Evaluation of Temperate Bamboo Species as Forages for Livestock

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Abstract

An initial composite test of the leaves of four hardy bamboo in December, 1995, in Coquille, Oregon, reflected a substantial crude protein and crude fat content (20.86 and 2.49) percent. In winter, much of the pasture grass in zones 8 and 9 in the Pacific Northwest is extremely low in nutrients, suggesting that bamboo may have potential as a winter forage for livestock in this region.

Eleven species of hardy bamboo were then tested individually from August, 1996, to May, 1997, to determine the nutrient composition and in vitro dry matter digestibility. The results of the tests and a general discussion are presented in this paper.

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Introduction

In August of 1995, when the pasture grasses had browned, the RKR Bamboo Plantation (RKR) in Coquille, Oregon, began feeding its normal trimmings of bamboo to two *beefmaster* steers. When the bases of the culms were lashed to fence posts and fence railings, the animals stripped the branches of leaves and the culms remained for future use for other purposes.

This practice continued to December when 20 leaves of each of four different hardy species were sent to a testing laboratory for feed analysis. The test indicated a composite 20.86% crude protein and 2.49% crude fat. Daily feeding continued.

Recognizing that the pasture grasses were grown on soils that are leached with 65 inches of annual rainfall and that the grass in winter had practically no nutritional value, feeding bamboo leaves to provide winter forage seemed to have potential. It also suggested the hypothesis that bamboo, flowering so seldom, might build and store protein and fat for the winter months.

At this point, a grant was requested from the American Bamboo Society for the purpose of testing eleven aggressive hardy species of bamboo to identify their values. The requested grant was eventually funded by the ABS, the Northern California Chapter, and the Pacific Northwest Chapter of the ABS. Testing began in August of 1996 and continued through May of 1997 by Agri-Check, Inc., in Umatilla, Oregon, and the Department of Animal Sciences, Oregon State University.

Experimental Methods and Results

The test samples were obtained by randomly plucking approximately 400 leaves from each stand of bamboo. The leaves were placed in plastic bags which were then perforated, packaged, and mailed to the laboratory.

The August, 1996, test had a crude protein range from a low of 14.34% to a high of 18.87% (*Table 1*). *Pleioblastus simonii* commenced flowering in February of 1996. The 15.91 % perhaps is evidence of the stress of going to seed. However, the crude fat percentage of 3.92 might contradict the stress factor.

The Pleioblastus simonii sample was resubmitted with leaves from planted second year seedlings rather than the original stand (*Aug. 27 samples, Table 1*), and showed a higher crude protein percentage of 18.87. Also in the second sampling, *Sasa pumila* was added to the test group. It tested 18.74 crude protein and 4.65 crude fat.

From August to December, 1996, seven bamboo increased their percentage of crude protein. *Phyllostachys bissetii* jumped from 14.80 % to 21.55 % (*Tables 1 and 2*). This, in part, supports the hypothesis that hardy bamboo store protein and fat for the winter months. The reason is not totally clear at this time.

Table 2 presents the test results for December, 1996, and

April, 1997, from the Umatilla lab and the acid detergent fiber and the in vitro dry matter digestibility tests performed by the Department of Animal Sciences at OSU. Note that there is considerable difference between the estimated TDN and the in vitro digestibility values. The TDN value is probably an over-estimate, using higher digestion coefficients than those representative of bamboo. The *in vitro* digestibility procedure, involving incubation of the feed sample with cattle rumen contents, is a reliable method of estimating digestibility in the live animal.

It is estimated that reed canary grass at this time of year contains approximately 1.0 digestible protein. Reed canary grass is one of the principal forage grasses in many wet areas of the Pacific Northwest. This would suggest that the leaves of *Phyllostachys nigra henon* may be a practical forage for beef cattle.

At the same time that the *in vitro* digestibilities of the bamboo samples were measured, several common forages were included as well. Values for these forages were as follows:

Forage	% D.M. digestibility
Tall fescue straw	46.7
Oat hay	56.2
Meadow hay	53.1
Alfalfa hay	75.4

Many of the bamboo samples had dry matter digestibilities in the range of 46-53%, suggesting that the bamboo leaves are a fairly low quality roughage. This would indicate that bamboo may have its greatest forage potential for mature beef cows, sheep, goats and horses. Both of these have relatively low nutritive requirements. Bamboo forage might also be useful for non-lactating (dry) dairy cows. The digestibility is too low to recommend inclusion of much bamboo in diets for high producing dairy cows. Bamboo forage might be especially useful for horses, sheep and goats. These are browsing animals which can effectively strip leaves from woody plants. Horses have low nutritive requirements, and they are adapted to low quality roughages and a high feed intake. When fed limited amounts of a high energy diet, they exhibit signs of feeding deprivation, and engage in "cribbing" (wood chewing), etc., in an effort to exercise their desire to consume feed. These signs of boredom can be eliminated by allowing horses to browse, so that they are "kept occupied" in meeting their daily feed needs. Bamboo foliage would appear to be ideal for this purpose.

The Honey Love Ranch[3] has planned and commenced planting nearly a mile of paddock fences for the Morgan horses that it breeds. The species planted have been selected from within one standard deviation and above from the plants listed in Table 2. The fences have been designed to provide shelter from the winds, to entrap moisture from the fog, and to supply forage for the breeding animals. The six percent protein standard for horse feed makes most of the bamboo in the test group acceptable for browse. The horses very efficiently strip all the leaves from any size of bamboo trimming.

There was a significant drop in crude protein between December, 1996, and April, 1997, 19.87% to 12.09%. Perhaps the protein stored for winter is then utilized by the plant in preparation for swelling and shooting buds. This would imply that nourishment could flow from the leaves down through the stems, branches, and culms to the rhizome system. From a practical standpoint, this could supply food balance. The drop in crude protein in bamboo is offset by the increase in nourishment of the pasture grasses with the onset of the spring season.

Also, in Tables 2 and 3, note that all test plants showed a drop in crude protein.

There was not a sufficient sample of *Pleioblastus simonii* remaining to test for the December group.

Fig. 1 shows three factors at a glance. The lowest digestibility of leaves was for *Hibanobambusa tranquillans shiroshima* in April. The highest was for *Phyllostachys nigra henon* in December.

Most previous testing of bamboo in the literature had been done on tropicals and sub-tropicals. This is a start on the temperate bamboo. It is hoped that representative species might now be tested monthly to trace the annual flow of nutrients through the plant.

Pertinent Literature and Discussion

David Farrelly writes in The Book of Bamboo, page 280, "The horses of the Chinese imperial stables were fed on bamboo leaves, which — half a world away — Jamaican exporters regard as a 'hard' forage conferring superior physical tone and stamina on horses compared with animals raised exclusively on succulent grasses. A favorite food of many wild animals elephants and buffalo in India, pandas in China, and gorillas in Zaire, to name a few, bamboo provides relished feed for cattle, sheep and horses to farmers all over the world where the plant abounds. *A. gigantea*, one of two bamboo native to the continental United States, is the highest yielding native range in its land of birth. Other species make significant contributions to animal food needs elsewhere. Dried leaves of *B. vulgaris and B. ventricosa* have been found an excellent source of vitamin A in chick rations. Of the *Phyllostachys* species, trimmings from all those at the Savannah, Georgia, groves of the USDA were routinely fed to cattle and mules. *Sasa paniculata* is used as pasture for horses and sheep in Japan."

In his paper, "*Bamboo as a source of forage*," Floyd McClure (1953) calls attention to, the fact that the foliage of some bamboo is more palatable and more nutritious to livestock than that of other kinds. He reports on many bamboo studies conducted back through the early 1900's. He identifies the serious problem that many of the bamboo were not accurately identified and that much of the information was hearsay and not validated.

Most of the bamboo tested were tropicals and would not grow in zones 8 and 9. McClure identifies the genus *Phyllostachys* as the most important group of hardy bamboo, from the point of view of actual and potential usefulness. He presents a lengthy discussion of the things that need to be known about a bamboo in order to determine its value and exploit it as a source of forage. Briefly stated, he covers the need for accurate identification, the need for it to be palatable, the chemical composition of the portion of the plant that is eaten, the digestibility of the portion eaten, and the management plan for the plantation for securing maximum sustained yields. And, that studies of ample scope are essential to the production of the kinds of data needed.

The feeding of bamboo continues on a daily basis at RKR by cutting the entire culms and placing them in an "X" feeder made from old fence posts. This places the bamboo at grass height level. There are tie down ropes on each "X" for the purpose of keeping the culms in the trough. Unlike with horses, for cattle, the culms need to be firmly held so the animals can strip the leaves off the branches with their tongues. Three cows, each with calf, and three yearling steers are currently being fed in this manner at RKR. It is a simple procedure and is supplemental to the pasture grass. The time requirement is negligible since the bamboo is close to the feeder and only six to eight culms are fed at a time. For small herds, probably up to ten cows, it is a practical method. For large herds, it could be cumbersome.

A design engineer has a leaf stripper on his drawing board. It appears that it would work. If it were affordable and it did work, it would not be difficult to feed larger numbers of animals as the leaves could be stripped from the branches in advance and fed in normal feeder troughs, making ensilage possible. In both scenarios, the culm is preserved. It takes only seconds to remove the branches with a Japanese hatchet. And, the culms have many uses around a ranch and, of course, there is marketing potential for the culms.

Shepherd and Dillard conducted a study from 1945 to 1947 on the cane breaks (*Arundinaria gigantea* sp. tecta) of coastal North Carolina to find what grazing rates would give profitable beef production and allow for sustained yields of native forage. They used six acre ranges with approximately equal areas of cane. Their findings recommended grazing to 55.0% foliage or less, and then removing the animals and allowing the range to recover.

RKR is planning a one acre site on which several high protein species of *Phyllostachys* will be observed for drought resistance and animal ride-down damage. Ride-down was not a problem in Shepherd and Dillard's study. They stated that the cows and calves grazed from the bottom foliage up and moved on. If there was ride-down, the *Arundinaria* cane was flexible enough that no appreciable damage was noted. One purpose at RKR is to see what damage, if any, is done to the *Phyllostachys* species culms. If the top leaves remain on undamaged culms, recovery of the stands should be more efficient.

Shepherd and Dillard estimated that about 2.8 to 3 acres of cane per cow were adequate for maximum gain over their seven month grazing season from May to November. For zones 8 and 9, seedling richer winter forage, the grazing period should be from September to March 31, based upon the protein storage indicated.

Conclusions

A number of hardy bamboo, some ranging up to 10.66% of digestible protein in the winter months, are beneficial winter feeds in the Pacific Northwest, zones 8 and 9, and probably elsewhere. Mineral supplement tub s are necessary unless further mineral testing proves otherwise.

The rancher needs to survey his land carefully to select the areas most suitable for bamboo growth. A reasonably high water table or irrigative floodability would be most important. There are a few species that grow well in swampy areas. Members of the bamboo societies would most likely be willing to assist with additional information.

Fertilizing requirements would need to be determined and at least a November feed analysis should be done for an indicator. At RKR, urea is hand spread about the middle of March and grass clippings are utilized for mulch.

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Table 1. Proximate analysis of temperate bamboo forage harvested August, 1996.

Species	Moisture %	Dry Matter %	Crude Protein %	Crude Fat %	Crude Fiber %	Ash %	NFE %	TDN[1] %
<u>Dry Weight Basis</u>								
Harvested Aug. 8, 1996:								
Hibanobambusa tran. shiroshima		100	14.34	3.31	31.53	7,97	42.85	60.10
Phyllostachys bissetii		100	14.80	3.55	30.15	7.25	44.25	60.57
Phyllostachys congesta		100	17.42	3.44	30.08	8.50	40.56	59.20
Phyllostachys henon		100	17.75	3.90	25.36	7.90	45.09	59.62
Phyllostachys heteroclada		100	17.16	2.25	29.78	6.67	44.14	59.56
Phyllostachys humilis		100	15.59	2.25	31.49	6.82	43.85	59.85
Phyllostachys meyeri		100	18.66	2.88	28.70	7.33	42.43	59.25
Phyllostachys nuda		100	18.47	3.20	28.50	7.17	42.66	59.60
Pleioblastus simonii		100	15.91	3.92	30.24	6.60	43.33	61.05
Semiarundinaria okuboi		100	18.01	3.14	26.71	10.31	41.83	57.54
Harvested Aug. 27, 1996:								
Pleioblastus simonii '94		100	18.87	3.53	31.44	7.45	38.71	59.73
Sasa pumila		100	18.74	4.65	28.55	9.12	38.94	59.33
<u>Wet Weight Basis</u>								
Harvested Aug. 8, 1996:								
Hibanobambusa tran. shiroshima	61.09	38.91	5.58	1.29	12.27	3.10	16.67	23.38
Phyllostachys bissetii	63.87	36.13	5.35	1.28	10.89	2.62	15.99	21.88
Phyllostachys congesta	65.74	34.26	5.97	1.18	10.31	2.91	13.90	20.28
Phyllostachys henon	65.09	34.91	6.20	1.36	8.85	2.76	15.74	20.81
Phyllostachys heteroclada	59.72	40.28	6.91	0.91	12.00	2.69	17.78	23.99
Phyllostachys humilis	59.93	40.07	6.25	0.90	12.62	2.73	17.57	23.98
Phyllostachys meyeri	61.49	38.51	7.19	1.11	11.05	2.82	16.34	22.82
Phyllostachys nuda	61.99	38.01	7.02	1.22	10.83	2.73	16.22	22.65
Pleioblastus simonii	62.44	37.56	5.98	1.47	11.36	2.48	16.27	22.93
Semiarundinaria okuboi	59.47	40.53	7.30	1.27	10.83	4.18	16.95	23.32
Harvested Aug. 27, 1996:								
Pleioblastus simonii '94	62.40	37.60	7.10	1.33	11.82	2.80	14.55	22.46
Sasa pulima	58.33	41.67	7.81	1.94	11.90	3.80	16.23	24.72

[1] TDN is estimated using standard digestion coefficients for mixed forages; digestion coefficients for bamboo are not available.

Table 2. Proximate analysis of temperate bamboo harvested December 17, 1996, and April 22, 1997.

Date	Species	Crude TDN	Crude Protein	Crude Fat	Fiber	Ash	NFE	IVDMD[1]	ADF	Digestible Crude Protein[2]
12/17/96	*Hibanobambusa tran. shiroshima*	57.85	14.89	4.05	27.83	11.86	41.37	43.61	40.02	6.49
04/22/97	*Hibanobambusa tran. shiroshima*	58.18	12.94	3.40	27.71	11.19	44.76	36.79	40.47	4.76
12/17/96	*Phyllostachys bissetii*	60.13	21.55	4.19	24.40	10.89	38.97	48.70	34.65	10.49
04/22/97	*Phyllostachys bissetii*	60.05	15.17	3.17	25.89	7.21	48.56	47.03	34.85	7.13
12/17/96	*Phyllostachys congesta*	58.69	16.89	3.48	27.50	9.30	42.83	48.30	35.40	8.16
04/22/97	*Phyllostachys congesta*	58.19	16.88	3.71	24.35	10.09	44.97	39.85	35.36	6.73
12/17/96	*Phyllostachys henon*	58.81	19.87	4.24	25.80	8.92	41.17	53.63	34.03	10.66
04/22/97	*Phyllostachys henon*	61.19	12.09	3.96	22.96	6.99	54.00	44.63	35.12	5.40
12/17/96	*Phyllostachys heteroclada*	57.28	18.38	3.92	25.46	11.38	40.86	42.59	38.83	7.83
04/22/97	*Phyllostachys heteroclada*	58.22	15.83	3.13	26.01	9.85	45.18	36.63	37.83	5.80
12/17/96	*Phyllostachys humilis*	58.66	18.57	3.53	26.15	8.78	42.97	52.16	34.69	9.69
04/22/97	*Phyllostachys humilis*	59.52	13.99	2.25	25.70	7.35	50.71	52.29	30.93	7.32
12/17/96	*Phyllostachys meyeri*	59.19	17.09	3.89	27.97	8.94	42.11	53.56	36.11	9.15
04/22/97	*Phyllostachys meyeri*	58.82	11.96	2.39	26.23	9.25	50.17	50.18	33.65	6.00
12/17/96	*Phyllostachys nuda*	59.79	16.57	3.19	25.45	7.20	47.59	57.10	32.94	9.46
04/22/97	*Phyllostachys nuda*	58.93	14.06	2.20	24.54	8.11	51.09	55.28	30.66	7.77
04/22/97	*Pleioblastus simonii*	58.53	15.94	2.50	26.75	8.69	46.12	58.45	32.91	9.32
12/17/96	*Sasa pumila*	56.45	19.35	2.59	26.08	10.98	41.00	54.45	34.82	10.54
04/22/97	*Sasa pumila*	58.72	17.34	3.24	25.19	8.65	45.58	52.83	35.91	9.16
12/17/96	*Semiarundinaria okuboi*	55.89	19.22	2.55	25.63	11.78	40.82	46.15	37.23	8.87
04/22/97	*Semiarundinaria okuboi*	54.14	17.54	2.83	24.77	15.27	39.59	40.37	37.55	7.08
	Average	58.44	16.48	3.26	25.83	9.65	44.78	48.31	35.43	7.99
	SD	1.55	2.58	0.66	1.27	2.01	4.24	6.54	2.60	1.76

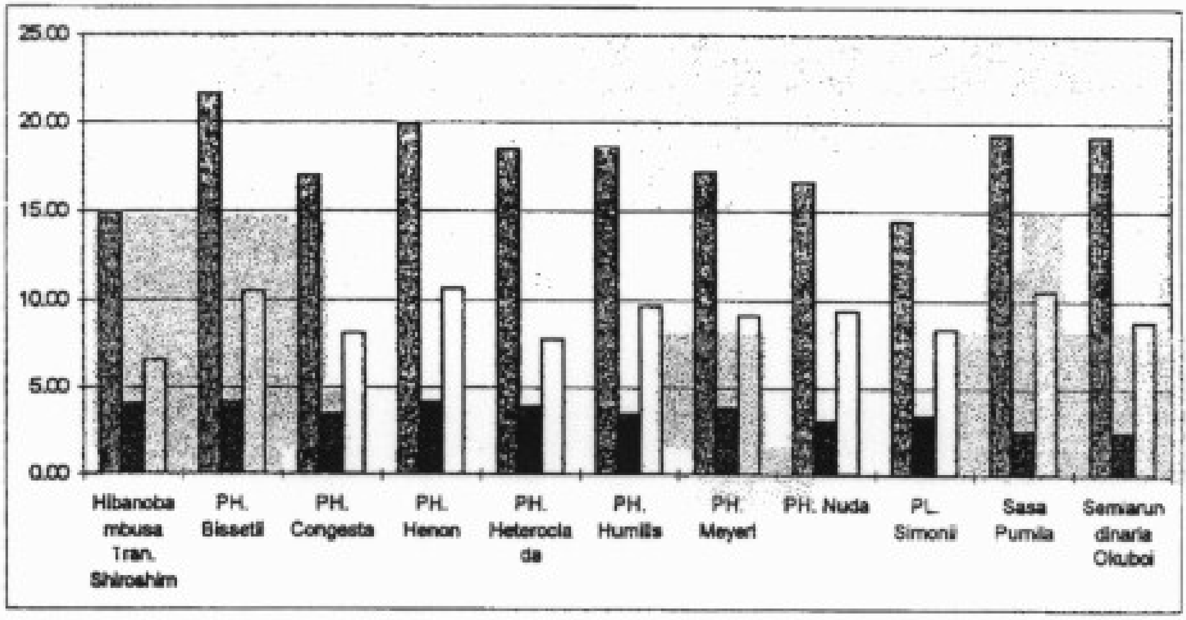
[1] In vitro dry matter digtestibility.

[2] Estimated crude protein digestibility: % CP x (IVDMD/100).

Table 3. Summary of nutrient values.

Date	Species	Crude Protein	Crude Fat	IVDMD	Digestible Crude Protein
12/17/96	*Hibanobambusa tran. shiroshima*	14.89	4.05	43.61	6.49
04/22/97	*Hibanobambusa tran. shiroshima*	12.94	3.40	36.79	4.76
12/17/96	*Phyllostachys bissetii*	21.55	4.19	48.70	10.49
04/22/97	*Phyllostachys bissetii*	15.17	3.17	47.03	7.13
12/17/96	*Phyllostachys congesta*	16.89	3.48	48.30	8.16
04/22/97	*Phyllostachys congesta*	16.88	3.71	39.85	6.73
12/17/96	*Phyllostachys henon*	19.87	4.24	53.63	10.66
04/22/97	*Phyllostachys henon*	12.09	3.96	44.63	5.40
12/17/96	*Phyllostachys heteroclada*	18.38	3.92	42.59	7.83
04/22/97	*Phyllostachys heteroclada*	15.83	3.13	36.63	5.80
12/17/96	*Phyllostachys humilis*	18.57	3.53	52.16	9.69
04/22/97	*Phyllostachys humilis*	13.99	2.25	52.29	7.32
12/17/96	*Phyllostachys meyeri*	17.09	3.89	53.56	9.15
04/22/97	*Phyllostachys meyeri*	11.96	2.39	50.18	6.00
12/17/96	*Phyllostachys nuda*	16.57	3.19	57.10	9.46
04/22/97	*Phyllostachys nuda*	14.06	2.20	55.28	7.77
04/22/97	*Pleioblastus simonii*	15.94	2.50	58.45	9.32
12/17/96	*Sasa pumila*	19.35	2.59	54.45	10.54
04/22/97	*Sasa pumila*	17.34	3.24	52.83	9.16
12/17/96	*Semiarundinaria okuboi*	19.22	2.55	46.15	8.87
04/22/97	*Semiarundinaria okuboi*	17.54	2.83	40.37	7.08

Fig. 1. **Comparison of crude protein, crude fat and estimated crude protein digestibility for winter and spring samples.**



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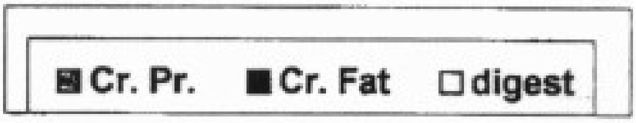

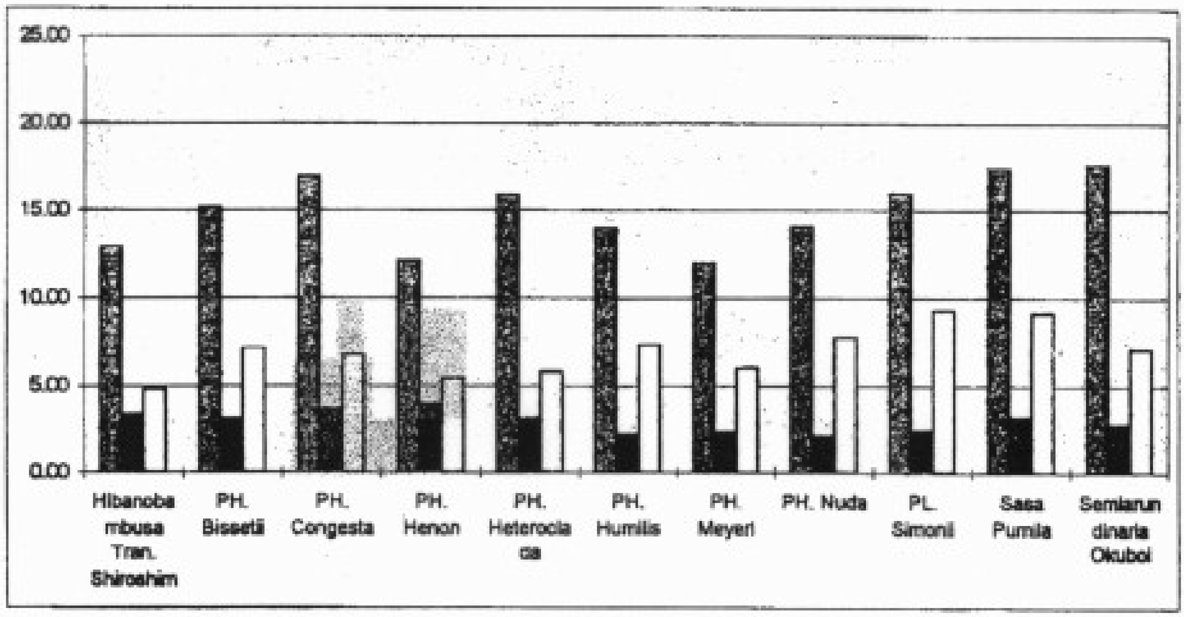

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