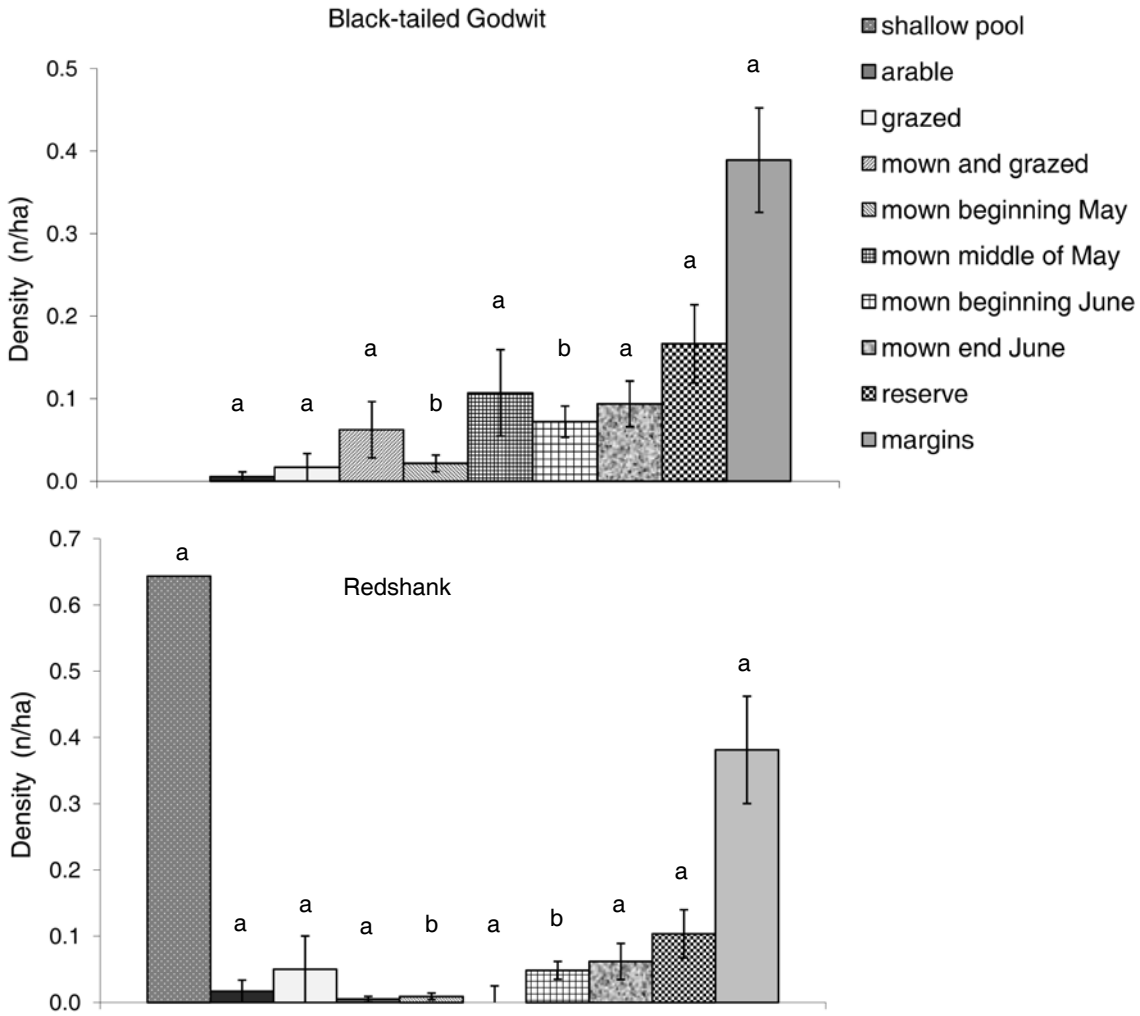

Fig. 4. Densities of Black-tailed Godwit and Redshank families (number/ha±SE) in the different management types on the study farm near Kollumerpomp, the Netherlands in May–June 2007. The letters above the columns (a & b) indicate significance of differences: non-significant ($P > 0.05$) if they are the same letter, significant ($P < 0.001$) if they are different letters (N = 159 Black-tailed Godwit families and 103 Redshank families).

On our study farm, the density of unfertilised margins was high (Fig. 2). Therefore we do not know whether there is a relationship between the density of margins and their attractiveness to wader families; especially whether there is a lower threshold of margin density below which they fail to perform their function of providing refuge for waders in land subject to intensive dairy farming. This is probably important in relation to chick survival and should be the subject of further study. It is also desirable to replicate our study elsewhere to confirm that our results are representative of other important meadow-bird areas.

Chick survival

The preference for the margins by wader families does not of itself mean that they lead to higher chick survival. There are indications that regularly fertilised farmland supports less vegetation-dwelling arthropods and that the vegetation is less easy for the chicks to penetrate than mildly-fertilised, herb-rich grassland (Kleijn *et al.* 2007). We did not study arthropods or the vegetation structure of the margins, but because the margins had not been fertilised for four years, their quality as chick land was probably better than regularly fertilised grassland.

The question remains whether unfertilised margins that are mown late in the season are a key factor in promoting chick survival rates that are high enough to sustain stable meadow-bird populations. The most vulnerable period for Black-tailed Godwit chicks is the first two weeks of May when there is large-scale mowing for the first cut (Kruk *et al.* 1997, Schekkerman & Beintema 2007, Schekkerman & Müskens 2000). The fact that the chicks show a strong preference for the margins during the mowing periods may mean that the margins allow them to survive this vulnerable period. But we did not study chick survival; so this needs further research.

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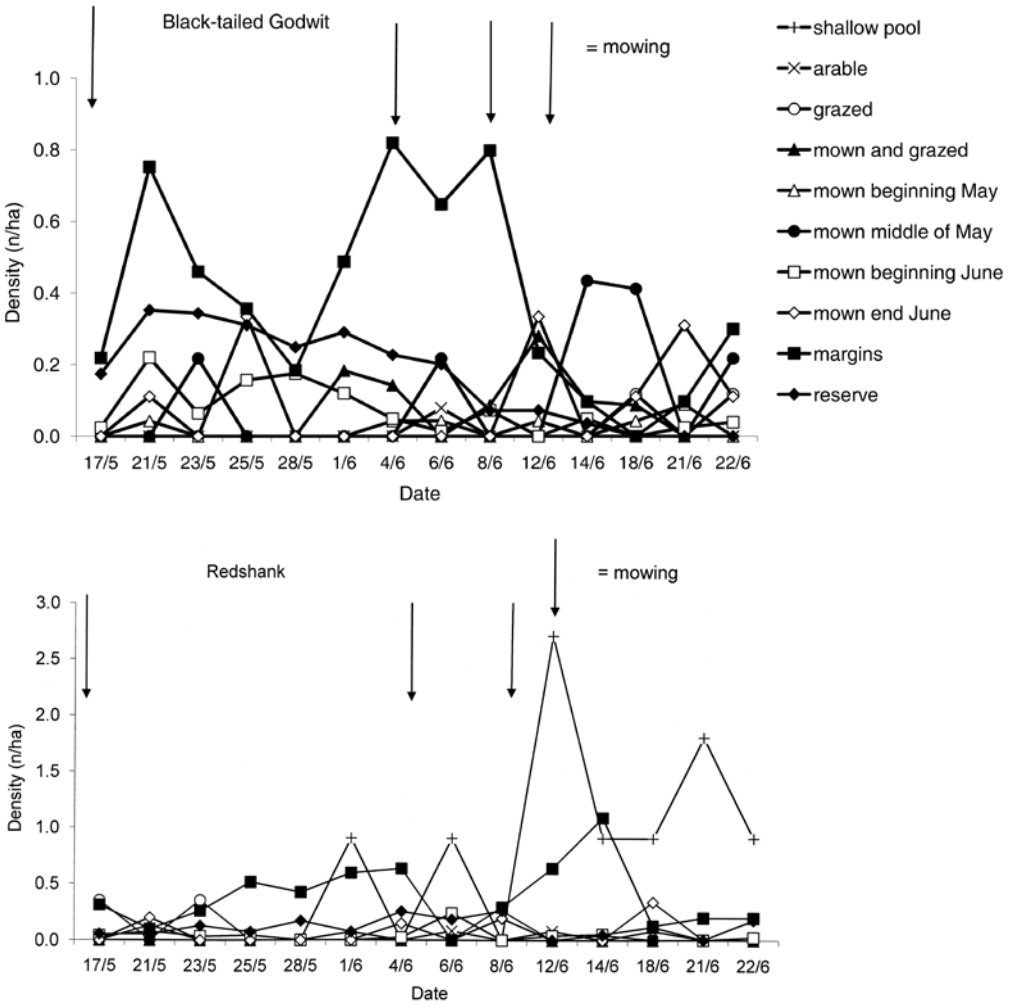

Fig. 5. Use of fields under different types of management by Black-tailed Godwit and Redshank families during May and June 2007 on the study farm near Kollumerpomp, the Netherlands (mowing dates are indicated by arrows).

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