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SOME PROBLEMS OF PASTURE PRODUCTION UNDER COCONUTS

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I. INTRODUCTION

In maintaining a pasture for cattle under coconut a complex ecological situation involving coconut, pasture species and animals is encountered. Each of these components while demanding certain conditions for its proper growth would at the same time affect the growth of the others.

The more important aspects of the problems involved are : the effect of the pasture on the yield and life span of the coconut palm; the effect of coconut on the growth, yield and persistency of the pasture and the efficiency of the available animal to convert this pasture into milk and/or meat.

The first two effects are that of competition between and within the two plant groups for the essential factors for growth such as, soil moisture, nutrients, light and possibly carbon dioxide. Competition is a purely physical process. In this particular case competition would arise from the reaction of the pasture upon the physical factors about it and the effect of these modified factors upon coconut. Conversely coconut would react and modify the factors about it and this would affect the growth of the pasture. Clearly then an interaction of a high order is evident. Competition for the above factors would arise as soon as any one or more of them are in supply below the combined requirements of the association. The successful cultivation of pasture would depend on providing all the nutrients required by the association, at least up to the point where the yield of coconut is not adversely affected, and minimising by various cultural methods the competition for soil moisture during the dry periods. For a fuller analysis of the competitive relationship between coconut and associated crops see Santhirasegaram 1965.

The indigenous cattle, the Sinhala, is a small animal with a very low yield potential. It will be shown later that it is not a suitable breed for dairy purposes and one of the main problems of pasture production under coconut is the lack of an efficient dairy breed in this country, and for that matter in most coconut growing countries.

The success of this venture will depend on the efficient utilization of the pasture with minimum loss of coconut yield. This paper reviews the information gathered and the work in progress at the Coconut Research Institute.

II. THE EFFECT OF PASTURE ON THE YIELD OF COCONUT

This aspect of the problem has been dealt with in some detail recently (Santhirasegaram 1964 a). All the coconut estates in the country carry a good flora of weeds of varying intensity of growth, and in establishing a pasture with species of proven yield potential and quality these weeds are replaced. Thus in assessing the effect of the pasture on the yield of coconut the relative difference in the effect of the pasture and weeds is measured.

In a mature stand of coconut, where the crowns are held at some considerable height from ground, there would not be any competition for light and carbon dioxide detrimental to the yield of coconut. On the other hand, there could be considerable competition for the soil factors.

While competition for the soil factors would depend on various attributes of the pasture plants, the quantity of herbage produced or yield is a convenient measurable attribute and this discussion employs it to study the competitive effect of pasture on the yield of coconut relative to the natural weed population.

On this basis the following three circumstances could be encountered :

(i)	Where $Yp > Yw$	then Yc would	decrease.
(ii)	" $Yp < Yw$	" " "	increase.
(iii)	" $Yp = Yw$	" " "	not be affected.

(Yp = Yield of pasture, Yw = Yield of weeds and Yc = Yield of coconuts).

From a practical point of view (ii) and (iii) would not pose any problems and would in fact be beneficial. Situation (i) however is more general as is to be expected. In Table 1 is given the dry matter yield of weeds and pastures and corresponding yield of coconut from experiments carried out at the Institute's properties at Bandirippuwa and Ratmalagara. These data would show that between pastures too the effect on coconut depends on the dry matter of herbage produced. Though the data are insufficient to generalise, it is suggested that the total yield of the association (Yp + Yc) in a given environment would be a constant. In other words as Yp increases there would be a corresponding decrease in Yc.

TABLE 2.

	Bandirippuwa		Ratmalagara.	
	Herbage (lb./ac.)	Coconut (Nuts/ac.)	Herbage (lb./ac.)	Coconut (Nuts/ac.)
Weeds	9719	4244	793	5085
Brachiaria brizantha (ungrazed)	-	-	1920	3672
B. brizantha (grazed)	7773	4487	1673	4446
B. miliiformis (")	7952	4398	-	-
Panicum maximum (")	14672	3570	-	-

(Dry matter yield of herbage beneath coconut and corresponding yield of coconut).

In the experiment at Ratmalagara, where the annual rainfall is 65 inches and only nitrogen (1 cwt. sulphate of ammonium/acre/year) was provided as additional manure (in excess of that recommended for coconut) to the double crop, the pasture generally reduced the yield of coconut compared to the weed control. Between the pastures, those ungrazed caused a greater reduction (28%) than those grazed (13%). It is not possible to say at the present whether in the grazed pasture there was better recycling of the nutrients or during the dry season grazing reduced loss of soil moisture due to reduced transpiration. Experiments now in progress at this station should show to what extent this reduction was due to soil moisture and or nutrient competition. It would also be possible to determine for which major nutrient (N, P and K) there is competition. It must however be pointed out that the weed control plot also received the additional nitrogen. To what extent the upward trend of the nut yield in these plots were caused by this nitrogen has to be taken into consideration in assessing the effect of pasture on the yield of coconuts.

At Bandirippuwa with an annual rainfall of 85 inches and additional manuring of nitrogen (2 cwt. sulphate of ammonia/acre/year) and potash (1 cwt. muriate of potash 60%/acre/year) all competitive effects have been eliminated. Here too the control plots received these additional fertilizers. These data and those of Salgado (1944) with a fodder grass (*Pennisetum purpureum*) near Bandirippuwa suggest that in this area competition was mainly for nutrients and that with adequate manuring this could be eliminated.

It may then be said tentatively that at or above 85 inches rainfall, provided it is at least as well distributed as at Bandirippuwa, any depressive effect of a grass sward could be eliminated by proper manuring. The possibilities of nitrogen competition could be reduced or even eliminated by the incorporation of an effectively nodulating legume into the pasture which would also improve the quality of the pasture. The search for a suitable legume and its associated strain of Rhizobium are receiving some consideration.

Extension of similar studies reported here into drier areas would show the critical rainfall below which soil moisture competition, if any, would be operative.

Adequately manuring the double crop is a very interesting problem indeed. Here knowledge of the requirements of each crop is a prerequisite. No doubt field experiments would be the ideal solution, but the time, space and energy for such work on an extensive scale is almost beyond the scope of an institution of the size of the C.R.I., particularly in relation to a secondary project of this nature. It is therefore reasonable to look for short cuts. To this end Paltridge (1955) commenced a programme of assessing the nutrient status of coconuts soils using indicator plants in pots assuming that "in general terms they do show what nutrients are in short supply" and "give us a lead to the probable deficiencies, in very much shorter time, and at much less cost." Further Paltridge and Santhirasegaram (1957) dealing with the nutrient status of the Bandirippuwa lateritic soils stated that "these experiments should give a general picture of local soil fertility problems, and it is at least highly probable that if a rapidly growing plant with high fertility requirements show no deficiency of any nutrient, then that nutrient is unlikely to be a limiting factor in the growth of coconuts". Both the soils at Bandirippuwa and Ratmalagara on which fertilizer trials on coconut are being conducted have been studied in pots and it would be of topical interest to compare these data. In Table 2 is given the percentage of the added levels of P and K over the Nil treatment for the dry matter yield of Paspalum commersonii in pots and copra yield in the field. These data not only completely

TABLE 2

	B/E		R/E	
	Copra(1)	Herbage(2)	Copra(3)	Herbage(4)
P_0	100	100	100	100
P_1	95	97	183	902
P_2	97	95	183	902
K_0	100	100	100	100
K_1	147	248	108	167
K_2	161	304	124	216

(o/o yield of P. commersonii and C. nucifera at 3 levels of P and K on two soils)

(1) Salgado (1953); (2) Santhirasegaram (1959);
(3) Nethsinghe (1963); (4) Santhirasegaram (unpublished).

justify the assumptions of Paltridge and Santhirasegaram (1957), but show that there are strong similarities in the response to the various levels of the two nutrients. In the case of nitrogen, regardless of the dosage, the response is maintained only for about six weeks in the pots and it is now standard practice for us to apply nitrogen as a basal nutrient every four or five weeks in the course of an experiment. Eden et al (1963) analysing the coconut trial at Bandirippuwa concluded that "the data show that the benefit from nitrogenous manuring was small or non existent". It must be pointed out that manuring in this experiment was biennial. They studied the response to potash in the manurial year and back year and found an average difference of 53 = 34 lb. copra/ac. in favour of the year of manure application which however was not significant.

A similar study of nitrogen, particularly at the higher levels of potash at six monthly intervals, should be worthwhile. Santhirasegaram (1964 b) has reported significant response to nitrogen at levels far in excess of that used by Eden et al. In Santhirasegaram's trials nitrogen was applied at six monthly intervals.

Adopting a manurial programme based on the results of pot experiments with indicator plants, Santhirasegaram (1964 a) was not only able to grow coconut satisfactorily in association with pasture, but also obtained positive "b values" for linear regression of yield of coconut with time in all control plots. Here, however, the effect of weather has to be taken into consideration. The similarity of the results should at best, at this stage, be treated as coincidental and considerably more comparisons and corrections should be made to establish the validity, if any, of this curious relationship.

III. EFFECT OF COCONUTS ON THE YIELD OF PASTURE

Just as pasture affects the yield of coconut, the yield of the pasture will be affected by coconut. Even when adequately manured the inevitable shade cast by coconut would reduce the yield of pasture. Black (1957), reviewing light and plant growth, showed that the yield of herbage was maximum at full solar radiation. More pertinent data were obtained by Santhirasegaram (1962) where the yield of clover beneath wheat was linearly related to the amount of solar radiation received.

The light received beneath a stand of coconut would depend on the age of the stand, the distance of planting and the level of soil fertility. In a juvenile stand considerable light reaches the ground and as the age of the stand increases the amount of light decreases up to about 10 years approximately. Thereafter there is gradual increase again. Though actual estimate of the fraction of incoming solar radiation available for growth of pasture beneath coconut is not yet available it is suggested that under a mature stand planted in 26' square about 50 o/o reaches ground level.

Cultivation of pasture during the seedling stage of a plantation would expose the seedlings to cattle damage. Fodder cultivation however would be a practical proposition. From about the 5th to the 20th year the light available would be so low that pasture growth would be very poor. Satisfactory growth should be possible beyond this stage.

Various pasture species respond differently to this reduced light. Within the same estate where the planting is closer or the stand of coconut slightly younger, Brachiaria miliiformis appears to replace B. brizantha. This is more pronounced where the level of nitrogen manuring is high. Persistency and nodulation of legumes will be considerably affected by this reduced availability of light.

IV. EFFICIENCY OF THE GRAZING ANIMAL

From the foregoing it is obvious that at least in the heavy rainfall areas a satisfactory pasture could be maintained with little or no loss of yield of coconut, but the economics of the practice would depend on the cost of the additional fertiliser required. The recovery of that expenditure would depend on the efficiency of the grazing animal to convert the pasture into milk and/or meat.

The local cattle, the Sinhala breed, is a small animal weighing 400 lbs. and yielding 100 gals. milk per lactation under the best management. The lactation characteristics of this breed were studied for a herd at Karagoda Uyangoda by Mahadevan (1953) and another at Bandirippuwa by Santhirasegaram et al (1964). In both herds the co-efficient of variation of the yield per lactation (39.0 for K.U. and 35.5 for B/E) and other characters were high suggesting possibilities of improvement by selection. The average yield per lactation of the daughter cows at Bandirippuwa was 138.5 gals. compared to 105.4 gals. of the foundation cows. However it would not be possible to maintain this rate of increase in subsequent generations, as shown by the yield of the grand-daughters which was only 141.7 gals.

These data confirm Mahadevan's view that the Sinhala is not a suitable dairy breed. Other tropical breeds though slightly better in their yield have a ratio of Yield/Body Wt. similar to the Sinhala (Table 3 and Fig. 1).. The better established European breeds do not perform satisfactorily in a tropical climate as shown by Mahadevan (1956). It will not be possible to replace the indigenous with an exotic breed in sufficient numbers to substantially increase the milk production of the country. Some use of the indigenous breed too has to be found.

The alternative then appears to be cross breeding the Sinhala to an exotic. Here the selection of the exotic parent and the desirable proportion of the two parents in the new breed are important considerations. The first inclination would be to cross to another tropical breed, but the results were not satisfactory as shown by the performance of the Sinhala x Sindhi whose body weight and milk yield are a mean of the two parents and the Y/B ratio similar to the parents.

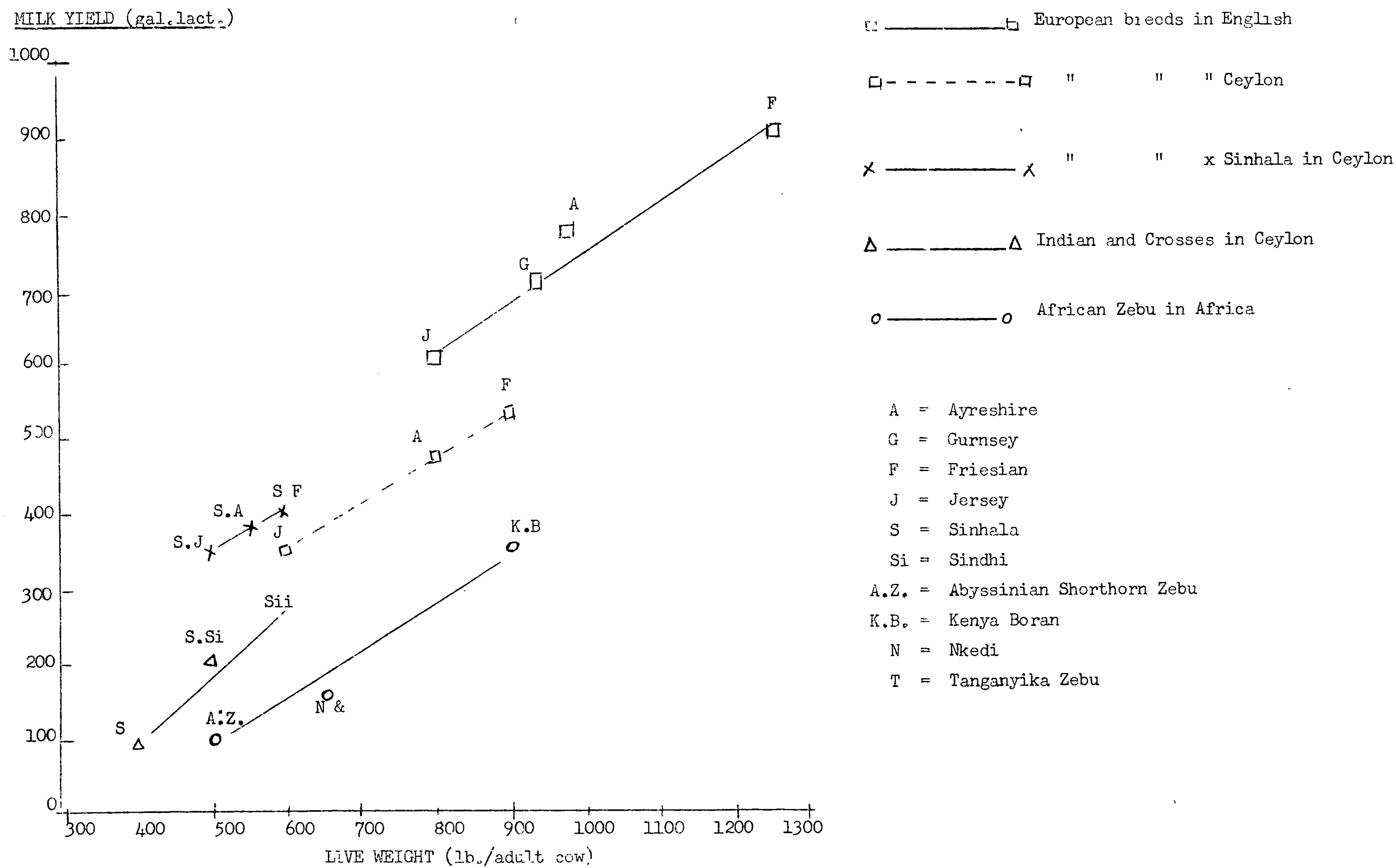
Crosses with European breeds such as the Jersy, Ayrshire and Friesian appear to be satisfactory. The F1 are able to withstand the tropical climate and have a very high Y/B ratio indicating high efficiency. While both the Sinhala x Sindhi and Sinhala x Jersey F1 weigh 500 lbs., the former yields only 250 gals./lact. compared to the latter's 350 gals. (See Fig. 1).

There is hardly any difference in the efficiency among crosses with the various European breeds. Their Y/B ratios are the same, and

TABLE 3

African		Indian		European in England		European in Ceylon		Indian Crosses		Sinhala x European crosses	
Breed	Y/B	Breed	Y/B	Breed	Y/B	Breed	Y/B	Breed	Y/B	Breed	Y/B
Kenya Boran	0.39	Sinhala	0.25	Friesian	0.72	Friesian	0.58	Sinhala x Sindhi	0.40	Sinhala x Friesian	0.66
Nkedi	0.23	Sindhi	0.40	Ayrshire	0.75	Ayrshire	0.59			Sinh.x Ayr.	0.68
Nysa Zebu	0.23			Jersey	0.74	Jersey	0.58			Sinh.x Jer.	0.70
Abyss.Sh.H.	0.20										
Mean	0.26		0.34		0.74		0.58		0.40		0.68

Ratio of milk yield per lactation in gals. (Y) to body weight of adult cow (B) of some popular dairy breeds and their crosses. The data of milk yield and body weight were obtained from various sources.



MILK YIELD (gal.lact.)
1000
900
800
700
600
500
400
300
200
100
0
300
400
500
600
700
800
900
1000
1100
1200
1300
LIVE WEIGHT (lb./adult cow)
F
A
G
J
F
A
S F
S.A
J
S.J
K.B
Sii
S.Si
N &
A.Z.
S
European breeds in English
" " " Ceylon
" " x Sinhala in Ceylon
Indian and Crosses in Ceylon
African Zebu in Africa
A = Ayreshire
G = Gurnsey
F = Friesian
J = Jersey
S = Sinhala
Si = Sindhi
A.Z. = Abyssinian Shorthorn Zebu
K.B. = Kenya Boran
N = Nkedi
T = Tanganyika Zebu

preference of one over the other would only be personal fancy.

The next problem would be the determination of the proportion of the exotic blood that should comprise the new breed. Here the degree of upgrading with Ayreshire and Friesian may be limited due to the dilution of the "gene complex" to withstand the rigours of a tropical climate. On the other hand with th availability of tropicalised Jersey the potentialities are enormous.

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